# CWMP Update

Appendices
Volume II of II

980 Washington Street
Dedham, Massachusetts 02026

225139
**Town of Nantucket**
October 2014

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COMMITMENT & INTEGRITY DRIVE RESULTS

# APPENDICES


Appendix A: MEPA Certificate 2004 CWMP Data 2004 Needs Areas Matrix
Appendix B: Nantucket Zoning By-Law Board of Health Data
Appendix C: Massachusetts Estuaries Report Summaries Massachusetts Estuaries Technical Memorandum on MOdel Run Scenarios total Maximum Daily Loads Landfill Backup Data
Appendix D: Wannacomet Water Data
Appendix E: Nantucket Sewer Act Board of Health Local Regulations Board of Health Administrative Consent Order Septic Management Plan Documents
Appendix F: Wastewater Data Flows and Loads Calculations
Appendix G: Madaket Wastewater Natural Heritage and Endnaged Species
Appendix H: Surfside WWTF Data Capacity Analysis Technical Memorandum Energy Memo Groundwater Discharge Permit BRP -11 BRP – 83 O&M Manual
Appendix I: Capital Improvements Plan Financing and Cost Scenarios
Appendix J: Ocean Outfall Information
Appendix K: Public Outreach Information

# APPENDIX A: 2004 MEPA CERTIFICATE

# 2004 CWMP DATA

# 2004 NEEDS MATRIX

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*Executive Office of Environmental Affairs*
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*Boston, MA 02114-2524*

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**May 14, 2004**

# CERTIFICATE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS ON THE SPECIAL PROCEDURE: PHASE III – COMPREHENSIVE WASTEWATER MANAGEMENT PLAN AND FINAL ENVIRONMENTAL IMPACT REVIEW

| | |
|---|---|
| **PROJECT NAME** | **: Comprehensive Wastewater Management Plan** |
| **PROJECT MUNICIPALITY** | **: Nantucket** |
| **PROJECT WATERSHED** | **: Islands** |
| **EOEA NUMBER** | **: 12617** |
| **PROJECT PROPONENT** | **: Town of Nantucket** |
| **DATE NOTICED IN MONITOR** | **: April 7, 2004** |

As Secretary of Environmental Affairs, I hereby determine that the Phase III Document: Comprehensive Wastewater Management Plan/Final Environmental Impact Report (CWMP/FEIR), submitted on this project **adequately and properly complies** with the Massachusetts Environmental Policy Act (G. L., c. 30, ss. 61-62H) and with its implementing regulations (301 CMR 11.00).

## OVERVIEW

The Town of Nantucket is developing a Comprehensive Wastewater Management Plan/Environmental Impact Report (CWMP/EIR) to address the short-term and long-term issues relating to the island's wastewater treatment and disposal needs. The goal of the CWMP/EIR is to examine the full range of Nantucket's wastewater management needs, and identify environmentally sustainable treatment and disposal alternatives that respond to the community's needs, and meet water quality and public health standards. The result will be a comprehensive plan outlining how the Town of Nantucket will treat and dispose of its sanitary sewage for the next 20 years.

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This project is subject to the Mandatory EIR provisions of the MEPA regulations since it will likely involve construction of more than ten miles of new sewers and may exceed other Mandatory EIR thresholds. The project will require several permits from the Department of Environmental Protection (DEP) for sewer extensions and connections, as well as compliance with revised water quality discharge limits specified in the federal National Pollutant Discharge Elimination System (NPDES) permits issued by the U.S. Environmental Protection Agency (EPA). Because the project will receive funding or financial assistance from DEP under the State Revolving Fund, this project is subject to broad scope jurisdiction under MEPA.

## Special Review Procedure

The Secretary's Certificate on the ENF/Phase I (EOEA #12617, November 16, 2001) granted the Town of Nantucket's request for a Special Review Procedure (SRP) for this project to facilitate the Town's development of environmentally sound wastewater management practices. The SRP provided for the filing of three documents: Phase I, including a definition of existing conditions, the Needs Analysis, and the Screening of Alternatives; Phase II, the Draft CWMP and Draft EIR, including the development and screening of wastewater management alternatives to address the needs defined in the Phase I document; and Phase III, the Final CWMP and Final EIR. The Town filed the ENF and Phase I report on October 10, 2001. The Secretary's Certificate on the ENF/Phase I (EOEA #12617, November 16, 2001) found that additional information was needed in the areas of project needs and alternatives before Phase I could be determined to be complete and adequate. In a May 17, 2002 letter to the proponent, the Secretary authorized the proponent to incorporate the requested additional Phase I information, and response to comments received on the ENF and Phase I report, within the Phase II document.

## Phase II – Draft CWMP/Draft EIR

In the Phase II document, the proponent evaluated and screened all potential treatment alternatives and groundwater disposal sites that could address the needs and problems identified in the Phase I – Needs Analysis document. The treatment alternatives considered included the full range of options available under Title 5 (conventional and innovative/alternative systems, both for individual properties and for shared and communal facilities to service multiple properties), and a centralized or decentralized satellite wastewater treatment plant with groundwater discharges.

The proponent also developed and applied screening criteria to identify the preferred wastewater management alternative including cost (both to individuals and the community), technical feasibility, environmental and public health protection (including maintenance of water balance in drainage sub-basins), institutional and management issues, and other relevant concerns.

As described in the Phase II document, the proponent's recommended plan involves upgrading and expanding the existing Surfside Wastewater Treatment Facility (WWTF), construction of a new Madaket Wastewater Treatment Facility, and construction of new sewers to service the wastewater flows generated from 5 Needs Areas (Madaket, Monomy, Shimmo, Somerset, and Warrens Landing). Under the proponent's preferred alternative, a new Septage Management Plan (SMP) will be designed for the Town's 5 remaining Needs Areas (Pocomo, Polpis, Quidnet, Wauwinet, and Town WPZ).

**Phase III – Final CWMP/FEIR**

The Certificate on the DEIR/Phase II document required the proponent to address a number of outstanding issues in the Phase III document including: clarification of cost estimates (both capital and operating) for each component of the proponent's recommended plan; consistency of the recommended plan with local and regional growth management policies; and sewering in coastal high hazard flood areas.

Rare Species

According to the comments received from the Natural Heritage and Endangered Species Program (NHESP), the project site contains rare species habitat. NHESP has identified at least eight state-listed plant and animal species that may be located in the vicinity of the proposed Madaket WWTF including; Short-eared Owl (*Asio flammeus*), Northern Harrier (*Circus cyaneus*), Pied-billed Grebe (*Podilymbus podiceps*), Nantucket Shadbush (*Amelanchier nantucketensis*), New England Blazing Star (*Liatris borealis*), Sandplain Flax (*Linum intercursum*), Lion's Foot (*Prenanthes serpentaria*), and the Sandplain Blue-eyed Grass (*Sisyrinchium arenicola*). NHESP has also identified four state-listed plant and animal species that may be located in the vicinity of the proposed Surfside WWTF sites; Short-eared Owl (*Asio flammeus*), Northern Harrier (*Circus cyaneus*), Piping Plover (*Charadrius melodus*), and the Bushy Rockrose (*Helianthemum dumosum*). In their comments, NHESP has indicated that the proposed project may experience severe MESA permitting constraints particularly at the Madaket WWTF site. I ask that the Town of Nantucket file a Notice of Project Change (NPC) when planning for the project has progressed further. I recommend that the Town arrange a pre-filing meeting with the MEPA Office before finalizing and submitting the NPC.

Cost Estimates and Funding Options

As designed, the Town of Nantucket's recommended plan will be constructed in seven phases over a twelve-year period. The estimated capital costs for the recommend plan are $92.1 million dollars. As described in the Phase III/FEIR document, the proponent intends to seek public financing for the proposed project's eligible capitol costs through the State Revolving Fund loan program (SRF). According to the information contained in the Phase III document, the proponent's recommended comprehensive wastewater management plan may also include additional construction activities, recommended in the Town of Nantucket's ongoing Evaluation and Mapping Project, involving the rehabilitation of the Town's existing wastewater and stormwater infrastructure to eliminate excessive infiltration and inflow (I/I), and stormwater flooding from being discharged into Nantucket Harbor. As described by the proponent, the estimated capital costs for the wastewater and stormwater infrastructure projects recommend in the Evaluation and Mapping Project are $83.4 million dollars.

In their comments DEP has indicated that SRF program regulations and CWMP planning guidelines require the proponent's final recommended plan include a financial analysis and presentation of average household costs.

I ask that the Town submit a copy of the financial analysis and presentation of average household costs for the proponent's final recommended plan to the MEPA Office for the project file. The financial analysis should include a presentation of cost estimates and funding options that includes the average household costs (capital and O&M) for: households located within a Sewer Overlay District and connected to the sewer system; households located within a Sewer Overlay District and not connected to the municipal sewer system; and households located in a Septic Overlay District who will continue to be serviced by on-site Title 5 septic systems and a Septage Management Plan. The financial analysis should also clearly identify those components (and capitol cost estimates) of the Town's Evaluation and Mapping Project that are proposed for inclusion in the proponent's recommended comprehensive wastewater management plan.

Planning for Growth (Executive Order 385)

Many comments received on the proponent's Phase II and Phase III documents concern growth management. Executive Order #385 requires that state and local agencies engage in protective and coordinated planning oriented towards both resource protection and sustainable economic development.

For reasons of both environmental protection and fiscal prudence, investments in public infrastructure should be carefully targeted toward those areas for which clear existing needs have been established and for areas where denser development is appropriate, thereby relieving development pressures on open space, agricultural lands, and other valuable natural resources.

According to the information contained in the Phase III document, the proposed Madaket sewer collection system and WWTF have been designed with low-pressure sewers and sized to service only those areas identified by the proponent as Needs Areas to be sewered. In their comments, CZM has indicated that the Town of Nantucket proposed and recently voted to adopt "Sewer" and "Septic" Overlay Districts to control the potential secondary growth impacts that may be induced by public sewers in Nantucket. Creation of the Sewer Overlay District will allow only those properties currently deemed developable by State Land Use Codes and local zoning to be part of the proposed sewer district.

I commend the Town for their initial efforts to work on this important and difficult issue, and anticipate the discussions and deliberations in public forums throughout the Town of Nantucket will help to ensure that acceptable growth control measures are implemented. Additional growth control measures can be discussed during the design and permit review process leading to the issuance of Sewer Extension Permits. I encourage the proponent to consult with the Nantucket Planning and Economic Development Commission (NP&EDC), and the Growth Management Policy staff at the Executive Office of Environmental Affairs as it continues to develop its growth management strategy.

Land Alteration in High Hazard Areas

As described in the Phase III document, the Town of Nantucket has prepared emergency response plans in response to the concerns identified by CZM in their comments on the Phase II document pertaining to naturally occurring erosion near the Siasconset and Surfside WWTFs. In their comments, CZM has recommended that the proponent identify and map emergency response trigger points as part of DEP's permitting process for the proposed project. I ask that the proponent work closely with CZM to design appropriate emergency response trigger points. The proponent should submit a copy of the final emergency response plan to the MEPA Office.

Historical / Archeological Resources

According to comments received by the Massachusetts Historical Commission (MHC), the proposed project areas contain archaeological sites associated with Native American occupation of Nantucket. MHC has requested that the proponent conduct an intensive archaeological survey of the project site.

The proponent has committed to working with MHC as project design progresses, and will conduct an intensive (locational) archaeological study of the project site. A copy of MHC's comments on the archaeological study should be forwarded to the MEPA Office for the project file along with a final Section 61 Findings for any state agency actions.

Reduction of Wastewater Flows

Reductions in wastewater flow should also play a significant role in meeting Nantucket's long-term wastewater treatment and disposal needs.
The reduction of wastewater flows can be achieved by implementing aggressive water conservation programs, increasing wastewater reuse (i.e., for irrigation purposes), and reducing infiltration/inflow (I/I) levels. I continue to encourage the proponent to propose tools to improve water conservation. The Town of Nantucket should give serious consideration to implementing any number of additional tools to improve water conservation, including, but not limited to: enactment of a bylaw regulating automatic sprinklers and/or clearing of land for grass lawns, outdoor water use restrictions and water use rates; retrofitting of municipal buildings with low flow devices; enactment of a bylaw regulating automatic sprinklers and/or clearing of land for grass lawns; promotion of the use of cisterns for outdoor watering; the use of a water bank; and the promotion of the use of new grey-water systems.

May 14, 2004
DATE

Ellen Roy Herzfelder, Secretary

Comments received: continued on next page

| | |
|---|---|
| 04/22/04 | Earth Tech |
| 05/04/04 | Massachusetts Historic Commission (MHC) |
| 05/05/04 | Earth Tech |
| 05/06/04 | Nantucket Planning and Economic Development Commission |
| 05/07/04 | Natural Heritage and Endangered Species Program (NHESP) |
| 05/07/04 | Massachusetts Coastal Zone Management (CZM) |
| 05/07/04 | Massachusetts Department of Environmental Protection – SERO |
| 05/07/04 | Nantucket Land Council, Inc. |
| 05/10/04 | Earth Tech |

SRP/CWMP FEIR #12617
ERH/NCZ/ncz

# Nantucket Land Council, Inc.

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May 7, 2004

Ellen Roy Herzfelder, Secretary
Executive Office of Environmental Affairs
Attn: MEPA Office
EOEA No. 12617, Nicholas Zavolas
251 Causeway Street, Suite 900
Boston MA 02114

Dear Ms. Herzfelder:

The Nantucket Land Council, Inc. is a non-profit, environmental organization, which is supported by more than 1700 members. We have reviewed the Phase III – Comprehensive Wastewater Management Plan and Final Environmental Impact Report for Nantucket, Massachusetts. We would like to take the opportunity to make the following comments.

**Madaket Treatment Plant**

The Nantucket Land Council still has serious concerns about the wastewater treatment facility planned for the Madaket area. We agree that the current on-site wastewater disposal systems are, for the most part, causing degradation to water quality and aquatic resources. We urge caution, however, on proceeding down an extremely expensive and perhaps unnecessary path for wastewater treatment.

In response to the Land Council's comments on the DEIR, the Phase III report states on page 1-17 Volume III that: "Proceeding with the current CWMP/EIR schedule allows further coordination with the Massachusetts Estuaries Project TMDLs. This may mean changing treatment technologies or prioritization. The CWMP/EIR is a dynamic and evolving process." We are pleased to see this statement and urge further coordination between The Madaket Area Plan Work Group, The Madaket Watershed Work Group, The Septic System Advisory Committee, The Town of Nantucket, The Massachusetts Estuaries Project, and any other concerned citizens or groups.

The phase III report states on page 1-19 that "the proposed CWMP requires significant legal, planning and analysis...Identifying and establishing "sewer overlay districts", by local bylaw changes or with the filing of special legislation, such as the 'checkerboard systems' approved in Provincetown, MA are options currently being reviewed. Town officials have pledged to have the necessary rules and regulations in place before the implementation of the CWMP." The town should explain within the public hearing process what rules and regulations are necessary so that all interested parties could provide comments and concerns. The town officials of today have pledged to ensure that these regulations are in place, how can we ensure that future town officials will feel the same way?

**Septage Management Plan (SMP)**
This document is perhaps the most important item in alleviating wastewater pollution. However, the plan is not included in the CWMP. The SMP is still in draft form. It is extremely difficult to agree with the assumptions made in the CWMP that references the benefits of the SMP without the document being before us. The contents and implementation of the SMP should be discussed in the public arena. We anticipate that public comment could be received when the Board of Selectmen and or Board of Health will be adopting the plan's various components. However, there should be a multi-step process whereby the public can voice their thoughts and concerns during the drafting phase, not right before a vote of action. The Board of Selectmen has intimated that they would be holding a series of workshops and or public hearings to discuss this plan. We urge them to continue on this path.

**Recharge Impacts on Sub-basins**
The potential impact on groundwater recharge in particular sub-basins is an issue that should be evaluated more closely. As our community grows, groundwater in certain basins may be impacted by increased pumping rates. Groundwater recharge will be affected when the wastewater will be transported out of the basin to the Surfside and Madaket plants. The Phase II and Phase III report states that water conservation education will be the primary focus to address this concern. The Nantucket Land Council would be willing to help develop an in-depth monitoring program that analyzes any potential impacts on ground water and wetland ecosystems. However, most importantly, if there are quantitative impacts, will there be any governmental oversight to ensure that beneficial solutions are put into place?

**Recommended Plan (Section 5.0) for Study Area 6 – Surfside (p.5-6)**
In accordance with an Administrative Consent Order between the Commonwealth and the Town of Nantucket the Surfside treatment plant must be designed and constructed by 2008.

The plant is designed with a number of project goals in mind listed on page 5-18. These include: Low maintenance, operate without the use or with a limited use of chemicals, meet high discharge limits. The project goals and rationale are not well defined we offer the following comments and questions:

**Low Maintenance**
The FEIR identifies O&M costs for only one, the SBR (Table 5-10, p.5-54), of the four biological unit process alternatives reviewed (e.g., MLE, SBRs, Trickling filters, or RBCs). The report does not describe how these four alternatives came to be identified for engineering evaluation. We believe that other biological alternatives should have been reviewed and that the four that have been reviewed are not representative of the treatment technology choices which are appropriate to Nantucket for the Surfside facility upgrade. For instance, at a minimum, the existing Surfside WWTF treatment system which uses chemically enhanced primary treatment (CEPT) during the six month peak flow season should have been included as an option which in our opinion would significantly reduce the cost of upgrading with one or more new biological unit process alternatives. Cost comparisons addressing both the initial capital cost and the annual O&M costs need to be developed to describe the most efficient and cost effective treatment plan. Additionally, O&M costs are not provided for the odor control system alternatives ( Packed Bed Scrubbers, Mist Chamber Scrubbers, or Bio-filters). A cost comparison addressing both the initial capital cost and the annual O&M costs needs to be developed to describe the most cost effective plan. Therefore, without O&M costs presented, we question how this project goal was addressed.

**Operation without the use or with a limited use of chemicals** - It is not at all clear what the basis for this goal is. The Surfside WWTF has operated, as a six month/year CEPT plant, for nine years using a non-toxic aluminum chloride compound (no more toxic that ordinary table salt.) To our knowledge, this chemical has not caused disruptions in treatment capability due to delivery nor have there been hazardous situations to plant staff or the public as a result of their use at the plant or transport to the plant. This goal is arbitrary as it only serves to restrict viable treatment alternatives from being considered for the Surfside upgrade.

**Meet High Discharge Limits** - High in relation to what? Does this mean higher than permit limitations? What are the permit limits for which this facility is being designed? How were they agreed on? It is not clear what the permit limits for the new plant will be. This is of great concern since the permit limits will significantly impact the treatment level required and the cost of such treatment. The plant's discharge limits must be based on sound science. This is an essential starting point and only after that is clearly documented, then treatment alternatives should be thoroughly investigated.

**Existing Surfside WWTF Performance**
CEPT is a wastewater treatment process in which a very small amount (less than 50 parts per million) of a chemical, such as aluminum chloride, is added to the raw sewage influent to promote coagulation of wastewater particles. Rapid settling of the large flocs that are created increases pollutant removal efficiency in the existing primary settling tanks.

The same chemical is routinely used in potable water treatment plants. Advances in the efficiency of CEPT technology in the past 20 years have led to its widespread adoption as a first stage wastewater treatment process in Southern California.

The FEIR on the existing Surfside plant does not discuss the fact that it has operated as a very efficient CEPT plant during the six-month high load period from 15 May to 15 October. Originally built in 1991 for conventional primary treatment, it was upgraded for seasonal use of CEPT in 1995.

It is never explicitly stated but it is clear that **the use of CEPT will be discontinued in the new Earth Tech upgrade facility.**

The two most important pollutant indicators that must be met in an effluent permit for domestic wastewater are the organic concentration measured as BOD (biochemical oxygen demand) and TSS (total suspended solids.) During the six-month summer CEPT period the average removal of BOD at Surfside is about 60% or three times that during the no CEPT winter period. The corresponding average removal of TSS in the CEPT period is over 80% or about twice that during the winter period. These seasonal CEPT removals are close to that obtained by conventional biological secondary treatment such as the SBR proposed by in the FEIR.

The NLC would like to thank Mr. Eric Schultz, Manager of the Surfside plant, for providing detailed data on plant operation in 2003 and to congratulate him for using the innovative CEPT technology and for running a very efficient treatment plant.

**Design Flows & Loadings**
The design flows and loads for year 2025 (Table 5-4.p.5-26) are significantly higher than the existing flows and loads to the Surfside plant. In 2003 the maximum monthly flow in August is about 2 MGD and the future design summer flow in the FEIR is 3.5 MGD. An amount 1.75 times greater. The projected values in terms of both flow peaking factors and waste strengths appear to be based on text book data and not on a historical review of existing system growth data. These values and the implications for growth in the historical area should be thoroughly reviewed by the Town.

**Review of Biological Treatment Upgrade Alternatives**
As stated above, the four biological treatment alternatives evaluated for the Surfside plant do not represent the full array of treatment choices to Nantucket and, on this basis, the FEIR does not represent a comprehensive technical review. Additional treatment processes should have been evaluated for this prominent and expensive part of the new plant. Two of the processes evaluated, Trickling Filters and RBCs should not be considered state-of the art treatment technologies for new or expanded plants. Two processes (MLE and SBRs) were carried forward for further analysis. As stated above, the existing CEPT plant should have been considered as part of the entire treatment train. CEPT allows loadings to the secondary treatment processes to be reduced, thereby reducing the size and cost of secondary treatment systems. The benefits would be lower capital costs for the new facilities and lower O&M related electric power costs because of the reduced need for blowers in the aeration tank.

A potentially viable treatment technology following the CEPT plant that is not considered in the FEIR would be biological aerated filters (BAF). These units occupy a relatively small area and can be set up to perform tertiary level treatment, including nitrogen reduction.

The Integrated Fixed Film Activated Sludge (IFAS) process, membrane bioreactors (MBRs) and the four stage Bardenpho process, among others, should all have been reviewed and compared for applicability at Surfside.

The PDR recommends SBRs over MLE for Surfside, without any documented analysis of O&M costs and life cycle cost analysis. Only capital costs are documented in the PDR. O&M and life cycle cost analyses are expected at this level of engineering study to fully evaluate the alternatives and to support recommendations. The report states that SBRs are recommended at Surfside since an SBR facility is under construction at Siasconset and one is proposed at Madaket. We question the significance of this to support what is being recommended at Surfside. It is noted that both Siasconset and Madaket will be

significantly smaller plants than the one planned at Surfside, therefore, due to scale, what may be appropriate at Siasconset and Madaket should not be assumed to be applicable at Surfside. Additionally, while the plant being constructed at Siasconset is an SBR facility, Nantucket does not yet have experience with an SBR facility and only real operating time will enable Nantucket to determine whether the SBR process is satisfactory.

**Sludge Dewatering**
An evaluation of BFPs, centrifuges and rotary presses resulted in a recommendation for centrifuges at the Surfside plant. While a life cycle analysis was performed, the details of the costs were not included. While mass balance calculations are presented in the report, there are no reported estimates of sludge quantities utilized to size the equipment in Section IV. Yet the sludge dewatering equipment costs are based on three 2-meter BFP units, three centrifuges and six rotary presses. Based on a 1.78 - 3.01 mgd plant, it appears that the number of dewatering equipment units identified in the PDR is significantly overstated. Additionally, we are concerned that not all of the costs have been identified and reflected in the analysis - for instance, it is not clear what modifications or additions will need to be made to the dewatering building to accommodate the units of the three technology options. We are also concerned that the PDR recommends the existing grit removal facilities at the plant headworks be decommissioned and not replaced as part of the new plant. This will result in grit load with the primary and secondary sludge. The grit in the sludge will cause the high speed centrifuge components to be subject to potentially excessive wear, decreasing the life of the equipment. This has been well documented at other locations throughout the country.

**Odor Control** - The Odor Control evaluation included three technologies (Packed bed scrubbers, Mist chamber scrubbers and bio-filters). However, similar to the evaluation for the biological treatment systems, the odor control recommendation is made without any documented analysis of O&M costs and life cycle costing. Again, we note that O&M and life cycle cost analyses are expected at this level of engineering study to fully evaluate the alternatives and to support recommendations. Additionally, the Odor Control System selected, (Packed Bed Scrubbers) utilizes chemicals. This again is in contradiction to the first project goal discussed above. It is also noted that a biological treatment alternative involving CEPT utilizing ferric salts will assist in tying up hydrogen sulfides, thus serving to mitigate odor generation. Additionally, a treatment train that incorporates CEPT will involve much smaller treatment tanks, again minimizing odor emissions.

In summary, the selected treatment option for the Surfside plant should be superior in a number of technical areas, including treatment capability, reliability, flexibility, cost ( both capital & O&M), and neighborhood and environmental resources protection (noise, odors and land encroachment).

**Section V - RECOMMENDED PLAN -**

**Effluent Disinfection** - A new UV system is identified for effluent disinfection. Why is a new system required? Why can't the existing disinfection system be utilized? Was an engineering evaluation conducted to support this recommendation? Are the plant's effluent limits requiring the UV system?

**Effluent Filtration** - Why is effluent filtration required when the plant discharges to rapid sand infiltration basins?

**Rapid Infiltration Basins (RIBs)** - What is the treatment capacity of the RIBs? These units can provide valuable pollutant removal capacity for the Surfside plant, potentially decreasing the sizing of upstream treatment systems.

**Cost**
It is our opinion that the projected cost of the order of $30 million for the Surfside upgrade is far in excess of recent upgrade experiences in towns of comparable size.

**Final Environmental Impact Report (FEIR)**
The FEIR explains on page 6-7 that "while the introduction of sewer infrastructure in itself does not serve to promote or deny growth, the local zoning and by-laws will." The town must enact special legislation and the development of new zoning sewer overlay districts in order to preserve the integrity of the Nantucket Comprehensive Community Plan and uphold Executive Order 385/Planning for Growth. Unfortunately the approval of such legislation at the local or state level is not always guaranteed. The town is presenting and promoting a town planning template for which the measures to protect against unwanted growth are not already in place and perhaps never will be. GROWTH

On page 6-8 the FEIR states that "A well managed Septage Management Plan (SMP) has the potential to provide the means with which to prevent areas on the island from overdevelopment due to the construction of infrastructure and utilities in areas previously not serviced by such as well as preserving the community structure that originally attracts (sic) to the island." We agree that the SMP will be of benefit, however, we again urge that the drafting process be done within the public hearing process.

There unfortunately is no information on endangered species impacts that will occur at the Madaket and Surfside treatment plant sites. We assume that the town will have to obtain all necessary approvals for the "take" of a state listed endangered species, and that the approval of the FEIR will not supercede this requirement. ENDANGERED SPECIES

We hope that the formulation and implementation of the CWMP is a dynamic and evolving process, subject to change and revision, as is stated throughout the Phase III and FEIR document. We understand the urgency to comply with the Administrative Consent Order, however, we hope that our comments regarding the Surfside upgrade are taken into consideration and implemented accordingly. We also hope that the recommended plans for Madaket and areas under the Septage Management Plan will be adaptable documents that can and will change if further environmental and cost analysis proves that such revisions are warranted.

Thank you for taking the time to review our comments

Sincerely,

Cormac Collier
Ecologist

MEMORANDUM

| | |
|---|---|
| TO: | Nicholas Zavolas, Environmental Reviewer, MEPA Unit |
| THROUGH: | David Johnston, Deputy Regional Director<br>David DeLorenzo, Deputy Regional Director<br>Millie Garcia-Surette, Deputy Regional Director |
| CC: DEP/SERO | David Burns, Municipal Facilities<br>Jeffrey Gould, Chief, Water Pollution Control<br>Frank Mezzacappa, Water Pollution Control<br>Tena Davies, Team Leader, Ten Mile River and Islands Watershed<br>Richard Keith, Chief, Municipal Services<br>Brian Dudley, Chief, Water and Nutrient Management |
| CC: DEP/Boston | Ronald Lyberger, Municipal Facilities<br>Thomas Mahin, Deputy Director, BRP<br>John O'Brien, BRP<br>Alan Slater, BRP<br>Jack Hamm, BRP<br>Sharon Pelosi, Legal<br>Leena McQuaid, Commissioner's Office |
| FROM: | Sharon Stone, SERO MEPA Coordinator |
| DATE: | May 7, 2004 |
| RE: | Phase III/FEIR<br>EOEA #12617 – NANTUCKET – Comprehensive Wastewater Management Plan (CWMP) |

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"For Use in Intra-Agency Policy Deliberations"

The Southeast Regional Office and the Boston Office of the Department of Environmental Protection have reviewed the Final Environmental Impact Report (FEIR/Phase III) for the proposed Comprehensive Wastewater Management Plan (CWMP) to be located on the Island of Nantucket, Massachusetts (EOEA #12617). The project proponent provides the following information for the project:

**"This document provides the basis for the design and ultimate implementation of the approved plan. The FEIR contains the results of evaluation of the available options for improving the existing on-site wastewater disposal systems. This Phase III Report is the final result of all comments received on the Phase II Report through the MEPA process as well as comments received during multiple public informational meetings and workshops held on the island and incorporates the**

**provisions contained in the Surfside ACO."**

The Department has reviewed the Final CWMP/EIR and supports its conclusions and recommendations. The Final CWMP/EIR did not respond, however, to the Department's comment #4 on the Draft CWMP/EIR. The SRF regulations and CWMP planning guidelines require that a financial analysis and presentation of average household costs be presented in the final plan, and it does not contain any analysis that meets that requirement. This information is also important to present at the public hearing on the recommended plan required by the SRF regulations. The Town and Earth Tech must develop, at a minimum, a set of possible financial mechanisms for funding the proposed plan and present the average household costs for the plan for each scenario. The CWMP/EIR cannot be approved for SRF funding purposes until that information is developed and submitted to the Department. The Department recommends that the MEPA Certificate for the Final EIR require that this information and analysis be developed and submitted to the Department.

COSTS

The DEP Southeast Regional Office appreciates the opportunity to comment on this proposed project. If you have any questions regarding these comments, please contact Sharon Stone at (508) 946-2846.

# The Commonwealth of Massachusetts

## Executive Office of Environmental Affairs

100 Cambridge Street, Suite 900

Boston, MA 02114-2524

MITT ROMNEY
GOVERNOR

KERRY HEALEY
LIEUTENANT GOVERNOR

ELLEN RODY HERZFELDER
SECRETARY

Tel. (617) 626-1000
Fax. (617) 626-1181
http://www.mass.gov/envir


MEMORANDUM

TO: Ellen Roy Herzfelder, Secretary, EOEA
ATTN: Nick Zavolas, MEPA Unit
FROM: Tom Skinner, Director, CZM
DATE: May 7, 2004
RE: EOEA 12617 – Nantucket CWMP/FEIR; Nantucket

The Massachusetts Office of Coastal Zone Management (CZM) has completed its review of the above-referenced Comprehensive Wastewater Management Plan (CWMP) and Final Environmental Impact Report (FEIR) and offers the following comments.

The CWMP reflects the Town of Nantucket's admirable and successful efforts to address in its infrastructure planning, the potential impacts of siting new facilities and infrastructure in coastal high hazards areas.

The CWMP proposes to use a combination of approaches to meet Nantucket's current and future wastewater disposal needs. Under the plan, a new wastewater treatment facility is currently under construction at Siasconset and another will be built in Madaket. The current facility located at Surfside will be upgraded and expanded. The two new facilities and most of the new collection system will be outside of the floodplain. In response to concerns about erosion near the Siasconset and Surfside facilities, the Town prepared emergency response plans triggered by specific thresholds. CZM believes that these plans are sufficient, and recommends that emergency response trigger points be identified and mapped as part of the DEP permitting process. The new collection systems will be predominantly low pressure sewers, although some gravity sewers will connect to the Surfside collection system. The construction of new pump houses will not be necessary under the proposed CWMP.

CZM understands that the Town of Nantucket voted at Town Meeting to create an overlay district that will allow only those lots currently deemed as developable by State Land Use Codes to be part of the sewer district. CZM applauds the Town of Nantucket for being proactive in limiting growth associated with the proposed new collection system.

The proposed project may be subject to CZM federal consistency review. For further information on this process, please contact Alex Strysky, Project Review Coordinator, at 617-626-1219.

TWS/th/rh/tpc

cc: Truman Henson,
CZM Cape Cod and Islands Regional Coordinator
Elizabeth Kouloheras, Section Chief
Southeast Regional Office, MA DEP
Ben Lynch, Acting Section Chief
Waterways Program, MA DEP

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Commonwealth of Massachusetts

# Division of Fisheries & Wildlife

MassWildlife

Wayne F. MacCallum, *Director*

NZ

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MEPA

7 May 2004

Ellen Roy Herzfelder, Secretary
Executive Office of Environmental Affairs
Attention: MEPA Office
Nicholas Zavolas, EOEA No. 12617
100 Cambridge Street, Suite 900
Boston, Massachusetts 02114

| | |
|---|---|
| Project Name: | Nantucket Comprehensive Wastewater Management Plan |
| Proponent: | Nantucket Department of Public Works |
| Location: | Nantucket |
| Document Reviewed: | Phase III/Final EIR |
| NHESP File Number: | 01-9335 |

Dear Secretary Roy Herzfelder,

The Natural Heritage & Endangered Species Program (NHESP) of the MA Division of Fisheries & Wildlife has reviewed the Phase III/FEIR for the Nantucket Comprehensive Wastewater Management Plan and would like to offer the following comments. We have enclosed a copy of recent correspondence with Earth Tech which includes the list of rare species that occur within or in the vicinity of the Madaket FAA and Surfside sites, which both fall within Priority Habitat of Rare Species. The Madaket FAA site is significant in that at least 8 state-listed plant and animal species inhabit the area, within two ecologically significant natural communities. These species are protected from "take" pursuant to the MA Endangered Species Act (MESA)(G.L. c.131A) and its implementing regulations (321 CME 10.00). Due to the sensitive habitat at this site we question the FEIR preliminary screening results which indicate (see Table 3-3) that there is "no constraint" at this site from the occurrence of "sensitive habitat." On the contrary, the project could experience severe MESA permitting constraints at the Madaket FAA site particularly since other seemingly viable alternatives exist. We recommend that site ranking be adjusted accordingly to guide the Nantucket Department of Public Works planning process.

If you have any questions regarding this review please contact Patricia Huckery, NHESP Endangered Species Project Analyst, at 508-792-7270 x 151.

We appreciate the opportunity to comment on this project.

Sincerely,

Thomas W. French

Thomas W. French
Assistant Director

Copies to:

Nantucket Department of Public Works
188 Madaket Road
Nantucket, MA 02554-2623

Earth Tech
196 Baker Avenue
Concord, MA 01742-2167

Nantucket Board of Selectmen
16 Broad Street
Nantucket, MA 02554

Nantucket Conservation Commission
16 Broad Street
Nantucket, MA 02554

Nantucket Planning Board
16 Broad Street
Nantucket, MA 02554

Cormac Collier
Nantucket Land Council, Inc.
Six Ash Lane
P.O. Box 502
Nantucket, MA 02554

Commonwealth of Massachusetts

# Division of Fisheries & Wildlife

MassWildlife

Wayne F. MacCallum, *Director*

January 14, 2004

Timothy Sullivan
Earth Tech
196 Baker Avenue
Concord, MA 01742

Re: Surfside and FAA Wastewater Management Sites
Nantucket, MA
**NHESP File: 01-9335**

Dear Mr. Sullivan,

Thank you for contacting the Natural Heritage and Endangered Species Program ("NHESP") of the MA Division of Fisheries & Wildlife for information regarding state-protected rare species in the vicinity of the above referenced site. I have reviewed the site and would like to offer the following comments.

Please see the attached species list for Priority Habitat 1737 (formerly PH 1792) and Estimated Habitat 688 as indicated in the 11th Edition of the Massachusetts Natural Heritage Atlas. Our database indicates that the following protected rare species occur within or in the vicinity of the following sites:

**FFA site**

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Asio flammeus* | Short-eared Owl | Bird | Endangered |
| *Circus cyaneus* | Northern Harrier | Bird | Threatened |
| *Podilymbus podiceps* | Pied-billed Grebe | Bird | Endangered |
| *Amelanchier nantucketensis* | Nantucket Shadbush | Plant | Special Concern |
| *Liatris borealis* | New England Blazing Star | Plant | Special Concern |
| *Linum intercursum* | Sandplain Flax | Plant | Special Concern |
| *Prenanthes serpentaria* | Lion's Foot | Plant | Endangered |
| *Sisyrinchium arenicola* | Sandplain Blue-eyed Grass | Plant | Special Concern |

**Surfside Site**

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Asio flammeus* | Short-eared Owl | Bird | Endangered |
| *Circus cyaneus* | Northern Harrier | Bird | Threatened |
| *Charadrius melodus* | Piping Plover | Bird | Threatened |
| *Helianthemum dumosum* | Bushy Rockrose | Plant | Special Concern |

These species are protected under the Massachusetts Endangered Species Act (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00). State-listed wildlife are also protected under the state's Wetlands Protection Act (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.37 and 10.59). Fact sheets for most of these species can be found on our website at: www.state.ma.us/dfwele/dfw/nhesp/nhfact.htm.

This evaluation is based on the most recent information available in the Natural Heritage database, which is constantly being expanded and updated through ongoing research and inventory. Should your site plans change, or new rare species information become available, this evaluation may be reconsidered.

**MA Endangered Species Act** (G.L. c. 131A)
Using the list of rare species provided above, we recommend that rare wildlife and/or plant surveys and assessments be conducted by qualified individuals within suitable habitats on and near the site according to scientifically accepted survey methodologies. A Rare Animal/Plant Observation Form, available at our website www.nhesp.org, should be submitted for each species encountered. If during this site evaluation rare species are found on or near the site, then site plans and a project description should be sent to NHESP Environmental Review to determine whether a probable "take" under the MA Endangered Species Act would occur (321 CMR 10.04).

If NHESP determines that the proposed project would "take" a rare species, and the site is greater than two acres, and within a Priority Habitat site, an Environmental Notification Form should be submitted pursuant to the MA Environmental Policy Act regulations (301 CMR 11.03(2)(b)(2)). If the project site does not occur within a Priority Habitat, but rare species have recently been found on or near the site, then site plans and a site description should be submitted for MESA review. A Conservation & Management Permit (301 CMR 10.04 (3)(b)) may be required for work in rare species habitat.

**Wetlands Protection Act**
If the project site is within Estimated Habitat for Rare Wildlife and a Notice of Intent (NOI) is required, then a copy of the NOI must be submitted to the NHESP in a timely manner, so that it is received at the same time as the local conservation commission. Using the species list provided above, the Resource Areas on the site should be evaluated as important wildlife habitat for state-protected species, focusing on those areas that provide feeding, breeding, over-wintering, shelter and migration functions. The project should be evaluated for compliance with the rare species performance standard, which is that there shall be no short or long-term adverse affects to the habitat (within Resource Areas) (310 CMR 10.37 and 10.59).

The NHESP is of the opinion that the FAA site in Madaket has far greater ecological significance than the Surfside WWTF site. If you have any questions regarding this review, please call Patricia Huckery, Endangered Species Analyst, at ext. 151.

Sincerely,

Thomas W. French

Thomas W. French, Ph.D
Assistant Director

cc: Nantucket Planning Board
Nantucket Conservation Commission

Nantucket Planning & Economic Development Commission
1 East Chestnut Street
Nantucket, MA 02554

May 6, 2004

Ellen Roy Herzfelder
Executive Office of Environmental Affairs
Attention: MEPA Office
251 Causeway Street, Suite 900
Boston, MA 02114
EOEA No. 12617

Subject: EOEA No 12617, Comprehensive Management Wastewater Plan, Nantucket, MA
Phase III, FEIR

Dear Secretary Hertzfelder:

The Nantucket Planning & Economic Development Commission ("NP&EDC") submits the following comments in connection with Phase III of the Nantucket Comprehensive Wastewater Management Plan ("CWMP") and Final Environmental Impact Report ("FEIR"). The NP&EDC previously submitted comments concerning Phase I (letter dated November 8, 2001) and Phase II (letter dated November 5, 2003).

We regret that the comments submitted by the NP&EDC are not as thorough and well articulated as we would have liked. The filing of Phase III regrettably fell within one of the busiest time periods of the year for Island residents, involving preparations for Town Meeting, and school vacations. Given the statutory constraints governing the granting of extensions, we, and other parties in interest, have had to operate within a narrow window already made narrower by these other commitments.

In consideration of the above, the NP&EDC will focus on issues raised previously, and further addressed by the Town in Phase III:

**Comprehensive Community Plan**

We are pleased to report that since our Phase II comments, significant progress has been made in further considering the objectives of the Comprehensive Community Plan, and measures taken to implement those objectives. Foremost among these is the consideration of the Town Overlay District, established through passage of Article 37, 2002 Annual Town Meeting. That Overlay District, among other things, is meant to serve as a growth

boundary which could serve as a policy basis for limiting the extension of utilities. The NP&EDC participated in the creation of a current buildout estimate based on existing service areas, and possible service area alternatives being considered for the establishment of sewer districts. One of the three scenarios was based on the limits of the Town Overlay District. The estimated buildout of all three generally confirmed the reasonableness of the buildout assumptions made by Earth Tech as a basis for the design of the expansion of the Surfside Wastewater Treatment Facility. Subsequent to the production of the buildout analysis, the Annual Town Meeting embraced a sewer district plan with a boundary substantially within the confines of the Town Overlay District.

**Growth Assumptions**

As a result of the buildout analysis for the Town Overlay District, the NP&EDC has greater confidence in the wastewater flow calculations for the Town, Somerset, Monomoy, Shimmo, and Town WPZ priority areas, which are the basis for the Surfside plant design. Similar confirmation of buildout potential for the remaining priority areas is outstanding and should be done.

The NP&EDC does not mean to imply that, because the buildout assumptions are an accurate basis for plant design, it feels that the growth that could occur as a consequence of those assumptions is acceptable. The preparers of the CWMP have acknowledged that an analysis and mitigation of growth impacts is beyond the scope of the CWMP. Consequently, the NP&EDC has convened a CWMP Growth Committee and allocated funds for the purpose of examining and recommending potential growth mitigation measures.

**Comments on Specific Priority Areas**

Our comments on areas 2 through 12, 14, 16, and 17 as contained in our letter of November 8, 2003 remain unchanged in connection with this Phase III document. The following are further comments on the remaining areas:

**Madaket**

The NP&EDC believes that it is premature to identify a specific solution for Madaket until the final results of water quality testing, and the final reports and conclusions of the Massachusetts Estuaries Project have been submitted and analyzed. We are also uncertain if the low-pressure sewer option, in concert with a legislated restriction similar to that implemented by Provincetown, is the correct solution to managing the growth induced by the possible extension of sewers. We intend to evaluate the growth consequences of this solution in Madaket through the NP&EDC's CWMP Growth Committee to determine if this is the most prudent answer to concerns over growth inducement.

growth impacts

**Shimmo**

We are still unconvinced that the extension of conventional sanitary sewers is the best solution for all of Shimmo, especially the area east of Rabbit Run and Drew Lane, where the lot sizes are generally large, and where there exists a substantial amount of preserved land. We agree that the final solution should be held in abeyance pending the submission of a final report under the auspices of the Massachusetts Estuaries Project.

**Proposed Sites for Treatment Plants**

We were pleased to learn that all but one possible plant site that we raised concerns about in the Phase II comment letter have been eliminated from consideration.

**Other Comments**

We note that the Town has satisfactorily answered miscellaneous comments made by the NP&EDC in its Phase II comment letter.

Once again, we are grateful for this opportunity to comment on this important project.

Very truly yours,

Alvin S. Topham
Chairman

Cc: Nantucket Board of Selectmen
Jeff Willett, Director, DPW

N2

# The Commonwealth of Massachusetts

William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

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MAY 4 2004

MEPA

May 3, 2004

Secretary Ellen Roy Herzfelder
Attn.: Nicholas Zavolas, MEPA Office
Executive Office of Environmental Affairs
251 Causeway Street, 9th Floor
Boston, MA 02114-2150

RE: Comprehensive Wastewater Management Plan/Final Environmental Impact Report, Nantucket
MHC #RC.22107, EOEA #12617

Dear Secretary Herzfelder:

Staff of the Massachusetts Historical Commission have reviewed the Final Environmental Impact Report (FEIR) for the proposed project referenced above and have the following comments.

Upon review of the DEIR for this project MHC requested that an intensive (locational) archaeological survey (950 CMR 70) be conducted for the project impact areas. MHC understands that the Town of Nantucket intends to have an intensive survey conducted (FEIR, Vol. III, p. 1-3). MHC looks forward to receiving for review an application for a State Archaeologist's Permit (950 CMR 70) for the intensive survey.

These comments are offered to assist in compliance with Massachusetts General Laws, Chapter 9, Sections 26-27C (950 CMR 71) and MEPA. If you have any questions concerning this review, please feel free to contact Eric Johnson at this office.

Sincerely,

Brona Simon

Brona Simon
State Archaeologist
Deputy State Historic Preservation Officer
Massachusetts Historical Commission

xc: Thomas E. Parece, Earth Tech
Michael Pappalardo, Earth Tech
DEP, SERO
Nantucket Historic District Commission
Nantucket Historical Commission

220 Morrissey Boulevard, Boston, Massachusetts 02125
(617) 727-8470 • Fax: (617) 727-5128
www.state.ma.us/sec/mhc

**TABLE 3D-2**

**CWMP/EIR**

**TOWN OF NANTUCKET, MASSACHUSETTS**

**RATING CRITERIA**

| CRITERIA NAME | | DESCRIPTION | Madaket | | Warren's Landing | | Cisco | | Somerset | | Miacomet | | Surfside | | Tom Nevers Hi-Density | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Number | Points | Number | Points | Number | Points | Number | Points | Number | Points | Number | Points | Number | Points |
| CRITERIA POINTS | | Total Number of Lots | 864 | | 99 | | 204 | | 206 | | 127 | | 419 | | 350 | |
| Actual Failure | 4 | Total Number of Developed Lots | 435 | | 68 | | 143 | | 161 | | 101 | | 281 | | 255 | |
| Imminent Failure | 3 | Total Number of Unsewered Developed Lots | 435 | | 68 | | 143 | | 161 | | 101 | | 281 | | 255 | |
| High Likelihood of Imminent Failure | 2 | Number of Resales since 3/31/95 | 70 | | 19 | | 27 | | 30 | | 15 | | 44 | | 26 | |
| Health / Water Quality Issue | 1 | Number of Acres per Study Area | 394 | | 49 | | 355 | | 151 | | 296 | | 685 | | 129 | |
| | | Number of Net Acres for Developed Lots | 232 | | 26 | | 143 | | 103 | | 197 | | 363 | | 63 | |
| | | No. of Acres of Severe Groundwater Limitation | 117 | | 10 | | 27 | | 7 | | 8 | | 49 | | 28 | |
| | | Number of Acres of Severe Soil Limitation | 86 | | 26 | | 178 | | 96 | | 149 | | 112 | | 61 | |
| Actual Failure | | 3/31/95 to 1999 | 31 | 124 | 4 | 16 | 8 | 32 | 21 | 84 | 8 | 32 | 21 | 84 | 2 | 8 |
| | | 1972 to 3/31/95 | 74 | 296 | 2 | 8 | 10 | 40 | 8 | 32 | 6 | 24 | 27 | 108 | | 0 |
| | | | 105 | 420 | 6 | 24 | 18 | 72 | 29 | 116 | 14 | 56 | 48 | 192 | 2 | 8 |
| | | Adjusted Total based on Developed/Unsewered Developed Ratio | | 420 | | 24 | | 72 | | 116 | | 56 | | 192 | | 8 |
| Imminent Failure | | System within Zone I Aquifer Recharge Area | 9 | 27 | | 0 | 6 | 18 | 1 | 3 | | 0 | 11 | 33 | | 0 |
| | | System within 50 feet of Private Drinking Water Well | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| | | System within 100 feet of Public Drinking Water Supply | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| | | Developed Lots with Less than 10,000 sq. ft. of area per Bedro | 260 | 780 | 66 | 198 | 105 | 315 | 152 | 456 | | 0 | | 0 | 110 | 330 |
| | | | 269 | 807 | 66 | 198 | 111 | 333 | 153 | 459 | 0 | 0 | 11 | 33 | 110 | 330 |
| High Likelihood of Imminent Failure | | Lots with Severe Groundwater Limitation | 130 | 260 | 14 | 28 | 11 | 22 | 8 | 16 | 3 | 6 | 20 | 40 | 54 | 108 |
| | | Systems Built before 1978 (Title 5) | 281 | 562 | 1 | 2 | 43 | 86 | 13 | 26 | 15 | 30 | 72 | 144 | 2 | 4 |
| | | Lot Size less than or equal to 1/2 acre | 246 | 492 | 62 | 124 | 34 | 68 | 100 | 200 | 2 | 4 | 52 | 104 | 97 | 194 |
| | | Lots with Severe Soil Limitation | 95 | 190 | 36 | 72 | 72 | 144 | 103 | 206 | 51 | 102 | 46 | 92 | 121 | 242 |
| | | Pumpouts Greater than 2 times per year | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| | | | 752 | 1,504 | 113 | 226 | 160 | 320 | 224 | 448 | 71 | 142 | 190 | 380 | 274 | 548 |
| Health / Water Quality Issue | | Density of Systems Greater Than 2 per Acre | 435 | 435 | 68 | 68 | 0 | 0 | 161 | 161 | 0 | 0 | 0 | 0 | 255 | 255 |
| | | System within 100 feet of Surface Water Body, Wetlands or Streams | | 0 | | 0 | 7 | 7 | 8 | 8 | 3 | 3 | 3 | 3 | | 0 |
| | | System located within 100 Year Flood Plain | 53 | 53 | | 0 | 6 | 6 | | 0 | | 0 | | 0 | | 0 |
| | | System within Zone II Aquifer Recharge Area | | 0 | | 0 | | 0 | | 0 | | 0 | 28 | 28 | | 0 |
| | | System within Harbor Watershed Line or 3,600' of Madaket Ha | 435 | 435 | 34 | 34 | | 0 | | 0 | | 0 | | 0 | | 0 |
| | | | 923 | 923 | 102 | 102 | 13 | 13 | 169 | 169 | 3 | 3 | 31 | 31 | 255 | 255 |
| | | Total Criteria Points for Study Area | | 3,654 | | 550 | | 738 | | 1,192 | | 201 | | 636 | | 1,141 |
| | | Rating Criteria Points Per Developed Lot | | 8.40 | | 8.09 | | 5.16 | | 7.40 | | 1.99 | | 2.26 | | 4.47 |
| | | **RECOMMENDED AS A NEED AREA** | | **YES** | | **YES** | | **NO** | | **YES** | | **NO** | | **NO** | | **NO** |

**(Conventional Title 5 System Not Feasible for Majority of Study Area)**

**TABLE 3D-2 (Continued)**
**CWMP/EIR**
**TOWN OF NANTUCKET, MASSACHUSETTS**
**RATING CRITERIA**

| CRITERIA NAME | | DESCRIPTION | m Nevers Lo-Density | | Siasconset | | Quidnet | | Wauwinet | | Pocomo | | Polpis | | Town | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Number | Points | Number | Points | Number | Points | Number | Points | Number | Points | Number | Points | Number | Points |
| CRITERIA POINTS | | Total Number of Lots | 195 | | 1,049 | | 77 | | 68 | | 140 | | 100 | | 4,741 | |
| Actual Failure | 4 | Total Number of Developed Lots | 122 | | 664 | | 45 | | 50 | | 81 | | 59 | | 3,943 | |
| Imminent Failure | 3 | Total Number of Unsewered Developed Lots | 122 | | 127 | | 45 | | 50 | | 81 | | 59 | | 890 | |
| High Likelihood of Imminent Failure | 2 | Number of Resales since 3/31/95 | 48 | | 27 | | 9 | | 3 | | 11 | | 10 | | 108 | |
| Health / Water Quality Issue | 1 | Number of Acres per Study Area | 653 | | 1,012 | | 68 | | 61 | | 457 | | 583 | | 1,922 | |
| | | Number of Net Acres for Developed Lots | 374 | | 349 | | 45 | | 51 | | 297 | | 395 | | 1,333 | |
| | | No. of Acres of Severe Groundwater Limitation | 31 | | 291 | | 22 | | 29 | | 162 | | 324 | | 419 | |
| | | Number of Acres of Severe Soil Limitation | 286 | | 479 | | 19 | | 9 | | 163 | | 371 | | 1,076 | |
| Actual Failure | | 3/31/95 to 1999 | 13 | 52 | 3 | 12 | 7 | 28 | 3 | 12 | 6 | 24 | 10 | 40 | 43 | 172 |
| | | 1972 to 3/31/95 | 15 | 60 | 15 | 60 | 13 | 52 | 11 | 44 | 9 | 36 | 12 | 48 | 99 | 396 |
| | | | 28 | 112 | 18 | 72 | 20 | 80 | 14 | 56 | 15 | 60 | 22 | 88 | 142 | 568 |
| | | Adjusted Total based on Developed/Unsewered Developed Ratio | | 112 | | 376 | | 80 | | 56 | | 60 | | 88 | | 2,516 |
| Imminent Failure | | System within Zone I Aquifer Recharge Area | | 0 | 2 | 6 | | 0 | 28 | 84 | | 0 | | 0 | | 0 |
| | | System within 50 feet of Private Drinking Water Well | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| | | System within 100 feet of Public Drinking Water Supply | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| | | Developed Lots with Less than 10,000 sq. ft. of area per Bedroom | | 0 | | 0 | 21 | 63 | 21 | 63 | 8 | 24 | 6 | 18 | 60 | 180 |
| | | | 0 | 0 | 2 | 6 | 21 | 63 | 49 | 147 | 8 | 24 | 6 | 18 | 60 | 180 |
| High Likelihood of Imminent Failure | | Lots with Severe Groundwater Limitation | 6 | 12 | 191 | 382 | 15 | 30 | 24 | 48 | 29 | 58 | 33 | 66 | 859 | 1,718 |
| | | Systems Built before 1978 (Title 5) | 42 | 84 | 461 | 922 | 30 | 60 | 42 | 84 | 41 | 82 | 40 | 80 | 2,439 | 4,878 |
| | | Lot Size less than or equal to 1/2 acre | 37 | 74 | 512 | 1,024 | 22 | 44 | 8 | 16 | 8 | 16 | 10 | 20 | 3,098 | 6,196 |
| | | Lots with Severe Soil Limitation | 53 | 106 | 60 | 120 | 12 | 24 | 8 | 16 | 29 | 58 | 38 | 76 | 498 | 996 |
| | | Pumpouts Greater than 2 times per year | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| | | | 138 | 276 | 1,224 | 2,448 | 79 | 158 | 82 | 164 | 107 | 214 | 121 | 242 | 6,894 | 13,788 |
| Health / Water Quality Issue | | Density of Systems Greater Than 2 per Acre | 0 | 0 | 127 | 127 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 890 | 890 |
| | | System within 100 feet of Surface Water Body, Wetlands or Str | 5 | 5 | 29 | 29 | 28 | 28 | 33 | 33 | 27 | 27 | 60 | 60 | 447 | 447 |
| | | System located within 100 Year Flood Plain | 2 | 2 | 1 | 1 | 1 | 1 | 13 | 13 | 8 | 8 | 16 | 16 | 65 | 65 |
| | | System within Zone II Aquifer Recharge Area | | 0 | 13 | 13 | | 0 | | 0 | | 0 | | 0 | 161 | 161 |
| | | System within Harbor Watershed Line or 3,600' of Madaket Harbor | | 0 | | 0 | | 0 | 50 | 50 | 81 | 81 | 59 | 59 | 1,972 | 1,972 |
| | | | 7 | 7 | 170 | 170 | 29 | 29 | 96 | 96 | 116 | 116 | 135 | 135 | 3,535 | 3,535 |
| | | Total Criteria Points for Study Area | | 395 | | 3,000 | | 330 | | 463 | | 414 | | 483 | | 20,019 |
| | | Rating Criteria Points Per Developed Lot | | 3.24 | | 4.52 | | 7.33 | | 9.26 | | 5.11 | | 8.19 | | 5.08 |
| | | **RECOMMENDED AS A NEED AREA** | | **NO** | | **NO** | | **YES** | | **YES** | | **NO** | | **YES** | | **NO** |

**(Conventional Title 5 System Not Feasible for Majority of Study Area)**

**TABLE 3D-2 (Continued)**
**CWMP/EIR**
**TOWN OF NANTUCKET, MASSACHUSETTS**
**RATING CRITERIA**

| CRITERIA NAME | | DESCRIPTION | Town - WPZ | | Shimmo | | Monomoy | | Other | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Number | Points | Number | Points | Number | Points | Number | Points | Number | Points | Number | Points | Number | Points |
| CRITERIA POINTS | | Total Number of Lots | 743 | | 284 | | 263 | | 2,539 | | 0 | | 0 | | 0 | |
| Actual Failure | 4 | Total Number of Developed Lots | 524 | | 137 | | 184 | | 818 | | 0 | | 0 | | 0 | |
| Imminent Failure | 3 | Total Number of Unsewered Developed Lots | 315 | | 137 | | 178 | | 812 | | 0 | | 0 | | 0 | |
| High Likelihood of Imminent Failure | 2 | Number of Resales since 3/31/95 | 37 | | 21 | | 19 | | 114 | | | | | | | |
| Health / Water Quality Issue | 1 | Number of Acres per Study Area | 744 | | 881 | | 276 | | 21,863 | | 0 | | 0 | | 0 | |
| | | Number of Net Acres for Developed Lots | 313 | | 380 | | 218 | | 5,422 | | 0 | | 0 | | 0 | |
| | | No. of Acres of Severe Groundwater Limitation | 7 | | 171 | | 44 | | 5,263 | | 0 | | 0 | | 0 | |
| | | Number of Acres of Severe Soil Limitation | 321 | | 230 | | 150 | | 7,538 | | 0 | | 0 | | 0 | |
| Actual Failure | | 3/31/95 to 1999 | 23 | 92 | 9 | 36 | 17 | 68 | 60 | 240 | | 0 | | 0 | | 0 |
| | | 1972 to 3/31/95 | 24 | 96 | 17 | 68 | 30 | 120 | 110 | 440 | | 0 | | 0 | | 0 |
| | | | 47 | 188 | 26 | 104 | 47 | 188 | 170 | 680 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Adjusted Total based on Developed/Unsewered Developed Ratio | | 313 | | 104 | | 194 | | 685 | | 0 | | 0 | | 0 |
| Imminent Failure | | System within Zone I Aquifer Recharge Area | | 0 | | 0 | | 0 | 10 | 30 | | 0 | | 0 | | 0 |
| | | System within 50 feet of Private Drinking Water Well | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| | | System within 100 feet of Public Drinking Water Supply | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| | | Developed Lots with Less than 10,000 sq. ft. of area per Bedro | 137 | 411 | 33 | 99 | 37 | 111 | | 0 | | 0 | | 0 | | 0 |
| | | | 137 | 411 | 33 | 99 | 37 | 111 | 10 | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| High Likelihood of Imminent Failure | | Lots with Severe Groundwater Limitation | 5 | 10 | 27 | 54 | 29 | 58 | 197 | 394 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Systems Built before 1978 (Title 5) | 74 | 148 | 40 | 80 | 108 | 216 | 337 | 674 | | 0 | | 0 | | 0 |
| | | Lot Size less than or equal to 1/2 acre | 229 | 458 | 4 | 8 | 29 | 58 | 73 | 146 | | 0 | | 0 | | 0 |
| | | Lots with Severe Soil Limitation | 136 | 272 | 36 | 72 | 97 | 194 | 280 | 560 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Pumpouts Greater than 2 times per year | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| | | | 444 | 888 | 107 | 214 | 263 | 526 | 887 | 1,774 | 0 | 0 | 0 | 0 | 0 | 0 |
| Health / Water Quality Issue | | Density of Systems Greater Than 2 per Acre | 315 | 315 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | System within 100 feet of Surface Water Body, Wetlands or St | 9 | 9 | 43 | 43 | | 0 | 204 | 204 | | 0 | | 0 | | 0 |
| | | System located within 100 Year Flood Plain | | 0 | 5 | 5 | 4 | 4 | 72 | 72 | | 0 | | 0 | | 0 |
| | | System within Zone II Aquifer Recharge Area | 473 | 473 | 3 | 3 | 116 | 116 | 117 | 117 | | 0 | | 0 | | 0 |
| | | System within Harbor Watershed Line or 3,600' of Madaket Harbor | | 0 | 103 | 103 | 184 | 184 | 161 | 161 | | 0 | | 0 | | 0 |
| | | | 797 | 797 | 154 | 154 | 304 | 304 | 554 | 554 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Total Criteria Points for Study Area | | 2,409 | | 571 | | 1,135 | | 3,043 | | 0 | | 0 | | 0 |
| | | Rating Criteria Points Per Developed Lot | | 4.60 | | 4.17 | | 6.17 | | 3.72 | | 0.00 | | 0.00 | | 0.00 |
| | | **RECOMMENDED AS A NEED AREA** | | **NO** | | **NO** | | **NO** | | **NO** | | **NO** | | **NO** | | **NO** |

**(Conventional Title 5 System Not Feasible for Majority of Study Area)**

# APPENDIX B: NANTUCKET ZONING BY-LAW

# Town of Nantucket

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OFFICE OF THE
**TOWN & COUNTY CLERK**
16 Broad Street
NANTUCKET, MASSACHUSETTS 02554-3590

Catherine Flanagan Stover, MMC, CMMC
Town & County Clerk

(508) 228-7216
FAX (508) 325-5313
Home: (508) 228-7841
Email: cstover@nantucket-ma.gov
townclerk@nantucket-ma.gov

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## 2009 SPECIAL TOWN MEETING 2009

**The following is a summary of the articles called, and the vote taken by the 2009 Special Town Meeting held at the Nantucket High School, Mary P. Walker Auditorium, 10 Surfside Road, on September 21, 2009.**

**Monday, September 21st – Meeting called to order at 6:15 PM with 622 voters present. There were ultimately 774 voters present. At the close of Voter Registration there were 7632 voters. The Quorum Requirements for the meeting are 229 and 382.**

---

**Article 1: Fiscal Year 2010 General Fund Operating Budget Adjustments** (Not Called) **Adopted by Unanimous Voice Vote [Quorum of 3% needed = 229]**

**Article 2: Fiscal Year 2010 Enterprise Fund Operating Budget Adjustments** (Not Called) **Adopted by Unanimous Voice Vote**

**Article 3: Appropriation: FY2010 Police and Fire Special Detail Fund** (Not Called) **Not Adopted by Unanimous Voice Vote [Quorum of 3% needed = 229]**

**Article 4: Appropriation: Unpaid Bills** (Not Called) **Adopted by Unanimous Voice Vote [Quorum of 3% needed = 229]**

**Article 5: Re-appropriation: Prior Year Articles** (Not Called) **Adopted by Unanimous Voice Vote [Quorum of 5% needed = 382]**

**Article 6: Appropriation: Collective Bargaining Agreement/Laborer's U*nion** (Not Called) **Adopted by Unanimous Voice Vote**

**Article 7: Acceptance of Massachusetts General Law: Local Option Meals Tax** (Called) **Adopted by Handcount Vote: YES – 464; NO - 304**

**Article 8: Acceptance of Massachusetts General Law: Amend Local Room Occupancy Excise Tax** (Called) **Adopted by Handcount Vote: YES – 398; NO - 386**

**Article 9: Appropriation: Adult Community Day Care Program** (Called) **Positive Sense-of-the-Meeting Adopted by Voice Vote**

**Article 10:** **Zoning Bylaw Amendment: Assisted Living Community (ALC) District – Age Restriction** (Called) **Adopted by Declared 2/3 Majority Voice Vote**

**Article 11:** **Zoning Bylaw Amendment: Assisted Living Community (ALC) District – Operating Entity** (Called) **Adopted by Declared 2/3 Majority Voice Vote**

**Article 12:** **Zoning Bylaw Amendment: Assisted Living Community (ALC) District – Skilled Nursing** (Not Called) **Adopted by Unanimous Voice Vote**

**Article 13:** **Zoning Bylaw Amendment: Assisted Living Community (ALC) District – Unit Ownership** (Not Called) **Adopted by Unanimous Voice Vote.**

**Article 14:** **Zoning Bylaw Amendment: Assisted Living Community (ALC) District – Major Site Plan Review** (Called) **Adopted by Declared 2/3 Majority Voice Vote**

**Article 15:** **Zoning Bylaw Amendment: Assisted Living Community (ALC) District – Affordable Housing** (Not Called) **Adopted by Unanimous Voice Vote**

**Article 16:** **Zoning Bylaw Amendment: Definitions and Special Districts** (Called, Call Withdrawn**) Adopted as moved by Planning Board by Declared 2/3 Majority Voice Vote**

**Article 17:** **Real Estate Disposition: Sherburne Commons** (Called) **Adopted by 2/3 Handcount Vote: YES – 517; NO – 134 2/3 = 434**

**Article 18:** **Zoning Map Change: Madaket RC to VTEC** (Not Called) **Adopted by Unanimous Voice Vote**

**Article 19:** **Zoning Map Change: Madaket R-20 to LUG-3** (Not Called) **Adopted by Unanimous Voice Vote**

**Article 20:** **Zoning Map Change: Madaket R-20 to VR** (Called) **Adopted by Declared 2/3 Majority Voice Vote**

**Article 21:** **Zoning Map Change: Madaket R-20 to LUG-1 (**Not Called) **Adopted by Unanimous Voice Vote**

**Article 22:** **Zoning Bylaw Amendment: Height** (Called) **Adopted by Unanimous Voice Vote**

**Article 23:** **Zoning Bylaw Amendment: Height Exemptions** (Not Called) **Not Adopted by Unanimous Voice Vote**

**Article 24:** **Real Estate Conveyance: North Pasture** (Not Called) **Adopted by Unanimous Voice Vote**

**Article 25:** **Real Estate Acquisition and Conveyance: North Pasture** (Not Called) **Adopted by Unanimous Voice Vote**

**<u>Article 26:</u> Real Estate Acquisition: Western Avenue** (Called) **Not Adopted by Handcount Vote: YES – 287; NO – 171 2/3 = 305**

**<u>Article 27:</u> Miller Lane Access (**Not Called) "**Moved that No Action Be Taken" by Unanimous Voice Vote**

**<u>Article 28:</u> Appropriation Reduction: Police Station** (Called) **Not Adopted by Majority Voice Vote [Quorum of 5% needed = 382]**

**<u>Article 29:</u> Size Reduction: Police Station** (Called) **Not Adopted by Declared 2/3 Majority Voice Vote. [Quorum of 5% needed = 382]**

**<u>Article 30:</u> Bylaw Amendment: Town Meeting Quorum Requirement** (Called) **Not adopted by Majority Voice Vote**

***Moved that the following articles be voted* in accordance with the motions *recommended by the Finance Committee or*, in the absence of a Finance Committee motion, then in accordance with the motions *as recommended by the Planning Board, as printed in the Finance Committee Report, with technical amendments brought forward during the course of the meeting:***

***1, 2, 3, 4, 5, 6, 7, 12, 13, 15, 18, 19, 21, 23, 24, 25, and 27.***

***Moved, seconded, and Voted Unanimously.***

**2009 Special Town Meeting was dissolved at 10:17 PM, on September 21, 2009.**

*Town of Nantucket, MA*
*Friday, September 5, 2014*

# Chapter 139. ZONING

## Article III. Use and Intensity Regulations

### § 139-7. Use chart; prohibited uses in all districts.

[Amended 11-13-1990 STM by Art. 13, AG approval 3-19-1991; 5-5-1992 ATM by Arts. 37 and 51, AG approval 8-3-1992; 4-12-1994 ATM by Art. 53, AG approval 4-29-1994; 4-8-1996 ATM by Arts. 34, 35, and 36, AG approval 7-15-1996; 4-12-1999 ATM by Art. 33, AG approval 8-10-1999; 4-10-2000 ATM by Arts. 27 and 44, AG approval 8-2-2000; 1-8-2001 STM by Art. 5, AG approval 4-10-2001; 4-9-2001 ATM by Arts. 36, 37 and 38, AG approval 8-2-2001; 4-15-2003 ATM by Arts. 30, 31 and 49, AG approval 8-27-2003; 4-4-2006 ATM by Art. 45, AG approval 8-2-2006; 4-11-2007 ATM by Art. 39, AG approval 6-28-2007; 4-8-2008 ATM by Art. 64, AG approval 8-18-2008; 4-6-2009 ATM by Art. 27, AG approval 8-10-2009]

A. Use Chart.[1]

[1]: *Editor's Note: The Use Chart is included at the end of this chapter.*

B. Prohibited uses in all districts. Notwithstanding any other provisions of this chapter, the following uses shall be prohibited in all districts:

(1) More than two dwellings or dwelling units per lot except as otherwise allowed in this chapter.

(2) Use of a trailer or a building-like container for residential purposes or as a principal or accessory building or structure except as necessary for storage of chemicals and/or equipment by the Nantucket Fire Department.

(3) Use of a trailer or building-like containers as a temporary office or for construction materials storage (permitted only when incidental and accessory to construction actively underway on the same lot) longer than 12 months total.

(4) Any building or structure or any use of any building, structure or premises which is injurious, obnoxious, offensive, dangerous or a nuisance to the community or to the neighborhood through noise vibration, concussion, odors, fumes, smoke, gases, dust, harmful fluids or substances, danger of fire or explosion or other objectionable feature detrimental to the community or neighborhood health, safety, convenience, morals or welfare.

(5) A motor vehicle which is and for the immediately preceding thirty-day period has been disabled, dismantled or inoperative shall not be stored on any land or lot unless such

vehicle is enclosed within a building or covered by a tarpaulin and screened from surrounding residential properties by a fence or hedge.

## § 139-8. Residential development options.

[Amended 11-13-1990 STM by Art. 19, AG approval 3-19-1991; 4-12-1994 ATM by Art. 48, AG approval 4-29-1994; 4-10-1995 ATM by Arts. 42 and 43, AG approval 5-22-1995; 4-9-2001 ATM by Art. 36, AG approval 8-2-2001; 4-15-2003 ATM by Art. 28, AG approval 8-27-2003; 4-12-2004 ATM by Arts. 35 and 36, AG approval 9-3-2004; 4-8-2008 ATM by Arts. 58, 59 and 64, AG approval 8-18-2008; 4-6-2009 ATM by Art. 27, AG approval 8-10-2009[1]; 4-6-2011 ATM by Arts. 63 and 64, AG approval 9-15-2011; 3-31-2012 ATM by Art. 54, AG approval 7-12-2012]

A. Flex development and open space residential development options shall become effective on January 1, 2013, and may be allowed as an alternative to a conventional subdivision. Flex development may be allowed in the Town Overlay District (TOD) through the issuance of a special permit by the Planning Board. Open space residential development is allowed by-right in the Country Overlay District (COD). The primary purposes of these development options are as follows:

(a) To allow for greater flexibility and creativity in the design of residential developments.

(b) To encourage a more efficient form of development that consumes less open land.

(c) To reduce infrastructure and site disturbance through the creation of compact development.

(d) To encourage the permanent preservation of open space.

(1) Requirements.

(a) The following requirements shall apply to flex development and open space residential development:

[1] All plans shall conform to the requirements of MGL c. 41, §§ 81K through 81GG and the "Rules and Regulations Governing the Subdivision of Land," as may be amended by the Planning Board from time to time.

[2] Building lots shall not be subject to the regularity formula in § **139-16D**.

[3] Building lots shall be restricted from any further lot division that results in additional building lots.

[4] To ensure that all common open space and common facilities within the development will be properly maintained, a homeowners' association shall be established in the form of a corporation, nonprofit organization, or trust. The homeowners' association legal documents shall be subject to approval by the Planning Board and shall be filed at the Nantucket County Registry of Deeds or the Registry District of the Land Court.

[5]

The maximum number of building lots, excluding any bonuses, shall not exceed the number which may otherwise have been created on a conventional subdivision plan meeting all dimensional and upland requirements of the Zoning Bylaw and in full conformance with (and requiring no waivers from) the "Rules and Regulations Governing the Subdivision of Land," as may be amended by the Planning Board from time to time, as demonstrated by the submission of a dimensioned lotting plan.

(b) Preservation of open space shall be required, with the amount based on the total tract size pursuant to Subsections **A(3)** and **(4)** below.

[1] A restriction defining the protection of the open space shall be enforceable by the Town or County of Nantucket and recorded at the Nantucket County Registry of Deeds or the Registry District of the Land Court. In addition, open space shall be:

[a] Owned by the Town of County of Nantucket; or

[b] Owned by the Nantucket Islands Land Bank; or

[c] Conveyed to an established nonprofit organization, a principal purpose of which is the conservation of open land; or

[d] Subject to a permanent conservation restriction, as provided in MGL c. 184, §§ 31 through 33, and owned in common by a corporation or trust composed of the owners of lots within the development.

[2] Open space shall be restricted to one or more of the following uses, subject to approval of the Planning Board, in accordance with MGL c. 184, §§ 31 and 32:

[a] Preservation of important natural features on a lot.

[b] Passive recreation, including, but not limited to, nature study, boating, fishing, hunting, picnicking, and horseback riding.

[c] Active recreation.

[d] Bicycle paths and walking trails.

[e] Agriculture.

[f] Structures accessory to the use of the open space which may include, but are not limited to: boathouses, duck walks, landings, barns, gazebos.

[g] Water features consistent with the purposes described above.

[h] Individual underground septic systems or wells that provide service to the lots within the development.

[3] Subject to Subsections **A(3)** and **(4)**, a maximum of 50% of the required open space may be located on noncontiguous parcels of land in common ownership with the tract to be developed. The Planning Board shall determine the

development potential of the noncontiguous parcel(s) and consider the open space value subject to the following criteria:

[a] Preservation of scenic views or vistas.

[b] Common border to existing open space.

[c] Existence of a fragile ecological environment.

[d] Agricultural importance.

[e] Importance to the community for recreation, water supply, cultural or historic municipal use.

[f] Importance to the community as determined by the Planning Board.

(2) Bonus lots.

(a) Flex developments and open space residential developments shall be entitled to bonus lots, subject to the requirements below. Bonus lots shall be based on the number of building lots which could have been created through a conventional subdivision plan, as set forth in § **139-8A(1)(a)[5]**. For all density calculations that result in a fractional number, only fractions equal to or greater than 0.51 should be rounded to the next highest whole number.

[1] A 10% increase in the number of building lots that could have been created through the submission of a conventional subdivision plan.

[2] A 10% increase if the open space remains open to the public through a permanent access easement or conveyance to the Town or County of Nantucket or the Nantucket Islands Land Bank.

[3] A 1% increase for each 10% of the cluster lots restricted to a single dwelling unit, provided that the restricted lots would otherwise be permitted a second dwelling pursuant to Board of Health regulations.

[4] The total increase in building lots shall not exceed 30% of the number of building lots which could have been created through a conventional subdivision plan.

(3) Flex development.

(a) Flex development may be allowed in the Town Overlay District (TOD) through the issuance of a special permit subject to the following:

[1] The Planning Board shall be the sole special permit granting authority for relief pursuant to any provision of this chapter.

[2] Planning Board approval of a special permit shall not substitute for approval of a definitive subdivision or approval not required (ANR) plan.

[3] Flex Development shall be permitted in the R-40, R-20, R-10, R-5, and ROH Districts only and shall conform to the following dimensional requirements:

| | R-40 | R-20 | R-10 | R-5 | ROH |
|---|---|---|---|---|---|
| Minimum tract area (acres) | 5 | 3 | 2 | 1 | 1 |
| Open land required (total tract) | 70% | 50% | 40% | 30% | 25% |
| Minimum lot size (square feet) | 10,000 | 7,500 | 4,000 | 3,000 | 3,000 |
| Maximum lot ground cover ratio | 35% | 30% | 50% | 60% | 65% |
| Minimum frontage | 20 | 20 | 20 | 0 | 0 |
| Front setback | 5 | 5 | 5 | 5 | 0 |
| Side/Rear setback | 5 | 5 | 5 | 5 | 0 |

[4] The Planning Board may reduce, by up to 100%, the setbacks, provided that the Planning Board finds that such a change will not have an adverse impact on the neighborhood and that it will promote the purposes and intent of this section.

[5] The Planning Board may reduce, by up to 100%, the required frontage, provided that the lot has sufficient access through an easement.

[6] The Planning Board may waive the required minimum tract area, provided that the Planning Board finds that the proposed flex development is more in keeping with the surrounding area, promotes a more efficient use of land, and that it will promote the purposes and intent of this section.

[7] Noncontiguous open space parcels, subject to Subsection **A(1)(b)[3]**, may be located in the Town Overlay District (TOD) or the Country Overlay District (COD).

(b) The following development and design criteria will be considered by the Planning Board during its review of an application for flex development:

[1] Landscaping features utilizing natural or man-made materials are encouraged and may include effective screening, planting of street trees, and preservation of existing mature vegetation.

[2] Sidewalks and walking paths which encourage pedestrian activity are encouraged, including connections to adjacent neighborhoods and bordering open spaces.

[3] Vehicular access should be consolidated in a small number of widely spaced access points where practicable.

[4] Common driveways and shared parking areas are encouraged.

(c) The following performance criteria shall be reviewed by the Planning Board. Mitigation measures proposed by the developer shall be considered:

[1] Traffic flow and safety in the proposed development, the neighborhood, and adjacent public and private ways will not be significantly impacted in comparison with other development options;

[2]

Quality of site design, building design (if applicable), and landscaping enhances the area in comparison with other development options;

[3] The provision of open land and any associated landscaping is appropriate for the scale and location of the development as determined by the Planning Board;

[4] That utilities and services, such as water and sewer, are adequate for the proposed development.

(4) Open space development.

(a) Open space development shall be allowed by-right within the Country Overlay District (COD), subject to the following:

[1] For parcels of land within an open space development, the Planning Board shall be the sole special permit granting authority for relief pursuant to any provision of this chapter.

[2] Open space development shall be permitted in the LUG-1, LUG-2, LUG-3, and VR Districts only and shall conform to the following dimensional requirements:

| | **LUG-3** | **LUG-2** | **LUG-1** | **VR** |
|---|---|---|---|---|
| Minimum tract area (acres) | 10 | 10 | 5 | 3 |
| Open land required (total tract) | 80% | 75% | 65% | 60% |
| Minimum lot size (square feet) | 10,000 | 10,000 | 10,000 | 10,000 |
| Maximum lot ground cover ratio | 20% | 20% | 20% | 20% |
| Minimum frontage | 20 | 20 | 20 | 20 |
| Front setback | 15 | 15 | 15 | 15 |
| Side/Rear setback | 10 | 10 | 10 | 10 |

[3] The Planning Board may issue a special permit to reduce, by up to 100%, the setbacks, provided that the Planning Board finds that such a change will not have an adverse impact on the neighborhood and that it will promote the purposes and intent of this section.

[4] Noncontiguous open space parcels, subject to Subsection **A(1)(b)[3]**, may be located in the Country Overlay District (COD) only.

[5] In any LUG Zone, a minimum buffer of 50 feet of permanently restricted and undisturbed open space (excluding walking paths and fire access easements) shall be required between the proposed lot line of any open space residential development lot and the outside boundary of the subdivision tract. The Planning Board, through the issuance of a special permit, may reduce or waive this requirement if it finds that:

(b) Such reduction or waiver is necessitated by the shape or topography of the tract of land; or

(c) Natural resources will be better protected by an alternative location; or

(d) Equivalent protection against inconsistency with the existing pattern of development has been provided.

B. Nantucket Housing Needs Program.

(1) Purpose. To create, make available and maintain housing that is affordable to people who earn less than 150% of the Nantucket County median household income; to maintain Nantucket's diversity and unique sense of community; to encourage moderate-income families to continue to reside on Nantucket; and to generate a supply of housing that will remain affordable.

(2) Definitions. The following definitions only apply to this § **139-8C**:

**HOUSING AUTHORITY**

The Nantucket Housing Authority (NHA) or its designee.

**MAXIMUM RENTAL PRICE**

Shall be no more than the fair market rent established for Nantucket County as published by the U.S. Department of Housing and Urban Development in Federal Register, Vol. 65 No. 185 (September 25, 2000) and as may hereafter be amended from time to time.

**MAXIMUM RESALE PRICE**

The greater of the maximum sales price or price the current Nantucket Housing Needs Covenant unit owner paid for the Nantucket Housing Needs Covenant unit.

**MAXIMUM SALES PRICE**

Shall be calculated by assuming a ten-percent down payment and an annual debt service (at prevailing thirty-year fixed interest rates) that is equal to 30% of the gross annual income of a household earning up to 125% of median income.

**MEDIAN INCOME**

Median family income for Nantucket County as published from time to time by the U.S. Department of Housing and Urban Development.

**NANTUCKET HOUSING NEEDS COVENANT**

A covenant placed on housing, which property owners choose to execute and which shall be enforceable by the NHA, to be recorded in the Registry of Deeds or the Land Court Registry District.

**PRINCIPAL RESIDENCE**

The locality where a person resides with the present intent to make it the person's fixed and permanent home. The person's physical presence alone will not establish a principal residence. In ascertaining one's intent, the Housing Authority shall consider, among other things, the person's employment status, voter registration, driver's license, motor vehicle registration, real property ownership, income tax returns, or the filing with the Housing Authority of a written declaration to establish or maintain a principal residence.

**QUALIFIED PURCHASER HOUSEHOLD**

A household whose gross annual income is less than 150% of median income.

**QUALIFIED RENTER HOUSEHOLD**

A household whose gross annual income is not more than 100% of median income.

(3) General requirements.

(a) Housing subject to the Nantucket Housing Needs Covenant shall be:

[1] Occupied by a qualified renter or qualified purchaser household.

[2] The principal residence of the qualified renter or qualified purchaser household.

[3] Enforceable for the greater of 99 years or the maximum time period allowable by law.

[4] The price of the unit shall not exceed the maximum sales price, or, in the case of resale, the maximum resale price.

[5] The unit rent shall not exceed the maximum rental price.

[6] The owner of a unit being rented shall provide the Housing Authority with an annual certification of compliance with the terms of the covenant.

(4) Monitoring and administration.

(a) The Housing Authority shall monitor and administer the Nantucket Housing Needs Program and may promulgate rules and regulations to implement it. Prior to promulgating such rules and regulations and prior to completing a model Nantucket Housing Needs Covenant, the Housing Authority shall hold a public hearing or hearings to solicit advice from the public. The Housing Authority shall publish notice of these hearings prominently in a newspaper of general circulation on Nantucket for two successive weeks.

(b) All legal documentation shall be submitted to the Housing Authority for review and approval.

C. Special permit to create secondary residential lots for year-round residents.

(1) Purpose: to create, make available and maintain housing that is affordable to those who earn at or below 150% of the Nantucket County median household income; to help those people or households to continue to reside on Nantucket if they wish to do so; to generate and preserve affordable housing in the Town of Nantucket in perpetuity, all in order to maintain Nantucket's diversity and unique sense of community.

(2) As authorized by MGL c. 40A, § 9, Paragraph 2, the Planning Board as special permit granting authority, in its discretion, pursuant to and subject to this § 139-8D, may issue a special permit, with conditions, authorizing the division of the original lot into a primary lot and a secondary lot, which special permit may include approval and endorsement of a plan not requiring approval under the Subdivision Control Law as such plan is defined and described in MGL c. 41, § 81P, provided the following requirements and/or conditions shall

apply to all applications for relief hereunder and all special permits granted hereunder, as the case may be:

(a) The original lot shall not be subject to any covenants, restrictions or similar encumbrances, whether appearing in a deed, easement, land-use permit or any other instrument, pertaining to the placement, use or occupancy of second dwellings on said original lot.

(b) The secondary lot shall be subject to an NHNC-Ownership Form, which shall provide, without limitation, that the owner of the secondary lot, and any occupant of any dwelling erected thereon, shall earn at or below 150% of the Nantucket County median household income.

(c) No more than one dwelling shall be permitted on the primary lot.

(d) No more than one dwelling shall be permitted on the secondary lot.

(e) The minimum area for the original lot, the primary lot and the secondary lot shall be as follows:

| Zoning District | Minimum Original Lot Size (§ 139-16A) | Minimum Secondary Lot Size | Minimum Primary Lot Size |
|---|---|---|---|
| LUG-1 | 40,000 | 15,000 | 25,000 |
| LUG-2 | 80,000 | 25,000 | 55,000 |
| LUG-3 | 120,000 | 35,000 | 85,000 |
| R-40 | 40,000 | 15,000 | 25,000 |
| R-10 | 10,000 | 4,000 | 6,000 |
| R-20/SR-20 | 20,000 | 8,000 | 12,000 |
| VR | 20,000 | 8,000 | 12,000 |
| R-1/SR-1 | 5,000 | 2,000 | 3,000 |
| ROH/SOH | 5,000 | 2,000 | 3,000 |
| RC | 5,000 | 2,000 | 3,000 |
| RC-2 | 5,000 | 2,000 | 3,000 |
| LC | 5,000 | 2,000 | 3,000 |
| R-5 | 5,000 | 2,000 | 3,000 |

(f) The primary lot and the secondary lot shall comply with the ground cover, front setback, side setback and rear setback requirements of the underlying zoning district, with the exception that the ground cover ratio solely for a secondary lot in the R-1 Zoning District shall be 36%. The Planning Board may waive the setback requirements only as they apply to the lot line(s) between the primary and secondary lot.

(g) The primary lot and the secondary lot each must have a minimum of 20 feet of frontage or an easement of sufficient width and grade to provide access.

(h) The primary lot and the secondary lot shall share a single driveway access. The Planning Board must be provided with an instrument, in recordable form, evidencing the common access rights to said access in accordance with this subsection.

(3) This § 139-8D shall not apply to major commercial developments (§ **139-11**); cluster developments (§ **139-8A**); major residential developments (§ **139-8B**); and are not permitted in the following zoning districts: Commercial Downtown (CDT); Moorlands Management (MMD); Special Academy Hill (AHD); Special Our Island Home (OIH); and Assisted/Independent Living Community District (ALC).

(4) The Planning Board may grant a special permit for the division of a duplex into two attached single-family dwellings, provided that one of the dwellings is subject to a NHNC covenant. Subsection D(2)(e) and (f) above shall not apply and the Planning Board shall establish minimum lot size, ground cover ratio, and setbacks during the special permit review. Ground cover ratios for the primary and secondary lot combined shall not exceed the maximum allowed in the underlying zoning district.

(5) Section **139-16D**, Regularity formula, shall not apply to this § 139-8D.

[1]: *Editor's Note: This enactment also repealed former § 139-8, Residential Districts R-1, R-10, SR-2 and ROH and Residential Commercial Districts RC, RC-2, CDT, CN, CTEC and LC, as amended.*

# APPENDIX C: MASSACHUSETTS ESTUARIES REPORTS SUMMARIES

# MASSACHUSETTS ESTUARIES TECHNICAL MEMORANDUMS ON MODEL RUN SCENARIOS

# TOTAL MAXIMUM DAILY LOADS

# LANDFILL BACKUP DATA

University of Massachusetts Dartmouth
The School for Marine Science and Technology

Massachusetts Department of Environmental Protection

# Massachusetts Estuaries Project

# Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Nantucket Harbor Nantucket, Massachusetts

# Executive Summary

## 1. Background

This report presents the results generated from the implementation of the Massachusetts Estuaries Project's Linked Watershed-Embayment Approach to the Nantucket Harbor embayment system, a coastal embayment of the Island of Nantucket within the Town of Nantucket, Massachusetts. Analyses of the Nantucket Harbor embayment system was performed to assist the Town with up-coming nitrogen management decisions associated with the Towns' current and future wastewater planning efforts, as well as wetland restoration, anadromous fish runs, shell fishery, open-space, and harbor maintenance programs. As part of the MEP approach, habitat assessment was conducted on the embayment based upon available water quality monitoring data, historical changes in eelgrass distribution, time-series water column oxygen measurements, and benthic community structure. Nitrogen loading thresholds for use as goals for watershed nitrogen management are the major product of the MEP effort. In this way, the MEP offers a science-based management approach to support the Town of Nantucket resource planning and decision-making process. The primary products of this effort are: (1) a current quantitative assessment of the nutrient related health of the Nantucket Harbor embayment, (2) identification of all nitrogen sources (and their respective N loads) to embayment waters, (3) nitrogen threshold levels for maintaining Massachusetts Water Quality Standards within embayment waters, (4) analysis of watershed nitrogen loading reduction to achieve the N threshold concentrations in embayment waters, and (5) a functional calibrated and validated Linked Watershed-Embayment modeling tool that can be readily used for evaluation of nitrogen management alternatives (to be developed by the Town) for the restoration of the Nantucket Harbor embayment system.

***Wastewater Planning:*** As increasing numbers of people occupy coastal watersheds, the associated coastal waters receive increasing pollutant loads. Coastal embayments throughout the Commonwealth of Massachusetts (and along the U.S. eastern seaboard) are becoming nutrient enriched. The elevated nutrients levels are primarily related to the land use impacts associated with the increasing population within the coastal zone over the past half-century.

The regional effects of both nutrient loading and bacterial contamination span the spectrum from environmental to socio-economic impacts and have direct consequences to the

culture, economy, and tax base of Massachusetts's coastal communities. The primary nutrient causing the increasing impairment of our coastal embayments is nitrogen, with its primary sources being wastewater disposal, and nonpoint source runoff that carries nitrogen (e.g. fertilizers) from a range of other sources. Nitrogen related water quality decline represents one of the most serious threats to the ecological health of the nearshore coastal waters. Coastal embayments, because of their shallow nature and large shoreline area, are generally the first coastal systems to show the effect of nutrient pollution from terrestrial sources.

In particular, the Nantucket Harbor embayment system within the Town of Nantucket is at risk of eutrophication (over enrichment) from enhanced nitrogen loads entering through groundwater from the increasingly developed watershed to this coastal system. Eutrophication is a process that occurs naturally and gradually over a period of tens or hundreds of years. However, human-related (anthropogenic) sources of nitrogen may be introduced into ecosystems at an accelerated rate that cannot be easily absorbed, resulting in a phenomenon known as cultural eutrophication. In both marine and freshwater systems, cultural eutrophication results in degraded water quality, adverse impacts to ecosystems, and limits on the use of water resources.

The relatively pristine nature of Nantucket's nearshore and Harbor waters has historically been a valuable asset to the island. However, concern over the potential degradation of Harbor water quality began to arise, which resulted in monitoring, scientific investigations and management planning which continues to this day. Nantucket Harbor is one of the largest enclosed bays in southeastern Massachusetts and one of the few with a relatively high water quality capable of supporting significant high quality ecological habitats, such as eelgrass beds, and sustain a scallop fishery. Ironically, it is the pristine nature of this system which may indirectly threaten its ecological health as the coastal waters throughout Southeastern New England become increasingly degraded and the pressure for access and development of remaining high quality environments increases. The Town of Nantucket and work groups have long ago recognized that a rigorous scientific approach yielding site-specific nitrogen loading targets was required for decision-making, alternatives analysis and ultimately, habitat protection. The completion of this multi-step process has taken place under the programmatic umbrella of the Massachusetts Estuaries Project, which is a partnership effort between all MEP collaborators and the Town. The modeling tools developed as part of this program provide the quantitative information necessary for the Towns' nutrient management groups to predict the impacts on water quality from a variety of proposed management scenarios.

***Nitrogen Loading Thresholds and Watershed Nitrogen Management:*** Realizing the need for scientifically defensible management tools has resulted in a focus on determining the aquatic system's assimilative capacity for nitrogen. The highest-level approach is to directly link the watershed nitrogen inputs with embayment hydrodynamics to produce water quality results that can be validated by water quality monitoring programs. This approach when linked to state-of-the-art habitat assessments yields accurate determination of the "allowable N concentration increase" or "threshold nitrogen concentration". These determined nitrogen concentrations are then directly relatable to the watershed nitrogen loading, which also accounts for the spatial distribution of the nitrogen sources, not just the total load. As such, changes in nitrogen load from differing parts of the embayment watershed can be evaluated relative to the degree to which those load changes drive embayment water column nitrogen concentrations toward the "threshold" for the embayment system. To increase certainty, the "Linked" Model is independently calibrated and validated for each embayment.

***Massachusetts Estuaries Project Approach:*** The Massachusetts Department of Environmental Protection (DEP), the University of Massachusetts – Dartmouth School of Marine Science and Technology (SMAST), and others including the Cape Cod Commission (CCC) have undertaken the task of providing a quantitative tool to communities throughout southeastern Massachusetts (the Linked Watershed-Embayment Management Model) for nutrient management in their coastal embayment systems. Ultimately, use of the Linked Watershed-Embayment Management Model tool by municipalities in the region results in effective screening of nitrogen reduction approaches and eventual restoration and protection of valuable coastal resources. The MEP provides technical guidance in support of policies on nitrogen loading to embayments, wastewater management decisions, and establishment of nitrogen Total Maximum Daily Loads (TMDLs). A TMDL represents the greatest amount of a pollutant that a waterbody can accept and still meet water quality standards for protecting public health and maintaining the designated beneficial uses of those waters for drinking, swimming, recreation and fishing. The MEP modeling approach assesses available options for meeting selected nitrogen goals that are protective of embayment health and achieve water quality standards.

The core of the Massachusetts Estuaries Project analytical method is the Linked Watershed-Embayment Management Modeling Approach, which links watershed inputs with embayment circulation and nitrogen characteristics.

The Linked Model builds on well-accepted basic watershed nitrogen loading approaches such as those used in the Buzzards Bay Project, the CCC models, and other relevant models. However, the Linked Model differs from other nitrogen management models in that it:

- requires site-specific measurements within each watershed and embayment;
- uses realistic "best-estimates" of nitrogen loads from each land-use (as opposed to loads with built-in "safety factors" like Title 5 design loads);
- spatially distributes the watershed nitrogen loading to the embayment;
- accounts for nitrogen attenuation during transport to the embayment;
- includes a 2D or 3D embayment circulation model depending on embayment structure;
- accounts for basin structure, tidal variations, and dispersion within the embayment;
- includes nitrogen regenerated within the embayment;
- is validated by both independent hydrodynamic, nitrogen concentration, and ecological data;
- is calibrated and validated with field data prior to generation of "what if" scenarios.

The Linked Model Approach's greatest assets are its ability to be clearly calibrated and validated, and its utility as a management tool for testing "what if" scenarios for evaluating watershed nitrogen management options.

For a comprehensive description of the Linked Model, please refer to the *Full Report: Nitrogen Modeling to Support Watershed Management: Comparison of Approaches and Sensitivity Analysis*, available for download at http://www.state.ma.us/dep/smerp/smerp.htm. A more basic discussion of the Linked Model is also provided in Appendix F of the *Massachusetts Estuaries Project Embayment Restoration Guidance for Implementation Strategies*, available for download at http://www.state.ma.us/dep/smerp/smerp.htm. The Linked Model suggests which management solutions will adequately protect or restore embayment water quality by enabling towns to test specific management scenarios and weigh the resulting water quality impact against the cost of that approach. In addition to the management scenarios modeled for this report, the Linked Model can be used to evaluate additional management scenarios and may be

updated to reflect future changes in land-use within an embayment watershed or changing embayment characteristics. In addition, since the Model uses a holistic approach (the entire watershed, embayment and tidal source waters), it can be used to evaluate all projects as they relate directly or indirectly to water quality conditions within its geographic boundaries. Unlike many approaches, the Linked Model accounts for nutrient sources, attenuation, and recycling and variations in tidal hydrodynamics and accommodates the spatial distribution of these processes. For an overview of several management scenarios that may be employed to restore embayment water quality, see *Massachusetts Estuaries Project Embayment Restoration Guidance for Implementation Strategies*, available for download at http://www.state.ma.us/dep/smerp/smerp.htm.

***Application of MEP Approach:*** The Linked Model was applied to the Nantucket Harbor embayment system by using site-specific data collected by the MEP and water quality data from the Water Quality Monitoring Program conducted by the Nantucket Marine Department, with technical guidance from the Coastal Systems Program at SMAST (see Section II). Evaluation of upland nitrogen loading was conducted by the MEP. Estuaries Project staff obtained digital parcel and tax assessors data from the Town of Nantucket Geographic Information Systems Department, watershed specific water use data from the Wannacomet Water Company (WWC) and watershed boundaries adopted by the town as the Harbor Watershed Protection District (http://www.nantucket-ma.gov). During the development of the Nantucket Water Resources Management Plan, an island-wide groundwater mapping project, using many of the USGS wells on the Island, was completed to characterize the water table configuration of Nantucket (Horsley, Whittan, Hegeman, 1990). Estuary watershed delineations completed in areas with relatively transmissive sand and gravel deposits, like most of Cape Cod and the Islands, have shown that watershed boundaries are usually better defined by elevation of the groundwater and its direction of flow, rather than by land surface topography (Cambareri and Eichner 1998, Millham and Howes 1994a,b). This approach was used by Horsley, Whittan and Hegeman, Inc. (HWH) to complete a watershed delineation for Nantucket Harbor (Section III); this watershed delineation was been largely confirmed by subsequent water table characterizations (*e.g.*, Lurbano, 2001, Gardner and Vogel, 2005). MEP staff compared the HWH Harbor watershed to a 2004 aerial base map. This comparison found some slight discrepancies likely based on a better characterization of the shoreline; changes were made based on best professional judgment and watershed/water table characterization experience in similar geologic settings

The land-use data obtained from the Town was used to determine watershed nitrogen loads within the Nantucket Harbor embayment system and each of the systems sub-embayments as appropriate (current and build-out loads are summarized in Section IV). Water quality within a sub-embayment is the integration of nitrogen loads with the site-specific estuarine circulation. Therefore, water quality modeling of this tidally influenced estuary included a thorough evaluation of the hydrodynamics of the estuarine system. Estuarine hydrodynamics control a variety of coastal processes including tidal flushing, pollutant dispersion, tidal currents, sedimentation, erosion, and water levels. Once the hydrodynamics of the system was quantified, transport of nitrogen was evaluated from tidal current information developed by the numerical models.

A two-dimensional depth-averaged hydrodynamic model based upon the tidal currents and water elevations was employed for the Nantucket Harbor embayment system. Once the hydrodynamic properties of the estuarine system were computed, two-dimensional water quality model simulations were used to predict the dispersion of the nitrogen at current loading rates. Using standard dispersion relationships for estuarine systems of this type, the water quality model and the hydrodynamic model was then integrated in order to generate estimates

regarding the spread of total nitrogen from the site-specific hydrodynamic properties. The distributions of nitrogen loads from watershed sources were determined from land-use analysis. Boundary nutrient concentrations in Nantucket Sound source waters were taken from water quality monitoring data. Measurements of current salinity distributions throughout the estuarine waters of the Nantucket Harbor embayment system was used to calibrate the water quality model, with validation using measured nitrogen concentrations (under existing loading conditions). The underlying hydrodynamic model was calibrated and validated independently using water elevations measured in time series throughout the embayments.

***MEP Nitrogen Thresholds Analysis:*** The threshold nitrogen level for an embayment represents the average water column concentration of nitrogen that will support the habitat quality being sought. The water column nitrogen level is ultimately controlled by the watershed nitrogen load and the nitrogen concentration in the inflowing tidal waters (boundary condition). The water column nitrogen concentration is modified by the extent of sediment regeneration. Threshold nitrogen levels for the embayment systems in this study were developed to restore or maintain SA waters or high habitat quality. High habitat quality was defined as supportive of eelgrass and infaunal communities. Dissolved oxygen and chlorophyll a were also considered in the assessment.

The nitrogen thresholds developed in Section VIII-2 were used to determine the amount of total nitrogen mass loading reduction required for restoration of eelgrass and infaunal habitats in the Nantucket Harbor system. Tidally averaged total nitrogen thresholds derived in Section VIII.1 were used to adjust the calibrated constituent transport model developed in Section VI. Watershed nitrogen loads were sequentially lowered, using reductions in septic effluent discharges only, until the nitrogen levels reached the threshold level at the sentinel station chosen for the Nantucket Harbor system. It is important to note that load reductions can be produced by reduction of any or all sources or by increasing the natural attenuation of nitrogen within the freshwater systems to the embayment. The load reductions presented below represent only one of a suite of potential reduction approaches that need to be evaluated by the community. The presentation is to establish the general degree and spatial pattern of reduction that will be required for protection/restoration of this nitrogen threatened embayment.

The Massachusetts Estuaries Project's thresholds analysis, as presented in this technical report, provides the site-specific nitrogen reduction guidelines for nitrogen management of the Nantucket Harbor embayment system in the Town of Nantucket. Future water quality modeling scenarios should be run which incorporate the spectrum of strategies that result in nitrogen loading reduction to the embayment. The MEP analysis has initially focused upon nitrogen loads from on-site septic systems as a test of the potential for achieving the level of total nitrogen reduction for restoration of the embayment system. The concept was that since septic system nitrogen loads generally represent 28% - 53% of the controllable watershed load to the Nantucket Harbor embayment system and are more manageable than other of the nitrogen sources, the ability to achieve needed reductions through this source is a good gauge of the feasibility for protection/restoration of the system.

## 2. Problem Assessment (Current Conditions)

A habitat assessment was conducted throughout the Nantucket Harbor system based upon available water quality monitoring data, historical changes in eelgrass distribution, time-series water column oxygen measurements, and benthic community structure. At present, the Nantucket Harbor System is showing variations in nitrogen enrichment among its 4 principal component basins. The inner basins of Head of the Harbor and Polpis Harbor are nitrogen

enriched over Quaise and the Town basins. Although the component basins of the Nantucket Harbor System are clearly enriched in nitrogen over the adjacent Nantucket Sound waters, the enrichment is relatively small, generally <0.100 mg $L^{-1}$ (see Chapter VI).

The effect of nitrogen enrichment is to cause oxygen depletion; however, with increased phytoplankton (or epibenthic algae) production, oxygen levels will rise in daylight to above atmospheric equilibration levels in shallow systems (generally ~7-8 mg $L^{-1}$ at the mooring sites). Overall, oxygen within the Harbor bottom waters appears to remain at ecologically healthy levels, except for periodic oxygen depletion within the deepest portions of the Quaise and Wauwinet basins. However, as there were some oxygen depletions below 5 mg L-1 in the main basins (although infrequent), it appears that the system is at or just beyond it ability to assimilate additional nitrogen/organic matter.

Within the highly flushed and generally well mixed waters of the lower basins of Nantucket Harbor, bottom waters were well oxygenated (>6mg $L^{-1}$). The few excursions below 6 mg $L^{-1}$ were isolated events, rather than a prolonged depletion such as generally associated with a phytoplankton bloom. However, these variations were small and overall the oxygen conditions are consistent with the observations of healthy infaunal and eelgrass communities. While Polpis Harbor also exhibited well oxygenated conditions, larger diurnal variations were recorded than in the outer basins. The higher diurnal fluctuations indicate waters supporting higher phytoplankton biomass. Quaise basin showed both significant diurnal oxygen fluctuations and an overall oxygen decline, although not to levels of high stress. There was a single "event" of a few days when each night oxygen levels reached 4 mg/L, but returned to ~5 mg $L^{-1}$ each following day. Since the meter was located deeper within the basin (~6 m), oxygen levels throughout most of the basin area were almost certainly higher given their shallower depths, only in the "deep hole" was oxygen depletion likely greater. Assessing oxygen conditions within the Quaise basin indicates generally non-stressful oxygen levels, except for the deep basin. However, it is likely that the presence of the deep hole (~30') creates a geomorphological (natural) cause of the low dissolved oxygen. Head of the Harbor showed generally high oxygen levels. As in the Quaise basin, the meter was deeper in the basin and observed oxygen depletions were greater than experienced by bottom waters throughout most of the basin area. The oxygen conditions are consistent with the observed distribution of habitat quality throughout the Harbor System, with the deep waters showing oxygen depletion, but with oxygen levels generally supportive of a high habitat quality for infauna. However, since the system does show oxygen levels less than full atmospheric saturation, additional organic matter loads, (e.g. through nitrogen inputs) will likely increase the magnitude and frequency of the oxygen declines, again indicating a system at or just beyond its nitrogen assimilative capacity (nitrogen threshold)

Based upon all available data it appears that eelgrass is presently a widespread critical habitat within the Nantucket Harbor System. The present distribution of eelgrass results from recolonization of the Harbor from its loss in the 1930's. A map of eelgrass from the 1940's "shows it to be primarily confined to parts of the Jetties and Horse shed at the Harbor entrance (Kelley 1989). Kelley (1989) concluded that from the 1960's to 1989, "eelgrass distribution has been relatively stable in Nantucket Harbor...". However, it is clear that eelgrass beds have been lost from this System. Both the MassDEP analysis and the direct observations of Kelley in 1989 indicated that there has been measurable eelgrass loss. The primary locations are within Head of the Harbor and East Polpis Harbor. The other major region experiencing gradual losses, the marginal areas of Head of the Harbor, is supported by both Kelley (1989) and the MassDEP survey data. This larger areal loss appears to be gradual and occurring primarily in the least well flushed areas of this basin (note the counterclockwise circulation). Eelgrass loss has also been noted to the west of Pocomo, which was observed in the 1980 surveys and more recently

in changes from 1995-2001. It is important to note that the eelgrass bed loss is both from the shallow area of the upper and mid regions of Head of the Harbor (<8' depth) and from the "deeper" areas (8'-12') in the lower reach and from the shallow east basin of Polpis. The data indicate that that on the order of 1000 acres of eelgrass habitat within the Nantucket Harbor System is impaired.

It is important to note that the nitrogen levels throughout the Nantucket Harbor System remain relatively low, consistent with the observed oxygen conditions, lack of macroalgae and chlorophyll a levels. However, due to the water depth in the Harbor, it is possible that vertical and horizontal mixing rates appear to have resulted in a decline in eelgrass bed coverage from the deeper areas and more enclosed basin areas.

Macro-algal abundance within the Harbor surveyed in 1994 (Harbor Study 1997) was typical of a relatively healthy environment. Algal cover was highest on the Nantucket Sound side between the points of Coatue (Figure VII-10). The highest concentrations of macro-algae were consistent with the circulation patterns associated with the cusps of land present around the Harbor edge. It also appears that the macro-algal accumulations are not related to terrestrial nitrogen inputs, since the "island" side of the Harbor, which dominates the land based loadings, had lower algal accumulations than Coatue. The absence of macroalgal accumulations and drift algae is consistent with the generally low nitrogen levels throughout this System and the relatively low watershed nitrogen input.

The infaunal data clearly show that the lower basins and shallower areas (<12') of the main Harbor basins generally support high quality infaunal habitat. The lowermost basin (Town) exhibited a dense, highly diverse and relatively evenly distributed community, with some variation. The shallower margins of both Quaise and Head of the Harbor were only slightly less diverse than areas nearer the tidal inlet, but were clearly of high quality. This is further evidenced by the growth of epibenthic scallops in these areas. Within the main Harbor basins, only the deep "holes" showed reduced numbers of species and individuals and organic enrichment indicators. This indication of moderate to poor habitat in these deep regions is consistent with previous analyses and supported by the observed accumulations of organic detritus in these natural depositional areas. It is unlikely that management of nitrogen loading will be able to create significant improvement within these deep basin regions and it is likely that these areas have been "stressed" by natural processes for a long time.

Overall, the MEP system-wide infaunal survey found higher numbers of species and individuals in communities that were generally more diverse and evenly distributed than the other 20 embayments examined to date by the MEP in southeastern Massachusetts. This is consistent with the relatively low tidally averaged nitrogen levels within the system, <0.40 mg N L-1 and generally 0.285-0.361 mg N $L^{-1}$.

## 3. Conclusions of the Analysis

The threshold nitrogen level for an embayment represents the average watercolumn concentration of nitrogen that will support the habitat quality being sought. The watercolumn nitrogen level is ultimately controlled by the integration of the watershed nitrogen load, the nitrogen concentration in the inflowing tidal waters (boundary condition) and dilution and flushing via tidal flows. The water column nitrogen concentration is modified by the extent of sediment regeneration and by direct atmospheric deposition.

Threshold nitrogen levels for this embayment system were developed to restore or maintain SA waters or high habitat quality. In this system, high habitat quality was defined as supportive of eelgrass and supportive of diverse benthic animal communities. Dissolved oxygen and chlorophyll *a* were also considered in the assessment.

Watershed nitrogen loads (Tables ES-1 and ES-2) for the Town of Nantucket, Nantucket Harbor embayment system was comprised primarily of runoff from impervious surfaces, fertilizers and wastewater nitrogen. Land-use and wastewater analysis found that generally about 28% - 53% of the controllable watershed nitrogen load to the embayment was from wastewater.

A major finding of the MEP clearly indicates that a single total nitrogen threshold can not be applied to Massachusetts' estuaries, based upon the results of the Great, Green and Bournes Pond Systems, Popponesset Bay System, the Hamblin / Jehu Pond / Quashnet River analysis in eastern Waquoit Bay, the analysis of the adjacent Rushy Marsh system and the Pleasant Bay and Nantucket Sound embayments associated with the Town of Chatham. This is almost certainly going to be true for the other embayments within the MEP area, as well.

The threshold nitrogen levels for the Nantucket Harbor embayment system in Nantucket were determined as follows:

***Nantucket Harbor Threshold Nitrogen Concentrations***

- Following the MEP protocol, the restoration target for the Nantucket Harbor system should reflect both recent pre-degradation habitat quality and be reasonably achievable. Determination of the critical nitrogen threshold for maintaining high quality habitat within the Nantucket Harbor Estuarine System is based primarily upon the nutrient and oxygen levels, temporal trends in eelgrass distribution and current benthic community indicators. The Nantucket Harbor System is presently supportive of infaunal habitat throughout its main basins, but is clearly impaired by nitrogen enrichment within the Head of the Harbor basin and in the eastern basin of Polpis Harbor, based upon eelgrass losses. Given the documented importance of eelgrass habitat to these basins and the demonstrable loss of eelgrass that were supported, eelgrass restoration in these basins was set as the primary nitrogen management goal for the overall System. Due to the semi-isolated nature of Polpis Harbor from Nantucket Harbor, it is necessary to establish 2 sentinel stations for eelgrass, one in the Head of the Harbor and one in the east basin of Polpis Harbor (e.g. where eelgrass had been observed in 1951-1989).

- It is important to note that the nitrogen levels throughout the Nantucket Harbor System remain relatively low, consistent with the oxygen conditions, lack of macroalgae and chlorophyll a levels. However, the water depth of the Harbor and possibly vertical and horizontal mixing rates appear to have resulted in a decline in eelgrass bed coverage from the deeper areas and more enclosed basin areas. While eelgrass was only recently lost from the east basin of Polpis Harbor, it is presently absent at a tidally average total nitrogen (TN) level of 0.361 mg N L-1. Loss at this nitrogen level is consistent with observed losses in West Falmouth Harbor above 0.350 mg N L-1, however, given the shallower depth of Polpis Harbor, it is likely that it is just slightly above its threshold level at present. Similarly, tidally averaged levels in the lower reach of Head of the Harbor (0.340-0.353) and mid and upper reach (0.390 mg N L-1) also suggest that the recent bed losses are from a recent exceedance of the supportive nitrogen threshold. Given all of the factors discussed above and the similarity of Head of

the Harbor to conditions in West Falmouth and Phinneys Harbors and its present nitrogen levels, a nitrogen threshold of 0.350 mg N L-1 was determined to be supportive of eelgrass habitat in this system. This threshold should also support eelgrass in the shallower regions as well. As the east basin of Polpis Harbor has only recently lost its eelgrass and is presently 0.361 mg N L-1, but has shallower waters than Head of the Harbor, only a slight reduction over present levels appears to be needed to support eelgrass habitat. Clearly the threshold must be lower than the present 0.361 mg N $L^{-1}$ and higher than that for Head of the Harbor (0.350 mg N $L^{-1}$). Therefore, a threshold of 0.355 mg N L-1 was set for the sentinel station in Polpis Harbor. It should be noted that the Polpis Harbor threshold is well constrained by the available data, but is at the limits of the sensitivity of the MEP approach.

It is important to note that the analysis of future nitrogen loading to the Nantucket Harbor estuarine system focuses upon additional shifts in land-use from forest/grasslands to residential and commercial development. However, the MEP analysis indicates that increases in nitrogen loading can occur under present land-uses, due to shifts in occupancy, shifts from seasonal to year-round usage and increasing use of fertilizers. Therefore, watershed-estuarine nitrogen management must include management approaches to prevent increased nitrogen loading from both shifts in land-uses (new sources) and from loading increases of current land-uses. The overarching conclusion of the MEP analysis of the Nantucket Harbor estuarine system is that protection/restoration will necessitate a reduction in the present (2003) nitrogen inputs and management options to negate additional future nitrogen inputs.

Table ES-1. Existing total and sub-embayment nitrogen loads to the estuarine waters of the Nantucket Harbor system, observed nitrogen concentrations, and sentinel system threshold nitrogen concentrations. Loads to estuarine waters of the Nantucket Harbor system include both upper watershed regions contributing to the major surface water inputs.

| Sub-embayments | Natural Background Watershed Load [1] (kg/day) | Present Land Use Load [2] (kg/day) | Present Septic System Load (kg/day) | Present WWTF Load [3] (kg/day) | Present Watershed Load [4] (kg/day) | Direct Atmospheric Deposition [5] (kg/day) | Present Net Benthic Flux (kg/day) | Present Total Load [6] (kg/day) | Observed TN Conc. [7] (mg/L) | Threshold TN Conc. [8] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| ***NANTUCKET HARBOR SYSTEM*** | | | | | | | | | | |
| Head of the Harbor | 0.526 | 1.152 | 0.705 | 0.000 | 1.858 | 22.239 | -17.211 | 6.886 | 0.34-0.41 | -- |
| Polpis Harbor | 1.836 | 3.094 | 0.435 | 0.000 | 3.529 | 2.190 | 27.441 | 33.160 | 0.36-0.39 | -- |
| Quaise Basin | 0.896 | 1.731 | 0.392 | 0.000 | 2.123 | 20.126 | 43.896 | 66.145 | 0.34 | -- |
| Town Basin | 1.321 | 10.708 | 5.194 | 0.000 | 15.901 | 13.888 | -2.793 | 26.997 | 0.30-0.34 | -- |
| **Nantucket Harbor System Total** | 4.578 | 16.685 | 6.726 | 0.000 | 23.411 | 58.443 | 51.333 | 133.187 | **0.30-0.41** | **0.355** |

[1] assumes entire watershed is forested (i.e., no anthropogenic sources)
[2] composed of non-wastewater loads, e.g. fertilizer and runoff and natural surfaces and atmospheric deposition to lakes
[3] existing unattenuated wastewater treatment facility discharges to groundwater
[4] composed of combined natural background, fertilizer, runoff, and septic system loadings
[5] atmospheric deposition to embayment surface only.
[6] composed of natural background, fertilizer, runoff, septic system atmospheric deposition and benthic flux loadings
[7] average of data collected between 1988 and 2005, ranges show the upper to lower regions (highest-lowest) of a sub-embayment.
[8] Eel grass threshold for sentinel site located at Polpis Harbor.

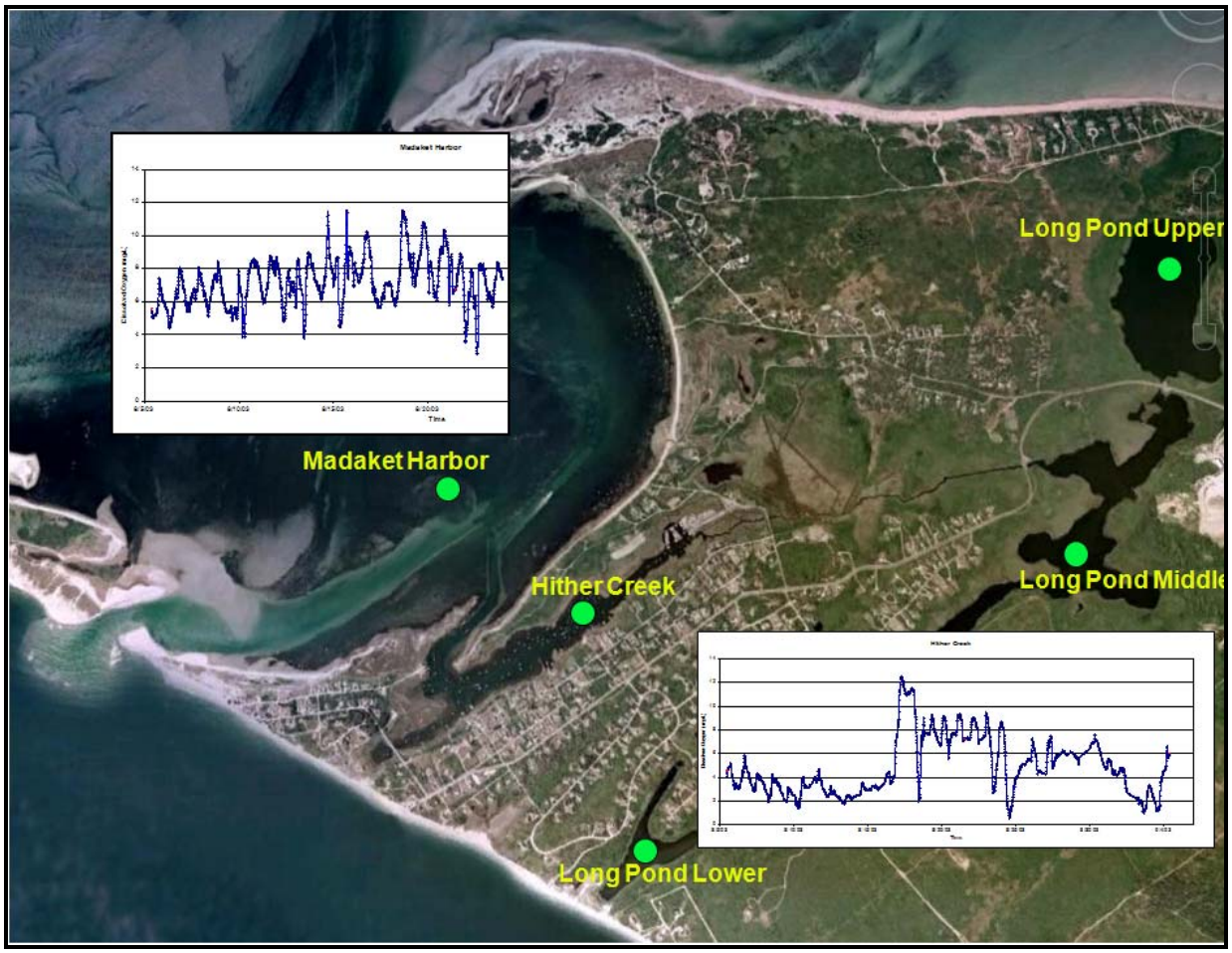
Table ES-2. Present Watershed Loads, Thresholds Loads, and the percent reductions necessary to achieve the Thresholds Loads for the Nantucket Harbor system. Two threshold scenarios are presented for the Harbor: Scenario A (**N1**) with 100% removal of septic load from the Town watershed together with 80% removal of anthropogenic watershed loads (septic, fertilizer and non-pervious surfaces) from the remaining three Harbor watersheds; and Scenario B (**N2**) with the removal of 100% of septic loads from all four of the Harbor Watersheds.

| Sub-embayments | Present Watershed Load [1] (kg/day) | Target Threshold Watershed Load [2] (kg/day) | Direct Atmospheric Deposition (kg/day) | Benthic Flux Net [3] (kg/day) | TMDL [4] (kg/day) | Percent watershed reductions needed to achieve threshold load levels |
|---|---|---|---|---|---|---|
| ***NANTUCKET HARBOR SYSTEM*** | | | | | | |
| Head of the Harbor | 1.858 | N1: 0.792<br>N2: 1.153 | 22.239 | N1: -16.795<br>N2: -17.182 | N1: 6.235<br>N2: 6.210 | N1: -57.4%<br>N2: -37.9% |
| Polpis Harbor | 3.529 | N1: 2.175<br>N2: 3.093 | 2.190 | N1: 26.450<br>N2: 26.655 | N1: 30.816<br>N2: 31.939 | N1: -38.4%<br>N2: -12.3% |
| Quaise Basin | 2.123 | N1: 1.140<br>N2: 1.732 | 20.126 | N1: 43.010<br>N2: 42.885 | N1: 64.276<br>N2: 64.743 | N1: -46.3%<br>N2: -18.5% |
| Town Basin | 15.901 | N1: 10.707<br>N2: 10.707 | 13.888 | N1: -2.892<br>N2: -2.892 | N1: 21.702<br>N2: 21.702 | N1: -32.7%<br>N2: -32.7% |
| **Nantucket Harbor System Total** | 23.411 | N1: 14.814<br>N2: 16.685 | 58.443 | N1: 49.772<br>N2: 49.466 | N1: 123.029<br>N2: 124.594 | N1: -36.7%<br>N2: -28.7% |

(1) Composed of combined natural background, fertilizer, runoff, and septic system loadings.
(2) Target threshold watershed load is the load from the watershed needed to meet the embayment threshold concentration identified in Table ES-1.
(3) Projected future flux (present rates reduced approximately proportional to watershed load reductions).
(4) Sum of target threshold watershed load, atmospheric deposition load, and benthic flux load.

# Massachusetts Estuaries Project

# Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Madaket Harbor and Long Pond Estuarine System, Town of Nantucket, MA





**University of Massachusetts Dartmouth**
**School of Marine Science and Technology**

**Massachusetts Department of**
**Environmental Protection**


***FINAL REPORT – November 2010***

# Massachusetts Estuaries Project

# Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Madaket Harbor and Long Pond System, Towns of Nantucket, MA

**FINAL REPORT – NOVEMBER 2010**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# Massachusetts Estuaries Project

# Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Madaket Harbor and Long Pond Nantucket, Massachusetts

# Executive Summary

## 1. Background

This report presents the results generated from the implementation of the Massachusetts Estuaries Project's Linked Watershed-Embayment Approach to the Madaket Harbor and Long Pond embayment system, a complex coastal embayment of the Island of Nantucket within the Town of Nantucket, Massachusetts. Analyses of the Madaket Harbor / Long Pond embayment system was performed to assist the Town with up-coming nitrogen management decisions associated with the Towns' current and future wastewater planning efforts, as well as wetland restoration, anadromous fish runs, shell fishery, open-space, and harbor maintenance programs. As part of the MEP approach, habitat assessment was conducted on the embayment based upon available water quality monitoring data, historical changes in eelgrass distribution, time-series water column oxygen measurements, and benthic community structure. Nitrogen loading thresholds for use as goals for watershed nitrogen management are the major product of the MEP effort. In this way, the MEP offers a science-based management approach to support the Town of Nantucket resource planning and decision-making process. The primary products of this effort are: (1) a current quantitative assessment of the nutrient related health of the Madaket Harbor / Long Pond embayment, (2) identification of all nitrogen sources (and their respective N loads) to embayment waters, (3) nitrogen threshold levels for maintaining Massachusetts Water Quality Standards within embayment waters, (4) analysis of watershed nitrogen loading reduction to achieve the N threshold concentrations in embayment waters, and (5) a functional calibrated and validated Linked Watershed-Embayment modeling tool that can be readily used for evaluation of nitrogen management alternatives (to be developed by the Town) for the protection of Madaket Harbor and restoration of Hither Creek and Long Pond.

***Wastewater Planning:*** As increasing numbers of people occupy coastal watersheds, the associated coastal waters receive increasing pollutant loads. Coastal embayments throughout the Commonwealth of Massachusetts (and along the U.S. eastern seaboard) are becoming nutrient enriched. The elevated nutrients levels are primarily related to the land use impacts associated with the increasing population within the coastal zone over the past half-century.

The regional effects of both nutrient loading and bacterial contamination span the spectrum from environmental to socio-economic impacts and have direct consequences to the culture, economy, and tax base of Massachusetts's coastal communities. The primary nutrient causing the increasing impairment of our coastal embayments is nitrogen, with its primary sources being wastewater disposal, and nonpoint source runoff that carries nitrogen (e.g. fertilizers) from a range of other sources. Nitrogen related water quality decline represents one of the most serious threats to the ecological health of the nearshore coastal waters. Coastal embayments, because of their shallow nature and large shoreline area, are generally the first coastal systems to show the effect of nutrient pollution from terrestrial sources.

In particular, the Madaket Harbor / Long Pond embayment system within the Town of Nantucket is at risk of eutrophication (over enrichment) from enhanced nitrogen loads entering through groundwater from the increasingly developed watershed to this coastal system. Eutrophication is a process that occurs naturally and gradually over a period of tens or hundreds of years. However, human-related (anthropogenic) sources of nitrogen may be introduced into ecosystems at an accelerated rate that cannot be easily absorbed, resulting in a phenomenon known as cultural eutrophication. In both marine and freshwater systems, cultural eutrophication results in degraded water quality, adverse impacts to ecosystems, and limits on the use of water resources.

The relatively pristine nature of Nantucket's nearshore and Harbor waters has historically been a valuable asset to the island. However, concern over the potential degradation of Harbor water quality began to arise, which resulted in monitoring, scientific investigations and management planning which continues to this day. Madaket Harbor is one of the largest enclosed bays in southeastern Massachusetts and one of the few with a relatively high water quality capable of supporting significant high quality ecological habitats, such as eelgrass beds. Ironically, it is the pristine nature of this system which may indirectly threaten its ecological health as the coastal waters throughout Southeastern New England become increasingly degraded and the pressure for access and development of remaining high quality environments increases. The Town of Nantucket and work groups have long ago recognized that a rigorous scientific approach yielding site-specific nitrogen loading targets was required for decision-making, alternatives analysis and ultimately, habitat protection. The completion of this multi-step process has taken place under the programmatic umbrella of the Massachusetts Estuaries Project, which is a partnership effort between all MEP collaborators and the Town. The modeling tools developed as part of this program provide the quantitative information necessary for the Towns' nutrient management groups to predict the impacts on water quality from a variety of proposed management scenarios.

***Nitrogen Loading Thresholds and Watershed Nitrogen Management:*** Realizing the need for scientifically defensible management tools has resulted in a focus on determining the aquatic system's assimilative capacity for nitrogen. The highest-level approach is to directly link the watershed nitrogen inputs with embayment hydrodynamics to produce water quality results that can be validated by water quality monitoring programs. This approach when linked to state-of-the-art habitat assessments yields accurate determination of the "allowable N concentration increase" or "threshold nitrogen concentration". These determined nitrogen concentrations are then directly relatable to the watershed nitrogen loading, which also accounts for the spatial distribution of the nitrogen sources, not just the total load. As such, changes in nitrogen load from differing parts of the embayment watershed can be evaluated relative to the degree to which those load changes drive embayment water column nitrogen concentrations toward the "threshold" for the embayment system. To increase certainty, the "Linked" Model is independently calibrated and validated for each embayment.

***Massachusetts Estuaries Project Approach:*** The Massachusetts Department of Environmental Protection (DEP), the University of Massachusetts – Dartmouth School of Marine Science and Technology (SMAST), and others including the Cape Cod Commission (CCC) have undertaken the task of providing a quantitative tool to communities throughout southeastern Massachusetts (the Linked Watershed-Embayment Management Model) for nutrient management in their coastal embayment systems. Ultimately, use of the Linked Watershed-Embayment Management Model tool by municipalities in the region results in effective screening of nitrogen reduction approaches and eventual restoration and protection of valuable coastal resources. The MEP provides technical guidance in support of policies on nitrogen loading to embayments, wastewater management decisions, and establishment of nitrogen Total Maximum Daily Loads (TMDLs). A TMDL represents the greatest amount of a pollutant that a waterbody can accept and still meet water quality standards for protecting public health and maintaining the designated beneficial uses of those waters for drinking, swimming, recreation and fishing. The MEP modeling approach assesses available options for meeting selected nitrogen goals that are protective of embayment health and achieve water quality standards.

The core of the Massachusetts Estuaries Project analytical method is the Linked Watershed-Embayment Management Modeling Approach, which links watershed inputs with embayment circulation and nitrogen characteristics.

The Linked Model builds on well-accepted basic watershed nitrogen loading approaches such as those used in the Buzzards Bay Project, the CCC models, and other relevant models. However, the Linked Model differs from other nitrogen management models in that it:

- requires site-specific measurements within each watershed and embayment;
- uses realistic "best-estimates" of nitrogen loads from each land-use (as opposed to loads with built-in "safety factors" like Title 5 design loads);
- spatially distributes the watershed nitrogen loading to the embayment;
- accounts for nitrogen attenuation during transport to the embayment;
- includes a 2D or 3D embayment circulation model depending on embayment structure;
- accounts for basin structure, tidal variations, and dispersion within the embayment;
- includes nitrogen regenerated within the embayment;
- is validated by both independent hydrodynamic, nitrogen concentration, and ecological data;
- is calibrated and validated with field data prior to generation of "what if" scenarios.

The Linked Model Approach's greatest assets are its ability to be clearly calibrated and validated, and its utility as a management tool for testing "what if" scenarios for evaluating watershed nitrogen management options.

For a comprehensive description of the Linked Model, please refer to the *Full Report: Nitrogen Modeling to Support Watershed Management: Comparison of Approaches and Sensitivity Analysis*, available for download at http://www.mass.gov/dep/water/resources/coastalr.htm. A more basic discussion of the Linked Model is also provided in Appendix F of the *Massachusetts Estuaries Project Embayment Restoration Guidance for Implementation Strategies*, available for download at http://www.mass.gov/dep/water/resources/coastalr.htm. The Linked Model suggests which management solutions will adequately protect or restore embayment water quality by enabling

towns to test specific management scenarios and weigh the resulting water quality impact against the cost of that approach. In addition to the management scenarios modeled for this report, the Linked Model can be used to evaluate additional management scenarios and may be updated to reflect future changes in land-use within an embayment watershed or changing embayment characteristics. In addition, since the Model uses a holistic approach (the entire watershed, embayment and tidal source waters), it can be used to evaluate all projects as they relate directly or indirectly to water quality conditions within its geographic boundaries. Unlike many approaches, the Linked Model accounts for nutrient sources, attenuation, and recycling and variations in tidal hydrodynamics and accommodates the spatial distribution of these processes. For an overview of several management scenarios that may be employed to restore embayment water quality, see *Massachusetts Estuaries Project Embayment Restoration Guidance for Implementation Strategies*, available for download at http://www.mass.gov/dep/water/resources/coastalr.htm.

***Application of MEP Approach:*** The Linked Model was applied to the Madaket Harbor / Long Pond embayment system by using site-specific data collected by the MEP and water quality data from the Water Quality Monitoring Program conducted by the Nantucket Marine Department, with technical guidance from the Coastal Systems Program at SMAST (see Section II). Evaluation of upland nitrogen loading was conducted by the MEP. Estuaries Project staff obtained digital parcel and tax assessors data from the Town of Nantucket Geographic Information Systems Department, watershed specific water use data from the Wannacomet Water Company (WWC) and watershed boundaries adopted by the town as the Harbor Watershed Protection District (http://www.nantucket-ma.gov). During the development of the Nantucket Water Resources Management Plan, an island-wide groundwater mapping project, using many of the USGS wells on the Island, was completed to characterize the water table configuration of Nantucket (Horsley, Whittan, Hegeman, 1990). Estuary watershed delineations completed in areas with relatively transmissive sand and gravel deposits, like most of Cape Cod and the Islands, have shown that watershed boundaries are usually better defined by elevation of the groundwater and its direction of flow, rather than by land surface topography (Cambareri and Eichner 1998, Millham and Howes 1994a,b). This approach was used by Horsley, Whittan and Hegeman, Inc. (HWH) to complete a watershed delineation for Madaket Harbor (Section III); this watershed delineation was been largely confirmed by subsequent water table characterizations (*e.g*., Lurbano, 2001, Gardner and Vogel, 2005). MEP staff compared the HWH Harbor watershed to a 2004 aerial base map. This comparison found some slight discrepancies likely based on a better characterization of the shoreline; changes were made based on best professional judgment and watershed/water table characterization experience in similar geologic settings. The watershed to Madaket Harbor has been adopted in the town zoning bylaws as the Madaket Harbor Watershed Protection District. (http://www.nantucket-ma.gov/Pages/NantucketMA_IT/gismapsfolder/madaketharborwpd.pdf).

The land-use data obtained from the Town was used to determine watershed nitrogen loads within the Madaket Harbor embayment system and each of the systems sub-embayments as appropriate (current and build-out loads are summarized in Section IV). Water quality within a sub-embayment is the integration of nitrogen loads with the site-specific estuarine circulation. Therefore, water quality modeling of this tidally influenced estuary included a thorough evaluation of the hydrodynamics of the estuarine system. Estuarine hydrodynamics control a variety of coastal processes including tidal flushing, pollutant dispersion, tidal currents, sedimentation, erosion, and water levels. Once the hydrodynamics of the system was quantified, transport of nitrogen was evaluated from tidal current information developed by the numerical models.

A two-dimensional depth-averaged hydrodynamic model based upon the tidal currents and water elevations was employed for the Madaket Harbor / Long Pond embayment system. Once the hydrodynamic properties of the estuarine system were computed, two-dimensional water quality model simulations were used to predict the dispersion of the nitrogen at current loading rates. Using standard dispersion relationships for estuarine systems of this type, the water quality model and the hydrodynamic model was then integrated in order to generate estimates regarding the spread of total nitrogen from the site-specific hydrodynamic properties. The distributions of nitrogen loads from watershed sources were determined from land-use analysis. Boundary nutrient concentrations in Nantucket Sound source waters were taken from water quality monitoring data. Measurements of current salinity distributions throughout the estuarine waters of the Madaket Harbor / Long Pond embayment system was used to calibrate the water quality model, with validation using measured nitrogen concentrations (under existing loading conditions). The underlying hydrodynamic model was calibrated and validated independently using water elevations measured in time series throughout the embayments.

***MEP Nitrogen Thresholds Analysis:*** The threshold nitrogen level for an embayment represents the average water column concentration of nitrogen that will support the habitat quality being sought. The water column nitrogen level is ultimately controlled by the watershed nitrogen load and the nitrogen concentration in the inflowing tidal waters (boundary condition). The water column nitrogen concentration is modified by the extent of sediment regeneration. Threshold nitrogen levels for the embayment systems in this study were developed to restore or maintain SA waters or high habitat quality. High habitat quality was defined as supportive of eelgrass and infaunal communities. Dissolved oxygen and chlorophyll a were also considered in the assessment.

The nitrogen thresholds developed in Section VIII-2 were used to determine the amount of total nitrogen mass loading reduction required for restoration of eelgrass and infaunal habitats in the Madaket Harbor / Long Pond system. Tidally averaged total nitrogen thresholds derived in Section VIII.1 were used to adjust the calibrated constituent transport model developed in Section VI. Watershed nitrogen loads were sequentially lowered, using reductions in septic effluent discharges only, until the nitrogen levels reached the threshold level at the sentinel station chosen for the Madaket Harbor system. It is important to note that load reductions can be produced by reduction of any or all sources or by increasing the natural attenuation of nitrogen within the freshwater systems to the embayment. The load reductions presented below represent only one of a suite of potential reduction approaches that need to be evaluated by the community. The presentation is to establish the general degree and spatial pattern of reduction that will be required for protection/restoration of this nitrogen threatened embayment.

The Massachusetts Estuaries Project's thresholds analysis, as presented in this technical report, provides the site-specific nitrogen reduction guidelines for nitrogen management of the Madaket Harbor / Long Pond embayment system in the Town of Nantucket. Future water quality modeling scenarios should be run which incorporate the spectrum of strategies that result in nitrogen loading reduction to the embayment. The MEP analysis has initially focused upon nitrogen loads from on-site septic systems as a test of the potential for achieving the level of total nitrogen reduction for restoration of the embayment system. The concept was that since septic system nitrogen loads generally represent 58% of the controllable watershed load to the Madaket Harbor embayment system and are more manageable than other of the nitrogen sources, the ability to achieve needed reductions through this source is a good gauge of the feasibility for protection/restoration of the system. Additionally, an alternative scenario was completed which focused on the elimination of nitrogen loads to the Long Pond portion of the embayment system as that source represents 24% of the controllable watershed load to the

Madaket Harbor embayment system and is also more manageable than other of the nitrogen sources.

## 2. Problem Assessment (Current Conditions)

A habitat assessment was conducted throughout the Madaket Harbor / Long Pond system based upon available water quality monitoring data, historical changes in eelgrass distribution, time-series water column oxygen measurements, and benthic community structure. The Madaket Harbor-Long Pond Embayment System is a complex estuary with full tidal marine basins (Madaket Harbor, Hither Creek) connected via Madaket Ditch to tidally restricted brackish water basins (Long Pond, North Head Long Pond) that have significant wetland influence.

Each of type of functional component (salt marsh basin, embayment, tidal river, deep basin (sometimes drown kettles), shallow basin, etc.) has a different natural sensitivity to nitrogen enrichment and organic matter loading. Evaluation of eelgrass and infaunal habitat quality must consider the natural structure of the specific type of basin and the ability to support eelgrass beds and the types of infaunal communities that they support. At present, some of the component basins within the Madaket Harbor-Long Pond Estuary are showing nitrogen enrichment and impairment of both eelgrass and infaunal habitats (Section VII), indicating that nitrogen management of this system will be for restoration rather than for protection or maintenance of an unimpaired system.

Overall, the large open water semi-enclosed main basin of Madaket Harbor is presently supporting high quality eelgrass habitat and productive benthic animal communities. Oxygen generally shows little depletion and chlorophyll a levels were consistently low. It is clear that the open nature of this basin and its relatively small watershed have resulted in only a low level of nitrogen enrichment and high quality habitat. In contrast, the enclosed basin of Hither Creek is presently nitrogen enriched, with high chlorophyll levels and periodic hypoxia (low oxygen). Habitat impairment is clear from the loss of previously existing eelgrass beds and the near absence of benthic animals in the upper reaches. The brackish basins of Long Pond and North Head of Long Pond are also nitrogen enriched beyond their assimilative capacity, but given the natural nutrient and organic matter enrichment of wetland influenced tidal basins their level of impairment is only moderate. There is no evidence that eelgrass habitat has existed previously in these basins, so the present absence does not indicate impairment of this habitat.

The level of oxygen depletion and the magnitude of daily oxygen excursion and chlorophyll a levels indicate only slightly nutrient enriched conditions within Madaket Harbor and moderate to significant impairment of the enclosed component basins. However, the degree of enrichment and subsequent effect on habitat quality varied widely between these impaired sub-basins.

Madaket Harbor, which functions as a open marine basin generally has only moderate declines in oxygen, moderate amounts of phytoplankton biomass (chlorophyll a), and a low level of nitrogen enrichment (tidally averaged TN <0.33 mg $L^{-1}$), all factors consistent with its high quality eelgrass habitat. In contrast, Hither Creek's oxygen and chlorophyll a levels indicate a nitrogen and organic matter enriched basin with oxygen frequently declining below 4 mg $L^{-1}$ and 3 mg $L^{-1}$. Chlorophyll a levels were also significantly elevated. These elevated levels of phytoplankton are consistent with the observed periodic bottom water hypoxia and organic rich soft sediments of the basin. The periodic hypoxia, elevated chlorophyll levels and sediment characteristics are consistent with a nitrogen enriched basin with significantly impaired eelgrass

habitat. The oxygen and chlorophyll a data further support the conclusion that Hither Creek habitats are likely presently impaired by nitrogen enrichment.

Long Pond is a tidally restricted brackish pond dominated by fringing wetlands. Oxygen depletion is large and frequent, generally following the diurnal light/dark cycle. Oxygen frequently declined to <2 mg $L^{-1}$, with a large daily excursion frequently rising to 2-3 times air equilibration. Although natural wetland channels periodically are hypoxic/anoxic at night, the large daily oxygen excursions are atypical and indicate impairment. Consistent with the oxygen levels, chlorophyll a levels were also very high. The oxygen and chlorophyll a data indicate that while the middle portion of Long Pond is a wetland dominated basin and therefore naturally nutrient and organic matter enriched, the large phytoplankton blooms coupled with the large oxygen excursions suggest that it is currently beyond its nutrient assimilative capacity. The southern tidal reach of Long Pond is less nutrient enriched and shows a lower degree of habitat impairment. While Long Pond, overall, has significant wetland influence and therefore is naturally enriched in nutrients and organic matter the chlorophyll a and to a lesser extent oxygen records indicate that this lower basin is also beyond its nutrient assimilative capacity.

Overall, the oxygen and chlorophyll a levels within the Madaket Harbor - Long Pond System indicate little to no impairment of the outer harbor consistent with its low level of nitrogen enrichment. In contrast, Hither Creek which receives high quality waters on the flooding tide from Madaket Harbor, but nutrient and organic matter enrichment from its watershed inputs and from the upper estuarine reaches via Madaket Ditch, has oxygen declines and chlorophyll levels consistent with its tidally averaged TN of 0.51 mg $L^{-1}$ (Section VI), indicating nitrogen related habitat impairment. Long Pond and North Head of Long Pond are brackish wetland influenced systems that are naturally enriched with nutrients and organic matter. The North Head of Long Pond supported generally high oxygen conditions and moderate chlorophyll a levels at a high tidally averaged TN (0.89 mg $L^{-1}$). Based upon the function type of this basin, the oxygen and chlorophyll a levels are indicative of high quality to possibly slightly impaired habitat. In contrast, the wetland dominated Long Pond basin is presently showing wide oxygen excursions, frequent hypoxia/anoxia and very high chlorophyll levels indicating that even this naturally enriched system is receiving external nitrogen loading that is resulting in habitat impairments.

The survey of infauna communities throughout the Madaket Harbor-Long Pond Estuary indicated a system presently supporting impaired benthic infaunal habitat in its enclosed component sub-basins (Hither Creek, Long Pond, North Head of Long Pond).

A wide range of benthic animal habitat quality exists within the Madaket Harbor-Long Pond Embayment System. The highest quality infauna habitat was found throughout the main basin of Madaket Harbor that also presently supports extensive eelgrass beds and sustains high oxygen levels and low chlorophyll levels, consistent with its low level of nitrogen enrichment. In contrast, Hither Creek has low numbers of individuals, species and diversity and is dominated by organic enrichment tolerant species (Capitellids). The upper reach of Hither Creek (between water quality monitoring sites MAD 9 & 10) did not support any significant infaunal habitat. The observed impaired infauna habitat is consistent with the observed oxygen and chlorophyll levels in this basin. Long Pond and North Head of Long Pond are brackish water basins with significant wetland influence. As such, these basins are naturally nutrient and organic matter enriched, and assessment of infaunal habitat accounted for their functional types. Overall, these brackish basins presently support productive benthic animal communities. Long Pond supports high numbers of individuals, but low species numbers, diversity and Evenness. The low numbers of total species and overall diversity indicate an impaired habitat consistent with

the observed hypoxic conditions and elevated chlorophyll levels. The North Head of Long Pond is similar to Long Pond with lower numbers of individuals, but the community is dominated by amphipods rather than oligochaeta worms, indicative of a productive organic rich habitat and consistent with the observed oxygen levels in this basin.

At present, eelgrass coverage is extensive and stable throughout the main portion of Madaket Harbor. The existing beds have increased significantly relative to the estimate from 1951. The temporal pattern of eelgrass coverage in Hither Creek clearly indicates that the eelgrass habitat within this basin is presently significantly impaired. In 1951, eelgrass beds covered much of the main basin of the Creek. However, by 1995 the beds had been significantly reduced and limited to the margins of the basin and eelgrass was not found in the 2001 and 2006 MassDEP surveys or the MEP 2003 observations. The recent loss of the 1995 beds coupled with measured periodic hypoxia and high chlorophyll a levels supports the contention that nitrogen enrichment caused the decline in eelgrass habitat. Deepening the basin does impact the ability to restore eelgrass in this basin to 1951 coverage, since the basin is now deeper and depositional. In its present basin configuration, restoration of the eelgrass habitat in Hither Creek, should focus on restoration of the fringing beds in the shallower margins of the basin to the inland extent of the 1951 coverage (water quality station, M11).

In contrast to Madaket Harbor and Hither Creek, the Long Pond basins do not appear to have eelgrass habitat, as there is not present or historical evidence of eelgrass within these basins. Management of nitrogen levels through reduction in watershed nitrogen inputs or increased tidal flushing, as appropriate, is required for restoration of eelgrass and infaunal habitats within the Madaket Harbor-Long Pond Embayment System.

## 3. Conclusions of the Analysis

The threshold nitrogen level for an embayment represents the average watercolumn concentration of nitrogen that will support the habitat quality being sought. The watercolumn nitrogen level is ultimately controlled by the integration of the watershed nitrogen load, the nitrogen concentration in the inflowing tidal waters (boundary condition) and dilution and flushing via tidal flows. The water column nitrogen concentration is modified by the extent of sediment regeneration and by direct atmospheric deposition.

Threshold nitrogen levels for this embayment system were developed to restore or maintain SA waters or high habitat quality. In this system, high habitat quality was defined as supportive of eelgrass and supportive of diverse benthic animal communities. Dissolved oxygen and chlorophyll *a* were also considered in the assessment.

Watershed nitrogen loads (Tables ES-1 and ES-2) for the Town of Nantucket, Madaket Harbor / Long Pond embayment system was comprised primarily of runoff from impervious surfaces, fertilizers and wastewater nitrogen. Land-use and wastewater analysis found that generally about 58% of the controllable watershed nitrogen load to the embayment was from wastewater.

A major finding of the MEP clearly indicates that a single total nitrogen threshold cannot be applied to Massachusetts' estuaries, based upon the results of the Great, Green and Bournes Pond Systems, Popponesset Bay System, the Hamblin / Jehu Pond / Quashnet River analysis in eastern Waquoit Bay and the analysis of the adjacent Nantucket Harbor and Sesechacha Pond systems on the Island of Nantucket. This is almost certainly going to be true for the other embayments within the MEP area, as well as Madaket Harbor and Long Pond.

The threshold nitrogen levels for the Madaket Harbor / Long Pond embayment system in Nantucket were determined as follows:

***Madaket Harbor / Long Pond Threshold Nitrogen Concentrations:***

- Following the MEP protocol, the restoration target for the Madaket Harbor / Long Pond system should reflect both recent pre-degradation habitat quality and be reasonably achievable. Determination of the critical nitrogen threshold for maintaining high quality habitat within the Madaket Harbor Estuarine System is based primarily upon the nutrient and oxygen levels, temporal trends in eelgrass distribution and current benthic community indicators. Given the information on a variety of key habitat and basin characteristics, it is possible to develop a site-specific threshold at a sentinel location within the embayment. The sentinel location is selected such that the restoration of that one site will necessarily bring the other regions of the system to acceptable habitat quality levels, which is a refinement upon more generalized threshold analyses frequently employed. Evaluation of eelgrass and infaunal habitat quality must consider the natural structure of the specific type of basin and the ability to support eelgrass beds and the types of infaunal communities that they support. At present, some of the component basins within the Madaket Harbor-Long Pond Estuary are showing nitrogen enrichment and impairment of both eelgrass and infaunal habitats (Section VII), indicating that nitrogen management of this system will be for restoration rather than for protection or maintenance of an unimpaired system.

- Overall, the large open water semi-enclosed main basin of Madaket Harbor is presently supporting high quality eelgrass habitat and productive benthic animal communities. Oxygen generally shows little depletion and chlorophyll a levels were consistently low, with only very sparse macroalgal abundance.

- The enclosed basin of Hither Creek is presently nitrogen enriched with a tidally averaged TN of 0.51 mg N $L^{-1}$ compared to 0.33 mg N L-1 in Madaket Harbor. The result is high chlorophyll levels and periodic hypoxia (low oxygen), complete loss of eelgrass habitat and regions of dense accumulations of drift macroalgae. In addition, the benthic animal habitat is impaired and nearly absent in much of the northern tidal basin. While nitrogen management needs to target eelgrass restoration in this basin, it will also restore benthic animal habitat, as benthic communities are generally more tolerant of nitrogen enrichment effects than is eelgrass.

- The brackish basins of Long Pond and North Head of Long Pond are also nitrogen enriched beyond their assimilative capacity, but given the natural nutrient and organic matter enrichment of wetland influenced tidal basins their level of impairment is only moderate. TN levels are elevated in these basins, 0.85 - 1.05 mg N L-1, typical of wetland basins and tidal creeks. However, some impairment of habitat presently exists, seen primarily in the high chlorophyll levels and periodic blooms and structure of the benthic animal community. There is no evidence that eelgrass habitat has existed previously in these basins, so the present absence does not indicate impairment of this habitat.

- The decline in eelgrass within Hither Creek makes restoration of eelgrass the target for TMDL development by MassDEP and the primary focus of threshold development for

this system. Additionally, restoration of the basins with impaired benthic animal habitat is also required. However, given the level of impairment in the brackish basins and the goal of restoring eelgrass in Hither Creek, it is certain that nitrogen management to restore eelgrass habitat within Hither Creek the will also result in restoration of the impaired infaunal habitat, as nitrogen enrichment will be significantly reduced to the overall estuary. As such, it appears that the appropriate sentinel station for the Madaket Harbor-Long Pond Embayment System should be located at the northern most extent of the 1951 eelgrass coverage in Hither Creek, which coincides with the baseline Nantucket Water Quality Monitoring Station, M11. To achieve the restoration target of restoring the fringing eelgrass beds in Hither Creek requires lowering the level of nitrogen enrichment. Within Madaket Harbor the basin-wide tidally averaged TN is presently <0.33 mg N L-1, and the basin is supporting high quality eelgrass and benthic infaunal habitat. However, Madaket Harbor eelgrass coverage includes areas in deeper water than that of the location of the fringing eelgrass beds to be restored in Hither Creek (< 1 m) and so a higher level of nitrogen is appropriate for restoration in Hither Creek.

- In shallow systems like the restoration area in Hither Creek, eelgrass beds are sustainable at higher TN (higher chlorophyll a) levels than in deeper waters, because of the "thinner" water column that light has to pass through to support eelgrass growth (less water to penetrate). Therefore to restore eelgrass habitat in Hither Creek the nitrogen concentration (tidally averaged TN) at the sentinel location needs to be between 0.48 and 0.43 mg TN $L^{-1}$. A threshold of 0.45 mg TN $L^{-1}$ was determined to be appropriate for the Hither Creek sentinel station to restore eelgrass (and infaunal habitat) within this basin.

- It should be noted that as the benthic habitats in the brackish components (Long Pond and the North Head of Long Pond) of the overall system are naturally nitrogen enriched, a moderate reduction in nitrogen levels should be sufficient to restore the benthic habitat. In tidal wetlands the nitrogen levels between 1 and 2 mg N $L^{-1}$ are associated with unimpaired habitat. This is consistent with the only slight impairment of the North Head of Long Pond at TN levels of 0.894 mg $L^{-1}$ and the moderately impaired benthic habitat in Long Pond at a basin averaged TN (tidally averaged) of 0.939 mg N $L^{-1}$. Given the observed level of impairment in these brackish basins and the frequent association of high quality benthic habitat in wetland influenced tidal channels at 1 mg N L-1, a threshold of 0.8 mg N L-1 is appropriate as the average basin TN level to be supportive of benthic animal habitat. This is a secondary threshold and one that should be met as nitrogen management options are implemented to meet the nitrogen threshold at the down-gradient sentinel station in Hither Creek.

It is important to note that the analysis of future nitrogen loading to the Madaket Harbor / Long Pond estuarine system focuses upon additional shifts in land-use from forest/grasslands to residential and commercial development. However, the MEP analysis indicates that increases in nitrogen loading can occur under present land-uses, due to shifts in occupancy, shifts from seasonal to year-round usage and increasing use of fertilizers. Therefore, watershed-estuarine nitrogen management must include management approaches to prevent increased nitrogen loading from both shifts in land-uses (new sources) and from loading increases of current land-uses. The overarching conclusion of the MEP analysis of the Madaket Harbor / Long Pond estuarine system is that protection/restoration will necessitate a reduction in the present (2009) nitrogen inputs and management options to negate additional future nitrogen inputs.

Table ES-1. Existing total and sub-embayment nitrogen loads to the estuarine waters of the Madaket Harbor and Long Pond estuary system, observed nitrogen concentrations, and sentinel system threshold nitrogen concentrations.

| Sub-embayments | Natural Background Watershed Load [1] (kg/day) | Present Land Use Load [2] (kg/day) | Present Septic System Load (kg/day) | Present WWTF Load [3] (kg/day) | Present Watershed Load [4] (kg/day) | Direct Atmospheric Deposition [5] (kg/day) | Present Net Benthic Flux (kg/day) | Present Total Load [6] (kg/day) | Observed TN Conc. [7] (mg/L) | Threshold TN Conc. (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| ***SYSTEMS*** | | | | | | | | | | |
| Madaket Bay | 0.238 | 0.279 | 0.384 | -- | 0.663 | 8.603 | 17.952 | 27.218 | 0.34-0.42 | -- |
| Hither Creek | 0.425 | 1.134 | 2.907 | -- | 4.041 | 0.534 | -0.583 | 3.992 | 0.58-0.78 | -- |
| Madaket Ditch | 0.507 | 0.923 | 1.510 | -- | 2.433 | - | 0.061 | 2.494 | -- | -- |
| Long Pond | 0.142 | 2.888 | 0.342 | -- | 3.230 | 0.975 | 3.065 | 7.270 | 0.24-0.40 | |
| **System Total** | **1.457** | **5.392** | **5.214** | **--** | **10.605** | **10.805** | **21.490** | **42.901** | **--** | **0.45[8]** |

[1] assumes entire watershed is forested (i.e., no anthropogenic sources)
[2] composed of non-wastewater loads, e.g. fertilizer and runoff and natural surfaces and atmospheric deposition to lakes
[3] existing wastewater treatment facility discharges to groundwater
[4] composed of combined natural background, fertilizer, runoff, and septic system loadings
[5] atmospheric deposition to embayment surface only
[6] composed of natural background, fertilizer, runoff, septic system atmospheric deposition and benthic flux loadings
[7] average of 2001 – 2008 data, ranges show the upper to lower regions (highest-lowest) of an sub-embayment. Individual yearly means and standard deviations in Table VI-1.
[8] Threshold for sentinel site located in Hither Creek at water quality station M-11

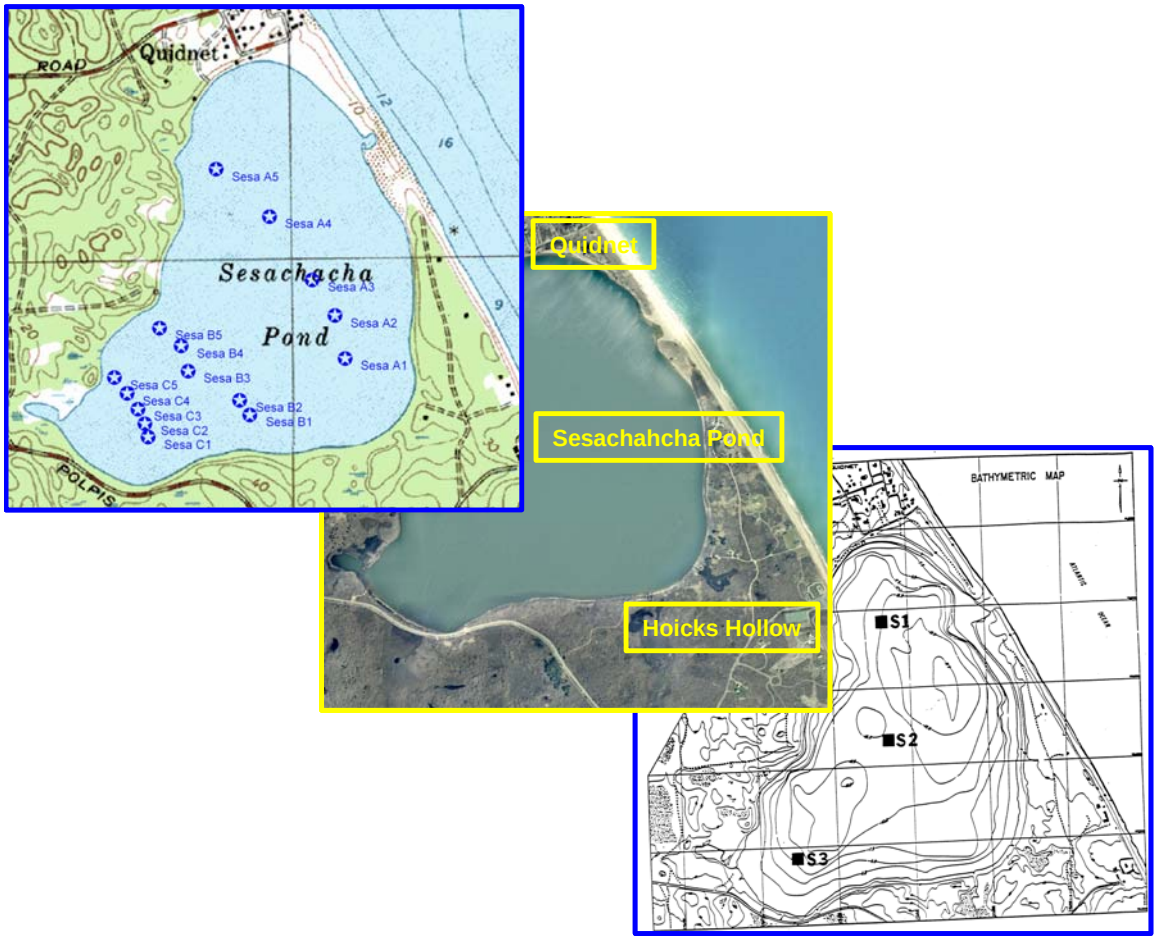
Table ES-2. Present Watershed Loads, Thresholds Loads, and the percent reductions necessary to achieve the Thresholds Loads for the Madaket Harbor and Long Pond estuary system, Town of Madaket, Massachusetts.

| Sub-embayments | Present Watershed Load [1] (kg/day) | Target Threshold Watershed Load [2] (kg/day) | Direct Atmospheric Deposition (kg/day) | Benthic Flux Net [3] (kg/day) | TMDL [4] (kg/day) | Percent watershed reductions needed to achieve threshold load levels |
|---|---|---|---|---|---|---|
| ***SYSTEMS*** | | | | | | |
| Madaket Bay | 0.663 | 0.663 | 8.603 | 17.952 | 27.22 | 0.00% |
| Hither Creek | 4.041 | 1.134 | 0.534 | -0.583 | 1.09 | -71.94% |
| Madaket Ditch | 2.433 | 2.433 | - | 0.061 | 2.49 | 0.00% |
| Long Pond | 3.230 | 1.101 | 0.975 | 3.065 | 5.14 | -65.91% |
| North Head Long Pond | 0.238 | 0.238 | 0.693 | 0.995 | 1.93 | 0.00% |
| **System Total** | **10.605** | **5.570** | **10.805** | **21.49** | **37.86** | **-47.48%** |

(1) Composed of combined natural background, fertilizer, runoff, and septic system loadings.
(2) Target threshold watershed load is the load from the watershed needed to meet the embayment threshold concentration identified in Table ES-1.
(3) Projected future flux (present rates reduced approximately proportional to watershed load reductions).
(4) Sum of target threshold watershed load, atmospheric deposition load, and benthic flux load.

# Massachusetts Estuaries Project

## Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Sesachacha Pond, Town of Nantucket, Massachusetts





University of Massachusetts Dartmouth
School of Marine Science and Technology

Massachusetts Department of
Environmental Protection


*FINAL REPORT – NOVEMBER 2006*

# Massachusetts Estuaries Project

## Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Sesachacha Pond, Town of Nantucket Nantucket Island, Massachusetts

**FINAL REPORT – NOVEMBER 2006**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# ACKNOWLEDGMENTS

The Massachusetts Estuaries Project Technical Team would like to acknowledge the contributions of the many individuals who have worked tirelessly for the restoration and protection of the critical coastal resources of the Nantucket Harbor System. Without these stewards and their efforts, this project would not have been possible.

First and foremost is the significant time and effort in data collection and discussion spent by members of the Town of Nantucket Water Quality Monitoring Program, particularly Dave Fronzuto and its Coordinator, Keith Conant and former Coordinator, Tracey Curley. These individuals gave of their time to collect nutrient samples from this system over many years and without this information, the present analysis would not have been possible. A special thank you is extended to Richard Ray of the Town of Nantucket Health Department for all the assistance provided over the years thus making this report as specific as possible to the Island. In addition, over the years, the Town of Nantucket Shellfish and Marine Department has worked tirelessly with SMAST Coastal Systems Staff, engineers from Applied Coastal Research and Engineering, and the Cape Cod Commission towards the development of a restoration and management strategy for this system over the past decade. The Marine Department has also provided important support to the present MEP effort. The technical team would also like to specifically acknowledge the efforts of Cormac Collier of the Nantucket Land Council and Andrew Vorce, Director of the Nantucket Planning and Economic Development Commission for facilitating the land use analysis effort within the MEP. A special thanks is given to Linda Holland the prior Director of the Nantucket Land Council who played a key role in promoting scientifically based management of Nantucket's estuarine systems throughout the 1990's.

In addition to local contributions, technical, policy and regulatory support has been freely and graciously provided by Dr. Tony Millham of the Lloyd Center for Environmental Studies who provided previously collected data on pond elevations. Tom Cambareri and Margo Fenn of the Cape Cod Commission; MaryJo Feurbach, Art Clark and Nora Conlon of the USEPA; and our MADEP colleagues: Andrew Gottlieb (now at ODC), Arleen O'Donnell, Art Screpetis, Rick Dunn, Steve Halterman, and Russ Issacs. We are also thankful for the long hours in the field and laboratory spent by the technical staff (Paul Henderson, Nat Donkin, George Hampson), interns and students within the Coastal Systems Program at SMAST-UMD.

Support for this project was provided by the Town of Nantucket (Shellfish and Marine Department), Barnstable County, MADEP, and the USEPA.


## CITATION


Howes B., S. W. Kelley, M. Osler, J. S. Ramsey, R. Samimy, D. Schlezinger, E. Eichner (2006). Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Sesachacha Pond, Town of Nantucket, Nantucket Island, Massachusetts. Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA.



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# TABLE OF CONTENTS

**I. INTRODUCTION ..... 1**

I.1 THE MASSACHUSETTS ESTUARIES PROJECT APPROACH ..... 6
I.2 SITE DESCRIPTION ..... 9
I.3 NUTRIENT LOADING ..... 12
I.4 WATER QUALITY MODELING ..... 13
I.5 REPORT DESCRIPTION ..... 14

**II. PREVIOUS STUDIES RELATED TO NITROGEN MANAGEMENT ..... 15**

**III. DELINEATION OF WATERSHEDS ..... 24**

III.1 BACKGROUND ..... 24
III.2 SESACHACHA POND CONTRIBUTORY AREAS ..... 24

**IV. WATERSHED NITROGEN LOADING TO EMBAYMENT: LAND USE, STREAM INPUTS, AND SEDIMENT NITROGEN RECYCLING ..... 27**

IV.1 WATERSHED LAND USE BASED NITROGEN LOADING ANALYSIS ..... 27
IV.1.1 Land Use and Water Use Database Preparation ..... 28
IV.1.2 Nitrogen Loading Input Factors ..... 30
IV.1.3 Calculating Nitrogen Loads ..... 34
IV.2 ATTENUATION OF NITROGEN IN SURFACE WATER TRANSPORT ..... 38
IV.2.1 Background and Purpose ..... 38
IV.3 BENTHIC REGENERATION OF NITROGEN IN BOTTOM SEDIMENTS ..... 38
IV.3.1 Sediment-Watercolumn Exchange of Nitrogen ..... 38
IV.3.2 Method for determining sediment-watercolumn nitrogen exchange ..... 39
IV.3.3 Rates of Summer Nitrogen Regeneration from Sediments ..... 42
Sesachacha Pond ..... 44

**V. HYDRODYNAMIC MODELING ..... 47**

V.1 INTRODUCTION ..... 47
V.1.1 System Physical Setting ..... 47
V.1.2 System Hydrodynamic Setting ..... 48
V.2 GEOMORPHIC AND ANTHROPOGENIC EFFECTS TO THE SYSTEM ..... 49
V.2.1 Pond Management Practices ..... 49
V.2.2 Shoreline Change Analysis ..... 50
V.3 HYDRODYNAMIC FIELD DATA COLLECTION AND ANALYSIS ..... 51
V.3.1. Bathymetry ..... 53
V.3.2 Tide Data ..... 53
V.4 HYDRODYNAMIC MODEL DEVELOPMENT ..... 53
V.4.1 Modeling flow through a breach ..... 54
V.4.2 Modeling the breach at Sesachacha Pond ..... 59
V.4.3 RMA2 model theory ..... 59
V.4.4 RMA2 model development ..... 60
V.5. FLUSHING CHARACTERISTICS ..... 62

**VI. WATER QUALITY MODELING ..... 63**

VI.1 DATA SOURCES FOR THE MODEL ..... 63
VI.1.1 Hydrodynamics and Tidal Flushing in the Embayments ..... 63
VI.1.2 Nitrogen Loading to the Embayments ..... 63

VI.1.3 Measured Nitrogen Concentrations in the Embayments ..... 64
VI.2 MODEL DESCRIPTION AND APPLICATION ..... 64
VI.2.1 Model Formulation ..... 65
VI.2.1.1 Dispersion Model ..... 65
VI.2.1.2 Mass Balance Model ..... 66
VI.2.2 Boundary Condition Specification ..... 67
VI.2.3 Development of Present Conditions Model ..... 67
VI.2.4 Total Nitrogen Model Verification ..... 70
VI.2.5 Build-Out and No Anthropogenic Load Scenarios ..... 72
VI.2.5.1 Build-Out ..... 72
VI.2.5.2 No Anthropogenic Load ..... 73

**VII. ASSESSMENT OF EMBAYMENT NUTRIENT RELATED ECOLOGICAL HEALTH ..... 75**

VII.1 OVERVIEW OF BIOLOGICAL HEALTH INDICATORS ..... 75
VII.2 BOTTOM WATER DISSOLVED OXYGEN ..... 76
VII.3 EELGRASS DISTRIBUTION - TEMPORAL ANALYSIS ..... 81
VII.4 BENTHIC INFAUNA ANALYSIS ..... 81

**VIII. CRITICAL NUTRIENT THRESHOLD DETERMINATION AND DEVELOPMENT OF WATER QUALITY TARGETS ..... 84**

VIII.1 ASSESSMENT OF NITROGEN RELATED HABITAT QUALITY ..... 84
VIII.2 THRESHOLD NITROGEN CONCENTRATIONS ..... 85
VIII.3 DEVELOPMENT OF TARGET NITROGEN LOADS ..... 86

**IX. REFERENCES ..... 91**

# LIST OF FIGURES


Figure I-1. Location of the Sesachacha Pond system, Island of Nantucket, Town of Nantucket, Massachusetts. Sesachacha Pond is a great salt pond, historically maintained by periodic breaching of the barrier beach to allow exchange with Atlantic Ocean waters....1

Figure I-2. Study region for the Massachusetts Estuaries Project analysis of the Sesachacha Pond System. Tidal waters enter the Pond from the Atlantic Ocean during periodic openings of the barrier beach. Freshwaters enter from the watershed primarily through direct groundwater discharge and direct precipitation. ....2

Figure I-3. Sesachacha Pond bathymetry depicting major basins, Town of Nantucket, Massachusetts (EIR 1989). ....4

Figure I-4. Massachusetts Estuaries Project Critical Nutrient Threshold Analytical Approach ....11

Figure II-1. Town of Nantucket Water Quality Monitoring Program sampling stations for Sesachacha Pond as provided by the Town of Nantucket Marine Department. ....23

Figure III-1. Watershed delineations for the Sesachacha estuary system. ....25

Figure IV-1. Land-use in the Sesachacha Pond watershed. The watershed is completely contained within the Town of Nantucket. Land use classifications are based on assessors' records provided by the town. ....29

Figure IV-2. Distribution of land-uses by area within the watershed to Sesachacha Pond. ....30

Figure IV-3. Parcels, Parcelized Watersheds, and Developable Parcels in the Sesachacha Pond watershed. ....35

Figure IV-4. Land use-specific unattenuated nitrogen load (by percent) to the Sesachacha Pond System watershed. "Overall Load" is the total nitrogen input within the watershed, while the "Local Control Load" represents only those nitrogen sources that could potentially be under local regulatory control. ....37

Figure IV-5. Sesachacha Pond embayment system sediment sampling sites (red symbols) for determination of nitrogen regeneration rates. Numbers are for reference to Table IV-3. ....41

Figure IV-6. Conceptual diagram showing the seasonal variation in sediment N flux, with maximum positive flux (sediment output) occurring in the summer months, and maximum negative flux (sediment up-take) during the winter months. ....43

Figure IV-7. Time course of average total nitrogen concentrations in Sesachacha Pond during non-open periods in summers of 2004 (top) and 2005 (bottom). The linear increase in total nitrogen is directly proportional to duration of pond closure. ....46

Figure V-1. Topographic map detail of Sesachacha Pond, Nantucket Island, Massachusetts. ....48

Figure V-2. Salinity of Sesachacha Pond between 1967 and 1988 (from Kelly, 1988). ....49

Figure V-3. Record of pond openings between 1997 and 2004 indicating the relative success of the opening (in days), as well average annual salinity levels (Curley, 2004). ....50

Figure V-4. Historical shoreline change rates (1955-2003) in the area of Sesachacha Pond. ....52

Figure V-5. Bathymetry survey lines (yellow) followed by the boat in Sesachacha Pond. The final RMA2 grid used for hydrodynamic and water quality modeling is also shown as the white mesh. .....54
Figure V-6. Nantucket Harbor tides used for the water level outside Sesachacha Pond for the hydrodynamic model. Elevations are referenced to MLLW. .....55
Figure V-7. Area map detail of Edgartown Great Pond, Martha's Vineyard, Massachusetts. .....56
Figure V-8. Water elevations during the breach event in Edgartown Great Pond.....57
Figure V-9. A comparison of the broad-crested weir model results with the recorded pond elevations during the breach event at Edgartown Great Pond. .....58
Figure V-10. Weir model results for a breach event at Sesachacha Pond. The blue line represents the predicted water elevation in the pond. These values were used as the boundary condition for the RMA2 hydrodynamic model of the pond. .....60
Figure V-11. Interpolated bathymetric contours of the final RMA2 computational mesh of Sesachacha Pond. Depth contours are relative to the MLLW. .....61
Figure VI-1. 2005 aerial photo showing monitoring station location in Sesachacha Pond that was used in the water quality analysis. .....65
Figure VI-2. RMA-4 salinity dispersion model output for simulation of the spring 2004 opening of Sesachacha Pond. For this opening event, the inlet allowed tidal exchange with the Atlantic Ocean for 25 days before it closed again.....68
Figure VI-3. Comparison of measured (black circles) and modeled (red triangles) salinities through the summer of 2004, beginning with the spring breaching of an inlet to the Atlantic Ocean. The first two data points bracket the period of time that the inlet was open, and the Pond was tidally flushed. This breach period was simulated using the RMA-4 model of the Pond. Between May and November, the breach was closed, which prevented any tidal exchange. This period through the summer was simulated using the mass balance model. Results of the sensitivity analysis are also presented, showing model output using recharge rate determined by the Cape Cod Commission (CCC) and zero recharge. .....69
Figure VI-4. Model salinity target values are plotted against measured concentrations, together with the unity line, for the simulation period from May through November 2004. RMS error for this model verification run is 0.89 ppt and the $R^2$ correlation coefficient is 0.75. .....69
Figure VI-5. RMA-4 total nitrogen dispersion model output for simulation of the spring 2004 opening of Sesachacha Pond. For this opening event, the inlet allowed tidal exchange with the Atlantic Ocean for 25 days before it closed again. .....70
Figure VI-6. Comparison of measured (black circles) and modeled (red triangles) total nitrogen concentrations through the summer of 2004, beginning with the spring breaching of an inlet to the Atlantic Ocean. The first two data points bracket the period of time that the inlet was open, and the Pond was tidally flushed. Between May and November, the breach was closed, which prevented any tidal exchange. Results of the sensitivity analysis are also presented, showing model output using recharge rate determined by the Cape Cod Commission (CCC) and zero recharge. .....71
Figure VI-7. Model total nitrogen calibration target values are plotted against measured concentrations, together with the unity line, for the simulation period from May through November 2004.. Computed correlation ($R^2$) and error (rms) for the model are also presented. .....71

Figure VII-1. Average watercolumn respiration rates (micro-Molar/day) from water collected throughout the Popponesset Bay System (Schlezinger and Howes, unpublished data). Rates vary ~7 fold from winter to summer as a result of variations in temperature and organic matter availability.....77
Figure VII-2. Aerial Photograph of the Sesachacha Pond system in Falmouth showing locations of Dissolved Oxygen mooring deployments conducted in the summer of 2002. .....77
Figure VII-3. Bottom water record of dissolved oxygen at the Sesachacha Pond station, summer 2002. Calibration samples represented as red dots. .....79
Figure VII-4. Bottom water record of chlorophyll-*a* at the Sesachacha Pond station, summer 2002. Calibration samples represented as red dots. .....79
Figure VII-5. Aerial photograph of the Sesachacha Pond system showing location of benthic infaunal sampling stations (red symbol). Station 1 in each of the transects is at the southern end of the pond (bottom). .....82
Figure VIII-1. Comparison of measured (black circles) and modeled (red triangles) salinities through the summer of 2003 ($R^2$=0.74, RMS error=1.31 ppt). Present conditions with pond openings in Spring and Fall. .....87
Figure VIII-2. Comparison of measured (black circles) and modeled (red triangles) TN concentrations through the summer of 2003 ($R^2$=0.83, RMS error=0.13 mg/L). Present conditions with pond openings in Spring and Fall. .....88
Figure VIII-3. Comparison of modeled 2003 salinities for case where the pond is breached only in the spring (thick black dot-dashed line) and also when it is breached an additional time mid-summer. Model results for the following 2004 spring- to-fall season (thin red dash dot line) show how salinities change if the mid-summer breach is performed again. .....89
Figure VIII-4. Comparison of modeled 2003 TN for case where the pond is breached only in the spring (thick black line) and also when it is breached an additional time mid-summer (dot-dashed line). Model results for the following 2004 spring- to-fall season (thin red dash dot line) show how TN concentrations change if the mid-summer breach is performed again. .....89

# LIST OF TABLES

Table IV-1. Primary Nitrogen Loading Factors used in the Sesachacha Pond MEP analyses. General factors are from MEP modeling evaluation (Howes & Ramsey 2001). Site-specific factors are derived from Barnstable data. *Data from MEP lawn study in Falmouth, Mashpee & Barnstable 2001. .....34
Table IV-2. Sesachacha Pond Nitrogen Loads. All values are kg N $yr^{-1}$. .....37
Table IV-3. Rates of net nitrogen return from sediments to the overlying waters of Sesachacha Pond. These values are combined with the basin areas to determine total nitrogen mass in the water quality model (see Chapter VI). Measurements represent July -August rates. N = number of sites .....44
Table V-1. Tide datums reported by NOAA for Nantucket Harbor. Datum elevations are given relative to MLLW. .....55
Table VI-1. Measured nitrogen concentrations and salinities for the Sesachacha Pond estuarine. "Data mean" values are calculated as the average of the separate yearly means. Data represented in this table were collected in 1992 through 2005 in Sesachacha Pond and the summer of 2005 in the Atlantic Ocean (offshore Pleasant Bay Inlet). .....64
Table VI-2. Sub-embayment and surface water loads used for total nitrogen modeling of Sesachacha Pond, with total watershed N loads, atmospheric N loads, and benthic flux. These loads represent **present loading conditions** for the listed sub-embayments. .....67
Table VI-3. Model TN concentrations and salinities verses inlet days open. For modeled Spring though Fall 2004 conditions. .....72
Table VI-4. Comparison of sub-embayment watershed loads used for modeling of present, build-out (scenarios "A" and "B"), and no-anthropogenic ("no-load") loading scenarios of Sesachacha Pond. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms. .....72
Table VI-5. **Build-out scenario** sub-embayment and surface water loads used for total nitrogen modeling of the Sesachacha Pond system, with total watershed N loads, atmospheric N loads, and benthic flux. .....73
Table VI-6. "**No anthropogenic loading**" ("no load") sub-embayment and surface water loads used for total nitrogen modeling of the Sesachacha Pond system, with total watershed N loads, atmospheric N loads, and benthic flux .....73
Table VII-1. Percent of time during deployment of in situ sensors that bottom water oxygen levels were below various benchmark oxygen levels. .....80
Table VII-2. Duration (% of deployment time) that chlorophyll a levels exceed various benchmark levels within the embayment system. "Mean" represents the average duration of each event over the benchmark level and "S.D." its standard deviation. Data collected by the Coastal Systems Program, SMAST. .....80
Table VII-3. Benthic infaunal community data for the Sesachacha Pond embayment system. Estimates of the number of species adjusted to the number of individuals and diversity (H') and Evenness (E) of the community allow comparison between locations. Samples represent surface area of 0.018 m2, N/A indicates that numbers of individuals prevent calculation of species numbers @ 75 individuals. .....83

Table VIII-1. Summary of Nutrient Related Habitat Health within the Sesachacha Pond Estuary on the eastern coast of Nantucket Island within the Town of Nantucket, MA, based upon assessment data presented in Chapter VII. The system is presently structured as a great salt pond consisting of a single basin formed from seawater entry to a coastal kettle pond.....85

# I. INTRODUCTION

The Sesachacha Pond Embayment is a simple estuary located within the Town of Nantucket on the Island of Nantucket, Massachusetts. Sesachacha Pond is stabilized as an estuarine system by periodic management breaching of the barrier beach which separates the salt pond from the marine waters of the Atlantic Ocean (Figure I-1 and I-2). The Pond is breached 2-3 times per year to lower its nitrogen levels and raise its salinity through the exchange of brackish pond waters with the high quality offshore waters. Pond openings are also to allow the entry of marine larvae and potentially herring. Studies of Sesachacha Pond in the late 1980's indicated that periodic tidal exchange was required to help stabilize the ecology. Data indicated that not breaching the Pond regularly for management would result in long term cycling of pond waters between saline and near freshwater (~1 ppt), due to the freshening by groundwater inflow and periodic storm inflows of salt water (Howes and Goehringer 1989). This salinity cycling would result in highly unstable conditions and impairment of habitat quality. The natural breaching of the barrier beach was subsequently observed during Hurricane Bob in 1991. Sesachacha Pond has been breached for management purposes for more than a century, with greater and lesser success. However, it is clear that the health of this estuary's habitats are dependent on the amount and timing of periodic tidal exchanges. One of the goals of the MEP analysis was to determine the best protocol for pond openings aimed at producing the highest quality habitat within this embayment.

Figure I-1. Location of the Sesachacha Pond system, Island of Nantucket, Town of Nantucket, Massachusetts. Sesachacha Pond is a great salt pond, historically maintained by periodic breaching of the barrier beach to allow exchange with Atlantic Ocean waters.

Figure I-2. Study region for the Massachusetts Estuaries Project analysis of the Sesachacha Pond System. Tidal waters enter the Pond from the Atlantic Ocean during periodic openings of the barrier beach. Freshwaters enter from the watershed primarily through direct groundwater discharge and direct precipitation.

Sesachacha Pond is approximately 6.0 miles northeast of the Nantucket town center and its watershed abuts the watershed to Nantucket Harbor. Sesachacha Pond is situated on the eastern coast of Nantucket Island between Squam Head and Sankaty Head. The watershed to Sesachacha Pond is fully within the Town of Nantucket, making Nantucket the sole municipal steward of this small estuary. Virtually all watershed freshwater and nutrients enter Sesachacha Pond via groundwater seepage, as there are no significant surface inflows to this system. As a result, there is little opportunity for nitrogen removal during transport from watershed source to estuarine waters.

Sesachacha Pond is comprised of a single basin and a narrow barrier beach which is periodically breached to the Atlantic Ocean for pond management. The open water area of 255-267 acres makes Sesachacha Pond a great salt pond. Sesachacha Pond was formed by the flooding of a kettle pond as a result of rising sea level following the last glaciation approximately 18,000 years BP. Sesachacha Pond consists of two deep "holes", reaching a maximum depth of 6.6 meters, and 3 functional sub-basin areas. The pond is approximately 1,320 meters long and is oriented north-northeast paralleling the shore of the Atlantic Ocean. The maximum width of the pond is 1,200 meters with an irregular shore that makes for an average width of approximately 850 meters. The pond possesses approximately 5.5 kilometers of shoreline, 870 meters of which is on the inland shore of the barrier beach separating the Pond from the Atlantic Ocean. The Pond is non-tidal and the salinity is maintained by periodic breaching of the barrier beach by the Town. Water levels vary from a low immediately after a breaching event and a high after an extended period of closure, which allows groundwater inflow to raise pond levels and dilute the salinity of pond waters.

Sesachacha Pond is predominantly groundwater fed with no significant surface inflows of freshwater. The Town openings of the channel from the Pond to the Atlantic Ocean is to enhance flushing of the Pond, maintain "acceptable" levels of salinity and nitrogen within the Pond waters and to allow for entry of marine organisms (e.g. fish and larvae). Generally, Sesachacha Pond is a brackish waterbody with salinities ranging between 10 – 25 ppt with salinities increasing to approximately 32 ppt during times when the Pond is opened to the Atlantic Ocean. Analysis of the long term record of the surface water salinity of the Pond indicates that with proper management salinities can be maintained at levels $\geq$20 ppt (Chapter VI).

***Recent Management History:***

Historically, Sesachacha Pond has been opened to tidal exchange each spring and fall to maintain salinity, manage nutrients and to allow passage of marine larvae and herring. The pond was not opened from 1981-1991, resulting in a freshening of Pond waters and a loss of all marine species (Howes and Goehringer 1989). After a decision to again manage the Pond as a “marine” resource area, the pond has been opened to Atlantic Ocean waters each spring and fall over the past decade, with openings persisting for 3.5 to 25 days per year (Curley 2004). During closed periods, groundwater inflow dilutes pond salinities periodically to ~10 ppt and raises pond levels by several feet. Water quality within this system is primarily controlled by the frequency and duration of openings to tidal exchange. There is very little nitrogen loading from development within the relatively small watershed to this great salt pond system and atmospheric deposition of nitrogen is the major source of external nitrogen to pond waters (Chapter IV). The embayment has traditionally been managed as a source of seed shellfish, although there are anecdotal reports of significant shellfish harvest from this system.

Based on the soundings, the depth of Sesachacha Pond averages approximately 5.5 meters. There are two deep basins (basin 1 and basin 2) 6.6 meters and 6.1 meters respectively, with a third less distinct basin being shallower, 4.3 m (Figure I-3). Basin 1 is the deepest of the three basins making up Sesachacha Pond and is situated in the northeastern quadrant of the pond closest to the location of historical and future breaches of the barrier beach. Moreover, this deepest of the three basins is closest to the area of the pond that supports the greatest extent of residential development.

While Sesachacha Pond presently has a relatively low nitrogen load from its watershed, due to its small watershed and proportionally large undeveloped areas, it is still significantly impaired by nitrogen enrichment and is clearly eutrophic. This apparent paradox results from its very low tidal exchange rate due to barrier beach processes closing the inlet to the Atlantic Ocean on an annual basis. As presented in a Sesachacha Pond 1989 Draft Environmental Impact Report (EIR), the barrier beach separating Sesachacha Pond from the Atlantic Ocean was dredged out once and sometimes twice per year as far back as the 1930’s. This cycle of periodic openings continued generally uninterrupted up until 1981. The man-made breach to the pond was developed using the hydraulic gradient between the pond and the ocean to create a rapid outflow of pondwater to scour a channel in the barrier beach to a depth low enough to allow tidal exchange to occur for as long as possible (1-14 days). Infrequently the opening was reported to have stayed open for longer than two weeks. These periodic openings were undertaken as a means of controlling salinity in the pond in order to safeguard shellfish resources as well as allow for the passage of finfish into the pond, lower pond levels as a flood control measure, and allow nutrient rich waters to flush out of the pond as a water quality control measure.

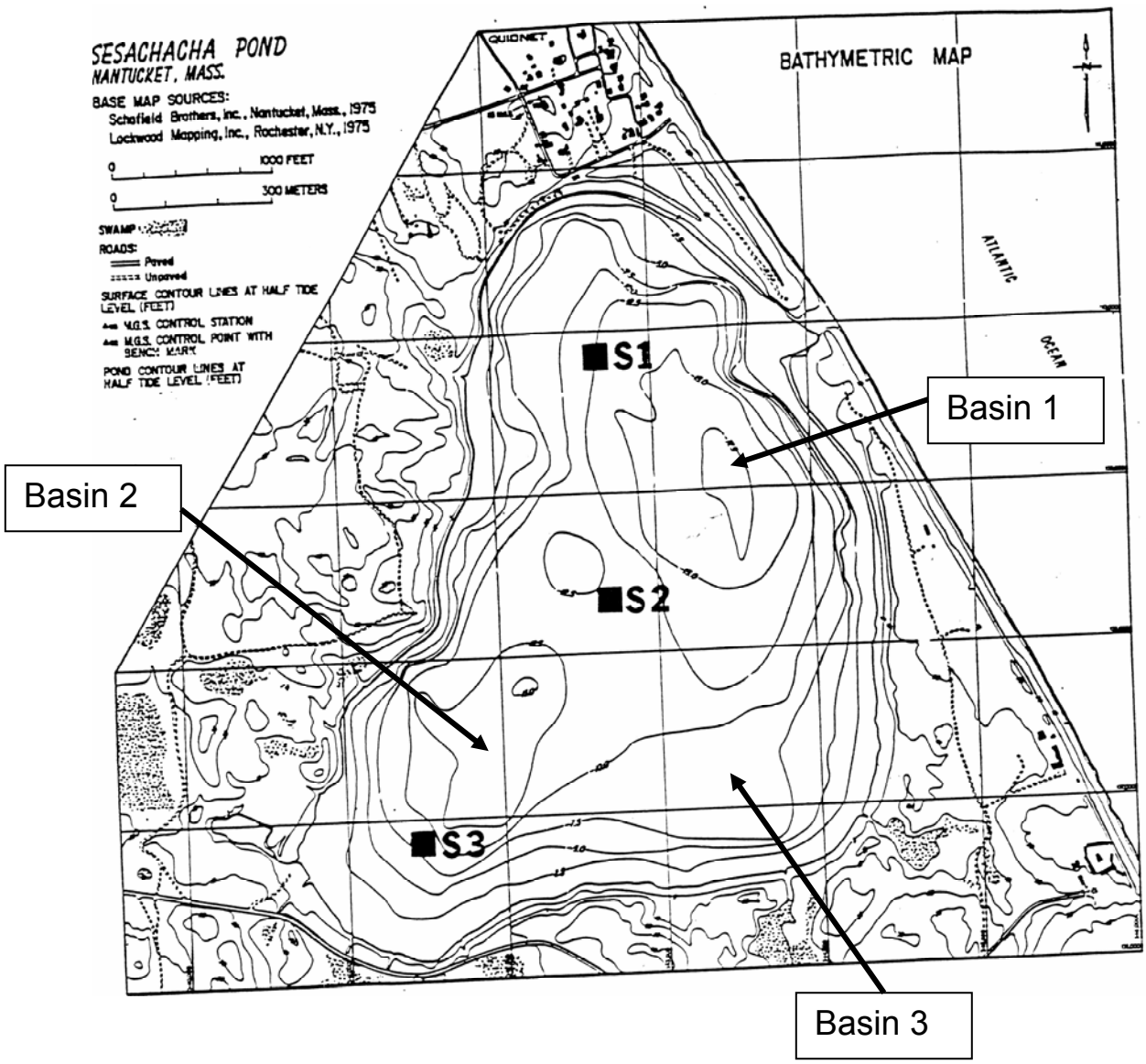



Figure I-3. Sesachacha Pond bathymetry depicting major basins, Town of Nantucket, Massachusetts (EIR 1989).

In the early 1980's ownership of the land that constitutes the barrier beach resided with a Mrs. Evans who reportedly initiated a study of the impact of periodic breaching on the pond. A hydrogeologic investigation of Sesachacha Pond was completed in 1985 (Perkins Jordan 1985), with the goal of understanding the interaction of the pond with surrounding groundwater and evaluate the long term changes in the quality of the pond water due to opening the pond to the ocean. It was reported in the 1989 Draft EIR of Sesachacha Pond that based on the findings of the hydrogeologic study, annual dredging of the pond was suspended for a period of time. In 1987, the barrier beach property changed ownership (Greenhill) at which point outstanding questions related to the value of pond openings on maintaining the ecological function of the system resurfaced. To address the pond opening issue, a scientific study to determine the likely impacts of various pond management alternatives on Sesachacha Pond and surrounding wetlands was initiated by the Greenhills and the Massachusetts Audubon Society. Based upon the data generated by this effort showing that the Pond habitats are best managed as estuarine

resources and that periodic opening are required to achieve the needed conditions. The 1989 EIR was developed and the Pond once again was breached for management.

As presented in various Sesachacha Pond Annual Reports (as far back as 1992) developed by the Town of Nantucket Shellfish and Marine Department, the Pond again opened in 1991 and periodically opened in each subsequent year to allow exchange with Atlantic Ocean water. However, the highly restricted "flushing" of pond waters per annum serves to greatly increase the nitrogen sensitivity of this system, such that even low rates of nitrogen loading cause eutrophic conditions. The difficulty in achieving adequate tidal exchange during any given opening attempt has resulted in the present ecological impairment of the Sesachacha Pond System. The low rate of nitrogen removal through tidal flushing results in high nitrogen levels, large phytoplankton blooms and periodic anoxia of bottom waters. It is clear that restoration of Sesachacha Pond will require evaluating the timing and duration of the periodic openings that would achieve the highest habitat quality within this system, relative to the logistical realities involved.

Although the nitrogen load to Sesachacha Pond is relatively low and dominated by atmospheric inputs, nitrogen management still needs to be evaluated in the development of the restoration and management plan. The Town of Nantucket has been among the steadily growing towns in the Commonwealth over the past two decades and does have a centralized wastewater treatment system that services the town center. However, the Sesachacha Pond watershed, being situated in a relatively remote and undeveloped area of the Island is not connected to any municipal sewerage system, but relies on privately maintained septic systems for treatment and disposal of wastewater. As existing and probable increasing levels of nutrients impact Nantucket's coastal embayments, water quality degradation will accelerate, with further harm to invaluable environmental resources.

As the stakeholder to the Sesachacha Pond System, the Town of Nantucket and its citizens have been active in promoting restoration of the coastal embayment systems of the Island. This local concern also led to the conduct of several studies (Section Chapter II) to support monitoring and restoration and the Town is presently willing to implement an appropriate plan for estuarine restoration. To this end, the Town of Nantucket Water Quality Monitoring Program was provided technical assistance by the Coastal Systems Program at SMAST-UMD and over the past several years has been able to develop a significant baseline of water quality in the embayments of the Island inclusive of Sesechacha Pond. This effort provides the quantitative water column nitrogen data (1988-89; 2000-2005) required for the implementation of the MEP's Linked Watershed-Embayment Approach used in the present study.

The common focus of the Nantucket water quality monitoring effort has been to gather site-specific data on the current nitrogen related water quality throughout the Sesachacha Pond System and determine its relationship to tidal flushing when the pond is opened to the ocean. This multi-year effort has provided the baseline information required for determining the link between upland loading, tidal flushing, and estuarine water quality. The MEP effort builds upon the Water Quality Monitoring Program, previous hydrodynamic studies and water quality analyses and includes high order biogeochemical analyses and water quality modeling necessary to develop critical nitrogen targets for each major sub-embayment. These critical nitrogen targets and the link to specific ecological criteria form the basis for the nitrogen threshold limits necessary to develop and implement management alternatives needed by the Town of Nantucket for estuarine restoration/protection. While the completion of this complex multi-step process of rigorous scientific investigation to support watershed and tidal flushing

based nitrogen management plans has taken place under the programmatic umbrella of the Massachusetts Estuaries Project, the results stem directly from the efforts of large number of Town staff and citizens over many years, most notably within the Shellfish and Marine Department, as well as the riparian land owners (most notably the Evans and Greenhills) and non-governmental entities such as the Nantucket Land Council. The modeling tools developed as part of this program provide the quantitative information necessary for the Town of Nantucket to develop and evaluate the most cost effective management alternatives to restore this coastal resource. Given this extensive prior data collection effort by the Town of Nantucket and its citizens, the MEP Technical Team conducted its analysis of Sesachacha Pond using Commonwealth matching funds at no additional cost to the Town.

## I.1 THE MASSACHUSETTS ESTUARIES PROJECT APPROACH

Coastal embayments throughout the Commonwealth of Massachusetts (and along the U.S. eastern seaboard) are becoming nutrient enriched. The nutrients are primarily related to changes in watershed land-use associated with increasing population within the coastal zone over the past half century. Many of Massachusetts' embayments have nutrient levels that are approaching or are currently over this assimilative capacity, which begins to cause declines in their ecological health. The result is the loss of fisheries habitat, eelgrass beds, and a general disruption of benthic communities and the food chain which they support. At higher levels, enhanced nitrogen loading from surrounding watersheds causes aesthetic degradation and inhibits even recreational uses of coastal waters. In addition to nutrient related ecological declines, an increasing number of embayments are being closed to swimming, shellfishing and other activities as a result of bacterial contamination. While bacterial contamination does not generally degrade the habitat, it restricts human uses. However like nutrients, bacterial contamination is frequently related to changes in land-use as watersheds become more developed. The regional effects of both nutrient loading and bacterial contamination span the spectrum from environmental to socio-economic impacts and have direct consequences to the culture, economy, and tax base of Massachusetts's coastal communities.

The primary nutrient causing the increasing impairment of the Commonwealth's coastal embayments is nitrogen and the primary sources of this nitrogen are wastewater disposal, fertilizers, and changes in the freshwater hydrology associated with development. At present there is a critical need for state-of-the-art approaches for evaluating and restoring nitrogen sensitive and impaired embayments. Within Southeastern Massachusetts alone, almost all of the municipalities (as is the case with the Town of Nantucket) are grappling with Comprehensive Wastewater Planning and/or environmental management issues related to the declining health of their estuaries.

Municipalities are seeking guidance on the assessment of nitrogen sensitive embayments, as well as available options for meeting nitrogen goals and approaches for restoring impaired systems. Many of the communities have encountered problems with "first generation" watershed based approaches, which do not incorporate estuarine processes. The appropriate method must be quantitative and directly link watershed and embayment nitrogen conditions. This "Linked" Modeling approach must also be readily calibrated, validated, and implemented to support planning. Although it may be technically complex to implement, results must be understandable to the regulatory community, town officials, and the general public.

The Massachusetts Estuaries Project represents the next generation of watershed based nitrogen management approaches. The Massachusetts Department of Environmental Protection (MA DEP), the University of Massachusetts – Dartmouth School of Marine Science

and Technology (SMAST), and others including the Cape Cod Commission (CCC) have undertaken the task of providing a quantitative tool for watershed-embayment management for communities throughout Southeastern Massachusetts.

The Massachusetts Estuary Project is founded upon science-based management. The Project is using a consistent, state-of-the-art approach throughout the region's coastal waters and providing technical expertise and guidance to the municipalities and regulatory agencies tasked with their management, protection, and restoration. The overall goal of the Massachusetts Estuaries Project is to provide the DEP and municipalities with technical guidance to support policies on nitrogen management of their embayments. In addition, the technical reports prepared for each embayment system will serve as the basis for the development of Total Maximum Daily Loads (TMDLs). Development of TMDLs is required pursuant to Section 303(d) of the Federal Clean Water Act. TMDLs must identify sources of the pollutant of concern (in this case nitrogen) from both point and non-point sources, the allowable load to meet the state water quality standards and then allocate that load to all sources taking into consideration a margin of safety, seasonal variations, and several other factors. The TMDL includes the role of nitrogen removal through tidal flushing, not just watershed nitrogen loading rates. In addition, each TMDL must contain an outline of an implementation plan. For this project, the DEP recognizes that there are likely to be multiple ways to achieve the desired goals, some of which are more cost effective than others and therefore, it is extremely important for each Town to further evaluate potential options suitable to their community. As such, DEP will likely be recommending that specific activities and timelines be further evaluated and developed by the Towns (sometimes jointly) through the Comprehensive Wastewater Management Planning process. However, it is absolutely clear that any remediation of the nitrogen related impairment presently within Sesachacha Pond must include an evaluation of periodic breaching.

In appropriate estuaries, TMDL's for bacterial contamination will also be conducted in concert with the nutrient effort (particularly if there is a 303d listing). In these cases, the MEP (through SMAST) will produce a Technical Analysis and Report to support a bacterial TMDL for the system from which MA DEP develops the TMDL. The goal of the bacterial program is to provide information to guide targeted sampling for specific source identification and remediation.

In contrast to the bacterial program, the MEP nitrogen program also includes site-specific habitat assessments and watershed/embayment modeling approaches to develop and assess various nitrogen management alternatives for meeting selected nitrogen goals supportive of restoration/protection of embayment health.

The major MEP nitrogen management goals are to:

- provide technical analysis and supporting documentation to Towns as a basis for sound nutrient management decision making towards embayment restoration
- develop a coastal TMDL working group for coordination and rapid transfer of results,
- determine the nutrient sensitivity of each of the 89 embayments in Southeastern MA
- provide necessary data collection and analysis required for quantitative modeling,
- conduct quantitative TMDL analysis, outreach, and planning,
- keep each embayment's model "alive" to address future municipal needs.

The core of the Massachusetts Estuaries Project analytical method is the Linked Watershed-Embayment Management Modeling Approach. This approach represents the "next

generation" of nitrogen management strategies. It fully links watershed inputs with embayment circulation and nitrogen characteristics. The Linked Model builds on and refines well accepted basic watershed nitrogen loading approaches such as those used in the Buzzards Bay Project, the CCC models, and other relevant models. However, the Linked Model differs from other nitrogen management models in that it:

- requires site specific measurements within each watershed and embayment;
- uses realistic "best-estimates" of nitrogen loads from each land-use (as opposed to loads with built-in "safety factors" like Title 5 design loads);
- spatially distributes the watershed nitrogen loading to the embayment;
- accounts for nitrogen attenuation during transport to the embayment;
- includes a 2D or 3D embayment circulation model depending on embayment structure;
- accounts for basin structure, tidal variations, and dispersion within the embayment;
- includes nitrogen regenerated within the embayment;
- is validated by both independent hydrodynamic, nitrogen concentration, and ecological data;
- is calibrated and validated with field data prior to generation of "what if" scenarios.

The Linked Model has been applied for watershed nitrogen management in approximately 15 embayments throughout Southeastern Massachusetts. In these applications it has become clear that the Linked Model Approach's greatest assets are its ability to be clearly calibrated and validated, and its utility as a management tool for testing "what if" scenarios for evaluating watershed nitrogen management options.

The Linked Watershed-Embayment Model when properly parameterized, calibrated and validated for a given embayment becomes a nitrogen management planning tool, which fully supports TMDL analysis. The Model facilitates the evaluation of nitrogen management alternatives relative to meeting water quality targets within a specific embayment. The Linked Watershed-Embayment Model also enables Towns to evaluate improvements in water quality relative to the associated cost. In addition, once a model is fully functional it can be "kept alive" and updated for continuing changes in land-use or embayment characteristics (at minimal cost). In addition, since the Model uses a holistic approach (the entire watershed, embayment and tidal source waters), it can be used to evaluate all projects as they relate directly or indirectly to water quality conditions within its geographic boundaries.

***Linked Watershed-Embayment Model Overview:*** The Model provides a quantitative approach for determining an embayment's: (1) nitrogen sensitivity, (2) nitrogen threshold loading levels (TMDL) and (3) response to changes in nitrogen loading rate or nitrogen removal through enhance tidal flushing. The approach is both calibrated and fully field validated and unlike many approaches, accounts for nutrient sources, attenuation, and recycling and variations in tidal hydrodynamics (Figure I-4). This methodology integrates a variety of field data and models, specifically:

- Watercolumn Monitoring - multi-year embayment nutrient sampling
- Hydrodynamics -
  - embayment bathymetry
  - site specific tidal record
  - current records (in complex systems only)
  - hydrodynamic model
- Watershed Nitrogen Loading
  - watershed delineation

- stream flow (Q) and nitrogen load
- land-use analysis (GIS)
- watershed N model

- Embayment TMDL - Synthesis
  - linked Watershed-Embayment N Model
  - salinity surveys (for linked model validation)
  - rate of N recycling within embayment
  - D.O record
  - Macrophyte survey
  - Infaunal survey

## I.2 SITE DESCRIPTION

Sesachacha Pond is a "simple" estuary, with a single basin and occasionally open tidal inlet. The open water area of 267 acres, makes Sesachacha Pond a great salt pond. The Sesachacha Pond System presently exchanges tidal water only during periodic opening through the barrier beach, primarily as part of a management program and occasionally during major storms. Sesachacha Pond has been breached for management purposes for more than a century, with greater and lesser success. It is clear that the health of this estuary's habitats are dependent on the amount and timing of periodic tidal exchanges. For the MEP analysis, Sesachacha Pond is the principal estuarine basin in the modeling and thresholds analysis.

Sesachacha Pond presently has a relatively low nitrogen load from its watershed, due to its small watershed and proportionally large undeveloped areas. It is still significantly impaired by nitrogen enrichment and is clearly eutrophic (Section VII). This apparent paradox results from its very low tidal exchange rate, resulting from barrier beach processes closing the inlet to the Atlantic Ocean on an annual basis. As presented in a Sesachacha Pond 1989 Draft Environmental Impact Report (EIR), the barrier beach separating Sesachacha Pond from the Atlantic Ocean was breached once and sometimes twice per year as far back as the 1930's. This cycle of periodic openings continued generally uninterrupted up until 1981. The man-made breach to the pond was developed using the hydraulic gradient between the pond and the ocean to create a rapid outflow of pondwater to scour a channel in the barrier beach to a depth low enough to allow tidal exchange to occur for as long as possible (1-14 days). Infrequently the opening was reported to have stayed open for longer than two weeks. These periodic openings were undertaken as a means of controlling salinity in the pond in order to safe guard shellfish resources as well as allow for the passage of finfish into the pond, lower pond levels as a flood control measure, and allow nutrient rich waters to flush out of the pond as a water quality control measure. However, the highly restricted "flushing" of pond waters per annum serves to greatly increase the nitrogen sensitivity of this system, such that even low rates of nitrogen loading cause eutrophic conditions. The difficulty in achieving adequate tidal exchange during any given opening attempt has resulted in the present ecological impairment of the Sesachacha Pond System. The low rate of nitrogen removal through tidal flushing results in high nitrogen levels, large phytoplankton blooms and periodic anoxia of bottom waters. It is clear that restoration of Sesachacha Pond will require evaluating the timing and duration of the periodic openings that would achieve the highest habitat quality within this system, relative to the logistical realities involved.

As management alternatives are being developed and evaluated, it is important to note that the Sesachacha Pond System is naturally a relatively dynamic system and has undergone significant alterations to its hydrologic and biological systems over the past 100 years. Within

such dynamic systems, restoration alternatives need to be evaluated relative to the system's "maximum level of sustainable environmental health" in addition to traditional standards.

While the nutrient related health of Sesachacha Pond as it exists today is linked to changes wrought by natural processes and human activities, it is the physical structure of the system laid down by the retreat of the Laurentide Ice Sheet that still controls much of the Systems' tolerance to nutrient inputs. The physical structure, shape and depth of a coastal embayment plays a major role in its susceptibility to ecological impacts from nutrient loading. Physical structure (geomorphology), which includes embayment bathymetry, isolation by the barrier beach and presence of saltwater reaches, when coupled with the tidal range of the adjacent open waters which helps drive the periodic flushing, all come together to define the dynamics of the system. System flushing rate is generally the primary factor for removing nutrients from active cycling within coastal bays and harbors. As a result maximizing system flushing is one of the standard approaches for controlling the nutrient related health of coastal embayments in general and Sesachacha Pond specifically.

The present configuration of the Sesachacha Pond system is relatively new in the coastal landscape, as the eastern coast of Nantucket Island is a dynamic region, where natural wave and tidal forces continue to reshape the shoreline (see Section V). All the while, Sesachacha Pond was formed by the flooding of a kettle pond as a result of rising sea level following the last glaciation, approximately 18,000 years BP.

While Sesachacha Pond presently has a relatively low nitrogen load from its watershed, due to its small size and proportionally large undeveloped areas, it is still significantly impaired by nitrogen enrichment. In addition, the proportionally large estuarine surface area results in a dominance of the external nitrogen loading being through direct atmospheric deposition to embayment waters. Even so, the total external nitrogen load to this great salt pond is low yet the system is eutrophic. This apparent paradox results from the low rate of annual tidal flushing which serves to greatly increase the nitrogen sensitivity of this system.

The inability of generate complete exchange of pond waters with normal breaching operations, has caused significant ecological degradation of the Pond System. The low rate of nitrogen removal through tidal flushing results in high nitrogen levels, large phytoplankton blooms and periodic anoxia of bottom waters. It is clear that restoration of Sesachacha Pond will require addressing the management openings, especially as the system has historically operated as a salt pond and its proximity to the Atlantic Ocean prevents its management as a freshwater system due to periodic overwash of salt water (similar to Oyster Pond, Falmouth, and Rushy Marsh, Barnstable see MEP Technical Reports 2005, 2006).

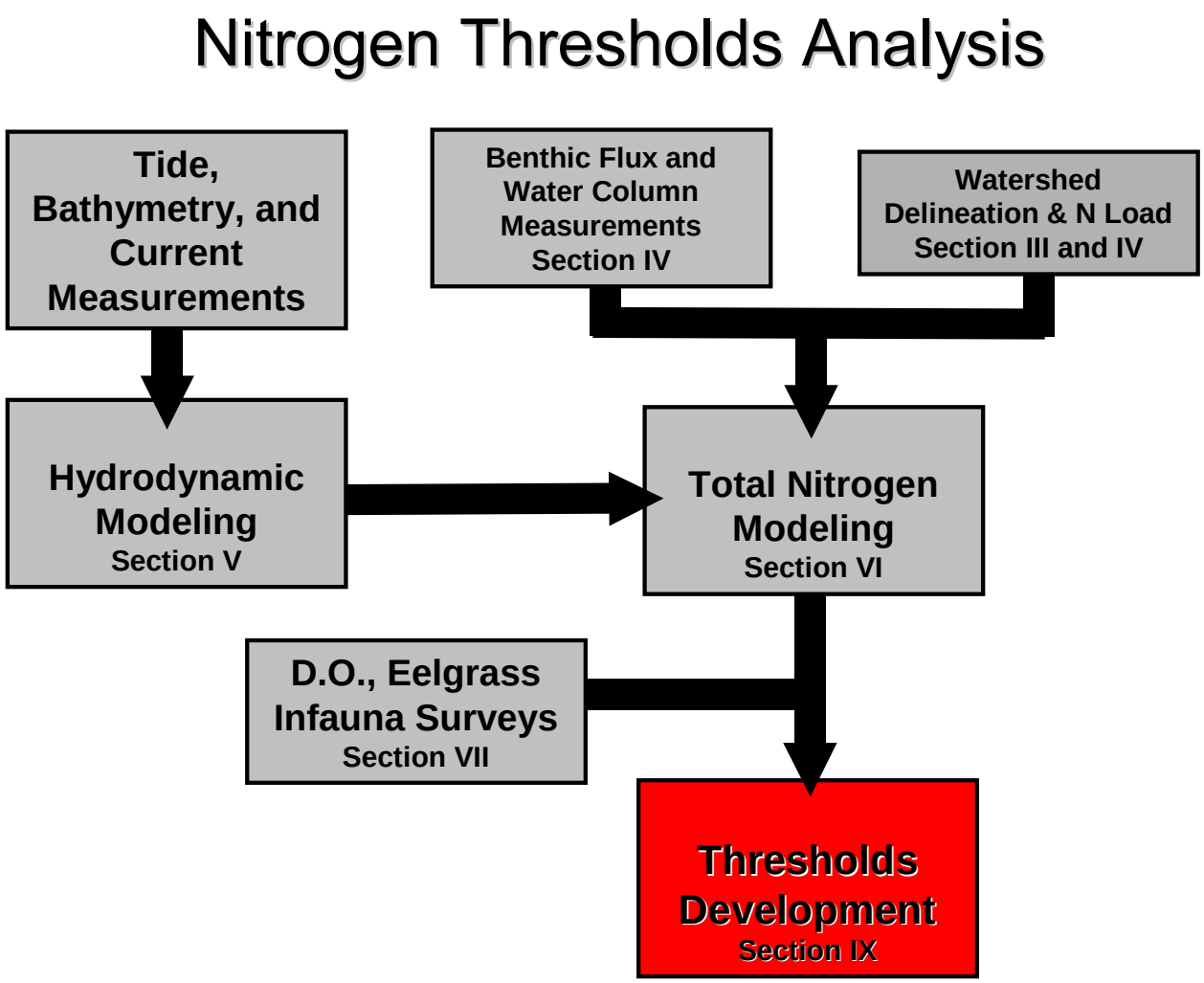



Figure I-4. Massachusetts Estuaries Project Critical Nutrient Threshold Analytical Approach

## I.3 NUTRIENT LOADING

Surface and groundwater flows are pathways for the transfer of land-sourced nutrients to coastal waters. Fluxes of primary ecosystem structuring nutrients, nitrogen and phosphorus, differ significantly as a result of their hydrologic transport pathway (i.e. streams versus groundwater). In sandy glacial outwash aquifers, such as in the watershed to the Sesachacha Pond System, phosphorus is highly retained during groundwater transport as a result of sorption to aquifer minerals (Weiskel and Howes 1992). Since even Cape Cod, Nantucket and Martha's Vineyard "rivers" are primarily groundwater fed, watersheds tend to release little phosphorus to coastal waters. In contrast, nitrogen, primarily as plant available nitrate, is readily transported through oxygenated groundwater systems on Cape Cod (DeSimone and Howes 1996, Weiskel and Howes 1992, Smith *et al.* 1991). The result is that terrestrial inputs to coastal waters tend to be higher in plant available nitrogen than phosphorus (relative to plant growth requirements). However, coastal estuaries tend to have algal growth limited by nitrogen availability, due to their flooding with low nitrogen coastal waters (Ryther and Dunstan 1971). Though Sesachacha Pond is only occasionally opened to the ocean, the system as a "tidally restricted" coastal embayment presently follows this general pattern, where the primary nutrient of eutrophication in the system is nitrogen.

Nutrient related water quality decline represents one of the most serious threats to the ecological health of the nearshore coastal waters. Coastal embayments, because of their enclosed basins, shallow waters and large shoreline area, are generally the first indicators of nutrient pollution from terrestrial sources. By nature, these systems are highly productive environments, but nutrient over-enrichment of these systems worldwide is resulting in the loss of their aesthetic, economic and commercially valuable attributes.

Each embayment system maintains a capacity to assimilate watershed nitrogen inputs without degradation. However, as loading increases a point is reached at which the capacity (termed assimilative capacity) is exceeded and nutrient related water quality degradation occurs. This point can be termed the "nutrient threshold" and in estuarine management this threshold sets the target nutrient level for restoration or protection. Because nearshore coastal salt ponds and embayments are the primary recipients of nutrients carried via surface and groundwater transport from terrestrial sources, it is clear that activities within the watershed, often miles from the water body itself, can have chronic and long lasting impacts on these fragile coastal environments.

Protection and restoration of coastal embayments from nitrogen overloading has resulted in a focus on determining the assimilative capacity of these aquatic systems for nitrogen. While this effort is ongoing (e.g. USEPA TMDL studies), southeastern Massachusetts has been the site of intensive efforts in this area (Eichner et al., 1998, Costa et al., 1992 and in press, Ramsey et al., 1995, Howes and Taylor, 1990, and the Falmouth Coastal Overlay Bylaw). While each approach may be different, they all focus on changes in nitrogen loading from watershed to embayment, and aim at projecting the level of increase in nitrogen concentration within the receiving waters. Each approach depends upon estimates of circulation within the embayment; however, few directly link the watershed and hydrodynamic models, and virtually none include internal recycling of nitrogen (as was done in the present effort). However, determination of the "allowable N concentration increase" or "threshold nitrogen concentration" used in previous studies had a significant uncertainty due to the need for direct linkage of watershed and embayment models and site-specific data. In the present effort we have integrated site-specific data on nitrogen levels and the gradient in N concentration throughout

the Sesachacha Pond System monitored by the Town of Nantucket Water Quality Monitoring Program, with site-specific habitat quality data (D.O., eelgrass, phytoplankton blooms, benthic animals) utilized to refine the general nitrogen thresholds typically used by the Cape Cod Commission, Buzzards Bay Project, and Massachusetts State Regulatory Agencies.

Unfortunately, Sesachacha Pond is presently beyond its ability to assimilate additional nutrients without further impairing the ecological health of this aquatic resource. This is in significant part due to the very restricted tidal exchange with Atlantic Ocean waters. Nitrogen levels are elevated, eelgrass beds have not been observed within Sesachacha Pond for the past half century or longer and there are large summer phytoplankton blooms and periodic hypoxia of bottom waters. The result is that nitrogen management of the Sesachacha Pond system is aimed at restoration, not protection or maintenance of existing conditions. In general, nutrient over-fertilization is termed “eutrophication” and when the nutrient loading is primarily from human activities, “cultural eutrophication”. Although the influence of human-induced changes has increased nitrogen loading to the systems and contributed to the degradation in ecological health, it is possible in systems like Sesachacha Pond that eutrophication occurs with only minor influence of humankind, which must be considered in the nutrient threshold analysis. While this finding would not change the need for restoration, it would change the approach and potential targets for management. As part of future restoration efforts, it is important to understand that it may not be possible to turn each embayment into a “pristine” system. In addition, to the impairment of Sesachacha Pond’s sub-tidal habitats, there has been a loss of emergent salt marsh from the system stemming from the restricted tidal exchange in recent years.

## I.4 WATER QUALITY MODELING

Evaluation of upland nitrogen loading provides important “boundary conditions” (e.g. watershed derived and offshore nutrient inputs) for water quality modeling of the Sesachacha Pond System; however, a thorough understanding of hydrodynamics is required to accurately determine nitrogen concentrations within each system. Therefore, water quality modeling of even periodically tidal estuaries must include a thorough evaluation of the hydrodynamics. Estuarine hydrodynamics control a variety of coastal processes including tidal flushing, pollutant dispersion, tidal currents, sedimentation, erosion, and water levels. Numerical models provide a cost-effective method for evaluating tidal hydrodynamics since they require limited data collection and may be utilized to numerically assess a range of management alternatives. Once the hydrodynamics of an estuary system are understood, computations regarding the related coastal processes become relatively straightforward extensions to the hydrodynamic modeling. The spread of pollutants may be analyzed from tidal current information developed by the numerical models. In the case of Sesachacha Pond, the hydrodynamic analysis is tailored to the fact that the pond is essentially a closed system for larger periods of the year with periodic openings that drive the circulation, mixing and exchange of pond waters with Atlantic Ocean water.

The MEP water quality evaluation examined the potential impacts of nitrogen loading into Sesachacha Pond under a variety of nitrogen input (loading) and hydrodynamic conditions (breaches of the barrier beach). A two-dimensional depth-averaged hydrodynamic model based upon the tidal currents resulting from barrier beach breaching, groundwater inflow to the pond and water elevations (both actual and projected under various breaching scenarios) was employed. Once the hydrodynamic properties of the estuarine system were computed, two-dimensional water quality model simulations were used to predict the dispersion of the nitrogen at current loading rates.

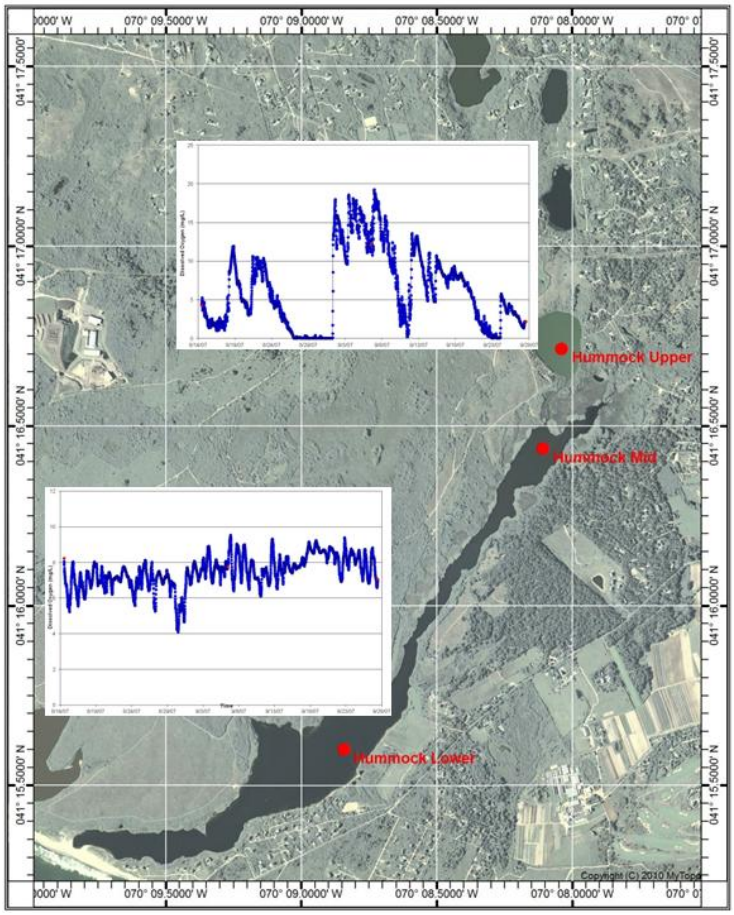
Using standard dispersion relationships for estuarine systems of this type, the water quality model and the hydrodynamic models were then integrated in order to generate estimates regarding the spread of total nitrogen from the site-specific hydrodynamic properties. The distributions of nitrogen loads from watershed sources were determined from land-use analysis, based upon watershed delineations and groundwater elevations (Section 3). Almost all nitrogen entering the Sesachacha Pond System is transported by freshwater, both through atmospheric deposition and through groundwater discharge. Concentrations of total nitrogen and salinity of Atlantic Ocean source waters and throughout Sesachacha Pond were taken from the Water Quality Monitoring Program (a coordinated effort between the Town of Nantucket, Coastal Systems Program at SMAST and others). Measurements of current salinity and nitrogen and salinity distributions throughout estuarine waters of the Systems (2000-2005), coupled to long-term salinity records were used to calibrate and validate the water quality model (under existing loading conditions).

## I.5 REPORT DESCRIPTION

This report presents the results generated from the implementation of the Massachusetts Estuaries Project linked watershed-embayment approach to the Sesachacha Pond System for the Town of Nantucket. A review of existing water quality studies is provided (Section II). The development of the watershed delineations and associated detailed land use analysis for watershed based nitrogen loading to the coastal system is described in Sections III and IV. In addition, nitrogen input parameters to the water quality model are described. Since benthic flux of nitrogen from bottom sediments is a critical (but often overlooked) component of nitrogen loading to shallow estuarine systems, determination of the site-specific magnitude of this component also was performed (Section IV). Nitrogen loads from the watershed and sub-watershed surrounding the estuary were derived from Cape Cod Commission, Town of Nantucket Planning Department and the Nantucket Land Council data. Offshore water column nitrogen values were derived from an analysis of monitoring stations in Nantucket Sound and the Atlantic Ocean (Section IV). Intrinsic to the calibration and validation of the linked-watershed embayment modeling approach is the collection of background water quality monitoring data (conducted by municipalities) as discussed in Section IV. Results of hydrodynamic modeling of embayment circulation are discussed in Section V and nitrogen (water quality) modeling, as well as an analysis of how the measured nitrogen levels correlate to observed estuarine water quality are described in Section VI. This analysis includes modeling of current conditions, conditions at watershed build-out, and with removal of anthropogenic nitrogen sources. In addition, an ecological assessment of the component sub-embayments was performed that included a review of existing water quality information and the results of a benthic analysis (Section VII). The modeling and assessment information is synthesized and nitrogen threshold levels developed for restoration of the Estuary in Section VIII. Additional modeling is conducted to produce an example of the type of watershed nitrogen reduction required to meet the determined Bay threshold for restoration. This latter assessment represents only one of many solutions and is produced to assist the Town in developing a variety of alternative restoration options for this system. Finally, analyses of the Sesachacha Pond System were relative to potential alterations of circulation and flushing, including an analysis to identify hydrodynamic idiosyncrasies of the pond and an examination of various breach options to improve nitrogen related water quality (and wetland communities). The results of the nitrogen modeling for each scenario have been presented (Section VIII).

# Massachusetts Estuaries Project

## Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Hummock Pond Estuarine System, Town of Nantucket, MA




**University of Massachusetts Dartmouth**
**School of Marine Science and Technology**

**Massachusetts Department of**
**Environmental Protection**

***DRAFT REPORT – December 2013***

# Massachusetts Estuaries Project

# Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Hummock Pond System, Towns of Nantucket, MA

**DRAFT REPORT –DECEMBER 2013**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# Massachusetts Estuaries Project

# Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Hummock Pond, Nantucket, Massachusetts

# Executive Summary

## 1. Background

This report presents the results generated from the implementation of the Massachusetts Estuaries Project's Linked Watershed-Embayment Approach to the Hummock Pond embayment system, a coastal embayment of the Island of Nantucket within the Town of Nantucket, Massachusetts. Analyses of the Hummock Pond embayment system was performed to assist the Town with up-coming nitrogen management decisions associated with the Towns' current update of its Comprehensive Wastewater Management Plan (CWMP), as well as wetland restoration, anadromous fish runs, shell fishery, and open-space maintenance programs. As part of the MEP approach, habitat assessment was conducted on the embayment based upon available water quality monitoring data, historical changes in eelgrass/macroalgal distribution, time-series water column oxygen measurements, and benthic community structure. Nitrogen loading thresholds for use as goals for watershed nitrogen management are the major product of the MEP effort. In this way, the MEP offers a science-based management approach to support the Town of Nantucket resource planning and decision-making process. The primary products of this effort are: (1) a current quantitative assessment of the nutrient related health of the Hummock Pond embayment, (2) identification of all nitrogen sources (and their respective N loads) to embayment waters, (3) nitrogen threshold levels for maintaining Massachusetts Water Quality Standards within embayment waters, (4) analysis of watershed nitrogen loading reduction to achieve the N threshold concentrations in embayment waters, and (5) a functional calibrated and validated Linked Watershed-Embayment modeling tool that can be readily used for evaluation of nitrogen management alternatives (to be developed by the Town) for the restoration of the Hummock Pond embayment system.

***Wastewater Planning:*** As increasing numbers of people occupy coastal watersheds, the associated coastal waters receive increasing pollutant loads. Coastal embayments throughout the Commonwealth of Massachusetts (and along the U.S. eastern seaboard) are becoming nutrient enriched. The elevated nutrients levels are primarily related to the land use impacts associated with the increasing population within the coastal zone over the past half-century.

The regional effects of both nutrient loading and bacterial contamination span the spectrum from environmental to socio-economic impacts and have direct consequences to the culture, economy, and tax base of Massachusetts's coastal communities. The primary nutrient causing the increasing impairment of our coastal embayments is nitrogen, with its primary sources being wastewater disposal, and nonpoint source runoff that carries nitrogen (e.g. fertilizers) from a range of other sources. Nitrogen related water quality decline represents one of the most serious threats to the ecological health of the nearshore coastal waters. Coastal embayments, because of their shallow nature and large shoreline area, are generally the first coastal systems to show the effect of nutrient pollution from terrestrial sources.

In particular, the Hummock Pond embayment system within the Town of Nantucket is showing clear signs of eutrophication (over enrichment) from extremely limited tidal exchange with clean Atlantic Ocean water, atmospheric deposition, flux of nutrients from bottom sediments, as well as and to a lesser extent, enhanced nitrogen loads entering through groundwater from the gradually increasing development of the watershed to this coastal system. Eutrophication is a process that occurs naturally and gradually over a period of tens or hundreds of years. However, human-related (anthropogenic) sources of nitrogen may be introduced into ecosystems at an accelerated rate that cannot be easily absorbed, resulting in a phenomenon known as cultural eutrophication. In both marine and freshwater systems, cultural eutrophication results in degraded water quality, adverse impacts to ecosystems, and limits on the use of water resources.

The relatively pristine nature of Nantucket's nearshore, Harbor and pond waters has historically been a valuable asset to the island. However, concern over the potential degradation of pond and Harbor water quality began to arise, which resulted in monitoring, scientific investigations and management planning which continues to this day. While Hummock Pond presently has a relatively low nitrogen load from its watershed, due to its moderately sized watershed and proportionally large undeveloped areas, it is still significantly impaired by nitrogen enrichment and is clearly eutrophic (e.g. Head of Hummock). This apparent paradox results from its very low tidal exchange rate, resulting from barrier beach processes closing the inlet to the Atlantic Ocean on an annual basis. The highly restricted "flushing" of pond waters per annum serves to greatly increase the nitrogen sensitivity of this system, such that even low rates of nitrogen loading cause eutrophic conditions. The difficulty in achieving adequate tidal exchange during any given opening attempt has resulted in the present ecological impairment of the Hummock Pond System. The low rate of nitrogen removal through tidal flushing results in high nitrogen levels, large phytoplankton blooms and periodic anoxia of bottom waters. As such, the Town of Nantucket and work groups have long ago recognized that a rigorous scientific approach yielding site-specific nitrogen loading targets was required for decision-making, alternatives analysis and ultimately, habitat restoration. The completion of this multi-step process has taken place under the programmatic umbrella of the Massachusetts Estuaries Project, which is a partnership effort between all MEP collaborators and the Town. The modeling tools developed as part of this program provide the quantitative information necessary for the Towns' nutrient management groups to predict the impacts on water quality from a variety of proposed management scenarios.

***Nitrogen Loading Thresholds and Watershed Nitrogen Management:*** Realizing the need for scientifically defensible management tools has resulted in a focus on determining the aquatic system's assimilative capacity for nitrogen. The highest-level approach is to directly link the watershed nitrogen inputs with embayment hydrodynamics to produce water quality results that can be validated by water quality monitoring programs. This approach when linked to state-of-the-art habitat assessments yields accurate determination of the "allowable N concentration

increase" or "threshold nitrogen concentration". These determined nitrogen concentrations are then directly relatable to the watershed nitrogen loading, which also accounts for the spatial distribution of the nitrogen sources, not just the total load. As such, changes in nitrogen load from differing parts of the embayment watershed can be evaluated relative to the degree to which those load changes drive embayment water column nitrogen concentrations toward the "threshold" for the embayment system. To increase certainty, the "Linked" Model is independently calibrated and validated for each embayment.

***Massachusetts Estuaries Project Approach:*** The Massachusetts Department of Environmental Protection (DEP), the University of Massachusetts – Dartmouth School of Marine Science and Technology (SMAST), and others including the Cape Cod Commission (CCC) have undertaken the task of providing a quantitative tool to communities throughout southeastern Massachusetts and the Islands (the Linked Watershed-Embayment Management Model) for nutrient management in their coastal embayment systems. Ultimately, use of the Linked Watershed-Embayment Management Model tool by municipalities in the region results in effective screening of nitrogen reduction approaches and eventual restoration and protection of valuable coastal resources. The MEP provides technical guidance in support of policies on nitrogen loading to embayments, wastewater management decisions, and establishment of nitrogen Total Maximum Daily Loads (TMDLs). A TMDL represents the greatest amount of a pollutant that a waterbody can accept and still meet water quality standards for protecting public health and maintaining the designated beneficial uses of those waters for drinking, swimming, recreation and fishing. The MEP modeling approach assesses available options for meeting selected nitrogen goals that are protective of embayment health and achieve water quality standards.

The core of the Massachusetts Estuaries Project analytical method is the Linked Watershed-Embayment Management Modeling Approach, which links watershed inputs with embayment circulation and nitrogen characteristics.

The Linked Model builds on well-accepted basic watershed nitrogen loading approaches such as those used in the Buzzards Bay Project, the CCC models, and other relevant models. However, the Linked Model differs from other nitrogen management models in that it:

- requires site-specific measurements within each watershed and embayment;
- uses realistic "best-estimates" of nitrogen loads from each land-use (as opposed to loads with built-in "safety factors" like Title 5 design loads);
- spatially distributes the watershed nitrogen loading to the embayment;
- accounts for nitrogen attenuation during transport to the embayment;
- includes a 2D or 3D embayment circulation model depending on embayment structure;
- accounts for basin structure, tidal variations, and dispersion within the embayment;
- includes nitrogen regenerated within the embayment;
- is validated by both independent hydrodynamic, nitrogen concentration, and ecological data;
- is calibrated and validated with field data prior to generation of "what if" scenarios.

The Linked Model Approach's greatest assets are its ability to be clearly calibrated and validated, and its utility as a management tool for testing "what if" scenarios for evaluating watershed nitrogen management options.

For a comprehensive description of the Linked Model, please refer to the *Full Report: Nitrogen Modeling to Support Watershed Management: Comparison of Approaches and Sensitivity Analysis*, available for download at http://www.state.ma.us/dep/smerp/smerp.htm. A more basic discussion of the Linked Model is also provided in Appendix F of the *Massachusetts Estuaries Project Embayment Restoration Guidance for Implementation Strategies*, available for download at http://www.state.ma.us/dep/smerp/smerp.htm. The Linked Model suggests which management solutions will adequately protect or restore embayment water quality by enabling towns to test specific management scenarios and weigh the resulting water quality impact against the cost of that approach. In addition to the management scenarios modeled for this report, the Linked Model can be used to evaluate additional management scenarios and may be updated to reflect future changes in land-use within an embayment watershed or changing embayment characteristics. In addition, since the Model uses a holistic approach (the entire watershed, embayment and tidal source waters), it can be used to evaluate all projects as they relate directly or indirectly to water quality conditions within its geographic boundaries. Unlike many approaches, the Linked Model accounts for nutrient sources, attenuation, and recycling and variations in tidal hydrodynamics and accommodates the spatial distribution of these processes. For an overview of several management scenarios that may be employed to restore embayment water quality, see *Massachusetts Estuaries Project Embayment Restoration Guidance for Implementation Strategies*, available for download at http://www.state.ma.us/dep/smerp/smerp.htm.

***Application of MEP Approach:*** The Linked Model was applied to the Hummock Pond embayment system by using site-specific data collected by the MEP and water quality data from the Water Quality Monitoring Program conducted by the Nantucket Marine Department, with technical guidance from the Coastal Systems Program at SMAST (see Section II). Evaluation of upland nitrogen loading was conducted by the MEP. Estuaries Project staff obtained digital parcel and tax assessors data from the Town of Nantucket Geographic Information Systems Department, watershed specific water use data from the Wannacomet Water Company (WWC) and watershed boundaries adopted by the town as the Harbor Watershed Protection District (http://www.nantucket-ma.gov). During the development of the Nantucket Water Resources Management Plan, an island-wide groundwater mapping project, using many of the USGS wells on the Island, was completed to characterize the water table configuration of Nantucket (Horsley, Witten, Hegeman, 1990). MEP staff compared the Hummock Pond watershed that was approved as part of the Nantucket Water Resources Management Plan (HWH, 1990) to available information on the configuration of Hummock Pond, including the now “permanent” separation of Hummock Pond and Clark Cove into two systems, the location of the barrier beach, the wetlands in the area, water level measurements in Hummock Pond and HWH (1990) regional water table mapping. Review of the most current (1977) USGS quadrangle of the area shows Hummock Pond and Clark Cove joined near their southern ends and in the vicinity of the barrier beach. However, recent aerial photographs show that Hummock Pond and Clark Cove have been separate systems since at least March 1995 (Google Earth). Indicating that overwash from storms between 20 and 40 years B.P. filled the channel and have built a barrier to flow that will not easily be removed. Based on the review of aerial photographs, MEP staff modified the 1990 combined Hummock Pond/Clark Cove watershed to delineate a watershed to only Hummock Pond.

Estuary watershed delineations completed in areas with relatively transmissive sand and gravel deposits, like most of Cape Cod and the Islands, have shown that watershed boundaries are usually better defined by elevation of the groundwater and its direction of flow, rather than by land surface topography (Cambareri and Eichner 1998, Millham and Howes 1994a,b). This approach was used by Horsley, Witten and Hegeman, Inc. (HWH) to complete the watershed

delineations for Nantucket including Hummock Pond (Section III); this watershed delineation was been largely confirmed by subsequent water table characterizations (*e.g.*, Lurbano, 2001, Gardner and Vogel, 2005). MEP staff compared the HWH Harbor watershed to a more current aerial base maps (1995 - 2012). This comparison found some slight discrepancies likely based on a better characterization of the shoreline; changes were made based on best professional judgment and watershed/water table characterization experience in similar geologic settings

The land-use data obtained from the Town was used to determine watershed nitrogen loads within the Hummock Pond embayment system (current and build-out loads are summarized in Section IV). Water quality within an embayment is the integration of nitrogen loads with the site-specific estuarine circulation. Therefore, water quality modeling of this estuarine system, which is periodically open to tidal forcing, included a thorough evaluation of the hydrodynamics of the estuarine system. Estuarine hydrodynamics control a variety of coastal processes including tidal flushing, pollutant dispersion, tidal currents, sedimentation, erosion, and water levels. Once the hydrodynamics of the system was quantified, transport of nitrogen was evaluated from tidal current information (during breach events) developed by the numerical models.

A two-dimensional depth-averaged hydrodynamic model based upon the tidal currents during breach events and water elevations was employed for the Hummock Pond embayment system. Once the hydrodynamic properties of the estuarine system were computed, two-dimensional water quality model simulations were used to predict the dispersion of the nitrogen at current loading rates. Using standard dispersion relationships for estuarine systems of this type, the water quality model and the hydrodynamic model was then integrated in order to generate estimates regarding the spread of total nitrogen from the site-specific hydrodynamic properties. The distributions of nitrogen loads from watershed sources were determined from land-use analysis. Boundary nutrient concentrations in Atlantic Ocean source waters were taken from water quality monitoring data. Measurements of current salinity distributions throughout the estuarine waters of the Hummock Pond embayment system was used to calibrate the water quality model, with validation using measured nitrogen concentrations (under existing loading conditions). The underlying hydrodynamic model was calibrated and validated independently using water elevations measured in time series throughout the embayments.

***MEP Nitrogen Thresholds Analysis:*** The threshold nitrogen level for an embayment represents the average water column concentration of nitrogen that will support the habitat quality being sought. The water column nitrogen level is ultimately controlled by the watershed nitrogen load and the nitrogen concentration in the inflowing tidal waters during breach events (boundary condition). The water column nitrogen concentration is modified by the extent of sediment regeneration. Threshold nitrogen levels for the embayment systems in this study were developed to restore or maintain SA waters or high habitat quality. High habitat quality was defined as supportive of infaunal communities. Dissolved oxygen and chlorophyll a were also considered in the assessment.

After developing the dispersion-mass balance model of Hummock Pond to simulate conditions that exist as a result of present management practices, the model was used to simulate a modified management approach that could be followed to improve water quality conditions in the pond year-round. The habitat quality in Hummock Pond has been historically moderate to poor, depending on the intensity of management, specifically the frequency and duration of openings to the ocean. To that effect, with a goal of seeking further improvements in water quality conditions in the Pond, an alternate management scheme was modeled using the dispersion-mass balance model developed for Hummock Pond. One goal of this proposed

management scenario is to convert the Head of Hummock into a freshwater pond year round in order to better manage water quality in the Head of Hummock Pond and also improve its function as a natural attenuator of nitrogen. Another goal is to reduce TN concentrations in the main body of Hummock Pond during the summer months, when benthic regeneration and algae production is greatest. A simple way to achieve these goals is to reduce load to the pond while also modifying the breaching schedule of the pond each year (Section V and VI).

The Massachusetts Estuaries Project's thresholds analysis, as presented in this technical report, provides the site-specific nitrogen reduction guidelines for nitrogen management of the Hummock Pond embayment system in the Town of Nantucket. Future water quality modeling scenarios should be run which incorporate the spectrum of strategies that result in nitrogen loading reduction to the embayment. For the current analysis, the MEP modeling team has initially focused upon modifying the breaching schedule for the Pond as a means of reaching a threshold water column nitrogen concentration supportive of infauna.

## 2. Problem Assessment (Current Conditions)

A habitat assessment was conducted throughout the Hummock Pond system based upon available water quality monitoring data, distribution of macroalgae, time-series water column oxygen measurements, and benthic community structure. At present, eelgrass is not found within Hummock Pond. The current lack of eelgrass beds is expected given the high chlorophyll a and low dissolved oxygen levels as well as water column nitrogen concentrations within this system. In addition, it does not appear that eelgrass beds have been present in this system at any time over the past century, due to the systems only periodic tidal exchange and "naturally" nitrogen enriched condition. Therefore, habitat restoration in this eutrophic system should focus on infaunal habitat quality.

The effect of nitrogen enrichment and extremely limited tidal flushing as is the case in Hummock Pond is to cause oxygen depletion; however, with increased phytoplankton (or epibenthic algae) production, oxygen levels will rise in daylight to above atmospheric equilibration levels in shallow systems (generally ~7-8 mg $L^{-1}$ at the mooring sites). The dissolved oxygen records indicate that the Hummock Pond system is currently under seasonal oxygen stress, consistent with its significant nitrogen enrichment. The oxygen records obtained from Hummock Pond show that the lower main basin of the system has moderate daily oxygen excursions, indicative of moderate nitrogen enrichment which gradually increases moving towards Head of Hummock. The evidence of oxygen levels slightly above atmospheric equilibration indicates that the main basin of the system is moderately nitrogen enriched whereas oxygen levels well above atmospheric equilibration in the Head of Hummock indicates this portion of the system is highly nitrogen enriched. However, in general in the lower portion of the main basin, the daily excursions reach upper concentrations approximating atmospheric equilibrium with a moderate number of significantly higher excursions, consistent with moderate nitrogen enrichment. Note that high levels of nitrogen enrichment can result in phytoplankton blooms that generate D.O. levels routinely in the 10-12 mg $L^{-1}$ range or higher at mid-day as observed in the Head of Hummock.

At present, eelgrass is not found within Hummock Pond. The current lack of eelgrass beds is expected given the high chlorophyll a and low dissolved oxygen levels as well as water column nitrogen concentrations within this system. In addition, it does not appear that eelgrass beds have been present in this system at any time over the past century, due to the systems

only periodic tidal exchange and "naturally" nitrogen enriched condition. Therefore, habitat restoration in this eutrophic system should focus on infaunal habitat quality.

Hummock Pond is presently supporting significantly to moderately degraded benthic infauna habitat quality. Hummock Pond is supporting a gradient in impairment from significantly impaired in the upper basin to moderately impaired in the lowest reach near the barrier beach. However, the tributary basin of Head of Hummock is currently supporting severely degraded habitat with no marine invertebrates and only 2 species of insect larvae. Head of Hummock contains lower salinity water than the Hummock Pond main basin, likely due to its function as a drown kettle pond in the uppermost reach of the system. As such, Head of Hummock is the focus of groundwater discharge from the watershed and as the entire system is usually without tidal currents, mixing is limited. The salinity of Head of Hummock is low enough (<5 ppt) to influence the plant and animal species present, although estuarine benthic animal communities are fully capable of colonizing at salinities to 3 ppt. However, the Head of Hummock basin is virtually devoid of benthic animals, only supporting 2 insect larval species and no estuarine infauna. In contrast, the main basin of Hummock Pond, does currently support benthic animal communities, even in the same salinity range as Head of Hummock. Therefore, the loss of benthic animals in Head of Hummock appears to be related to the high organic matter loading and periodic anoxia, rather than the low salinity (as was also observed in Oyster Pond, Falmouth).

## 3. Conclusions of the Analysis

The threshold nitrogen level for an embayment represents the average watercolumn concentration of nitrogen that will support the habitat quality being sought. The watercolumn nitrogen level is ultimately controlled by the integration of the watershed nitrogen load, the nitrogen concentration in the inflowing tidal waters (boundary condition) and dilution and flushing via tidal flows during breach events. The water column nitrogen concentration is modified by the extent of sediment regeneration and by direct atmospheric deposition.

Threshold nitrogen levels for this embayment system were developed to restore or maintain SA waters or high habitat quality. In this system, high habitat quality was defined as supportive of diverse benthic animal communities. Dissolved oxygen and chlorophyll *a* were also considered in the assessment.

Watershed nitrogen loads (Tables ES-1 and ES-2) for the Town of Nantucket, Hummock Pond embayment system was comprised primarily of runoff from natural surfaces, load directly to the waterbody surface, nitrogen from farm animals and wastewater nitrogen. Land-use and wastewater analysis found that generally about 81% of the controllable watershed nitrogen load to the embayment was from wastewater and 6 percent was from farm animals in the watershed.

A major finding of the MEP clearly indicates that a single total nitrogen threshold can not be applied to Massachusetts' estuaries, based upon the results of the Nantucket Harbor analysis as well as that completed for Sesachacha Pond, Madaket Harbor and Long Pond, in addition to analyses conducted across Martha's Vineyard and Cape Cod (e.g. Great, Green and Bournes Pond Systems, Popponesset Bay System, the Hamblin / Jehu Pond / Quashnet River analysis in eastern Waquoit Bay, the analysis of the adjacent Rushy Marsh system and the Pleasant Bay and Nantucket Sound embayments associated with the Town of Chatham).

The threshold nitrogen level for the Hummock Pond embayment system in Nantucket was determined as follows:

***Hummock Pond Threshold Nitrogen Concentrations***

- With a goal of seeking further improvements in water quality conditions in the Pond, an alternate management scheme was modeled using the dispersion-mass balance model developed for Hummock Pond. One goal of this proposed management scenario is to maintain the Head of Hummock Pond as a freshwater feature year round. Another goal is to reduce TN concentrations in the main basin of Hummock Pond during the summer months, when benthic regeneration and algae production is greatest. Both of these goals are related, as better flushing management results in both higher salinities and lower nitrogen levels in pond waters. A simple way to achieve these goals is to add an additional mid-summer breach event each year.

- A significant improvement in the nitrogen related health of Hummock Pond infaunal animal habitat would result from the modeled addition of a mid summer opening. It would be possible to use the monthly monitoring data to indicate when the mid-summer breach should occur. Total nitrogen levels within the upper basin (Head of Hummock) >1.0 mg N $L^{-1}$ is a level associated with impoverished and degraded benthic animal habitat in other southeastern Massachusetts estuaries. Benthic communities have been found to be impaired at TN levels lower than found in Hummock Pond, e.g. Falmouth Inner Harbor, 0.58 mg TN $L^{-1}$, Fiddlers Cove and Rands Harbor, 0.56 mg TN $L^{-1}$ and 0.57 mg TN $L^{-1}$, respectively. It appears that Hummock Pond (particularly the Head of Hummock Pond) is well beyond its threshold TN level to support healthy benthic habitat. As there is no evidence of present or historic eelgrass beds within the Hummock Pond Estuary, management actions should focus on restoration of benthic animal habitat.

- A sentinel station was established for the Hummock Pond Estuary for development of a nitrogen threshold target that when met will restore benthic animal habitat throughout its estuarine reach. Since there is a relatively small gradient in nitrogen in the main basin, the sentinel station was selected at the basin's mid-point, which reflects the average conditions within Hummock Pond. The sentinel station for Head of Hummock was established at the long-term monitoring station 3 (HUM-3). The average total nitrogen levels at the sentinel station are currently 0.72 mg N $L^{-1}$. It should be noted that the freshening of Head of Hummock must be managed as part of restoration of benthic animal habitat in this estuary. This TN level is comparable to other estuarine basins throughout the region that show similar levels of oxygen depletion, organic enrichment and moderately impaired benthic animal habitat. TN levels >0.70 mg N L-1 are generally characterized as having significantly impaired benthic habitat, phytoplankton blooms and periodic hypoxia and even fish kills (e.g. finger ponds in Falmouth). Given that in numerous estuaries it has been previously and empirically determined that 0.500 mg TN $L^{-1}$ is the upper limit to sustain unimpaired benthic animal habitat (Eel Pond, Parkers River, upper Bass River, upper Great Pond, upper Three Bays, as well as the 7 inner basins of Pleasant Bay) this level is deemed most appropriate for restoration of benthic animal habitat within Hummock Pond.

- It should be noted that the above mentioned management scenarios oriented around altering the timing of breaches of the barrier beach, effective as these may be, are contingent on the ability of the Town of Nantucket to obtain necessary permitting of such

actions. Breaching of the barrier beach is necessarily subject to compliance with applicable federal, state and local statutes and regulations.

It is important to note that the analysis of future nitrogen loading to the Hummock Pond estuarine system focuses upon additional shifts in land-use from forest/grasslands to residential and commercial development. However, the MEP analysis indicates that increases in nitrogen loading can occur under present land-uses, due to shifts in occupancy, shifts from seasonal to year-round usage and increasing use of fertilizers. In the case of the Hummock Pond watershed, these potential increases are likely to be slight. Nevertheless, given the highly over-loaded state of the system, watershed-estuarine nitrogen management should consider management approaches to prevent increased nitrogen loading from both shifts in land-uses (new sources) and from loading increases of current land-uses. The overarching conclusion of the MEP analysis of the Hummock Pond estuarine system is that restoration will necessitate a modified breaching schedule for the pond in order to enhance flushing with low nutrient, clean Atlantic Ocean waters. Reduction in the present nitrogen inputs and management options to negate additional future nitrogen inputs should also be considered in the context of additional breaching.

Table ES-1. Existing total and sub-embayment nitrogen loads to the estuarine waters of the Hummock Pond estuary system, observed nitrogen concentrations, and sentinel system threshold nitrogen concentrations.

| Sub-embayments | Natural Background Watershed Load [1] (kg/day) | Present Land Use Load [2] (kg/day) | Present Septic System Load (kg/day) | Present WWTF Load [3] (kg/day) | Present Watershed Load [4] (kg/day) | Direct Atmospheric Deposition [5] (kg/day) | Present Net Benthic Flux (kg/day) | Present Total Load [6] (kg/day) | Observed TN Conc. [7] (mg/L) | Threshold TN Conc. (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| Hummock Pond | 0.693 | 2.759 | 8.436 | -- | 11.195 | 1.918 | 0.196 | 13.309 | 0.65-0.99 | 0.50 |
| Head of Hummock | 0.137 | 0.315 | 1.366 | -- | 1.682 | 0.208 | 1.321 | 3.211 | 1.63 | -- |
| **Combined Total** | **0.830** | **3.074** | **9.801** | **--** | **12.877** | **2.126** | **1.517** | **16.520** | **0.65-1.63** | **0.50[8]** |

[1] assumes entire watershed is forested (i.e., no anthropogenic sources)
[2] composed of non-wastewater loads, e.g. fertilizer and runoff and natural surfaces and atmospheric deposition to lakes
[3] existing wastewater treatment facility discharges to groundwater
[4] composed of combined natural background, fertilizer, runoff, and septic system loadings
[5] atmospheric deposition to embayment surface only
[6] composed of natural background, fertilizer, runoff, septic system atmospheric deposition and benthic flux loadings
[7] average of 2011 and 2012 data, ranges show the upper to lower regions (highest-lowest) of the sub-embayment. Individual yearly means and standard deviations in Table VI-1.
[8] Average concentration through summer months at water quality monitoring station HUM-3, achieved by load reduction and successful breaching of the inlet in late spring and mid-summer.

Table ES-2. Present Watershed Loads, Thresholds Loads, and the percent reductions necessary to achieve the Thresholds Loads for the Hummock Pond estuarine system on Nantucket Island.

| Sub-embayments | Present Watershed Load [1] (kg/day) | Target Threshold Watershed Load [2] (kg/day) | Direct Atmospheric Deposition (kg/day) | Benthic Flux Net [3] (kg/day) | TMDL [4] (kg/day) | Percent watershed reductions needed to achieve threshold load levels |
|---|---|---|---|---|---|---|
| Hummock Pond | 11.195 | 4.446 | 1.918 | 0.109 | 6.473 | -60.3% |
| Head of Hummock | 1.682 | 0.383 | 0.208 | 0.473 | 1.064 | -77.2% |
| **Combined Total** | **12.877** | **4.829** | **2.126** | **0.582** | **7.537** | **-62.5%** |

(1) Composed of combined natural background, fertilizer, runoff, and septic system loadings.
(2) Target threshold watershed load is the load from the watershed needed to meet the embayment threshold concentration identified in Table ES-1.
(3) Projected future flux (present rates reduced approximately proportional to watershed load reductions).
(4) Sum of target threshold watershed load, atmospheric deposition load, and benthic flux load.

# ACKNOWLEDGMENTS

The Massachusetts Estuaries Project Technical Team would like to acknowledge the contributions of the many individuals who have worked tirelessly for the restoration and protection of the critical coastal resources of the Hummock Pond System. Without the long term efforts of these stewards, this project and other efforts to manage and restore this estuary would not be possible.

First and foremost is the significant time and effort in data collection and discussion spent by members of the Town of Nantucket Water Quality Monitoring Program conducted by the Town of Nantucket Marine Department with technical, analytical and field support from the Coastal Systems Analytical Facility at SMAST. Of particular note are Dave Fronzuto and past Coordinators, Tracey Sundell and Keith Conant and currently Ms. Tara Riley. These individuals gave of their time to collect nutrient samples from this system over many years and without this information, the present analysis would not have been possible. Similarly, we would like to thank the Hummock Pond Association for its care and concern for the pond and for providing critical information on historic surveys of aquatic vegetation. A special thank you is extended to the Board of Selectmen, Libby Gibson (Town Manager), Kara Buzanoski (Town of Nantucket, Director, Department of Public Works) and Richard Ray of the Town of Nantucket Health Department for all the assistance provided over the years thus making this report as site-specific as possible. In addition, over the years, the Town of Nantucket Shellfish and Marine Department has worked tirelessly with SMAST Coastal Systems Staff and engineers from Applied Coastal Research and Engineering towards the development of a restoration and management strategy for this system and systems island-wide. The Marine Department has also provided important support to the present MEP effort. The technical team would also like to specifically acknowledge the efforts of Cormac Collier of the Nantucket Land Council and Andrew Vorce, Director of the Nantucket Planning and Economic Development Commission for facilitating the land use analysis effort within the MEP. We would also like to thank Rosemary Blacquier (Woodard and Curran), who has been instrumental to getting this analysis funded and who has facilitated obtaining historical data sets that nobody else seemed capable of finding as well as Dr. Sarah Oktay from the University of Massachusetts-Boston, Nantucket Field Station.

In addition to numerous local contributions, technical, policy and regulatory support has been freely and graciously provided by MaryJo Feurbach and Art Clark of the USEPA; and our MassDEP colleagues: Rick Dunn, Dave DeLorenzo, Geri Lambert and Brian Dudley. We are also thankful for the long hours in the field and laboratory spent by the technical staff (Jennifer Benson, Michael Bartlett, Sara Sampieri and Dahlia Medieros), interns and students within the Coastal Systems Program at SMAST-UMD both to support the water quality monitoring program and the assessment of the estuarine resources of Hummock Pond.

Support for this project was provided entirely by the Town of Nantucket and its taxpayers as well as generous patrons of Hummock Pond, specifically Bob Williams, President of and representative for individuals of the Hummock Pond Association in addition to Cormac Collier and the Nantucket Land Council.

## PROPER CITATION

Howes B.L., S. Kelley, , E.M. Eichner, R.I. Samimy, D.R. Schlezinger J. Ramsey (2013). Linked Watershed-Embayment Model to Determine the Critical Nitrogen Loading Threshold for Hummock Pond, Massachusetts. SMAST/DEP Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA.

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# Table of Contents

**I. INTRODUCTION ..... 1**

I.1 THE MASSACHUSETTS ESTUARIES PROJECT APPROACH ..... 5

I.2 NUTRIENT LOADING ..... 8

I.3 WATER QUALITY MODELING ..... 10

I.4 REPORT DESCRIPTION ..... 11

**II. PREVIOUS STUDIES RELATED TO NITROGEN MANAGEMENT ..... 13**

**III. DELINEATION OF WATERSHEDS ..... 24**

III.1 BACKGROUND ..... 24

III.2 HUMMOCK POND CONTRIBUTORY AREAS ..... 24

**IV. WATERSHED NITROGEN LOADING TO EMBAYMENT: LAND USE, STREAM INPUTS, AND SEDIMENT NITROGEN RECYCLING ..... 31**

IV.1 WATERSHED LAND USE BASED NITROGEN LOADING ANALYSIS ..... 31

IV.1.1 Land Use and Water Use Database Preparation ..... 32
IV.1.2 Nitrogen Loading Input Factors ..... 34
IV.1.3 Calculating Nitrogen Loads ..... 39

IV.2 ATTENUATION OF NITROGEN IN SURFACE WATER TRANSPORT ..... 45

IV.2.1 Background and Purpose ..... 45

IV.3 BENTHIC REGENERATION OF NITROGEN IN BOTTOM SEDIMENTS ..... 47

IV.3.1 Sediment-Watercolumn Exchange of Nitrogen ..... 47
IV.3.2 Method for determining sediment-water column nitrogen exchange ..... 48
IV.3.3 Rates of Summer Nitrogen Regeneration from Sediments ..... 50
Hummock Pond ..... 53

**V. HYDRODYNAMIC MODELING ..... 54**

V.1 INTRODUCTION ..... 54

V.1.1 System Physical Setting ..... 55
V.1.2 System Hydrodynamic Setting ..... 55
V.1.3 Pond Management Practices ..... 56

V.2 HYDRODYNAMIC FIELD DATA COLLECTION AND ANALYSIS ..... 56

V.2.1. Bathymetry ..... 56
V.2.2 Tide Data ..... 57

V.3 HYDRODYNAMIC MODEL DEVELOPMENT ..... 62

V.3.1 Modeling flow through a breach ..... 63
V.3.2 RMA-2 Model Theory ..... 64
V.3.3 Model Setup ..... 65
V.3.3.1 Grid generation ..... 65

V.3.3.2 Boundary condition specification ..... 67

V.3.3.3 Calibration ..... 67

V.3.4 Flushing Characteristics ..... 70

**VI. WATER QUALITY MODELING ..... 74**

VI.1 DATA SOURCES FOR THE MODEL ..... 74

VI.1.1 Hydrodynamics and Tidal Flushing in the Embayments ..... 74
VI.1.2 Nitrogen Loading to the Embayments ..... 75
VI.1.3 Measured Nitrogen Concentrations in the Embayments ..... 75

VI.2 MODEL DESCRIPTION AND APPLICATION ..... 75

VI.2.1 Model Formulation ..... 77
VI.2.2 Boundary Condition Specification ..... 78
VI.2.3 Development of Present Conditions Model ..... 78
VI.2.4 Total Nitrogen Model Development ..... 80
VI.2.5 Build-Out and No Anthropogenic Load Scenarios ..... 84
VI.2.5.1 Build-Out ..... 84

VI.2.5.2 No Anthropogenic Load ..... 85

**VII. ASSESSMENT OF EMBAYMENT NUTRIENT RELATED ECOLOGICAL HEALTH ..... 87**

VII.1 OVERVIEW OF BIOLOGICAL HEALTH INDICATORS ..... 87

VII.2 BOTTOM WATER DISSOLVED OXYGEN ..... 88

VII.3 EELGRASS DISTRIBUTION - TEMPORAL ANALYSIS ..... 99

VII.4 BENTHIC INFAUNA ANALYSIS ..... 102

**VIII. CRITICAL NUTRIENT THRESHOLD DETERMINATION AND DEVELOPMENT OF WATER QUALITY TARGETS ..... 108**

VIII.1. ASSESSMENT OF NITROGEN RELATED HABITAT QUALITY ..... 108

VIII.2 THRESHOLD NITROGEN CONCENTRATIONS ..... 111

VIII.3 DEVELOPMENT OF TARGET NITROGEN LOADS ..... 113

**IX.1 FRESH WATER HEAD OF HUMMOCK ..... 116**

IX.2 FRESH WATER HEAD OF HUMMOCK THRESHOLD N LOADING ..... 117

**X. REFERENCES ..... 119**

# List of Figures


Figure I-1. Location of the Hummock Pond system, Island of Nantucket, Town of Nantucket, Massachusetts. Hummock Pond is a significant coastal salt pond, maintained by periodic breaching of the barrier beach to allow exchange with Atlantic Ocean waters. ..... 1

Figure I-2. Study region for the Massachusetts Estuaries Project analysis of the Hummock Pond Embayment System. Tidal waters enter the Pond through periodic breaching of the barrier beach and flow in from the Atlantic Ocean. Freshwaters enter from the watershed primarily through direct groundwater discharge. ..... 3

Figure I-3. Massachusetts Estuaries Project Critical Nutrient Threshold Analytical Approach ..... 9

Figure II-1a. Town of Nantucket Water Quality Monitoring Program. Hummock Pond Estuarine water quality monitoring stations sampled by the Nantucket Marine Department (2002-2007). ..... 15

Figure II-1b. Town of Nantucket Island-wide Water Quality Monitoring Program: Hummock Pond Estuarine water quality monitoring stations sampled by the Nantucket Marine and Coastal Resources Department (2010 and 2012). ..... 16

Figure II-2. Location of shellfish growing areas and their status relative to shellfish harvesting as determined by Mass Division of Marine Fisheries. Closures are generally related to bacterial contamination or "activities", such as the location of marinas. ..... 21

Figure II-3. Estimated Habitats for Rare Wildlife and State Protected Rare Species within the Hummock Pond Estuary as determined by the Massachusetts Natural Heritage and Endangered Species Program (NHESP). ..... 22

Figure II-4. Anadromous fish run within the Hummock Pond Estuary as determined by Mass Division of Marine Fisheries. The red diamond shows area where fish were observed. ..... 23

Figure III-1. Watershed and sub-watershed delineations for the Hummock Pond estuary system. This MEP delineation is based an updated review of HWH (1990) and Town of Nantucket Watershed Protection District delineation, which has a watershed that includes both Hummock Pond and Clark Cove. MEP adjusted the watershed to include only Hummock pond and confirmed the delineation based on measured water level in the pond, wetland delineations and comparison to similar systems in the region. ..... 25

Figure III-2. Comparison of HWH and MEP Watersheds. HWH (1990) watershed includes Clark Cove and a northeastern bulge that includes a wetland system. Review of aerial photos shows that the Cove and Pond have not been hydraulically connected since at least 1995. Review of the wetlands in the upper watershed area shows a nearly radial distribution of streams around its borders, which is consistent with the HWH water table map that showed the regional groundwater divide in this area. ..... 26

Figure III-3. Water Elevations in Hummock Pond follow 2006 and 2012 openings. Data collected by Applied Coastal Research and Engineering and the SMAST Coastal Systems Program. Change in water levels reflects groundwater discharge into Hummock Pond. Comparison of this data with the estimated inflows from the MEP watershed delineation show good agreement and reinforce the reasonableness of the watershed delineation. ..... 28

Figure IV-1. Land-use in the Hummock Pond watershed. The 3 sub-watersheds are delineated by the heavy blue line, the outer blue line encompasses the entire contributing area to the estuary. The watershed is completely contained within the Town of Nantucket. Parcels and land use classifications are based on 2012 assessor's records provided by the town and county and are grouped into the generalized categories used by MADOR (2012). Parcels in the "900s" category are lands owned by the town or non-profit entities, such as land banks or churches. Parcels in the "unknown" category do not have land use classifications in the provided town assessor's database. ..... 33
Figure IV-2. Distribution of land-uses within the 3 subwatersheds and whole system watershed to Hummock Pond. Land use categories are generally based on town assessor's land use classification and groupings recommended by MADOR (2012). Unclassified parcels do not have an assigned land use code in the town assessor's databases. Only percentages greater than or equal to 4% are labeled. ..... 35
Figure IV-3. Land use-specific unattenuated nitrogen load (by percent) to the overall Hummock Pond System watershed. "Overall Load" is the total nitrogen input within the watershed, while the "Local Control Load" represents those nitrogen sources that could potentially be under local regulatory control. ..... 42
Figure IV-4. Developable Parcels in the Hummock Pond watershed. Developable parcels were determined by reviewing minimum lot sizes specified under current town zoning. Initial MEP buildout results were reviewed with the town planner and modified. Parcels colored yellow are developed residential parcels with additional development potential based on existing zoning, while parcel colored green are undeveloped parcels classified as developable for residential land uses by the town assessor. Parcels colored purple do not have assigned land use codes in the town assessor's database, but are classified as developable. ..... 46
Figure IV-5. Hummock Pond embayment system sediment sampling sites (yellow symbols) for determination of nitrogen regeneration rates. Numbers are for reference to Table IV-3. ..... 49
Figure IV-6. Conceptual diagram showing the seasonal variation in sediment N flux, with maximum positive flux (sediment output) occurring in the summer months, and maximum negative flux (sediment up-take) during the winter months. ..... 51
Figure V-1. Topographic map detail of Hummock Pond on the southern shore of Nantucket Island. ..... 54
Figure V-2. Bathymetry survey lines (yellow) and tide locations (red) in Hummock Pond. ..... 58
Figure V-3. Observed water levels at the time of the autumn 2006 breach event. The blue line shows water levels in the pond, while tides recorded offshore of the pond are shown by the black line. ..... 59
Figure V-4. Observed water levels at the time of the autumn 2012 breach event. The blue line shows water levels in the pond, the black line shows tides recorded at the Martha's Vineyard Coastal Observatory. ..... 59
Figure V-5. Example of an observed astronomical tide as the sum of its primary constituents. ..... 60
Figure V-6. Measured tide from the gauge station offshore of Hummock Pond, starting in October 2006, with the computed 22 components of astronomical tide

resulting from the harmonic analysis, and the resulting non-tidal residual water level. ..... 62
Figure V-7. A comparison of the broad-crested weir model results with the recorded pond elevations during a simulated breach of Hummock Pond that is open for one month. This simulation show the likely range of possible tides in the pond after a breaching. ..... 64
Figure V-8. Bathymetry data interpolated to the finite element mesh used with the RMA-2 hydrodynamic model. Contours represent the bottom elevation relative to North American Vertical Datum 1988. The primary data sources used to develop the grid mesh are the February 2012 surveys of the system. ..... 66
Figure V-9. Plot of hydrodynamic model grid mesh for Hummock Pond. Colors are used to designate the different model material types used to vary model calibration parameters and compute flushing rates. ..... 68
Figure V-10. Comparison of results calculated using the breach model (section V.4.1) and the hydrodynamic model of Hummock Pond. The R2 correlation between the two models for the time period shown in the plot is 0.89, with a RMS error of 0.07 feet. ..... 70
Figure V-11. Time variation of computed flow rates for the modeled Hummock Pond breach. Model period shown corresponds to spring tide conditions, where the tide range is the largest, and resulting flow rates are correspondingly large compared to neap tide conditions. Positive flow indicated flooding tide flows into the Pond, while negative flow indicates ebbing tide flows discharging from the pond. ..... 71
Figure VI-1. USGS topographic map showing monitoring station locations in Hummock Pond that were designated by the Nantucket Marine Department. ..... 76
Figure VI-2. Model salinity target values are plotted against measured data, together with the unity line, for the simulation period from June 27 through August 24, 2012. RMS error for this model verification run is 0.9 ppt. ..... 80
Figure VI-3. Plot of salinity contours in Hummock Pond and Black Point Pond at the end of the modeled August 2006 calibration period. ..... 81
Figure VI-4. RMA-4 model output for Hummock Pond showing how pond salinities vary with the number of days open for a breached inlet. Model output is taken at monitoring station HUM-3. Model results also assume a fully open breach for the complete simulation period. ..... 81
Figure VI-5. Model TN target values are plotted against measured concentrations, together with the unity line, for the simulation period from June 27 through August 24, 2012. RMS error for this model verification run is 0.058 mg/L and the $R^2$ correlation coefficient is 0.71. ..... 82
Figure VI-6. Plot of TN contours in Hummock Pond and Black Point Pond at the end of the modeled August 2006 calibration period. ..... 83
Figure VI-7. RMA-4 model output for Hummock Pond showing how pond TN concentrations vary as a function of initial salinity concentration (here for 10, 15 and 20 ppt) and number of days open for the breach. Model output is taken at monitoring station HUM-3. Model results also assume a fully open breach for the complete simulation period. ..... 83
Figure VI-8. Modeled TN concentrations in the main basin of Hummock Pond (at monitoring stations HUM-3) after a simulated four-day open breach and its subsequent closure, with an initial concentration of 0.60 mg/L, for the build-out N loading scenario. ..... 85

Figure VI-9. Modeled TN concentrations in the main basin of Hummock Pond (at monitoring stations HUM-3) after a simulated four-day open breach and its subsequent closure, with an initial concentration of 0.60 mg/L, for the no anthropogenic N loading scenario. ..... 86
Figure VII-1. Example of typical average water column respiration rates (micro-Molar/day) from water collected throughout the Popponesset Bay System, Cape Cod (Schlezinger and Howes, unpublished data). Rates vary ~7 fold from winter to summer as a result of variations in temperature and organic matter availability. ..... 90
Figure VII-2. Aerial Photograph of the Hummock Pond embayment system in the Town of Nantucket showing the location of the continuously recording Dissolved Oxygen / Chlorophyll-*a* sensors deployed during the Summer of 2007.The gauge, "Hummock Pond Upper", is located in Head of Hummock, while the 2 other gauges are located within the upper and lower reaches of the main basin of Hummock Pond. ..... 91
Figure VII-3. Bottom water record of dissolved oxygen in Head of Hummock (Hummock Pond upper station, Figure VII-2), Summer 2007. Calibration samples represented as red dots. ..... 92
Figure VII-4. Bottom water record of Chlorophyll-*a* in the Hummock Pond upper station in Head of Hummock, Summer 2007. Calibration samples represented as red dots. ..... 93
Figure VII-5. Bottom water record of dissolved oxygen at the Hummock Pond middle gauge, Summer 2007. Calibration samples represented as red dots. ..... 93
Figure VII-6. Bottom water record of Chlorophyll-*a* in the Hummock Pond middle gauge, Summer 2007. Calibration samples represented as red dots. ..... 94
Figure VII-7. Bottom water record of dissolved oxygen at the Hummock Pond lower station, Summer 2007. Calibration samples represented as red dots. ..... 94
Figure VII-8. Bottom water record of Chlorophyll-*a* in the Hummock Pond lower station, Summer 2007. Calibration samples represented as red dots. ..... 95
Figure VII-9. Redhead Pondgrass, mixed Redhead Pondgrass and Sago Pondweed. ..... 100
Figure VII-10. Sago Pondweed. ..... 100
Figure VII-11. Eel Grass. ..... 100
Figure VII-12. Coontail. ..... 101
Figure VII-13. Submerged aquatic vegetation survey of the Hummock Pond embayment system showing location of different types of aquatic vegetation observed in 2005 (courtesy of Hummock Pond Association - 2006 Weed Inventory Map). This map and associated data can be obtained by contacting Bob Williams, President HPA, rwilliams@npb.com or Toni Moores, "Chief Weed Watcher" HPA, tonimoores@comcast.net. ..... 102
Figure VII-14. Submerged aquatic vegetation survey of the Hummock Pond embayment system showing location of different types of aquatic vegetation observed in 2006 (courtesy of Hummock Pond Association - 2006 Weed Inventory Map). This map and associated data can be obtained by contacting Bob Williams, President HPA, rwilliams@npb.com or Toni Moores, "Chief Weed Watcher" HPA, tonimoores@comcast.net. ..... 103
Figure VII-15. Aerial photograph of the Hummock Pond embayment system showing location of benthic infaunal sampling stations (yellow symbols) within the main pond basin and Head of Hummock Pond. ..... 104
Figure VII-16. Location of shellfish growing areas and their status relative to shellfish harvesting as determined by Mass Division of Marine Fisheries. Closures

are generally related to bacterial contamination or "activities", such as the location of marinas. ..... 107
Figure VIII-1. Time series of modeled TN concentrations at monitoring station TGP 7 from the threshold model scenario where the pond is breached in late May for four days. ..... 115
Figure IX-1. Modeled TN concentrations in the main basin of Hummock Pond (at monitoring stations HUM-3) after a simulated four-day open breach and its subsequent closure, with an initial concentration of 0.60 mg/L, showing the N attenuation effect of changing Head of Hummock into a fresh water pond, with no other change in watershed loading. ..... 117
Figure IX-2. Modeled TN concentrations in the main basin of Hummock Pond (at monitoring stations HUM-3) after a simulated four-day open breach and its subsequent closure, with an initial concentration of 0.60 mg/L, for the alternate Threshold N loading scenario that includes the attenuation effect of turning Head of Hummock into a fresh water pond. ..... 118

# List of Tables


Table III-1. Daily groundwater discharge from each of the sub-watersheds to the Hummock Pond Estuary. ..... 29

Table IV-1. Primary Nitrogen Loading Factors used in the Hummock Pond MEP analyses. General factors are from MEP modeling evaluation (Howes & Ramsey 2001). Site-specific factors are derived from watershed-specific data. ..... 40

Table IV-2. Hummock Pond Nitrogen Loads. Present nitrogen loads are based on current conditions. Buildout nitrogen loads are based on the additional development allowed under current zoning at minimum lot sizes. Factors used to determine nitrogen loads are discussed in the text. Attenuation assigned to Maxcy Pond is a standard MEP assumption based on data collected from other ponds within the same ecoregion. All values are kg N $yr^{-1}$. ..... 41

Table IV-3. Rates of net nitrogen return from sediments to the overlying waters of the Hummock Pond Basins. These values are combined with the basin areas to determine total nitrogen mass in the water quality model (see Chapter VI). Measurements represent July -August rates. N = number of sites ..... 53

Table V-1. Annual Hummock Pond openings between 1995 and 2007, Town Marine Department records. ..... 56

Table V-2. Tide datums computed from 92-day records collected offshore Hummock Pond starting October 20, 2006. Datum elevations are given relative to the mean sea level reference of the area. ..... 60

Table V-3. Tidal constituents computed for tide station offshore Hummock Pond using the record from October 2006 through January 2007. ..... 61

Table V-4. Percentages of Tidal versus Non-Tidal Energy using a 23 constituent analysis for the full tide record recorded offshore of Hummock Pond between October 20, 2006 and January 19, 2007. ..... 62

Table V-5. Manning's Roughness and eddy viscosity coefficients used in simulations of Hummock Pond. These embayment delineations correspond to the material type areas shown in Figure V-10. ..... 69

Table V-6. Embayment mean volumes and average tidal prism for the Hummock Pond system. ..... 72

Table V-7. Computed System and Local residence times for the whole of the Hummock Pond estuarine system and for the Head of Hummock sub-embayment. ..... 73

Table VI-1. Measured nitrogen concentrations and salinities for Hummock Pond. "Data mean" values are calculated as the average of the separate yearly means. TN data represented in this table were collected in 2010 and 2012. The offshore Atlantic Ocean data (offshore Pleasant Bay Inlet) are from the summer of 2005. ..... 75

Table VI-2. Present conditions sub-embayment and surface water loads used for total nitrogen modeling of Hummock Pond, with total watershed N loads, atmospheric N loads, and benthic flux. ..... 78

Table VI-3. Values of longitudinal dispersion coefficient, E, used in calibrated RMA4 model runs of salinity and nitrogen concentration for the Hummock Pond estuary system. ..... 79

Table VI-4. Comparison of sub-embayment watershed loads used for modeling of present (2003), present 2007, build-out, and no-anthropogenic ("no-load")

loading scenarios of Hummock Pond. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms. ..... 84
Table VI-5. Build-out conditions sub-embayment and surface water loads used for total nitrogen modeling of Hummock Pond, with total watershed N loads, atmospheric N loads, and benthic flux. ..... 84
Table VI-6. No Anthropogenic conditions sub-embayment and surface water loads used for total nitrogen modeling of Hummock Pond, with total watershed N loads, atmospheric N loads, and benthic flux. ..... 85
Table VII-1. Days and percent of time during deployment of *in situ* sensors that bottom water oxygen levels were below various benchmark oxygen levels within the Hummock Pond (including Head of Hummock) Embayment System. ..... 97
Table VII-2. Duration (days and % of deployment time) that chlorophyll-*a* levels exceed various benchmark levels within the Hummock Pond (including Head of Hummock, "upper") Estuary. "Mean" represents the average duration of each event over the benchmark level and "S.D." its standard deviation. Data collected by the Coastal Systems Program, SMAST. ..... 98
Table VII-3. Benthic infaunal community data for the Hummock Pond Embayment System (inclusive of Head of Hummock). Estimates of the number of species adjusted to the number of individuals and diversity (H') and Evenness (E) of the community allow comparison between locations (Samples represent surface area of 0.0625 m2). Stations refer to map in Figure VII-15, Head of Hummock is fresher than Hummock Pond and was colonized by insect larvae (chironomidae, chaoboridae) not estuarine benthic animals. Note the clear gradient in habitat quality from the uppermost to lowermost regions. ..... 105
Table VIII-1. Summary of nutrient related habitat quality within the Hummock Pond Estuary, Town of Nantucket, MA, based upon assessments detailed in Section VII. Head of Hummock is a kettle pond opened via a channel to the upper main basin of Hummock Pond. Hummock Pond is periodically opened to tidal flows, but receives salt water in storm overwash of the barrier beach. ..... 112
Table VIII-2. Comparison of sub-embayment septic loads used for modeling of present and modeled threshold loading scenarios of Hummock Pond. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms. ..... 114
Table VIII-3. Comparison of sub-embayment watershed loads used for modeling of present and modeled threshold loading scenarios of Hummock Pond. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms. ..... 114
Table VIII-4. Sub-embayment and surface water loads used for total nitrogen modeling of threshold conditions for Hummock Pond, with total watershed N loads, atmospheric N loads, and benthic flux. ..... 115
Table IX-1. Comparison of sub-embayment watershed loads used for modeling of present (2003), present 2007, build-out, and no-anthropogenic ("no-load") loading scenarios of Hummock Pond. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms. ..... 118
Table IX-2. Build-out conditions sub-embayment and surface water loads used for total nitrogen modeling of Hummock Pond, with total watershed N loads, atmospheric N loads, and benthic flux. ..... 118

# MEP TECHNICAL MEMORANDUMS ON MODEL RUNS

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********** **Technical Memorandum** **********

**To:** **David Fronzuto, Nantucket Marine Department**
**Richard Ray, Nantucket Health Department**

**From:** **Brian Howes, Director Coastal Systems Program**
**Ed Eichner, Coastal Systems Program**
**Roland Samimy, Coastal Systems Program**
**John Ramsey, Applied Coastal Research & Engineering, Inc.**

**RE:** **Scenarios 1, 2, 3, 4 of Nantucket Harbor MEP Linked Model**
**Date:** **Original: August 23, 2011**
**Updated: January 4, 2012**

**********

The present Technical Memorandum details the results of four (4) Scenario Runs completed using the MEP Linked Watershed-Embayment Model developed for the Nantucket Harbor System. Development of the model and establishment of the nitrogen thresholds for the Nantucket Harbor System are described in the MassDEP/SMAST MEP Nitrogen Threshold Report for the Nantucket Harbor Estuary[1]. These Scenarios are the initial planning runs for this system for the Town of Nantucket. The scenarios focus on nitrogen management strategies within the watershed (scenario 1 and 2), increasing tidal flushing (scenario 3 which elevates the jetties) and a combination of increasing tidal flushing and nitrogen management within the watershed (scenario 4 elevates the jetties and utilizes watershed loading developed for scenario 2). The effects of the watershed and flushing alterations on nitrogen levels throughout the waters of the Nantucket Harbor System are compared to the MEP target nitrogen levels (thresholds) needed to achieve restoration. The scenarios were developed by the Town of Nantucket in order to provide guidance to municipal officials, private citizens and environmental groups to support decisions regarding the nitrogen management planning and load allocation related to the stewardship of this critical coastal system.

At present, historic eelgrass and benthic animal habitat within Nantucket Harbor is showing impairment in the Head of the Harbor and Polpis Harbor sub-basins, although most of the estuary is generally supporting high quality habitat. Impairment stems from nitrogen enrichment due to watershed nitrogen inputs that exceed this estuary's assimilative capacity under its present hydrodynamic regime. As part of nitrogen management planning, the Town of Nantucket is working with the MEP Technical Team (through SMAST) in the use of the MEP Linked Model developed for this estuary.

[1] Howes, B.L., S.W. Kelley, J.S. Ramsey, R.I. Samimy, D.R. Schlezinger, E. Eichner. 2006. Linked Watershed-Embayment Modeling Approach to Determine Critical Nitrogen Loading Thresholds for Nantucket Harbor, Town of Nantucket, MA. Massachusetts Estuaries Project Final Report to Massachusetts Department of Environmental Protection, Boston MA. 168pp.

The two sewering scenarios assume that wastewater is collected in two areas within the Harbor watershed and is then treated and discharged at the existing Town Waste Water Treatment Facility. The third modeling run (scenario 3) focuses on tidal flushing by elevating the main jetties at the Harbor inlet. The fourth modeling run combines the wastewater loading reduction from scenario 2 with the tidal flushing alteration in scenario 3. Details of the scenarios are as follows:

**Scenario 1, Monomoy:**
The MEP Nantucket Harbor linked model was used to evaluate the extent of improvement in nitrogen related water quality that would be achieved by lowering nitrogen loading to the watershed from septic systems through the extension of sewer lines into the Monomoy area (Figure 1) and connecting all dwellings possible. This scenario is based on existing, not buildout, watershed nitrogen loading and model output was assessed relative to the MassDEP TMDL targets for Nantucket Harbor.

**Scenario 2, Monomoy / Shimmo:**
The MEP Nantucket Harbor linked model was used to evaluate the extent of improvement in nitrogen related water quality that would be achieved by lowering nitrogen loading to the watershed from septic systems through the extension of the sewer lines into both the Monomoy and Shimmo areas (see Figure 1) and connecting all dwellings possible. This scenario is based on existing, not buildout, watershed nitrogen loading and model output was assessed relative to the MassDEP TMDL targets for Nantucket Harbor.

**Scenario 3, Elevate jetties:**
The MEP Nantucket Harbor linked model was used to evaluate the extent of improvement in nitrogen related water quality that would be achieved by elevating the jetties to the main tidal inlet of the Harbor to at or above high tide (full tide jetty). This scenario is based on existing watershed nitrogen loading documented in the MEP threshold report and model output was assessed relative to the MassDEP TMDL targets for Nantucket Harbor.

**Scenario 4, Monomoy / Shimmo + elevate jetties:**
The MEP Nantucket Harbor linked model was used to evaluate the extent of improvement in nitrogen related water quality that would be achieved by the combined actions of (a) lowering nitrogen loading to the watershed from septic systems through the extension of sewer lines into Monomoy and Shimmo areas (Scenario 2) plus (b) increased tidal flushing by elevating the jetties to the main tidal inlet of the Harbor to at or above high tide (full tide jetty; Scenario 3). This scenario is based on existing watershed nitrogen loading modification developed in Scenario 2 and model output was assessed relative to the MassDEP TMDL targets for Nantucket Harbor.

**Scenario Results:**

As part of the development of the Monomoy and Shimmo sewering scenarios, MEP staff noted the following watershed/sewer district characteristics:

1. Monomoy sewering scenario (Scenario 1) has 181 new properties to be sewered, all are in the Harbor subwatershed, some are also within the existing sewer district but not connected (see figure 1).

2. Monomoy/Shimmo scenario (Scenario 2) has 443 new properties to be sewered (including the properties in the Monomoy sewering scenario above); 369 are in the Harbor subwatershed & 74 are in the Quaise subwatershed.

3. In the Monomoy scenario (Scenario 1) there are 1,014 properties that remain unsewered in the Town subwatershed, 716 of which are developed or developable.

4. Among the remaining 716 developed or developable properties in the Town subwatershed, 666 are in the existing town sewer district and have either a listing in the database we received from the town as using a septic system (262 parcels)[2] or no listing of wastewater treatment type (404 parcels).

5. Among the 404 properties within the existing sewer district that have no wastewater classification type, 106 of them have town assessor-assigned land use codes that would indicate that they are developed and would need a septic system or sewer connection.

6. Review of the town-supplied databases used in the MEP N loading model indicates that some of the properties with land use classifications that would not automatically mean they have a wastewater system have buildings on them. Adjusting the count with these properties, indicates that the number of potential septic systems inside the sewer district would be close to 400.

7. Connecting the ~400 properties already inside the existing town sewer district would have approximately the same watershed nitrogen loading reduction as the proposed combined sewering of Monomoy/Shimmo. The caveat to this is the need to confirm the listings in the Town database, which might be a useful next step if the Town opts to move in this direction at some time in the future.

The effect of extending the sewer lines into the Monomoy area (Scenario 1) and the combined Monomoy and Shimmo area (Scenario 2) to remove nitrogen loads from existing on-site wastewater septic systems was to lower the watershed nitrogen load to the Nantucket Harbor Town basin (Scenario 1: Table 1) and Town and Quaise basins (Scenario 2: Table 2), respectively. No changes in the watershed nitrogen loads occurred in Scenario 3, only tidal flushing was effected (Table 3). Scenario 4 was the combination of the septic effluent removal in Monomoy and Shimmo (Scenario 2) plus the tidal flushing enhancement (Scenario 3). All scenarios resulted in lower nitrogen levels within the receiving waters of the Harbor (Table 4).

The resulting nitrogen levels within the waters of Nantucket Harbor and its tributary basin, Polpis Harbor, were lower compared to present conditions in all scenarios, with resulting TN levels in:

Scenario 1 > Scenario 2 > Scenario 3 > Scenario 4.

Scenario 4, the combined effect of extending sewers to Monomoy and Shimmo plus elevating the main inlet jetties, results in the greatest level of improvement throughout Nantucket Harbor relative to the TMDL. However, Scenario 3 yields nearly identical results, indicating that almost all of the improvement in the combined Scenario 4 results were due to the increase in tidal flushing resulting from the modification of the jetties. Both Scenario 3 and Scenario 4 attain the threshold nitrogen level/TMDL

[2] Note that connecting these 262 parcels within the existing sewer district (according to the Town database), would have a similar effect on lowering watershed wastewater nitrogen as the reductions proposed in Scenario 1.

(0.350 mg/L TN) at the sentinel station within the Head of the Harbor and both are extremely close to the threshold level/TMDL (0.355 mg/L TN) at the secondary sentinel station within Polpis Harbor. It should also be noted that all of the scenarios (1,2,3,4) are based upon existing, not build-out, conditions, the Town must mitigate any new loads from new development to sustain the improvements in any of the scenarios.

These results indicate that sewer extension to Monomoy and Shimmo areas, alone, is insufficient to meet the threshold targets for restoring Nantucket Harbor's impaired resources. The elevation of the jetties provides more improvement in nitrogen levels, but also is insufficient on its own to meet the threshold nitrogen level/TMDL at ***both*** sentinel stations. Both sewer extension and alteration of hydrodynamics had positive effects on nitrogen levels. It should also be noted that the parcel analysis conducted within the existing Town sewered area indicated that a large number of parcels may not presently be connected to the existing sewer system presenting an opportunity for additional removal of septic nitrogen (if the town database can be confirmed).

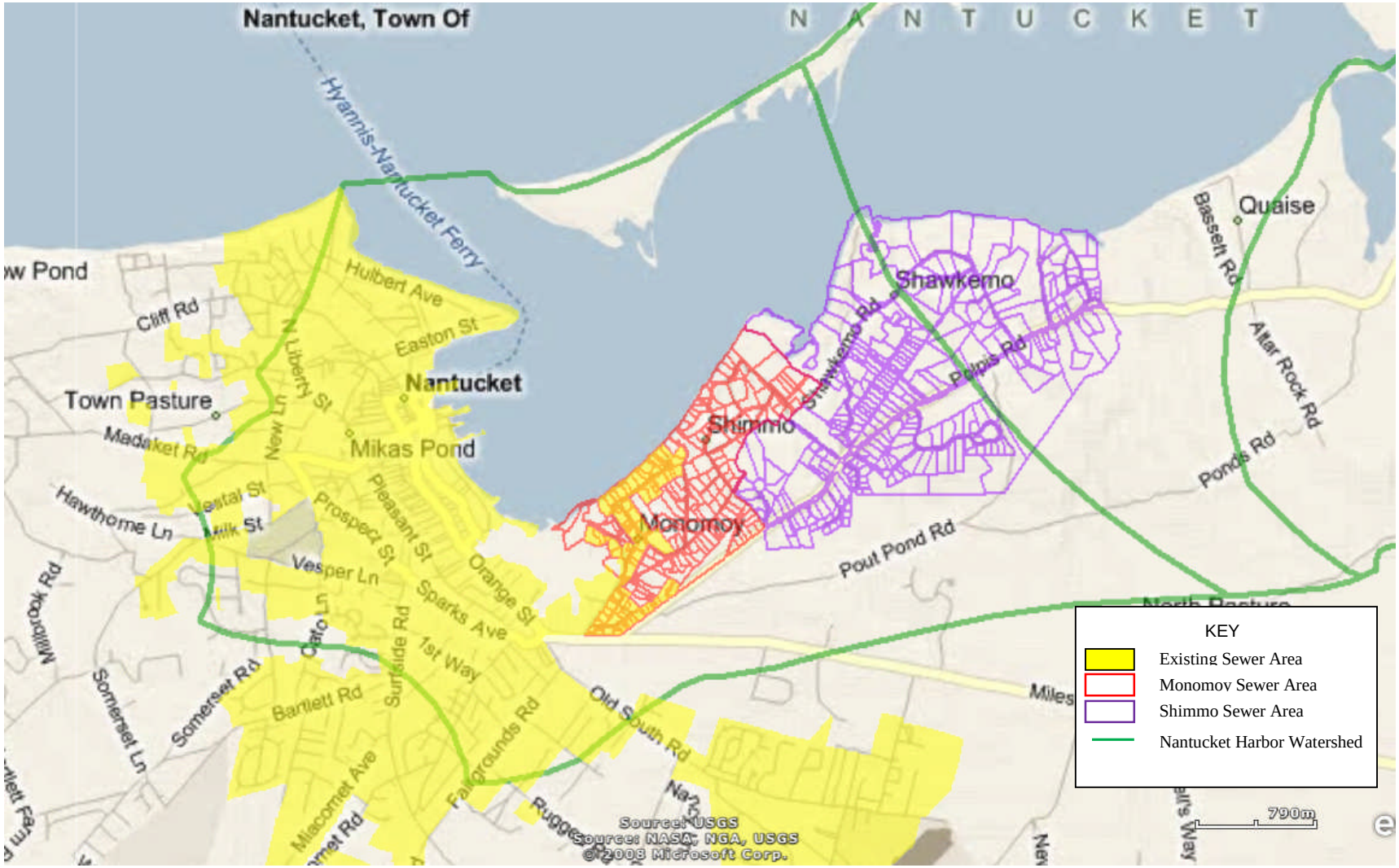


Figure 1. Nantucket Harbor Existing and Proposed Wastewater Collection Areas. The area colored yellow indicates the existing sewer collection area, while the parcels outlined in red are in the Scenario 1/Monomoy collection area and the parcels outlined in purple are in the Shimmo collection area. Scenario 2 combines the Monomoy and Shimmo collection areas. Subwatershed boundaries for Nantucket Harbor are shown in green. Scenario 3 uses existing nitrogen loads and elevates the inlet jetties, increasing tidal flushing. Scenario 4 combines the results of Scenario 2 with elevating the main jetties to the Harbor.

**Table 1.** Nitrogen loads used for Scenario 1. The difference between the present watershed load and Scenario 1 stems from the removal of septic system wastewater nitrogen load from the Monomoy area (Figure 1).

| Subwatershed Area | Present Watershed (kg/day) | Scenario 1 Watershed (kg/day) | Atmospheric (kg/day) | Benthic (kg/day) |
|---|---|---|---|---|
| Head of the Harbor | 1.858 | 1.858 | 22.239 | -17.082 |
| Polpis Harbor | 3.529 | 3.529 | 2.190 | 27.370 |
| Quaise | 2.123 | 2.123 | 20.126 | 43.643 |
| Town | 15.901 | 15.208 | 13.888 | -2.775 |

**Table 2.** Nitrogen loads used for Scenarios 2 and 4. The difference between the present watershed load and Scenario 1 stems from the removal of septic system wastewater nitrogen load from the Monomoy and Shimmo areas (Figure 1).

| Subwatershed Area | Present Watershed (kg/day) | Scenarios 2 & 4 Watershed (kg/day) | Atmospheric (kg/day) | Benthic (kg/day) |
|---|---|---|---|---|
| Head of the Harbor | 1.858 | 1.858 | 22.239 | -16.953 |
| Polpis Harbor | 3.529 | 3.529 | 2.190 | 27.335 |
| Quaise | 2.123 | 1.962 | 20.126 | 43.517 |
| Town | 15.901 | 14.784 | 13.888 | -2.775 |

**Table 3.** Nitrogen loads used for Scenarios 3. Since this scenario only involves the elevation of the jetties, the present watershed nitrogen load, atmospheric load, and benthic flux is the same as used in the MEP Threshold Report assessment of existing conditions.

| Subwatershed Area | Present Watershed (kg/day) | Scenarios 3 Watershed (kg/day) | Atmospheric (kg/day) | Benthic (kg/day) |
|---|---|---|---|---|
| Head of the Harbor | 1.858 | 1.858 | 22.239 | -17.211 |
| Polpis Harbor | 3.529 | 3.529 | 2.190 | 27.441 |
| Quaise | 2.123 | 2.123 | 20.126 | 43.896 |
| Town | 15.901 | 15.901 | 13.888 | -2.793 |

**Table 4.** Results of watershed loading reductions and elevation of jetties detailed as Scenarios 1-4 above. Total nitrogen concentrations at each water quality station under present conditions and for each scenario are presented in mg/L. Sentinel stations (stations 2.1 and 4) are shown in bold. TN threshold levels at the respective sentinel stations are **0.350** and **0.355** mg/L.

| Station | Station ID | Present TN mg/L | Scenario 1 mg/L | Scenario 2 mg/L | Scenario 3 mg/L | Scenario 4 mg/L |
|---|---|---|---|---|---|---|
| Head of the Harbor-Upper | 2 | 0.397 | 0.396 | 0.396 | 0.395 | 0.394 |
| Head of the Harbor- Mid | 2.2 | 0.390 | 0.389 | 0.388 | 0.387 | 0.387 |
| **Head of the Harbor- Lower** | **2.1** | **0.353** | **0.352** | **0.352** | **0.350** | **0.349** |
| Pocomo Head | 3 | 0.340 | 0.339 | 0.339 | 0.336 | 0.336 |
| Quaise Basin | 3.1 | 0.325 | 0.325 | 0.324 | 0.321 | 0.321 |
| **East Polpis** | **4** | **0.361** | **0.361** | **0.360** | **0.357** | **0.357** |
| West Polpis | 4.1 | 0.371 | 0.370 | 0.370 | 0.367 | 0.367 |
| Abrams Point | 5 | 0.296 | 0.296 | 0.296 | 0.292 | 0.292 |
| Monomoy | 6 | 0.291 | 0.290 | 0.290 | 0.287 | 0.286 |
| Mooring Area | 7 | 0.285 | 0.284 | 0.284 | 0.281 | 0.281 |

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January 24, 2012

Ms. C. Elizabeth Gibson, Town Manager
Town of Nantucket
16 Broad Street
Nantucket, MA 02554

Re: **Summary Update for the Nantucket Harbor MEP Linked Model Technical Memorandum Dated January 4, 2012**

Dear Ms. Gibson:

The following summarizes the work completed by the University of Massachusetts Dartmouth School of Marine Science and Technology Coastal Systems Group (SMAST) for the Town of Nantucket on Nantucket Harbor. Nantucket is the site of four SMAST Massachusetts Estuaries Program (MEP) projects that identify Nitrogen thresholds in the following embayment areas:

- Sesechacha Pond (Completed)
- Nantucket Harbor (Completed)
- Madaket Harbor / Long Pond (Completed)
- Hummock Pond (in queue)

SMAST completed three MEP Reports for the above embayment areas and produced Technical Memorandums with individual recommended "scenarios" or "plans of action" to reduce the Nitrogen enrichment in order to restore the quality habitat in these embayments areas. There are many "scenarios" that can be developed for each embayment for SMAST to evaluate to see if they will meet the Total Maximum Daily Loads (TMDLs) established as a result of the MEP Reports and for which the Massachusetts Department of Environmental Protection (MassDEP) will enforce. These include, but are not limited to, removing on-site wastewater disposal systems, reducing fertilizers within watersheds, treating stormwater, etc.

This summary deals with the Nantucket Harbor MEP, subsequent TMDLs and scenarios evaluated to date to provide solutions to meet the TMDLs. There is opportunity during the CWMP Update process to evaluate other "scenarios", completed as model runs by SMAST, in order to identify alternative solutions to meet the TMDL requirements. It is in the Town's best interest to find and develop solutions that not only meet the target thresholds, but in most cases exceed thresholds in order to preserve the quality and integrity of Nantucket's water resources.

The "Updated Technical Memorandum" on the Nantucket Harbor MEP Linked Model was received on Friday, January 6, 2012. It contains the additional (now a total of four) model run requested of SMAST for the Nantucket Harbor MEP Linked Model. The additional model run (not included in the Draft August 23, 2011 TM) includes data and results by raising the jetties in the Harbor without utilizing any land-based solutions.

The four model run scenarios are as follows:

**Scenario 1** – Sewering the Monomoy Needs Area (as shown delineated in the 2004 CWMP and included in the 2012 TM). This includes ONLY the currently developed lots and no future build-out.

**Scenario 2** – Sewering the Monomoy and Shimmo Needs Areas (as shown delineated in the 2004 CWMP and included in the 2012 TM). This includes ONLY the currently developed lots and no future build-out.

**Scenario 3** – Elevating the Jetties – exclusive of any land-based solutions

**Scenario 4** – Sewering Monomoy/Shimmo AND raising the jetties in the Harbor - combination of sewering the two Needs Areas as delineated in the 2004 CWMP in conjunction with raising the jetties. This includes ONLY the currently developed lots and no future build-out.

**All scenarios above result in lower Nitrogen levels in the Harbor; however, none of them meet the requirements of the two TMDLs established by MassDEP (threshold Nitrogen levels at both sentinel stations located in Nantucket Head of Harbor and East Polpis Harbor).**

The model runs show that sewering alone (as in the scenarios above) in the Nantucket Harbor area will not meet the TMDLs established at either the Nantucket Harbor or East Polpis sentinel stations. The TMDLs require Nitrogen reductions, as in the following Table, in order to meet the maximum Nitrogen load allowed in order to maintain required water quality as per threshold established:

**TABLE: Embayment Area, Present Watershed Nitrogen Loading Rate, Target Threshold Nitrogen Loading Rate, and Difference Necessary to Achieve the Target Threshold Load**

| Embayments | Present Watershed Load [1] (kg/day) | Target Threshold Watershed Load [2] (kg/day) | Difference |
|---|---|---|---|
| Head of Harbor | 1.86 | 0.79 | 1.07 |
| Quaise Basin | 2.12 | 1.14 | 0.98 |
| Town Basin | 12.22 | 10.71 | 1.51 |
| Polpis Harbor | 3.52 | 2.18 | 1.34 |
| **TOTAL** | **19.72 kg/day** | **14.89 kg/day** | **4.9 kg/day** |

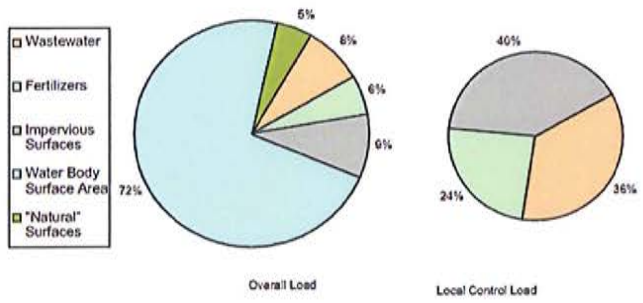
[1] Composed of combined fertilizer, runoff, on-site wastewater disposal system loads and atmospheric deposition to natural surfaces.

[2] Target threshold watershed load is the load from the watershed needed to meet the target threshold Nitrogen concentrations. See Figure below for graphic of this text. Refer to Figure on Page 4 for Sentinel Station locations.

The above TABLE clearly shows that a reduction of **4.9 kg/day of Nitrogen** in Nantucket Harbor at the two sentinel stations (Head of Harbor and East Polpis) is needed to meet the target threshold - the maximum Nitrogen loading allowed in order to maintain required water quality. Based on this **4.9 kg/day,** the Town is evaluating projects that can reduce the Nitrogen loading in the overall Harbor that will reach this goal.

The MEP Report completed for Nantucket Harbor identifies the Nitrogen loadings to the Harbor as wastewater, fertilizers, impervious surfaces, water body surface area and atmospheric deposition - see Figure below. The MEP also details those contributors that can be controlled under local regulatory control as on-site wastewater disposal systems, fertilizers and impervious surfaces. Atmospheric deposition - nutrients received through the atmosphere cannot be controlled, nor can the water body surface areas themselves. In evaluating solutions to reduce the Nitrogen loading to the receiving waters, we are looking towards the locally controllable means. Refer to the Figure below for a description of the Nitrogen loadings from the MEP Report:

MASSACHUSETTS ESTUARIES PROJECT




a. Nantucket Harbor System Overall

The above Figure details all the Nitrogen contributors in the overall Nantucket Harbor system. The circle on the left details **ALL** Nitrogen contributors and the circle on the right shows those contributors that can be **LOCALLY CONTROLLED**. The controllable contributors are stormwater at 40%, wastewater at 36% and fertilizer at 24%. Based on this, it makes sense to look at projects that can reduce these sources, and ultimately their Nitrogen loading, from the overall Harbor Watershed.

The Figure below, from the November 2006 Nantucket Harbor MEP Report, shows the sentinel station locations (both SMAST and Town) where water quality data was collected and evaluated to attain the results previously stated.

MASSACHUSETTS ESTUARIES PROJECT

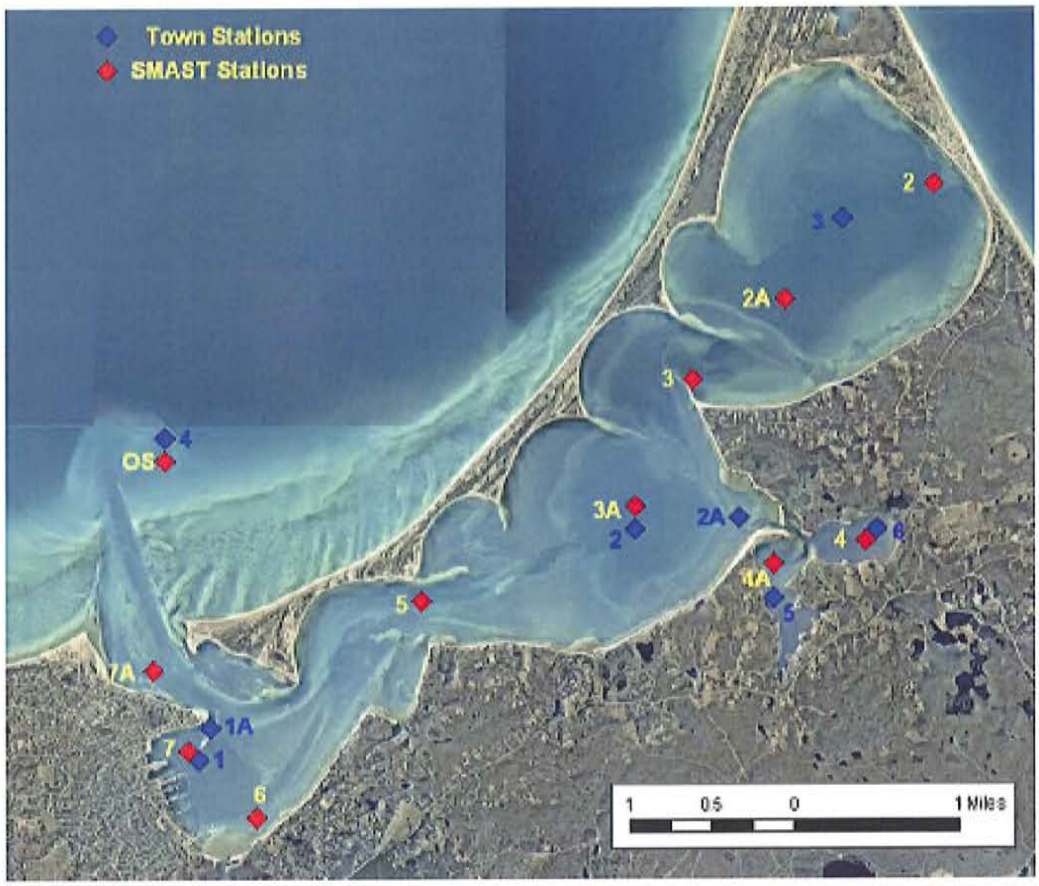



Figure VI-1. Estuarine water quality monitoring station locations in the Nantucket Harbor estuary system. Station labels correspond to those provided in Table VI-1.

The two scenarios in this Technical Memorandum that show promise in their ability to reduce the Nitrogen loading in the overall Harbor System are Scenarios 3 and 4. One is only the tidal flushing - which is not a land-based solution, but could provide a cleansing action by flushing fresh tidal water further into the Harbor thus removing nutrients as the tide flows back out to sea. The other deals with removing wastewater from the Harbor (a controllable source of Nitrogen) and adds a tidal flushing solution with the wastewater removal.

Scenario 3 – Raising the jetties without any land-based solution (no sewering in Monomoy or Shimmo) attains the threshold Nitrogen level of the May 12, 2009 established TMDL at the sentinel station at the Head of the Harbor and comes very close to attaining the Nitrogen threshold level at East Polpis. We need to further review any potential sewering for future developable parcels within Monomoy to see if this land-based solution will assist raising of the jetties to meet both TMDLs established in this area.

Scenario 4 – Sewering existing properties in Monomoy and Shimmo AND raising the jetties meets the TMDL established in Nantucket Head of Harbor, but does not meet the TMDL established in East Polpis This solution comes very close to meeting both TMDLs, but falls just shy in meeting the TMDL established in East Polpis. Again, this is but one solution evaluated in this scenario and needs to be further explored.

The additional work completed by SMAST in Scenario 1, adding full build - out of all developable lots in the Monomoy Needs Area and sewering currently existing AND build-out parcels, results in the same as sewering existing dwellings in Monomoy and Shimmo (Scenario 2). So, it could be assumed that, if the Town continues sewering Monomoy AND sewers future developable parcels in this Needs Area, while also raising the jetties, both Nitrogen threshold levels (Nantucket Harbor and East Polpis Harbor) could be met. This could be evaluated in another model run by SMAST in the CWMP Update to see if this particular scenario could meet the TMDLs. The 2004 CWMP recommended sewering Monomoy and included full build-out, so estimated flows from the 2004 Report would encompass this.

In summary, these are four "scenarios" and their respective results in attempting to reduce the Nitrogen loading to Nantucket Harbor by **4.9kg/day**. There are other "scenarios" that could be evaluated.

The planned CWMP Update includes tasks to further research alternative solutions to meet not only the target Nitrogen thresholds, but a host of other criteria in order to protect and preserve our water resources. We will look at the "Big Picture" when evaluating solutions, including technical feasibility, costs, and local, state and federal permitting required and the potential for any negative impacts. For example, by raising the jetties, there are a host of "caveats" that must be taken into consideration and further evaluated, including, but not limited to the following:

- Technical aspects of design and construction to raise the jetties
- Approval by Army Corps of Engineers (ACOE)
- Approval by regulatory agencies – MassDEP, Coastal Zone Management, etc.
- Town approval and acceptance
- Timeframe to permit, design and construct – when will this solution be actively reducing Nitrogen
    - Will MassDEP accept the schedule and/or solution
- Ability to raise and/or leverage the funds to design and construct the project
- Environmental and other impacts, both direct and indirect will need review including:
    - Marine and Coastal Resources
    - Fisheries and Shellfisheries
    - Historical, Archaeological, Cultural, Conservation and Recreation
    - Surface and Groundwater Resources
    - Displacement of Business, Services, etc.
    - Noise, Air, Odor and Public Health Pollution
    - Federal, State and local laws
    - Changes in Development or Land Use Patterns
    - Damage to Ecosystems
    - Boating
    - Fishing
    - Other Economic Development Opportunities

**IMPORTANT NOTE:**

The results contained in the January 4, 2012 TM are all related specifically to Nitrogen reductions and do not take into account any of the other multiple criteria required by MassDEP and used in the 2004 CWMP to establish "Need" for wastewater solutions other than on-site wastewater disposal. One of the major criterion in 2004 was a Needs Area based on these "other" criteria being located within the Nantucket Harbor Watershed District. The identified Needs Areas of Monomoy and Shimmo are wholly within this District and continue to contribute nutrients and degradation other than Nitrogen from on-site wastewater disposal systems!

All of the information contained in the January 4, 2012 TM will be further evaluated and incorporated into the proposed CWMP Update planned to start later in 2012. The Update is mandated by MassDEP to include the results of all Massachusetts Estuaries Projects on Island and their resultant TMDLs. The information contained in the January 4, 2012 TM will be added to the list of criteria that was established, approved by MassDEP and utilized in the 2004 CWMP, as well as any new criteria that has come to fruition since 2004. The updated criteria list will be utilized to reassess and update areas of wastewater disposal "Need" on Island in order to determine any potential changes to the 2004 identified areas of "Need".

Sincerely,

WOODARD & CURRAN INC.

Rosemary T. Blacquier
Technical Leader

John L. Daniels
Vice President

RB/rb
223970

Enclosure(s)

SMAST University of Massachusetts Dartmouth
The School for Marine Science and Technology

Coastal Systems Program SMAST

# ---------- Technical Memorandum ----------

**To:** **Rosemary Blaquier, Woodard and Curran**
**Kara Buzanoski, Town of Nantucket**

**From:** **Brian Howes, Director Coastal Systems Program**
**Ed Eichner, Coastal Systems Program**
**Roland Samimy, Coastal Systems Program**
**John Ramsey, Applied Coastal Research & Engineering, Inc.**
**Sean Kelley, Applied Coastal Research & Engineering, Inc.**

**RE:** **Round 2 Scenarios: Nantucket Harbor MEP Modeling Results in support of CWMP Update**

**Date:** **February 4, 2014**

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The Massachusetts Estuaries Project (MEP) completed an assessment of Nantucket Harbor in 2006.[1] The MEP assessment included an assessment of the ecological status of the Harbor and development of a calibrated and validated water quality model linked to a watershed nitrogen loading model. This assessment indicated that the Harbor system had portions that were moderately impaired (*i.e.*, Polpis Harbor and Head of Harbor) based on loss of historic eelgrass, impacted benthic communities, and periodic oxygen depletion. MEP staff developed recommended nitrogen thresholds to restore the system. These thresholds were converted into Total Maximum Daily Loads (TMDLs) by the Massachusetts Department of Environmental Protection[2] and approved by the US Environmental Protection Agency.

The MEP team has worked closely with the Town of Nantucket to use the MEP linked model to evaluate potential options to restore the Nantucket Harbor water quality and meet the TMDLs. The present Memorandum details the results from a second round of estuary water quality scenario runs for Nantucket Harbor in support of the Town of Nantucket CWMP.[3] The details of these scenario runs were developed in consultation with the Town's CWMP consultants (Woodard and Curran) and were completed using an updated version of the MEP linked model. The effects of the proposed watershed and flushing alterations on nitrogen levels throughout the waters of the Nantucket Harbor System are compared to the TMDL

[1] Howes B., S.W. Kelley, J.S. Ramsey, R. Samimy, D. Schlezinger, and E. Eichner. 2006. Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Nantucket Harbor, Town of Nantucket, Nantucket Island, MA. Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA. 183 pp.

[2] Nantucket Harbor Embayment System Total Maximum Daily Loads For Total Nitrogen. January 28, 2009. Report # 97-TMDL-2 Control #249.0. Commonwealth of Massachusetts, Department of Environmental Protection.

[3] First round of scenarios were detailed in a January 4, 2012 CSP Technical Memorandum from MEP team to David Fronzuto and Richard Ray of the town.

thresholds needed to achieve restoration. The Round 2 Scenarios discussed in this memorandum focus on:

a) updating the watershed nitrogen loading model to reflect the correction parcels connected to the municipal sewer system that were previously classified as being on septic,
b) increased tidal flushing of Polpis Harbor based on planned dredging,
c) increased tidal flushing of the overall Nantucket Harbor system based on elevation of the jetty structure that defines the entrance to the harbor and
d) nitrogen management strategies (sewering) to be undertaken within the Monomoy service area.

## Nantucket Harbor Scenarios: Round 2 Results

Scenario staff worked with the Town and the Town's CWMP consultant to develop the details of the scenarios. The consultants supplied base information, including GIS coverages, that was used in the completion of the scenarios. Each scenario description below includes the review of the base information and scenario details.

### Scenario 1: Update the Nantucket Harbor MEP Watershed Nitrogen Loading Model to reflect Historically Sewered Parcels

Scenario staff was asked to update the existing MEP watershed nitrogen loading to the Harbor to reflect revised listing of properties connected to the municipal sewer system. The parcel information utilized during both the original MEP assessment and the first round of scenarios was originally supplied by the town. Town staff completed a comprehensive review of this parcel information and indicated that there were 478 parcels within the Town Sewer District that were originally identified as connected to septic systems that were actually tied in to the Town of Nantucket Sewer system. These properties were not included in the town sewer billing databases, but are connected to the sewer system and have generally been connected for a number of years. Woodard and Curran utilized this updated database to indicate that 197 of these parcels are located within the Nantucket Harbor watershed. This review also found that there were also 5 parcels that were initially indicated as being sewered, but rely on septic systems for wastewater treatment.

Scenario staff reviewed the updated GIS parcel coverage and database and compared the results to the sewered parcels identified in the MEP watershed nitrogen loading model for Nantucket Harbor. This review indicated the following:

a) 115 of the 197 watershed parcels were already considered sewered in the MEP model,
b) 35 were new parcels created since the original MEP land use database was received from the Town, so they would be counted in the buildout scenario rather than existing conditions,
c) 9 were duplicate parcel listings, and
d) 38 were previously identified as utilizing septic systems for wastewater treatment (among these are 4 that were listed as undeveloped lots in the original MEP land use database).

The 38 newly-identified sewered parcels were corrected in the MEP watershed nitrogen loading model. Among the 38 parcels are six that were listed in the MEP land use database as developable residential parcels and that have subsequently been developed and are now listed in the 2013 land use database as developed properties (either single family or multi-family residences). If these parcels are maintained as undeveloped, the change in the remaining 32 from septic to sewer plus the 5 parcels changed from sewered to septic results in a decrease in the existing conditions system nitrogen load of 25 kg/yr or 0.08% of the total load (Table 1). If the 35 new parcels and the 6 parcels developed since the MEP

assessment are both added to the nitrogen loading model, the nitrogen load would increase slightly due to the associated increases in fertilized lawn areas and impervious surfaces.

The relatively small change in the MEP existing conditions nitrogen load means the MEP water quality model does not need to be recalibrated and can be used to assess the impact of the other scenarios. The original estimated error in the MEP water quality model for predicting measured nitrogen concentrations was 5.1%.[4] If one adds the nitrogen contributions from the harbor sediments to the updated watershed nitrogen load incorporating the corrected sewer properties, the cumulative system nitrogen loading change is less than the 0.08% change in the watershed load. Since this change is significantly less than the estimated error in the water quality modeling, no change in the calibration of the water quality model is required and it can be used for modelling of the other scenarios.

**Scenario 2: Update the Nantucket Harbor MEP Watershed Nitrogen Loading Model Buildout Conditions**

Scenario 2 was developed to review and confirm an alternative buildout scenario included in the Nantucket Harbor MEP Report that included sewering of all sewer district properties. The 2006 MEP report includes two buildout assessments: a) a standard MEP buildout assuming subdivision of all qualifying properties according to minimum lot sizes specified in the then-current town zoning regulations and b) an alternative assessment assuming that all potential future properties within the municipal sewer district, both existing and new buildout ones, are connected to the sewer system. Since the sewer system removes all wastewater nitrogen loads from the Nantucket Harbor watershed, new development within the sewer district only contributes watershed nitrogen loads from roads, roofs, and fertilized lawns in the alternative buildout scenario. The current Scenario 2 was developed in order to assess the impact of any changes in the original MEP buildout assessment in light of the findings in Scenario 1.

For the current project, scenario staff initially reviewed the boundaries of the sewer district and found that the boundaries have also changed since the MEP assessment (Figure 1). The most significant changes in the district boundaries are outside of the Nantucket Harbor watershed; the changes within watershed are relatively minor. There are seven (7) properties within the watershed that have been added to the sewer district since the initial MEP assessment.

In addition, as mentioned in Scenario 1, there are 35 new parcels that have been created since the MEP assessment. Many of these parcels were anticipated and were included in the original MEP alternative buildout scenario, but some of the new development occurred on properties that were originally assessed as having no additional development potential (*e.g.*, properties previously classified as the town assessor as undevelopable). These properties have been included in the updated buildout scenario. The net result of the expansion of the sewer district and the buildout additions to the MEP Nantucket Harbor buildout scenario with sewering for all properties within the town sewer district is relatively insignificant increase of 17.5 kg/yr (a 0.06% increase) from the original MEP alternative buildout assessment. This updated buildout scenario is the starting point for the changes in the inlet to Polpis Harbor/the main Harbor jetties in Scenario 3 and the inclusion of sewering in the Monomoy needs area evaluated in Scenario 4.

**Scenario 3: Dredging the Inlet to Polpis Harbor and Elevating the Nantucket Harbor Inlet jetties**
Scenario 3 was developed to evaluate the water quality impacts of the planned dredging of the inlet to Polpis Harbor and the modification of the Nantucket Harbor inlet jetty structure to reflect the US Army Corps of Engineers approved height of +3 feet (MLW +1). The existing MEP hydrodynamic and water quality model was slightly modified to reflect the ACOE existing conditions and the model's calibration

[4] Figure VI-3 (p. 111) in the Nantucket Harbor MEP report.

was checked; the calibration held and the model was then modified to reflect the proposed changes. All changes were based on materials submitted to the scenario staff by the town. The watershed nitrogen loading in this scenario is based on the updated buildout TN loading to Nantucket Harbor as completed under Scenario 2, while the atmospheric deposition and net benthic flux are the same as developed originally under the MEP (Table 2). Scenario staff reviewed and confirmed the details of the dredging and jetty configurations with Woodard and Curran staff before proceeding with the scenario.

The combined effect of dredging of the inlet to Polpis Harbor and the modification of the Nantucket Harbor inlet jetty structure does not attain the TN thresholds at either of the system sentinel stations (Table 3). The changes in this scenario reduce the TN concentration at the Head of the Harbor sentinel station closer to the 0.350 mg/L TN threshold compared to the buildout conditions in Scenario 2, but the threshold concentration is not attained. Similarly, the TN threshold concentration is not attained at the East Polpis sentinel station either. The East Polpis Harbor sentinel station TN concentration increases above the buildout concentration (0.3605 mg/L to 0.3614 mg/L). TN concentrations decrease throughout the system except for the increase at the East Polpis Harbor sentinel station. Increases in TN concentrations are often seen where dredging within the interior of a bay increases the volume of water that needs to be flushed out by the tides; water lingers longer in the system and, therefore, TN concentrations increase.

**Scenario 4: Combine Sewering of Monomoy Needs Area with Scenario 3 changes**

Scenario 4 was developed to evaluate the nitrogen concentration changes in Nantucket Harbor resulting from combining the:

a) Scenario 3 changes (elevated jetty at Harbor entrance, dredging of Polpis Harbor inlet),
b) Scenario 2 sewering of all developed and future buildout properties within the town Sewer District, and
c) sewering of an additional set of parcels within the Monomoy Sewer Needs Area (Figure 2).

The Monomoy Sewer Needs Area contains 168 parcels; 76% of the parcels are residential units (land use codes 101 or 109). This sewer needs area is different than the Monomoy area that was identified during the first round of scenarios for Nantucket Harbor.[5] The sewering of the current Monomoy Sewer Needs Area reduces the Nantucket Harbor buildout load in Scenario 2 by 187 kg/yr (see Table 1).

The combined effect of all the changes in this scenario does not attain the TN thresholds at either of the sentinel stations for Nantucket Harbor (see Table 3). The additional reduction in watershed nitrogen loading in the Town subwatershed further reduces the TN concentration at the Head of Harbor sentinel concentration below the TN concentration result in Scenario 3, but the 0.350 threshold is not attained. The sewering in the Monomoy needs area does not change the TN concentration at the East Polpis sentinel station in Scenario 3 (0.3614 mg/L in both Scenario 3 and 4). TN concentrations decrease throughout the system except for the increase at the East Polpis Harbor sentinel station; the decreases are generally greater than those modeled in Scenario 3.

**Further Discussion**

- None of the scenarios attain the threshold TN concentrations at the two sentinel stations.
- Scenario 1 (existing conditions) has TN concentrations that are closest to the threshold concentrations at the sentinel stations.
- Scenario 2 (buildout conditions) increases the TN concentrations at both sentinel stations with a greater increase projected at the East Polpis sentinel station. This suggests that this more interior sentinel station is more sensitive to watershed nitrogen loading increases. The watershed load

[5] January 4, 2012 CSP Technical Memorandum, Figure 1

increase in the Polpis subwatershed is proportionally larger (+16%) than in the Town subwatershed (+4%).

- Most of the increase in the Polpis subwatershed (60%) is septic system wastewater, as opposed to only 13% in the Town subwatershed. Lawn fertilizer loads are the predominant load (54%) in the Town subwatershed, followed by roads (24%), wastewater, and roofs.
- Scenario 3 (buildout watershed conditions with elevation of the Nantucket Harbor inlet jetties, and dredging in Polpis Harbor inlet) reduces TN concentrations throughout the system except for the East Polpis sentinel station, where the TN concentration increased. This scenario results show that the increase in volume created by the dredging in Polpis Harbor has a greater impact on TN concentrations in Polpis than the increased tidal flushing created by the changes in the inlet.
- Scenario 4 (scenario 2 changes plus sewering in the Monomoy Sewer Needs area) generally reduces TN concentrations throughout the system at greater reductions than Scenario 3 except for the East Polpis sentinel station, where the TN concentration remains the same. The sewering of the Monomoy area reduces the TN concentration at the Head of the Harbor sentinel station to a level less than the watershed buildout condition (Scenario 2), but not less than existing condition (Scenario 1) or the threshold TN concentration (0.350 mg/L).
- Comparison of Scenario 3 and Scenario 4 results seem to indicate that the planned dredging of the Polpis Harbor inlet will make the TN concentration at the East Polpis sentinel station somewhat less sensitive to changes in watershed loading in other portions of the Nantucket Harbor system watershed.
- Overall, the scenario results suggest that watershed management strategies should review nitrogen loading plans that address
    1) septic system loads outside of the current sewer district,
    2) lawn and stormwater loads with a particular focus on the Town subwatershed, and
    3) future development and buildout within the watershed.

  For tidal management strategies, Scenario 3 demonstrates the general benefits of raising the jetties at the Harbor inlet, but the proposed dredging of the Polpis Harbor inlet will require additional watershed nitrogen reductions in order to balance the increase in Polpis Harbor TN concentration caused by the dredging.

The MEP team is available to continue to assist the Town and Woodard and Curran with evaluations of planned water quality management strategies.

**Table 1. Nantucket Harbor Watershed Nitrogen Loads used for Scenarios.** Whole system and subwatershed nitrogen loads are shown (in kg/yr) for scenarios evaluated in this Technical Memo. Nitrogen loads developed in the MEP Nantucket Harbor Report are also provided for comparison. Brief descriptions of the scenarios are:

Scenario 1 nitrogen loads are based on existing conditions and are modified from the original MEP existing conditions based on new information provided by the town about properties connected to the municipal sewer system. All changes in properties occurs in the Town subwatershed and changed the subwatershed nitrogen load from the original MEP existing conditions by <0.5%.

Scenario 2 assumes development of all developable properties according to town zoning (*i.e.*, buildout conditions) where all properties within the municipal sewer district are connected to the sewer system. This is the same assumption as an alternative buildout included in the original MEP Report and includes the corrections noted in Scenario 1. All changes in properties occurs in the Town subwatershed and changed the subwatershed nitrogen load from the original MEP alternative buildout conditions by <0.5%.

Scenario 3 uses the Scenario 2 watershed loads assumes raising the main Harbor jetties to the USACOE recommended height and implementation of the proposed dredging within the inlet to Polpis Harbor.

Scenario 4 uses the same system modifications in Scenario 3 and further modifies the watershed buildout loads by assuming that the properties within the Monomoy sewer service area are connected to the municipal sewer system. It should be noted that this service area is different than the area with the same label included in the first round of scenarios completed for Nantucket Harbor.

| | | ***Scenario 1 Existing N Loads*** | | | ***Original MEP Existing N Loads*** | | | ***Scenario 2 and 3 Buildout N Loads*** | | | ***Original MEP Alt Buildout N Loads*** | | | ***Scenario 4 Buildout N Loads: Monomoy*** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Name** | **Watershed ID#** | **UnAtten N Load** | **Atten %** | **Atten N Load** | **UnAtten N Load** | **Atten %** | **Atten N Load** | **UnAtten N Load** | **Atten %** | **Atten N Load** | **UnAtten N Load** | **Atten %** | **Atten N Load** | **UnAtten N Load** | **Atten %** | **Atten N Load** |
| Nantucket Harbor | | 29852 | | 29852 | 29877 | | 29877 | 30579 | | 30579 | 30562 | | 30562 | 30393 | | 30393 |
| Head of the Harbor | | 8795 | | 8795 | 8795 | | 8795 | 8984 | | 8984 | 8984 | | 8984 | 8984 | | 8984 |
| Head of the Harbor | 1 | 678 | | 678 | 678 | | 678 | 867 | | 867 | 867 | | 867 | 867 | | 867 |
| Head of the Harbor Estuary surface deposition | | 8117 | | 8117 | 8117 | | 8117 | 8117 | | 8117 | 8117 | | 8117 | 8117 | | 8117 |
| Polpis | | 2087 | | 2087 | 2087 | | 2087 | 2294 | | 2294 | 2294 | | 2294 | 2294 | | 2294 |
| Polpis | 2 | 1288 | | 1288 | 1288 | | 1288 | 1494 | | 1494 | 1494 | | 1494 | 1494 | | 1494 |
| Polpis Estuary surface deposition | | 799 | | 799 | 799 | | 799 | 799 | | 799 | 799 | | 799 | 799 | | 799 |
| Quaise | | 8121 | | 8121 | 8121 | | 8121 | 8225 | | 8225 | 8225 | | 8225 | 8225 | | 8225 |
| Quaise | 3 | 775 | | 775 | 775 | | 775 | 878 | | 878 | 878 | | 878 | 878 | | 878 |
| Quaise Estuary surface deposition | | 7346 | | 7346 | 7346 | | 7346 | 7346 | | 7346 | 7346 | | 7346 | 7346 | | 7346 |
| Town | | 10849 | | 10849 | 10873 | | 10873 | 11077 | | 11077 | 11059 | | 11059 | 10890 | | 10890 |
| Town | 4 | 5780 | | 5780 | 5804 | | 5804 | 6008 | | 6008 | 5990 | | 5990 | 5821 | | 5821 |
| Town Estuary surface deposition | | 5069 | | 5069 | 5069 | | 5069 | 5069 | | 5069 | 5069 | | 5069 | 5069 | | 5069 |

**Table 2. Sub-embayment and surface water nitrogen loads used for total nitrogen modeling of the Nantucket Harbor system in Scenarios 1, 2, 3 and 4.** Total watershed N loads, atmospheric N loads, and benthic flux are shown for a) Scenario 1 existing conditions, b) Scenario 2 and 3 buildout conditions with all properties within the existing sewer district connected to the municipal system, and c) Scenario 4 buildout conditions with all properties within the existing sewer district and properties within the Monomoy service area connected to the municipal sewer system. These loads represent the loading conditions for the listed sub-embayments and used in the water quality model. Totals may not add due to rounding.

| | a) Existing: properties connected to the municipal sewer system based on town data (corrected based on Scenario 1 findings) | | | b) Buildout: all properties in existing sewer district connected to the municipal sewer system (corrected based on Scenario 2 findings; also used in Scenario 3) | | | c) Buildout: all properties in existing sewer district and properties within the Monomoy service area connected to the municipal sewer system (used in Scenario 4) | | |
|---|---|---|---|---|---|---|---|---|---|
| Sub-watershed | Watershed Load (kg/day) | Direct atmospheric deposition (kg/day) | Benthic flux net (kg/day) | Watershed Load (kg/day) | Direct atmospheric deposition (kg/day) | Benthic flux net (kg/day) | Watershed Load (kg/day) | Direct atmospheric deposition (kg/day) | Benthic flux net (kg/day) |
| Head of the Harbor | 1.86 | 22.24 | 62.71 | 2.38 | 22.24 | 62.86 | 2.38 | 22.24 | 62.81 |
| Polpis Harbor | 3.53 | 2.19 | 27.44 | 4.09 | 2.19 | 27.67 | 4.09 | 2.19 | 27.58 |
| Quaise | 2.12 | 20.13 | 43.90 | 2.40 | 20.13 | 43.90 | 2.40 | 20.13 | 44.15 |
| Town | 15.84 | 13.89 | -2.79 | 16.46 | 13.89 | -2.81 | 15.95 | 13.89 | -2.79 |
| System Total | 23.35 | 58.44 | 131.25 | 25.33 | 58.44 | 131.62 | 24.82 | 58.44 | 131.74 |

**Table 3. Total nitrogen concentrations for the modeled Nantucket Harbor scenarios.** Total nitrogen concentrations at each water quality station under present conditions and for each scenario are presented in mg/L. Sentinel stations (stations 2.1 and 4) are shown in **bold**. TN threshold levels at the respective sentinel stations are **0.350** and **0.355** mg/L. Changes between scenarios are based on comparison to offshore Nantucket Sound TN concentration (0.267 mg/L in these calculations); this comparison emphasizes the change between scenarios.

| | | Scenario 1 | Scenario 2 | Compare 1 and 2 | Scenarios 3 | Compare 2 and 3 | Scenario 4 | Compare 2 and 4 | Compare 3 and 4 |
|---|---|---|---|---|---|---|---|---|---|
| Station | Station ID | Existing Loads | Buildout Loads | Change above bkg | Buildout Loads, rebuilt jetties, Polpis Harbor inlet dredging | Change above bkg | Buildout Loads, rebuilt jetties, Polpis Harbor inlet dredging, Monomoy Sewer | Change above bkg | Change above bkg |
| Head of the Harbor - Upper | 2 | 0.4111 | 0.4124 | +0.9% | 0.4121 | -0.2% | 0.4118 | -0.4% | -0.2% |
| Head of the Harbor - Mid | 2.2 | 0.4011 | 0.4023 | +0.9% | 0.4020 | -0.2% | 0.4017 | -0.4% | -0.2% |
| **Head of the Harbor - Lower** | **2.1** | **0.3539** | **0.3548** | **+1.0%** | **0.3544** | **-0.5%** | **0.3542** | **-0.7%** | **-0.2%** |
| Pocomo Head | 3 | 0.3380 | 0.3388 | +1.1% | 0.3383 | -0.7% | 0.3382 | -0.8% | -0.1% |
| Quaise Basin | 3.1 | 0.3234 | 0.3241 | +1.2% | 0.3236 | -0.9% | 0.3235 | -1.1% | -0.2% |
| **East Polpis** | **4** | **0.3590** | **0.3605** | **+1.6%** | **0.3614** | **+1.0%** | **0.3614** | **+1.0%** | **0.0%** |
| West Polpis | 4.1 | 0.3690 | 0.3705 | +1.5% | 0.3703 | -0.2% | 0.3703 | -0.2% | 0.0% |
| Abrams Point | 5 | 0.2957 | 0.2961 | +1.4% | 0.2954 | -2.4% | 0.2954 | -2.4% | 0.0% |
| Monomoy | 6 | 0.2908 | 0.2911 | +1.3% | 0.2905 | -2.5% | 0.2903 | -3.3% | -0.9% |
| Mooring Area | 7 | 0.2847 | 0.285 | +1.7% | 0.2843 | -3.9% | 0.2842 | -4.4% | -0.6% |

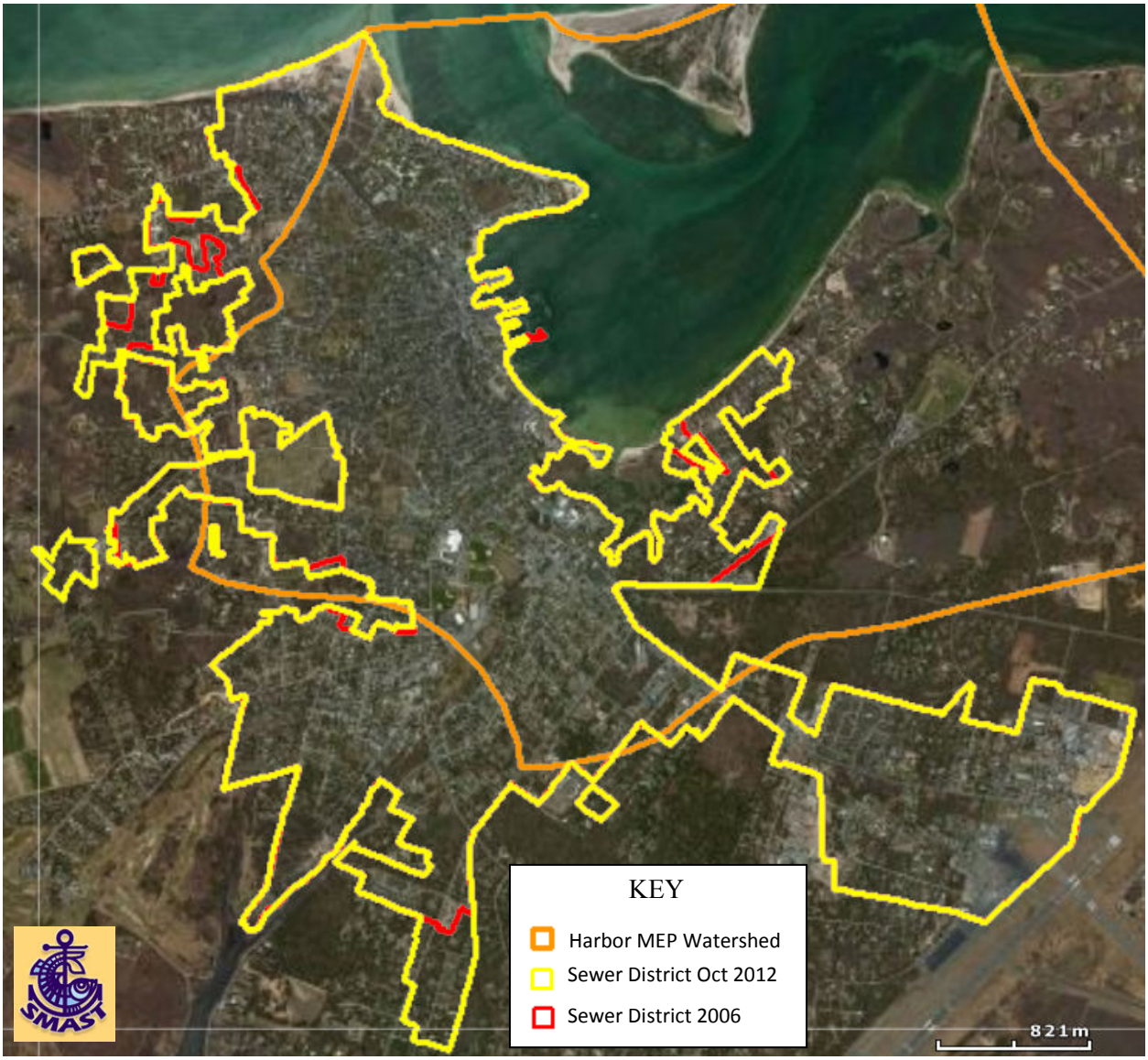


**Figure 1. Comparison of Nantucket Sewer Districts 2006 and 2012.** The orange line shows the Nantucket Harbor MEP watershed, while the yellow line outlines the October 2012 municipal sewer district. The red lines show the former 2006 boundaries of the sewer district, which was used for the MEP Nantucket Harbor assessment (Howes, *et al.*, 2006). Scenario 2 assumes all properties within the sewer district are connected to the municipal sewer system and utilizes the 2012 delineation. As a result, seven (7) properties, which were excluded from the sewer district in the original MEP assessment, are included in the district in Scenario 2 evaluation.

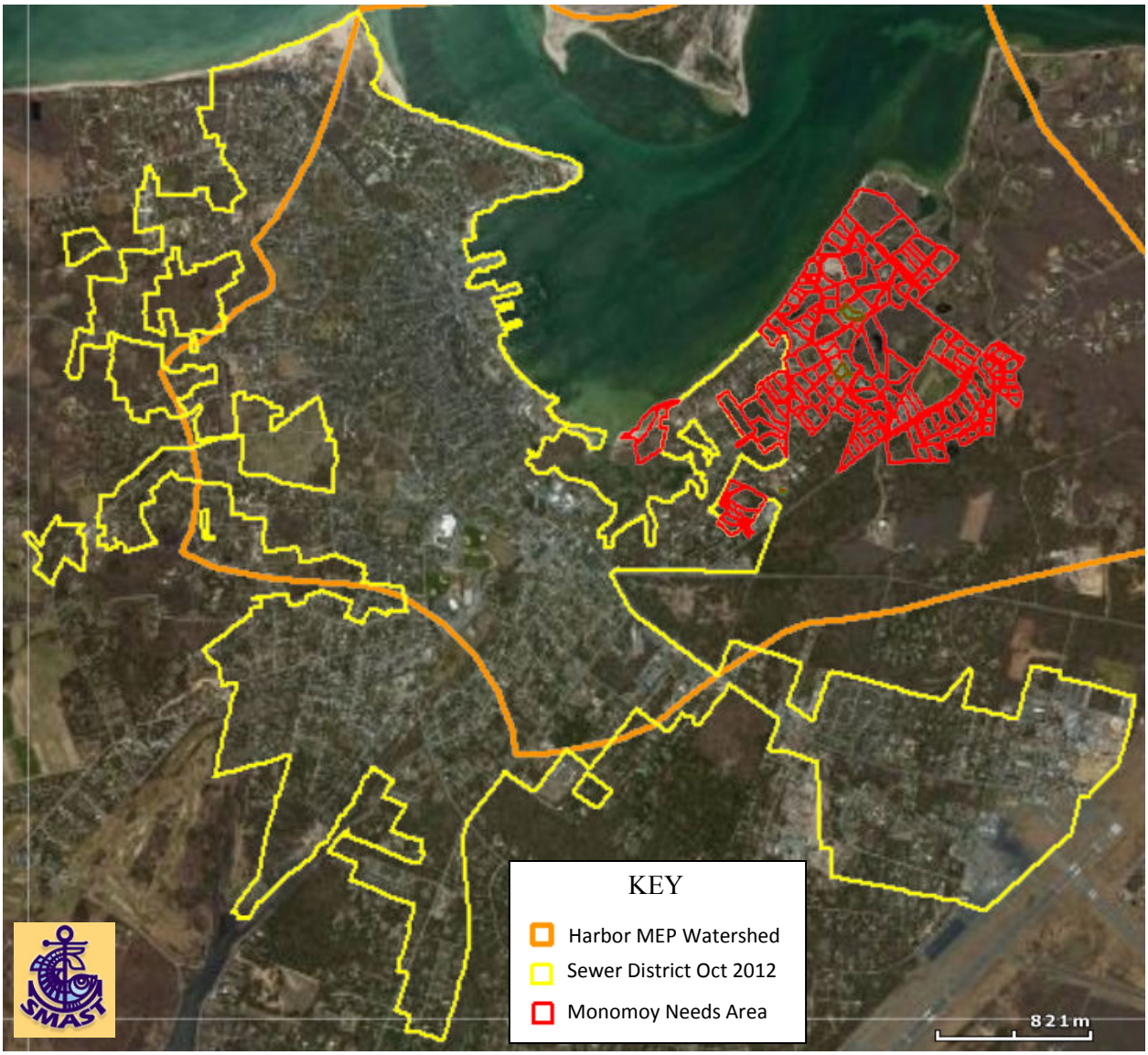


**Figure 2. Monomoy Sewer Needs Area: Nantucket Harbor Watershed.** The orange line shows the Nantucket Harbor MEP watershed, while the yellow line outlines the October 2012 municipal sewer district and the parcels outlined in red are included in the Monomoy Sewer Needs area. Scenario 4 evaluates the nitrogen water quality impact of connecting the properties in the Monomoy area to the municipal sewer system combined with the Scenario 3 system configuration changes to the Harbor inlet jetties and the inlet to Polpis Harbor. The Monomoy area includes 168 parcels of which 76% are residential land uses.

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The School for Marine Science and Technology

Coastal Systems Program SMAST

---------- **Technical Memorandum** ----------

**To:** **Rosemary Blaquier, Woodard and Curran**
**Kara Buzanoski, Town of Nantucket**

**From:** **Brian Howes, Director Coastal Systems Program**
**Ed Eichner, Coastal Systems Program**
**Roland Samimy, Coastal Systems Program**
**John Ramsey, Applied Coastal Research & Engineering, Inc.**
**Sean Kelley, Applied Coastal Research & Engineering, Inc.**

**RE:** **Comprehensive Scenario Review and Round 3 Scenario Results: Nantucket Harbor MEP Modeling Results in support of CWMP Update**

**Date:** **May 30, 2014**

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The Massachusetts Estuaries Project (MEP) completed an assessment of Nantucket Harbor in 2006.[1] The MEP assessment included an assessment of the ecological status of the Harbor and development of a calibrated and validated water quality model linked to a watershed nitrogen loading model. This assessment indicated that the Harbor system had portions that were moderately impaired (*i.e.*, Polpis Harbor and Head of Harbor) based on loss of historic eelgrass, impacted benthic communities, and periodic oxygen depletion. MEP staff developed recommended nitrogen thresholds to restore the system. These thresholds were converted into Total Maximum Daily Loads (TMDLs) by the Massachusetts Department of Environmental Protection[2] and approved by the US Environmental Protection Agency.

The MEP team has worked closely with the Town of Nantucket to use the MEP linked model to evaluate potential options to restore the Nantucket Harbor water quality and meet the TMDLs. The present Memorandum reviews all of the scenarios completed to date and details the results from a third round of estuary water quality scenario runs for Nantucket Harbor in support of the Town of Nantucket CWMP.[3] Details of scenario runs, including the third round of runs, were developed in consultation with the Town's CWMP consultants (Woodard and Curran) and town staff. Each run has included changes in the watershed nitrogen loading and/or the configuration

[1] Howes B., S.W. Kelley, J.S. Ramsey, R. Samimy, D. Schlezinger, and E. Eichner. 2006. Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Nantucket Harbor, Town of Nantucket, Nantucket Island, MA. Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA. 183 pp.

[2] Nantucket Harbor Embayment System Total Maximum Daily Loads For Total Nitrogen. January 28, 2009. Report # 97-TMDL-2 Control #249.0. Commonwealth of Massachusetts, Department of Environmental Protection.

[3] First round of scenarios were detailed in a January 4, 2012 CSP Technical Memorandum from MEP team to David Fronzuto and Richard Ray of the town. Second round were detailed in a February 4, 2014 CSP Technical Memorandum from MEP team to Rosemary Blaquier, Woodard and Curran and Kara Buzanoski, Town of Nantucket.

of the Harbor inlet and/or bathymetry. All of these changes have been incorporated into revised versions of the MEP linked model. The effects of the proposed watershed and flushing alterations on nitrogen levels throughout the waters of the Nantucket Harbor System are compared to the MassDEP/USEPA TMDL thresholds needed to achieve restoration.

## Nantucket Harbor Scenarios: Round 3 Results

Scenario staff worked with the Town and the Town's CWMP consultant to develop the details of the Round 3 scenarios. Woodward and Curran supplied base information, including GIS coverages, which was used in the completion of the scenarios. Each scenario description below includes the review of the scenario details.

### Round 3, Scenario 1 (overall Scenario 9): Hybrid Watershed Land Use, Sewering of Monomoy Needs Area, and Raised Jetties

In Scenario 1, existing land use development patterns were used, but watershed nitrogen loads are adjusted based on the assumption that all developed properties within the Town Sewer District will be connected to the Town of Nantucket Sewer system, including those that are in the District, but are not currently connected. This land use pattern does not include any additional new development over present conditions. This scenario also includes the sewer connection updates that were identified in the Round 2 scenarios (Scenario 5). In addition, all properties within the Monomoy Needs Area are also connected to the Town Sewer system. Finally, this scenario also includes the effect of raising the elevation of the jetties at the Harbor Inlet to reflect the US Army Corps of Engineers approved height of +3 feet (MLW +1). Watershed nitrogen loads, by sub-watershed, for this scenario are shown in Table 1.

### Round 3, Scenario 2 (overall Scenario 10): Hybrid Watershed Land Use, Sewering of Monomoy Needs Area, Lawn Fertilizer Restriction, and Raised Jetties

In Scenario 2, the hybrid land use developed in Scenario 1 was used, along with the raising of the Harbor inlet jetties. The land use nitrogen loads in this scenario also includes a potential nitrogen reduction from a lawn fertilizer restriction applied throughout the Harbor System watershed. The fertilizer reduction relates to the Town's recent efforts to reduce this nitrogen source.

Current town BMP manual and regulation limit annual fertilizer N applications to 3 lbs/1,000 sq ft of lawn and individual N applications to 0.5 lbs/1,000 sq ft. Review of information gathered in the development of the BMP manual shows that healthy lawns can be sustained through minimal use of nitrogen fertilizers. Reduction of nitrogen fertilizer additions from an upper limit of 3 lbs/1,000 sq ft/yr can occur through established practices such as a) recycling of clippings, b) balancing of fast and slow release nitrogen applications, c) use of various nitrogen sources (compost, leaf litter, fertilizers), d) "spoon feeding" of nitrogen, and e) use of grasses and other ground cover with low fertilizer needs. Combining these practices with other established healthy turf practices, such as regular aeration, irrigation, and assessment of nutrient needs, can maintain the turf appearance and wear goals while minimizing nitrogen leaching into coastal waters.

The MEP lawn fertilizer N loading rate (1.08 lbs/1,000 sq ft) was developed based on a thesis-level review of fertilizer practices of over 2,300 residences in three towns on Cape Cod. A

similar review has not been completed on Nantucket, but town and CWMP project staff observations within the Nantucket Harbor watershed seem to indicate that the majority of homeowners do not utilize fertilizers and most of the turf areas within the watershed are long-established and, therefore, would require only low levels of N application. In addition, CWMP staff consulted with MEP staff and found that selected golf courses, which rely on healthy turf and were contacted during MEP assessments, sustained various high-use turf types with low N application rates (1.2 to 1.7 lbs/1,000 sq ft/yr). It is thought that if professional turf areas such as golf courses can sustain turf that is extensively used, then more ornamental turf areas such as lawns can be sustained with even lower N application rates and proper maintenance.

Given Nantucket's interest in reducing nitrogen loading to coastal waters, these consultations with MEP staff, and the willingness of the town to institute formal fertilizer reduction rules, CWMP staff selected a reduced N application rate (0.9 lbs/1,000 sq ft/yr) for use in this scenario. This annual rate is thought to be reasonably conservative given CWMP staff watershed observations and estimated homeowner practices. In this scenario, this rate was applied to 75% of the homeowners within the whole Nantucket Harbor watershed with the remaining 25% utilizing the standard MEP lawn fertilizer loading factor. This application split is based on regulatory compliance rates observed for similar turf limits approved within the Chesapeake Bay watershed. The net result of the inclusion of all these factors is that the standardized N application rate for turf areas within the Nantucket Harbor watershed is reduced to 0.945 lbs/1,000 sq ft/yr for this scenario. Watershed nitrogen loads, by sub-watershed, for this scenario are shown in Table 1.

**Round 3, Scenario 3 (overall Scenario 11): Hybrid Watershed Land Use, Sewering of Monomoy Needs Area (adjusted), Lawn Fertilizer Restriction, and Raised Jetties**

During the midst of the preliminary review of results from Scenarios 1 and 2, questions arose about the delineation of the Monomoy Needs Area. This issue had previously arisen during the development of the Round 2 scenarios because there had been updates in the Town Sewer District that necessitated changes in the Monomoy Needs Area delineation previously evaluated during the Round 1 scenarios. As a result, additional properties along Brewster Road were excluded from the Monomoy Needs Area during the Round 2 scenarios and during Round 3, Scenarios 1 and 2 discussed in this Technical Memorandum (Figure 1). For the present Round 3, Scenario 3 analysis, these properties were included along with the other changes previously included in Scenario 2. The inclusion of these properties in the Monomoy Needs area reduced the overall system watershed load by <0.1%. Watershed nitrogen loads, by sub-watershed, for this scenario are shown in Table 1.

**<u>Comprehensive Review of Nantucket Scenario Results (including Round 3 Scenarios)</u>**

Table 1 shows the watershed nitrogen loadings for all eleven (11) of the MEP scenarios conducted to date, including the scenarios discussed in this Technical Memorandum. Table 1 also shows the original scenarios in the MEP report. Table 2 shows the water quality modeling results, including concentrations at the TMDL threshold stations (2.1 and 4). The respective total nitrogen (TN) threshold concentrations are: 0.350 mg/L at Head of the Harbor – Lower (Station 2.1) and 0.355 mg/L at East Polpis (Station 4). The scenarios developed to date have include proposed changes in the Nantucket Harbor system configuration to improve tidal

flushing (*e.g.*, raising the Harbor inlet jetties) and reductions in watershed nitrogen loads (*e.g.*, wastewater N removal by sewering portions of the watershed). Scenarios have also evaluated differences in land use loads over time (*i.e.*, looking at existing and buildout conditions). The completion of the scenarios has provided quantitative information as to which changes provide the largest reductions in nitrogen concentrations.

The initial scenarios in the MEP Nitrogen Threshold Report were conducted to establish a baseline to review potential management options.[4] Development of the existing conditions scenario combines all the various nitrogen loads from the watershed, on the surface of the Harbor, and regeneration from the sediments with the physical characteristics of the Harbor, including its volume and tidal movements, and ensures that the model results reasonably match the measured water quality throughout the Harbor System. Once this baseline is established and verified with field data, the model can then be used to reliably assess impacts of changes in the various nitrogen sources. Included in the original MEP report were five scenarios, including two buildout versions, a no anthropogenic loading scenario, and two scenarios demonstrating two of the many alternatives by which the threshold concentrations can be attained. It should be noted that the threshold concentrations can be attained any number of ways; MassDEP generally requires at least one scenario indicating that the threshold concentration can be attained before the MEP report is finalized.

A total of eleven (11) scenarios (numbered 1-11 in Table 1) have been developed since the completion of the MEP report, including those described as Round 3 in this Technical Memorandum (described above). These scenarios have been developed through discussions between MEP staff and town staff and consultants and have included various refinements to portions of the linked Nantucket Harbor watershed/estuary models. Some of these refinements have created circumstances where past and current scenarios cannot be easily compared because the base model configuration has been updated based upon new information developed as part of the scenario process. For example, while the new existing conditions scenario (overall Scenario 5 in Table 1) did not have a substantial change in the watershed nitrogen loading, there was a refinement in treatment of the benthic flux in the water quality model for the Head of the Harbor that evolved from the conduct of the previous scenarios. This change in benthic flux did not alter the calibration of the model (*i.e.*, everything remained in balance), but it slightly altered the baseline for the system and limits the comparison between Scenarios 5-11 and Scenarios 1-4.

Round 3, Scenarios 1, 2, and 3 in this Technical Memo (overall Scenarios 9, 10, 11) are sufficient to meet the TN levels needed for restoration of the Nantucket Harbor System. These scenario results round directly to the TN thresholds of 0.350 mg/L and 0.355 mg/L for the Head of Harbor and Polpis Harbor locations, respectively. There was no difference in outcome between scenario 9 vs 10 vs 11 (see Table 2). These results are based primarily upon the MEP base model with the refinements developed in concert with the Town and its consultants. It is anticipated that monitoring will continue in order to allow for adaptive management as restoration progresses.

The Round 3 scenario results indicate that combining complete sewering in the Sewer District and the Monomoy Service Area with raising of the jetties at the Harbor inlet are sufficient to

[4] Howes B., S.W. Kelley, J.S. Ramsey, R. Samimy, D. Schlezinger, and E. Eichner. 2006.

attain restoration in the system (*i.e.*, Scenario 9). Addition of the lawn fertilizer reductions (Scenario 10) and connection of the development along Brewster Road to the sewer system (Scenario 11) reduce nitrogen loads, but only change TN concentrations by <0.001 mg/L.

Scenarios results show that lawn fertilizer reductions and sewering within the Shimmo Service provide relatively smaller nitrogen reductions, although fertilizer management does provide a buffer for new unanticipated future N loads. However, implementation of these nitrogen mitigation strategies may be delayed until after the water quality impact of the other system changes are assessed. It is also worth noting that the fertilizer reductions were based on the assumptions developed for Scenario 10 above and the impact of fertilizer reduction may be more meaningful if a more significant lawn fertilizer reduction is attained (*i.e.*, higher compliance or watershed-specific data based on post-implementation surveys)..

It is also notable that the dredging of the Polpis Harbor inlet does not reduce TN concentrations in the overall Harbor and causes TN concentrations at the Polpis Harbor sentinel station to increase. This increase in TN concentration due to interior system dredging has also been noted several times in scenarios for other MEP systems, mainly on Cape Cod. This increase is based on the physics of tidal flushing: since the volume of water coming through the inlet remains the same, increasing the volume of the basin inside of the inlet, in this case Polpis Harbor, results in more water remaining in the basin (*i.e.* longer residence time). This water then gathers more nitrogen inputs from the watershed and sediments, so that TN concentrations increase. The scenario results indicate that dredging within the Polpis Harbor inlet will have to be offset by greater reductions in nitrogen loading inputs or an increase in system tidal volumes in order move closer to the threshold concentrations.

Overall, the scenario results show which management approaches provide sufficient reductions in TN concentrations within the Harbor to meet the N threshold levels and suggest that different mixes of alternatives used in scenarios 9, 10, and 11 are possible. As these results indicate threshold levels are attained, but are at the margin of the predictive ability of the Nantucket Harbor models, we recommend an adaptive management approach that includes implementation of the most impactful management steps based on the scenario modeling and a monitoring program to regularly assess the progress toward the TMDL. This regular, on-going monitoring and feedback review of collected data will allow the town to measure the actual improvements within the Harbor system and address additional issues of future management including nitrogen loading impacts of buildout/new development within the watershed, consideration of additional lawn fertilizer restrictions, completion of sewering within the existing Town Sewer District, and expansion of sewering to other portions of the Harbor watershed. This sort of approach would also allow future refinements of the MEP models as new data helps to better understand the details within the system.

The MEP team is available to continue to assist the Town and Woodard and Curran with further evaluations of planned water quality management strategies.

**Table 1. Comprehensive Listing of Watershed Nitrogen Loads used in MEP Nantucket Harbor Scenarios.** Whole system and subwatershed nitrogen loads are shown (in kg/yr) for all past scenarios and the scenarios evaluated in this Technical Memo. Scenario are grouped by the four reporting documents: 1) Nantucket Harbor MEP Report, 2) January 4, 2012 MEP Technical Memorandum [Scenarios 1-4], 3) February 4, 2014 MEP Technical Memorandum [Scenarios 5-8], and 4) this current MEP Technical Memorandum [Scenarios 9-11]. It should be noted that watershed nitrogen loads in the MEP Report and the January 4, 2012 used the same land use database and listing of parcels connected to the Town sewer system, while later scenarios used updated information developed during each subsequent group of scenarios.

| Overall Scenario Count | | *Original MEP N Loads* | | | | | | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference | | *MEP Report* | | | | | | *Jan 4, 2012 MEP Tech Memo Scenario 1* | *Jan 4, 2012 MEP Tech Memo Scenario 2* | *Jan 4, 2012 MEP Tech Memo Scenario 3* | *Jan 4, 2012 MEP Tech Memo Scenario 4* | *Feb 4, 2014 MEP Tech Memo Scenario 1* | *Feb 4, 2014 MEP Tech Memo Scenario 2* | *Feb 4, 2014 MEP Tech Memo Scenario 3* | *Feb 4, 2014 MEP Tech Memo Scenario 4* | *May 19, 2014 MEP Tech Memo Scenario 1* | *May 19, 2014 MEP Tech Memo Scenario 2* | *May 19, 2014 MEP Tech Memo Scenario 3* |
| Watershed Land Use | | *Existing* | *Buildout* | *Alt Buildout* | *No Anthro* | *Existing* | *Existing* | *Existing* | *Existing* | *Existing* | *Existing* | *New Existing* | *New Buildout* | *New Buildout* | *New Buildout* | *Hybrid Existing* | *Hybrid Existing* | *Hybrid Existing* |
| Brief Scenario Description | | | | *All Sewer District connected to town sewer* | | *Threshold A: 100% removal of septic from Town subwatershed + 80% of all anthro N loads from other sheds* | *Threshold B: 100% removal of septic from whole shed* | *Monomoy Sewering* | *Monomoy and Shimmo Sewering* | *Elevate Jetties* | *Monomoy and Shimmo Sewering, Elevate Jetties* | *Update Historically Sewered Properties, changes to Sewer District* | *Update Historically Sewered Properties, changes to Sewer District* | *Dredging the Inlet to Polpis Harbor, Elevate Inlet Jetties* | *Monomoy Sewering, Dredging the Inlet to Polpis Harbor, Elevate Inlet Jetties* | *Monomoy Sewering, Elevate Inlet Jetties* | *Monomoy Sewering, Lawn Fertilizer Restriction, Elevate Inlet Jetties* | *Monomoy Sewering (adjusted), Lawn Fertilizer Restriction, Elevate Inlet Jetties* |
| Watershed Name | Watershed ID# | | | | | | | | | | | | | | | | | |
| Nantucket Harbor | | 29,877 | 31,905 | 30,562 | 23,003 | 26,739 | 27,422 | 29,624 | 29,410 | 29,877 | 29,410 | 29,852 | 30,579 | 30,579 | 30,393 | 28,277 | 28,068 | 28,042 |
| Head of the Harbor | | 8,795 | 8,984 | 8,984 | 8,309 | 8,406 | 8,538 | 8,795 | 8,795 | 8,795 | 8,795 | 8,795 | 8,984 | 8,984 | 8,984 | 8,795 | 8,788 | 8,788 |
| Head of the Harbor | 1 | 678 | 867 | 867 | 192 | 289 | 421 | 678 | 678 | 678 | 678 | 678 | 867 | 867 | 867 | 678 | 671 | 671 |
| Head of the Harbor Estuary surface deposition | | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 | 8,117 |
| Polpis | | 2,087 | 2,294 | 2,294 | 1,470 | 1,593 | 1,928 | 2,088 | 2,088 | 2,088 | 2,088 | 2,087 | 2,294 | 2,294 | 2,294 | 2,087 | 2,079 | 2,079 |
| Polpis | 2 | 1,288 | 1,494 | 1,494 | 670 | 794 | 1,129 | 1,288 | 1,288 | 1,288 | 1,288 | 1,288 | 1,494 | 1,494 | 1,494 | 1,288 | 1,279 | 1,279 |
| Polpis Estuary surface deposition | | 799 | 799 | 799 | 799 | 799 | 799 | 799 | 799 | 799 | 799 | 799 | 799 | 799 | 799 | 799 | 799 | 799 |
| Quaise | | 8,121 | 8,225 | 8,225 | 7,673 | 7,762 | 7,978 | 8,121 | 8,062 | 8,121 | 8,062 | 8,121 | 8,225 | 8,225 | 8,225 | 8,121 | 8,114 | 8,114 |
| Quaise | 3 | 775 | 878 | 878 | 327 | 416 | 632 | 775 | 716 | 775 | 716 | 775 | 878 | 878 | 878 | 775 | 768 | 768 |
| Quaise Estuary surface deposition | | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 | 7,346 |
| Town | | 10,873 | 12,402 | 11,059 | 5,551 | 8,977 | 8,977 | 10,620 | 10,465 | 10,873 | 10,465 | 10,849 | 11,077 | 11,077 | 10,890 | 9,274 | 9,086 | 9,061 |
| Town | 4 | 5,804 | 7,333 | 5,990 | 482 | 3,908 | 3,908 | 5,551 | 5,396 | 5,804 | 5,396 | 5,780 | 6,008 | 6,008 | 5,821 | 4,204 | 4,017 | 3,992 |
| Town Estuary surface deposition | | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 | 5,069 |

**Table 2. Comprehensive Listing of Nantucket Harbor MEP Scenario Water Quality Results.** Modeling total nitrogen concentrations (all in mg/L) at each of the Nantucket Harbor water quality sampling stations are shown, along with brief descriptions of each of the scenarios and where the results were reported. Results for the two sentinel stations (stations 2.1 and 4) are indicated in the gray shade cells; cells shaded green are scenario results that attained the threshold concentrations at the sentinel stations: 0.350 mg/L TN at station 2.1 and 0.355 mg/L at station 4. Scenarios are grouped by the four reporting documents: 1) Nantucket Harbor MEP Report, 2) January 4, 2012 MEP Technical Memorandum [Scenarios 1-4], 3) February 4, 2014 MEP Technical Memorandum [Scenarios 5-8], and 4) this current MEP Technical Memorandum [Scenarios 9-11]. It should be noted that watershed nitrogen loads in the MEP Report and the January 4, 2012 Technical Memorandum used the same land use database, including listing of parcels connected to the Town sewer system. Later scenarios used updated information developed during each subsequent group of scenarios that supports refinement of water quality modeling results.

| **Overall Scenario Count** | | ***Original MEP N Loads*** | | | | | | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** | ***11*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reference** | | ***MEP Report*** | | | | | | ***Jan 4, 2012 MEP Tech Memo Scenario 1*** | ***Jan 4, 2012 MEP Tech Memo Scenario 2*** | ***Jan 4, 2012 MEP Tech Memo Scenario 3*** | ***Jan 4, 2012 MEP Tech Memo Scenario 4*** | ***Feb 4, 2014 MEP Tech Memo Scenario 1*** | ***Feb 4, 2014 MEP Tech Memo Scenario 2*** | ***Feb 4, 2014 MEP Tech Memo Scenario 3*** | ***Feb 4, 2014 MEP Tech Memo Scenario 4*** | ***May 19, 2014 MEP Tech Memo Scenario 1*** | ***May 19, 2014 MEP Tech Memo Scenario 2*** | ***May 19, 2014 MEP Tech Memo Scenario 3*** |
| **Watershed Land Use** | | ***Existing*** | ***Buildout*** | ***Alt Buildout*** | ***No Anthro*** | ***Existing*** | ***Existing*** | ***Existing*** | ***Existing*** | ***Existing*** | ***Existing*** | ***New Existing*** | ***New Buildout*** | ***New Buildout*** | ***New Buildout*** | ***Hybrid Existing*** | ***Hybrid Existing*** | ***Hybrid Existing*** |
| **Brief Scenario Description** | | | | ***All Sewer District connected to town sewer*** | | ***Threshold A: 100% removal of septic from Town subwatershed + 80% of all anthro N loads from other sheds*** | ***Threshold B: 100% removal of septic from whole shed*** | ***Monomoy Sewering*** | ***Monomoy and Shimmo Sewering*** | ***Elevate Jetties*** | ***Monomoy and Shimmo Sewering, Elevate Jetties*** | ***Update Historically Sewered Properties, changes to Sewer District*** | ***Update Historically Sewered Properties, changes to Sewer District*** | ***Dredging the Inlet to Polpis Harbor, Elevate Inlet Jetties*** | ***Monomoy Sewering, Dredging the Inlet to Polpis Harbor, Elevate Inlet Jetties*** | ***Monomoy Sewering, Elevate Inlet Jetties*** | ***Monomoy Sewering, Lawn Fertilizer Restriction, Elevate Inlet Jetties*** | ***Monomoy Sewering (adjusted), Lawn Fertilizer Restriction, Elevate Inlet Jetties*** |
| Station | Station ID | | | | | | | | | | | | | | | | | |
| Head of the Harbor - Upper | 2 | 0.397 | 0.400 | 0.398 | 0.387 | 0.392 | 0.393 | 0.396 | 0.396 | 0.395 | 0.394 | 0.411 | 0.412 | 0.412 | 0.412 | 0.409 | 0.408 | 0.408 |
| Head of the Harbor - Mid | 2.2 | 0.390 | 0.392 | 0.391 | 0.380 | 0.385 | 0.386 | 0.389 | 0.388 | 0.387 | 0.387 | 0.401 | 0.402 | 0.402 | 0.402 | 0.399 | 0.399 | 0.399 |
| **Head of the Harbor - Lower** | **2.1** | **0.353** | **0.355** | **0.354** | **0.345** | **0.349** | **0.350** | **0.352** | **0.352** | **0.350** | **0.349** | **0.354** | **0.355** | **0.354** | **0.354** | **0.352** | **0.352** | **0.352** |
| Pocomo Head | 3 | 0.340 | 0.342 | 0.340 | 0.333 | 0.336 | 0.337 | 0.339 | 0.339 | 0.336 | 0.336 | 0.338 | 0.339 | 0.338 | 0.338 | 0.336 | 0.336 | 0.336 |
| Quaise Basin | 3.1 | 0.325 | 0.327 | 0.326 | 0.319 | 0.322 | 0.323 | 0.325 | 0.324 | 0.321 | 0.321 | 0.323 | 0.324 | 0.324 | 0.324 | 0.322 | 0.322 | 0.322 |
| **East Polpis** | **4** | **0.361** | **0.364** | **0.363** | **0.351** | **0.356** | **0.358** | **0.361** | **0.360** | **0.357** | **0.357** | **0.359** | **0.361** | **0.361** | **0.361** | **0.357** | **0.357** | **0.357** |
| West Polpis | 4.1 | 0.371 | 0.374 | 0.373 | 0.360 | 0.365 | 0.367 | 0.370 | 0.370 | 0.367 | 0.367 | 0.369 | 0.371 | 0.370 | 0.370 | 0.367 | 0.367 | 0.367 |
| Abrams Point | 5 | 0.296 | 0.297 | 0.296 | 0.293 | 0.294 | 0.295 | 0.296 | 0.296 | 0.292 | 0.292 | 0.296 | 0.296 | 0.295 | 0.295 | 0.294 | 0.294 | 0.294 |
| Monomoy | 6 | 0.291 | 0.292 | 0.291 | 0.286 | 0.289 | 0.289 | 0.290 | 0.290 | 0.287 | 0.286 | 0.291 | 0.291 | 0.291 | 0.290 | 0.289 | 0.289 | 0.289 |
| Mooring Area | 7 | 0.285 | 0.286 | 0.285 | 0.282 | 0.284 | 0.284 | 0.284 | 0.284 | 0.281 | 0.281 | 0.285 | 0.285 | 0.284 | 0.284 | 0.283 | 0.283 | 0.283 |

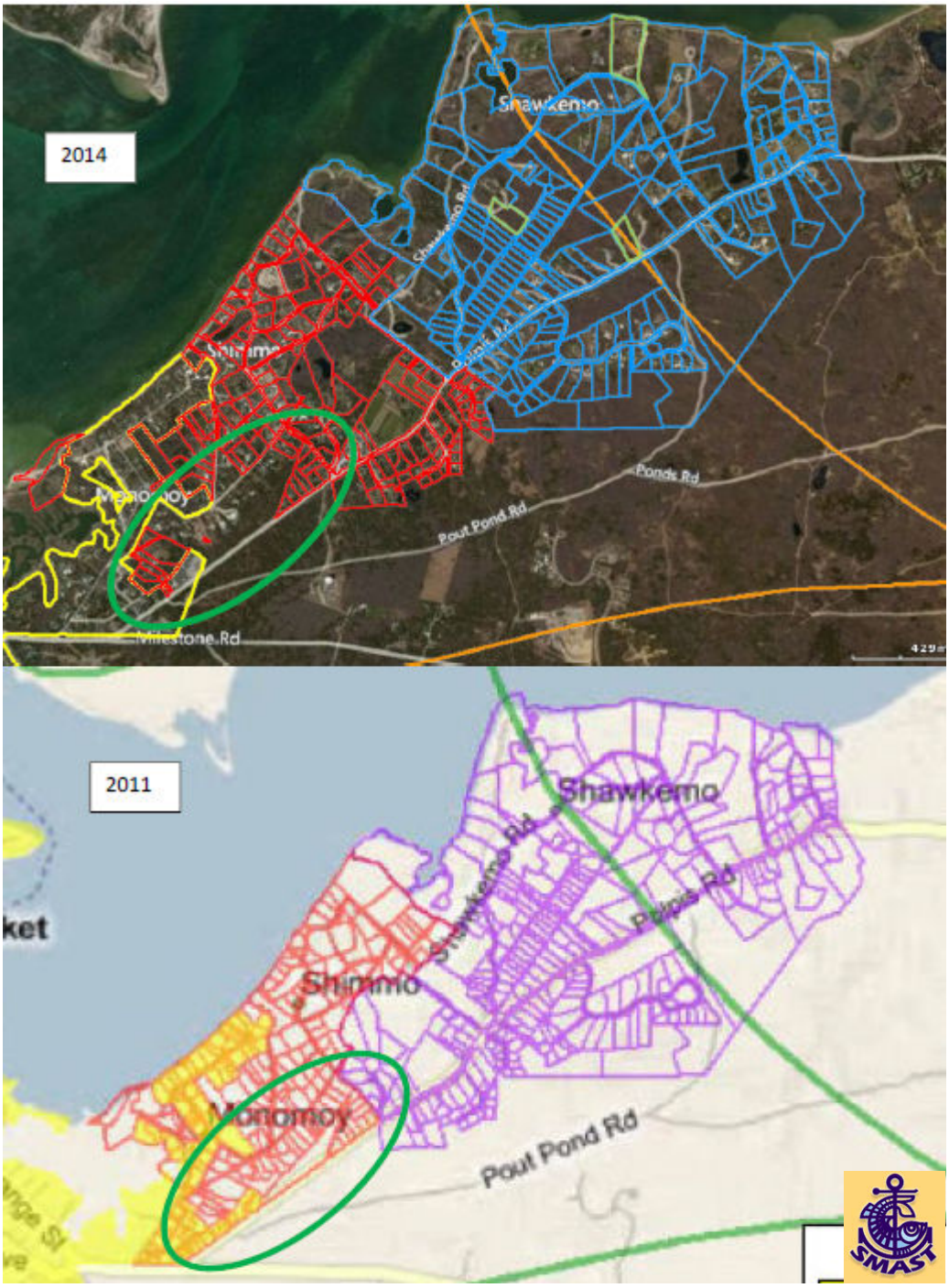



**Figure 1. Comparison of Monomoy Service Area 2011 and 2014.** The area along Brewster Road, which is within the green oval, was excluded from the Monomoy Service Area in Scenarios 9 and 10 during the initial review of scenarios completed for this Technical Memorandum. These parcels were included in Scenario 11. It should also be noted that the parcels included in the Monomoy and Shimmo Service Areas changed between the development of Scenarios 4 and 5 and that the boundary of the Town Sewer District also changed over the course of Nantucket Harbor MEP scenario reviews. The Service Areas shown above in the 2014 aerial map are the current delineation with the addition of the parcels along Brewster Road.

# TMDLS and WATER QUALITY THRESHOLDS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
ONE CONGRESS STREET SUITE 1100
BOSTON, MASSACHUSETTS 02114-2023

May 12, 2009

Laurie Burt, Commissioner
Department of Environmental Protection
1 Winter Street
Boston, MA 02108

Re: Approval of Nantucket Harbor Embayment System Total Maximum Daily Loads For Total Nitrogen

Dear Commissioner Burt:

Thank you for submission of the Total Maximum Daily Loads (TMDLs) for total nitrogen in Nantucket Harbor and the work that went into these analyses.

The U.S. Environmental Protection Agency (EPA) has reviewed the document entitled "Nantucket Harbor Embayment System Total Maximum Daily Loads for Total Nitrogen (Report # 97-TMDL-2 Control #249.0)" and approves these two TMDLs. EPA has determined, as set forth in the enclosed review document, that these TMDLs meet the requirements of Section 303(d) of the Clean Water Act (CWA) and EPA's implementing regulations at 40 Code of Federal Regulations (CFR) part 130.

My staff and I look forward to continued cooperation with the MassDEP in exercising our shared responsibility of implementing the requirements under Section 303(d) of the CWA. If you have questions regarding this approval, please contact Steve Silva at (617) 918-1561 or Mary Garren at (617) 918-1322.

Sincerely,

/s/

Ken Moraff, Acting Director
Office of Ecosystem Protection

Enclosure

cc: Glenn Haas, MassDEP
Rick Dunn, MassDEP

Brian Dudley, MassDEP
Steve Silva, EPA
Mary Garren, EPA

# EPA NEW ENGLAND'S TMDL REVIEW

**DATE:** May 12, 2009

**TMDL:** Nantucket Harbor Embayment System TMDL for Total Nitrogen (Report # MA97-TMDL-2, Control #249.0)

**STATUS:** Final

**IMPAIRMENT/POLLUTANT**: 2 TMDLs for Total Nitrogen (See Attachment 1)

**BACKGROUND:**

The Massachusetts Department of Environmental Protection (MassDEP) released a draft TMDL on September 25, 2007 for public review. Key stakeholders received copies of the document in the mail. The draft TMDL was posted on the Department's web site on that date as well. In addition, a public meeting was held in the Town of Nantucket, Veteran's Community Center on October 9, 2007. The public comment period was extended and comments accepted until November 2, 2007. MassDEP prepared a response to public comment which was submitted along with the final TMDL to EPA. All comments from the public were taken into account in the Response to Comments and the final TMDL submission. MassDEP notes that the public meeting was for Nantucket Harbor and Polpis Harbor. As such their response to comments document includes responses to issues and concerns raised for both embayments. The final submission to EPA was sent on February 3, 2009. In addition to the TMDL itself, the submittal included, either directly or by reference, the following additional documents:

- Response to Comments for Draft TMDL Report for the Nantucket Harbor System. (Report dated September 12, 2007)
- Massachusetts Year 2008 Integrated List of Waters, Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 303(d) and 305(b) of the Clean Water Act (CN 282.1), December, 2008. http://www.mass.gov/dep/water/resources/2008il1.pdf
- Howes B., S. W. Kelley, J. S. Ramsey, R. Samimy, D. Schlezinger, and E. Eichner (2006). Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Nantucket Harbor, Town of Nantucket, Nantucket Island, MA. Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA. http://www.oceanscience.net/estuaries/Nantucket.htm
- Massachusetts Estuaries Project Embayment Restoration and Guidance for Implementation Strategies, MassDEP 2003. http://www.mass.gov/dep/water/resources/mepmain.pdf

The following review explains how the TMDL submission meets the statutory and regulatory requirements of TMDLs in accordance with §303(d) of the Clean Water Act and EPA's implementing regulations in 40 CFR Part 130.

**REVIEWER:** Mary Garren, telephone number 617-918-1322,
email: garren.mary@epa.gov

## REVIEW ELEMENTS OF TMDLs

*Section 303(d) of the Clean Water Act (CWA) and EPA's implementing regulations at 40 C.F.R. § 130 describe the statutory and regulatory requirements for approvable TMDLs. The following information is generally necessary for EPA to determine if a submitted TMDL fulfills the legal requirements for approval under Section 303(d) and EPA regulations, and should be included in the submittal package. Use of the verb "must" below denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation.*

### 1. Description of Waterbody, Pollutant of Concern, Pollutant Sources and Priority Ranking

*The TMDL analytical document must identify the waterbody as it appears on the State/Tribe's 303(d) list, the pollutant of concern and the priority ranking of the waterbody. The TMDL submittal must include a description of the point and nonpoint sources of the pollutant of concern, including the magnitude and location of the sources. Where it is possible to separate natural background from nonpoint sources, a description of the natural background must be provided, including the magnitude and location of the source(s). Such information is necessary for EPA's review of the load and wasteload allocations which are required by regulation. The TMDL submittal should also contain a description of any important assumptions made in developing the TMDL, such as: (1) the assumed distribution of land use in the watershed; (2) population characteristics, wildlife resources, and other relevant information affecting the characterization of the pollutant of concern and its allocation to sources; (3) present and future growth trends, if taken into consideration in preparing the TMDL; and, (4) explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments, or chlorophyl a and phosphorus loadings for excess algae.*

The document for the Nantucket Harbor Embayment System TMDL for Total Nitrogen adequately describes the water body segment, nature and cause or threat of the impairments. Impairments include loss of eelgrass beds. Approximately 38% of eelgrass beds have been lost since a survey completed in 1951. There are healthy or slightly impaired conditions relative to dissolved oxygen, macro-algae, and benthic fauna. The TMDL identifies excess total nitrogen originating primarily from sediments and atmospheric deposition. Septic systems, runoff, and fertilizers are lesser causes of the impairments.

The TMDL document identifies two water body segments needing TMDLs for total nitrogen (Nantucket Harbor and Polpis Harbor). These water bodies are listed as impaired for nutrients on the Massachusetts' 2008 Clean Water Act (CWA) §303(d) list. Nantucket Harbor and Polpis Harbor are identified as waterbody segment number MA97-01_2004 and MA97-26_2004, respectively.

The TMDL document provides a good overview of the description and priority ranking of the water bodies, pollutants of concern and pollutant sources (pages 2-6). The companion Massachusetts Estuaries Project final report (November 2006) presents detailed information on the Nantucket Harbor Embayment System, Nantucket Island, and the Town of Nantucket. MassDEP has determined that all nutrient impaired segments in the Commonwealth are a high priority. See the Massachusetts 2008 Integrated List of Waters at:
http://www.mass.gov/dep/water/resources/2008il1.pdf

*Assessment:*

EPA New England concludes that the TMDL document meets the requirements for describing water body segment, pollutant of concern, identifying and characterizing sources of impairment, and priority ranking.

## 2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

*The TMDL submittal must include a description of the applicable State/Tribe water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criterion, and the antidegradation policy. Such information is necessary for EPA's review of the load and wasteload allocations which are required by regulation. A numeric water quality target for the TMDL (a quantitative value used to measure whether or not the applicable water quality standard is attained) must be identified. If the TMDL is based on a target other than a numeric water quality criterion, then a numeric expression, usually site specific, must be developed from a narrative criterion and a description of the process used to derive the target must be included in the submittal.*

The TMDL document identifies several provisions of the Commonwealth's water quality standards that are relevant to the cultural eutrophication in these waters, including numeric criteria for dissolved oxygen and narrative criteria for nutrients, and aesthetics. As stated on page 8 of the TMDL document and in EPA guidance, individual estuarine and coastal marine waters tend to have unique characteristics and therefore, individual water body criteria are typically required. For example, the loading of nitrogen that a specific water body can handle without becoming impaired varies. Factors that influence the effect of nitrogen include: flow velocity, tidal hydraulics, dissolved oxygen, and sediment adsorption and desorption of nitrogen.

The Massachusetts Estuaries Project analytical method is the Linked Watershed-Embayment Management Model (Linked Model) and is discussed on pages 8 - 14 of the TMDL document. It links watershed inputs with embayment circulation and nitrogen characteristics, and:

- requires site-specific measurements within each watershed and embayment;
- uses realistic "best-estimates" of nitrogen loads from each specific type of land-use;
- spatially distributes the watershed nitrogen loading to the embayment;
- accounts for nitrogen attenuation during transport to the embayment;
- includes a 2D or 3D embayment circulation model depending on embayment structure;
- accounts for basin structure, tidal variations, and dispersion within the embayment;
- includes nitrogen regenerated within the embayment;
- is validated by both independent hydrodynamic, nitrogen concentration, and ecological data; and
- is calibrated and validated with field data prior to generation of "what if" scenarios.

Sentinel locations were identified in the embayment system as locations at which restoration will necessarily result in high quality habitat throughout the system and attainment of water quality standards (page 12 and Appendix A, Figure A of the TMDL document). These sentinel locations

are located within the lower Head of the Harbor basin and in the eastern basin of Polpis Harbor and are based on eelgrass loss.

Attaining the modeled nitrogen target at the sentinel locations through implementation of the TMDL will lead to restoration of eelgrass and infaunal habitats in each of the sub-embayments. The target threshold nitrogen concentrations which have been determined to be protective for each embayment system are 0.35 mg/L at the Head of the Harbor sentinel station and 0.36 mg/L at the Polpis Harbor sentinel station (Table 2, page 12 of the TMDL document). These concentrations, which represent the average water column concentrations of nitrogen, will restore or maintain high habitat quality in these embayments.

*Assessment:*

The use of the Linked Model, the description of the process in the TMDL document, and the companion Technical Report to this TMDL document adequately demonstrate the basis for deriving the target nitrogen loads and demonstrating that the targets will achieve water quality standards. EPA concludes that Massachusetts has properly presented its numeric water quality standards and has made a reasonable and appropriate interpretation of its narrative water quality criteria for the designated uses of the Nantucket Harbor embayment system.

## 3. Loading Capacity - Linking Water Quality and Pollutant Sources

*As described in EPA guidance, a TMDL identifies the loading capacity of a waterbody for a particular pollutant. EPA regulations define loading capacity as the greatest amount of loading that a water can receive without violating water quality standards (40 C.F.R. § 130.2(f) ). The loadings are required to be expressed as either mass-per-time, toxicity or other appropriate measure (40 C.F.R. § 130.2(i)). The TMDL submittal must identify the waterbody's loading capacity for the applicable pollutant and describe the rationale for the method used to establish the cause-and-effect relationship between the numeric target and the identified pollutant sources. In most instances, this method will be a water quality model. Supporting documentation for the TMDL analysis must also be contained in the submittal, including the basis for assumptions, strengths and weaknesses in the analytical process, results from water quality modeling, etc. Such information is necessary for EPA's review of the load and wasteload allocations which are required by regulation.*

*In many circumstances, a critical condition must be described and related to physical conditions in the waterbody as part of the analysis of loading capacity (40 C.F.R. § 130.7(c)(1) ). The critical condition can be thought of as the "worst case" scenario of environmental conditions in the waterbody in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence. Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards.*

The Linked Model, as stated in the TMDL document is a robust and fairly complicated model that determines an embayment's nitrogen sensitivity, nitrogen threshold loading levels (TMDL) and response to changes in the loading rate. A key feature of the approach involves the selection of sentinel sub-embayments that have the poorest water quality in the embayment system. If these degraded areas come into compliance with the TMDL, other areas will also achieve water quality standards for nitrogen in the system. This approach captures the critical targets needed to address the impaired segments.

The percent reductions of existing nitrogen loads necessary to meet the target thresholds are: 58% at Head of Harbor, 46% at Quaise Basin, 12% at Town Basin, and 38% at Polpis Harbor (page 15 of the TMDL document). These loads represent one scenario using the Linked Model. The TMDL loading capacity value for each sub-embayment represents the sum of the calculated target threshold load, atmospheric deposition load, and benthic flux load from sediment sources. For example at Head of Harbor, the TMDL is calculated by adding the target threshold load of 0.79 kg/day, the atmospheric load of 22.24 kg/day and the benthic input which is 0 kg/day. The TMDLs for Nantucket Harbor embayment system are 23 kg/day at Head of Harbor, 64 kg/day at Quaise Basin, 25 kg/day at Town Basin, and 31 kg/day at Polpis Harbor (page 19 and Appendix D of the TMDL document). See also Tables 4 and 5 below taken from MassDEP's TMDL document.

**TABLE 4: Present Watershed Nitrogen Loading Rate, Target Threshold Nitrogen Loading Rate, and the Percent Reduction of the Existing Load Necessary to Achieve the Target Threshold Load**
(taken from page 15 of the TMDL document)

| Embayments | Present Watershed Load [1] (kg/day) | Target Threshold Watershed Load[2] (kg/day) | Percent Watershed Load Reductions Needed to Achieve Threshold Loads |
|---|---|---|---|
| Head of Harbor | 1.86 | 0.79 | 58 % |
| Quaise Basin | 2.12 | 1.14 | 46 % |
| Town Basin | 12.22 | 10.71 | 12 % |
| Polpis Harbor | 3.52 | 2.18 | 38 % |

[1] Composed of combined fertilizer, runoff, septic system loadings, and atmospheric deposition to freshwater lakes and natural surfaces

[2] Target threshold watershed load is the load from the watershed needed to meet the target threshold N concentrations identified in Table 2 above

**TABLE 5: The Total Maximum Daily Load (TMDL) for Nantucket Harbor Embayment System, Represented as the Sum of the Calculated Target Threshold Load (from Watershed Sources), Atmospheric Deposition, and Benthic Input**
(taken from page 19 of the TMDL document)

| Sub-embayment | Target Threshold Watershed Load [1] (kg/day) | Atmospheric Deposition (kg/day) | Benthic Input (kg/day) | TMDL [2] (kg/day) |
|---|---|---|---|---|
| Head of Harbor | 0.79 | 22.24 | 0 | 23 |
| Quaise Basin | 1.14 | 20.13 | 43.01 | 64 |
| Town Basin | 10.71 | 13.89 | 0 | 25 |
| Polpis Harbor | 2.18 | 2.19 | 26.45 | 31 |

[1] Target threshold watershed load is the load from the watershed needed to meet the embayment threshold concentrations identified in Table 2

[2] Sum of target threshold watershed load, atmospheric deposition load, and the benthic input load

*Assessment:*

The TMDL document explains and EPA concurs with the approach for applying the Linked Model to specific embayments for the purpose of developing target nitrogen loading rates and in identifying sources of needed nitrogen load reduction. EPA believes that this approach is reasonable because the factors influencing and controlling nutrient impairment were well justified.

## 4. Load Allocations (LAs)

*EPA regulations require that a TMDL include LAs, which identify the portion of the loading capacity allocated to existing and future nonpoint sources and to natural background (40 C.F.R. § 130.2(g) ). Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. § 130.2(g) ). Where it is possible to separate natural background from nonpoint sources, load allocations should be described separately for background and for nonpoint sources.*

*If the TMDL concludes that there are no nonpoint sources and/or natural background, or the TMDL recommends a zero load allocation, the LA must be expressed as zero. If the TMDL recommends a zero LA after considering all pollutant sources, there must be a discussion of the reasoning behind this decision, since a zero LA implies an allocation only to point sources will result in attainment of the applicable water quality standard, and all nonpoint and background sources will be removed.*

Using the Linked Model, Mass DEP has identified the portion of the loading capacity allocated to existing and future non-point sources necessary to meet water quality standards. These non-point sources are primarily on-site subsurface wastewater disposal systems (i.e. septic systems), runoff (stormwater) and fertilizer. Because there are no NPDES-regulated sources and there is

an implicit Margin of Safety (see Section 6 below), the LA in this TMDL is equal to the TMDL loading capacity in Section 3 above [TMDL (loading capacity) = LA + WLA + MOS; where the WLA and MOS are respectively zero and implicit in this case].

*Assessment:*

EPA concludes that the TMDL document sufficiently addresses the calculation of the load allocations.

## 5. Wasteload Allocations (WLAs)

*EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to existing and future point sources (40 C.F.R. § 130.2(h)). If no point sources are present or if the TMDL recommends a zero WLA for point sources, the WLA must be expressed as zero. If the TMDL recommends a zero WLA after considering all pollutant sources, there must be a discussion of the reasoning behind this decision, since a zero WLA implies an allocation only to nonpoint sources and background will result in attainment of the applicable water quality standard, and all point sources will be removed.*

*In preparing the wasteload allocations, it is not necessary that each individual point source be assigned a portion of the allocation of pollutant loading capacity. When the source is a minor discharger of the pollutant of concern or if the source is contained within an aggregated general permit, an aggregated WLA can be assigned to the group of facilities. But it is necessary to allocate the loading capacity among individual point sources as necessary to meet the water quality standard.*

*The TMDL submittal should also discuss whether a point source is given a less stringent wasteload allocation based on an assumption that nonpoint source load reductions will occur. In such cases, the State/Tribe will need to demonstrate reasonable assurance that the nonpoint source reductions will occur within a reasonable time.*

As discussed in Section 4 above, there are no NPDES-regulated sources in the watershed, therefore, the WLA which is the load from NPDES permit regulated discharges (CWA point sources) is zero. MassDEP has provided, for informational purposes, an estimated (non-CWA) "WLA" in Appendix C of the TMDL document based on the impervious cover in each sub-embayment. Appendix C illustrates the relative amount of impervious cover and associated stormwater runoff between the sub-embayments.

*Assessment:*

EPA concludes that the TMDL document sufficiently addresses the determination of the waste load allocation which is zero in this TMDL because there are no NPDES regulated point sources.

## 6. Margin of Safety (MOS)

*The statute and regulations require that a TMDL include a margin of safety to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA § 303(d)(1)(C), 40 C.F.R. § 130.7(c)(1) ). EPA guidance explains that the MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be identified.*

The implicit margin of safety is set out in the TMDL document on pages 17 - 18. There are several factors that contribute to the margin of safety inherent in the approach used to develop this TMDL including:

1) **Use of conservative data in the Linked Model as follows**:
   - Nitrogen concentrations in the watershed that were used in the model were higher and more conservative than those actually measured in the streams;
   - Agreement between the modeled and observed values has been approximately 95%;
   - Attenuation factors used were lower and more conservative than those that were actually measured;
   - Lawn fertilization rates were based on actual survey. These rates represent a conservative estimate of the nitrogen load;
   - Loading calculations assumed that 90% of water used is converted to wastewater, which is a conservative assumption; and
   - Loading calculations for homes that do not have metered water use were made conservatively;

2) **Conservative sentinel station/target threshold nitrogen concentrations**
   Sites were chosen that had stable eelgrass or benthic (infaunal) communities. Selection of sites that were starting to show impairment would have resulted in higher nitrogen concentrations; and

3) **Conservative approach**
   Target loads were based on averaged nitrogen concentrations on the outgoing tide. This is the worst case scenario because this is when the nitrogen concentrations are highest. Nitrogen concentrations will be lower on the flood tides, due to dilution from the incoming tide.

*Assessment:*

EPA concludes that the implicit margin of safety for the TMDL is acceptable.

## 7. Seasonal Variation

*The statute and regulations require that a TMDL be established with consideration of seasonal variations. The method chosen for including seasonal variations in the TMDL must be described (CWA § 303(d)(1)(C), 40 C.F.R. § 130.7(c)(1)).*

The TMDL for the water body segment identified in the document are based on achieving the nitrogen loads during the most critical time period, i.e., the summer growing season. Since the other seasons are less sensitive to nitrogen loading, the TMDL is protective of all seasons throughout the year. Seasonal variation is addressed on page 19 of the TMDL document.

*Assessment:*

Since the other seasons are less sensitive to nitrogen loading, EPA concludes that the TMDL is protective of all seasons throughout the year.

## 8. Monitoring Plan for TMDLs Developed Under the Phased Approach

*EPA's 1991 document, Guidance for Water Quality-Based Decisions: The TMDL Process (EPA 440/4-91-001), and EPA's 2006 guidance, Clarification Regarding "Phased" Total Maximum Daily Loads, recommend a monitoring plan when a TMDL is developed using the phased approach. The guidance indicates that a State may use the phased approach for situations where TMDLs need to be developed despite significant data uncertainty and where the State expects that the loading capacity and allocation scheme will be revised in the near future. EPA's guidance provides that a TMDL developed under the phased approach should include, in addition to the other TMDL elements, a monitoring plan that describes the additional data to be collected and a scheduled timeframe for revision of the TMDL.*

Because this TMDL is not a "phased" TMDL, a monitoring plan is not required in order to assure that data is available for updating the TMDL in the near future. Nevertheless, in order to assess the progress in obtaining the TMDLs' water quality goals, MassDEP has recommended that the Town of Nantucket track implementation progress as approved in the Town Comprehensive Wastewater Management Planning (CWMP) and monitor ambient water quality conditions at the sentinel stations (pages 21-22 of the TMDL document). MassDEP presents suggested guidelines for water quality, benthic habitat and community, and eelgrass bed monitoring.

*Assessment:*

EPA New England concludes that the anticipated monitoring by and in cooperation with MassDEP is sufficient to evaluate the adequacy of the TMDL and attainment of water quality standards, although not a required element for TMDL approval.

## 9. Implementation Plans

*On August 8, 1997, Bob Perciasepe (EPA Assistant Administrator for the Office of Water) issued a memorandum, "New Policies for Establishing and Implementing Total Maximum Daily Loads (TMDLs)," that directs Regions to work in partnership with States/Tribes to achieve nonpoint source load allocations established for 303(d)-listed waters impaired solely or primarily by nonpoint sources. To this end, the memorandum asks that Regions assist States/Tribes in developing implementation plans that include reasonable assurances that the nonpoint source load allocations established in TMDLs for waters impaired solely or primarily by nonpoint sources will in fact be achieved. The memorandum also includes a discussion of renewed focus on the public participation process and recognition of other relevant watershed management processes used in the TMDL process. Although implementation plans are not approved by EPA, they help establish the basis for EPA's approval of TMDLs.*

The implementation plan for the total nitrogen TMDL for the Nantucket Harbor Embayment System is described on pages 20 and 21 of the TMDL document. EPA concludes that the approach taken by MassDEP is reasonable because of the resources available to the towns to address nitrogen, such as the CWMP, additional linked model runs at nominal expense, assessment of cost-effective options for reducing loadings from individual on-site subsurface wastewater disposal systems, land use planning and controls, water conservation, and stormwater control and treatment. MassDEP advised the town to incorporate the nitrogen loading reduction

strategies outlined in the Massachusetts Estuaries Implementation Guidance report http://www.mass.gov/dep/water/resources/restore.htm into the implementation plan.

*Assessment:*

MassDEP has addressed the implementation plan, although it is not required. EPA is taking no action on the implementation plan.

## 10. Reasonable Assurances

*EPA guidance calls for reasonable assurances when TMDLs are developed for waters impaired by both point and nonpoint sources. In a water impaired by both point and nonpoint sources, where a point source is given a less stringent wasteload allocation based on an assumption that nonpoint source load reductions will occur, reasonable assurance that the nonpoint source reductions will happen must be explained in order for the TMDL to be approvable. This information is necessary for EPA to determine that the load and wasteload allocations will achieve water quality standards.*

*In a water impaired solely by nonpoint sources, reasonable assurances that load reductions will be achieved are not required in order for a TMDL to be approvable. However, for such nonpoint source-only waters, States/Tribes are strongly encouraged to provide reasonable assurances regarding achievement of load allocations in the implementation plans described in section 9, above. As described in the August 8, 1997 Perciasepe memorandum, such reasonable assurances should be included in State/Tribe implementation plans and "may be non-regulatory, regulatory, or incentive-based, consistent with applicable laws and programs."*

The Commonwealth has statutory and regulatory authority to encourage implementation of this TMDL. Nitrogen loading reductions are currently being required through a consent decree and the CWMP. In addition, Nantucket has demonstrated its commitment to implement this TMDL through the comprehensive wastewater planning that they initiated well before the generation of this TMDL. The town expects to use the information in this TMDL to generate support from their citizens to take the necessary steps to remedy existing problems related to nitrogen loading from septic systems, stormwater, and runoff (including fertilizers), and to prevent any future degradation of these valuable resources. Enforcement of local, state, and federal programs for pollution control contribute to the level of reasonable assurance. There are also financial incentives to encourage the community to follow through with its plans and prevent further degradation to water quality.

*Assessment:*

Reasonable assurance is not necessary for this TMDL to be approvable, since the point sources are not given less stringent wasteload allocations based on projected nonpoint source load reductions. MassDEP has provided reasonable assurance that water quality standards will be met.

## 11. Public Participation

*EPA policy is that there must be full and meaningful public participation in the TMDL development process. Each State/Tribe must, therefore, provide for public participation consistent with its own continuing planning process and public participation requirements (40 C.F.R. § 130.7(c)(1)(ii) ). In guidance, EPA has explained that final TMDLs submitted to EPA for review and approval must describe the State/Tribe's public participation process, including a summary of significant comments and the State/Tribe's responses to those comments. When EPA establishes a TMDL, EPA regulations require EPA to publish a notice seeking public comment (40 C.F.R. § 130.7(d)(2) ).*

*Inadequate public participation could be a basis for disapproving a TMDL; however, where EPA determines that a State/Tribe has not provided adequate public participation, EPA may defer its approval action until adequate public participation has been provided for, either by the State/Tribe or by EPA.*

MassDEP publicly announced the draft TMDL on September 25, 2007 and copies were distributed to all key stakeholders. The draft TMDL was also posted on the Department's web site for public review on that date. A public meeting was held at the Town of Nantucket, Veteran's Community Center on October 9, 2007 for information and solicitation of comments. The public comment period was extended until November 2, 2007. MassDEP submitted a response to comments to EPA along with the final submission on February 3, 2009.

*Assessment:*

EPA concludes that MassDEP has involved the public during the development of the TMDL, has provided adequate opportunities for the public to comment on the TMDL, and has provided reasonable responses to the public comments.

## 12. Submittal Letter

*A submittal letter should be included with the TMDL analytical document, and should specify whether the TMDL is being submitted for a technical review or is a final submittal. Each final TMDL submitted to EPA must be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute. The submittal letter, whether for technical review or final submittal, should contain such information as the name and location of the waterbody, the pollutant(s) of concern, and the priority ranking of the waterbody.*

On February 3, 2009, MassDEP submitted a final TMDL for total nitrogen in the Nantucket Harbor Embayment System for EPA approval. The final TMDL contained revisions based upon public comments. The TMDL document contained all of the elements necessary to approve the TMDL.

*Assessment:*

MassDEP's letter of February 3, 2009 states that the TMDL is being formally submitted for EPA review and approval.

## Attachment 1

**2 Total Nitrogen TMDLs**

| **Embayment** | Description | Sub-Embayment | TMDL (kg/day) |
|---|---|---|---|
| **Nantucket Harbor Water Body Segment # MA97-01_2004** | Determined to be impaired for nutrients, pathogens, and noxious aquatic plants by MassDEP. | Head of Harbor | 23 |
| | | Quaise Basin | 64 |
| | | Town Basin | 25 |
| **Polpis Harbor Water Body Segment # MA97-26_2004** | Determined to be impaired for nutrients, other habitat alterations, and pathogens by MassDEP. | | 31 |

| **Data for entry in EPA's National TMDL Tracking System** | |
|---|---|
| TMDL Name * | Nantucket Harbor Bay System |
| Number of TMDLs* | 2 |
| Type of TMDLs* | Nutrients<br>(Nitrogen) |
| Number of listed causes (from 303(d) list) | 2 |
| Information/prevention TMDLs, Y/N? (#) | No |
| Lead State | Massachusetts |
| TMDL Status | Final |

**Individual TMDLs listed below**

| ***TMDL sub-embayments systems and segment names*** | ***TMDL Segment ID #*** | ***TMDL Pollutant ID# & name*** | ***TMDL Impairment Cause(s)*** | ***Pollutant endpoint*** | ***Unlisted?*** | ***NPDES Point Source & ID#*** | ***Listed for something else?*** |
|---|---|---|---|---|---|---|---|
| Nantucket Harbor: Head of Harbor [See note below] | MA97-01_2004 | 511 (total nitrogen) | Nutrients | 0.35 mg/L Total Nitrogen | No | | Yes<br>Pathogens, noxious aquatic plants |
| Polpis Harbor | MA97-26_2004 | 511 (total nitrogen) | Nutrients | 0.36 mg/L Total Nitrogen | No | | Yes<br>Pathogens, Other habitat alterations |

| | |
|---|---|
| TMDL Type | Nonpoint Source (Stormwater) |
| Establishment Date (approval)* | May 12, 2009 |
| EPA Developed | No |
| Towns affected* | Nantucket |

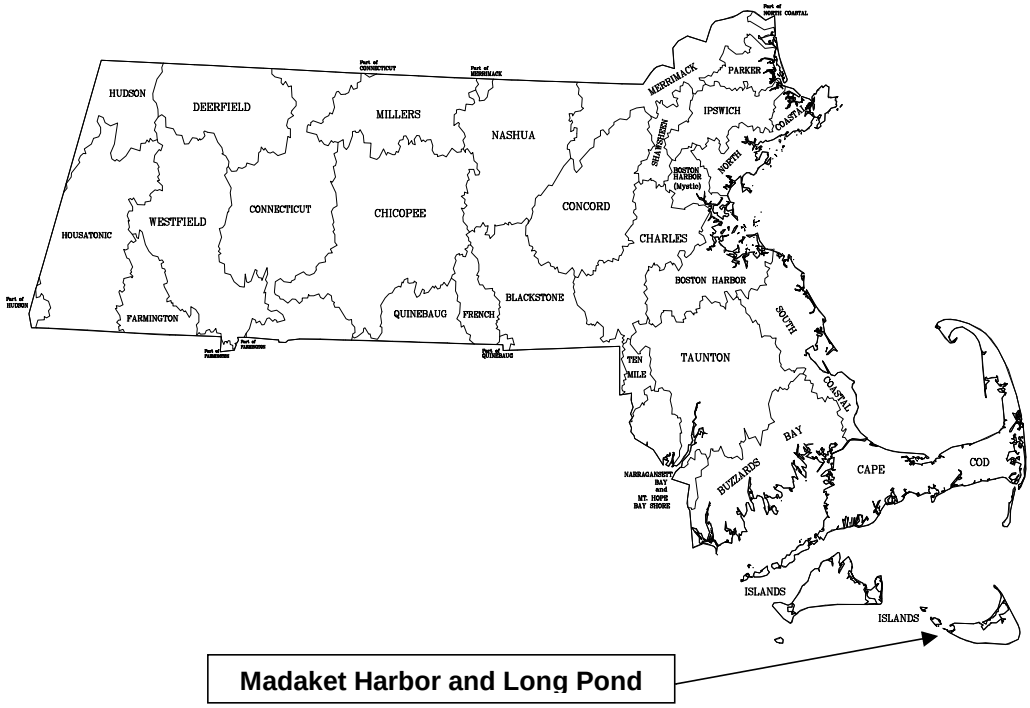
Note: Nantucket Harbor has 3 sentinel locations within one segment for purposes of the TMDL: Head of Harbor, Quaise Basin, and Town Basin

# DRAFT
# Madaket and Long Pond Estuarine System Total Maximum Daily Loads For Total Nitrogen
## (Report # 97-TMDL-5  Control # 283.0)

**COMMONWEALTH OF MASSACHUSETTS**
**EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS**
RICHARD K. SULLIVAN, SECRETARY
**MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION**
KENNETH L. KIMMELL, COMMISSIONER
**BUREAU OF RESOURCE PROTECTION**
ANN LOWERY, DEPUTY ASSISTANT COMMISSIONER

**August 2011**

# Madaket Harbor and Long Pond Estuarine System
# Total Maximum Daily Loads
# For Total Nitrogen




**Key Feature:** Total Nitrogen TMDLs for Madaket Harbor and Long Pond Estuarine System

**Location:** EPA Region 1

**Land Type:** New England Coastal

**303d Listing:** The water body segments impaired and on the Category 5 list include Hither Creek, Long Pond and Madaket Harbor.

**Data Sources:** University of Massachusetts – Dartmouth/School for Marine Science and Technology; US Geological Survey; Applied Coastal Research and Engineering, Inc.; Town of Nantucket

**Data Mechanism:** Massachusetts Surface Water Quality Standards, Ambient Data, and Linked Watershed Model

**Monitoring Plan:** Town of Nantucket monitoring program (technical assistance from SMAST)

**Control Measures:** Sewering, Storm Water Management, Attenuation by Impoundments and Wetlands, Fertilizer Use By-laws, Landfill Management

# Executive Summary

## Problem Statement

Excessive nitrogen (N) originating from a range of sources has added to the impairment of the environmental quality of the Madaket Harbor and Long Pond Estuarine System. Excessive N is indicated by:

- Undesirable increases in macro algae
- Periodic extreme decreases in dissolved oxygen concentrations that threaten aquatic life
- Reductions in the diversity of benthic animal populations
- Periodic algae blooms

With proper management of N inputs these trends can be reversed. Without proper management more severe problems might develop, including:

- Periodic fish kills
- Unpleasant odors and scum
- Benthic communities reduced to the most stress-tolerant species, or in the worst cases, near loss of the benthic animal communities

Coastal communities rely on clean, productive, and aesthetically pleasing marine and estuarine waters for tourism, recreational swimming, fishing, and boating, as well as for commercial fin fishing and shellfishing. Failure to reduce and control N loadings could result in an overabundance of macro-algae, a higher frequency of extreme decreases in dissolved oxygen concentrations and fish kills, widespread occurrence of unpleasant odors and visible scum, and a complete loss of benthic macroinvertebrates throughout most of the embayments. As a result of these environmental impacts, commercial and recreational uses of the Madaket Harbor and Long Pond Estuarine System will be greatly reduced.

## Sources of Nitrogen

Nitrogen enters the waters of coastal embayments from the following sources:

- The watershed
    - Natural background
    - Septic Systems
    - Runoff
    - Fertilizers
    - Wastewater treatment facilities
- Atmospheric deposition
- Nutrient-rich bottom sediments in the embayments

Figure ES-A and Figure ES-B illustrate the percent contribution of all the sources of N and the controllable N sources to the estuary system, respectfully. Values are based on Table IV-2 and Figure IV-6 from the Massachusetts Estuaries Project (MEP) Technical Report. As evident, most of the present *controllable* load to this system comes from septic systems.

**Figure ES-A: Percent Contributions of All Nitrogen Sources to the Madaket Harbor and Long Pond Estuarine System**

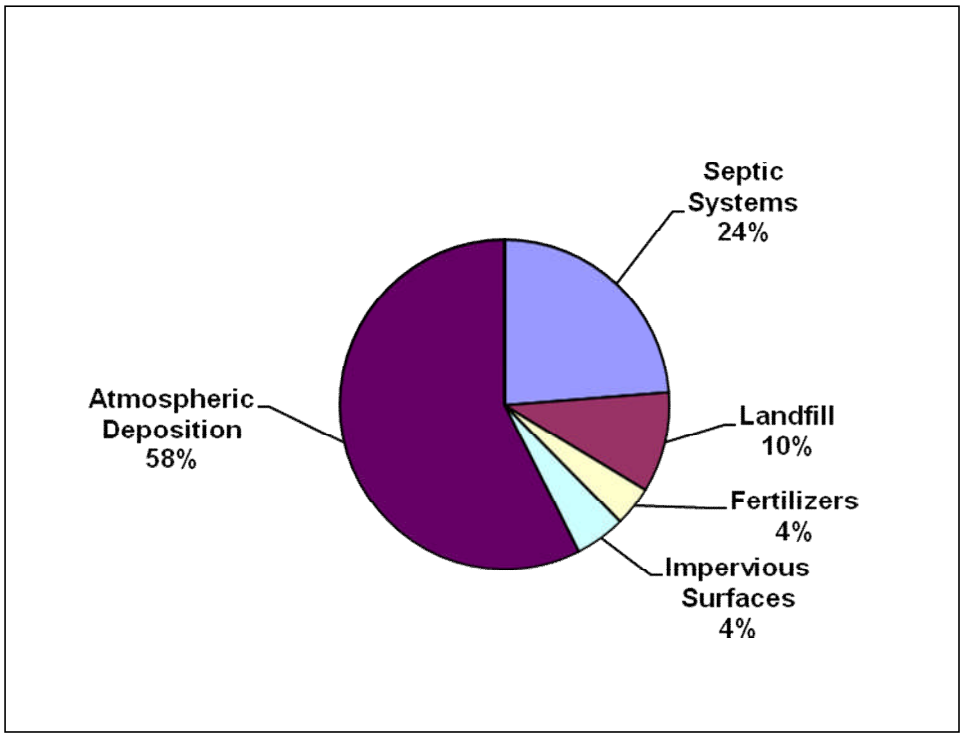
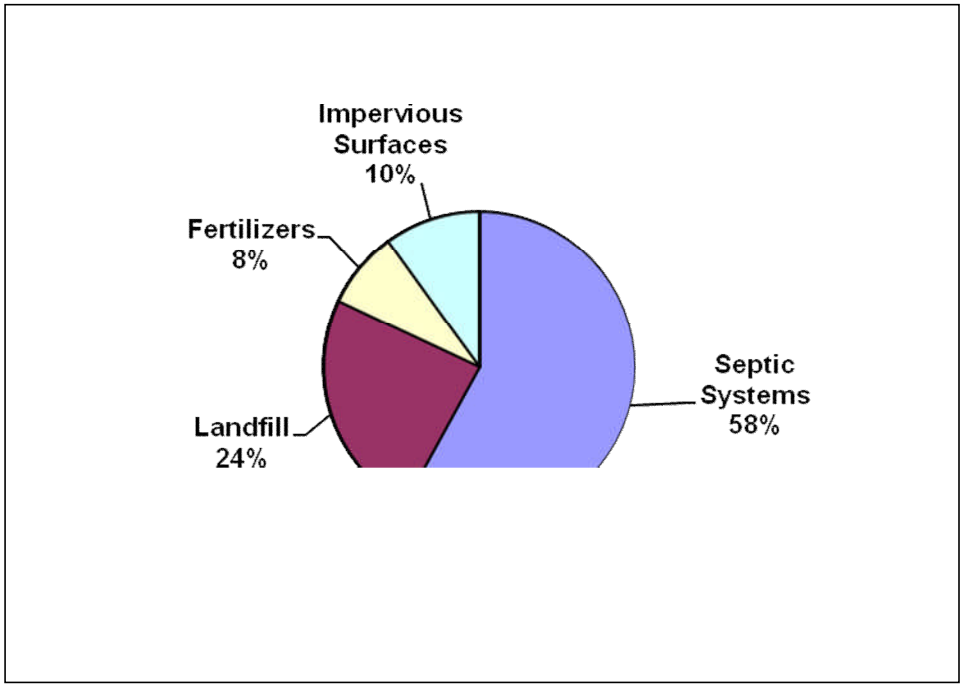



**Figure ES-B: Percent Contributions of Controllable Nitrogen Sources to the Madaket Harbor and Long Pond Estuarine System**



## Target Threshold N Concentrations and Loadings

The N loadings (the quantity of N) to this system ranged from 9.27 kg/day in Madaket Harbor to 4.58 kg/day in Hither Creek, and 5.14 kg/day in Long Pond with total loads for the Madaket Harbor and Long Pond Estuarine System of 21.41 kg N/day (as reported in Table IV-2 of the MEP Technical Report). The resultant concentrations of N ranged from 0.336-0.422 mg/L in Madaket Harbor, 0.581-0.780 mg/L in Hither Creek and 0.894 – 1.058 mg/L in Long Pond (range of average annual means collected from 13 stations during 2002-2004 as reported in Table VI-1 of the MEP Technical Report, and included in Appendix A of this report).

In order to restore and protect this estuarine system, N loadings, and subsequently the concentrations of N in the water, must be reduced to levels below those that cause the observed environmental impacts. This N concentration will be referred to as the *target threshold N concentration*. The Massachusetts Estuaries Project (MEP) has determined that by achieving a N concentration of 0.45 mg/L near sentinel station M11 in Hither Creek, water and habitat quality will be restored in these systems. The mechanism for achieving the target threshold N concentrations is to reduce the N loadings to the watershed of the harbor estuarine system. Based on the MEP sampling and modeling analyses and their Technical Report, the MEP study has determined that the Total Maximum Daily Loads (TMDL) of N that will meet the target threshold N concentration of 0.45 mg/L range from 1.67 kg/day in the Hither Creek subwatershed to 27.218 kg/day in the Madaket Harbor subwatershed. To meet these TMDLs this report recommends a reduction of 100% of the septic load for the Hither Creek subwatershed and assumes that the landfill load will be eliminated by completing the ongoing mining and capping project being conducted by the town. This document presents the TMDLs for these water body systems and provides guidance to the watershed community of Nantucket on possible ways to reduce the N loadings to within the recommended TMDL and protect the waters of these embayment systems.

## Implementation

The primary goal of TMDL implementation will be lowering the concentrations of N by reducing the loadings from on-site subsurface wastewater disposal systems by 100% in the Hither Creek subwatershed. However, there is a variety of loading reduction scenarios that could achieve the target threshold N concentrations. Local officials can explore other loading reduction scenarios through additional modeling as part of their Comprehensive Wastewater Management Plan (CWMP). In addition, the Town of Nantucket is currently involved in an implementation process to reduce the landfill contribution to the nitrogen load of Long Pond. It is expected that the landfill nitrogen loads will likely be eliminated after completion of this project and these TMDLs are calculated based on that assumption. Implementing best management practices (BMPs) to reduce N loadings from fertilizers and runoff where possible will also help to lower the total N load to these systems. Methods for reducing N loadings from these sources are explained in detail in the "MEP Embayment Restoration Guidance for Implementation Strategies" that is available on the MassDEP website http://www.mass.gov/dep/water/resources/coastalr.htm#guidance. The appropriateness of any of the alternatives will depend on local conditions and will have to be determined on a case-by-case basis using an adaptive management approach.

# Table of Contents

Executive Summary ..... 3
Table of Contents ..... 6
List of Figures ..... 6
List of Tables ..... 7
Introduction ..... 8
Description of Water Bodies and Priority Ranking ..... 9
Problem Assessment ..... 13
Pollutant of Concern, Sources, and Controllability ..... 14
Description of the Applicable Water Quality Standards ..... 17
Methodology - Linking Water Quality and Pollutant Sources ..... 17
Application of the Linked Watershed-Embayment Model ..... 19
Total Maximum Daily Loads ..... 24
TMDL Values for the Madaket Harbor and Long Pond Estuarine System ..... 29
Implementation Plans ..... 29
Monitoring Plan ..... 31
Reasonable Assurances ..... 31
Appendix A: Summary of the Nitrogen Concentrations for Madaket Harbor/Long Pond Estuarine System. ..... 33
Appendix B: Madaket Harbor/ Long Pond Estuarine System Five Total Nitrogen TMDLs ..... 34

# List of Figures

Figure ES-A: Percent Contributions of All Nitrogen Sources to the Madaket Harbor and Long Pond Estuarine System ..... 4
Figure ES-B: Percent Contributions of Controllable Nitrogen Sources to the Madaket Harbor and Long Pond Estuarine System ..... 4
Figure 1: Watershed Delineations for the Madaket Harbor and Long Pond Estuarine System ..... 11
Figure 2: Map of the Madaket Harbor and Long Pond Estuarine System ..... 12
Figure 3: Resident Population for Nantucket ..... 13
Figure 4a: Percent Contribution of Nitrogen Sources to the Madaket Harbor ..... 16
and Long Pond Estuarine System ..... 16
Figure 4b: Percent Contributions of Controllable Nitrogen Sources to the ..... 16
Madaket Harbor and Long Pond Estuarine System ..... 16
Figure 5: Water Quality Sampling Stations in the Madaket Harbor and Long Pond Estuarine System ..... 20
Figure 6: Madaket Harbor and Long Pond Estuarine System Locally Controllable N Sources ..... 26

# List of Tables

Table 1. Nantucket MEP Study Waterbodies in Category 5 of the MA 2008 Integrated List ..... 9
Table 2: Comparison of Impaired Parameters for the Nantucket Segments..... 10
Table 3: General Summary of Conditions Related to the Major Indicators of Habitat Impairment Observed in the Madaket Harbor and Long Pond Estuarine System..... 14
Table 4: Present Nitrogen Concentrations and Sentinel Station Target Threshold Nitrogen Concentrations for the Madaket Harbor and Long Pond Estuarine System ..... 20
Table 5: Present Nitrogen Loadings to the Madaket Harbor and Long Pond Estuarine System..... 23
Table 6: Present Watershed Nitrogen Loading Rates, Calculated Loading Rates that are Necessary to Achieve Target Threshold Nitrogen Concentrations, and the Percent Reductions of the Existing Loads Necessary to Achieve the Target Threshold Loadings ..... 24
Table 7: The Total Maximum Daily Loads (TMDL) for the Madaket Harbor and Long Pond Estuarine System, Represented as the Sum of the Calculated Target Threshold Loads, Atmospheric Deposition and Sediment Load ..... 29

## Introduction

Section 303(d) of the Federal Clean Water Act requires each state to identify waters that are not meeting water quality standards and to establish Total Maximum Daily Loads (TMDLs) for such waters for the pollutants of concern. The TMDL allocation establishes the maximum loadings (of pollutants of concern) from all contributing sources that a water body may receive and still meet and maintain its water quality standards and designated uses, including compliance with numeric and narrative standards. The TMDL development process may be described in four steps, as follows:

1. Determination and documentation of whether or not a water body is presently meeting its water quality standards and designated uses.

2. Assessment of present water quality conditions in the water body, including estimation of present loadings of pollutants of concern from both point sources (discernable, confined, and concrete sources such as pipes) and non-point sources (diffuse sources that carry pollutants to surface waters through runoff or groundwater).

3. Determination of the loading capacity of the water body. EPA regulations define the loading capacity as the greatest amount of loading that a water body can receive without violating water quality standards. If the water body is not presently meeting its designated uses, then the loading capacity will represent a reduction relative to present loadings.

4. Specification of load allocations, based on the loading capacity determination, for non-point sources and point sources that will ensure that the water body will not violate water quality standards.

After public comment and final approval by the EPA, the TMDL will serve as a guide for future implementation activities. The MassDEP will work with the watershed town of Nantucket to develop specific implementation strategies to reduce N loadings, and will assist in developing a monitoring plan for assessing the success of the nutrient reduction strategies.

In the Madaket Harbor and Long Pond Estuarine System the pollutant of concern for these TMDLs (based on observations of eutrophication) is the nutrient nitrogen. Nitrogen is the limiting nutrient in coastal and marine waters, which means that as its concentration is increased so is the amount of plant matter. This leads to nuisance populations of macro-algae and increased concentrations of phytoplankton and epiphyton which impairs the healthy ecology of the affected water bodies.

The TMDLs for total N for the Madaket Harbor and Long Pond Estuarine System are based primarily on data collected, compiled and analyzed by University of Massachusetts Dartmouth's School of Marine Science and Technology (SMAST) Coastal Systems Program and the Town of Nantucket Marine Department as part of the Massachusetts Estuaries Project (MEP). The data were collected over a study period from 2001 through 2007. This study period will be referred to as the "present conditions" in the TMDL report since it contains the most recent data available. The accompanying MEP Technical Report can be found at http://www.oceanscience.net/estuaries/reports.htm. The MEP Technical Report presents the results of the analyses of the coastal embayment systems using the MEP Linked Watershed-Embayment N Management Model (Linked Model). The analyses were performed to assist the watershed community with decisions on current and future wastewater planning, wetland restoration, anadromous fish runs, shellfisheries, open-space and harbor maintenance programs. A critical element of this approach is the assessment of water quality monitoring data, historical changes in eelgrass distribution, time-series water column oxygen measurements and benthic community structure that was conducted on this embayment. These assessments served as the basis for generating a N loading threshold for use as a goal for watershed N management. The TMDLs are based on the site specific N threshold generated for this estuarine system. Thus, the MEP offers a science-based

management approach to support the wastewater management planning and decision-making process in the watershed community of Nantucket.

## Description of Water Bodies and Priority Ranking

The Madaket Harbor and Long Pond Estuarine System is located entirely within the Town of Nantucket making Nantucket the sole municipal steward of this system (see Figures 1 and 2).

The estuarine system is located at the western end of Nantucket Island. Madaket Harbor is an open-water, well flushed shallow basin with its western boundary generally open to Nantucket Sound and the Atlantic Ocean. A dynamic network of sand shoals along the harbor boundary may restrict circulation somewhat. The southern boundary of the Harbor is defined by a long sand spit that periodically is breached to the Atlantic Ocean and the northern shore is defined by Eel Point.

The only surface water tributary to Madaket Harbor is Hither Creek, which is connected to brackish Long Pond via Madaket Ditch. Hither Creek is an artificially deepened basin that opens into Madaket Harbor, Madaket Ditch is a shallow, narrow ditch and inland Long Pond is brackish and shallow. This tributary component obtains freshwater inflow primarily via groundwater contributions due to the highly permeable nature of the watershed soils. Compared to the harbor, circulation and flushing are limited, especially within Long Pond. Long Pond was divided into a northern, middle and lower section in the MEP study.

This estuarine system constitutes an important component of the area's natural and cultural resources. The nature of enclosed embayments in populous regions brings two opposing elements to bear: 1) as protected marine shoreline, they are popular regions for boating, recreation, and land development; and 2) as enclosed bodies of water, they may not be readily flushed of the pollutants that they receive due to the proximity and density of development near and along their shores. In particular, the Madaket Harbor and Long Pond Estuarine system are at risk of further eutrophication from high nutrient loads in the groundwater and runoff from their watersheds. Hither Creek and Long Pond are already listed as impaired for nutrients and requiring a TMDL (Category 5) in the MA 2008 Integrated List of Waters, as summarized in Table 1. Madaket Harbor and Long Pond are listed as impaired for pathogens and are included in Table 1 for completeness. Further discussion of pathogens is beyond the scope of this TMDL.

**Table 1. Nantucket MEP Study Waterbodies in Category 5 of the MA 2008 Integrated List** (MassDEP 2008)

| Name | Water Body Segment | Description | Size | Pollutant Listed |
|---|---|---|---|---|
| Hither Creek (9764000) | MA97-28_2008 | From the outlet of Madaket Ditch to Madaket Harbor at an imaginary line drawn easterly from Jackson Point to Little Neck, Nantucket | 0.07 sq mi | -Nutrients<br>-Organic enrichment/Low DO |
| Long Pond (97050) | MA97-29_2008 | South of Madaket Road, including White Goose Cove, Nantucket | 0.12 sq mi | -Nutrients<br>-Organic enrichment/Low DO<br>-Pathogens<br>-Turbidity |
| Madaket Harbor (97910) | MA97-27_2008 | Waters encompassed within imaginary lines from Eel Point to the northern tip of Esther Island, from the southern tip of Esther Island southeasterly to the opposite shore and from Jackson Point easterly to Little Neck, Nantucket | 1.4 sq mi | -Pathogens |

Complete descriptions of these embayment systems are presented in Chapters I and IV of the MEP Technical Report. A majority of the information presented here is drawn from this report. Chapters VI and VII of the MEP Technical Report provide assessment data that show that the Madaket Harbor and Long Pond Estuarine System is impaired because of nutrients, low dissolved oxygen levels, elevated chlorophyll *a* levels, and benthic fauna habitat. Table 2 identifies the segments previously listed in Category 5 of the Integrated List of Waters by MassDEP and the segments that were observed to be impaired through the MEP analysis.

The embayments addressed by this document have been determined to be "high priority" based on three significant factors: (1) the initiative that the Town of Nantucket has taken to assess the conditions of the entire embayment system; (2) the commitment made by the town to restore the Madaket Harbor and Long Pond; and (3) the extent of impairment in the Madaket Harbor and Long Pond Estuarine System. In both marine and freshwater systems, an excess of nutrients results in degraded water quality, adverse impacts to ecosystems and limits on the use of water resources. Observations are summarized in the Problem Assessment section below and detailed in Chapter VII, Assessment of Embayment Nutrient Related Ecological Health, of the MEP Technical Report.

**Table 2: Comparison of Impaired Parameters for the Nantucket Segments**

| Name | DEP Listed Impaired Parameter | SMAST Listed Impaired Parameter |
|---|---|---|
| Madaket Harbor | - Pathogens | -Nutrients |
| Hither Creek | -Nutrients<br>-Organic enrichment/Low DO | -Nutrients<br>-DO level<br>-Chlorophyll<br>-Benthic fauna |
| Long Pond | -Nutrients<br>-Organic enrichment/Low DO<br>-Pathogens<br>-Turbidity | -Nutrients<br>-DO level<br>-Chlorophyll<br>-Benthic fauna |

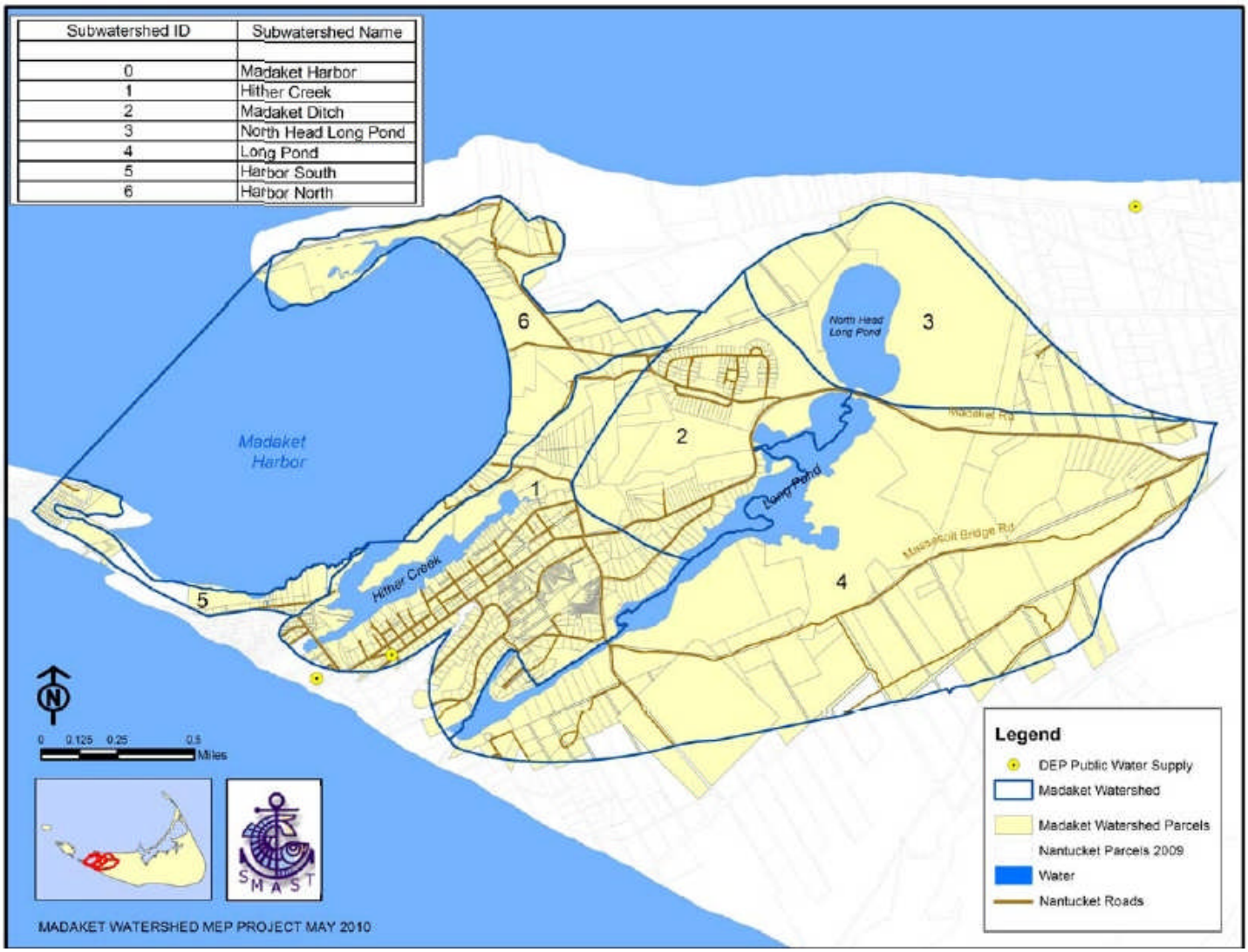



**Figure 1: Watershed Delineations for the Madaket Harbor and Long Pond Estuarine System**

**Figure 2: Map of the Madaket Harbor and Long Pond Estuarine System**
(from United States Geological Survey topographic maps).

## Problem Assessment

Water quality problems associated with development within the watershed result primarily from septic systems and from runoff, including fertilizers.

The water quality problems affecting nutrient-enriched embayments generally include periodic decreases of dissolved oxygen, decreased diversity and quantity of benthic animals and periodic algae blooms. In the most severe cases habitat degradation could lead to periodic fish kills, unpleasant odors and scums and near loss of the benthic community and/or presence of only the most stress-tolerant species of benthic animals.

Coastal communities, including Nantucket, rely on clean, productive and aesthetically pleasing marine and estuarine waters for tourism, recreational swimming, fishing and boating, as well as commercial fin fishing and shell fishing. The continued degradation of this coastal embayment, as described above, will significantly reduce the recreational and commercial value and use of these important environmental resources.

Figure 3 shows how the population of Nantucket has more than doubled from less than 4,000 people in 1930 to over 9,500 people in 2000. Increases in N loading to estuaries are directly related to increasing development and population in the watershed. The Town of Nantucket has been among the fastest growing towns in the Commonwealth over the past two decades. This increase in population contributes to a decrease in undeveloped land and an increase in septic systems, runoff from impervious surfaces and fertilizer use. Although the Nantucket downtown area is serviced by a centralized wastewater treatment facility, all the residences in the Madaket Harbor and Long Pond watershed are serviced by septic systems. The greatest level of development and residential load is situated in the nearshore regions of the system. These unsewered areas contribute significantly to the system through transport in direct groundwater discharges to estuarine waters and through surface water flows from Long Pond to Madaket Ditch and Hither Creek.

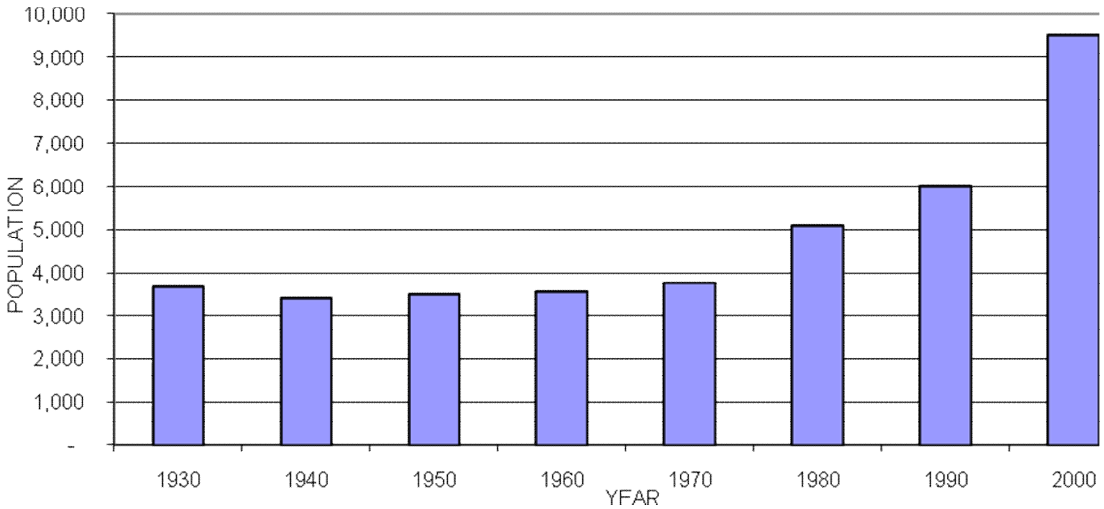



**Figure 3: Resident Population for Nantucket**

Habitat and water quality assessments were conducted on this estuarine system based upon water quality monitoring data, changes in eelgrass distribution, time-series water column oxygen measurements and benthic community structure. The MEP evaluation of habitat quality supported by each area considers its natural structure and its ability to support eelgrass beds and the types of infaunal communities that they support (Table 3). At present, Madaket Harbor and particularly Hither Creek and Long Pond appear to have reached their nitrogen loading thresholds. This is demonstrated by the existing low habitat and water quality of Hither Creek (loss of eelgrass) and Long Pond. Although large portions of Madaket Harbor still support eelgrass, the slight

decline of eelgrass in certain areas suggests a degree of impairment. Consistent with a system at its nitrogen threshold for eelgrass habitat, most of the Harbor is currently supporting productive benthic animal communities, oxygen is not depleted, chlorophyll *a* levels are low and macroalgae is sparse. In contrast Hither Creek is nitrogen enriched with a tidally averaged TN concentration of 0.51 mg N/l compared to 0.33 mg N/l seen in Madaket Harbor. This results in high chlorophyll *a*, periodic hypoxia, and complete loss of eelgrass, dense macroalgae and impaired benthic communities. Long Pond is also nitrogen enriched, however due to the influence of natural wetland systems the level of impairment is moderate as demonstrated by high chlorophyll *a* levels and periodic blooms, and somewhat altered benthic community structure. There is no evidence that eelgrass habitat existed previously in the Long Pond basins so absence does not indicate impairment of this habitat.

**Table 3: General Summary of Conditions Related to the Major Indicators of Habitat Impairment Observed in the Madaket Harbor and Long Pond Estuarine System**

| Health Indicator | Madaket Harbor Estuarine System | | | | |
|---|---|---|---|---|---|
| | Madaket Harbor | Hither Creek | Long Pond | | |
| | | | Mid | Lower | North Head |
| Dissolved Oxygen | H | SI | MI/SI | MI | H |
| Chlorophyll | H | MI/SI | SI | MI/SI | H/MI |
| Macroalgae | H | SI | - | - | - |
| Eelgrass | H | SI | -- | -- | -- |
| Infaunal Animals | H | SI | MI | MI | H/MI |
| **Overall** | **H** | **SI** | **MI** | **MI** | **H/MI** |

H - Healthy Habitat Conditions*
MI – Moderately Impaired*
SI – Significantly Impaired- considerably and appreciably changed from normal conditions*
* - These terms are more fully described in MEP report "Site-Specific Nitrogen Thresholds for Southeastern Massachusetts Embayments: Critical Indicators" December 22, 2003 http://www.mass.gov/dep/water/resources/nitroest.pdf
- drift algae sparse or absent
-- no evidence this basin is supportive of eelgrass

## Pollutant of Concern, Sources, and Controllability

In the coastal embayments of the Town of Nantucket, as in most marine and coastal waters, the limiting nutrient is N. Nitrogen concentrations beyond those expected naturally contribute to undesirable conditions including the severe impacts described above, through the promotion of excessive growth of plants and algae, including nuisance vegetation.

The embayments addressed in this TMDL report have had extensive data collected and analyzed through the Massachusetts Estuaries Program (MEP) and with the cooperation and assistance from the Town of Nantucket,

the USGS, and the Cape Cod Commission. Data collection included both water quality and hydrodynamics as described in Chapters I, IV, V, and VII of the MEP Technical Report.

Figure 4a illustrates all of the sources of N to the Madaket Harbor and Long Pond Estuarine System and Figure 4b shows just the controllable sources. As evident, most of the controllable N affecting these systems originates from on-site subsurface wastewater disposal systems (septic systems). The level of "controllability" of each source, however, varies widely:

Atmospheric deposition– Although helpful, local controls are not adequate – it is only through region- and nation-wide air pollution control initiatives that significant reductions are feasible, however the N from these sources might be subjected to enhanced natural attenuation as it moves towards the estuary.

Fertilizer –Fertilizer and related N loadings can be reduced through best management practices (BMPs), bylaws and public education.

Impervious surfaces and storm-water runoff sources of N can be controlled by BMPs, bylaws and storm-water infrastructure improvements and public education;

Septic system sources of N can be controlled by a variety of case-specific methods including: sewering and treatment at centralized or decentralized locations, transporting and treating septage at treatment facilities with N removal technology either in or out of the watershed, or installing N-reducing on-site wastewater treatment systems.

Landfill – the Town of Nantucket operates a landfill adjacent to the north eastern shore of Long Pond. Nitrogen loads from the landfill are currently being reduced by a 5 year program to mine the accumulated deposits and line and cap remaining materials. Nitrogen loads from the landfill site will be reduced by activities completed during the present 5 year phase, and will likely be eliminated if the landfill is capped in the future.

Cost/benefit analyses will have to be conducted on all possible N loading reduction methodologies in order to select the optimal control strategies, priorities and schedules.

**Figure 4a: Percent Contribution of Nitrogen Sources to the Madaket Harbor and Long Pond Estuarine System**

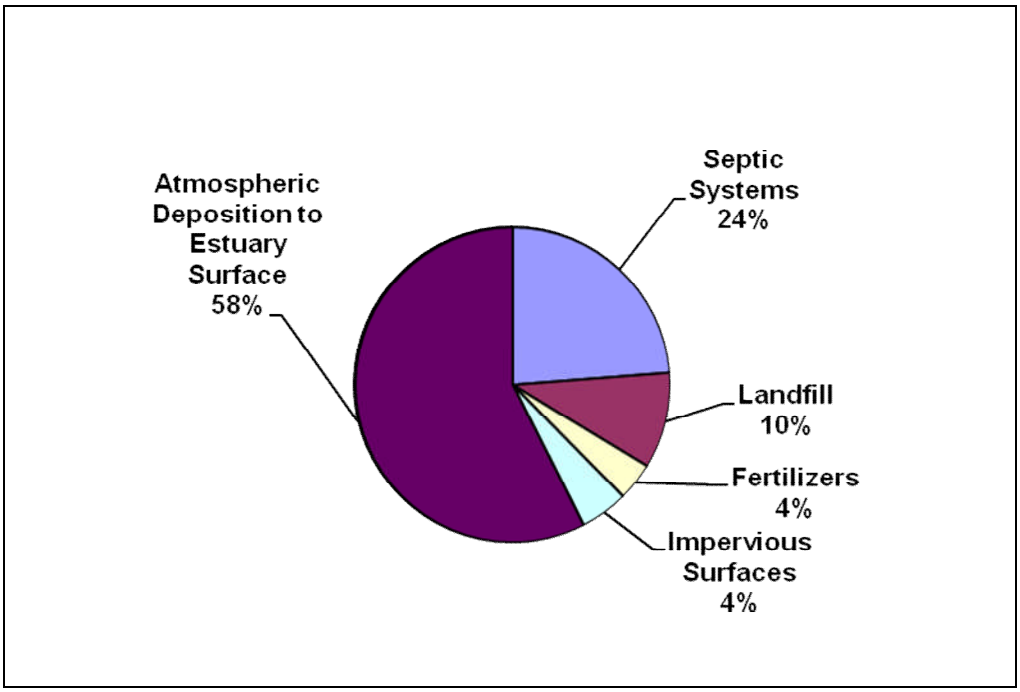
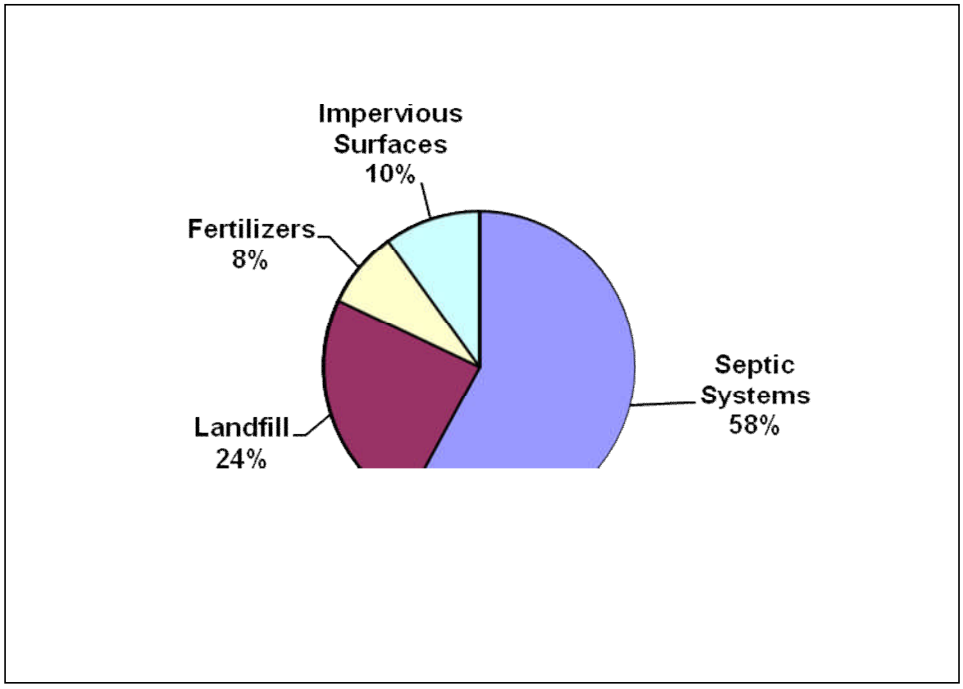



**Figure 4b: Percent Contributions of Controllable Nitrogen Sources to the Madaket Harbor and Long Pond Estuarine System**



## Description of the Applicable Water Quality Standards

The water quality classifications of the saltwater portions of Madaket Harbor and Long Pond Estuarine System are SA (all surface waters subject to the rise and fall of the tide), and the freshwater portions of the system are classified as B. Water quality standards of particular interest to the issues of cultural eutrophication are dissolved oxygen, nutrients, aesthetics, and excess plant biomass and nuisance vegetation. The Massachusetts water quality standards (314 CMR 4.0) contain numeric criteria for dissolved oxygen but have only narrative standards that relate to the other variables, as described below:

314 CMR 4.05(5)(a) states "Aesthetics – All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum, or other matter to form nuisances; produce objectionable odor, color, taste, or turbidity; or produce undesirable or nuisance species of aquatic life."

314 CMR 4.05(5)(c) states, "Nutrients - Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established…"

314 CMR 4.05(b) 1:

Class SA:
Dissolved Oxygen -
a. Shall not be less than 6.0 mg/L unless background conditions are lower;
b. Natural seasonal and daily variations above this level shall be maintained.

Class B:
Dissolved Oxygen -
a. Shall not be less than 6.0 mg/L in cold water fisheries and not less than 5.0 mg/L in warm water fisheries;
b. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

Thus, the assessment of eutrophication is based on site-specific information within a general framework that emphasizes impairment of uses and preservation of a balanced indigenous flora and fauna. This approach is recommended by the US Environmental Protection Agency in their draft Nutrient Criteria Technical Guidance Manual for Estuarine and Coastal Marine Waters (EPA-822-B-01-003, Oct 2001). The Guidance Manual notes that lakes, reservoirs, streams and rivers may be subdivided by classes, allowing reference conditions for each class and facilitating cost-effective criteria development for nutrient management. However, individual estuarine and coastal marine waters tend to have unique characteristics and development of individual water body criteria is typically required.

## Methodology - Linking Water Quality and Pollutant Sources

Extensive data collection and analyses have been described in detail in the MEP Technical Report. Those data were used by SMAST to assess the loading capacity of each embayment. Physical (Chapter V), chemical and biological (Chapters IV, VII, and VIII) data were collected and evaluated. The primary water quality objective was represented by conditions that:

1) Restore the natural distribution of eelgrass because it provides valuable habitat for shellfish and finfish;
2) Prevent harmful or excessive algal blooms;

3) Restore and preserve benthic communities;
4) Maintain dissolved oxygen concentrations that are protective of the estuarine communities.

The details of the data collection, modeling and evaluation are presented and discussed in Chapters IV, V, VI, VII and VIII of the MEP Technical Report. The main aspects of the data evaluation and modeling approach are summarized below.

The core of the Massachusetts Estuaries Project analytical method is the Linked Watershed-Embayment Management Modeling Approach. It fully links watershed inputs with embayment circulation and N characteristics, and is characterized as follows:

- Requires site specific measurements within the watershed and each sub-embayment;
- Uses realistic "best-estimates" of N loads from each land-use (as opposed to loads with built-in "safety factors" like Title 5 design loads);
- Spatially distributes the watershed N loading to the embayment;
- Accounts for N attenuation during transport to the embayment;
- Includes a 2D or 3D embayment circulation model depending on embayment structure;
- Accounts for basin structure, tidal variations, and dispersion within the embayment;
- Includes N regenerated within the embayment;
- Is validated by both independent hydrodynamic, N concentration, and ecological data;
- Is calibrated and validated with field data prior to generation of "what if" scenarios.

The Linked Model has been applied previously to watershed N management in over 30 embayments thus far throughout Southeastern Massachusetts. In these applications it became clear that the model can be calibrated and validated and has use as a management tool for evaluating watershed N management options.

The Linked Model, when properly calibrated and validated for a given embayment becomes a N management-planning tool as described in the model overview below. The model can assess solutions for the protection or restoration of nutrient-related water quality and allows testing of management scenarios to support cost/benefit evaluations. In addition, once a model is fully functional it can be refined for changes in land-use or embayment characteristics at minimal cost. Also, since the Linked Model uses a holistic approach that incorporates the entire watershed, embayment and tidal source waters, it can be used to evaluate all projects as they relate directly or indirectly to water quality conditions within its geographic boundaries.

The Linked Model provides a quantitative approach for determining an embayment's (1) N sensitivity, (2) N threshold loading levels (TMDL) and (3) response to changes in loading rate. The approach is fully field validated and unlike many approaches, accounts for nutrient sources, attenuation and recycling and variations in tidal hydrodynamics. This methodology integrates a variety of field data and models, specifically:

- Monitoring - multi-year embayment nutrient sampling

- Hydrodynamics
  - Embayment bathymetry (depth contours throughout the embayment)
  - Site-specific tidal record (timing and height of tides)
  - Water velocity records (in complex systems only)
  - Hydrodynamic model

- Watershed Nitrogen Loading
  - Watershed delineation
  - Stream flow (Q) and N load
  - Land-use analysis (GIS)

- Watershed N model

• Embayment TMDL - Synthesis
- Linked Watershed-Embayment Nitrogen Model
- Salinity surveys (for linked model validation)
- Rate of N recycling within embayment
- Dissolved oxygen record
- Macrophyte survey
- Infaunal survey (in complex systems)

## Application of the Linked Watershed-Embayment Model

The approach developed by the MEP for applying the linked model to specific embayments for the purpose of developing target N loading rates includes:

1) Selecting one or two stations within the embayment system located close to the inland-most reach or reaches which typically have the poorest water quality within the system. These are called "sentinel" stations;

2) Using site-specific information and a minimum of three years of sub-embayment-specific data to select target threshold N concentrations for each sub-embayment. This is done by refining the draft target threshold N concentrations that were developed as the initial step of the MEP process. The target threshold N concentrations that were selected generally occur in higher quality waters near the mouth of the embayment system;

3) Running the calibrated water quality model using different watershed N loading rates to determine the loading rate that will achieve the target threshold N concentration at the sentinel station. Differences between the modeled N load required to achieve the target threshold N concentration and the present watershed N load represent N management goals for restoration and protection of the embayment system as a whole.

Previous sampling and data analyses and the modeling activities described above resulted in four major outputs that were critical to the development of the TMDL. Two outputs are related to **N concentration:**

a) The present N concentrations in the sub-embayments
b) Site-specific target threshold N concentrations

And, two outputs are related to **N loadings:**

a) The present N loads to the sub-embayments
b) Load reductions necessary to meet the site specific target N concentrations

In summary: if the water quality standards are met by reducing the N concentration (and thus the N load) at the sentinel station(s), then the water quality goals will be met throughout the entire system.

A brief overview of each of the outputs follows:

<u>Nitrogen concentrations in the embayment</u>

a) Observed "present" conditions:

Table 4 presents the average concentrations of N measured in this estuarine system from three years of data collection by the Nantucket Marine Department and SMAST (2002, 2003 and 2004). The overall means and standard deviations of the averages are presented in Appendix A (taken from Table VI-1 of the MEP Technical Report). Water quality sampling stations are shown in Figure 5. The sentinel station, M11 is labeled in bold italics.

**Table 4: Present Nitrogen Concentrations and Sentinel Station Target Threshold Nitrogen Concentrations for the Madaket Harbor and Long Pond Estuarine System**

| Sub-embayment | Range of Observed Nitrogen Concentration [1] (mg/L) | Target Threshold Nitrogen Concentration (mg/L) |
|---|---|---|
| Madaket Harbor | 0.336-0.422 | |
| Hither Creek | 0.581-0.780 | 0.45[2] |
| Long Pond | 0.894-1.058 | 0.80[3] |

[1] Average total N concentrations from present loading based on an average of the annual N means from 2002 - 2004.
[2] Target threshold N concentration at Hither Creek sentinel station M11
[3] Secondary target threshold N concentration for Long Pond (pond average of stations LOP01, LOP02, LOP03, LOP04)

**Figure 5: Water Quality Sampling Stations in the Madaket Harbor and Long Pond Estuarine System**

b) Modeled site-specific target threshold N concentrations:

A major component of TMDL development is the determination of the maximum concentrations of N (based on field data) that can occur without causing unacceptable impacts to the aquatic environment. Prior to conducting the analytical and modeling activities described above, SMAST selected appropriate nutrient-related environmental indicators and tested the qualitative and quantitative relationship between those indicators and N concentrations. The Linked Model was then used to determine site-specific target threshold N concentrations by using the specific physical, chemical and biological characteristics of each harbor embayment system.

The target threshold N concentration for an embayment represents the average water column concentration of N that will support the habitat quality and dissolved oxygen concentrations being sought. The water column N level is ultimately controlled by the integration of the watershed N load, the N concentration in the inflowing tidal waters (boundary condition), dilution and flushing via tidal flows. The water column N concentration is modified by the extent of sediment uptake and/or regeneration and by direct atmospheric deposition.
Target threshold N concentrations in this study were developed to restore or maintain SA waters or high habitat quality. In this system, high habitat quality was defined as stable fringing eelgrass beds in Hither Creek and overall diverse benthic animal communities and dissolved oxygen levels that would support Class SA waters.

The target threshold nitrogen concentrations for the sub-embayments listed in Table 4 were determined as follows:

The approach for determining nitrogen loading rates, which will maintain acceptable habitat quality throughout an embayment system, is to first identify a sentinel location within the embayment and second to determine the nitrogen concentration within the water column which will restore that location to the desired habitat quality. The sentinel location is selected such that the restoration of that one site will necessarily bring the other regions of the system to acceptable habitat quality levels. Once the sentinel site and its target threshold nitrogen concentration are determined, the MEP study modeled nitrogen loads until the targeted nitrogen concentration was achieved.

The determination of the critical nitrogen threshold for maintaining high habitat with the Madaket Harbor and Long Pong Estuarine System is based on the nutrient and oxygen levels, temporal trends in eelgrass distribution and benthic community indicators. Overall the main, open water basin of Madaket Harbor is supporting high quality eelgrass habitat and productive benthic animal communities. However, the enclosed basin of Hither Creek is nitrogen enriched, demonstrated by high chlorophyll, periodic episodes of low oxygen, complete loss of eelgrass habitat, areas of dense drift algae and impaired benthic animal habitat. Long Pond is also nitrogen enriched beyond its assimilative capacity, but given the natural and organic matter enrichment of wetland influenced tidal basins such as brackish Long Pond the level of impairment is only moderate, demonstrated by high chlorophyll levels and a somewhat impaired benthic community. There is no evidence that eelgrass habitat ever existed previously in Long Pond, so this absence does not indicate impairment. Therefore, the threshold analysis focused on the goal of restoring eelgrass habitat for Hither Creek. Restoration of eelgrass to pre- 1951 coverage is now unlikely due to the enhanced depth of this sub-basin therefore restoration of the fringing eelgrass beds that existed in 1951 and 1995 is the management target. Nitrogen management to restore eelgrass habitat within Hither Creek will also result in restoration of the impaired benthic habitat, as nitrogen enrichment will be significantly reduced to the overall estuary. The most appropriate sentinel station for this system was determined to be located at the northern-most extent of the 1951 eelgrass coverage in Hither Creek which coincides with the baseline Nantucket water quality monitoring station M11.

To achieve the restoration target of restoring the fringing eelgrass bends in Hither Creek requires lowering the level of nitrogen enrichment. In shallow systems like Hither Creek, eelgrass beds are sustainable at higher TN levels than in deeper waters. For example, the observed loss of eelgrass in Hither Creek is similar to that in shallow Farm Pond on Martha's Vineyard where declining eelgrass was observed at a tidally averaged TN of 0.51 mg/L. Other similar examples include Bournes Pond where eelgrass can still be found (although stressed)

at the mouth of a tributary at a tidally averaged TN concentration of 0.481 mg/L, while the more stable beds in Israel's Cove had a tidally average TN of 0.429 mg/L. Therefore to restore eelgrass habitat in Hither Creek the nitrogen concentration at the sentinel location needs to be between 0.48 and 0.43 mg/L TN. A threshold concentration of 0.45 mg/l TN was determined to be appropriate for the Hither Creek sentinel station to restore eelgrass and infaunal habitat with this basin. This target threshold concentration is consistent with high quality shallow water habitat in Bournes Pond and is similar to eelgrass observed within the Parker's River at a tidally averaged TN level of 0.45 mg/L TN. This represents a relatively high target threshold nitrogen concentration as a result of the shallow depth of the area of potential eelgrass habitat.

The benthic habitats in the brackish Long Pond system are naturally nitrogen enriched so a moderate reduction in nitrogen levels was determined to be sufficient to restore benthic habitat here. In tidal wetlands nitrogen levels between 1 and 2 mg/L TN are associated with unimpaired habitat. This is consistent with the only slight impairment of the North Head of Long Pond at TN levels of 0.894 mg/L and the moderately impaired benthic habitat in Long Pond at a basin averaged TN of 0.939 mg/L. Therefore, a secondary target nitrogen threshold concentration of 0.8 mg/L TN (pond-wide average) was determined to be supportive of benthic animal habitat in this system. Watershed nitrogen management to achieve this "check" nitrogen level will ensure restoration of infaunal habitats within the down-gradient reach as well. The secondary criteria should be met when the target threshold is met at the sentinel station. Based on this, eelgrass is the primary nitrogen management goal for Hither Creek and improved infaunal habitat quality the management target for Long Pond.

The findings of the analytical and modeling investigations for theses embayment systems are discussed and explained below.

<u>Nitrogen loadings to the embayment</u>

a) Present Loading rates:

In the Madaket Harbor and Long Pond Estuarine System overall, the highest N loading from ***controllable*** sources is from on-site wastewater treatment systems. The MEP Technical Report calculates that septic systems account for 58% of the controllable N load to Madaket Harbor and Long Pond. Other sources include the landfill (24%), fertilizers (8%), and runoff from impervious surfaces (10%). The MEP study determined that sediments did not contribute nitrogen to this system. Atmospheric nitrogen deposition to the estuary and watershed surface area was found to be significant (58% of the total load) however this source is considered uncontrollable. (See Figures 4a and 4b.)

A subwatershed breakdown of N loading, by source, is presented in Table 5. The data on which Table 5 is based can be found in Table ES-1 and Table IV-2 of the MEP Technical Report.

As previously indicated, the present N loadings to these embayment systems must be reduced in order to restore the impaired conditions and to avoid further nutrient-related adverse environmental impacts. The critical final step in the development of the TMDL is modeling and analysis to determine the loadings required that will achieve the target threshold N concentrations.

**Table 5: Present Nitrogen Loadings to the Madaket Harbor and Long Pond Estuarine System**

| Sub-embayment | Present Land Use Load[1] (kg N/day) | Present Septic System Load (kg N/day) | Present Watershed Load[2] (kg N/day) | Present Atmospheric Deposition[3] (kg N/day) | Present Benthic Flux[4] (kg N/day) | Total Nitrogen Load from All Sources[5] (kg N/day) |
|---|---|---|---|---|---|---|
| Madaket Harbor | 0.279 | 0.384 | 0.663 | 8.603 | 17.952 | 27.218 |
| Hither Creek | 1.134 | 2.907 | 4.041 | 0.534 | 0 | 4.575 |
| Madaket Ditch | 0.923 | 1.510 | 2.433 | -- | 0.061 | 2.494 |
| Long Pond | 2.888 | 0.342 | 3.230 | 0.975 | 3.283 | 7.488 |
| North Head Long Pond | 0.167 | 0.071 | 0.238 | 0.693 | 0.995 | 1.926 |
| System Total | 5.392 | 5.214 | 10.605 | 10.805 | 22.291 | 43.701 |

[1] Includes fertilizers, runoff, landfill and atmospheric deposition to lakes and natural surfaces
[2] Includes fertilizer, runoff, landfill, atmospheric deposition to lakes and natural surfaces and wastewater inputs
[3] Atmospheric deposition to the estuarine surface only
[4] Nitrogen loading from sediments, negative fluxes have been set to zero
[5] Composed of fertilizer, runoff, landfill, wastewater, atmospheric deposition and benthic nitrogen input

b) Nitrogen loads necessary for meeting the site-specific target threshold N concentrations:

Table 6 lists the present watershed N loadings from the Madaket Harbor and Long Pond Estuarine System and the percent watershed load reductions necessary to achieve the target threshold N concentration at the sentinel stations.

It is very important to note that load reductions can be produced through a variety of strategies: reduction of any or all sources of N; increasing the natural attenuation of N within the freshwater systems; and/or modifying the tidal flushing through inlet reconfiguration (where appropriate). This scenario establishes the general degree and spatial pattern of reduction that will be required for restoration of the N impaired portions of this system. The Town of Nantucket should take any reasonable actions to reduce the controllable N sources.

**Table 6: Present Watershed Nitrogen Loading Rates, Calculated Loading Rates that are Necessary to Achieve Target Threshold Nitrogen Concentrations, and the Percent Reductions of the Existing Loads Necessary to Achieve the Target Threshold Loadings**

| Sub-embayment System | Present Total Watershed Load [1] (kg/day) | Target Threshold Watershed Load[2] (kg/day) | Percent Watershed Load Reductions Needed to Achieve Target |
|---|---|---|---|
| Madaket Harbor | 0.663 | 0.663 | 0% |
| Hither Creek | 4.041 | 1.134 | 71.9% |
| Madaket Ditch | 2.433 | 2.433 | 0% |
| North Head Long Pond | 0.238 | 0.238 | 0% |
| Long Pond | 3.230 | 1.101 | 65.9% |
| Total for Madaket Harbor/ Long Pond Estuarine System | 10.605 | 5.570 | 47.5% |

[1] Composed of septic, fertilizer, landfill and runoff loadings.
[2] Target threshold watershed load is the N load from the watershed (including natural background) needed to meet the target threshold N concentrations identified in Table 4, above.
Taken from Tables ES-2 and VIII-3 in the MEP Technical Report

## Total Maximum Daily Loads

As described in EPA guidance, a total maximum daily load (TMDL) identifies the loading capacity of a water body for a particular pollutant. EPA regulations define loading capacity as the greatest amount of loading that a water body can receive without violating water quality standards. The TMDLs are established to protect and/or restore the estuarine ecosystem, including eelgrass, the leading indicator of ecological health, thus meeting water quality goals for aquatic life support. Because there are no "numerical" water quality standards for N, the TMDLs for the Madaket Harbor and Long Pond estuarine system are aimed at establishing the loads that would correspond to specific N concentrations determined to be protective of the water quality and ecosystems.

The development of a TMDL requires detailed analyses and mathematical modeling of land use, nutrient loads, water quality indicators, and hydrodynamic variables (including residence time) for each waterbody system. The results of the mathematical model are correlated with estimates of impacts on water quality, including negative impacts on eelgrass (the primary indicator), as well as dissolved oxygen, chlorophyll *a* and benthic infauna.

The TMDL can be defined by the equation:

$$TMDL = BG + WLAs + LAs + MOS$$

Where:
TMDL = loading capacity of receiving water
BG = natural background
WLAs = portion allotted to point sources
LAs = portion allotted to (cultural) non-point sources

MOS = margin of safety

**Background Loading**

Natural background N loading is included in the loading estimates, but is not quantified or presented separately. It is a component of the target watershed threshold.

**Waste Load Allocations**

Waste load allocations identify the portion of the loading capacity allocated to existing and future point sources of wastewater. In the Madaket Harbor and Long Pond estuary system there are no NPDES regulated point source discharges in the watershed. EPA interprets 40 CFR 130.2(h) to require that allocations for NPDES regulated discharges of storm water also be included in the waste load component of the TMDL. It should be noted that no part of the Town of Nantucket is designated as an urbanized area by EPA and thus is not required to obtain coverage under the NPDES Phase II General Permit for Storm-water Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) in 2003. Subsequently, in the Madaket Harbor and Long Pond watershed there are no Phase II NPDES permitted stormwater discharges. However, there are a few storm water pipes that discharge directly to water bodies and MassDEP has determined that these must also be treated as part of a waste load allocation.

In the Madaket/Long Pond watershed, as in much of Cape Cod and the Islands, the vast majority of storm-water percolates into the ground and aquifer and proceeds into the embayment systems through groundwater migration. The Linked Model accounts for storm-water and groundwater loadings in one aggregate allocation as a non-point source – combining the assessments of waste water and storm-water (including storm-water that infiltrates into the soil and direct discharge pipes into water bodies) for the purpose of developing control strategies. Based on land use, the Linked Model accounts for loading from storm-water, but does not differentiate storm-water into a load and waste load allocation.

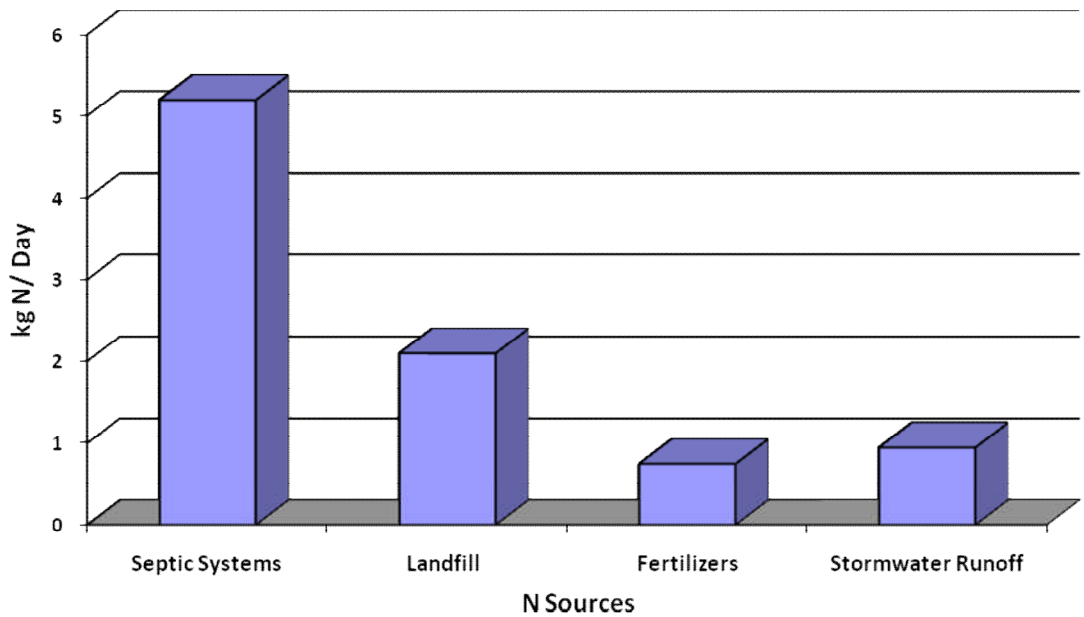
Since the majority of the nitrogen loading comes from septic systems, and to a lesser extent fertilizer, the landfill and storm-water runoff that infiltrates into the groundwater, the allocation of nitrogen for any storm-water pipes that discharge directly to any of the embayments is expected to be insignificant as compared to the overall groundwater load. This is based on determining the percent of impervious surface within 200 feet of the waterbody and calculating the potential relative load from this area via storm drains compared to the overall load. (For the purposes of waste load allocation it was assumed that all impervious surfaces within 200ft of the shoreline discharge directly to the waterbody.) MassDEP has calculated the potential waste load allocation for this 200 foot buffer zone previously in nitrogen TMDLs for eleven embayments on Cape Cod. Percent contribution of N into these waterbodies when all impervious surface within 200 feet of the shoreline is considered ranged from 0.2% - 1.1% (mean = 0.53%). Without exception, this calculated load was negligible when compared to other sources. Because the land use and soils in Nantucket surrounding Madaket Harbor and Long Pond is typical of Cape Cod and the Islands and similar to other embayments where this calculation was performed it is assumed that the load from stormwater runoff from impervious surfaces within 200 feet of the Madaket Harbor and Long Pond system is also negligible.

**Load Allocations**

Load allocations identify the portion of loading capacity allocated to existing and future nonpoint sources. In the case of the Madaket Harbor and Long Pond estuary system the locally controllable nonpoint source loadings are from on-site subsurface wastewater disposal systems (septic systems) and other land uses (which include storm-water runoff, except from impervious cover within 200 feet of the waterbody which is defined above as part of the waste load, the landfill and fertilizers). Figure 4b (above) and Figure 6 (below) illustrate that septic systems are the most significant portion of the controllable N load (5.2 kg N/day), with landfill contribution a distant second (2.1 kg N/day). Fertilizers and runoff combined contribute 1.7 kg N/day (from

Table IV-2 in the MEP Technical Report). In addition, there are nonpoint sources of N from sediments, natural background and atmospheric deposition that are not feasibly controllable.

**Figure 6: Madaket Harbor and Long Pond Estuarine System Locally Controllable N Sources**




Generally, storm-water that is subject to the EPA Phase II Program is considered a part of the waste load allocation, rather than the load allocation (see waste load allocation discussion). As discussed above and presented in Chapter IV, V, and VI, of the MEP Technical Report, on Cape Cod and the Islands the vast majority of storm-water percolates into the aquifer and enters the embayment system through groundwater, thus defining the stormwater in pervious areas to be a component of the nonpoint source load allocation. Therefore, the TMDL accounts for storm-water and groundwater loadings in one aggregate allocation as a non-point source, thus combining the assessments of wastewater and storm-water for the purpose of developing control strategies. As the Phase II Program is implemented in Nantucket, new studies, and possibly further modeling, will identify what portion of the storm-water load may be controllable through implementation of Best Management Practices (BMPs).

The sediment loading rates incorporated into the TMDL are lower than the existing benthic input listed in Table 5 above because projected reductions of N loadings from the watershed will result in reductions of nutrient concentrations in the sediments and therefore, over time, reductions in loadings from the sediments will occur. Benthic N flux is a function of N loading and particulate organic N (PON). Projected benthic fluxes are based upon projected PON concentrations and watershed N loads and are calculated by multiplying the present N flux by the ratio of projected PON to present PON using the following formulae:

Projected N flux = (present N flux) (PON projected / PON present)

When: $PON\ projected = (R_{load})\ (D_{PON}) + PON_{present\ offshore}$

When: $R_{load} = (projected\ N\ load) / (Present\ N\ load)$

And: $D_{PON}$ is the PON concentration above background determined by:
$D_{PON} = (PON_{present\ embayment} - PON_{present\ offshore})$

The benthic flux modeled for the Madaket Harbor and Long Pond estuary system is reduced from existing conditions based on the load reduction and the observed PON concentrations within each sub-embayment relative to Nantucket Sound (boundary condition). The benthic flux input to each sub-embayment was reduced (toward zero) based on the reduction of N in the watershed load.

The loadings from atmospheric sources incorporated into the TMDL however, are the same rates presently occurring because, as discussed above, local control of atmospheric loadings is not considered feasible.

**Margin of Safety**

Statutes and regulations require that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality [CWA para 303 (d)(20©, 40C.G.R. para 130.7©(1)]. The EPA's 1991 TMDL Guidance explains that the MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. The MOS for the Madaket Harbor and Long Pond TMDLs are implicit and the conservative assumptions in the analyses that account for the MOS are described below.

1. Use of conservative data in the linked model:

The watershed N model provides conservative estimates of N loads to the embayment. Nitrogen transfer through direct groundwater discharge to estuarine waters is based upon studies indicating negligible aquifer attenuation and dilution, i.e. 100% of load enters embayment. This is a conservative estimate of loading because studies have also shown that in some areas less than 100% of the load enters the estuary. Nitrogen from the upper watershed regions, which travels through ponds or wetlands, almost always enters the embayment via stream flow, and is directly measured (over 12-16 months) to determine attenuation. In these cases the land-use model has shown a slightly higher predicted N load than the measured discharges in the streams/rivers that have been assessed to date. Therefore, the watershed model as applied to the surface water watershed areas again presents a conservative estimate of N loads because the actual measured N in streams was lower than the modeled concentrations.

The hydrodynamic and water quality models have been assessed directly. In the many instances where the hydrodynamic model predictions of volumetric exchange (flushing) have also been directly measured by field measurements of instantaneous discharge, the agreement between modeled and observed values has been >95%. Field measurement of instantaneous discharge was performed using acoustic doppler current profilers (ADCP) at key locations within the embayment (with regards to the water quality model, it was possible to conduct a quantitative assessment of the model results as fitted to a baseline dataset - a least squares fit of the modeled versus observed data showed an $R^2>0.95$, indicating that the model accounted for 95% of the variation in the field data). Since the water quality model incorporates all of the outputs from the other models, this excellent fit indicates a high degree of certainty in the final result. The high level of accuracy of the model provides a high degree of confidence in the output; therefore, less of a margin of safety is required.

Similarly, the water column N validation dataset was also conservative. The model is validated to measured water column N. However, the model predicts average summer N concentrations. The very high or low measurements are marked as outliers. The effect is to make the N threshold more accurate and scientifically defensible. If a single measurement two times higher than the next highest data point in the series raises the average 0.05 mg N/L, this would allow for a higher "acceptable" load to the embayment. Marking the very high outlier is a way of preventing a single and rare bloom event from changing the N threshold for a system. This effectively strengthens the data set so that a higher margin of safety is not required.

Finally, the predicted reductions in benthic regeneration of N are most likely underestimates, i.e. conservative. The reduction is based solely on a reduced deposition of PON, due to lower primary production rates under the reduced N loading in these systems. As the N loading decreases and organic inputs are reduced, it is likely that rates of coupled remineralization-nitrification, denitrification and sediment oxidation will increase.

Benthic regeneration of N is dependent upon the amount of PON deposited to the sediments and the percentage that is regenerated to the water column versus being denitrified or buried. The regeneration rate projected under reduced N loading conditions was based upon two assumptions (1) PON in the embayment in excess of that of inflowing tidal water (boundary condition) results from production supported by watershed N inputs and (2) Presently enhanced production will decrease in proportion to the reduction in the sum of watershed N inputs and direct atmospheric N input. The latter condition would result in equal embayment versus boundary condition production and PON levels if watershed N loading and direct atmospheric deposition could be reduced to zero (an impossibility of course). This proportional reduction assumes that the proportion of remineralized N will be the same as under present conditions, which is almost certainly an underestimate. As a result, future N regeneration rates are overestimated which adds to the margin of safety.

2. Conservative sentinel station/target threshold nitrogen concentration:

Conservatism was used in the selection of the sentinel stations and target threshold N concentrations. The sites were chosen that had stable eelgrass or benthic animal (infaunal) communities, and not those just starting to show impairment, which would have slightly higher N concentration. Meeting the target threshold N concentrations at the sentinel stations will result in reductions of N concentrations in the rest of the system.

3. Conservative approach:

The target loads were based on tidally averaged N concentrations on the outgoing tide, which is the worst case condition because that is when the N concentrations are the highest. The N concentrations will be lower on the flood tides and therefore this approach is conservative.

In addition to the margin of safety within the context of setting the N threshold levels as described above, a programmatic margin of safety also derives from continued monitoring of these embayments to support adaptive management. This continuous monitoring effort provides the ongoing data to evaluate the improvements that occur over the multi-year implementation of the N management plan. This will allow refinements to the plan to ensure that the desired level of restoration is achieved.

**Seasonal Variation**

Since the TMDLs for the waterbody segments are based on the most critical time period, i.e. the summer growing season, the TMDLs are protective for all seasons. The daily loads can be converted to annual loads by multiplying by 365 (the number of days in a year). Nutrient loads to the embayment are based on annual loads for two reasons. The first is that primary production in coastal waters can peak in both the late winter-early spring and in the late summer-early fall periods. Second, as a practical matter, the types of controls necessary to control the N load, the nutrient of primary concern, by their very nature do not lend themselves to intra-annual manipulation since the majority of the N is from non-point sources. Thus, the annual loads make sense since it is difficult to control non-point sources of N on a seasonal basis and N sources can take considerable time to migrate to impacted waters.

## TMDL Values for the Madaket Harbor and Long Pond Estuarine System

As outlined above, the total maximum daily loadings of N that would provide for the restoration and protection of the embayment were calculated by considering all sources of N grouped by natural background, point sources and non-point sources. A more meaningful way of presenting the loadings data from an implementation perspective is presented in Table 7.

In this table the N loadings from the atmosphere are listed separately from the target watershed threshold loads which are composed of natural background N along with locally controllable N from the on-site subsurface wastewater disposal systems, the landfill, storm-water runoff and fertilizer sources. In the case of the Madaket Harbor and Long Pond system the TMDLs were calculated by projecting reductions in locally controllable septic systems in the Hither Creek subwatershed as well as removing the landfill load from the Long Pond subwatershed. Once again the goals of these TMDLs are to achieve the identified target threshold N concentration at the identified sentinel stations. The target loads identified in this table represents one alternative-loading scenario to achieve that goal but other scenarios may be possible and approvable as well.

**Table 7: The Total Maximum Daily Loads (TMDL) for the Madaket Harbor and Long Pond Estuarine System, Represented as the Sum of the Calculated Target Threshold Loads, Atmospheric Deposition and Sediment Load**

| Sub-embayment System | Target Threshold Watershed Load[1] (kg N/day) | Atmospheric Deposition (kg N/day) | Nitrogen Load from Sediments[2] (kg N/day) | TMDL[3] (kg N/day) |
|---|---|---|---|---|
| Madaket Harbor | 0.663 | 8.603 | 17.952 | 27.218 |
| Hither Creek | 1.134 | 0.534 | 0 | 1.668 |
| Madaket Ditch | 2.433 | - | 0.061 | 2.494 |
| North Head Long Pond | 0.238 | 0.693 | 0.995 | 1.926 |
| Long Pond | 1.101 | 0.975 | 2.273 | 4.349 |
| Total for Systems | 5.570 | 10.805 | 21.281 | 37.656 |

[1] Target threshold watershed load (including natural background) is the load from the watershed needed to meet the embayment target threshold nitrogen concentration identified in Table 4.
[2] Projected sediment N loadings obtained by reducing the present benthic flux loading rates (Table 5) proportional to proposed watershed load reductions and factoring in the existing and projected future concentrations of PON. (Negative fluxes set to zero.)
[3] Sum of target threshold watershed load, sediment load and atmospheric deposition load.

## Implementation Plans

The critical element of this TMDL process is achieving the sentinel station specific target threshold N concentrations presented in Table 4 above that are necessary for the restoration and protection of water quality and eelgrass habitat within the Madaket Harbor and Long Pond estuarine system. In order to achieve these target threshold N concentrations, N loading rates must be reduced throughout the harbor embayment system.

It should be noted that the Town of Nantucket is currently involved in a five year implementation process to reduce the landfill contribution to the nitrogen load of Long Pond by mining and removing some material and lining/capping the remaining material. It is expected that the landfill nitrogen loads will likely be eliminated after completion of this project. Based on a modeled future scenario of removing the landfill N load from the system, the MEP study predicts that removal of the landfill load will result in a 20% reduction in total watershed N load. This reduction is not sufficient to reach the target threshold nitrogen concentration of 0.45 mg/l at the sentinel station. Additional load reductions are required to meet the 0.45 mg/l target threshold nitrogen concentration. However, as previously noted, there is a variety of loading reduction scenarios that could achieve the target threshold N concentrations. Local officials can explore other loading reduction scenarios through additional modeling as part of their Comprehensive Wastewater Management Plan (CWMP). It must be demonstrated however, that any alternative implementation strategies will be protective of the entire embayment system. To this end, additional linked model runs can be performed by the MEP at a nominal cost to assist the planning efforts of the town in achieving target N loads that will result in the desired target threshold N concentration.

The CWMP should include a schedule of the selected strategies and estimated timelines for achieving those targets. However, the MassDEP realizes that an adaptive management approach may be used to observe implementation results over time and allow for adjustments based on those results.

Because the vast majority of controllable N load is from septic systems for private residences the CWMP should assess the most cost-effective options for achieving the target N watershed loads, including but not limited to, sewering and treatment for N control of sewage and septage at either centralized or de-centralized locations and denitrifying systems for all private residences.

Nantucket is urged to meet the target threshold N concentrations by reducing N loadings from any and all sources, through whatever means are available and practical, including reductions in storm-water runoff and/or fertilizer use within the watershed through the establishment of local by-laws and/or the implementation of storm-water BMPs in addition to reductions in on-site subsurface wastewater disposal system loadings.

Based on land-use and the fact that the watersheds of these systems are located completely within the Town of Nantucket it follows that nitrogen management necessary for the restoration of the Madaket Harbor and Long Pond Estuarine System may be formulated and implemented entirely through the Town of Nantucket's actions.

MassDEP's MEP Implementation Guidance report:
http://www.mass.gov/dep/water/resources/coastalr.htm#guidance provides N loading reduction strategies that are available to Nantucket and could be incorporated into the implementation plans. The following topics related to N reduction are discussed in the Guidance:

- Wastewater Treatment
    - On-Site Treatment and Disposal Systems
    - Cluster Systems with Enhanced Treatment
    - Community Treatment Plants
    - Municipal Treatment Plants and Sewers
- Tidal Flushing
    - Channel Dredging
    - Inlet Alteration
    - Culvert Design and Improvements
- Storm-water Control and Treatment *
    - Source Control and Pollution Prevention
    - Storm-water Treatment
- Attenuation via Wetlands and Ponds

- Water Conservation and Water Reuse
- Management Districts
- Land Use Planning and Controls
    - Smart Growth
    - Open Space Acquisition
    - Zoning and Related Tools
- Nutrient Trading

*Nantucket is not one of the 237 communities in Massachusetts covered by the Phase II storm-water program requirements.

## Monitoring Plan

MassDEP is of the opinion that there are two forms of monitoring that are useful to determine progress towards achieving compliance with the TMDL. MassDEP's position is that implementation will be conducted through an iterative process where adjustments maybe needed in the future. The two forms of monitoring include 1) tracking implementation progress as approved in the Nantucket CWMP plan and 2) monitoring water quality and habitat conditions in the estuaries, including but not limited to, the sentinel stations identified in the MEP Technical Report.

The CWMP will evaluate various options to achieve the goals set out in the TMDL report and the MEP Technical Report. It will also make a final recommendation based on existing or additional modeling runs, set out required activities, and identify a schedule to achieve the most cost effective solution that will result in compliance with the TMDL. Once approved by the Department, tracking progress on the agreed upon plan will, in effect, also be tracking progress towards water quality improvements in conformance with the TMDL.

Relative to water quality MassDEP believes that an ambient monitoring program much reduced from the data collection activities needed to properly assess conditions and to populate the model, will be important to determine actual compliance with water quality standards. Although the TMDL values are not fixed, the target threshold N concentrations at the sentinel stations are fixed. Through discussions amongst the MEP it is generally agreed that existing monitoring programs which were designed to thoroughly assess conditions and populate water quality models can be substantially reduced for compliance monitoring purposes. Although more specific details need to be developed on a case-by-case basis MassDEP believes that about half the current effort (using the same data collection procedures) would be sufficient to monitor compliance over time and to observe trends in water quality changes. In addition, the benthic habitat and communities would require periodic monitoring on a frequency of about every 3-5 years. Finally, in addition to the above, existing monitoring conducted by MassDEP for eelgrass should continue into the future to observe any changes that may occur to eelgrass populations as a result of restoration efforts.

The MEP will continue working with the watershed communities to develop and refine monitoring plans that remain consistent with the goals of the TMDL. It must be recognized however that development and implementation of a monitoring plan will take some time, but it is more important at this point to focus efforts on reducing existing watershed loads to achieve water quality goals.

## Reasonable Assurances

MassDEP possesses the statutory and regulatory authority, under the water quality standards and/or the State Clean Water Act (CWA), to implement and enforce the provisions of the TMDL through its many permitting programs including requirements for N loading reductions from on-site subsurface wastewater disposal systems. However, because most non-point source controls are voluntary, reasonable assurance is based on the

commitment of the locality involved. Nantucket has demonstrated this commitment through the comprehensive wastewater planning that they initiated well before the generation of the TMDL. The town expects to use the information in this TMDL to generate support from their citizens to take the necessary steps to remedy existing problems related to N loading from on-site subsurface wastewater disposal systems, storm-water, and runoff (including fertilizers), and to prevent any future degradation of these valuable resources. Moreover, reasonable assurances that the TMDL will be implemented include enforcement of regulations, availability of financial incentives and local, state and federal programs for pollution control. Storm-water NPDES permit coverage will address discharges from municipally owned storm-water drainage systems. Enforcement of regulations controlling non-point discharges include local implementation of the Commonwealth's Wetlands Protection Act and Rivers Protection Act, Title 5 regulations for on-site subsurface wastewater disposal systems and other local regulations (such as the Town of Rehoboth's stable regulations). Financial incentives include federal funds available under Sections 319, 604 and 104(b) programs of the CWA, which are provided as part of the Performance Partnership Agreement between MassDEP and EPA. Other potential funds and assistance are available through the Massachusetts Department of Agriculture's Enhancement Program and the United States Department of Agriculture's Natural Resources Conservation Services. Additional financial incentives include income tax credits for Title 5 upgrades and low interest loans for Title 5 on-site subsurface wastewater disposal system upgrades available through municipalities participating in this portion of the state revolving fund program.

As the town implements these TMDLs the loading values (kg/day of N) will be used by MassDEP for guidance for permitting activities and should be used by the community as a management tool.

## Appendix A: Summary of the Nitrogen Concentrations for Madaket Harbor/Long Pond Estuarine System.

(From the MEP Technical Report, Linked Watershed-embayment Model to Determine Critical Nitrogen Loading Threshold for the Madaket Harbor and Long Pond Estuarine System, Town of Nantucket, MA, March, 2011)

Table VI-1. Town of Madaket water quality monitoring data, and modeled Nitrogen concentrations for the Madaket Harbor System used in the model calibration plots of Figure VI-2. All concentrations are given in mg/L N. "Data mean" values are calculated as the average of the separate yearly means.

| Sub-Embayment | Monitoring station | 2002 mean | 2003 mean | 2004 mean | mean | s.d. all data | N | model min | model max | model average |
|---|---|---|---|---|---|---|---|---|---|---|
| Madaket Bay | M1 | 0.402 | 0.333 | 0.272 | 0.336 | 0.098 | 25 | 0.3053 | 0.3197 | 0.3107 |
| Madaket Bay | M2 | 0.427 | 0.413 | 0.349 | 0.395 | 0.083 | 27 | 0.3165 | 0.324 | 0.3205 |
| Madaket Bay | M3 | 0.501 | 0.387 | 0.347 | 0.415 | 0.090 | 27 | 0.3186 | 0.3411 | 0.328 |
| Hither Creek | M4 | 0.644 | 0.647 | 0.422 | 0.581 | 0.193 | 35 | 0.3986 | 0.5423 | 0.4639 |
| Hither Creek | M5 | 0.883 | 0.691 | 0.684 | 0.780 | 0.178 | 19 | 0.4946 | 0.6945 | 0.613 |
| Madaket Bay | M6 | 0.419 | 0.317 | 0.315 | 0.347 | 0.067 | 10 | 0.3095 | 0.3279 | 0.3161 |
| Madaket Bay | M10 | 0.527 | 0.431 | 0.312 | 0.422 | 0.127 | 16 | 0.3192 | 0.3424 | 0.3266 |
| Hither Creek | M11 | 0.690 | 0.636 | 0.441 | 0.620 | 0.215 | 24 | 0.4587 | 0.5732 | 0.5107 |
| Long Pond | LOPO1 | 1.243 | 0.746 | 1.185 | 1.058 | 0.404 | 18 | 0.9997 | 1.1027 | 1.0394 |
| Long Pond | LOPO2 | 1.157 | 0.860 | 0.895 | 0.971 | 0.369 | 18 | 0.9336 | 1.0513 | 0.9827 |
| Long Pond | LOPO3 | -- | 1.001 | 0.848 | 0.924 | 0.234 | 10 | 0.818 | 0.956 | 0.8821 |
| Long Pond | LOPO4 | 0.939 | 0.889 | 0.821 | 0.894 | 0.278 | 25 | 0.7542 | 0.9319 | 0.8515 |
| North Head Long Pond | LOPO5 | 1.029 | 0.929 | 0.781 | 0.954 | 0.271 | 26 | 0.8674 | 0.9345 | 0.8937 |

## Appendix B: Madaket Harbor/ Long Pond Estuarine System Five Total Nitrogen TMDLs

| Sub-embayment | Segment ID | Description | TMDL (kg N/day) |
|---|---|---|---|
| Madaket Harbor | MA97-27_2008 | Waters encompassed within imaginary lines from Eel Point to the northern tip of Esther Island, from the southern tip of Esther Island southeasterly to the opposite shore and from Jackson Point easterly to Little Neck, Nantucket. Listed on the 2008 CWA §303(d) list for pathogens. | 27.22 |
| Hither Creek | MA97-28_2008 | From the outlet of Madaket Ditch to Madaket Harbor at an imaginary line drawn easterly from Jackson Point to Little Neck, Nantucket. Listed on the 2008 CWA §303(d) list for nutrients, organic enrichment/low DO. | 1.67 |
| Madaket Ditch | -- | Determined to be impaired for nutrients during the development of this TMDL. | 2.49 |
| North Head Long Pond | -- | Determined to be impaired for nutrients during the development of this TMDL. | 1.93 |
| Long Pond | MA97-29_2008 | South of Madaket Road, including White Goose Cove, Nantucket. Listed on the 2008 CWA §303(d) list for nutrients, organic enrichment/low DO, pathogens, turbidity. | 4.35 |
| Total for System | | | 37.66 |

that the system should be capable of supporting healthy infaunal communities should the organic matter loadings be reduced.

The infaunal community based classification (Table VIII-1) throughout Sesachacha Pond is fully supported by the lack of eelgrass habitat and the water quality data discussed in the text above.

Table VIII-1. Summary of Nutrient Related Habitat Health within the Sesachacha Pond Estuary on the eastern coast of Nantucket Island within the Town of Nantucket, MA, based upon assessment data presented in Chapter VII. The system is presently structured as a great salt pond consisting of a single basin formed from seawater entry to a coastal kettle pond.

| Health Indicator | Sesachacha Pond System |
|---|---|
| | **Main Basin** |
| Dissolved Oxygen | **SI**[1] |
| Chlorophyll | **SD**[2] |
| Macroalgae | **--**[3] |
| Eelgrass | **--**[4] |
| Infaunal Animals | **SI**[5]**/SD** [6] |
| **Overall:** | **SD** |

1 – oxygen depletions frequent to 4 mg/L., and periodically to <2 mg/L.
2 – chlorophyll levels generally >20 ug/L, reaching 60 ug/l and >100 ug/L in bloom periods.
3 -- macroalgae was difficult to assess due to poor light penetration, however, large accumulations of drift algae have not been reported for this system
4 – no evidence this basin is supportive of eelgrass.
5 – main basin low numbers of species (generally <6) moderate numbers of individuals, but dominated by opportunistic species (primarily *Streblospio*).
6 – western basin (Transect B, figure VII-9) infaunal community severely depleted, low numbers of individuals (≤72) & species (≤4).

H = healthy habitat conditions; MI = Moderate Impairment; SI = Significant Impairment; SD = Severe Degradation; -- = not applicable to this estuarine reach

## VIII.2 THRESHOLD NITROGEN CONCENTRATIONS

The approach for determining nitrogen loading rates, which will maintain acceptable habitat quality throughout and embayment system, is to first identify a sentinel location within the embayment and second to determine the nitrogen concentration within the water column which will restore that location to the desired habitat quality. The sentinel location is selected such that the restoration of that one site will necessarily bring the other regions of the system to acceptable habitat quality levels. Once the sentinel site and its target nitrogen level are determined, the Linked Watershed-Embayment Model is used to sequentially adjust nitrogen loads until the targeted nitrogen concentration is achieved.

Within the Sesachacha Pond System the most appropriate sentinel station location is generally in the center of the basin, but given the horizontally well mixed nature of this great salt pond, Station 1 in Figure II-1 was selected as the sentinel station for threshold development. This location was selected because it is relatively deep and has prior data collection from which to assess long-term trends. As noted in previous sections, concentrations at the sentinel station approximate concentrations throughout the pond waters (i.e. it is representative of other pond locations).

Following the MEP protocol, since eelgrass has not been documented in Sesachacha Pond, restoration of infaunal habitat is the restoration goal for this aquatic system. Infaunal animal habitat is a critical resource to the Sesachacha Pond System and estuaries in general. Since the infaunal community at all sites within the Pond are either dominated by organic matter enrichment species or are depleted, comparisons to the muddy basins of other estuarine systems in the MEP region were relied upon. This analysis would suggest that a healthy infaunal habitat would clearly be achieved at an average nitrogen level of TN <0.5 mg TN $L^{-1}$. This level was found for Popponesset Bay where, based upon the infaunal analysis coupled with the nitrogen data (measured and modeled), nitrogen levels on the order of 0.4 to 0.5 mg TN L-1 were found supportive of high infaunal habitat quality. Similarly, in the deeper basins of Three Bays System, healthy infaunal areas are found at nitrogen levels of TN <0.42 mg TN $L^{-1}$ (Cotuit Bay and West Bay), with moderate impairment in areas where nitrogen levels of TN >0.5 mg TN $L^{-1}$.

Sesachacha Pond currently has a low watershed nitrogen load, with external loading dominated by direct atmospheric input, and moderate summer input from its sediments and only periodic tidal exchange. The result is nitrogen levels reaching 1.5 mg TN $L^{-1}$ and average TN levels of ~ 1 mg TN $L^{-1}$. Therefore it is not clear if average summer TN levels can be reduced to <0.5 mg $L^{-1}$ or if this level has been achieved at any time in past centuries. The Pond was always cited to be used for shellfish transplanting and therefore likely has been somewhat nitrogen enriched, supporting moderate phytoplankton levels. Therefore, the MEP Technical Team determined that a higher TN level <0.6 mg TN $L^{-1}$ would likely support a moderately impaired infaunal community, yet conditions that should also support shellfish. The modeling simulations in Section VIII-3 targeted the 0.5 mg TN L-1 for healthy habitat and also assessed a higher level of 0.6 mg TN L-1 for a moderately impaired condition that may be more reflective of the natural condition of this system in its present configuration. It is important to note that the modeled maximum and average TN levels are likely conservative estimates as they do not include potential reductions in the rate of sediment nitrogen regeneration often associated with the lowering of nitrogen enrichment of embayment waters.

## VIII.3 DEVELOPMENT OF TARGET NITROGEN LOADS

After developing the dispersion-mass balance model of Sesachacha Pond to simulate conditions that exist as a result of present management practices, the model was used to simulate a modified management approach that could be followed to improve water quality conditions in the pond year-round.

The habitat quality in Sesachacha Pond has been historically moderate to poor, depending on the intensity of management, specifically the frequency and duration of openings to the ocean. Throughout the 1980's, the pond was not actively managed (openings ceased), and salinities dropped as low as 2 ppt in 1989. It was in this year that the Town sought the proper environmental permits that would allow again the periodic breaching of an inlet to the Atlantic Ocean, in order to improve water quality conditions. Beginning in the early 1990's, with

the permits in place, the latest era of active management of Sesachacha Pond began. Presently, Pond water quality is managed by bi-annual breachings of the barrier beach, once each in the spring and fall (Curley, 2004). Other breaches are cut as required in order to lower the water level of Pond when it threatens lower lying properties along its shore (Conant, 2006).

Between 1967 and 2005, there have been only seven years where maximum recorded salinities have been equal to or greater than 25 ppt (see Chapter 6). Five of those years fall within the 10-year period from 1996 through 2005, which indicates that present management practices have been more effective in controlling conditions in the pond.

With a goal of seeking further improvements in water quality conditions in the Pond, an alternate management scheme was modeled using the dispersion-mass balance model developed for Sesachacha Pond. One goal of this proposed management scenario is to prevent salinity in the pond from dropping below 22 ppt at any point of the year. Another goal is to reduce TN concentrations in the pond during the summer months, when benthic regeneration and algae production is greatest. Both of these goals are related, as better flushing management results in both higher salinities and lower nitrogen levels in pond waters. A simple way to achieve these goals is to add an additional mid-summer breach event each year.

To model the effect of adding this mid-summer breach, first, the spring-to-fall 2003 time period was modeled. This period was selected because it offers a good approximation of typical conditions with regard to the duration of the spring-time opening (6 days), water quality data was available for this period, and the average net fresh water recharge rate (2.2 $ft^3$/sec) could be determined by an analysis of the salinity data records from 1998, 2003, 2004 and 2005. Similar to the results of the modeled 2004 spring-to-fall season discussed in Chapter VI, Figures VIII-1 and VIII-2 show comparisons between measured data and concentrations predicted by the pond model. The resulting average modeled salinity over the whole modeled period is 24.7 ppt, and the average TN concentration is 0.87 mg/L.

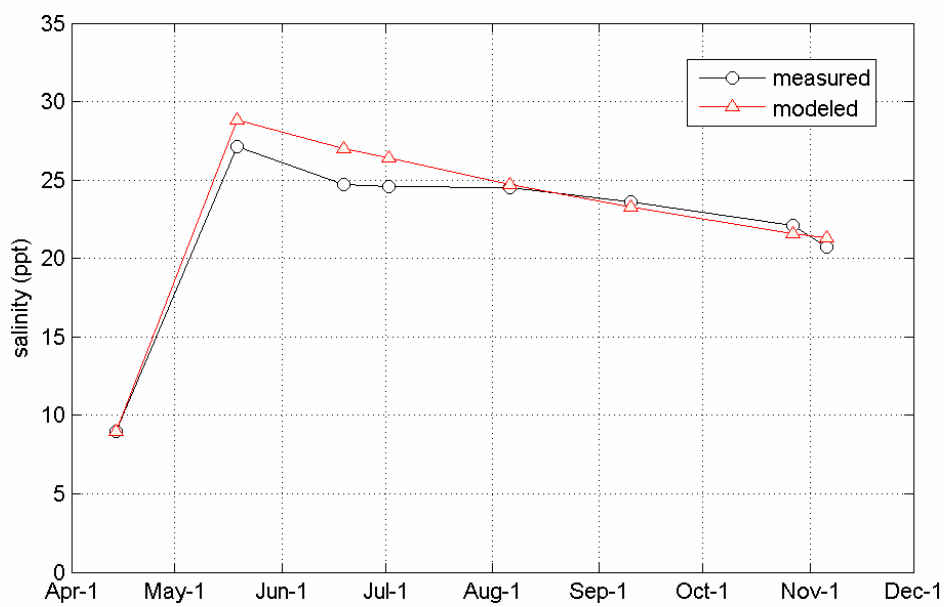



Figure VIII-1. Comparison of measured (black circles) and modeled (red triangles) salinities through the summer of 2003 ($R^2$=0.74, RMS error=1.31 ppt). Present conditions with pond openings in Spring and Fall.

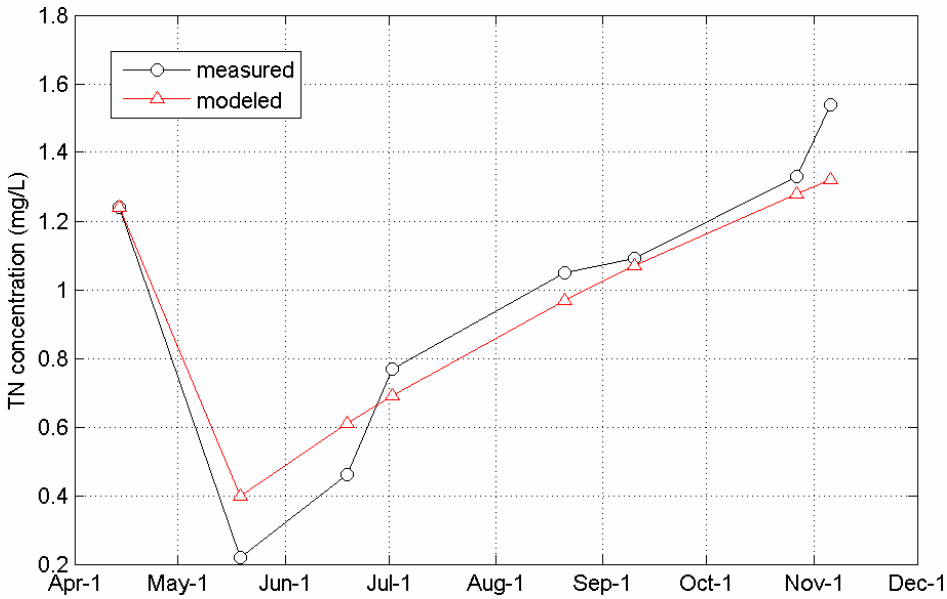



Figure VIII-2. Comparison of measured (black circles) and modeled (red triangles) TN concentrations through the summer of 2003 ($R^2$=0.83, RMS error=0.13 mg/L). Present conditions with pond openings in Spring and Fall.

After modeling the 2003 season, the alternative of including a mid-summer breach was modeled. For this scenario, the mid-summer breach was made 90 days after the closure of the first breach. This breach was modeled as if it were as successful as the spring 2003 breach, which lasted for six days.

A comparison of modeled salinities, showing results for runs with the mid-summer breach and without (i.e., present management practice) is presented in Figure VIII-3. After the second breach, salinities rise above 30 ppt. At the end of the simulation period, the pond salinities with the mid-summer breach are approximately 5 ppt greater then the salinities under existing management conditions (i.e. spring and fall breaches only). Both model runs include a fall breach which only draws down the pond volume, but does not permit tidal exchange with the ocean. This is the typical effect of the fall breach. The average salinity for the mid-summer breach run is 26.0 ppt, which represents an improvement of 1.3 ppt over the entire modeled period.

The attendant comparison of modeled TN is presented in Figure VIII-4. The mid-summer breach lowers TN levels by 0.50 mg/L to approximately 0.40 mg/L. At the end of the simulation period, TN concentrations are 0.4 mg/L lower after the mid-breach simulation compared to the concentrations for the simulations of existing conditions. The average TN level for the entire simulation period also drops to 0.68 mg/L, which is a substantial improvement of 0.09 mg/l over modeled 2003 average conditions.

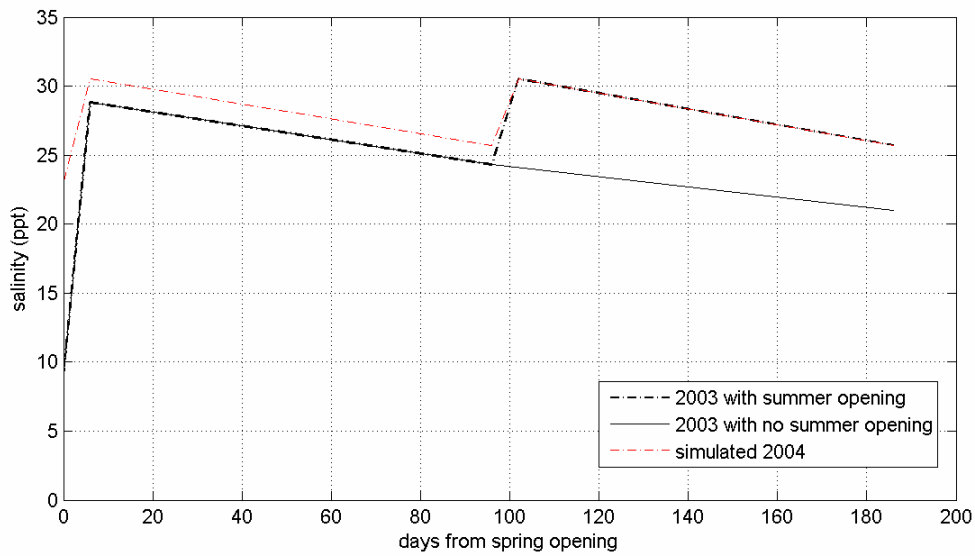



Figure VIII-3. Comparison of modeled 2003 salinities for case where the pond is breached only in the spring (thick black dot-dashed line) and also when it is breached an additional time mid-summer. Model results for the following 2004 spring- to-fall season (thin red dash dot line) show how salinities change if the mid-summer breach is performed again.

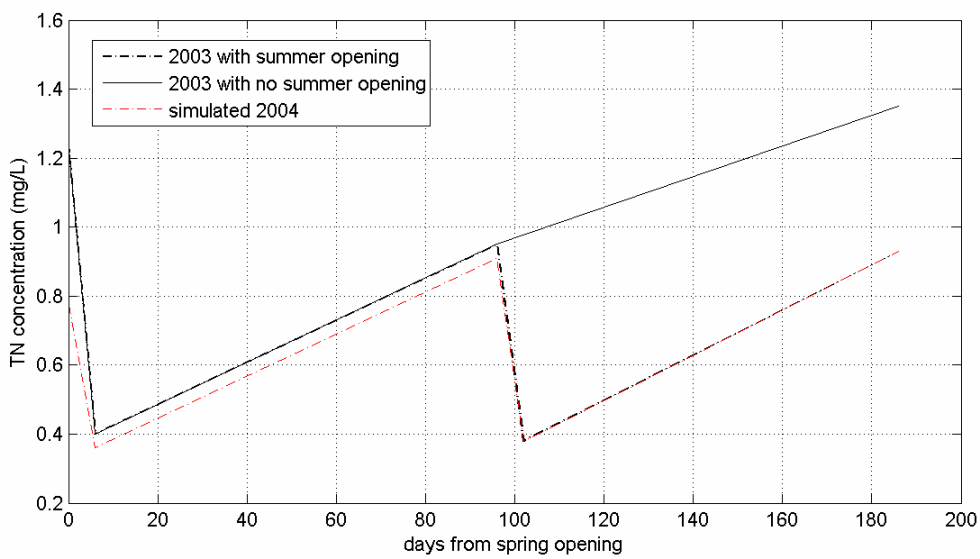



Figure VIII-4. Comparison of modeled 2003 TN for case where the pond is breached only in the spring (thick black line) and also when it is breached an additional time mid-summer (dot-dashed line). Model results for the following 2004 spring- to-fall season (thin red dash dot line) show how TN concentrations change if the mid-summer breach is performed again.

The simulation was re-run through the same 2003 spring-to-fall period in order to investigate how the mid-summer breaching would affect water quality starting the following spring. These results are presented also in Figures VIII-3 (salinity) and VIII-4 (TN). The final salinity of the 2003 mid-summer breach is 25.7 ppt. The salinity drops through the winter to 23.3 ppt, at which point the spring (2004) breach is made. Assuming that the spring and mid-

summer breaches of the following year are as successful as the actual 2003 spring breach, the simulation shows that salinities never drop below 25 ppt after the spring, and average 27.4 ppt over the course of the entire simulation period.

A similar improvement in the TN concentration in the following year was found, with the simulated spring level set to 0.82 mg/L. This starting concentration was derived using the difference in the TN concentrations computed at the end of the 2003 simulations with and without the mid-summer breach. This difference was determined to be 0.42 mg/L, and was assumed to carry through to the simulated 2004 spring. This 0.42mg/L difference was subtracted from the measured 2003 pre-breach concentration of 1.24 mg/L to arrive at the modified starting concentration of 0.82 mg/L.. Simulation results from the second consecutive year with a mid-summer breach show that the TN concentration never rises above 1.00 mg/L, and that the average TN concentration is 0.64, which is a 0.13 mg/L improvement over average conditions computed for the 2003 season without a mid-summer breach.

Model results indicate that water quality improvements that may provide more stable environment for flora and fauna is possible with the addition of a successful mid-summer breach. Data indicate that openings as short as six days are sufficient to provide sufficient tidal flushing and raise salinity levels near 30 ppt. Pond salinity is a useful indicator of breach success, as opposed to the duration of the opening. With the mid-summer breach, it should be possible to maintain salinities above 25 ppt and TN concentrations below 1.00 mg/L.

A significant improvement in the nitrogen related health of Sesachacha Pond infaunal animal habitat would result from the above modeled addition of a mid summer opening. It would be possible to use the monthly monitoring data to indicate when the mid-summer breach should occur. The primary indicator would be when the pond salinity drops below 25 ppt. The secondary indicator would be when the pond TN concentration rises above 0.95 mg/L. If this strategy is followed in the future, the result would be year-round salinities above 22 ppt and TN concentrations below 1.00 mg/L. It is important to note that the modeled maximum and average TN levels are likely conservative estimates as they do not include potential reductions in the rate of sediment nitrogen regeneration often associated with the lowering of nitrogen enrichment of embayment waters.

It should be noted that the above mentioned management scenarios oriented around altering the timing of breaches of the barrier beach, effective as these may be, are contingent on the ability of the Town of Nantucket to obtain necessary permitting of such actions. Breaching of the barrier beach is necessarily subject to compliance with applicable federal, state and local statutes and regulations.

# VIII. CRITICAL NUTRIENT THRESHOLD DETERMINATION AND DEVELOPMENT OF WATER QUALITY TARGETS

## VIII.1. ASSESSMENT OF NITROGEN RELATED HABITAT QUALITY

Determination of site-specific nitrogen thresholds for an embayment requires integration of key habitat parameters (infauna and eelgrass), sediment characteristics, and nutrient related water quality information (particularly dissolved oxygen and chlorophyll). Additional information on temporal changes within each sub-embayment of an estuary and its associated watershed nitrogen load further strengthen the analysis. These data were collected to support threshold development for the Hummock Pond Estuarine System by the MEP and were discussed in Chapter VII. Nitrogen threshold development builds on this data and links habitat quality to summer water column nitrogen levels from the baseline Water Quality Monitoring Program conducted by Town staff and by staff and graduate researchers at and with analytical support from the Coastal Systems Analytical Facility at SMAST-UMass Dartmouth.

Determination of site-specific nitrogen thresholds for an embayment requires integration of key habitat parameters (infauna and eelgrass), sediment characteristics, and nutrient related water quality information (particularly dissolved oxygen and chlorophyll a). Additional information on temporal changes within each sub-embayment and its associated watershed nitrogen load and geomorphological considerations of basin depth, stratification and functional type further strengthen the analysis. These data were collected to support threshold development for the Hummock Pond Estuarine System by the MEP Technical Team and were discussed in Chapter VII. Nitrogen threshold development builds on this data and links habitat quality to summer water column nitrogen levels from the long-term baseline Water Quality Monitoring Program conducted by the Town of Nantucket, with technical guidance and analytical support from the Coastal Systems Program at SMAST-UMass Dartmouth.

The Hummock Pond Estuary is comprised of two major functional units, each with different levels of habitat quality, both are brackish (varying from 4-8 ppt). The main basin of Hummock Pond (e.g. the drown valley formed perpendicular to the barrier beach) which is generally closed to tidal exchange, and opened by breaching the barrier beach twice per year for pond management. Hummock Pond is a shallow narrow "finger pond" with moderate-significant impairment of benthic animal habitat and no historic eelgrass coverage. The second unit, Head of Hummock, is a man-altered basin which was once a freshwater kettle pond which has a channel to Hummock Pond which now allows salt water to enter. Head of Hummock supports severely degraded benthic animal habitat and no historic eelgrass coverage. The salinity of Head of Hummock and possibly Hummock Pond are at the limit for grow of eelgrass (5 ppt) consistent with the lack of eelgrass coverage historically. There is a clear gradient in infaunal habitat quality from severely degraded conditions in Head of Hummock to the lower main basin of Hummock Pond adjacent the barrier beach having the highest quality habitat.

Part of the MEP assessment of the Hummock Pond Estuarine System was confirmation that the critical parameter controlling habitat quality is nitrogen, hence managing nitrogen enrichment would result in restoration of observed impairments. Analysis of inorganic N/P molar ratios within the water column of the Hummock Pond Estuarine System are consistent with virtually all of the estuaries in southeastern Massachusetts and New England in that nitrogen is the critical nutrient to be managed. The measured Redfield Ratio (inorganic N/P) ranges from 3.6-5.2 within the main basin and 1.8 within Head of Hummock. These data and the low concentration of inorganic nitrogen (~0.03 mg $L^{-1}$) indicate that nitrogen additions will increase phytoplankton production, organic matter levels and turbidity within this system.

Increased phytoplankton and organic matter levels increase oxygen consumption within the waters and sediments and increase the extent of oxygen depletion and habitat impairment. It should be noted that nitrogen enrichment occurs through two primary mechanisms, high rates of nitrogen entering from the surrounding watershed and/or low rates of flushing due to restriction of tidal exchange with low nitrogen offshore waters. The Hummock Pond Estuary has seen increasing nitrogen loading from its watershed from shifting land-uses and due to coastal processes along its barrier beach, it is only periodically opened to tidal exchange. Fundamentally, restrictions of tidal exchange increase the sensitivity of an estuary to nitrogen inputs. Decreasing watershed nitrogen inputs or increasing tidal flushing will reduce nitrogen enrichment and its impacts. The present distribution and level of benthic animal habitat quality observed within the estuary is consistent with degree of nitrogen enrichment, and its resulting increase in phytoplankton biomass, organic matter and oxygen levels. All of the habitat indicators are consistent with the above assessment of the whole of the Hummock Pond System (Chapter VII).

At present, eelgrass beds are not present in the Hummock Pond Estuary. The absence of eelgrass beds within Hummock Pond is expected given the measured levels of nitrogen enrichment and resulting chlorophyll a and dissolved oxygen. Total nitrogen levels (TN) within the lower basin have mean summer time levels >0.7 mg N $L^{-1}$ compared to the levels in other similarly configured southeastern Massachusetts estuarine basins currently supporting eelgrass, 0.35-0.45 mg N $L^{-1}$ (range of Cape Cod systems). Other key water quality indicators, dissolved oxygen and chlorophyll a, show similar levels of enrichment with chlorophyll levels averaging 9 to 33 ug $L^{-1}$ in lower and upper reaches of main basin. Given the sensitivity of eelgrass to declining light penetration resulting from nutrient enrichment and secondary effects of organic enrichment and oxygen depletion, the lack of eelgrass habitat within Hummock Pond is consistent with observed eelgrass habitat and areas of loss in numerous other estuaries throughout the region. While Hummock Pond lacks eelgrass habitat, benthic animal habitat is also a critical estuarine resource and it is impaired throughout the Hummock Pond Estuary. Benthic animal habitat is generally has a higher tolerance for nitrogen enrichment than eelgrass, as unlike eelgrass, benthic animals do not require light for growth and therefore higher levels of turbidity and phytoplankton biomass are tolerated. Infauna habitat quality is the primary habitat for management of the basins comprising eh Hummock Pond Estuary.

The is also no evidence that Hummock Pond supported eelgrass coverage over the past 60 years. Review of historic maps and information that indicate that none of the basins comprising the Hummock Pond Estuary were capable of supporting eelgrass historically. First, Head of Hummock appears to have been connected to Hummock Pond via an artificial channel, therefore it is a transformed freshwater kettle pond, rather than a natural estuarine basin. As such, it would not have historically supported eelgrass. In addition, a review of available records did not reveal any evidence of eelgrass beds in the main basin of Hummock, most likely due to its dynamic inlet resulting in periodic loss of tidal exchange, historically and today, and resulting poor water quality. Historical eelgrass beds have not been found in other embayments with similar inlet closures, throughout the region, although ephemeral patches may occur during periods of prolonged or frequent tidal exchange (e.g. Tisbury Great Pond). Equally significant, under present salinity conditions, Head of Hummock is below the lowest salinity where eelgrass is found to grow (5 ppt), and Hummock Pond is periodically below or just above that level as well. Only at higher salinity levels would eelgrass colonization even be possible in this system and the nature of the inlet makes this occurance unlikely over any prolonged period.. It should also be noted that eelgrass beds throughout the regions are typically found at salinities within the 20-32 ppt range.

The Weed Study conducted by the Hummock Pond Association provides additional support for the prolonged low salinity of the waters in Head of Hummock and in the upper reach of the main basin of Hummock Pond, as many of the plants found have a low tolerance for salt water, generally less than the 5 ppt lower limit for eelgrass growth.

Based upon these multiple lines of evidence, it appears that the basins comprising the Hummock Pond Estuary have not historically supported eelgrass beds or significant eelgrass habitat. Therefore, the threshold analysis for this system is necessarily focused on restoration/protection of infaunal animal habitat.

Overall, the main basin of Hummock Pond is supporting a gradient in impairment from significantly impaired in the upper basin to moderately impaired in the lowest reach near the barrier beach. However, the tributary basin of Head of Hummock is currently supporting severely degraded habitat with no marine invertebrates only 2 species of insect larvae. Head of Hummock contains lower salinity water than the Hummock Pond main basin, likely due to its function as a drown kettle pond in the uppermost reach of the system. As such, Head of Hummock is the focus of groundwater discharge from the watershed and as the entire system is usually without tidal currents, mixing is limited. The salinity of Head of Hummock is low enough (<5 ppt) to influence the plant and animal communities that colonize, although estuarine benthic animal communities are fully capable of colonizing at salinities to 3 ppt. However, the Head of Hummock basin is virtually devoid of benthic animals, only supporting 2 insect larval species and no estuarine infauna. The likely results from the periodic anoxic events during summer in this basin. In contrast, the main basin of Hummock Pond in areas with similar salinities, currently support benthic anaimal communities. Therefore, the loss of benthic animals in Head of Hummock appears to be related to the high organic matter loading and periodic anoxia, rather than the low salinity (as was also observed in Oyster Pond, Falmouth).

The main basin of Hummock Pond is presently supporting significantly impaired benthic animal habitat in its upper reaches as seen by the low numbers of species (4) and individuals (~90), with a moderate to low diversity (1.6). Significantly, stress indicator species (Capitellids, Tubificids) are not prevalent at any station within the main basin, comprising a minor fraction (<2%) of the population. Benthic habitat quality improves moving toward the barrier beach with the lower main basin having moderat numbers of species (8) and individuals (~120) but still moderate to low diversity (1.8). Similarly, the in the basin nearest the barrier beach, habitat is only showing moderate impairment with moderate numbers of species(10) and individuals (~200) and diversity (2.3). Both the values of the habitat indicators and the gradient in quality from upper to lower estuary, are consistent with the observed levels of oxygen depletion (periodic anoxia in Head of Hummock), organic enrichment (chlorophyll a at 40-60 ug $L^{-1}$ in Head of Hummock and <10 ug $L^{-1}$ in the lower main basin of Hummock Pond. The gradient in habitat quality also parallels the TN levels fo 1.6 mg N $L^{-1}$ declining to ~0.7 mg N $L^{-1}$ in the lower main basin. This range in TN has been found to support only impaired benthic animal habitat in open water systems throughout s.e. Massachusetts. Further evidence of impairment of the main basin of Hummock Pond is the dominance of the benthic community by amphipods (*Ampelisca, Leptocheiris*), which are typical of transitional environments (between high and low quality habitat)..

In addition to the watercolum indicators, the lower basin of Hummock Pond has accumulations of macroalgae along the margins of the basin which are associated with poor benthic habitat. Macroalgae can have a "smothering" effect on benthic animals as observed in the most extreme situation of the main basin of Waquoit Bay. The accumulations result in low oxygen at the sediment surface resulting in decline of benthic populations. These

accumulations in the lower main basin provide additional stress to benthic communities and are consistent with the observed TN level and observed benthic communities.

The benthic animal communities within the basins of the Hummock Pond System were compared to high quality environments, such as the Outer Basin of Quissett Harbor, which provides additional confirmation of impaired habitat. The Outer Basin of Quissett Harbor supports benthic animal communities with $\geq$28 species, >400 individuals with high diversity (H' $\geq$3.7) and Evenness (E $\geq$0.77). Similarly, outer stations within Lewis Bay in Barnstable currently support similarly high quality benthic habitat as seen in the numbers of individuals (502 per sample), number of species (32), diversity (3.69) and Eveness (0.74). Equally important these communities are not consistent with nutrient enrichment being composed of a variety of polychaete, crustacean and mollusk species, as opposed to stress tolerant small opportunistic oligochaete worms (tubificids, capitellids). These habitats represent the highest quality and exist in well flushed basins and have consistently high oxygen and low chlorophyll a levels and low amounts of organic enrichment. While these represent a theoretical goal for restoration, the reality of the tidal flushing characteristics of Hummock Pond must also be taken into account, as with other periodically opened estuaries (Edgartown Great Pond, Tisbury Great Pond).

Overall, the pattern of infaunal habitat quality throughout the Hummock Pond Estuary is consistent with measured dissolved oxygen concentration, chlorophyll, nutrients and organic matter enrichment in this system (Table VIII-1). Classification of habitat quality necessarily includes the structure of the specific estuarine basin and its tidal characteristics (continuously or periodically opened to tidal flows). Based upon this analysis it is clear that the upper regions of the estuary, Head of Hummock and upper main basin of Hummock Pond, are severely degraded and significantly impaired, respectively, by nitrogen and organic matter enrichment while the lower main basin is presently supporting moderately impaired benthic animal habitat. The proximate cause of impairment is organic matter enrichment and oxygen depletion, stemming ultimately from nitrogen enrichment. Total nitrogen levels within the upper basin (Head of Hummock) >1.0 mg N $L^{-1}$, a level associated with impoverished and degraded benthic animal habitat in other s.e. Massachusetts estuaries. Benthic communities have been found to be impaired at TN levels lower than found in Hummock Pond, e.g. Falmouth Inner Harbor, 0.58 mg TN $L^{-1}$, Fiddlers Cove and Rands Harbor, 0.56 mgTN $L^{-1}$ and 0.57 mgTN $L^{-1}$, respectively. It appears that Hummock Pond is well beyond its threshold TN level to support healthy benthic habitat. As there is no evidence of present or historic eelgrass beds within the Hummock Pond Estuary, management actions should focus on restoration of benthic animal habitat.

## VIII.2 THRESHOLD NITROGEN CONCENTRATIONS

The approach for determining nitrogen loading rates that will support acceptable habitat quality throughout an estuary and salt pond is to first identify a sentinel location within the embayment and secondly, to determine the nitrogen concentration within the water column at that site which will result in the desired habitat quality. The sentinel location is selected such that the restoration of that one site (or group of sites) will necessarily bring the other regions of the system to acceptable habitat quality levels. Once the sentinel site and its target nitrogen level are determined (Section VIII.2), the Linked Watershed-Embayment Model is used to sequentially adjust nitrogen loads until the targeted nitrogen concentration is achieved (Section VIII.3.

Table VIII-1. Summary of nutrient related habitat quality within the Hummock Pond Estuary, Town of Nantucket, MA, based upon assessments detailed in Section VII. Head of Hummock is a kettle pond opened via a channel to the upper main basin of Hummock Pond. Hummock Pond is periodically opened to tidal flows, but receives salt water in storm overwash of the barrier beach.

| Health Indicator | Hummock Pond Estuarine System | |
|---|---|---|
| | Head of Hummock Basin | Hummock Pond Main Basin |
| Dissolved Oxygen | SI/SD[1] | H/MI[2] |
| Chlorophyll | SI[3] | SI/MI[4] |
| Macroalgae | --[5] | SI[6] |
| Eelgrass | --[7] | --[8] |
| Infaunal Animals | SD[9] | MI/SI [10] |
| **Overall:** | **SD[11]** | **MI/SI[12]** |

1- mooring oxygen <3 mg/L 31%, with multiple day anoxic events, daily excursion 3-5 mg/L, but extended oxygen levels about air saturation (10-15 mg/L versus 8 mg/L) consistent with eutrophic conditions. D.O. less than 4 mg/L is stressful to estuarine organisms. Sediments anoxic-sulfidic mud.

2- mooring oxygen: moderate daily excursions in oxygen levels in upper and lower reach of main basin, generally ranging from 6 mg/L to 8 mg/L, rarely to 5 mg/L; <6mg/L 6% and 5% of record respectively.

3- levels moderate/high, mooring average 34 ug $L^{-1}$, >25ug $L^{-1}$ 85% of record; blooms >60 ug $L^{-1}$; WQMP: high chlorophyll a, summer averages of 20-30 ug $L^{-1}$, averages >10 indicate N enrichment

4- levels moderate/high, in upper main basin mooring average 33 ug $L^{-1}$, >25ug $L^{-1}$ 75% of record; strong gradient to lower main basin where mooring average was only 8 ug $L^{-1}$, and >10 ug $L^{-1}$ for 16% or record. Possibility of Head of Hummock influencing upper main Hummock Pond basin. WQMP: shows similar gradient of high chlorophyll a upper main basin declining to 9 ug L-1 in lower main basin.

5- drift algae generally absent, some areas of brackish water macrophytes in shallow margins, sediments of basin are black anoxic sulfidic unconsolidated muds, highly enriched with organic matter.

6- drift algae generally not observed in upper half of basin, but consistently in shallow margins of lower half of main basin; oxidized surface to sediments, and varying levels of medium to fine sand.

7- artificial brackish water basin, no historical evidence of eelgrass beds

8- periodically breached basin, no historical evidence of eelgrass beds, but possibly few sparse patches

9- low numbers of species (2), individuals (<100) diversity and Evenness. Appears that salinity and freshwater inflow areas have shifted bottom community toward freshwater community.

10- sparse stress indicator species, but generally dominated by intermediate organic enrichment species, amphipods (*Ampelisca, Leptocheiris*). Clear gradient: upper HP main basin→mid→barrier beach: increasing # species (4,8,10), numbers (~100 -> ~200), diversity (1.6 -> 2.3) and moderate to good Evenness. Near inlet mollusks, crustaceans, polychaetes, but at levels lower than high quality areas.

11- Severely degraded benthic animal habitat, present community indicative of brackish highly stressed habitat, consistent with periodic anoxia & frequent hypoxia & high phytoplankton biomass (>30 ug $L^{-1}$). Low species and organism numbers and anoxic sulfidic fluid muds indicative of unstable organic enriched system.

12- Moderately impaired to significantly impaired benthic animal habitat, upper and lower reaches, respectively; community indicates gradient in impairment from the uppermost to the lowermost basin which mirrors the gradient in chlorophyll a and TN. Oxygen conditions generally show little to modest depletion, generally to 5-6 mg/L. Benthic community dominated by amphipods indicative of a system impaired by nitrogen and organic matter enrichment, few stress indicators (capitellids, tubificids).

H = High quality habitat conditions; MI = Moderate Impairment; SI = Significant Impairment;
SD = Severely Degraded; -- = not applicable to this estuarine reach
WQMP: Water Quality Monitoring Program

Determination of the critical nitrogen threshold for maintaining high quality habitat within the Hummock Pond Estuary is based primarily upon the nutrient and oxygen levels and current benthic community indicators, as there is no history of eelgrass colonization of the 2 major basins. Given the information on a variety of key habitat characteristics, it is possible to develop a site-specific threshold, which is a refinement upon more generalized threshold analyses frequently employed.

The Hummock Pond Estuary presently shows a moderate to significant impairment of its benthic animal habitat in its main basin and severely degraded habitat in Head of Hummock and is clearly beyond its nitrogen threshold (i.e. the level of nitrogen a system can tolerate without impairment). The indications of impairment to infaunal animal habitat are supported by the observed levels of oxygen depletion and clearly enhanced chlorophyll a levels, sediment organic matter enrichment and macroalgal accumulations, are similar to other estuaries with similar levels of nitrogen enrichment.

A Sentinel station was established for the Hummock Pond Estuary for development of a nitrogen threshold target that when met will restore benthic animal habitat throughout its estuarine reach. Since there is a relatively small gradient in nitrogen in the main basin, the sentinel station was selected at the basin's mid point, which reflects the average conditions within Hummock Pond. The uppermost station was not selected as it appears to be effected by outflows from Head of Hummock and not reflective of typical conditions within the main basin. Sentinel Station for Head of Hummock was established at the long-term monitoring station 3 (HUM-3). The main basin is typically non-tidal except for 2 brief periods per year, so the main basin supports only a modest gradient in nitrogen. The average total nitrogen levels at the sentinel station are currently 0.72 mg N $L^{-1}$. It should be noted that the freshening of Head of Hummock must be managed as part of restoration of benthic animal habitat in this estuary. This TN level is comparable to other estuarine basins throughout the region that show similar levels of oxygen depletion, organic enrichment and moderately impaired benthic animal habitat. TN levels >0.70 mg N L-1 are generally characterized as having significantly impaired benthic habitat, phytoplankton blooms and periodic hypoxia and even fish kills (e.g. finger ponds in Falmouth). Benthic animal habitat is typically impaired even at TN levels of 0.58 mg TN $L^{-1}$ (Falmouth Inner Harbor), 0.56 mgTN $L^{-1}$ (Fiddlers Cove) and 0.57 mgTN $L^{-1}$ (Rands Harbor). Given that in numerous estuaries it has been empirically previously determined that 0.500 mg TN $L^{-1}$ is the upper limit to sustain unimpaired benthic animal habitat (Eel Pond, Parkers River, upper Bass River, upper Great Pond, upper Three Bays, as well as the 7 inner basins of Pleasant Bay) this level is deemed most appropriate for restoration of benthic animal habitat within Hummock Pond. Watershed management to meet the restoration threshold for benthic animal habitat is the focus of the nitrogen management threshold analysis (Section VIII.3).

## VIII.3 DEVELOPMENT OF TARGET NITROGEN LOADS

After developing the dispersion-mass balance model of Hummock Pond to simulate conditions that exist as a result of present management practices, the model was used to simulate a modified management approach that could be followed to improve water quality conditions in the pond year-round.

With a goal of seeking further improvements in water quality conditions in the Pond, an alternate management scheme was modeled using the previously developed dispersion-mass balance model. The main goal of this proposed management scenario is to prevent time averaged pond-wide TN concentrations in the pond from rising above 0.50 mg/L in the main basin of the Pond (at monitoring station HUM-3) during the summer months, when benthic

regeneration and algae production is greatest. A way to achieve these goals is to reduce the watershed loading to the pond, together with an additional mid-summer breach.

Watershed loading was reduced from present conditions until the time averaged TN concentration at station HUM-3 would remain below 0.50 mg/L during a complete breaching cycle, where the pond is open to tidal flushing for at least four days and subsequently closed for 60 days.

The resulting threshold septic loading is presented in Table VIII-1. A 82% reduction from present conditions together with a functioning breach duration of 4 days was required in the septic load to the pond to achieve the threshold requirements. In this scenario 80% of the septic load is removed from the main watershed of the pond, and 95% was removed from the smaller Head of Hummock sub-watershed.

This septic load change results in a 63% change in the total watershed load to the pond, as shown in Table VIII-2. A tabulation of all the loads to the pond is provided in Table VIII-3. The benthic loading term is effected by the change in watershed load. The method described in section VI.2.5.1 was used to adjust the benthic regeneration load to the pond for threshold conditions.

Table VIII-2. Comparison of sub-embayment septic loads used for modeling of present and modeled threshold loading scenarios of Hummock Pond. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms.

| sub-embayment | Present load (kg/day) | threshold (kg/day) | threshold change |
|---|---|---|---|
| Hummock Pond main basin | 8.436 | 1.687 | *-80.0%* |
| Head of Hummock | 1.366 | 0.068 | *-95.0%* |
| Total | 9.801 | 1.755 | *-82.1%* |

Table VIII-3. Comparison of sub-embayment watershed loads used for modeling of present and modeled threshold loading scenarios of Hummock Pond. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms.

| sub-embayment | Present load (kg/day) | threshold (kg/day) | threshold change |
|---|---|---|---|
| Hummock Pond main basin | 11.195 | 4.446 | *-60.3%* |
| Head of Hummock | 1.682 | 0.383 | *-77.2%* |
| Total | 12.877 | 4.829 | *-62.5%* |

Table VIII-4. Sub-embayment and surface water loads used for total nitrogen modeling of threshold conditions for Hummock Pond, with total watershed N loads, atmospheric N loads, and benthic flux.

| sub-embayment | watershed load (kg/day) | direct atmospheric deposition (kg/day) | benthic flux net (kg/day) |
|---|---|---|---|
| Hummock Pond main basin | 4.446 | 1.918 | 0.109 |
| Head of Hummock | 0.383 | 0.208 | 0.473 |
| Total | 4.829 | 2.126 | 0.582 |

The effect on TN concentrations through the course of the summer of the threshold management scenario suggested for Hummock Pond is presented in Figure VIII-1. For the 64-day period shown in Figure VIII-1, the time averaged TN concentration is 0.50 mg/L at the HUM-3 monitoring.

It is important to note that the threshold scenario provided as part of this report is one of many possible loading and breaching combinations that could work to improve water quality in the Pond. If the inlet remained open for a period longer than 4 days, the threshold concentration could likely be achieved with less watershed load reduction.

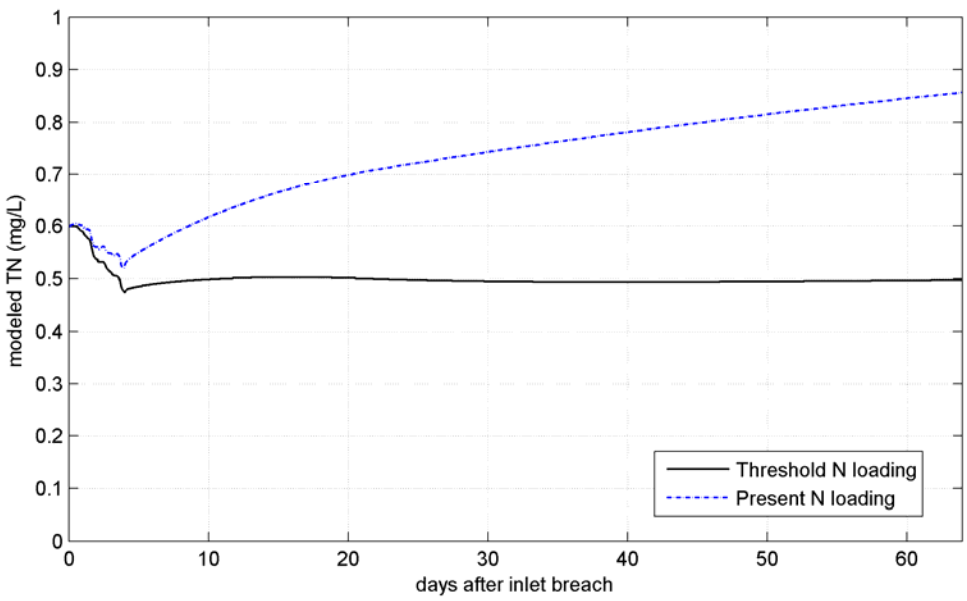



Figure VIII-1. Time series of modeled TN concentrations at monitoring station TGP 7 from the threshold model scenario where the pond is breached in late May for four days.

## IX.1 FRESH WATER HEAD OF HUMMOCK

In reviewing historic maps and examining the topography around Head of Hummock, it appears likely that this small brackish kettle pond was artificially connected to the Main Basin of Hummock Pond. The appearance is that Head of Hummock was once fresh water and with the channel and subsequent actions, the pond is now brackish, although consistently less saline than the main basin of Hummock Pond. Head of Hummock remains moderately isolated from Hummock Pond, with outflow of freshwater and some salt water inflows, such as due to storm events. Head of Hummock, as a kettle pond, is deeper than the outer basins (>3 m versus generally 1-2 m). It is highly nitrogen enriched and its sediments reflect its depth and depositional nature, being black fluid muds, which are anoxic and sulfidic and devoid of benthic animals with net nitrogen release to the overlying waters, seen in many kettle ponds opened to salt water inputs (Oyster Pond, Falmouth, Areys Pond, Orleans).

At present, Head of Hummock is a brackish estuarine basin whose nutrient related water quality and habitat quality is dominated by nitrogen availability. This is typical of estuarine systems throughout the region. However, as it appears that this kettle pond was artificially connected to Hummock Pond and now allows input of salt, as part of the MEP restoration analysis, a preliminary analysis of restoring freshwater conditions was undertaken. The concept is that freshwater systems are biogeochemically structured such that phosphorus is the nutrient of management concern and there are multiple “in pond” phosphorus controls available should phosphorus levels result in eutrophic conditions. More important, freshwater systems remove nitrogen that passes through them, lowering nitrogen loads to downgradient estuarine basins. Therefore, the management alternative to be evaluated is to isolate Head of Hummock from Hummock Pond, allowing freshwater outflow for pond level control and fish passage (should it become necessary). This restoration of freshwater conditions would allow Head of Hummock restoration as a freshwater pond, and would provide a reduction in nitrogen load to the main basin of Hummock Pond as part of its restoration of water quality and habitat.

To quantify the possible water quality benefits that would result from returning Head of Hummock to a fresh water pond, a model scenario was developed by modifying the grid developed for existing conditions. Though Head of Hummock is removed from the tidal reach of the system, its watershed would continue to be a nitrogen source to the main basin of Hummock Pond, but with some additional removal by the now freshwater pond. The amount of load that passes to Hummock Pond is controlled by the attenuating capacity of the modified fresh water basin. Based on TN attenuation observed in freshwater ponds with similar depths and retention times throughout the region, it is estimated that Head of Hummock would be able to attenuate 50% of the TN load entering the pond from its watershed. At present, Head of Hummock as a brackish water basin transforms significant amounts of nitrogen but ultimately passes nitrogen to the downgradient main basin.

The changes that result from this modification are large enough to cause noticeable improvements throughout the main basin of Hummock Pond, particularly in how it flushes and how TN concentrations increase during periods when tidal exchange is closed off. However, these changes are not large enough to fully restore the habitat quality of Hummock Pond. The flushing rate of the entirety of Hummock Pond decreases from 4.2 to 3.5 days, an improvement of 17%. The average TN concentration over the entire 64-day simulation period (Figure IX-1) decreases by 0.04 mg/L, which represents an 8% decrease (over open ocean background concentration).

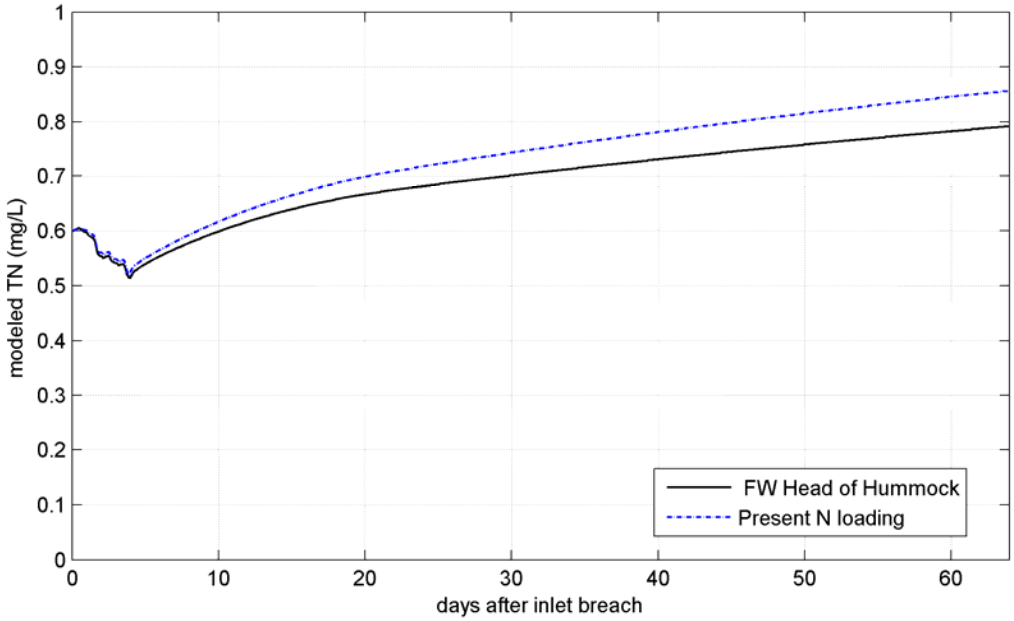



Figure IX-1. Modeled TN concentrations in the main basin of Hummock Pond (at monitoring stations HUM-3) after a simulated four-day open breach and its subsequent closure, with an initial concentration of 0.60 mg/L, showing the N attenuation effect of changing Head of Hummock into a fresh water pond, with no other change in watershed loading.

## IX.2 FRESH WATER HEAD OF HUMMOCK THRESHOLD N LOADING

Although the freshwater Head of Hummock scenario is not enough by itself to achieve the N load reductions required to meet the threshold set for the pond, it is possible that it could be used together with additional watershed N load reductions. The N load reduction needed to meet the threshold would be less than the scenario provided in Chapter VIII since Head of Hummock attenuates 50% of the incoming load as a freshwater pond. In addition, restoring freshwater conditions to Head of Hummock also allows separate restoration of this kettle basin in parallel with the restoration of Hummock Pond.

The N loading scenario developed using the freshwater Head of Hummock is presented in Tables IX-1 and IX-II. The freshwater Head of Hummock scenario requires 7% less reduction in total N load and ~9%reduction in wastewater load to meet the threshold. The plot of model output over the 64-day simulation period is shown in Figure IX-II.

Table IX-1. Comparison of sub-embayment watershed loads used for modeling of present (2003), present 2007, build-out, and no-anthropogenic ("no-load") loading scenarios of Hummock Pond. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms.

| sub-embayment | Present load (kg/day) | Threshold Scenario (kg/day) | Threshold Scenario change | FW Head of Hummock (kg/day) | FW Head of Hummock % change |
|---|---|---|---|---|---|
| Hummock Pond main basin | 11.195 | 4.446 | *-60.3%* | 4.868 | *-56.5%* |
| Head of Hummock | 1.682 | 0.383 | *-77.2%* | 0.840 | *-50.0%* |
| Total | 12.877 | 4.829 | *-62.5%* | 5.708 | *-55.7%* |

Table IX-2. Build-out conditions sub-embayment and surface water loads used for total nitrogen modeling of Hummock Pond, with total watershed N loads, atmospheric N loads, and benthic flux.

| sub-embayment | watershed load (kg/day) | direct atmospheric deposition (kg/day) | benthic flux net (kg/day) |
|---|---|---|---|
| Hummock Pond main basin | 4.868 | 1.918 | 0.119 |
| Head of Hummock | 0.840 | 0.104 | - |
| Total | 5.708 | 2.022 | 0.119 |

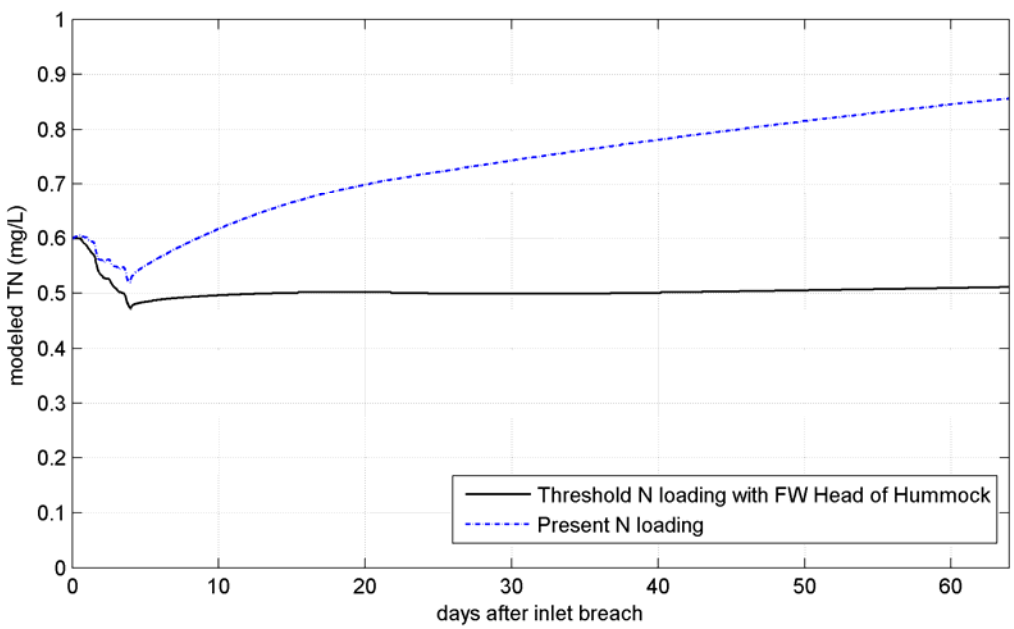



Figure IX-2. Modeled TN concentrations in the main basin of Hummock Pond (at monitoring stations HUM-3) after a simulated four-day open breach and its subsequent closure, with an initial concentration of 0.60 mg/L, for the alternate Threshold N loading scenario that includes the attenuation effect of turning Head of Hummock into a fresh water pond.

# Landfill Data

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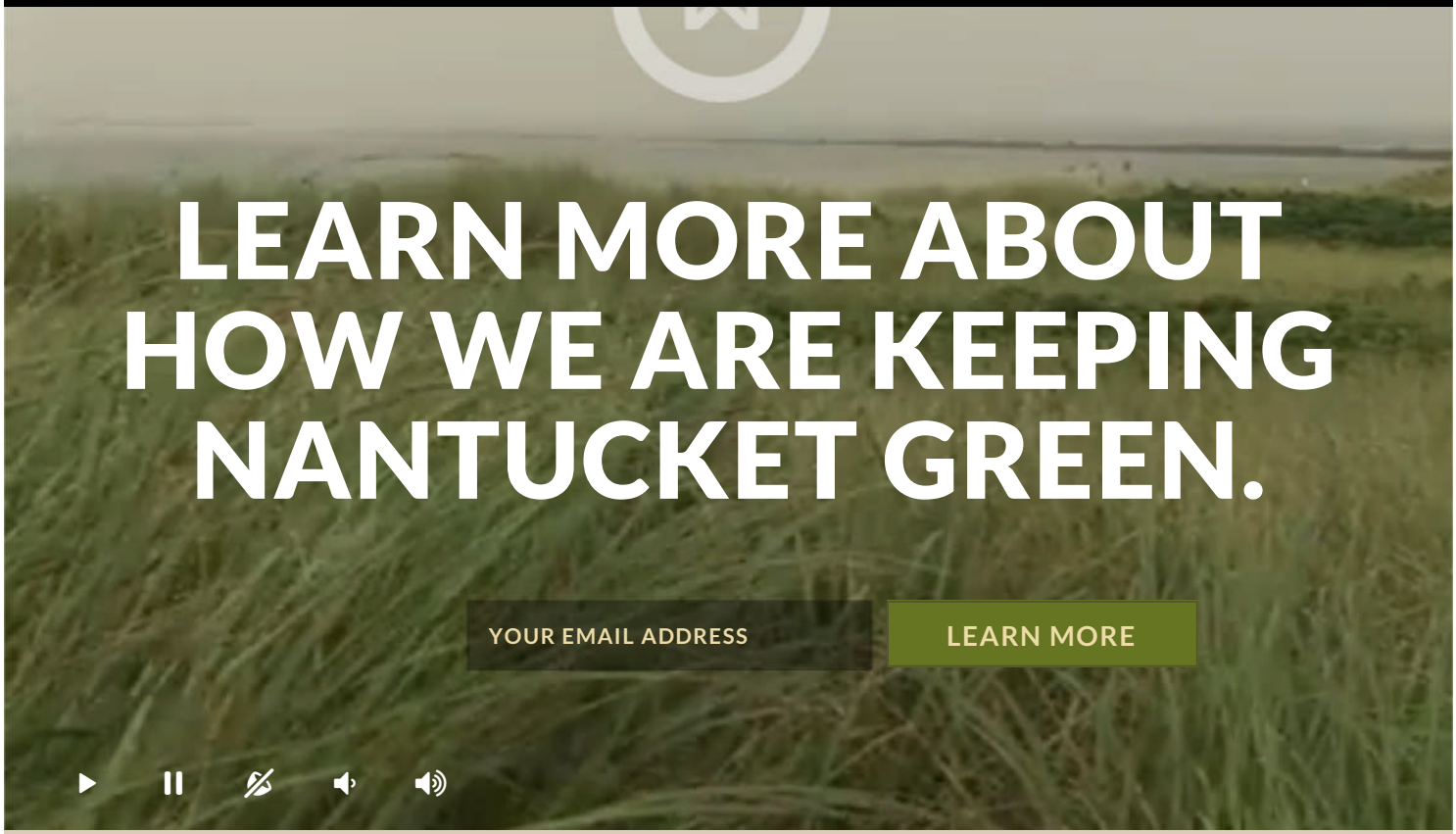


# OUR SERVICES

Waste Options Nantucket, LLC operates and manages the Town of Nantucket's solid waste management and recycling facility, which includes operating the Town's new state-of-the-art lined cell landfill and materials recycling facility, 100 ton per day co-composting facility, a construction and demolition materials recycling facility, mining of the old unlined landfill and processing leaf/yard waste,

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clean and pristine at a reasonable cost to the residents of Nantucket. We utilize proprietary know-how to turn what was once an embarrassing problem for Nantucket into a world-class solid waste processing facility with the highest recycle rate in the nation.

The estimated amount of materials recycled and diverted from the landfill exceeds 92%. Our facility combines traditional recycling of metals, plastic, paper, cardboard and glass with the recycling of more difficult items such as tires, refrigerators, stoves, mattresses, sofas, chairs, clothing and shoes.

Residents can drop off or pick up used belongings such as clothing, books or toys free of charge at the Take-It-or-Leave-It-Swap facility. Unclaimed items are sent for recycling. Additionally, construction & demolition waste, wood waste and yard waste are processed and recycled. The Take-It-or-Leave-It-Swap facility is adjacent to the Materials Recycling Facility (MRF) and operated by the Town.

A state-of-the-art, enclosed in-vessel composting system converts organic wastes and municipal biosolids into valuable topsoil, which results in no more than 20% of all incoming materials (processed through the Co-Composting Facility) being placed in the lined cell. The "residue" from the composting operation is inert and non-polluting, and is baled and deposited into a state-of-the-art lined cell to protect the aquifer.

## HOW WE CLEAN NANTUCKET:

**Residential Waste**: We recycle or dispose of residential waste without separately billing residents for our services.

**Leaf and Yard Waste**: Trees and shrubs are chipped along with wood extracted from the Construction & Demolition Facility. This material is mixed with the compost produced from the Co-Composting Facility and is also used as media material for the Co-Composting Facility biofilter system or as mulch.

magazines, mixed paper, mixed plastics, steel and aluminum are sorted, baled, stored and shipped to the mainland. Glass is collected separately at two designated areas (commercial and non-commercial).

**Co-Composting**: Our proprietary Bedminster co-composting technology – an enclosed, controlled-environment rotating kiln technology – is used to recycle organics by processing municipal solid waste and municipal sewage sludge together, utilizing natural biological processes to produce a compost end product that can be used for landscaping, land reclamation, as a soil additive, and for landfill covers. The facility produces highly beneficial organic compost and soils which meet the most stringent standards for unrestricted use by the Massachusetts Department of Environmental Protection and the United States Environmental Protection Agency. This rich, organic compost is made available free of charge to Island residents at the facility, saving money on those gardening projects. Additionally, by composting organics instead of placing them in the landfill where the natural decomposition process would produce methane, the Waste Options treatment reduces greenhouse gas production and improves the environment.

**Construction & Demolition Waste**: Construction and demolition (C&D) waste is manually sorted to extract recyclable materials. The largest single component in this waste stream is wood. Clean, source separated wood and pallets go to a chipper; the clean chipped wood is mixed with the compost or leaf/yard waste and later used for beneficial uses such as landscaping. Other recyclable materials such as metal and cardboard are extracted from the C&D Waste and recycled. Non-recyclable materials are shipped off island and further processed at facilities on the mainland.

**Remediation of Site**: Starting in 1997 and prior to the construction of the Co-Composting Facility, Waste Options remediated the site and reduced the foot print of the environmentally unfriendly and outdated unlined landfill previously operated by the Town from 42 acres down to 22 acres. Part of the remediation

the landfill. Prior to 2008, a portion of the 7 acre uncapped section of the old unlined landfill was mined and recyclable materials were extracted for further processing.

**Mining**: In 2009, Waste Options started accelerated mining of the old unlined landfill. Waste Options has mined an average of approximately 100,000 cubic yards per year of material from the landfill. Soils that pass the S-1/GW-1 soil clean up criteria (every 1,000 cubic yards of material) is reused on site for new lined cell construction and site improvements. Soil that does not pass the S-1/GW-1 standard and residuals (e.g., plastic) are placed back into the landfill. To date, Waste Options has mined over 400,000 cubic yards of material. Much of the soil mined that meets the S-1/GW-1 standard has been used to grade and slope the site, and to create storm retention ponds on the backside of the new lined cells, or is being stockpiled to be used for future lined cell construction. The mining operation has further reduced the unlined landfill from the 22 acres that existed when the Co-Composting Facility went into operation to less than 19 acres.

**Lined Cell Landfills**: Waste Options, working with the Town (which owns the lined landfill cells), have developed two new landfill cells that include a state-of-the-art liner system used for the disposal of residuals from the Co-Composting Facility. All leachate is collected and transported to the Town's Waste Water Treatment Plant. The new lined landfills are periodically inspected by the Massachusetts Department of Environmental Protection for gas and groundwater monitoring, leachate generation monitoring, leak detection and filling rates.
Mining is currently being performed in a section of the old unlined landfill where a future lined cell landfill will be constructed. Much of the soil mined from the landfill mining operation will be able to be reused to help with the future construction of a new lined cell landfill. These actions defer the need for the Town to cap and close the landfill, and will provide significant savings to the Town.

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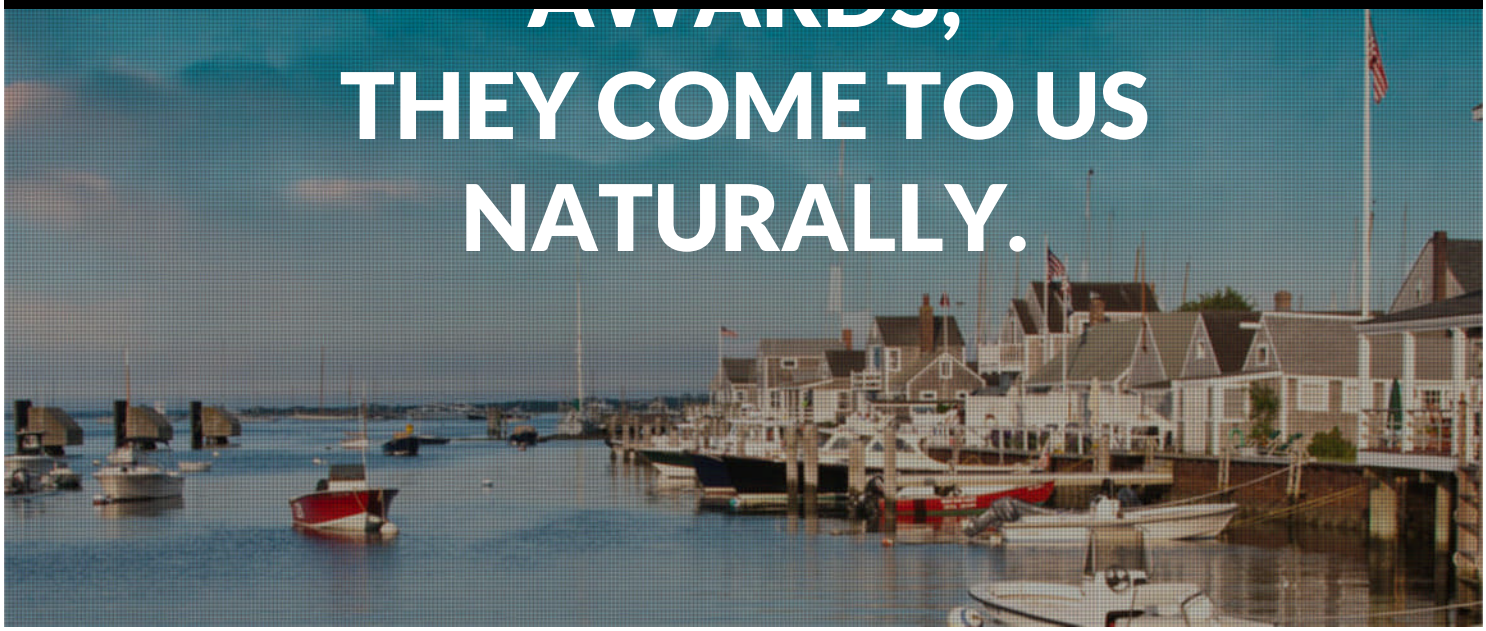


# AWARDS

**Nantucket tops in nation for recycling.** The island was recognized by a national advocacy group (Grassroots Recycling Network) for obtaining a 92 percent recycling rate, knocking San Francisco off its perch as the top recycling community in the country. (October 2009)

In 1996, in conjunction with Waste Options, "Nantucket commenced implementation of a complex solid waste disposal program that incorporated landfill clean-up, recycling and composting to develop the most complete waste management system in the Commonwealth."

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- is the most advanced municipal solid waste recycling and processing facility in the U.S. The estimated amount of materials recycled and diverted from landfilling now exceeds 92%.
- is an integrated waste processing and recycling facility which maximizes the ability to recycle and divert materials from being landfilled.
- has reduced the footprint of the landfill to below the original permitted footprint.
- uses a proprietary, state-of-the-art, enclosed in-vessel composting system, which converts organic wastes and municipal biosolids into valuable soil.
- produces compost that exceeds the quality standards of both the U.S. Environmental Protection Agency and the Commonwealth of Massachusetts.
- was the first compost facility to be registered for carbon credits with the Chicago Climate Exchange in 2009.
- achieves the highest recycling rate in the Commonwealth of Massachusetts, saving the island millions of dollars by vastly reducing the amount of waste that must be shipped off-island.

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# HISTORY. With you since 1997

During the mid-1990's, the ever growing popularity and population of the island placed increasing strain on the Island's infrastructure, particularly as it related to the treatment of solid waste. The Town was facing a serious crisis over its solid waste handling and its associated costs. Its unlined landfill, created at the end of World War II, was a mountain of uncovered garbage and trash. Seagulls swarmed the landfill to feed upon the waste. The volume of waste from construction and demolition projects was overflowing the landfill. The Town was facing a serious dilemma of how to deal with the health, environmental and safety hazards resulting from its handling of waste, and to prepare for the future needs of the Town's waste disposal.

In 1994, the Commonwealth of Massachusetts mandated that Nantucket close its landfill, and that its waste be shipped off-island for disposal on the mainland. If this had occurred, the trash bills for all islanders would have quadrupled.

In 1997, the Town entered into a public-private partnership with Waste Options to remediate the landfill site, manage the landfill operation and recycling facility, and to construct and operate a 100 ton per day compost facility. Originally, an interim operating agreement provided for an orderly transition from the Town operations to Waste Options. Then, in 2000, when the compost facility was completed, Waste Options began its 25 year term of operations.

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for the Town into a world-class solid waste processing facility with the highest recycle rate in the nation.

Through its operation, Waste Options has operated, improved, and constructed new facilities, including a new state-of-the-art lined landfill cell for the multi-stream waste management facility which has met and exceeded the expectations of the original public-private partnership. The Nantucket Solid Waste Recycling and Composting Facility is the most comprehensive in the Commonwealth. That's what comes from a public-private partnership – we all benefit.

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We have made significant investments in improving and repairing our facility to maintain our world-class solid waste and recycling operation right here on Nantucket. Here's what's been happening:

DECEMBER 14, 2013

New Digester Feed Conveyor

DECEMBER 13, 2013

Rebuilding the Construction and Demolition (C&D) Building

OCTOBER 8, 2013

Digester Ram Feed System Overhaul

AUGUST 8, 2013

New Processing Equipment

BROWSE ALL NEWS >

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# RECYCLING TIPS

Why Recycle? Because the process of converting used waste and materials into new products helps us keep Nantucket green. We are also able to minimize pollution and save energy.

Many different materials can be recycled including glass, metal, paper, textiles, and computer equipment.

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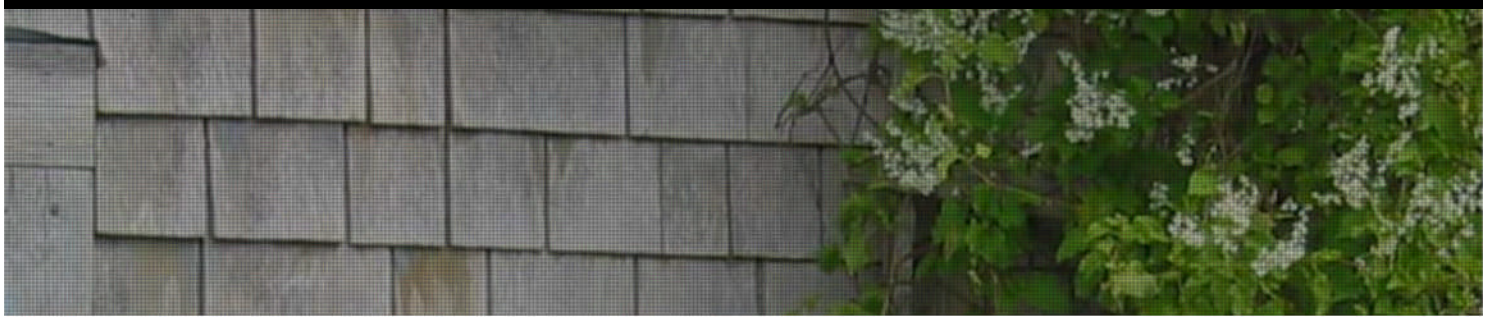

# CONTACT US. Come and say hello to our team.

Name

Email Address

Street Address

City

State

ZIP

## WE'RE HERE FOR YOU.

Feel free to reach out and contact us at any time.

## WHERE ARE WE?

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F - 508-238-4144

188 Madaket Road
Nantucket, Massachusetts
02554

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*Town of Nantucket, MA*
*Friday, September 5, 2014*

# Chapter 125. SOLID WASTE DISPOSAL

[HISTORY: Adopted by the Town Meeting of the Town of Nantucket as indicated in article histories. This chapter was formerly included in the Code as Ch. 91, but was renumbered 4-15-2003 ATM by Art. 26, approved 8-27-2003. Amendments noted where applicable.]

**GENERAL REFERENCES**
Solid waste enterprise — See Ch. **42**.

## Article I. General Provisions

[Adopted 4-10-1989 ATM by Art. 49, approved 7-24-1989]

### § 125-1. Solid waste rules and regulations; landfill user fees.

The Board of Selectmen is hereby empowered to establish the necessary rules, regulations and fees for handling, processing and disposal of the Town's solid waste. Such fees are to be credited to the general fund of the Town of Nantucket and held and expended in accordance with the General Laws of the commonwealth.

### § 125-2. Mandatory segregation and recycling.

[Amended 4-8-1996 ATM by Art. 49, approved 7-24-1996]
The Board of Selectmen, acting as the Board of Public Works, is hereby required to instruct the department responsible for solid waste disposal to establish, promulgate and enforce regulations to the extent permitted by the General Laws of the commonwealth concerning the following matters:

A. The Department shall establish, promulgate and enforce regulations for recycling. The program shall include but not be limited to, newspapers, cardboard, other paper articles and magazines; clear, green and brown glass; aluminum and tin, including cans; all numbered plastics and styrofoam; grass cuttings, leaves, brush and limbs; metal appliances; tires; recyclable construction debris; and all materials listed as hazardous waste by the Massachusetts Department of Environmental Protection. The rules and regulations shall provide penalties and fines.

B. Restrictions upon the sale or distribution of certain materials deemed to be detrimental to the Nantucket Municipal Landfill, composting facility or the island's environment in general.

### § 125-3. Biodegradable packaging.

[Amended 12-12-1989 STM by Art. 2, approved 3-14-1990]

All packaging added to or supplied by vendors or commercial establishments within the Town of Nantucket for merchandise of any type being removed from the establishment shall comply with such rules and regulations requiring the use of biodegradable packaging to the maximum extent reasonably practicable as might be established by the Board of Public Works after a public hearing; provided, however, that this section shall take effect April 15, 1990. "Biodegradable packaging" means any packaging other than plastic or styrofoam.

## § 125-4. Transport of solid waste to disposal facility.

All loads of solid waste that are undergoing transport to the Town's solid waste disposal site for disposal shall be fully covered in such a manner as to prevent strewing litter along the road during transportation. The disposal materials must be in a tied bag, covered container or otherwise fully covered, such as by a properly secured tarpaulin.

## § 125-5. Segregation of solid waste.

All persons entering the Town of Nantucket solid waste disposal facility for the purpose of disposal of solid waste shall be responsible for the segregation of such solid waste into separate categories for separate disposal or recycling, as follows: glass, rigid plastics, aluminum cans and ferrous metal cans or additional categories as may be more fully defined from time to time by regulations of the Board of Public Works or its designee.

## § 125-6. Violations and penalties.

All persons violating any section of this article shall be subject to the penalties set forth in Chapter **1** of the Code of the Town of Nantucket.

# Article II. Unlawful Disposal of Garbage

[Adopted 5-5-1992 ATM by Art. 70, approved 8-3-1992]

## § 125-7. Trash barrels and containers; restricted use.

A. It shall be unlawful for any person to dispose of household or commercial garbage or refuse by placing it in or causing it to be placed in a trash barrel or other container which has been set upon a public street, sidewalk or bicycle path or upon other public property by the Town for the convenience of the traveling public.

B. It shall be unlawful for any person to dispose of household or commercial garbage or refuse by placing it in or causing it to be placed in a trash barrel or other container which has been lawfully set upon private property by any owner or occupant of the property for the exclusive use of said owner or occupant or his or her visitors or patrons, without the authorization of said owner or occupant.

# § 125-8. Violations and penalties.

A. Any police officer of the Town, the Superintendent of Public Works or his designee may utilize the noncriminal disposition specified in MGL c. 40, § 21D.

B. A violation of this article shall be punishable by a fine of $200.

The New York Times

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FROM THE AUTHOR OF MYSTIC RIVER

August 20, 1998

# Nantucket: What a Dump

By KIMBERLY STEVENS

**NANTUCKET, Mass.—** THE early morning August sun beat down on Mary Langdon, 86, a manager of estate sales, as she stooped to pick two yellowing botanical prints in cherry wood frames from the ground. She blew the dust off.

"We all agree," Mrs. Langdon said with a dry smile. "The only difference between us and the sea gulls is they have wings." Not that they get to everything first, though.

Nantucket island -- off the coast of Massachusetts, harbor to generations of 19th-century whaling captains and haven to 20th-century summer residents, rich with stretches of unspoiled beach and rotten with wooden sailboats and shingled cottages weathered the gray of a widow's hair -- has a local scene that does not show up on postcards.

A popular decorating and renovation resource, islanders call it the Madaket Mall.

What it is is the dump. Inaugurated in 1988, the 17,500-square-foot Nantucket Citizens Recycling Drop-Off Center and Landfill -- complete with gray shingled shed -- has its own weekly social set, from year-round local residents to summer people. The Mercedeses pull in next to the trucks. "The only thing that's missing is the coffee and doughnuts," said Mrs. Langdon, who has summered on Nantucket for 40 years.

But oh, the things you'll find. Open from 7 A.M. until 3 P.M. on weekdays and 7 A.M. until noon on weekends, the dump, regulars agree, offers the best "diving" on Sunday, when what did not sell at Saturday tag sales gets, well, dumped. Spring and fall are good, when the season-rental storms of heavy cleaning wash up on Madaket's shores.

In addition to a thick, down-easter flotsam of chintz chairs, wicker settees, architectural salvage, antique trunks, monogrammed Brooks Brothers shirts and late-model mountain bikes, there is real treasure. Last summer, Mrs. Langdon found an Empire sofa, circa 1850, in mint condition.

"Mind you, this never hit the ground," she said later that afternoon at home, gesturing with a willowy tanned arm toward the prize peach-upholstered sofa. "It went from one man's truck right into the back of mine."

Jeff Willett, director of public works, said, "I don't think anyone has found the missing Rembrandts out there, but some valuable antiques have surfaced."

Ole Lokensgard, 52, an architect who visits the dump twice a week, has done devotees like Mrs. Langdon one better.

It is not the ornate clock, found there two years ago, signed "E. Ingraham Co., Bristol, CT," that now graces his mantel.

It is Mr. Lokensgard's house, which was largely built and furnished with dump items found and then incorporated into his design: from the cottage's oddly shaped windows to its mismatched doors, from the icebox hardware on the kitchen cabinets to the refuse lattice that encloses an outdoor shower.

Each brick in the fireplace, which took Mr. Lokensgard three months to build, was handpicked. His wife, Mary, painted the family's eight dining chairs -- from multiple dives -- a sea-foam green, to make a set.

Mr. Lokensgard pointed wistfully at a window that was a tad smaller than the one next to it. "It's a mixed blessing with found stuff," he said. "I refer to my house as the idiot savant house because of its eccentric nature."

Last Saturday, as regulars took their positions by the drive-in entrance, the chatter was about the new one -year-old Nantucket Golf Club (with an initiation fee of $300,000), the horror of Kathy Lee Gifford buying a house on the island and a bald eagle that had taken up residence in the back section of the landfill. No one seemed to be paying attention to the sign in the corner of the discard shed: NO LOITERING , 15 MINUTES . The rule is not enforced. There are simple rules of etiquette at the dump that most seem to follow. If you pick something up, it is yours until you put it down. And so it goes.

Regulars are quick to say the glory days may be ending. Stories of entire trunks filled with antique books, old photographs and estate jewelry are already folklore. With the island's new construction boom, the demolition of old homes and the influx of people with decorators on the payroll, the drop-offs have been good but the diving has become more competitive. And tidy innovations like recycling and the somewhat controversial "take it or leave it" pile have made it easier -- and more attractive -- for amateurs.

Mr. Lokensgard, a former divinity student, is philosophical. "If you are using the dump regularly, you become part of the community, and that means a lot to people," he said. He recalled dropping off an old boat chair. "Gosh, I was hoping for one of these all morning," the man next to him exclaimed.

Photos: PRO DIVING -- Mary Langdon, top, finds a framed botanical. Above, a wing chair arrives, and the "gulls" move in. Center, the "take it or leave it" shed. HOUSE OF DISCARDS -- Ole Lokensgard, above, with his daughter, Sonja, in the cottage he designed and furnished with dump materials, including ceiling and cabinetry wood, dining table and chairs, and the carved wood and cast iron clock, left, signed, "E. Ingraham Co., Bristol, CT." (Photographs by Ed Quinn for The New York Times)

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# APPENDIX D: WANNACOMET WATER DATA

Wannacomet Water Company 2012

# Annual Water Quality Report

## We are pleased to present the 2012 edition of our annual water quality report.

It is being delivered to all customers, the Nantucket Board of Health, the Massachusetts Department of Public Health (DPH), and the Massachusetts Department of Environmental Protection (DEP). We strive to provide high quality drinking water that exceeds all Federal and Commonwealth drinking water standards, provide the highest level of customer and water related support services achievable, educate and inform the public of the need to protect Nantucket's water resources, and to accomplish this using prudent utility practices and responsible fiscal management. As your water provider, we are carefully monitoring your water quality, improving our aging infrastructure and expanding service areas to make sure water is safe and available 24/7.

Congress passed the Safe Drinking Water Act (SDWA) in 1974 to protect public health by regulating the nation's public drinking water supply and protecting sources of drinking water. A public water system (PWS) is defined as one that serves piped water to at least 25 persons or 15 service connections for at least 60 days each year. SDWA is administered by the U. S. Environmental Protection Agency (EPA) and its state partners. The SDWA requires public notification of water systems violations, other notices and annual reports (Consumer Confidence Reports) to customers on contaminants found in their drinking water – www.eap.gov/safewater/ccr.

This report is mandated by the federal government and presents many topics of interest along with the results of our 2012 Water Quality Data completed from January 1, 2012 through December 31, 2012 and summarizes the past year's activities at Wannacomet Water Company. It is intended to inform the public about the quality of the water and the effort made by us to maintain it. We are committed to ensuring the quality of your water and strive to adopt new and better methods for delivering drinking water to you.

*Please take a moment to read this report as there is a great deal of information enclosed.*

## Your Water System - where the water comes from...

Wannacomet's water is a groundwater supply. Water is pumped from three different groundwater wells located in Nantucket's Sole Source Aquifer (geologic formations containing water). Our customers receive their drinking water from two different levels of the aquifer. The wells are located throughout the mid-island. The water is distributed through a network of water mains ranging in size from 2 inches to 16 inches in diameter. We depend on rainfall to recharge our water supply. The annual recharge to the aquifer from an average of 43 inches of precipitation more than makes up for the amount of water pumped from all sources.

# Water Conservation

Wasted water can add up quickly. We take our water supplies for granted, yet they are limited. The average American uses about 90 gallons of water each day in the home. By using water wisely, we can save money and help the environment. More efficient water use can reduce the impact on the water supply and on your wallet:

- Turn off the tap while brushing your teeth or shaving: save 1-2 gallons per minute.

- That trickling sound you hear in the bathroom could be a leaky toilet wasting 50 gallons of water a day or more. But sometimes it leaks silently. Try this: Crush a dye tablet in its envelope and carefully empty the contents into the center of the toilet tank and allow it to dissolve. Wait about 10 minutes. Inspect the toilet bowl for signs of blue dye indicating a leak.

  If the dye has appeared in the bowl, your flapper or flush valve may need to be replaced. Parts are inexpensive and fairly easy to replace. If no dye has appeared in 10 minutes time, you probably don't have a leak.

## What is SWAP?

The Source Water Assessment and Protection (SWAP) program, established under the federal Safe Drinking Water Act, requires every state to:

- inventory land uses within the recharge areas of all public water supply sources;
- assess the susceptibility of drinking water sources to contamination from these land uses; and
- publicize the results to provide support for improved protection.

## Source Water Assessment and Protection (SWAP) Report

The SWAP report was compiled by the Massachusetts Department of Environmental Protection with assistance from the Wannacomet Water Company staff to inventory land uses within the Wellhead Protection District (WPD) and assess their potential to negatively impact the aquifer.

Wannacomet Water Company's complete SWAP report can be viewed at: http://www.mass.gov/dep/water/drinking/4197000.pdf

***Our constant goal is to provide you with a safe and dependable supply of drinking water. Major water issues are presented at monthly water commission meetings. The public is invited to participate in and voice its concerns about our drinking water. For meeting dates and location visit www.nantucket-ma.gov.***

# Water Demand & Statistics

Wannacomet Water Company during 2012 produced and delivered 612,314,000 gallons of drinking water from all of its wells. Our highest pumpage day in 2012 was 4,327,732 gallons on July 6, 2012. Total measured rainfall reported on Nantucket for the year 2012 was 32 inches, about 10 inches less than average. We installed 54 new service connections, 24 new fire hydrants and 10,806 feet of new water mains into the system by private developers and Wannacomet Water.

**REMINDER:** ***Emergency on-call person – 7 days a week – 24 hours a day. We have an emergency on-call utility person available during non-business hours, weekends and holidays. In the event of an emergency during non-business hours please contact us through the Nantucket Police Department at 508-228-1212.***

# What the EPA Says About Drinking Water Contaminants

## Contaminants in Bottled Water and Tap Water

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that the water poses a health risk. More information about contaminants and potential health effects can be obtained from the Environmental Protection Agency's Safe Drinking Water Hotline (800-426-4791).

In order to ensure that tap water is safe to drink, Massachusetts DEP and the EPA prescribe regulations which limit the amount of certain contaminants in water provided by public water systems. Food and Drug Administration (FDA) and the Massachusetts Department of Public Health regulations establish limits for contaminants in bottled water that must provide the same protection for public health.

## Contaminants

General sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from animal or human activity. Contaminants that may be present in source water include:

- Microbial contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife;
- Radioactive contaminants, which can be naturally occurring or the result of oil and gas production and mining activities;
- Pesticides and herbicides, which may come from a variety of sources such as agriculture, urban storm water run off, and residential uses;
- Inorganic contaminants, such as salts and metals, which can be naturally occurring or result from urban storm water run off, industrial or domestic waste water discharges, oil and gas production, mining, or farming;
- Organic chemical contaminants, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban storm water run off and septic systems.

## Special Health Information

Some people may be more vulnerable to contaminants in drinking water than the general population. Immunocompromised persons such as persons undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk of infection. These people should seek advice about drinking water from their health care providers. Environmental Protection Agency (EPA) and Centers for Disease Control and Prevention (CDC) guidelines on appropriate means to lessen the risk of infection by cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (800-426-4791).

## Important Contacts

**Massachusetts Department of Environmental Protection**
*www.state.ma.us/dep* (617) 292-5500

**Massachusetts Department of Public Health**
www.state.ma.us/dph (617) 624-6000

**Town of Nantucket**
www.nantucket-ma.gov

**US Centers for Disease Control & Prevention**
www.cdc.gov (800) 232-4636

**Environmental Protection Agency**
www.epa.gov (800) 426-4791

**List of Certified Water Quality Testing Labs**
www.mwra.com (617) 242-5323

**Wannacomet Water Company**
www.wannacomet.org for our staff directory (508) 228-0022

The U.S. EPA Office of Water (www.epa.gov/watrhome) and the Centers for Disease Control and Prevention (www.cdc.gov) websites provide a substantial amount of information on many issues relating to water resources, water conservation and public health. Also, the Massachusetts Department of Environmental Protection has a website (www.state.ma.us/dep) that provides complete and current information on water issues in our state.

Our Public Water Supply (PWS) ID # MA 4197000
Member: American Water Works Association (AWWA),
New England Water Works Association (NEWWA),
Barnstable County Water Utility Association (BCWUA),
Massachusetts Water Works Association (MWWA),
The Groundwater Foundation

# Office Update

**This year's report is dedicated to Jan Davis who retired on July 1, 2012 after 34 years of service.**

## Retirement

Customer Service Supervisor **Jan Davis** retired on July 1, 2012 after thirty-four years of service to Wannacomet Water Company. We value her friendship and wish her the very best in her future endeavors.

*Andrea Mansfield and Bob Gardner*

## Staff News – Service Awards

On December 12, 2012 at the Public Safety Facility Community Room the Board of Selectmen recognized and presented a service award pin to **Andrea Mansfield** recognizing her ten years of service.

## Nantucket Island Chamber of Commerce

Wannacomet Water Company general manager **Bob Gardner** was elected in October, 2012 as the President of the Nantucket Island Chamber of Commerce.

## Public Outreach

In 2012 Wannacomet Water Company partnered with the **Maria Mitchell Association** and **Sustainable Nantucket**. We look forward to working with these agencies to communicate our message about the value of Nantucket's tap water and the need to invest in water infrastructure to our customers, seasonal visitors and media.

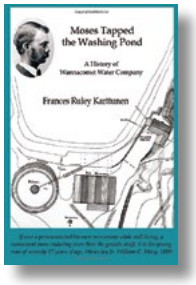
## Water Commission

**Commissioner Slavitz** was voted chairman of the commission effective April 12, 2012.

## Wannacomet Water Historical Preservation Project

Wannacomet Water Company has an extensive collection of historical documents and photographs tracing the evolution of the Wannacomet Water Company. A complete searchable historical documents index was completed in 2012.

## A History of Wannacomet Water Company – *Moses Tapped the Washing Pond*




The Nantucket Water Commission is pleased to announce the publication of ***Moses Tapped the Washing Pond - A History of Wannacomet Water Company*** by Frances Ruley Karttunen. Copies are available for sale locally at **Bookworks** and **Mitchell's Book Corner.**

## Nantucket Community Sailing

For the fourth year Wannacomet Water Company provided sponsorship, water stations and reusable water bottles to **Nantucket Community Sailing** for the 2012 Nantucket Race Week during the Annual Opera House Cup. The stations allowed participants and spectators to fill their reusable water bottles with local tap water from Wannacomet Water Company. These stations removed the equivalent of 4,000 one time use plastic bottles from Nantucket's waste stream.

## Nantucket Arts Council

Wannacomet Water Company was proud to host and be the site for the 2012 **Nantucket Arts Council Giant Magic Daffodil Garden**.

# Office Update

## Sign up for e-bills
Electronic bills are available. For information and to enroll for paperless statements contact us at ebill@wannacomet.org.

## On-Line Bill Payment with Unipay Gold
Wannacomet accepts payments on-line using Unipay Gold. Customers can securely pay their bills either using their credit card (Mastercard and Discover) or bank account. Visit on the web at www.wannacomet.org. (please note: beginning January 1, 2013 there is a $0.25 processing fee assessed by Unipay Gold for all electronic check payments.)

## Auto Draft Bill Pay
Wannacomet Water Company offers automatic bill pay at no cost to you. You may set up bill pay through your checking account or we can set you up as an auto draft customer. Auto draft customers receive bills by mail and/or by e-mail. Two weeks after the bills are issued on/or about the 15th of each month your balance due will be drafted as an ACH (Automated Clearing House) fund transfer from the designated bank account you authorize us to debit the amount due from. Sign up at www.wannacomet.org.

## Meter Upgrade Project
The Flexnet meter replacement program continued in 2012. Upon completion in late 2013 all water meters will be read from our main office at 1 Milestone Road. The system will have the ability to track the water use patterns of individual accounts for a defined period of time.

## Washing Pond Tank Maintenance
The Washing Pond Tank was recoated in 2012 by Rockwood Corporation. The project entailed replacing the external access ladder with a stainless steel ladder and safety climb system, redesigning the mounting system for communications equipment on the top of the standpipe, a new cable tray and complete internal and external recoating.

## Distribution System Continued Expansion to Madaket
Phase III of the Madaket Road Water Main Extension was completed in 2012.

## Water Rates
Effective 7/1/12 the water rate remained unchanged at $3.50 per 100 cubic feet. Visit our website at www.wannacomet.org for current rates and important notices.

## Sewer Rates
The Board of Selectmen acting as the Board of Sewer Commissioners review sewer rates on an annual basis. The Board voted on January 18, 2012 to increase seasonal rates (May 1 through October 31) to $8.00/ccf and off-season rates (November 1 through April 30) to $6.00/ccf. Rate payers should routinely check the town's website (www.nantucket-ma.gov) and search budget information for the latest in proposed sewer rate increases and current project proposals under consideration by the town.

## A Civic Salute to Town of Nantucket Volunteers
On April 23, 2012 the **Nantucket Civic League** recognized and thanked over 250 citizen volunteers for their service on elected and appointed Boards, Committees and Commissions. Commissioners Reinhard, Slavitz and Eldridge were honored for their service to the Wannacomet Water Company.

## Distribution System
Wannacomet continues to strengthen its distribution system by installing new water meter mains to improve fire flows and circulation patterns. Upgrades have been undertaken and completed for water mains, services, gate valves and fire hydrants.

## Siasconset Water Department
The management agreement between Siasconset Water Department and the Wannacomet Water Company continued in 2012. We continue to provide certified operators, technical, and administrative support to the Siasconset Water Department.

## We urge you to visit our website at www.wannacomet.org.

The updated site has many customer service forms and tips for water efficiency. There is also an on-line water use calculator. The calculator is effective in determining our water use patterns. We encourage you to check it out and see how much water you use on a daily basis.

You can re-fill your own water bottles at Wannacomet! If you don't have access to the town water supply at home, you can bring containers to Wannacomet Water Company at 1 Milestone Rd and fill up right outside the building. (fifty cents per gallon)

# What you need to know about lead in your tap water

***The last time lead and copper samples were collected from our system was in September, 2010. Based upon the excellent results of lead and copper sampling from 2008-2010 the Wannacomet Water Company was placed by the Massachusetts DEP on a reduced sampling schedule for lead and copper. The next scheduled sampling for lead and copper will take place in 2014. The Wannacomet Water Company is taking steps to further reduce the amount of lead in contact with drinking water by only installing water service materials that have been certified as being "no-lead".***

# Water Quality Testing Results 2012

| | *Level Detected* | *Unit of Measurement* | *MCLG* | *MCL* | *Possible Source of Contamination* |
|---|---|---|---|---|---|
| ***Volatile Organic Compounds*** | | | | | |
| Wannacomet Water Company sampled for 56 VOC contaminants and none were detected in the source water. | | | | | |
| ***Inorganic Contaminants*** | | | | | |
| Nitrate | 0.48 to 0.74 | ppm | 10 | 10 | Runoff from fertilizer use, leaching from septic systems & erosion of natural deposits |
| Fluoride | 0 | mg/l | 4 | 4 | Leaching from fertilizers and erosion of natural deposits |
| Mercury | 0 | mg/l | 0 | 0.002 | Metal processing, coal incineration medical waste & atmospheric deposition |
| Arsenic | 0 | mg/l | 0 | 0.05 | Erosion of natural deposits & runoff from orchards |
| Cadmium | 0 | mg/l | 0.005 | 0.005 | Erosion of natural deposits & corrosion of galvanized pipe |
| ***Microbiological Contaminates*** | | | | | |
| Total Coliform Bacteria | 1 | presence or absence | 0 | presence of coliform in 5% of monthly samples | Naturally present in environment - Coliform bacteria are used as an indicator to the presence of other potentially harmful bacteria. |
| | One violation resolved by re-sampling at location and up and down stream locations<br>The follow-up sample and the up and down stream locations showed no coliform present | | | | |
| ***Radioactive Contaminants*** | | | | | |
| Gross Alpha | 0 | pCi/l | 0 | 15 | Erosion of natural deposits |
| Radium 226 | 0 | pCi/l | 0 | 5 | Decay of natural deposits & some man made deposits |
| Radium 228 | 0 | pCi/l | 0 | 5 | Decay of natural deposits & some man made deposits |

**SMCL** = secondary maximum contaminant level. These standards are developed to protect the aesthetic qualities of drinking water and are not health based.

**ORSG** = Massachusetts Office of Research and Standards guideline. This is the concentration of a chemical in drinking water, at or below which, adverse health effects are unlikely to occur after chronic (lifetime) exposure. If exceeded, it serves as an indicator of the potential need for further action.

**Public Notice for Coliform Violation** – We routinely monitor for drinking water contaminants. We took 26 samples to test for the presence of coliform bacteria on September 10, 2012. Three (3) of our samples showed the presence of total coliform bacteria. The standard is that no more than (1) may do so. Follow-up samples were taken at the locations as well as an additional sample upstream and downstream at these locations. The follow-up samples and the upstream and downstream samples indicated no presence of coliform bacteria. All of the three locations were included in routine sampling done on September 20, 2012 and all sample results were coliform absent and this testing showed the problem to be resolved. This notice was published in *The Inquirer and Mirror* on October 4, 2012. For more information, please contact Robert Gardner or Mark Willett at 508-228-0022.

# Important Definitions

**Maximum Contaminant Level Goal (MCLG):** The "Goal" is the level of a contaminant in drinking water below which there is no known or expected risk to healthy persons. MCLGs allow for a margin of safety.

**Maximum Contaminant Level (MCL):** The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs is feasible using the best available treatment technology.

**CDC** = Centers for Disease Control and Prevention

**ND:** Not detected. Laboratory analysis indicated that the constituent is not present.

**Variances and Exemptions:** State or EPA permission not to meet an MCL or a treatment technique under certain conditions. The data presented in this report is from the most recent testing done in accordance with regulations.

**Treatment Technique (TT):** A required process intended to reduce the level of a contaminant in drinking water.

**Action Level (AL):** The concentration of a contaminant, which, if exceeded, triggers a treatment or other requirements that a water system must follow.

**Parts Per Million (ppm):** one part per million corresponds to one minute in two years or a single penny in $10,000.

**Parts Per Billion (ppb):** one part per billion corresponds to one minute in 2,000 years, or a single penny in $10,000,000.

**PCI/L:** picoCuries per liter (a measure of radiation)

**DEP** = Department of Environmental Protections

**EPA** = Environmental Protection Agency

**NA:** Not applicable.

# Our Annual Water Quality Report

Wannacomet Water Company has prepared this annual drinking water Consumer Confidence Report (CCR) to provide you with information regarding your drinking water. This report includes detected contaminants found in your drinking water, compliance issues related to the water quality, operational matters, and general education information regarding the condition of your drinking water.

**Share this report:** Landlords, businesses, schools, hospitals, and other groups are encouraged to share this important water quality information with water users at their location.

For water or meter problems, leaks, fire hydrants, water billing, and miscellaneous questions – call Wannacomet Water at 508-228-0022. For comments and suggestions, please email us at info@wannacomet.org.

Robert L. Gardner
General Manager

Nelson K. Eldridge
Commissioner

Noreen Slavitz
Commissioner

Allen Reinhard
Commissioner

(PWS) ID #MA4197000

## Nantucket Water Commission

Nelson K. Eldridge, Commissioner
Noreen "Nonie" Slavitz, Chairman
Allen Reinhard, Commissioner

**General Manager,** Robert L. Gardner
**Operations Manager,** Christopher R. Pykosz
**Business Manager,** Heidi Holdgate

***Photo (from left to right):***
***Nelson Eldridge, Nonie Slavitz, Bob Gardner and Allen Reinhard***

**If you need a large print version of this Annual Water Quality report, please contact us at 508-228-0022**

**Wannacomet Water Company**
1 Milestone Road
Nantucket, MA 02554

# Wannacomet Water Company 2009
# Annual Water Quality Report

## *Meeting the Challenge*

We are once again proud to present our annual water quality report. Over the years, we have dedicated ourselves to providing drinking water that meets all state and federal drinking water standards. As your water provider, we are constantly monitoring your water to make sure that it's safe and available 24/7.

This report presents our 2009 Water Quality Data compiled from January 1, 2009 through December 31, 2009 and summarizes the past year's activities at Wannacomet Water Company. The Safe Drinking Water Act (SDWA) requires that utilities issue an annual "Consumer Confidence" report to customers. It is intended to inform the public about the quality of the water and the effort made by us to maintain it. We are committed to ensuring the quality of your water and strive to adopt new and better methods for delivering drinking water to you.

This publication is mandated by the federal government to provide water quality information to consumers. Please take a moment to read this report as there is a great deal of information enclosed.

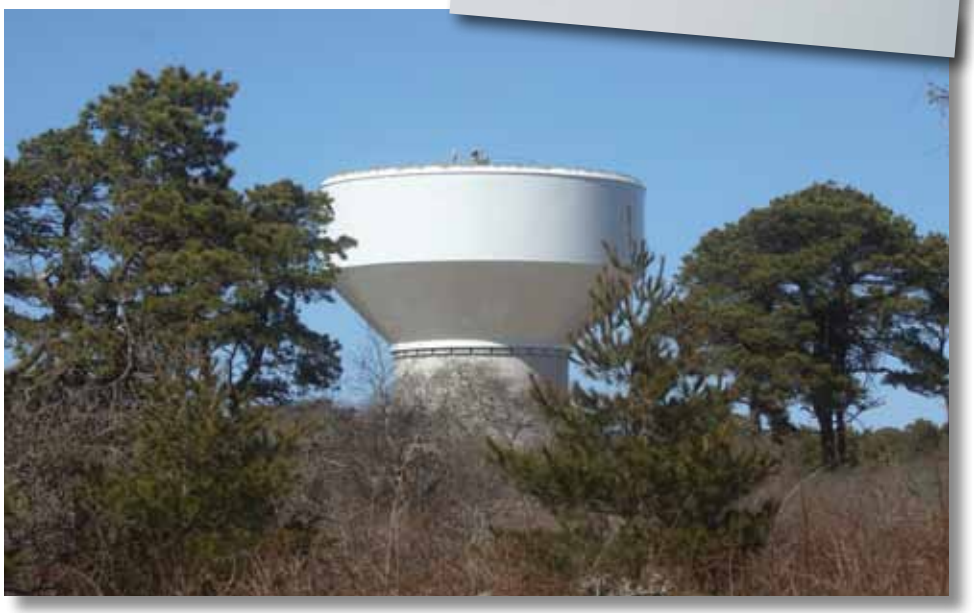
## *Investing In Our Future*

## *On the horizon...*

Construction is underway and the North Pasture water tank is expected to be completed in July, 2010.

The new water tank will have a capacity of two million gallons, with all of it considered "usable" and will be painted slate gray.

The construction of both the North Pasture and the Siasconset tanks will provide a significant boost for the Nantucket economy. The project manager for Chicago Bridge & Iron has stated that they expect to inject $1,600,000 into the local economy by utilizing local contractors and purchasing goods and services whenever possible. At calendar year-end 2009 we estimate over three dozen local businesses benefited from these two projects.



**REMINDER:Emergency on-call person – 7 days a week – 24 hours a day. We have an emergency on-call utility person available during non-business hours, weekends and holidays. In the event of an emergency during non-business hours please contact us through the Nantucket Police Department at 508-228-1212.**

## Where does Wannacomet's Water come from?

Wannacomet's water is a groundwater supply. Water is pumped from three different groundwater wells located in Nantucket's Sole Source Aquifer – the only source of drinking water on Nantucket. Our customers receive their drinking water from two different levels of the aquifer. The wells are located throughout the mid-island. The water is distributed through a network of water mains ranging in size from 2 inches to 16 inches in diameter. We depend on rainfall to recharge our water supply, which we draw from the groundwater. The annual recharge to the aquifer from an average of 43 inches of precipitation more than makes up for the amount of water pumped from all sources.

## Should I buy bottled water?

You don't need to buy bottled water for health reasons if your drinking water meets all of the federal, state, or provincial drinking water standards. If you want a drink with a different taste, you can buy bottled water, but it costs up to 1,000 times more than municipal drinking water. Of course, in emergencies bottled water can be a vital source of drinking water for people without water.

The US Food and Drug Administration (FDA) requires bottled water quality standards to be equal to those of the US Environmental Protection Agency for tap water, but the quality of the finished product is not government-monitored. Bottlers must test their source water and finished product once a year. Currently, any bottled water that contains contaminants in excess of the allowable level is considered mislabeled unless it has a statement of substandard quality.

## Educational and Community News

**Wannacomet celebrated National Drinking Water Week May 3-9, 2009.** A safe, reliable water supply is critical to the success of any community. It creates jobs, attracts industry and investment, and provides for the health and welfare of citizens in ways ranging from disease prevention to fire suppression. We often take water supply for granted until it is threatened, either by drought, water main breaks, or some other event. For more than 30 years, the American Water Works Association and its members have celebrated Drinking Water Week – a unique opportunity for both water professionals and the communities they serve to join together to recognize the vital role water plays in our daily lives. The Wannacomet Water Company is committed to providing educational water-related programs and resources to the community.

**Opera House Race Week** - Wannacomet assisted with the Opera House Race organizers with a water system to help reduce the number of water bottles used during the event. It was estimated that 4500 plastic water bottles were saved.

Major water issues are presented at monthly water commission meetings. The public is invited to participate in and voice concerns about our drinking water. Meetings are at 8:00am on the second Thursday of every month.

## Water Use Calculator

**We urge you to visit our website at www.wannacomet.org.**

We have on-line a water use calculator for our customers. The calculator is effective in determining your water use patterns. We encourage you to check it out and see how much water you use on a daily basis. Water used for irrigation and landscaping should be used in accordance with the recommendations of professional landscapers and irrigation specialists.

## Our Mission Statement

*The Wannacomet Water Company shall strive to provide high quality drinking water that exceeds all established Federal and Commonwealth drinking water standards, provide the highest level of customer and water related services achievable, educate and inform the public of the need to protect Nantucket's water resources, and to accomplish this mission using prudent utility practices and responsible fiscal management.*

# Water Conservation

Just a few reminders....wasting water can add up quickly. On average, each person uses about 65 gallons of water each day.

- **Fix Leaks.** Dripping, trickling, or leaking faucets, showerheads and toilets can waste up to several hundred gallons of water a week depending on the size of the leaks. That trickling sound you hear in the bathroom could be a leaky toilet, but some times toilets leak silently. One way to test your toilet is to drop a dye tablet in the toilet tank and allow it to dissolve. After about 20 minutes inspect the toilet bowl for signs of dye indicating a leak, if the dye has appeared in the bowl, your flapper or flush valve may need to be replaced. Parts are inexpensive and fairly easy to replace.
- **Take shorter showers.**
- **Install a Low-Flow Showerhead and Faucet Aerator.** Some showerheads may still use over 5 gallons per minute. A low-flow showerhead uses 2.5 gallons or less and can save you over 200 gallons per 10-minute shower. A low flow-aerator can reduce the flow by about 25%.
- **Turn the faucet off** while brushing teeth, washing your face, and/or shaving.
- **Run dishwashers** and washing machines only when full.
- **Water your lawn** (and other landscaping) in the early morning or evening to avoid evaporation.
- **Visually inspect your sprinkler system** once a month during daylight hours. Check and fix any tilted, clogged or broken heads.

# Did you know...

In 1974, the federal government established the Safe Drinking Water Act to protect the public from water-related illnesses. This law requires community water systems to regularly test their water supplies and meet strict federal water quality standards. Many states have even more stringent requirements. Water providers conduct thousands of analyses each year to verify that the public water supply meets these standards, and the Safe Drinking Water Act requires they provide annual water quality reports to their customers. Contact us if you have not received a copy of your report.

# What the EPA Says About Drinking Water Contaminants

## Contaminants in Bottled Water and Tap Water

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that the water poses a health risk. More information about contaminants and potential health effects can be obtained from the Environmental Protection Agency's Safe Drinking Water Hotline (800-426-4791).

In order to ensure that tap water is safe to drink, Massachusetts DEP and the EPA prescribe regulations which limit the amount of certain contaminants in water provided by public water systems. Food and Drug Administration (FDA) and the Massachusetts Department of Public Health regulations establish limits for contaminants in bottled water that must provide the same protection for public health.

## Contaminants

General sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from animal or human activity. Contaminants that may be present in source water include:

- Microbial contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife;
- Inorganic contaminants, such as salts and metals, which can be naturally occurring or result from urban storm run off, industrial or domestic waste water discharges, oil and gas production, mining, or farming;
- Pesticides and herbicides, which may come from a variety of sources such as agriculture, urban storm water run off, and residential uses;
- Organic chemical contaminants, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban storm water run off and septic systems;
- Radioactive contaminants, which can be naturally occurring or the result of oil and gas production and mining activities.

## Special Health Information

Some people may be more vulnerable to contaminants in drinking water than the general population. Immunocompromised persons such as persons undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk of infection. These people should seek advice about drinking water from their health care providers. Environmental Protection Agency (EPA) and Centers for Disease Control and Prevention (CDC) guidelines on appropriate means to lessen the risk of infection by cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (800-426-4791).

# Office Update

**Staff news** – Utilityman Kyle Roberts passed the Massachusetts Board of Certification Water Treatment Operator's Certification examination.

**Water Rates and Connection Fees** – There was no increase in the water rate, basic charge or the water connection fee in 2009. As a reminder the basic charge for water service is set by the Nantucket Water Commission. Customers are billed this charge even though the water meter is turned off for the winter or if there is zero usage read on the meter. This charge covers our operating expenses; such as debt, insurance costs, distribution system maintenance and billing and customer support services.

**Sewer Rate Increase** – The Board of Selectmen acting as the Board of Sewer Commissioners voted to increase sewer user fees for fiscal year 2010 by adopting a seasonal demand model developed with the Abrahams Group and increasing the quarterly non-metered user fee. New rates were effective July 1, 2009. The model is reviewed monthly with quarterly reports presented to the Board of Selectmen.

**On-Line Bill Payment Option** – Wannacomet accepts payments on-line using Unibank Financial Services. Customers can securely access and pay their bills either using their credit card (Mastercard and Discover) or checking account. Visit on the web at www.wannacomet.org. Electronic bills (paperless statements) are scheduled for late spring, 2010.

**Computer and Information Technology** – In 2009 we completed the main office computer network systems upgrade. Wannacomet's information systems and infrastructure are supported by the Town of Nantucket's IT department.

**Siasconset Water Department**– In 2009 the Nantucket Water Commission and the Siasconset Water Commission renewed their Memorandum of Agreement whereby Wannacomet Water Company provides certified operators and technical and administrative support to the Siasconset Water Department. This agreement is reviewed on an annual basis. The new water tank in Siasconset is under construction with an estimated completion date of September, 2010.

**Retirement** – David D. Worth concluded his service to the Nantucket Water Commission when his term ended in April, 2009. David's service to the Wannacomet Water Company as General Manager and Commissioner spanned 39 years of dedicated service.

*David D. Worth*

**New Commissioner** – Allen Reinhard was elected in April, 2009 to his first term as Water Commissioner. We welcome Allen and look forward to his service to Wannacomet.

**A.W.W.A. Public Officials Certification** – Commissioner Nonie Slavitz completed the American Water Works Public Officials Certification program at the A.W.W.A. Annual Conference in San Diego, CA. The program focuses specifically on water issues and provides elected and appointed public officials with ongoing professional development and a platform for networking opportunities with other policy leaders. It is designed to develop and enhance critical skills and abilities necessary to achieve excellence in organizations, and to enhance communication and sharing between public officials from diverse communities. Nonie is a strong advocate of continuing education for public officials and has been an active participant since inception of the program.

Nonie Slavitz was also re-elected to the NWC and elected Chairperson effective 4/15/09.

**Commissioner Eldridge celebrates 50 years of service with the Nantucket Fire Department** – Nelson Eldridge – celebrated 22 years of service as a water commissioner and 50 years of service to the Nantucket Fire Department.

**Customer Outreach** – In 2009 Wanncomet continued its partnership with Plum TV to provide information about Nantucket's water supply. Our goal is to build the public's confidence in our drinking water. Plum TV is a valuable partner in communicating Wannacomet's message about the value of Nantucket's tap water and the need to invest in water infrastructure to our customers, seasonal visitors, media and other key stakeholders.

**Neighborhood Improvement** – In 2009 Wannacomet continued to strengthen its distribution system by installing new water mains to improve fire flows and circulation patterns (some of the mains were installed in the late 1880's). Working in partnership with the Department of Public Works, new water mains (5,888 feet), services (106), gate valves and fire hydrants (12) were installed in those areas under construction in the core historic district specifically on Orange, Pine, Liberty and Easton streets for sewer and storm water improvements. This partnership resulted in substantial savings for Wannacomet.

**Town Water in the Works for Madaket** – The water main extension project to Madaket continued during 2009. Engineering, design and permitting are complete. In April, 2009 Wannacomet announced the town's intention to extend town water to Madaket for expedited firefighting and improved water quality, and simply because the costs for installing the main were so low during this recession that the Wannacomet could not afford to miss this opportunity. The bid process is scheduled for spring, 2010.

# Important Contacts

**Massachusetts Department of Environmental Protection (DEP)**
*www.state.ma.us/dep (617) 292-5500*

**Massachusetts Department of Public Health (DPH)**
www.state.ma.us/dph (617) 624-6000

**Town of Nantucket**
www.nantucket-ma.gov

**US Centers for Disease Control & Prevention (CDC)**
www.cdc.gov (800) 232-4636

**Environmental Protection Agency (EPA)**
www.epa.gov (800) 426-4791

**List of Certified Water Quality Testing Labs**
www.mwra.com (617) 242-5323

**Wannacomet Water Company**
www.wannacomet.org for our staff directory

The U.S. EPA Office of Water (www.epa.gov/watrhome) and the Centers for Disease Control and Prevention (www.cdc.gov) websites provide a substantial amount of information on many issues relating to water resources, water conservation and public health. Also, the Massachusetts Department of Environmental Protection has a website (www.state.ma.us/dep) that provides complete and current information on water issues in our state.

Our Public Water Supply (PWS) ID # MA 4197000
Member: American Water Works Association (AWWA),
New England Water Works Association (NEWWA),
Barnstable County Water Utility Association (BCWUA),
Massachusetts Water Works Association (MWWA),
The Groundwater Foundation

## What is SWAP?

The Source Water Assessment and Protection (SWAP) program, established under the federal Safe Drinking Water Act, requires every state to:

- inventory land uses within the recharge areas of all public water supply sources:
- assess the susceptibility of drinking water sources to contamination from these land uses; and
- publicize the results to provide support for improved protection

## Source Water Assessment (SWAP) Report

*The SWAP report was compiled by the Massachusetts Department of Environmental Protection with assistance from the Wannacomet Water Company staff to inventory land uses within the Wellhead Protection District (WPD) and assess their potential to negatively impact the aquifer.*

Wannacomet Water Company's complete SWAP report can be viewed at:
**http://www.mass.gov/dep/water/drinking/4197000.pdf**

# Water Demand & Statistics

Like many organizations Wannacomet Water Company is experiencing the effects of the recent economic slowdown. New service connections continued to decline in 2009. Production is at all time lows and is reflective on the cool and wet weather of the past summer months.

In 2009, the Wannacomet Water Company pumped 519,397 million gallons of drinking water from our wells. Our highest pumpage day in 2009 was 3,295,265 gallons on July 27, 2009. Total measured rainfall reported for the year 2009 was 38 inches (Nantucket's average rainfall is 43 inches per year). We installed over 37 new service connections, 5 new fire hydrants and 625 feet of new water mains were installed by private developers and individuals.

We are required to monitor your drinking water for specific man-made and naturally occurring contaminants on a regular basis. Results of regular monitoring are an indicator of whether or not our drinking water meets with health standards. During the third quarter of 2009 (July – September) we did not monitor or test lead and copper and therefore cannot be sure of the quality of our drinking water during that time.

We had received a revised sampling schedule from the Massachusetts D.E.P. that required sampling for lead and copper in the 3rd quarter of 2009. The previous schedule did not require this sampling. We inadvertently referred to the old schedule for 3rd quarter sampling and did not take the lead and copper samples in the 3rd quarter. When we were made aware of this error we immediately took the required lead and copper samples. The results of those samples were received and did not indicate lead and copper levels above those allowed by the drinking water regulations for these contaminants.

Thirty-three samples were taken 10/29/09-11/5/09 and should have been taken 7/1/09-9/30/09.

# What you need to know about lead in Your Tap Water

*The last time lead samples were collected from our system was in September, 2009. The results are below:*

## Lead & Copper (samples taken second quarter 2009)

| | Range of Detection (mg/l) | MCLG (mg/l) | Action Level (mg/l) | # of Samples | 90% Percentile Value | # of sites Exceeding Action Level | Possible Source of Contamination |
|---|---|---|---|---|---|---|---|
| **Lead** | 0.0 - 0.003 | 0 | 0.015 | 30 | 0.002 | 0 | Corrosion of Plumbing |
| **Copper** | 0 - 0.66 | 1.3 | 1.3 | 30 | 0.12 | 0 | Corrosion of Plumbing |

If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. Wannacomet Water Company is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at: http://www.epa.gov/safewater/lead

Call the Department of Public Health at 1-800-532-9571 or EPA at 1-800-424-LEAD (5323) for health information.

Lead can get into tap water through pipes in your home, your lead service line, lead solder used in plumbing, and some brass fixtures. Corrosion or wearing away of lead-based materials can add lead to tap water, especially if water sits for a long time in the pipes before it is used.

Under EPA rules, each year Wannacomet must test tap water in a sample of homes that are likely to have high lead levels. These are usually homes with lead service lines or lead solder. The EPA rule requires that 9 out of 10, or 90%, of the sampled homes must have lead levels below the Action Level of 15 parts per billion (ppb).

## Water Quality Testing Results 2009

| | Level Detected | Unit of Measurement | MCLG | MCL | Possible Source of Contamination |
|---|---|---|---|---|---|
| **Volatile Organic Compounds** | | | | | |
| Tetrachloroethylene (PCE) | 0 | ppb | 0 | 5 | Leaching from vinyl lined pipes, dry-cleaning operations & some degreasing agents. |
| Benzene | 0 | ppb | 0 | 5 | Leaching from gas storage tanks & landfills |
| **Inorganic Contaminants** | | | | | |
| Nitrate | 0.59 | ppm | 10 | 10 | Runoff from fertilizer use, leaching from septic systems & erosion of natural deposits |
| Mercury | 0 | ppb | 2 | 2 | Leaching from municipal landfills and sewage, and metal refining |
| **Synthetic Organic Contaminants** | | | | | |
| 2,4,5-TP (Silvex) | 0 | ppb | 50 | 50 | Runoff/leaching from herbicide and pesticide use |
| Atrazine | 0 | ppb | 3 | 3 | Runoff/leaching from herbicide and pesticide use |
| Simazine | 0 | ppb | 4 | 4 | Runoff/leaching from herbicide and pesticide use |
| **Microbiological Contaminates** | | | | | |
| Total Coliform Bacteria | 0 | presence or absence | 0 | presence of coliform in 5% of monthly samples | Naturally present in environment Coliform bacteria are used as an indicator to the presence of other potentially harmful bacteria. |

**Unregulated and Secondary Contaminants with State Standards (ORSGs and/or SMCLs)**

| MTBE (ppb) | Range Detected | Average | SMCL | ORSG | Possible Sources |
|---|---|---|---|---|---|
| Methyl Tertiary Butyl Ether | ND | 0 | 20-40 | 70 | Fuel Additive |

**SMCL** = secondary maximum contaminant level. These standards are developed to protect the aesthetic qualities of drinking water and are not health based.

**ORSG** = Massachusetts Office of Research and Standards guideline. This is the concentration of a chemical in drinking water, at or below which, adverse health effects are unlikely to occur after chronic (lifetime) exposure. If exceeded, it serves as an indicator of the potential need for further action.

*There were no total coliform violations for Wannacomet in 2009.*

# Important Definitions

**Maximum Contaminant Level Goal (MCLG)**: The "Goal" is the level of a contaminant in drinking water below which there is no known or expected risk to healthy. MCLGs allow for a margin of safety.

**Maximum Contaminant Level (MCL)**: The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs is feasible using the best available treatment technology.

**Variances and Exemptions**: State or EPA permission not to meet an MCL or a treatment technique under certain conditions. The data presented in this report is from the most recent testing done in accordance with regulations.

**Treatment Technique (TT)**: A required process intended to reduce the level of a contaminant in drinking water.

**ND**: Not detected. Laboratory analysis indicated that the constituent is not present.

**Action Level (AL)**: The concentration of a contaminant, which, if exceeded, triggers a treatment or other requirements that a water system must follow.

**NA**: Not applicable.

**Parts Per Million (ppm)**: one part per million corresponds to one minute in two years or a single penny in $10,000.

**Parts Per Billion (ppb)**: one part per billion corresponds to one minute in 2,000 years, or a single penny in $10,000,000.

**PCI/L** - picoCuries per liter (a measure of radiation)

**EPA** = Environmental Protection Agency

**DEP** = Department of Environmental Protections

**CDC** = Centers for Disease control and Prevention

## Our Annual Water Quality Report

Wannacomet Water Company has prepared this annual drinking water Consumer Confidence Report (CCR) to provide you with information regarding your drinking water. This report includes detected contaminants found in your drinking water, compliance issues related to the water quality, operational matters, and general education information regarding the condition of your drinking water.

**Share this report:** Landlords, businesses, schools, hospitals, and other groups are encouraged to share this important water quality information with water users at their location.

For water or meter problems, leaks, fire hydrants, water billing, and miscellaneous questions – call Wannacomet Water at 508-228-0022.
For comments and suggestions, please email us at info@wannacomet.org.

Robert L. Gardner
General Manager

Nelson K. Eldridge
Commissioner

Noreen Slavitz
Commissioner

Allen Reinhard
Commissioner

*Allen Reinhard, Nelson Eldridge, Nonie Slavitz and Bob Gardner*

(PWS) ID #MA4197000

Nantucket Water Commission
Nelson K. Eldridge, Chairman
Noreen "Nonie" Slavitz, Commissioner
Allen Reinhard, Commissioner

*General Manager*, Robert L. Gardner
*Operations Manager,* Christopher R. Pykosz
*Business Manager*, Heidi Holdgate

If you need a large print version of this
Annual Water Quality report, please contact us at 508-228-0022

**Wannacomet Water Company**
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**Massachusetts Department of Environmental Protection**

**Source Water Assessment and Protection (SWAP) Report**

**for**

# Wannacomet Water Company

### What is SWAP?

The Source Water Assessment and Protection (SWAP) program, established under the federal Safe Drinking Water Act, requires every state to:

- inventory land uses within the recharge areas of all public water supply sources;
- assess the susceptibility of drinking water sources to contamination from these land uses; and
- publicize the results to provide support for improved protection.

### Susceptibility and Water Quality

Susceptibility is a measure of a water supply's potential to become contaminated due to land uses and activities within its recharge area.

A source's susceptibility to contamination does *not* imply poor water quality.

Water suppliers protect drinking water by monitoring for more than 100 chemicals, disinfecting, filtering, or treating water supplies, and using source protection measures to ensure that safe water is delivered to the tap.

Actual water quality is best reflected by the results of regular water tests. To learn more about your water quality, refer to your water supplier's annual Consumer Confidence Reports.

### Table 1: Public Water System Information

| | |
|---|---|
| ***PWS Name*** | Wannacomet Water Company |
| ***PWS Address*** | 1 Milestone Road |
| ***City/Town*** | Nantucket, Massachusetts 02554 |
| ***PWS ID Number*** | 4197000 |
| ***Local Contact*** | Robert Gardner |
| ***Phone Number*** | (508) 228-0022 |

## Introduction

We are all concerned about the quality of the water we drink. Drinking water wells may be threatened by many potential contaminant sources, including storm runoff, road salting, and improper disposal of hazardous materials. Citizens and local officials can work together to better protect these drinking water sources.

**Purpose of this report**

This report is a planning tool to support local and state efforts to improve water supply protection. By identifying land uses within water supply protection areas that may be potential sources of contamination, the assessment helps focus protection efforts on appropriate Best Management Practices (BMPs) and drinking water source protection measures.

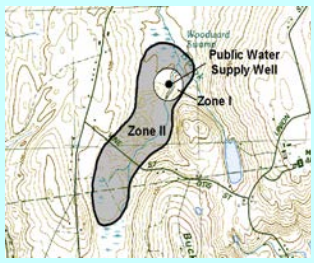
Refer to Table 3 for Recommendations to address potential sources of contamination. Department of Environmental Protection (DEP) staff are available to provide information about funding and other resources that may be available to your community.

**This report includes the following sections.**

1. Description of the Water System
2. Land Uses within Protection Areas
3. Source Water Protection Conclusions and Recommendations
4. Appendices

## What is a Protection Area?

A well's water supply protection area is the land around the well where protection activities should be focused. Each well has a Zone I protective radius and a Zone II protection area.




## Glossary

**Aquifer:** An underground water-bearing layer of permeable material that will yield water in a usable quantity to a well.

**Hydrogeologic Barrier:** An underground layer of impermeable material (i.e. clay) that resists penetration by water.

**Recharge Area:** The surface area that contributes water to a well.

**Zone I:** The area closest to a well; a 100 to 400 foot radius proportional to the well's pumping rate. This area should be owned or controlled by the water supplier and limited to water supply activities.

**Zone II:** The primary recharge area for the aquifer. This area is defined by hydrogeologic studies that must be approved by DEP. Refer to the attached map to determine the land within your Zone II.

## Section 1: Description of the Water System

***Zone II #:*** 215 ***Susceptibility:*** High

| ***Well Names*** | ***Source IDs*** |
|---|---|
| Milestone Road Well #1 (Wellfield) | 4197000-01G |
| Milestone Road Well #2 | 4197000-02G |
| State Forest Well #3 | 4197000-03G |

Wannacomet Water Company pumps groundwater from three different groundwater wells located in Nantucket's Sole Source Aquifer. All of the wells are located in one Zone II primary recharge area. The Milestone Well #2 and State Forest Well #3 have Zone I protection areas with a radius of 400 feet. The Milestone Well #1 has a Zone I protection area that extends 250 feet from the perimeter of the wellfield (each individual wellpoint). The wells are located in an aquifer with a high vulnerability to contamination due to the absence of hydrogeologic barriers (i.e. clay) that can prevent contaminant migration. Please refer to the attached map to view the boundaries of the Zone Is and Zone II.

Presently, Wannacomet Water Company does not treat the water. For current information on monitoring results, please contact the Public Water System contact person listed above in Table 1 for a copy of the most recent Consumer Confidence Report. Drinking water monitoring reporting data are also available on the web at http://www.epa.gov/safewater/ccr1.html.

## Section 2: Land Uses in the Protection Areas

The Zone II for Wannacomet Water Company is dominated by open space, forest and residential land uses with smaller areas of commercial and light industrial land uses (refer to attached map for details). Land uses and activities that are potential sources of contamination are listed in Table 2, with further detail provided in the Table of Regulated Facilities and Table of Underground Storage Tanks in Appendix A.

**Key Land Uses and Protection Issues include:**

1. Zone Is;
2. residential land uses;
3. transportation corridors;
4. hazardous materials storage and use;
5. oil or hazardous material contamination sites; and
6. comprehensive wellhead protection planning.

The overall ranking of susceptibility to contamination for the system is high, based on the presence of at least one high threat land use within the water supply protection areas, as seen in Table 2.

**1. Zone Is –** The Zone I for each of the wells is a 400 foot radius around the wellhead and the Zone I for the wellfield is 250 feet around the individual well points. Massachusetts drinking water regulations (310 CMR 22.00 Drinking Water) requires public water suppliers to own the Zone I, or control the Zone I through a conservation restriction. The three Zone Is for the wells are owned or controlled by the public water system. Only water supply activities are allowed in the Zone I. However, many public water supplies were developed prior to the Department's regulations and contain non water supply activities such as homes and public roads. The following activities of concern occur in the Zone

Is of the system wells:

**Zone I - Milestone Wellfield #1 4197000-01G** – Above ground storage of diesel fuel in the Zone I.

**Zone I Recommendations**

- ✓ Consider switching from diesel to propane to reduce the risk of potential groundwater contamination.
- ✓ Keep any new non water supply activities from the Zone Is to comply with DEP's Zone I requirements.
- ✓ Use BMPs for the storage, use, and disposal of hazardous materials such as water supply chemicals and maintenance chemicals.
- ✓ Do not use or store pesticides, fertilizers or road salt within the Zone Is.

**2. Residential Land Uses –** Residential land use is common throughout the Zone II. Approximately eighty five percent of the areas have public sewers, therefore, fifteen percent use septic systems. If managed imp roperly, activities associated with residential areas can contribute to drinking water contamination. Common potential sources of contamination include:

- **Septic Systems** – Improper disposal of household hazardous chemicals to septic systems is a potential source of contamination to the groundwater because septic systems lead to the ground. If septic systems fail or are not properly maintained they can be a potential source of microbial contamination.
- **Household Hazardous Materials** - Hazardous materials may include automotive wastes, paints, solvents, pesticides, fertilizers, and other substances. Improper use, storage, and disposal of chemical products used in homes are potential sources of contamination.
- **Heating Oil Storage** - If managed improperly, Underground and Above ground Storage Tanks (UST and AST) can be potential sources of contamination due to leaks or spills of the fuel oil they store.
- **Stormwater** – Catch basins transport stormwater from roadways and adjacent properties to the ground. As flowing stormwater travels, it picks up debris and contaminants from streets and lawns. Common potential contaminants include lawn chemicals, pet waste, and substances from automotive leaks, maintenance, washing, or accidents.

**Residential Land Use Recommendations**

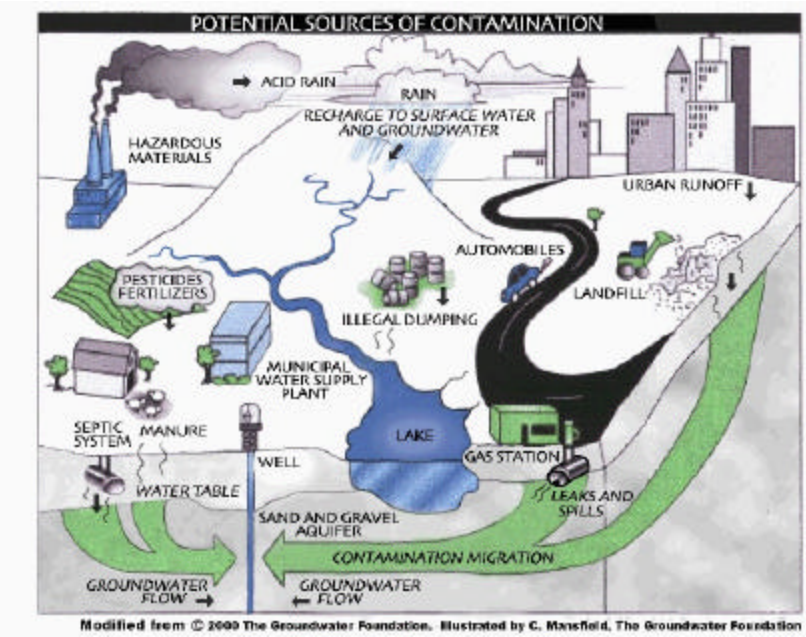
- ✓ Educate residents on best management practices (BMPs) for protecting water supplies. Distribute the fact sheet *Residents Protect Drinking Water* available in Appendix C and on www.mass.gov/dep/brp/dws/protect.htm, which provides BMPs for common residential issues.
- ✓ Work with planners to control new residential developments in the water supply protection areas.
- ✓ Promote BMPs for stormwater management and pollution controls. Visit DEP's web site for additional

**Benefits of Source Protection**

Source Protection helps protect public health and is also good for fiscal fitness:

- Protects drinking water quality at the source
- Reduces monitoring costs through the DEP Waiver Program
- Treatment can be reduced or avoided entirely, saving treatment costs
- Prevents costly contamination clean-up
- Preventing contamination saves costs on water purchases, and expensive new source development

Contact your regional DEP office for more information on Source Protection and the Waiver Program.



information and assistance at http://www.state.ma.us/dep/brp/wm/nonpoint.htm.

**3. Transportation Corridors -** Local roads are common throughout the Zone II. Roadway construction, maintenance, and typical highway use can all be potential sources of contamination. Accidents can lead to spills of gasoline and other potentially dangerous transported chemicals. Roadways are frequent sites for illegal dumping of hazardous or other potentially harmful wastes. De-icing salt, automotive chemicals and other debris on roads are picked up by stormwater and washed into catch basins.

**Transportation Corridor Recommendations**

- ✓ Wherever possible, ensure that drains discharge stormwater outside of the Zone I.
- ✓ Identify stormwater drains and the drainage system along transportation corridors. If maps aren't yet available, work with town officials to investigate mapping options such as the upcoming Phase II Stormwater Rule requiring some communities to complete stormwater mapping.
- ✓ Work with local emergency response teams to ensure that any spills within the Zone II can be effectively contained. Review storm drainage maps with emergency response teams.
- ✓ Work with the Town and State to best manage stormwater in the Zone II. Best management practices include street sweeping, vegetative swales, and regular catch basin inspection, cleaning and maintenance.

**4. Hazardous Materials Storage and Use** – Small areas of the Zone II are used for commercial or industrial land uses. Activities associated with commercial and industrial land use are often the greatest concern when evaluating water supply protection. Many small businesses and industries use hazardous materials, produce hazardous waste products, and/or store large quantities of hazardous materials in UST/AST. If hazardous materials are improperly stored, used, or disposed, they become potential sources of contamination. Hazardous materials should never be disposed of to a septic system or floor drain leading directly to the ground.

**Hazardous Materials Storage and Use Recommendations**

- ✓ Educate local businesses on best management practices for protecting water supplies. Distribute the fact sheet *Businesses Protect Drinking Water* available in Appendix C and on www.mass.gov/dep/brp/dws/protect.htm, which provides BMP's for common business issues.
- ✓ Work with local businesses to register those facilities that are unregistered generators of hazardous waste or waste oil. Partnerships between businesses, water suppliers, and communities enhance successful public drinking water protection practices.
- ✓ Educate local businesses on Massachusetts floordrain requirements. See brochure *Industrial Floor Drains* for more information.

**5. Presence of Oil or Hazardous Material Contamination Site –** The Zone II contains DEP

*(Continued on page 7)*

### What are "BMPs?"

Best Management Practices (BMPs) are measures that are used to protect and improve surface water and groundwater quality. BMPs can be structural, such as oil & grease trap catch basins, nonstructural, such as hazardous waste collection days or managerial, such as employee training on proper disposal procedures.

### For More Information

Contact Isabel Collins of DEP's Southeast Regional Office at (508) 946-2726 for more information and assistance on improving current protection measures.

Copies of this report have been provided to the public water supplier, board of health, and the town.

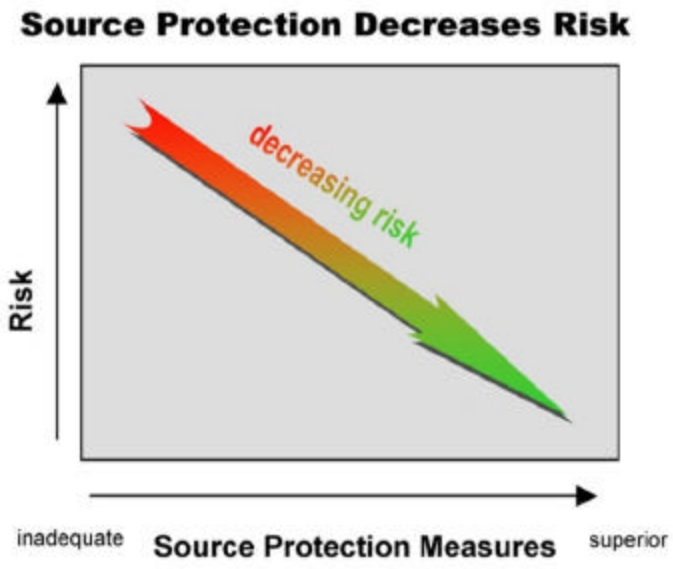



Figure 2: Risk of contamination decreases as source protection increases. This is true for public water systems of any susceptibility ranking, whether High, Moderate, or Low.

**Potential Source of Contamination vs. Actual Contamination**

The activities listed in Table 2 are those that typically use, produce, or store contaminants of concern, which, if managed improperly, are potential sources of contamination (PSC).

It is important to understand that a release may never occur from the potential source of contamination provided facilities are using best management practices (BMPs). If BMPs are in place, the actual risk may be lower than the threat ranking identified in Table 2. Many potential sources of contamination are regulated at the federal, state and/or local levels, to further reduce the risk.

## Table 2: Land Use in the Protection Areas (Zones I and II)

For more information, refer to Appendix A: Regulated Facilities within the Water Supply Protection Area

| Activities | Quantity | Threat* | Potential Source of Contamination |
|---|---|---|---|
| **Agricultural** | | | |
| Nurseries | 1 | M | Fertilizers, pesticides, and other chemicals: leaks, spills, improper handling, or over-application |
| **Commercial** | | | |
| Car/Truck/Bus Washes | 1 | L | Vehicle wash water, soaps, oils, greases, metals, and salts: improper management |
| Auto Repair Shops | 2 | H | Automotive fluids, vehicle paints, and solvents: spills, leaks, or improper handling |
| Gas Stations | 3 | H | Automotive fluids and fuels: spills, leaks, or improper handling or storage |
| Boat Yards/Builders | 1 | H | Fuels, paints, and solvents: spills, leaks, or improper handling |
| Cemeteries | 1 | M | Over-application of pesticides: leaks, spills, improper handling; historic embalming fluids |
| Dry Cleaners | 1 | H | Solvents and wastes: spills, leaks, or improper handling |
| Laundromats | 1 | L | Wash water: improper management |
| Medical Facilities | 1 | M | Biological, chemical, and radioactive wastes: spills, leaks, or improper handling or storage |
| Nursing Homes | 1 | L | Microbial contaminants: improper management |
| Paint Shops | 1 | H | Paints, solvents, other chemicals: spills, leaks, or improper handling or storage |
| Photo Processors | 2 | H | Photographic chemicals: spills, leaks, or improper handling or storage |
| Sand And Gravel Mining/Washing | 1 | M | Heavy equipment, fuel storage, clandestine dumping: spills or leaks |
| **Industrial** | | | |
| Fuel Oil Distributors | | H | Fuel oil: spills, leaks, or improper handling or storage |
| Hazardous Materials Storage | | H | Hazardous materials: spills, leaks, or improper handling or storage |

## Table 2 Continued: Land Use in the Protection Areas (Zones I and II)

For more information, refer to Appendix A: Regulated Facilities within the Water Supply Protection Area

| Activities | Quantity | Threat* | Potential Source of Contamination |
|---|---|---|---|
| **Residential** | | | |
| Fuel Oil Storage (at residences) | numerous | M | Fuel oil: spills, leaks, or improper handling |
| Lawn Care / Gardening | numerous | M | Pesticides: over-application or improper storage and disposal |
| Septic Systems / Cesspools | numerous | M | Hazardous chemicals: microbial contaminants, and improper disposal (About 15% of the Zone II are on private septic) |
| **Miscellaneous** | | | |
| Aboveground Storage Tanks | numerous | M | Materials stored in tanks: spills, leaks, or improper handling |
| Aquatic Wildlife | some | L | Microbial contaminants |
| Oil or Hazardous Material Sites | 1 | -- | Tier Classified Oil or Hazardous Materials Sites are not ranked due to their site-specific character. Individual sites are identified |
| Schools, Colleges, and Universities | 1 | M | Fuel oil, laboratory, art, photographic, machine shop, and other chemicals: spills, leaks, or improper handling or storage |
| Small quantity hazardous waste generators | 2 | M | Hazardous materials and waste: spills, leaks, or improper handling or storage |
| Stormwater Drains/ Retention Basins | numerous | L | Debris, pet waste, and chemicals in stormwater from roads, parking lots, and lawns |
| Underground Storage Tanks | 3 | H | Stored materials: spills, leaks, or improper handling |
| Utility Substation Transformers | 2 | L | Chemicals and other materials including PCBs: spills, leaks, or improper handling |

**Notes:**

1. When specific potential contaminants are not known, typical potential contaminants or activities for that type of land use are listed. Facilities within the watershed may not contain all of these potential contaminant sources, may contain other potential contaminant sources, or may use Best Management Practices to prevent contaminants from reaching drinking water supplies.
2. For more information on regulated facilities, refer to Appendix A: Regulated Facilities within the Water Supply Protection Area information about these potential sources of contamination.
3. For information about Oil or Hazardous Materials Sites in your protection areas, refer to Appendix B: Tier Classified Oil and/or Hazardous Material Sites.

*** THREAT RANKING -** The rankings (high, moderate or low) represent the relative threat of each land use compared to other PSCs. The ranking of a particular PSC is based on a number of factors, including: the type and quantity of chemicals typically used or generated by the PSC; the characteristics of the contaminants (such as toxicity, environmental fate and transport); and the behavior and mobility of the pollutants in soils and groundwater.

*(Continued from page 4)*
Tier Classified Oil and/or Hazardous Material Release Site indicated on the map as Release Tracking Number 4-0006036. Refer to the attached map and Appendix B for more information.

**Oil or Hazardous Material Contamination Sites Recommendation**

- ✓ Monitor progress on any ongoing remedial action conducted for the known oil or contamination sites.

**6. Protection Planning** – Currently, Nantucket has water supply protection controls that meet DEP's Wellhead Protection regulations 310 CMR 22.21(2). Protection planning protects drinking water by managing the land area that supplies water to a well. A Wellhead Protection Plan coordinates community efforts, identifies protection strategies, establishes a timeframe for implementation, and provides a forum for public participation. There are resources available to help communities develop a plan for protecting drinking water supply wells.

**Protection Planning Recommendations**

- ✓ Use Wellhead Protection Committee to implement goals of Wellhead Protection Plan.
- ✓ Coordinate efforts with local officials to compare local wellhead protection controls with current MA Wellhead Protection Regulations 310 CMR 22.21 (2). For more information on DEP land use controls see http://mass.gov /dep/ brp/dws/protect.htm.
- ✓ If local controls do not regulate floordrains, be sure to include floordrain controls that meet 310 CMR 22.21(2).
- ✓ Work with town boards to review and provide recommendations on proposed development within your water supply protection areas. To obtain information on build-out analyses for the town, see the Executive Office of Environmental Affairs' community preservation web site, http://commpres. env.state.ma.us/.

Other land uses and activities within the Zone II include auto repair shops, gas stations, and a dry cleaner. Refer to Table 2 and Appendix A for more information about these land uses.

**Top 5 Reasons to Develop a Local Wellhead Protection Plan**

❶ Reduces Risk to Human Health

❷ Cost Effective! Reduces or Eliminates Costs Associated With:

- Increased groundwater monitoring and treatment
- Water supply clean up and remediation
- Replacing a water supply
- Purchasing water

❸ Supports municipal bylaws, making them less likely to be challenged

❹ Ensures clean drinking water supplies for future generations

❺ Enhances real estate values – clean drinking water is a local amenity. A community known for its great drinking water in a place people want to live and businesses want to locate.

Identifying potential sources of contamination is an important initial step in protecting your drinking water sources. Further local investigation will provide more in-depth information and may identify new land uses and activities that are potential sources of contamination. Once potential sources of contamination are identified, specific recommendations like those below should be used to better protect your water supply.

## Section 3: Source Water Protection Conclusions and Recommendations

**Current Land Uses and Source Protection**

As with many water supply protection areas, the Zone II contains potential sources of contamination. However, source protection measures reduce the risk of actual contamination, as illustrated in Figure 2. The water supplier is commended for taking an active role in promoting source protection measures in the Water Supply Protection Areas through:

- having complete control over activities in the Zone Is for all three groundwater sources;
- maintaining a good working relationship with Nantucket's planning and zoning boards resulting in consideration of water supply protection issues as a part of the approval process for commercial or industrial development; and

**Table 3: Current Protection and Recommendations**

| Protection Measures | Status | Recommendations |
|---|---|---|
| **Zone I** | | |
| Does the Public Water Supplier (PWS) own or control the entire Zone I? | **YES** | Follow Best Management Practices (BMPs) that focus on good housekeeping, spill prevention, and operational practices to reduce the use and release of hazardous materials. |
| Is the Zone I posted with "Public Drinking Water Supply" Signs? | **YES** | Additional economical signs are available from the Northeast Rural Water Association (802) 660-4988. |
| Is Zone I regularly inspected? | **YES** | Continue regular inspections of drinking water protection areas. |
| Are water supply-related activities the only activities within the Zone I? | **NO** | Continue to restrict non-water supply activities in Zone Is. |
| **Municipal Controls** (Zoning Bylaws, Health Regulations, and General Bylaws) | | |
| Does the municipality have Wellhead Protection Controls that meet 310 CMR 22.21(2)? | **YES** | The Nantucket's "Aquifer Protection District" bylaw meets DEP's requirements for wellhead protection. Refer to www.state.ma.us/dep/brp/dws/ for model bylaws and health regulations, and current regulations. |
| Do neighboring communities protect the Zone II areas extending into their communities? | **N/A** | Work to protect Nantucket's Sole Source Aquifer through island wide cooperation efforts. |
| **Planning** | | |
| Does the PWS have a Wellhead Protection Plan? | **YES** | Use Wellhead Protection Committee to implement goals of the Wellhead Protection Plan. Submit plan to DEP for approval. |
| Does the PWS have a formal "Emergency Response Plan" to deal with spills or other emergencies? | **YES** | Augment plan by developing a joint emergency response plan with fire department, Board of Health, DPW, and local and state emergency officials. Coordinate emergency response drills with local teams. |
| Does the municipality have a wellhead protection committee? | **YES** | Ensure committee includes representatives from citizens' groups and the business community. |
| Does the Board of Health conduct inspections of commercial and industrial activities? | **YES** | For more guidance see "Hazardous Materials Management: A Community's Guide" at www.state.ma.us/dep/brp/dws/files/hazmat.doc. |
| Does the PWS provide wellhead protection education? | **YES** | Aim additional efforts at commercial, industrial and municipal uses within the Zone II. |

- persuading Nantucket to approve bylaws that meet DEP's wellhead protection controls found in 310 CMR 22.21(2).

**Source Protection Recommendations**

- ✓ Continue regular Zone I inspections, and when feasible, remove any non-water supply activities.
- ✓ Convert all backup power sources to propane.
- ✓ Educate residents on ways they can help you to protect drinking water sources.
- ✓ Work with emergency response teams to ensure that they are aware of the stormwater drainage in your Zone II and to cooperate on responding to spills or accidents.
- ✓ Partner with local businesses to ensure the proper storage, handling, and disposal of hazardous materials.
- ✓ Monitor progress on any ongoing remedial action conducted for the known oil or contamination sites.
- ✓ Continue to implement your Wellhead Protection Plan.

**Conclusions**
These recommendations are only part of your ongoing local drinking water source protection. Additional source protection recommendations are listed in Table 3, the Key Issues above and Appendix C.

DEP staff, informational documents, and resources are available to help you build on this SWAP report as you continue to improve drinking water protection in your community. Grants and loans are available through the Drinking Water State Revolving Loan Fund, the Clean Water State Revolving Fund, and other sources. For more information on grants and loans, visit the Bureau of Resource Protection's Municipal Services web site at: http://mass.gov/dep/brp/mf/mfpubs.htm.

The assessment and protection recommendations in this SWAP report are provided as a tool to encourage community discussion, support ongoing source protection efforts, and help set local drinking water protection priorities. Citizens and community officials should use this SWAP report to spur discussion of local drinking water protection measures. The water supplier should supplement this SWAP report with local information on potential sources of contamination and land uses. Local information should be maintained and updated periodically to reflect land use changes in the Zone II. Use this information to set priorities, target inspections, focus education efforts, and to develop a long-term drinking water wellhead protection plan.

## Section 4: Appendices

A. Regulated Facilities within the Water Supply Protection Area
B. Table of Tier Classified Oil and/or Hazardous Material Sites within the Water Supply Protection Areas
C. Additional Documents on Source Protection

**What is a Zone III?**

A Zone III (the secondary recharge area) is the land beyond the Zone II from which surface and ground water drain to the Zone II and is often coincident with a watershed boundary.

The Zone III is defined as a secondary recharge area for one or both of the following reasons:

1. The low permeability of underground water bearing materials in this area significantly reduces the rate of groundwater and potential contaminant flow into the Zone II.
2. The groundwater in this area discharges to a surface water feature such as a river, rather than discharging directly into the aquifer.

The land uses within the Zone III are assessed only for sources that are shown to be groundwater under the direct influence of surface water.

**Additional Documents:**

To help with source protection efforts, more information is available by request or online at mass.gov/dep/brp/dws including:

1. Water Supply Protection Guidance Materials such as model regulations, Best Management Practice information, and general water supply protection information.
2. MA DEP SWAP Strategy
3. Land Use Pollution Potential Matrix
4. Draft Land Use/Associated Contaminants Matrix

# APPENDIX A: REGULATED FACILITIES WITHIN THE WATER SUPPLY PROTECTION AREA

## DEP Permitted Facilities

| DEP Facility Number | Facility Name | Street Address | Town | Permitted Activity | Activity Class |
|---|---|---|---|---|---|
| 37709 | NANTUCKET AUTOMOTIVE | 12 BOYNTON LN | NANTUCKET | Generator of Hazardous Waste | Very Small Quantity Generator of Hazardous Waste |
| 54429 | WALTER J GLOWACKI & SONS INC | OLD SOUTHROAD | NANTUCKET | Plant | Air Quality Permit |
| 54429 | WALTER J GLOWACKI & SONS INC | OLD SOUTH RD | NANTUCKET | Generator of Hazardous Waste | Very Small Quantity Generator of Waste Oil or PCBs |
| 131043 | HARBOR FUEL OIL | 155 SPARKS AVE | NANTUCKET | Toxics Use Reduction Filer | Below Toxics Use Reduction Regulated Levels |
| 131043 | HARBOR FUEL OIL CORP | 15 SPARKS AVE | NANTUCKET | Plant | Air Quality Permit |
| 131043 | HARBOR FUEL OIL | 15 SPARKS AVE | NANTUCKET | Sewer Connection or Groundwater Discharge | Below Industrial Waste Water Regulated Levels |
| 131043 | HARBOR FUEL OIL CORP | 15 SPARKS AVE | NANTUCKET | Generator of Hazardous Waste | Very Small Quantity Generator of Hazardous Waste |
| 132137 | NANTUCKET ELECTRIC COMPANY | 2 FAIRGROUNDS RD | NANTUCKET | Plant | Air Quality Permit |
| 132137 | NANTUCKET ELECTRIC CO | FAIRGROUNDS RD | NANTUCKET | Generator of Hazardous Waste | Small Quantity Generator |
| 132137 | NANTUCKET ELECTRIC CO | FAIRGROUNDS RD | NANTUCKET | Generator of Hazardous Waste | Large Quantity Generator of Hazardous Waste |
| 132138 | NANTUCKET AUTO BODY INC | 36 SPARKS AVE | NANTUCKET | Generator of Hazardous Waste | Very Small Quantity Generator of Hazardous Waste |
| 132139 | ISLAND RESTORATION | MADAKET RD | NANTUCKET | Generator of Hazardous Waste | Very Small Quantity Generator of Hazardous Waste |
| 132140 | ALLEN DON AUTO SERVICE INC | POLPIS RD | NANTUCKET | Generator of Hazardous Waste | Very Small Quantity Generator of Hazardous Waste |
| 132750 | HOLDGATES ISLAND LAUNDRY | 4 VESPER LN | NANTUCKET | Generator of Hazardous Waste | Very Small Quantity Generator of Hazardous Waste |

| DEP Facility Number | Facility Name | Street Address | Town | Permitted Activity | Activity Class |
|---|---|---|---|---|---|
| 132750 | HOLDGATES ISLAND LAUNDRY | 4 VESPER LN | NANTUCKET | Generator of Hazardous Waste | Very Small Quantity Generator of Hazardous Waste |
| 132751 | NANTUCKET COTT HOSP | 57 PROSPECT ST | NANTUCKET | Plant | Air Quality Permit |
| 132752 | NANTUCKET HIGH SCHOO | ATLANTIC AVE | NANTUCKET | Plant | Air Quality Permit |
| 137088 | BUTNELL CORPORATION | 127 ORANGE ST | NANTUCKET | Fuel Dispenser | Fuel Dispenser |
| 137089 | D & B AUTO SERVICE INC | 41 SPARKS AVE | NANTUCKET | Fuel Dispenser | Fuel Dispenser |
| 137090 | ON ISLAND GAS INC | 34 SPARKS AVE | NANTUCKET | Fuel Dispenser | Fuel Dispenser |
| 314966 | POETS CORNER PRESS | 2 BARTLETT RD | NANTUCKET | Generator of Hazardous Waste | Very Small Quantity Generator of Hazardous Waste |
| 314966 | POETS CORNER PRESS | 2 BARTLETT RD | NANTUCKET | Generator of Hazardous Waste | Very Small Quantity Generator of Hazardous Waste |
| 364014 | NANTUCKET FIRE DEPT | 131 PLEASANT ST | NANTUCKET | Fuel Dispenser | Fuel Dispenser |
| 368831 | MIKE LAMB INC | 149 HUMMOCK POND RD | NANTUCKET | Generator of Hazardous Waste | Very Small Quantity Generator of Hazardous Waste |

## Underground Storage Tanks

| Facility Name | Address | Town | Tank Material | Tank Type | Tank Leak Detection | Capacity (gal) | Contents |
|---|---|---|---|---|---|---|---|
| **D & B AUTO SERVICE INC ID #11610** | 41 SPARKS AVE | NANTUCKET | Reinforced | 2 Walls | Interstitial Monitoring | 10000 | Gasoline |
| | | | Reinforced | 2 Walls | Interstitial Monitoring | 10000 | Gasoline/D |
| **HATCH'S GAS ID #83319** | 129 ORANGE ST | NANTUCKET | Cathodic | 2 Walls | Interstitial Monitoring | 10000 | Gasoline |
| **ISLAND MARINE SERVICE INC ID #40240** | 96 WASHINGTON ST EXT | NANTUCKET | Epoxy Coat | 1 Wall | Inventory Record-Keeping | 1000 | Diesel |
| **NANTUCKET ELECTRIC CO ID #16715** | 2 FAIRGROUNDS RD | NANTUCKET | Steel | N/A | N/A | 500 | Waste Oil |
| **ON ISLAND GAS ID #16722** | 34 SPARKS AVE | NANTUCKET | Composite | 2 Walls | Interstitial Monitoring | 15000 | Gasoline |
| **VERIZON MASSACHUSETTS ID #11604** | 3 UNION ST | NANTUCKET | Reinforced | 2 Walls | Interstitial Monitoring | 500 | Diesel |

For more information on underground storage tanks, visit the Massachusetts Department of Fire Services web site: http://www.state.ma.us/dfs/ust/ustHome.htm

Note: This appendix includes only those facilities within the water supply protection area(s) that meet state reporting requirements and report to the appropriate agencies. Additional facilities may be located within the water supply protection area(s) that should be considered in local drinking water source protection planning.

**APPENDIX B – Table of Tier Classified Oil and/or Hazardous Material Sites within the Water Supply Protection Areas**

DEP's datalayer depicting oil and/or hazardous material (OHM) sites is a statewide point data set that contains the approximate location of known sources of contamination that have been both reported and classified under Chapter 21E of the Massachusetts General Laws. Location types presented in the layer include the approximate center of the site, the center of the building on the property where the release occurred, the source of contamination, or the location of an on-site monitoring well. Although this assessment identifies OHM sites near the source of your drinking water, the risks to the source posed by each site may be different. The kind of contaminant and the local geology may have an effect on whether the site poses an actual or potential threat to the source.

The DEP's Chapter 21E program relies on licensed site professionals (LSPs) to oversee cleanups at most sites, while the DEP's Bureau of Waste Site Cleanup (BWSC) program retains oversight at the most serious sites. This privatized program obliges potentially responsible parties and LSPs to comply with DEP regulations (the Massachusetts Contingency Plan – MCP), which require that sites within drinking water source protection areas be cleaned up to drinking water standards.

For more information about the state's OHM site cleanup process to which these sites are subject and how this complements the drinking water protection program, please visit the BWSC web page at http://www.state.ma.us/dep/bwsc. You may obtain site - specific information two ways: by using the BWSC Searchable Sites database at http://www.state.ma.us/dep/bwsc/sitelist.htm, or you may visit the DEP regional office and review the site file. These files contain more detailed information, including cleanup status, site history, contamination levels, maps, correspondence and investigation reports, however you must call the regional office in order to schedule an appointment to view the file.

The table below contains the list of Tier Classified oil and/or Hazardous Material Release Sites that are located within your drinking water source protection area.

**Table 1**: Bureau of Waste Site Cleanup Tier Classified Oil and/or Hazardous Material Release Sites (Chapter 21E Sites) - Listed by Release Tracking Number (RTN)

| RTN | Release Site Address | Town | Contaminant Type |
|---|---|---|---|
| 4-0006036 | 129 ORANGE ST | NANTUCKET | Oil |

For more location information, please see the attached map. The map lists the release sites by RTN.
* Site recently classified, not reflected in current GIS map.

# APPENDIX E: NANTUCKET SEWER ACT

## BOARD OF HEALTH LOCAL REGULATIONS

## BOARD OF HEALTH ADMINISTRATIVE CONSENT ORDER

## SEPTIC MANAGEMENT PLAN DOCUMENTS

# Chapter 396 of the Acts of 2008

## AN ACT AUTHORIZING THE ESTABLISHMENT OF THE NANTUCKET SEWER COMMISSION AND SEWER DISTRICTS IN THE TOWN OF NANTUCKET.

*Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same as follows:*

**SECTION 1.** The town of Nantucket, acting by and through the Nantucket sewer commission described in section 3, may lay out, plan, construct, maintain and operate a system or systems of common sewers for a part or whole of its territory, as may be from time to time defined and established by adoption by town meeting of one or more by-laws as a designated sewer district under the jurisdiction and control of the sewer commission, with such capacity limitations, connections, pumping stations, treatment plants and other works, as may be allocated in such by-law to such sewer district as required for a system or systems of sewage treatment and disposal, and may construct such sewers and related works in said sewer districts defined and established by by-law as may be necessary. No other sewers shall be constructed in any public roads or ways of the town which are not within the limits of such designated sewer districts and which are not under the control of the sewer commission.

**SECTION 2.** The town may make and maintain, within sewer districts defined and established as set forth in section 1 in any way therein where common sewers are constructed, such connecting sewers within the limits of such way as may be necessary to connect any estate which abuts upon the way within such district.

**SECTION 3.** Notwithstanding the provisions of chapter 169 of the acts of 1965, the town may, at any town meeting, by a two-thirds vote, vote that the board of selectmen shall act as a Nantucket sewer commission, or that there shall be a separate Nantucket sewer commission, the members of which shall be appointed by the board of selectmen or elected by popular vote for 3 year terms. The number, constitution and the choice of elected or appointed commissioners of a separate sewer commission shall also be determined by a two-thirds vote of town meeting. If a separate Nantucket sewer commission is established by town meeting, any selectman shall be eligible to serve as a member thereof. Town meeting shall be authorized to change the method of establishment of the Nantucket sewer commission described herein without any limitation on the number of times such commission may be established or re-established as the case may be, by a two-thirds vote. Whenever the phrase "Nantucket sewer commissioners" appears in this act, such phrase shall include within its meaning either the board of selectmen acting as Nantucket sewer commissioners, or the separate appointed or elected Nantucket sewer commission.

**SECTION 4.** The Nantucket sewer commission, acting for and on behalf of the town of Nantucket, shall have charge of and shall be responsible for the policies, finances, and overall goals of the sewer system, but shall be subject to the charter of the town of Nantucket as to the administration and management of the systems operation and maintenance, and shall be responsible for the good order of all sewers, pipes, pumping stations, treatment and disposal works, and the like. The operations of the Nantucket sewer commission shall be governed by, and any staff or employees shall be considered part of town administration within the meaning of, the charter of the town of Nantucket unless changed or modified pursuant to said charter.

**SECTION 5.** The board of selectmen acting for and on behalf of the town of Nantucket, after being duly authorized to do so by town meeting, may take by eminent domain pursuant to chapter 79 of the General Laws or otherwise may, utilizing the procedures described in the charter of the town of

Nantucket acquire by purchase or gift any lands, rights of way, or easements, public or private, in the town necessary for accomplishing any purpose mentioned in this act and may construct such sewers under or over any state road, any bridge, pier, tidelands, boulevards or other public way, or within the location of any state land, without the necessity for any formal filings in the registry of deeds, and may enter upon and dig up any private land or any public land or public way, for the purpose of laying such sewers and of maintaining and repairing the same, and may do any other thing proper or necessary for the purposes of this act.

**SECTION 6.** The financial operations of the sewer system shall be an Enterprise Fund within the meaning of section 53F1/2 of chapter 44 of the General Laws, except as modified herein, and any expenditure from such fund shall be only upon authorization of the Nantucket sewer commission. The town shall, by vote at town meeting, determine whether it shall pay the whole or a portion of the cost of said system or systems of sewerage and sewage disposal, and if a portion, what proportion. If the town votes to pay less than the whole cost, in providing for the payment of the remaining portion of the cost of said system or systems, the town, acting through the Nantucket sewer commission, may avail itself of any or all of the methods permitted by the General Laws; and the provisions of the General Laws relative to the assessment, apportionment, division, reassessment, abatement and collection of sewer assessments or the additional methods set forth in section 8, and as to liens therefor and to interest thereon, shall apply to assessments made pursuant to this act by the Nantucket sewer commission, except that interest shall be at the rate as may be established by the Nantucket sewer commission from time to time.
At the same meeting at which town meeting determines that any portion of the cost is to be borne by the town, it may by vote determine by which of such methods the remaining portion of said cost shall be provided for.
The collector of taxes of said town shall certify the payment or payments of any such assessment or apportionments thereof to the sewer commission or to the selectmen acting as such, who shall preserve a record thereof.

**SECTION 7.** The revenues received by the fund described in section 6 of this act from sewer assessments, fees, charges, contributions from the town towards the costs of such sewer system as described in section 6, and the like as receipts or revenues, shall be applied to the payment of charges and expenses incident to the design, construction, maintenance, and operation of said system or systems of sewerage and sewage disposal or to the extensions thereof, to the payment of principal or interest upon bonds or notes issued for sewer purposes, or to the payment or redemption of such bonds or notes.

**SECTION 8.** The Nantucket sewer commission may, in its discretion, prescribe for the users of said sewer systems and disposal works such annual charges, connection fees, assessments, privilege fees, and the like, based on the benefits derived therefrom as such sewer commission may deem proper, subject however, to such by-laws as may be adopted by vote of the town, or as may be provided for in the General Laws. Notwithstanding any law to the contrary, the commission is authorized to impose and collect such charges, fees, or assessments prior to connection or operation of such system of sewers, and may enter into agreements for the payment thereof over such time as the sewer commission shall determine. In fixing the charges to be imposed for said system, the Nantucket sewer commission is authorized to make use of any fee, charge, assessment or betterment provided for by the General Laws and further may take into consideration all costs for ongoing removal of infiltration and inflow of non-wastewater into the system as part of the normal operating costs of the system; may include, in setting privilege fees, capital costs and interest charges applicable thereto; may impose late fees for unpaid billings; may assess a capacity utilization fee to new estates and properties added to a sewer district authorized by this act from outside a designated needs area in addition to any privilege fee; may charge betterments, special assessments, or any other charge to the estates and properties being served by collection system improvements and extensions to pay for all costs for sewer line extensions to serve

new connections, both within the sewer districts authorized by the act and in any areas added to such sewer district; and may impose such charges on properties within a sewer district authorized by the act whether or not such estates and properties are then connected to the sewer system.

**SECTION 9.** The Nantucket sewer commission may, from time to time, adopt and prescribe rules and regulations for the means of connection of estates and buildings with sewers and for inspection of the materials, the construction, alteration, and use of all connections entering to such sewers, but not including the expansion of districts except as provided in sections 1 and 10, and may prescribe penalties, not exceeding $300 for the violation of any such rule or regulation. Such rules and regulations shall be available for public review at the sewer commission's designated office during regular office hours. Any changes, deletions, additions or revisions to said rules and regulations deemed necessary by the Nantucket sewer commission from time to time, shall take full effect after a notice of change has been published at least once a week for 2 successive weeks in a newspaper of general circulation in the town of Nantucket, which notice shall detail where and when such revised rules and regulations may be viewed by the general public.

**SECTION 10.** Notwithstanding any provision of law to the contrary, owners of land not within the sewer districts defined and established pursuant to section 1 of this act shall not be permitted to connect to the town's sewer system except as is set forth in this act. The territory covered by said sewer districts may be amended from time to time by the board having charge of sewers, after a public hearing conducted to consider such amendment, upon approval of the department of environmental protection if otherwise required by law and upon enactment by town meeting of a by-law defining or establishing a new or expanded sewer district. In the event that the board having charge of sewers votes not to amend the territory of any sewer district in accordance with the foregoing sentence, the amendment may nevertheless be enacted in a form of a by-law upon a two-thirds vote of town meeting.
Any by-law adopted pursuant to the authority granted to the town of Nantucket by this act may include authorization to the Nantucket sewer commission without a town meeting vote to add to the sewer districts created pursuant to this act properties located within "needs areas" as defined by Nantucket's Comprehensive Wastewater Management Plan prepared by Earth Tech dated March 2004, approved by the secretary of environmental affairs on May 14, 2004, with such conditions and limitations with respect to such authorization as such by-law may provide.

**SECTION 11.** Notwithstanding anything to the contrary contained herein, the board having charge of the maintenance and repair of sewers may at any time permit extensions, new connections or increases in flow to the sewer system, subject to capacity, to serve municipal buildings or public restrooms or other public service uses as defined by the municipality; provided, however, that such uses may include, but shall not be limited to, affordable housing constructed pursuant to chapters 40B and 40R of the General Laws, without thereby creating any entitlement on the part of any person to connect to such sewer system, and subject to capacity, in order of application, may permit or if in the public interest, may require, extensions, new connections or new flow to the sewer system within such districts.

**SECTION 12.** This act shall take effect as of July 1, 2008.

*Approved December 17, 2008*

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**Return to:**
List of Laws passed in 2008 Session

# TOWN OF NANTUCKET BOARD OF HEALTH REGULATIONS AFFECTING MADAKET

## LOCAL REGULATION 51.00

**In order to preserve, protect, and manage the quality and supply of fresh water, and to protect the health and welfare of the inhabitants of the town of Nantucket, the following regulations are hereby adopted by the Board of Health of the Town of Nantucket, pursuant to authority granted by General Laws, Chapter 111, Section 31 on September 19, 1973, to be effective upon publication.**

**51.01SUBJECT AREA.**

**A. These Regulations shall be applicable in that part of the Town of Nantucket known as Madaket, more particularly described to be within the area bounded by the center line of Hither Creek; the center line of Cambridge Street ; Madaket Harbor; Broad creek; and the Atlantic Ocean.**

**51.02 DISTANCES.**

**A. In any part of said area where the percolation rate is two minutes or less per inch, the distance between the soil absorption system, and any potable water supply well, shall be one hundred and fifty (150) feet, not withstanding the fact that such a system or well is located on an adjacent lot of land.**

**B. The distance of a soil absorption system from a property line shall be fifty (50) feet. Where the property abuts a road way or other land restricted from building, the width of the road way or restricted land can be included as part of the 50-foot set-back requirement. No soil absorption system may be located closer than 10 feet to any property line.**

**C. Every soil absorption system shall have a one hundred percent (100%) reserve area which shall be no closer than fifteen (15) feet to such a soil absorption system.**

# TOWN OF NANTUCKET BOARD OF HEALTH REGULATIONS: INSPECTION AND UPGRADING OF SUBSTANDARD ONSITE SEWAGE DISPOSAL SYSTEMS WITHIN THE MADAKET HARBOR WATERSHED

## LOCAL REGULATIONS - SECTION 53.00

### 53.00 Inspection and upgrading of on-site sewage disposal systems.

A. Purpose.

Whereas ongoing research by the Town of Nantucket in co-operation with the Commonwealth of Massachusetts Department of Environmental Protection has documented increasing levels of nutrient loading in the Madaket Harbor/Hither Creek watershed system, these Regulations are promulgated to further limit said nutrient and other sources of contamination loading and to protect and enhance the quality of groundwater flowing into and affecting Nantucket's harbor waters.

B. Authority.

These Regulations are adopted by the Town of Nantucket's Board of Health as authorized by Massachusetts General Laws, Chapter 111, Section 31.

## 53.01 Definition

A. Madaket Harbor Watershed.

The area constituting the watershed for Madaket Harbor/Hither Creek, as delineated on a map entitled "Madaket Harbor Watershed with Sub-Areas," Nantucket GIS, dated January 13, 2003.

## 53.02 Compliance Requirements

A. Properties utilizing in-ground soil absorption systems located within Zone A of the Madaket Harbor Watershed District as established by these Regulations and as demonstrated on a map titled Madaket Harbor Watershed District shall have the existing soil absorption system inspected by a Massachusetts licensed system inspector within 42 months of promulgation of these Regulations. Said Inspection Report shall be recorded with the Nantucket Health Department within 21 days of the completed inspection.

B. Properties utilizing in-ground soil absorption systems located within Zone B of the Madaket Harbor Watershed District as established by these Regulations and as demonstrated on a map entitled Madaket Harbor Watershed District shall have the existing soil absorption system inspected by a Massachusetts licensed system inspector within 48

months of promulgation of these Regulations. Said Inspection Report shall be recorded with the Nantucket Health Department within 21 days of the completed inspection.

53.03 Inspections.

A. All systems shall be inspected to determine the presence and/or absence of hydraulic failure and depth to ground water. Depth to ground water shall be determined by direct observation of highest ground water elevation ( including seasonal perched and tidally influenced ground water) in a test pit excavation, unless an alternative method for accurately determining the depth to ground water has been approved in writing by the Health Director.

***B***. The Health Director may, based on unique development conditions or due to the proximity of multiple systems within a limited geographic area, substitute a pre-approved ground water monitoring protocol for test pit excavation.

The monitoring protocol shall require as a minimum;

- data collected over a 12 month period
- a minimum of 3 wells offset to define ground water flow direction as well as depth.

## 53.04 Repairs to failed systems

A. The owner of a system meeting hydraulic failure criteria pursuant to these regulations as stated on the Town of Nantucket Board of Health Septic System Inspection Report/Certificate of Compliance Form shall bring the system into compliance with all applicable state and local regulations within 30 days of the date of inspection.

B. The owner of a system meeting failure criteria, exclusive of hydraulic failure, pursuant to these Regulations as stated on the Town of Nantucket Board of Health Septic System Inspection Report/Certificate of Compliance Form shall bring the system into compliance with all state and local regulations within 18 months of the adoption of the Assessment Report required in 53.05 and/or within 30 months of the expiration date of Zone A and B inspections.

## 53.05 Inspection evaluation period

A. Within three months of the inspection date of Zone A and B inspections, the Health Department shall tabulate and publish the inspection results.

B. Within six months of the expiration date of zone A and Zone B inspections, the Health Department shall provide a preliminary assessment report to the Board of Health. This report shall include a brief evaluation of treatment options to effectuate implementation of best available engineering design for all required repairs/upgrades.

C. No later than six months of the expiration date of Zone B inspections, the Board of Health shall adopt the Nantucket/Madaket Assessment Report, including recommendations.

## 53.04 Exemptions

A. Properties whose onsite sewage disposal design is documented to be based on test pit and percolation testing observed by the Board of Health after November 1st 2003.

B. Properties which have been inspected and have both a Town of Nantucket Board of Health Septic System Inspection Report and a Certificate of Compliance Form filed with the Nantucket Health Department and dated within 24 months before promulgation of these Regulations are exempt from inspection and compliance standards as set forth in these Regulations.

C. In all areas where Town of Nantucket mapping shows that the separation between the bottom of the soil absorption system and the predicted groundwater elevation (based on Horsley/Whitten/Hegeman study and/or USGS Hydrologic Investigation Atlas Water resources Map 1980) exceeds ten (10) feet, documentation of high ground water levels shall not be required.

## 53.07 Enforcement

A. Enforcement of these Local Regulations shall be effected through Town of Nantucket Board of Health Local regulations 67.00 Miscellaneous Provisions.

B. These Regulations and the amendments thereto shall become effective upon the date of publication

Nantucket Board of Health

_____
Whitey Willauer, Chairman

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Patricia Roggeveen

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Brian Chadwick

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Michael Kopko

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Allen Reinhard

Effective Date June 14, 2006
Amended Date November 28, 2007

End of Inspection period for Zone A – December 14 2009
End of Inspection Period for Zone B – June 14 2010

**51.03 SYSTEM LOCATION ON LOT.**

**A. Every on site system and potable water supply well shall be on the same lot of land as the building, dwelling, facility, or structure which they serve.**

**51.04 CERTIFICATE OF COMPLIANCE & WATER TEST.**

**A. No well shall be connected to the water distribution system of any dwelling or other building without a Certificate of Compliance issued by the Board of Health that said potable well and water distribution system does not endanger the health of any potential user. Prior to the issuance of such a Certificate of Compliance, the applicant therefore shall provide the Board of Health with proof of a satisfactory bacteriological and chemical analysis of the water from such a well.**

# TOWN OF NANTUCKET BOARD OF HEALTH
# LOCAL REGULATION 54.00

SEPTIC WASTE WATER FLOW LIMITATIONS
WITHIN MADAKET HARBOR WATERSHED PROTECTION DISTRICT

54.00 Purpose:
Whereas ongoing research by the Town of Nantucket in co-operation with the Commonwealth of Massachusetts's Department of Environmental Protection has documented increasing levels of nutrient loading with resultant degradation of water quality within the Madaket Harbor/Hither Creek watershed system, these Regulations are promulgated to maintain and/or restrict additional effluent flows which may further degrade Madaket Harbor/Hither Creek water quality through increased nutrient loading.

54.01 Definitions:

Madaket Harbor Watershed Protection District –The area constituting the watershed for Madaket Harbor / Hither Creek, as delineated on a map entitled "Madaket Harbor Watershed with Sub Areas" Nantucket GIS, as dated January 13, 2003.

Nitrogen Sensitive Area – Areas that have been determined by the Nantucket Board of Health to be particularly sensitive to the discharge of pollutants from on site sewage disposal systems, including nitrogen, nitrogen as nitrate, phosphorous and pathogens. Such areas are depicted on a plan entitled "Board of Health Nitrogen Sensitive Areas" which is hereby incorporated by reference herein, and as such warrant the imposition of the loading restrictions set forth within these regulations.

54.02 Effluent flows within Madaket Harbor Watershed Protection District:

A. All properties currently existing or created and located within the Madaket Harbor Watershed Protection District as defined within these regulations shall not be constructed or re-constructed to receive design flows over 110 gallons of effluent for every 10,000 feet of lot area. The use of abutting roads and right of ways, to a property shall not be considered in calculating the permissible effluent flows for the subject property.
B. Existing developed properties shall be allowed to repair/replace existing subsurface disposal systems for existing flows determined by a qualified licensed Massachusetts professional with nutrient

reducing technologies or technologies acceptable to the Nantucket Board of Health as deemed appropriate.

C. Properties connected to a municipal water service shall not be exempted from compliance with Section 54.02 (A) of these regulations.

54.03 Modification or rescinding of regulations:

A. No part of these regulations may be modified and/or rescinded without a majority vote of Town of Nantucket Board of Health.

54.04 Enforcement:

A. Without limiting any other available remedies or penalties, the Board of Health may punish any person or entity that violates these regulations by assessing a penalty of $300.00. Each day or part thereof which violation occurs or continues shall constitute a separate offense. As an alternative to criminal prosecution or civil action, the non-criminal disposition procedure set forth in M.G.L. c40, Section 21D, and Sections 1-2, 1-3, 1-4, 1-5, and 1-6 of the Code of the Town of Nantucket may be used with a penalty of $300.00 for each violation, each day or part thereof during which such violation occurs or continues constituting a separate offense. The Health Director and Assistant Health Officer are hereby empowered to enforce this Section 54.00.

54.05 Authority:

These regulations are adopted by the Town of Nantucket's Board of Health as authorized by Massachusetts General Laws, Chapter 111, Section 31.

_____
Michael Kopko – Chairman – Nantucket Board of Health

_____
Patricia Roggeveen

_____
Brian Chadwick

_____ Approved: August 24, 2009
Alan Reinhard

_____ Attest_____
Rick Atherton Catherine Stover – Town Clerk

# TOWN OF NANTUCKET BOARD OF HEALTH REGULATIONS:

# INSPECTION AND UPGRADING OF SUBSTANDARD ONSITE SEWAGE DISPOSAL SYSTEMS WITHIN THE HUMMOCK POND WATERSHED PROTECTION DISTRICT

## LOCAL REGULATION – 55.00

55.00 Inspection and upgrading of onsite sewage disposal systems

A. Purpose.

Whereas ongoing research by the Town of Nantucket in co-operation with the Commonwealth of Massachusetts Department of Environmental Protection has documented increasing levels of nutrient loading in the Hummock Pond watershed system, these Regulations are promulgated to further limit said nutrients and other sources of contamination loading, and to protect and enhance the quality of groundwater flowing into and affecting the waters of Hummock Pond.

B. Authority.

These Regulations are adopted by the Town of Nantucket's Board of Health as authorized by Massachusetts General Laws, Chapter 111, Section 31.

55.01 Definition.

A. Hummock Pond Watershed Protection District.

The area constituting the watershed for Hummock Pond as delineated on a map entitled Hummock Pond Watershed, Nantucket GIS, dated July 1, 2010.

55.02 Compliance Requirements.

A. Properties utilizing in-ground soil absorption systems located within Zone A of the Hummock Pond Watershed Protection District as established by these Regulations, and as demonstrated on a map titled Hummock Pond Watershed Protection District, as established by these Regulations, shall have the existing soil absorption system(s) inspected by a Massachusetts licensed system inspector prior to March 1, 2014. Said Inspection Report shall be recorded with the Nantucket Health department within 21 days of the completed inspection.

B. Properties utilizing in-ground soil absorption systems located within Zone B of the Hummock Pond Watershed Protection District as established by these Regulations and as demonstrated on a map entitled Hummock Pond Watershed Protection District shall have their existing soil absorption system(s) inspected by a Massachusetts licensed system inspector prior to June 1, 2014. Said Inspection report shall be recorded with the Nantucket

Health Department within 21 days of the completed inspection.

55.03 Inspections.

A. All systems shall be inspected to determine the presence and/or absence of hydraulic failure and depth to groundwater. Depth to groundwater shall be determined by direct observation of highest groundwater elevation (including seasonal perched and tidally influenced groundwater) in a test pit excavation, unless an alternative method for accurately determining the depth to groundwater has been approved in writing by the Health Director.

B. The Health Director may, based on unique development conditions or due to the proximity of multiple systems within a limited geographic area, substitute a pre-approved groundwater monitoring protocol for test pit excavation.

This monitoring protocol shall require a minimum;

- Data collected over a 12 month period
- A minimum of three wells off set to define groundwater flow direction as well as depth

55.04 Repairs to failed systems.

A. The owner of a system meeting hydraulic failure criteria pursuant to these Regulations as stated on the Town of Nantucket Board of Health Septic System Inspection Report/Certificate of Compliance Form shall bring the

system into compliance with all applicable state and local regulations within 60 days of the date of the inspection.

B. The owner of a system meeting failure criteria, exclusive of hydraulic failure, pursuant to these Regulations as stated on the Town of Nantucket Board of Health Septic System Inspection Report/Certification of Compliance Form shall bring the system into compliance with all state and local regulations within 18 months of the adoption of the Assessment report required in 55,05 and/or within 30 months of the expiration date of Zone A and B inspections.

55.05 Inspection evaluation period.

A. Within three months of the inspection expiration date of Zones A & B, the Health Department shall tabulate and publish the inspection results.

B. Within six months of the inspections expiration date of Zones A & B, the Health Department shall provide a preliminary assessment report to the Board of Health. This report shall include a brief evaluation of treatment options to effectuate implementation of best available engineering design for all required repairs/upgrades.

C. No later than six months following the expiration date of Zone B inspections,

the Board of Health shall adopt the Hummock Pond Watershed Protection Area Assessment Report, including recommendations.

55.06 Exemptions.

A. Properties whose onsite sewage disposal design is documented to be based on test pit and percolation testing observed by the Board of Health after June 1, 2008.

B. Properties which have been inspected and have both a Town of Nantucket Board of Health Septic System Inspection Report and a Certificate of Compliance Form filed with the Nantucket Health Department and dated within 24 months prior to promulgation of these Regulations are exempt from inspection and compliance standards as set forth in these Regulations.

55.07 Enforcement.

A. Enforcement of these Local Regulations shall be effective through Town of Nantucket Board of Health Local Regulations 67.00 Miscellaneous Provisions.

B. These Regulations and any amendments thereto shall become effective upon the date of publication.

Nantucket Board of Health

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Patricia Roggeveen, Chairman

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Michael Kopko

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Brian Chadwick

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Whitey Willauer

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Rick Atherton

Effective date: September 2, 2010

Amended: February 21, 2013

# TOWN OF NANTUCKET – BOARD OF HEALTH

# LOCAL REGULATIONS 59.00 – SEPTIC SYSTEM UPGRADES DEFERRALS

## 59.01 Purpose

**The Town is mandated through the Massachusetts Estuaries Program (MEP), under the jurisdiction of the Massachusetts Department of Environmental protection (MassDEP), to reduce nitrogen loading in specific areas of Nantucket and to meet Total Maximum Daily Loads (TMDL's) set by the commonwealth in Nantucket harbor, Madaket harbor, Long Pond, Sesachacha Pond and potentially other embayment areas of Nantucket, including the Hummock Pond Area. Nantucket's harbor watershed Districts (Nantucket & Madaket) also detail reductions of nutrient loading from on-site waste water disposal systems.**

**In order to meet these mandates, the Town is currently engaged in facilities planning for future phases of a municipal Comprehensive Wastewater Management Plan (CWMP), which includes provisions for additional sewering of portions of the Town. Because the planning design and installation of sewers in these new areas is expected to take some time, the Board of Health wishes to provide options for property owners who currently have failed on-site waste water systems in areas proposed for municipal sewer. Therefore to alleviate the burden on property owners who may have to pay for an expensive septic system upgrade, replacement or repair and then have to pay again to connect to the municipal sewer, the Board is enacting this regulation to provide for deferrals in certain circumstances'.**

## 59.02 Septic System Upgrade, Replacement or Repair deferrals

1. **Owners or Operators of residential or commercial property on the Island of Nantucket shall upgrade, replace, or repair any on-site waste water disposal system that fails to meet the requirements of the State Environmental Code, Title 5, the Nantucket Board of Health Regulations, and/or orders of the**

**Nantucket Board of Health, within the time required by such code, regulations, and/or orders.**

2. **The Board of health may defer any requirement to upgrade, replace, or repair a failing on-site wastewater disposal system until such time as a municipal sewer is available, for Owners and Operators of residential and commercial property located in a proposed future municipal sewer service area, identified as a Needs Area in the CWMP Update.**

3. **Any such deferrals shall be subject to the conditions set forth in section 59.03 of this regulation and the terms of an Administrative Consent order (ACO) executed by the owner and operator of the property.**

**59.03 Deferral Conditions**

1. **The issuance of a deferral shall be at the sole discretion of the Board of health, which shall determine that the costs of upgrading, replacing, or repairing the System is excessive in light of the probability that Municipal Sewer will be available in the near future and that such upgrade, replacement, or repair can be deferred for a definite period of time without creating an unreasonable threat to public health, safety, or the environment.**

2. **All upgrade deferrals shall be subject to the following minimum conditions:**

    a. **The applicant must demonstrate that the system is not in Hydraulic Failure, as that term is defined in Section 59.05 of this regulation and that the condition of the System does not pose an imminent threat to public health, safety, or the environment;**
    b. **The applicant must execute an Administrative Consent Order (ACO) acknowledging that the system fails to meet the requirements of the State Environmental Code, Title 5, the Nantucket Board of Health regulations and/or orders of the Nantucket Board of Health;**

c. **The Applicant shall agree, in writing, to abandon the system and connect the property to the Municipal Sewer within sixty (60) days of receipt of notice of Sewer Availability, or to upgrade, repair or replace the System as required by the Board of Health, within sixty (60) days of receipt of notice that such upgrade, repair, or replacement is required;**
d. **The Applicant shall deposit a sum of money into an insured and interest-bearing escrow account of the Town established and maintained by the Finance Director pursuant to G.L. c.44 Subsection 53A, said sum to be used solely for the purpose of defraying the cost of connecting to Municipal Sewer or upgrading, repairing, or replacing the system;**
e. **The Applicant shall agree to have the system periodically inspected by a duly licensed Title 5 Inspector;**
f. **The Applicant shall agree to comply with all interim orders of the Board of Health;**
**and**
g. **Said Administrative Consent Order shall be recorded with the title to the Property and shall run with the land.**

**59.04 Deferral Procedure**

1. **Any property owner seeking a deferral in accordance with Section 59.02 of this regulation shall apply, in writing, to the Board of Health.**

2. **The Application shall include an Inspection Report from a Duly licensed Title 5 Inspector showing the nature of the failure.**

3. **If the Applicant is approved, the Applicant shall execute an Administrative Consent Order and shall pay, by certified check, bank or cashiers check, a sum of money for the escrow account required by Section 59.03(2)(d) of this Regulation.**

4. **Within fourteen days (14) of the execution of the ACO, the Applicant shall provide the Board of health with proof that it**

**has been recorded with the Nantucket County Registry of Deeds.**

5. **The Applicant shall make any interim repairs required by the Board of Health within the time ordered by the Board.**

6. **If the Applicant is denied, the Applicant may request a hearing before the Board of Health. Said request, shall be in writing, and shall be received by the Board no later than thirty (30) days after the Boards decision to deny the Application. The Board's decision after said hearing shall be final.**

**59.05 Definitions**

a. **Administrative Consent Order –**
**Duly executed and recorded document that affords a property owner in a specific area of Nantucket to defer major repair and /or upgrade of a failed on-site wastewater treatment system until Municipal sewer is available for connection. Specific provisions for deferment are detailed in the ACO Document.**

b. **Board of Health –**
**The Town of Nantucket Department with local jurisdiction of on-site wastewater systems in addition to all other health-related matters.**

c. **Comprehensive Wastewater Management Plan –**
**The Town's 20 year wastewater planning document completed according to the Department of Environmental Protection Bureau of Municipal Finances guide to Comprehensive Wastewater Management Planning, January 1996.**

d. **Escrow Account –**
**Account set up with the Town's Finance Department for the purpose of collecting funds, based on an estimate to repair failed on-site wastewater system to Title 5 and local standards, to apportion towards the capital cost assessed to the property owner for municipal sewer or for repair/upgrade of on-site system.**

e. **Hydraulic Failure –**
**An onsite wastewater system failure due to ponding of surface water, back-up of sewage into the dwelling and/or evidence of flooding within the wastewater system's distribution box, septic tank, cesspool, or metal tank.**

f. **Massachusetts Department of Environmental Protection –**
**The Massachusetts Department of Environmental Protection (MassDEP) is a name used for the agency charged with proposing and enforcing environmental law.**

g. **Massachusetts Estuaries Program –**
**The Massachusetts DEP and the UMASS/Dartmouth School of marine Science and Technology (SMAST) collaborating together with Coastal Zone Management, The Cape Cod Commission, and several municipalities to classify the nitrogen sensitivity of Southeastern Massachusetts's coastal bays and estuaries. SMAST technical experts work with MassDEP to evaluate the nitrogen sensitivity through comprehensive water quality testing, quantitative TMDL (Total Maximum Daily Load) model, and preparation of technical reports allowing communities to consider how implementation of nitrogen management scenarios within water sheds will influence water quality in embayments.**

h. **Municipal Sewer –**
**The physical infrastructure that collects, treats, and discharges wastewater through a public system.**

i. **Nantucket –**
**"Nantucket" encompasses the land and water of the Town and County of Nantucket including Tuckernuck and Muskeget.**

j. **Nantucket County Registry of Deeds –**
**The County of Nantucket office of recorder of deeds is a government office tasked with maintaining public records and documents, especially records relating to real estate.**

**k. Needs Area –**

**Geographic delineation of land/property area that has been determined to be unsustainable in the long-term with on-site wastewater disposal systems in the Town of Nantucket's Comprehensive Wastewater Management Plan.**

**l. Technical Failure –**

**An on-site wastewater system failure due to diminished distance To groundwater, less than 6 feet in designated watershed Protection zones, less than 5 feet in non-watershed protection areas/within 100 feet to private drinking water well, missing or undersized system components and leach fields within 100 feet of a private drinking water well.**

**m. Title 5 –**

**The environmental code in Massachusetts governing on-site wastewater systems in Massachusetts found under 310 CMR 15.00.**

**n. Total Maximum Daily Load / TMDL –**

**"Total maximum Daily Load / TMDL" is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards**

**o. Town –**

**"Town" means the bodies politic created by statute (of the Commonwealth of Massachusetts General Court) to govern said lands and waters.**

**59.06 Modifications**

**No part of these Regulations may be modified and/or rescinded without a majority vote of the Board of Health.**

**59.07 Enforcement**

**Without limiting any other remedies or penalties, the Board of Health and/or the Board of Health's Agent may punish any person or entity that violates these Regulations by assessing without demand a stipulated penalty of $500.00 per day. Each day of non-compliance shall constitute a separate violation.**

**Penalty shall be paid by certified check, cashier's check or money order payable to the Town of Nantucket.**

**59.08 Authority**

**These Regulations are adopted by the Town of Nantucket's Board of Health as authorized by Massachusetts General Laws Chapter 111, Section 31.**

**_____**
**Patricia Roggeveen – Chair Nantucket Board of Health**

**_____**
**Malcolm MacNab MD,PhD**

**_____**
**Helene Weld RN**

**_____**
**James Cooper**

**_____**
**Stephen Visco**

**Approved:_____**

**Attest:_____**
**Catherine Stover – Town Clerk**

# TOWN OF NANTUCKET BOARD OF HEALTH REGULATIONS

## ON SITE SEWAGE DISPOSAL SYSTEMS

## LOCAL REGULATION 64.00

**64.00 ON SITE SEWAGE DISPOSAL SYSTEMS**

**A. Purpose**

**The purpose of these regulations is to protect the public health and general welfare by regulating onsite soil absorption systems in a manner which will protect the quality of the Town of Nantucket's groundwater and surface waters. These regulations are intended to compliment Title Five of the State Environmental Code.**

**B. Authority**

**These regulations are adopted pursuant to the authority granted to the Board by Massachusetts General Laws, Chapter 111 Section 31.**

**C. Preamble**

**The Board has determined that the State Environmental Code Title Five - Minimum Requirements for the Subsurface Disposal of Sanitary Sewage is not adequate to protect ground and surface waters from contamination by nutrients, bacteria, viruses, and hazardous materials associated with septic systems effluent, particularly in areas with extremely rapid infiltration rates, and in coastal areas characterized by tidally induced ground water fluctuations, coastal flooding, and shifting sand.**

## 64.01 GENERAL REQUIREMENTS FOR INDIVIDUAL DISPOSAL SYSTEMS.

**A. Disposal Works Construction Permit,**

**No individual on site septic system or other means of sewage disposal, shall be located, constructed, altered, repaired, or installed where a common sanitary sewer is accessible adjoining the property and where permission to enter such sewer can be obtained from the Nantucket Board of Public Works having jurisdiction over it (310 CMR 15.00) or if a common sanitary sewer is not accessible until a permit for an on site system's location, construction, alteration, repair or installation shall have been issued by the Board of Health. A permit shall not be issued for any system of individual sewage disposal when the total volume of the sewage to be disposed of on any lot is in excess of 10,000 gallons per day, or where an on site system is proposed on the lot to be served, until the plans for such system have been approved by the Massachusetts Department Of Environmental Protection in accordance with M.G.L., C 111 section 17. Where sewage flows on a lot exceed 10,000 gallons per day, the Department of Environmental Protection may require additional treatment of the waste prior to its disposal to the ground. The applicant is also obligated to comply with any applicable requirements established by the Division of Water pollution Control pursuant to M.G.L., C.21 section 43, and the Wetlands Protection Act M.G.L., C. 131 section 40. A permit shall not be issued in designated Nantucket Nitrogen, Phosphorous and/or Pathogen Sensitive Areas except as provided in the Town of Nantucket Board of Health Regulations 64.04.**

**B. Application for Disposal Works Construction Permit.**

**An application for a Disposal Works Construction Permit shall be submitted to the Board of Health and must be accompanied by a plan stamped by a qualified licensed professional engineer or Registered Sanitarian. The Board shall revoke such permit if conditions different from those set forth in the application are found to exist prior to or during actual construction of the system. The permit so granted shall expire in two (2) years from the date of issue in accordance with Section 51.04 (a) of the Board's regulations if the work authorized by the permit is not completed within two years of the date the permit was issued.**

**C. Plan of onsite System or Subsurface sewage Disposal System, or Systems.**

**The submitted plan must show as a minimum: the lot to be served, location and dimensions of the system (including reserve area), design calculations, existing and proposed contours at one or two foot intervals, location and log of deep observation holes, locations and results of percolation tests, location of any streams, surface and subsurface drains and wetland resource areas within 100 feet of the system, known sources of water supply within 200 feet of the system, location of any proposed well to serve the lot, location of water lines on the property, depth to ground water/maximum ground water elevation in the area of the soil absorption system, and a profile of the system. The plan must be prepared, reviewed and stamped, by a professional engineer, or a registered sanitarian and stamped by a licensed professional land surveyor as required.**

**D. Use**

**The use of an individual system shall be in compliance with the terms of the permit issued therefore and shall not exceed the design capacity of the system. Design capacity shall not be reduced for seasonal use.**

**E. Building or Plumbing Permits/Subdivision Plans.**

**No Building Permit, foundation permit, special building permit or plumbing permit shall be issued until a Disposal Works Construction Permit has been first obtained, unless the Board of Health determines that the existing system is adequate for a proposed alteration or addition to an existing dwelling.**

**F. Certificate of Compliance.**

**A new individual system and alteration and repairs to an existing individual system shall not be placed in service, nor shall new dwellings or buildings or additions thereto, which must rely on new individual systems for sewage disposal; be occupied until the Board of Health has issued a Certificate of Compliance indicating that said system has been located, constructed, altered, or repaired in compliance with the terms of the permit and the requirements of this regulation. The Board shall require inspection of all construction by a professional engineer or a registered sanitarian and the agent of the Board of Health; and require certification in writing that all work has been completed in accordance with the terms of the permit and**

**the approved plans. Such certification shall include an As-Built plan stamped by the licensed professional engineer or registered sanitarian and stamped by a professional land surveyor as required.**

**G. Fees.**

**Fees for the issuance of a construction permit, issuance of a Certificate of Compliance, and test pit/percolation test observation shall be charged by the Board of Health at the time an application is made, and shall be in accordance with the fee schedule adopted by the Board of Health.**

**H. Conditions for Permit Issuance.**

**In addition to the obligation to meet the general requirements above, and those set forth in Title Five of the State Environmental Code hereby incorporated by reference, no certificate of compliance and no permit for the construction of an individual system shall be granted unless the additional standards set forth in sections 64.02 through 64.06 and all other applicable Town of Nantucket Board of Health Regulations are met.**

**64.02 DETERMINATION OF MAXIMUM GROUND WATER ELEVATION- DEPTH TO GROUNDWATER.**

**A. On any lot there will be at least two deep observation holes in the area to be used for leaching plus any additional number of deep observation holes which in the opinion of the Health Agent will be necessary to determine the consistency (or lack thereof) of the character of the soil. The observation holes shall be examined to a depth of at least 6 feet below the bottom of the proposed leach facility, but in no case shallower than 10 feet total depth, unless this depth is unattainable because of existing site conditions as determined by an agent for the Board. Ground water elevations/depth to groundwater shall be determined as set forth in Board of Health Regulation 50.00.**

**B. All deep observation holes shall be witnessed by the Board of Health or its designated agent.**

**C. Maximum groundwater elevation/depth to groundwater shall be determined for all soil absorption system (SAS) repairs, expansions and/or new construction of onsite sewage disposal systems.**

**64.03 LOCATION OF SOILS ABSORPTION SYSTEMS.**

**A. All soil absorption systems located in non Nitrogen Sensitive areas shall be designed and located so that at least five (5) feet of naturally occurring pervious material remains below the bottom of the system. The bottom of the system shall be constructed at least five (5) above maximum ground water elevation /depth to ground water (Town of Nantucket Board of Health Regulations 50.00 Definitions) as determined by soils tests conducted by a Certified Soil Evaluator and witnessed by an Agent for the Board of Health. Soil absorption systems shall be located in accordance with the Town of Nantucket Board of Health Regulation 64.04**

**B. All soil absorption systems located within a Nitrogen Sensitive area that incorporate Innovative/Alternative technologies with enhanced nitrogen/phosphorous removal shall be designed and located so that at least five (5) feet of naturally occurring pervious material remains below the bottom of the system. The bottom of the system shall be constructed at least five (5) feet above maximum ground water elevation/depth to ground water (Town of Nantucket Board of Health Regulation 50.00 Definitions) as determined by soils tests conducted by a Certified Soils Evaluator and witnessed by an Agent for the Board of Health. Soils absorption systems shall be located in accordance with the Town of Nantucket Board of Health Regulations 64.04.**

**C. All soil absorption systems located in Nitrogen Sensitive areas shall be designed and located so that at least six (6) feet of naturally occurring pervious material remains below the bottom of the system. The bottom of the system shall be constructed at least six (6) feet above maximum ground water elevation/depth to ground water (Town of Nantucket Board of Health Regulations 50.00 Definitions) as determined by soil tests conducted by a Certified Soils Evaluator and witnessed by an Agent for the Board of health. Soil absorption systems shall be located in accordance with the Town of Nantucket Board of health regulations 64.04**

**D. Repair/upgrades of existing failed on site sewage disposal absorption systems that service existing structure, where no addition of habitable space is proposed, shall be designed to incorporate innovative/alternative technologies with enhanced nutrient removal and constructed to meet the minimum separation of five (5) feet above**

**maximum ground water elevation/depth to ground water (Town of Nantucket BOH Regulations 50.00 Definitions) as determined by soils tests conducted by a Certified Soil Evaluator and witnessed by an agent for the Board of Health. Soil absorption systems shall be located in accordance with the Town of Nantucket Board of Health regulations 64.04.**

**E.** ***No system shall be permitted within coastal wetlands resource areas, including but not limited to coastal wetlands as defined in Chapter 136 of the Nantucket Code and regulations adopted there-under, except as provided in 64.03C***

**F. No system shall be permitted within the V or VE zones shown on the "FEMA Maps" for the Town of Nantucket. Systems approved by the Board or it's designated agent may be constructed within other special flood hazard areas 100-Year flood zones) if designed to minimize the release of contaminants from the disposal system into the flood waters. Disposal systems in these areas shall include the following features:**

1. **Vents shall extend at least 1 foot above the 100 year flood elevation.**
2. **Access ports for all components of the system shall be watertight and shall either have bolted lids or shall extend above the level of the 100 year flood.**
3. **Where sewage or effluent pumping is necessary, electrical switching shall be provided to prevent to the pumps from operating during periods of inundation.**
4. **No plumbing fixtures below the 100 year flood elevation shall be connected to the disposal system except by means of an ejector pump connected to the gravity waste plumbing of the structure at a point above the flood level.**

## 64.04 PERFORMANCE STANDARDS FOR LEACHING FACILITIES

**A. No soils absorption system shall be installed within 300 feet of any designated Nantucket Nitrogen, Phosphorous and/or Pathogen Sensitive Area (Board Regulations 50.00).**

**B. Nitrogen Loading Limitations:**

1. **No system serving new construction in nitrogen sensitive areas as defined in Regulation 50.00 shall be designed to receive or shall receive more than 110 gallons of design flow per day per 10,000 square feet of lot area.**

2. **No system serving new construction in areas where the use of both on-site systems and drinking water supply wells is proposed to serve the facility may be designed to receive or may receive more than 110 gallons of design flow per day per 10,000 square feet of lot area from residential uses provided that any cumulative flow exceeding 330 gallons of design flow per day demonstrates a minimum 25% TN effluent reduction.**

**C. Phosphorous loading limitations:**

1. **No system serving new construction in nitrogen sensitive areas shall be designed to received or shall receive more than 440 gallons of design flow per day per acre.**

2. **All on-site leaching facilities for new construction and repairs/upgrades shall be located a minimum of 300 feet from the edge of the down gradient surface water body, unless documented that water recharge beneath subject on-site system is not directed to the adjacent surface water body. All on-site system leaching facilities for repairs/upgrades shall be located a minimum 300 feet from the edge of the down gradient freshwater surface water body or demonstrate maximum feasible compliance.**

**D. Pathogen Loading Limitations.**

**E. System Weight Loading Criteria.**

1. **All such systems shall be installed to withstand H-20 Wheel Loading.**

## 64.05 SEPTIC SYSTEM ACCESS.

**A. A minimum of one access hole and one inspection hole and cover for septic tanks and leach pits shall be provided and brought to grade for new construction. Access and covers for any pump chambers shall be at grade.**

**B. Access and inspection hole covers must be a minimum diameter of eighteen (18) inches. The cast iron ring and cover must be of medium or heavier duty weight and must withstand a minimum of H-20 wheel loading.**

**64.06 RELIEF PROCEDURES.**

A. **Any lot referred to in a deed or shown on a plan duly recorded at the Nantucket Registry of Deeds or filed in the land registration office before the effective date of this regulation August 31, 1990 shall comply with Sections 64.03 A and 64.04 of this regulation to obtain maximum feasible compliance, meaning that soil absorption systems shall be located as close to the regulation distance requirements as lot size allows.**

**B. In the event that a pre-existing lot cannot comply with the 300 foot horizontal set back requirement set forth in Section 64.04 A and/or the six (6) foot separation requirement set forth in section 64.03 A of these regulations, then , in that event, the Board may, in it's sole discretion grant to said lot an exemption from said requirements upon the following conditions:**

**B.1. The applicant shall submit to the agent of the Board of Health a design plan stamped by a licensed professional engineer, registered sanitarian, and licensed professional land surveyor as required, showing the location of the proposed soils absorption system on said lot, the location of all wells, soils absorption systems and water bodies within 300 feet of said soils absorption system, or as far from said locus as deemed necessary to determine that compliance with this section cannot be met, and the groundwater gradient and direction of flow for said lot (as determined by use of Horsley Whitten & Heggimin Report of March 1990 on file with the Board of Health, the United States Geologic Survey Map HA 615, or more detailed map duly adopted by the Board at a Public Hearing.**

**B.2. For pre-existing vacant lots held in contiguous ownership prior to the effective date of this regulation, August 31, 1990, the applicant shall also file a stamped plan with such design and location information showing maximum feasible compliance with the 300 foot down gradient set back requirements and/or 6 foot vertical separation from ground water requirement for contiguous lots abutting the subject lot.**

**B.3.** **Failed soil absorption systems on an improved lot shall, if necessary, be relocated on said lot at the time said soils absorption systems are replaced to the maximum set back distances attainable up to 300 feet and/or maximum vertical separation distance attainable up to 6 feet with incorporation of I/A (innovative/alternative) technology.**

**B.4.** **Adjustments to pre-existing lot lines shall not subject said lot to compliance with the 300 foot setback requirements on the condition that such adjustments do not create an additional "buildable" lot and the distance between the soils absorption system on said lot and water body is not diminished.**

**B.5** **In addition to these requirements, on site systems constructed within the 100 year flood zone as shown on the current FEMA map shall be subject to the engineering design requirements for "mounded" systems as set forth in Section 64.03 A of this regulation.**

**C** **The applicant may design a system using design flows for a smaller number of bedrooms than are presumed in this definition by granting to the approving authority, a deed restriction limiting the number of bedrooms to the smaller number.**

## 64.07 SPECIAL VARIANCE.

**A. The Board of Health, in its sole discretion. May issue a variance from the strict application of these regulations to any particular case in accordance with its procedures and its regulations set forth below.**

**B. Prior to granting a variance from its regulations, the Board of Health shall conduct a hearing to consider granting a variance from the strict application of its regulations. The Board of Health may grant a variance, with or without conditions, upon its finding that :**

1. **the person requesting the variance has established that enforcement of the provisions of these Regulations from which a variance is sought would be manifestly unjust, considering all the relevant facts and circumstances of the individual case; and**
2. **The person requesting a variance has established that a level of environmental protection that is at least equivalent to that provided under these Regulations can be achieved without strict application of the provision of these Regulations from which a variance is sought.**

**B. Pursuant to its regulations and other applicable law, The Board of Health shall enact rules and regulations pertaining to its hearings and its review hereunder. Said rules and regulations shall be known as the "Nantucket Board of Health Special Variance Regulations", and shall be on file with the Town Clerk of the Town of Nantucket.**

**64.08 ENFORCEMENT**

**Without limiting any other available remedies or penalties, the Board of Health may punish any person or entity that violates these regulations by assessing a penalty of $300.00. Each day or part thereof during which such violation occurs or continues shall constitute a separate offense. As an alternative to criminal prosecution or civil action, the non-criminal disposition procedure set forth in M.G.L. c40, Section 21D, and Sections 1-2,-1-3,1-4,1-5, and 1-6 of the Code of the Town of Nantucket may be used with 5 and 1-6 of the Code of the Town of Nantucket may be used with a penalty of $300.00 for each violation, each day or part thereof during which such violation occurs or continues constituting a separate offense.**

**Approved: December 1, 2004**

_____
**Whitey Willeaur – Chairman**

_____
**Brian Chadwick**

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**Michael Kopko**

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**Michael Glowacki**

_____
**Douglas Bennett**

**Effective date: January 1, 2005**
**Amended: June 14, 2006**

# TOWN OF NANTUCKET BOARD OF HEALTH UPGRADING OF SUBSTANDARD ON-SITE SEWAGE DISPOSAL SYSTEMS

## LOCAL REGULATIONS 66.00

**66.00 upgrading of substandard on site sewage disposal systems.**

**A. purpose.**

**These regulations are intended to protect the public health and general welfare by ensuring the upgrading of substandard sewage disposal systems in a manner which will protect the quality of the ground water on the Island of Nantucket.**

**B. Authority.**

**These regulations are adopted by the town of Nantucket's Board of Health as authorized by Massachusetts general Laws, Chapter 111, Section 31.**

**66.01 Compliance requirements .**

**A. Systems of domestic sewage disposal which do not presently comply with the minimum standards specified by the state and local regulations shall be brought in to compliance when:**

**A.1 An application for a building permit for which expansion of the existing system is required is filed with the proper departments. The soil absorption system shall comply with the maximum separation and/or set back distance attainable up to 300 feet without the use of a lift pump.**

**A.2 Any property transfer, not exempt, takes place. Exempt property transfers are defined in section 66.03 B.**

**66.02 Compliance standards.**

**A. All subject systems shall comply with the minimum standards of the 1978 State Sanitary Code, and with current local regulations to the maximum extent possible, meaning that systems shall be located as close to the horizontal separation distance requirements as lot contours and size allow unless the attainable increase in required**

**horizontal separation distance is 20 feet or less. Systems which can not meet 1978 Title Five standards shall require a variance (sec. 67.06).**

**B. Prior to selling, conveying, or transferring title to real property in Nantucket which contains an existing system, the owner thereof shall have had an inspection of said system by a system inspector certified by the State, indicating that said system is functioning, non-functioning, or in failed condition.**

**C. The inspection shall take place not more than 270 days prior to, or 180 days after the transfer of property. The Agent of the Board of Health must receive the signed official inspection form and/or Certificate of Compliance within seven (7) days of the inspection.**

**<u>66.03 EXEMPTIONS.</u>**

**A. The systems described in the following paragraphs shall be exempt from this upgrade regulation to the extent therein provided.**

**A.1 Any system complying with the 1978 State Sanitary Code as evidenced by an "as-built" plan on file with the Nantucket Board of Health which permit is dated less than three (3) years from the date of transfer and has proof of annual pumping shall be exempt from this compliance standard and no inspection of the system shall be required.**

**A.2 Any system which complies with the 1978 State Sanitary Code as evidenced by an "as-built" plan on file with the Nantucket Board of Health which has been inspected less than three (3) years from date of transfer and has proof of annual pumping shall be exempt from these compliance standards and no inspection of the system shall be required.**

**B. Any transfer of real-estate which qualifies for a (b) through (l) exemption, inclusive, from the Nantucket Island Land Bank fee imposed by Chapter 669 of the acts of 1983 of the Commonwealth of Massachusetts, as amended, as more specifically set forth in Section 12 of such Act, as amended shall also be exempt from these upgrade upon transfer compliance requirements unless said transfer is to a third party for fair market, monetary consideration.**

**C. Whenever a person has submitted a subdivision, or preliminary subdivision plan followed within 7 months by a definitive plan, or a plan referred to in M.G.L. Chapter 41, Section 81P as the case may be, the land shown on such plan shall be governed by the provisions of the State Environmental Code and Board of Health Regulations, if any, which differ from the health codes which are in effect at the time of first submission of the plan. Such provisions shall apply while the plan is processed until rejected, or if approved, until three (3) years from the date of filing pursuant to M.G.L. Chapter 111 Section 127P.**

**D. Notwithstanding the general effective date of these regulations in section 67.08, the effective date of this upgrade upon transfer requirement (Section 66.01 A. 2 et. Sec.) shall be February 1, 1991.**

# TOWN OF NANTUCKET BOARD OF HEALTH REGULATIONS : INSPECTION AND UPGRADING OF SUBSTANDARD ONSITE SEWAGE DISPOSAL SYSTEMS WITHIN THE NANTUCKET HARBOR WATERSHED PROTECTION DISTRICT

## LOCAL REGULATIONS 68.00

### 68.00 INSPECTION AND UPGRADING OF ON-SITE SEWAGE DISPOSAL SYSTEMS.

**A. Purpose.**
**Whereas the Nantucket Harbor Study of March 1997, as completed by the Woods Hole Oceanographic Institution, denotes increasing levels of nutrient loading in Nantucket Harbor, these Regulations are promulgated to further limit said nutrient loading and other sources of contamination and to protect and enhance the quality of ground water flowing into and affecting Nantucket's harbor waters.**

**B. Authority.**
**These Regulations are adopted by the Town of Nantucket's Board of Health as authorized by Massachusetts General Laws, Chapter 111, Section 31.**

### 68.01 Definition.

**A. *NANTUCKET HARBOR WATERSHED –***
**The area constituting the watershed for Nantucket Harbor, as described in a technical report entitled "Nantucket Water Resource Management Plan," 1990, by Horsley Witten Hegemann, Inc., and as delineated**

**on a map entitled "Nantucket Harbor Watershed," Nantucket GIS, dated January, 1999.**

**68.02 Compliance Requirements.**

**A. Properties utilizing in-ground soil absorption systems located within Zone A of the Nantucket Harbor Watershed District as established by these Regulations and as demonstrated on a map entitled Nantucket Harbor Watershed District with 1000 foot Buffer Belt, shall have the existing soil absorption system inspected by a Massachusetts licensed system inspector within 30 months of promulgation of these Regulations. Said Inspection Report shall be recorded with the Nantucket Health Department within 21 days of the completed inspection.**

**B. Properties utilizing in-ground soil absorption systems located within Zone B of the Nantucket Harbor Watershed District as established by these Regulations and as demonstrated on a map entitled Nantucket Harbor Watershed District with 1000 foot Buffer Belt, shall have the existing soil absorption system inspected by a Massachusetts licensed system inspector within 36 months of promulgation of these Regulations. Said Inspection Report shall be recorded with the Nantucket Health Department within 21 days of the completed inspection.**

**68.03 Inspections.**

**A. All systems shall be inspected to determine the presence and/or absence of hydraulic failure and depth to ground water. Depth to ground water shall be determined by direct observation of highest ground water elevation (including seasonal perched and tidally influenced ground water) in a test pit**

**excavation, unless an alternative method for accurately determining the depth to ground water has been approved in writing by the Health Director.**

**B. The Health Director may, based on existing unique development conditions or due to the proximity of multiple systems within a limited geographic area, substitute a pre-approved ground water monitoring protocol for the test pit excavation.**

**The monitoring protocol shall require as a minimum;**
- **data collected over a 12 month period**
- **a minimum of 3 wells offset to define ground water flow direction as well as depth.**

**<u>68.04 Repairs to failed systems.</u>**

**A. The owner of a system meeting hydraulic failure criteria pursuant to these Regulations as stated on the Town of Nantucket Board of Health Septic System Inspection Report/Certificate of Compliance Form shall bring the system into compliance with all applicable state and local regulations within 30 days of the date of inspection.**

**B. The owner of a system meeting failure criteria, <u>exclusive</u> of hydraulic failure, pursuant to these Regulations as stated on the Town of Nantucket Board of Health Septic System Inspection Report/Certificate of Compliance Form shall bring The system into compliance with all state and local regulations within 18 month of the adoption of the Assessment Report as required in 68.05 B and/or within 30 months of the expiration date of**

**Zone A and B inspections, subject to 68.05C**

**68.05 INSPECTION EVALUATION PERIOD**

**A. Within three months of the inspection date of Zone A and B inspections, the Health Department shall tabulate and publish the inspection results.**

**B. Within six months of the expiration date of Zone A and Zone B inspections, the Health Department shall provide a preliminary assessment report to the Board of Health. This report shall include a brief evaluation of treatment options to effectuate implementation of best available engineering design for all required repairs/upgrades.**

**C. No later than six months after the expiration date of Zone B inspections, the Board of Health shall adopt the Nantucket/Madaket Assessment report, including recommendations.**

**68.06 Exemptions.**

**A. Properties whose on site sewage disposal design is documented to be based on test pits and percolation testing observed by the Board of Health after November 1, 2003.**

**B. Properties which have been inspected and have both a Town of Nantucket Board of Health Septic System Inspection Report and a Certificate Of Compliance Form filed with the Nantucket Health Department and dated within 24 months before promulgation of these Regulations are exempt from inspection and compliance standards as set forth in these Regulations.**

**C. In all areas where Town of Nantucket mapping shows that the separation between the bottom of the soil absorption system and the predicted ground water elevation (based on HWH study and/or USGS Hydrologic Investigation Atlas Water resources Map dated 1980) exceeds ten (10) feet, testing will not be required.**

**68.07 Enforcement.**

**A. Enforcement of these Local Regulations shall be effected through Town of Nantucket Board of Health Local Regulations 67.00 Miscellaneous Provisions.**

**B. These Regulations and the amendments thereto shall become effective upon the date of publication. Nantucket Board of Health**

_____
-Whitey Willauer- Chairman

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Patricia Roggeveen

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Brian Chadwick

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Michael Kopko

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Allen Reinhard

Date Published September 29,2005
Date Amended June 14, 2006
Date Amended November 28, 2007

End of inspection period Zone A – December 14 2008
End of inspection period Zone B - June 14 2009

TOWN OF NANTUCKET
SEPTAGE MANAGEMENT PLAN
ADOPTED 11-9-05 BY
BOARD OF SELECTMEN

## INTRODUCTION

Long term protection of Nantucket's quality of life depends on the Town's ability to prevent adverse impacts to human and environmental health. Successful management of the treatment and disposal of human waste and wastewater is the single most important factor in achieving long term protection for Nantucket's ground and surface water resources. Sustaining high quality ground and surface water resources is absolutely necessary to protect human health, to maintain healthy environmental resources, the economy and the quality of life expected by residents of and visitors to our island. Management of the treatment and disposal of human waste and wastewater on Nantucket involves direct management and regulation of flows carried to treatment plant facilities and of flows disposed of through onsite sewage disposal facilities. Currently the Town of Nantucket is in the process of constructing and upgrading treatment facilities in Siasconset and Surfside in accordance with approvals from the Massachusetts Department of Environmental Protection (DEP) and as authorized by Town Meeting.

The goal of this Septage Management Plan (SMP) is provide the tools, options and resources necessary for Nantucket to manage onsite wastewater management systems so as to protect and maintain public health, ensure the protection of ground and surface water quality, maintain water resources as environmental, economic, recreational and aesthetic assets, retain local control of onsite wastewater disposal systems without regulatory or management intervention, to protect investments with respect to property values, to maximize options for onsite management based on implementation of best available management practices tailored to local conditions and in compliance with state and local regulatory requirements and to identify man power and financial needs . The successful long-term sustainability of onsite wastewater disposal systems is dependent upon proper design, operation and maintenance in order to prevent adverse health and environmental impacts. This SMP is intended to operate in conjunction with the Town's municipal wastewater collection systems. It should be noted here however, that depending on future management and design implementation options that may become available through currently proposed changes to DEP Title 5, the implementation of the SMP may result in flow quantity and strength changes discharged to the Town's wastewater treatment facilities that may require future retooling of plant processing practices.

## **GENERAL**

In the late 1990's, the Town of Nantucket initiated two distinct processes to address the protection of its ground and surface water resources. First, in 1997, Town Meeting authorized a study with resultant recommendations for protecting the Nantucket Harbor Watershed with the intent that the efforts of the Nantucket Harbor Watershed

Work Group would result in the evaluation of existing data to determine and rank sources of pollutants. This Work Group completed their review of existing data and produced a report that ranked pollutant sources, prioritized local regulatory actions that has resulted in the implementation of Board of Health regulations for the Nantucket Harbor Watershed, sponsored educational forums for professionals, regulators and landowners, and established by its example, the prototype for a public participation process and action template for the Madaket Harbor Watershed Planning Group and future defined needs areas across the island. Second, in 1998, the Town of Nantucket authorized an Island-wide Comprehensive Management Plan/Environmental Impact Report to address the wastewater needs of the Island. A large component of the CWMP was to identify those areas on the Island, based on available local file information and available mapping information, that cannot sustain onsite wastewater disposal systems and those areas that can sustain long term use of onsite wastewater disposal systems under the guidance of a SMP. The SMP is intended to provide a comprehensive management program that encompasses the design, construction, inspection, maintenance, monitoring, disposal and treatment of septage, record keeping, public outreach and education, regulatory changes, identification of financial sources and options to fund implementation, define personnel needs and outline SMP compatibility with existing and proposed improvements to existing municipal treatment plan facilities.

The SMP as currently proposed recognizes the actions already taken by the Board of Health since 2003 and presumes that the SMP will be administered by the Board of Health and implemented through the Health Department. Further, the SMP recognizes the uncertainties of the Commonwealth's Massachusetts Estuaries Program and proposed changes to DEP's Title 5 Regulations and maximizes locally generated data from actual onsite observations and inspections as the basis for ongoing and future management actions.

## BENEFITS

Benefits of the SMP accrue to the Town of Nantucket, individual property owners, residents and visitors to the island. This SMP will serve to protect the public health and minimize adverse environmental impacts. This SMP will offer an opportunity to obtain the same level of service for onsite sewage disposal systems as the areas on Island serviced by the municipal sewer and treatment plant system.

Specific benefits of this SMP include:

- protection of ground and surface water quality (elimination of failed systems, potential elimination of black water contaminants, reduction of pollutant loading source, regulatory changes tailored to existing conditions and documented sensitive areas)
- protection of public health (elimination of failed systems)
- ground water conservation and more effective watershed based recharge (repair and upgrades in place will allow for infiltration of "treated effluent" which will recharge groundwater within watershed it is generated rather than as a transfer to municipal plant facilities in a different watershed)

tax rate equity for financing of municipal costs for treatment plant upgrades and operation and maintenance (black water pump out/discharge available to all with transport to/treatment at plant)

- cost savings to property owner for long term operation and maintenance of onsite systems (fewer failures and repairs, co-ordination of inspection/monitoring requirements, etc.)
- funding assistance options to owners for repair and town for management
- education and outreach to targeted recipients to maximize effectiveness
- ability to develop effective enforcement policies, practices and penalties
- Board of Health/Health Department implementation maximizes public exposure and outreach opportunities and allows for variance procedure as deemed necessary

**STANDARDS**

The SMP is designed to work in conjunction with the Town's municipal wastewater system and with state and local standards for inspection, design, construction, repair, monitoring and record keeping of onsite systems as referenced below.

- 310CMR15.00 (Title 5, including proposed revisions relative to blackwater/graywater separation, holding tanks, etc.)
- TON Board of Health Regulations Sections 50.00, 51.00, 60.00, 61.00, 62.00, 64.00, 66.00, and 68.00 as most recently revised in 5/05
- TON Chapter 99, Nantucket Harbor Watershed
- TON Bylaws
- Massachusetts DEP TMDL Program, Massachusetts Estuaries Project

TOWN OF NANTUCKET
SEPTAGE MANAGEMENT PLAN COMPONENTS

The primary elements/components of the Nantucket Septage Management Plan are as follows:

1) Regulations (including variance provisions and escrow options)
2) Inspections (Nantucket Harbor Watershed, other identified needs areas/environmentally sensitive areas, Island wide)
3) Staffing (Health Department analysis; consultant staffing options)
4) Funding Options (Homeowner assistance; Town facilities & management- User fees &/or tax base)
5) Record Keeping (inspections, monitoring, tracking)
6) Education and Outreach (Nantucket Harbor Watershed, other identified needs areas/environmentally sensitive areas, Island wide)
7) Management of Onsite Sewage Disposal Systems (Nantucket Harbor Watershed, other identified needs areas/environmentally sensitive areas, Island wide)
8) Timeline

Since 2003, when Earth Tech provided its Draft Septage Management Plan for Nantucket, local regulatory boards, commissions and advisory committees have worked to revise and/or implement regulations, update inspection standards, develop education and outreach materials and strategies, investigate funding options and determine staffing options and needs for septage management. In each instance the Board of Health and Health Department has taken the lead in implementing septage management actions for the Island based on actual existing conditions and/or Island based studies. The following table summarizes actions taken to date and lists actions identified for future action.

| MILESTONE/ACTION/PLAN COMPONENT | TARGET DATE/TIMELINE |
|---|---|
| 1) REGULATIONS: | |
| Local: | |
| A. Update & implement Nantucket Harbor Watershed (NHW) regulations | adopted 5/05 |
| 1. include variance process, enforcement procedures, inspection & certification schedules | |
| 2. develop repair options (escrow account) | proposed 8/05 |

| | |
|---|---|
| 3. adopt blackwater separation separation options | anticipated 6/06 |
| B. Adopt & implement Madaket Harbor Watershed (MHW) regulations, using NHW regs as template | anticipated 12/05 |
| C. Identify remaining "needs areas/ environmentally sensitive areas" | anticipated fall 2006 |
| D. Adopt & implement regulations, using NHW regs as template, for remaining identified "needs areas/environmentally sensitive areas" | anticipated 1/07 – 12/07 |

State:

| | |
|---|---|
| A. Title 5 changes | |
| 1. actively participate as advocate for blackwater separation | 5/05 – 7/06 |
| 2. actively participate as advocate for holding tank and "environ-mentally sensitive areas" changes | 5/05 – 7/06 |
| B. Massachusetts Estuaries Program | 1/03 to post designation hearings |
| 1. assist with program | |
| 2. stay informed to maximize benefit to town | |

2. <u>INSPECTIONS (record keeping, funding and staffing listed separately)</u>

| | |
|---|---|
| A. Revise inspection and certification standards | 5/05 |
| B. Revise inspection schedules | |
| 1. Nantucket Harbor Watershed | 5/05 |
| 2. Madaket Harbor Watershed | anticipated 12/05 |
| 3. other identified "needs areas/ environmentally sensitive areas" | 1/07 – 12/07 |
| 4. other island areas: real estate transfers, failed systems | no changes currently anticipated |

3. STAFFING

| | |
|---|---|
| A. Develop staffing cost needs analysis for implementation of NHW regs and revised inspection/certification standards | 4/05 |
| B. Implement staffing assignments for for NHW regulations, inspections & certifications | 9/05 – 10/05 |
| C. Seek additional staff support | |
| 1. food service, housing inspections | 5/05 – 12/05 |
| 2. consultant assistance for for septic | as deemed necessary by separate contract |
| D. Develop staffing cost and needs analysis for implementation of Madaket Harbor Watershed regs, inspections, certifications | 11/05 |
| E. Implement staffing assignments for MHW regulations, inspections, Certifications | 1/06 – 3/06 |
| F. Seek additional staff support | |
| 1. consultant assistance for septic | as deemed necessary by separate contract |
| 2. additional personnel for for Health Department | 3/06 |
| G. Develop staffing cost & needs analysis for implementation of regulations for other identified "needs areas/environmentally sensitive areas", inspections certifications | 12/06 |
| H. Implement staffing assignments for other identified "needs areas/environmentally sensitive areas", inspections, certifications | 1/07 – 3/07 |
| I. Seek additional staff support | |
| 1. consultant assistance for septic | as deemed necessary by separate contract |
| 2. additional personnel for Health Department | 3/07 |

4. <u>FUNDING</u>

A. Town Wide

1. user fees - to offset non-septic inspections (cover shift in personnel work assignment); to cover additional staffing costs for septic work, including field work, reports & record keeping; and cover costs of consultant services

| | |
|---|---|
| a. develop cost analysis for increase in Health Department staff, for consultant services and/or combination of both | preliminary assessment 4/05 |
| b. establish user fee schedule | 9/05 |
| c. establish revolving account | done |

2. tax base – for O&M, retooling and capital cost offsets fro treatment plant facilities

| | |
|---|---|
| a. develop cost analysis for regular septic system maintenance schedule use of treatment plant | done ? |
| b. develop cost analysis for blackwater treatment (retooling, etc) | 7/06 |

3. grants — ongoing

B. Onsite septic system owner

1. research available loan programs — 10/05

2. establish necessary protocols, agreements, infrastructure for loan programs — 1/06
   a. Nantucket
   b. co-operative with Barnstable County

## 5. RECORD KEEPING

| | |
|---|---|
| A. Board of Health – establish clerical accounting system for inspections, Compliance, scheduling, tracking | prelim computer accounting program in place, update as Needed, ongoing |
| B. Board of Health – system performance Monitoring | |
| 1. Town of Nantucket based | ongoing |
| 2. co-operative with Barnstable County | to be negotiated but available – 9/05 |
| 3. private maintenance contracts | ongoing based on need |
| C. Financial Accounting | |
| 1. Health Department option | ongoing system to be expanded as implementation needs require |
| 2.TON Accounting Dept option if deemed viable | 1/06 |

## 6. EDUCATION & OUTREACH

| | |
|---|---|
| A. Nantucket Harbor Watershed | |
| 1. Nantucket Harbor Watershed Work Group | |
| a. public informational meetings held | 1998- 2002 |
| b. public workshops held | 2002 |
| c. reports issued | 2002 |
| d. information posters & pamphlets developed & distributed | 2000-2002 |
| 2. Health Department | |
| a. participation in civic group meetings | 2004 |
| b development & distribution of NHW regulations/compliance explanation | 2004 |
| c. development & distribution NHW informational notice of regs and noncompliance consequences | 10/05 |

d. development & distribution of warning notice for noncompliance to NHW regs — 3/06

B. Madaket Harbor Watershed
   1. Madaket Harbor Watershed Work Group
      a. public informational meetings — 10/05 – 12/06
      b. development of outreach materials using NHW efforts as template
   2. Health Department
      a. same actions/items as listed for NHW, tailored to Madaket — 10/05 – 12/06

C. Other identified "needs areas/ environmentally sensitive areas"
   1. Dependent upon area identified but will use information developed for NHW and MHW as template — 12/06 – 12/07+

D. Town wide
   1. Board of Health — 2003- ongoing
   2. Town Meetings — 1997-2004
   3. Other public meetings/hearings of boards, commissions, committees — ongoing

## 7. MANAGEMENT OF ONSITE SEWAGE DISPOSAL SYSTEMS

A. Nantucket Harbor Watershed
   1. Board of Health/Health Department
      a. establish tracking system — 2004
      b. establish inspection schedule — 10/05
      c. establish maintenance pumping schedule — 2/06
      d. evaluate & determine whether onsite O & M plans will be established by BOH/Health Department; private sector Contractual agreements; Guidelines provided from — 10/5

| | |
|---|---|
| Other sources (i.e. Barnstable County Health Dept.) | |
| e. evaluate & determine need for consultant contractual agreement to provide assistance | 10/05 & ongoing |
| f. determine user fee schedule to offset costs to TON | 10/05 & ongoing |
| 2. Onsite sewage disposal system owner/manager | |
| a.professional O & M contract required | 10/05 |
| B. Madaket Harbor Watershed | |
| 1. Board of Health/Health Department – same as for NHW, tailored to MHW | 12/05 |
| 2. Onsite sewage disposal system owner/manager – same as for NHW, tailored to MHW | 12/05 |
| C. Other identified "needs areas/ environmentally sensitive areas" | |
| 1. Board of Health/Health Department – same as for NHW & MHW, tailored to needs areas | 12/06 |
| 2. Onsite sewage disposal system owner/manager – same as for NHW & MHW, tailored to Needs areas | 12/06 |
| D. Island wide | |
| 1. Board of Health/Health Department | |
| a. establish maintenance pumping and inspection schedule | 6/06 |
| b. require O & M Plan and contract for all I/A systems | 10/05 |
| c. establish tracking system | 2004 |
| d. establish user fee schedule | 10/05 & ongoing |

8. TIMELIINE; (reference attached graph)

The timeline for the SMP as currently proposed is extremely aggressive and will be impacted both by state and local actions. However, it is clear that the basic components of the SMP can be implemented locally within the existing framework of Town and County of Nantucket government structure. It is also clear that implementation of the SMP as proposed will require strong administrative and financial commitment from governmental officials and voters, not only to achieve the goals as set forth but to have a chance at meeting the proposed schedule. The costs to implement this SMP will be significant but the rewards to the community and the island will be more than quadruple the dollars and time spent.

DISREGUARD AS FIRST DRAFT ATTEMPT----CHOSE DIFFERENT FORMAT

# CURRENT STATUS OF SEPTIC MANAGEMENT PLAN COMPONENTS

1. REGULATIONS: During the last two years, the Nantucket Board of Health has adopted regulations strengthening the management of onsite sewage disposal systems within the Nantucket Harbor Watershed and the Island in general. It is anticipated that the Board of Health will adopt regulations for the Madaket Harbor Watershed by the end of 2005 and determine future "needs areas/environmentally sensitive areas" by 2007. The Conservation Commission has revised its regulatory performance standards to require a 100 foot set back for septic

A. LOCAL -

<u>Board of Health</u>

1. Nantucket Harbor Watershed (updated 5/05)
    - includes variance provisions, mandatory inspection schedule, mandatory repair schedule and enforcement (updated 5/05)
    - proposed "escrow" option to be presented 8/05
    - intended to serve as template for Madaket Harbor Watershed and other to be designated "needs areas/environmentally sensitive areas"
2. Septic System Design and Inspections (updated 5/05)
    - standards applied to all areas of island
    - Nantucket Harbor Watershed establishes mandatory inspection schedule and may require enhanced treatment design
    - Madaket Harbor Watershed regulations establishing mandatory inspection schedule and enhanced treatment provisions anticipated for adoption in 12/05
    - Regulations for other "needs areas/environmentally sensitive areas" as documented by existing conditions data or required by DEP TMDL's is targeted for 1/07

<u>Other Local Regulatory Agencies/Boards/Commissions (as deemed appropriate)</u>

1. Planning Board – consideration of communal space dedicated for "subdivision septic system design" with association required O & M and monitoring may be warranted in environmentally sensitive areas.
2. Conservation Commission – currently requires all leaching facilities to be in

excess of 100 feet from all wetland resource areas. If waiver granted, septic design most likely to require enhanced treatment.

3. Department of Public Works – consideration of existing sewer hook up requirements and blackwater holding tank discharge impacts will be necessary

B. STATE

1. DEP Title 5
2. DEP Groundwater Discharge Permit (POWTF)

# APPENDIX F: WASTEWATER DATA

# FLOWS AND LOADS CALCULATIONS

COMMITMENT & INTEGRITY
DRIVE RESULTS

980 Washington Street | Suite 325
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# MEMORANDUM

**TO:** File
**FROM:**
**DATE:** March 20, 2013
**RE:** Nantucket CWMP – Flows and Loads

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This memorandum presents the methodology for estimating wastewater flows and loads for the CWMP Update.

In order to update the assessment of the Town's wastewater disposal needs and recommend appropriate wastewater disposal solutions for each Need Area and Study Area, Woodard & Curran estimated the wastewater flows and waste loads that would likely be generated in these Areas.

W&C updated the flows and loads for the Need and Study Areas by first revising the counts of developed and undeveloped residential and commercial parcels in each Area, and verifying zoning and land use for each parcel using the Town's Assessor's Database, State Land Use Codes, and the Town's Zoning mapping in GIS.

All developed single-family residential parcels were assumed to have at least one wastewater connection.

All developable or potentially developable residential parcels that met zoning were assumed to have at least one wastewater connection.

We assumed any parcel that meets zoning could have a second dwelling. For example, single-family residential parcels that met zoning were assumed to have two wastewater connections. However, based on discussions with the Town Planner and the fact that approximately only 12% of residences on the island currently have second dwellings, therefore to be conservative, overall, we assumed only 25% of the second dwellings would be built.

All developed commercial parcels were assigned a flow based on acreage. Developable and potentially developable commercial parcels that met zoning were also assigned a wastewater flow based on acreage.

Based on discussions with Nantucket Assessor, we assumed all multi-family parcels in the Areas are equal to two residential wastewater connections.

Average Daily Flow estimates for both summer and winter were developed using the above described parcel count methods and applying the unit flows consistent with the previous CWMP work. In the Phase I CWMP, wastewater flows from 1999 at the Surfside Wastewater Treatment Facility were analyzed in conjunction with the number of residential and commercial units connected to the system to estimate unit wastewater flows. Population data were used to determine the average number of people per residential household. Table XX presents the results of this analysis from the Phase I CWMP. These values were used in calculations for this CWMP update.

| Season | Residential Wastewater Flow (GPD) | Average Number of People per Household | Gallons per Capita Per Day | Commercial Wastewater Flow (GPD) |
|---|---|---|---|---|
| Summer (June – September) | 320 | 4.5 | 71.1 | 445 |
| Winter (December – March) | 185 | 2.5 | 74 | 260 |

"Peak Hourly Flow" and "Maximum Daily Flow" were estimated using peaking factors from TR-16, as was done in the Phase I CWMP. Note that, typically wastewater is composed of residential, commercial and industrial sources. As was the case in both the Phase I CWMP and the 2004 CWMP/FEIR, industrial sources continue to be absent in Nantucket and therefore to be representative of current conditions and consistent with these reports, only residential and commercial flows are developed for this update.

Infiltration and inflow (I/I) was estimated assuming 250 gallons per day-inch-mile (gpdim) for new pipe per MassDEP standards. Infiltration/inflow was not estimated for any low pressure sewer. The length of gravity sewer in Somerset presented in the 2004 CWMP was included in these calculations. The 2004 CWMP identified Madaket and Warrens Landing as being sewered with 100% low pressure. For the remaining needs areas, to determine the total length of sewer, the approximate length of streets within each area was extracted from GIS mapping.

To be consistent with the Phase I CWMP, wastewater loads were calculated by applying industry standard factors from the New England Interstate Water Pollution Control Commission Guides for the Design of Wastewater Treatment Works (TR-16) to the estimated average daily wastewater flows.

**Table 2 - Influent Flows and Pollutant Loads**

| | Flow (MGD) | | | | BOD Load (lbs/day) | | TSS Load (lbs/day) | | Total Nitrogen Load (lbs/day) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average Daily - Summer | Maximum Monthly | Maximum Daily | Peak Hourly | Average Daily | Maximum Monthly | Average Daily | Maximum Monthly | Average Daily | Maximum Monthly |
| Projected by Study / Need Area | | | | | | | | | | |
| Madaket | 0.16 | | | | 490 | | 560 | | 90 | |
| Warren's Landing | 0.03 | | | | 100 | | 110 | | 20 | |
| Hummock Pond South | 0.07 | | | | 200 | | 230 | | 40 | |
| Hummock Pond North | 0.09 | | | | 290 | | 330 | | 50 | |
| Somerset | 0.10 | | | | 320 | | 360 | | 60 | |
| Monomoy | 0.08 | | | | 260 | | 300 | | 50 | |
| Shimmo | 0.06 | | | | 190 | | 220 | | 30 | |
| Town | 0.59 | | | | 1,800 | | 2,050 | | 330 | |
| Nantucket PLUS | 0.07 | | | | 230 | | 260 | | 40 | |
| Miacomet | 0.07 | | | | 210 | | 240 | | 40 | |
| Subtotal Projected | 1.33 | 1.42 | 1.82 | 3.52 | 4,090 | | 4,660 | | 750 | |
| Infiltration/Inflow | 0.06 | 0.06 | 0.06 | 0.06 | | | | | | |
| Total Projected | 1.39 | 1.48 | 1.88 | 3.58 | 4,090 | 4,790 | 4,660 | 6,150 | 750 | 860 |
| Existing Conditions at Surfside WWTF | 1.53 | 1.64 | 2.10 | 4.06 | 4,990 | 5,830 | 3,490 | 4,610 | 530 | 610 |
| **Total Projected and Existing** | **2.92** | 3.13 | 4.00 | 7.74 | **9,080** | 10,620 | **8,150** | 10,760 | **1,280** | 1,470 |

# APPENDIX G: MADAKET WASTEWATER

## NATURAL HERITAGE AND ENDANAGED SPECIES PROGRAM

## MASSACHUSETTS HISTORICAL COMMISSION

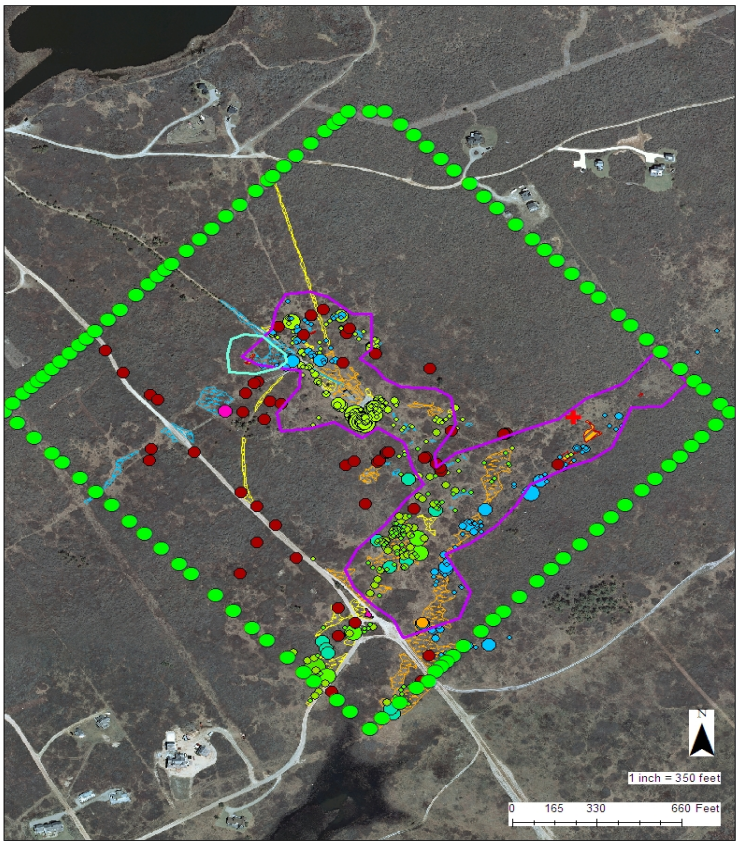
# FAA Property Habitat Assessment and Rare Plant Species Inventory

## NHESP Tracking No. 09-26832

**February 20, 2012**

**Prepared for:**

**Woodard & Curran**
**980 Washington Street, Suite 325N**
**Dedham, MA 02026**




**Prepared by:**

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## Introduction

In 1998, the Nantucket Department of Public works initiated a project to identify areas of the island with sub-surface wastewater disposal problems. The result was a two-part "Comprehensive Waste Water Management Plan and Environmental Impact Report". Within this report, areas with wastewater disposal problems were ranked based on the severity of the issue and ways to mitigate or eliminate the problem were proposed. The west end of Nantucket was noted for having substantial disposal issues, resulting in the potential for both marine resources and ground water to be compromised. To mitigate disposal issues, the development of a new wastewater treatment facility at the former site of the FAA tower has been proposed.

The FAA tower property is a 91.71 acre site located at the west end of Nantucket Island (Figure 1). The property is currently owned by the Federal Government and the Town of Nantucket is working to acquire the parcel. Red Barn Road bisects the property and there is a small building that was utilized when the FAA tower was on the site. With the exception of a few dirt roads and the small building, the property is currently undisturbed.

The FAA property is considered Priority Habitat 15 (PH15) as defined by the Massachusetts Natural Heritage Atlas (13th Edition) for the following rare species:

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Amelanchier nantucketensis* | Nantucket Shadbush | Plant | Special Concern* |
| *Crocanthemum dumosum* | Bushy Rockrose | Plant | Special Concern |
| *Liatris scariosa var. novae-angliae* | New England Blazing Star | Plant | Special Concern |
| *Linum intercursum* | Sandplain Flax | Plant | Special Concern |
| *Scleria pauciflora* | Papillose Nut-Sedge | Plant | Endangered |
| *Sisyrinchium fuscatum* | Sandplain Blue-Eyed Grass | Plant | Special Concern |
| *Asio flammeus* | Short-Eared Owl | Bird | Endangered |
| *Circus cyaneus* | Northern Harrier | Bird | Threatened |
| *Podilymbus podiceps* | Pied-Billed Grebe | Bird | Endangered |
| *Abagrotis nefascia* | Coastal Heathland Cutworm | Butterflies and Moths | Special Concern |
| *Acronicta albarufa* | Barrens Daggermoth | Butterflies and Moths | Threatened |
| *Cingilia catenaria* | Chain Dot Geometer | Butterflies and Moths | Special Concern |
| *Cicindela purpurea* | Purple Tiger Beetle | Beetle | Special Concern |

* *Amelanchier nantucketensis* was a species of Special Concern in the state of Massachusetts when this project began but was recently delisted.

Although there are a large number of rare species listed as being present on or in the vicinity of the FAA property, the decision was made to begin by focusing on plant surveys. The goals of the plant survey were to identify the vegetation communities on the property and determine the locations of any rare plants. Information about the vegetation communities or habitat types present on the property can be used to infer how other rare species may utilize the site.

## Survey Protocol

Plant surveys were performed between May 14 and September 21, 2011. To ensure that the entire site was surveyed, we established transect lines running from the northwest property line to the southeast property line in ArcGIS (ESRI ArcView 9.3, 2008). We used the "intersect" tool to place points 10m apart along each of the property lines. By connecting the points on the northwest and southeast property lines, we created 67 transects that ran the length of the site (Figure 2). These transect lines were uploaded to Trimble Geo XT and Trimble Juno GPS units, which were used to navigate the length of each line.

These transects were primarily utilized during the initial surveys for *Amelanchier nantucketensis.* Not only could this plant theoretically be found throughout much of the site, it was the first survey of the property and so it was important that we cover the whole area to gain a better understanding of the habitat types. Subsequent plant surveys were performed by searching during the time each plant was most visible and within the specific habitat type where the plant occurs.

In the initial survey design, transects were 10m apart. While walking adjacent transects in the field, we determined that it was easy to see between transects that were 20m apart and therefore the decision was made to survey every other transect line for the majority of the site. The vegetation on the eastern third of the property is extremely dense and is almost entirely a monoculture of 2-3m high *Quercus ilicifolia.* After navigating along a number of transects, we determined that the best use of our time would be had by only surveying a subset of transects in this area. In general, areas we felt demanded more intense survey, such as the frost valley, were more thoroughly searched while areas where we did not expect to locate any rare plants were less intensively searched.

### *Habitat Assessment*

We used ArcGIS (ESRI ArcView 9.3, 2008) to define the vegetation communities present on the FAA property. First, we created polygons in ArcGIS (ESRI ArcView 9.3, 2008) by outlining the natural changes in vegetation visible on the 2007 aerial photographs of Nantucket Island. After the polygons were created, we utilized our knowledge of the plants on the FAA property to name and describe the community types present at the site.

### *Rare Species Survey*

When a rare species was located, the species name, number of plants, and representative associated species were recorded. If there were relatively few individuals, and they could all be found within a 1m diameter circle, a GPS point was taken at the center of the occurrence. When a greater number of individuals were present, a line file showing the perimeter around all of the individuals was created. A polygon shapefile was created using the perimeter lines in ArcGIS (ESRI ArcView 9.3, 2008).

## Results

## Geology and Soils

Nantucket Island was the southern terminus of the Wisconsin Glacier. The terminal moraine that transects the island from west to east was pushed ahead of the glacier and deposited as it retreated. The outwash plains on the south-western shore of Nantucket were formed as the melt waters of the glacier flowed to the ocean. The western end of the island, where the FAA site is located, is classified as "young outwash" because it was formed in the most recent retreat of the ice sheet. These younger outwash deposits are mostly gravelly sand with some pebble, cobble and local deposits of silt and clay (Odale 1992).

The soils types found on the FAA property are of the Evesboro and Riverhead associations (Figure 3). Specifically there is Evesboro A, which is a sandy soil with a low 0 – 3% slope, Evesboro B, which is similar but has a slightly greater 3 – 8% slope, and Riverhead A, which is a sandy loam with a low 0 – 3% slope. The Evesboro A, B, and Riverhead A soil types are all well-drained soils, with the Evesboro associations being excessively well-drained (Langlois 1979).

## Habitat Assessment

Seven plant communities were identified on the FAA property (Figure 4). The names for the communities were primarily derived from the "Natural Communities" classifications utilized by the Massachusetts Natural Heritage and Endangered Species Program (Swain and Kearsley 2001). However, we created the community types "Huckleberry Heathland" and "Transitional Scrub Oak Shrubland" to describe areas of the FAA property where woody species are encroaching on early successional communities and they are transitioning to mid-successional communities. Often these transitional communities are not separated from the main vegetation communities but for the purpose of discussing habitat utilization by rare species and habitat management, we decided to increase the resolution of our assessment to include transition zones.

| Community Type | Acres |
|---|---|
| Disturbed | 0.85 |
| Grassland | 0.25 |
| Huckleberry Heathland | 5.6 |
| Huckleberry Scrub Oak Heathland | 17.66 |
| Maritime Shrubland | 1.44 |
| Road | 2.86 |
| Sandplain Heathland | 17.67 |
| Scrub Oak Shrubland | 28.24 |
| Transitional Scrub Oak Shrubland | 17.08 |

### *Disturbed Areas and Roads*

There are multiple dirt and abandoned roads that traverse the FAA property. The largest of these, Red Barn Road, travels from Massasoit Bridge over Long Pond and south to the beach. This road is heavily travelled year-round by automobiles and walkers.

There are also two smaller roads that access the building in the center of the property. The dirt road that turns east off of Red Barn Road is passable with a car. Whereas, the road that proceeds directly north from the building can only be used for pedestrian access because several large pitch pines have decreased the width of the road.

There are two abandoned road beds that proceed northeast from the building. The abandoned road to the west was mowed during the course of the study this summer. The timing of mowing was such that the rare species *Sisyrinchium fuscatum* and *Crocanthemum dumosum*, that had been observed growing there, could not be documented.

Although these roads are abandoned, they remain beneficial habitat for the rare plant species located on the FAA property. The dominant characteristic of the rare plant species and habitats documented on the FAA property is that they are disturbance-dependant. Without frequent disturbance, either in the form of mowing or prescribed fire, these habitats will become overgrown by *Gaylussacia baccata, Quercus ilicifolia,* and *Pinus rigida*. As the habitats undergo succession to later stage communities, the state-listed rare plant species that inhabit them are gradually pushed out.

*Grassland*

The only areas on the FAA property that qualify as grassland are located directly north of the former tower operations building. The reason for the dominance of grasses in this area is likely that the site was disturbed during the construction of the building and may have been mowed when the building was in use. The dominant herbaceous species include *Agrostis spp*, *Dicanthelium spp.*, *Euthamia caroliniana*, *Festuca spp.*, *Panicum virgatum,* and *Schizachyrium scoparium*. The rare species found within the grasslands at the FAA property are *Crocanthemum dumosum, Sisyrinchium fuscatum,* and *Cingilia catenaria.* Sandplain Grasslands are rare and valuable habitat. Although this area is dominated by grasses, it does not have the forb species diversity of a Sandplain Grassland and may be closer to a Cultural Grassland.

*Huckleberry-Scrub Oak Heathlands and Huckleberry Heathlands*

Dunwiddie et al. (1996) subdivided Heathlands into two associations: Tall Shrub and Low Shrub. The Tall Shrub Heathland is further divided into Mixed Maritime Shrubland and Huckleberry-Scrub Oak Heathland. The heathlands found on the FAA property are primarily Tall Shrub, Huckleberry – Scrub Oak Heathlands. This community is dominated by *Gaylussacia baccata* and *Quercus ilicifolia* but retains the interstitial spaces and grassy areas typical of a heathland. We added Huckleberry Heathlands to describe areas where *Gaylussacia baccata* dominates. Areas where there is a monoculture of *Gaylussacia baccata* are likely in transition from Sandplain Heathland to Huckleberry-Scrub Oak Heathland.

Both these communities are found on well-drained soils and have a large component of sub-shrubs such as *Arctostaphylos uva-ursi, Hudsonia ericoides* and *Vaccinium angustifolium*. Interspersed between the shrubs are grass and forb species such as *Carex pensylvanica, Danthonia spicata*, *Ionactis linariifollius* and *Schizachyrium scoparium* (Swain and Kearsley 2001).

Numerous rare plants and animals are found in Huckleberry-Scrub Oak and Huckleberry Heathlands. At the FAA property the following rare species that utilize this habitat were located: *Amelanchier nantucketensis* (delisted January 2012), *Circus cyaneus, Hemileuca maia* and *Cingilia catenaria.*

*Maritime Shrubland*

The shrubs on the south western edge of the FAA property are growing within a low lying swale that, closer to the coast, forms Sheep Pond. The combination of *Gaylussacia baccata*, *Morella pensylvanica*, *Prunus serotina* and *Rosa spp.* most closely resembles a Maritime Shrubland. The Maritime Shrubland community type is represented by low growing shrubs that may be regularly impacted by salt spray (Swain and Kearsley 2001). Although only brackish, there is great potential for salt spray from Sheep Pond and the ocean to impact this area during even small storm events.

*Sandplain Heathland*

The Sandplain Heathland located at the FAA property is known as a glacial plain community because the assemblage of dwarf shrubs is found growing on well-drained, glacially deposited, upland soils. The combination of low growing shrubs interspersed with grasses and forbs observed at the FAA site is typical of a Sandplain Heathland. Sandplain Heathlands and Sandplain Grasslands are very similar in

species composition but Heathlands have a greater proportion of shrub species. Grasslands are also known for having a higher diversity of vascular plants (Swain and Kearsley 2001).

Dominant shrub species in Sandplain Heathlands include *Arctostaphylos uva-ursi, Gaylussacia baccata, Hudsonia ericoides, Quercus ilicifolia* and *Vaccinium angustifolium. Carex pensylvanica* and *Schizachyrium scoparium* are the dominant grasses and are interspersed with forb species such as *Achillea millefolium, Sericocarpus asteroides* and *Tephrosia virginiana*.

Numerous rare plants and animals are found in Sandplain Heathlands. At the FAA property the following rare species that utilize this habitat were located: *Amelanchier nantucketensis* (delisted January 2012), *Circus cyaneus, Hemileuca maia* and *Cingilia catenaria.* This habitat is ranked as S1 in the state of Massachusetts, indicating that there are five or fewer "good" examples of this habitat type (Swain and Kearsley 2001).

*Scrub Oak Shrubland*

Scrub Oak Shrublands occur on dry, sandy soils and are dominated by tall (1-3m) *Quercus ilicifolia* and/or *Quercus prinoides*. The shrubs can be quite dense, often forming an impenetrable thicket. In areas where there is sufficient light penetration, additional species such as *Arctostaphylos uva-ursi, Carex pensylvanica, Comptonia peregrina, Gaylussacia baccata*, *Photinia melanocarpa*, *Schizachyrium scoparium* and *Vaccinium angustifolium* may be found.

Scrub Oak Shrublands are important for several rare species of Lepidoptera, including *Hemileuca maia*, which was located on the site during 2011 surveys. This habitat is ranked as S1 in the state of Massachusetts, indicating that there are five or fewer "good" examples of this habitat type. (Swain and Kearsley 2001)

*Transitional Scrub Oak Shrubland*

The Transitional Scrub Oak Shrubland was constructed for the FAA property to describe the large areas of heathland that contain upwards of 50%, of *Quercus ilicifolia*. This community type may also be referred to as "Open Scrub Oak". In addition to a greater proportion of *Quercus ilicifolia,* there are few to no open areas with sparse cover. For the most part, areas of heathland with increased cover and higher proportions of scrub oak are in the process of evolving from a Huckleberry-Scrub Oak Heathland to a Scrub Oak Shrubland community.

## Rare Species Surveys

*Amelanchier nantucketensis* (Nantucket shadbush), *Sisyrinchium fuscatum*, *Crocanthemum dumosum*, *Linum intercursum*, and *Liatris scariosa var. novae-angliae* were all found on the FAA tower property. During the surveys, three additional rare species were recorded; a pair of *Circus cyaneus* (Northern Harrier, State Rank - Threatened), a single 3rd instar larva of *Hemileuca maia* (Coastal Barrens Buck moth, State Rank – Special Concern), and countless *Cingilia catenaria* (Chain Dot Geometer, State Rank – Special Concern).

| Scientific name | Common name | Approximate bloom time or survey time on Nantucket | State Rank |
|---|---|---|---|
| *Amelanchier nantucketensis* | Nantucket shadbush | Early May | Special Concern<br>(Delisted January 2012) |
| *Crocanthemum dumosum* | bushy rockrose | Late May to mid June | Special Concern |
| *Liatris scariosa var. novae-angliae* | New England blazing star | Late August to late-September | Special Concern |
| *Linum intercursum* | sandplain flax | July and early August | Special Concern |
| *Scleria pauciflora var. caroliniana* | papillose nut-sedge | Mid August to mid-September | Endangered |
| *Sisyrinchium fuscatum* | sandplain blue-eyed grass | Late May to early July | Special Concern |

*Amelanchier nantucketensis*

*Amelanchier nantucketensis* Bickn. (Rosaceae) was officially removed from the state list of Rare and Endangered Species in January 2012. However, we performed surveys for this species during our fieldwork in 2011 and therefore our findings are included in this report.

*Amelanchier nantucketensis* is an upright, colonial shrub that can be up to 3m in height. The leaves are unexpanded at anthesis and buds are densely pubescent. After expansion, leaves become glabrous with a shiny upper surface and gray-green underside. Leaves are dentate and have an acute to acuminate tip. Fruits generally ripen in July (Haines 2011, Cullina and Polloni 2007). In Massachusetts, it blooms in May and early June and produces 4-10(15) cream colored flowers in a raceme. Flowers are diminutive, with short (≥7mm), spatulate petals.

Short petal length and andropetally are the major characteristics that differentiate this species from others in the genus *Amelanchier* (Cullina and Polloni 2007). While *Amelanchier arborea, Amelanchier laevis,* and *Amelanchier canadensis* are also known from Nantucket, none have the diminutive petals that are characteristic of *A. nantucketensis*. There is ongoing discussion as to the existence of *Amelanchier stolonifera* on Nantucket. Sorrie and Dunwiddie (1996) list one historic collection of *Amelanchier stolonifera* (*Amelanchier spicata*) in his book "The Vascular and Non-Vascular Flora of Nantucket, Tuckernuck, and Muskeget Islands" but it is not considered to be commonly found on the island. Both *Amelanchier nantucketensis* and *Amelanchier canadensis* are found on Nantucket in similar habitats. To accurately identify this species, it must be observed in flower.

Searches were performed for *Amelanchier nantucketensis* on May 14, 15, 18, 19 and 20, 2011. During that time, 55 occurrences were located for a total of 734 plants (Figure 5). All of the occurrences were located on the western two thirds of the property where the vegetation is not as dense. *Amelanchier nantucketensis* is known for inhabiting disturbed areas and 15 of the occurrences were located along road edges. Common associated species include *Epigaea repens, Gaylussacia baccata, Morella pensylvania, Quercus ilicifolia, Vaccinium angustifolium,* and *Viburnum dentatum.*

*Crocanthemum dumosum*

*Crocanthemum dumosum* is a yellow, perennial wildflower that is found in the sandplain grasslands and sandplain heathlands throughout Nantucket. There are four species of rock-rose on Nantucket Island, *Crocanthemum dumosum, Crocanthemum propinquum, Crocanthemum bicknellii,* and *Crocanthemum canadense.*

This species is a member of the taxonomically cryptic rockrose genus (Cistaceae). While the vast majority of the individuals can be attributed definitively to one species, there are situations where it is not clear. At least two species of *Crocanthemum* are known to occur commonly in sandplain grassland habitat: *Crocanthemum dumosum* and *Crocanthemum propinquum*. The primary characteristic that can be used to differentiate these two species is their growth form. *Crocanthemum propinquum* exhibits a clonal growth form and produces numerous short, upright, unbranched stems. In contrast, *Crocanthemum dumosum* is highly branched and while it can be low growing and grow in clusters, there are always distinct individuals.

*Crocanthemum dumosum* and *Crocanthemum canadense* can be very challenging to differentiate when found growing in overlapping habitat. The dominant characters cited to differentiate the two species are the growth habit and density of pubescence on the mid-stem leaves. *Crocanthemum dumosum* is known to be densely pubescent with low lying and branched stems while *Crocanthemum canadense* has fewer leaf hairs and more upright stems. The other characteristic noted in Arthur Haines' key (2011) is the papillae on the surface of the seeds. In *Crocanthemum dumosum,* the papillae are described as "low and broad" whereas the papillae in *Crocanthemum canadense* are described as "elongate". Phenology is another trait that may aid in identifying individuals. *Crocanthemum dumosum* blooms earlier in the season than *Crocanthemum canadense* (Haines 2011).

The timeframe and habitat for *Sisyrinchium fuscatum* and *Crocanthemum dumosum* searches overlapped and so flagging for both species was concurrent. Flagging for *Sisyrinchium* and *Crocanthemum* occurred on May 30, June 1, 13, 15, 18 through 22, July 6 and 11, 2011. We waited to GPS most plants until the end of August, specifically August 24, 29, and September 21, 2011, so that we could examine seeds and make conclusive species determinations when necessary. Any additional plants observed unflagged were marked at this time. At the FAA property there were three *Crocanthemum* species located; *Crocanthemum dumosum, Crocanthemum propinquum,* and *Crocanthemum. canadense.* Only *Crocanthemum dumosum* was GPSed. Nine hundred and forty-four individuals of *Crocanthemum dumosum* were located throughout the areas defined as sandplain heathland habitat (Figure 6). Common associated species include *Arctostaphylos uva-ursi, Gaylussacia baccata, Morella pensylvanica, Rosa virginiana, Schizachyrium scoparium,* and *Sericocarpus asteroides*.

*Liatris scariosa var. novae-angliae*

*Liatris scariosa var. novae-angliae* is a rare grassland perennial found primarily on road edges and in disturbed habitats throughout Nantucket. It is a member of the Asteraceae and is endemic to the Northeastern United States. *Liatris scariosa* var. *novae-angliae* is the only *Liatris* species found on Nantucket and is easily identifiable when it is in bloom by the purple, thistle-like flower heads it produces. Plants are able to reproduce for multiple years by over-wintering as a corm (Kane and Schmidt 2001).

Searches for *Liatris scariosa var. novae-angliae* were performed on September 2 and 19, 2011. Sixty four *Liatris scariosa var. novae-angliae* were located on the FAA property. There were only two locations where plants were found and both were highly disturbed sites (Figure 7). The largest occurrence,

containing 57 plants, was located on the southern end of the triangle at the intersection of Red Barn and Sheep Pond Roads. Associated species include *Arctostaphylos uva-ursi, Panicum virgatum, Rubus flagellaris, Schizachyrium scoparium* and *Gaylussacia baccata.*

*Linum intercursum*

*Linum intercursum* Bickn. (Linaceae) is a small, perennial herb that flowers in late July and early August. The yellow flowers have five petals and are produced at the top of stiff ascending branches. The leaves are narrowly elliptic. *Linum intercursum* is generally found growing in colonies in open, upland habitats that are frequently disturbed (http://www.mass.gov/dfwele/dfw/nhesp/species_info/nhfacts/linint.pdf).

A search for *Linum intercursum* was performed on August 8, 2011 and was restricted to areas within the frost valley that were very dry, open and grassy. One occurrence with three plants was located on the western edge of the frost valley (Figure 8). The associated species include *Arctostaphylos uva-ursi, Gaylussacia baccata, Potentilla simplex, Rubus flagellaris, Schizachyrium scoparium,* and *Tephrosia virginiana.*

*Scleria pauciflora var. caroliniana*

*Scleria pauciflora* is a taxonomically distinct species that is found in maritime grasslands and sandy soils on glacial till or outwash in the northeast. This member of the Cyperaceae is known from 12 sites in Massachusetts and is currently listed as endangered. There are two varieties of *S. pauciflora* known from New England: *S. pauciflora var. caroliniana* and *S. pauciflora var. pauciflora*. Although they are both listed as endangered in the state of Massachusetts, *Scleria pauciflora var. caroliniana* is the more common of the two varieties. The two varieties are differentiated by the degree of hairiness. *Scleria pauciflora var. caroliniana* is villous with hairs from 0.5 to 1mm long on the stems and leaves while *S. pauciflora var. pauciflora* is glabrous or sparsely hairy with hairs less than 0.4mm long. However, the two varieties are known to interbreed and therefore differentiating between them can be challenging (Zaremba 2004).

*Scleria pauciflora* is most easily identifiable by the small, white achenes it produces in the fall post-flowering. The achenes are subglobose and when examined under a hand lens are visibly covered with small protrusions.

A search for *Scleria pauciflora* was performed on September 19, 2011. Similar to *Linum intercursum*, the search for *Scleria pauciflora* was restricted to areas defined as sandplain heathland. No *Scleria pauciflora* was located even though there is appropriate habitat located on the property.

*Sisyrinchium fuscatum*

*Sisyrinchium fuscatum* is a perennial member of the Iridaceae (Iris family). This plant is differentiated from *Sisyrinchium atlanticum*, which is known from predominantly wetland habitats on Nantucket, by its persistent, thick, dark, fibrous leaf bases (Boufford 1997). *Sisyrinchium fuscatum* is cespitose. Inflorescences are borne singly on individual stems in June. Seed capsules are a light to medium brown color.

The timeframe and habitat for *Sisyrinchium fuscatum* and *Crocanthemum dumosum* searches overlapped and so flagging for both species was concurrent. Flagging for *Sisyrinchium* and *Crocanthemum* occurred on May 30, June 01, 13, 15, 18 through 22, July 6 and 11, 2011. Survey time was focused on areas of sandplain heathland and grassland. A total of 7205 *Sisyrinchium fuscatum* were found in the sandplain heathland and disturbed areas on the FAA property. The largest numbers of plants were concentrated in the frost valley that runs along the southern edge of the property from the southwest corner to the eastern property line (Figure 9). Common associated species include *Arctostaphylos uva-ursi, Gaylussacia baccata, Morella pensylvanica, Rosa virginiana, Schizachyrium scoparium,* and *Sericocarpus asteroides*.

*Additional Rare Species*

Three additional rare species, a pair of *Circus cyaneus* (Northern Harrier), a single 3rd instar larva of *Hemileuca maia* (Barrens buck moth), and large numbers of *Cingilia catenaria* (Chain dot geometer moths), were observed on the FAA property while rare plant surveys were being performed. The first, a pair of Northern Harriers (*Circus cyaneus*), is believed to have been nesting northwest of the old FAA tower operations building. Sightings of a male and female *Circus cyaneus* calling to each other were reported on May 19, 2011. The pair was flying near the house just beyond the northwest corner of the FAA property. The following day, May 20, a female *Circus cyaneus* was reported hunting at 10:30 am just north of the old FAA tower operations building. That afternoon, at 4:30pm, a male *Circus cyaneus* was reported hunting to the southeast of the FAA operations tower building. On June 1, at 2pm, a male *Circus cyaneus* was observed hunting to the south and east of the building. On June 5, a prey transfer was observed between a male and female *Circus cyaneus* at 5:30pm to the northwest of the building. Using the position of the prey transfer, we put an approximate nest location on the map (Figure 10). After the prey transfer, no more *Circus cyaneus* activity was noted and on June 13, an empty *Circus cyaneus* egg (Figure 11) with a piece missing was found slightly east of where the prey transfer occurred. Based on the appearance of the egg and after discussion with avian experts, we were informed that the nest was probably predated and the pair left.

In addition, a single *Hemileuca maia* was found on a small *Quercus ilicifolia* in the frost valley on July 18, 2011 (Figure 12). The larva was a third instar larva and therefore quite large and noticeable (Figure 13). The bright yellow larva and white adults of the *Cingilia catenaria* (Figure 14) were observed throughout the heathlands on the FAA property (Figure 15) during June, July and August. No assessment of the number of larvae was performed but there were large areas where the vegetation, particularly, *Gaylussacia baccata*, was completely defoliated due to the larva. Adults were observed while performing surveys in September.

## Discussion

Surveys at the FAA property clearly show that the site is host to a number of state-listed individual rare species as well as globally rare vegetation communities. The ecological value of such a property cannot be understated. However, there are a number of things to keep in mind when evaluating the results of this report.

Our report shows that the greatest density of state-listed rare plant species is found within the early successional sandplain heathland, grassland, and disturbed habitats. While this is true, had we been surveying the property for rare Lepidoptera or *Circus cyaneus* habitat, the mid-successional scrub oak shrublands would appear equally important. *Quercus ilicifolia* is a primary host plant for a number of rare Lepidoptera, such as *Hemileuca maia.* Therefore, when examining our results and seeing the

predominance of rare species occurrences throughout certain areas of the property, it should be kept in mind that we are only showing the locations of rare plants and if other species were included, the maps would appear entirely different.

When selecting how to define our vegetation communities, we elected to separate what we refer to as transition zones. We decided to do this because we felt it was important to show that the property itself is undergoing successional changes. Without management in the future, many of the areas that are currently sandplain heathland, huckleberry heathland and huckleberry scrub oak heathland will be further encroached upon by woody species and will continue transitioning towards scrub oak shrublands or pitch pine- scrub oak communities.

Sandplain communities in the northeastern United States require periodic disturbance to be maintained (Lorimer and White 2002, Wagner et al. 2003). Prior to current fire suppression practices, fire was a common natural disturbance in sandplain habitats. The frequency of historic seasonal fires and severe summer wildfires resulted in fire-adapted plant communities. On Nantucket, intense sheep grazing was also a prominent form of disturbance. In the absence of severe fires or intensive grazing practices, a combination of mechanical cutting and prescribed fire may be used to achieve the varied landscape of a sandplain community (Wagner et al. 2003). Maintaining the current communities through management will help to preserve the abundant diversity that is present at the FAA property.

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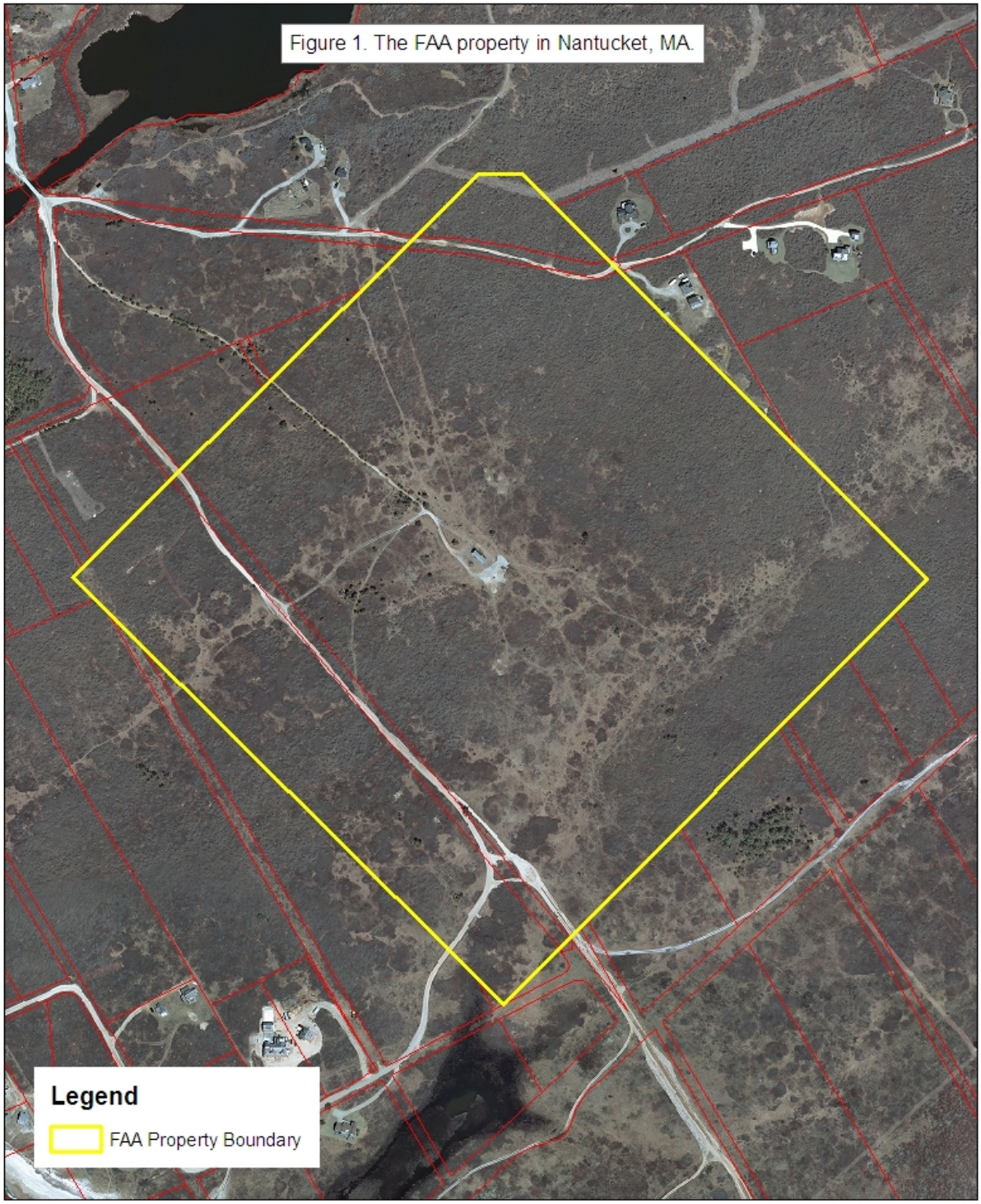
Zaremba, Robert 2004. *Scleria pauciflora* Muhlenberg ex Willdenow var. *caroliniana* Alph. Wood and *Scleria pauciflora* Muhlenberg ex Willdenow var. *pauciflora*. (Fewflowered nut-rush) Conservation and Research Plan for New England. New England Wild Flower Society, Framingham, Massachusetts, USA.




1 inch = 400 feet

0 185 370 740 Feet

N

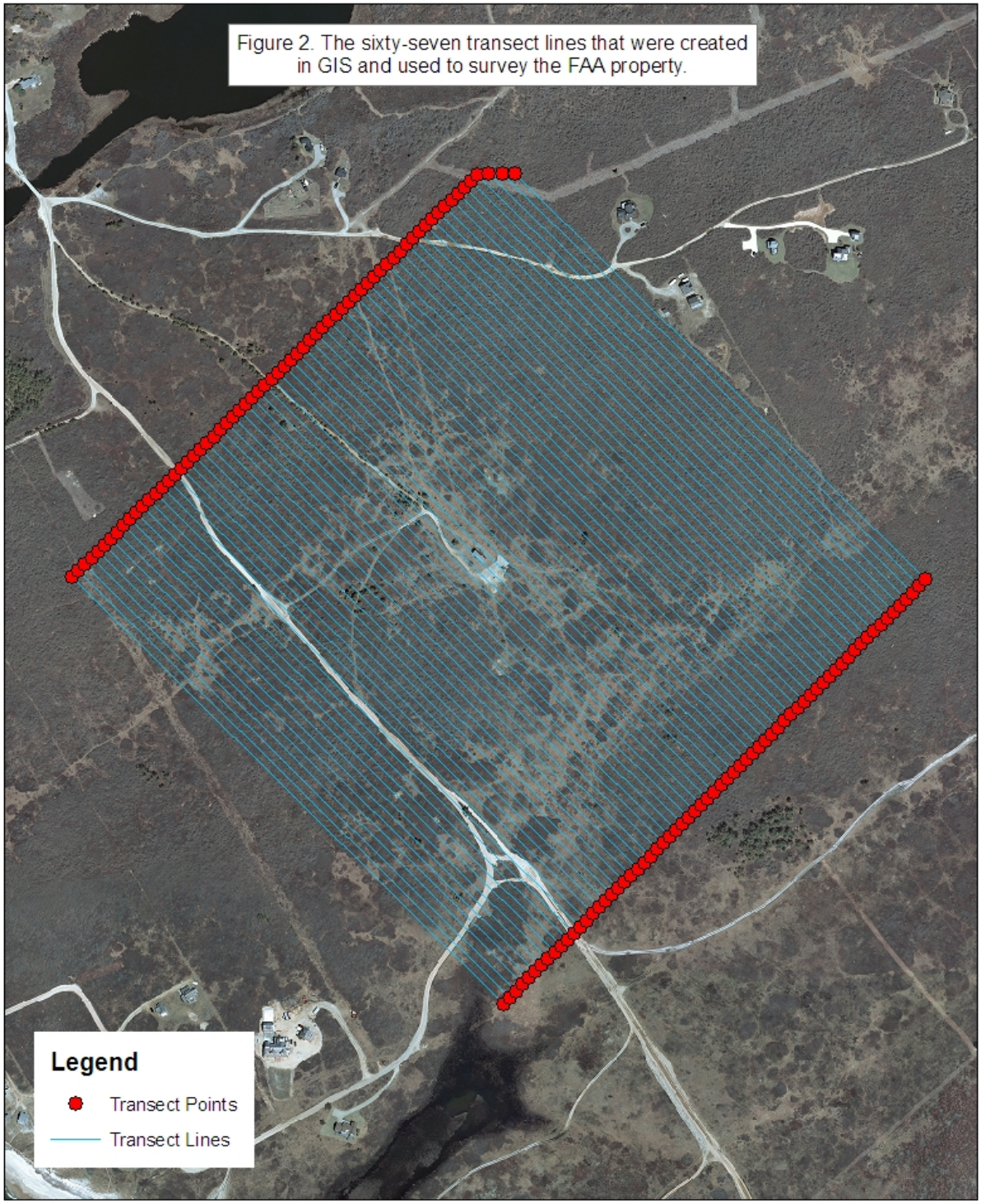



Figure 2. The sixty-seven transect lines that were created in GIS and used to survey the FAA property.

1 inch = 400 feet

0 187.5 375 750 Feet

N

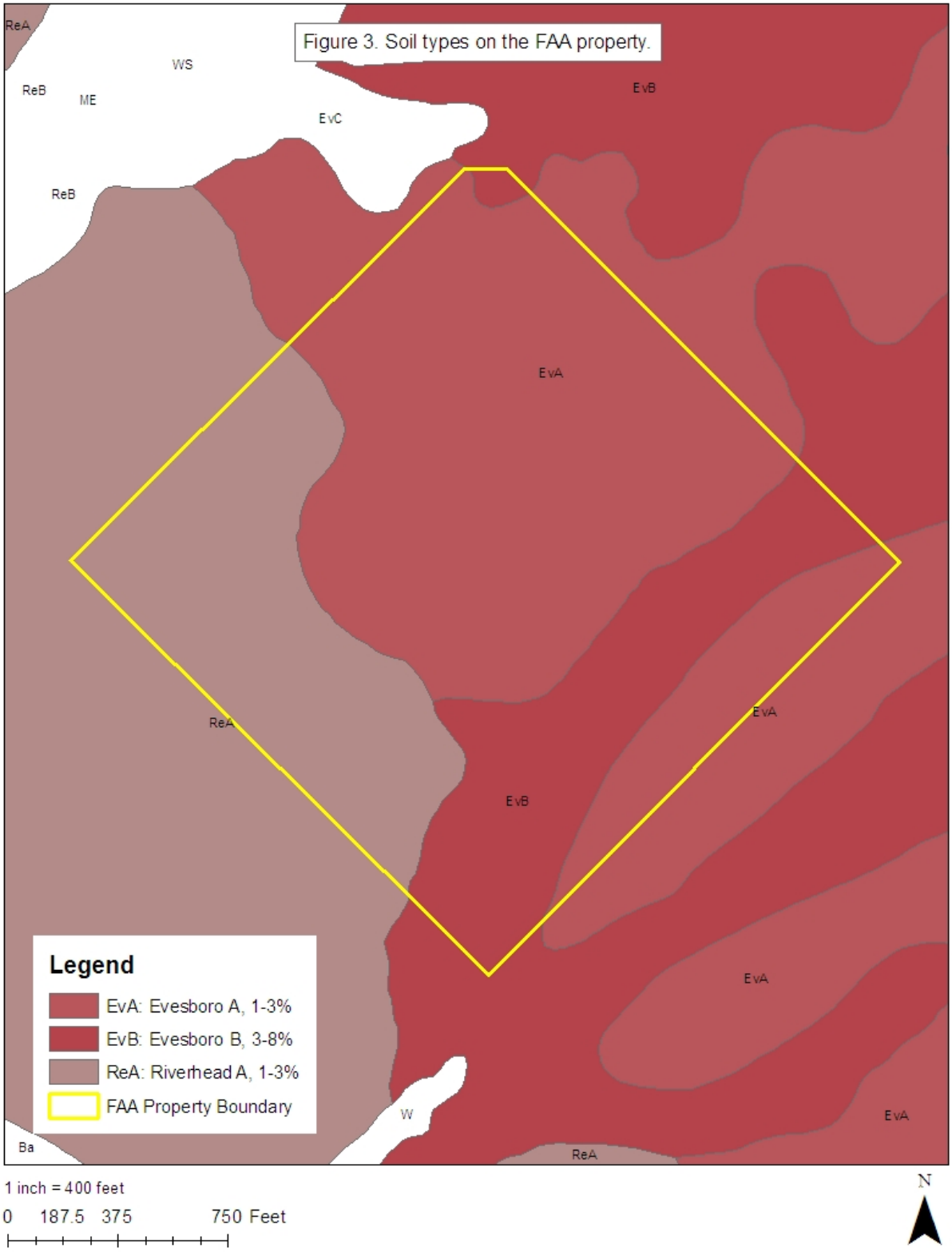


Figure 3. Soil types on the FAA property.
ReA
WS
ReB
ME
EvC
EvB
ReB
EvA
ReA
EvA
EvB
EvA
W
EvA
Ba
ReA
Legend
EvA: Evesboro A, 1-3%
EvB: Evesboro B, 3-8%
ReA: Riverhead A, 1-3%
FAA Property Boundary
1 inch = 400 feet
0 187.5 375 750 Feet
N

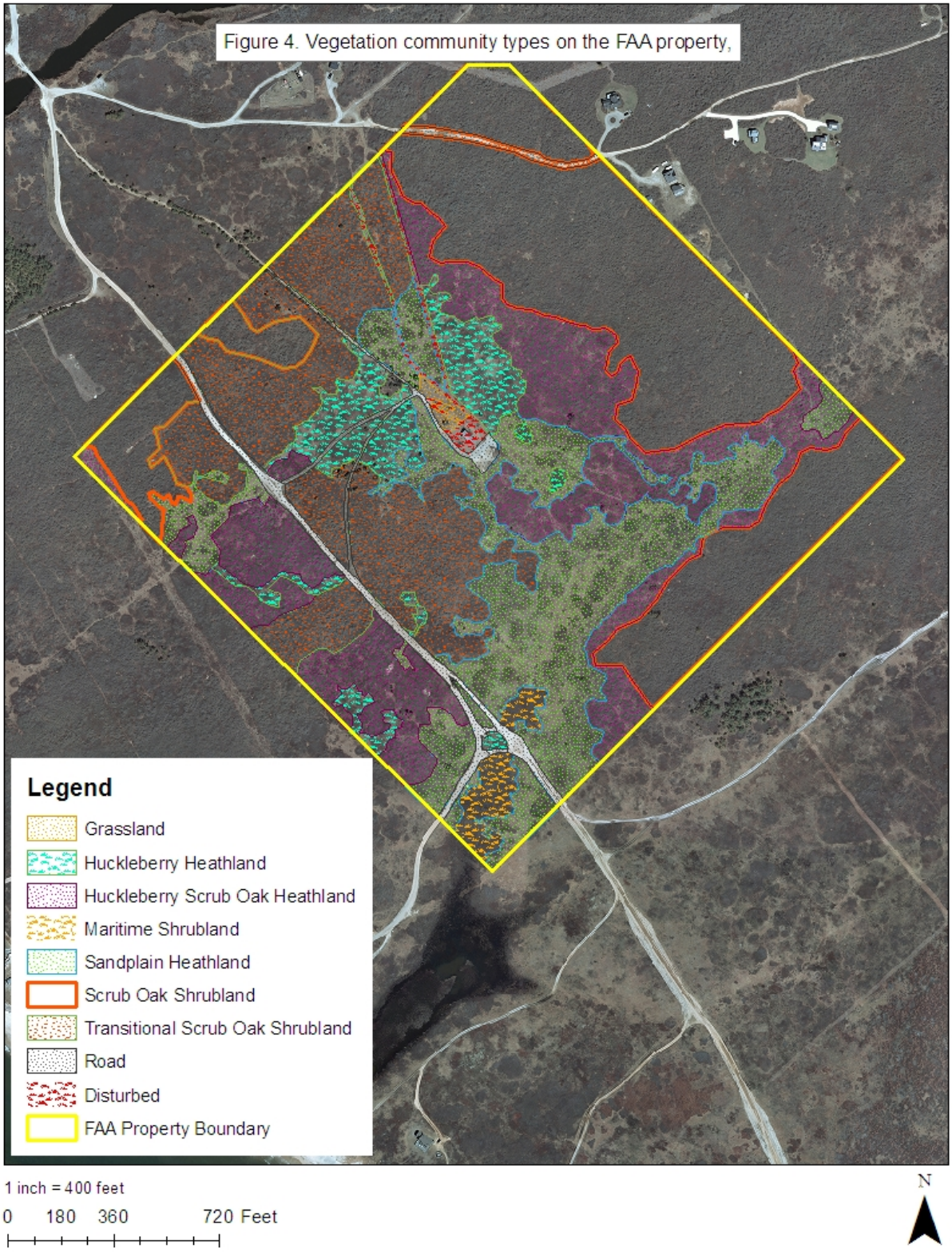


Figure 4. Vegetation community types on the FAA property,
Legend
Grassland
Huckleberry Heathland
Huckleberry Scrub Oak Heathland
Maritime Shrubland
Sandplain Heathland
Scrub Oak Shrubland
Transitional Scrub Oak Shrubland
Road
Disturbed
FAA Property Boundary
1 inch = 400 feet
0 180 360 720 Feet
N

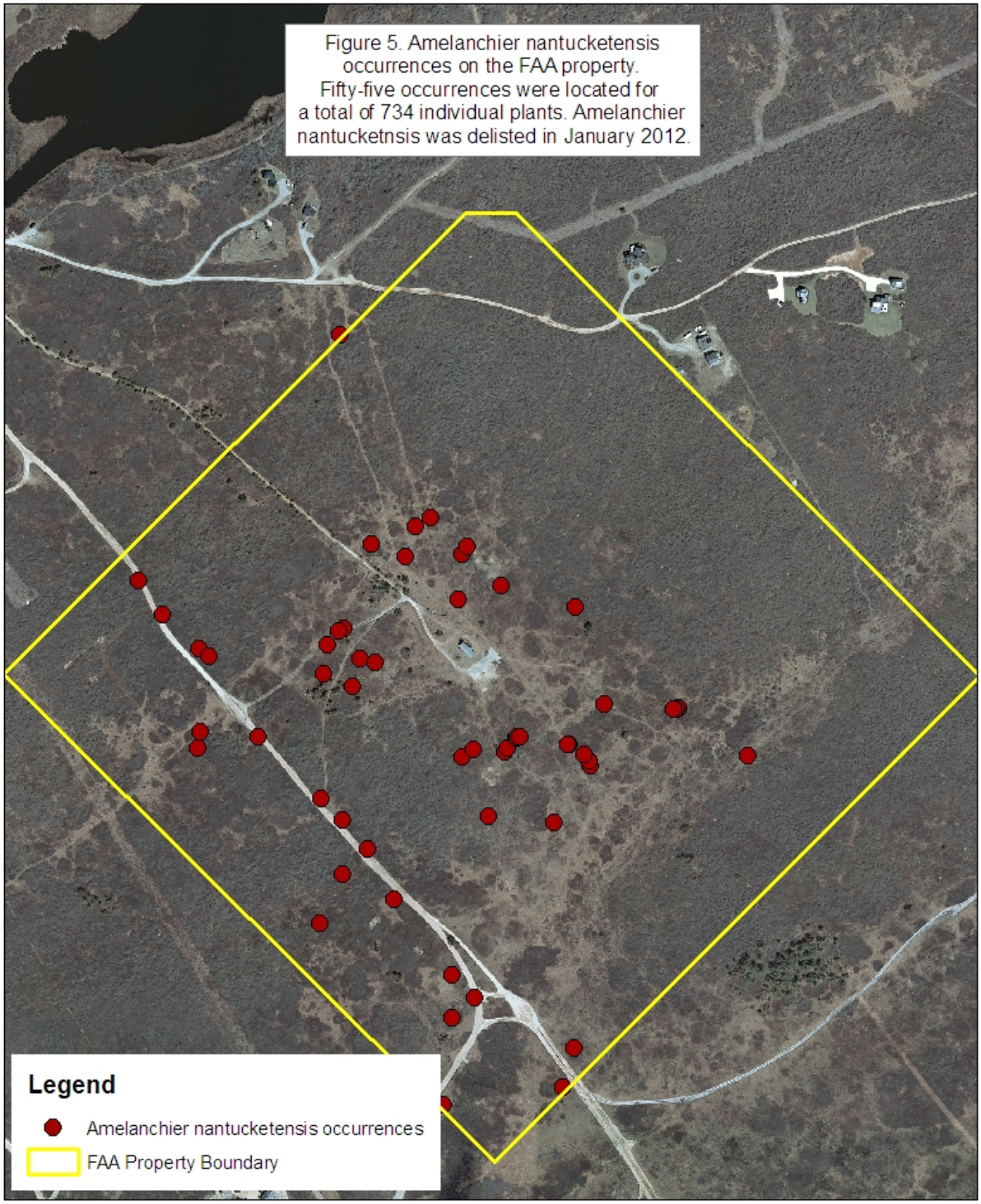



Figure 5. Amelanchier nantucketensis occurrences on the FAA property. Fifty-five occurrences were located for a total of 734 individual plants. Amelanchier nantucketnsis was delisted in January 2012.

1 inch = 350 feet

0 155 310 620 Feet

N

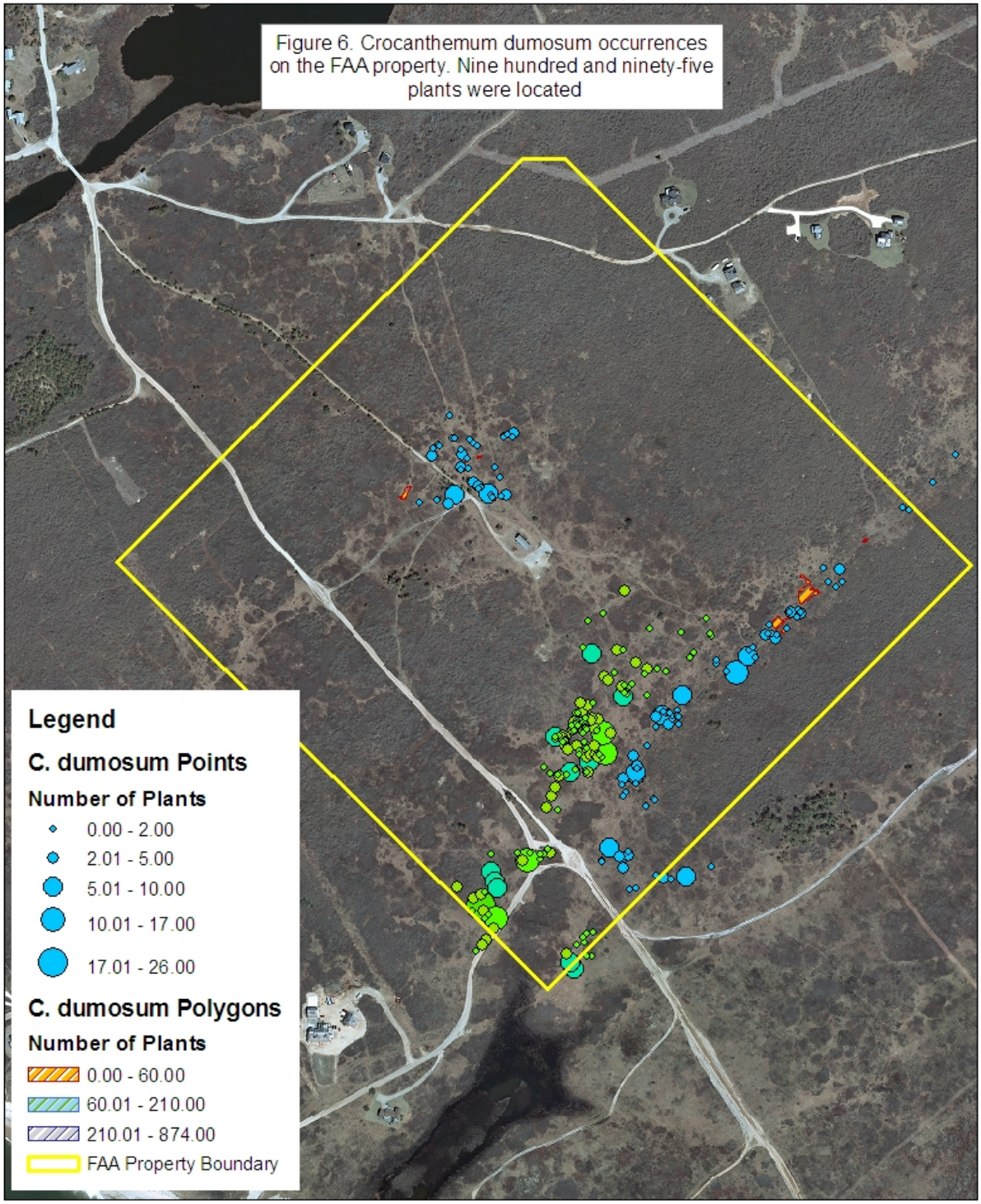



Figure 6. Crocanthemum dumosum occurrences on the FAA property. Nine hundred and ninety-five plants were located

1 inch = 400 feet

0 175 350 700 Feet

N

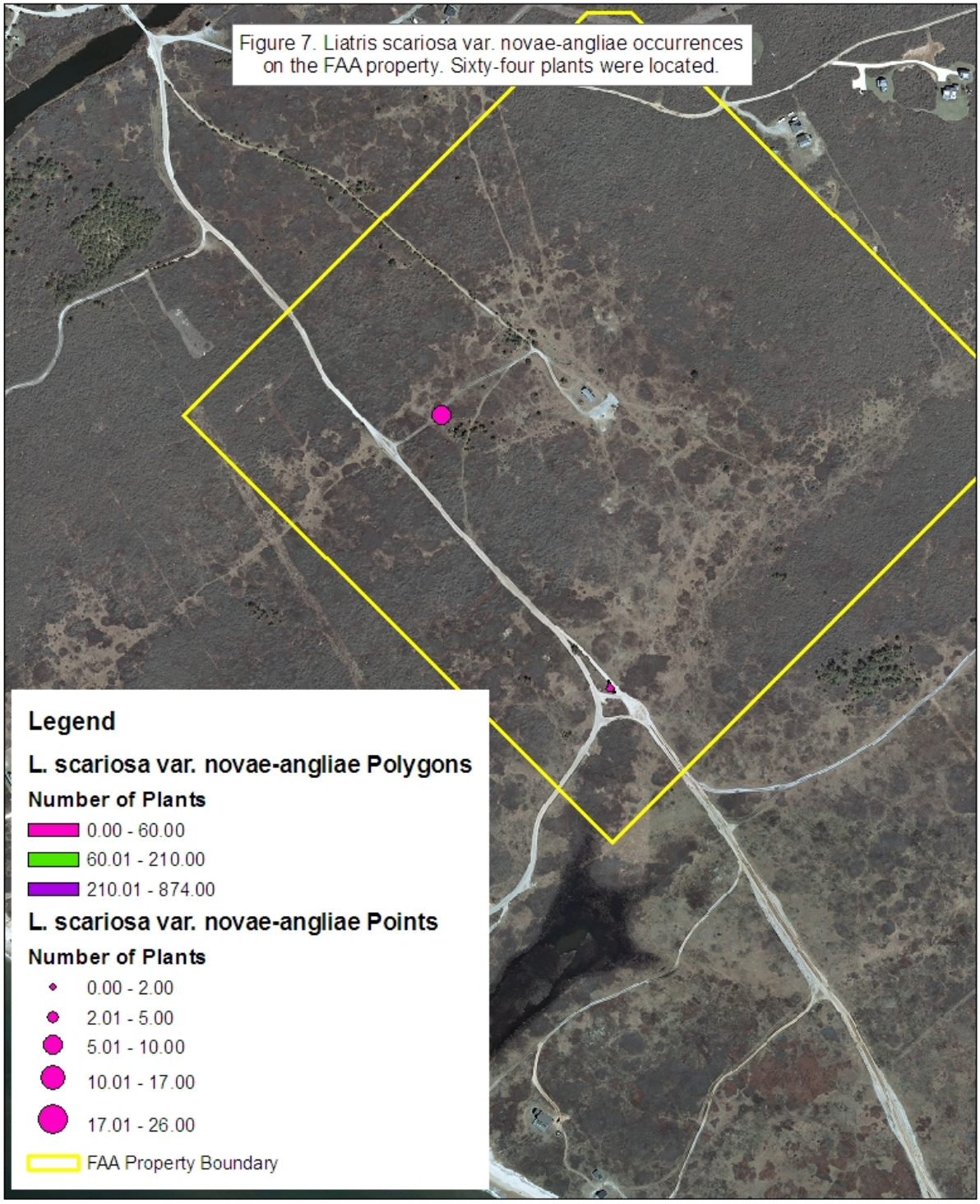



Figure 7. Liatris scariosa var. novae-angliae occurrences on the FAA property. Sixty-four plants were located.

1 inch = 400 feet

0 175 350 700 Feet

N

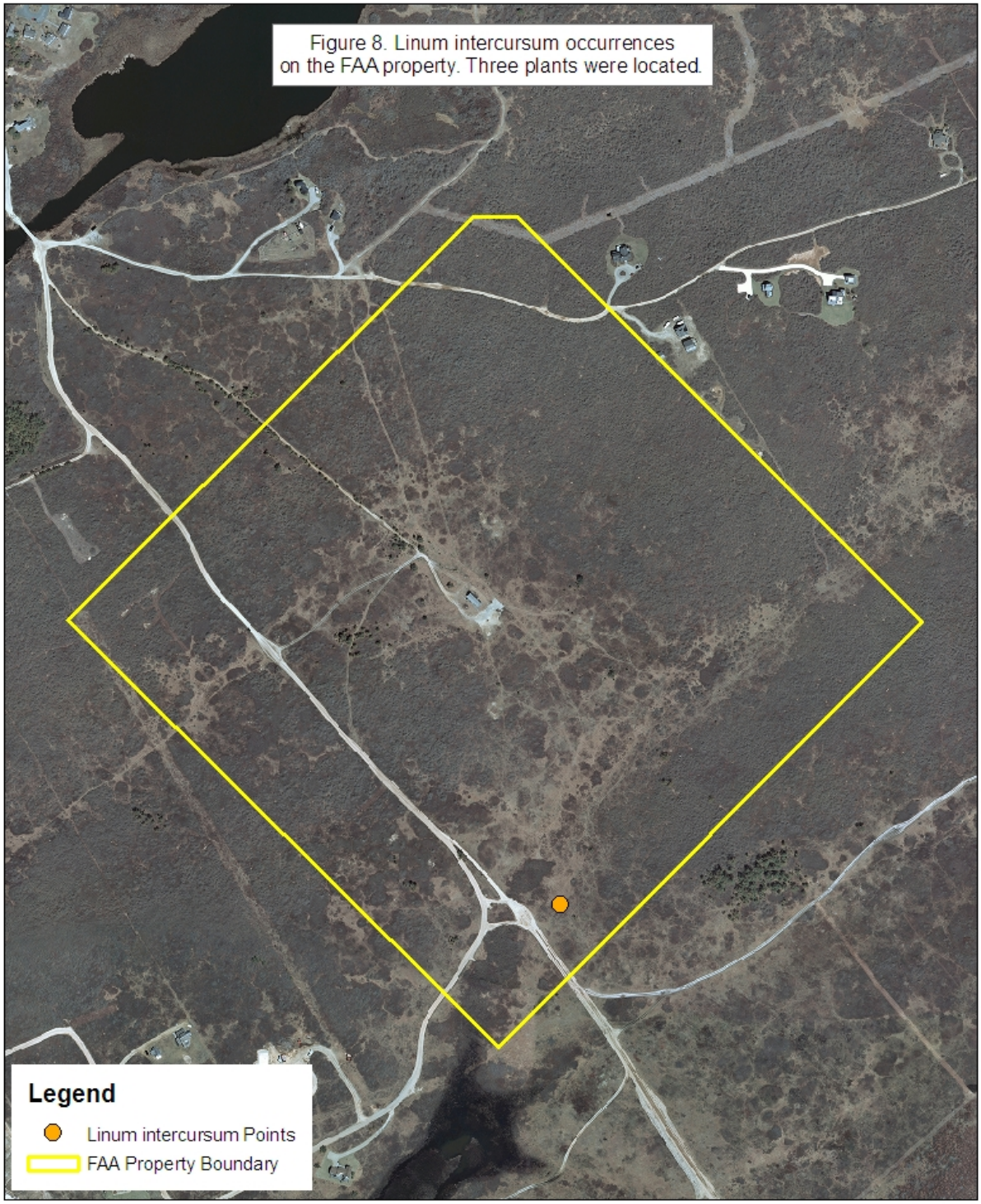



Figure 8. Linum intercursum occurrences on the FAA property. Three plants were located.

1 inch = 400 feet

0 175 350 700 Feet

N

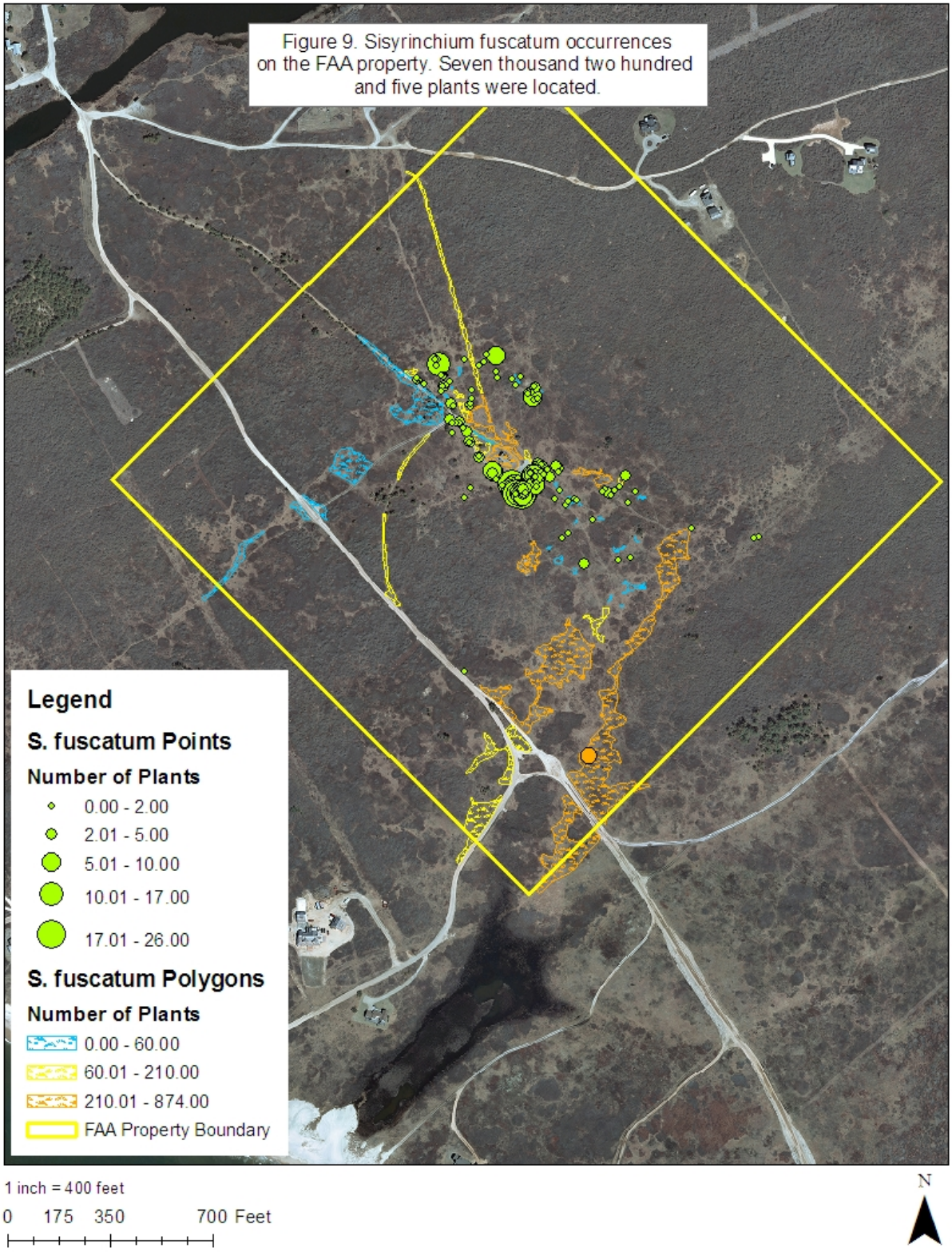



Figure 9. Sisyrinchium fuscatum occurrences on the FAA property. Seven thousand two hundred and five plants were located.

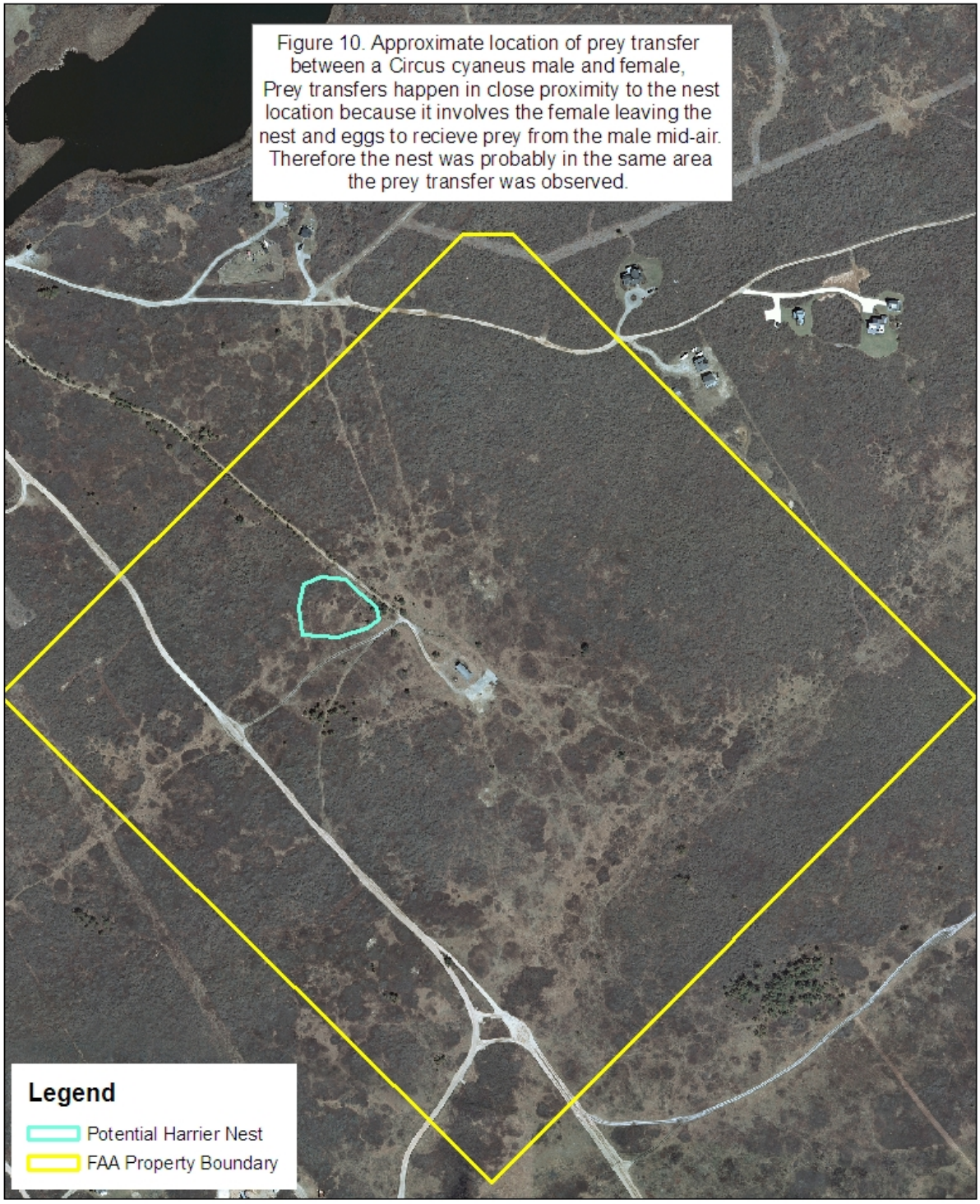



Figure 10. Approximate location of prey transfer between a Circus cyaneus male and female, Prey transfers happen in close proximity to the nest location because it involves the female leaving the nest and eggs to recieve prey from the male mid-air. Therefore the nest was probably in the same area the prey transfer was observed.

1 inch = 350 feet

0 150 300 600 Feet

N

Figure 11. Probable *Circus cyaneus* egg.

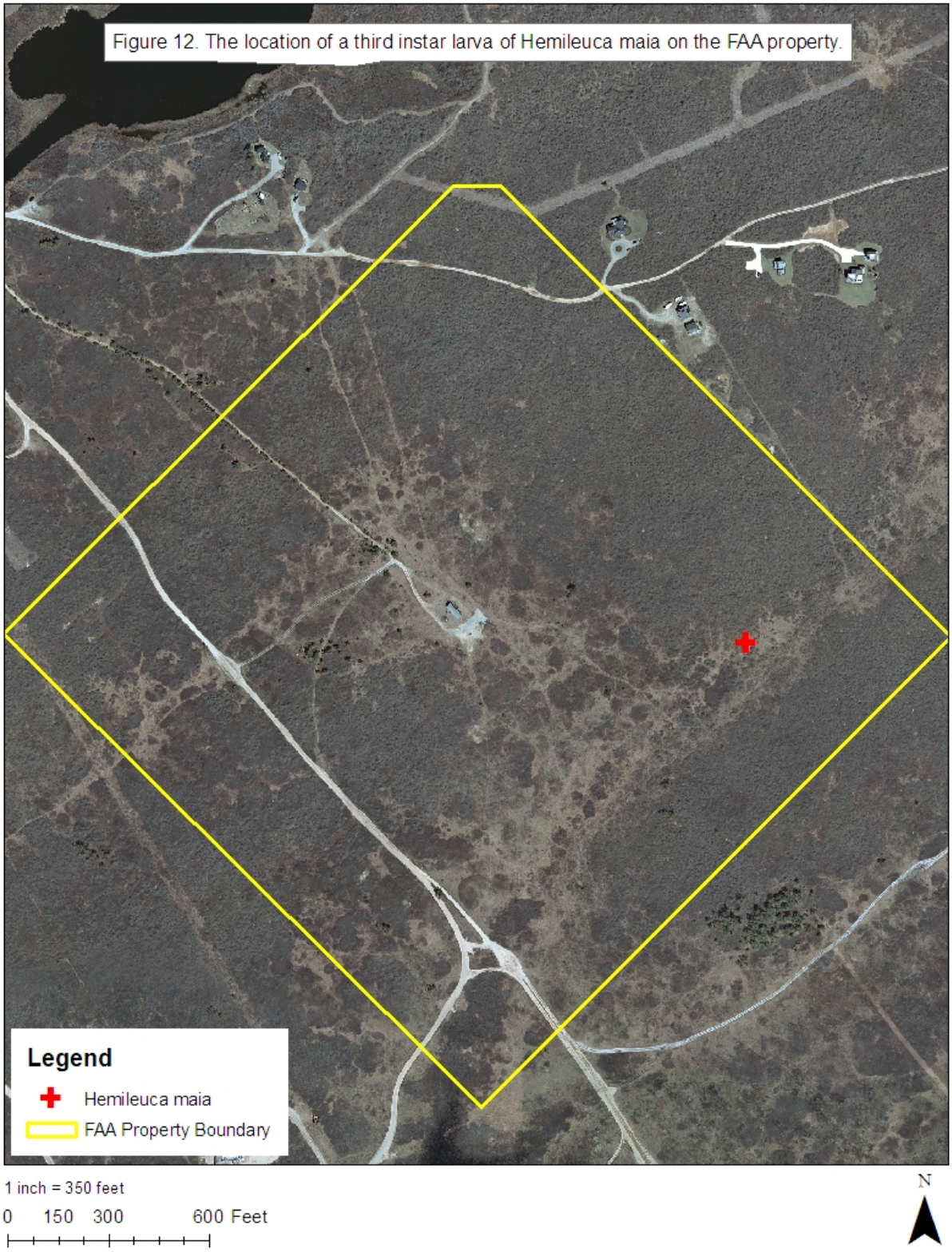



Figure 12. The location of a third instar larva of Hemileuca maia on the FAA property.

Figure 13. Third instar *Hemileuca maia*.

Figure 14. Larva and adult *Cingilia catenaria.*

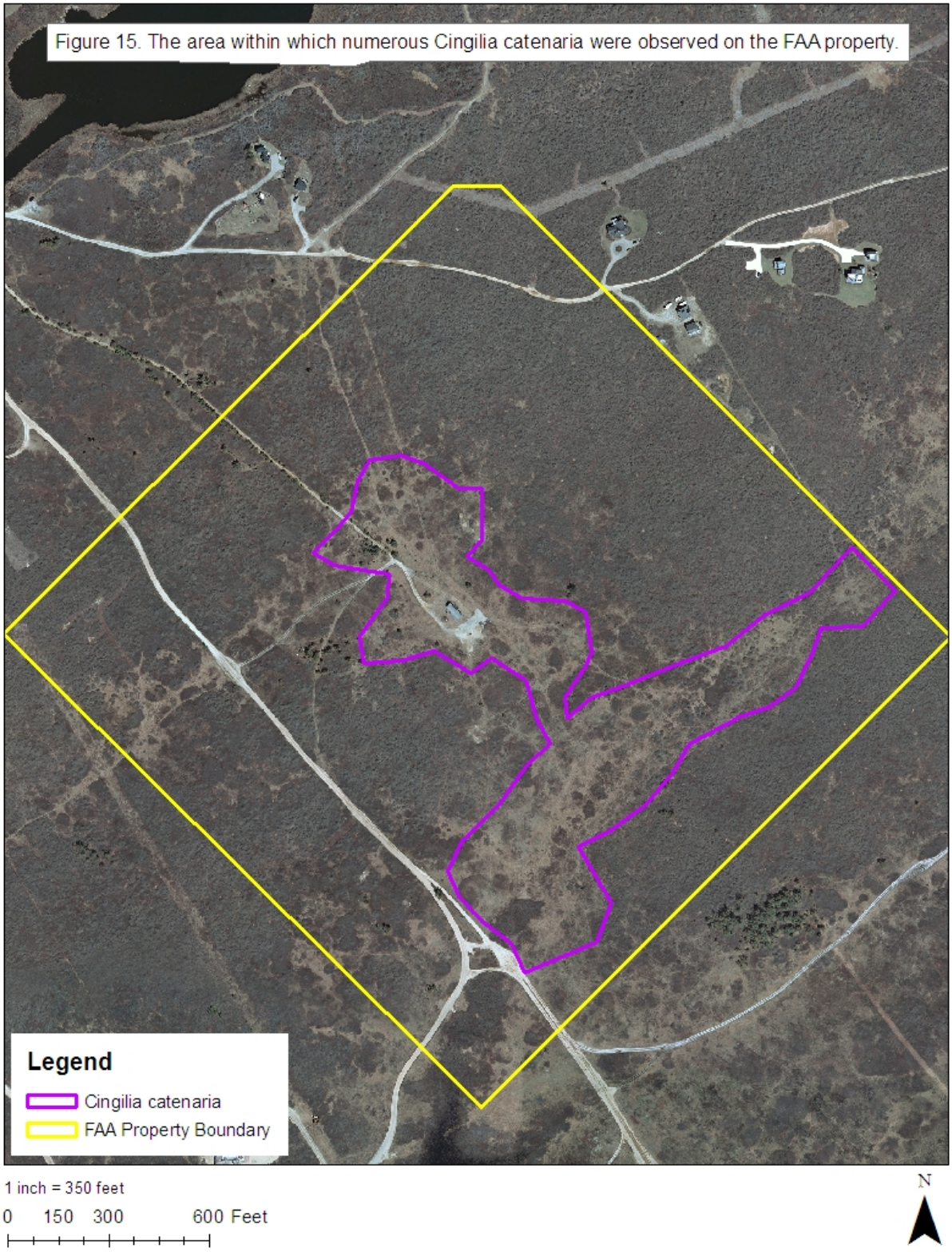
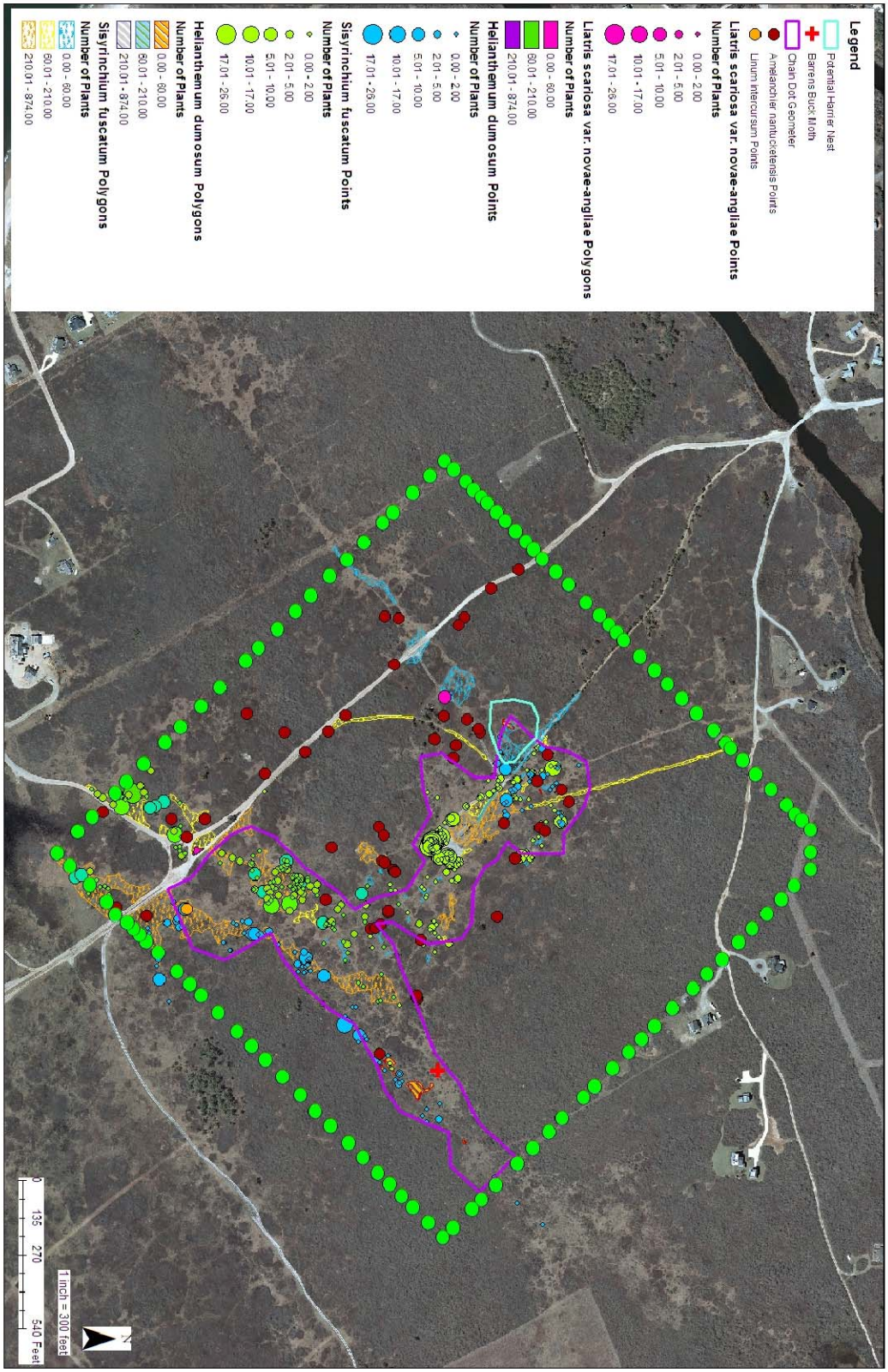



Figure 15. The area within which numerous Cingilia catenaria were observed on the FAA property.


Legend
Potential Harrier Nest
Barrens Buck Moth
Chain Dot Geometer
Amelanchier nantucketensis Points
Linum intercursum Points
Liatris scariosa var. novae-angliae Points
Number of Plants
0.00 - 2.00
2.01 - 5.00
5.01 - 10.00
10.01 - 17.00
17.01 - 26.00
Liatris scariosa var. novae-angliae Polygons
Number of Plants
0.00 - 60.00
60.01 - 210.00
210.01 - 874.00
Helianthemum dumosum Points
Number of Plants
0.00 - 2.00
2.01 - 5.00
5.01 - 10.00
10.01 - 17.00
17.01 - 26.00
Sisyrinchium fuscatum Points
Number of Plants
0.00 - 2.00
2.01 - 5.00
5.01 - 10.00
10.01 - 17.00
17.01 - 26.00
Helianthemum dumosum Polygons
Number of Plants
0.00 - 60.00
60.01 - 210.00
210.01 - 874.00
Sisyrinchium fuscatum Polygons
Number of Plants
0.00 - 60.00
60.01 - 210.00
210.01 - 874.00
N
1 inch = 300 feet
0
135
270
540 Feet

# NHESP ANIMAL OBSERVATION REPORT

## A1960

### ANIMAL IDENTIFICATION

**Common Name:**
*Northern Harrier*

**Scientific Name:**
*Circus cyaneus*

**Conservation Status:**
*Threatened*

**Town:**
*Nantucket*

**Site Name:**
*FAA Property*

**Description of the diagnostic characteristics upon which the ID was based (including how distinguished from similar species):**
*Ground nest with female sitting on eggs. The female was identified by the white stripe across her tail.*

**Was the organisms's species identification made by someone other than the observer?**
*Yes*
*Name: Not Answered*
*Permanent Address: Not Answered*
*Email Address: Not Answered*
*Telephone: Not Answered*
*Affiliations/Qualifications: Not Answered*

**Was this animal observed adjacent to or in a roadway?:**
*Yes,*

**If found dead, was the carcass removed and brought to a state facility or other institution?**
*No*
*Institution or Personal Collection: Not Answered*
*Collection # (if known): Not Answered*

**Photographs or slides taken?**
*Yes*

## LOCATIONS

**Directions:**

*Proceed out Madaket Road to the west. Turn left onto Massasoit Bridge Road (to the south). Continue along Massasoit Bridge Road until you reach the left hand turn to the old radio tower building (to the northeast). Park here. The nest was located on the south side of Massasoit Bridge Road slightly north of the intersection with the radio tower building road.*

**Location Name:** Location #1

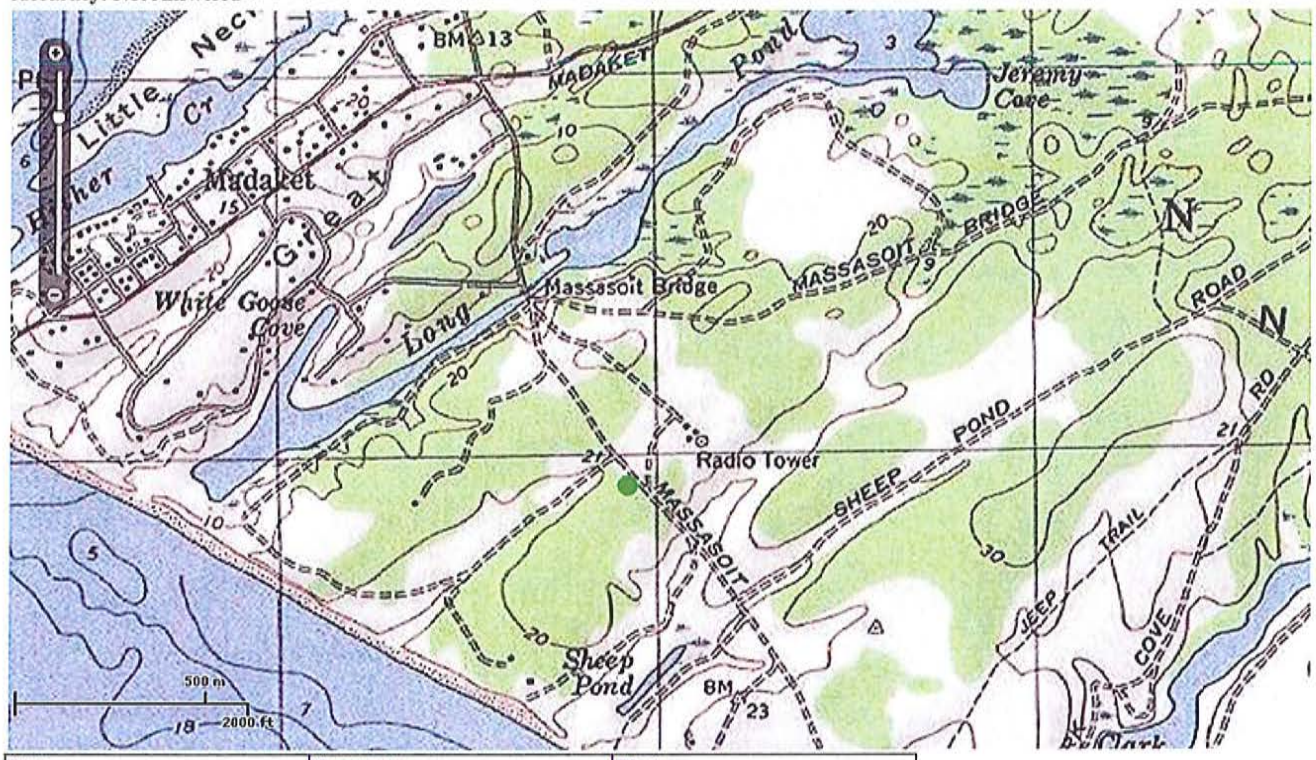
**Location Type:** Point

**Coordinates(x,y):** -70.1823030805655,41.2675791913403

**Coordinate Source:** Unknown or N/A

**Other Coordinate Source:** Not Answered

**Accuracy:** Not Answered




| Date | Comments | Photo |
|---|---|---|
| 5/21/2013 | The nest was located during an archaeological survey being performed on the site by PAL (Public Archaeological Laboratory) based out of Pawtucket, Rhode Island. Yvonne Benny-Basque and John Campbell are the people who located and photographed the nest during their transect surveys. | |

## POPULATION INFO

**Have you obsereved this species at this site in previous years?**

*Yes, Details: Numerous northern harriers and northern harrier nests have been located in this area in previous years.*

**Number of individuals observered:**

*1 adult female and 5 eggs*

**If known, provide sex and age/life stage:**

*1 adult female and five eggs*

**Plese describe how the age and sex were determined:**

*The female was sitting on the nest and incubating the eggs.*

**Evidence (if any) of breeding activity at this site:**

*Nest with five eggs*

**Other behavioral notes:**

*She flew off the nest defensively when approached.*

## Site Info

**Describe the habitat at site where the animal was observed:**

*The nest was located in a dense area of Gaylussacia baccata, Viburnum dentatum, and Morella pensylvanica. The site is approximately 90 acrea and about 1/3 of the area is a huckleberry / scrub oak heathland. The land gently slopes to the south shore of Nantucket Island and is part of the outwash plain. The soils in the area are Riverhead A (1-3% slope).*

**Associated species at this site:**

*Quercus ilicifolia, Prunus serotina, Gaylussacia baccata, Viburnum dentatum, and Morella pensylvanica*

**Observed or potential threats to the species or its habitat at this site (e.g., land clearing, invasive species):**

*Development*

**Property Owners**

| *Name* | *Address* | *Town* | *State* | *Zip* | *Parcel* | *Comment* |
|---|---|---|---|---|---|---|
| Government Services Agency | | | | | | |

## Other Observation Info

**Was this observation associated with a formal survey?**

*Survey ID: Not Answered*

**Is this observation associated with a collection permit?**

*No, Collection Permit #: Not Answered*

**Is this observation associated with a NHESP review file?**

*Yes ,Tracking #: 09-26832*

**List the names of other observers(and qualifications):**

*Unknown*

**Observer Information:**

***First Name:*** *Rachael*
***Last Name:*** *Freeman*
***Address 1:*** *53 Polpis Road*
***Address 2:*** *Not Answered*
***Town:*** *Nantucket*
***State:*** *MA*
***Zip:*** *02554*
***Telephone:*** *617-901-9370*
***Email:*** *rachaelslosek@gmail.com*

## OBSERVER COMMENTS

| *Observation Date* | *Comment* |
|---|---|
| Wednesday, August 14, 2013 | The nest was observed during archaeological surveys being performed by PAL (Public Archaeology Laboratory based out of Pawtucket, Rhode Island) for Mass. Historic. The observer is not available at this time to fill out the form. I did not return to the nest site because I did not want to disurb the female again. |
| Wednesday, August 14, 2013 | The survey crew had no prior knowledge of the nest location. |

## PHOTOS/DOCUMENTS

| *Title* | *Filename* | *Type* | *Description* | *Thumbnail* |
|---|---|---|---|---|

*Commonwealth of Massachusetts*

# Division of Fisheries & Wildlife

**MassWildlife**

Wayne F. MacCallum, *Director*

April 5, 2012

Elizabeth Gibson
Town Manager
16 Broad Street, 1st Floor
Nantucket, MA 02554

| | | |
|---|---|---|
| RE: | Project: | Madaket Wastewater Plan, Red Barn Road (former FAA site) |
| | Project Description: | wastewater treatment facility, groundwater discharge and piping infrastructure |
| | NHESP Tracking No.: | 09-26832 |

Dear Ms. Gibson,

Thank you for consulting with the Natural Heritage and Endangered Species Program (NHESP) of the Massachusetts Division of Fisheries and Wildlife on the Town of Nantucket's proposed Madaket Wastewater Plan. As you are aware, the project (treatment facility, groundwater discharge, and piping infrastructure) is proposed within mapped Priority Habitat for state-listed species and requires review pursuant to the Massachusetts Endangered Species Act and it is implementing regulations (MESA; 321 CMR 10.00). Based on a preliminary review of the information you have provided, the proposed project will impact state-listed species and their habitats. The NHESP anticipates being able to permit the proposed project through a MESA Conservation and Management Permit if appropriate mitigation is provided. Typically, this level of impact (approximately 25 acres with potential additional impacts associated with the piping infrastructure) would require a mitigation ratio in the range of 2:1 (acres of land protection to acres of impact) as well as a commitment to long-term habitat management. Please note that the Madaket site represents one of the most important unprotected tracts of land remaining on Nantucket and provides high conservation value for 17 state-listed species as well as other interests. Once the NHESP has received the actual project design and not a conceptual plan, the actual mitigation may change and final mitigation proposed may deviate from this standard under certain circumstances, but would not be less than 2:1 in any case.

The NHESP appreciates the Town of Nantucket's efforts to work with NHESP early in the process towards an environmentally sound solution. We look forward to continued consultations with the Town of Nantucket on the development of its Madaket Wastewater Plan.

Please do not hesitate to contact me if you have any further questions.

Sincerely,

Thomas W. French, Ph.D.
Assistant Director

Public Archaeology Laboratory

# Memorandum
## Madaket WWTF
Nantucket, Massachusetts

*Archaeological Sensitivity Assessment*
*May 23, 2011*
**PAL No. 2585**

Submitted to:
**Woodward & Curran**
980 Washington Street, Suite 325
Dedham, MA 02026

PAL has completed a walkover and sensitivity assessment of the Madaket Waste Water Treatment Facility (WWTF) project area, including the 92-acre parcel and the associated roadways within the Madaket and Warren's Landing infrastructure expansion areas, where new pipe is to be installed. The survey resulted in identifying areas of low, moderate and high archaeological sensitivity (Figures 1 and 2). The area of the proposed WWTF is relatively flat to slightly undulating with low bush blueberry, scrub vegetation, and scattered pines. There is one existing building on the parcel, dirt access roads, and utility boxes (telephone and electric) along the existing dirt roadway running south off of Madaket Bridge Road.

The purpose of the walkover survey was to assess the integrity of the ground surface and to collect data on current environmental settings. During the walkover survey, PAL staff also looked for any surface indications of archaeological sites. Although Native American sites in New England are most often found below the present ground surface, it is not unusual to find artifact scatters exposed on the surface because of cultural or natural processes, including road use, gravel pitting, construction activity, and erosion. EuroAmerican sites types that might be visible include cellar holes (depressions), agricultural landscape features, and trash deposits. There were no unrecorded pre-contact or post-contact period sites identified on the surface during the walkover survey.

Native American archaeological sensitivity is determined by assessing key environmental attributes, the presence of documented cultural resources in and adjacent to the project area, and the degree of disturbance. As mentioned above, key environmental attributes are proximity to fresh or salt water, well-drained soils, and level topography (Table 1). EuroAmerican archaeological sensitivity is determined by assessing information collected during the background research and walkover. Numerous large-scale surveys have determined that historic EuroAmerican sites are not directly correlated with specific environmental variables and that documentary information is not always accurate.

Generally, the project area is located in areas sensitive for containing historical or archaeological resources. In addition to the favorable environmental factors, several known pre-contact sites have been recorded in the area (Figure 3). Archaeological sensitivity however is limited to areas that have not been severely disturbed by previous construction and utilities, and which appear to maintain natural stratigraphic integrity.

**Table 1. Criteria Used in the Assessment of Archaeological Sensitivity for the Madaket WWTF Project Area.**

| Presence of Sites | | Proximity to Favorable Cultural/Environmental Characteristics | | | Degree of Disturbance | | | Sensitivity Ranking |
|---|---|---|---|---|---|---|---|---|
| Known | Unknown | < 150 m | ≥ 150 ≤ 500 m | > 500 m | None/Minimal | Moderate | Extensive | |
| • | | • | | | • | | | High |
| • | | • | | | | • | | High |
| • | | • | | | | | • | Low |
| • | | | • | | • | | | High |
| • | | | • | | | • | | Moderate |
| • | | | • | | | | • | Low |
| • | | | | • | • | | | High |
| • | | | | • | | • | | Moderate |
| • | | | | • | | | • | Low |
| | • | • | | | • | | | High |
| | • | • | | | | • | | Moderate |
| | • | • | | | | | • | Low |
| | • | | • | | • | | | Moderate |
| | • | | • | | | • | | Moderate |
| | • | | • | | | | • | Low |
| | • | | | • | • | | | Moderate |
| | • | | | • | | • | | Low |
| | • | | | • | | | • | Low |

Areas of "moderate" archaeological sensitivity primarily include those that are generally located in environmentally sensitive areas that have only been surficially impacted by construction. Highly sensitive areas include those with the best potential for containing cultural deposits and include those that have not been markedly affected by previous land-altering activities. These are also areas where sites have been previously recorded.

Overall, the only areas to have a low sensitivity for pre-contact and early post-contact Native American cultural resources are those that are disturbed by existing structures and utilities. These areas include the existing structure within the WWTF parcel as well as an approximate 90-x-45 meter area (300-x-150 feet) surrounding the structure that has been disturbed by utilities and a

previously existing shed (see Figures 1 and 2). The shed is shown on the 2004 map produced by Earth Tech along with a metal fence surrounding the two structures, but neither is present today (see Figure 1). There is no demolition debris from the shed evident on the surface but a soil core revealed that the soil surrounding the existing building is not intact and lacks integrity. Soil cores taken outside of this area were shown to be intact and not disturbed. Undisturbed soil profiles within the project area consist of very dark grayish brown sand Ao horizon down to 2-centimeters below the surface (cmbs), underlain by brown sand $A_1$ horizon to 9 cmbs. The underlying $A_2$ horizon consists of dark yellow brown sand with gravel to 25 cmbs overlying yellow brown sand $B_1$ to 40 cmbs and light yellow brown $B_2$ to 50 cmbs. Background research did not reveal that any historic structures resided within the project parcel and the earliest homes seen on historic maps along the roadways are still standing. Three monitoring wells that are recorded on the project map were located, as well as six unrecorded test pits. Disturbance from the wells and test pits is minimal, measuring approximately 2.5-meters in diameter around each one.

A reconnaissance of the Madaket and Warren's Landing infrastructure expansion areas was conducted along every roadway where pipe will be installed (see Figure 3). The Madaket area consists of a combination of dirt and paved roads and the Warren's Landing area consists of all paved roads, which are narrow, one lane roadways. Several recorded pre-contact sites surround these areas spanning back at least 5000 years. At the Hughes Site (19-NT-92), located at Massasoit Bridge on the east side of Long Pond, three human burials were found in the 1940s dating to the Late Woodland Period (ca. 1000 to 450 years ago). Other sites nearby and within the project area include the Tristram's Landing Site (19-NT-36) at the southwestern end of Starbuck Road that yielded Late Archaic and Susquehana projectile points (ca. 5000-2700 years ago), and the PCM-4 Site (19-NT-88), where stone tools and a metal knife associated Native American burials were recovered dating to the Late Archaic and Late Woodland time periods. The site was discovered during the excavation of a house foundation and trench for a utility pipe in the fall of 1970 along Little Neck, just north of Hither Creek. The Hither Creek Site (19-NT-20) is a Late Archaic shell midden in the vicinity of Ames and California avenues. The Dunham and Brooks Site (19-NT-103) yielded projectile points, steatite vessels and copper artifacts—evidence of Late Archaic through Contact Period occupation (ca. 5000 to 450 years ago). Given the location of these known sites within and around the project area, undisturbed sections of the project are considered to be archaeologically sensitive and exhibit environmental characteristics that are favorable for ancient and historic period land use and occupation. The archaeological sensitivity of the project area is also based on its favorable environmental setting.

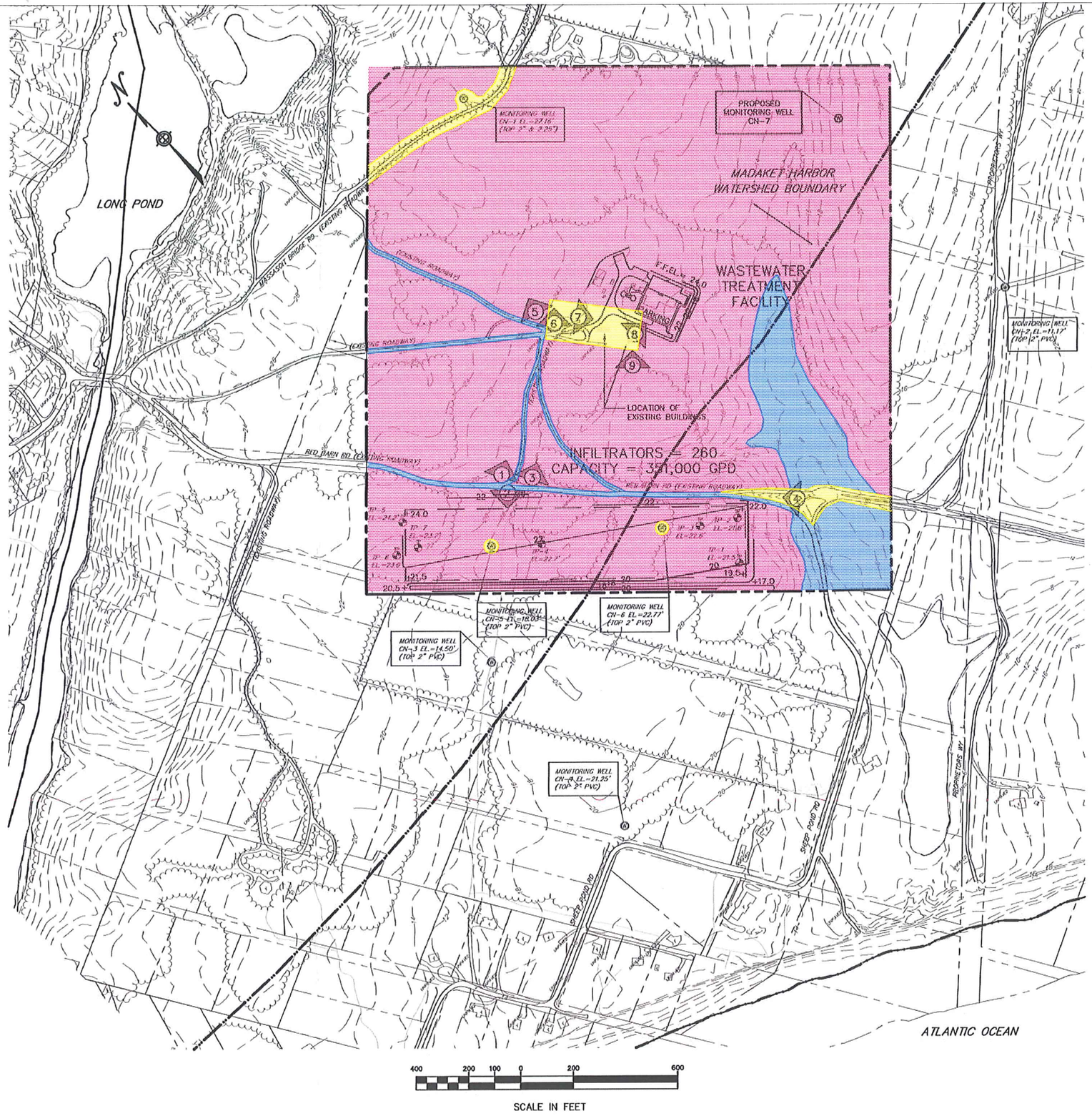
**Recommendations**

Areas of low sensitivity for cultural resources are unlikely to contain archaeological properties potentially eligible for listing in either the State or National Registers of Historic Places and therefore no further archaeological investigation is recommended within the 90-x-45 meter area (300-x-150 feet) meter area surrounding the existing structure. Intact archaeological properties could possibly be located in areas assessed as having moderate to high archaeological sensitivity. Systematic archaeological hand testing is recommended for these areas where future construction could disturb buried archaeological deposits.

The roadways within the Madaket and Warren's Landing infrastructure expansion areas are sensitive for archaeological resources based on the favorable environmental conditions and the proximity to recorded archaeological sites. PAL recommends that all of the roads be archaeologically monitored during construction, unless existing utility trenches will be utilized. A separate scope is needed for the archaeological monitoring.

TOWN OF NANTUCKET

# COMPREHENSIVE WASTEWATER MANAGEMENT PLAN
# PROPOSED FAA WASTEWATER TREATMENT FACILITY AND GROUNDWATER DISPOSAL SITE FOR MADAKET AND WARREN'S LANDING NEEDS AREAS




## MAP KEY

| | |
|---|---|
| MAP/PARCEL: | MAP 63, PARCEL 9 |
| ADDRESS: | MASSASOIT BRIDGE ROAD |
| LAND AREA: | 91.71 ACRES |
| TEST PIT | |
| MONITORING WELL | |
| MADAKET HARBOR WATERSHED BOUNDARY | |
| PHOTO LOCATION | |

*Archaeological Sensitivity*

- *High*
- *Moderate*
- *Low*

| Source/Revision/Issue | Date |
|---|---|
| | |
| PAL modified: Sensitivity | 05-20-11 |
| Map source: EarthTech | 12-08-11 |

PAL makes no warranties, either expressed or implied, regarding the fitness or suitability of this map for any other purpose than to depict the location and/or results of cultural resource investigations conducted by PAL.

PRIVILEGED INFORMATION - DO NOT RELEASE

Project: Madaket WWTF

Date: May 20, 2011

Figure 1

**Figure 1. Archaeological sensitivity within the Madaket WWTF Project area.**

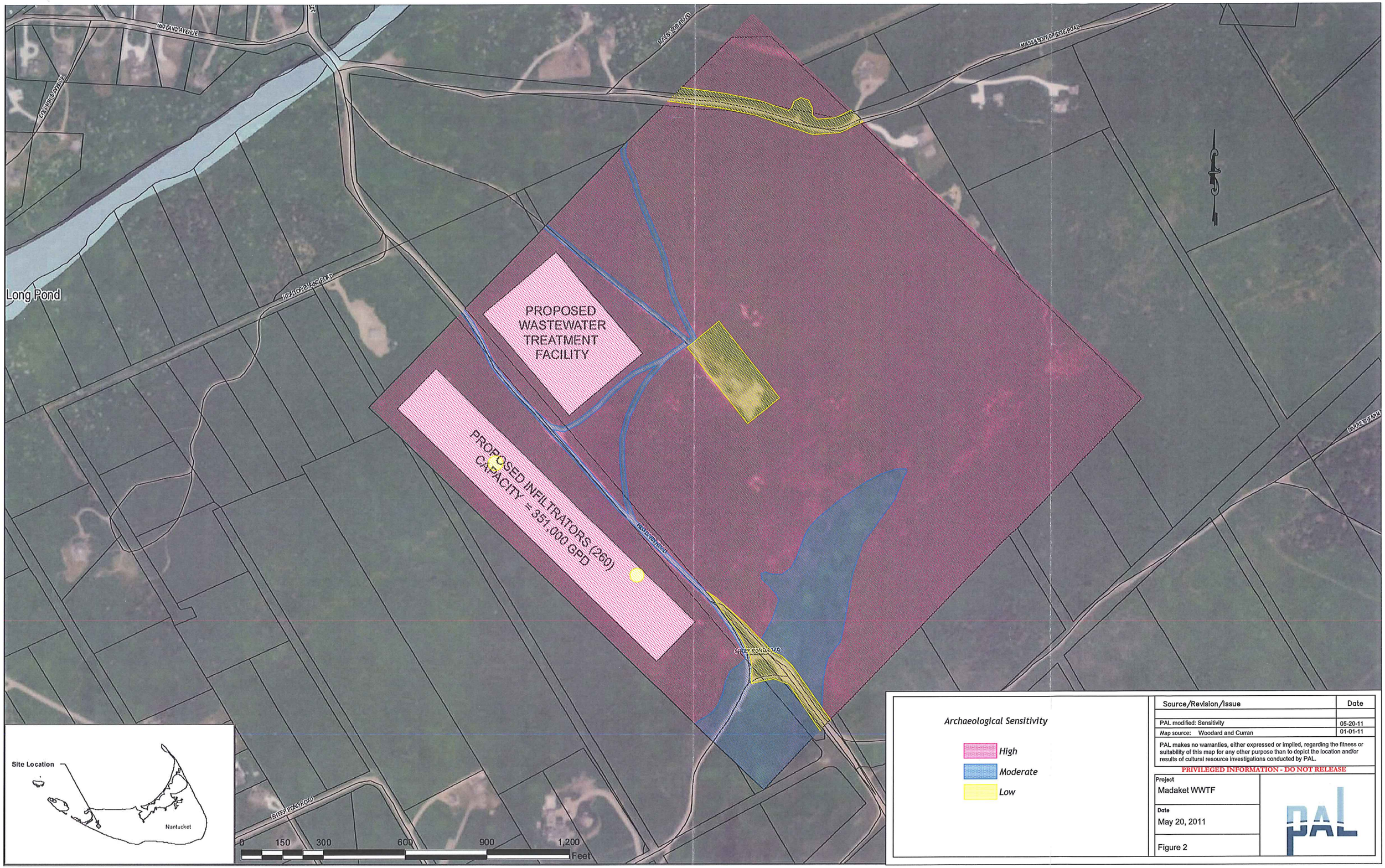



**Figure 2. Archaeological sensitivity within the Madaket WWTF Project area.**

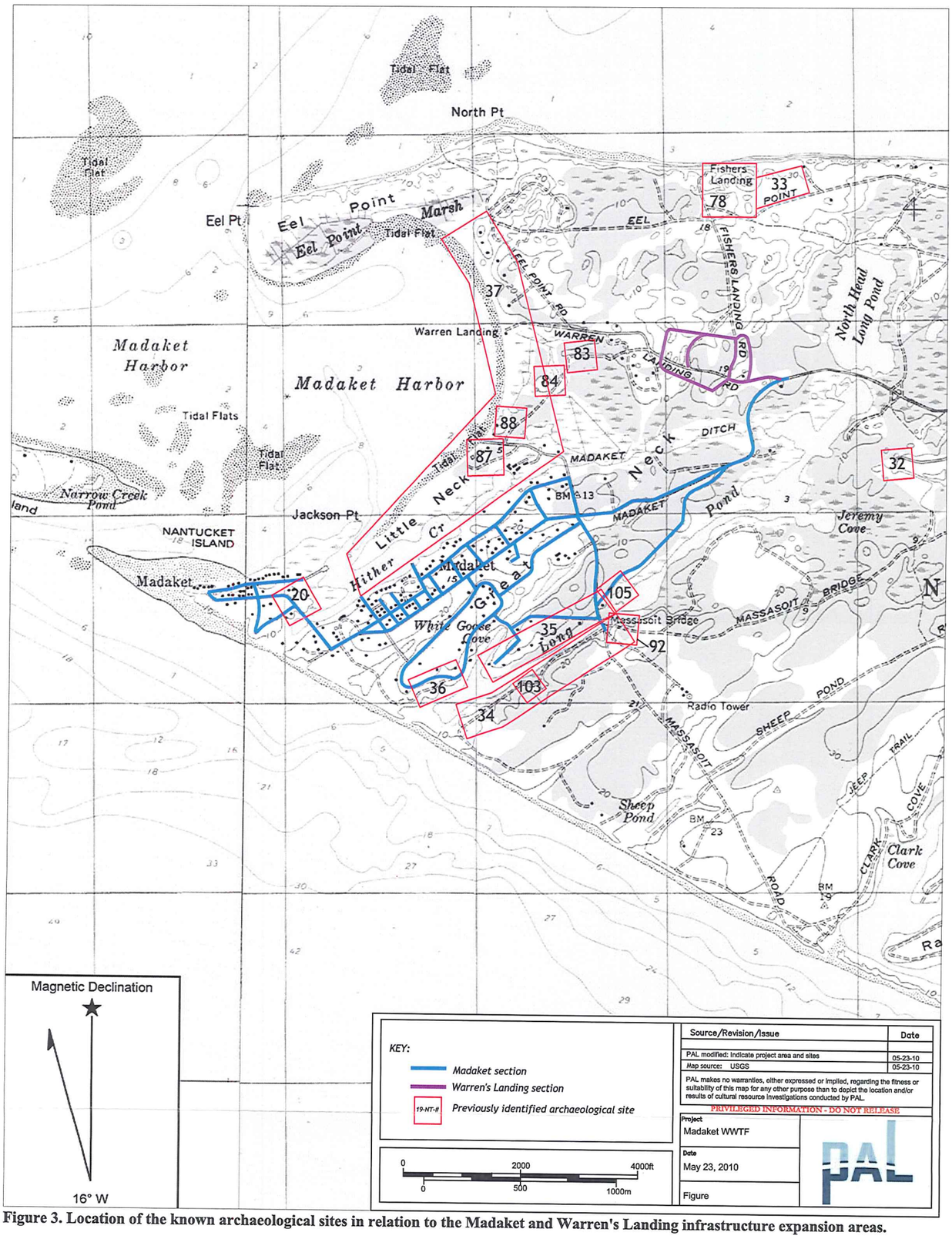



**Figure 3. Location of the known archaeological sites in relation to the Madaket and Warren's Landing infrastructure expansion areas.**

**TECHNICAL REPORT**

# INTENSIVE (LOCATIONAL) ARCHAEOLOGICAL SURVEY
# MADAKET WASTEWATER TREATMENT FACILITY

**Nantucket, Massachusetts**

Dianna L. Doucette

Submitted to:

**Woodard & Curran**
980 Washington Street, Suite 325
Dedham, MA 02026

Submitted by:

**PAL**
26 Main Street
Pawtucket, Rhode Island 02860

PAL Report No. 2585 June 2013

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# MANAGEMENT ABSTRACT

PAL completed an Intensive (Locational) Archaeological survey for the proposed Madaket Wastewater Treatment Facility project area in Nantucket, Massachusetts. The proposed project will be located on 25-acres within an approximately 92-acre parcel between Massasoit Bridge Road and Red Barn Road at the eastern end of Nantucket. It will include the construction of a wastewater treatment facility consisting of tanks, equipment, an access road, and groundwater discharge site.

The goal of the intensive (locational) archaeological survey was to determine the absence or presence of potentially significant archaeological sites. PAL personnel conducted extensive subsurface testing within the project area based on the results of the walkover survey and sensitivity ranking. Subsurface testing with 124, 50-x-50-cm test pits documented undisturbed and disturbed soil horizons within the project area, relatively little cultural material, and no subsurface or above ground features. A total of 42 artifacts were recovered including ceramic sherds, nails, shell, white-clay smoking pipe fragments, clam shell, and burned bone. The cultural material came from fill contexts or from the ground surface, and while it includes some early post-contact materials such as ceramics (e.g., redware, pearlware), hand-made brick, and white-clay pipe bowl fragments, there were also more recent finds such as wire nails and machine made clear bottle glass. The fill and surface contexts in which this material was recovered suggest that the deposits were likely redeposited, potentially during the construction of an unnamed dirt road running through the project area.

The generally diffuse distribution of the cultural material assemblage from road fill contexts combined with the lack of any associated structural, landscape, or household features suggests that it is best characterized as yard/field scatter with no locational or associative integrity. Fill deposits in the project area contained a mixture of recent and historic cultural materials, demonstrating that the deposits are more recent. Analysis of the soil profiles and cultural material suggests that these fill deposits are likely related to road construction as well as more isolated utility installations, driveway construction, and landscaping events associated with an abandoned Federal Aviation Administration building with the larger 92-acre parcel. Based on the results of this survey, the proposed construction within the Madaket WWTF project area will not impact any potentially significant archaeological resources. No further archaeological investigations are recommended.

**TABLE OF CONTENTS**

**MANAGEMENT ABSTRACT** ..... **i**

**1. INTRODUCTION** ..... **1**
Scope and Authority ..... 1
Project Personnel ..... 5
Disposition of Project Materials ..... 5

**2. RESEARCH DESIGN AND FIELDWORK METHODOLOGIES** ..... **6**
Evaluating Significance and Historic Contexts ..... 6
Archival Research ..... 9
State Site Files and Reports, Artifact Collection Reports, and Town Reconnaissance Surveys ..... 9
Cultural Resource Management Reports ..... 9
Professional Journal Articles and Other Publications ..... 10
Histories and Maps ..... 10
Environmental Studies ..... 11
Consultation ..... 11
Walkover Survey ..... 11
Archaeological Sensitivity Assessment ..... 11
Pre-Contact Period Archaeological Sensitivity ..... 12
Contact Period Archaeological Sensitivity ..... 13
Post-Contact Period Archaeological Sensitivity ..... 13
Archaeological Sensitivity Ranking ..... 14
Subsurface Testing ..... 15
Laboratory Processing and Analyses ..... 16
Processing ..... 16
Cataloging and Analyses ..... 16
Curation ..... 16

**3. ENVIRONMENTAL CONTEXT** ..... **17**
Geomorphology and Surficial Deposits ..... 17
Soils and Hydrology ..... 19
Existing Conditions ..... 20

**4. CULTURAL CONTEXT** ..... **21**
Pre-contact Period ..... 21
PaleoIndian Period (12,500–10,000 B.P.) ..... 21
Early Archaic Period (10,000–8000 B.P.) ..... 23
Middle Archaic Period (8000–6000 B.P.) ..... 23
Late Archaic Period (6000–3000 B.P.) ..... 24
The Transitional Archaic Cremation Burial District of Nantucket, ca. 3800–2600 B.P. ..... 24
Early Woodland Period (3000–1600 B.P.) ..... 26
Middle Woodland Period (1600–1000 B.P.) ..... 26
Late Woodland Period (1000–450 B.P.) ..... 27
Contact Period (A.D. 1500–1620) ..... 28
Post-Contact Period ..... 28
Plantation Period (1620–1675) ..... 28

Native American Land Use and Settlement Patterns of the Miacomet Indian Village ca. A.D. 1693–1800 ..... 31
Federal Period (1775–1830) ..... 34
Early and Late Industrial Periods (1830–1915) ..... 36
Modern Period (1915–Present) ..... 38

**5. RESULTS, INTERPRETATIONS, AND RECOMMENDATIONS ..... 40**
Results ..... 40
Archival Research ..... 40
Results of the Field Investigations ..... 41
Interpretations and Recommendations ..... 42
Recommendations ..... 42

**REFERENCES ..... 47**

**APPENDICES**

**A CATALOG OF CULTURAL MATERIAL ..... 57**

**B PROJECT CORRESPONDENCE ..... 61**

## LIST OF TABLES


Figure 1-1. Location of the Madaket Waste Water Treatment Facility project area on the Nantucket USGS quadrangle map ..... 1

Figure 1-2. Map of the Madaket Waste Water Treatment Facility project area ..... 2

Figure 3-1. Ice lobes of the Wisconsinan glaciation and the formation of end moraines (source: Oldale 1992) ..... 18

Figure 3-2. Geologic map of Nantucket Island showing the approximate location of the project area (source: Oldale 1992) ..... 19

Figure 3-3. Photograph showing general project area conditions on either side of Red Barn Road, view north northwest ..... 20

Figure 3-4. Photograph showing general project area conditions along dirt road in the facilities section of the project area, view northwest ..... 20

Figure 4-1. 1782 Map of Nantucket showing the approximate location of the project area (source: De Crevecoeur 1782) ..... 41

Figure 4-2. Territories of major sachems at Nantucket and Tuckernuck in the late seventeenth century (source: Little 1988a:3, Figure 2) ..... 33

Figure 4-3. 1776 map of Nantucket showing the approximate location of the project area (source: DesBarres 1776) ..... 35

Figure 4-4. 1869 map of Nantucket showing the approximate location of the project area (source: Ewer 1869) ..... 36

Figure 4-5. Map of Nantucket showing the location and ownership of farms in 1850 (source: Gardner and Gibbs 1946) ..... 37

Figure 4-6 1887 USGS map of Nantucket showing the approximate location of the project area (source: USGS 1901) ..... 38

Figure 5-1. Location of intensive survey testing within the Madaket Waste Water Treatment Facility project area ..... 43

Figure 5-2. Representative soil profiles within the Madaket Waste Water Treatment Facility project area ..... 45

Figure 5-3. Photograph showing test pit 19 along Transect F (TF-19) and general soil profile, view east ..... 46

**LIST OF TABLES**

Table 2-1. Archaeological Sensitivity ..... 15

Table 4-1. Pre-Contact Cultural Chronology for Southern New England ..... 22

Table 5-1. Summary of Cultural Material Recovered from the Madaket WWTF Project, Intensive Survey ..... 41

# CHAPTER ONE

# INTRODUCTION

In response to a request from Woodard & Curran, on behalf of the Town of Nantucket, PAL completed archaeological investigations at the proposed Madaket Wastewater Treatment Facility (WWTF) project area in Nantucket, Massachusetts (Figure 1-1). The proposed project will be located on 25-acres within an approximately 92-acre parcel currently owned by the Federal Aviation Administration, between Massasoit Bridge Road and Red Barn Road at the eastern end of Nantucket. It will include the construction of a wastewater treatment facility consisting of tanks, equipment, an access road, and groundwater discharge site that will encompass approximately 25 acres of land not including buffer areas and/or land required for conservation protection (Figure 1-2). The project will also involve the installation of sewer pipe ranging from 1-1/4 to 4-inch diameter along existing roadways throughout the Madaket and Warren's landing study areas, which will pump wastewater flows to the Madaket WWTF.

The Massachusetts Historical Commission (MHC) commented on the Draft Environmental Impact Report (DEIR) for this project submitted by the Town of Nantucket back in 2004 (letter to MEPA Office May 3, 2004), and requested that an intensive (locational) archaeological survey (950 CMR 70) by conducted for the project impact areas. The proposed project area is included in the Nantucket Archaeological District, an island-wide designation that reflects the overall high archeological sensitivity of Nantucket. Native and EuroAmerican cultural resources have been documented across the island and represent nearly 10,000 years of continuous human land use. There are more than two dozen previously recorded Native American archaeological sites located within one and a half miles (2.4 kilometers) of the project area spanning back at least 5000 years. At the Hughes Site (19-NT-92), located 900-feet (275 meters) north of the study area on the east side of Long Pond, three human burials were found in the 1940s dating to the Late Woodland Period (ca. 1000 to 450 years ago). Undisturbed sections of the project area may be considered to be archaeologically sensitive and exhibit environmental characteristics that are favorable for ancient and historic period land use and occupation.

The goal of the intensive (locational) archaeological survey will be to locate and identify any significant archaeological deposits that may be present within the project area. The intensive survey will also be designed to collect basic information on the locations and densities of cultural deposits and to make recommendations regarding the need for additional archaeological testing, if necessary. The results of the intensive survey will be used to facilitate consultation with the Massachusetts State Historic Preservation Officer (MA SHPO) regarding the potential impacts of the project in accordance with Section 106 of the National Historic Preservation Act of 1966 (as amended) (36 CFR 800).

### Scope and Authority

The intensive (locational) archaeological survey (950 CMR 70) was conducted under State Archaeologist's permit number 3253 issued by the MHC. The archaeological survey work was undertaken in accordance with the National Historic Preservation Act of 1966 as amended (36 CFR 800); the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (48 FR 44716, September 29, 1983); the Advisory Council on Historic Preservation's handbook *Treatment of*

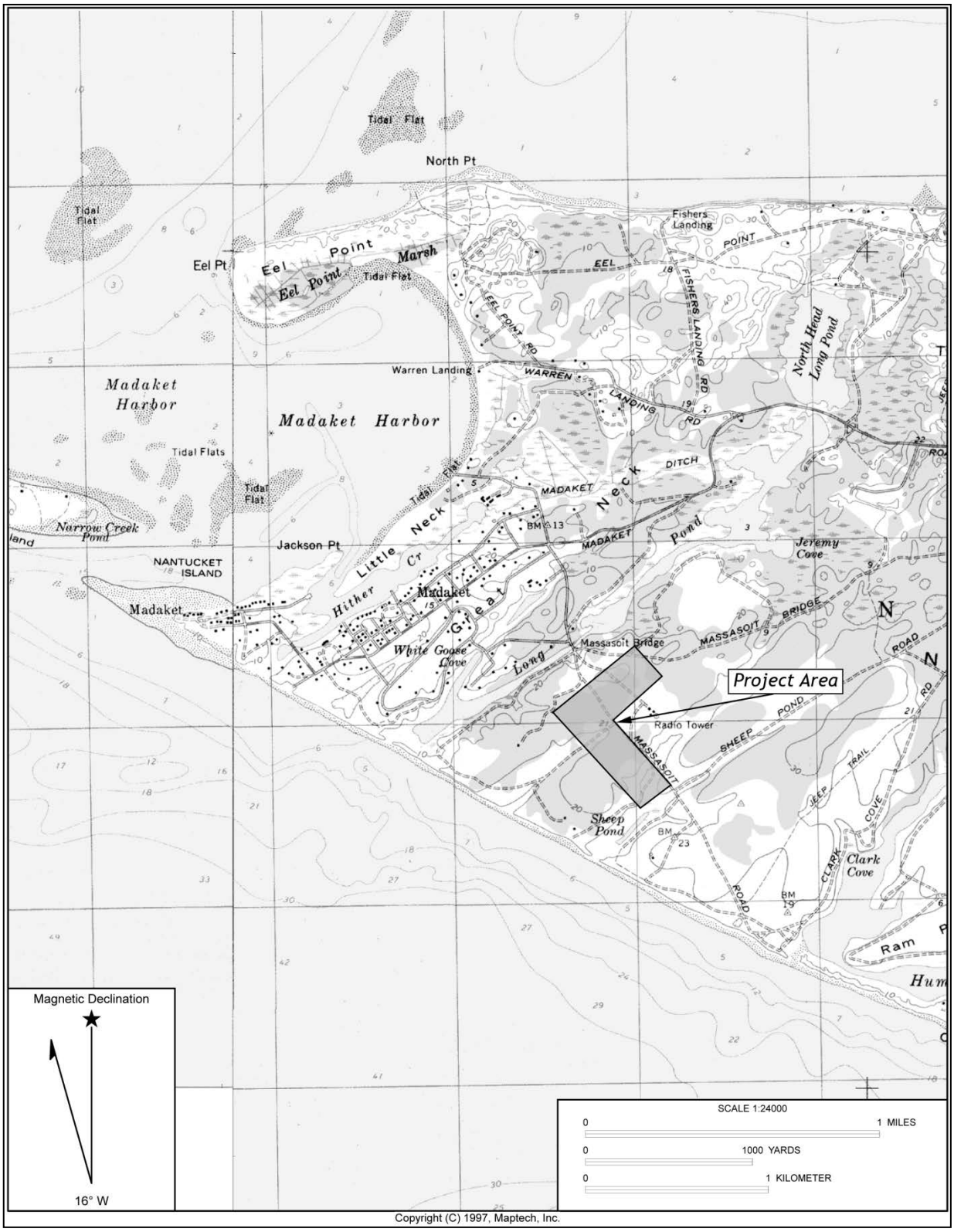


**Figure 1-1. Location of the Madaket Waste Water Treatment Facility project area on the Nantucket USGS quadrangle map.**

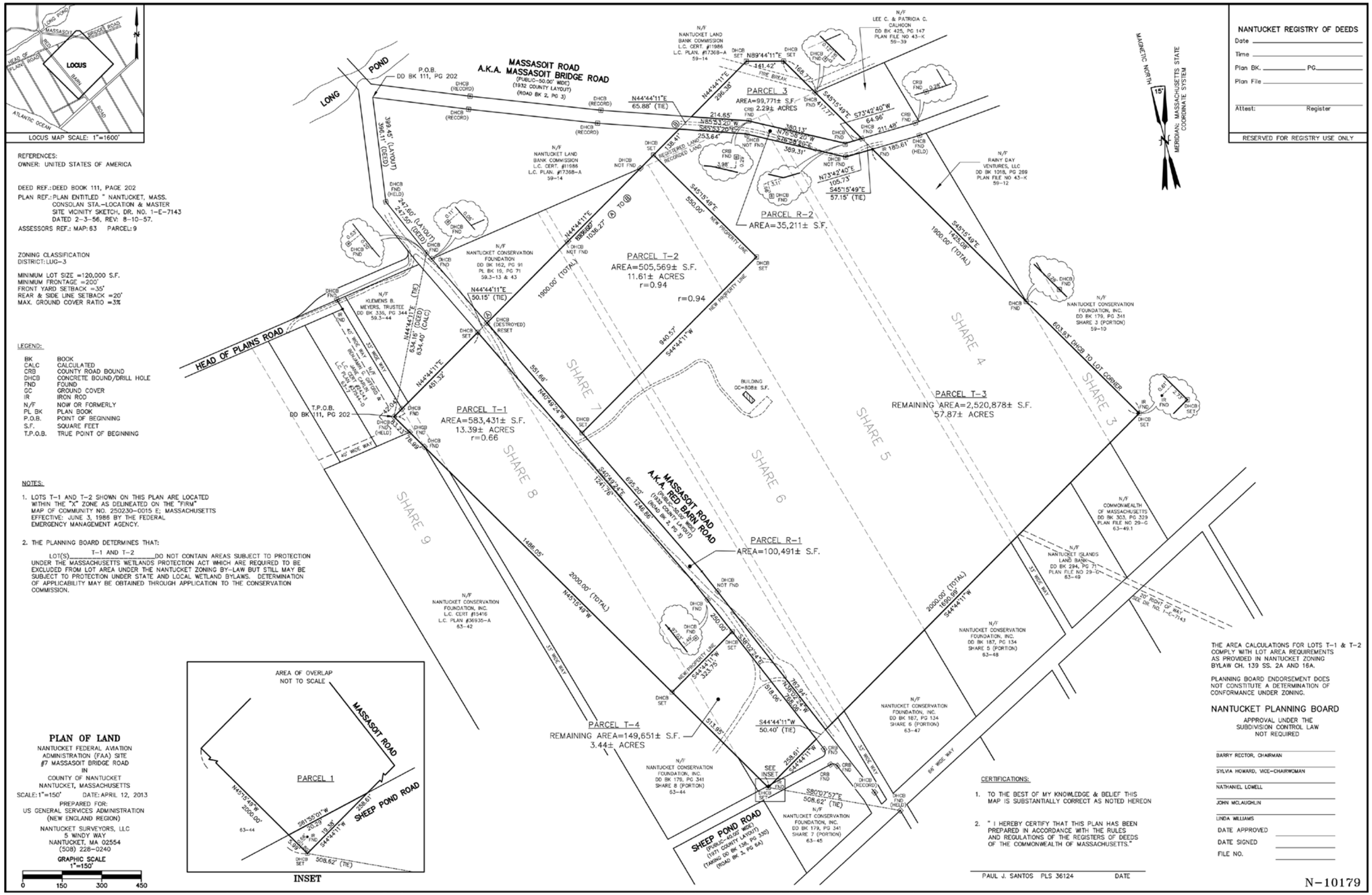


**Figure 1-2. Map showing proposed site plans for the Madaket Waste Water Treatment Facility.**

*Archaeological Properties* (1980); Massachusetts General Laws, Chapter 9, Sections 26–27c as amended by Chapter 254 of the Acts of 1988 (950 CMR 71.00); and the MHC's handbook *Public Planning and Environmental Review: Archeology and Historic Preservation* (1985). This technical report follows the guidelines established by the National Park Service (NPS) in the *Recovery of Scientific, Prehistoric, Historic, and Archeological Data* (36 CFR Part 66, Appendix A) and by the MHC. The intensive survey fieldwork was conducted the week of May 20, 2013 utilizing the methodology outlined in the technical proposal for this project.

**Project Personnel**

PAL personnel involved in the project included Dianna L. Doucette (project manager and principal investigator), Kirk VanDyke (project archaeologist), Jesse Daubert, Dawn Beemer, Yvonne Benny-Basque, John Campbell, and Shawn Joy (archaeological assistants). Laboratory processing and analyses of recovered cultural materials were undertaken at the PAL laboratory facility in Pawtucket, Rhode Island under the supervision of Heather Olson.

**Disposition of Project Materials**

All project information (i.e., artifacts, field recording forms, maps, photographic records, etc.) is currently on file at PAL, 26 Main Street, Pawtucket, Rhode Island. PAL serves as a temporary curation facility until a final repository is designated by the Commonwealth of Massachusetts.

# CHAPTER TWO

# RESEARCH DESIGN AND FIELDWORK METHODOLOGIES

The goal of the intensive (locational) archaeological survey of the Madaket WWTF project area was to locate and identify any significant archaeological properties that might be affected by project activities. To accomplish this objective, two research strategies were used:

- archival research, including a review of literature and maps; and
- field investigations, consisting of a "walkover" visual reconnaissance survey and subsurface testing.

The archival research and walkover survey provided the information needed to develop environmental and historic contexts for the project area and develop a predictive model for archaeological sensitivity. Archaeological sensitivity is defined as the likelihood for belowground cultural resources to be present and is based on various categories of information:

- locational, functional, and temporal characteristics of previously identified cultural resources in the project area or vicinity; and
- local and regional environmental data reviewed in conjunction with existing project area conditions documented during the walkover survey, and archival research about the project area's land use history.

Subsurface archaeological testing was conducted in areas determined during the sensitivity assessment to have high or moderate potential for containing archaeological deposits.

**Evaluating Significance and Historic Contexts**

The different phases of archaeological investigation (survey, evaluation, and data recovery) reflect preservation planning standards for the identification, evaluation, registration, and treatment of archaeological resources (NPS 1983). An essential component of this planning structure is the identification of archaeological and traditional cultural properties that are eligible for inclusion in the National Register, the official federal list of properties that have been studied and found worthy of preservation. Archaeological properties can be a district, site, building, structure, or object, but are most often sites and districts (Little et al. 2000). Traditional cultural properties are defined generally as ones that are eligible for inclusion in the National Register because of their association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community (Parker and King 1998). The results of professional surveys and consultation with Native American or other ethnic communities are used to make recommendations about the significance and eligibility of archaeological and traditional cultural properties.

An archaeological property may be pre-contact, post-contact, or contain components from both periods. Pre-contact (or what is often termed "prehistoric") archaeology focuses on the remains of indigenous

American societies as they existed before substantial contact with Europeans and resulting written records (Little et al. 2000). In accordance with the NPS guidelines, the term "pre-contact" instead of "prehistoric" is used unless directly quoting materials that use the term "prehistoric." The date of contact varies across the country and in the New England region. There is no single year that marks the transition from pre-contact to post-contact. Post-contact (or what is often termed "historical") archaeology is the archaeology of sites and structures dating from time periods since significant contact between Native Americans and Europeans. Documentary records as well as oral traditions can be used to better understand these properties and their inhabitants (Little et al. 2000). Again, for reasons of consistency with the NPS guidelines, the term "post-contact" instead of "historical" is used when referring to archaeology unless directly quoting materials that use the term "historical."

The NPS has established four criteria for listing significant properties in the National Register (36 CFR 60). The criteria are broadly defined to include the wide range of properties that are significant in American history, architecture, archaeology, engineering, and culture. The quality of significance may be present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association. The criteria allow for the listing of properties:

A. that are associated with events that have made a significant contribution to the broad patterns of our history; or

B. that are associated with the lives of persons significant in our past; or

C. that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. that have yielded, or may be likely to yield, information important to prehistory or history.

Archaeological and traditional cultural properties can be determined eligible for listing in the National Register under all four criteria (Little et al. 2000; Parker and King 1998). Significance under any of these criteria is determined by the kind of data contained in the property, the relative importance of research topics that could be addressed by the data, whether these data are unique or redundant, and the current state of knowledge relating to the research topic(s). A defensible argument must establish that a property "has important legitimate associations and/or information value based upon existing knowledge and interpretations that have been made, evaluated, and accepted" (McManamon 1990:15).

The criteria are applied in relation to the historic contexts of the resources. A historic context is defined as follows:

> A historic context is a body of thematically, geographically, and temporally linked information. For an archaeological property, the historic context is the analytical framework within which the property's importance can be understood and to which an archaeological study is likely to contribute important information (Little et al. 2000).

For traditional cultural properties, a historic context is further defined as follows:

> A historic context is an organization of available information about, among other things, the cultural history of the area to be investigated, that identifies "the broad patterns of development in an area that may be represented by historic properties" (48 FR 44717). The traditions and lifeways of a planning area may represent such "broad patterns," so information about them should be used as a basis for historic context development.

> Based on federal standards and guidelines, groups that may ascribe traditional cultural values to an area's historic properties should be contacted and asked to assist in organizing information on the area (Parker and King 1998).

The formulation of historic contexts is a logical first step in the design of an archaeological investigation and is crucial to the evaluation of archaeological and traditional cultural properties in the absence of a comprehensive survey of a region (NPS 1983:9). Historic contexts provide an organizational framework that groups information about related historic properties based on a theme, geographic limits, and chronological periods. A historic context should identify gaps in data and knowledge to help determine what is significant information that may be obtained from the resource. Each historic context is related to the developmental history of an area, region, or theme (e.g., agriculture, transportation, waterpower), and identifies the significant patterns of which a particular resource may be an element. Only those contexts important to understanding and justifying the significance of the property must be discussed.

Historic contexts are developed by:

- identifying the concept, time period, and geographic limits for the context;
- collecting and assessing existing information within these limits;
- identifying locational patterns and current conditions of the associated property types;
- synthesizing the information in a written narrative; and
- identifying information needs.

"Property types" are groupings of individual sites or properties based on common physical and associative characteristics. They serve to link the concepts presented in the historic contexts with properties illustrating those ideas (NPS 1983; 48 FR 44719).

A summary of an area's history can be developed by a set of historical contexts. This formulation of contexts is a logical first step in the design of any archaeological survey. It is also crucial to the evaluation of individual properties in the absence of a comprehensive survey of a region (NPS 1983:9). The result is an approach that structures information collection and analyses. This approach further ties work tasks to the types and levels of information required to identify and evaluate potentially important cultural resources.

The following research contexts have been developed to organize the data relating to the Native American and Euro-American cultural resources identified within the proposed project area:

a. Native American land use and settlement in the central outwash plains region of Nantucket Island, circa (ca.) 12,500 to 350 years before present (B.P.); and

b. Historic Native American and Euro-American land use and settlement patterns in the central outwash plains region of Nantucket Island, ca. A.D. 1650 to present.

These historical contexts, along with expected property types and locational patterns, are discussed in detail in Chapter 4. An evaluation of the survey findings, along with management recommendations, is presented in Chapter 5.

**Archival Research**

The development of a historic context and a predictive model of expected property types and densities within the project area began with archival research, consisting of an examination of primary and secondary documentary sources. These sources include written and cartographic documents relating both to past and present environmental conditions as well as documented/recorded sites in the general project area. The information contained in archival sources formed the basis of the predictive models developed for the project area, and were an integral part of the archaeological survey.

Specific sources reviewed as part of the archival research for the Madaket WWTF project area include:

**State Site Files and Reports, Artifact Collection Reports, and Town Reconnaissance Surveys**

State site files maintained at the MHC offices in Boston were examined to obtain information about the location, temporal period, and other data about known pre- and post-contact sites, structures, or districts in the vicinity of Madaket Road. Known sites as they are reported to the state are plotted on a United States Geological Survey (USGS) topographic map and given an official site number. Each number is keyed to an individual file containing all available information about that site. Many of the known pre- and post-contact sites in the central outwash plains region of Nantucket were recorded during the 1970s as a result of private artifact collection inventories. Some site forms contain information about the types of artifacts recovered, although many of the known sites are simply the reported locations of artifact finds, with no additional information regarding site size, characteristics, contents, etc. A regional synthesis of pre- and post-contact settlement and goals for future research in the region was consulted (*Historic and Archaeological Resources of Cape Cod and the Islands,* MHC 1987*).* The MHC town reconnaissance survey report for Nantucket (MHC 1984b) provided general information about the pre- and post-contact cultural chronology and archaeological resource potential for the island.

**Cultural Resource Management Reports**

Numerous cultural resource management (CRM) reports from project areas across the island as well as within the immediate project area vicinity have contributed to a general reconstruction of Nantucket's pre- and post-contact land use and settlement patterns. Since 1988, PAL has completed several CRM studies in the area directly surrounding the current project area and much of this previously accumulated information was synthesized in these reports and extracted and adapted for inclusion in the current report. PAL recently completed surveys for the 2 Fairgrounds Road (Elquist and Doucette 2007), Ellen's Way Subdivision (Doucette 2007), and the proposed Nantucket Human Services Center at the corner of Miacomet Road and Surfside Road (PAL 2007; Rainey and Ingham 2005). In addition, PAL has completed surveys of the proposed Old South Road, Polpis, Fairgrounds Road, Nobadeer Farm Road, Quaker Road, and Cliff Road bicycle paths (Rainey 2001, 2004; Doucette 2008b; Doucette 2009; Doucette and Gillis 2010), Nantucket Memorial Airport property (Rainey 1998; Willan and Ritchie 1995), Nobadeer Recreational Facility (Doucette 2008a), Nantucket High School (Rainey and Ritchie 1998; Ritchie 1988), Wannacomet Water Company (Ingham and Rainey 2005b), Miacomet Golf Course (Rainey and Ritchie 1997, 2001), within town-owned land slated for a newly proposed golf course (Rainey 2000), Nantucket Disc Golf (Ritchie 2010), and for a proposed new Post Office (Ingham and Rainey 2005a).

PAL conducted archaeological surveys associated with Nantucket High School (Rainey and Ritchie 1998; Ritchie 1988 ), Wannacomet Water Company (Ingham and Rainey 2005b) and Miacomet Golf Course (Rainey and Ritchie 1997). Of particular significance to the project area is the proximity of the Miacomet Indian burying grounds and territory associated with the historic Miacomet Indian village. Information about the history and archaeology of this settlement was drawn from the reports of archaeological

investigations of the Nantucket Housing Authority project area on Surfside Road (Donta and Mullholland 1994).

Discovery and partial excavation of eighteenth-century Native American domestic and institutional sites likely associated with the Miacomet settlement on Cow Pond Lane and Miacomet Road provided further site specific information about the Miacomet settlement as well as data from documentary sources relating to the eighteenth-century colonial practice of allowing indentured Native Americans to reside on common lands outside Nantucket town center (PAL 2004; Rainey and Ingham 2005).

#### Professional Journal Articles and Other Publications

Archival information for this project was drawn in part from the Nantucket Algonquin Studies, a series of research manuscripts developed by Elizabeth Little under the auspices of the Nantucket Historical Association (NHA) (Little 1983, 1988a, 1988b). These papers address specific and general issues in the subjects of archaeology, ethnohistory, and linguistics on Nantucket Island and include mainly primary source materials. Of particular relevance to sections of the project area was the *Nantucket Algonquian Studies* No. 12, History of the Town of Miacomet (Little 1988a) and No. 4, Historic Indian Houses of Nantucket (Little 1981). A more recent discourse by Dr. Little (1996) on the eighteenth-century Nantucket Sachem Spotso was consulted. Finally, a manuscript by Aimee E. Newell, Curator of Collections for the NHA, provided new insights specific to the twentieth-century agricultural history of the project area (Newell 2001).

The majority of journal articles referenced in this report were cited for their information pertaining to Nantucket prehistory in general. The *Bulletin of the Massachusetts Archaeological Society* (MAS) contains a number of references to archaeological sites and finds on Nantucket Island (Bullen and Brooks 1948; Little 1984; Trinkaus 1982). Other journals containing information used in this report included the *Bulletin of the Archaeological Society of Connecticut* (Pretola and Little 1988) and *Man in the Northeast* (Little and Andrews 1982).

#### Histories and Maps

Several histories of Nantucket were consulted as part of the development of the project area's general and specific historic context. The principal early, secondary sources used included Macy (1972), Starbuck (1924), and Worth (1992). Descriptions of the evolution and history of the whaling industry were drawn primarily from Hohman (1928) and Starbuck (1989). A more recently published analysis of Nantucket's social and political history from 1660 to 1820 provided a contemporary and scholarly assessment of the island's historic development (Byers 1987). Incidental information has been taken from several other secondary histories (Barber 1839; Douglas-Lithgow 1911; Forman 1966; Goodwin 1879; Karr 1995; Marshall 1962; Mooney and Sigourney 1980). Other histories reviewed included ethnohistoric accounts that describe early Nantucket and the Native American groups occupying the island during and after the contact period (de Crevecoeur 1971; Gookin 1806), the Massachusetts Historical Society collections (early-nineteenth-century volumes), and other original documents housed in the Foulger Museum Research Center collections (Macy 1972).

General histories and historical maps and atlases were examined to assess changes in land use, and to locate any historic sites, structures, roads, bridges, or other landscape features that might exist within the project area. Reviewed maps included de Crevecoeur (1782), DesBarres (1776), Ewer (1869), Mitchell (1838), Prescott (1831), Walling (1856), and the 1901 USGS map.

### Environmental Studies

Environmental data regarding the project area geomorphology, soils, hydrology/drainage, and vegetation composition was collected. Bedrock and surficial geological studies provided information about the region's physical structure and history, and about geological resources near the project area (Chamberlain 1964; Oldale 1992). The United States Department of Agriculture (USDA) Soil Conservation Service soil survey (Langlois 1979) supplied information about soil types and surficial deposits within the project area and the general categories of flora and fauna that these soil types support. In addition, studies of past environmental settings of New England were consulted (Dunwiddie 1990). The discussion of existing conditions was based on observations made during the walkover survey.

### Consultation

Since the current project is considered an undertaking under Section 106 of the National Historic Preservation Act of 1966, as amended, PAL coordinated with interested Native American groups and historical commissions. In this regard, PAL sent letters to the Aquinnah Wampanoag and Mashpee Wampanoag tribal historic preservation officers (THPOs). Follow up telephone and e-mail contact was made informing them of the project's field schedule.

### Walkover Survey

A walkover survey was conducted to collect environmental information and to examine the current physical condition of the project area. Topography, vegetation, and soils were considered. The current physical condition of the project area is defined by the degree of disturbance to the natural landscape. Disturbances may occur as a result of plowing, gravel or soil mining, or construction and site preparation activities. These conditions usually affect the potential for cultural resources to be discovered in their original archaeological contexts. Plowing, which can move artifacts from their original vertical and horizontal contexts, is the most common type of disturbance in New England. The consequences of plowing are not as severe as the effects of soil or gravel mining, which may completely remove archaeological deposits.

Another purpose of the walkover was to note surface indications of archaeological sites. While pre-contact sites in New England are most often found belowground, artifact scatters are sometimes exposed on the surface through cultural and natural processes such as road use, gravel pitting, construction activity, or erosion. Historic Native American or Euro-American sites types that might be visible include cellar holes, structural remains, trash deposits, or landscape features.

### Archaeological Sensitivity Assessment

Information collected during the archival research and walkover survey was used to develop a predictive model of potential site types and their cultural and temporal affiliation. The development of predictive models for locating archaeological resources has become an increasingly important aspect of CRM planning.

The predictive model considers various criteria to rank the potential for the Madaket WWTF project area to contain archaeological sites. The criteria are proximity of recorded and documented sites, local land use history, environmental data, and existing conditions. The project area was stratified into zones of expected archaeological sensitivity to determine which areas would be tested.

### Pre-Contact Period Archaeological Sensitivity

Archaeologists have documented 12,500 years of pre-contact Native American occupation of the region, and oral traditions of some contemporary tribes tell of a 50,000-year cultural legacy. Prior to 7,000 years ago, peoples focused primarily on inland-based resources, hunting and collecting along the Northeast's waterways. After 7,000 years ago, settlement became more concentrated within the region's major river drainages. By 3,000 years ago, concurrent with a focus on coastal and riverine settlement, large populations were living in nucleated settlements and developing complex social ties, with language, kinship, ideology, and trade linking peoples across the Northeast. During the centuries prior to European contact, these groups began to coalesce into the peoples known as Pocumtucks, Nipmucks, Massachusetts, Wampanoags, Pokanokets, Mohegans, Pequots, and Narragansetts. The chronology of the pre-contact period is presented in detail in Chapter 4. Assessing the pre-contact archaeological sensitivity of any given project area depends on a consideration of past and present geographical and ecological characteristics, known site location databases, and knowledge of distinctive temporal and cultural patterns.

The choices that pre-contact Native Americans made about where they settled, how they organized themselves, and their technologies were all results of the dynamic relationship between culture and environment. Predictive modeling for larger-scale site location in southern New England has its roots in academic research including Dincauze's (1974) study of reported sites in the Boston Basin and Mullholland's (1984) dissertation research about regional patterns of change in pre-contact southern New England. Peter Thorbahn applied ecological modeling and quantitative spatial analysis, synthesizing data from several hundred sites in southeastern New England (Thorbahn et al. 1980), demonstrating that the highest concentration of pre-contact sites occurred within 300 meters (m) of low-ranking streams and large wetlands. The distribution of sites found along a 14-mile I-495 highway corridor in the same area reinforced the strong correlations between proximity to water and site locations (Thorbahn 1982). These and other large-scale projects provided data toward developing models of Native American locational and temporal land use (MHC 1982a, 1982b, 1984a; RIHPC 1982) that became the foundation for site predictive modeling employed during CRM surveys through the next two decades.

Today, assessment of archaeological sensitivity within a given project area, and the sampling strategy applied to it, continues to take existing physiographic conditions into consideration but at multiple scales, from bedrock geology, to river drainages, to microenvironmental characteristics. These categories of data are used to establish the diversity of possible resources through time, the land use patterns of particular cultures, and the degree to which the landscape has been altered since being occupied (Leveillee 1999). Increasingly, social and cultural perspectives, as reflected in both the archaeological and historical records (Johnson 1999), and as expressed by representatives of existing Native American communities (Kerber 2006), are being taken into consideration when assessing archaeological sensitivity. Archaeological sampling strategies have also been evaluated and refined through applications of quantitative analyses (Kintigh 1992).

Geologic data provides information about lithic resources and about current and past environmental settings and climates. Bedrock geology helps to identify where raw materials for stone tools were obtained by pre-contact groups and gives indications of how far from their origin lithic materials may have been transported or traded. The variety and amount of available natural resources are dependent on soil composition and drainage, which also play a significant role in determining wildlife habitats, and forest and plant communities.

Geomorphology assists in reconstructing the paleoenvironment of an area and is particularly useful for early Holocene (PaleoIndian and Early Archaic Period) sites in areas that are different physically than they were 10,000 years ago (Simon 1991). Recent landscape changes such as drainage impoundments for

highways and railroads, the creation of artificial wetlands to replace wetlands impacted by construction, or wetlands drained for agricultural use, can make it difficult to assess an area's original configuration and current archaeological potential (Hasenstab 1991:57).

Beyond predicting where sites are located, archaeologists attempt to associate cultural and temporal groups with changes in the environmental settings of sites. Changes in the way pre-contact groups used the landscape can be investigated through formal multivariates such as site location, intensity of land use, and specificity of land use (Nicholas 1991:76). However, distinguishing the difference between repeated short-term, roughly contemporaneous occupations and long-term settlements is difficult and can make interpreting land use patterns and their evolution problematic (Nicholas 1991:86).

### Contact Period Archaeological Sensitivity

The contact period in New England roughly dates from AD 1500 to 1650, and predates most of the permanent Euro-American settlements in the region. This period encompasses a time when Native and non-Native groups interacted with one another through trade, exploration of the coastal region, and sometimes conflict. While contact period sites are usually associated with Native American activity during this period, they can also include sites utilized by Native and non-Native groups such as trading posts.

Native settlement patterns during the contact period are generally thought to follow Late Woodland traditions, but with an increased tendency toward the fortification of village settlements. Larger village settlements are frequently expected along coastal and riverine settings, often at confluences. Inland villages are known to occur near swamp systems, which were exploited both as resource areas and as places of refuge in the event of attack. Such sites would likely contain material remnants reflecting the dynamics of daily life, trade, and preparedness for defense.

The identification of contact period deposits is most frequently tied to the types of artifacts located within archaeological sites. Unfortunately, the majority of the archaeological data for this period in southern New England comes from the analysis of grave goods within identified Native American burial grounds, rather than from habitation sites and/or activity areas (Gibson 1980; Robinson et al. 1985; Simmons 1970). The available data suggest that sites dating to this period often contain traditionally pre-contact features and artifacts (e.g., storage pits, chipped-stone tools) as well as non-Native trade goods and objects (e.g., glass beads, iron kettles and hoes) (Bragdon 1996). The earliest contact period sites are often located at or near the coast and estuarine margin, since European visits to New England occurred via ship. Non-Native artifacts passed from the coastal region to the interior through trade and/or seasonal travel.

### Post-Contact Period Archaeological Sensitivity

The landscape of a project area is used to predict the types of post-contact period archaeological sites likely to be present. Major locational attributes differ according to site type. Domestic and agrarian sites (houses and farms) are characteristically located near water sources, arable lands, and transportation networks. Industrial sites (e.g., mills, tanneries, forges, and blacksmith shops) established before the late nineteenth century are typically located close to waterpower sources and transportation networks. Commercial, public, and institutional sites (e.g., stores, taverns, inns, schools, and churches) are usually situated near settlement concentrations with access to local and regional road systems (Ritchie et al. 1988).

Written and cartographic documents aid in determining post-contact period archaeological sensitivity. Historical maps are particularly useful for locating sites in a given area, determining a period of

occupation, establishing the names of past owners, and providing indications of past use(s) of the property. Town histories often provide information, including previous functions, ownership, local socioeconomic conditions, and political evolution, which is used in the development of a historic context and to assess the relative significance of a post-contact period site.

The written historical record, however, tends to be biased toward the representation of Euro-American cultural practices and resources, particularly those of prominent individuals and families. Archival materials generally are less sensitive to the depiction of cultural resources and activities associated with socioeconomically or politically "marginalized" communities (MacGuire and Paynter 1991; Scott 1994). These communities may include, but are not limited to, Native Americans, African-Americans, and "middling" farming or working-class Euro-Americans.

Several archaeological studies conducted throughout New England have demonstrated the methodological pitfalls of relying exclusively on documentary or cartographic materials as a means to identify potential site locations associated with these types of communities. A large-scale archaeological study by King (1988) showed that in rural areas only 63 percent of the sites discovered were identifiable through documentary research. This suggests that approximately one-third of New England's rural Euro-American archaeological sites may not appear on historical maps or in town and regional histories.

More recent archaeological and ethnohistoric studies in the region have focused on the identification of other historically "invisible" communities, notably post-contact Native American communities. Several townwide surveys in southeastern Massachusetts have compiled archaeological and historical data about eighteenth- and nineteenth-century Native and African-American communities that are poorly represented or are altogether absent in written town histories (Herbster and Cox 2002; Herbster and Heitert 2004). In central Massachusetts, active and influential Native Americans have been identified through archival research despite the recorded "disappearance" of this group in the early eighteenth century (Doughton 1997, 1999). The cultural continuity of groups such as the Aquinnah Wampanoag is more thoroughly documented in archival sources, but until recently archaeologists focused their attention on pre-contact archaeological deposits. Current studies include predictive models for distinctly Native American post-contact sites, as well as interpretations of eighteenth- through twentieth-century archaeological sites (Cherau 2001; Herbster and Cherau 2002).

Information about post-contact period land use within a project area can also be collected through written and oral histories passed through family members and descendant communities. These types of information sources can often fill in gaps in the documentary record and provide details that are not available through more conventional archival sources. While informants and other oral sources are subject to contradictory interpretations just like the documentary record, this type of information can also provide important data for the identification and interpretation of archaeological sites. The sole use of and reliance on the written and oral historical records during archival research, however, can lead to an underestimation of the full range of post-contact period sites in any given region. Therefore, walkover surveys and subsurface testing, in conjunction with the critical evaluation of available documentary and cartographic resources, are required to locate and identify underdocumented post-contact sites.

### Archaeological Sensitivity Ranking

The project area was ranked according to the potential for the presence of cultural resources based on information collected during the background research and walkover. Subsurface testing was planned for areas assigned high and moderate sensitivity rankings and where project impacts will occur. Table 2-1 is a summary of the different factors used to develop the archaeological rankings.

**Table 2-1. Archaeological Sensitivity Ranking.**

| Presence of Sites | | Proximity to Favorable Cultural/Environmental Characteristics | | | Degree of Disturbance | | | Sensitivity Ranking |
|---|---|---|---|---|---|---|---|---|
| **Known** | **Unknown** | **< 150 m** | **≥ 150 ≤ 500 m** | **> 500 m** | **None/Minimal** | **Moderate** | **Extensive** | |
| • | | • | | | • | | | High |
| • | | • | | | | • | | High |
| • | | • | | | | | • | Low |
| • | | | • | | • | | | High |
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| | • | | • | | | • | | Moderate |
| | • | | • | | | | • | Low |
| | • | | | • | • | | | Moderate |
| | • | | | • | | • | | Low |
| | • | | | • | | | • | Low |

### Subsurface Testing

Subsurface testing was conducted in proposed project impact areas with moderate and high archaeological sensitivity to locate and identify any archaeological resources. A total of 124 test pits was excavated within the proposed infiltrator and facilities parcels of the Madaket WWTF project area. These test pits, 50-x-50 centimeters (cm) in size, were excavated along eight linear transects.

All test pits were excavated by shovel in arbitrary 10-cm levels to sterile subsoil, unless impediments to excavation such as rocks, bedrock, or roots were encountered. Excavated soil was hand-screened through ¼-inch hardware cloth, and all cultural materials remaining in the screen were bagged and tagged by level within each unit. The count and type of all recovered cultural material were noted. Soil profiles, including depths of soil horizons, colors, and textures, were recorded for each test pit on standard PAL test pit profile forms. All test pits were filled and the ground surface was restored to its original contour following excavation. Digital images were taken of the general project area.

## Laboratory Processing and Analyses

### Processing

The cultural material recovered from the Madaket WWTF project area during the archaeological investigations was organized by site and provenience and recorded and logged in on a daily basis. Cultural material was cleaned with tap water.

### Cataloging and Analyses

The cultural material was cataloged using a customized computer program designed in Microsoft Access 2000. The program is a relational database, which provides the flexibility that is needed when cataloging archaeological collections that often contain disparate cultural materials such as stone, ceramics, and/or glass. Artifacts with similar morphological attributes are grouped into lots, which allows for faster and more efficient cataloging. The artifacts are stored in 2-millimeter thick polyethylene resealable bags with an acid-free tag containing provenience identification information. The artifacts are placed in an acid-free box that was labeled and stored in PAL's curatorial facility in accordance with current NPS standards.

Non-lithic artifacts were cataloged by material (e.g., ceramic, glass, coal, synthetic) and functional (e.g., plate, bowl, bottle, building material) categories. Artifacts having known dates of manufacture such as ceramics were also identified in terms of type (e.g., redware, pearlware, whiteware) when possible. In addition, ceramic sherds and bottle glass were examined for distinguishing attributes that provide more precise date ranges of manufacture and use. These included maker's marks, decorative patterns, and embossed or raised lettering. Tentative dating of post-contact archaeological resources was performed using ceramic indices according to Hume (1969), Miller (1990, 1991), Miller and Hurry (1983), and South (1977). An analysis of the different nail and bottle types was used to refine the tentative date ranges of historic occupation generated by the ceramic assemblages.

The analyses of the cultural materials recovered during the archaeological investigations also included mapping the density and horizontal and vertical distribution of these materials within the project area. Given the preliminary nature of the survey and the relatively small sample of cultural material recovered, analysis was limited to these basic tasks.

## Curation

Following laboratory processing and cataloging activities, all recovered cultural material was placed in acid-free Hollinger box with a box content list and label printed on acid-free paper. This box was stored at PAL in accordance with state and federal curation guidelines until such time as a permanent repository is designated.

# CHAPTER THREE

# ENVIRONMENTAL CONTEXT

This chapter summarizes the geomorphology, surficial deposits, soils, hydrology, and existing conditions of the Madaket WWTF project area. An initial overview of Nantucket's physiography is provided with project-specific detail, where applicable. The discussion of existing conditions within the project area was drawn from observations made by PAL archaeologists involved in the project.

The Madaket WWTF project area is located at the western end of Nantucket Island, just east of Long Pond and closer to the south shore. The local topography is typical of the central outwash plains region, with characteristic flat terrain and little surface relief (see Figure 1-1). Glacial meltwater stream channels once crosscut the outwash plains in a north/south orientation. The southern extent of this valley is marked by a series of ponds, all of which were once elements of a complex Native American cultural landscape on Nantucket. In terms of surficial deposits, the project area is mapped as Nantucket younger outwash deposits with the stream channel itself marking a boundary with older outwash deposits (Oldale 1992:86).

**Geomorphology and Surficial Deposits**

Nantucket is the largest of four islands that combined measure 31,520 acres (49 square miles) and make up Nantucket County (Langlois 1979:1). Esther, Tuckernuck, and Muskeget islands trail off the western tip of Nantucket and are considerably smaller landforms. Nantucket lies approximately 25 miles south of Cape Cod's southern shoreline. Along with Cape Cod, the Elizabeth Islands, and Martha's Vineyard, Nantucket was created by geologic processes that occurred during the Pleistocene Epoch, between about 1.6 million and 10,000 years ago (Oldale 1992:183). Nantucket is situated within the Atlantic Coastal Plain physiographic province (Oldale 1992:3). The coastal plain margins generally correspond with the New England coastline to the north and the terminus of George's Bank to the south. It includes the continental shelf in the areas presently known as Nantucket Sound, Vineyard Sound, and portions of the Gulf of Maine.

The bedrock underlying Nantucket is composed of different kinds of consolidated sedimentary, igneous, and metamorphic rock buried by 1,500 to 1,800 feet of glacial deposits (Oldale 1992:19). Details about the bedrock composition are uncertain because very few geological borings have been taken. Overlying the bedrock are various sedimentary layers that accumulated during the Late Cretaceous (140 to 66 million years ago), Tertiary (66 to 1.6 million years ago), and Quaternary periods (1.6 million years ago to present). The Quaternary Period includes the Pleistocene Epoch, or great ice age, characterized by periods of glacial development interrupted by climatic warming trends and glacial recession.

The modern configuration of Nantucket Island resulted from the effects of the Laurentide continental ice sheet and, after its deterioration, natural processes of erosion and deposition. Nantucket Island today consists mostly of coastal plain deposits buried by debris accumulated during the late Wisconsinan glaciation that began in Canada approximately 75,000 B.P. Glacial ice advanced across New England by 25,000 B.P. reaching the offshore islands by about 21,000 B.P. (Oldale 1992:95). The ice mass in this region was in the form of three abutting lobes: the Buzzard's Bay Lobe to the west, the Cape Cod Lobe extending across central Cape Cod south to Nantucket and portions of Martha's Vineyard, and the South Channel Lobe to the east including the Gulf of Maine (Figure 3-1). Terminal moraine deposits on

Nantucket and Martha's Vineyard mark locations of the Cape Cod Lobe glacial maximum. In simple terms, these are the unconsolidated particles of sand, gravel, silt, clay, boulders, and rock that built up as the ice sheet was melting at the same speed it was pushing forward. Terminal moraine deposits stretch from Chappaquiddick on Martha's Vineyard east to Tuckernuck Island and along the northern part of Nantucket Island.

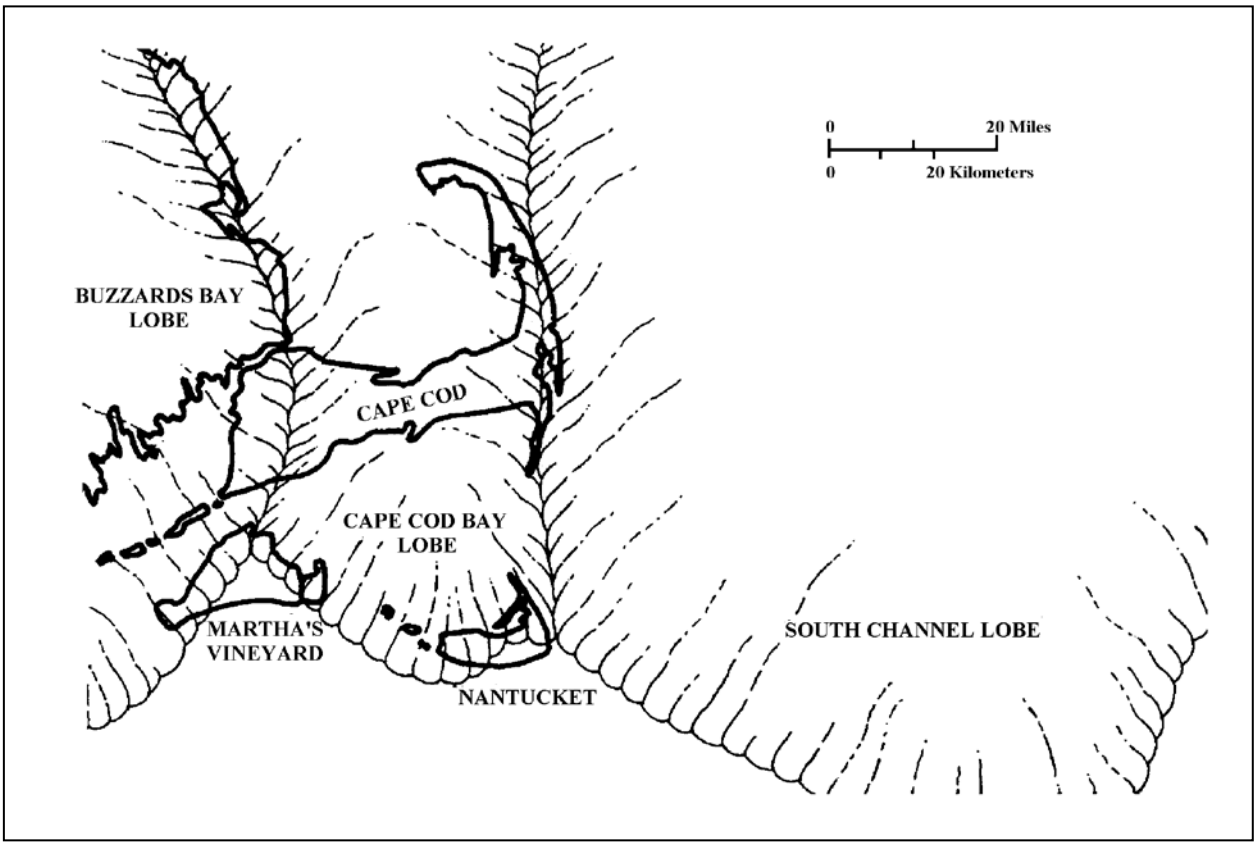


**Figure 3-1. Ice lobes of the Wisconsinan glaciation and the formation of end moraines (source: Oldale 1992).**

Over most of Nantucket, the southern limit of the moraine is marked by ice contact slopes that drop down to a belt of low-lying swampland. This poorly drained region marks the front edge of the Cape Cod Lobe where it ceased advancing and separates the moraine deposits to the north from the outwash plains to the south. At this time, sea levels were approximately 300 feet lower than they are today. The continental shelf was an exposed landscape characterized by swamps, marshlands, and an abundance of plant and animal life (Oldale 1992:96). The Laurentide ice lobes retreated from the off-shore islands by 18,000 B.P. as the global climatic warming trend continued. All of New England was ice-free by 14,000 B.P. (Oldale 1992).

As the recession continued northward across the mainland, meltwater streams springing from the ice front passed southwesterly toward the sea carving out channels and depositing a mixture of gravel, sand, and silt. These broad, flat, alluvial surfaces or outwash plains are the predominant glacial features on Nantucket (Oldale 1992:61). The project area intersects younger Nantucket outwash plains deposited over remnant ice blocks left behind during the glacial retreat (Oldale 1992:87). These deposits are described as sandy outwash with some gravel beds containing pebble to cobble size material and scattered boulders (Figure 3-2). Outwash deposits on this part of Nantucket also contain a few beds of silt and clay

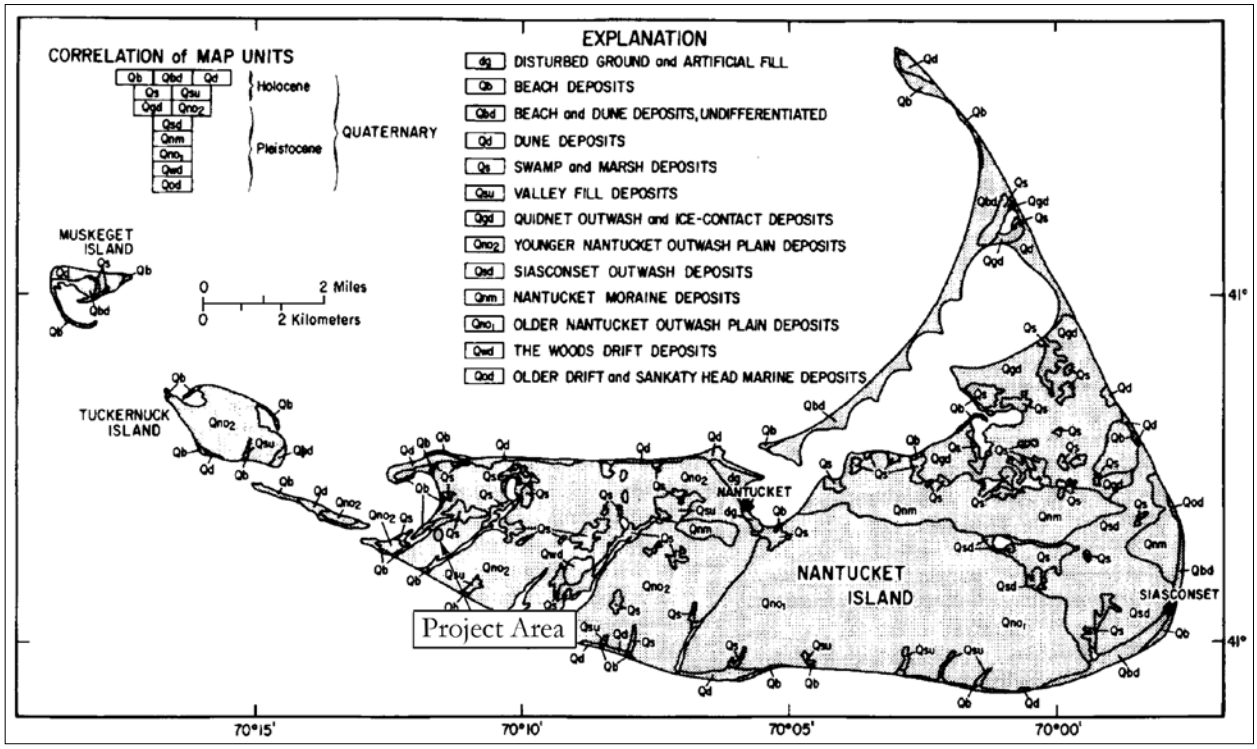


**Figure 3-2. Geologic map of Nantucket Island showing the approximate location of the project area (source: Oldale 1992).**

and occasional areas of fill. Moraine deposits marked by slightly more dramatic topographic features lie to the north of the project area from the Nantucket High School property west across Prospect Hill.

The surficial deposits found on Nantucket were valuable resources for Native American groups, providing a lithic source for stone tool technologies and perhaps clay for making pottery. Archaeological studies have shown that Native Americans on Nantucket made most of their stone tools from glacially deposited cobbles available on the beach or by digging into moraine features. These deposits contain rocks carried south by the Laurentide ice sheet from the mainland bedrock. The most common rock types found in the drift include granite, volcanic rocks, basalt, and quartzite with some samples traceable to specific formations within the Massachusetts mainland (Oldale 1992:78–82). The range of source areas for the glacial till of Sankaty Head include volcanic rocks from near Boston [probably referring to Blue Hills, Lynn, and Mattapan complexes], sedimentary fossil-bearing sandstones from eastern Massachusetts and Rhode Island, pebbly conglomerate resembling that of southeastern Massachusetts, cretaceous sediments from the coastal plain including bits of lignite, and metamorphic rocks (gneisses and schists) like some of the rocks along the mainland's coast from Newport eastward (Chamberlain 1964:144).

**Soils and Hydrology**

On Nantucket, soils have developed over the past 18,000 years since the retreat of the Wisconsin ice front (Oldale 1992:134). The major soil association within the project area is Riverhead sandy loam and Evesboro sand. These soils are usually found on gently undulating (0 to 3 percent slopes) and in nearly level areas. They are well-drained sandy soils formed on glacial outwash deposits. While these soils are well suited to use as building sites, they are poorly suited for farming, open land wildlife habitat, and woodland wildlife habitat (Langlois 1979:12).

**Existing Conditions**

The area of the proposed Madaket WWTF is relatively flat to slightly undulating with low bush blueberry, scrub vegetation, and scattered pines (Figures 3-3 and 3-4). The two parcels for the infiltrators and the facility are intersected by Red Barn Road—a dirt road running northwest to southeast from the bridge over Long Pond. A dirt access also runs south off of Madaket Bridge Road through the proposed facility parcel.

**Figure 3-3. Photograph showing general project area conditions on either side of Red Barn Road, view north northwest.**

**Figure 3-4. Photograph showing general project area conditions along dirt road in the facilities section of the project area, view northwest.**

# CHAPTER FOUR

# CULTURAL CONTEXT

This chapter provides a synthesis of archaeological and historical data relevant to the pre-contact and post-contact human occupation of Nantucket. Research contexts pertaining to the Madaket WWTF project area draw in various degrees of the cultural chronology of the greater Northeast region, southern New England, the Cape and Islands region of Massachusetts, and Nantucket Island. For each recognized chronological subdivision within the pre-contact and post-contact periods, an overview of current knowledge and general developmental trends is provided. The pre-contact period cultural chronology establishes a set of expectations about the project area relative to Native American occupation from the PaleoIndian through the contact periods based on what is known about Native land on Nantucket Island, and in consideration of regional published data. The post-contact period cultural chronology does the same for Native American and Euro-American occupation and use of the project lands during and after contact.

## Pre-contact Period

Nantucket Island was first explored by Native Americans approximately 11,000 to 12,000 years ago during the early Holocene PaleoIndian migration into the coastal Northeast. Archaeological remains from Nantucket illustrate a chronology of Native American land use that began soon after coastal deglaciation and continued through the nineteenth century. As in other parts of coastal southern New England, climatic fluctuations, sea level rise, and resulting ecological changes have influenced the capacity for human adaptation and settlement on this landscape since the PaleoIndian Period. From a modest peak on an extensive coastal plain to a relatively small and remote island, Nantucket's environment has changed drastically since the Wisconsin glacial recession. Inundation of the coastal plain caused the formation of Nantucket, Vineyard, and Block Island sounds during the Early/Middle Archaic Period, as early as 8,000 years ago. Once cut off from the mainland, Nantucket's proportions gradually diminished and it was not until the Early Woodland Period (ca. 2000 B.P.) that the island began to resemble its modern configuration (Oldale 1992:98).

The following discussion provides a general overview of Nantucket pre-contact period from the PaleoIndian Period (12,000–10,000 B.P.) through the Late Woodland Period (1000–450 B.P.). Table 4-1 supplements the discussion with a chronological guideline of pre-contact temporal subdivisions correlated with changing cultural and technological developments over time.

### PaleoIndian Period (12,500–10,000 B.P.)

Pre-contact human occupation on Nantucket began in the early Holocene Period ca. 12,000 to 10,000 years ago. During this time, Nantucket, Martha's Vineyard, and Cape Cod were part of a continuous land mass. Archaeological evidence of PaleoIndian Period activity is limited throughout southern New England. However, an increasing number of PaleoIndian sites have been discovered and investigated in the southern New England region leading to a number of ideas about the settlement and subsistence patterns of these early groups. Most researchers have characterized PaleoIndian populations in the Northeast as highly mobile, small groups that explored and colonized the local area as resource-rich territories evolved from the postglacial landscape.

**Table 4-1. Native American Cultural Chronology for Southern New England.**

| Period | Years | Identified Temporal Subdivisions[1] | Cultural Aspects |
|---|---|---|---|
| **PaleoIndian** | 12,500–10,000 B.P.[2] (10,500–8000 B.C.) | • Eastern Clovis<br>• Plano | Exploitation of migratory game animals by highly mobile bands of hunter-gatherers with a specialized lithic technology. |
| **Early Archaic** | 10,000–7500 B.P. (8000–5500 B.C.) | • Bifurcate-Base Point Assemblages | Few sites are known, possibly because of problems with archaeological recognition. This period represents a transition from specialized hunting strategies to the beginnings of more generalized and adaptable hunting and gathering, due in part to changing environmental circumstances. |
| **Middle Archaic** | 7500–5000 B.P. (5500–3000 B.C.) | • Neville<br>• Stark<br>• Merrimack<br>• Otter Creek<br>• Vosburg | Regular harvesting of anadramous fish and various plant resources is combined with generalized hunting. Major sites are located at falls and rapids along river drainages. Ground-stone technology first utilized. There is a reliance on local lithic materials for a variety of bifacial and unifacial tools. |
| **Late Archaic** | 5000–3000 B.P. (3000–1000 B.C.) | • Brewerton<br>• Squibnocket<br>• Small Stemmed Point Assemblage | Intensive hunting and gathering were the rule in diverse environments. Evidence for regularized shellfish exploitation is first seen during this period. Abundant sites suggest increasing populations, with specialized adaptations to particular resource zones. Notable differences between coastal and interior assemblages are seen. |
| **Transitional** | 3600–2500 B.P. (1600–500 B.C.) | • Atlantic<br>• Watertown<br>• Orient<br>• Coburn | Same economy as the earlier periods, but there may have been groups migrating into New England, or local groups developing technologies strikingly different from those previously used. Trade in soapstone became important. Evidence for complex mortuary rituals is frequently encountered. |
| **Early Woodland** | 3000–1600 B.P. (1000 B.C.–A.D. 300) | • Meadowood<br>• Lagoon | A scarcity of sites suggests population decline. Pottery was first made. Little is known of social organization or economy, although evidence for complex mortuary rituals is present. Influences from the midwestern Adena culture are seen in some areas. |
| **Middle Woodland** | 1650–1000 B.P. (A.D. 300–950) | • Fox Creek<br>• Jack's Reef | Economy focused on coastal resources. Horticulture may have appeared late in the period. Hunting and gathering were still important. Population may have increased from the previous low in the Early Woodland. Extensive interaction between groups throughout the Northeast is seen in the widespread distribution of exotic lithics and other materials. |
| **Late Woodland** | 1000–450 B.P. (A.D. 950–1500) | • Levanna | Horticulture was established in some areas. Coastal areas seem to be preferred. Large groups sometimes lived in fortified villages, and may have been organized in complicated political alliances. Some groups may still have relied solely on hunting and gathering. |
| **ProtoHistoric and Contact** | 450–300 B.P. (A.D. 1500–1650) | • Algonquian | Groups such as the Wampanoag, Narragansett, and Nipmuck were settled in the area. Political, social, and economic organizations were relatively complex, and underwent rapid change during European colonization. |

[1] Termed Phases or Complexes
[2] Before Present

Most PaleoIndian sites are identified by the presence of fluted or lanceolate projectile points, exotic lithic materials, or assemblages that include gravers, scrapers, and channel flakes. On Nantucket, five fluted points have been inventoried in artifact collections, and one has been identified as a reworked Clovis point (Pretola and Little 1988). The MHC mentions the area of Coskata on the eastern shore of the Island as the site of a fluted point find (MHC 1987). On Surfside Road, a local collector found a quartz projectile point that appears to have been fluted and may date to the PaleoIndian Period. The specimen was reported by Dr. Elizabeth Little and its present location is unknown. Despite evidence that PaleoIndian groups were visiting Nantucket, there are no known sites that have undergone systematic excavations. Areas sensitive for PaleoIndian sites would include stable, postglacial landforms that have not been subject to coastal erosion and have access to sources of fresh water.

**Early Archaic Period (10,000–8000 B.P.)**

The discovery of Early Archaic tool forms and sites in a variety of environmental settings throughout the southern New England region indicates the development of a more broad-based subsistence pattern during this period. This phenomenon is presumed to have developed gradually as the postglacial boreal forest evolved into a mixed deciduous/coniferous forest. On Nantucket, the forest composition for this period was pine dominant with gradually increasing percentages of birch and oak (Dunwiddie 1990). Archaeological evidence on a regional scale indicates that Early Archaic groups probably had established territories that were much smaller than those exploited by PaleoIndian groups. Bifurcate-base projectile points are diagnostic artifacts of the Early Archaic Period, and assemblages may also include ground-stone tools, drills, anvil stones, choppers, and scrapers (Snow 1980:172).

A few bifurcate-base projectile points have been discovered on Nantucket as evidenced in the NHA private collections inventories; however, contextual information is limited. Of the 644 projectile points analyzed during a 1978 site inventory sponsored by the NHA, only 8 percent were attributed to either the Early or Middle Archaic periods. A small concentration of Early Archaic points was collected from the northeast corner of the Island consistent with the trend for PaleoIndian and later Middle Archaic Period settlement. A lanceolate, “Dalton-like” projectile point found on a site bordering Foulger Creek has also been interpreted as evidence for Early Archaic activity (MHC site files). Otherwise, documented sites in the northern outwash plains region and in the project area vicinity do not appear to contain Early Archaic Period components. Since most site documentation on Nantucket has come from the 1978 inventory of large, private artifact collections, there is potential that early lithic materials could be overshadowed and possibly misidentified in these contexts. Given the suspected PaleoIndian find along Surfside Road, and the concentrated Late Archaic Period activity area in central interior Nantucket, Early Archaic sites could be expected within or near the project area.

**Middle Archaic Period (8000–6000 B.P.)**

Middle Archaic Period settlement patterns in the southern New England region suggest the development of localized group territories. When compared to the PaleoIndian and Early Archaic periods, Middle Archaic sites are found in a much wider range of environmental settings and contain evidence for an expanded resource base. During this period, inundation of coastal plain areas due to rising sea levels was ongoing, and both Vineyard and Nantucket Sounds were formed (Oldale 1986:100). Pine-oak and pine forests were well established on Nantucket, and some sections of the Island also supported a heathland vegetation type (Dunwiddie 1990). Known Middle Archaic sites on Nantucket have been discovered near freshwater ponds, wetland margins, and shoreline bluffs. Middle Archaic components mark some of the earliest occupations within several large multicomponent sites. The collections inventory appears to include a few Stark projectile points (based on site form sketches) diagnostic of the Middle Archaic Period from the Bartlett Farm Site (19-NT-102). Other Middle Archaic (Stark) or Early Woodland (Rossville) Period projectile points have been identified in the southern outwash plains region where a

cluster of collector sites surrounding Great Mioxes Pond and the former Little Mioxes Pond have been identified (Sites 19-NT-11, 19-NT-12, and 19-NT-99). A quartz Snappit point, diagnostic of the late Middle Archaic Period, ca. 6000 to 5000 B.P. was recovered during a recent CRM survey for the Nobadeer Farm Road bike path (Doucette 2008a).

The recovery of Middle Archaic tools has been documented elsewhere within the Nantucket outwash plains • in particular, on the margins of freshwater ponds. For example, diagnostic Neville and Stark projectile points have been collected by avocational archaeologists from sites in the western and southwestern section of Nantucket near Gibbs Pond and Tom Nevers Pond (19-NT-61). Similar finds have been recorded along interior ponds, creeks, and former pond locations now marked by wetlands. Like the intermittent finds dating to the PaleoIndian and Early Archaic periods, sites from the Middle Archaic Period appear to be associated with very specific microenvironmental settings on the Island.

#### Late Archaic Period (6000–3000 B.P.)

The Late Archaic Period may be better defined than previous periods because there is a significant increase in the numbers of known sites. This is due in large part to the diminishing rate of sea level rise during this period and the stabilization of coastal landforms. Late Archaic pre-contact sites have been identified in many different types of environmental settings across the Island including coastal, estuarine, and interior areas. Palynological research indicates that after about 5,500 years ago the vegetation on Nantucket consisted of a mixed hardwood forest with oak as the dominant species and some beech, tupelo, and maple. There was an increase in the variety of tree species on the Island, but forests appear to have been less diverse than those on the mainland of southeastern Massachusetts (Dunwiddie 1990).

Stone tools diagnostic of the three major cultural traditions (Laurentian, Small Stemmed, Susquehanna) within the Late Archaic have been collected from sites across many sections of Nantucket. Projectile points attributed to the Laurentian tradition include Otter Creek, Vosburg, and Brewerton styles. Brewerton projectile points have been noted in artifact collections from Nantucket but do not appear to be widespread. Pretola and Little (1988:49) found that only 2 percent of the 644 projectile points identified by Dincauze in 1978 fell into the Brewerton classification and 11 percent were identified as either Small Stemmed or Squibnocket Triangle points. Recently, a chert Brewerton point (ca. 5000 to 4000 B.P.) was recovered in a fill context along Nobadeer Farm Road during a CRM survey for the Nobadeer Farm Recreation Center (Doucette 2008b).

The Transitional Archaic Period dates from about 3800 B.P. to 2600 B.P., and important technological innovations include the manufacture and long-distance transport of steatite or soapstone vessels and probably some early forms of ceramic production. The exploitation of shellfish is likely to have begun during the period concurrent with the slowing of sea level rise and development of tidal flats and estuarine zones that provided a habitat for shellfish species. Cremation burial rituals are also a significant cultural aspect of the Transitional Archaic Period, as described below.

### The Transitional Archaic Cremation Burial District of Nantucket, ca. 3800–2600 B.P.

The project area lies west of a zone of Native American archaeological sensitivity based on the documentation of six sites containing possible evidence of Transitional Archaic Period cremation burial practices. In 1978, Dr. Elizabeth Little participated in an effort sponsored by the NHA to inventory known sites on the island (Little 1983). Subsequently, she used the data to produce a predictive model for Native American archaeological sites that identified patterns in site and artifact types within four broad environmental zones. Zone 4 was referred to as “High Sandy Plain,” and was defined to include land lying above 33 feet above mean sea level on the northern half of the outwash plain as far east as Gibbs Pond (Little 1983:7). The six sites containing possible evidence of cremation burials were all located in

this environmental setting, and were concentrated in proximity to the Nantucket High School in the south-central section of the Island. Although there was no confirmation of human remains at these sites, the archaeological signature indicated by the presence of certain artifact types suggests that cremation burials once existed in these locations. Specific point types such as Mansion Inn, Orient, Coburn, and Hawes found in combination with steatite vessel fragments, calcined bone, and dense charcoal deposits are characteristic of cremation burial sites.

In 1986, PAL was contracted to conduct an intensive archaeological survey on Nantucket Public School property in preparation for expansion of the high school and elementary school (Ritchie 1988). This was the first opportunity to test the predictive model proposed by Dr. Little with regard to the existence of a cremation burial district. In developing a research design for the project, Ritchie (1988:26) suggested that several identified sites may have been elements of one cremation cemetery. He further mapped a "cremation burial district" surrounding and including all of the discovered sites in the immediate vicinity of the high school property both above and below the 33 ft contour, but not including the entire High Sandy Plain zone identified by Little (1983). The southern boundary of the district extends as far south as Sewer Bed Road, encompassing the Miacomet burying ground. The 1986 survey at the high school did not locate any evidence of cremation burials, or other site types. This was attributed to the 1950s facility construction and the resulting alteration of the original landscape. To date, although Late and Transitional Archaic Period artifacts continue to be recovered in this area, confirmation of undisturbed cremation burials in either zone (Little 1983) or district (Ritchie 1989) has yet to be made.

Of the original six sites that were considered to justify the cremation burial sensitivity zone, one (19-NT-156) consists of a single complete Mansion Inn blade discovered in 1977 by a local artifact collector on a back dirt pile along Surfside Road. Although the state site form depicts a location for the find, it was estimated based on a local newspaper article that referred to a dirt pile, ". . . near the Thurston property" (MHC site files). The other five sites were all discovered to the north on private properties along Surfside Road or at the High School and Hospital properties. The Austin Site was identified from interviewing a resident of Surfside Road during a CRM survey. On the west side of Surfside Road opposite the Nantucket High School, excavations for a garage foundation on the Richard Austin property uncovered a charcoal-filled pit feature approximately 32 inches below the ground surface. Fragments of one or more steatite bowls, calcined bone, antler and shell, and a mixed assemblage of projectile points and bifacial tool blades were recovered. Five of the points were Coburn-like, side notched types of felsite comparable to those found on the high school property. Other diagnostic tools from the Austin property included an Early Woodland Period Meadowood point of chert, and three Small Stemmed points (Ritchie 1988:26). The charcoal feature description and contents represent the most compelling evidence suggestive of cremation practices on Nantucket.

The other Transitional Archaic Period sites within this district consist of individual tool finds. For example, a large Atlantic projectile point was found in a disturbed context along Surfside Road. Another large projectile point of the Coburn/Hawes type was found in Wyers' gravel pit along Surfside Road by a local collector, Nelson O. Dunham. This tool is currently in the archaeological collections of the NHA. Site 19-NT-85 located on the high school property consisted of Susquehanna tradition tools and steatite bowl fragments reported by a local collector (Roy 1956). During construction of the Nantucket Cottage Hospital on Prospect Street, another local collector reported finding steatite vessel fragments (MHC site form; 19-NT-93). In the absence of contextual data and archaeological records, little can be said about the meaning and significance of these individual tool discoveries other than that they are consistent with Native American activity during a broad period of time, the Late Archaic Period.

Additional Late and Transitional Archaic Period tool types have been located throughout the central outwash plains as isolated finds and in association with small campsites and tool production or maintenance locations. Orient fishtail and Small Stemmed points are the most common among these, and

have been discovered at the Nantucket Housing Authority Site on the opposite side of Miacomet Road (Carlson et al. 1992); at the proposed site of new high school staff housing to the north along First Way (PAL 2004); to the east at Nantucket Memorial Airport property (Willan and Ritchie 1995); at the proposed South Shore Links golf course (Rainey 2000); and southwest in Miacomet valley, on lands that were once considered for Miacomet Golf Course expansion (Rainey and Ritchie 1997).

Late and Transitional Archaic diagnostic projectile points have also been found at many of the larger, multicomponent sites within the southern outwash plains generally on large pond or swamp margins. Interior settings for these settlement areas include Herrecater Swamp Site, Hummock Pond, and Gibbs Pond, all of which have been targeted by local artifact collectors and amateur archaeologists for at least 100 years. While these sites do not contribute to our understanding of Native American burial rites and traditions during the Late Archaic Period, they are evidence of a substantial community of island residents during that time.

#### Early Woodland Period (3000–1600 B.P.)

Following a pattern observed across other sections of coastal southern New England, Early Woodland sites on Nantucket contain some of the earliest evidence for the intensive use of shellfish resources. Settlement and resource procurement targeted the rich estuarine and salt marsh environments. In 1987 the MHC (1987:35) had on record 20 known sites on the Island with components attributed to the Early Woodland Period. Certain locations on the margins of larger, brackish wetlands and salt marshes with Early Woodland components continued to be used during the Middle and Late Woodland periods. A range of activities was staged from these sites such as shellfish collection and processing, marine and freshwater fishing, procurement of lithic raw materials, and deer hunting.

Early Woodland sites on Nantucket often contain assemblages consisting of Meadowood, Lagoon, and Rossville type projectile points and thick, grit-tempered, cord-marked ceramics. During the Polpis Road data recovery program, similar lithic and ceramic types were found at two sites within coastal pond and marsh settings. At sites 19-NT-50 and 19-NT-68, there were Early Woodland components with numerous Rossville-like or untyped lanceolate points and bifacial preforms for similar projectile points. Ceramic sherds from thick-walled, cord-marked vessels tempered with crushed granite were also part of the assemblages. Recovered shellfish remains were primarily quahog; other food remains included deer, fish, and bird bone (Rainey 2004).

#### Middle Woodland Period (1600–1000 B.P.)

Sixteen sites dating to the Middle Woodland Period are listed in the MHC inventory of known sites for Nantucket. Middle Woodland Period settlement and resource exploitation was concentrated in the coastal zone near freshwater or brackish wetlands, streams, or salt marshes. Numerous locations in the coastal zone south of Nantucket Harbor were occupied with some of the sites containing evidence of intensive activity. Sites adjacent to the larger freshwater ponds on the western half of the Island were also occupied. For example, Middle Woodland components near Long Pond contain both shell midden and non-midden deposits.

Locus Q-6 in the Quidnet section of the Island contained a Middle Woodland component radiocarbon dated to 1680 ± 80 and 1575 ± 160 B.P. This site and others in the coastal pond, and salt marsh and estuary zone contain evidence of intensive shellfish harvesting. At Locus Q-6, shellfish remains were primarily oyster most likely collected from Sesachacha Pond (Little 1984). At Site 19-NT-50 in the Sesachacha Pond area, a later Middle Woodland component contained small deposits of shellfish remains. A sample of oyster shell from one deposit was radiocarbon dated to 1290 ± 60 B.P. Activity areas within the site contained shellfish remains, bone fragments, and lithic workshops with dense deposits of chipping

debris. The lithic tool assemblage is dominated by lanceolate projectile points similar to the Greene and Fox Creek types and point preforms made of local felsites. Jack's Reef Corner Notched points were a minority in the assemblage from 19-NT-50 and from other sites with Middle Woodland components (Rainey 2004).

The occasional appearance on Middle Woodland sites of projectile points and bifacial tool blades made of cryptocrystalline lithic materials (chert, jasper) from sources outside southern New England indicates some participation in long-distance trading networks. On Nantucket, this pattern seems to be less prevalent than on the mainland of southeastern Massachusetts. Like the Early Woodland Period, there is little documented evidence of Middle Woodland Period activity in the immediate project area vicinity or in general throughout the central outwash plains region. The Creeks at the southern end of Nantucket Harbor and the northern reaches of Miacomet valley would be an expected setting for Woodland Period sites given the tidal estuarine environment.

**Late Woodland Period (1000–450 B.P.)**

Of the 644 projectile points identified in the 1978 NHA survey, 47 percent were Levanna types diagnostic of the Late Woodland Period. Based on variations in frequency among Early, Middle, and Late Woodland projectile point styles inventoried at that time, it was estimated that local Native American populations were steadily increasing in numbers throughout the Woodland Period and reached a peak by the Late Woodland (Pretola and Little 1988:49). The 1987 MHC inventory (MHC 1987:35) of known pre-contact sites on Nantucket does not reflect such a trend, showing a slight drop in the number of locations occupied in the Middle Woodland Period.

Late Woodland Period settlement was concentrated in the coastal/estuarine zone in many of the same locations occupied by Early and Middle Woodland populations on the Island. A few large Woodland Period sites have been identified along the margins of the outwash plain ponds such as Long and Hummock ponds. Ram Pasture is one example of an extensive Late Woodland site. It appears to have functioned as a base camp in the Late Woodland Period about 1,100 to 500 years ago. Numerous Late Woodland projectile points as well as other tool types (drills, flake knives, hammerstones, ground stone axes) are indicative of a wide range of activities. Fragments of bone from various mammal (deer, fox, muskrat) and fish (tautog, sturgeon, shark) species indicate that both terrestrial and marine resources were elements of the pre-contact subsistence regime.

While hunting and gathering was still an integral part of Native American life throughout the Woodland Period, horticulture or cultivation of domestic plants such as maize was probably established in the region by 1,000 years ago. Evidence for large-scale horticulture has yet to be discovered on Nantucket, however investigations of a large, Late Woodland pit feature at a site in Quaise was interpreted as possible evidence for storage of corn (Luedtke 1980:115). Ground-stone pestles have also been recovered on Late Woodland sites suggesting the processing of vegetal material, possibly of corn (Brooks 1942). Two of the Polpis Road data recovery excavations resulted in the recovery of substantial Levanna Point collections, Late Woodland radiocarbon dates, and small maize samples that span the Late Woodland to contact periods (Rainey 2004).

Late Woodland components also often include both human and dog burials (Bullen and Brooks 1948; Trinkaus 1982; Turchon 1979). The Hughes Site, for example, on the east side of Long Pond contained three human burials found near a shell midden deposit. A single adult male, two children, and a dog were found in this multiple interment (Bullen and Brooks 1948). Late Woodland burials have not been discovered in the interior central region of Nantucket, although Ram Pasture may have contained a single burial. The Miacomet Burial Ground contains the remains of eighteenth-century Native Americans,

although there was no evidence that the site was used for interment during the Late Woodland Period (Simon 1988).

**Contact Period (A.D. 1500–1620)**

The initial English claim to the Island of Nantucket, Massachusetts can be traced to the fifteenth-century voyages of John and Sebastian Cabot (1497–1498), who sailed under King Henry VII (Douglas-Lithgow 1911:5–6). It was not until 1659, however, that a permanent English settlement was initiated there, long after the colonial foothold on mainland territory had been established, and 17 years after settlement of Martha's Vineyard. As a result, primary accounts describing the Island's Native population prior to 1659 are virtually unknown with the exception of some obscure mainland reports. Although the Cabots did not land on Nantucket, the inhabitants of the Island were soon in contact with the sixteenth-century stream of traders, fisherman, and explorers who ventured into the waters off New England's coastline seeking better fishing territories or new land claims. The English mariner Gosnold is said to have landed at Sankaty Head in the summer of 1602 (Douglas-Lithgow 1911:6), although most accounts indicate that he passed the Island and landed at Cuttyhunk. Both Captain Weymouth (1605) and Captain Dermer (1620) visited Nantucket, although no European settlements were established during this period (MHC 1987:56). While it is certain that explorers and fishermen were knowledgeable of Nantucket during the contact period, the lack of primary accounts may be attributed to the general difficulty these men may have had in reaching the shoreline (Byers 1987:18).

To date, contact period archaeological sites on Nantucket are rare and are generally represented by small assemblages on Native American domestic sites that were established during the Woodland Period and occupied until the contact period, or were established during the contact period and remained in use into the eighteenth century. As such, material culture and specific Native American activities representing trade and exchange from off island European explorers and settlers prior to 1659 are often difficult to isolate and study. For example, the Polpis Road data recovery excavations at two traditional residential sites concluded that these home sites were occupied repeatedly for at least 3,000 years, yet were abandoned during the contact period. Traces of contact period cultural material were recovered from each site, and included seventeenth-century kaolin pipes, ballast flint flakes, radiocarbon-dated maize kernels, and early buff-bodied earthenware fragments (Rainey 2004). In contrast, site examination investigations at the Nantucket Golf Club project area identified one Native American site containing contact period artifacts such as a red clay pipe bowl fragment, as well as eighteenth-century European-made domestic wares, bottle glass, maize, beans, and faunal remains (Rainey and Ritchie 1996). The manufacturing date ranges for many classes of cultural material from this site spanned the contact period through eighteenth century, and were not spatially patterned. In this case, the site was interpreted as a residence established during the contact period and occupied well into the eighteenth century, a time of rapid change for Native Americans living on the islands off the Massachusetts coastline.

**Post-Contact Period**

The post-contact period context presented below includes a general overview of the processes that led up to an initial European settlement on Nantucket Island in 1659, and the progress of that community through the next several centuries. It is an abbreviated history developed by PAL as a result of CRM projects on the island. The historical context for Miacomet village is an evolving narrative as archaeological investigations continue to reveal new information about this community.

**Plantation Period (1620–1675)**

In 1621 Nantucket was included in the Royal Grant to Plymouth Company along with Cape Cod and Martha's Vineyard (Douglas-Lithgow 1911:11). Management of this territory was the responsibility of

William Earl of Sterling and Sir Ferdinand Georges, the two principal Commissioners of the Plymouth Company in charge of promoting colonization. In 1641 James Forrett, acting as the New York agent to the Earl of Sterling, sold all the islands south of Cape Cod to the Medford merchant Thomas Mayhew (Worth 1992:6). This conveyance granted only the right to use the surface of the land (Worth 1992:7). It seems that Georges also held a royal grant to the Island, and Mayhew apparently secured title to the Island from him as well (Mooney and Sigourney 1980:12).

In 1642 Mayhew acquired Martha's Vineyard and the Elizabeth Islands, and he sent his son Thomas (age 26) to the Vineyard in the same year to begin a settlement (Goodwin 1879:538). The young Mayhew quickly learned the Algonquian language of the Native inhabitants and began the work of converting Native Americans to Christianity. By 1643 his Puritan missionary work on Martha's Vineyard began to influence the Native population, and the religious ideologies were soon accepted. Thomas Mayhew Sr. joined his son in Edgartown in 1644 to propagate the work initiated by the younger. A permanent settlement on Nantucket had yet to be established, although the Mayhews made brief missionary visits to the Island during this early period (MHC 1987; Mooney and Sigourney 1980:13). Byers (1987:25) notes that the Mayhews and other Vineyard English families pastured sheep on the western end of Nantucket during this period and kept horses there for use during their periodic visits.

Although the Mayhew family's missionary efforts on Nantucket were well underway by the late 1640s, Native converts were soon used to facilitate the process (Byers 1987:27). This practice lessened the degree of direct contact between the Mayhews and Nantucket Native Americans, thereby reducing the frequency of recorded primary observations. Publications dating to this period of religious conversion offer the earliest insights into general aspects of the Island's Native population, most of which reflect on the numbers of Native Americans converted, or the nature of Native American moral character. According to the extensive primary research conducted by Edward Byers (1987:18–19), "Not even the Mayhews of Martha's Vineyard, who began missionary work on Nantucket in the late 1640s, left a record of Indian life." In 1643, Thomas Mayhew Jr. converted the Native American Hiacoomes from Martha's Vineyard, who then became partly responsible for the conversion of the Nantucket Indians. Daniel Gookin, supervisor of the English missionary effort, wrote in 1674 about Nantucket, "The first light of the gospel that came to this Island, was by means of Messr's Thomas Mayhew, father and son; and also by Hiacoomes, now pastor of one of the churches upon that Vineyard" (Gookin 1806).

Thomas Mayhew Jr's missionary efforts were well known throughout England, and in 1656 he sailed for his homeland to gather additional support for the work. His ship never arrived, leaving the aging Thomas Mayhew Sr. to continue the missionary efforts (Goodwin 1879:538). In 1659 Mayhew sold the islands to a group of 10 investors, himself included, and in the next year a settlement was initiated on the west end of the island at Madaket. Tristram Coffin, one of the investors, traveled from Salisbury, Massachusetts in 1659 to assess conditions on the island and returned to Salisbury with favorable reports. He secured the services of Peter Folger of Martha's Vineyard on that trip, Mayhew's business agent and a fluent speaker of the Native language. As a result of the trip, a group of Salisbury residents, including Thomas Macy (Mayhew's cousin), Edward Starbuck, James Coffin, Isaac Coleman, and several of their family members sailed to Nantucket to spend the winter of 1659–1660. In the next year, each of the original proprietors was permitted to name an associate, and the Island was divided into 20 shares. Before the legalities of the matter were settled, the number of shares was increased to 27, excluding the common land and land reserved for Thomas Mayhew (Douglas-Lithgow 1911:12). A list of the original 28 proprietors (Mayhew included) is presented in Barber's 1839 sketch of Nantucket.

The initial 1660 settlement was established in Sherburne—a high ground at Cappamet Harbor (Capaum), around the head of Hummock Pond and to the west of Reed Pond, where house lots were laid out (Forman 1966:22–23; MHC 1984b; Figure 4-1). The first gristmill was constructed on Wesko Pond in the 1660s to accommodate the processing of agricultural products (MHC 1984b). By 1671 the governor

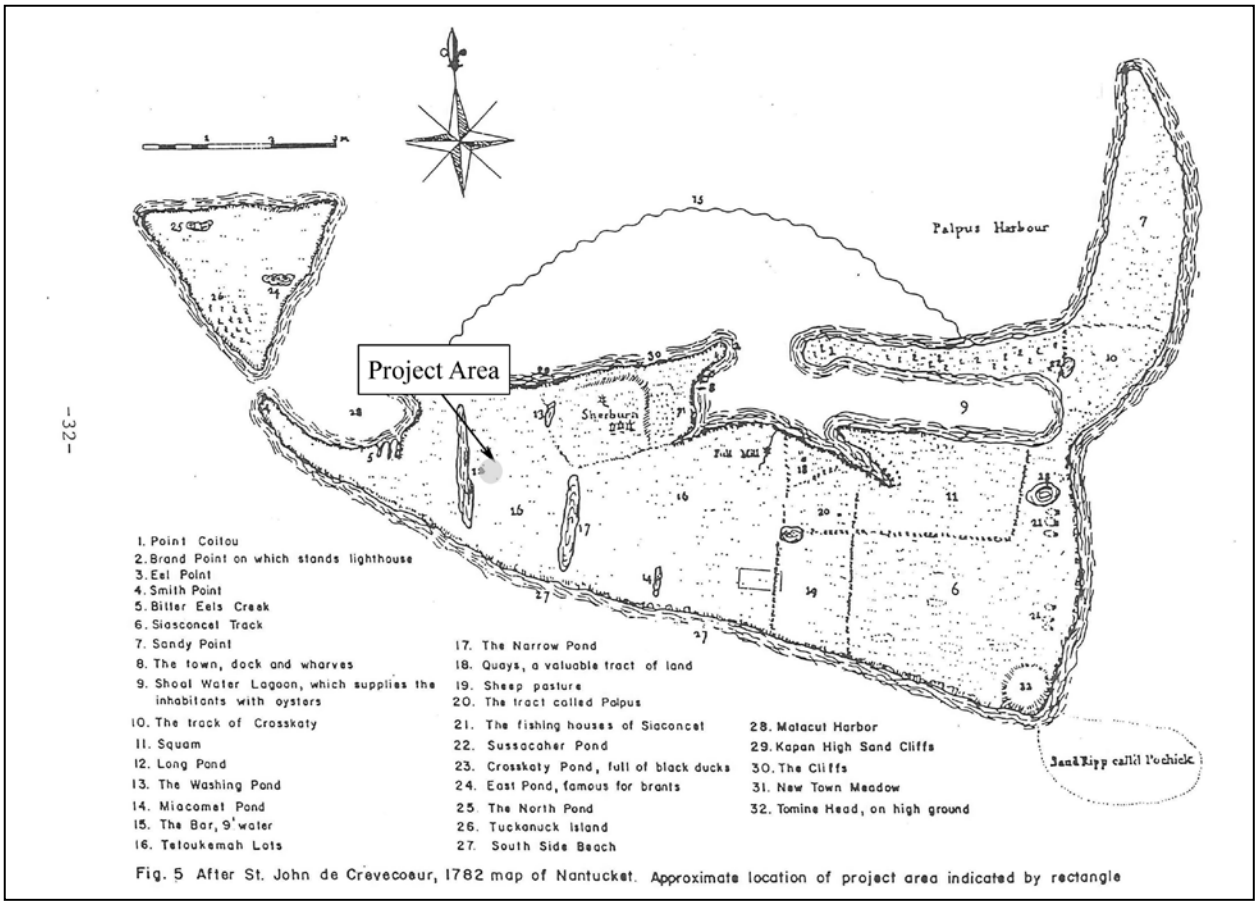


**Figure 4-1. 1782 Map of Nantucket showing the approximate location of the project area (source: De Crevecoeur 1782).**

of New York granted a patent to the Nantucket proprietors, confirming their ownership and authority (Barber 1839:447). By the early 1670s, colonial interests turned to the potential benefits of the local fisheries to supplement the moderate productivity of the island meadows. The MHC (1984b) notes the beginnings of cod fishing and weir fishing industries during this period, with the participation of local Natives. In addition, Dr. Elizabeth Little and island resident, J. Clinton Andrews examined the Native tradition of drift whaling (meaning stranded alive or drifted ashore dead) on Nantucket as a precursor to the development of alongshore and pelagic whaling (Little and Andrews 1982).

On Nantucket, compelling evidence of Native maritime aptitude rooted in tradition is found in seventeenth and early-eighteenth-century county records as well as Native legend. Like many other coastal New England groups, the Nantucket Indians valued the drift whale as a source of food, fuel, raw materials for tools, and as customary tribute in what Dr. Elizabeth Little refers to as a structured whaling industry (Little and Andrews 1982:17). Sachem rights to drift whales on Nantucket were retained until at least 1728, despite the widespread sale of land and other natural resources by sachems to the English settlers (Little and Andrews 1982). There is currently no documentary or archaeological evidence of a Native offshore whaling industry emanating from Nantucket during or prior to the contact period. The account of Captain George Weymouth who explored the region in 1605 describes in detail the Native Americans manner of killing whales from canoes using a bone harpoon tied to a rope (Rosier 1843). Weymouth's journey reportedly included Nantucket, although there is yet no substantial proof of this. According to Little and Andrews (1982:19), the frequency of drift whales on Nantucket may have

eliminated the need to go hunt for them at sea. Data recovery investigations at Site 19-NT-68 along Polpis Road resulted in the collection of a substantial faunal assemblage from a residential site that was abandoned during the seventeenth century. Among the marine resources that may have been procured from a canoe by Native Americans during the Woodland Period are spiny dogfish, sturgeon, sea bass, striped bass, gray seal, and dusky shark.

Alongshore whaling by the colonists began off the south shores of Nantucket after 1690. The Nantucket Indians' involvement in the development of the industry has been well documented: "given the supply of right whales close to shore, and a labor pool of Native Americans with a maritime aptitude as well as an interest in drift whales, we can readily understand the successful European introduction of alongshore whaling to southeastern New England and eastern Long Island" (Little and Andrews 1982:29). The success of the pelagic whale fishery, according to de Crevecoeur (1971:116), ". . . grew out of the success of the alongshore whale fishery." As the industry grew, whaling and codfish stations were established in Siasconset, Polpis Harbor, Quidnet, and Great Point, and the road network expanded to link these areas to the main harbor. Alongshore whaling expeditions usually lasted one to two weeks. The English ship owners employed Native Americans for crew and paid them with a stipulated portion of oil (Starbuck 1989). The lowest positions of the labor force were filled by the Native Americans, in many cases as a result of debts incurred through the purchase of alcohol from the colonists (Byers 1987:6–7). In 1687 the expanding village was incorporated as the town of Sherburne. Nantucket was transferred from New York to Massachusetts's jurisdiction through a 1692 act of Parliament, and in 1695 it became a county (MHC 1984b).

By the early 1700s, Nantucket had taken the lead in the system of boat-whaling from the shore, which involved the construction of lookout stations (called spars) at prominent points along the coast from which sightings were reported. The whale-boat crews were quartered in small huts near the spars, and the lookout man would alert them when whales were spotted. The harpooner and one or two other members of each crew were Native Americans. It was soon recognized that the deep-water sperm whales produced oil of a much finer quality than that of the right whales, which were pursued alongshore. New technologies were designed for the necessities of offshore whaling, including larger and faster boats, new and better gear, and on-board processing systems. Nantucket whalers enthusiastically moved into the new era, and by 1715, six sloops were making voyages of several weeks duration, sometimes as far as the waters off Newfoundland (Hohman 1928:27).

The development of the present downtown area was directly related to the growth of the whaling industry. In 1678, the Wescoe Acre Lots were laid out, initiating a gradual shift in the population core from the original Sherburne location at Capaum to the sheltered area along Nantucket Harbor (see Figure 4-1). Prior to 1717, development in this area was restricted to a few homes not necessarily within the bounds of the Wescoe lots. By 1717, a series of storms resulted in the transformation of Capammet Harbor into an enclosed pond (Worth 1992:203). With the whaling industry fast becoming the Island's economic mainstay, a population migration to the large and protected Great Harbor area was eminent. In 1717, a second division of land adjacent to the Great Harbor called the Fish Lots was set off to include 27 equal parcels, one for each Proprietor. By 1720, the community was officially relocated to Nantucket Harbor (Lang and Stout 1995:26). Through the eighteenth and nineteenth centuries, the sequence of lot divisions reflects the rapid expansion of the downtown community in response to a successful local whaling industry.

#### Native American Land Use and Settlement Patterns of the Miacomet Indian Village ca. A.D. 1693–1800

A review of past and ongoing research into the history of Miacomet Indian Village is providing new insights into the span of its existence, its location within the Miacomet valley, the nature of community

structure, and the larger social context of its residents. A comprehensive consideration of the documentary record of this settlement, including ethnohistoric accounts, descriptions in secondary histories, and the manuscripts prepared by Dr. Little, reveals a marginalized community that formed out of necessity, remained autonomous through part of the eighteenth century, and was quickly forgotten by the early nineteenth century, less than 50 years after the devastating epidemic of 1763–1764.

The following discussion begins with an overview of primary records that support Miacomet Village as a late-eighteenth-century development rather than a traditional, pre-contact period settlement territory. This is followed by an assessment of Dr. Little's manuscripts on Indian Houses (1981) and the History of Miacomet Village (1988a), which chronicle the span of the village and it's associated meetinghouse, identifies residents who she believed owned wood-framed houses, and proposes a community layout. The analysis was in part an outcome of a recent study in the upper Miacomet valley that resulted in the discovery of a longhouse and wigwam feature complex, interpreted as the possible site of the Miacomet meetinghouse (PAL 2004). The assessment calls into question the proposition by Little and others that the Miacomet meetinghouse was built of wood, and that its construction coincided with the arrival of Minister Timothy White. Because there is an extant sketch map produced by Dr. Little that links individual Native Americans with specific property locations, it is essential that the path of her reasoning in these documents is addressed. Information about each of the Miacomet residents named by Dr. Little is also provided (1988a:12).

### *Initial Settlement of Miacomet, 1674–1694*

There are no historic references to Miacomet as a community or a Christian Indian village during the era immediately following the initial English settlement in 1659. Most descriptions of Nantucket's Native population in the seventeenth century refer to the existence of four main settlement areas, or villages, when Mayhew's group arrived in 1659 (Gookin 1806; Macy 1972; Starbuck 1924; Worth 1992). This is based on the recognition of four sachems from whom the English were negotiating with immediately upon occupation of the island. The largest territories in the eastern part of the island were under the leadership of Wanachmamak and Nickornoose, and the two smaller territories were led by Attapeat (also called Autopscott) and Spotso. Although Wanachmamak and Nickornoose did not live in the west end, the first 1659 land transfer of the West End to Mayhew was from these two important sachems (Figure 4-2). Wanachmamak also participated in many other transactions to the English conveying territory under the authority of less-powerful sachems, particularly in the western end where the English initially settled. In 1660, Wanachmamak conveyed to the proprietors land in the west end of Nantucket, the winter seed of the entire Island from the end of Native American harvest until planting time, liberty to take wood and timber throughout the island, and half of the meadows and marshes (Worth 1992:113–115). In the first decade of English occupation, a rapid succession of similar agreements followed, resulting in the depletion of Native held territory, and the cultivation of internal conflict among the various sachemships. It is unclear why Wanachmamak so willingly inspired the practice of selling the Islands' natural resources, critical elements of Native subsistence at the time. His generous exercise of authority in these matters may have been designed to protect his traditional homeland, known historically as Occawa, through an uncertain future beyond his imminent death.

By 1684 there appears to be five main sachemships on Nantucket, three of whom had some jurisdiction over central and western territory (Little 1996:194). They were Seiknout (Muskeget Island), Pattacohonet (Tuckernuck Island), and Attapeat (central interior lands). In terms of Native settlement patterns, the late seventeenth century writings of Daniel Gookin provide the earliest characterization of the Island's "praying Indians" (Gookin 1806). Based on Gookin's discussions with Nantucket Indians who had become Christian ministers, including John Gibbs and Caleb, in 1674 he writes:

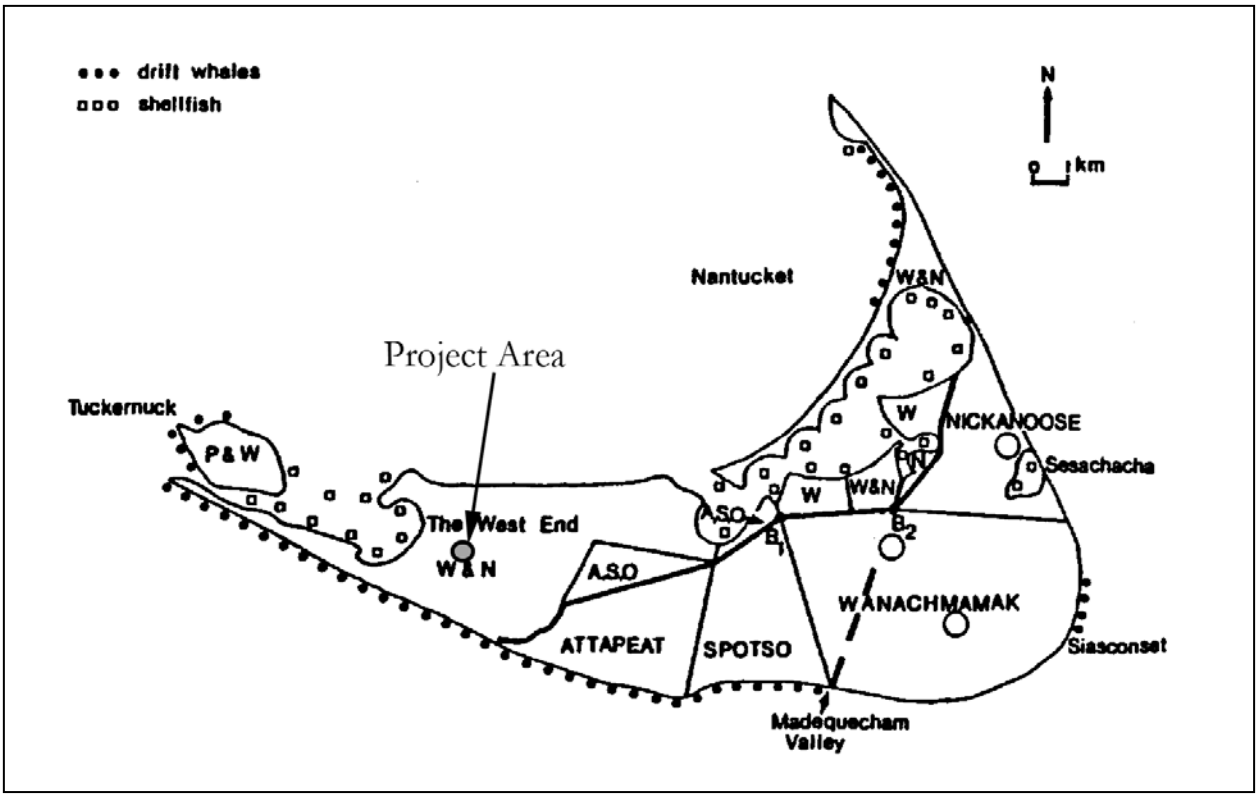


**Figure 4-2. Territories of major sachems at Nantucket and Tuckernuck in the late seventeenth century (source: Little 1988a:3, Figure 2).**

> *there is one church at Nantucket, whereof John Gibbs aforesaid is pastor: that there is about thirty men and women in full communion in the church, whereof twenty are men: that there is about forty children and youths baptized: and that there is about three hundred Indians, young and old, who pray to God and keep the sabbath upon that island: that they meet to worship God at three places: viz. Oggawame where the church meets, at Wammasquid, and Squatesit: that there are four Indian teachers upon that island, viz. John Gibbs, pastor, Joseph, Samuel, and Caleb, who also teacheth school (Gookin 1806).*

In the same passage, he relates a section of a letter from a "Mr. Cotton" dated September 1674:

> *at Nantucket, according to my best intelligence, there are three praying towns; and praying Indians, about three hundred males and females; one church, the pastor is John Gibbs; the men in church fellowship are about twenty; the women, ten. Their children are all baptized. The English upon that island, who are about twenty seven families, and many of them Anabaptists, did as first seek to hinder them from administering baptism to infants; but now they are quiet, and meddle not with them. Caleb is preacher to one town there.*

None of the three places mentioned by Gookin clearly correspond with Miacomet. Worth (1992:293) indicates that the word Miacomet derived from the Algonquian word "maayeakomuk" meaning "the Meeting House," although the source of that information is not given. A postscript in Gookin's Historic Collections states that by 1694, there were about 500 adult Indians on Nantucket, five assemblies of praying Indians, and three churches (John Gardner's 1694 letter in Gookin 1806). The documentary evidence indicates that between 1674 and 1694, the number of Christian Indian communities (assemblies)

increased from three to five, while there were still only three Indian churches. It is likely then, that Miacomet evolved as a new residential Indian community within that 20-year span. Genealogical links established by Little (1988a:9) between descendants of Attapeat and eighteenth-century Miacomet Indian ministers were in her view support for the existence of Miacomet as one of the five assemblies mentioned in Gardner's 1694 letter (Little 1988b:9).

In 1700 there were an estimated 800 Native Americans remaining on Nantucket (Byers 1987:27). Despite an influx of Native American whalers and laborers in the 1740s, by the mid-eighteenth century most of the remaining Native American lands were sold to the English, and the Native population continued to decline. A series of eighteenth-century court records printed in Starbuck (1924:163–169) documents a succession of Native American/English disputes from remnant settlement areas across the central and eastern sections of the island through the mid-eighteenth century. Although it is clear that some of the Native Americans garnered financial success as part of the burgeoning whaling industry, they appear to be those with the closest genealogical links to important seventeenth-century sachems who initiated the disposal of Native held territory and resources (Little 1996). In 1763 a plague spread through the Native community, killing 222 of the 358 surviving Native Americans on the Island (Little 1988b).

It is uncertain how long Native Americans may have continued to live in this area after the epidemic, although early-nineteenth-century maps indicate that much of the land bordering the east side of Miacomet Pond was taken over for Sheep Pens (Ewer 1869; Figure 4-3) De Crevecoeur (1971:123) acknowledged a Native American community living in decent houses along Miacomet Pond in 1782, while the Reverend Freeman referred to Miacomet as a former Native American village 25 years later (Freeman 1815). According to one secondary account, only four male Native Americans and 16 females were left on Nantucket in 1791, and by 1809 there remained only three or four persons of pure Native American blood (Douglas-Lithgow 1911:29). If the estimates are correct (Macy 1972:57), the large relative proportion of Native deaths in 1763–1764 (62 percent of the island's total Native population) would have accelerated the demise of any remaining community structure in Miacomet and elsewhere on Nantucket where settlements and meetinghouses once existed. Thus it appears that by the last decade of the century, Miacomet appears to have dissolved as a community. Three twentieth-century references found in the Nantucket Historical Commission manuscript collections (Grace Brown Gardner's Collection 57, Scrapbook 20) indicate that the last wigwams standing on the island were in Squam, and were removed by the last decade of the eighteenth century.

#### Federal Period (1775–1830)

During the Revolutionary War, the English residents of Nantucket chose a position of neutrality because of their exposed and indefensible position at sea, and also as a result of the beliefs of its large population of Quakers. Despite the fact that neither the British nor the Americans would recognize their position, they continued to send out ships on whaling expeditions. The repeated capture and plundering of the island's vessels during the war resulted in great losses to the community. In 1784, only 28 whalers were left, many of which had been repaired. Approximately 1,200 Nantucket seamen had been lost and captured, and more than 200 women found themselves newly widowed (Hohman 1928:35). This period was marked by economic depression and the emigration of a number of the island's inhabitants. The demand for sperm candles in American as well as in foreign markets brought renewed short-lived prosperity in the 1790s. The War of 1812 created a similar phenomenon of commercial ruin, with a second rebound after the war's end.

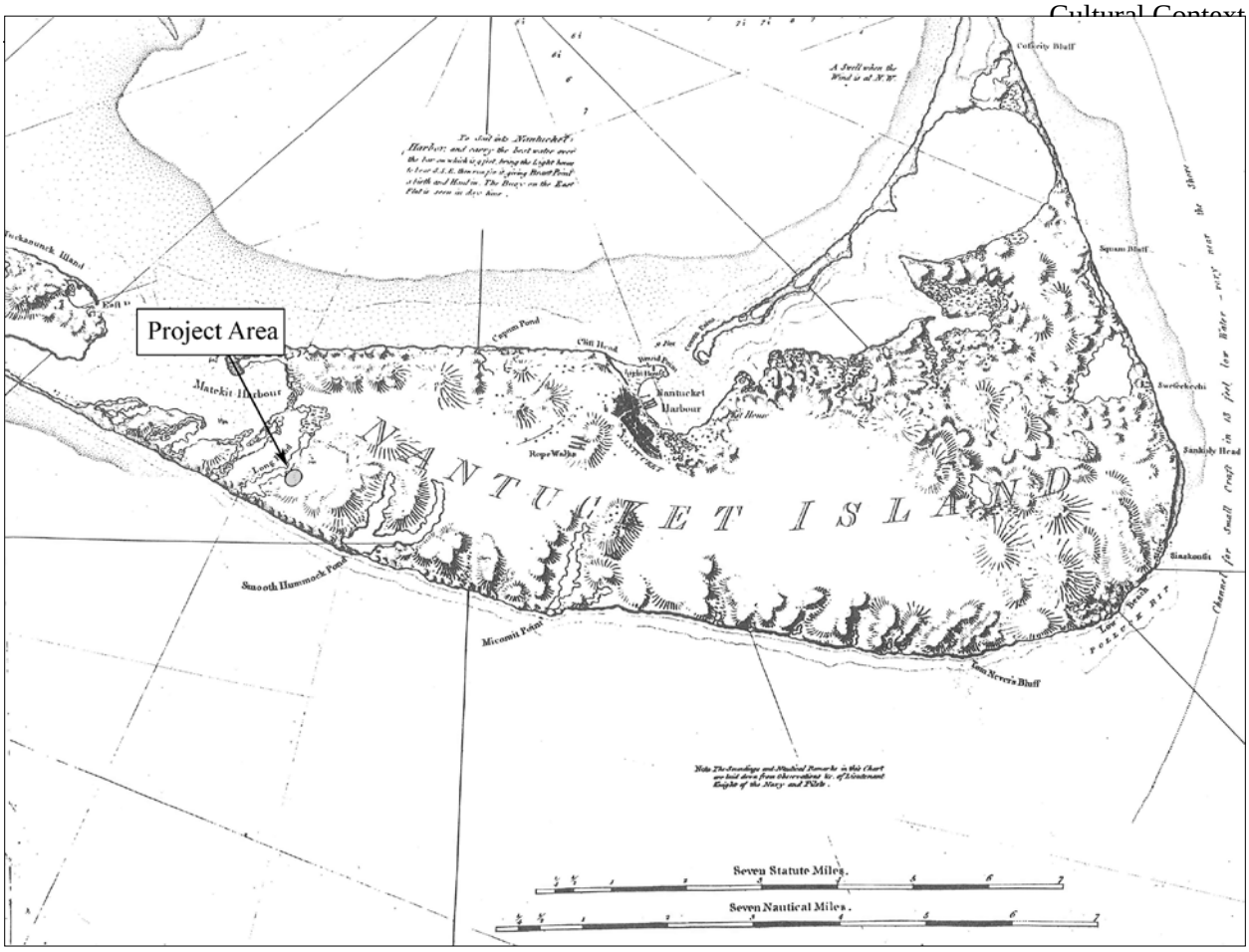


**Figure 4-3. 1776 map of Nantucket showing the approximate location of the project area (source: DesBarres 1776).**

It was during this time that the sheep-raising industry, largely focused in the outwash plains region, began to develop an increasing significance in the island economy (Figure 4-4). A succession of annual events evolved including the driving of flocks prior to shearing events, the actual shearing, and community social events following the tradition (Marshall 1962:15). In order to regulate the use of common land by sheep owners, the Nantucket proprietors translated each persons share of common land into a specific number of "sheep commons." It was estimated that an acre of common land would maintain one sheep (Worth 1992:198). In the early eighteenth century, the survey of the land held in common was calculated at 19,440 acres, the equivalent of the number of sheep that could be pastured. A "sheep common" meant the right to pasture one sheep, or 1/19440 of the common land. Originally, the island common land was held in 27 shares, which is the number of original Nantucket proprietors. As time passed, the shares were subdivided into very small fractions as families grew (Worth 1992:198–200).

The concept of owning a right or percentage of a right to pasture an animal on a large area of land created a variety of problems during the nineteenth and twentieth centuries. In the early nineteenth century, a lawsuit brought by the Mitchell family demanded that a tangible tract of land with recorded boundaries be conveyed for their shares of sheep commons. They owned a sizeable territory in the eastern section of the island called Plainfield, the former setting of Occawa Village.

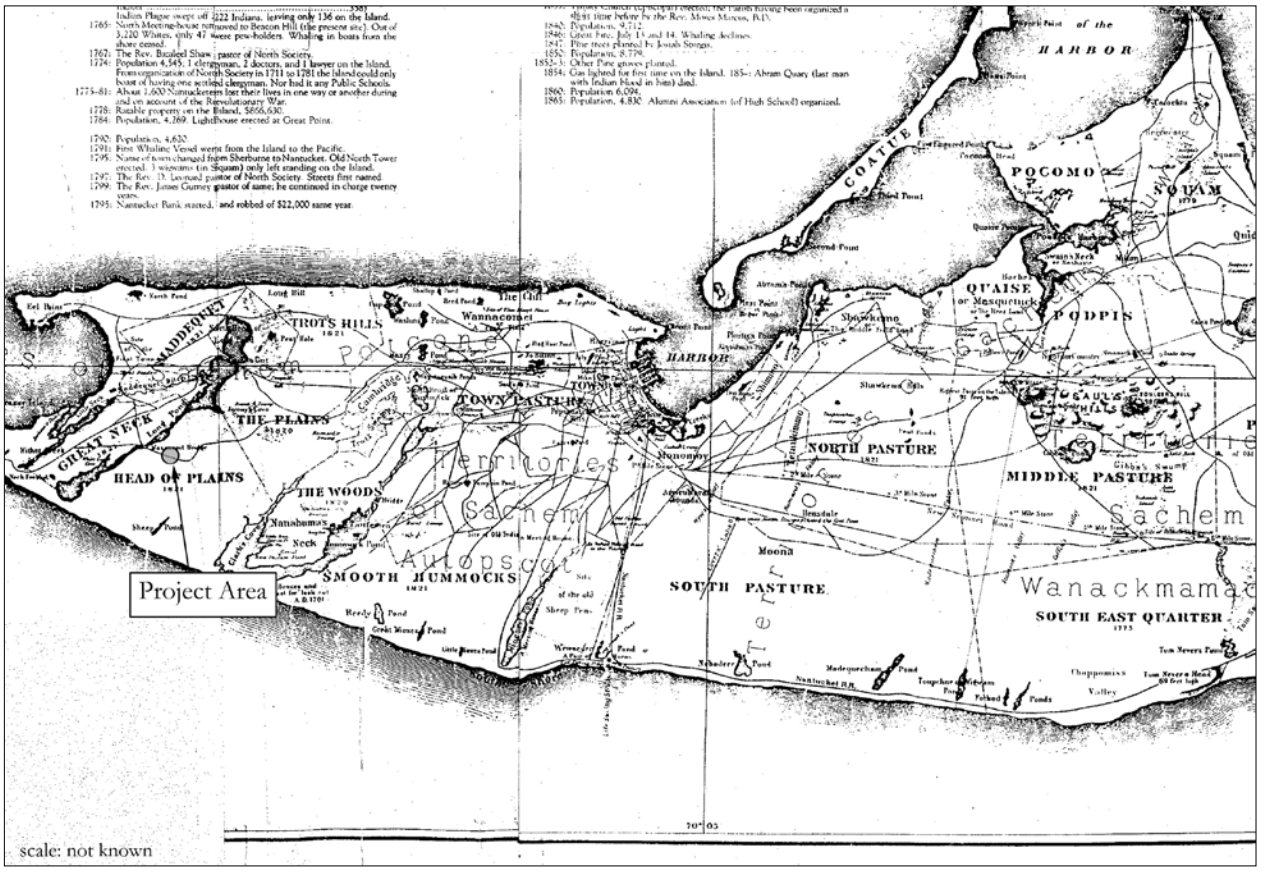


**Figure 4-4. 1869 map of Nantucket showing the approximate location of the project area (source: Ewer 1869).**

A decision by the Supreme Court in 1815 allowed for a man owning 100 sheep commons to sell his commons for a defined piece of land, thereby giving up any future rights to common lands (Worth 1992:210). The new practice required that the proprietors conduct formal surveys, and that all of the common land be surveyed and set off in the records. In 1821, the proprietors voted to lay out into 27 shares all of the common and undivided land on the island excluding the South Pasture (Nantucket County Records: Proprietors Book 1:50). According to DeYoung (1984:2), many people obtained common land set offs in exchange for their sheep commons within South Pasture excluding tracts adjacent to Miacomet Pond. In 1822, a large sheer pen pasture was established east of the pond, which is depicted on a number of historical maps. DeYoung found evidence to suggest that this land was at one point to be set off in severalty to a group of influential proprietors. This apparently never transpired. In addition, the lot containing the Miacomet burial ground and adjacent lot to the south was never laid out and remained common land until the 1980s.

### Early and Late Industrial Periods (1830–1915)

This general period in Nantucket's history was marked by a peak in population and prosperity from maritime activities, followed by a decline in growth within these areas. In 1840, Nantucket's population reached 9,012 (MHC 1987:114). During this time, 64.7 percent of Nantucket's economic prosperity was derived from maritime activities, with agricultural pursuits totaling only 4.7 percent (MHC 1987:116–117). The gradual decline in maritime trade led to a high unemployment rate and a loss of population from 9,012 in 1840 to 4,123 in 1870 (MHC 1987:114). Residents left the island for more prosperous, industrialized population centers on the mainland. The California Gold Rush of 1849 also drew hundreds

of unemployed island residents. Residential and commercial development in downtown Nantucket, which had continued since the Federal Period, came to a halt in 1850.

The maritime economy of Nantucket suffered in part because of its dependence on the mainland for food and manufactured items that could not be locally produced. Between 1840 and 1870 the economic base provided by agricultural pursuits nearly equaled that of maritime efforts (MHC 1987:117). Residents began to grow their own food, and much of the vast, open land on the island was utilized as pasture for grazing livestock. Small, local, short-term manufacturing enterprises also developed at this time, producing commodities such as hosiery, straw goods, and shoes. In the 1850s, there were more than 100 farms on Nantucket (Gardner and Gibbs 1947) (Figure 4-5). In 1856, the Nantucket Agricultural Society was formed by local residents with the intent of educating island farmers, and fostering community cohesion, prosperity, and pride (Newell 2001:2). Land adjacent to Fairgrounds Road was purchased for the annual fair, which grew into a three-day event featuring cattle and oxen shows, fruit and vegetable displays, an arts and crafts show, and entertainment. The Nantucket Agricultural Society realized the potential for the fair to draw tourists to Nantucket and revitalize the local economy, and began advertising the event on the mainland (Newell 2001).

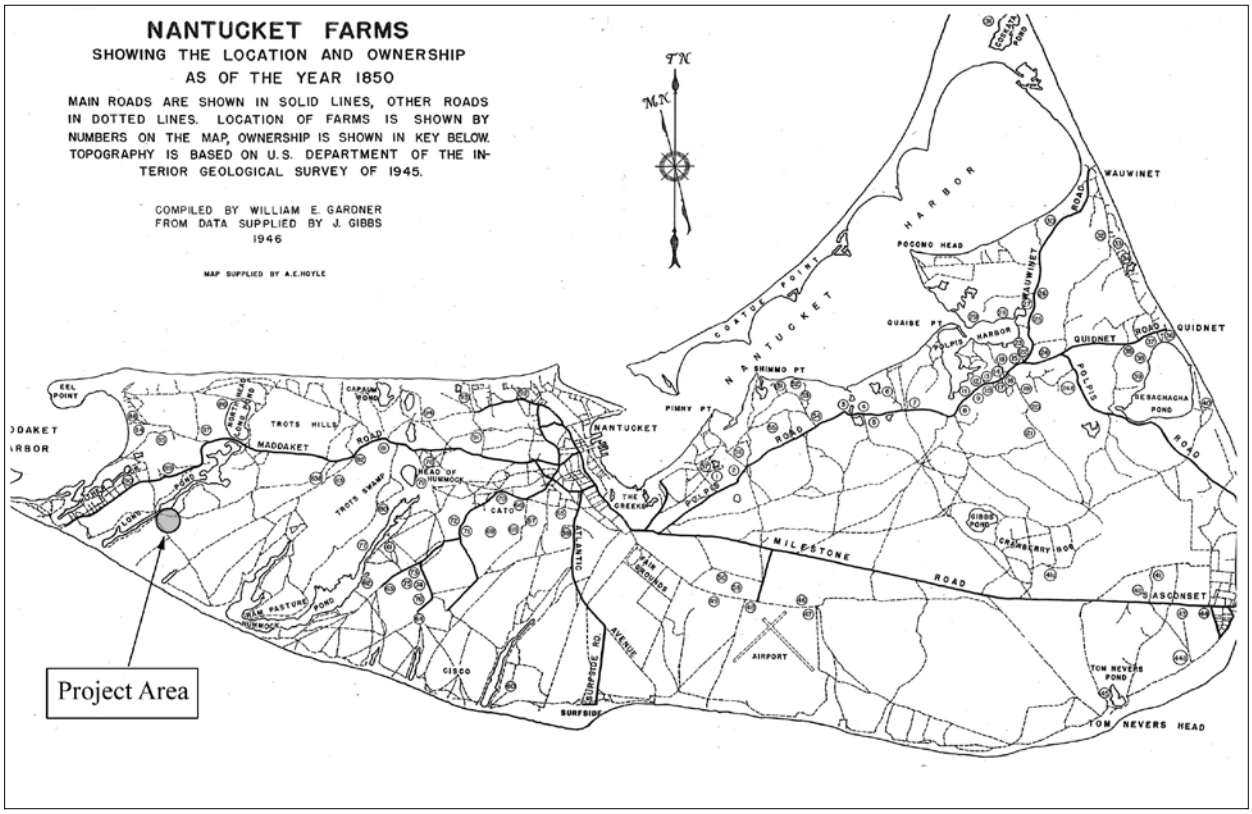


**Figure 4-5. Map of Nantucket showing the location and ownership of farms in 1850 (source: Gardner and Gibbs 1946).**

Toward the end of the nineteenth century, a focus on island-based activities emerged with new improvements in overland transportation. Tourism became important to the local economy, and hotels, cottage colonies, and summer estate districts sprang up around the central village, and in several outlying areas of the island. A trolley also served these summer resort populations during this period (MHC 1987). The growth in tourism drew labor away from agricultural enterprises across the island, and ultimately contributed to the demise of the Agricultural Society. Despite the growing decline in

attendance, the society held their annual fairs through 1939. In 1879, a group of Boston-based investors joined together to promote the design and construction of the Nantucket Railroad (Figure 4-6). The idea was to provide passenger service to a growing summer community of tourists, while promoting their own land sales. In 1881, the initial segment from Nantucket Village to Surfside was complete and running. A second section connecting a resort hotel at Surfside to Siasconset along the southern coastline was completed in 1884. This route was abandoned in 1894 because of coastal erosion, forcing the Nantucket Railroad company into foreclosure. The succeeding Nantucket Central Railroad company built a new rail line to Siasconset, which ran intermittently under various owners until the onset of the First World War in 1917 (Karr 1995).

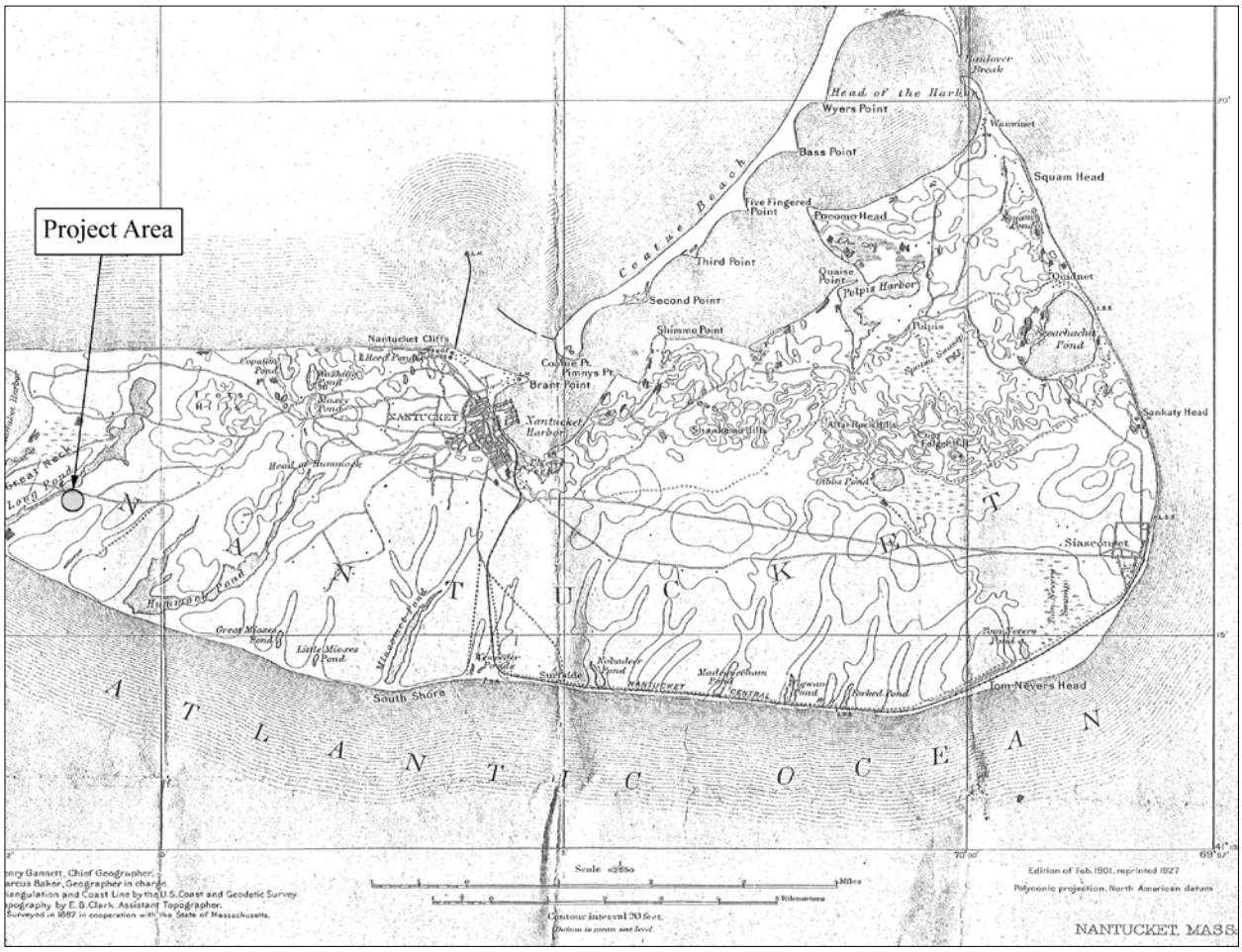


**Figure 4-6 1887 USGS map of Nantucket showing the approximate location of the project area (source: USGS 1901).**

### Modern Period (1915–Present)

The advent of tourism as a new industry on Nantucket in the late nineteenth century was promoted by improvements to the harbor and existing transportation systems (ferry service) connecting Nantucket with the mainland. Island resort centers grew, and the population of Nantucket increased slightly during this period. Although the automobile was introduced to the island in 1900, residents succeeded in prohibiting summer auto traffic in the downtown area through a state law that lasted from 1906 to 1918. The most significant change of the era in the central interior section of the island was the development of the Nantucket Airport. The airport property was part of a larger tract of farmland owned by Leslie Holmes

(or Holms) during the years prior to World War II. At that time, Mr. Holmes decided to allocate part of his farm to build a small landing field. Small dirt landing strips, a hanger, and an administrative building were established. At the outbreak of World War II, the town purchased the land for use as a training base by the Navy. Some antisubmarine patrol reconnaissance flights were also initiated from the site. Improvements to runways and construction of additional facilities were undertaken by the Navy. In 1946, the airport was turned over to the Town of Nantucket.

# CHAPTER FIVE

# RESULTS, INTERPRETATIONS, AND RECOMMENDATIONS

## Results

This chapter presents the results of the intensive (locational) survey conducted within the Madaket WWTF project area, and the interpretations and management recommendations based on these findings. Following the completion of archival research, the fieldwork aspect of the survey included a walkover inspection of the project area and subsurface testing. Subsurface testing focused on those sections of the project area considered to have high and moderate archaeological sensitivity.

### Archival Research

The archival research carried out for the Madaket WWTF project resulted in the collection of information about known archaeological and cultural resources in the central outwash plains area of Nantucket and the surrounding vicinity.

A review of the MHC site files indicates that there are more than two dozen previously recorded Native American archaeological sites located within one and a half miles (2.4 kilometers) of the project area spanning back at least 5000 years. At the Hughes Site (19-NT-92), located just north of the project area, on the east side of Long Pond, three human burials were found in the 1940s dating to the Late Woodland Period (ca. 1000 to 450 years ago). Other Woodland Period sites nearby include the Madaket Dump (19-NT-32), the PCM-15 Site (19-NT-36), and the Dunham and Brooks Site (19-NT-103), which yielded evidence of Late Archaic through Contact Period occupation. Given the location of known sites in the vicinity, undisturbed sections of the project area were considered to be archaeologically sensitive, exhibiting environmental characteristics favorable for ancient and historic period land use and occupation.

Based on the frequency and temporal range of pre-contact sites surrounding the project area, potential pre-contact site types that could be expected within the Madaket WWTF project area could range from find spots of single artifacts and small temporary camps to larger multi-component sites dating from the Middle Archaic Period through the Late Woodland Periods, and possibly into the Contact Period.

The historic period archaeological sensitivity of the project area is based on the previously identified eighteenth-century historic Native American settlement of Miacomet on the island. Activities associated with the community may have continued until 1782, when the meetinghouse was finally removed. Eighteenth century Native American houses adapted from the pre-contact period wigwam style were most likely constructed on the ground surface, and could be identified archaeologically based on assemblages found at other historic Native American house sites on Nantucket (Rainey and Ritchie 1996). Archaeological evidence of later historic period sheep raising activity is also possible. Records indicate that the first Quaker Burial Ground was located near the south end of Maxcey's Pond between 1711 and 1760. The Quaker Cemetery at the corner of Madaket and Quaker Roads, was established in 1730.

The project area also lies approximately .8 miles (1.3 km) southwest of the Madaket Ditch, a canal dug around 1665 by both English settlers and Native Americans connecting Long Pond to Madaket Harbor. The ditch was used to hold a fish weir that was especially good for catching herring (http://yesterdaysisland.com/madaket-ditch-hither-creek-and-millie/).

### Results of the Field Investigations

Based on a walkover inspection, the majority of the project area was considered to have high archaeological sensitivity and does not appear to have been disturbed in recent times by human activity.

A total of 124 test pits was excavated within the proposed infiltrator and facilities parcels of the Madaket WWTF project area (Figure 5-1). These test pits, 50-x-50 cm in size, were excavated along eight linear transects (Transect A-Transect H). There was no pre-contact material or features recovered within the project area. A low density of post-contact cultural material was recovered in two of the 124 test pits and from the ground surface near one of those pits (TB-15).

Subsurface testing documented undisturbed soil horizons over the majority of the project area. Soil profiles were generally consistent throughout the project area. A typical profile included a 6-cm Ao horizon overlying dark brown silty fine sand plowzone/Apz extending down to an average depth of 22 centimeters below surface (cmbs), which overlay a dark yellow-brown silty sand $B_1$ subsoil to 40 cmbs and a yellow-brown sand $B_2$ down to approximately 62 cmbs. A light yellow-brown sand C horizon was exposed under $B_2$. The extent of excavation was approximately 75 cmbs (Figures 5-2 and 5-3). No cultural features were identified on the basis of soil color or texture.

A total of 42 artifacts was recovered during the intensive survey (Appendix A). A range of domestic post-contact cultural material was identified including ceramic sherds, nails, shell, white-clay smoking pipe fragments, clam shell, and burned bone (Table 5-1). The cultural material came from fill contexts or from the ground surface, and while it includes some early post-contact materials such as ceramics (e.g., redware, pearlware), hand-made brick, and white-clay pipe bowl fragments, there were also more recent finds such as wire nails and machine made clear bottle glass. The fill and surface contexts in which this material was recovered suggest that the deposits were likely redeposited, potentially during the construction of an unnamed dirt road running through the facilities parcel.

**Table 5-1. Cultural Material Recovered from the Madaket WWTF Project, Intensive Survey.**

| | Bivalve | Bottle/ Jar | Brick | Ceramic Sherd | Clinker/ Coal | Hollo -ware | Nail | Smoking Pipe | Mammal Bone | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Ball Clay | | | | | | | | 2 | | 2 |
| Calcined Bone | | | | | | | | | 1 | 1 |
| Clinker | | | | | 1 | | | | | 1 |
| Coarse Earthenware | | | | | | 2 | | | | 2 |
| Earthenware | | | 9 | | | | | | | 9 |
| Ferrous | | | | | | | 3 | | | 3 |
| Glass | | 1 | | | | | | | | 1 |
| Porcelain | | | | | | 1 | | | | 1 |
| Refined Earthenware | | | | 19 | | 1 | | | | 20 |
| Shell | 2 | | | | | | | | | 2 |
| Total | 2 | 1 | 9 | 19 | 1 | 4 | 3 | 2 | 1 | 42 |

The majority of the diagnostic material consists of ceramics with date ranges falling between 1600 and present; beginning dates range between 1600 and 1934 and terminal dates range between 1890 and present. The older assemblage of ceramics includes lead glazed redware, creamware, and hand painted and shell-edged pearlware, and the later ceramic assemblage includes two fragments of whiteware.

### Interpretations and Recommendations

Archival research conducted for the intensive (locational) archaeological survey of Madaket WWTF project area reviewed information about patterns of Native American and Euro-American settlement/land use in the general vicinity of the project area. The scope of archival research included the island of Nantucket, especially sites identified within and near the project area. Information reviewed at these different scales was used to predict the types of archaeological sites that might be present. Archival research indicated that the project area had a strong potential to contain pre- and post-contact Native American archaeological sites given the reported presence of several sites adjacent to the project area, and the dozens of sites located on Nantucket in similar environmental contexts.

The goal of the intensive survey was to determine the absence or presence of potentially significant archaeological sites. PAL personnel conducted extensive subsurface testing within the project area based on the results of the walkover survey and sensitivity ranking. Subsurface testing with 124, 50-x-50-cm test pits documented undisturbed and disturbed soil horizons within the project area, relatively little cultural material, and no subsurface or above ground features.

The generally diffuse distribution of the cultural material assemblage from road fill contexts combined with the lack of any associated structural, landscape, or household features suggests that it is best characterized as yard/field scatter with no locational or associative integrity. Fill deposits in the project area contained a mixture of recent and historic cultural materials, demonstrating that the deposits are more recent. Analysis of the soil profiles and cultural material suggests that these fill deposits are likely related to road construction as well as more isolated utility installations, driveway construction, and landscaping events associated with an abandoned Federal Aviation Administration building within the larger 92-acre parcel, but outside the project area.

The project vicinity was characterized by scattered farmsteads through the nineteenth century, until summer communities were established beginning in the twentieth century. While the cultural materials recovered from the project area are evocative of the early post-contact period use of this portion of Nantucket Island, the materials do not constitute potentially significant cultural resources. Both the fill and surface scatter contexts suggest that the deposits have a limited potential to provide new or substantive information about the history of the area, and as such do not constitute potentially significant archeological resources.

### Recommendations

Based on the results of this survey, the proposed construction within the Madaket WWTF project area will not impact any potentially significant archaeological resources. No further archaeological investigations are recommended.

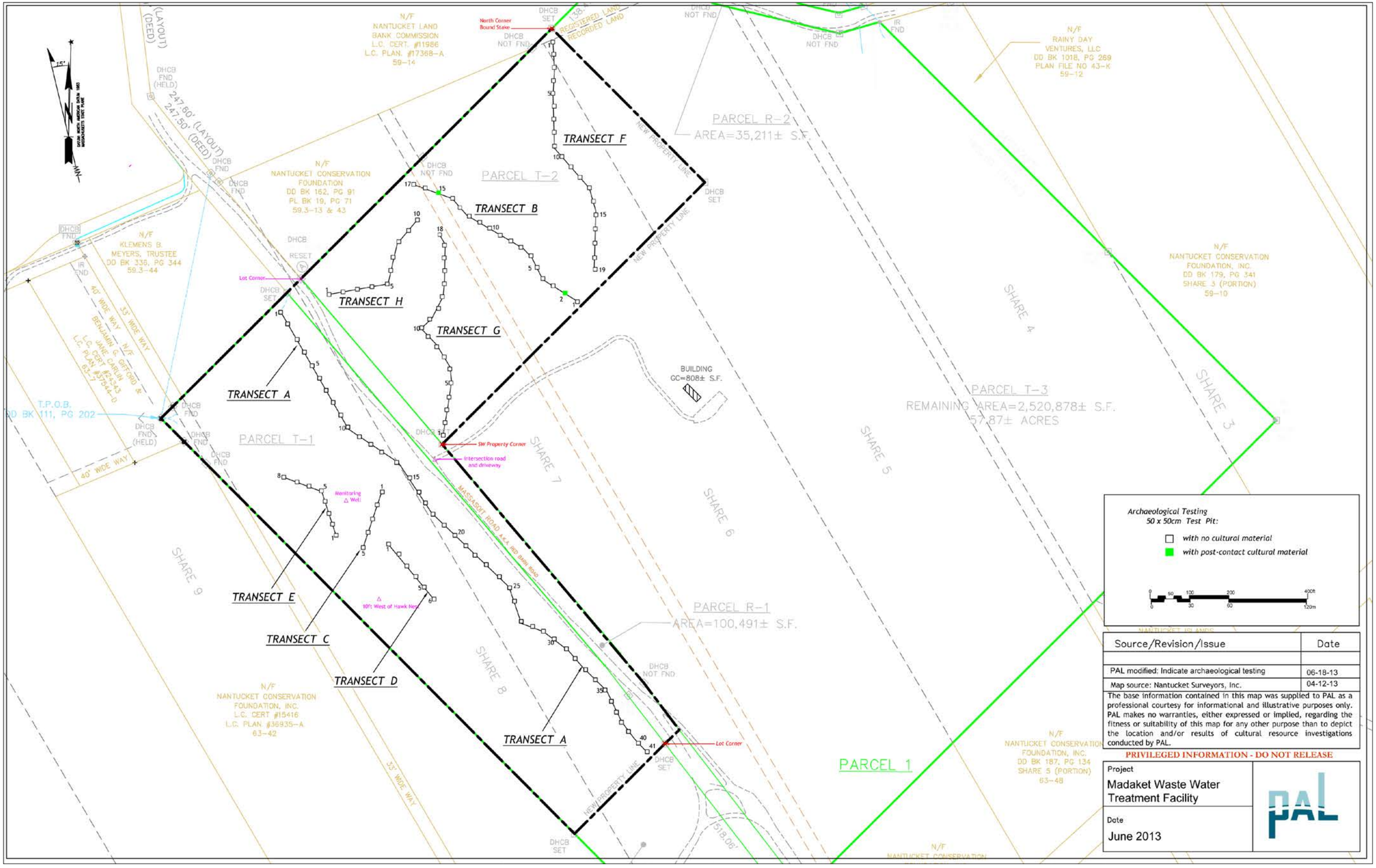


**Figure 5-1. Location of intensive survey testing within the Madaket Waste Water Treatment Facility project area.**

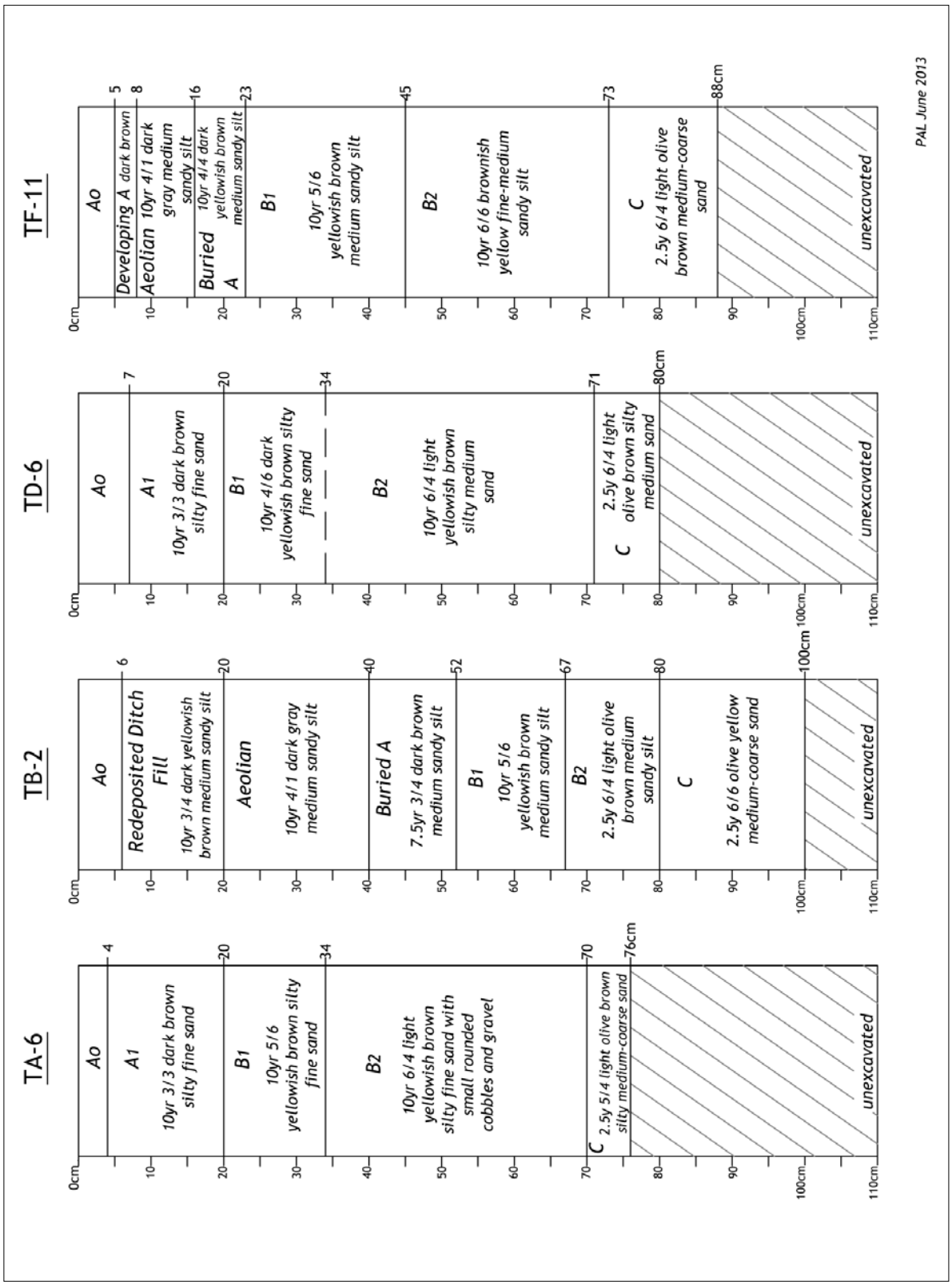


**Figure 5-2. Representative soil profiles within the Madaket Waste Water Treatment Facility project area.**

**Figure 5-3. Photograph showing test pit 19 along Transect F (TF-19) and general soil profile, view east.**

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# The Commonwealth of Massachusetts

William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

September 25, 2013

Kara Buzanoski
Director
Nantucket Department of Public Works
188 Madaket Road
Nantucket, MA 02554

RE: Nantucket Wastewater Treatment Facility, 7 Massasoit Bridge Road, Nantucket, MA. PAL # 2585. MHC # RC.47114/22107. EEA # 12617. **GSA # MA-0895**.

Dear Ms. Buzanoski:

Staff of the Massachusetts Historical Commission, office of the Massachusetts State Historic Preservation Officer, have reviewed the technical report, *Intensive (Locational) Archaeological Survey, Madaket Waster Water Treatment Facility, Nantucket, Massachusetts*, submitted by the PAL for the project referenced above, received August 26, 2013 and have the following comments.

The MHC requests that copies of the PAL's technical report be provided to the General Services Administration (GSA) and the Wampanoag Tribe of Gay Head (Aquinnah) (WTGH(A)).

The MHC has not yet received current project information for the preferred project alternative layout for the wastewater facility project. Scaled existing and proposed conditions project plans for the project as a whole should be submitted to the MHC for review and comment.

The Wastewater Treatment Facility project impact area is within the area of potential effect for the GSA's real estate disposition of 91.7 acres of former FAA Property (MHC # RC.47114). The MHC is participating as a consulting party in the GSA's review of the real estate disposition under Section 106 of the National Historic Preservation Act (36 CFR 800). The MHC offers the following comments to assist the Town of Nantucket and the GSA.

Results of archaeological testing conducted within portions of the proposed wastewater facility project impact area did not identify any significant historic or archaeological resources in the specific areas tested. However, the survey noted intact, natural soils within the estimated maximum project impact area, indicating that significant artifacts, features and soil deposits associated with ancient and historic period Native American occupation and land use could be present within portions of the project parcels not yet subject to systematic archaeological testing. The MHC has previously commented that this archaeological survey was not designed to locate and identify historic and archaeological resources within the entire GSA parcel.

The MHC notes that project impacts may be proposed within other archaeologically sensitive portions of the property, and additional archaeological survey may be required. The PAL also indicated that

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archaeological monitoring may be required for pipeline installations within existing roadways. The proposed project impact areas for these project elements are not shown on the preliminary project plans included in the technical report. The MHC requires the complete, current project plans to review and comment on the proposal for archaeological monitoring in the roadways.

The MHC looks forward to receiving for MHC's review and comment, a draft scope for an archaeological site identification effort (36 CFR 800.4) for the complete GSA parcel and for areas of the wastewater treatment plant project that are archaeologically sensitive and that have not yet been tested, with the current project plans.

The MHC looks forward to reviewing the additional information requested above, and to consultation to avoid, minimize or mitigate adverse effects to significant historic and archaeological resources.

These comments are offered to assist in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (36 CFR 800) and Massachusetts General Laws, Chapter 9, Sections 26-27C (950 CMR 70-71) and MEPA (301 CMR 11). If you have questions please contact Jonathan K. Patton at this office.

Sincerely,

Brona Simon

Brona Simon
State Historic Preservation Officer
Executive Director
State Archaeologist
Massachusetts Historical Commission

xc: John E. Kelly, GSA
Kristen Brinker Kulis, ACHP
Bettina Washington, THPO, WTGH(A)
C. Elizabeth Gibson, Nantucket Town Manager
Secretary Richard K. Sullivan, Jr., EEA, Attn: Nicolas Zavolas, MEPA Unit
Mark Voigt, Nantucket Historical Commission
Rosemary Blacquier, Woodward & Curran
Deborah C. Cox, PAL, Attn: Dianna Doucette

# APPENDIX H: SURFSIDE WWTF DATA

## CAPACITY ANALYSIS TECHNICAL MEMORANDUM

## AECOM MEMO

## MUIR ENERGY MEMO

## GROUNDWATER DISCHARGE PERMIT

## BRP – 11 (CD)

## BRP – 83 (CD)

## O&M MANUAL (CD)

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# MEMORANDUM

**TO:** Kara Buzanoski, DPW Director and David Gray, Chief Operator
**FROM:** Jon Himlan
**DATE:** July 2, 2014
**RE:** Surfside Wastewater Treatment Facility Capacity Assessment

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This memo provides a summary of Woodard & Curran's assessment of the capacity for the Surfside Wastewater Treatment Facility (WWTF) to receive and treat the future wastewater flow from the existing sewer areas and the needs areas, identified through in the Comprehensive Wastewater Management Plan (CWMP) Update, at the future build-out condition. This assessment is important for the Town's sewer planning with the primary focus being whether or not projected wastewater flow from Madaket and Warren's Landing can be sent to the Surfside WWTF. If the Surfside WWTF has capacity for these areas, it eliminates the need to construct a new WWTF for Madaket and Warren's Landing which has been estimated by others to cost $45 million dollars. For this assessment, we estimated the Surfside WWTF existing and projected influent flow and pollutant loads; reviewed the current operation and performance; and calculated the hydraulic capacity and the treatment capacity.

Our findings were as follows:

- The future condition, identified in the CWMP Update, is a maximum daily flow of 4.0 million gallons per day (MGD) which includes build-out of the existing sewer areas and sewer extension to the needs areas.
- The Surfside WWTF has sufficient capacity to receive wastewater at the future condition provided that minor changes are made to operational practices and two additional blowers are installed.
- Although the Surfside WWTF has capacity, the future maximum daily flow of 4.0 MGD exceeds the MassDEP groundwater discharge permit limit of 3.5 MGD for daily flow to the groundwater discharge beds. Therefore, expansion of the groundwater discharge capacity or revisions to the groundwater discharge permit are required. Note that revisions to the groundwater discharge permit would be required at the future condition even if Madaket and Warren's Landing wastewater was not treated at the Surfside WWTF. Woodard & Curran and the Town have submitted the required documentation to MassDEP for this increased capacity and based on our discussions with MassDEP we understand that a revised discharge permit with the required flow increase will be issued soon.

The following table summarizes the capacity of each unit process on a maximum daily flow equivalent basis. It is noted that each unit process was not necessarily evaluated on a maximum daily flow basis, but for comparison with the WWTF discharge permit (maximum daily limit), the applicable flow parameter used in our analysis (average daily, maximum monthly, or peak hourly) was converted to the equivalent maximum daily flow. The table also describes what the limiting parameter is (either hydraulic or treatment capacity).

**Table 1: Summary of Unit Process Capacity**

| Unit Process | Capacity at Maximum Daily Flow Equivalent (MGD) | Limiting Parameter (Hydraulic or Treatment Capacity) |
|---|---|---|
| Aerated Grit Chamber | 4.0 | Treatment capacity limited to 7.7 MGD on a peak hourly flow basis |
| Primary Clarifiers | 4.6 | Hydraulic capacity limited to 8.8 MGD on a peak hourly flow basis |
| Advanced Treatment System | 4.0 | Treatment capacity (membrane filters) limited to 7.7 MGD on a peak hourly flow |

| Unit Process | Capacity at Maximum Daily Flow Equivalent (MGD) | Limiting Parameter (Hydraulic or Treatment Capacity) |
|---|---|---|
| | | basis |
| Ultraviolet Disinfection | 4.0 | Treatment capacity limited to 7.7 MGD on a peak hourly flow basis |
| Effluent Disposal Beds (Based on Permit not Hydraulic Analysis) | 3.5 | Hydraulic capacity limited to 3.5 MGD on a maximum daily flow basis (results from permitted limit which could potentially be increased) |

The following further describes the existing and projected influent flow and pollutant loads and the capacity analysis.

## 1. Influent Flow and Pollutant Loads

We developed the influent flow and pollutant loads for the future condition from the existing average daily summer (June to August) flow and loads data by adding the projected increase in average daily flow and loads resulting from build-out and sewer system expansion to the needs areas. The parameters of maximum monthly, maximum daily, and peak hourly at the future condition were determined by applying the respective ratio to average daily summer flow and loads from existing data to the projected increase (i.e. existing average daily plus projected average daily multiplied by the ratio from existing data). Table 2 describes the existing and projected influent flows and pollutant loads.

### 1.1. Existing Flow

Existing flow is based on the data collected by the Surfside WWTF Supervisory Control and Data Acquisition (SCADA) system and the data contained in the Discharge Monitoring Reports (DMRs) that the Town submits to the Massachusetts Department of Environmental Protection (MassDEP). The data evaluated was for the period between February 2009 and March 2013. Woodard & Curran analyzed the existing flow data for the following parameters:

- Average Daily Summer: The average daily conditions for the months of June, July and August based on the DMR data. The average daily summer flow is important as a "benchmark" condition because the Surfside WWTF experiences a seasonal variation in flow as a result of the transient / tourist nature of the population with the highest occupancy occurring during the summer months.
- Maximum Monthly: Represents conditions that are expected to be exceeded once for each 12 occurrences, or one month per year. The maximum monthly flow is important as the parameter used for assessment of the biological treatment capacity of the advanced treatment system (membrane bioreactor) and the capacity of the solids processing systems. The maximum monthly flow is determined by developing the frequency distribution for the DMR data and selecting the value closest to the 91.7 percent exceedance value (i.e., exceeded 8.3 percent of the time, or one in twelve). Figure 1 illustrates the maximum monthly flow in relation to the average monthly flow and the 30-day moving average flow. From this data we calculated that the ratio of maximum monthly flow to average daily summer flow is approximately 1.1.

**Table 2 - Projected and Existing Influent Flows and Pollutant Loads**

| | Flow (MGD) | | | | $BOD_5$ Load (lbs/day) | | TSS Load (lbs/day) | | Total Nitrogen Load (lbs/day) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average Daily - Summer | Maximum Monthly | Maximum Daily | Peak Hourly | Average Daily | Maximum Monthly | Average Daily | Maximum Monthly | Average Daily | Maximum Monthly |
| Projected by Study / Need Area | | | | | | | | | | |
| Madaket | 0.16 | | | | 490 | | 560 | | 90 | |
| Warren's Landing | 0.03 | | | | 100 | | 110 | | 20 | |
| Hummock Pond South | 0.07 | | | | 200 | | 230 | | 40 | |
| Hummock Pond North | 0.09 | | | | 290 | | 330 | | 50 | |
| Somerset | 0.10 | | | | 320 | | 360 | | 60 | |
| Monomoy | 0.08 | | | | 260 | | 300 | | 50 | |
| Shimmo | 0.06 | | | | 190 | | 220 | | 30 | |
| Town | 0.59 | | | | 1,800 | | 2,050 | | 330 | |
| Nantucket PLUS | 0.07 | | | | 230 | | 260 | | 40 | |
| Miacomet | 0.07 | | | | 210 | | 240 | | 40 | |
| Subtotal Projected | 1.33 | 1.42 | 1.82 | 3.52 | 4,090 | | 4,660 | | 750 | |
| Projected Infiltration/Inflow (Future) | 0.06 | 0.06 | 0.06 | 0.06 | | | | | | |
| Total Projected | 1.39 | 1.48 | 1.88 | 3.58 | 4,090 | 4,790 | 4,660 | 6,150 | 750 | 860 |
| Existing Conditions at Surfside WWTF | 1.53 | 1.64 | 2.10 | 4.06 | 4,990 | 5,830 | 3,490 | 4,610 | 530 | 610 |
| **Total Projected and Existing (Future Conditions)** | **2.9** | 3.1 | 4.0 | 7.7 | **9,100** | 10,600 | **8,200** | 10,800 | **1,300** | 1,500 |

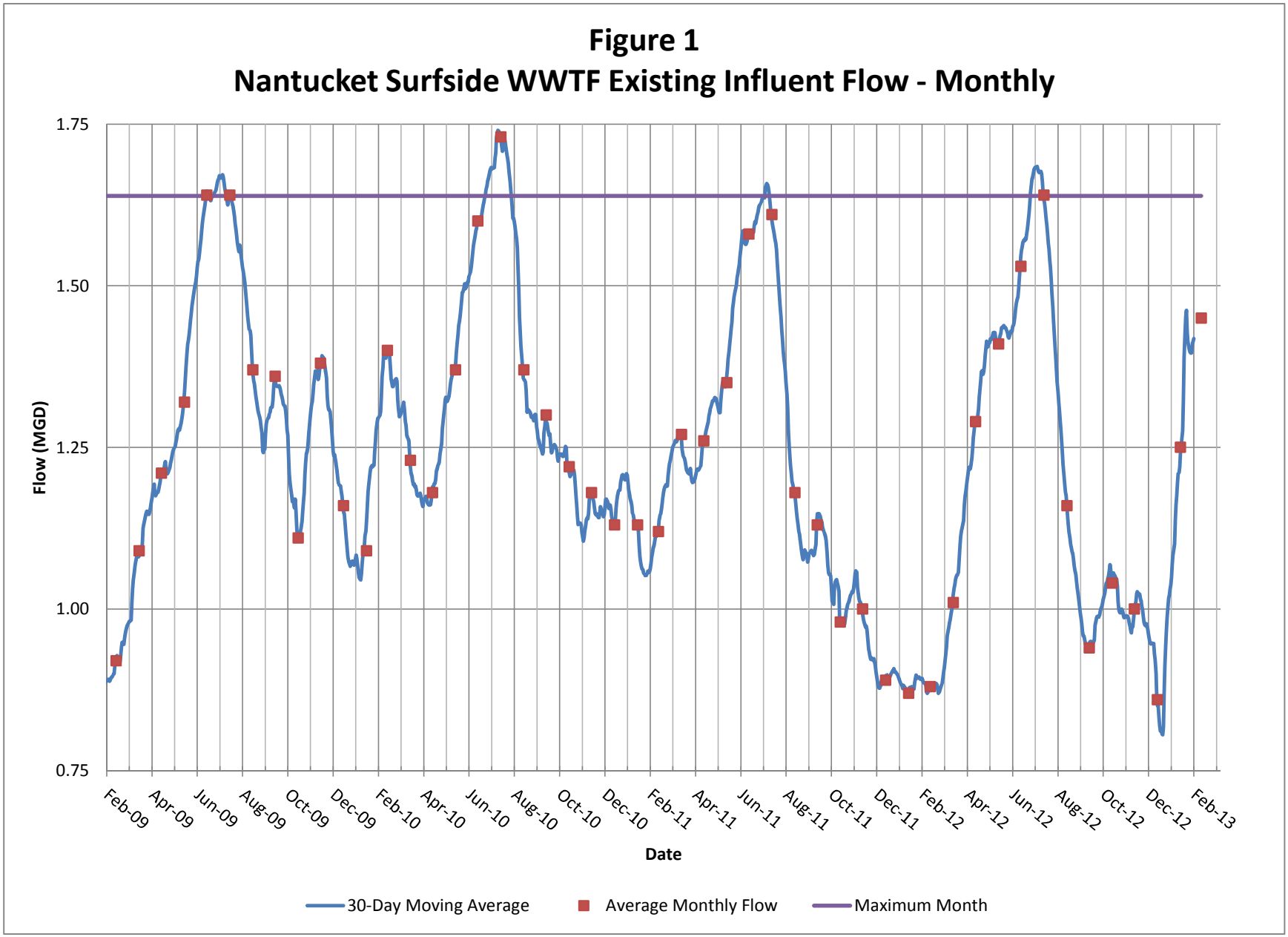


Figure 1
Nantucket Surfside WWTF Existing Influent Flow - Monthly
1.75
1.50
1.25
1.00
0.75
Flow (MGD)
Feb-09
Apr-09
Jun-09
Aug-09
Oct-09
Dec-09
Feb-10
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
Dec-11
Feb-12
Apr-12
Jun-12
Aug-12
Oct-12
Dec-12
Feb-13
Date
30-Day Moving Average
Average Monthly Flow
Maximum Month

- Maximum Daily: Represents conditions that are expected to be exceeded once for each 365 occurrences, or once per year. The maximum daily flow is important because the Surfside WWTF Groundwater Discharge Permit specifies the maximum daily flow that can be discharged. The maximum daily flow is determined by developing the frequency distribution for the DMR data and selecting the value closest to the 99.7 percent exceedance value (i.e., exceeded 0.3 percent of the time – one in three hundred sixty five). Figure 2 illustrates the maximum daily flow in relation to the daily flow values and the average monthly flow. From this data we calculated that the ratio of maximum daily flow to average day summer flow is approximately 1.4.
- Peak Hourly: The peak hourly condition represents the highest flow observed during any 60-minute period over the range of data. The peak hourly flow is important as the parameter used for assessment of the hydraulic capacity of the Surfside WWTF. The peak hourly flow was determined by calculating a running average of 60 one-minute intervals from the SCADA data. The highest 60-minute running average of the entire data range was considered the peak hourly flow. From this data we calculated that the ratio of peak hourly flow to average daily summer flow is approximately 2.6.

1.2. Existing Influent Pollutant Loads

Woodard & Curran evaluated the existing influent pollutant load data for the average daily summer and maximum month parameters using the same methodology as described for the existing flows. The existing load data is based on the DMRs for the period from January 2010 to December 2011[1] for the following pollutants:

- Biochemical oxygen demand, 5-day ($BOD_5$): influent data is collected once per week. Figure 3 illustrates the weekly data, the 30-day moving average and the maximum monthly $BOD_5$ load. From this data we calculated that the ratio of maximum monthly $BOD_5$ to average daily $BOD_5$ is 1.2. This ratio is consistent with the typical ratio of 1.26 referenced in the New England Interstate Water Pollution Control Commission, 2011 Guides for the Design of Wastewater Treatment Works (TR-16).
- Total suspended solids (TSS): influent data is collected once per week. Figure 4 illustrates the weekly data, the 30-day moving average and the maximum monthly TSS load. From this data we calculated that the ratio of maximum monthly TSS to average daily TSS is 1.3. This ratio is consistent with the typical ratio of 1.3 referenced in TR-16.
- Total nitrogen (TN): influent TN data is not collected as it is not a permit requirement. However, influent ammonia-nitrogen data is collected once per week. To estimate influent TN, we assumed that the influent ammonia is 65-percent of the influent total Kjeldahl nitrogen (TKN) based on information from the Metcalf & Eddy, Wastewater Engineering Treatment and Reuse Textbook, fourth edition (page 670). We also assume that the influent TKN is equal to the influent TN, because the concentration of nitrate and nitrite in raw wastewater is typically negligible. From this data we calculated that the ratio of maximum monthly TN to average daily TN is 1.2

As shown in Figures 3 and 4, there is the strong seasonal variation in wastewater load resulting from the seasonal fluctuations in population. The flows and concentrations approximately double from a low point in mid-winter (February) to a high point in mid-summer (August). This results in a three- to four-fold increase in influent pollutant loads to the WWTF from winter to summer.

[1] The pollutant data from 2012 was excluded from our analysis because the loadings in July and August were extremely high even though the flow rate was typical. Based on input from the WWTF staff, we believe this high loading condition was the result of high solids in the WWTF internal recycle streams and not representative of the influent wastewater.

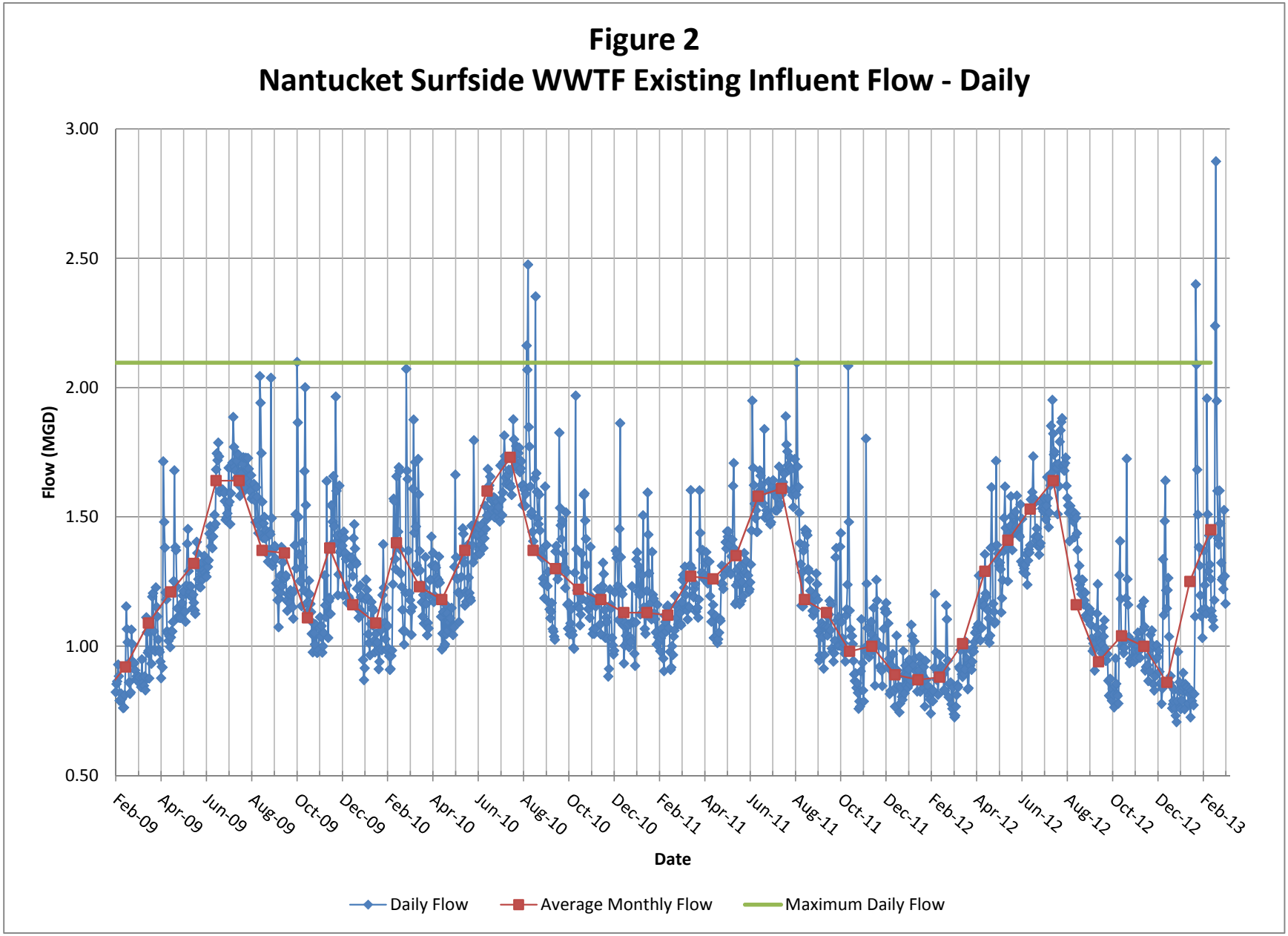
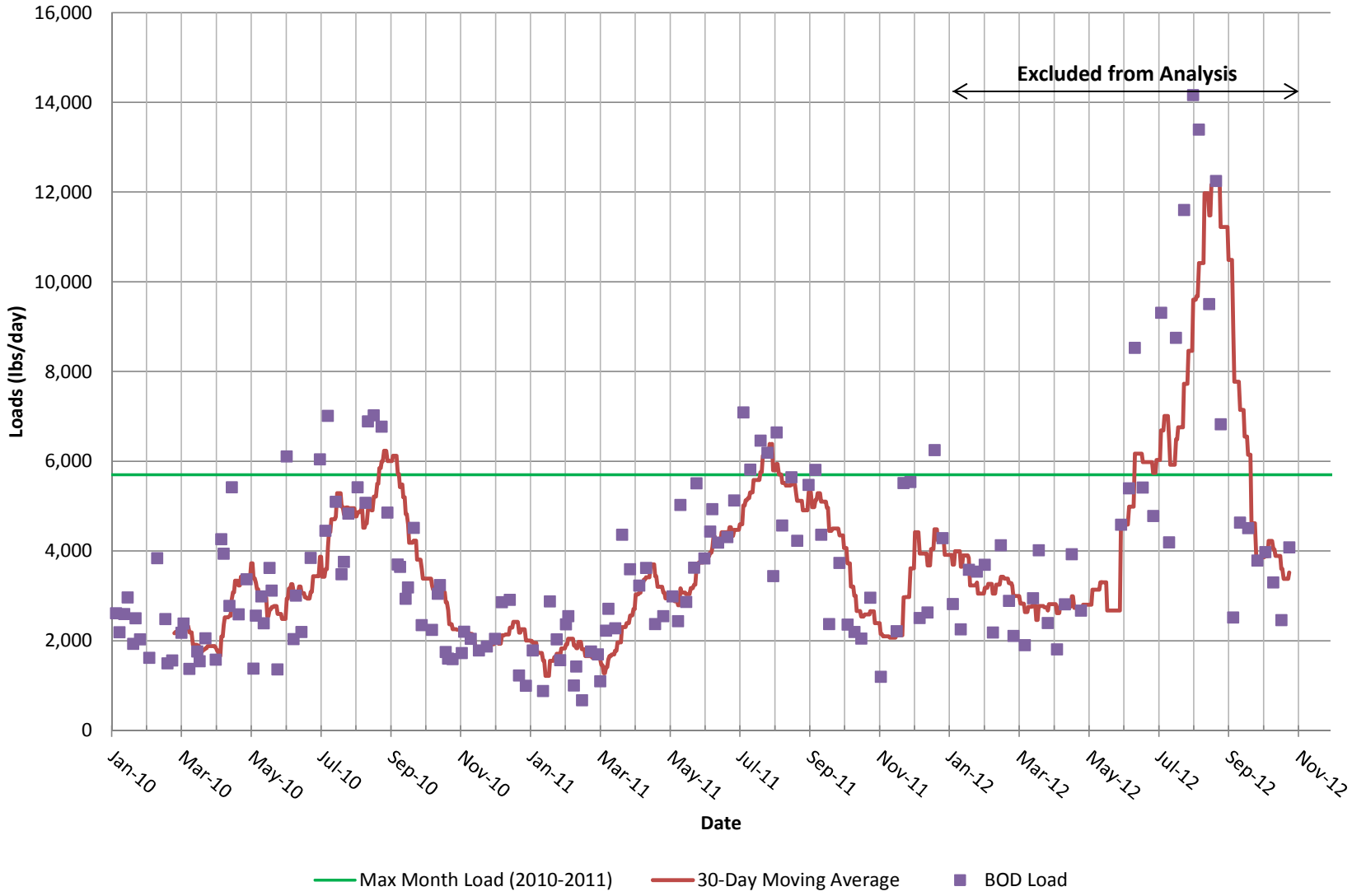
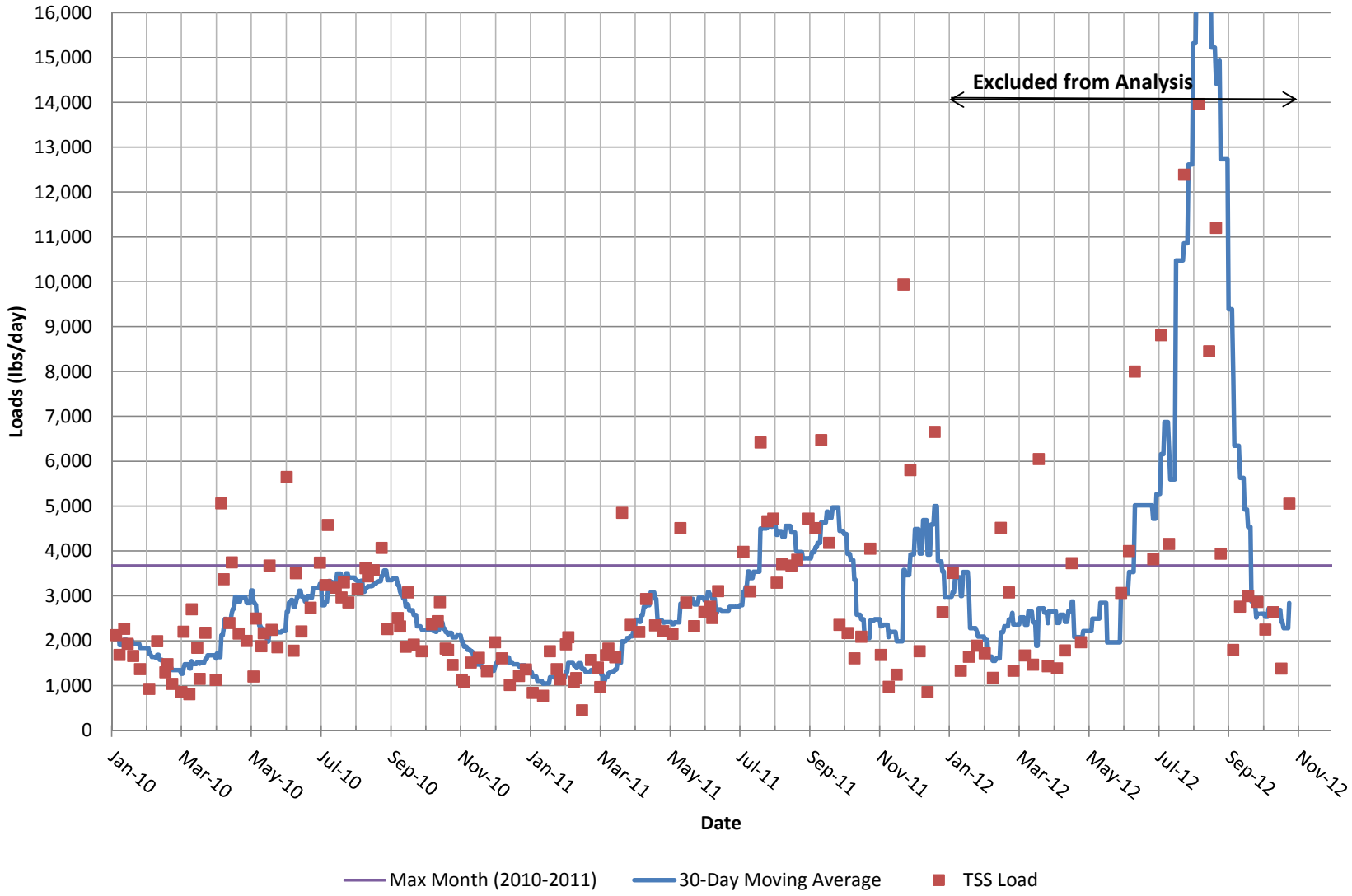


Figure 2
Nantucket Surfside WWTF Existing Influent Flow - Daily
3.00
2.50
2.00
1.50
1.00
0.50
Flow (MGD)
Feb-09
Apr-09
Jun-09
Aug-09
Oct-09
Dec-09
Feb-10
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
Dec-11
Feb-12
Apr-12
Jun-12
Aug-12
Oct-12
Dec-12
Feb-13
Date
Daily Flow
Average Monthly Flow
Maximum Daily Flow

# Figure 3
## Nantucket Surfside WWTF Existing Influent BOD Load



# Figure 4
# Nantucket Surfside WWTF Influent TSS Load



We compared the average daily summer existing influent pollutant data on a concentration basis (load divided by flow), in milligrams per liter (mg/l), with published data on typical domestic wastewater concentrations (Metcalf & Eddy, Wastewater Engineering, Fourth Edition, Table 3-15). We found that the Surfside WWTF influent wastewater, during summer conditions, would generally be considered high-strength as shown in the following Table 3. It is also noted that the $BOD_5$ concentration is higher than the TSS concentration, which is somewhat unusual ($BOD_5$ concentration is typically about 80 to 85 percent of the TSS concentration). This high $BOD_5$ concentration could be caused by the decant of the sludge holding tanks which are not being consistently aerated which could result in fermentation and the production of volatile fatty acids ($BOD_5$ source).

**Table 3: Comparison of Existing Wastewater Pollutant Concentration with Published Values**

| Pollutant | Average Summer Existing Surfside WWTF Concentration | Typical Medium Strength Concentration | Typical High Strength Concentration |
|---|---|---|---|
| $BOD_5$, mg/l | 390 | 190 | 350 |
| TSS, mg/l | 270 | 210 | 400 |

1.3. Projected Flow

Woodard & Curran projected future flow based on a build-out analysis of the defined needs areas. The selection of needs areas and the build-out projections were performed as part of our ongoing comprehensive review and update to the Town's 2004 Comprehensive Wastewater Management Plan (CWMP). The needs areas and our build-out analysis included input and data from the Nantucket Planning & Economic Development Department. The primary changes from the 2004 CWMP for our projections are as follows:

- Included the Hummock Pond South and Hummock Pond North study areas.
- Utilized new zoning adopted by the Town.
- Performed a detailed account of the potential build-out from secondary dwelling units.

The previously presented Table 2 provides the projected wastewater flow which was determined based on the following:

- The of number of future residential units and commercial land acres that could be connected to the sewer collection system (existing or through sewer extensions) for each needs area were projected from the build-out analysis.

- The number of residential units and commercial acres were multiplied by the unit flow rates (taken from the 2004 CWMP) of 320 gallons per day per unit (gpd/unit) and 345 gpd/acre, respectively, to estimate the projected flow from each needs area on an average daily basis.

- The ratios (determined from existing data) of average daily flow to maximum monthly flow, maximum daily flow, and peak hourly flow were applied to calculate the respective flow parameter.

The wastewater flow presented in Table 2 consists of the sanitary wastewater component generated from the residential and commercial sources, septage received from haulers, and the extraneous inflow and infiltration (I/I) flow component contributed from groundwater and precipitation. We have accounted for the future I/I and septage as follows:

- Inflow and Infiltration: The flow at the future condition includes an increase in I/I resulting from the installation of new sewer pipe and manholes. Although the Town is undergoing work to remove I/I, for this analysis, we have conservatively assumed that the existing I/I amount will remain constant.
- Septage: We have made the assumption that the septage volume received in the future will remain constant. This assumption is conservative because as sewer expansion occurs, there will be fewer active septic systems and the volume of septage will likely decrease.

1.4. Projected Pollutant Loads

The projected pollutant loads were determined based on the build-out analysis described above. The previously presented Table 2 provides the projected pollutant loads in pounds per day (lbs/day) which were calculated based on the following:

- The of number of future residential units and commercial land acres that could be connected to the sewer collection system (existing or through sewer extensions) for each needs area were projected from the build-out analysis.
- The number of residential units and commercial acres were multiplied by the following unit load rates (taken from the 2004 CWMP) to estimate the projected pollutant load from each needs area on an average daily basis:
    - $BOD_5$: 0.99 lbs/day-unit (0.22 lbs/day-person x 4.5 persons per unit) for residential; and 0.72 lbs/day-acre (250 mg/l x 345 gpd/acre) for commercial.
    - TSS: 1.13 lbs/day-unit (0.25 lbs/day-person x 4.5 persons per unit) for residential; and 0.86 lbs/day-acre (300 mg/l x 345 gpd/acre) for commercial.
    - TN: 0.18 lbs/day-unit (0.04 lbs/day-person x 4.5 persons per unit) for residential; and 0.12 lbs/day-acre (40 mg/l x 345 gpd/acre) for commercial.
- The ratio (determined from existing data) of average daily load to maximum monthly load was applied to calculate the load for each pollutant ($BOD_5$, TSS, and TN).

## 2. Capacity Assessment

Our capacity assessment included calculation of the hydraulic capacity and treatment capacity for each of the Surfside WWTF unit processes. As previously described, each unit process was not necessarily evaluated on a maximum daily flow basis, but for comparison with WWTF discharge permit limit, the applicable flow parameter for our analysis (average daily, maximum monthly, or peak hourly) was converted to the equivalent maximum daily flow.

Section 2.1 describes the hydraulic capacity for the WWTF followed by Sections 2.2 through 2.6 which describe our assessment of the treatment capacity for each individual unit process, including the current operation and performance, calculated capacity, and our recommendations.

2.1. Hydraulics

Computations were made of the connecting piping and the unit processes through the WWTF at incremental peak hourly flows of one MGD. A summary of peak hourly flow limitations and the maximum daily flow equivalent for all the unit processes is presented in Table 4. The WWTF was found to have sufficient hydraulic capacity to handle the projected maximum daily flow of 4.0 MGD (peak hourly flow of 7.7 MGD).

**Table 4: Unit Process Hydraulic Capacity**

| Unit Process | Hydraulic Peak Hourly Flow Capacity (MGD) | Maximum Daily Flow Equivalent (MGD) |
|---|---|---|
| Influent Parshall Flume | 10.4 | 5.4 |
| Grit Chamber | 13.6 | 7.0 |
| Primary Clarifiers | 8.8 | 4.6 |
| Advance Treatment – Anoxic/Aeration Tanks[1] | 24.0 | 4.8 |
| Advanced Treatment - Membranes | 7.7 | 4.0 |
| Ultraviolet Disinfection | 7.7 | 4.0 |
| Effluent Parshall Flume | 21.4 | 11.1 |
| Effluent Piping to Disposal Beds | 8.0 | 4.1 |

## 2.2. Headworks

### 2.2.1. Current Operation and Performance

The upgrades completed in 2009 included installation of a grinder that has been rendered inoperable due to hydrogen sulfide corrosion. In addition, concrete corrosion from hydrogen sulfide is visible at the grit chamber effluent weir. Woodard & Curran performed an evaluation recommending the installation of a fine screen to replace the grinder. In addition, we performed an assessment for corrosion control which recommends installation of a pure oxygen injection system at the Sea Street Pump Station to mitigate hydrogen sulfide corrosion.

According the 2010 Facility O&M Manual, Appendix A, the aerated grit chamber has dimensions of 17 feet by 15 feet, with a side water depth of 14.83 feet. The 2010 Facility O&M Manual, Appendix A, also indicates there are two blowers each with a capacity of 120 cubic feet per minute.

The existing aerated grit chamber appears to be performing sufficiently under current operating conditions. Operations staff report concerns with the location of the grit screw mechanism as it is in the direct path of influent flow and is therefore vulnerable to wear from the grit in the influent wastewater.

### 2.2.2. Capacity

The grit chamber has sufficient volume and aeration for a peak hourly flow of 7.7 MGD (4.0 MGD maximum daily flow equivalent). Table 5 summarizes the Surfside WWTF grit chamber in comparison to TR-16 recommended values. As indicated, the grit chamber length-to-width ratio is not consistent with TR-16 standards.

[1] Anoxic/Aeration tanks were designed to receive return activated sludge flow at 4 times the influent forward flow.

**Table 5: Comparison of Grit System Design Data with Recommended Values**

| Parameter | TR-16 Recommended Value (1) | Surfside WWTF (2) |
|---|---|---|
| Length-to-Width Ratio | 3:1 to 8:1 | 0.9:1 |
| Residence Time (minutes) at Peak Hour Flow of 7.7 MGD | 3 to 10 | 7.8 |
| Air Flow Rate (scfm) per foot of length (3) | 3 to 8 | 8 |

Notes:
(1) Recommended values from TR-16 (2011)
(2) Data for Surfside WWTF calculated from values presented in the O&M manual
(3) Assumes 1 of 2 blowers on line.

Although the TR-16 recommended residence time and air flow rate suggest higher flows could be acceptable, we do not recommend increasing peak flows to the existing grit system above 7.7 MGD as it may result in bypassing of more and larger grit to the primary clarifiers.

#### 2.2.3. Recommendations

Woodard & Curran performed an evaluation recommending the installation of screening and a new vortex grit system to replace the grinder and corroded grit chamber structure. These findings and recommendations are provided in a memo titled, "Influent Screening Alternatives Assessment." In addition, we engaged a subconsultant (Bowker &Associates, Inc.), who performed an assessment of corrosion control which recommends installation of a pure oxygen injection system at the Sea Street Pump Station to mitigate corrosion. These findings and recommendations are provided in a report prepared by Bowker &Associates, Inc. titled, "Control of Hydrogen Sulfide Corrosion at the Surfside WWTF."

### 2.3. Primary Clarifiers

#### 2.3.1. Current Operation and Performance

The current practice is to utilize all three primary clarifiers under normal conditions. According the 2010 Facility O&M Manual, each primary clarifier has a surface area of 1,467 square feet (81.5 feet by 18 feet). At the current average daily flow condition, the clarifiers have low overflow rates and high residence times. As a result, the $BOD_5$ removal has been greater than 50 percent under both average and maximum month conditions. This exceeds both the typical values found in industry literature and the design performance of 30 percent $BOD_5$ removal listed in the 2010 Facility O&M Manual. Data was not available to estimate TSS removal but it assumed to be a high removal rate given the $BOD_5$ removal performance.

#### 2.3.2. Capacity

The primary clarifiers have sufficient capacity to handle the projected flow and pollutant loads. Table 6 summarizes the highest flow that can be received and not exceed the TR-16 recommendations for maximum surface overflow rate (SOR), in gallons per day per square foot (gpd/sf), at average daily flow and the SOR at peak hourly flow with one clarifier out of service. At the projected maximum monthly flow rate, we estimate the $BOD_5$ and TSS removal to be 33 percent and 55 percent respectively.

**Table 6: Primary Clarifier Analysis**

| | Flow, MGD | Maximum Daily Flow Equivalent, MGD |
|---|---|---|
| Average Daily SOR; maximum of 1,200 gpd/sf | 5.3 | 7.2 |
| Peak Hourly SOR with one Clarifier Out of Service; maximum of 3,000 gpd/sf | 8.8 | 4.6 |

#### 2.3.3. Recommendations

There are no improvements required for capacity reasons.

### 2.4. Advanced Treatment

#### 2.4.1. Current Operation and Performance

Current operation of the advanced treatment system (ATS) has resulted in effluent that is compliant with the MassDEP Groundwater Discharge Permit, however, during our operational assessment on April 15 through April 17, 2013 we identified several items that were a concern for future capacity. These items are summarized in the following:

- Insufficient Oxygen and Filamentous Organisms: We found a significant amount of filaments in the mixed liquor suspended solids (MLSS) biomass which is the result of insufficient oxygen and anaerobic conditions. The abundance of filaments is a concern because it indicates that the environment is potentially inhibiting or stressful to the bacteria that the ATS system relies on for biological removal of $BOD_5$, TSS and nitrogen. To evaluate this condition, we took a sample of the MLSS and performed a microbiological assessment which showed an abundance of Thiothrix - a sulfide induced filament. This finding indicated that there was insufficient oxygen and anaerobic conditions at the WWTF. To address these conditions the Woodard & Curran worked with the Surfside WWTF staff to implement the following measures: :

    - The sludge storage tanks were not being aerated resulting in the sludge becoming anaerobic. The sludge tank decant and sludge dewatering pressate streams were conveyed to the WWTF influent which ultimately flows to the ATS and contributes to an unhealthy biomass. On/off aeration operation of the sludge holding tanks was implemented to prevent anaerobic conditions from developing there.

    - Septage and leachate received at the WWTF were conveyed to the WWTF influent. Septage and leachate are anaerobic and high in sulfide, organic acids, and other constituents that contribute to an unhealthy biomass. The current operation is to send septage and leachate directly to the sludge holding tanks as opposed to the WWTF influent which corrected this concern.

    - The aeration tanks were being operated with an on/off aeration strategy which was not consistent with the design of the ATS. It is our understanding that the reason for this operating strategy was a concern from the former Chief Operator that return activated sludge (RAS) to the anoxic tanks was high in dissolved oxygen (DO) from the membrane scour air and that the high DO was inhibiting denitrification.

While we agreed that RAS with a high DO is a concern to some extent, DO profiles performed by operations staff on April 21, 2013 and July 2, 2013 found that the DO concentrations were significantly low in the aeration tanks (less than 1 mg/l) and acceptable, although not ideal, in the anoxic tanks (0.11 to 0.26 mg/l in the anoxic tanks with 3 to 9 mg/l in the membrane tanks). In addition, our review of the available effluent nitrate data did not indicate denitrification problems. We believe that the denitrification concerns (high effluent total nitrogen) could have been misinterpreted and could just as easily have been a lack of nitrification (conversion of ammonia to nitrate), because if there is not sufficient oxygen to convert ammonia to nitrate, then there is not enough nitrate in the anoxic tanks to denitrify.

Operations staff have now increased aeration in the aeration tanks which should help to establish a healthy biomass and result in more robust nitrification. Because WWTF staff are concerned with denitrification they have extended the anoxic zone by turning off the air to the first zone of the aeration tanks.. This practice has been successful and has resulted in very low effluent total nitrogen. However, under the projected future load conditions, the first zone of the aeration tanks will likely be needed to provide adequate aeration. Therefore to further understand the staff's denitrification concerns and plan for future conditions, we have recommended a program of nitrate sampling and analysis for various locations in the process train .

- Dissolved Oxygen Control: During the operational assessment site visit, operations staff reported that the dissolved oxygen control instrumentation is not reliable and cannot be utilized for aeration tank blower control as was the original design intent. While DO control is not a direct capacity concern, replacement of these instruments with more reliable DO and oxidation reduction potential (ORP) measurement capability would enhance the ability to operate the WWTF at the future condition.

2.4.2. Capacity

The ATS treatment capacity is a function of two processes: (1) biological (activated sludge) treatment in the anoxic and aeration tanks and (2) solids separation through membrane filtration. To assess the activated sludge treatment capacity, we performed calculations to predict the amount of biomass and oxygen required to remove the $BOD_5$, TSS and nitrogen loads to meet the permit limits at the future condition. For oxygen requirements we used maximum daily load conditions (as recommended by TR-16 for blower capacity), for all other parameters, we used maximum monthly load conditions. To assess the membrane filtering capacity, we calculated the flow rate at the manufacturer's recommended maximum flux rate for the square footage of membranes installed.

Based on our calculations for oxygen requirements, we determined that the 3 existing aeration tank blowers do not have enough capacity for the future condition, therefore two additional blowers are needed (one to provide the additional capacity required and one to serve as a redundant backup). We also assessed the air diffusers and air distribution piping and determined that they have capacity to receive the higher air flow rates as follows:

- Diffusers: the air flow rate per diffuser would be 2.4 cubic feet per minute (cfm) at maximum monthly conditions and 4.7 cfm at maximum daily conditions. These values are within the manufacturer's recommended maxim air flow rates of 4 cfm for long-term durations and 7 cfm for short-term durations.

- Air Distribution Piping: at maximum monthly conditions, the velocity in the air distribution piping would be 3,800 feet per minute (fpm) in the 8-inch diameter air piping (1,330 cfm). The typical recommended maximum air flow rate in air distribution piping is 4,000 fpm.

With this additional blower capacity, the ATS has sufficient capacity for the flow and loads at the future condition. Table 7 summarizes the key parameters of our assessment of the ATS capacity.

**Table 7: Advanced Treatment Capacity Assessment**

| Parameter | Value | Notes/Basis |
|---|---|---|
| **Influent/Effluent Flow and Quality** | | |
| Flow, Maximum Month (MGD) | 3.1 | |
| Flow, Maximum Daily (MGD) | 4.0 | For comparison with permitted flow. The capacity assesment is based on maximum monthly flow and load conditions. |
| Raw Influent BOD (mg/l) | 408 | Flow and load projections at maximum month |
| Raw Influent TSS (mg/l) | 414 | Flow and load projections at maximum month |
| Raw Influent TKN (mg/l) | 56 | Flow and load projections at maximum month |
| ATS Influent BOD (mg/l) | 273 | Primary clarifier removal percentage previously described at maximum month |
| ATS Influent TSS (mg/l) | 187 | Primary clarifier removal percentage previously described at maximum month |
| ATS Influent TKN (mg/l) | 56 | Flow and load projections at maximum month |
| ATS Effluent BOD (mg/l) | 5 | GE Zenon, 2006 Design Calculations |
| ATS Effluent TSS (mg/l) | 5 | GE Zenon, 2006 Design Calculations |
| ATS Effluent TN (mg/l) | 10 | Discharge Permit Limit |
| Temperature (degrees C) | 21 | Summer, when maximum flows and loads occur |
| **Anoxic** | | |
| Preanoxic Tank Volume (gallons) | 192,393 | AECOM 2012 Record Drawings |
| Mixed Liquor Volatile Suspended Solids (MLVSS) Concentration in the Preanoxic Tank (mg/l) | 5,700 | Calculated |
| Specific Denitrification Rate (g Nitrate Removed / g MLVSS) | 0.2 | Metcalf & Eddy, Wastewater Engineering, 4th Edition, Figure 8-23 |
| **Aeration** | | |
| Aeration Tank Volume (gallons) | 560,781 | AECOM 2012 Record Drawings and aeration in the post anoxic tanks |
| Membrane Tank Volume (gallons) | 220,554 | AECOM 2012 Record Drawings and assume 10% of membrane tank occupied by equipment (same assumption as GE Zenon 2007 Design Calculations) |
| Aeration Tank and Membrane Tank Total Hydraulic Retention Time (hours) | 6 | Calculated |
| Return Activated Sludge Rate (MGD) | 15.6 | 4 times influent flow per GE Zenon 2006 Design |

| Parameter | Value | Notes/Basis |
|---|---|---|
| | | Calculation |
| Mixed Liquor Suspended Solids Concentration (mg/l) | 8,000 | GE Zenon, 2006 Design Calculations |
| Target Solids Retention Time (days) | 13 | AECOM O&M Manual, page 4-33 |
| Sludge Yield (lbs TSS/lbs BOD) | 0.56 | Calculated |
| Total Oxygen Required, Maximum Month (lbs/day) | 13,500 | Calculated |
| Oxygen Required to Aeration Tanks, Maximum Month (lbs/day) | 9,700 | Remainder of required oxygen provided by membrane scour air |
| Total Oxygen Required, Maximum Day (lbs/day) | 22,000 | Calculated |
| Oxygen Required to Aeration Tanks, Maximum Day (lbs/day) | 16,000 | Remainder of required oxygen provided by membrane scour air |
| Aeration Tank Actual Oxygen Transfer Efficiency (%) | 10% | Calculated |
| Required Air Flow Rate, Aeration Tanks, Maximum Month (scfm) | 3,900 | Calculated |
| Required Air Flow Rate, Aeration Tanks, Maximum Day (scfm) | 6,400 | Calculated |
| Available Air Flow Rate, Aeration Tanks (scfm) | 2,900 | Aerzen O&M Manual for 3 aeration tank blowers |
| **Membrane Filtration** | | |
| Total Membrane Area (sq. ft.) | 312,800 | GE Zenon O&M Manual, page 3-7 - 4 trains x 230 modules/train x 340 sf/module |
| Flux at Average Daily Flow (gal/day-sq. ft) | 4.2 | Recommended maximum flux is 13.3 gal/day-sq. ft. per GE Zenon, 2006 Design Calculations |
| Flux at Maximum Daily Flow (gal/day-sq. ft) | 6.5 | Recommended maximum flux is 20.7 gal/day-sq. ft. per GE Zenon, 2006 Design Calculations |
| Flux at Peak Hourly Flow (gal/day-sq. ft.) | 7.7 | Recommended maximum flux is 24.5 gal/day-sq. ft. per GE Zenon, 2006 Design Calculations |

Note that the ATS design included tankage between the aeration tank and the membrane tank that can be operated in either an aerobic mode or an anoxic mode. In the facility O&M Manual, this tankage is referred to as the "future post-anoxic stage." Although it is not clear what the future condition is that would require a post-anoxic stage, we interpret it to be in case the Town were to be issued a new ground water discharge permit with a more stringent total nitrogen limit. While we do not anticipate that the Surfside WWTF would be receiving a more stringent total nitrogen limit, we calculated the ATS capacity with and without aeration in the post anoxic tank and maintaining the same design solids retention time (SRT) of 13 days. Under either condition (with or without aeration in the post anoxic tank), the ATS has enough capacity for the future projected flows and loads at the existing total nitrogen limit.

2.4.3. Recommendations.

- Operational Recommendations: Incorporate the operational recommendations described in 2.4.1.

- Aeration Capacity: As described in Table 7, the required air flow rate to the aeration tanks is less than the existing available air flow rate (3 aeration blowers with a capacity of 951 scfm each). The addition of two blowers, each with a capacity of 3,200 cfm would provide enough aeration capacity for the maximum day load at the future condition.

- Denitrification Concerns: As previously discussed, operations staff have expressed concerns with having the ability to denitrify at the future condition because of anoxic tank volume and nitrate recycle from the membrane tanks may have a high DO which could inhibit denitrification. Our calculations (as well as the original GE Zenon design calculations) and the plant data that we have been provided indicate that these two items would not be a problem. However, there are many variables that can affect the actual results. Therefore, to address this concern, we recommend gathering additional nitrate data and monitoring the results as flows and loads to the Surfside WWTF increase in the future. We have recommend budgeting for improvements to the nitrate recycle system in case future problems are encountered. The improvements would address the potential for high DO in the nitrate recycle by modifying the existing recycle from the membrane tanks with redirection to the aeration tanks and an additional, separate, nitrate recycle from the end of the aeration tanks to the anoxic tanks.

## 2.5. Disinfection

### 2.5.1. Current Operation and Performance

The Facility O&M Manual indicates that the ultraviolet (UV) disinfection system operates with the UV dose automatically adjusted by the control system based on effluent flow and UV transmittance. It is our understanding that UV performance has been sufficient under current conditions. The data provided by the Surfside Operations Staff in a report titled, "Monthly Maximum Data Report" for the period from April 2010 to April 2011 indicates non-detect measurements for fecal coliform each month.

### 2.5.2. Capacity

The UV system consists of two banks of UV lamps. Consistent with TR-16 requirements, each bank has the capacity for a peak hourly flow of 7.7 MGD (4.0 MGD maximum daily flow equivalent) with one bank offline. Based on the UV system manufacturer design information, the UV system can provide 65 percent UV transmittance at a peak hourly flow of 7.7 MGD at a 10 mg/l TSS concentration to meet a 200 FC/100 ml standard.

### 2.5.3. Recommendations

There are no improvements required for capacity reasons.

## 2.6. Solids Processing

### 2.6.1. Current Operation and Performance

At the time of our site visit (April 15, 2013 through April 17, 2013), primary sludge and waste activated sludge (WAS) from the ATS were being segregated. The primary sludge was going to the primary sludge holding tanks located at the primary treatment building and WAS was going to the advanced treatment building sludge holding tanks. The primary sludge and WAS were then

blended just prior to dewatering in the rotary presses. At the time of our visit, WWTF staff reported good dewatering performance.

It is our understanding that WWTF staff have implemented Woodard & Curran's recommendations to blend primary and WAS sludge without segregation. We also believe that this practice has not negatively affected dewatering capabilities.

2.6.2. Capacity

We evaluated sludge storage capacity by developing a solids balance for the WWTF using the parameters described in Table 7 for the ATS. From this solids balance we determined that the solid processing system (storage tanks, pumping and rotary presses) has the capacity to handle the future condition. At the maximum monthly flow, we estimated the rotary presses would need to be operated at a flow rate of approximately 22 gallons per minute for 24 hours per week.

2.6.3. Recommendations

As previously discussed, we recommend continuing with the on/off aeration operation of the sludge holding tanks to prevent anaerobic conditions from developing.

## 3. Summary of Findings, Recommendations, and Estimated Conceptual Cost

The following is a summary of our findings:

- The projected future flow from the needs areas is 4.0 MGD on a maximum daily flow basis.
- With the addition of two blowers, the Surfside WWTF has sufficient capacity to receive and treat the projected future flow.
- The MassDEP groundwater discharge permit limit for flow to the groundwater discharge beds is 3.5 MGD which is less than the projected future flow. Therefore, expansion of the groundwater discharge capacity or revisions to the groundwater discharge permit are required. The expansion of groundwater discharge capacity for the Surfside WWTF would be required at the future condition even if Madaket and Warren's Landing wastewater was not treated at the Surfside WWTF. Woodard & Curran and the Town have submitted the required documentation to MassDEP for this increased capacity and based on our discussions with MassDEP we understand that a revised discharge permit with the required flow increase will be issued soon.
- It is noted that the calculations for our capacity analysis were performed prior to the summer 2013 data being available. At the request of the Town, we subsequently evaluated the pollutant data for June to August of 2013 and found that the load data, when including this period, were consistent with the data used in our capacity analysis as summarized in the following table.

| Parameter | Total Projected and Existing (Future Condition) Maximum Monthly Load (lbs/day) |
|---|---|
| $BOD_5$ | 11,000 |
| TSS | 9,000 |
| Total Nitrogen | 1,400 |

Our recommendations for improvements to the Surfside WWTF included the following:

- Incorporate recommendations from the influent screening and corrosion control feasibility studies currently being performed.

- Consider installation of more reliable DO and ORP instrumentation to improved aeration control for the ATS.

- Installation of two additional blowers with a capacity of 3,200 cfm each will be required for the ATS at the future condition.

- Include a future capital budget item for improvements to the nitrate recycle system if problems with denitrification are encountered.

We estimated the conceptual capital costs for our recommendations for additional blowers and the nitrate recycle system as summarized in the following table:

**Table 8: Conceptual Capital Cost Estimate**

| | Blower Addition | Nitrified Recycle |
|---|---|---|
| Construction | $ 388,000 | $ 371,000 |
| Design Engineering, Permitting and Construction Administration | $ 85,400 | $ 81,600 |
| **Subtotal** | **$ 473,000** | **$ 453,000** |
| Contingency (30%) | $ 142,000 | $ 136,000 |
| **Project Total** | **$ 615,000** | **$ 589,000** |

The estimate is based on the Engineering News Record (ENR) construction cost index of 9681 for February 2014.

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# MEMORANDUM

**TO:** Kara Buzanoski, DPW Director and David Gray, Chief Operator
**FROM:** Krista Forti and Jon Himlan
**DATE:** September 11, 2014
**RE:** Influent Screening Alternatives Assessment
Surfside WWTF, Town of Nantucket, Massachusetts

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## 1. Introduction

This memorandum describes Woodard & Curran's conceptual analysis of the screenings alternative assessment for the Surfside WWTF.

### 1.1. Background/Existing Conditions

The Surfside WWTF is located in the southwest region of Nantucket, MA and has a future peak hour design capacity of 7.7 million gallons per day (MGD) and an existing average daily flow of 1.23 MGD. Upgrades to the plant were completed in 2009 with the installation of a General Electric (GE) / Zenon membrane bioreactor (MBR) system. The current process train includes upstream of the include an aerated grit chamber, primary clarifiers, pre-anoxic tanks, aeration tanks, membrane filters, ultraviolet disinfection and groundwater disposal beds.

An influent grinder was also installed during the 2009 upgrade, however due to severe hydrogen sulfide corrosion, the grinder is no longer functional and was removed. To evaluate this issue a screening analysis was conducted and documented in a memorandum entitled "Enhancements to the Surfside Wastewater Treatment Facility" by AECOM, dated January 9, 2012. The memorandum outlined the importance of MBR system pretreatment, identified pretreatment alternatives, and ultimately recommended the installation of a new grinder in the headworks to breakdown influent debris.

Because they were interested in receiving a second opinion regarding the need for membrane pretreatment (screen versus grinder), the Town of Nantucket contracted Woodard & Curran to provide an Influent Screening Alternatives Assessment.

### 1.2. Scope

The purpose of our screenings alternative assessment is to:

a) Review existing documentation related to influent screening including design plans, operation and maintenance manuals, plant hydraulics, and the AECOM Memorandum dated January 9, 2012.
b) Identify feasible screening alternatives and/or combinations of alternatives suitable for a membrane bioreactor treatment facility with primary clarifiers with the Surfside WWTF specific hydraulic and spatial requirements and operational needs.
c) Provide a recommendation of the most desirable screening alternative with consideration given to process, cost, operation and maintenance concerns.
d) Provide an opinion of probable cost for the recommended alternative including design, construction, engineering and contingency suitable for securing funding.

### 1.3. Recommendation

After analysis of multiple alternatives, as further described in the subsequent sections of this memorandum, Woodard & Curran recommends the installation of a new headworks consisting of two 6-mm screens, two 2-mm band screens, and two wash presses for screenings handling. We do not recommend installation of a grinder.

## 2. Review of Existing Documentation

Woodard & Curran's assessment was based on the following:

- The AECOM memorandum dated January 9, 2012
- WWTF Operation and Maintenance (O&M) manuals
- WWTF record drawings
- GE/Zenon documentation and discussions with GE/Zenon representatives
- Discussions with screen manufacturers and review of their documentation
- Discussions with the Surfside WWTF operations staff;
- Industry technical publications such as the New England Interstate Water Pollution Control Commission's *Guides for Design of Wastewater Treatment Works*, Technical Report 16, 2011 Edition (TR-16) and the Water Environment Federation (WEF) Manual of Practice No. 8 (MOP 8), 5th Edition.

## 3. Membrane Pretreatment Alternatives Evaluation

Adequate pretreatment is essential to the stable, long-term operation of the membranes. Materials such as rags, paper, plastics, fibers, hair, and metals can accumulate on the membranes because they cannot pass through the pores of the membranes. These materials are likely to result in densely packed formations that will wrap around the membrane fibers and can break the fibers or reduce the available membrane filtering surface area. Membrane areas that are not blocked by such formations will have a higher loading/flow through them, making them more susceptible to fouling. The undesirable material can also plug or block the diffusers that provide scour air which is an important part of the membrane cleaning system. Providing pretreatment upstream of the membranes to remove the undesirable material will reduce the potential for damage and likely extend the membrane service life. Grinding and screening were the two pretreatment methods we evaluated for the purposes of the Alternative Assessment.

### 3.1. Grinding

As a part of the 2009 upgrades, an in-channel grinder was installed at the headworks of the WWTF as a low-cost method to protect the membranes. According to the AECOM memo, the design intent was for the grinder to break down material at the influent of the plant. The AECOM memo also states that "the primary clarifiers are intended to function to remove objectionable materials prior to the membranes." Although grinding may be beneficial upstream of certain pump applications to prevent clogging, TR-16 states that grinding is not a desirable option upstream of sensitive processes (such as membranes), due to re-aggregation of ground material. Through discussions with Surfside operations staff, we understand that when the grinder was in place, the ground up material did not fully settle out in the primary clarifiers and traveled into the membrane tanks (as well as the anoxic tanks, aeration tanks, and sludge holding tanks). Therefore, we have concluded that a grinder is not effective for membrane pretreatment because the ground up particles will still accumulate in the membrane tank and potentially damage the membranes.

## 3.2. Screening

Woodard & Curran recommends the installation of a 2-mm screen as a more effective approach to remove objectionable influent debris and better protect the membranes. Our recommendation is supported by the following:

- The Surfside WWTF GE/Zenon Operations & Maintenances (O&M) manual, Section 7.5.2 states that improper pre-screening can lead to difficulties in membrane cleaning and potential damage to the membranes. It also states that appropriate pre-screening with a 2 mm screen helps eliminate the build-up of trash, hair, lint and other fibrous materials and it decreases the risk of solids accumulation.

- TR-16, Chapter 5.1.1.3.4 states that downstream treatment processes such as MBRs require fine screening as low as 1 to 2 mm. To avoid excessive head loss and damage to very fine screens, multiple stages with screens of progressively smaller openings are typically required.

- MOP 8, Volume 2: Liquid Treatment Processes, Chapter 14, Section 6.4 discusses the importance of membrane pretreatment and states that fine screening equipment with a maximum of 1 to 2 mm openings is typically provided to protect membranes from debris and fibrous materials.

It is also noted that the AECOM memo states that, "modifications to the existing Headworks to include screening were considered as part of the upgrade project but were ruled out in an effort to minimize project costs."

# 4. Screening Alternatives Evaluation

This section describes the screening alternatives and preliminary design criteria that we evaluated for the installation of a screen to protect the membranes. The parameters we considered included; type of screen, screen location, redundancy, screenings handling, and the need for enclosing the screen and associated equipment.

## 4.1. Type of Screen

Four types of 2-mm screens were evaluated for the Surfside WWTF and we recommend the band screen. The advantages and disadvantages of installing each type of screen are listed in Table 4.1 below:

**Table 4.1: Types of Screens – Advantages & Disadvantages**

| Screen Type | Advantages | Disadvantages |
|---|---|---|
| Band Screen | • Recommended for MBR Pretreatment by screen manufacturers<br>• Small channel width required for installation<br>• Low screening carry-over<br>• Type of screen recommended by GE/Zenon for their MBR systems | • Requires additional wash press to minimize odor, collect organics, and reduce screen disposal costs |
| In-Channel Rotary Drum Screen | • Recommended for MBR pretreatment by screen manufacturers<br>• Screenings washing and pressing is integral to the screen and a separate piece of equipment (wash press) is not required<br>• Low screenings carry-over | • Requires a wider channel than other alternatives<br>• Introduces higher headloss that other alternatives |
| Perforated Plate Screen | • Small channel width required for installation<br>• High separation efficiency<br>• Reliable cleaning with the use of a rotating brush. | •<br>• Requires additional wash press to minimize odor, collect organics, and reduce screen disposal costs<br>• Potential for screenings carry-over due to the screen moving in the direction of the flow |
| Step/Stair Screen | • Small channel width required for installation<br>• Causes lower headloss than other alternatives<br>• Allows a pivot design for more convenient servicing of the unit above the channel | • Requires additional wash press to minimize odor, collect organics, and reduce screen disposal costs<br>• Potential for screenings carry-over due to the screen moving in the direction of the flow. |

We do not recommend the perforated plate and step/stair screens as most screening manufacturers who we contacted discouraged the use of a these alternatives for membrane protection. The perforated plate and step/stair screens have the potential for screenings carry-over due to the screen moving in the direction of the flow path. Band screens and rotary drum screens have an in-to-out flow pattern, which can prevent screenings carry-over and and the manufacturers offer zero by-pass screening warrantees . We recommend the installation of a band screen over the rotary drum screen because it is the type recommended in the GE/Zenon O&M manual and because it has a smaller footprint.

4.2. Screen Location

We evaluated the following locations for the installation of the 2 mm screen:

- Upstream of the existing headworks in a new structure
- Within the existing headworks structure
- Downstream of the aerated grit chamber in a new structure
- Downstream of the primary clarifiers in a new structure
- Downstream of the pre-anoxic tanks within the existing advanced treatment structure

Our evaluation of these locations included consideration of the following:

- Spatial Requirements: The new screen will need to be installed either within an existing structure or construction of a new structure will be required.

- Hydraulics: The new screen will add headloss and raise the water surface elevations upstream of its location. We assessed the effect of the screen location on plant hydraulics at the future peak hourly flow of 7.7 MGD.

- Screen Pretreatment Requirements: Depending on the location, a 6 mm screen may be needed to protect the 2 mm screen and allow it to operate more efficiently by reducing the potential for blinding and/or allowing bypass and carryover. Technical References such as TR-16 and MOP 8, as well as screen manufacturers such as Ovivo Water Technologies, Huber Technology, and Lakeside Equipment Corporation highly recommend the installation of coarser screen upstream of a 2 mm screen and the membranes. These references also stated that installing a 2 mm screen without pretreatment could cause premature wear and stress on the 2 mm screen, reducing the life of the screen by as much as 40% to 50%.

- Operation and Maintenance Benefits: In addition to protecting the membranes, depending on the location, the new screen may provide additional operation and maintenance benefits including protection of other plant equipment. These potential operation and maintenance benefits are important because operations staff report the following problems:

  - Headworks valves are clogging with rags and plugging flow to the primary clarifiers.

  - Rags are getting caught in the primary clarifier sprockets and derailing the sludge collection chains and flights.

  - Rags are ground up in the primary sludge pump grinders and transferred to the sludge holding tanks where the ground up rags plug aeration diffusers and clog the decanters.

The following table summarizes our evaluation the screen location alternatives.

**Table 4.2: Screen Location Alternatives**

| Screen Locations | Spatial Requirements | Hydraulics | Pretreatment | Operation & Maintenance |
|---|---|---|---|---|
| Upstream of Existing Headworks | Sufficient land is available southeast of the existing headworks for the installation of a new influent channel and screen. | There are no hydraulic restrictions. | A 6-mm screen is required upstream of the 2-mm screen. | Would resolve the ragging and clogging in the headworks, primary clarifiers, and primary sludge pumps. |
| Existing Headworks | A 2mm screen cannot fit within the existing influent channel at the headworks. | The channel depth cannot accommodate the future peak hourly flows with the installation of a screen in this location. | | |
| Downstream of Aerated Grit Chamber | Space is limited and would likely require special/costly construction | The additional headloss introduced at this location could be accomodated. | | Would resolve the ragging and clogging in the primary clarifiers and primary sludge pumps . Clogging in the existing headworks woud still be a problem. |
| Downstream of Primary Settling Tanks | This location has space available to install a fine screen but would eliminate the roadway and access between the disposal beds and the primary clarifiers and advanced treatment area. | This location is somewhat hydraulically limited based on the primary effluent v-notch weir elevation at peak flow conditions. Modifications to the primary clarifiers would likely be required or short-term bypasses of the screen at peak hour flows would need to be allowed. | Primary clarifiers would protect the 2-mm screen and a 6-mm screen would not be required. | Problems with ragging and clogging in the headworks, primary clarifiers, and primary sludge pumps would remain. |
| Downstream of Pre-Anoxic Tanks | Modification of the existing anoxic tank/aeration tanks would be required which would likely require special/cost construction. | The flow from the preanoxic tanks is pumped to aeration tanks, so there is a hydraulic break. The pumps would need to be replace with higher head models to overcome the additional losses introduced by the screen. | | |

Based on the criteria described above, Woodard & Curran recommends the installation of the 2 mm screen upstream of the existing headworks. Although this location would require the installation of a new structure and a 6 mm screen for pretreatment, it allows for the most flexibility spatially, has the least negative impacts on the plant hydraulics and provides the most operation and maintenance benefits.

## 4.3. Redundancy

It is common practice to recommend the installation of one duty and one standby piece of equipment for wastewater treatment process. Redundancy allows for the wastewater to be treated when equipment is down for maintenance or repair. TR-16 recommends the installation of multiple mechanically cleaned screens such that any one unit can be removed from service without sacrificing capability of the other screen to handle peak design flows. Therefore, Woodard & Curran recommends the installation of two 6-mm mechanical screens, and two 2-mm mechanical screens, each designed to handle the future peak hourly flow of 7.7 MGD.

## 4.4. Screenings Handling

To handle the screenings that will be collected by the 2 mm and 6 mm screen, Woodard & Curran recommends the installation of a wash press to:

- Wash influent screenings to remove organic material from the screenings and return it to the wastewater flow. Returning organics to the wastewater stream reduces odor and handling hazards associated with the high concentrations of pathogens in the organic matter in screenings. The organics are also needed for the proper operation of the biological system downstream.

- Compact the influent screenings to reduce storage and disposal cost.

Woodard & Curran recommends the installation of two wash presses. One shall be dedicated to the 6 mm screenings and one dedicated to the 2 mm screenings. Both wash presses will direct screenings into a common roll-off dumpster for disposal.

## 4.5. Enclosure

Woodard & Curran recommends the installation of a building around the screening equipment for the following reasons:

- Protects the screens and associated equipment from freezing temperatures

- Protect the screens and associated equipment from salt air corrosion.

- Provides a means for containing and controlling potential odors.

- Protects the operators from the elements when they need to maintain or service the equipment.

Our recommendation is based on the TR-16 recommendation that screening devices are located in weatherproof enclosures whenever possible. In addition, screen manufacturer representatives stated installing a screen without an enclosure is not recommended.

# 5. Recommendation

Woodard & Curran's recommendation includes the installation of screening equipment in a new headworks building upstream of the existing headworks, which includes 6-mm screening, 2-mm screening, and screenings handling.

We also recommend that a new vortex grit removal system is incorporated into the new headworks as follows:

- Grit removal upstream of the 2mm screen will make screening more efficient. Incorporating the existing grit chamber into the flow path would be difficult and costly to construct because of the limited space between the existing headworks and the primary clarifiers.

- The existing grit chamber has significant hydrogen sulfide corrosion that would need to be repaired.

- Operations staff report concerns with the location of the grit screw mechanism as it is in the direct path of influent flow and is therefore vulnerable to wear from the grit in the influent wastewater.

Note that due to relatively new grit pumps and grit washing equipment, our conceptual plan includes reuse of this equipment.

A conceptual layout of the proposed headworks building is shown in the figure below. The force main shall be extended from the existing influent manhole to the new headworks. A Parshall flume will be located outside of the headworks building for the measurement of plant influent flow. The headworks building will house two parallel channels for the 6-mm screens, one channel for the vortex grit system, followed by two channels for the 2-mm screens. The wash presses (not shown in the figure) will be located behind and centered between the two 6-mm screens and two 2-mm screens, and will discharge screenings to the roll-off dumpster for storage and disposal. The 2-mm screen effluent will discharge into a pipe which will travel underground and adjacent to the existing headworks. A new distribution chamber will be installed to control the flow between the three primary clarifiers. New piping will be installed from the distribution chamber to the existing wall penetrations in the primary treatment building.

The conceptual headworks design and layout includes the following:

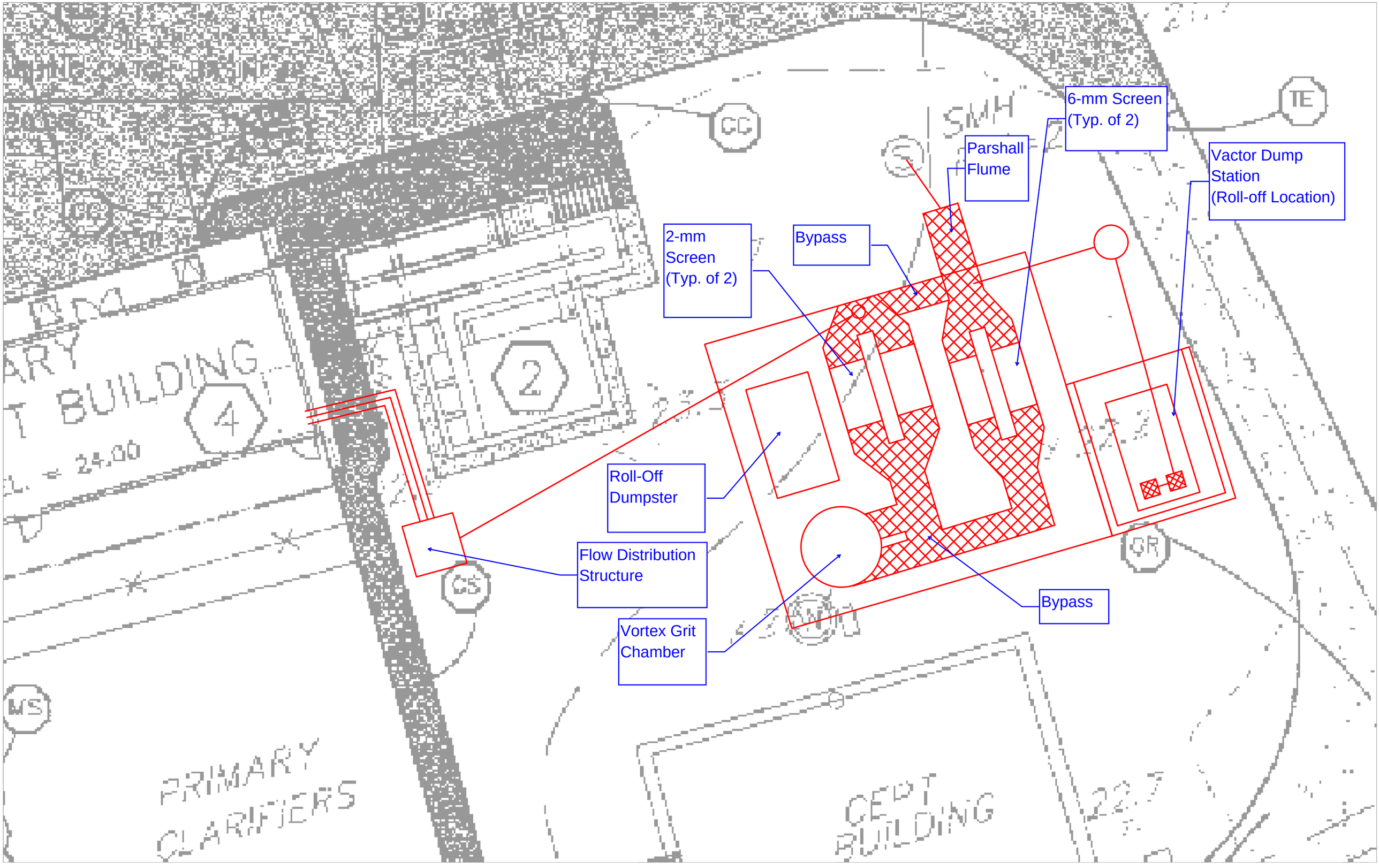
- Two (2) 6mm band screens, each rated for 7.7 MGD.
- Two (2) 2-mm band screens, each rated for 7.7 MGD.
- Two (2) Wash presses (one dedicated to the coarse screens and one dedicated to the fine screens). Each wash press will contain a discharge header that travels approximately 20 feet to a dumpster
- One 10-foot diameter mechanical vortex grit removal system with a bypass channel
- Fourteen (14) Stainless Steel slide gates to isolate channels and unit processes
- One (1) Parshall flume located outside of the building, within a concrete channel
- (5) Ultrasonic level transducers to measure water level upstream of each screen as well as within the Parshall flume.
- One (1) concrete flow distribution structure (approximately 6'x6') located downstream of the headworks facility to evenly split flow between the three existing primary clarifiers.
- One (1) cedar shingled building (approximately 41'x37') to house the headworks equipment and channels, including HVAC, electrical, and plumbing connections. All concrete channels will be covered with heavy- duty grating.
- One (1) monorail system & hoist for the removal of equipment within the headworks building
- One (1) roll-up door for equipment and dumpster access into and out-of the building.
- One (1) 15 yard dumpster is recommended to be located inside of the building for the collection of dewatered screening material (wash press effluent).
- Approximately 10 feet of extension of the 20" influent force main
- Approximately 50 feet of 20" gravity pipe connecting the headworks effluent to the distribution structure
- Three (3) 16" pipes of approximately 35 feet long to connect the distribution structure to the three pipes at the primary treatment building wall.

6. Opinion of Probable Cost

The total project cost is estimated to be $4,970,000 which includes a thirty percent contingency. The total project costs are estimated in the table below:

| Total Project Cost | |
|---|---|
| Construction | $3,136,000 |
| Design & Engineering (10% of Construction Cost) | $314,000 |
| Permitting (4% of Construction Cost) | $125,000 |
| Construction Administration (8% of Construction Cost) | $251,000 |
| **Sub-Total** | **$3,826,000** |
| Project Contingency (30%) | $1,148,000 |
| **Project Total** | **$4,970,000** |

The estimate based on the Engineering News Record (ENR) construction cost index of 9681 for February 2014.


6-mm Screen
(Typ. of 2)
Parshall
Flume
Vactor Dump
Station
(Roll-off Location)
2-mm
Screen
(Typ. of 2)
Bypass
Roll-Off
Dumpster
Flow Distribution
Structure
Vortex Grit
Chamber
Bypass
PRIMARY
CLARIFIERS
BUILDING
CC
TE
CS
WS
GR

# CONTROL OF HYDROGEN SULFIDE CORROSION AT THE SURFSIDE WWTF

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October, 2013

# EXECUTIVE SUMMARY

## INTRODUCTION

The Surfside Wastewater Treatment Facility (Surfside WWTF) serves residential and commercial development on the island of Nantucket. The facility underwent a major upgrade in 2008. The headworks facility, which includes a comminutor and a grit chamber, has been subjected to severe corrosion caused by the presence of hydrogen sulfide ($H_2S$) gas. The comminutor was destroyed by the corrosion and has been removed, but the concrete has also been attacked, exposing the aggregate in the concrete. In addition, odors from the headworks are strong due to elevated levels of $H_2S$.

In May of 2013, Bowker & Associates was retained by Woodard & Curran to investigate the severity and extent of the corrosion problem, characterize the wastewater in the collection system with regard to its propensity to generate and release hydrogen sulfide, and evaluate and recommend appropriate and economical alternatives for controlling the hydrogen sulfide. This report provides a description of the facilities, the results of a wastewater and headspace sampling program, an evaluation of hydrogen sulfide control alternatives, and recommendations.

## DESCRIPTION OF FACILITIES

### Wastewater Collection System

The Nantucket wastewater collection system includes 11 pump stations and force mains. The largest pump station is the Sea St. Pump Station in "downtown" Nantucket. Approximately 70 percent of the total flow to the Surfside WWTF comes through this pump station. There are two force mains from Sea St., both 20-inch diameter, that are between three and four miles long. These two force mains manifold together with force mains from Surfside PS and South Valley PS before reaching the Surfside treatment plant.

The average daily flow from Sea St. PS ranges from 0.6 to 1.4 mgd. At a flow of 1.0 mgd, the detention time in the force main is 7 or 8 hours depending on which force main is used. In general, force mains can be expected to generate sulfide when the sewage detention time exceeds two hours.

### Wastewater Treatment Facility

The Surfside Wastewater Treatment Facility is an advanced wastewater treatment plant with an average daily design flow of 3.5 mgd. Current average flow ranges from approximately 0.9 to 1.9 mgd depending on season. Unit processes at the plant consist of comminutors (currently out of service due to corrosion), aerated grit chambers, primary clarifiers, aeration basins, membrane biological reactors, and ultraviolet disinfection system. Effluent is discharged into groundwater recharge basins. Solids handling processes include aerated sludge holding and rotary press dewatering. Dewatered sludge is landfilled or composted on the island.

## SAMPLING PROGRAM

A sampling program was developed to 1) characterize the wastewater with regard to its propensity to generate and release hydrogen sulfide, and 2) quantify headspace $H_2S$ levels at various locations throughout the wastewater collection and treatment system. The program consisted of wastewater sampling at four locations in the collection system and plant headworks, and continuous monitoring of headspace $H_2S$ concentrations at five locations. The sampling program was conducted in May, 2013.

## EVALUATION OF SULFIDE CONTROL ALTERNATIVES

Testing at the Nantucket WWTF showed relatively high levels of sulfide attributed to the 20-inch force main(s) from Sea St. Pump Station. The headworks of the plant exhibits severe corrosion. Although there is no apparent corrosion damage to the primary clarifiers, sufficient levels of headspace $H_2S$ exist to put the concrete tanks at risk for accelerated corrosion. For this reason, efforts were focused on reducing the sulfide in the wastewater entering the plant as a means to control corrosion due to hydrogen sulfide.

Special considerations for any chemical used on the island of Nantucket include the following:

1. The cost of transportation to the island
2. Safety of the chemical (hazardous vs. non-hazardous)
3. Availability of access for chemical delivery and bulk storage

Because the force main from Sea St. Pump Station generates the vast majority of sulfide entering the plant, a sulfide control chemical would need to be added at Sea St. PS in order to control formation in the main. Alternatives subjected to detailed evaluation included injection of magnesium hydroxide, calcium nitrate solution (Bioxide), sodium hypochlorite, and pure oxygen.

## CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

1. The Surfside WWTP in Nantucket, MA has experienced severe corrosion of the headworks due to the presence of hydrogen sulfide gas.

2. Although the primary clarifiers do not exhibit obvious symptoms of hydrogen sulfide corrosion damage, the concrete is at risk for corrosion.

3. The majority of the sulfide entering the Surfside WWTF is formed in the force main from the Sea Street Pump Station, which is responsible for about 70 percent of the flow entering the plant.

4. Sulfide concentrations in the wastewater entering the plant were measured at 1 to 4 mg/L. Headspace $H_2S$ levels at the headworks averaged 36 ppm, which are very corrosive concentrations. Concrete pH was 2.

5. Although some hydrogen sulfide is returned to the headworks in the rotary press filtrate and the storage decant, the contribution is very low compared to that from the Sea Street force main.

6. Hydrogen sulfide headspace concentrations were low in the wet wells of Sea St. PS, Surfside PS and South Valley PS. There is little evidence of hydrogen sulfide corrosion at these locations.

**Recommendations**

1. The headworks should be rehabilitated by high-pressure, water-blast cleaning of the concrete, removal of corrosion products, and application of a high-build, amine-cured epoxy that is resistant to attack by hydrogen sulfide and sulfuric acid.

2. The Town should conduct a trial injecting sodium hypochlorite at Sea St. to control sulfide generation in the force main. Effectiveness should be determined by monitoring headspace $H_2S$ at the headworks and measuring influent sulfide and chlorine residual in the wastewater.

3. If successful, bleach addition at Sea St. could be implemented as an interim solution to the hydrogen sulfide problem.

4. The Town should plan to implement a sidestream oxygen injection system as a permanent solution to corrosion and odor problems at the headworks. This will also ensure protection of the concrete in the primary clarifiers. The estimated capital cost of the system is $489,000, with annual O & M costs projected at $17, 500/yr.

5. The Town should collect and analyze influent WWTP samples for sulfide on a weekly basis, *year-round*, so that a data base can be developed. Currently, there is no information on sulfide loadings during winter months. Weekly samples should be collected at the same time (approx. 10 AM) and analyzed using the sulfide test kit provided to the Town.

6. The Town should consider purchasing a datalogging $H_2S$ analyzer for monitoring $H_2S$ concentrations in the headspace of the covered headworks and/or primary clarifiers. $H_2S$ levels should be monitored for one week per month for one year to document how levels fluctuate with seasons. The cost of a datalogging $H_2S$ analyzer is approximately $1,500.

7. Air flow rates in the two 4-inch air ducts from the headworks should be increased to a minimum of 150 cfm each. An air flow rate of 300 cfm will ventilate the covered space at 12 air changes per hour. It may be possible to adjust other dampers to increase the air flow, which is currently less than 200 cfm total.

## TABLE OF CONTENTS

**Page No.**

EXECUTIVE SUMMARY ..... i

1. INTRODUCTION ..... 1

2. DESCRIPTION OF FACILITIES ..... 3
   2.1 Wastewater Collection System ..... 3
   2.2 Wastewater Treatment Facility ..... 3

3. SAMPLING PROGRAM ..... 7
   3.1 Methodology ..... 7
   3.2 Results ..... 8

4. EVALUATION OF SULFIDE CONTROL ALTERNATIVES ..... 16
   4.1 Overview ..... 16
   4.2 Economic evaluation ..... 22

5. CONCLUSIONS AND RECOMMENDATIONS ..... 25
   5.1 Conclusions ..... 25
   5.2 Recommendations ..... 26

APPENDIX A: SAMPLING DATA

APPENDIX B: OXYGEN INJECTION PROPOSAL

## LIST OF TABLES

Page No.


Table 1 Detention Times in Sea St. Force Mains .....5

Table 2 Average Daily Flows to Surfside WWTF by Month; 2012.....6

Table 3 Average Values of Sampling Data.....9

Table 4 Overview of Hydrogen Sulfide Control Techniques.....18

Table 5 Daily Operating Cost of Screened Sulfide Control Alternatives.....23

Table 6 Economic Analysis of Oxygen Injection vs. Chemical Addition.....24

## LIST OF FIGURES


Page No.

Figure 1 Photograph of Concrete and Metal Corrosion; Surfside WWTF Headworks ..... 2

Figure 2 Schematic of Nantucket Pump Stations and Force Mains ..... 4

Figure 3 $H_2S$ Concentration vs. Time, Sea Street PS Wet Well ..... 10

Figure 4 $H_2S$ Concentration vs. Time, Surfside PS Wet Well ..... 11

Figure 5 $H_2S$ Concentration vs. Time, South Valley PS Wet Well ..... 13

Figure 6 $H_2S$ Concentration vs. Time, Surfside WWTP Headworks ..... 14

Figure 7 $H_2S$ Concentration vs. Time, Surfside WWTP Primary Effluent Channel ..... 15

# 1. INTRODUCTION

The Surfside Wastewater Treatment Facility (Surfside WWTF) serves residential and commercial development on the island of Nantucket. The facility underwent a major upgrade in 2008. The headworks facility, which includes a comminutor and a grit chamber, has been subjected to severe corrosion caused by the presence of hydrogen sulfide ($H_2S$) gas. The comminutor was destroyed by the corrosion and has been removed, but the concrete has also been attacked, exposing the aggregate in the concrete. Figure 1 shows a photograph of the concrete corrosion. In addition, odors from the headworks are strong due to elevated levels of $H_2S$.

In May of 2013, Bowker & Associates was retained by Woodard & Curran to investigate the severity and extent of the corrosion problem, characterize the wastewater in the collection system with regard to its propensity to generate and release hydrogen sulfide, and evaluate and recommend appropriate and economical alternatives for controlling the hydrogen sulfide. This report provides a description of the facilities, the results of a wastewater and headspace sampling program, an evaluation of hydrogen sulfide control alternatives, and recommendations.

Figure 1. Photograph of Concrete and Metal Corrosion; Surfside WWTF Headworks

# 2. DESCRIPTION OF FACILITIES

## 2.1 Wastewater Collection System

Figure 2 is a schematic diagram of the Nantucket wastewater collection system, showing the major pump stations and force mains. The largest pump station is the Sea St. Pump Station in "downtown" Nantucket. Approximately 70 percent of the total flow to the Nantucket WWTF comes through this pump station. There are two force mains, both 20-inch diameter. The "old" line is approximately 17,300 ft long, and the new force main is about 21,100 ft long. There is no set procedure or schedule for rotating the mains in and out of service, and there is no provision to drain the force mains. Note in Figure 2 that the force mains manifold together prior to reaching the plant, so there is no way to isolate or sample the individual force main discharges.

Assuming Sea St. PS represents 70 percent of the total plant flow, the average daily flow from Sea St. PS is expected to range from 0.6 to 1.4 mgd. At an average dry weather flow from Sea St. PS of 1.0 mgd, the detention time in the force main is 7 or 8 hours depending on which force main is used. At low flow periods during late evening and early morning hours, wastewater detention time likely exceeds 12 hours. Table 1 shows estimates of detention times in the two force mains. In general, force mains can be expected to generate sulfide when the sewage detention time exceeds two hours.

## 2.2 Wastewater Treatment Facility

The Surfside Wastewater Treatment Facility is an advanced wastewater treatment plant with an average daily design flow of 3.5 mgd (according to AECOM design manual). Current average flows range from approximately 0.9 to 1.9 mgd depending on season. Table 2 shows average daily flows for 2012. Average daily flows during the summer season can be over double the off-season flows. Unit processes at the plant consist of comminutors, aerated grit chambers, primary clarifiers, aeration basins, membrane biological reactors, and ultraviolet disinfection system. Effluent is discharged into groundwater recharge basins. Solids handling processes include aerated sludge holding and rotary press dewatering. Dewatered sludge is landfilled on the island.

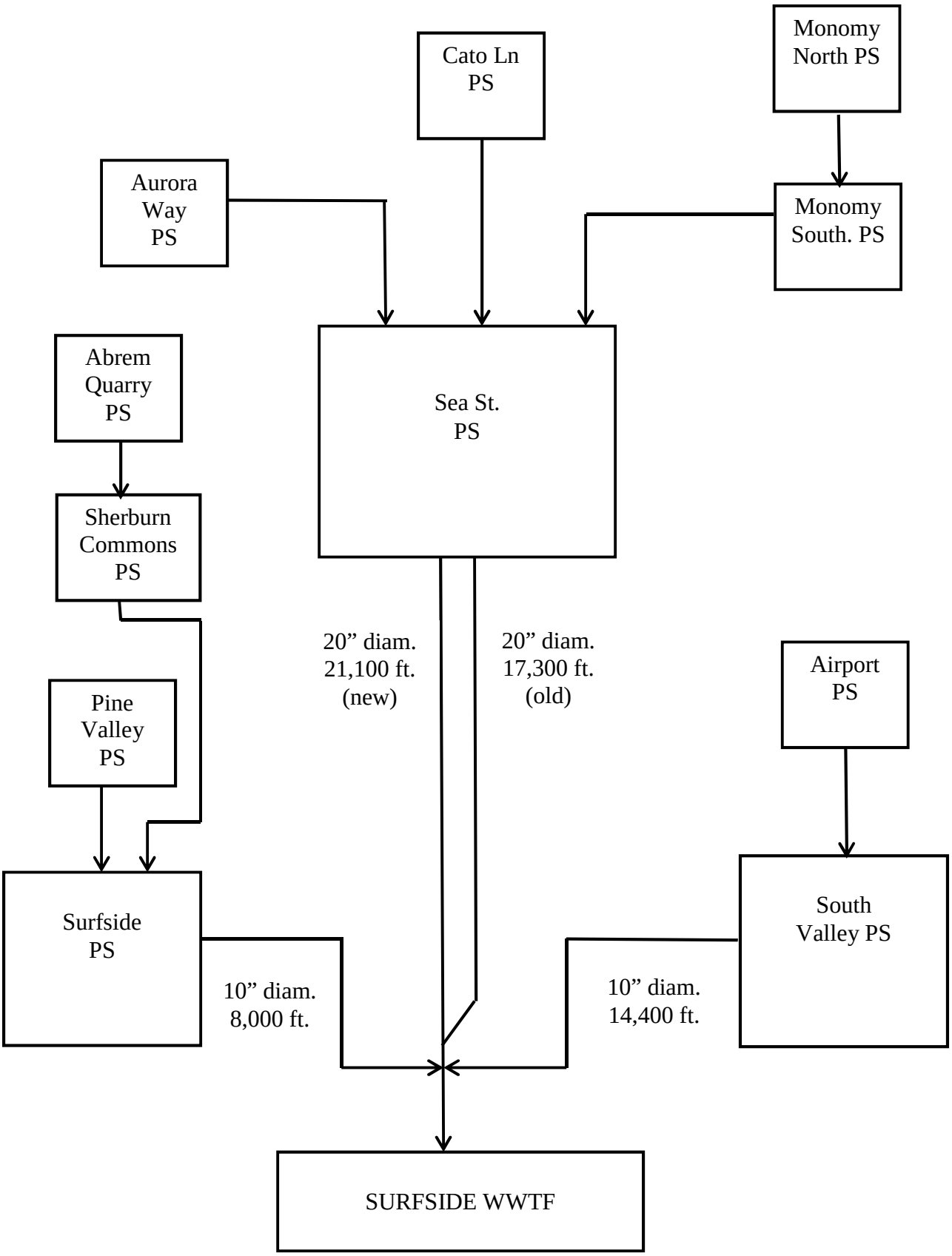



Figure 2. Schematic of Nantucket Pump Stations and Force Mains

| TABLE 1<br><br>DETENTION TIMES<br>IN SEA ST. FORCE MAINS | | |
|---|---|---|
| | Detention Time, hr. | |
| **Flow (million gal/day)** | **Old FM[1]** | **New FM[2]** |
| 0.5 | 13.5 | 16.5 |
| 0.6 | 11.3 | 13.8 |
| 0.7 | 9.7 | 11.8 |
| 0.8 | 8.4 | 10.3 |
| 0.9 | 7.6 | 9.2 |
| 1.0 | 6.8 | 8.3 |
| 1.1 | 6.1 | 7.5 |
| 1.2 | 5.6 | 6.9 |
| 1.3 | 5.2 | 6.4 |
| 1.4 | 4.9 | 5.9 |
| 1.5 | 4.5 | 5.5 |

[1] Old Force Main: 20” diameter; 17,300 ft. long

[2] New Force Main: 20” diameter; 21,100 ft. long

| TABLE 2<br><br>AVERAGE DAILY FLOWS TO SURFSIDE WWTF BY MONTH; 2012 | |
|---|---|
| **Month** | **Avg. Daily Flow, mgd** |
| Jan | 0.91 |
| Feb | 0.87 |
| Mar | 0.86 |
| Apr | 0.94 |
| May | 1.29 |
| June | 1.44 |
| July | 1.84 |
| Aug | 1.93 |
| Sept | 1.34 |
| Oct | 1.09 |
| Nov | ? |
| Dec | ? |

# 3. SAMPLING PROGRAM

## 3.1 Methodology

A sampling program was developed to 1) characterize the wastewater with regard to its propensity to generate and release hydrogen sulfide, 2) quantify headspace $H_2S$ levels at various locations throughout the wastewater collection and treatment system. The program is described below.

Liquid Stream Testing

Wastewater samples were collected twice per day for three days from the following locations:

1. Sea St. PS wet well
2. Surfside PS wet well
3. South Valley PS wet well
4. Surfside WWTF influent

Samples were analyzed in the field for the following parameters:

1. pH (Myron L Model 3P analyzer)
2. Oxidation-reduction potential (Myron L)
3. Temperature (Myron L)
4. Total sulfide (Chemetrics Sulfide Kit)

Additional single grab samples were collected from:

1. Airport PS wet well
2. Sludge holding tank decant
3. Primary effluent channel
4. Rotary press filtrate

Hydrogen Sulfide Testing

Datalogging $H_2S$ analyzers (OdaLogs) were deployed for up to two weeks to track hydrogen sulfide levels in the headspaces of the following pump stations and structures:

1. Sea St. PS wet well
2. Surfside PS wet well
3. South Valley PS wet well
4. Surfside WWTF influent channel after flume
5. Primary clarifier effluent channel

### 3.2 Results

Table 3 is a summary of the collected data, showing the average values of the wastewater testing, as well as the range and average concentrations of $H_2S$ in the headspace. A tabulation of all wastewater data is included in Appendix A. Data are discussed below by location.

Sea St. Pump Station

Although the ORP of the incoming wastewater is negative, indicating septic conditions (no dissolved oxygen), no sulfide was detected in the samples. The pH was neutral at 7.1. As shown in Figure 3, no $H_2S$ gas was detected in the headspace of the wet well, and the average $H_2S$ concentration was 0 ppm. However, there is some evidence of corrosion at Sea Street PS, which may be due to low levels of $H_2S$ and poor ventilation.

Surfside Pump Station

Wastewater samples from the Surfside PS showed a more negative ORP (-122 mV) and an elevated pH of 8.1. The reason for the elevated pH is not clear, although Town staff suggested a car wash may be a source of alkaline discharges. However, only traces of sulfide were detected in the samples (up to 0.2 mg/L). Furthermore, headspace $H_2S$ levels were low, with a peak of 5 ppm and an average of 0.5 ppm. Figure 4 shows the $H_2S$ data. The higher pH of the wastewater

**TABLE 3**

**AVERAGE VALUES OF SAMPLING DATA;**
**Nantucket Sewerage System**
**May 21 -23. 2013**

| Location | pH s.u. | ORP mV | Temp, °C | Total Sulfide mg/L | Headspace $H_2S$, ppm Range | Headspace $H_2S$, ppm Average | Wall pH |
|---|---|---|---|---|---|---|---|
| Sea St. PS | 7.1 | -83 | 17.7 | 0.0 | 0 - 1 | 0 | 4 |
| Surfside PS | 8.1 | -122 | 19.3 | 0.1 | 0 - 5 | 1 | 4 |
| South Valley PS | 8.1 | -112 | 18.9 | 0.0 | 0 - 7 | 0 | 4 |
| Surfside WWTP Headworks | 6.9 | -224 | 18.6 | 2.3 | 0 - 1674 | 36 | 2 |
| **Other locations (single sample)** | | | | | | | |
| Airport PS | 8.3 | +64 | 19.8 | 0.0 | - | - | - |
| Sludge tank decant | 7.2 | -150 | 19.9 | 0.2 | - | - | - |
| Primary effl. channel | 6.7 | -210 | 17.8 | 2.0 | 0 - 237 | 4 | 3 |
| Rotary press filtrate | 5.4 | -145 | 18.1 | 3.0 | - | - | - |

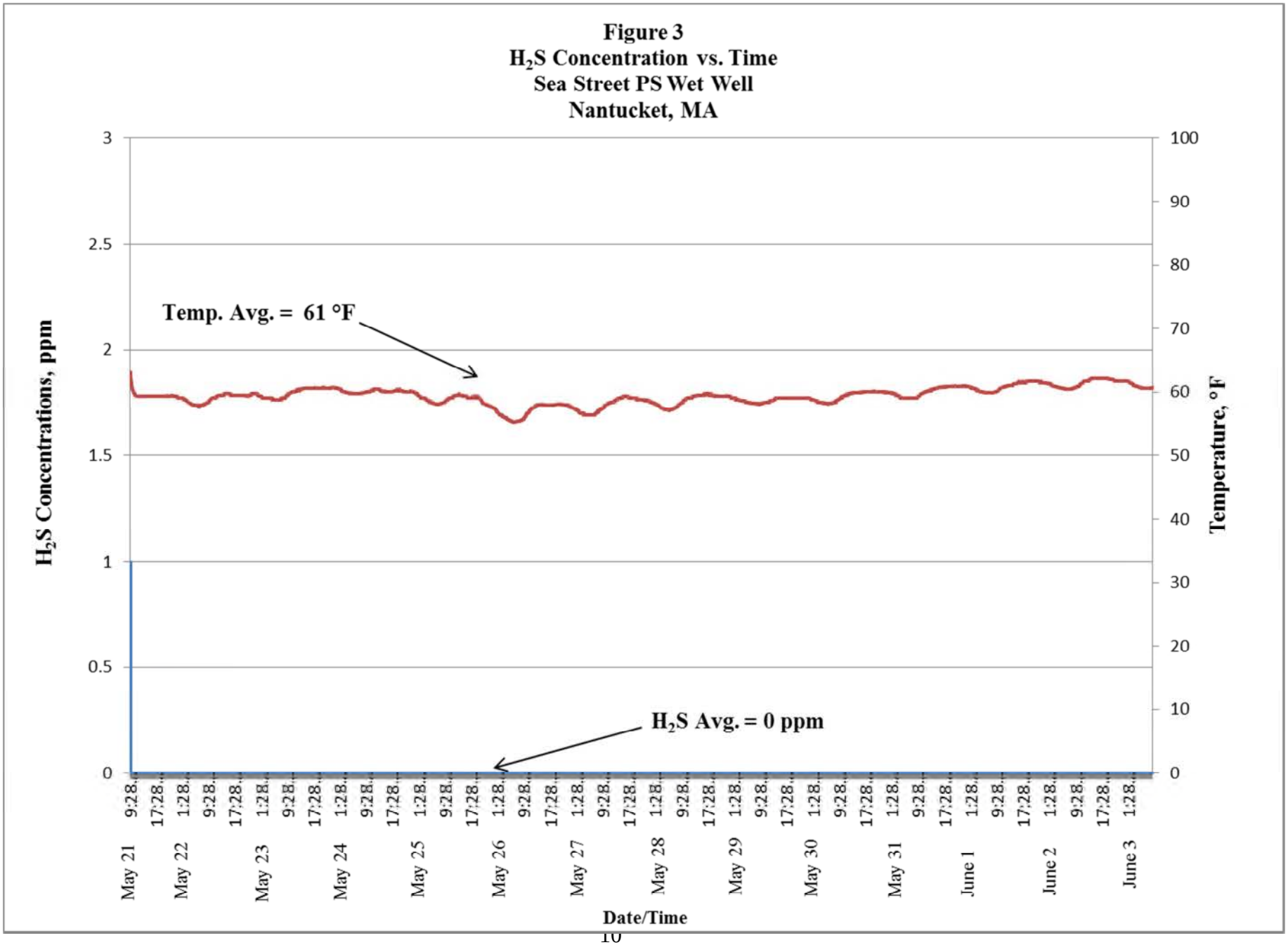


Figure 3
H2S Concentration vs. Time
Sea Street PS Wet Well
Nantucket, MA
Temp. Avg. = 61 °F
H2S Avg. = 0 ppm
H2S Concentrations, ppm
Temperature, °F
Date/Time
3
2.5
2
1.5
1
0.5
0
100
90
80
70
60
50
40
30
20
10
0
May 21
May 22
May 23
May 24
May 25
May 26
May 27
May 28
May 29
May 30
May 31
June 1
June 2
June 3

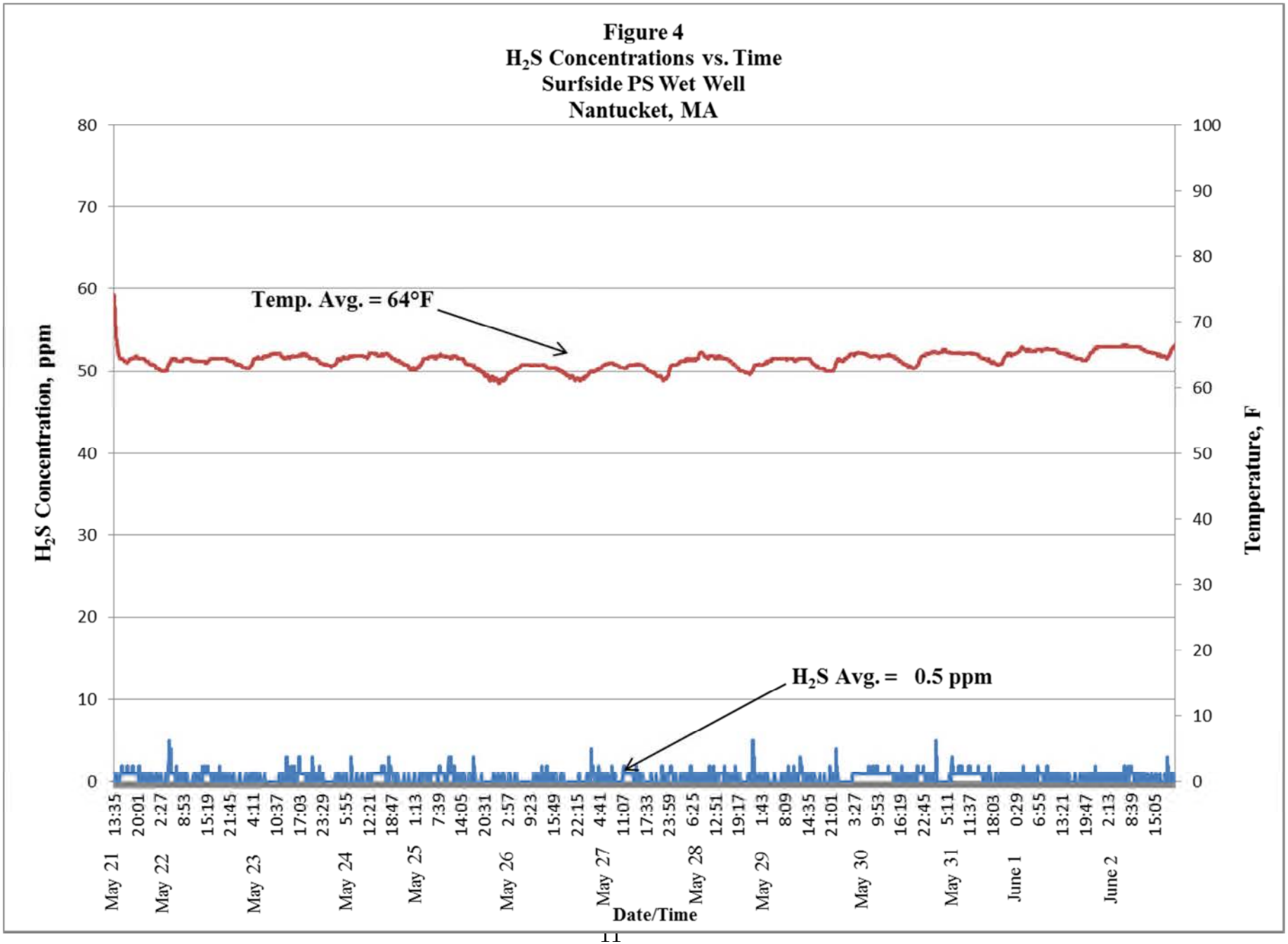


Figure 4
H2S Concentrations vs. Time
Surfside PS Wet Well
Nantucket, MA
Temp. Avg. = 64°F
H2S Avg. = 0.5 ppm
H2S Concentration, ppm
Temperature, F
Date/Time
May 21
May 22
May 23
May 24
May 25
May 26
May 27
May 28
May 29
May 30
May 31
June 1
June 2

can have several benefits – the sulfide-producing bacteria prefer a neutral pH, so sulfide generation is suppressed, and the higher pH keeps any sulfide in solution so that it cannot be released as hydrogen sulfide gas.

South Valley Pump Station

Samples from South Valley Pump Station showed similar results to Surfside PS with an average pH of 8.1 and an average ORP of -112 mV. Headspace $H_2S$ averaged 0 ppm, with a peak of 7 ppm (see Figure 5). Again, the somewhat elevated pH likely helps suppress sulfide generation as well as prevent the release of $H_2S$ gas.

Surfside WWTP

Influent wastewater samples collected from the Surfside WWTF showed very low ORP of -224 mV, a pH of 6.9 and sulfide levels ranging from 0.8 to 4 mg/L. Hydrogen sulfide levels in the headspace ranged from 0 to 1,674 ppm, and averaged 36 ppm (see Figure 6). These are very corrosive levels of hydrogen sulfide gas. Concrete pH was approximately 2 due to the biological conversion of $H_2S$ to sulfuric acid.

On May 22, the "new" force main was placed into operation, and the septic wastewater in the line was pumped to the plant. As can be seen in Figure 6, this resulted in a major spike in wastewater sulfide and resulting headspace $H_2S$. The wastewater sample collected showed sulfide levels of 4 mg/L and had high grease and solids content. During this time, headspace $H_2S$ reached its peak of over 1,600 ppm. NOTE: $H_2S$ concentrations above 300 ppm are considered an imminent life threat.

A single wastewater sample was collected from the primary effluent channel on the final day of sampling. Results were similar to those for the plant influent. Total sulfide was 2 mg/L. Average headspace $H_2S$ in the effluent channel was 4 ppm, with a peak of 237 ppm on May 22 when the idle force main was brought on-line (see Figure 7). Concrete pH was approximately 3.

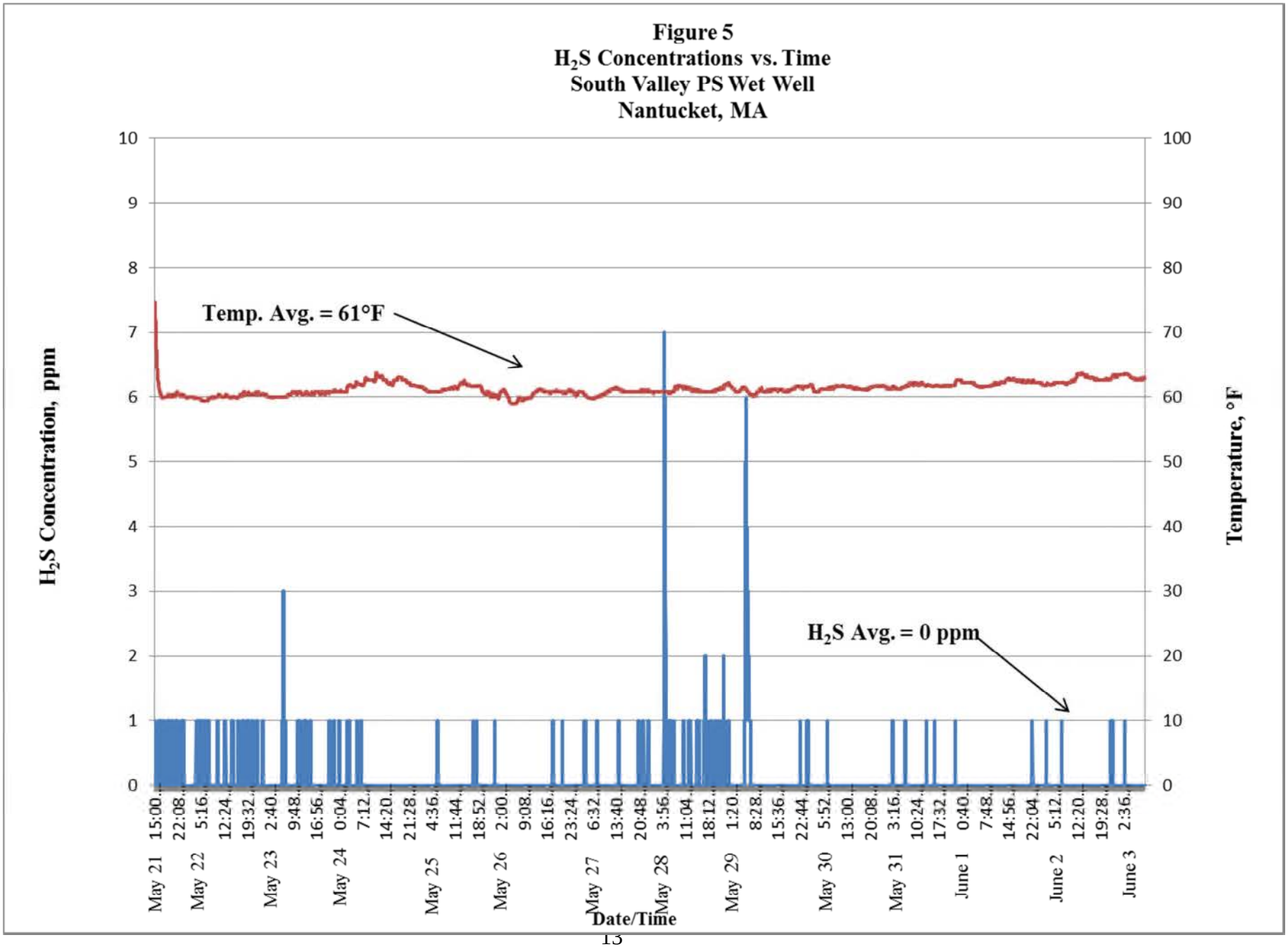


Figure 5
H2S Concentrations vs. Time
South Valley PS Wet Well
Nantucket, MA
Temp. Avg. = 61°F
H2S Avg. = 0 ppm
H2S Concentration, ppm
Temperature, °F
Date/Time
May 21
May 22
May 23
May 24
May 25
May 26
May 27
May 28
May 29
May 30
May 31
June 1
June 2
June 3

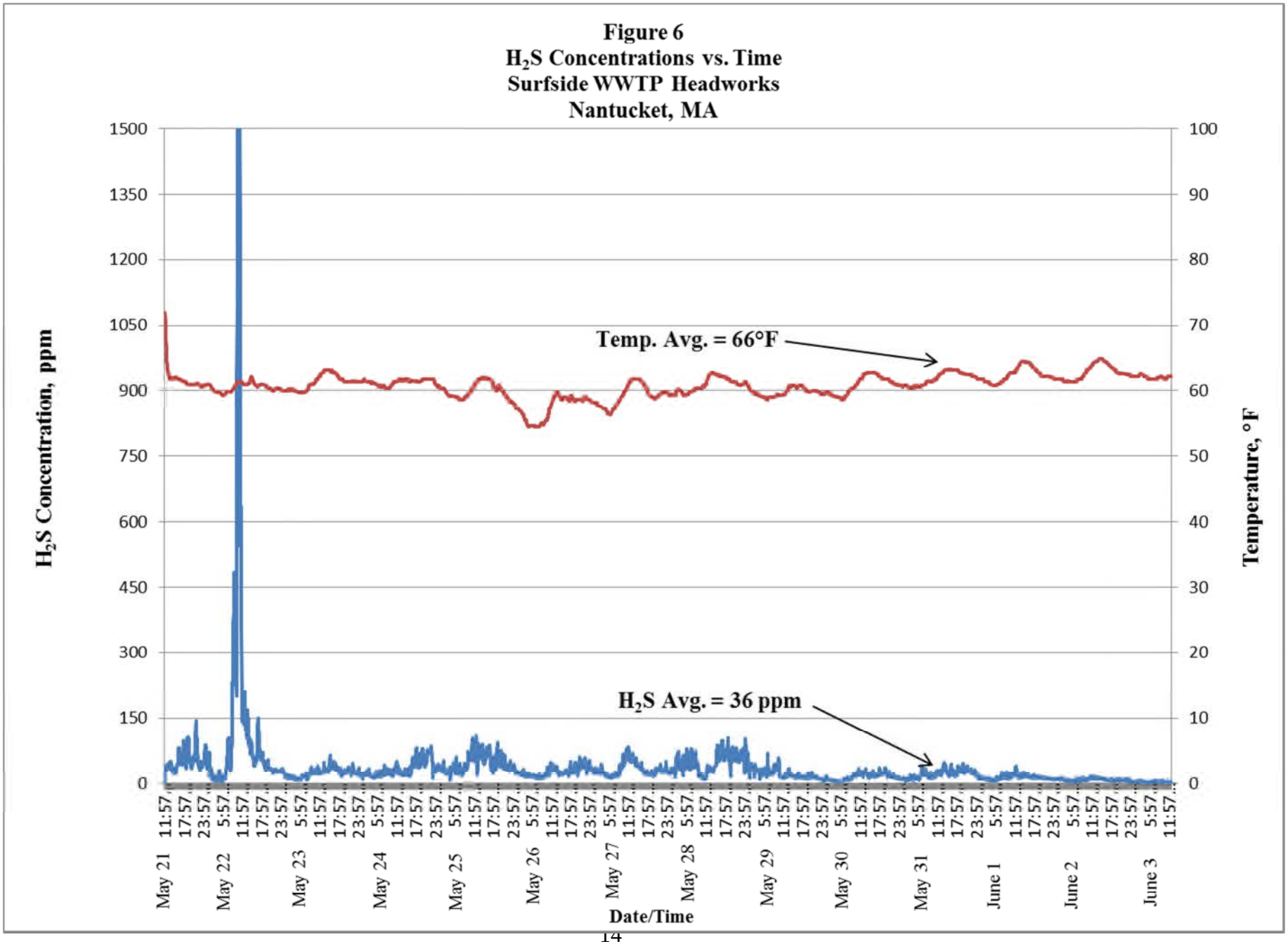


Figure 6
H2S Concentrations vs. Time
Surfside WWTP Headworks
Nantucket, MA
H2S Concentration, ppm
Temperature, °F
Temp. Avg. = 66°F
H2S Avg. = 36 ppm
1500
1350
1200
1050
900
750
600
450
300
150
0
100
90
80
70
60
50
40
30
20
10
0
May 21
May 22
May 23
May 24
May 25
May 26
May 27
May 28
May 29
May 30
May 31
June 1
June 2
June 3
Date/Time

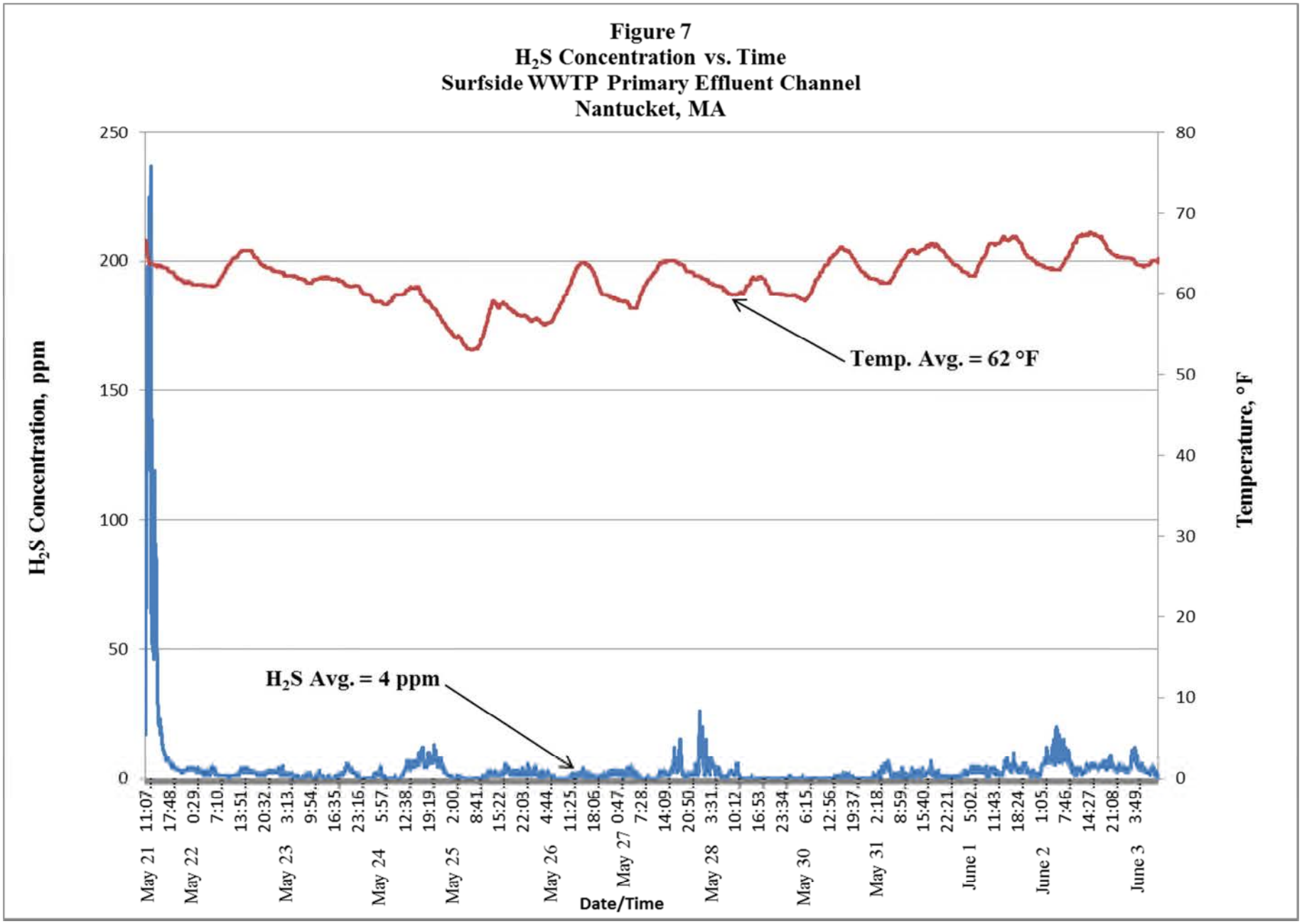


Figure 7
H2S Concentration vs. Time
Surfside WWTP Primary Effluent Channel
Nantucket, MA
H2S Concentration, ppm
Temperature, °F
Temp. Avg. = 62 °F
H2S Avg. = 4 ppm
Date/Time
May 21
May 22
May 23
May 24
May 25
May 26
May 27
May 28
May 30
May 31
June 1
June 2
June 3

Although the primary clarifiers show little obvious corrosion damage, the concrete is considered to be at risk for corrosion due to the presence of sulfide in the wastewater.

Miscellaneous Locations

Grab samples of wastewater were collected and analyzed from the Airport PS, the sludge decant line, and the filtrate from the rotary sludge press. The press filtrate had a sulfide content of 3 mg/L, with low pH of 5.4 and ORP of -145 mV. Although the sulfide level is relatively high, the flow rate of filtrate is very low compared to the influent flow. The rotary press filtrate is not considered a significant contributor of sulfide to the plant headworks. The sludge holding tank decant line showed a sulfide concentration of only 0.2 mg/L, and is not a major source of sulfide.

Headworks Air Flow Measurements

Poor ventilation of enclosed spaces can often exacerbate hydrogen sulfide corrosion by allowing build-up of high, corrosive concentrations of $H_2S$ gas. Although ventilation alone is unlikely to prevent corrosion, it is recommended in order to control headspace $H_2S$ concentrations.

Two 4-inch diameter ducts serve the headworks. Air flow measurements showed approximately 125 cfm in the northwest duct, and 70 cfm in the southeast duct, for a total of 195 cfm. Based on the volume of the headspace below the covers, this flow rate corresponds to an air exchange rate of 8 air changes per hour. The channels and grit chamber should be ventilated at a minimum of 300 cfm, which is the design air flow from the headworks (based on 12 air changes per hour)

# 4. EVALUATION OF SULFIDE CONTROL ALTERNATIVES

## 4.1 Overview

Testing at the Nantucket WWTF showed relatively high levels of sulfide attributed to the 20-inch force main(s) from Sea St. Pump Station. The headworks of the plant exhibits severe corrosion.

Although there is no apparent corrosion damage to the primary clarifiers, sufficient levels of headspace $H_2S$ exist to put the concrete tanks at risk for accelerated corrosion. Concrete pH at the effluent channel was 3. For this reason, efforts are focused on reducing the sulfide in the wastewater entering the plant as a means to control corrosion due to hydrogen sulfide.

There are a number of chemicals that can be added to wastewater to oxidize, precipitate, or prevent the formation of sulfide. These are summarized in Table 4.

Special considerations for any chemical used on the island of Nantucket include the following:

1. The cost of transportation to the island
2. Safety of the chemical (hazardous vs. non-hazardous)
3. Availability of access for chemical delivery and bulk storage

Because the force main from Sea St. Pump Station generates the vast majority of sulfide entering the plant, most likely a sulfide control chemical would be added at Sea St. PS in order to control formation in the main.

There are several options listed in Table 4 that are *not* considered viable for this application. These are discussed below:

<u>Hydrogen peroxide and potassium permanganate</u> - These chemicals are only effective for removing existing sulfide, not preventing its formation. Hydrogen peroxide is too costly to be used as a source of oxygen to prevent sulfide generation. The chemicals would have to be added about 10 to 20 minutes flow time upstream of the WWTF at a remote chemical feed station. The chemicals are hazardous.

<u>Air injection</u>- The detention time in the force main is too long to make air injection a viable alternative. Unless air were to be injected at multiple locations along the force main, it would be impossible to maintain aerobic conditions and prevent sulfide formation, particularly during low-flow periods.

**TABLE 4**

**OVERVIEW OF HYDROGEN SULFIDE CONTROL TECHNIQUES**

| Technique | Frequency of Use | Advantages | Disadvantages |
|---|---|---|---|
| I. OXIDATION | | | |
| Air injection | Low | Low cost, adds DO to wastewater to prevent sulfide generation | Applicable only to force mains; potential for air binding; limited rate of $O_2$ transfer |
| Oxygen injection | Low | 5 times solubility of air; high DO possible; economical for force mains | Applicable only to force mains; requires on-site generation or purchase as liquid $O_2$ |
| Hydrogen peroxide | Medium | Effective for sulfide control in gravity sewers or force mains; simple installation | Costs can be high to achieve low (<0.5 mg/L) sulfide; safety |
| Sodium hypochlorite | High | Applicable to gravity sewers or force mains; effective for broad range of odorants | Safety considerations; high chemical costs |
| Potassium permanganate | Medium | Effective, powerful oxidant; good for sludge handling applications | High cost, difficult to handle |
| II. PRECIPITATION | | | |
| Iron salts | High | Economical for sulfide control in gravity sewers or force mains | Does not control non-$H_2S$ odors; sulfide control to low levels may be difficult; increased sludge production |
| III. pH ELEVATION | | | |
| Sodium hydroxide (shock dosing) | Medium | Intermittent application; simple, little equipment required | Does not provide consistent control; safety considerations |
| Magnesium hydroxide | Low | Maintains pH at 8–8.5; adds alkalinity; economical for high (>5 mg/L) sulfide levels; safe | Requires mixer to maintain slurry in suspension; cost is independent of sulfide concentration |
| IV. PREVENTION | | | |
| Nitrate formulations | High | Can be used to prevent sulfide generation or oxidize sulfide in gravity sewers and force mains; safe to handle | Dosages vary depending on use: prevention vs. removal |
| Anthraquinones | Low | Prevents sulfide generation biochemically by disrupting sulfur cycle | Not well developed; results inconsistent and difficult to predict |

Sodium hypochlorite - Sodium hypochlorite is a powerful disinfectant that can be dosed into a force main to prevent the bacteria from producing sulfide. However, the chemical is hazardous, and a bulk storage tank of a hazardous chemical at the Sea St. Pump Station is likely to meet with resistance from neighbors. However, the plant receives sodium hypochlorite in bulk.

Ferrous chloride - Ferrous chloride is a corrosive chemical that causes the sulfide to be precipitated as a solid, preventing release of hydrogen sulfide gas. It is a hazardous chemical with a pH of <2 and storage of this material at the Sea St. PS is not considered appropriate.

The following alternatives are considered for further evaluation because of their proven effectiveness and non-hazardous nature:

1. Oxygen injection
2. Nitrate addition
3. Magnesium hydroxide addition

For comparison purposes, sodium hypochlorite was included in the analysis because the plant currently purchases bulk chemical for use in the chemical scrubber odor control system. The four alternatives are discussed below.

1. Oxygen Injection

Because pure oxygen is five times more soluble in water than air, it is possible to achieve higher DO levels in sewage by injecting pure oxygen instead of air. Pure oxygen may therefore be a more effective method of sulfide control for cases where the total oxygen requirement exceeds that which can be transferred using air injection. Use of pure oxygen as a sulfide control measure is particularly advantageous in pressurized systems (force mains) because dissolution of oxygen is greater at higher pressures. Since less oxygen gas is required than air to achieve the desired DO levels, the potential for gas pocket generation in force mains is substantially reduced. The initial oxygen dosage is dependent on the oxygen uptake rate of the wastewater, the uptake

by the slime layer, the detention time in the force main, and the concentration of dissolved sulfide.

Pure oxygen systems historically have included a liquid oxygen storage vessel, vaporizer, pressure regulator, oxygen feed and injection systems, and a control system. The oxygen storage vessel, vaporizer, and pressure regulator are normally leased from an oxygen supplier. Within the past 15 years, small, skid-mounted on-site oxygen generation systems using pressure swing absorption (PSA) or vacuum swing absorption (VSA) technology have become available at relatively low cost, making on-site generation attractive for pump station applications. Oxygen can be injected: 1) in a pressurized side stream that is mixed with the main flow, 2) through a U-tube oxygen dissolver that increases dissolution of oxygen under pressure created by the raw sewage pumps, or 3) directly into a force main at the pump discharge. A proprietary sidestream oxygen dissolver is now being marketed for sulfide control in force mains. It can use atmospheric air or oxygen from an on-site PSA/VSA unit. These systems have an excellent track record for preventing sulfide formation in force mains.

2. Nitrate addition

Use of sodium nitrate and formulations containing nitrate and nitrite have been successfully used for sulfide control. The presence of nitrate suppresses sulfide generation because anaerobic bacteria preferentially use the nitrate ion before sulfate as a source of oxygen. In addition, nitrate promotes the biological oxidation of sulfide if sulfide is already present.

Use of nitrate has become very popular for sulfide control applications. At the proper dosage, it can be effective for both preventing sulfide generation and removing existing sulfide. The theoretical dosage for prevention is 9.3 lb $NO_3$ per lb sulfide, and for oxidation, 3.1 lb $NO_3$ per lb sulfide. For the proprietary calcium nitrate product Bioxide™, this translates into *theoretical* chemical requirements of 2.1 gal/lb S and 0.7 gal/lb S, respectively. One advantage that is at least partially responsible for its popularity is the non-hazardous nature of the chemical. Equipment typically consists of a bulk storage tank, metering pumps, and a timer to step up the dosage rate during times of peak diurnal sulfide concentrations.

3. Magnesium hydroxide addition

A chemical that is relatively new to the odor/corrosion control market is magnesium hydroxide. A magnesium hydroxide slurry (approximately 58% $Mg(OH_2)$ is added to the wastewater to achieve a pH of about 8.5. This shifts the hydrogen sulfide equilibrium from dissolved hydrogen sulfide gas (which is easily stripped from solution) to hydrosulfide ion, which cannot be released. The dosage required to achieve pH 8.5 is a function of the pH and alkalinity of the wastewater and is independent of the sulfide concentration. Dosages of $Mg(OH)_2$ solution typically range from 50 to 100 gal per million gallons of wastewater. According to one vendor, it is more economical than other chemicals when the sulfide levels approach 5 mg/L. For long force mains with long detention times, use of magnesium hydroxide may be an economical solution to sulfide control. Equipment consists of a storage tank with a mixer to maintain the slurry in suspension, and a metering pump, preferably flow-paced. Magnesium hydroxide (milk of magnesia) is non-corrosive and safe to handle.

4. Sodium hypochlorite injection

Chlorine will oxidize sulfide to sulfate or to elemental sulfur, depending on pH. It is typically added at a dosage rate of 10 to 15 lb $Cl_2$ per lb $H_2S$ removed. The stoichiometric weight ratio is 8.9:1 to oxidize sulfide to sulfate according to the following reaction:

$$4Cl_2 + HS^- + 4H_2O \rightarrow SO_4^{2-} + 9H^+ + 8Cl^-$$

However, observed dosage ratios for force main applications may be as low as 5:1, possibly due to a disinfection effect on the slime layer. This has been observed by Bowker & Associates as well as other practitioners. Chlorine is typically added as an aqueous solution (sodium hypochlorite) due to safety concerns of storing and feeding gaseous chlorine, particularly in residential or commercial areas. Sodium hypochlorite is a hazardous chemical, and must be handled accordingly.

### 4.2 Economic evaluation

Table 5 is a comparison of the daily cost of various chemicals that could be added at the Sea Street Pump Station to control sulfide generation. These estimates are based on measured sulfide loadings in May 2013, field experience with dosage rates, and vendor quotes for chemical delivered to Nantucket. It is likely that during winter months, chemical requirements would be reduced below the estimated dosages due to colder wastewater temperature. However, it is also possible that dosages could exceed the estimates during peak summer months of July, August, and September.

The table shows oxygen to have the lowest daily cost of any of the chemical control alternatives, with a daily cost that is 75 percent lower than other chemicals, even when using a relatively high unit oxygen cost of $0.10/lb. However, the equipment necessary to generate and dissolve the oxygen is considerably more expensive that a simple chemical storage tank and metering system. After oxygen, the least expensive chemical is sodium hypochlorite at a projected cost of $195/day, followed by magnesium hydroxide and calcium nitrate.

Table 6 is an economic analysis of oxygen injection vs. chemical addition for the Sea Street force main. As can be seen, the capital cost for the oxygen system is significantly greater than the capital cost of the chemical metering system. However, the low operating cost for oxygen results in an annualized cost that is approximately 30% lower than the chemical addition system. Therefore, oxygen injection represents the most cost-effective and reliable long-term strategy for controlling hydrogen sulfide corrosion at the Surfside WWTF.

At the current price of $1.30/gal for bulk purchases of sodium hypochlorite, this chemical is competitive with other sulfide control chemicals, and appears to be the lowest cost chemical. Daily usage is estimated to be 150 gal/day, equating to a daily cost of about $200/day, or nearly $75,000/yr. According to plant staff, the town has the capability to transfer bleach from the bulk storage tank at the Surfside WWTF to a smaller tank located at the Sea St. PS. Disadvantages of sodium hypochlorite include 1) it is a hazardous chemical, requiring proper safety equipment and procedures when handling, and 2) overdosing could cause a biological upset at the plant.

**TABLE 5**

**DAILY OPERATING COST OF SCREENED SULFIDE CONTROL ALTERNATIVES**
**- Nantucket, MA –**

| Chemical | Dosage Basis | Chemical Consumption[1] | Unit Price | Daily Cost[1] |
|---|---|---|---|---|
| Calcium nitrate (Bioxide™) | 3 gal/lb S | 100 gal/d | $3.35/gal | $335 |
| | | | | |
| Magnesium Hydroxide | 100 gal per Million | 100 gal/d | $2.05/gal | $265 |
| | | | | |
| Oxygen | 10 mg/L-hr uptake rate | 700 lb/d | $0.10/lb | $70 |
| | | | | |
| Sodium hypochlorite | 5 lb $Cl_2$ per lb S | 150 gal/d | $1.30/gal | $195 |

[1] Daily chemical consumption will vary depending on seasonal wastewater temperatures, flow rate, and BOD. Estimates reflect sulfide loadings measured in May, 2014.

**TABLE 6**

**ECONOMIC ANALYSIS OF**
**OXYGEN INJECTION VS. CHEMICAL ADDITION**
**- Nantucket, MA -**

| | **Oxygen Injection** | **Chemical Addition[1]** |
|---|---|---|
| **CAPITAL COST, $** | | |
| 1. Site work/mobiliz. | $ 10,000 | $ 10,000 |
| 2. Equipment | 270,000 | 25,000 |
| 3. Installation | 81,000 | 20,000 |
| 4. Eng'r'g. & conting. @ 35% | 126,000 | 19,000 |
| | | |
| Total Capital Cost | $489,000 | $ 74,000 |
| **O & M COST, $/yr** | | |
| 1. Chemicals | -- | $ 73,000/yr |
| 2. Power @ $0.12/kwh | $ 15,000 | 200 |
| 3. Maintenance | 2,500 | 1,000 |
| | | |
| Total O & M Cost | $ 17,500/yr | $74,200/yr |
| **ANNUALIZED COST** | | |
| 1. Annualized capital (20 yr @ 5%) | $ 39,200 | $ 5,900 |
| 2. O & M | 17,500 | 74,200 |
| | | |
| Total Annualized Cost | $ 56,700/yr | $ 80,100/yr |

[1] Chemical is assumed to be sodium hypochlorite for this analysis

Sodium hypochlorite dosage should be flow-paced to prevent overdosing and to maintain the necessary concentration to control sulfide generation.

## 5. CONCLUSIONS AND RECOMMENDATIONS

Based on analysis of data collected from the Nantucket collection system and Surfside WWTP, and the evaluation of alternatives to control hydrogen sulfide corrosion, the following conclusions and recommendations are presented.

### 5.1 Conclusions

1. The Surfside WWTP in Nantucket, MA has experienced severe corrosion of the headworks due to the presence of hydrogen sulfide.

2. Although the primary clarifiers do not exhibit obvious symptoms of hydrogen sulfide corrosion damage, the concrete is at risk for corrosion.

3. The majority of the sulfide entering the Surfside WWTF is formed in the force main from the Sea Street Pump Station, which is responsible for about 70 percent of the flow entering the plant. It was not possible to sample the other contributing force mains, since they manifold into the force main from Sea St.

4. Sulfide concentrations in the wastewater entering the plant were measured at 1 to 4 mg/L. Headspace $H_2S$ levels at the headworks averaged 36 ppm, which are very corrosive concentrations. Concrete pH was 2.

5. Although some hydrogen sulfide is returned to the headworks in the rotary press filtrate, the contribution is very low compared to that from the Sea Street force main.

6. Hydrogen sulfide headspace concentrations were low in the wet wells of Sea St. PS, Surfside PS and South Valley PS. There is little evidence of hydrogen sulfide corrosion at these locations.

### 5.2 Recommendations

1. The headworks should be rehabilitated by high-pressure, water-blast cleaning of the concrete, removal of corrosion products, and application of a high-build, amine-cured epoxy that is resistant to attack by hydrogen sulfide and sulfuric acid.

2. The Town should conduct a trial injecting sodium hypochlorite at Sea St. to control sulfide generation in the force main. Effectiveness should be determined by monitoring headspace $H_2S$ at the headworks and measuring influent sulfide and chlorine residual in the wastewater.

3. If successful, bleach addition at Sea St. could be implemented as an interim solution to the hydrogen sulfide problem. The cost to control sulfide using bleach is estimated at $73,000/yr.

4. The Town should plan to implement a sidestream oxygen injection system as a permanent solution to corrosion and odor problems at the headworks. This will also ensure protection of the concrete in the primary clarifiers. The estimated capital cost of the system is $489,000, with annual O & M costs projected at $17, 500/yr.

5. The Town should collect and analyze influent WWTP samples for sulfide on a weekly basis, *year-round*, so that a data base can be developed. Currently, there is no information on sulfide loadings during winter months. Weekly samples should be collected at the same time (approx. 10 AM) and analyzed using the sulfide test kit provided to the Town.

6. The Town should consider purchasing a datalogging $H_2S$ analyzer for monitoring $H_2S$ concentrations in the headspace of the covered headworks and/or primary clarifiers. $H_2S$ levels should be monitored for one week per month for one year to document how levels fluctuate with seasons. The cost of a datalogging $H_2S$ analyzer is approximately $1,500.

7. Air flow rates in the two 4-inch air ducts from the headworks should be increased to a minimum of 150 cfm each. An air flow rate of 300 cfm will ventilate the covered space at 12 air changes per hour. It may be possible to adjust other dampers to increase the air flow, which is currently less than 200 cfm total.

# APPENDIX A:

## SAMPLING DATA

**TABLE A-1**

**LIQUID SAMPLING DATA**
**NANTUCKET PUMP STATIONS AND WWTP**
**May 21, 2013**

| Location | Time | pH, s.u. | ORP, mV | Temp, °C | Total Sulfide mg/L |
|---|---|---|---|---|---|
| Sea St. PS | 9:30 | 7.1 | -75 | 16.8 | 0.0 |
| South Valley PS | 10:40 | 8.2 | -79 | 19.7 | 0.0 |
| Surfside PS | 11:25 | 7.9 | -165 | 20.3 | 0.2 |
| Airport PS | 11:05 | 8.3 | +64 | 19.8 | 0.0 |
| Surfside WWTP | 11:50 | 7.3 | -245 | 19.8 | 2.5 |
| Sludge tank decant | 1:40 | 7.2 | -150 | 19.9 | 0.2 |
| | | | | | |
| Sea St. PS | 2:15 | 7.1 | -70 | 20.7 | 0.0 |
| South Valley PS | 3:00 | 7.6 | -145 | 19.3 | 0.0 |
| Surfside PS | 3:30 | 8.0 | -120 | 19.8 | 0.1 |
| Surfside WWTP | 3:50 | 6.8 | -260 | 18.4 | 2.0 |
| | | | | | |

**TABLE A-2**

**LIQUID SAMPLING DATA**
**NANTUCKET PUMP STATIONS AND WWTP**
**May 22, 2013**

| Location | Time | pH, s.u. | ORP, mV | Temp, °C | Total Sulfide mg/L |
|---|---|---|---|---|---|
| Sea St. PS | 8:40 | 7.2 | -95 | 15.4 | 0.0 |
| Surfside PS | 9:10 | 8.2 | -65 | 18.4 | 0.0 |
| South Valley PS | 9:30 | 8.5 | -155 | 17.6 | 0.0 |
| Surfside WWTP | 10:10 | 6.3 | -220 | 18.0 | 4.0 |
| | | | | | |
| Primary effluent channel | 11:10 | 6.7 | -210 | 17.8 | 2.0 |
| Rotary press filtrate | 11:55 | 5.4 | -145 | 18.1 | 3.0 |
| | | | | | |
| Sea St. PS | 1:20 | 7.1 | -110 | 18.8 | 0.0 |
| South Valley PS | 2:20 | 7.8 | -130 | 19.3 | 0.0 |
| Surfside PS | 2:45 | 8.2 | -120 | 18.4 | 0.0 |
| Surfside WWTP | 3:30 | 6.9 | -155 | 18.0 | 0.8 |
| | | | | | |

**TABLE A-3**

**LIQUID SAMPLING DATA**
**NANTUCKET PUMP STATIONS AND WWTP**
**May 23, 2013**

| Location | Time | pH, s.u. | ORP, mV | Temp, °C | Total Sulfide mg/L |
|---|---|---|---|---|---|
| Sea St. PS | 8:15 | 7.2 | -65 | 16.9 | 0.0 |
| So. Valley PS | 8:45 | 8.4 | -50 | 18.7 | 0.0 |
| Surfside PS | 9:30 | 8.2 | -140 | 19.8 | 0.0 |
| Surfside WWTP | 11:00 | 7.2 | -240 | 18.8 | 2.0 |
| Primary effluent | 12:10 | 7.0 | -70 | 18.9 | 0.0 |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

# APPENDIX B:

## OXYGEN INJECTION PROPOSAL

**Odor and Corrosion Control**

**By**
**SuperOxygenation**

**Nantucket, MA**
**Sea St. Pump Station**

**July 1st , 2013**

July 1, 2013

**Bob Bowker**
**Bowker and Associates**
**Portland, ME**

**PROJECT: Nantucket, Sea St. PS and FM**

**Dear Bob:**

$ECO_2$ is pleased to provide you with a design and proposal for a SuperOxygenation System that will raise the D.O. level in the Sea Street force main to prevent anaerobic conditions and the formation of sulfides. Assuming 47psi of pressure under continuous VFD operation, the D.O. in the discharge of the $ECO_2$ Cone can be raised to 114mg/L. At an oxygen uptake rate (OUR) of 10mg/L/hr, this will maintain aerobic conditions for approximately 11 hours, sufficient for treatment of the old force main and only a couple of hours short for low winter flows in the new force main.
It may be possible that the oxygen uptake rate during the winter is lower than 10mg/L/hr, which would extend the reach of the D.O. level. Typically, sulfide production is down during the winter months and often receptors aren't as sensitive during the winter months (fewer people that are mainly inside).

The $ECO_2$ System would be able to reliably prevent sulfide formation and the associated odors and corrosion, during the higher flows during the summer months and for most of the time during the winter months.

We thank you for the opportunity to provide a proposal. Please contact us with any questions you may have. We look forward to working with you on this project.

Best regards,

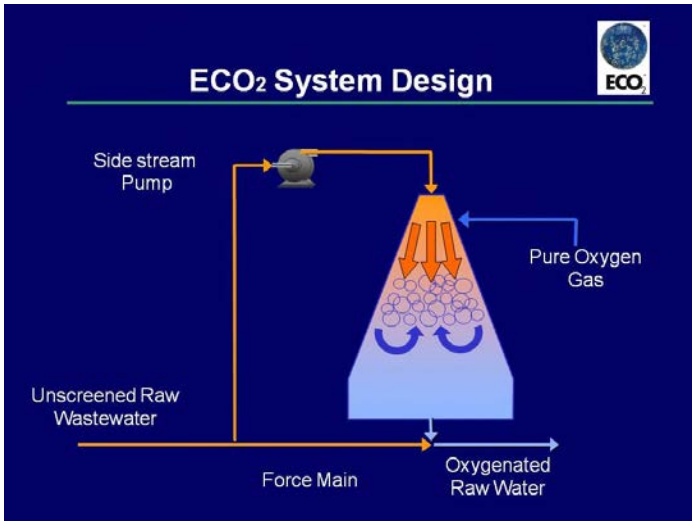
*Inken Mello*

Inken Mello
Director of Sales & Marketing
**Eco Oxygen Technologies, LLC**
Phone: 858-272-7102
e-mail: imello@eco2tech.com

## I. $ECO_2$ SYSTEM DESCRIPTION

### $ECO_2$ System Design

$ECO_2$'s technology is based on Henry's Law and works by trapping pure oxygen bubbles inside the $ECO_2$ cone until they are dissolved. The system operates by pumping a side stream of water through a conical shaped oxygen transfer reactor, also known as the Speece Cone. Gaseous oxygen is fed into the cone and broken up into an intense bubble swarm by the velocity of the wastewater. The cone shape design provides sufficient contact time for the oxygen to fully dissolve in the water. The cone achieves an average oxygen transfer efficiency of 95%.




### Odor Control with $ECO_2$

Sulfides are produced by Sulfate Reducing Bacteria only under anaerobic conditions in a sewer. By adding a sufficient amount of D.O. to the sewer, the $ECO_2$ System maintains aerobic conditions and with this, PREVENTS the formation of sulfides and $H_2S$ in the sewer. The results are consistently near non-detect levels of $H_2S$ at the discharge of the force main.

### Corrosion Control with $ECO_2$

When gaseous $H_2S$ reaches the surface of the sewer infrastructure, Thiobacillus thiooxidans bacteria oxidize $H_2S$ to sulfuric acid ($H_2SO_4$), which quickly and tenaciously corrodes concrete and steel. According to the ASCE Manual for manhole rehab, $H_2S$ concentrations of 20ppm corrode concrete at a rate of 1 inch per 5 years.
It is therefore crucially important to not just reduce sulfide concentrations, but to eliminate the formation of sulfides, in order to achieve effective corrosion control.

## II. $ECO_2$ BASIS OF DESIGN

The design is based on data provided by you as outlined in the table below. The design accounts for 1mg/L existing sulfides in the wastewater, an oxygen uptake rate of 10mg/L/hr and a slightly positive DO at the discharge.

| **Force Main** | **Sea St. PS** |
|---|---|
| Average Flow (gpm) | 350 |
| Force Main Length (ft) | 21,000 |
| Force Main Diameter (inches) | 18 |
| Static Head- assumed (ft of head) | 80 |
| TDH (ft of head) | 108 |
| Fill/Draw or Continuous Operation | Continuous |
| Maximum HRT (hrs) | 11 |
| Existing Dissolved Sulfides (mg/L) | 1 |
| **Required amount of $O_2$ per day (lbs/day)** | **700** |
| $ECO_2$ System Size (ft dia.) | 3 |
| Flow Rate through $ECO_2$ System (gpm) | 450 |
| HP of side stream pump (HP) | 7 |

**<u>$ECO_2$ System Construction</u>**

The $ECO_2$ System consists of a hollow, stainless steel cone with no internal mixers, baffles or moving parts. The influent and effluent pipes are a minimum of 4'' diameter, capable of passing dirty wastewater without clogging. The dish-shaped bottom with the discharge pipe at the low point provides for a self-cleaning device with no need for maintenance.

**The $ECO_2$ System has a life expectancy of 20+ years.** The oxygen feed is fully automated. The only moving part is the side stream pump that requires standard maintenance.

## III. $ECO_2$ PROPOSAL

### Capital Cost

The Sea St. Force Main requires a 3ft diameter $ECO_2$ System to add the appropriate amount of oxygen to the force main. The system is equipped with a PLC controlled oxygen flow control system that fully automates the oxygen feed rate depending on the actual force main flow. A 10HP sidestream pump is required to pump a continuous sidestream through the $ECO_2$ System.

| **Capital Cost $ECO_2$ System** | **Sea St. PS** |
|---|---|
| **System includes:** | |
| $ECO_2$ System | 195,000 |
| PLC Oxygen Flow Control System | Incl. |
| Side Stream Pump (Estimate) | 10,000 |
| Oxygen Generator (Estimate) | 65,000 |
| **Total Capital Cost $ECO_2$ System** | **$270,000** |

Quote is valid for 90 days.

### Anticipated O&M Costs

The system operates a sidestream pump that requires standard maintenance. The electrical draw for the pump is 7HP (450gpm). The oxygen generator generates oxygen on demand. It is operated on a VFD and will automatically turn down when the demand is low, resulting in a very energy efficient operation.

| **Operating Cost $ECO_2$ System** | **Sea St. PS** |
|---|---|
| Side Stream Pumping (7 HP)* | 4,700 |
| Electricity for $O_2$ Generator ( 213 kWhr/day)* | 7,800 |
| O&M (20%) | 2.500 |
| **Annual O&M Cost $ECO_2$ System** | **$15,000** |

* Cost of power assumed at $0.10/kWhr

## IV. $ECO_2$ GUARANTEE

### Experience

$ECO_2$ has over 10 years of experience in the design, assembly, start-up and operation of SuperOxygenation Systems. $ECO_2$ brought the SuperOxygenation Technology to the wastewater market for odor and corrosion control with our first three systems installed in 2003. By now we have over 30 installations across the U.S. that are all running successfully. We're happy to share our installation list with you and have you talk to any of our clients.

### The $ECO_2$ Approach to Successful Installations

We have gained valuable experience in the design of our systems for various applications. Especially force main applications can get very complicated and the SuperOxygenation Technology is not always a technical fit. We recognize the limitations of our systems and share these with our clients before we get into a project. We will not waste your time or money with extended pilot tests or trial and error installations. If you receive a quote from us, we know that our design will work and we will guarantee our design.

### $ECO_2$ Performance Guarantee

$ECO_2$ will provide a Performance Guarantee based on the provided data. $ECO_2$ will provide performance monitoring until the system is dialed in and operating according to the design specifications.

## V. OXYGEN SOURCE

Oxygen can either be generated on-site or delivered to the site as liquid oxygen (LOX) by a local gas supplier. $ECO_2$ is available to help evaluate the various oxygen sources depending on site specifics and client preferences.

For this particular project, $ECO_2$ recommends a VSA On-Site Oxygen Generator.

**VSA On-Site Oxygen Generation**

$ECO_2$ has been successful working with PCI out of Riverside, CA using their vacuum swing adsorption (VSA) oxygen generators. VSA systems use a reversible blower system to generate oxygen at low pressure and then compress only the 21% of oxygen that have been removed from the air, as opposed to PSA oxygen generators that compress 100% of the air with an air compressor. VSA Systems are therefore much more energy efficient.

Furthermore, a VSA System employs fewer parts, making it a more reliable oxygen source than PSA Systems. A Spec Sheet of the proposed oxygen generator is attached to this proposal.

## VI. COMPETITIVE ADVANTAGES

**95% Transfer Efficiency**

Every $ECO_2$ System is tested for its transfer efficiency at start-up. The average transfer efficiency that has been documented on our systems is 95%. This is important because:

- Oxygen costs money, any oxygen that is not dissolved is wasted money.
- Systems with a lower transfer efficiency need to make up for it in size or they will not have the same results.

**No Bubbles**

The $ECO_2$ System dissolves the oxygen bubbles outside of the force main in the cone. The bubbles are trapped in the cone until they are dissolved. Basically no gaseous oxygen enters the force main. This is important because:

- Gaseous oxygen is not available to the microorganisms as an oxygen source
- Gaseous oxygen will rise to the crown of the pipe and create a potentially hazardous headspace in the sewer
- Gaseous oxygen is either lost through air release valves or may air lock the pipe or pumps.

**No small openings**

All openings on every $ECO_2$ System are a minimum of 4'' in diameter, capable of passing dirty wastewater without clogging. This is important because:

- A system with small openings such as nozzles or venturis is prone to clogging and is therefore not a reliable odor control technology
- Small openings will clog and require constant attention and maintenance, raising the O&M costs and wasting valuable man-power.
- Chopper or grinder pumps may alleviate the problem, but they add another piece of equipment to the maintenance cycle and require additional horse power. They are also designed to pass particles through the pump itself, not necessarily small openings downstream of the pump.

**10 Years of Experience**

$ECO_2$ has over 10 years of experience in the design, assembly, start-up and operation of SuperOxygenation Systems. $ECO_2$ brought the SuperOxygenation Technology to the wastewater market for odor and corrosion control with our first three systems installed in 2003. By now we have over 30 installations across the U.S. that are all running successfully. But don't take our word for it. Ask for our installation list and have our happy customers validate our claims.

## VII. TERMS & CONDITIONS

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Chelmsford, MA 01824
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978.905.2101 fax

# Memorandum

| | | | |
|---|---|---|---|
| To | Kara Buzanoski, DPW Director<br>Mohamed Nabulsi, DPW Assistant Director<br>Town of Nantucket, MA | Page | 1 |
| CC | File | | |
| Subject | Enhancements to the Surfside Wastewater Treatment Facility | | |
| From | Thomas E. Parece, P.E., Erik Meserve, P.E., Jarrod Trainor | | |
| Date | January 9, 2012 | | |

Table of Contents

1. Influent Screening ..... 3
1.1 Band Screen ..... 4
1.2 Inclined Screen ..... 6
1.3 Installation Location Options ..... 9
1.4 Evaluation ..... 18
2. Vacuum Truck Discharge Connection and Location ..... 20
3. Miscellaneous Items ..... 21

The Surfside Wastewater Treatment Facility (WWTF) is located on South Shore Road in the southwest region of Nantucket and has a design capacity of 3.5 million gallons per day (mgd). Upgrades to the Facility were completed in 2009. The facility has been operating very well since it went on-line, consistently meeting its effluent permit limits. The operations staff has identified several improvements that they feel may result in more efficient operations and/or result in better control flexibility on the performance of the facility.

Suggestions for operational enhancements offered by a plant's operations staff are typical after having several years of operational data and experience history. While improvements can make a difference in a plant's operations, many times they are not required for a facility to meet its effluent permit requirements.

DRAFT

These potential enhancements suggested by the Nantucket WWTF operating staff relate to the following processes and areas of the facility:

- Influent Screening
- Vacuum Truck Discharge Connection and Location
- Miscellaneous Items

This memorandum summarizes AECOM's evaluation and recommendations for these potential improvements.

## 1. INFLUENT SCREENING

The Surfside WWTF uses a GE/Zenon membrane bioreactor (MBR) system to produce high quality effluent. The lifespan and successful operation of MBRs is highly dependent on having a certain quality of wastewater in contact with the membrane surfaces. One item of concern can be so called “stringy” material being present in the wastewater and in contact with the membranes. Too much of this material can cause excessive fouling or breakage of the membranes. Currently, influent at the Surfside WWTF passes through an in-channel grinder in the Headworks, followed by a Parshall flume, an aerated grit chamber, primary clarifiers, pre-anoxic tanks and aeration tanks prior to the membrane bioreactors. In case of grinder failure, there is a bypass channel equipped with a manually cleaned bar rack. This design was reviewed, approved and accepted by GE/Zenon based on the fact that the facility has primary clarifiers and that the primary clarifiers will be operating and maintained in good operating condition. The primary clarifiers are intended to function to remove objectionable materials prior to the membranes. Many MBR facilities are not equipped with primary clarifiers and instead have a screening process. Currently a 10 year warranty for the membrane bioreactors which began upon facility startup is still in effect.

Under the current operating conditions, the facility has continued to meet the requirements of its groundwater discharge permit. However, the operators at the Surfside WWTF have noted some buildup of stringy material such as hair, mop strings and rags on the membrane bioreactor cassettes. This buildup has caused some concern with the operating staff who requested a review of the influent screening options available to minimize the fouling of the membranes.

The concern of the staff regarding fibrous material fouling the membrane bioreactors coupled with the recent failure of the in-channel grinder located at the Headworks has made replacement of the in-channel grinder a viable consideration. Replacing the grinder with a screening system is not required but could improve the removal of “stringy” material prior to the clarifiers. Modifications to the existing Headworks to include screening were considered as part of the upgrade project but were ruled out in an effort to minimize project costs.

A 2 mm screening technology would provide the amount of screening generally recommended by membrane manufacturers. Screen openings smaller than 2 mm generate too much head loss for use in this application and could remove excessive organic material necessary for downstream processes. The existing manual bar rack would be retained for operational flexibility.

Note that the manufacturers of the screening options generally recommend a washer/compactor be paired with the screens. The washer/compactor processes the screenings after they have been removed from the flow stream in order to wash them of organic material, reduce the volume of the material to be handled and disposed of, and to reduce odor generation potential, all as needed to comply with local disposal laws.

The following is a discussion of the various screening technology options. This discussion will first review the various types of screens and present uninstalled costs for each screening technology investigated. A discussion of possible methods of installation as well as conceptual drawings of the installations is presented thereafter, as different equipment may have different preferred locations for their successful operation and maintenance. Installed costs for each of these installation options are presented.

## 1.1 Band Screen

A band screen has a rotating band of panels oriented parallel to the flow. Wastewater enters the screen and flows left or right through the rotating panels. Screenings are captured and lifted to the discharge level by the rotation of the band of panels. Solids are washed into a sluice by a spray wash system. Three manufacturers were contacted to obtain design requirements and preliminary pricing: JWC Environmental, Ovivo USA and Headworks.

**JWC Environmental**

The JWC Environmental band screen is intended to function as an in-channel unit and therefore it could be installed in the space vacated by the in channel grinder. Refer to Figure 1 which illustrates a typical band screen from JWC Environmental. Attachment A is a brochure of a band screen as manufactured by JWC Environmental.

JWC Environmental indicated the band screen would fit in the 3.5 foot wide channel that exists in the Surfside WWTF Headworks and pass the Facility's peak flows of 7 mgd. However, based on the layout of the existing Headworks structure this would leave little room for the washer/compactor that is recommended by the manufacturer. In addition, AECOM strongly recommends that the equipment be installed in an enclosure for weather protection. JWC Environmental stated that coarse screening is not required ahead of such a system.

**Ovivo USA**

Ovivo USA markets band screens under the Brackett Green brand name. While they offer a screen that would fit in the 3.5 foot wide Headworks channel, this screen is only sized for a maximum flow of 3.5 mgd and is insufficient for Surfside's peak flows. In addition, Ovivo USA indicated that this system would require some form of coarse screening prior to the fine screen. Ovivo USA stated that it would be unwilling to warrantee its 2 mm screens unless they were installed after 6 mm coarse screening and grit removal. This limitation impacts the potential location for this band screen. AECOM strongly recommends that the equipment be installed in an enclosure for weather protection.

**Headworks**

The Headworks Eliminator band screen is similar in operation to the JWC Environmental and Ovivo USA band screens. A unit sized to pass Surfside's peak flows would not fit in the existing channel, as it requires eight feet of channel depth. The manufacturer indicated that coarse screening would not be required ahead of the screen based on a verbal description of the influent flow. Additionally, Headworks stated that the unit should not be installed in an outdoor location without weather protection.

Based on the information received, the equipment produced by the three manufacturers are similar in operation but different in capabilities. Whereas JWC Environmental indicated that their band screen could fit in the existing channel, pass the peak flow and did not require coarse screening, Ovivo USA and Headworks indicated that a band screen with the desired characteristics was not available. The reason why manufacturers of similar equipment would have such significant differences in their installation recommendations is not clear.

Table 1 summarizes the estimated uninstalled equipment costs for the three manufacturers.

**Table 1 - Band Screen Estimated Equipment Costs**

| | Manufacturer | | |
|---|---|---|---|
| Item | JWC Environmental | Ovivo USA | Headworks |
| Band Screen | $191,100 | $230,000 | $166,691 |
| Washer/Grinder | $65,500 | $54,500 | $66,099 |
| Freight and Field Services | $25,000 | $25,000 | $25,000 |
| Total Uninstalled Cost | $281,500 | $309,500 | $257,790 |

The installation of a band screen in the existing channel in place of the in-channel grinder would likely be limited to a single manufacturer due to the limitations discussed above. It is desirable that the design be structured such that multiple manufacturers could provide cost proposals and warranties that follow good engineering practice. Hence, AECOM cannot recommend installing a band screen in the existing channel in place of the in-channel grinder. However, a band screen

could be installed in another location or along with modifications to the existing channel as discussed in Section 1.3. Because the equipment costs for all three manufacturers are similar, the installation costs will likely be more important than equipment costs.

## 1.2 Inclined Screen

Inclined screens intercept flow with a rotating drum inserted into the flow at an angle. This is a flexible system as it can be installed in a channel or in a self contained tank with flanged connections. Flow passes through the drum leaving a screenings mat on the inside of the drum. When the upstream water level reaches a certain height, a cleaning cycle begins and screenings are removed by the combined action of a spray bar and brush. Screenings fall into a hopper and are conveyed by an inclined auger which transports, compacts and dewaters the screenings prior to dropping them into a container or integrated bagging system. This integrated screening, washing, and compacting system presents an advantage over the band screens, which require a two separate pieces of equipment to accomplish these steps. Huber Technology, Lakeside Equipment Corporation and Headworks were contacted to obtain design requirements and preliminary pricing for inclined screens.

### Huber Technology

Figure 2 illustrates a typical inclined screen installed in-channel and as manufactured by Huber Technology. Figure 3 illustrates a typical tank mounted design as manufactured by Huber Technology. The installation options available at the Surfside WWTF do not lend themselves to a tank mounted installation so this option is not discussed further. Attachment B is a brochure regarding the Huber Technology inclined screen.

**Figure 2 - Inclined Screen In-Channel Installation**

**Figure 3 - Inclined Screen In Tank Installation**

Huber Technology manufactures an inclined screen which would fit in the existing headworks channel in place of the existing in-channel grinder. However, it is unable to pass the design capacity flow of 3.5 mgd. Therefore modifications to the existing Headworks would have to be made in order for an inclined screen capable of handing Surfside's average and peak flows to be installed at that location. Specific modifications and conceptual layouts are presented in subsequent sections.

**Lakeside Equipment Corporation and Headworks**

Inclined screens are not exclusive to Huber Technology and could be bid competitively if specified. Headworks and Lakeside Equipment Corporation also manufacture inclined screens. The TurboDrum IN by Headworks and the RAPTOR 66RDS by Lakeside are very similar in size and design to the Huber Technology inclined screen with a 2 mm rotating screen and screenings washing, conveying, compacting and bagging integrated into the unit. Like the Huber Technology unit, equipment from Lakeside Equipment Corporation and Headworks would require modifications to the existing channel for installation.

Table 2 summarizes the estimated uninstalled equipment cost for inclined screens as provided by Huber Technology and Lakeside Equipment Corporation. A cost proposal from Headworks was not received.

**Table 2 - Inclined Screen Estimated Equipment Cost**

| Item | Manufacturer | |
|---|---|---|
| | Huber RPPS/1800/2 | Lakeside Raptor 66 RDS |
| Inclined Screen | $210,000 | $172,000 |
| Add for Trace Heating | $15,000 | $11,000 |
| Add for 316SS Construction | $35,000 | $14,000 |
| Estimated Total Uninstalled Cost with All Options | $260,000 | $197,000 |

The inclined screens reviewed have similar dimensions and flow capacities. Unfortunately, none are capable of meeting plant flows in the existing channel. However, an inclined screen could be installed in another location or along with modifications to the existing channel as discussed in Section 1.3. Because the equipment costs for all three manufacturers are similar, the installation costs will likely be more important than equipment costs.

## 1.3 Installation Location Options

Two major types of equipment — band screens and inclined screens — were evaluated above. However, the method of installation for selected equipment will have the most influence on cost of any factor. In increasing order of cost, the screening alternatives could be installed in the following ways: in the existing channel, in the channel of a modified Headworks, after the primary settling tanks, or in a completely new Headworks. This section will describe each of these installation options, present conceptual drawings of each installation option, provide estimated costs for design, construction and installation, and evaluate the various options. For comparison purposes, the price of re-installing a new grinder is also presented as this is a viable option that has proven to work successfully at the Surfside WWTF.

### In the Existing Channel

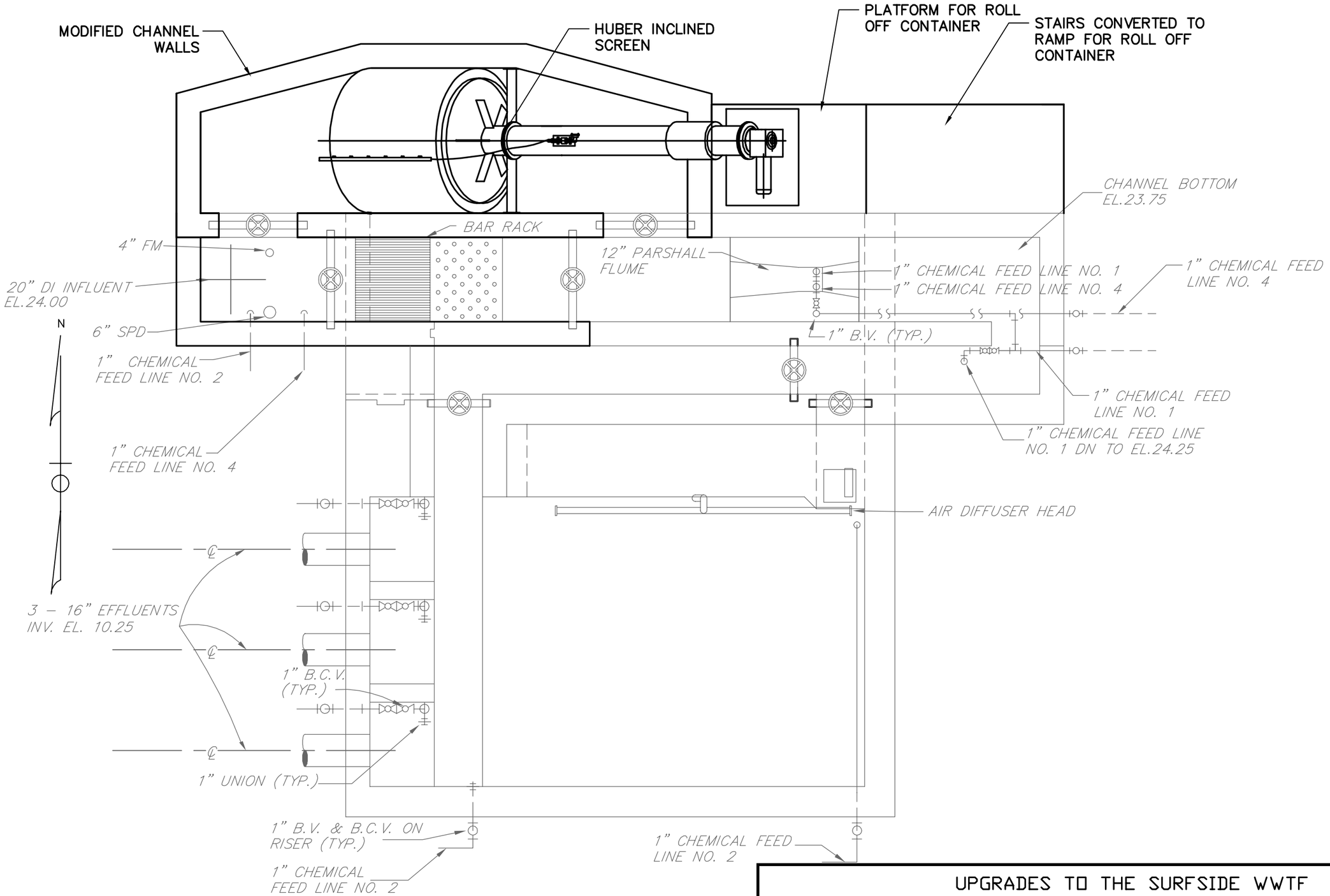
Installation of the screen in the existing channel would be the least expensive option after replacement of the existing grinder. However, there are limitations to this approach. As discussed under Section 1.1, AECOM does not recommend this approach because the number of screening options would be very limited. Only one of the three band screens would fit in the existing channel and have the ability to

process Surfside's peak flows. Because of the wide variation in flow capacity, AECOM cannot recommend this approach. Additionally, the Town may be required to sole source a product, which is undesirable from a regulatory and economic point of view. Lastly, the existing Headworks is not designed for screening and the associated solids handling. The personnel may find themselves working in tight quarters to maintain the equipment and remove the solids. Equipment such as the screenings washer/compactor may be located over the existing channel. A structural modification would have to be made to accommodate this setup and provide freeze protection to the screen, so it should be considered that even installation in the existing channel would require some design and construction.

**Modification of the Existing Headworks**

Modifying the existing Headworks channel is the next option in order of cost. For this option, the cost of the equipment and its installation would have to be considered, as well as the costs of demolition and construction. AECOM estimates this option to cost approximately $765,000. Refer to the detailed cost estimate attached to this memo. See Figure 4 for a conceptual drawing of a modified headworks installation using the Huber inclined screen. Each screening alternative type and brand would require slightly different modifications to the headworks. For the option presented, the 3.5 foot wide channel which presently houses the bar rack is shown expanded to the north to accommodate the 6 foot clearance required by the Huber Technology inclined screen. The cost breakdown described above is based on the concept presented in Figure 4, but other types and brands of screens would have slightly different costs associated.

Both of the above installation options (installation in the existing channel and modification of the existing headworks) feature direct screening of the influent wastewater with the 2 mm screen. This is a viable option because of Surfside's influent characteristics according to several manufacturers. Large objects such as planks or cobbles which can cause damage are not expected to flow into the headworks. In large installations where these issues do exist, a screen with larger openings (6 mm) as well as grit removal and/or primary settling is installed upstream of the 2 mm screen to extend the life of the equipment and reduce the risk of maintenance issues.




UPGRADES TO THE SURFSIDE WWTF

| | | | | |
|---|---|---|---|---|
| Title: **REVISED HEADWORKS OPTION** | | Date: **DEC. 2011** | Scale: **1/4"=1'** | FIG. 4 |
| Consultant: AECOM 701 EDGEWATER DRIVE WAKEFIELD, MA 01880 781.246.5200 | Des. by: **JCT** | Chk. by: **EM** | Prj Mgr: **TEP** | |

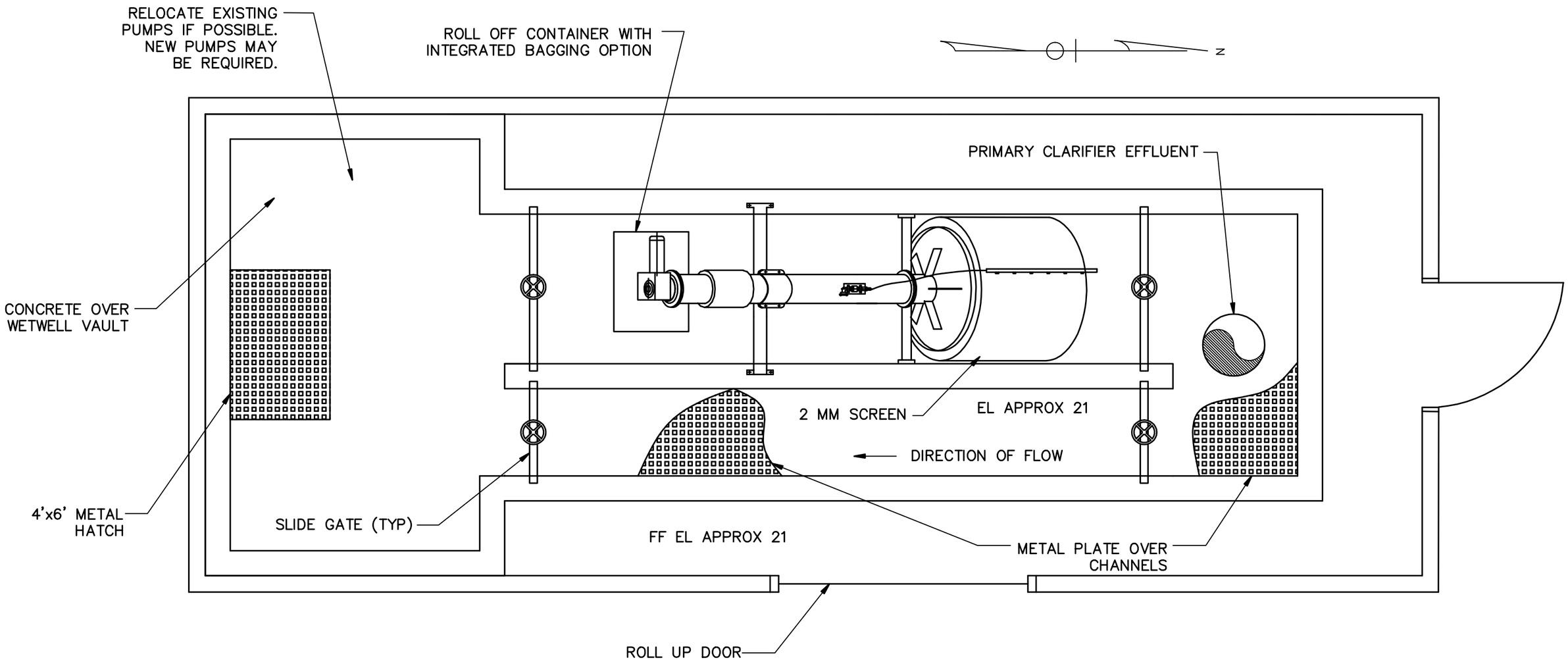
It should be noted that screens cause headloss in a flow stream, particularly when they are intercepting large amounts of solids. The headloss manifests itself as a backup of flow prior to the screen. It is estimated that the increase in water level would be approximately 1 to 2 feet upstream of the screen. For this reason AECOM recommends installation of the screen prior to the Parshall flume, as a backup of flow in the Parshall flume would cause it to give faulty readings. Considering this, the options of installation in the existing channel, in a modified headworks, or in a new Headworks would have little or no effect on the facility's hydraulics and only a minor impact on the Sea Street Pump Station.

**Post Primary Settling Tanks**

The next option in order of cost is installation of the screen after the Primary Settling Tanks. This option would have considerable impact on the hydraulics depending upon the type of screen utilized and location of the equipment. Currently, flow at the Surfside WWTF is by gravity up to the anoxic zone, where it is then pumped into the aeration tanks. Installing screens after the Primary Settling Tanks may require an additional pumping system to be installed to pump primary effluent through the screens and into the anoxic tanks.

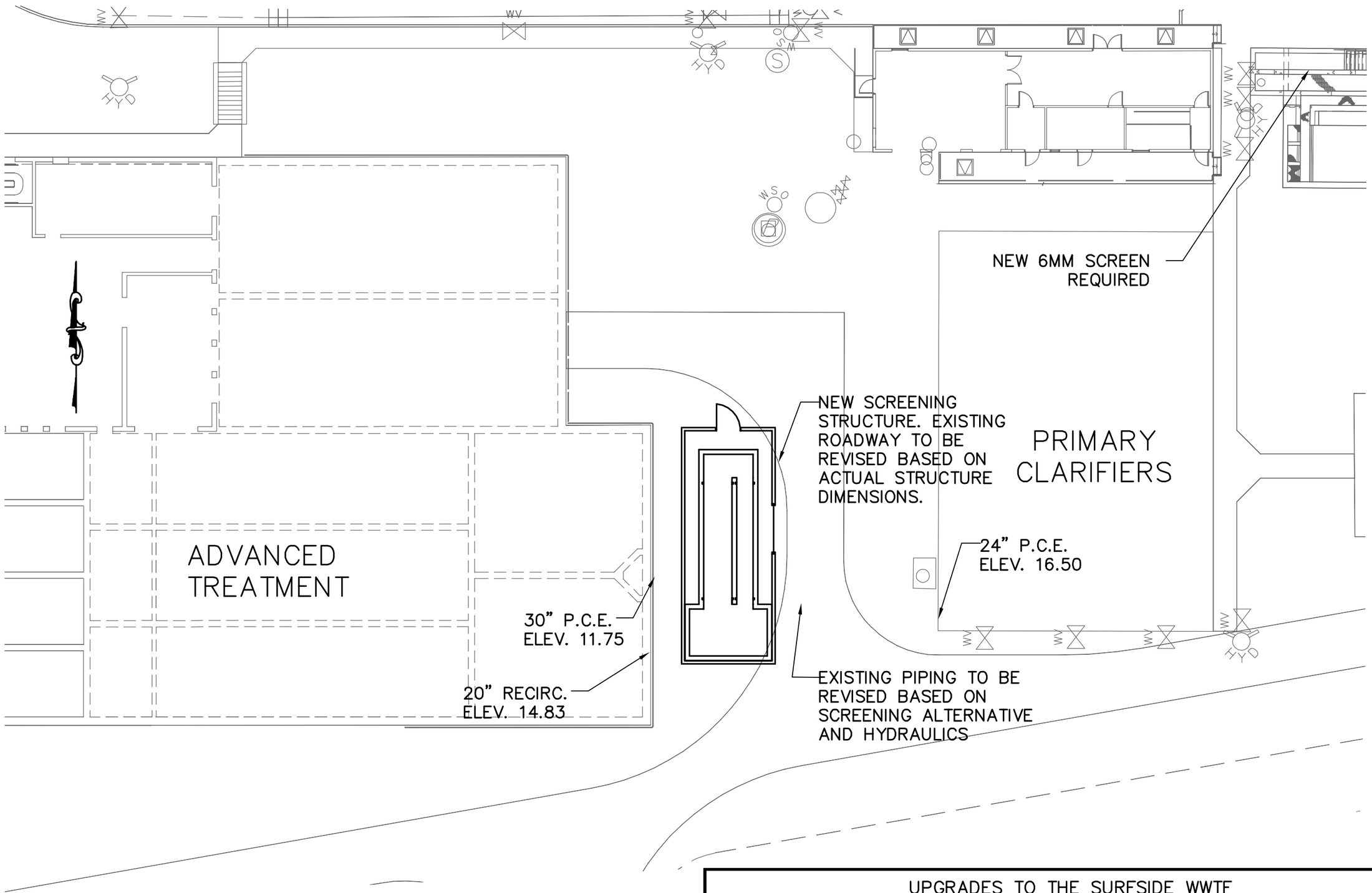
Installation after the primary settling tanks would be more expensive than either of the in-channel options. A new structure would be required, as well as new piping and a revised pumping system. The revised pumping system may feature relocation of the existing anoxic zone pumps or addition of new pumps. Note that the estimate of cost for this alternative assumes new pumps will not be required and the anoxic zone pumps can be relocated. A conceptual layout and conceptual site plan of this installation is presented in Figures 5 and 6.

Standard industry practice in this situation would include a 6 mm screen installed in the existing Headworks to prevent damage to the Aerated Grit or Primary Clarification processes. Note that installation of the 6 mm screen in the existing headworks would present similar technical difficulties to those previously discussed regarding installation of a screening option in the existing channel. The grinder is not recommended for the prescreening as it would grind material small enough to pass the 2 mm screen. A manual bar rack at the Headworks may be able to replace the need for a 6 mm screen however it would increase the time and effort by operations staff and increase the cost of screenings disposal due to the lack of compaction.




NOTE: 6 MM PRESCREENING REQUIRED IN EXISTING HEADWORKS.

| UPGRADES TO THE SURFSIDE WWTF | | | | |
|---|---|---|---|---|
| Title: POST PST OPTION | | Date: DEC. 2011 | Scale: 1/4"=1' | FIG. 5 |
| Consultant: AECOM 701 EDGEWATER DRIVE WAKEFIELD, MA 01880 781.246.5200 | Des. by: JCT | Chk. by: EM | Prj Mgr: TEP | |




UPGRADES TO THE SURFSIDE WWTF

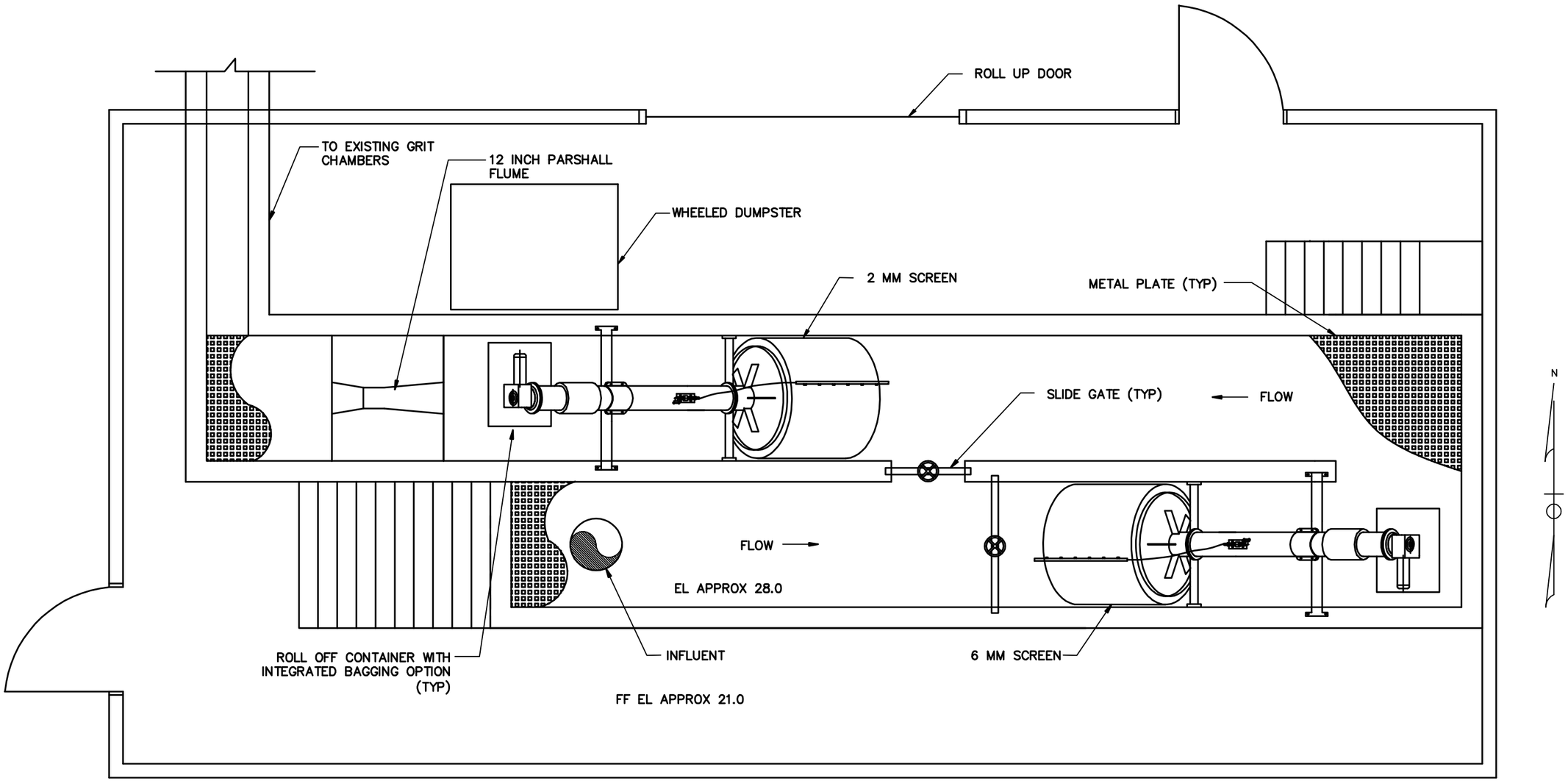
| | | | | |
|---|---|---|---|---|
| Title: **POST PST INSTALLATION OPTION** | | Date: **DEC. 2011** | Scale: **1"=20'** | FIG. 6 |
| Consultant: AECOM 701 EDGEWATER DRIVE WAKEFIELD , MA 01880 781.246.5200 | Des. by: **JCT** | Chk. by: **EM** | Prj Mgr: **TP** | |

The total cost for this alternative including the slab, shingled building, 2 mm screening equipment and 6 mm screening equipment is estimated to be about $2,200,000. Cost savings of approximately 5 percent could be realized by using a pre-engineered structure or shed roof if this would be approved by the Nantucket Historical Commission. Cost savings of approximately 20 percent could be realized by using a manual bar rack instead of a 6 mm screen. Refer to the detailed cost estimate attached to this memo.

**New Headworks**

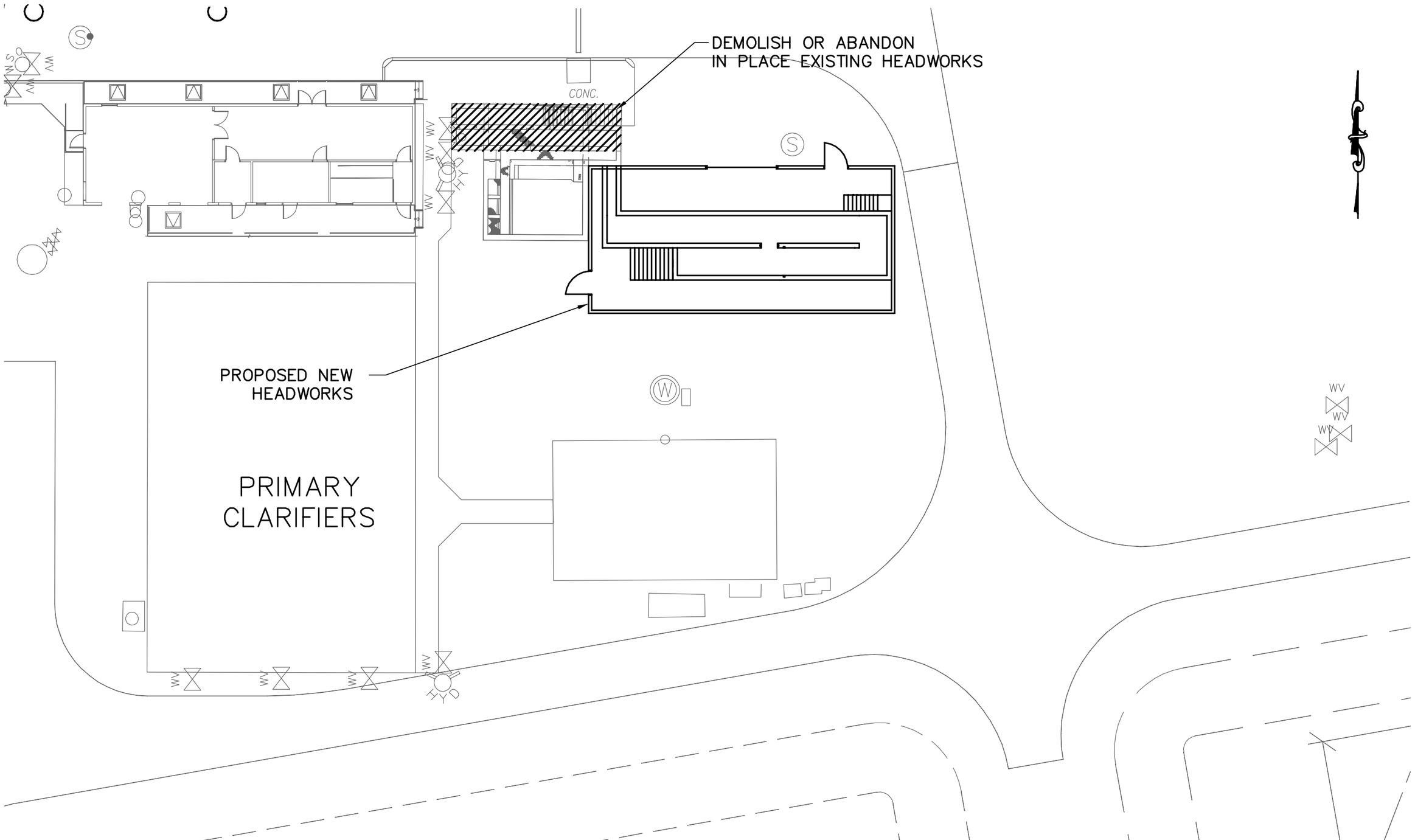
The most expensive option would be construction of an entirely new Headworks structure. While this option would be the most expensive, it would offer the most flexibility and convenience from an operations standpoint and minimize operations impacts during construction. The options considered previously are retrofits and involve installing equipment in locations not originally designed for such equipment. Compromises would be involved. A new Headworks gives the opportunity to provide a thoroughly engineered solution. A new Headworks, including demolition/disposal, new slab and channels, new brick and block structure, and the new screening equipment is estimated to be approximately $2,600,000. Refer to the detailed cost estimate attached to this memo.

The installation is conceptually illustrated in Figure 7. Note that it includes a 6 mm screen upstream of the 2 mm screen to minimize wear and tear on the fine screen. Cost savings of approximately 20 percent could be realized by eliminating the 6 mm screen and directly screening the sewage with the 2 mm screen although this arrangement would likely reduce the useful life of the 2 mm screen by several years. Figure 8 shows the proposed location of the new Headworks.




UPGRADES TO THE SURFSIDE WWTF

| | | | | |
|---|---|---|---|---|
| Title: NEW HEADWORKS LAYOUT | | Date: DEC. 2011 | Scale: 3/16"=1' | FIG. 7 |
| Consultant: AECOM 701 EDGEWATER DRIVE WAKEFIELD , MA 01880 781.246.5200 | Des. by: JCT | Chk. by: EM | Prj Mgr: TEP | |




| UPGRADES TO THE SURFSIDE WWTF | | | | |
|---|---|---|---|---|
| Title: **NEW HEADWORKS OPTION** | | Date: **DEC. 2011** | Scale: **1"=20'** | FIG. 8 |
| Consultant: AECOM 701 EDGEWATER DRIVE WAKEFIELD, MA 01880 781.246.5200 | Des. by: **JCT** | Chk. by: **EM** | Prj Mgr: **TP** | |

### 1.4 Evaluation

Table 3 presents a summary comparison of the equipment options discussed above. Table 4 presents a summary of the capital costs of the options evaluated above. Table 5 presents a summary of the qualitative pros and cons for these alternatives. In both tables, replacement of the grinder is presented as a comparison.

**Table 3 – Installation Option Summary Comparison**

| | Type of Modification | | | | | |
|---|---|---|---|---|---|---|
| | Grinder | Screen | | Location | | Building |
| Installation Option | | 2 mm | 6 mm | Existing | New | |
| Replace Existing Grinder | ● | | | ● | | |
| Modify Existing Headworks | | ● | | ● | | |
| Post PST | | ● | ● | ● | ● | ● |
| New Headworks | | ● | ● | | ● | ● |

**Table 4 – Capital Cost Comparison**

| | Replace Existing Grinder | Existing Headworks | Modified Headworks | Post Primary Settling Tanks | New Headworks |
|---|---|---|---|---|---|
| **Civil** | $0 | $0 | $900 | $10,100 | $62,500 |
| **Structural** | $0 | $20,000 | $13,200 | $57,800 | $114,500 |
| **Architectural** | $0 | $0 | $6,000 | $202,300 | $365,600 |
| **Mechanical** | $15,000 | $332,000 | $312,000 | $603,000 | $522,000 |
| **HVAC** | $0 | $0 | $0 | $52,400 | $60,400 |
| **Plumbing** | $0 | $0 | $0 | $26,200 | $30,200 |
| **Electrical** | $0 | $0 | $39,900 | $104,800 | $120,800 |
| **Instrumentation** | $0 | $0 | $23,300 | $61,200 | $70,500 |
| **Subtotal** | $15,000 | $352,000 | $395,300 | $1,117,800 | $1,346,500 |
| **Contingency (30%)** | $4,500 | $105,600 | $118,600 | $335,400 | $404,000 |
| **Subtotal** | $19,500 | $457,600 | $513,900 | $1,453,200 | $1,750,500 |
| **Contractor Overhead & Profit (17%)** | $0 | $77,800 | $87,400 | $247,100 | $297,600 |
| **Estimated Construction Cost (2011)** | $19,500 | $535,400 | $601,300 | $1,700,300 | $2,048,100 |
| **Professional Services (27%)** *(includes Legal and Administrative)* | $0 | $145,000 | $163,000 | $460,000 | $553,000 |
| **Total Capital Cost (2011)** | $19,500 | $680,400 | $764,300 | $2,160,300 | $2,601,100 |

Conclusions and recommendations to be determined.

**Table 5 - Influent Screening Summary**

| Alternative | Pros | Cons |
|---|---|---|
| Replacement of grinder | • Lowest cost<br>• Short construction/installation time<br>• Operations staff can install themselves<br>• No interference with facility hydraulics | • Will not solve operator's concern about "stringy" material building up on membrane cassettes. |
| Screen installed in the existing channel | • Relatively low cost<br>• Short construction/installation time<br>• Little or no interference with facility hydraulics | • AECOM cannot recommend this option without further investigation of the discrepancies in the manufacturer's installation recommendations. See the subheading "Band Screen".<br>• Site and structural constraints may limit competitive bidding.<br>• Some structural modifications may be required to accommodate the recommended washer/compactor and provide weather protection<br>• Difficult solids handling and maintenance due to limited space |
| Screen installed in modified channel | • Moderate cost<br>• Can be designed to accommodate almost any manufacturer<br>• Little or no interference with facility hydraulics | • Longer construction/installation time relative to existing channel installation<br>• Outdoor installation may limit equipment life, require extras such as trace heating<br>• Operation/maintenance would take place outdoors during inclement weather<br>• Odor generation potential |
| Screen installed after the Primary Settling Tanks | • Less expensive than new headworks<br>• Fewer site constraints compared to in channel installations<br>• Indoor installation of the 2 mm screen is an option<br>• Can be designed to accommodate almost any manufacturer | • Influences facility hydraulics. Hydraulic analysis required to determine if this is a viable option<br>• More expensive than in channel options<br>• Estimate assumes existing pumps can be relocated and does not account for cost of new pumps, if needed.<br>• Requires two stage (6 mm and 2 mm) screening.<br>• 6 mm screen may have to be installed outdoors.<br>• Requires revision of site piping<br>• Longer construction time compared to in channel options |
| Screen installed in new headworks | • Fewest constraints of any option, resulting in ease of operation and maintenance<br>• Indoor installation<br>• Can be designed to accommodate almost any manufacturer<br>• Little or no interference with facility hydraulics | • Most expensive alternative<br>• Longest construction time |

## 2. VACUUM TRUCK DISCHARGE CONNECTION AND LOCATION

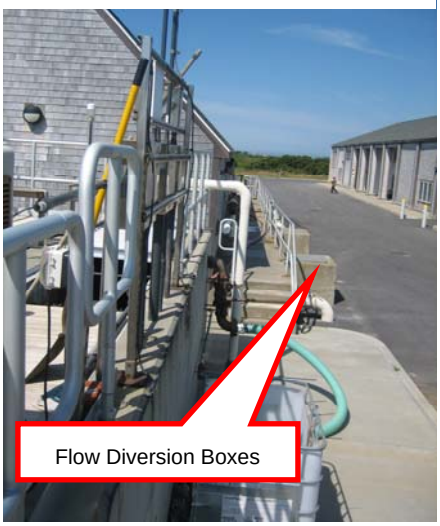
Surfside WWTF personnel have noted some difficulty in discharging the contents of the vacuum truck the Town uses for sewer maintenance. The difficulty arises from the lack of a convenient discharge point adapted to the vacuum truck's available connections. Currently, WWTF personnel lift one of the covers on a Primary Settling Tank (PST) located near the effluent end of the tanks and dump the contents of the vacuum truck directly into the PST. However, this means of discharging the vacuum truck is inconvenient and upsets both settling operations and the truck's contents. It also bypasses the screening, flow measurement and de-gritting operations. AECOM understands from conversations with Town personnel that the existing vacuum truck, which is more than 20 years old, is failing and is scheduled to be replaced.

AECOM has identified two methods of increasing the convenience and functionality of discharging the contents of the vacuum truck and avoiding potential process upsets.

### Modify Existing Flow Diversion Boxes

There are several existing concrete flow diversion boxes located on the north side of the Primary Treatment Building that are piped to the septage holding tanks and sludge holding tanks. However, the walls of the boxes are too high for the truck to empty directly into the boxes. One of the boxes could be modified to become a discharge station for the vacuum truck by cutting the walls down to a lower height. This would allow the operators to dump the contents of the truck into the box. However, this option would also limit the capacity of the septage holding tank due to the lower wall height. Figure 9 shows the flow diversion boxes which could be modified to receive the vacuum truck discharge.

**Figure 9 - Location of Flow Diversion Boxes**

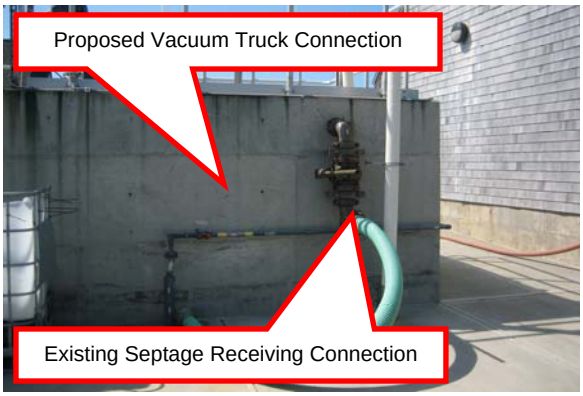



### Add Connection at Headworks

AECOM has discussed the purchase of a new vacuum truck with Mr. Brad Zangla (904-529-1316), who is a representative for Vac Con, which is a manufacturer of sewer vacuum trucks. New vacuum trucks are available with 10-inch discharge hoses with quick disconnect type fittings as a no cost option, according to Mr. Zangla. A 10-inch connection and associated piping would be added at the Headworks to complement the existing 4-inch connection used

by septage haulers. Refer to Figure 10 for the proposed location for the new connection. This would allow the vacuum truck to connect to the Headworks in order to discharge wastewater without making major modifications to the Headworks. The cost of including the quick disconnect option with the new vacuum truck and providing the new piping at the Headworks would be nominal compared to modifying the height of the existing flow diversion boxes. Alternately, the 10-inch discharge connection could be added at the flow diversion box. Although the cost for adding the connection to the headworks or flow diversion box would be the same, it is preferable to add the connection at the headworks in order to keep similar processes together.

**Figure 10 - Location of 10-inch Connection**




The cost for adding the connection to the headworks or flow diversion box is the same and is approximately $7,000 to $10,000. Surfside WWTF personnel could coordinate the design requirements and construction oversight of the discharge connection with a local contractor or this task could be grouped with several other projects into larger plant repair project.

Based on the above evaluation, AECOM recommends when the Town proceeds to purchase a new vacuum truck and that the truck be equipped with 10-inch discharge hoses with quick disconnect type fittings. AECOM also recommends that the existing Headworks be modified to add a new 10-inch connection and associated piping to complement the existing 4-inch connection used by septage haulers.

## 3. MISCELLANEOUS ITEMS

### Manhole Cross Connection

Based on observations by the operating staff, there is a possible cross connection between the stormwater drain system and a wastewater collection system process manhole at the Surfside WWTF. The cross connection allows wastewater to enter the stormwater system resulting in untreated wastewater being discharged into a rapid infiltration basin. Refer to Figure 11 which shows the interior of the process manhole.

**Figure 11 - Manhole Cross Connection**

Prior to the upgrade, the Surfside WWTF processed solids via aerated static pile composting. Runoff from this operation was captured, flowed by gravity into the wastewater collection system and pumped to the Headworks for treatment. As part of the upgrade, the stormwater system was separated from the wastewater system by installing a plug constructed of bricks and mortar.

Based on AECOM's review, it appears that the cross connection exists because of the failure of a plug in the storm drain line which enters the process manhole. AECOM recommends replacing the plug. The cost for this repair is approximately $500 to $1,500. Surfside WWTF and/or DPW personnel could undertake this work themselves or this task could be grouped with several other projects into larger plant repair project. It should be noted that entry into the process manhole is a confined space and therefore proper safety procedures should be followed, regardless of which repair option is used.

**Aeration Header**

The Surfside WWTF features three aeration headers for the three aeration basins. Each header has three actuated valves. It is AECOM's understanding from discussions with the plant operators that aeration header "A" has two nonfunctional valves - the actuators spin but the valves do not open or close. The valves and actuators must be repaired or replaced.

The aeration basins should be drained down and maintained on a regular basis. AECOM recommends that during the next scheduled maintenance of the aeration basins the personnel inspect and repair the valves as required. Since this operation will increase the downtime of the aeration basin, it should be scheduled to occur when the aeration basin is not required (e.g. influent flows are low). It is assumed that the inspection and repairs can be performed by the personnel. Since the condition of the valves is unknown, and therefore the type of repairs required, it is not possible to estimate the cost.

It should be noted that entry into the aeration basin is a confined space entry and therefore repairs should be undertaken only when using the proper safety procedures.

**Odor Control Exhaust Plenum**

A portion of the aluminum odor control exhaust plenum located in the Sludge Processing Building is corroded. The plenum directs treated air from odor control fan of the odor control system through an exhaust louver and discharges the treated air to atmosphere. The corroded section of the plenum needs to be replaced using similar materials of construction (if the recommendations below are implemented) or with a material that provides a higher level of corrosion resistance, such as fiberglass. Shop drawings for the plenum were

provided to the facility and can be utilized, along with field measurement verification, to manufacture the replacement plenum. AECOM estimates that materials and installation for this replacement would total approximately $7,500 to $10,000.

**Figure 12 - Chemical Buildup at Plenum Joints**

While this replacement is necessitated by plenum corrosion, it will not address the cause of the corrosion. Inspection by AECOM revealed solid chemical buildups at duct joints. Refer to Figure 12. These chemical deposits are caused by excess chemical usage in the chemical scrubber upstream of the plenum.

The chemical scrubber uses sodium hypochlorite and sodium hydroxide to remove/inactivate odors. AECOM recommends preventing future corrosion issues by optimizing the amount of chemicals used in the scrubber. The chemical scrubber operation and maintenance manual provides optimum chemical dosing guidelines. The equipment manufacturer can also be consulted in order to determine the optimum dosing of chemicals and provide additional guidance in optimizing the system. Alternately, the facility operators could use a trial-and-error method. This would involve gradually reducing the amount of chemicals used until the minimum functional amount of chemical is determined. Reducing chemical usage will result in lower operating costs and stop or slow further chemical attack causing the corrosion of the plenum, as well as address secondary issues such as the solid chemical deposits noted above.

# Memo

**To:** Jon Himlan, Woodard & Curran, Dedham, MA

**From:** JKMuir, LLC

**Date:** July 2, 2014

**Re:** Nantucket Surfside Wastewater Treatment Plant Energy Efficiency Analysis

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This memo is being submitted as an analysis of the proposed energy efficiency improvements at the Nantucket Surfside Wastewater Treatment Plant in Nantucket, MA.

This evaluation is a follow up to the Scoping Study Energy Evaluation, provided by JKMuir in 2011, and funded by National Grid. The proposed energy savings measures are summarized below.

| Item | Measure | Annual Energy Savings | Annual Cost Savings | Project Cost | Simple Payback (yrs) | Implementation Recommended |
|---|---|---|---|---|---|---|
| ECM 1 | Grit Blower Turndown | 11,388 | $2,050 | $13,000 | 6 | No[2] |
| ECM 2 | Sludge Blower Cycling | 22,075 | $3,974 | $13,000 | 3 | Yes |
| ECM 3 | Secondary Sludge Blower Cycling | 158,881 | $28,599 | $6,500 | 0.2 | Yes |
| ECM 4a | Draft Pump Piping Modifications | 33,549 | $6,039 | $10,000 | 2 | Yes |
| ECM 4b | Draft Pump Replacement | 38,166 | $6,870 | $139,500 | 20 | No[2] |
| ECM 5 | Odor Control Fan VFD Implementation | 66,138 | $11,905 | $39,650 | 3 | Yes |
| ECM 6 | Aeration Blower Turndown | - | - | - | - | Yes |
| ECM 7a | MBR System Optimization | 142,788 | $25,702 | $81,250 | 3 | Yes |
| ECM 7b | LEAPmbr Upgrade | 218,124 | $39,262 | $570,011 | 15 | No[2] |
| | **Total** | **439,436** | **$77,049** | **$279,900** | **4** | |

Note:

1) Totals only include recommended ECMs

2) While not recommended for implementation at this time, these measures could be implemented in the future.

## 1. ECM #1 - Grit Blower Speed Reduction

a. Existing conditions
   i. 1 - 5HP positive displacement blower, operated on a VFD.
   ii. Typically controlled manually at 100% speed.
   iii. Based on blower curves, data sheets, and operating pressure conditions, the blower is providing approximately 120 ICFM of aeration.

b. Current Energy Usage
   i. Based on December 2013 site visit/field measurements:

| Speed | Power Draw (KW) | Annual Run Time (hrs) | Annual Energy Usage (kWh) |
|---|---|---|---|
| 100% | 4.36 | 8760 | 38,194 |

c. Proposed Operation
   i. Utilize the VFD to vary blower speed and airflow based on influent flow
   ii. Metcalf & Eddy Waste Water design recommends 3-8 cfm aeration per foot of channel length.
   iii. Airflow range for Nantucket facility based on M&E recommendations:

| Based on 15' Grit Channel Length | |
|---|---|
| M&E Recommended Airflow (cfm/ft) | For Nantucket Grit Channel (CFM) |
| 3 | 45 |
| 4 | 60 |
| 5 | 75 |
| 5.5 | 82.5 |
| 6 | 90 |
| 8 | 120 |

   iv. Airflow is currently exceeding maximum M&E recommendations; because the facility sees significant seasonal fluctuation in flow, airflow rate could likely be reduced without compromising grit removal performance. This could be achieved on a trial basis by the operations staff, and using engineer's recommendations. Assuming between 5.5 and 6 cfm/ft of aeration is adequate, using existing blower curves, appropriate potential speeds were calculated:

| Motor Speed (RPM) | Power (BHP) | Inlet airflow (ICFM) | Power (KW) | |
|---|---|---|---|---|
| 1400 | 2.73 | 52 | 2.42 | |
| 1600 | 3.00 | 67 | 2.67 | |
| 1800 | 3.30 | 81 | 2.93 | |
| 1900 | 3.45 | 89 | 3.06 | **Proposed** |
| 2000 | 3.61 | 96 | 3.20 | |
| 2200 | 3.93 | 110 | 3.49 | |
| 2400 | 4.28 | 125 | 3.79 | **Existing** |
| 2600 | 4.63 | 140 | 4.11 | |
| 2800 | 5.01 | 154 | 4.44 | |
| 3000 | 5.40 | 169 | 4.79 | |
| 3200 | 5.81 | 184 | 5.15 | |
| 3400 | 6.23 | 198 | 5.53 | |

As shown, the current full speed operation is at 2400 RPM. Using the M&E aeration requirements, it appears the blower can be turned down to 1900 RPM and still meet aeration requirements.

d. Energy Savings
   i. Shown below is the annual energy savings associated with a reduction in grit blower speed. Note that aeration requirements may prevent the blower speeds from being reduced, which would alter the feasibility of this project.

| Speed | Power Draw (KW) | Annual Run Time (hrs) | Annual Energy Usage (kWh) |
|---|---|---|---|
| 100% | 4.36 | 8760 | 38,194 |
| 79% | 3.06 | 8760 | 26,806 |
| | | **Total Savings** | **11,388** |

Note: Power draw for 100% operating speed based on field kW readings; power draw for 79% operating speed calculated from blower curves

e. Project cost
   i. Shown below is a budgetary estimate of the total cost and simple payback of this project:

| Item | Qty | Cost |
|---|---|---|
| Instrumentation/Signal Wiring | LS | $5,000 |
| Systems Integration/Programming | LS | $5,000 |
| Contingency | 30% | $3,000 |
| **Total Project Cost** | | **$13,000** |
| | | |
| Annual Energy Cost Savings | | $2,050 |
| **Simple Payback (yrs)** | | **11** |

Note:
1) Energy Cost Savings calculated using $0.18/kWh
2) Project cost does not reflect National Grid Incentive

f. Incentive
   i. Through National Grid's Municipal Incentive program, this project is eligible for up to $0.35/kWh of funding, totaling up to approximately $3,900.
g. Recommendations and Next Steps
   i. While this project is eligible for incentive funding and will provide an energy savings, further analysis is required to determine if adequate grit removal can be achieved at this turndown. This information may not be easily attainable under current conditions. Additionally, the extensive payback of the project cost reduces the feasibility, and the project is not recommended at this time.

## 2. ECM #2 - Septage/Primary Sludge Tank Blower Cycling

a. Existing conditions
   i. 4 x 5HP positive displacement blower, operated on VFDs
   ii. Typically controlled automatically based on level .
   iii. Identical units as grit blowers; 100% speed provides 120 ICFM at 6psi
   iv. There are 4 primary sludge/septage storage tanks, and one blower is dedicated to each tank.
b. Current Energy Usage
   i. Base Case energy usage assumes two blowers operate continuously throughout the year (i.e. sludge/septage is held in at least 2 tanks at any given time)
   ii. Assume that there is typically at least 9' of sludge/septage in the holding tanks while the blowers are operating, and the blowers see approximately 4 psi, operating at approximately 80% speed.
   iii. Based on the blower curve for 4psi operation, and assuming year-round operation, the estimated power draw while operating at 80% speed was calculated

| Speed | RPM | Blowers Operating | Total Power Draw (KW) | Annual Run Time (hrs) | Annual Energy Usage (kWh) |
|---|---|---|---|---|---|
| 80% | 1920 | 2 | 5.04 | 8760 | 44,150 |

c. Proposed Operation
   i. Utilize SCADA programming to cycle blower operation on/off to minimize energy usage
   ii. Assume each blower cycles on/off every 15 minutes and operates 50% of the time.

d. Energy Savings
   i. Operational improvements reduce energy usage and costs by 50%

| Speed | RPM | Power Draw (KW) | Annual Run Time (hrs) | Annual Energy Usage (kWh) |
|---|---|---|---|---|
| 80% | 1920 | 5.04 | 8760 | 44,150 |
| 80% | 1920 | 5.04 | 4380 | 22,076 |
| | | | **Total Savings** | **22,076** |

e. Project cost
   i. Shown below is a budgetary estimate of the total project cost, as well as the simple payback of the project:

| Item | Qty | Cost |
|---|---|---|
| Systems Integration/Programming | LS | $5,000 |
| Instrumentation/Signal Wiring | LS | $5,000 |
| Contingency | 30% | $3,000 |
| **Total Project Cost** | | **$13,000** |
| | | |
| Annual Energy Cost Savings | | $3,974 |
| **Simple Payback (years)** | | **3** |

Note:
1) Energy Cost Savings calculated using $0.18/kWh
2) Project cost does not reflect National Grid Incentive

   ii. In order to implement blower cycling, additional controls, set points, and operator interface screens would need to be created within the existing SCADA program.

f. Incentive
   i. Through National Grid's Municipal Incentive program, this project is eligible for up to $0.35/kWh of funding, or 70% of the project cost, totaling up to at least $3,800. Programming modifications for the various energy savings measures could be summarized in a single combined incentive application, to maximize the overall project funding.

g. Recommendations and Next Steps
   i. This project is recommended for implementation and completion of allow the National Grid Incentive Applications is required to obtain the available funding.

## 3. ECM #3 - Secondary Sludge Tank Blower Cycling

a. Existing conditions
   i. 3 x 60HP positive displacement blower, operated on VFDs
   ii. Typically one blower operates at a time, and the speed is controlled automatically based on level.
   iii. 100% speed provides approximately 1080 ICFM at 6psi
   iv. There are 2 sludge holding tanks, and one tank is receiving aeration at any given time.

b. Current Energy Usage
   i. Base Case energy usage assumes one blower operates continuously throughout the year.
   ii. Assume that there is typically at least 12-14' of sludge in the holding tanks while the blowers are operating, and the blowers see approximately 6 psi, operating at approximately 100% speed.
   iii. Site visit measurements show a 37.8 kW power load from the pump, reflecting high sludge tank levels, and is not considered the average for the calculations below

| Speed | RPM | Power Draw (KW) | Operation (hrs) | Annual Energy Usage (kWh) |
|---|---|---|---|---|
| 100% | 3000 | 31.8 | 8760 | 278,568 |

c. Proposed Operation
   i. TR-16 guidelines for sludge mixing requirements recommend 25-30 cfm/1000ft$^3$ of tank volume for blended primary and waste-activated sludge:

| Based on 24000 CF Sludge Tank Volume | |
|---|---|
| TR-16 Recommended Air Volume (cfm/1000cf) | For Nantucket Sludge Tank (cfm) |
| 25 | 600 |
| 26 | 624 |
| 27 | 648 |
| 28 | 672 |
| 29 | 696 |
| 30 | 720 |

ii. Each sludge tank is 74'x27' with an estimated typical operating depth of 12', for a total estimated volume of approximately 24,000 $ft^3$. The calculated recommended air volume is 600-720 cfm. Based on the blower curves, 720 cfm at 6 psi could be provided with the blowers operating at 70% speed.

iii. Adequate mixing could likely be maintained while cycling the blowers intermittently on/off

iv. Utilize SCADA programming to reduce blower speed and cycle blower operation on/off to minimize energy usage

| Speed (RPM) | Brake HP | Inlet Airflow (ICFM) | Power (KW) | |
|---|---|---|---|---|
| 2000 | 23.4 | 682.8 | 19.3 | |
| 2100 | 24.7 | 722.5 | 20.4 | Proposed |
| 2200 | 26.0 | 762.2 | 21.5 | |
| 2400 | 28.8 | 841.9 | 23.8 | |
| 2600 | 31.7 | 921.8 | 26.2 | |
| 2800 | 34.8 | 1002.0 | 28.7 | |
| 3000 | 37.9 | 1082.4 | 31.3 | Existing |
| 3200 | 41.2 | 1163.1 | 34.1 | |

d. Energy Savings

i. Operational changes reduce energy usage and cost by 67%

| Speed | RPM | Power Draw (KW) | Operation (hrs) | Annual Energy Usage (kWh) |
|---|---|---|---|---|
| 100% | 3000 | 31.8 | 8760 | 278,568 |
| 70% | 2100 | 20.7 | 5782 | 119,687 |
| | | | **Total Savings** | **158,881** |

e. Project cost

i. Shown below is a budgetary estimate of the total project cost, as well as the simple payback of the project:

| Item | Qty | Cost |
|---|---|---|
| Systems Integration/Programming | LS | $5,000 |
| Contingency | 30% | $1,500 |
| **Total Project Cost** | | **$6,500** |
| | | |
| Annual Energy Cost Savings | | $56,765 |
| **Simple Payback (years)** | | **0.2** |

Note:

1) Energy Cost Savings calculated using $0.18/kWh

2) Project cost does not reflect National Grid Incentive

ii. In order to implement blower cycling, additional controls, set points, and operator interface screens would need to be created within the existing SCADA program. The additional control screens would also allow greater control for the operators to reduce the blower speed, as recommended above.

f. Incentive
   i. Through National Grid's Municipal Incentive program, this project is eligible for up to $0.35/kWh of funding, or 70% of the total project cost.

g. Recommendations and Next Steps
   i. This project is recommended for implementation and completion of allow the National Grid Incentive Applications is required to obtain the available funding.

## 5. ECM #4 - Draft Pump Modifications and Replacement

a. Existing conditions
   i. The draft pumps operate under an average peak-season flow of 1.53 MGD, with a 400% recycle flow rate (5313gpm total), and an off-season flow of 1.13 MGD, with 250% recycle flow rate (2750gpm total).
   ii. There are 2 draft pumps associated with each of the 2 anoxic tanks. Typically, all 4 draft pumps operate during peak flow periods.
   iii. Head calculations were made in the field, and it was conservatively estimated that the pumps operate at 2.5 ft of TDH.

b. Current Energy Usage
   iv. Assuming a pump efficiencies calculated from pump curves, a nominal motor efficiency of 85%, 2 months of Summer Peak operation, and using TDH measured in the field:

| Condition | Flow Per Pump (gpm) | Head (ft) | Motor eff. | VFD eff. | Pump eff. | Total Power (KW) | Annual Operation (hrs) | Annual Energy Usage (kWh) |
|---|---|---|---|---|---|---|---|---|
| Peak | 1328 | 2.5 | 85% | 95% | 45% | 6.88 | 2190 | **33,924** |
| Off-peak | 687 | 2.5 | 85% | 95% | 30% | 5.34 | 6570 | **52,611** |
| | | | | | | | **Total** | **86,536** |

c. Proposed Operation
   v. **Option 1 - Pipe Modifications**
      1. Currently, all pumps operate continuously to prevent backflow at the discharge. If structural modifications could be made to extent the discharge pipe above the water level to stop backflow, it may

be feasible for the plant to continuously operate 2 pumps at all times, as opposed to 4.

2. With 2 pumps running, the flow per pump would be increased. This would improve the efficiency of the draft pumps at the given head conditions.

| Pumps Running | Flow per Pump (gpm) | Head (ft) | Motor eff. | VFD eff. | Pump eff. | Total Power (kW) | Annual Operation (hrs) | Energy Usage (kWh) |
|---|---|---|---|---|---|---|---|---|
| 2 (Peak) | 2656 | 3 | 85% | 95% | 45% | 8.26 | 2190 | **18,093** |
| 2 (off-peak) | 1328 | 3 | 85% | 95% | 35% | 5.31 | 6570 | **34,894** |
| | | | | | | | **Total** | **52,987** |

vi. **Option 2 - New Pump Installation**

3. Assume a new pump could be installed given existing conditions, and that it can be sized to meet the flow conditions of two draft pumps at the actual head.
4. The new pump would operate at a more efficient point on its curve Assuming a 50% pump efficiency (a higher efficiency is very likely)

| Pumps Running | Flow Per Pump (gpm) | Head (ft) | Motor eff. | VFD eff. | Pump eff. | Total Power (kW) | Annual Operation (hrs) | Energy Usage (kWh) |
|---|---|---|---|---|---|---|---|---|
| 2 (Peak) | 2656 | 3 | 85% | 95% | 53% | 7.01 | 2190 | **15,362** |
| 2 (off-Peak) | 1328 | 3 | 85% | 95% | 37% | 5.02 | 6570 | **33,008** |
| | | | | | | | **Total** | **48,370** |

d. Savings

vii. Presented below is a kWh savings for each proposed option

| Condition | Energy Use (kWh) | Savings Associated |
|---|---|---|
| Existing | 86,536 | |
| Proposed - Pump operations | 52,987 | **33,549** |
| Proposed - New pump | 48,370 | **38,166** |

e. Project Cost

a. Shown below is the project cost and simple payback of the proposed structural modifications:

| Item | Qty | Cost |
|---|---|---|
| Piping Modifications | LS | $2,500 |
| Labor/Installation | LS | $5,000 |
| Engineering | LS | $1,900 |
| Contingency | 30% | $2,800 |
| **Total Project Cost** | | **$12,200** |
| | | |
| Annual Energy Cost Savings | | $6,039 |
| **Simple Payback (yrs)** | | **2** |

Note:
1) Energy Cost Savings calculated using $0.18/kWh
2) Project cost does not reflect National Grid Incentive

b. Shown below is the project cost and simple payback of the proposed pump replacement:

| Item | Qty | Cost |
|---|---|---|
| Piping modifications | LS | $7,500 |
| New Pumps | LS | $30,000 |
| Pump Piping/Hardware | LS | $5,000 |
| Structural Modifications/Hatch Installation | LS | $30,000 |
| Systems Integration/Programming | LS | $7,500 |
| VFDs/Instrumentation/Controls | LS | $10,000 |
| Contingency | 30% | $27,000 |
| Engineering | 25% | $22,500 |
| **Total Project Cost** | | **$139,500** |
| | | |
| Annual Energy Cost Savings | | $6,870 |
| **Simple Payback (yrs)** | | **20** |

Note:
1) Energy Cost Savings calculated using $0.18/kWh
2) Project cost does not reflect National Grid Incentive

f. Incentive

viii. Through National Grid's Municipal Incentive program, this project is eligible for up to $0.35/kWh of funding, or up to 70% of the total project cost.

g. Recommendations and Next Steps

While only implementing structural modifications of the piping system has the lowest capital cost and shortest payback, the operations staff at Nantucket may find it useful to replace the pump at some point in the future. This could be a result of pump age and wear, increased flow, or process modifications. If replacing the pump would provide operational and maintenance benefits, in addition to energy savings, the project can be combined with the other ECMs, to maximize funding and reduce the long-term payback of the pump replacement.

## 6. ECM #5 - Odor Control Fans

a. Existing conditions

i. Odor control provided by a 60hp fan, operated continuously at full speed. Power draw based on kW readings taken during 2011 scoping study site visit representing fan operating at 100% speed (1339rpm).

ii. Current winter operation is at low speed, which is 1194 rpm. KW at low speed is estimated using the Affinity laws, using a conservative value of 2.5:

$$\left(\frac{P_1}{P_2}\right) = \left(\frac{n_1}{n_2}\right)^3 \qquad \left(\frac{q_1}{q_2}\right) = \left(\frac{n_1}{n_2}\right)$$

$$\left(\frac{29.5kW}{P_2}\right) = \left(\frac{1785rpm}{1339rpm}\right)^{2.5}$$

$$P_2 = 14.4\ kW$$

| Condition | kW[1] | Hrs/yr | kWh/yr |
|---|---|---|---|
| Summer Operation | 29.5 | 4380 | 129,210 |
| Winter Operation | 14.4 | 4380 | 63,072 |
| Annual Total | | | 192,282 |

Note: kW based on on-site readings circa 2011 site visit

b. Proposed conditions

i. Odor Control System is currently drawing from various spaces throughout the plant, some which may not need as much ventilation as is currently provided; specifically, the aeration tanks, Membrane tanks, effluent channel. It may be feasible to eliminate or reduce airflow from these spaces, which would allow for further reduction in fan speed. For the purposes of these calculations, it is assumed that the fan can then run in low speed year round. Based on modified airflows proposed by Woodard & Curran, the total airflow through the Odor Control system could be reduced to 22,905 CFM, in comparison to the original AECOM O&M manual, which indicates a designed airflow of 35,300 CFM. This provides additional energy savings, as the fan speed could be reduced further. Fan data/cut sheets are not currently available, so full speed operation is assumed to be based on the original design condition (35,300 CFM). Based on Affinity Laws, 22,905 CFM represents 65% fan speed. Shown below is the power usage at this speed, using a conservative value of 2.5 for the Affinity Law calculation:

$$\left(\frac{29.5}{P_2}\right) = \left(\frac{1785}{1160}\right)^{2.5}$$

$$P_2 = 10.0$$

c. Savings

| Condition | kW | Hrs/yr | kWh/yr | Savings kWh/yr |
|---|---|---|---|---|
| Existing-Summer | 29.5 | 4380 | 129,210 | |
| Existing - Winter | 14.4 | 4380 | 63,072 | |
| Proposed - Year-Round | 10.0 | 8760 | 87,600 | **104,682** |

d. Project cost

i. VFD is proposed, which would allow for a range of operating conditions to optimize ventilation while minimizing energy usage.

ii. Installation would include new VFD, programming and SCADA modifications to allow for operator speed set points and control

iii. Shown below is the estimated project cost and simple payback of this project:

| Item | Qty | Cost |
|---|---|---|
| Systems Integration/Programming | LS | $5,000 |
| Instrumentation/Wiring | LS | $10,000 |
| 60 HP VFD | LS | $15,500 |
| Contingency | 30% | $9,150 |
| **Total Project Cost** | | **$39,700** |
| | | |
| Annual Energy Cost Savings | | $11,905 |
| **Simple Payback (yrs)** | | **3** |

Note:
1) Energy Cost Savings calculated using $0.18/kWh
2) Project cost does not reflect National Grid Incentive

e. Incentive

Through National Grid's Municipal Incentive program, this project is eligible for up to $0.35/kWh of funding. In addition, this project is eligible for funding under National Grid's Prescriptive Incentive program, for up to $8,250 for a 60HP VFD installation.

f. Recommendations and Next Steps

i. This project has a short-term simple payback, which will be further improved by National Grid incentive funding. It is recommended that this project be prioritized, and applications be submitted.

## 7. ECM #6 - Aeration Blowers

a. Existing Conditions

i. 3 x 60HP positive displacement blowers, on VFDs, with manual speed control.

ii. Currently operating one blower at minimum speed, typical for winter operation. Operators manually increase the number of blowers and their speeds based on influent loading and nitrification/denitrification requirements which vary significantly between the summer tourist season and off-season conditions.

iii. There are three tanks with three zones in each tank. Currently, air is turned off to Zone A; the valves are closed in Zone B; and aeration is being provided in Zone C. The control valves for each of these zones are manually operated. It appears that the throttling of these valves has created additional backpressure on the blowers.

b. Proposed conditions

i. Potential short term system modifications:

1. At the time of the scoping study site visit, pressure was measured in the field at 10.8psi. Electrical readings were taken with the blower operating at 100% speed, and a power draw of 43.9 KW was measured. At this time, further blower and motor information is needed to determine if it is possible to reduce operating speed based on pressure or airflow
2. Implement blower cycling, additional controls, and a DO set point system through the existing SCADA program to minimize blower operation and still meet DO requirements

ii. Potential long term system modifications:

1. Process control and operational modifications are being recommended as part of the plant's capital improvements plan. This includes providing additional blowers to meet projected future wastewater flows and loads. As process airflow requirements are developed, additional analysis of blower types and manufacturers should be included.

c. Savings

i. As new airflow requirements are analyzed, the type of blower and manufacturer can be chosen, and specific models can be selected based on energy efficiency.

d. Project Cost

i. The budgetary cost of this project will include the cost of installing a VFD and associated controls and instrumentation, as well as any upgrades or improvements to the existing SCADA system, as well as the associated operational changes

e. Through National Grid's Municipal Incentive program, this project would be eligible for funding. The modifications to the secondary treatment process and aeration requirements will be developed as part of the long term planning and design of plant improvements. As the design of the plant upgrades are developed the energy savings can be quantified and applications submitted to National Grid. This project is not included in the short term recommendations for energy savings.

## 8. ECM #7 - MBR System Optimization

a. Existing Conditions

i. The plant currently operates 5, 100-HP scour air blowers to the Membrane Bioreactor System. The MBR system consists of 4 membrane filter trains, with one scour air blower per train, and 1 on standby. There are 2 modes of scour aeration at each train - 10/10 and 10/30 aeration. 10/10 aeration indicates 10 seconds of aeration, followed by 10 seconds off, for each side of the membrane train. 10/30 aeration indicates 10 seconds of aeration, followed by 30 seconds off, for each side of the membrane. The MBR system is designed for an average flow of 3.5

MGD. The flow data suggests that the maximum day summer flow rarely, if ever, exceeds 2.5 MGD; and in the Winter Months, remains around 1 MGD. Typical MBR operation suggests 10/10 aeration for periods of high flow, and 10/30 aeration for periods of low flow. In 10/30 aeration, the energy usage of the blowers is much lower than it is in 10/10 aeration, so it is more efficient to run 10/30 aeration whenever possible. Due to the aeration piping configuration of the system, one train must remain in 10/10 operation when an odd number of trains is running (i.e. one or three trains). The current control scenario and set points result in frequent cycle between 1 and 3 trains running, based on membrane tank level.

b. Current Energy Usage

i. KW taken as the average of all field readings:

| Active Blowers | Annual Operation (cum. hrs)[1] | Power per blower (KW) | Annual Energy Usage (kWh) |
|---|---|---|---|
| 2 | 13140 | 32.6 | **428,364** |

Note:
1) Cumulative hours reflects total annual operating hours of both blowers

c. Proposed Conditions

**i. Option 1 - System Optimization**

1. It may be possible for the plant to reduce the number of active trains to 1 or 2, by adjusting operations programming to allow higher flux rates through the membrane. This would allow the system to operate with 1 scour air blower in operation (on average). Shown below is an estimate of the total energy savings that would result from modifications to the air scour system by a GE engineer:

| Condition | KW | Hrs per year | Annual Energy Usage (kWh) |
|---|---|---|---|
| Existing | 32.6 | 13140 | 428,364 |
| Proposed - Modifications | 32.6 | 8760 | 285,576 |
| **Savings** | | | **142,788** |

2. Shown below is a budgetary estimate of the project cost and simple payback:

| Item | Qty | Cost |
|---|---|---|
| GE Rep/Programming Modifications/Training | LS | $25,000 |
| New Instrumentation/Additional Controls | LS | $22,500 |
| Engineering Oversight & Field Assistance | LS | $15,000 |
| Contingency | 30% | $18,800 |
| **Total Project Cost** | | **$81,300** |
| | | |
| Annual Energy Cost Savings | | $25,702 |
| **Simple Payback (yrs)** | | **3** |

Note:
1) Energy Cost Savings calculated using $0.18/kWh
2) Project cost does not reflect National Grid Incentive

### ii. Option 2 - LEAPmbr Upgrade

1. GE's LEAPmbr system offers improved MBR performance as well as energy reduction. The energy savings, as well as the feasibility of this implementation in Nantucket, were assessed. Power reduction of the LEAPmbr system was assessed by the engineer and manufacturer, and the estimated energy savings is shown below:

| Condition | kW | Hrs/yr | kWh/yr |
|---|---|---|---|
| Existing | 32.6 | 13140 | 428,364 |
| Proposed - LEAPmbr | 24 | 13140 | 315,360 |
| **Savings** | **8.6** | | **113,004** |

2. Shown below is the estimate of the project cost, using information provided by the manufacturer (GE), as well as installation and engineering estimates

| Item | Qty | Cost |
|---|---|---|
| LEAPmbr System[1] (includes controls and VFDs) | LS | $257,924 |
| Engineering | LS | $25,792 |
| Installation | LS | $128,962 |
| GE Representative oversight and programming | LS | $25,792 |
| **Contingency** | **30%** | **132,580** |
| **Total Project Cost** | | **$570,000** |
| | | |
| Annual Energy Cost Savings | | $39,262 |
| **Simple Payback (years)** | | **8** |

Note:

1) Based on November 2013 quote provided by GE

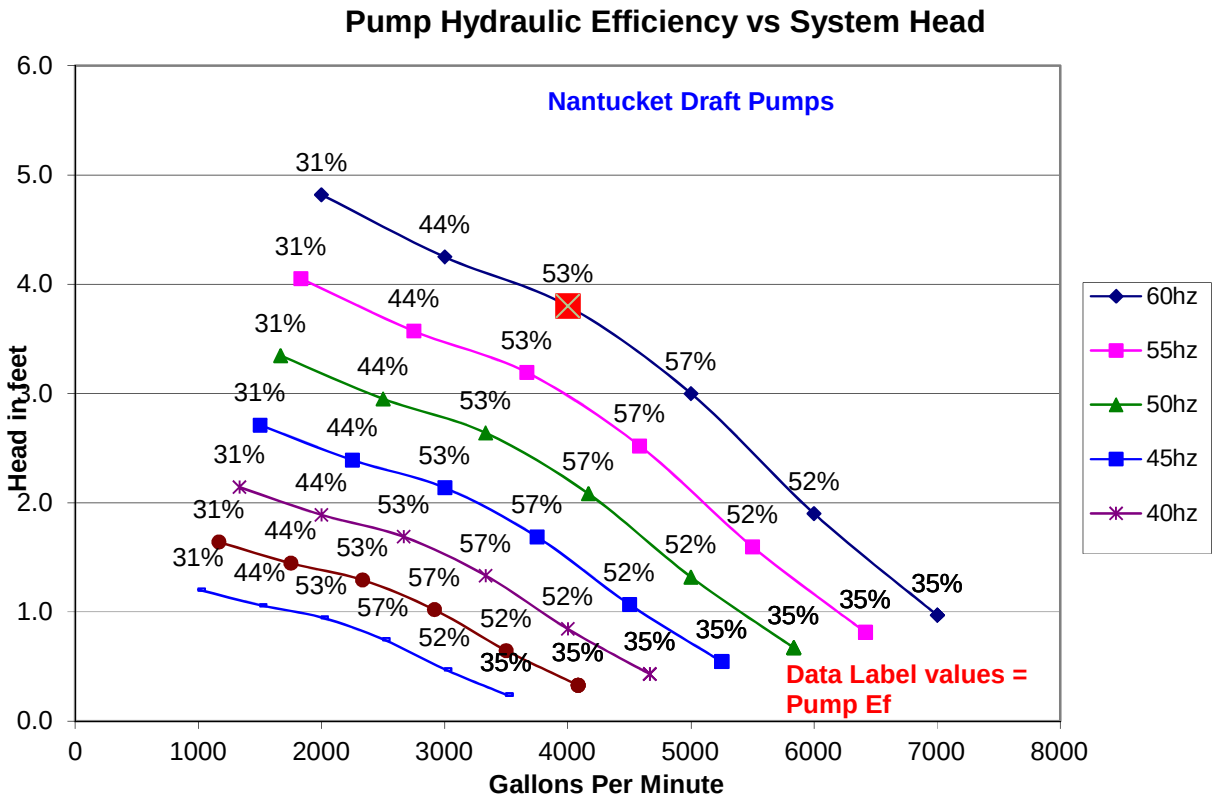
2) Energy Cost Savings calculated using $0.18/kWh

3) Project cost does not reflect National Grid Incentive

d. Recommendations and Next Steps

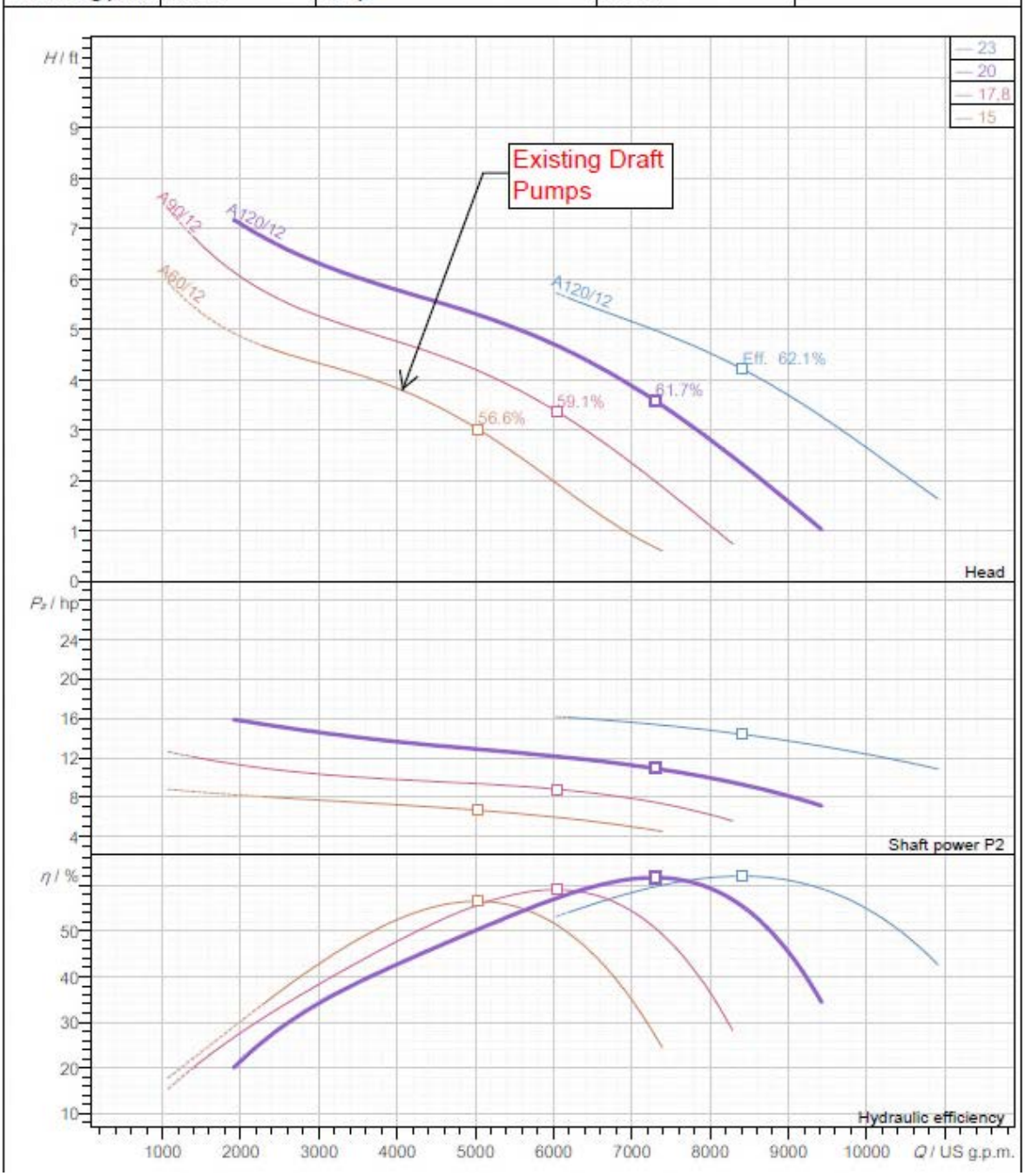
i. The long-term payback of the LEAPmbr system does not justify the initial project cost at this point, and it is recommended that the plant move forward with existing system optimizations. Through National Grid's Municipal Incentive program, this project is eligible for up to $0.35/kWh of funding. After the system optimization has been implemented in may be appropriate to assess additional upgrades, such as the LEAPmbr system in the future.

**VFD Analysis of Draft Pumps**



**Draft Pump Curves**

| Density | Viscosity | Testnorm | Rated speed | Date |
|---|---|---|---|---|
| 62.31 lb/ft³ | 1.077E-5 ft²/s | Hydraulic Institute | 576 rpm | 2013-12-06 |
| **Flow** | **Head** | **Rated power** | **Hydraulic efficiency** | **NPSH** |
| 4890 US g.p.m. | 5.37 ft | 13 hp | 49.3 % | |



## APPENDIX B – MASSDEP GROUNDWATER DISCHARGE PERMIT

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
SOUTHEAST REGIONAL OFFICE
20 RIVERSIDE DRIVE, LAKEVILLE, MA 02347 • 508-946-2700

MITT ROMNEY
Governor

KERRY HEALEY
Lieutenant Governor

STEPHEN R. PRITCHARD
Secretary

ROBERT W. GOLLEDGE, Jr.
Commissioner

RECEIVED
JUN 19 2006
EARTHTECH
196 BAKER AVE CONCORD MA

COPY

June 15, 2006

Jeffrey Willett
Town of Nantucket
Department of Public Works
P.O. Box 239
Nantucket, Massachusetts 02554

RE: FINAL GROUNDWATER DISCHARGE PERMIT

AT: Surfside Wastewater Treatment Facility
South Shore Road, Nantucket

Transmittal No. W065519
Permit No. 200-2

Dear Mr. Willett:

In response to your application for a permit to discharge into the ground, a treated effluent from the proposed upgraded wastewater treatment facility located at South Shore Road in Nantucket, Massachusetts, and after due public notice, I hereby issue the attached final permit.

No comments objecting to the issuance or terms of the permit were received by the Department during the public comment period. Therefore, in accordance with 314 CMR 2.08, the permit becomes effective on the date of issuance.

Parties aggrieved by the issuance of this permit are hereby advised of their right to request an Adjudicatory Hearing under the provision of Chapter 30A of the Massachusetts General Laws and 314 CMR 1.00, Rules for the Conduct of Adjudicatory Proceedings. Unless the person requesting the adjudicatory hearing requests and is granted a stay of the terms and conditions of the permit, the permit shall remain fully effective.

This information is available in alternate format. Call Donald M. Gomes, ADA Coordinator at 617-556-1057. TDD Service - 1-800-298-2207.
MassDEP on the World Wide Web: http://www.mass.gov/dep
Printed on Recycled Paper

2

Please contact David Burns at 508-946-2738 or Ron White at 617-292-5790, should you have any questions.

Sincerely,

David R. Burns
Bureau of Resource Protection

DRB/cb

cc: w/enclosures
Nantucket Board of Selectmen
Nantucket Board of Health
Earthtech
DEP Municipal Assistance-Boston
Attn: Mr. Hamm
DEP Watershed Permitting Program-Boston
Attn: Mr. Ferris
DEP OGC Boston
Attn: Mr. Lehan
DEP/Boston
Attn: Marybeth Chubb

Surfside WWTF Groundwater
Discharge Permit 200-2

1

RECEIVED
JUN 19 2006
EARTHTECH
196 BAKER AVE CONCORD MA

**GROUNDWATER**
**DISCHARGE PERMIT**

Name and Address of Applicant: Town of Nantucket, Broad Street, Nantucket, MA

Date of Application: June 28, 2005

Application/**Permit No. SE# 200-2**

Date of Issuance: June 15, 2006

Date of Expiration: June 15, 2011

Effective Date: June15, 2006

**AUTHORITY FOR ISSUANCE**

Pursuant to authority granted by Chapter 21, Sections 26-53 of the Massachusetts General Laws, as amended, the following permit hereby issued to: **the Town of Nantucket** (hereinafter called "the permittee") authorizing discharges from an upgraded wastewater treatment facility located at **Surfside** _to the ground, such authorization being expressly conditional on compliance by the permittee with all terms and conditions of the permit hereinafter set forth.

6/15/06
Date

David R. Burns, DEP BRP SERO

Surfside WWTF Groundwater
Discharge Permit 200-2

2

## I. SPECIAL CONDITIONS

### A. Effluent Limits

The permittee is authorized to discharge into the ground from the modified wastewater treatment facilities for which this permit is issued a treated effluent whose characteristics within one month of startup and continuing thereafter shall not exceed the following values:

| Effluent Characteristics | Discharge Limitations |
|---|---|
| Flow | 3.5 million gallons per day |
| Oil & Grease | 15 mg/l |
| Total Suspended Solids (TSS) | 30 mg/l |
| Biochemical Oxygen Demand 5-day @ 20c (BOD5) | 30 mg/l |
| Total Nitrogen (TKN+NO2+NO3) | 10 mg/l |
| Nitrate Nitrogen | 10 mg/l |
| Settleable Solids | 0.1 ml/l |
| Total Dissolved Solids | 1000 mg/l |
| Fecal Coliform Bacteria | 200 org/100 ml |

a) The pH of the effluent shall not be less than 6.5 nor greater than 8.5 at any time, or not more than 0.2 standard units outside the naturally occurring range.

b) The discharge of the effluent shall not result in any demonstrable adverse effect on the groundwater or violate any water quality standards that have been promulgated.

c) The monthly average concentration of BOD and TSS in the discharge shall not exceed 15 percent of the monthly average concentrations of BOD and TSS in the influent into the permittee's wastewater treatment facility.

d) When the effluent discharged for a period of 90 consecutive days exceeds 80 percent of the permitted flow limitations, the permittee shall submit to the permitting authorities projected loadings and a program for maintaining satisfactory treatment levels consistent with approved water quality management plans.

Surfside WWTF Groundwater 3
Discharge Permit 200-2

**B. Monitoring and Reporting**

1) The permittee shall monitor and record the quality of the **influent** and the quality and quantity of the **effluent** prior to discharge to the leaching facilities according to the following schedule and other provisions:

**INFLUENT:**

| Parameter | Minimum Frequency of Analysis | Sample Type |
|---|---|---|
| PH | Daily | Grab |
| TSS | Weekly | 24 hour composite |
| BOD5 | Weekly | 24 hour composite |
| Ammonia Nitrogen | Weekly | 24 hour composite |

**EFFLUENT:**

| Parameter | Minimum Frequency of Analysis | Sample Type |
|---|---|---|
| Flow | Daily Reading | Max-Min-Avg |
| PH | Daily | Grab |
| TSS | Weekly | 24 hour composite |
| BOD5 | Weekly | 24 hour composite |
| Oil & Grease | Monthly | 24 hour composite |
| Nitrate Nitrogen | Monthly | 24 hour composite |
| Total Nitrogen (NO2+NO3+TKN) | Monthly | 24 hour composite |
| Total Phosphorous | Quarterly | 24 hour composite |
| Orthophosphate | Quarterly | 24 hour composite |
| Fecal Coliform | Monthly | grab |
| Total Dissolved Solids | Monthly | grab |
| Volatile Organic Compounds* | Quarterly | grab |

* EPA Method 624

Surfside WWTF Groundwater
Discharge Permit 200-2

4

2) The permittee shall monitor a minimum of five (5) monitoring wells identified as N-1(UG), N-3R, N-8, N-9, N-10, and N-11 on the plan entitled "Surfside WWTF Upgrade Plans and Specifications dated July 2005" as follows:

| Parameter | Frequency of Analysis |
|---|---|
| Static Water Level | Quarterly |
| Specific Conductance | Quarterly |
| PH | Quarterly |
| Total Nitrogen (NO2+NO3+TKN) | Quarterly |
| Nitrate Nitrogen | Quarterly |
| Total Phosphorus | Quarterly |
| Orthophosphate | Quarterly |
| Volatile Organic Compounds | Annually* |

*EPA Method 624

3) Any grab sample or composite sample required to be taken less frequently than daily shall be taken during the period of Monday through Friday inclusive. All composite samples shall be taken over the operating day.

The permittee shall submit all monitoring reports within 30 days of the last day of the reporting month. Reports shall be on an acceptable form, properly filled and signed and shall be sent to: the **Regional Director, Department of Environmental Protection, Southeast Regional Office, 20 Riverside Drive, Lakeville, MA 02347**, and to the **Program Director, Watershed Permitting, Department of Environmental Protection, One Winter Street/6th Floor, Boston, MA 02108**, and to the **Board of Health, Nantucket, MA.**

**C. Supplemental Conditions**

* A staffing plan for the facility shall be submitted to the Department once every two years or whenever there are staffing changes.

* The permittee shall contract to have any and all solids and sludge generated by the treatment system for which this permit is issued removed off site by a properly licensed waste hauler for disposal at an EPA/DEP approved facility. The name and license number of the hauler along with the quality of wastes removed and the date(s) of removal shall be reported by the permittee in writing to the Department.

**Appeal Rights**

This Permit is an action of the Department. Any person aggrieved by this action, may request an Adjudicatory Hearing. A request for a hearing must be made in writing and postmarked within thirty (30) days of the Permit issuance date. Under 310 CMR 1.01(6)(b), the request must state clearly and concisely the facts, which are the grounds for the request, and the relief sought.

The Hearing request along with a valid check payable to the Commonwealth of Massachusetts in the amount of one hundred dollars ($100.00) must be mailed to:

Commonwealth of Massachusetts
Department of Environmental Protection
P.O. Box 4062
Boston, MA 02211-4062

The request will be dismissed if the filing fee is not paid, unless the appellant is exempt or granted a waiver as described below. The filing fee is not required if the appellant is a city or town (or municipal agency), county, or district of the Commonwealth of Massachusetts, or a municipal housing authority. The Department may waive the adjudicatory hearing filing fee for a person who shows that paying the fee will create an undue financial hardship. A person seeking a waiver must file, together with the hearing request as provided above, an affidavit setting forth the facts believed to support the claim of undue financial hardship.

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# MassDEP BRP WP 11 Application

## Individual Permit Renewal / Modification with Plan Approval

MassDEP Transmittal X259168

## Surfside Wastewater Treatment Facility

Groundwater Discharge Permit

Project No. 223970

**Town of Nantucket, Massachusetts**

**Department of Public Works**

January 2014

**980 Washington Street, Suite 325**
**Dedham, MA 02026**
**(781) 251 - 0200**

woodardcurran.com
COMMITMENT & INTEGRITY DRIVE RESULTS

**COMMITMENT & INTEGRITY**
**DRIVE RESULTS**

980 Washington Street, Suite 325N
Dedham, Massachusetts 02026
www.woodardcurran.com

T 800.446.5518
T 781.251.0200
F 781.251.0847

January 23, 2014

Mr. Alan Slater
MassDEP Boston Office
One Winter Street
Boston, Massachusetts 02108

Mr. Steven Hallem
MassDEP Boston Office
One Winter Street
Boston, MA 02108

Mr. Ronald White
MassDEP Boston Office
One Winter Street
Boston, MA 02108

Mr. Brian Dudley
MassDEP Barnstable Office
3195 Main Street
Barnstable, MA 02630

Re: BRP WP 11 Application – Individual Permit Modification Application- Town of Nantucket Surfside WWTF Groundwater Discharge Permit

Dear Gentlemen:

As discussed, please find enclosed the full BRP WP 11 Application for an Individual Permit Renewal/Modification with plan Approval to amend the existing Groundwater Discharge Permit, SE#1-200 for the Surfside WWTF. This Application is being filed in tandem with a BRP WP 83 Hydrogeological Evaluation for the same site.

We look forward to your positive review of the two applications. If you need any additional information, please contact me direct

Sincerely,

WOODARD & CURRAN INC.

Rosemary T. Blacquier
Project Manager

RTB/rtb
223970

Enclosure(s)

cc: Kara Buzanoski, Nantucket DPW Director
Tom Hazlett, Woodard & Curran
Cary Parsons, Woodard & Curran

# TABLE OF CONTENTS

**SECTION**

**Transmittal Letter**

**Transmittal Form**

**BRP WP 11 Form**

**SUPPLEMENTAL INFORMATION**

# LIST OF FIGURES

**FIGURE**

Figure 1: MassGIS Site Data Map with Private and Public Supplies

Figure 2: MassDEP Coordinate Map

# APPENDICES

**Appendix**

Appendix A: Hydrogeological Technical Memorandum Report

Appendix B: Map of Surfside WWTF Monitoring Wells

Appendix C: 2005 Surfside WWTF Groundwater Discharge Permit Application

Appendix D: Appendix A from Surfside WWTF O & M Manual - WWTF Design Criteria

Appendix E: Engineering Reports - Comprehensive Wastewater Management Plan and Operations & Maintenace Manual (in CD Format)

**Enter your transmittal number** → X259168
Transmittal Number

Your unique Transmittal Number can be accessed online: http://mass.gov/dep/service/online/trasmfrm.shtml

**Massachusetts Department of Environmental Protection**

# Transmittal Form for Permit Application and Payment

**1.** Please type or print. A separate Transmittal Form must be completed for each permit application.

**2.** Make your check payable to the Commonwealth of Massachusetts and mail it with a copy of this form to: DEP, P.O. Box 4062, Boston, MA 02211.

**3.** Three copies of this form will be needed.

**Copy 1 - the original** must accompany your permit application. **Copy 2** must accompany your fee payment. **Copy 3** should be retained for your records

**4.** Both fee-paying and exempt applicants must mail a copy of this transmittal form to:

**MassDEP**
**P.O. Box 4062**
**Boston, MA**
**02211**

*** Note:**
For BWSC Permits, enter the LSP.

## A. Permit Information

BRP WP 11
1. Permit Code: 7 or 8 character code from permit instructions

Individual Permit Renewal/Modification with Plan Approval

Modification of Existing Groundwater Discharge Permit
3. Type of Project or Activity

## B. Applicant Information – Firm or Individual

Town of Nantucket Department of Public Works
1. Name of Firm - Or, if party needing this approval is an individual enter name below:

Buzanoski
2. **Last Name** of Individual

Kara
3. **First Name** of Individual

4. MI

188 Madaket Road
5. Street Address

Nantucket
6. City/Town

MA
7. State

02554
8. Zip Code

508.228.7244
9. Telephone #

10. Ext. #

Kara Buzanoski
11. Contact Person

kbuzanoski@nantucket-ma.org
12. e-mail address (optional)

## C. Facility, Site or Individual Requiring Approval

Surfside Wastewater Treatment Facility
1. Name of Facility, Site Or Individual

South Shore Road
2. Street Address

Nantucket
3. City/Town

MA
4. State

02554
5. Zip Code

508.228.7244
6. Telephone #

7. Ext. #

Unknown
8. DEP Facility Number (if Known)

Unknown
9. Federal I.D. Number (if Known)

N/A
10. BWSC Tracking # (if Known)

## D. Application Prepared by (if different from Section B)*

Rosemary Blacquier Woodard & Curran, Inc.
1. Name of Firm Or Individual

980 Washnington Street
2. Address

Dedham
3. City/Town

MA
4. State

02026
5. Zip Code

781.251.0200
6. Telephone #

2510
7. Ext. #

Rosemary Blacquier
8. Contact Person

N/A
9. LSP Number (BWSC Permits only)

## E. Permit - Project Coordination

1. Is this project subject to MEPA review? ☐ yes ☒ no
   If yes, enter the project's EOEA file number - assigned when an Environmental Notification Form is submitted to the MEPA unit:

EOEA File Number

## F. Amount Due

*DEP Use Only*

*Permit No:*

*Rec'd Date:*

*Reviewer:*

### Special Provisions:

1. ☒ **Fee** Exempt (city, town or municipal housing authority)(state agency if fee is $100 or less).
   *There are no fee exemptions for BWSC permits, regardless of applicant status.*
2. ☐ Hardship Request - payment extensions according to 310 CMR 4.04(3)(c).
3. ☐ Alternative Schedule Project (according to 310 CMR 4.05 and 4.10).
4. ☐ Homeowner (according to 310 CMR 4.02).

Check Number | Dollar Amount | Date

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection – Individual Permits
Groundwater Discharge Permits, Reclaimed Water Use Permit or Permit Renewal/Modification

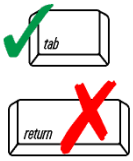
X259168
Transmittal Number #
SE #1-200
Facility ID/Permit # (if known)

Application for Permit to Discharge to Groundwaters of the Commonwealth or for Reclaimed Water Use

**BRP WP 11** Individual Permit Renewal/Modification with Plan Approval
**BRP WP 12** Individual Permit Renewal/Modification without Plan Approval
**BRP WP 79** Individual Permit for Groundwater Discharge from a Sewage Treatment Plant
**BRP WP 84** Individual Permit for Reclaimed Water Use
**BRP WP 85** Individual Permit for Other Groundwater Discharges

# A. General Information

**Important:** When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.




1. Which permit category are you applying for?

☒ **BRP WP 11** Individual Permit Renewal/Modification with Plan Approval

☐ **BRP WP 12** Individual Permit Renewal/Modification without Plan Approval

☐ **BRP WP 79** Individual Permit for Groundwater Discharge from Sewage Treatment Plant

☐ **BRP WP 84** Individual Permit for Reclaimed Water Use

☐ **BRP WP 85** Individual Permit for Other Groundwater Discharge

*Please Note: In accordance with 314 CMR 5.09, these permit categories may require that a Hydrogeological Evaluation be submitted to the Department prior to the submittal of the permit application. Please see the application form and instructions for* ***BRP WP 83.***

2. Applicant Information:

Kara Buzanoski — Contact Name
Town of Nantucket Department of Public Works — Company Name (If applicable)
188 Madaket Road — Address
Nantucket — City/Town
MA — State
02554 — Zip Code
508.228.7244 — Telephone
kbuzanoski@nantucket-ma.gov — Email

3. Applicant Contact Information (if different from above):

Contact Name
Company Name (If applicable)
Title
Address
City/Town
State
Zip Code
Telephone
Email address

4. The legal entity which owns this facility is: ☐ Individual ☐ Private ☐ Corporation

☐ Federal ☐ State/County ☒ Municipality ☐ Other (specify): _____

## A. General Information (cont.)

5. Facility Information:

Surfside Wastewater Treatment Facility
Name of facility

South Shore Road
Address

| Nantucket | MA | 02554 |
|---|---|---|
| City/Town | State | Zip Code |

| 508.325.5333 | kbuzanoski@nantucket-ma.gov |
|---|---|
| Telephone | Email |

6. Facility Operator Information:

Give the name, as it is legally referred to, of the person, firm, public organization or other entity which will operate the facility described in this application. If the facility owner is also the operator, write owner and list mailing address only if different from that listed in number 1 above.

| Owner | Town of Nantucket |
|---|---|
| Operator Name | Operator Company |

188 MAdaket Road
Address

| Nantucket | MA | 02554 | 508.228.7244 |
|---|---|---|---|
| City/Town | State | Zip Code | Telephone |

| | |
|---|---|
| License Number and Operator Grade | Email address |

## B. Project Information

1. Does the project affect a site of historic or archeological significance, as defined in regulations of the Massachusetts Historical Commission, 950 CMR 71.00?

☐ Yes ☒ No

2. Does this project require a filing under 301 CMR 11.00, the Massachusetts Environmental Policy Act?

☐ Yes ☒ No

If yes, has a filing been made? (Please indicate the EOEA File Number)

☐ Yes ☐ No

N/A
EOEA File Number

3. Is this a RCRA facility as defined in 314 CMR 8.03? ☐ Yes ☒ No

If yes, submit the information on Form HW contained in 314 CMR 8.20 in accordance with the provisions of 314 CMR 8.08.

## B. Project Information (cont.)

4. Is the discharge for this facility within:

   a. The Zone I, Zone A, Zone II, or Interim Wellhead Protection Area of a public water supply?

   ☐ Yes ☒ No

   b. A private water supply area? *Refer to Figure 1 for site map. Refer to Appendix A for Particle Trace of flow to ocean and not impacting wells.*

   ☐ Yes ☒ No

   c. A sole source aquifer?

   ☒ Yes ☐ No

   d. 100 feet of an Outstanding Resource Water designated in 314 CMR 4.00, a Special Resource Water designated in 314 CMR 4.00, a cold-water fishery as defined in 314 CMR 9.02, a bathing beach as defined in 104 CMR 445.000, or a shellfish growing area as defined in 314 CMR 9.02?

   ☐ Yes ☒ No

   e. A nitrogen-sensitive area as designated by the Department in accordance with 310 CMR 15.215?

   ☐ Yes ☒ No

   f. An area where the Department has determined based on a Total Maximum Daily Load or other technical report that more stringent effluent limits than those set forth in the General Permit are required to achieve or maintain compliance with the Massachusetts Surface Water Quality Standards, 314 CMR 4.00?

   ☐ Yes ☒ No

5. Improvements - Are you required by any Federal, State or local authority to meet any implementation schedule for the construction, upgrading or operation of wastewater treatment equipment or practices or any other environmental programs which may affect the discharges described in this application? This includes, but is not limited to, permit conditions, administrative or enforcement orders, enforcement compliance schedule letters, stipulations, court orders, and grant or loan conditions.

   ☐ Yes ☒ No

   If yes, answer the following:

## B. Project Information (cont.)

Description of order or agreement (include enforcement document number, if applicable):

Enforcement Document Number: N/A

Description:

Identification No. of Affected Treatment Facility

Description of Project

Final Compliance Date

6. Has a hydrogeologic study been performed to determine the potential impact on the groundwater of the discharge or activity?
   ☒ Yes - Application Transmittal Number: X259157 Date of Approval: Pending-Submitted concurrently w/this

   **Please attach copy of the DEP Hydrogeologic Report Approval Letter.** *See Appendix A.*

   ☐ No – ***STOP: Please Note:*** *In accordance with 314 CMR 5.09, these permit categories may require that a Hydrogeological Evaluation be submitted to the Department prior to the submittal of the permit application. Please see the application form and instructions for BRP WP 83.*

7. Are there any groundwater monitoring wells currently in place in the vicinity of the discharge or proposed discharge?
   ☒ Yes **If yes, please attach information on the type and location of the wells and available monitoring data.** *See Appendix B for a map of the well locations***.**

   ☐ No

8. Have plans and specifications for the treatment works been approved (see instructions) by the Department or if approved prior to July 1975, by the Department of Public Health?
   ☒ Yes **If yes, please attach copy of plans and specifications and approval letter.** *Plans and Specs for WWTF were submitted to MassDEP on July 1, 2005 in Transmittal W065519.*

   ☐ No

## B. Project Information (cont.)

9. Is there a local regulation governing the construction of wastewater treatment facilities?

   ☐ Yes **If yes, please include a copy of the local approval.**

   ☐ No

10. Have opportunities for reclaimed water been evaluated? ☐ Yes ☒ No

## C. Facility Information

1. Facility Status: ☒ Existing ☐ Proposed
2. When did or when will this discharge begin? 2008-WWTF Upgrade. Addt'l flows ~2024
   Date of Startup
3. Check type of establishment producing or contributing to discharge:

   ☐ Residential:

   ☐ Condominium

   ☐ Apartment

   ☐ Elderly Housing

   ☐ Nursing Home

   ☐ Other (specify): _____

   Total # of Bedrooms: _____

   ☒ Municipality

   ☐ Business Nature of Business: _____

   ☐ School

   ☐ Other (specify): _____

## C. Facility Information (cont.)

4. Design Flow: See Appendices C, D and E
Daily Maximum gpd

   a) ☒ Check here if discharge occurs all year, or

   b) List months discharge occurs _____

   c) Number of days per week discharge occurs _____

5. Basis for design flow:

   ☐ The State Environmental Code – Title 5

   ☒ Other: 2004 CWMP and Surfside O& M Manual - See Appendix E (CD Format)
   Specify

6. Type of treatment and disposal system:

   Membrane Bioreactor (MBR) facility (2005) with Class I Discharge to 15 open sand beds

7. Location and method of wastewater treatment solids disposal:

   Sludge is discharged at Liquid Sludge Station and into ATB Sludge Holding Tanks for storage and eventual dewatering by Rotary Presses. Sludge cakes are transported to Town's Landfill for disposal.

8. If a commercial establishment:

   A. Are any types of wastewater other than sanitary sewage produced?

   ☐ Yes ☒ No

   If yes: _____
   Specify type of wastewater

   _____
   Quantity gpd

   _____
   Method and location of disposal

## C. Facility Information (cont.)

B. Are any hazardous wastes generated?

☐ Yes ☒ No

9. Does or will the treatment/disposal facility receive industrial wastes?

☐ Yes ☒ No

10. Location of Facility:

A. GPS Coordinates:

1) Enter Latitude and Longitude to the nearest whole second for both the wastewater treatment facility and the effluent disposal area.

Latitude: 41.244 Longitude: -70.104

2) Provide a narrative description of the site and the feature to be permitted. As an example: "The site is on the west side of Main Street, the third building north of High Street. The disposal field lies 100 feet off the southwest corner of the building."
3) Attach a site map based on the MassGIS Coordinate Information Tool that clearly indicates the site. The Coordinate Information Tool is available at http://maps.massgis.state.ma.us/images/dep/xyinfo/get_xy.html. *See Figure 2*

B. Provide a topographic map or maps of the area extending at least to one mile beyond the property boundaries of the facility which clearly show the following: *See Figure 1*

1) The legal boundaries of the facility;
2) The location and serial number of each of your existing and proposed intake and discharge structures;
3) All hazardous waste management facilities;
4) All springs and surface water bodies in the area, plus all drinking water wells within one mile of the facility which are identified in the public record or otherwise known to you.
5) All Zone II's or IWPA's.

If an intake or discharge structure, hazardous waste disposal site, or injection well associated with the facility is located more than one mile from the plant, include it on the map, if possible. If not, attach additional sheets describing the location of the structure, disposal site, or well, and identify the U.S. Geological Survey (or other) map corresponding to the location.

## C. Facility Information (cont.) *Refer to Figure 1 and Section C Narrative*

C. Please list any public or private drinking water supply wells within 2,500 feet of the discharge area:

| Well Location | Type of Well (Public/Private) | Status (Active/Inactive) | Safe Yield |
|---|---|---|---|
| See Figure 1 | | | |
| | | | |
| | | | |

11. Water Supply Data

A. List sources of water supply and annual water consumption for the past five years. *Refer to Appendix E*

| Water Sources | Year 1 | Year 2. | Year 3. | Year 4. | Year 5. |
|---|---|---|---|---|---|
| 1. | | | | | |
| 2. | | | | | |
| 3. | | | | | |
| Total: | | | | | |

B. Please show the location of your water sources on the map described in question 10.

## D. Additional Information for Reclaimed Water Use (WP 84) N/A

1. Has a Reuse Management Plan been prepared?

☐ Yes **If yes, please attach copy.**

☐ No

2. Will the reclaimed water be used by persons other than the permittee?

☐ Yes **If yes, a Service & Use Agreement must be submitted with the application.**

☐ No

## D. Additional Information for Reclaimed Water Use (WP 84) (cont.)

3. Has the reclaimed water system been prepared in accordance with all applicable requirements of 248 CMR 10.00: Uniform State Plumbing Code?

   ☐ Yes

   ☐ No

4. List the Reclaimed Water Use(s) as defined by 314 CMR 20.17.

   _____

   _____

   _____

## E. Additional Information for Other Groundwater Discharges (WP 85)

1. Flows, Sources of Pollution and Treatment Technologies

   A. Attach a line drawing showing the water flow through the facility. Indicate sources of intake water, operations contributing wastewater to the effluent, and treatment units labeled to correspond to the more defined descriptions in Item E.1.B. Construct a water balance on the line drawing by showing average flows between intakes, operations, treatment units and outfalls. If a water balance cannot be determined provide a pictorial description of the nature and amount of any sources of water and any collection or treatment measures.

   B. For each discharge, provide a description of:

      1) All operations contributing wastewater to the effluent, cooling water and runoff;
      2) The average flow contributed by each operation; and
      3) The treatment received by the wastewater. (Attach additional sheets if necessary.)
      4) With the exception of storm water runoff, leaks, or spills please note if any of the discharges described are intermittent or seasonal.

**Operations Contributing to Flow:**

| Identification Number | Operations | Average Flow | Treatment |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

## E. Additional Information for Other Groundwater Discharges (WP 85)

2. Effluent Limitations:

A. List any pollutant you know or have reason to believe is discharged or may be discharged from the treatment facilities. For every pollutant you list, briefly describe the reason you believe it to be present, its approximate concentration in the discharge and any analytical data in your possession, which will support your statement. Additional wastewater analysis may be required as part of this application.

| Pollutant | Concentration | Source | Available Data |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

B. Are your operations such that your raw materials, processed, or products can reasonably be expected to vary so that your discharges of pollutants may during the next five years exceed three times the approximate concentrations reported in item 2A?

☐ Yes (please explain) ☐ No

C. Are you planning on adding any new processes over the next five years?

☐ Yes (please specify) ☐ No

D. Are organic compounds used at your facility?

☐ Yes (please explain) ☐ No

## E. Additional Information for Other Groundwater Discharges (WP 85)

3. Were any of the analyses or testing reported in item E.2.A. performed by a contract laboratory or consulting firm?

   ☐ Yes (provide contact information) ☐ No

   Name of Laboratory or Consulting Firm/Contact Person

   Address

   City/Town | State | Zip Code

   Telephone | Email Address

   **For Individual permits BRP WP 11, 12, 79, 85, please complete Section F on this form. For Reclaimed Water System Permits and renewals of those permits, please skip Section F and complete Section G of this form.**

## F. Applicant Certification for Individual Permits BRP WP 11, 12, 79, 85

1. I hereby acknowledge that it is my responsibility:

   a. to ensure that I understand the "Requirements for Privately Owned Wastewater Treatment Facilities" set forth at 314 CMR 5.15 (1), (2), and (3) and in related provisions of the Ground Water Discharge Permit Program regulations, 314 CMR 5.00, before I provide the certification in paragraph 2, below;

   b. to ensure that I have compiled, evaluated and/or established all pertinent documents, instruments, records and information necessary to provide the certification in paragraph 2, below; and

   c. to consult with legal, technical and other qualified professionals, as necessary for me to understand and comply with the above requirements and to make the certification in paragraph 2, below.

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection – Individual Permits
Groundwater Discharge Permits,
Reclaimed Water Use Permit or
Permit Renewal/Modification

X259168
Transmittal Number #
SE #1-200
Facility ID/Permit # (if known)

Application for Permit to Discharge to Groundwaters of the Commonwealth or for Reclaimed Water Use

**BRP WP 11** Individual Permit Renewal/Modification with Plan Approval
**BRP WP 12** Individual Permit Renewal/Modification without Plan Approval
**BRP WP 79** Individual Permit for Groundwater Discharge from a Sewage Treatment Plant
**BRP WP 84** Individual Permit for Reclaimed Water Use
**BRP WP 85** Individual Permit for Other Groundwater Discharges

## F. Applicant Certification for Individual Permits BRP WP 11, 12, 79, 85

2. Based on the foregoing (select either a or b):
   a. ☒ I hereby certify that I have fully and completely satisfied and complied with each and every requirement set forth in 314 CMR 5.15 (1), (2), and (3), as applicable to the existing or proposed privately owned wastewater treatment facility ("PWTF"), for an individual permit issued under 314 CMR 5.00 to construct, install, modify, operate and maintain a PWTF; and will continue to do so until a final decision on this application has been issued by the Department and, if this application is approved, will do so thereafter in accordance with permit conditions.
   b. ☐ I hereby acknowledge that no later than sixty (60) days from the date of this application, unless I request in writing and the Department agrees in writing to a later date, and in any case prior to the issuance of a notice of a draft permit pursuant to 314 CMR 2.06, "Public Notice and Comment," I am required to submit to the Department a fully signed and dated **Supplemental Applicant Certification** (Appendix A), which will include the certification in paragraph 2a, above, and the other paragraphs of this section F.

3. I shall maintain a copy of all records, regardless of form (e.g., both printed and electronic) upon which I rely in making the certifications in this Section F, until a final decision on this application has been issued by the Department and, if this application is approved, will do so thereafter in accordance with permit conditions. Such records shall include without limitation all documents described in paragraph 1, above, and any supporting documentation provided to me by, or relied upon by, such qualified professionals as I may consult in certifying as to the information set forth in paragraph 2, above.

4. I am aware that submitting a false and misleading certification could lead to modification, suspension, or revocation of any permit granted pursuant to this application, as set forth in 314 CMR 5.12.

5. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my diligent inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

6. I will be responsible for publication of public notice of the applicable permit proceedings identified under 314 CMR 2.06(1)(a) through (d).

Kara Br
Signature of Applicant

Kara Buzanoski
Printed Name of Applicant

1/17/14
Date Signed

Rosemary Blacquier
Name of Preparer

781.251.0200
Telephone

Project Manager
Title of Preparer

rblacquier@woodardcurran.com
Email

## G. Applicant Certification for Reclaimed Water Use Permit BRP WP 84

1. I hereby acknowledge that it is my responsibility:

a. to ensure that I understand the "Requirements for Privately Owned Reclaimed Water Systems" set forth at 314 CMR 20.14(1) and in related provisions of the Reclaimed Water Permit Program regulations, 314 CMR 20.00, before I provide the certification in paragraph 2, below;

b. to ensure that I have compiled, evaluated and/or established all pertinent documents, instruments, records and information necessary to provide the certification in paragraph 2, below; and

c. to consult with legal, technical and other qualified professionals, as necessary for me to understand and comply with the above requirements and to make the certification in paragraph 2, below.

2. Based on the foregoing **(select either a or b)**:

a. ☐ I hereby certify that I have fully and completely satisfied and complied with each and every requirement set forth in 314 CMR 20.14(1), as applicable to the existing or proposed reclaimed water system, for a permit issued under 314 CMR 20.00; and will continue to do so until a final decision on this application has been issued by the Department and, if this application is approved, will do so thereafter in accordance with permit conditions.

b. ☐ I hereby acknowledge that no later than sixty (60) days from the date of this application, unless I request in writing and the Department agrees in writing to a later date, and in any case prior to the issuance of a notice of a draft permit pursuant to 314 CMR 2.06, "Public Notice and Comment," I am required to submit to the Department a fully signed and dated **Supplemental Reclaimed Water Applicant Certification** (Appendix B), which will include the certification in paragraph 2a, above, and the other paragraphs of this Section G.

3. I shall maintain a copy of all records, regardless of form (e.g., both printed and electronic) upon which I rely in making the certifications in this Section G, until a final decision on this application has been issued by the Department and, if this application is approved, will do so thereafter in accordance with permit conditions. Such records shall include without limitation all documents described in paragraph 1, above, and any supporting documentation provided to me by, or relied upon by, such qualified professionals as I may consult in certifying as to the information set forth in paragraph 2, above.

4. I am aware that submitting a false and misleading certification could lead to modification, suspension, or revocation of any permit granted pursuant to this application, as set forth in 314 CMR 20.19.

## G. Applicant Certification for Reclaimed Water Use Permit BRP WP 84

5. I attest under the pains and penalties of perjury that I have personally examined and am familiar with the information contained in this document and all attachments, and that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my diligent inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information contained in this submittal is, to the best of my knowledge and belief, true, accurate, and complete. I am authorized to make this attestation on behalf of this permittee. I am aware that there are significant penalties for submitting false, inaccurate or incomplete information, including, but not limited to, the possibility of fine and imprisonment for knowing violations.

6. I will be responsible for publication of public notice of the applicable permit proceedings identified under 314 CMR 2.06(1)(a) through (d).

| | |
|---|---|
| Signature of Applicant | Printed Name of Applicant |
| Date Signed | |
| Name of Preparer | Telephone |
| Title of Preparer | Email |

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection – Individual Permits
Groundwater Discharge Permits,
Reclaimed Water Use Permit or
Permit Renewal/Modification

X259168
Transmittal Number #
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Facility ID/Permit # (if known)

Application for Permit to Discharge to Groundwaters of the Commonwealth or for Reclaimed Water Use

**BRP WP 11** Individual Permit Renewal/Modification with Plan Approval
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**BRP WP 79** Individual Permit for Groundwater Discharge from a Sewage Treatment Plant
**BRP WP 84** Individual Permit for Reclaimed Water Use
**BRP WP 85** Individual Permit for Other Groundwater Discharges

# Appendix A: Supplemental Applicant Certification (BRP WP 11,12, 79, 85)

On January 23, 2014 (insert date),

the undersigned applicant submitted a BRP WP 11 (insert permit type number) application for a Individual Permit renewal/Modification with Plan Approval (insert permit type name) for the Surfside Wastewater Treatment Facility (insert facility name)

By its signature hereto, the undersigned applicant hereby incorporates this instrument into and makes this instrument a part of, said application.

1. I hereby acknowledge that it is my responsibility:

   a. to ensure that I understand the "Requirements for Privately Owned Wastewater Treatment Facilities" set forth at 314 CMR 5.15 (1), (2), and (3) and in related provisions of the Ground Water Discharge Permit Program regulations, 314 CMR 5.00, before I provide the certification in paragraph 2, below;

   b. to ensure that I have compiled, evaluated and/or established all pertinent documents, instruments, records and information necessary to provide the certification in paragraph 2, below; and

   c. to consult with legal, technical and other qualified professionals, as necessary for me to understand and comply with the above requirements and to make the certification in paragraph 2, below.

2. Based on the foregoing, I hereby certify that I have fully and completely satisfied and complied with each and every requirement set forth in 314 CMR 5.15 (1), (2), and (3), as applicable to the existing or proposed privately owned wastewater treatment facility ("PWTF"), for an individual permit issued under 314 CMR 5.00 to construct, install, modify, operate and maintain a PWTF; and will continue to do so until a final decision on this application has been issued by the Department and, if this application is approved, will do so thereafter in accordance with permit conditions.

3. I shall maintain a copy of all records, regardless of form (e.g., both printed and electronic) upon which I rely in making the certifications in this Appendix A, until a final decision on this application has been issued by the Department and, if this application is approved, will do so thereafter in accordance with permit conditions. Such records shall include without limitation all documents described in paragraph 1, above, and any supporting documentation provided to me by, or relied upon by, such qualified professionals as I may consult in certifying as to the information set forth in paragraph 2, above.

4. I am aware that submitting a false and misleading certification could lead to modification, suspension, or revocation of any permit granted pursuant to this application, as set forth in 314 CMR 5.12.

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection – Individual Permits
Groundwater Discharge Permits,
Reclaimed Water Use Permit or
Permit Renewal/Modification

X259168
Transmittal Number #

SE #1-200
Facility ID/Permit # (if known)

Application for Permit to Discharge to Groundwaters of the Commonwealth or for Reclaimed Water Use

**BRP WP 11** Individual Permit Renewal/Modification with Plan Approval
**BRP WP 12** Individual Permit Renewal/Modification without Plan Approval
**BRP WP 79** Individual Permit for Groundwater Discharge from a Sewage Treatment Plant
**BRP WP 84** Individual Permit for Reclaimed Water Use
**BRP WP 85** Individual Permit for Other Groundwater Discharges

## Appendix A: Supplemental Applicant Certification (cont.)

5. I certify under penalty of law that this document was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my diligent inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature of Applicant

Kara Buzanoski
Printed Name of Applicant

1/17/14
Date Signed

Rosemary Blacquier
Name of Preparer

781.251.0200
Telephone

Project Manager
Title of Preparer

rblacquier@woodardcurran.com
Email

# Appendix B: Supplemental Reclaimed Water Applicant Certification

On _____ (insert date),

the undersigned applicant submitted a BRP WP _____ (insert permit type number) application for a

_____ (insert permit type name) for the

_____ (insert facility name)

By its signature hereto, the undersigned applicant hereby incorporates this instrument into and makes this instrument a part of, said application.

1. I hereby acknowledge that it is my responsibility:

   a. to ensure that I understand the "Requirements for Privately Owned Reclaimed Water Systems" set forth at 314 CMR 20.14(1) and in related provisions of the Reclaimed Water Permit Program regulations, 314 CMR 20.00, before I provide the certification in paragraph 2, below;

   b. to ensure that I have compiled, evaluated and/or established all pertinent documents, instruments, records and information necessary to provide the certification in paragraph 2, below; and

   c. to consult with legal, technical and other qualified professionals, as necessary for me to understand and comply with the above requirements and to make the certification in paragraph 2, below.

2. Based on the foregoing, I hereby certify that I have fully and completely satisfied and complied with each and every requirement set forth in 314 CMR 20.14(1), as applicable to the existing or proposed privately owned reclaimed water system, for a permit issued under 314 CMR 20.00; and will continue to do so until a final decision on this application has been issued by the Department and, if this application is approved, will do so thereafter in accordance with permit conditions.

3. I shall maintain a copy of all records, regardless of form (e.g., both printed and electronic) upon which I rely in making the certifications in this Appendix B, until a final decision on this application has been issued by the Department and, if this application is approved, will do so thereafter in accordance with permit conditions. Such records shall include without limitation all documents described in paragraph 1, above, and any supporting documentation provided to me by, or relied upon by, such qualified professionals as I may consult in certifying as to the information set forth in paragraph 2, above.

4. I am aware that submitting a false and misleading certification could lead to modification, suspension, or revocation of any permit granted pursuant to this application, as set forth in 314 CMR 20.19.

# Appendix B: Supplemental Reclaimed Water Applicant Certification

5. I certify under penalty of law that this document was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my diligent inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

| | |
|---|---|
| Signature of Applicant | Printed Name of Applicant |
| Date Signed | |
| Name of Preparer | Telephone |
| Title of Preparer | Email |

## C. Facility Information

**10 (A) (2) *Provide a narrative description of the site and the feature to be permitted.***

The Surfside WWTF Facility and Discharge Beds site is located on the southern shore directly abutting the Atlantic Ocean. Refer to Figures 1 and 2 for locus plans. The wastewater complex is situated at the end of south Shore Road and east of Miacomet Pond. The WWTF is immediately north of fifteen open sand beds that abut the shoreline adjacent to the Atlantic Ocean. The open sand beds range in size from 35,717 square feet (bed #4) to 47,306 square feet (bed #8) encompassing a total of almost 15 acres. The WWTF utility is located wholly on Town-owned parcels that encumber approximately 80 acres, with multiple smaller Town-owned properties immediately abutting the WWTF to the west.

This modification to the existing Groundwater Discharge Permit No. SE#1-200 is requesting that additional flow be allowed to be discharged to the existing 15-bed configuration-from existing permit 3.4 MGD to 4.0 MGD. The Particle Trace Analyses completed as part of the Hydrogeological Study detailed in the December 16, 2013 Technical Memorandum included in the Hydrogeological Technical Memorandum Report in Appendix A supports the modification to the current Groundwater Discharge Permit, details all flow from the WWTF and subsequent flow from open sand beds are contained within Town property limits and/or to the ocean. The detail also confirms maintaining a four-foot separation during high flow periods for 30-days in August. Historically, the Town sees high flows for two weeks in August, so the August Particle Trace is a conservative analysis.

**A (3) Attach a site map based on the MassGIS Coordinate Information Tool that clearly indicates the site.**

Refer to Figure 2 included herein.

**B Provide topographic map or maps of the area extending at least to one mile beyond the property boundaries of the site which clearly show the following:**

1. **Legal boundaries of the site**
2. **All hazardous waste management facilities**
3. **All springs and surface water bodies in the area, plus all drinking water wells within one mile of the facility which are identified in the public record or otherwise know to you**
4. **All Zone II's or IPWA's**

Refer to Figure 1 from MassGIS and Town Assessor and GIS records that detail the following:

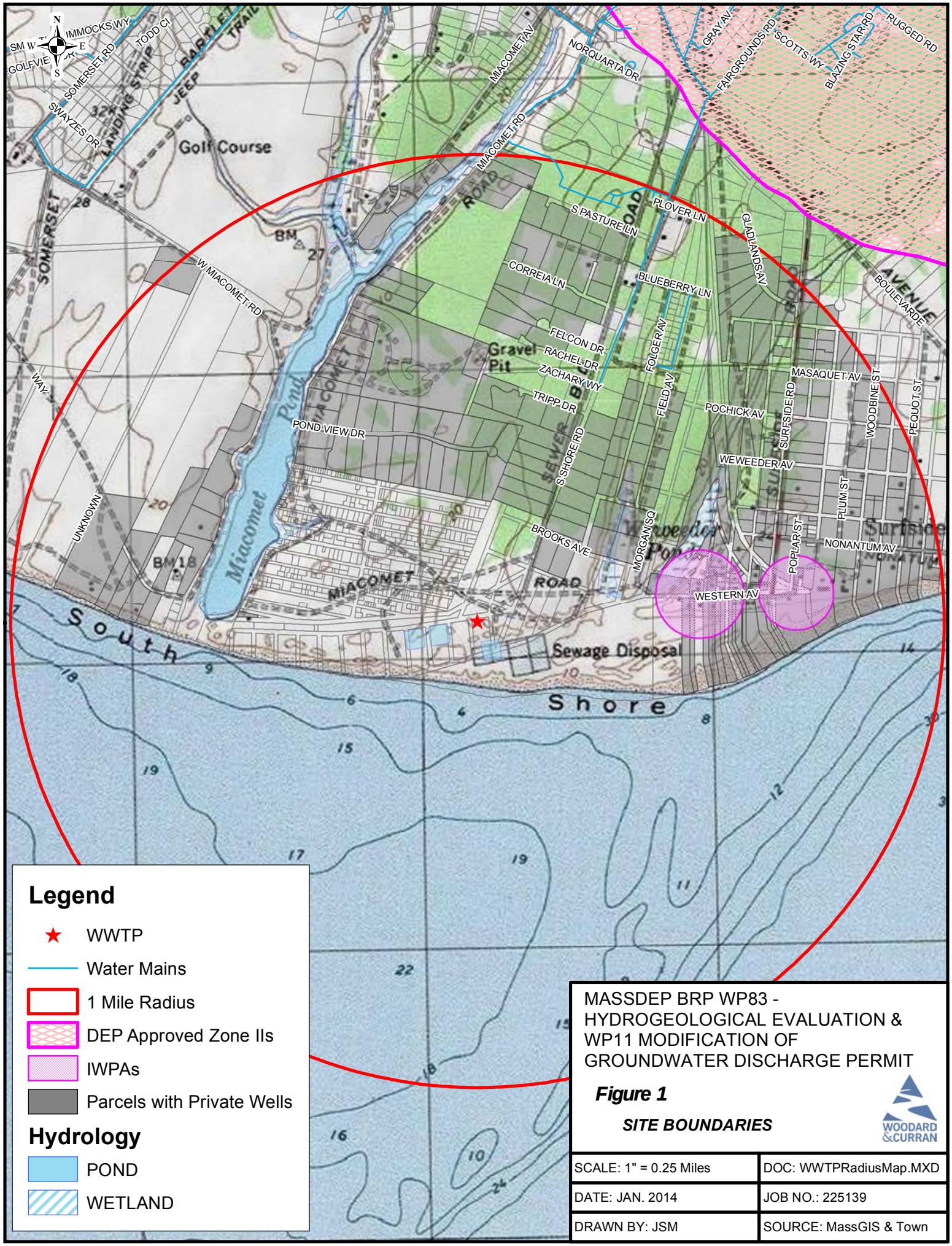
1. Legal boundaries of site, as well as surrounding sites
2. No hazardous waste management facilities within one mile of the site
3. All water bodies and wetlands from MassGIS shown. Approximately 334 parcels within the one mile radius with private wells. All private wells are upgradient to the WWTF discharge and not in an area of impact to the existing or proposed discharge. The Particle Trace Analyses completed and in the Hydrogeological Technical Memorandum detail all flow going south to the Atlantic Ocean.

**3 Please list any public or private drinking water supply wells within 2,500 feet of the proposed site**

Figure 1 from MassGIS shows two public water supply wells within 2,500 feet from the WWTF site:

| | | | |
|---|---|---|---|
| Source ID 4197010-01G | Star of the sea Youth Hostel | Public Water Supply –TNC | Yield-Unknown |
| Source ID 4197008-01G | Surfside Beach | Public Water Supply | Yield-Unknown |

Refer to Appendix B included herein for a map of the site's monitoring wells.


Legend
WWTP
Water Mains
1 Mile Radius
DEP Approved Zone IIs
IWPAs
Parcels with Private Wells
Hydrology
POND
WETLAND
Miacomet Pond
Golf Course
Gravel Pit
Sewage Disposal
South Shore
MIACOMET ROAD
W MIACOMET RD
MIACOMET AV
NORQUARTA DR
S PASTURE LN
PLOVER LN
CORREIA LN
BLUEBERRY LN
FELCON DR
RACHEL DR
ZACHARY WY
TRIPP DR
POND VIEW DR
S SHORE RD
BROOKS AVE
MORGAN SQ
FOLGER AV
FIELD AV
GLADLANDS AV
POCHICK AV
WEWEEDER AV
MASAQUET AV
SURFSIDE RD
WOODBINE ST
PEQUOT ST
PLUM ST
POPLAR ST
NONANTUM AV
WESTERN AV
GRAY AV
FAIRGROUNDS RD
SCOTTS WY
BLAZING STAR RD
RUGGED RD
SOMERSET RD
SWAYZES DR
TODD CI
IMMOCKS WY
GOLFVIEW DR
JEEP TRAIL
LANDING STRIP
UNKNOWN WAY
BOULEVARDE AVENUE
MASSDEP BRP WP83 - HYDROGEOLOGICAL EVALUATION & WP11 MODIFICATION OF GROUNDWATER DISCHARGE PERMIT
Figure 1
SITE BOUNDARIES
WOODARD & CURRAN
SCALE: 1" = 0.25 Miles
DOC: WWTPRadiusMap.MXD
DATE: JAN. 2014
JOB NO.: 225139
DRAWN BY: JSM
SOURCE: MassGIS & Town

MassDEP
Massachusetts Department of Environmental Protection

## Coordinate Information Tool

Click on the map and get coordinate information in NAD83UTM and WGS84 (Lat/Lon).

Enter Address: South shore Road Nantucket MA [Search]

1. Enter a complete street address then click the Search button.
2. To refine the map display use the Map Tools then click on location with the XY tool.

**Helpful Links**

Priority Resource Map View

MCP NRS Map

Commonwealth of Massachusetts Office of Geographic Information (MassGIS)

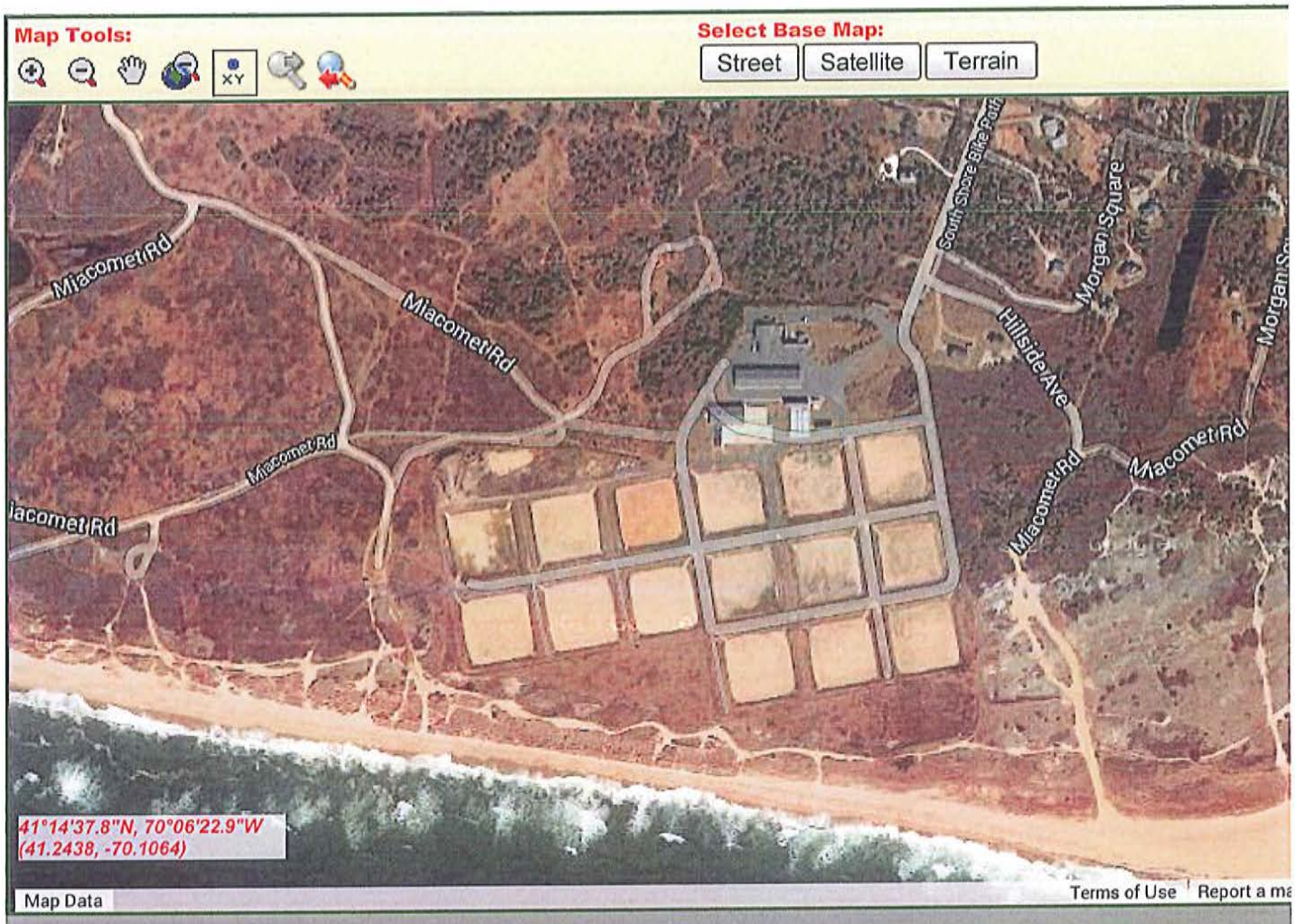



Figure 2

# APPENDIX A: HYDROGEOLOGICAL TECHNICAL MEMORANDUM REPORT

COMMITMENT & INTEGRITY
DRIVE RESULTS

980 Washington Street | Suite 325
Dedham, Massachusetts 02026
www.woodardcurran.com

T 800.446.5518
T 781.251.0200
F 781.251.0847

**TECHNICAL MEMORANDUM**

**TO:** Massachusetts Department of Environmental Protection (MassDEP)
**FROM:** Cary Parsons, Tom Hazlett and Rosemary Blacquier
**DATE:** December 16, 2013
**RE:** Final Hydrogeological Report – Analysis For Additional Loading of Groundwater Disposal Beds at Surfside WWTF, Nantucket, MA

## BACKGROUND

The Town of Nantucket is in the process of completing a Comprehensive Wastewater Management Plan (CWMP) Update based on the Final Recommended Plan detailed in the 2004 CWMP Report. The major driver to the Update is the completion of Massachusetts Estuaries Program (MEP) Reports at various embayment/estuary locations on Island that are documented as degraded due to nutrient loading with the major contributor being on-site wastewater disposal systems. A review was completed and based on the MEP recommendations additional areas are now being recommended to be connected to the municipal wastewater system at Surfside WWTF. Revised wastewater flows were calculated that identified a need for additional capacity at the Town's main WWTF at Surfside. A capacity analysis determined the WWTF could handle the additional flows under its current permit with the limiting factor being the groundwater discharge beds that are permitted to handle 3.4 MGD. A total of 4.0 MGD is needed to handle the additional flows.

An initial meeting with MassDEP at their Boston offices on June 18, 2013 opened the discussion of increasing the loading to the beds based on existing conditions and current operations. Subsequent to the June meeting, a Scope of Work was developed and sent to MassDEP on August 16, 2013 and ultimately approved by MassDEP to complete a hydrogeological evaluation to determine if loading the existing beds at a higher rate was feasible. This evaluation agreed to look at three main items: 1) Capacity of existing beds to handle additional discharge through hydrogeological analysis; 2) Analysis of existing shoreline down gradient from WWTF relating to stability of shoreline; and 3) Determination of additional loading to identify any potential threat of breakout conditions to the down gradient beach/shoreline area as a result of additional loading. At the meeting on December 6, 2013 it was agreed that the model would be re-run utilizing both summer maximum and average daily build out flows, with the summer max run for the month of August (4.0 MGD for August) and the remainder of the year run at summer average daily flows at build out flows of 2.92 MGD. This schedule would also be considered conservative as the Town stated the Surfside WWTF only receives the maximum summer flows for two weeks in August.

This Technical Memorandum represents the final deliverable for the above referenced tasks. This Technical Memorandum summarizes current site conditions, the data utilized in the hydrogeological evaluation, including the model and method for determining high groundwater, the actual analysis and results, the shoreline stability analysis, potential for breakout determination and conclusions. This analysis will serve as the basis for the CWMP Update recommendation for Surfside WWTF and for renewal of the Town's Groundwater Discharge Permit No.SE#1-200, which was extended by Chapter 238 of the Acts of 2012 and is now due on 6/15/2015. At the December 6, 2013 meeting MassDEP agreed that once the hydrogeological analysis was in order to support the additional flow, they will re-issue the new permit now and not wait until it expires in June 2015.

Additional information requested at the December 6, 2013 meeting was a copy of the revised FEMA maps for the site. Refer to Figure 18 for a copy of the map of the site. The Emergency Management Director for Nantucket, Dave Fronzuto, was contacted to discuss the site and any changes to the area that would be of concern. He also contacted Coastal Zone Management (CZM) to assess their

conclusions of this area and it was stated that there were very few changes, if any, to this area and that the site was considered stable.

The Woodard & Curran approach to this Technical Memorandum, as described in our August 16th Scope of Work was to replicate the modeling exercise that was completed in 2002 by EarthTech and reported on in their 2005 Groundwater Discharge Permit Application to support additional loading of existing beds without environmental or public health impact.

The Town is in the process of having the wells on site surveyed, as discussed and agreed to on December 6, 2013, and will utilize the new data resulting from the survey for future well readings. Once this is complete, the Department will be notified that all survey work is complete.

## 1.0 CURRENT SITE CONDITIONS

The Surfside WWTF is located on the south side of Nantucket Island directly abutting the Atlantic Ocean. There are presently 15 open sand beds currently in use for wastewater disposal after treatment at the Surfside MBR Facility. Each of the beds contains approximately one acre in bottom area. On Sept 11, 2013, W&C's geologist and Kevin Manning (treatment plant operator from Nantucket) measured the bottom dimensions of each bed not described in the As Built drawings developed by EarthTech, totaling 10 in all. The beds are of slightly different sizes, ranging from the smallest at 35,700 square feet to the largest which is about 44,900 square feet. The median size is 42400 square feet. The bed dimensions are shown in Table 1 below.

**Table 1**
**Nantucket Surfside Bed Areas**

| | | North South (ft) | East West (ft) | | Bed Area (sqft) | | |
|---|---|---|---|---|---|---|---|
| **1** | * | 216 | 208 | | 44928 | | |
| **2** | * | 211 | 210 | | 44310 | | |
| **3** | * | 212 | 211 | | 44732 | | |
| **4** | * | 191 | 187 | | 35717 | | |
| **5** | * | 201 | 204 | | 41004 | | |
| **6** | * | 199 | 204 | | 40596 | | |
| **7** | * | 206 | 204 | | 42024 | | |
| **8** | * | 217 | 218 | | 47306 | | |
| **9** | * | 211 | 215 | | 45365 | | |
| **10** | x | 200 | 193 | | 38600 | | |
| **11** | * | 198 | 201 | | 39798 | | |
| **12** | * | 189 | 204 | | 38556 | | |
| **13** | x | 206 | 206 | | 42436 | | |
| **14** | x | 212 | 212 | | 44944 | | |
| **15** | x | 212 | 212 | | 44944 | | |
| **TOTAL** | | | | | **635,260** | | |

* measured by Cary and Kevin 9-11-13
x taken from record drawings

Using the above Table 1, with a 2,000,000 GPD Daily Flow and a total bed area of 635,260 that relates to a current loading factor of 3.15 GPD/sqft.

The entire Surfside WWTF site is located in an area similar to Cape Cod and is composed of glacial outwash sands and gravels. The aquifer is a simple water table aquifer with no complexities such as confining beds or semi-confined layers. The full depth of the working aquifer is not known from borings

Woodard& Curran has access to; however, the EarthTech report utilized and noted in the next section suggests that the aquifer materials may extend to depths greater than 200 feet. The EarthTech report details that the fresh water aquifer may only extend to 100 or 200 feet based on the Ghyben-Herzberg principal. Ghyben-Herzberg states that for every 1 foot of fresh water that is standing above sea level, the fresh water / salt water interface should be 40 feet below sea level.

The following map downloaded from Google Earth, Figure 1, shows an aerial view of the entire Surfside site, including the WWTF, discharge beds and lower beach/shoreline area.

Google earth

feet 3000
km 1

Figure 1

FIG X

## 1.1 DATA UTILIZED IN HYDROGEOLOGICAL EVALUATION

The greatest effort in this task was to establish the appropriate water table map for a typical August from data that is available at this time. Fortunately, the earlier reports completed by EarthTech and GZA, provided the appropriate fall high water table using the Frimpter method. Data obtained from various reports in the paper trail for the Surfside location, (noted when used); have given Woodard & Curran some basic information to manipulate in trying to create a typical August water table map. The process of creating the August water table map is described in a section below.

Groundwater levels for the 2002 EarthTech report, drew on earlier work compiled in the 1980's and 1990's and used the Frimpter Method to establish the necessary water table maps. The EarthTech report and the GZA report of 1980 both referenced a Sept 1979 GWL map presented in the GZA report of 1980. Woodard & Curran accepted the Sept 20, 1979 GWL map as representative of typical conditions in the August and Sept period of high flow for the treatment plant and utilized this same data for this exercise.

Based on the description from EarthTech in their June 2005 report, Woodard & Curran built a nearly duplicate groundwater model to the model presented in the EarthTech report. Woodard & Curran located the existing 15 disposal beds as they are now found in the field. Each disposal bed was given a different color in the model to signify its disposal load. Refer to Figure 1 for the map downloaded from Google Earth as a site plan of the facility. The Woodard & Curran model has three model layers as does the EarthTech model. These layers represent the thickness of the fresh water aquifer and the aquifer thickness increases as one moves from the shore line back into the interior of the island.

An additional large scale site plan of the facility is included in Attachment A. Previous reports and data utilized in this evaluation are listed in the August 16, 2013 Scope of Work included in Attachment B.

The GW model chosen for this modeling exercise is the same as used by EarthTech. This is the MODFLOW model from the USGS, perhaps the most widely used model in groundwater level prediction. The Woodard & Curran model was constructed to mimic the EarthTech model as closely as possible. The model was calibrated against the only recently published groundwater table map for the area, the Sept 20, 1979 map published by GZA in their 1980 report and reused by EarthTech in the GDP application of 2005.

Exact model data files were not published by EarthTech in their 2005 report, however, from the data given, Woodard & Curran has closely reproduced the model. The calibration statistics for the Woodard & Curran model are given in the Table 2 below.

**Table 2**
**Woodard & Curran Calibration Statistics**

| Name | Observed | Computed | Residual |
|---|---|---|---|
| N-1 | 2.7 | 2.9 | -0.19149 |
| N-8 | 2 | 2.9 | -0.88175 |
| SU-M | 3.7 | 3.3 | 0.354274 |
| N-13 | 3.8 | 3.7 | 0.108642 |
| N-5 | 4.3 | 4.2 | 0.130373 |
| N-3 | 4.1 | 4.1 | 0.044081 |
| N-4 | 4.5 | 3.8 | 0.685391 |
| N-6 | 4.3 | 4.5 | -0.22127 |
| N-9 | 4.6 | 5.2 | -0.59368 |
| | | | |
| Residual Mean | | -0.06283 | |
| Absolute Residual Mean | | | 0.356774 |
| Residual Std. Deviation | | 0.447967 | |
| Sum of Squares | | 1.841593 | |
| RMS Error | 0.452351 | | |
| Min. Residual | | -0.88175 | |
| Max. Residual | | 0.685391 | |
| Number of Observations | | | 9 |
| Range in Observations | | 2.6 | |
| Scaled Residual Std. Deviation | | | 0.172295 |
| Scaled Absolute Residual Mean | | | 0.137221 |
| Scaled RMS Error | | 0.173981 | |
| Scaled Residual Mean | | -0.02416 | |

The calibration statistical values presented in Table 2 above are representative to those presented in the EarthTech Report and suggests a reasonably solid calibration for the W&C model.

**Calculations of Typical Fall Water Table**

As mentioned above, the earlier reports from GZA and EarthTech have reported that due to conditions of the beds being in continual service, the Frimpter Method is the only method for determining reasonable groundwater levels at the site.(see page 5-EarthTech GWD permit application-6-28-05). Woodard & Curran has not attempted to rerun the Frimpter method for estimating groundwater levels in the fall. We have accepted the water levels as presented via the Frimpter method in the EarthTech report for Sept 20, 1979.

Below, we present our discussion for working with the Frimpter groundwater levels.

**Water Table**

Woodard & Curran prepared a water-table contour map for Surfside using September 1979 data, the period for which a pre-existing groundwater-flow model was constructed (EarthTech, 2002). Groundwater-elevation data are from gauging events conducted by GZA personnel (GZA, 1980) prior to construction of the Surfside treatment facility. The contours presented in Figure 2 from the Earth Tech Report, below, indicate a southerly flow of groundwater toward the coastline. It should be noted that GZA adjusted the manually gauged water levels via the Frimpter Method to obtain an annually average

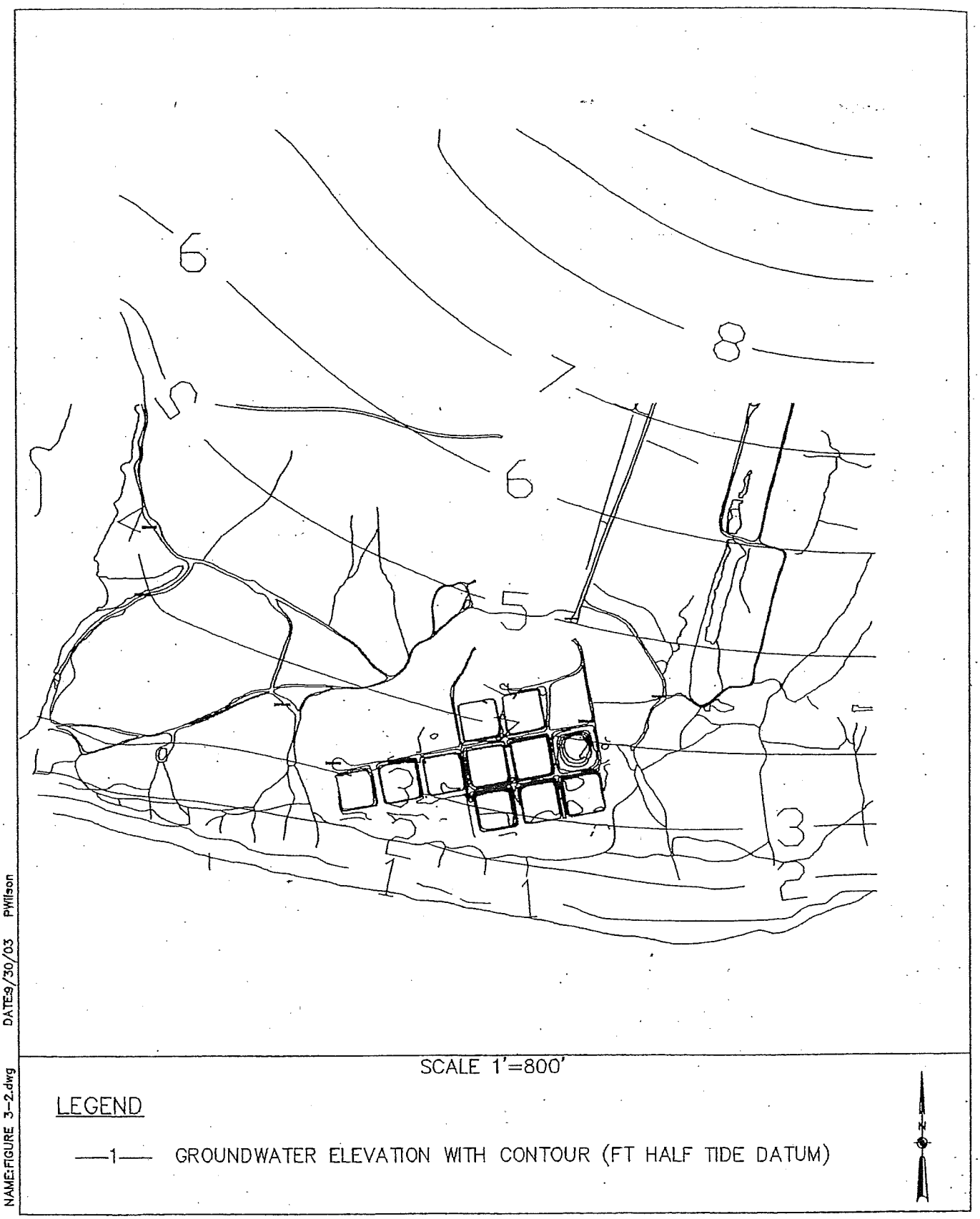



FIGURE 3–2
STEADY STATE WATER TABLE CONTOURS
SURFSIDE WWTF SITE
NANTUCKET, MASSACHUSETTS

EARTH TECH

Figure 2

data set, which was used for calibration of the flow model. The original data represented a seasonally dry period, and were increased by approximately 0.2 feet. Woodard & Curran incorporated the historic 1979 data, with the 2002 Frimpter adjustment, to generate potentiometric contours and flow directions, and to calibrate a steady state flow model. The model then is used to simulate groundwater mounding at Surfside in response to increases in discharge of treated effluent.

Current data are available at Surfside, which include five groundwater wells which are gauged by Surfside personnel on a quarterly basis. However, the newly installed wells do not have surveyed measuring points, and topographic maps exhibit a discrepancy of elevation compared with historical well surveys. In addition, the methodology for recent gauging events includes measuring the height of water column from the bottom of the well. Over time, wells may accumulate silt from the surrounding formation, or may be clogged with foreign material deposited in the well. Thus, the height of water column may change over time irrespective of a constant depth to groundwater. Furthermore, the recent data represents a system currently subjected to discharged effluent, whereas the historical data set is more representative of a steady state, long-term, ambient environment. For these reasons, the historical data set is used for constructing a base model upon which to observe the response to discharged of treated effluent. As was discussed at the December 6th meeting, the Town will have the wells surveyed for future readings.

In an additional effort to compare the Woodard& Curran model to the EarthTech model, we duplicated the EarthTech example of loading the beds with 3.4 MGD to try for similar groundwater contours. The match of groundwater levels was very close, confirming that the Woodard & Curran model is a close replica of the models previously approved.

One can reference the following Figure 3 as an example of the groundwater level that was used as the calibrated groundwater map to which the proposed increased effluent flow to a maximum load of 4 MGD in the August timeframe was applied. The groundwater levels shown on Figure 3 are very similar to the levels shown on Figure 2 in the 2005 EarthTech GDA submittal.

With the Woodard & Curran Groundwater model properly calibrated, we moved on with the effort to simulate the aquifer response to applying the treated effluent as discussed at the December 6th meeting; summer flow at full build out at 4.0 MGD for the entire month of August only and the remainder of the year at the summer average daily flow at full buildout of 2.92 MGD to the beds at Surfside. The results of this transient modeling effort are shown on Figures 4 through 15, with Figure 11 - August, showing the most dramatic mound. The simulation shows 4.0 MGD for the entire month of August, which is conservative given the Town receives maximum flows for a two week period in August.

The groundwater elevation under the beds in the no-load static condition, Figure 4, is 2.73 feet msl with the month of August loading rate at 9.26 feet msl, which shows a 6.53 foot groundwater mound. Referring to the Earth Tech record drawing in Attachment A, this shows the bottom of bed #12 at elevation 13 feet. In Figure 13, the modeling shows contours on bed #12 (highest groundwater elevation is in bed #12) at approximately 9 feet at end of month. This shows an approximate vertical separation of 4 feet as the worst case scenario in all models. All other loading scenarios exceed the four foot separation with the mound considerably less than in August.

## 1.2 SUMMARY OF HYDROGEOLOGIAL ANALYSIS

The aquifer response to application of 3.4 MGD as modeled by EarthTech was to mound to levels of 8 feet (+) in the center of the discharge beds. When the discharge was increased to the transient model in the Woodard & Curran models, as expected the August scenario showed the most dramatic mound. All other scenarios showed considerably less mounds with vertical separations exceeding four feet in all beds.

The new models also show that all flow is directed towards the ocean. With the maximum load period of August at full build out flow of 4.0 MGD, Figure 19 details a Particle Trace that shows all flows going to the ocean. There is no impact of flow shown towards Miacomet Pond.

The revised transient models clearly show that a vertical separation of four feet is maintained at all beds during the year. Refer to Figures 4 through 15 for each month scenario modeled.

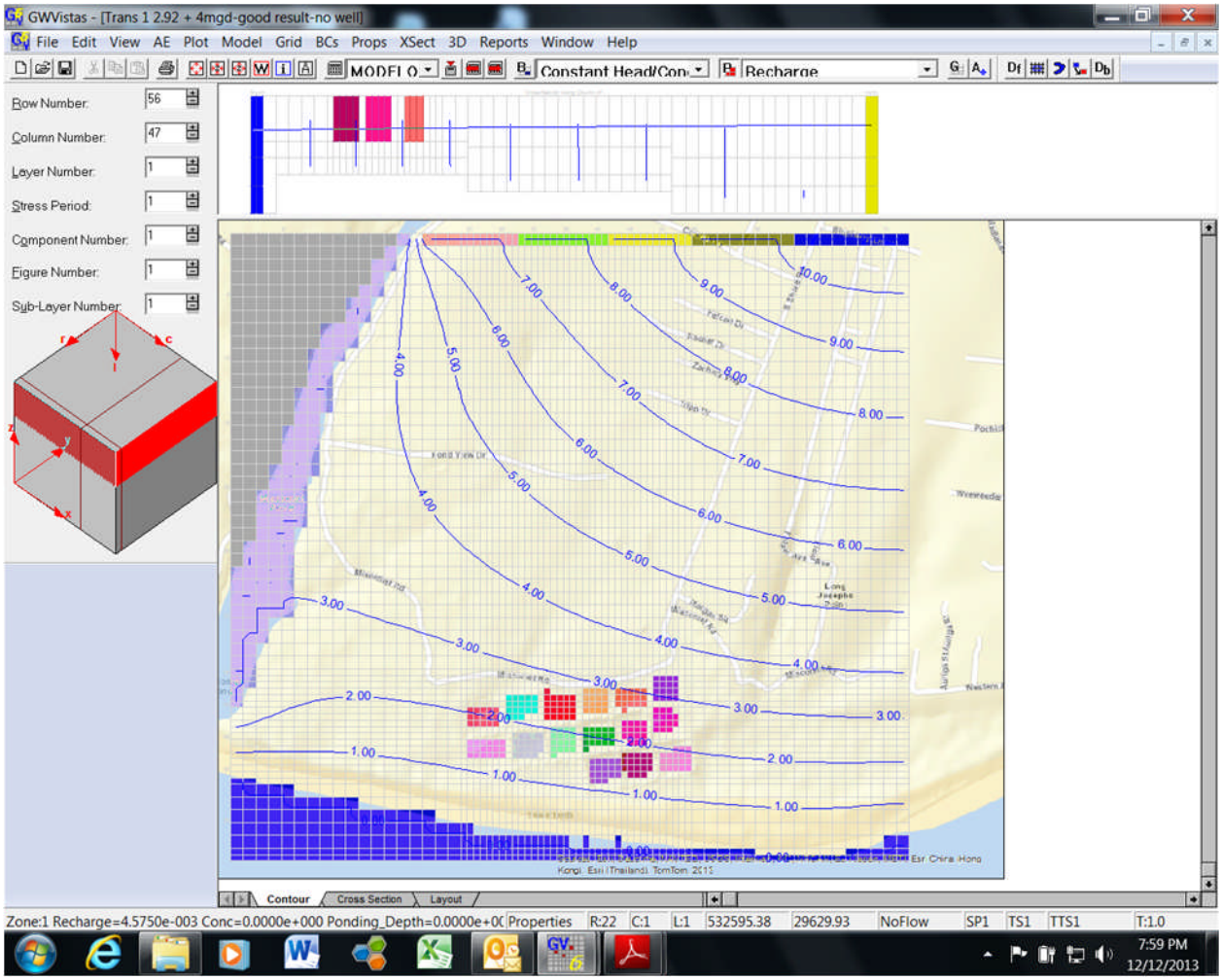



Figure 3

STATIC GROUNDWATER

CONTOURS

(NO LOADING)

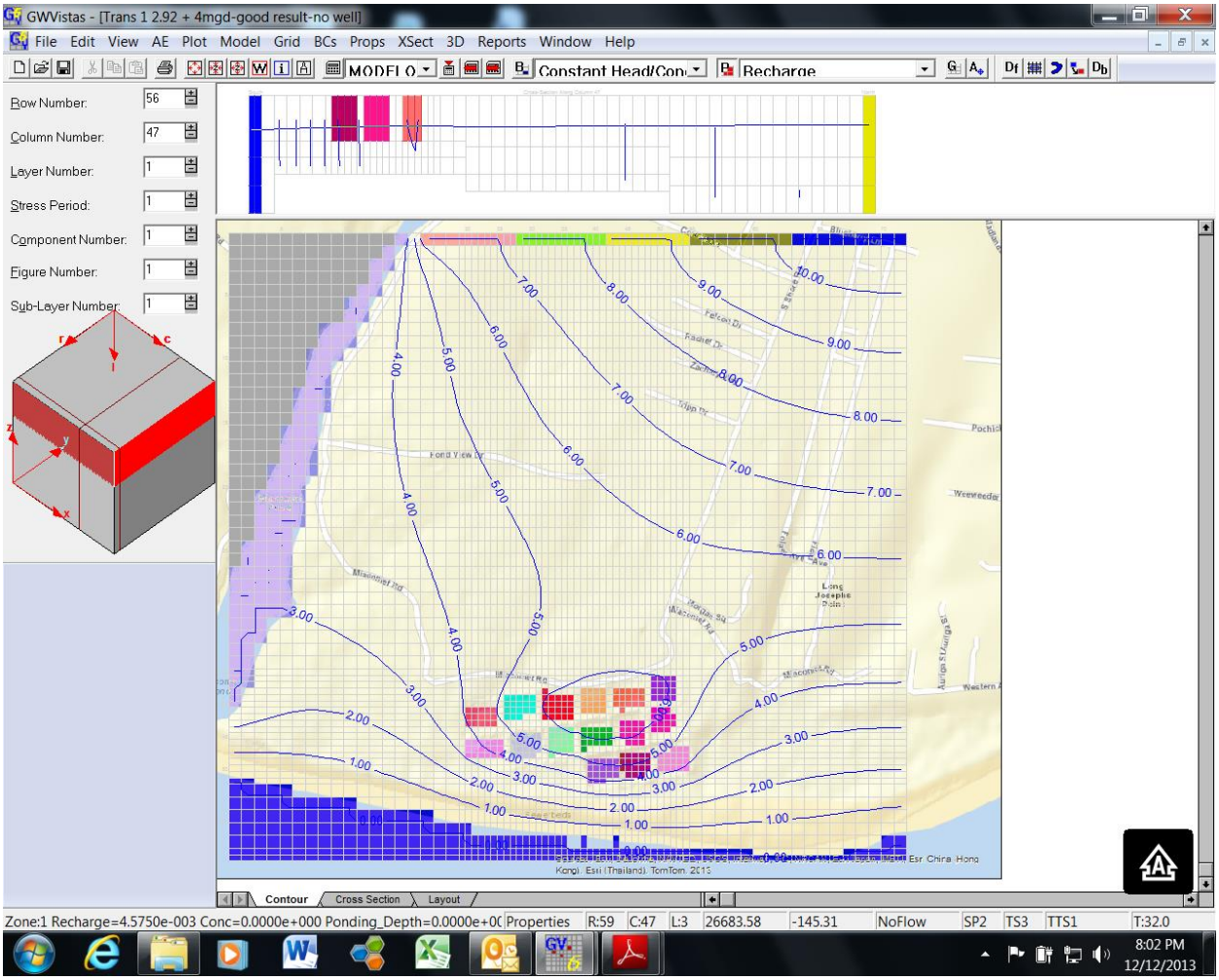



Figure 4

JANUARY AT

2.92 MGD

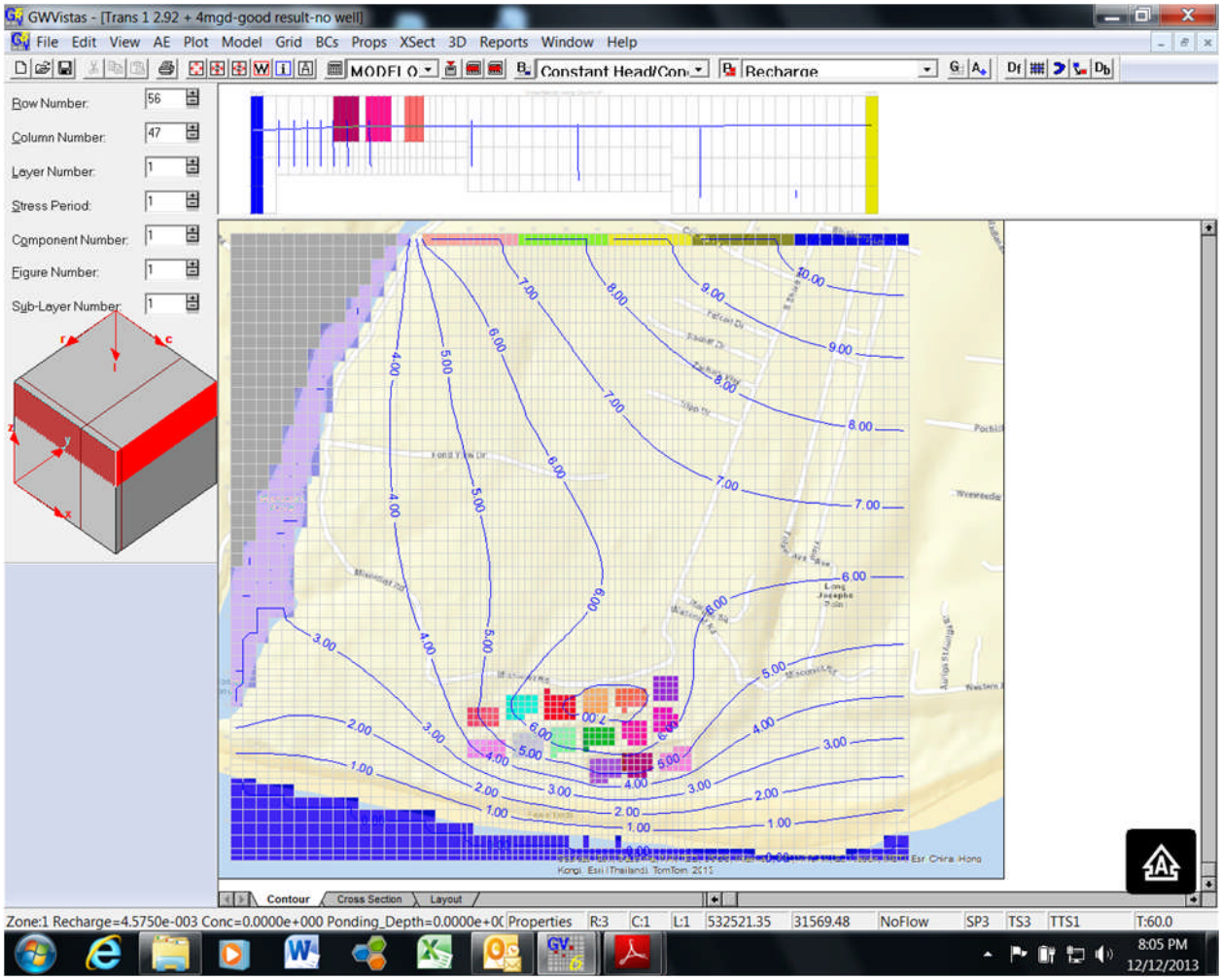



Figure 5

FEB AT

2.92 MGD

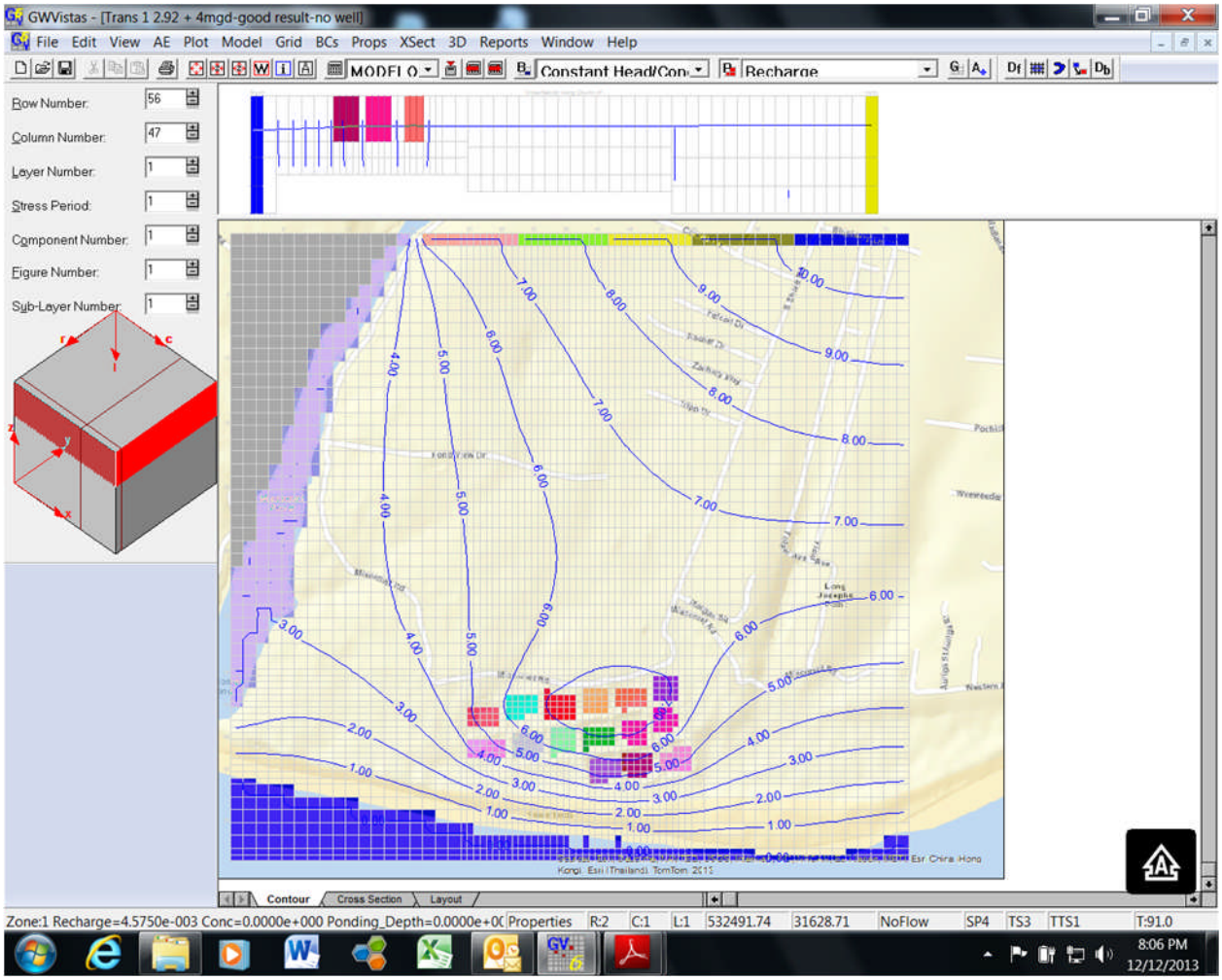



Figure 6

MAR AT

2.92 MGD

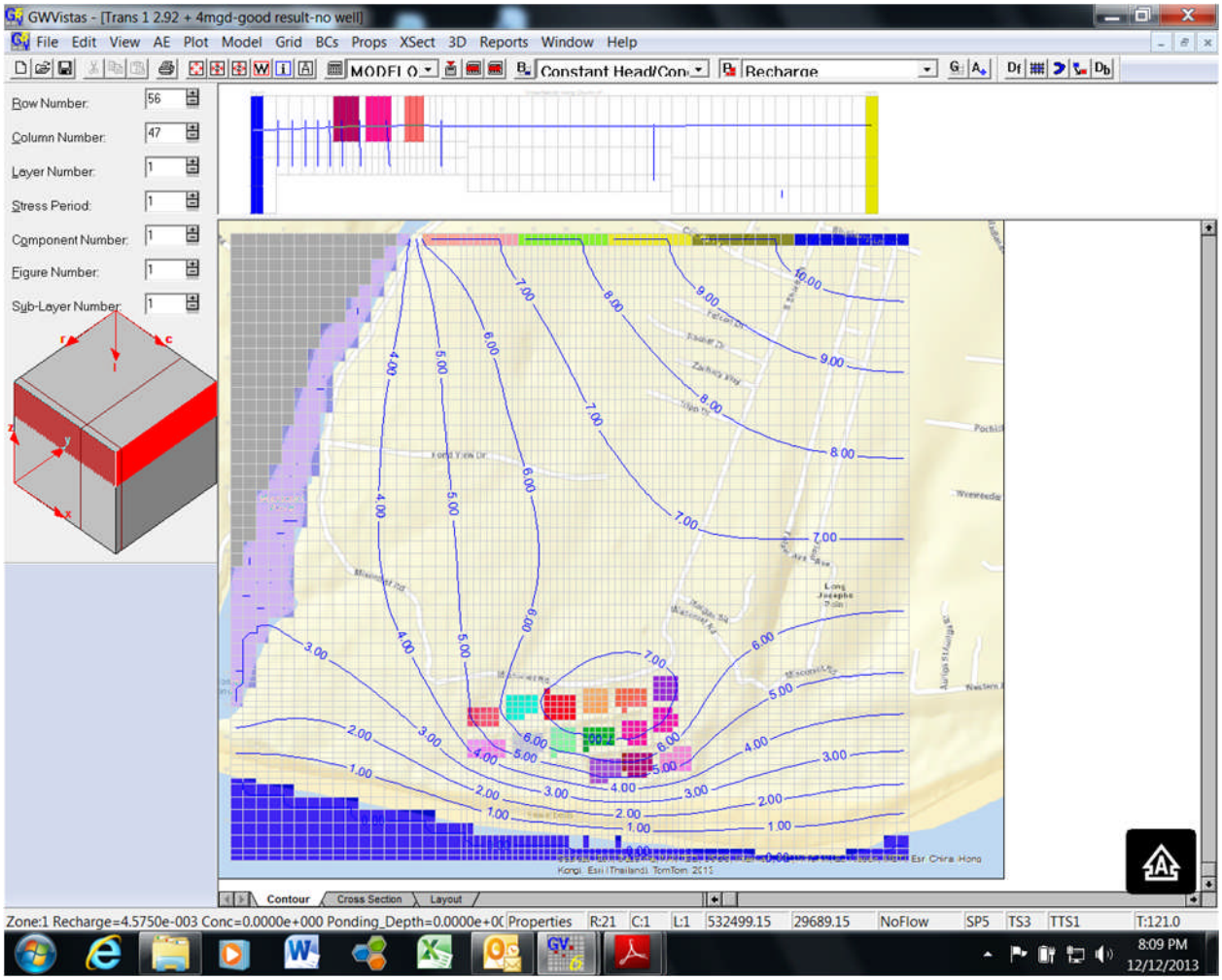



Figure 7

APR AT

2.92 MGD

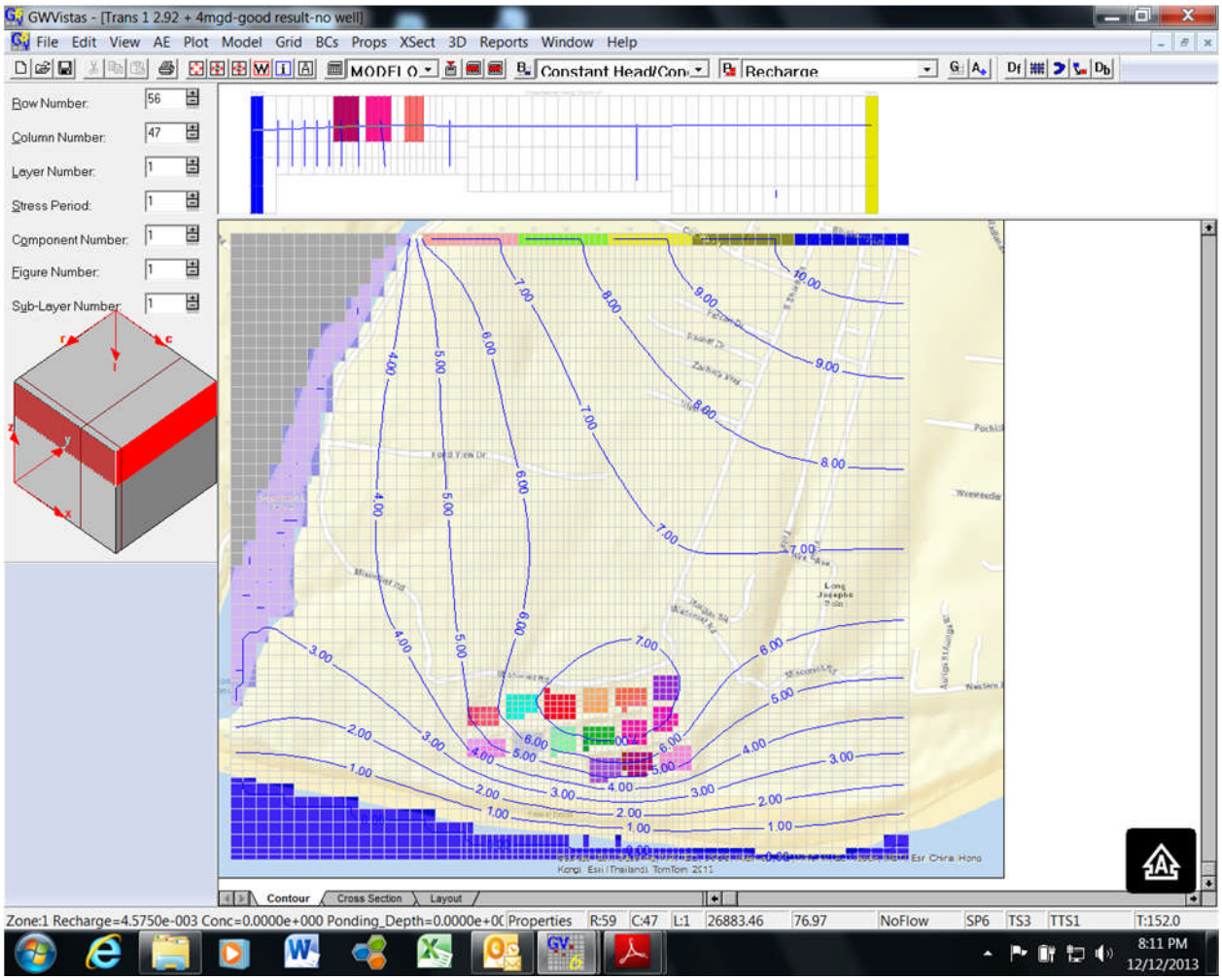



Figure 8

MAY AT

2.92 MGD

Figure 9

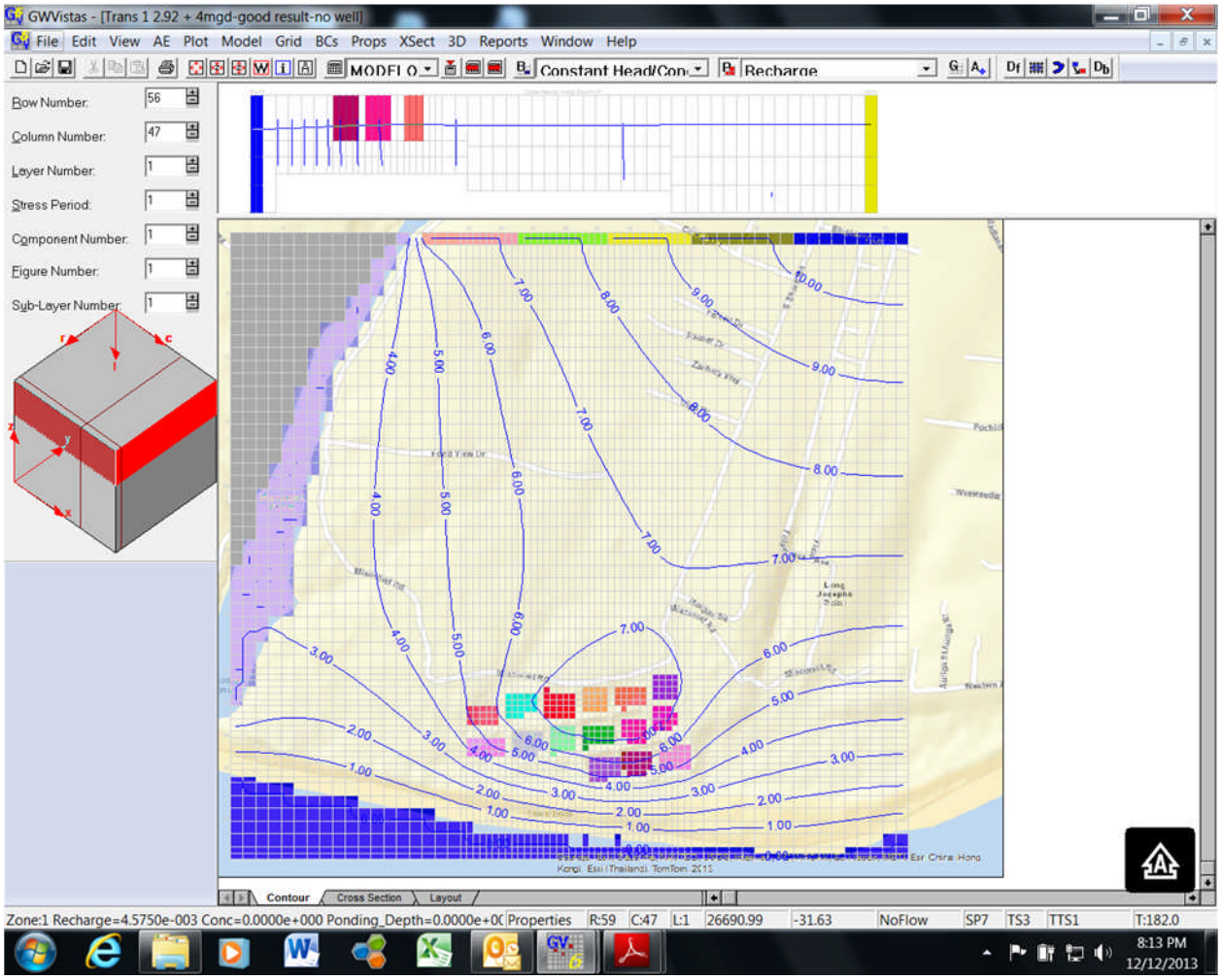



Figure 9

JUNE AT

2.92 MGD

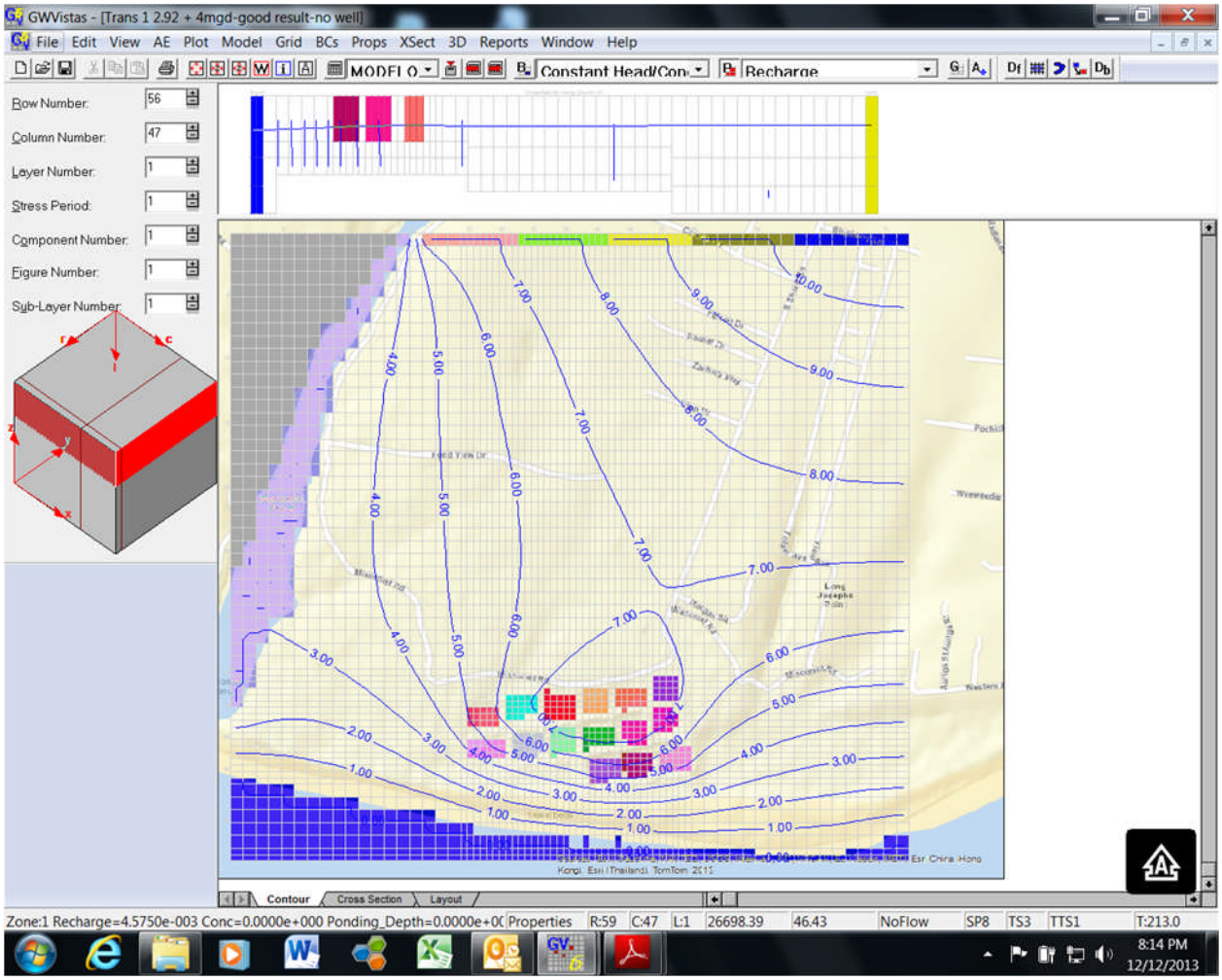



Figure 10

JULY AT

2.92 MGD

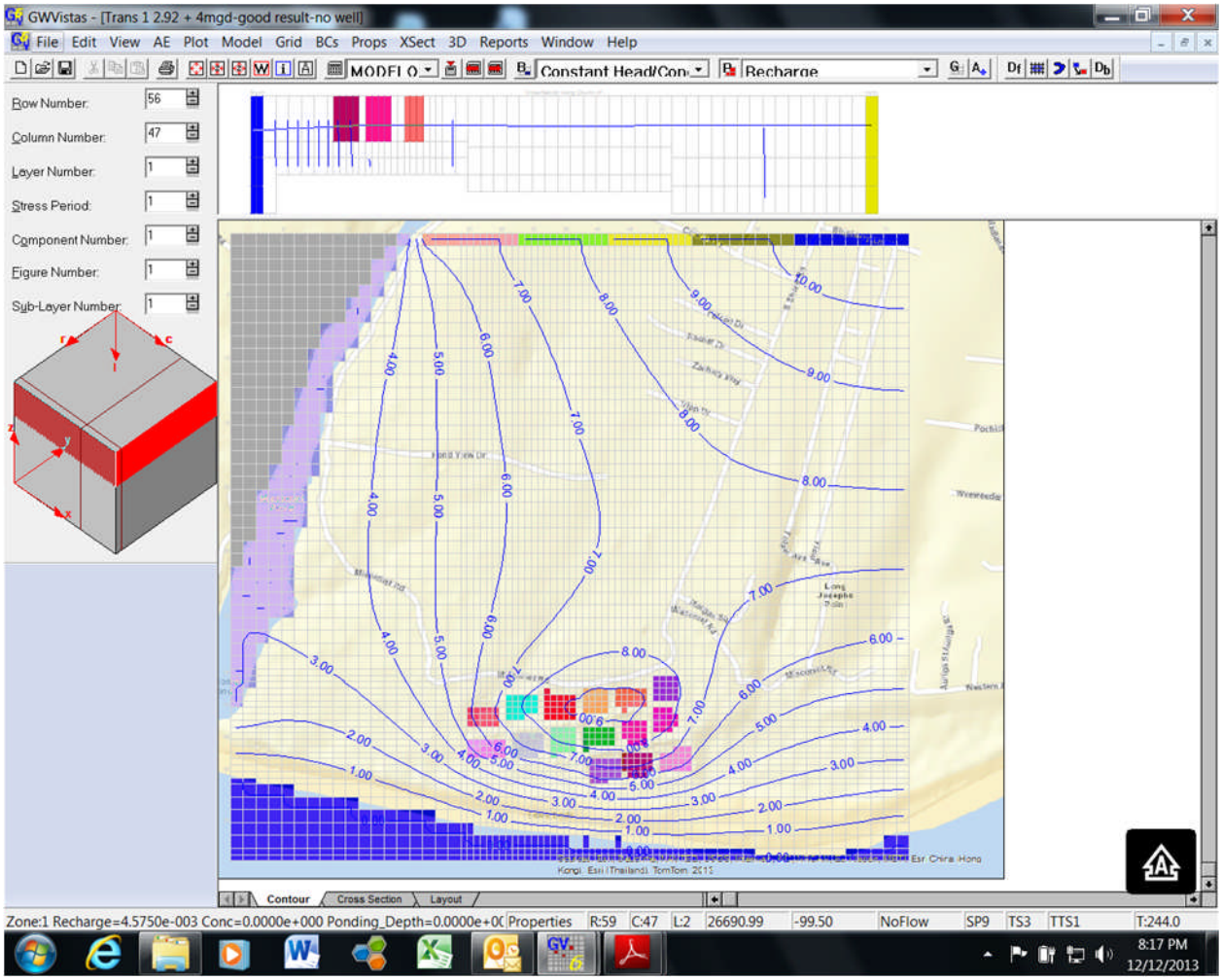



Figure 11

AUG AT

4.0 MGD

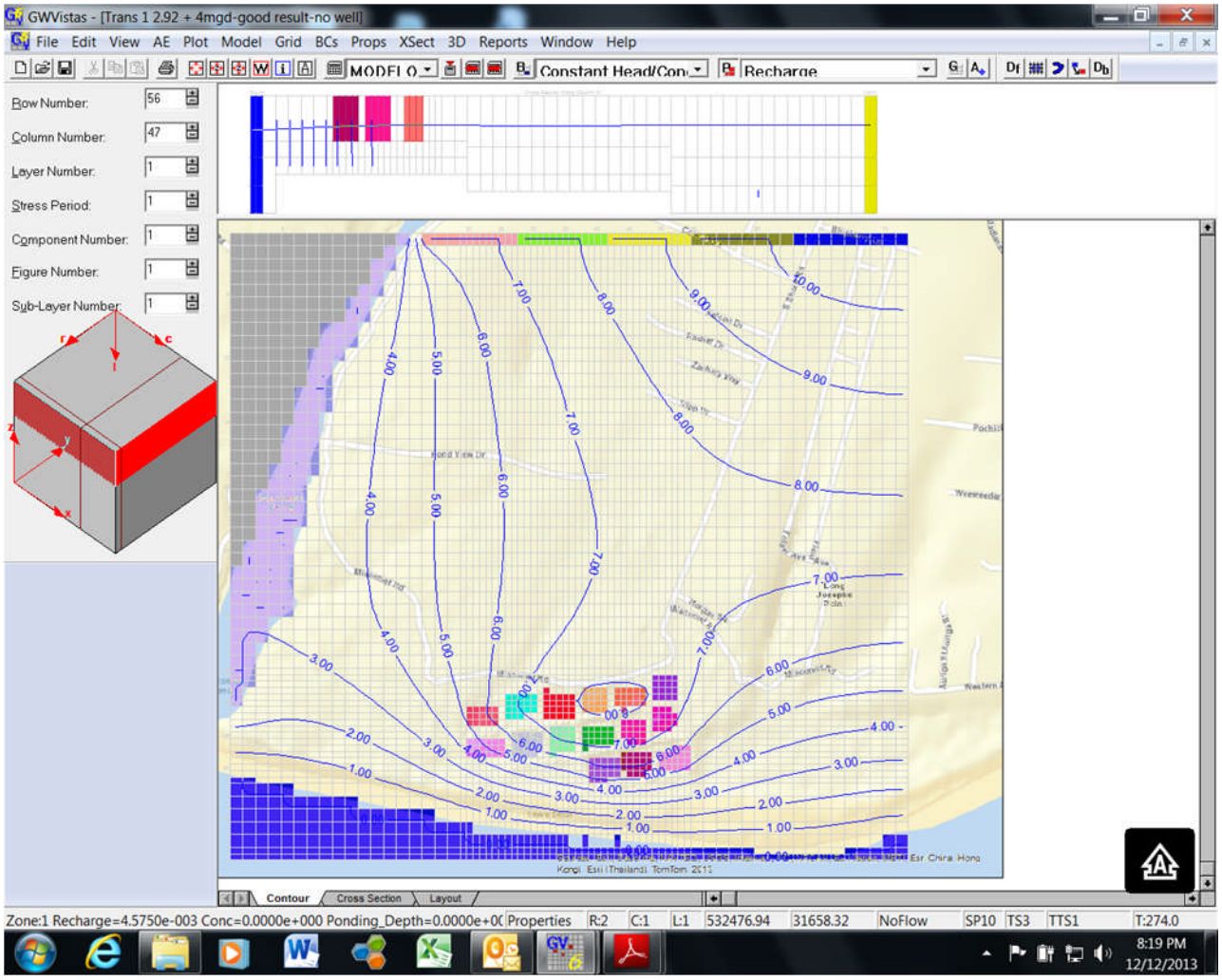



Figure 12

SEPT AT

2.92 MGD

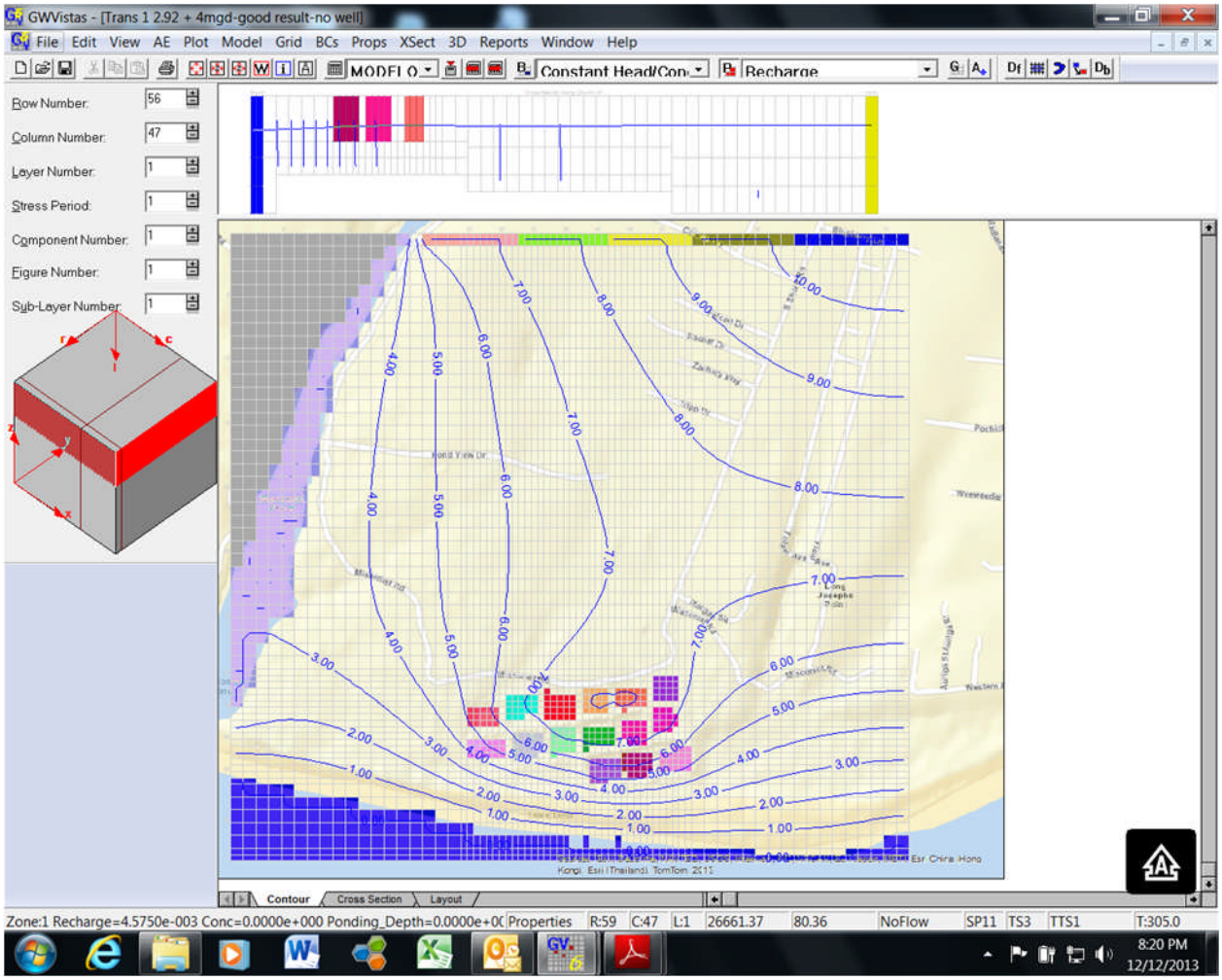



Figure 13

OCT AT

2.92 MGD

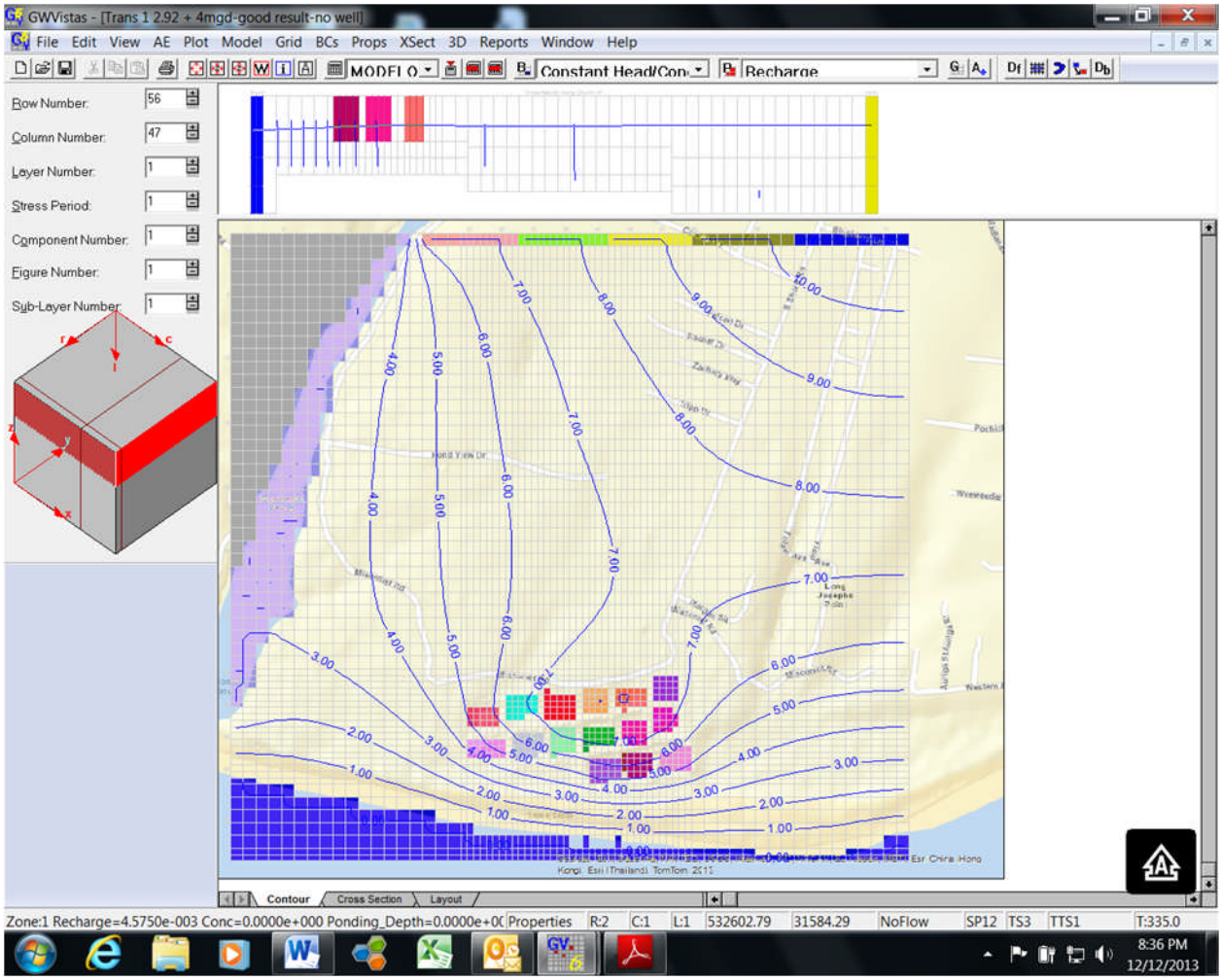



Figure 14

NOV AT

2.92 MGD

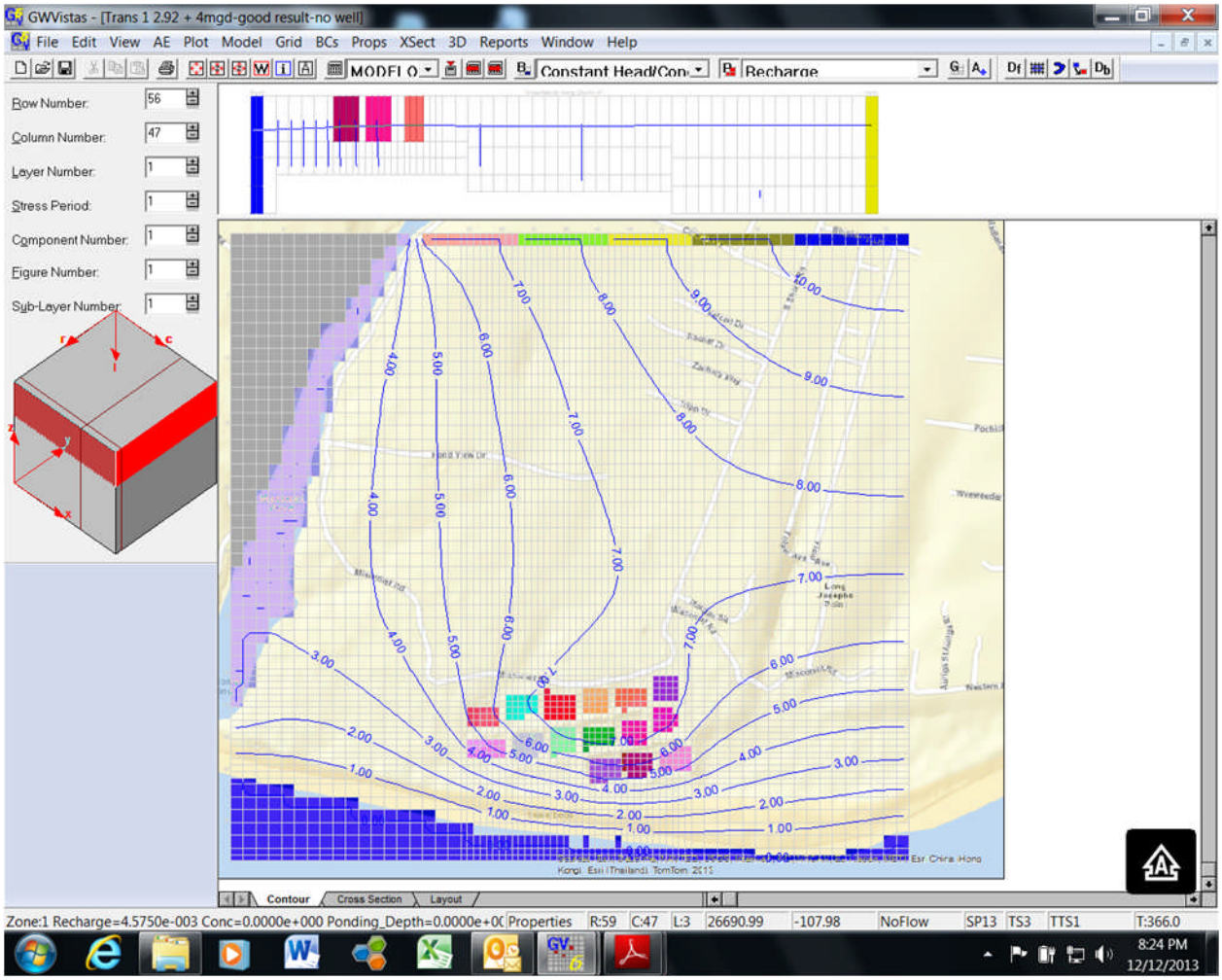



Figure 15

DEC AT

2.92 MGD

## 2.0 SHORELINE STABILITY ANALYSIS AND BREAKOUT DETERMINATION

The second task to address is the potential impact that additional flow at the Surfside Beds could have to the shoreline immediately down gradient by some 250 to 300 feet. We evaluated impacts of both shoreline stability and any potential for additional flow to breakout in the down gradient areas. To address this concern, Woodard & Curran resorted to existing published document from the Woods Hole Group, as well as recent datasets produced by the United States Army Corps of Engineers (ACOE). These documents address the stability of the shore line near the Surfside Beds with a review of several existing studies of the shoreline position in the area.

**Shoreline**

A review of the shoreline analysis by the Woods Hole Group (WHG, 2002) suggests that the shoreline near the Surfside WWTF has experienced consistent patterns of accretion or erosion from 1955 to 2002. Shoreline change during older datasets in the 1800s show greater fluctuation, which is not mimicked in recent data, either due to unique climatic factors or to greater discrepancies in data translation. Data from the WHG report indicate overall slight erosional trends in the shoreline immediately west of Surfside, stable trends south of Surfside, and accretion southeast and east of Surfside. WHG determined the average accretion or erosion rate for the period from 1955 to 2002 along transects running perpendicular to the shoreline. In general, the erosion rates southwest and west of Surfside range from zero to 0.4 ft/year, the rates immediately south of Surfside show little variance around zero, and the rate of change southeast and east of Surfside range from less than 1 ft/yr to 5 ft/yr.

An investigation by Woodard & Curran, using data from the Massachusetts Ocean Resource Information System (MORIS) database, yielded similar trends as shown on Figure 16 below. Erosion and accretion rates from 1955 to 2009 were calculated along MORIS shoreline transects in the vicinity of Surfside. In general, the western half of Surfside experienced weak erosion during the study period (less than 1 ft/yr), and the shoreline in the eastern half of Surfside experienced strong accretion (0.7 to 3.6 ft/yr).

Figure 16 represents the general shore line progression near the Surfside Beds from 1955 until 2009. In general, the shore line appears to be accreting along the area of the Beds. The shore line in place now includes the passage of Hurricane Sandy. Thus it seems that the natural shoreline processes are not eroding the area around the Surfside Beds.

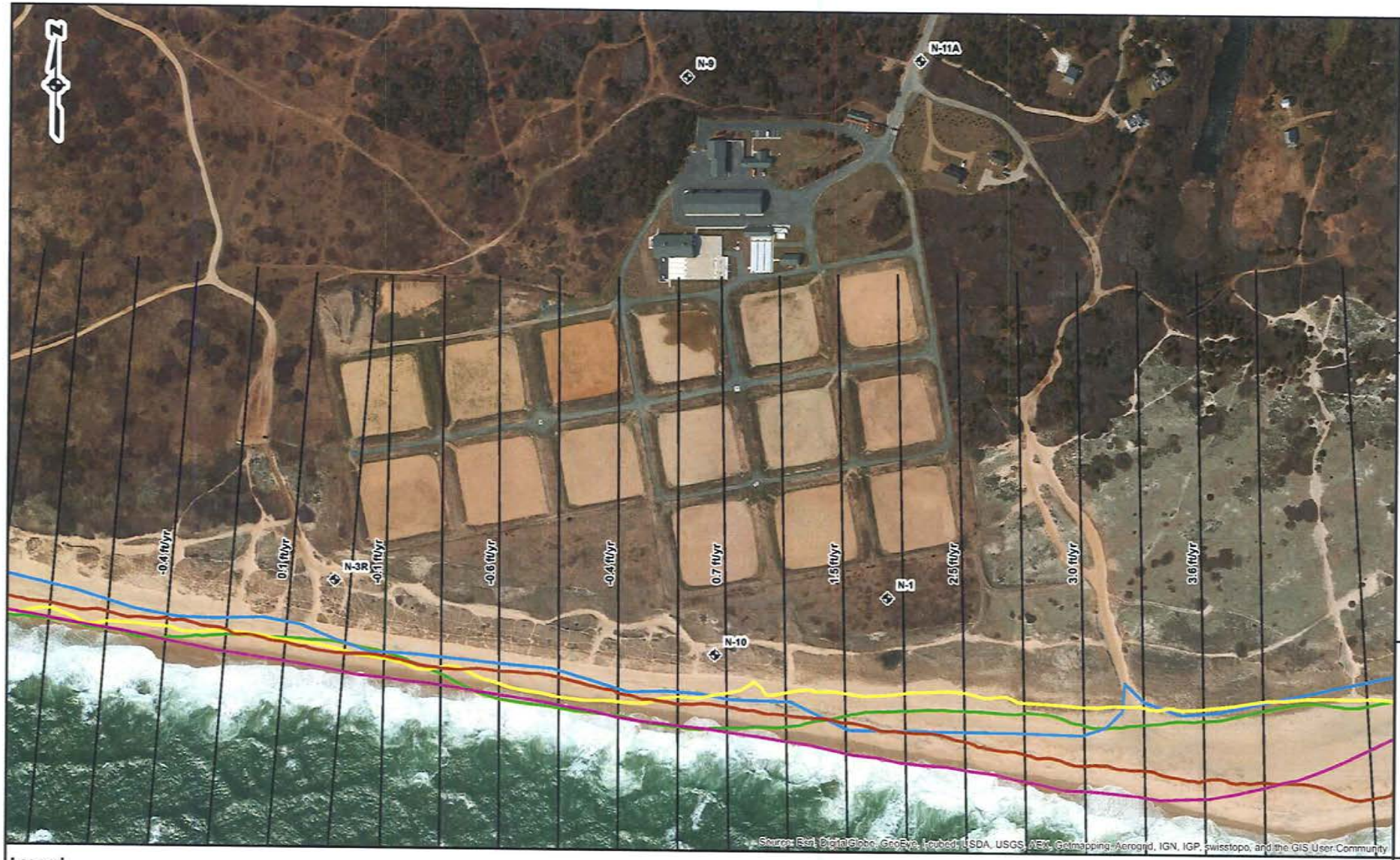
A second part of the question about shoreline stability dealt with the likelihood that the additional groundwater movement of groundwater from the Surfside Beds toward the ocean will make the dune banking in the area more susceptible to erosion under natural processes. To address this question Woodard& Curran compared the groundwater gradient in the area under the proposed increased discharge of wastewater to the typical required gradient in wastewater plumbing for domestic use. Domestic plumbing codes typically require a 1 inch drop in 8 feet of piping to move solids along an open pipe. This is a gradient of 0.125 inches per foot. The groundwater gradient after the proposed additional disposal at Surfside will be 0.016667 inches /inch, about 1/10 the gradient in domestic wastewater piping. Based on this comparison, the new groundwater gradient will not be steep enough to destabilize the slope at the ocean.

Additional datasets produced by the ACOE after Hurricane Sandy also support the shoreline stability in the Surfside WWTF area. Refer to Figure 17.

Additionally, the revised FEMA maps were reviewed to determine any changes as a result of the mapping updates and what, if any, issues this presents at this site. As discussed in previous sections of this TM, the Town's Emergency Management Director who is in charge of the flood zones stated that there were no changes to the site and that there are no potential impacts to the Surfside Site. CZM

also conferred with him and referred to the site as stable. Refer to Figure 18 for a copy of the FEMA map.

Results of the WHG, ACOE, FEMA and Woodard & Curran investigations suggest that the shoreline of Surfside is experiencing overall accretion from the mid-20th century to present. Weak erosion along the western region of the study area may continue, with an associated accretion of shoreline to the east with no impact to the WWTF.




**Legend**

**MORIS SHORELINE**

- 1955
- 1978
- 1994
- 2000
- 2009

MORIS SHORELINE TRANSECT AND 1955-2009 RATE OF CHANGE

SURFSIDE MONITORING WELL

MORIS = Massachusetts Ocean Resource Information System

0 125 250 500 Feet

WOODARD & CURRAN
COMMITMENT & INTEGRITY DRIVE RESULTS
980 WASHINGTON STREET | SUITE 325
DEDHAM, MA 02026
800.446.5518 | www.woodardcurran.com

# HISTORICAL SHORELINE 1955 - 2009

SURFSIDE TREATMENT PLANT
NANTUCKET, MASSACHUSETTS

PN: 223970

BY: BVA

DATE: OCTOBER 2013

Figure 16

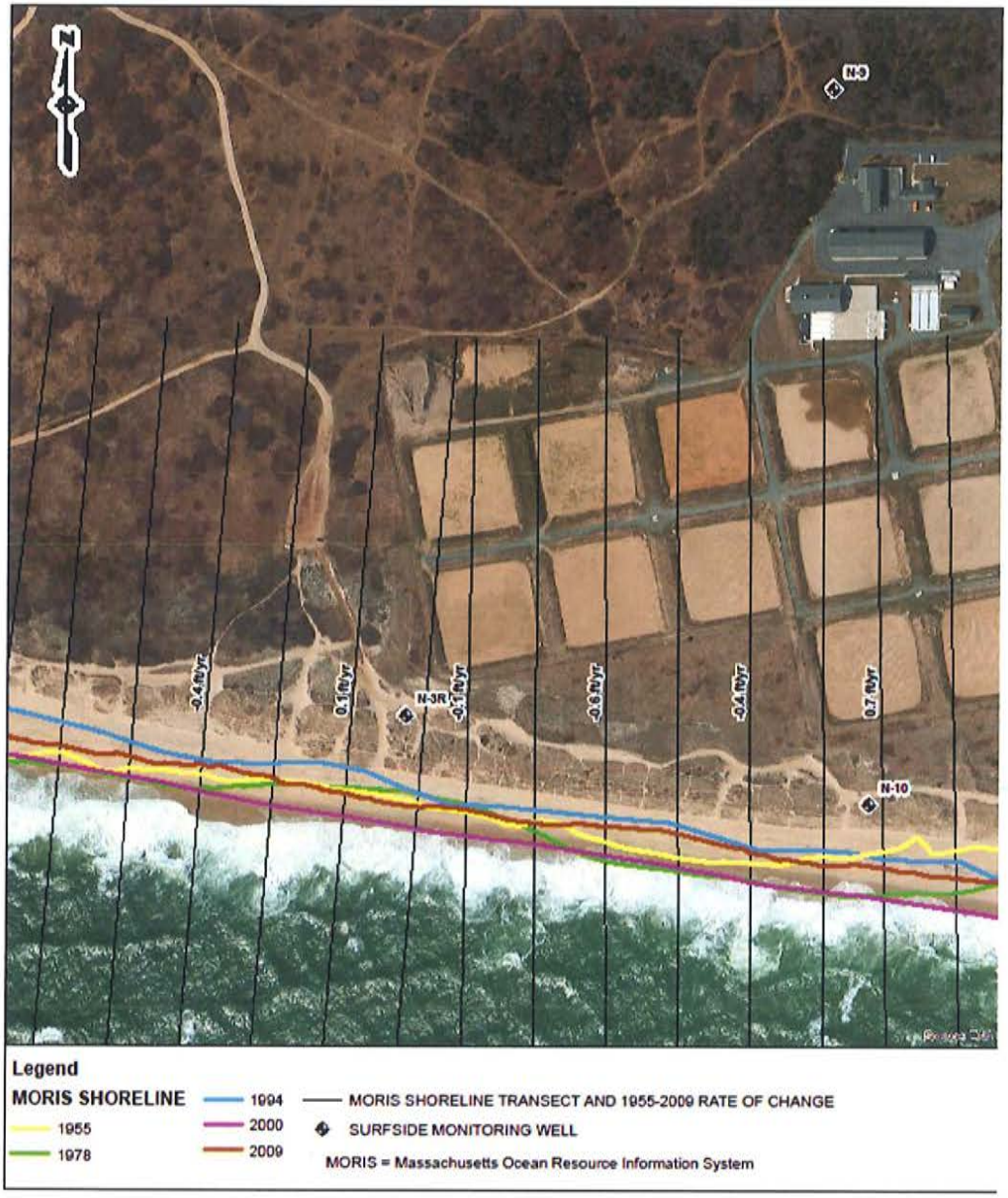

N-9
-0.4 ft/yr
0.1 ft/yr
N-3R
-0.1 ft/yr
-0.8 ft/yr
-0.4 ft/yr
0.7 ft/yr
N-10
Legend
MORIS SHORELINE
1955
1978
1994
2000
2009
MORIS SHORELINE TRANSECT AND 1955-2009 RATE OF CHANGE
SURFSIDE MONITORING WELL
MORIS = Massachusetts Ocean Resource Information System

Figure 17

26K
26L
26M
26N
27K
27L
27M
27N
28K
28L
28M
28N
29L
29M
MIACOMET RD
W MIACOMET RD
MIACOMET RD
POND VIEW DR
RACHEL DR
ZACHARY WY
TRIPP DR
S SHORE
CHERRY ST
FOLGER
FIELD A
S SHORE RD
FOLGER AV
FIELD AV
POCHICK AV
WEWEEDER AV
SURESIDE RD
NOBADEER AV
NONANTUM AV
MORGAN SQ
MORGAN SQ
MORGAN SQ
HILL SIDE AV
POLLOCK AV
STATION ST
AURIGA ST
CANONICUS ST
SURFSIDE RD
POPLAR ST
WESTERN AV
Legend
Flood Hazard (old)
Flood Zones (New)
FLD_ZONE
0.2 % Annual Flood Hazard
A
AE
VE
X

Figure 18

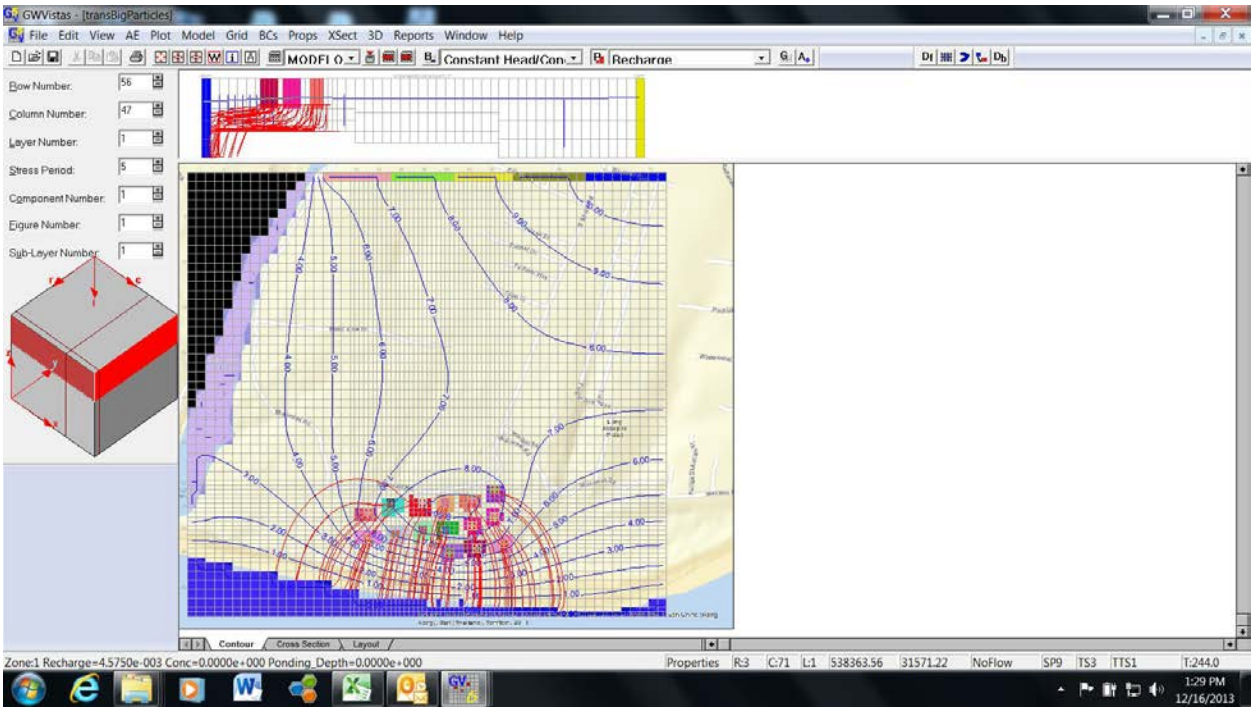



Figure 19

Aug Flow @ 4MGD

Particles added

( Note –all flow direct to Ocean)

## 3.0 CONCLUSIONS OF EVALUATION

The conclusions of the above tasks are as follows:

**Additional Bed Loading**

Additional loading to the existing beds at the Surfside WWTF, from 3.4 MGD to 4.0 MGD, based on summer loading at 4.0 MGD for the entire month of August only and at 2.92 MGD (summer average daily flow) for the remainder of the year is feasible under current conditions. The transient models detail the most dramatic mound during the month of August, which is expected given the maximum loading rate of 4.0 MGD for the entire month. While the modeling shows that additional loading raises the mounds in the upper beds, the overall system is able to handle the additional flow with vertical separation in the four foot range in bed #12, which previous records detail with the highest groundwater elevation. The remainder of the year under the transient models clearly shows considerably less mounding with vertical separations exceeding four feet. Additionally, the upgrades at the WWTF, most notably the upgrade to MBR technology, afford a highly treated effluent discharge that travels to the open Atlantic Ocean with no environmental impacts.

The full flow to 4.0 MGD will not be seen immediately, but, rather over a 20-year planning period. It is also in the Town's CWMP Update as an alternative, to maintain communication with MassDEP and various Cape and southeastern Massachusetts towns in the use of an ocean outfall. In a best case scenario at some point in the future, the treated effluent from Surfside could be discharged through an outfall to the Atlantic Ocean.

**Shoreline Stability**

This evaluation determined that the shoreline is stable and not subject to severe, impacts of erosion.

**Breakout Potential**

The evaluation determined that no breakout will occur as a result of additional loading to the existing beds.

**Particle Trace Analysis**

The model was re-run utilizing the August load period of 4.0 MGD in order to determine the direction of the flow. Figure 19 clearly details all flow towards the ocean. No flow is directed towards Miacomet Pond.

The Town of Nantucket looks forward to a positive review of this Technical Memorandum by MassDEP and an extension to its current Groundwater Discharge Permit No.SE#1-200 from 3.4 MGD to 4.0 MGD based on the conclusions stated above.

---

Attachment A: Large Scale record Drawing of Site from Earth Tech Report
Attachment B: August 16, 2013 Scope of Work

# ATTACHMENT A
# Large Scale Record Drawing of Surfside Site – Earth Tech Report

N-9
N-11A
N-3R
N-1
N-10
MATERIALS LEGEND
BITUMINOUS CONCRETE PAVEMENT
BITUMINOUS CONCRETE THICKENED EDGE
GRAVEL ROADWAY
CRUSHED STONE MAINTENANCE STRIP
PRECAST CONCRETE CURB
PRECAST CONCRETE CURB CORNER
CONCRETE SIDEWALK
BRICK SIDEWALK
STEEL BOLLARD
PAVEMENT MARKINGS
HIGHWAY GUARDRAIL
SLUDGE PROCESSING BUILDING
EQUIPMENT STORAGE BUILDING
SOIL ANALYSIS BUILDING
ADVANCED TREATMENT BUILDING
PRIMARY TREATMENT BUILDING
PRIMARY CLARIFIER
PROPOSED INFILTRATION BED #15
PROPOSED INFILTRATION BED #14
PROPOSED INFILTRATION BED #13
PROPOSED INFILTRATION BED #10
EXISTING INFILTRATION BED #12
EXISTING INFILTRATION BED #11
EXISTING INFILTRATION BED #9
EXISTING INFILTRATION BED #8
EXISTING INFILTRATION BED #7
MATCH LINE
GRAPHIC SCALE
EarthTech
RECORD DRAWING
NANTUCKET, MASSACHUSETTS
UPGRADES TO THE SURFSIDE WASTEWATER TREATMENT FACILITY
PROPOSED SITE PLAN
EXISTING CONDITIONS AND DEMOLITION PLAN
LA-3
SHEET 6 OF 162

# ATTACHMENT B
## Scope of Work

**COMMITMENT & INTEGRITY**
**DRIVE RESULTS**

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T 800.446.5518
T 781.251.0200
F 781.251.0847

August 16, 2013

Mr. Alan Slater
MassDEP Boston Office
One Winter Street
Boston, Massachusetts 02108

Mr. Steven Hallem
MassDEP Boston Office
One Winter Street
Boston, MA 02108

Mr. Brian Dudley
MassDEP Barnstable Office
3195 Main Street
Barnstable, MA 02630

**RE: PROPOSAL TO MassDEP - SCOPE OF WORK REGARDING ADDITIONAL LOADING OF TREATED WASTEWATER TO SURFSIDE WWTF DISPOSAL BEDS, NANTUCKET, MA**

Dear Gentlemen:

Please accept this letter as the Town's proposed Scope of Work to determine additional loading of treated wastewater to the Surfside WWTF discharge beds on Nantucket as requested at our meeting held on June 18, 2013 at MassDEP Boston. The meeting on June 18, 2013 at Mass DEP Boston office was attended by the three of you and me, Rosemary Blacquier, and Cary Parsons of Woodard & Curran. We discussed the proposal for Nantucket to increase its wastewater discharge to the Surfside WWTF disposal facility by approximately 400,000 gpd or loading at 6 gallons per day per square foot versus the current practice of loading at 5 gallons per day per square foot. The existing Groundwater Discharge Permit, No. 200-2, limits the facility to disposing of 3.5 mgd (Max Day) at the Surfside WWTF beds. Based on the results of the on-going Comprehensive Wastewater Management Plan (CWMP) Update, updated flows to the sewer service collection areas will require the treatment and disposal of 3.9 mgd. Despite the limitations on disposal of 3.5 mgd to the existing Surfside WWTF beds, the Surfside WWTF beds had previously been permitted by MassDEP (March 4, 1992) for disposal of 5.8 mgd. In 1992, the WWTF was primary treatment and included 10 discharge beds. At this time, the Town has upgraded its WWTF to MBR Technology and added five additional beds for discharge, with a WWTF design of 5.8mgd and a 3.5 mgd (Max Day) Groundwater Discharge Permit.

During our meeting in Boston, the various sources of this new wastewater demand were considered and geographical and financial advantages of using the Surfside WWTF for treating the additional flows and loads were discussed. The financial advantage is self-evident, in not having to permit, design and construct an additional WWTF at a new site. There are however, multiple reasons to utilize the existing infrastructure at Surfside at its highest and best use versus designing, permitting and constructing an additional WWTF on Island. Politically, the public has spoken loud and clear against a WWTF on the former FAA site as proposed in the 2004 CWMP. Environmentally, there are also strong issues that will make the Madaket site difficult and expensive to permit that evolved during intensive surveys through the Natural Heritage and Endangered Species Program (NHESP) and the Massachusetts Historical

Commission (MHC) Intensive Survey. The Town, in its effort to be proactive and address the issues detailed in the Massachusetts Estuaries Program (MEP) and subsequent Total Maximum Daily Loads (TMDLs) issued in the Madaket area, understands that an approach to a facility in Madaket will not be received positively by the residents and taxpayers, thus foiling a long and arduous journey with a federally-owned property.

Technically and financially, the feasibility of piping the wastewater from the Madaket area of the Island was discussed and all agreed that a re-evaluation of the permit limit for the Surfside WWTF groundwater disposal beds was in the Town's best interest at this point in time. The potential for resident and taxpayer approval of the Surfside option is far greater than a separate facility in Madaket as it already exists and functions well within the Community. Prior to our meeting, W&C had gathered some technical documents, which suggest that the Surfside disposal beds may be hydrogeologically able to accept more than the presently permitted 3.5 mgd (Max Day).

In addition to the possible hydrogeological ability of the Surfside beds to accept additional highly treated effluent (MBR Facility), Woodard &Curran brought up several policy aspects of adding more water to the disposal beds. The first aspect is the likelihood that given the area of the existing beds, the proposed additional loading would probably push the loading rate of the beds over the current limit of 5 gallons per square foot per day. During the meeting it was discussed that current operations at the beds could serve as a demonstration of the capability of the Surfside beds to infiltrate the additional loading and facilitate permitting a higher loading rate than the traditional limit. It was discussed that the methods currently used by staff at the facility to load the beds include loading one or two beds at a time, which accounts for a loading rate of approximately 30 to 40 gallons per day per square foot. The Town is prepared to show that this manner of operation is sound, technically feasible and meets the existing permit intent.

A second policy aspect of additional loading involves the traditional requirement that any permit should be based on the concept of estimating groundwater mounding from wastewater loading at the time of seasonal high groundwater. That mounding should maintain an unsaturated separation of 4 feet between the top of the mound and bottom of the disposal facility. The information available at the time of the meeting was not sufficient to know the actual elevation of groundwater below the beds at the seasonal high period, which typically occurs in the spring. However, there is some groundwater mounding analysis done with a computer groundwater model from earlier permitting rounds (1990s) that suggests that a loading of 3.4 mgd will maintain the traditional 4 foot separation in the seasonal high groundwater condition. Woodard & Curran will translate this to current conditions utilizing existing record information.

Woodard & Curran discussed one distinctive condition at the Surfside site with respect to seasonal high groundwater policy; namely that the spring seasonal high groundwater condition never coincides with the seasonal high wastewater flows. The highest wastewater flows and highest mounding condition occurs in August of each year due to the seasonality of the community and August being the most populous month. MassDEP personnel acknowledged this offset of the two traditionally limiting conditions. It was also discussed that based on historical water level records at the site, the existing data can potentially determine if future reloading of the beds at the previously-mentioned rate would require a permit with different limits based on time of year.

Woodard & Curran is prepared to review and summarize the Town's historical records in order to make a determination here. As mentioned above, at the time of the MassDEP meeting, we had limited information on the hydrogeological conditions at the Surfside beds location. However, it was known from various reference lists that several significant reports and sets of site data existed at one time, as well as recent water groundwater level readings since the most recent permitting in 2006. Woodard & Curran was able to obtain and review much of this historical data as referenced below. Based on

review of such, it is our preliminary conclusion that the potential to load the Surfside beds at an additional square foot per day (from 5 to 6) is plausible based on the current loading methodology.

This, in addition to, previous permits on this site dating back to the early 1990s, supports the additional load. With the MassDEP response to the policy issues as discussed, it seems plausible for Woodard & Curran to pursue the analysis of conditions at the Surfside beds location if the suggested discharge to the existing beds were increased. Our goal is to receive approval from MassDEP to allow the additional wastewater flows permitted at a minimal cost and time to our client based on historical data and current conditions. To that end, Woodard & Curran has been able to acquire additional existing, historical information. The references available to date for review include:

- Groundwater Discharge Permit Application BRP WP 11
  Town of Nantucket, Department of Public Works - 188 Madaket Road - Nantucket, MA
  Prepared by Earth Tech 196 Baker Ave Concord, MA June 28, 2005
- Goldberg, Zoino, Dunnicliff & Associates, Inc. Nantucket EIS Geohydrologic Report. Newton Upper Falls, MA. May9, 1980
- Pleistocene Hydrology of Nantucket Island, Massachusetts
  Person, Mark, et al. Presented April 2001 First International Conference on Saltwater Intrusion and Coastal Aquifers – Essaouira, Morocco
- Approval of Groundwater Discharge Permit No. I-200 Surfside, Nantucket, MA Feb 25, 1992
  To Department of Public Works, Nantucket, MA
  Signed – Brian Donahoe, Division of Water Pollution Control
- Woods Hole Group - July 2002 – Historical Change Analysis for the Surfside, Nantucket Coastline
- Final Permit – Groundwater Discharge Permit No. 200-2 June 15, 2006 – approval signed by David R. Burns, Bureau of Resource Protection
- Final Environmental Impact Statement – Wastewater Treatment Facilities Nantucket, Nantucket County Mass. August 1981
- Additional records of groundwater levels from at least the last three years are being collected at this time and will be available for analysis when W&C does the groundwater mounding analysis. It is likely that more groundwater level data in addition to the last three years will also become available.

**Proposed Scope of Work – Analysis for Additional Bed Loading**

Given the conditions and regulatory discussions mentioned above, Woodard & Curran proposes the following tasks to confirm that the Surfside WWTF disposal beds can properly accept the proposed additional loading of one gallon per day per square foot, from 5 gallons per day per square foot to 6 gallons per day per square foot. To support this, Woodard & Curran proposes to complete the following tasks:

**Task 1:** Using available recorded water level data (or estimates based on the Frimpter Method); develop a suitable typical water table elevation map for the month with highest recorded wastewater flows historically (August).

**Task 2:** With reference to the Earth Tech record drawings for bed sizes, and field observations, Woodard &Curran will calculate the actual loading of the beds (gallons per square foot per day) in present day operation during the rotation sequence when only one or two beds are used per day to accept all of the flow as is currently done.

**Task 3:** Collect any additional water level readings or anecdotal information to document that the existing beds are able to accept greater than 5 gpd/ ft sq. This Task may also include a mounding analysis to estimate mound and clearance of four feet to groundwater in August (Nantucket high flow time period) conditions.

**Task 4:** .Utilizing existing Massachusetts Shoreline Data, show that the coastal area of the beds is stable and actually experiencing accretion in order to defray any existing erosion concerns.

**Task 5:** Utilizing existing information, prepare calculations to demonstrate that an increased loading to the existing beds does not impact the stability of the beach or present any velocity or gradient issues.

Once MassDEP approves of the above-detailed scope, Woodard & Curran will prepare a Letter Report, with all appropriate back-up data, to support the additional loading of the Surfside beds from five (5) gallons per day per square foot to six (6) gallons per day per square foot. The current Surfside Groundwater Discharge permit renewal was extended by Chapter 238 of the Acts of 2012 to 6/15/2015. The timing of the renewal is optimal as the CWMP Update is due to be finalized in December 2013 with a Final Recommended Plan that includes an increase of wastewater collection, treatment and discharge over a 20-year planning period, of 400,000 GPD. This timing will give the Town the necessary back-up for the Groundwater Discharge Permit Renewal application.

We look forward to your positive response to our proposed scope of work. Once approved, Woodard & Curran will initiate the required work in order to complete this task by mid-September 2013.

Sincerely,

WOODARD & CURRAN INC.

Thomas F. Hazlett, P.E.
Project Manager

TFH/rtb
Project #223970
cc: C. Elizabeth Gibson, Nantucket Town Manager
Kara Buzanoski, Nantucket DPW Director
Kevin Manning, Nantucket DPW
Helen T. Gordon, Woodard & Curran
Cary Parsons, Woodard & Curran
Jon Himlan, Woodard & Curran
Rosemary Blacquier, Woodard & Curran

# APPENDIX B: MAP OF SURFSIDE WWTF MONITORING WELLS

Figure 3
BRP WP 83 - Hydrogeological Evaluation
Bed Locations and Monitoring Well Locations

# APPENDIX C: COPY OF 2005 SURFSIDE WWTF GROUNDWATER DISCHARGE PERMIT APPLICATION – ON CD

**Enter your transmittal number** → W 065519 (Transmittal Number)

Your unique Transmittal Number can be accessed online: http://www.mass.gov/dep/counter/trasmfrm.shtml or call DEP's InfoLine at 617-338-2255 or 800-462-0444 (from 508, 781, and 978 area codes).

**Massachusetts Department of Environmental Protection**

# Transmittal Form for Permit Application and Payment

1. Please type or print. A separate Transmittal Form must be completed for each permit application.

2. Make your check payable to the Commonwealth of Massachusetts and mail it with a copy of this form to: DEP, P.O. Box 4062, Boston, MA 02211.

3. Three copies of this form will be needed.

**Copy 1 - the original** must accompany your permit application. **Copy 2** must accompany your fee payment. **Copy 3** should be retained for your records

4. Both fee-paying and exempt applicants must mail a copy of this transmittal form to:

**DEP**
**P.O. Box 4062**
**Boston, MA**
**02211**

*** Note:**
For BWSC Permits, enter the LSP.

## A. Permit Information

BRP WP 11
1. Permit Code: 7 or 8 character code from permit instructions

Groundwater Discharge Permit
2. Name of Permit Category

Modification of Permit with Plan Approval
3. Type of Project or Activity

## B. Applicant Information – Firm or Individual

Town of Nantucket , Department of Public Works
1. Name of Firm - Or, if party needing this approval is an individual enter name below:

2. **Last Name** of Individual
3. **First Name** of Individual
4. MI

188 Madaket Road
5. Street Address

| 6. City/Town | 7. State | 8. Zip Code | 9. Telephone # | 10. Ext. # |
|---|---|---|---|---|
| Nantucket | MA | 02554 | 508-228-7244 | |

Jeffrey L. Willett
11. Contact Person

12. e-mail address (optional)

## C. Facility, Site or Individual Requiring Approval

Surfside Wastewater Treatment Facility
1. Name of Facility, Site Or Individual

South Shore Road
2. Street Address

| 3. City/Town | 4. State | 5. Zip Code | 6. Telephone # | 7. Ext. # |
|---|---|---|---|---|
| Nantucket | MA | 02554 | 508-325-5333 | |

8. DEP Facility Number (if Known)
9. Federal I.D. Number (if Known)
10. BWSC Tracking # (if Known)

## D. Application Prepared by (if different from Section B)*

Earth Tech, Inc.
1. Name of Firm Or Individual

196 Baker Avenue
2. Address

| 3. City/Town | 4. State | 5. Zip Code | 6. Telephone # | 7. Ext. # |
|---|---|---|---|---|
| Concord | MA | 01742 | 978-371-4000 | 4142 |

Thomas E. Parece, P.E.
8. Contact Person

9. LSP Number (BWSC Permits only)

## E. Permit - Project Coordination

1. Is this project subject to MEPA review? ☒ yes ☐ no
   If yes, enter the project's EOEA file number - assigned when an Environmental Notification Form is submitted to the MEPA unit: 12617
   EOEA File Number

## F. Amount Due

*DEP Use Only*

*Permit No:*

*Rec'd Date:*

*Reviewer:*

### Special Provisions:

1. ☒ **Fee** Exempt (city, town or municipal housing authority)(state agency if fee is $100 or less).
   *There are no fee exemptions for BWSC permits, regardless of applicant status.*
2. ☐ Hardship Request - payment extensions according to 310 CMR 4.04(3)(c).
3. ☐ Alternative Schedule Project (according to 310 CMR 4.05 and 4.10).
4. ☐ Homeowner (according to 310 CMR 4.02).

Check Number | Dollar Amount | Date

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection – Groundwater Discharge Permits

W 065519
Transmittal Number #

Facility ID (if known)

**BRP WP 05 Experimental or Alternative Treatment Technology or Permits Requiring Groundwater Reclassification**
**BRP WP 06 Major Groundwater Discharge Permit**
**BRP WP 08 Minor Groundwater Discharge Permit**
**BRP WP 10 Other Groundwater Discharges**
**BRP WP 11 Modification or Renewal with Plan Approval**
**BRP WP 12 Modification or Renewal without Plan Approval**
**BRP WP 42 Groundwater Reclamation Projects**

Application for Permit to Discharge to Groundwaters of the Commonwealth

## A. Applicant Information

**Important:** When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

1. Name, address, location, and telephone number of facility producing the discharge:

Surfside Wastewater Treatment Facility
Name

South Shore Road
Address

Nantucket — MA
City/Town — State

02554 — 508-325-5333
Zip Code — Telephone

2. Facility location:

South Shore Road
Address

Nantucket — MA
City/Town — State

508-325-5333
Telephone

3. Contact Person:

Mr. Jeffrey L. Willett
Name

Director of Public Works — 508-228-7244
Title — Telephone

Owner

- ☐ Individual
- ☐ Corporation
- ☐ Partnership
- ☒ Other

If other, please specify:
Municipal

Status

- ☐ Private
- ☒ Public
- ☐ Other

If other, please specify:

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection – Groundwater Discharge Permits

W 065519
Transmittal Number #

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Application for Permit to Discharge to Groundwaters of the Commonwealth

## B. Facility Operator

Give the name, as it is legally referred to, of the person, firm, public organization or other entity which operates the facility described in this application. If the facility owner is also the operator, write owner and list mailing address only if different from that listed in number 1 above.

Town of Nantucket, Department of Public Works
Name

188 Madaket Road
Address

| Nantucket | MA | 02554-2623 |
|---|---|---|
| City/Town | State | Zip Code |

## C. Project Information

1. Does the project affect a site of historic or archeological significance, as defined in regulations of the Massachusetts Historical Commission, 950 CMR 71.00?

   ☐ Yes ☒ No

2. Does this project require a filing under 301 CMR 11.00, the Massachusetts Environmental Policy Act?

   ☒ Yes ☐ No

   If yes, has a filing been made? (Please indicate the EOEA File Number)

   ☒ Yes ☐ No 12617
   EOEA File Number

3. Is this a RCRA facility as defined in 314 CMR 8.03?

   ☐ Yes ☒ No

   If yes, submit the information on Form HW contained in 314 CMR 8.20 in accordance with the provisions of 314 CMR 8.08.

4. Are you seeking a reclassification of the groundwaters impacted by your discharge?

   ☐ Yes ☒ No

   If the answer to this question is yes additional information should be submitted pursuant to 314 CMR 6.00, The Massachusetts Groundwater Quality Standards.

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection – Groundwater Discharge Permits

**BRP WP 05 Experimental or Alternative Treatment Technology or Permits Requiring Groundwater Reclassification**
**BRP WP 06 Major Groundwater Discharge Permit**
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**BRP WP 42 Groundwater Reclamation Projects**

W 065519
Transmittal Number #

Facility ID (if known)

Application for Permit to Discharge to Groundwaters of the Commonwealth

## C. Project Information (cont.)

5. Improvements - Are you required by any Federal, State or local authority to meet any implementation schedule for the construction, upgrading or operation of wastewater treatment equipment or practices or any other environmental programs which may affect the discharges described in this application? This includes but is not limited to, permit conditions, administrative or enforcement orders, enforcement compliance schedule letters, stipulations, court orders, and grant or loan conditions.

   ☒ Yes ☐ No

   If yes, answer the following:

   Description of order or agreement:

   Administrative Consent Order, File No. ACOP-BO-03-1G002 (ACO included in Appendix E)

   Identification No. of Affected Treatment Facility DEP GW Discharge Permit SE#1-200

   Description of Project

   See Appendix A for Facility Description

   Full Operation by June 30, 2008
   Final Compliance Date

6. Has a hydrogeologic study been performed to determine the potential impact on the groundwater of the discharge or activity?

   ☒ Yes (please attach a copy) ☐ No **See Appendix B.**

7. Have plans and specifications for the treatment works been approved (see instructions) by the Department or if approved prior to July 1975, by the Department of Public Health? (If yes, please attach copy of plans and specifications and approval letter.)

   ☐ Yes ☒ No **Plans and Specs submitted to DEP on July 1, 2005.**

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection – Groundwater Discharge Permits

W 065519
Transmittal Number #

Facility ID (if known)

**BRP WP 05 Experimental or Alternative Treatment Technology or Permits Requiring Groundwater Reclassification**
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Application for Permit to Discharge to Groundwaters of the Commonwealth

## C. Project Information (cont.)

8. Are there any groundwater monitoring wells currently in place in the vicinity of the discharge or proposed discharge? (If yes, please attach information on the type and location of the wells and available monitoring data.)

   ☒ Yes ☐ No **See Appendix B and Appendix C.**

9. Do you own the property at the discharge site? (Please provide legal ownership documents with the application.)

   ☒ Yes ☐ No **Town owned property, documents previously submitted to DEP.**

10. Have opportunities for reclaimed water been evaluated?

    ☐ Yes ☒ No

11. Is there a local regulation governing the construction of wastewater treatment facilities? (If so, please include a copy of the local approval.)

    ☐ Yes ☒ No

## D. Facility Information

1. Facility Status: ☐ Existing ☒ Proposed
2. When did or when will this discharge begin? April 2008 (date)
3. Check type of establishment producing or contributing to discharge:
   - ☒ Residential Housing — 2.75 mgd residential flow (Total number of bedrooms)
   - ☐ Remediation Project
   - ☒ Other: Commercial (Nature of Business)
4. Design Flow: 3.5 mgd (Daily Maximum gpd)
   a) ☒ Check here if discharge occurs all year, or
   b) List months discharge occurs _____
   c) Number of days per week discharge occurs _____

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection – Groundwater Discharge Permits

**BRP WP 05 Experimental or Alternative Treatment Technology or Permits Requiring Groundwater Reclassification**
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**BRP WP 42 Groundwater Reclamation Projects**

W 065519
Transmittal Number #

Facility ID (if known)

Application for Permit to Discharge to Groundwaters of the Commonwealth

## D. Facility Information (cont.)

5. Basis for design flow:

☐ The State Environmental Code – Title 5

☒ Other: Comprehensive Wastewater Management Plan, completed March 2004
Specify

6. Type of treatment and disposal system for discharge to ground:

See Facility Description in Appendix A.

7. Location and method of wastewater treatment solids disposal:

Primary sludge, waste activated sludge and primary/secondary scum will be stored in covered aerated holding tanks. The sludge and scum will be dewatered on-site using centrifuges and dewatered solids will be transported to the Town's municipal solid waste composting facility located at 188 Madaket Road for processing and disposal.

8. If a commercial establishment:

A. Are any types of wastewater other than sanitary sewage produced?

☐ Yes ☒ No

If yes:
Specify type of wastewater

Quantity gpd

Method and location of disposal

## D. Facility Information (cont.)

B. Are any hazardous wastes generated?

☐ Yes ☒ No

9. Does or will the treatment/disposal facility receive industrial wastes?

☐ Yes ☒ No

10. Location of Facility:

A. Is the facility located on Native American Lands? ☐ Yes ☒ No

B. GPS Coordinates: **See Figures.**
1) Enter Latitude and Longitude to the nearest whole second for both the wastewater treatment facility and the effluent disposal area.
2) Provide a narrative description of the site and the feature to be permitted. As an example: "The site is on the west side of Main Street, the third building north of High Street. The disposal field lies 100 feet off the southwest corner of the building."
3) Attach a site map based on a USGS topographical map or MassGIS Color Ortho Photography that clearly indicates both your facility and the location of the discharge. The USGS topographical map is available on http://maps.massgis.state.ma.us/MassGISTopos/viewer.htm or the Color Orthophotography on http://maps.massgis.state.ma.us/MassGISColorOrthos/viewer.htm.

C. Provide a topographic map or maps of the area extending at least to one mile beyond the property boundaries of the facility which clearly show the following: **See Figures.**

1) The legal boundaries of the facility;
2) The location and serial number of each of your existing and proposed intake and discharge structures;
3) All hazardous waste management facilities;
4) All springs and surface water bodies in the area, plus all drinking water wells within one mile of the facility which are identified in the public record or otherwise known to you.
5) All Zone II's or IWPA's.

If an intake or discharge structure, hazardous waste disposal site, or injection well associated with the facility is located more than one mile from the plant, include it on the map, if possible. If not, attach additional sheets describing the location of the structure, disposal site, or well, and identify the U.S. Geological Survey (or other) map corresponding to the location.

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection – Groundwater Discharge Permits

**BRP WP 05 Experimental or Alternative Treatment Technology or Permits Requiring Groundwater Reclassification**
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W 065519
Transmittal Number #

Facility ID (if known)

Application for Permit to Discharge to Groundwaters of the Commonwealth

## D. Facility Information (cont.)

D. Please list any public or private drinking water supply wells within 2,500 feet of the discharge area:

| Well Location | Type of Well (Public/Private) | Status (Active/Inactive) | Safe Yield |
|---|---|---|---|
| See Figures 3 and 4 | | | |
| | | | |

11. Water Supply Data **Please refer to CWMP for Town of Nantucket Water Supply Data.**

A. List sources of water supply and annual water consumption for the past five years.

| Water Sources | Year 1 | Year 2. | Year 3. | Year 4. | Year 5. |
|---|---|---|---|---|---|
| 1. | | | | | |
| 2. | | | | | |
| 3. | | | | | |
| Total: | | | | | |

B. Please show the location of your water sources on the map described in question 10.

**Note:** Answer questions in section E only if you are applying for permits under categories BRP WP 10, BRP WP 42, or, if you are applying under BRP WP 08, when a car wash or laundromat will discharge to groundwater.

## E. Required Information for Certain Categories

1. Flows, Sources of Pollution and Treatment Technologies

A. Attach a line drawing showing the water flow through the facility. Indicate sources of intake water, operations contributing wastewater to the effluent, and treatment units labeled to correspond to the more defined descriptions in Item E.1.B. Construct a water balance on the line drawing by showing average flows between intakes, operations, treatment units and outfalls. If a water balance cannot be determined provide a pictorial description of the nature and amount of any sources of water and any collection or treatment measures.

## E. Required Information for Certain Categories (cont.)

B. For each discharge, provide a description of:

1) All operations contributing wastewater to the effluent, cooling water and runoff;
2) The average flow contributed by each operation; and
3) The treatment received by the wastewater. (Attach additional sheets if necessary.)
4) With the exception of storm water runoff, leaks, or spills please note if any of the discharges described are intermittent or seasonal.

**Operations Contributing to Flow:**

| Identification Number | Operations | Average Flow | Treatment |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

2. Effluent Limitations:

A. List any pollutant you know or have reason to believe is discharged or may be discharged from the treatment facilities. For every pollutant you list, briefly describe the reason you believe it to be present, its approximate concentration in the discharge and any analytical data in your possession, which will support your statement. Additional wastewater analysis may be required as part of this application.

| Pollutant | Concentration | Source | Available Data |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

## E. Required Information for Certain Categories (cont.)

B. Are your operations such that your raw materials, processed, or products can reasonably be expected to vary so that your discharges of pollutants may during the next five years exceed three times the approximate concentrations reported in item 2A?

☐ Yes (please explain) ☐ No

C. Are you planning on adding any new processes over the next five years?

☐ Yes (please specify) ☐ No

D. Are organic compounds used at your facility?

☐ Yes (please explain) ☐ No

3. Were any of the analyses or testing reported in item E.2.A. performed by a contract laboratory or consulting firm?

☐ Yes (please explain) ☐ No

Name of Facility

Address

City/Town State

Zip Code Telephone

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection – Groundwater Discharge Permits

**BRP WP 05 Experimental or Alternative Treatment Technology or Permits Requiring Groundwater Reclassification**
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**BRP WP 11 Modification or Renewal with Plan Approval**
**BRP WP 12 Modification or Renewal without Plan Approval**
**BRP WP 42 Groundwater Reclamation Projects**

W 065519
Transmittal Number #

Facility ID (if known)

Application for Permit to Discharge to Groundwaters of the Commonwealth

## E. Required Information for Certain Categories (cont.)

4. Check any of the following that apply to this site:

A. ☐ Superfund Site — If yes, Federal ID #

☐ Bureau of Waste Site Cleanup Priority Site — If yes, File Number

☐ Bureau of Waste Site Cleanup Waiver Site (Please include a copy of the waiver with the application) — If yes, File Number

B. If the site is currently being regulated by the Bureau of Waste Site Cleanup, check any of the following that apply:

☐ Incident Response ☐ Short Term Measure

Please provide a copy of the letter of authorization if applicable.

## F. Certification

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I will be responsible for publication of public notice of the applicable permit proceedings identified under 314 CMR 2.06(1)(a) through (d)."

Jeffrey L. Willett
Signature of Applicant

Jeffrey L. Willett
Printed Name of Applicant

6-28-05
Date Signed

Thomas E. Parece, P.E.
Name of Preparer

508-228-7244
Telephone

Senior Program Director
Title of Preparer

# List of Figures, Tables and Appendices

*Appendices*

Appendix A. Supplemental Responses for Groundwater Discharge Permit Application
Appendix B. Hydrogeological Report, September 2002
Appendix C. Boring Logs, Test Pit Logs and Grain Size Analyses
Appendix D. Laboratory Reports – Groundwater Samples, April 2005
Appendix E. Administrative Consent Order

*Tables*

Table 1. Groundwater Quality Summary, April 13, 2005 Monitoring

*Figures*

Figure 1. Site Locus
Figure 2. Site Plan and Monitoring Wells
Figure 3. Public Water Supply Wells
Figure 4. Private Water Supplies
Figure 5. Existing Piping, Plumbing and Subsurface Utilities

# Appendix A. Supplemental Responses for Groundwater Discharge Permit Application

**Supplemental Responses - Groundwater Discharge Permit Application**
**Proposed Upgrade to Surfside Wastewater Treatment Plant**
**Nantucket, MA**

A. Historical Review

The Surfside Wastewater Treatment Facility (WWTF) has been in operation since the early 1900s, originally discharging raw wastewater to open beds. In the late 1980s, the Town began construction of a primary treatment facility that began operation in April 1991. In the mid 1990s, the WWTF was upgraded to consist of chemically enhanced primary treatment during the summer months. In the late 1990s the Town began the planning process for upgrading the WWTF. The Comprehensive Wastewater Management Plan/Environmental Impact Report was complete in March 2004 and approved in June 2004. The upgrades to the WWTF require the modification to the existing Groundwater Discharge Permit SE #1-200, dated March 4, 1992. In general, the Town of Nantucket is seeking to modify its permit from a Class III discharge to a Class I discharge, and to revise the Total Average Daily Flow from 1.80 million gallons per day (mgd) to 3.50 mgd.

A Locus of the site is shown as Figure 1 and Site Plan as Figure 2.

See plans and specifications for process flow schematic, hydraulic flow diagram.

Previous subsurface work was completed in the late 1970s and 1980s in support of Groundwater Discharge Permit SE #1-200, dated March 4, 1992. In 2002, Earth Tech completed a Hydrogeological Report to evaluate the maximum potential discharge at the Surfside site, considering both mounding potential and seasonal high groundwater levels. This report made use of previously collected subsurface data, and is attached as Appendix B. Most recently, in November 2004, Earth Tech performed ten test pits and installed 14 borings to evaluate both the structural and groundwater conditions on site. These logs are included as Appendix C. As a result of all these investigations, there are currently nine functioning groundwater monitoring wells on site. These are used for monitoring of both water levels and groundwater quality.

B. Regional Survey

Based on MassGIS data, two public supply wells are present within one mile of the Surfside WWTF (see Figure 3):

| | |
|---|---|
| 4197003-01G | Miacomet Golf Course |
| 4197008-01G | Surfside Beach |

Both of these wells appear to supply small and/or transient populations. Approximately 12 private wells are present within one-quarter mile of the WWTF (see Figure 4), on Pond View Drive, South Shore Road, and Morgan Square. Given the groundwater flow conditions at the Surfside WWTF – groundwater flows southerly and toward the ocean – these wells should not be impacted by the discharges at the Surfside WWTF.

The one-mile radius around the Surfside WWTF does not intersect with any Zone II, large public water supply well or surface-water supply (see Figure 3). Several wetlands, water bodies and the ocean are within one mile of the Surfside WWTF (see Figure 3). The WWTF is inside Natural Heritage & Endangered Species Program (NHESP) habitat, as shown on Figure 3.

B. Subsurface Conditions

On-site borings indicate that the shallow soils on site consist of glacial sand-and-gravel outwash deposits of Wisconsinan age. In November 2004, a boring advanced to 150 feet indicates that the outwash becomes finer (very-fine to fine sand) at a depth of about 75 feet. At the 95-foot depth, the soils are silty sand. At 105 feet, gray clay and silt was found along with a green sandy layer containing shell fragments. Other layers containing shell fragments were found to a depth of 115 feet. Similar shell fragment layers have been found in Siasconset at a similar depth, and are thought to represent a marine unit deposited during the Sangamonian, about 120,000 to 140,000 years before present. The Sangamonian period represents the inter-glacial period (non-glaciated) preceding the Wisconsinan glacial period. Beneath the shell fragment layers, the soils are fine to medium sand at 125 feet, but become finer gradationally to very-fine to fine sand at 135 feet and silt at 150 feet. Crystalline bedrock is believed to be at least 1,500 feet below sea level. Boring logs, test-pit logs and grain-size analysis are in Appendix C.

As mentioned above, Earth Tech completed a hydrogeologic evaluation of the Surfside WWTF in 2002 to evaluate the maximum potential rate of discharge rate. This report is attached as Appendix B. Additional information on the hydrogeologic conditions, as well as a mounding analysis, and a calculation of high groundwater table are included in that report.

C. Groundwater Quality

In April 2005, Earth Tech sampled groundwater in four on-site groundwater monitoring wells, N-1, N-3R, N-10 and N-11A. The well locations are shown on Figure 2. Note that N-11A is upgradient of the groundwater discharge and the remaining wells are downgradient. Water samples were tested for a variety of inorganic and organic parameters. The results of these tests are tabulated on Table 1. The laboratory reports are included as Appendix D.

Note that the metals were analyzed as both "totals" and "dissolved". The "total" samples were unfiltered; the "dissolved" were filtered. This approach was taken because monitoring wells tend to produce turbid water, which often skews the metals analyses. In a turbid sample, the laboratory result could reflect both fine particles and colloids, as well as the truly dissolved metal species. In the case of the monitoring wells in Nantucket, the "dissolved" result should be more reflective of the dissolved concentrations of metals in groundwater.

## FACILITY DESCRIPTION
### Background

The existing Surfside Wastewater Treatment Facility (WWTF) has been in operation since the early 1900s, originally discharging raw wastewater to open beds. In the late 1980s, the Town began construction of a primary treatment facility that began operation in April 1991. In the mid 1990s, the WWTF was upgraded to consist of chemically enhanced primary treatment during the summer months.

In the late 1990s, the Town began the planning process for upgrading the WWTF. The Comprehensive Wastewater Management Plan/Environmental Impact Report was complete in March 2004 and approved in June 2004. The upgrades to the WWTF require the modification to the existing Groundwater Discharge Permit SE #1-200, dated March 4, 1992. In general, the Town of Nantucket is seeking to modify its permit from a Class III discharge to a Class I discharge, and to revise the Total Average Daily Flow from 1.80 million gallons per day (mgd) to 3.50 mgd.

### Existing Facilities

Wastewater generated from a majority of the Town Sewer District is pumped from the Sea Street Pump Station to the Surfside WWTF. Flow from the Sea Street Pump Station enters the headworks were the wastewater is screened through a manually cleaned bar rack. After screening, the wastewater flow is measured through a Parshall flume prior to entering an aerated grit chamber where sand and gravel are removed from the wastewater. Screenings and grit are placed into containers and are transported to the Town's municipal solid waste composting facility located at 188 Madaket Road for processing and disposal.

From the headworks, the flow is split equally into three primary clarifiers where the settleable solids and floatables are removed. Effluent from the primary clarifiers is discharged into ten rapid infiltration basins.

The settled solids, or primary sludge, are pumped to three aerated sludge holding tanks. The primary sludge is dewatered using belt filter presses and is than transported to the Town's municipal solid waste composting facility located at 188 Madaket Road for processing and disposal.

### Proposed Facilities

Wastewater generated from a majority of the Town Sewer District is pumped from the Sea Street Pump Station to the Surfside WWTF. Flow from the Sea Street Pump Station enters the headworks were grinding of the wastewater solids will occur in a mechanical grinder. After grinding, the wastewater flow will be measured through a Parshall flume prior to entering an aerated grit chamber where sand and gravel are removed from the wastewater. Screenings and grit are placed into containers and are transported to the Town's municipal solid waste composting facility located at 188 Madaket Road for processing and disposal.

From the headworks, the flow will be equally split into three primary clarifiers where the settleable solids and floatables are removed. The settled solids, or primary solids, will be pumped into two aerated sludge holding tanks. Effluent from the primary clarifiers will be split equally into three anoxic tanks / pre-aeration tanks and membrane bioreactor units where biological treatment and filtration will remove over 95 percent of the pollutants remaining after primary clarification. Solids, or waste activated sludge, from this process will be pumped into two aerated sludge holding tanks.

Flow from the membrane bioreactor units will be disinfected using ultraviolet light prior to discharge into fifteen rapid infiltration basis.

The primary sludge, waste activated sludge and primary/secondary scum will be dewatered using centrifuges and than transported to the Town's municipal solid waste composting facility located at 188 Madaket Road for processing and disposal.

# Appendix B. Hydrogeological Report, September 2002

# HYDROGEOLOGICAL REPORT
# SURFSIDE WASTEWATER TREATMENT FACILITY
# NANTUCKET, MASSACHUSETTS

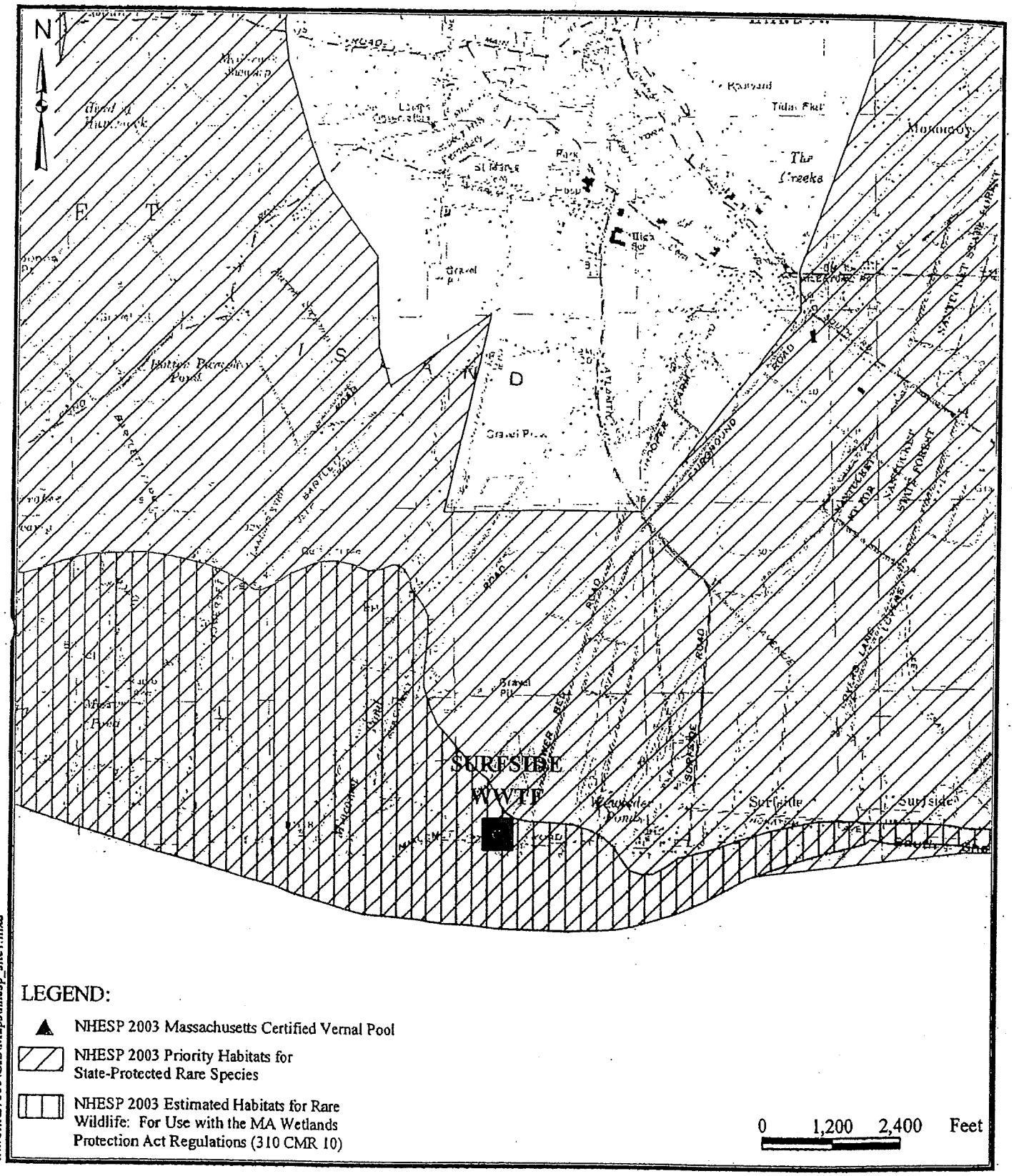
# 1.0 INTRODUCTION

## 1.1 PURPOSE AND SCOPE

The purpose of this investigation was to evaluate the potential for the discharge of additional quantities of treated wastewater at the Surfside Wastewater Treatment Facility (WWTF) site in Nantucket (see Figure 1-1). The WWTF currently has the capacity to discharge approximately 2.24 million gallons per day (MGD) but is currently permitted to discharge only 1.8 MGD. The goal of the investigation is to determine the maximum potential discharge rate at the site as additional capacity is being sought at this and other sites as part of the island-wide Comprehensive Wastewater Management Plan (CWMP).

In order to determine the maximum potential discharge at the site, it was necessary to determine the rate of discharge that corresponds to the highest allowable groundwater mound beneath the discharge beds. According to DEP regulations, the highest allowable groundwater mound would be four feet below the beds under seasonal high groundwater conditions. Therefore, the first step was to establish the seasonal high groundwater levels at the site. Once established, the groundwater mound resulting from the proposed discharge was predicted on the basis of a numerical groundwater model of the site.

The data for this analysis was obtained from existing data reports and publications including: (a) "Geohydrological Report from the Nantucket E.I.S.", Goldberg, Zoino and Dunnicliff & Associates, 1980; (b) "Public Wellfield Water Resource Management Study, Nantucket, Massachusetts", Perkins Jordan Inc., 1983; (c) "Sharp Interface Models of Saltwater Intrusion and Wellhead Delineation on Nantucket Island, Massachusetts," M. Person, L. Urbano, J. Taylor, M. Willet J. Swenson and B. Dugan, 2001, Groundwater, v.36.; and (d) "Water Resources of Nantucket Island, Massachusetts", E.H. Walker, 1980, Hydrologic Atlas 615, U.S. Geological Survey.

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AUGUST 2002

Scale 1:25,000

EARTH TECH

A TYCO INTERNATIONAL LTD COMPANY

SURFSIDE WASTEWATER TREATMENT PLANT
NANTUCKET, MASSACHUSETTS

## 1.2 SITE DESCRIPTION

The WWTF site is located near the southern shore of Nantucket (see Figure 1-1). The WWTF has been operational since 1991. There are presently 10 discharge beds on the site with an area of approximately 45,000 square feet each. A map of the site layout is shown in Figure 1-2.

The entire site is located in an area composed of glacial outwash deposits of sand and gravel. The aquifer in this location is a simple water table aquifer with no significant confining or semi-confining units. The depth of the aquifer at this location is uncertain. None of the borings at the site exceeded a depth of 100 feet. Based on deep borings conducted on the island (Walker, 1980) (Person and Taylor, 2001) the sand outwash unit probably extends to depths greater than 200 feet. However, the thickness of the freshwater aquifer is dependant on the depth of the saltwater interface. Under hydrostatic conditions, the Ghyben-Herzberg principle would predict that the depth to saltwater at the site would be approximately 100 to 200 feet.

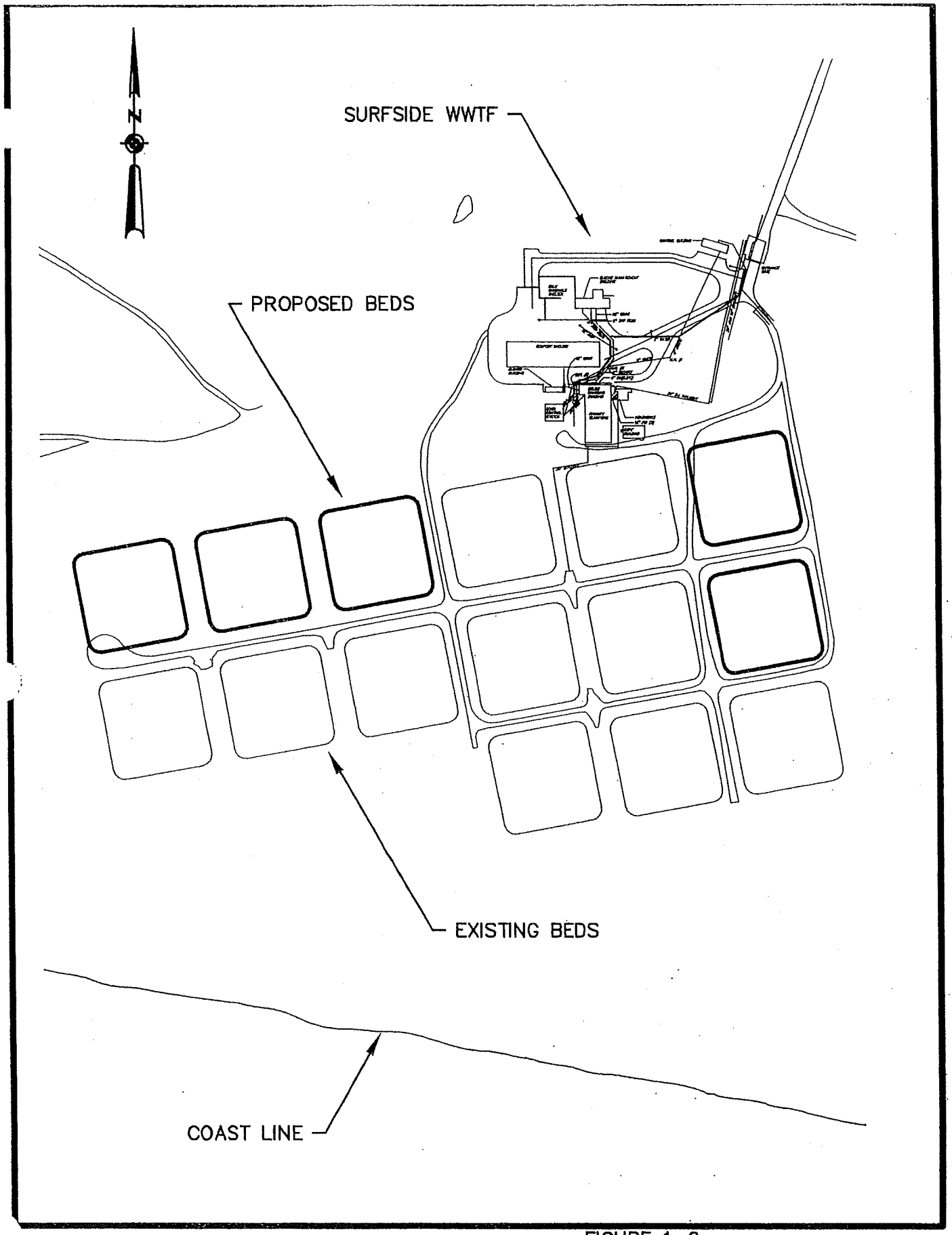


FIGURE 1–2
TOWN OF NANTUCKET
CWMP/DEIR
SITE PLAN

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EARTH TECH

## 2.0 CALCULATION OF HIGH GROUNDWATER TABLE

### 2.1 GENERAL

DEP regulations require that potential groundwater mounding as a result of wastewater discharge must be calculated with respect to seasonal high groundwater levels. There are several acceptable means for determining seasonal high groundwater levels including: (a) measuring water levels during high groundwater conditions (generally March or April); (b) evidence from soil mottling; and (c) calculations based on a technique developed by the U.S. Geological Survey (Frimpter, 1981).

A determination of the seasonal high groundwater level at this site required some data manipulation. This is primarily because there is already an existing discharge at the site and that discharge impacts surrounding water levels. Therefore, determination of high groundwater using soil mottling was not an option. Water level data from nearby monitoring wells in the spring months are available for the last two years but these were relatively dry years and the water levels are also impacted by the discharge. Therefore, the Frimpter (1981) method in order to estimate high groundwater levels.

Although water levels in the existing monitoring wells have been measured regularly at the site since prior to the WWTF beginning operation, there is no corresponding data on exactly which beds were being discharged into or for how long. Therefore it is difficult to determine which water levels represent ambient conditions and which are impacted by the discharge. However, an investigation was conducted at the site by Goldberg, Zoino, Dunnicliff & Associates (GZA) in 1979 (the report is dated May, 1980) in which a series of water levels were obtained under controlled conditions.

The purpose of the GZA investigation was to determine the potential extent of a contaminant plume extending from the wastewater discharge. Although the number and orientation of the discharge beds have been changed since that investigation, the aquifer conditions are not impacted by that change so the data obtained is still considered valid.

The GZA study contains a groundwater contour map based on water levels measured on September 20, 1979 and has been reproduced as Figure 2-1. At that time, wastewater had been discharging solely to Bed No. 7 in preparation for a loading test at Bed No. 4. Since none of the observation wells used to develop this map are in close proximity to Bed No. 7 it is assumed that the impacts of the discharge on observed water levels is minimal. Therefore, these groundwater contours are assumed to be as close to ambient conditions as can be determined.

The GZA report states that tidal fluctuations have a minimal impact on water levels. Recent water level measurements taken at the site over the course of a day (data included in Appendix A) agree with this assessment, although water level fluctuations in the wells closest to the shoreline (N-1 and N-10) appear to fluctuate within a couple of tenths of a foot over a tidal cycle.

## 2.2 Applying the Frimpter Method

The Frimpter method for determining high groundwater conditions (Frimpter, 1980) is based on comparing water levels at a site at a given time with water levels at a nearby long-term reference well and then applying an adjustment factor. The formula used by Frimpter is:

$$Sh = Sc - Sr/Owr(Owc - Owmax)$$

where:

Sh = estimated high water level at site

Sc = measured water level at site at a particular time

Sr = the range of water level fluctuations at the WWTF site

Owr = the range in water levels at the long-term reference well

Owc = water level at the long-term reference well at the time that the site water level was obtained

Owmax = maximum water level at long-term reference well

SOURCE: USGS HYDROLOGIC ATLAS HA-615 (1980)

LEGEND

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-- 10 -- GROUNDWATER ELEVATION WITH CONTOUR (FT NGVD 27)

O[8] O[9.5] WELL\OBSERVATION WELL WITH WATER LEVEL (FT NGVD 27)

→ APPROXIMATE GROUNDWATER FLOW DIRECTION

N

NAME:FIGURE 3-2.dwg DATE9/30/03 PWilson

FIGURE 2-1
REGIONAL GROUNDWATER CONTOURS
SURFSIDE WWTF SITE
NANTUCKET, MASSACHUSETTS

EARTH TECH

Note that this equation is based on water levels expressed in depth to water. It should also be noted that this technique can also be used to estimate long-term average water levels at a site by re-arranging the last portion of the equation to account for average levels rather than high levels. As part of this analysis, the average levels will be calculated in order to calibrate the groundwater level to long-term average conditions. The high groundwater conditions will then be simulated in the model in order to simulate the high groundwater mounding condition (in spite of the fact that the highest discharge will occur at times of generally low water levels).

The reference well used in this analysis was the USGS monitoring well NBW 228, located approximately five miles northeast of the site. This well has the longest and most consistent period of record of all of the wells on Nantucket. Water levels have been monitored at this well since 1976. The range in water levels (Owr) for that period of record is 6.95 feet. The range in water levels for the monitoring wells at the Surfside WWTF (Sr) averages 1.6 feet. The difference in range is due to the fact that monitoring well NBW 228 is located inland of the Surfside monitoring wells.

The WWTF site water levels to be adjusted to average and high groundwater conditions are the levels obtained by GZA on September 20, 1979. Water levels were obtained at NBW 228 on September 26, 1979. These water levels are summarized in Table 1.

The depth to water for the historic high at NBW 228 is 20.65 feet. Therefore, the expression (Owc-Owmax) in the Frimpter equation is equal to 3.49 feet (24.14 – 20.65). The ratio Sr/Owr is equal to 0.231 feet (6/6.95). Since the site water levels are expressed in terms of elevation rather than depth to water, the Frimpter equation becomes:

$Sh = Sc + (0.23 * 3.49)$ or $Sh = Sc + 0.8$ feet.

Based on this calculation, the estimated high groundwater level at each site well is approximately 0.8 feet greater than that observed on September 20, 1979 (see Table 1).

TABLE 2-1

Summary of Observed and Calculated Water Levels

| Well No. | Water Level Sept., 1979 (ft., NGVD) | Average Water Level (ft., NGVD) | High Water Level (ft., NGVD) |
|---|---|---|---|
| N-1 | 2.5 | 2.7 | 3.3 |
| N-3 (old) | 3.9 | 4.1 | 4.7 |
| N-4 | 3.7 | 3.9 | 4.5 |
| N-5 | 4.1 | 4.3 | 4.9 |
| N-6 | 4.1 | 4.3 | 4.9 |
| N-8 | 1.8 | 2.0 | 2.6 |
| N-9 | 4.4 | 4.6 | 5.2 |
| N-11 | 5.1 | 5.3 | 5.9 |
| N-13 | 3.6 | 3.8 | 4.4 |
| SU-M | 3.5 | 3.7 | 4.3 |
| NBW 228 | 14.69 | 14.01 | 18.18 |

The estimated average levels can be calculated in a similar way, except that Owmax is substituted with Owavg in the equation and the signs are reversed. The average depth to water at NBW 228 is 24.82. The expression (Owc-Owavg) in the modified Frimpter equation is equal to 0.68 feet (24.82 – 24.14). This indicates that the water level at the USGS observation well measured on September 26, 1979 was 0.68 feet lower than average. The equation for average water levels at the Surfside site then becomes:

Savg = Sc + (0.23 * 0.68) or Sh = Sc + 0.16 feet.

In order to correct the observed water levels obtained on September 26, 1979 it is necessary to add 0.16 feet or about 0.2 feet (see Table 1).

## 3.0 GROUNDWATER MODELING

### 3.1 CONCEPTUAL MODEL OF AQUIFER SYSTEM

As previously discussed, the aquifer is a simple water table aquifer with no significant confining or semi-confining units. The depth of the aquifer at this location is uncertain. None of the borings at the site exceeded a depth of 100 feet. Based on deep borings conducted on the island (Walker, 1980) (Person and Taylor, 2001) the sand outwash unit probably extends to depths greater than 200 feet. However, the thickness of the freshwater aquifer is dependant on the depth of the saltwater interface. Under hydrostatic conditions the Ghyben-Herzberg principle would predict that the depth to saltwater at the site would be approximately 100 to 200 feet. For the purposes of this groundwater model, it was assumed that the aquifer depth corresponds to the saltwater interface as predicted by the Ghyben-Herzberg equation (the depth to saltwater is 40 times the elevation of the water table above sea level).

### 3.2 MODEL DESIGN

The model code used in this study is the USGS's Modular Three-Dimensional Finite Difference Groundwater Flow Model (MODFLOW) (McDonald and Harbaugh, 1988). This model is well documented and is one of the most widely used groundwater flow models.

The modeled area is shown in Figure 3-1 along with the model grid. The area modeled is approximately one square mile. The model grid consists of 71 columns, 59 rows and 3 layers. The model cell sizes range from 50 feet by 50 feet near the discharge beds to 100 feet by 100 feet in more remote areas.

The southerly boundary is simulated as constant head nodes representing the Atlantic Ocean. The majority of the western boundary is also composed of constant head nodes representing Miacomet Pond. The northern region is also composed of constant head nodes that provides groundwater fluxes comparable to ambient flows. These constant head values were interpolated from the water level data provided in the 1980 GZA report. The eastern model boundary is composed of no flow nodes because flow is approximately perpendicular to the boundary.

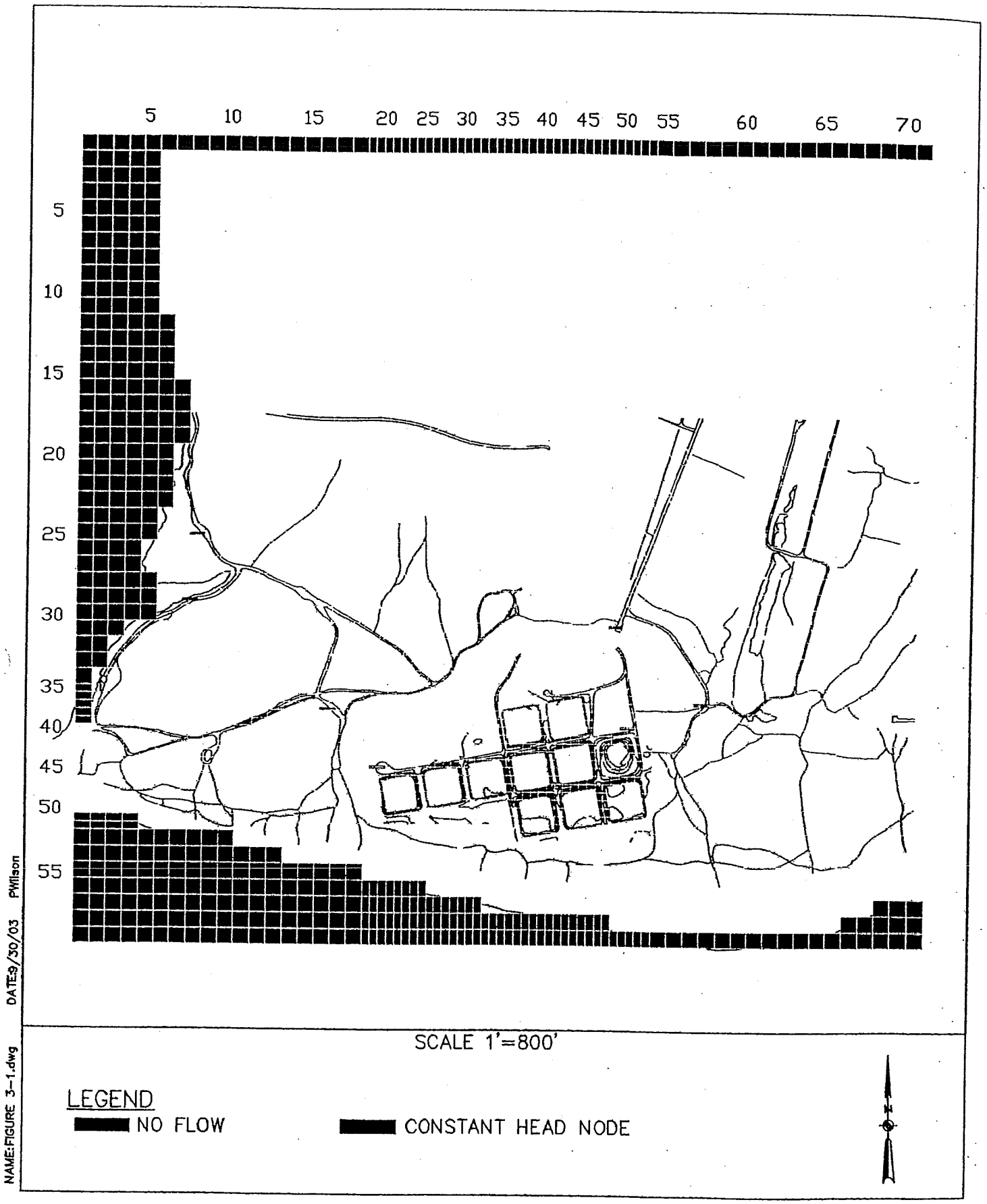


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FIGURE 3-1
MODEL GRID AND BOUNDARY CONDITIONS
SURFSIDE WWTF SITE
NANTUCKET, MASSACHUSETTS

## 3.3 MODEL INPUT PARAMETERS

Input data files were prepared using values primarily obtained from the 1980 GZA study but other sources include Person and Taylor (2001), Masterson and Barlow (1994) and Walker (1980). Model input parameters include: (a) hydraulic conductivity; (b) elevations of the aquifer bottom; and (c) rainfall recharge.

### 3.3.1. Hydraulic Conductivity

Estimated hydraulic conductivity (K) values for the site were obtained from three primary sources: (a) GZA (1980); (b) Person and Taylor (2001); and (c) Walker (1980). The estimated K values from these sources were approximately 165, 186 and 240 ft./day, respectively. The groundwater model calibrated closest to estimated average water levels using a K value of 180 ft./day.

### 3.3.2. Storage Coefficient

Storage coefficients were not required since all simulations were run in steady state mode.

### 3.3.3 Rainfall Recharge

Walker (1980) proposed an average annual recharge rate for Nantucket of 18 inches per year. Noting that the USGS has been consistently raising the estimated recharge rates for Cape Cod and the Islands for the last 10 years, we have chosen to use an average annual recharge rate of 20 inches per year. This recharge rate provides the best match to estimated average water table conditions.

### 3.3.4 Aquifer Bottom Elevations

As noted above, the aquifer bottom elevations were estimated on the basis of the Ghyben-Herzberg approximation. Depending on the elevation of the water table, the aquifer bottoms range from –80 to –240 feet relative to National Geodetic Vertical Datum of 1929 (NGVD).

## 3.4 MODEL CALIBRATION

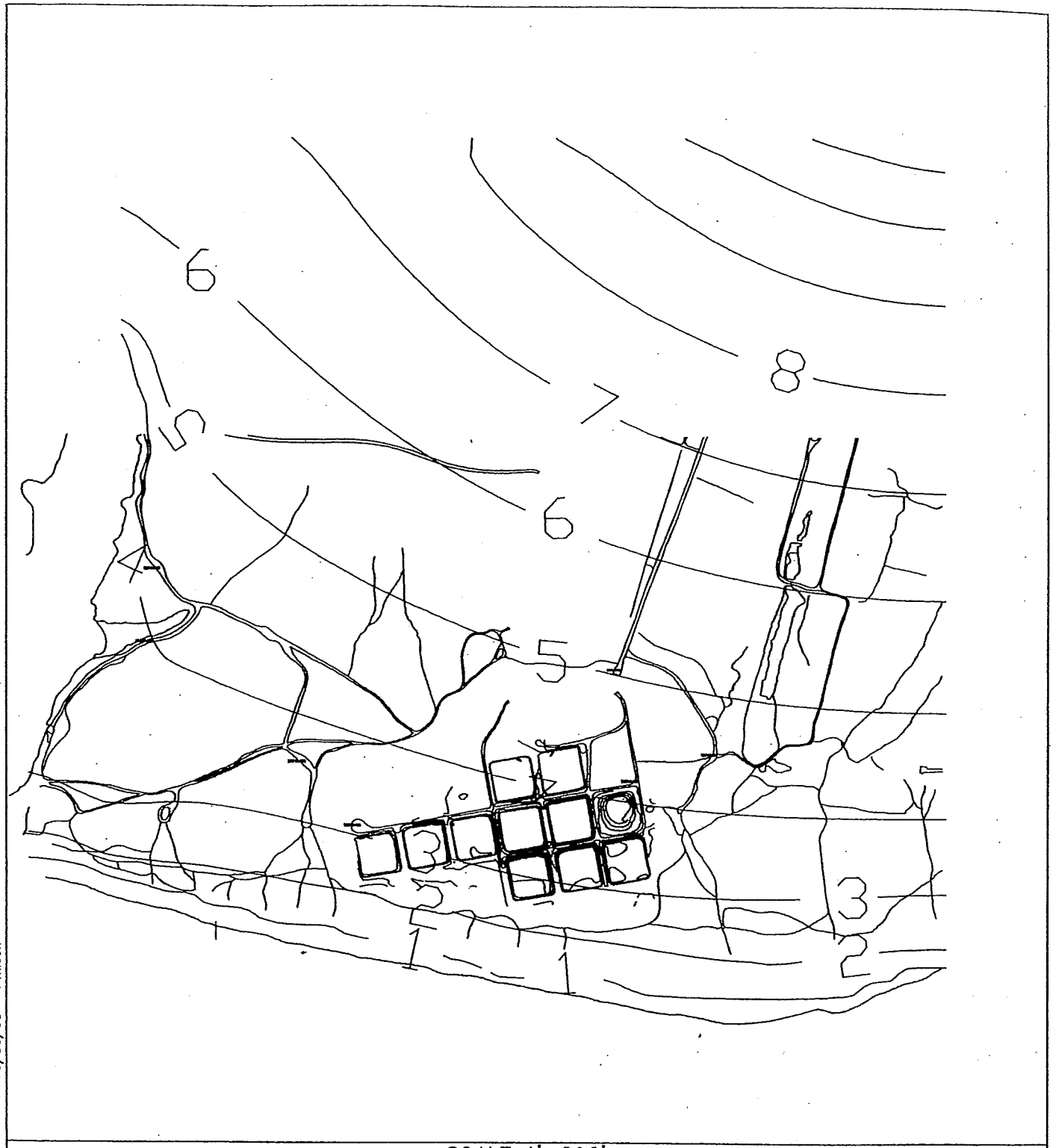
The calibration process ordinarily consists of comparing observed and simulated groundwater elevations and/or fluxes, and then adjusting the input parameters to obtain results that more closely match the observed conditions. In this case, the model was calibrated to the estimated average water levels presented in Table 2-1. The observed levels, model residuals and model statistics are presented in Table 3-1.

Table 3-1

Model Calibration

| Well Number | Average Water Level (ft. NGVD) | Simulated Level | Residual |
|---|---|---|---|
| N-1 | 2.7 | 2.68 | 0.02 |
| N-8 | 2.0 | 2.11 | -0.11 |
| N-9 | 4.6 | 4.83 | -0.23 |
| N-3 | 4.1 | 4.00 | 0.10 |
| SU-M | 3.7 | 3.57 | 0.13 |
| N-13 | 3.8 | 3.78 | 0.02 |
| N-6 | 4.3 | 4.45 | -0.15 |
| N-5 | 4.3 | 4.21 | 0.09 |
| N-4 | 3.9 | 3.82 | 0.08 |
| Residual Mean | | | 0.00 |
| Res. Std. Dev. | | | 0.12 |
| Sum of Squares | | | 0.13 |
| Abs. Res. Mean | | | 0.10 |
| Min. Residual | | | -0.23 |
| Max. Residual | | | 0.13 |
| Head Range | | | 2.60 |
| Std/Head Range | | | 0.05 |

The results of the model-simulated average steady state conditions (without significant discharge) are shown in Figure 3-2.




SCALE 1'=800'

LEGEND

—1— GROUNDWATER ELEVATION WITH CONTOUR (FT HALF TIDE DATUM)

N

NAME:FIGURE 3-2.dwg DATE:9/30/03 PWilson

EARTH TECH

FIGURE 3-2
STEADY STATE WATER TABLE CONTOURS
SURFSIDE WWTF SITE
NANTUCKET, MASSACHUSETTS

## 3.5 SENSITIVITY ANALYSIS

A sensitivity analysis is applied to numerical groundwater flow models in order to evaluate which parameters have the greatest impact on the model output. The sensitivity analysis was undertaken by applying a module of the USGS inverse modeling program called UCODE (Poeter and Hill, 1998). UCODE automatically subjects each model run to an extensive sensitivity analysis. Each parameter was adjusted by a specified amount (10 percent higher and lower than the calibrated values) and the differences in water levels are compiled from each target location. In this case, the target locations are the observation wells for the pumping test.

UCODE calculates the sensitivity of each parameter with respect to each observation point and then takes the mean of all of the sensitivities. The sensitivity is expressed as a dimensionless scaled sensitivity. The term "dimensionless" refers to the fact that the units of the parameter (e.g. feet or feet/day) are factored out so that the sensitivity of each parameter can be compared on an equal basis. They are "scaled" in that the sensitivity value takes into account a weighting factor for each observation (water levels). The weighting factor is a measure of the reliability of each observation. In this case, the reliability of each observation is assumed to be the same, so there is no need for scaling the sensitivities. Refer to Hill (1998) for a full description of dimensionless-scaled sensitivities.

The sensitivity analysis was conducted on horizontal hydraulic conductivity, vertical hydraulic conductivity, and recharge. Since the sensitivities are dimensionless, it is possible to directly compare the sensitivities, regardless of the parameter type. The dimensionless scaled sensitivities for horizontal K, vertical K and recharge are 1.39, 0.003 and 1.89, respectively. These values indicate that the model is marginally more sensitive to recharge. However, there is a fairly close correlation between horizontal K and recharge.

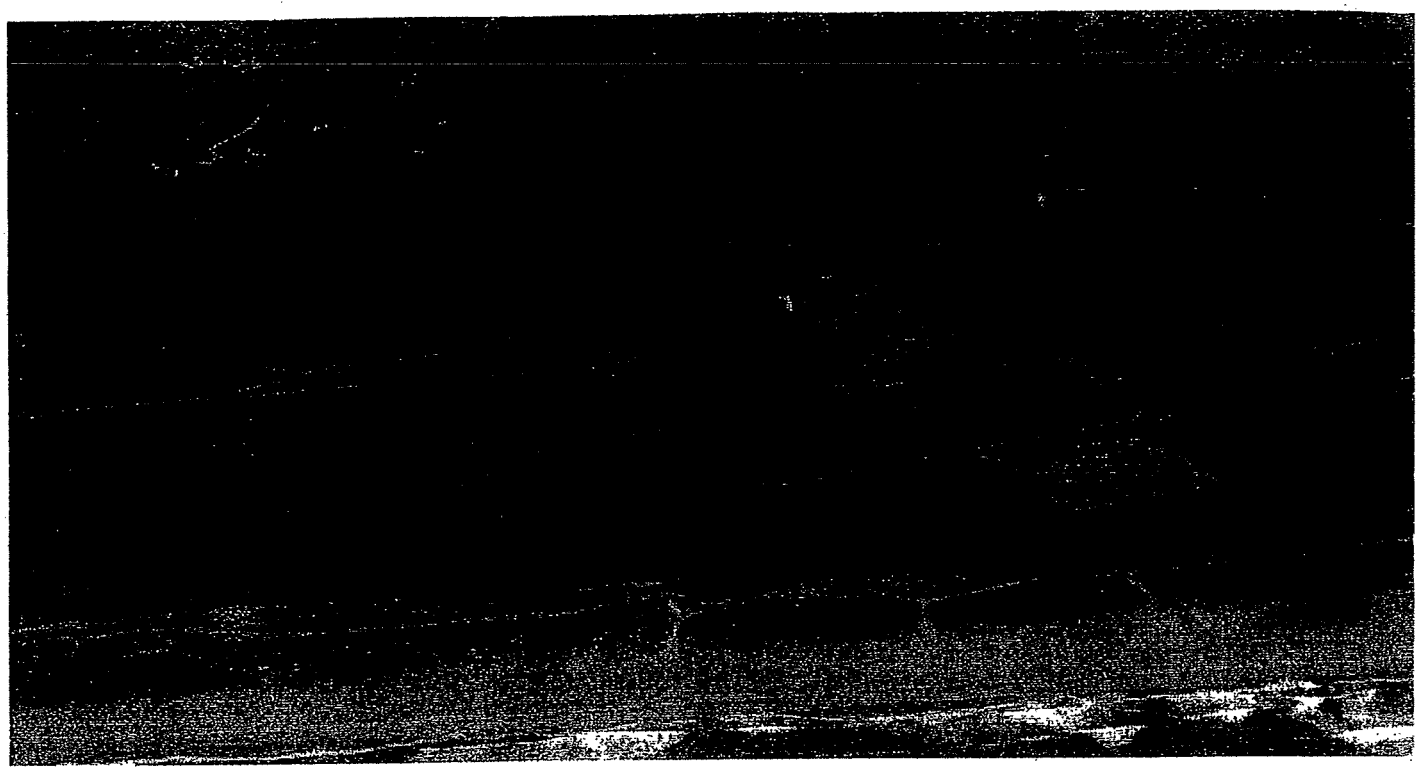
## 4.0 MODELING RESULTS

The high groundwater condition described Section 2 and listed in Table 2-1 was used for all of the model simulations to predict the groundwater mound under discharge conditions. The initial model runs indicated that the existing bed configuration would not be able to accommodate significantly greater flows while still maintaining a four-foot separation between the top of the mound and the bottom of the beds. Since there is sufficient land area for the construction of additional beds at the site, it was decided to use those potential beds in the maximum discharge simulation.

The aerial photographs in Figure 4-1 show: (a) the layout of the existing facility with the 10 existing beds of the existing site (upper photo); and (b) the layout the existing facility with the 10 existing beds and 5 new beds (lower photo). The discharge was allocated equally among the beds.

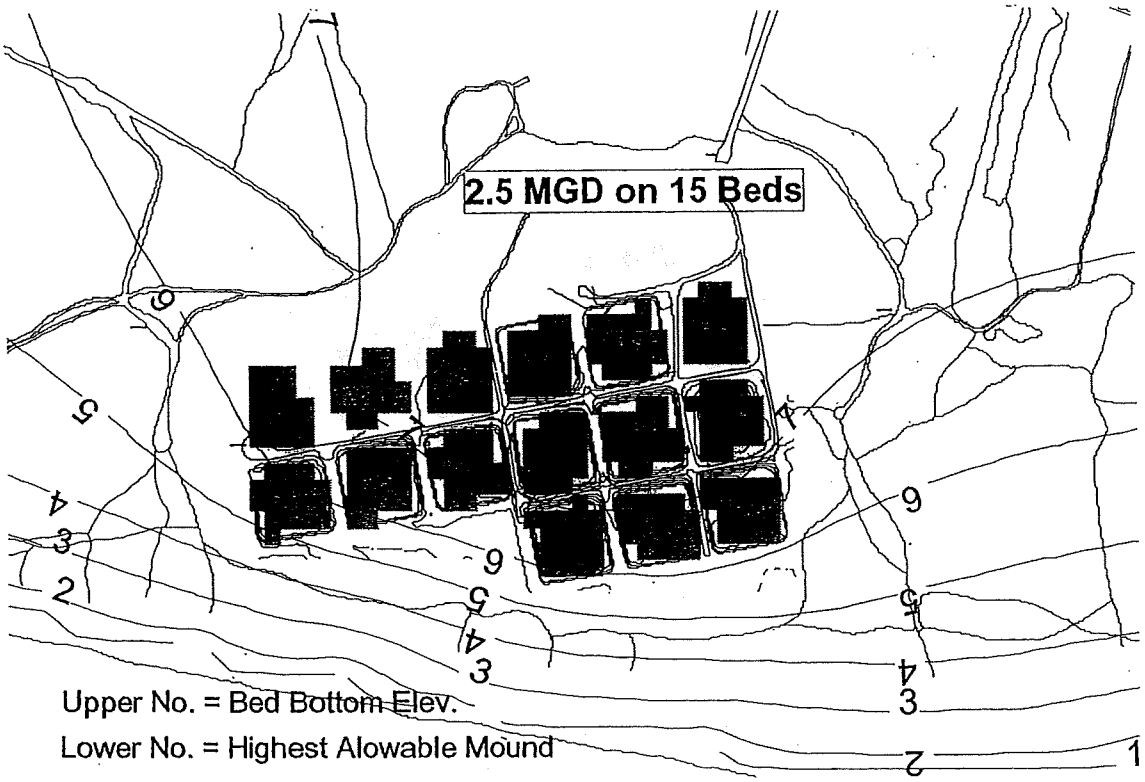
Figure 4-2

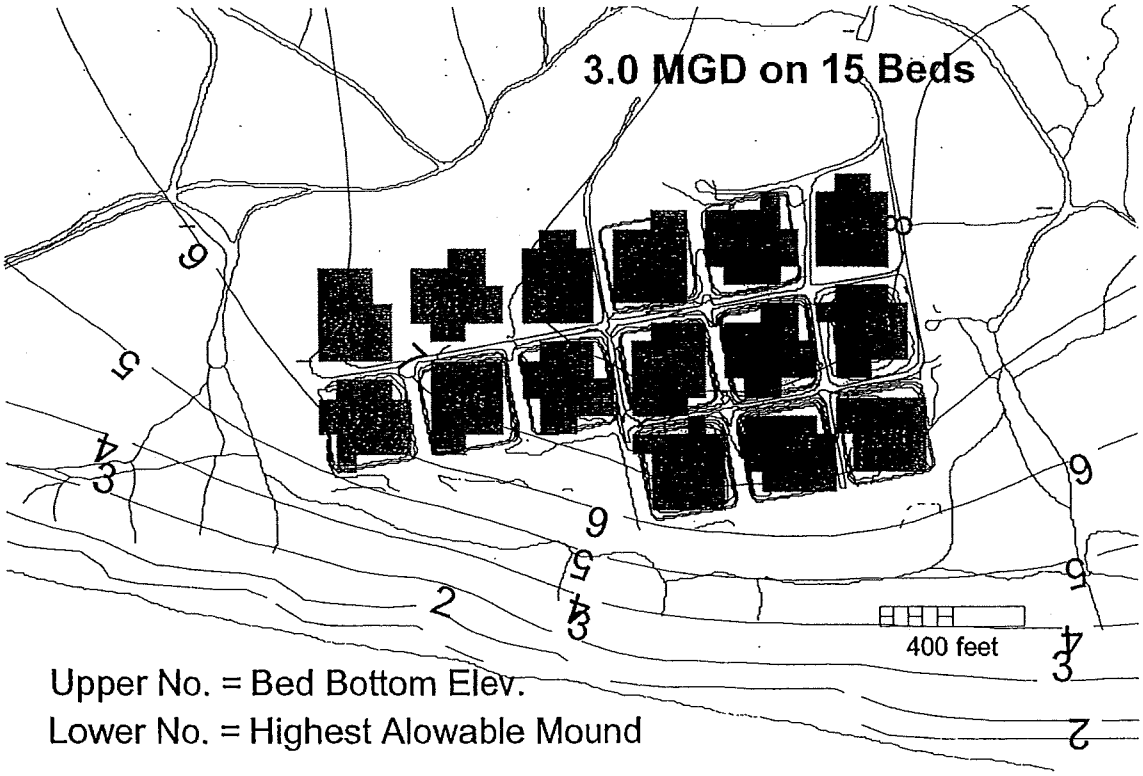
Existing (Upper) and Proposed (Lower) Discharge Beds

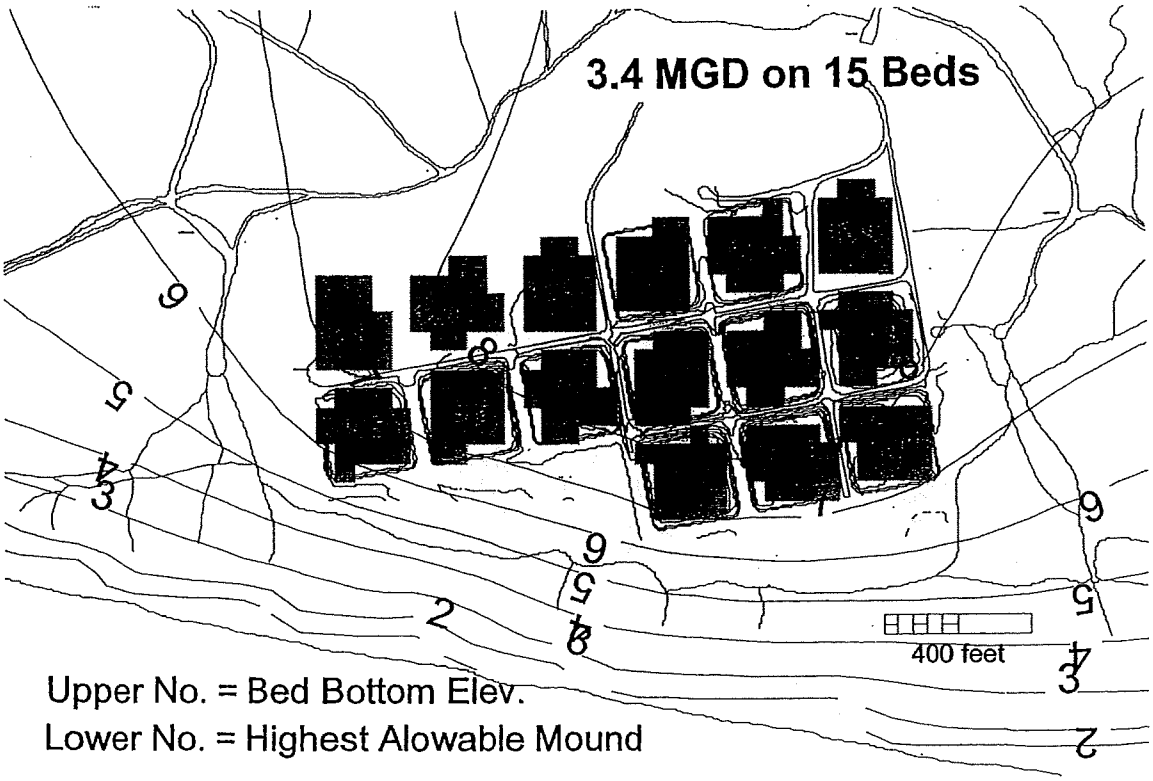


Three discharge scenarios of 2.5 MGD, 3.0 MGD and 3.4 MGD, were simulated using 15 beds (10 existing and 5 proposed). The model results are shown in Figure 4-2, Figure 4-3, and Figure 4-4. The shaded areas represent the modeled bed areas. The upper number within the beds is the maximum allowable elevation of the groundwater mound in order to keep the four-foot separation. The simulated mound contours are also shown.

The limiting factor for maximizing the discharge at the site is the current elevations of the lower (western and southern) beds. For the 2.5 MGD scenario, the bottom elevation of 5 beds would need to be raised by 1 foot. For the 3.0 MGD scenario, the bottom elevation of 3 beds would need to be raised by approximately 1 foot and the bottom elevation of 2 beds raised by approximately 2 feet. For the 3.4 MGD scenario, the bottom elevation of 4 beds would need to be raised by 2 feet and the bottom elevation of 1 bed by 3 feet.


2.5 MGD on 15 Beds
Upper No. = Bed Bottom Elev.
Lower No. = Highest Alowable Mound


3.0 MGD on 15 Beds
400 feet
Upper No. = Bed Bottom Elev.
Lower No. = Highest Alowable Mound


3.4 MGD on 15 Beds
400 feet
Upper No. = Bed Bottom Elev.
Lower No. = Highest Alowable Mound

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NEW ENGLAND BORING CONTRACTORS, INC.
P. O. Box 583
Glastonbury, CT 06033
203 - 633-8158

1387 Main Street
Springfield, MA 01103
413 - 733-1232

CLIENT: Sheaffer & Roland
PROJECT NAME: Proposed Sewers
LOCATION: Nantucket, MA

BORING NUMBER: C-1
SHEET No. 1 of

DRILLER: G. Preli
INSPECTOR: Ron
DATE START: 10/1/82
DATE FINISH: 10/1/82

ARCHITECT ENGINEER:

| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | HSA | SS | |
| SIZE I.D. | 3-3/8" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30". | |

FILE NO.:
SURFACE ELEV.:
LINE & STATION:
OFFSET:

| DEPTH | SAMPLE NO. | SAMPLE DEPTH RANGE | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | REC. | COL. A | STRATA CHANGE | FIELD CLASSIFICATION AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | 0-1.5 | 1 | 2 | 2 | 14" | | | .5 Black Fine Sand and Silt - |
| | | | | | | | | | Br. Fine-Med. Sand, Tr. Silt |
| 5' | S2 | 5.0-6.5 | 17 | 29 | 36 | 16" | | 4.0 | |
| | | | | | | | | | Br. Fine-Crs. Sand, Some Fine-Med. Gravel |
| | | | | | | | | 8.0 | |
| 10' | S3 | 10.0-11.5 | 5 | 6 | 7 | 18" | | | |
| | | | | | | | | | Br. Fine-Crs. Sand |
| 15' | S4 | 15.0-16.5 | 3 | 2 | 3 | 18" | | | |
| | | | | | | | | 18.0 | |
| 20' | S5 | 20.0-21.5 | 1 | 2 | 3 | 10" | | | Gray Br. Fine-Crs. Sand, Some Fine-Med. Gravel |
| | | | | | | | | 21.5 | |
| 25' | | | | | | | | | Bottom of Boring 21.5<br>Water @ 15.2 |

SAMPLE IDENTIFICATION
S — SPLIT SPOON
T — THIN WALL TUBE
U — UNDISTURBED PISTON
O — OPEN END ROD
W — WASH SAMPLE
A — AUGER SAMPLE

PENETRATION RESISTANCE
140 lb. Wt. falling 30" on 2" O.D. Sampler

| Cohesionless Density | | Cohesive Consistency | |
|---|---|---|---|
| 0-4 | Very Loose | 0-2 | Very Soft |
| 5-9 | Loose | 3-4 | Soft |
| 10-29 | Med. Dense | 5-8 | M/Stiff |
| 30-49 | Dense | 9-15 | Stiff |
| 50 + | Very Dense | 16-30 | V-Stiff |
| | | 31 + | Hard |

PROPORTIONS USED

| | |
|---|---|
| trace | 0 to 10% |
| little | 10 to 20% |
| some | 20 to 35% |
| and | 35 to 50% |

REMARKS:

COL. A

NEW ENGLAND BORING CONTRACTORS, INC.
P.O. Box 583
Glastonbury, CT 06033
203 - 633-8158

1387 Main Street
Springfield, MA 01103
413 - 733-1232

CLIENT: Sheaffer & Roland
PROJECT NAME: Proposed Sewers
LOCATION: Nantucket, MA

BORING NUMBER: C-2
SHEET No. 1 of 1

DRILLER: G. Preli
INSPECTOR: Ron
DATE START: 9/30/82
DATE FINISH: 9/30/82

ARCHITECT ENGINEER:

| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | HSA | SS | |
| SIZE I.D. | 3-3/8" | 1-3/8" | |
| HAMMER WT. | -- | 140 | |
| HAMMER FALL | -- | 30" | |

FILE NO.:
SURFACE ELEV.:
LINE & STATION:
OFFSET:

| DEPTH | SAMPLE NO. | DEPTH RANGE | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | REC. | COL. A | STRATA CHANGE | FIELD CLASSIFICATION AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | 0-1.5 | 1 | 2 | 2 | 17" | | | Dark Br. Fine-Med. Sand, Some Silt |
| | | | | | | | | 4.0 | |
| 5' | S2 | 5.0-6.5 | 5 | 14 | 16 | 18" | | | Br. Fine-Crs. Sand |
| | | | | | | | | 8.0 | |
| 10' | S3 | 10.0-11.5 | 4 | 4 | 8 | 18" | | | Br. Fine-Crs. Sand, Some Fine-Med. Gravel |
| 15' | S4 | 15.0-16.5 | 2 | 2 | 3 | 18" | | | |
| 20' | S5 | 20.0-21.5 | 3 | 6 | 8 | 10" | | | |
| | | | | | | | | 21.5 | |
| 25' | | | | | | | | | Bottom of Boring 21.5<br>Water @ 14.5 |

SAMPLE IDENTIFICATION
S — SPLIT SPOON
T — THIN WALL TUBE
U — UNDISTURBED PISTON
O — OPEN END ROD
W — WASH SAMPLE
A — AUGER SAMPLE

PENETRATION RESISTANCE
140 lb. Wt. falling 30" on 2" O.D. Sampler

| Cohesionless Density | | Cohesive Consistency | |
|---|---|---|---|
| 0-4 | Very Loose | 0-2 | Very Soft |
| 5-9 | Loose | 3-4 | Soft |
| 10-29 | Med. Dense | 5-8 | M/Stiff |
| 30-49 | Dense | 9-15 | Stiff |
| 50 + | Very Dense | 16-30 | V-Stiff |
| | | 31 + | Hard |

PROPORTIONS USED

| | |
|---|---|
| trace | 0 to 10% |
| little | 10 to 20% |
| some | 20 to 35% |
| and | 35 to 50% |

REMARKS:

COL. A

NEW ENGLAND BORING CONTRACTORS, INC.
P. O. Box 583
Glastonbury, CT 06033
203 - 633-8158

1387 Main Street
Springfield, MA 01103
413 - 733-1232

CLIENT: Sheaffer & Roland
PROJECT NAME: Proposed Sewers
LOCATION: Nantucket, MA

BORING NUMBER: C-3
SHEET No. 1 of

DRILLER: G. Preli
INSPECTOR: Ron
DATE START: 9/30/82
DATE FINISH: 9/30/82

ARCHITECT ENGINEER:

| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | HSA | SS | |
| SIZE I.D. | 3-3/8" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

FILE NO.:
SURFACE ELEV.:
LINE & STATION:
OFFSET:

| DEPTH | SAMPLE NO. | DEPTH RANGE | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | REC. | COL. A | STRATA CHANGE | FIELD CLASSIFICATION AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | 0-1.5 | 1 | 1 | 3 | 18" | | | .5 Dark Br. Fine-Med. Sand, Some Silt - |
| 5' | S2 | 5.0-6.5 | 8 | 14 | 17 | 18" | | | Br. Fine-Crs. Sand, Little Fine Gravel |
| 10' | S3 | 10.0-11.5 | 3 | 7 | 7 | 18" | | | |
| | | | | | | | | 14.0 | |
| 15' | S4 | 15.0-16.5 | 2 | 3 | 3 | 14" | | | Gray Br. Fine-Crs. Sand, Some Fine Gravel |
| 20' | S5 | 20.0-21.5 | 12 | 13 | 11 | 18" | | | |
| | | | | | | | | 21.5 | |
| 25' | | | | | | | | | Bottom of Boring 21.5<br>Water @ 12.0 |

SAMPLE IDENTIFICATION
S — SPLIT SPOON
T — THIN WALL TUBE
U — UNDISTURBED PISTON
O — OPEN END ROD
W — WASH SAMPLE
A — AUGER SAMPLE

PENETRATION RESISTANCE
140 lb. Wt. falling 30" on 2" O.D. Sampler

| Cohesionless Density | | Cohesive Consistency | |
|---|---|---|---|
| 0-4 | Very Loose | 0-2 | Very Soft |
| 5-9 | Loose | 3-4 | Soft |
| 10-29 | Med. Dense | 5-8 | M/Stiff |
| 30-49 | Dense | 9-15 | Stiff |
| 50 + | Very Dense | 16-30 | V-Stiff |
| | | 31 + | Hard. |

PROPORTIONS USED

| | |
|---|---|
| trace | 0 to 10% |
| little | 10 to 20% |
| some | 20 to 35% |
| and | 35 to 50% |

REMARKS:

COL. A

NEW ENGLAND BORING CONTRACTORS, INC.
P. O. Box 583 / 1387 Main Street
Glastonbury, CT 06033 / Springfield, MA 01103
203 - 633-8158 / 413 - 733-1232

CLIENT: Sheaffer & Roland
PROJECT NAME: Proposed Sewers
LOCATION: Nantucket, MA

BORING NUMBER: C-4
SHEET No. 1 of 1

DRILLER: G. Preli
INSPECTOR: Ron
DATE START: 10/1/82
DATE FINISH: 10/1/82

ARCHITECT ENGINEER:

| | Casing | Sampler | Core Barrel |
|---|---|---|---|
| TYPE | HSA | SS | |
| SIZE I.D. | 3-3/8" | 1-3/8" | |
| HAMMER WT. | | 140 | |
| HAMMER FALL | | 30" | |

FILE NO.:
SURFACE ELEV.:
LINE & STATION:
OFFSET:

| DEPTH | SAMPLE NO. | SAMPLE DEPTH RANGE | BLOWS PER 6" ON SAMPLER 0-6 | 6-12 | 12-18 | REC. | COL. A | STRATA CHANGE | FIELD CLASSIFICATION AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | 0-1.5 | 1 | 2 | 3 | 14" | | 3.5 | Black Br. Fine-Med. Sand, Some Silt |
| 5' | S2 | 5.0-6.5 | 10 | 16 | 17 | 16" | | 13.0 | Br. Fine-Crs. Sand, Little Fine-Med. Gravel |
| 10' | S3 | 10.0-11.5 | 3 | 2 | 6 | 18" | | | |
| 15' | S4 | 15.0-16.5 | 2 | 3 | 3 | 18" | | 21.5 | Gray Br. Fine-Crs. Sand |
| 20' | S5 | 20.0-21.5 | 3 | 4 | 4 | 12" | | | |
| 25' | | | | | | | | | Bottom of Boring 21.5<br>Water @ 15.3 |

SAMPLE IDENTIFICATION
S — SPLIT SPOON
T — THIN WALL TUBE
U — UNDISTURBED PISTON
O — OPEN END ROD
W — WASH SAMPLE
A — AUGER SAMPLE

PENETRATION RESISTANCE
140 lb. Wt. falling 30" on 2" O.D. Sampler

| Cohesionless Density | | Cohesive Consistency | |
|---|---|---|---|
| 0-4 | Very Loose | 0-2 | Very Soft |
| 5-9 | Loose | 3-4 | Soft |
| 10-29 | Med. Dense | 5-8 | M/Stiff |
| 30-49 | Dense | 9-15 | Stiff |
| 50 + | Very Dense | 16-30 | V-Stiff |
| | | 31 + | Hard |

PROPORTIONS USED
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

REMARKS:

COL. A

# Appendix C. Boring Logs, Test Pit Logs and Grain Size Analyses

# Geologic - Earth Exploration, Inc.

7 Sherwood Drive
TEL (508) 384-4434
Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-1



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/15/04 | SIZE | 4" | 2" | |
| Date Completed: | 11/15/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | P. Majeski | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date Depth
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 23 | 2-2-3-1 | S-1 Dark brown medium to fine SAND, some organic silt, TOPSOIL<br>Dark brown medium to fine SAND, trace organic silt, TOPSOIL |
| | S-2 | 2.0-4.0 | 24 | 21 | 8-26-26-25 | Dark brown peaty, medium to fine SAND, some organic silt<br>S-2 Dark brown medium to fine SAND, trace organic silt, TOPSOIL<br>Dark brown peaty GRAVEL, some coarse to fine sand, little silt |
| 5 | S-3 | 4.0-6.0 | 24 | 13 | 14-19-18-16 | Reddish/brown medium to fine SAND,<br>trace gravel |
| | S-4 | 6.0-8.0 | 24 | 20 | 9-9-112-16 | S-3 Reddish brown changes to reddish gray<br>Medium to fine SAND, trace coarse sand, trace gravel |
| | S-5 | 8.0-10.0 | 24 | 14 | 8-12-13-14 | S-4 Gray, medium fine, SAND, trace coarse SAND, trace gravel<br>S-5 Gray/brown, medium to fine SAND, trace coarse sand, trace gravel<br>Gray/brown fine SAND, trace silt |
| 10 | S-6 | 10.0-12.0 | 24 | 12 | 8-6-9-10 | S-6 Gray, fine SAND, trace silt<br>Gray fine to medium SAND, trace coarse sand,<br>trace gravel |
| | S-7A | 12.0-13.0 | 12 | 9 | 9-7 | S-7A Gray, medium to fine SAND |
| | S-7B | 13.0-14.0 | 12 | 9 | 6-12 | Gray, medium to fine SAND, trace coarse sand, trace gravel |
| 15 | S-8 | 14.0-16.0 | 24 | 8 | 4-6-7-7 | S-7B Brown/rust SILT, little fine sand<br>S-8 Gray, medium to fine SAND, trace gravel |
| | S-9 | 16.0-18.0 | 24 | 9 | 8-7-9-7 | S-9 Gray, medium to fine SAND,<br>Gray, medium to fine GRAVEL and coarse to fine SAND |
| | S-10 | 18.0-20.0 | 24 | 0.5 | 4-4-3-4 | S-10 Gray, medium to fine SAND, trace coarse sand<br>poor sample |
| 20 | S-11 | 20.0-22.0 | 24 | 1 | 2-3-4-5 | S-11 Gray, coarse to fine SAND, some gravel<br>poor sample |
| | S-12 | 22.0-24.0 | 24 | 7 | 13-14-14-14 | S-12 Gray, medium to fine SAND, trace coarse sand,<br>trace gravel |
| 25 | S-13 | 24.0-26.0 | 24 | 0 | 3-5-7-7 | S-13 No Recovery |
| | S-14 | 26.0-28.0 | 24 | 0 | 6-5-5-6 | S-14 No Recovery |
| | S-15 | 28.0-30.0 | 24 | 0 | 8-9-5-5 | S-15 No Recovery |
| 30 | S-16 | 30.0-34.0 | 48 | 12 | 2-6-8-9-11-7<br>-8-10 | S-16 Gray, medium to fine SAND, mostly medium sand<br>Gray medium to fine SAND, trace coarse sand,<br>trace gravel |
| 35 | S-17 | 34.0-36.0 | 24 | 4 | 4-5-7-8 | S-17 Gray, medium to fine SAND, trace coarse sand<br>trace gravel |
| | S-18 | 36.0-38.0 | 24 | 0 | 8-10-10-10 | S-18 No Recovery |
| | S-19A | 38.0-39.0 | 12 | 4 | 3-4-5-7 | S-19A Gray, medium to fine SAND, trace coarse sand, trace gravel |
| | S-19B | 39.0-40.0 | 12 | 4 | 11-11-13-12 | S-19B Rust/brown, coarse to fine SAND, mostly coarse to medium SAND, some gravel |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** All soil sample descriptions are based on site representatives interpretation.

NEW ADDRESS 04291ET.GPJ GEOLOGIC.GDT 12/15/04

# Geologic - Earth Exploration, Inc.

7 Sherwood Drive
TEL (508) 384-4434

Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-1



| Depth ft | Sample No. | Sample Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-20 | 42.0-44.0 | 24 | 4 | 9-10-8-7 | S-20 Gray, coarse to fine SAND, some gravel<br>start 2" spoon |
| 45 | S-21 | 44.0-46.0 | 24 | 10 | 6-5-7-6 | S-21 Greenish/gray medium to fine SAND |
| | S-22 | 46.0-50.0 | 48 | 48 | NR | S-22 Greenish/gray, fine SAND<br>trace medium sand<br>Greenish/gray medium fine SAND<br>greenish/gray fine SAND<br>little coarse silt |
| 50 | | | | | | Bottom of exploration at 50.0'<br>Samples S-1 - S-19, used 3" dia. spilt spoon |
| 55 | | | | | | |
| 60 | | | | | | |
| 65 | | | | | | |
| 70 | | | | | | |
| 75 | | | | | | |
| 80 | | | | | | |
| 85 | | | | | | |

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** All soil sample descriptions are based on site representatives interpretation.

NEW ADDRESS 04291ET.GPJ GEOLOGIC.GDT 12/15/04

# Geologic - Earth Exploration, Inc.

7 Sherwood Drive
TEL (508) 384-4434
Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-2



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/12/04 | SIZE | 4" | 2" | |
| Date Completed: | 11/14/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | P. Majeski | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date Depth
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 20 | 3-2-2-3 | S-1 Brown, medium to fine SAND, some silt with roots, TOPSOIL<br>Brown, medium to fine SAND, little silt, trace gravel and coarse sand |
| | S-2 | 2.0-4.0 | 24 | 16 | 6-8-11-17 | S-2 Brown, medium to fine SAND, little gravel, trace silt<br>gray, medium to fine SAND, little gravel, trace silt<br>Brown, fine SAND, little silt |
| 5 | S-3 | 4.0-6.0 | 24 | 13 | 20-46-50-68 | S-3 Brown, medium to fine SAND, trace coarse sand, trace gravel, trace silt |
| | S-4A | 6.0-8.0 | 24 | 19 | 55-52-44-42 | S-4A Brown, medium, fine SAND, trace coarse sand, trace gravel, trace silt<br>Gray, coarse to medium SAND and GRAVEL, trace fine sand |
| | S-5 | 8.0-10.0 | 24 | 6 | 11-14-16-13 | Brown, coarse to fine SAND, some gravel, trace silt<br>Brown, fine SAND, little silt<br>Brown, coarse to fine SAND, some gravel trace silt |
| 10 | S-6 | 10.0-12.0 | 24 | 5 | 8-7-8-9 | S-5 Brown, medium to fine SAND, trace coarse sand, trace gravel, trace silt<br>S-6 Brown, coarse to fine SAND, trace gravel |
| | S-7 | 12.0-14.0 | 24 | 10 | 10-7-7-9 | S-7 Gray, medium to fine SAND, trace coarse sand, trace gravel, slight trace of silt |
| 15 | S-8 | 14.0-16.0 | 24 | 0 | 7-5-5-5 | S-8 No Recovery |
| | S-9 | 16.0-18.0 | 24 | 4 | 5-5-5-5 | S-9 Gray, coarse to fine SAND, some gravel |
| | S-10 | 18.0-20.0 | 24 | 7 | 7-4-6-6 | S-10 Gray, medium to fine SAND, trace coarse sand, trace gravel |
| 20 | S-11 | 20.0-22.0 | 24 | 5 | 7-3-4-2 | S-11 Gray, coarse to fine SAND, little gravel<br>Gray fine SAND, trace silt |
| | S-12 | 22.0-24.0 | 24 | 5 | 2-3-3-4 | S-12 Gray, coarse to fine SAND, some gravel |
| 25 | S-13A | 24.0-26.0 | 24 | 8 | 5-4-4-4 | S-13A Gray, coarse to fine SAND, mostly medium sand, trace gravel<br>Gray, medium to fine SAND |
| | S-14 | 26.0-28.0 | 24 | 7 | 4-6-3-5 | S-14 Gray, medium to fine SAND, trace coarse sand, trace gravel |
| | S-15 | 28.0-30.0 | 24 | 0 | 8-7-9-9 | S-15 No Recovery |
| 30 | S-16 | 30.0-32.0 | 24 | 1 | 5-4-6-5 | S-16 Gray, medium to fine SAND, trace coarse sand |
| | S-17 | 32.0-34.0 | 24 | 5 | 6-3-3-4 | S-17 Gray, medium fine SAND, trace coarse sand, trace gravel |
| | S-18 | 34.0-36.0 | 24 | 0 | 7-7-5-5 | S-18 No Recovery |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** All soil sample descriptions are based on site representatives interpretation.

NEW ADDRESS 04291ET.GPJ GEOLOGIC.GDT 12/15/04

# Geologic - Earth Exploration, Inc.

7 Sherwood Drive
TEL (508) 384-4434

Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-2



| Depth ft | Sample No. | Sample Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-19 | 36.0-38.0 | 24 | 7 | NR | S-19 Gray, medium to fine SAND, trace coarse sand |
| | S-20 | 38.0-40.0 | 24 | 0 | 5-5-6-7 | S-20 No Recovery |
| 40 | S-21 | 40.0-42.0 | 24 | 1 | 8-10-14-10 | S-21 Gray, coarse to fine SAND, little gravel |
| | S-22A | 42.0-42.5 | 6.5 | 6.5 | 8-5 | S-22A Gray, medium to fine SAND, trace coarse sand |
| 45 | S-23 | 44.0-46.0 | 24 | 7 | 8-6-8-6 | S-23 Gray, fine SAND, trace medium sand, trace silt |
| | S-24 | 46.0-48.0 | 24 | 13 | 4-4-8-9 | S-24 Gray, medium to fine SAND, slight trace silt<br>Gray medium to fine SAND |
| 50 | S-25 | 48.0-50.0 | 24 | 11 | 7-8-7-6 | S-25 Gray, coarse to fine SAND, little gravel<br>Gray, medium to fine SAND |
| 55 | S-26 | 54.0-56.0 | 24 | 14 | 8-13-13-15 | S-26 Gray, fine SAND, little medium SAND, trace silt<br>Gray, medium to coarse SAND, little fine sand |
| 60 | S-27 | 59.0-61.0 | 24 | 14 | 14-15-11-9 | S-27 Gray, fine to medium SAND<br>GRay, coarse SAND, little medium sand<br>Gray, very fine to fine SAND, trace silt |
| 65 | S-28 | 64.0-66.0 | 24 | 11 | 8-11-11-12 | S-28 Gray, fine SAND, little medium sand<br>Gray, fine to medium SAND |
| 70 | S-29 | 69.0-71.0 | 24 | 11 | 9-11-7-7 | S-29 Fine to coarse SAND, little gravel (wash?)<br>Fine to medium SAND |
| 75 | S-30 | 74.0-76.0 | 24 | 7 | 14-314-14-11 | S-30 Gray, very fine to fine SAND, trace medium sand |

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** All soil sample descriptions are based on site representatives interpretation.

NEW ADDRESS 04291ET.GPJ GEOLOGIC.GDT 12/15/04

# Geologic - Earth Exploration, Inc.

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Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-2



| Depth ft | Sample No. | Sample Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| 80 | S-31 | 79.0-81.0 | 24 | 8 | 19-15-14-9 | S-31 Gray, very fine to fine SAND, trace silt |
| 85 | S-32 | 84.0-86.0 | 24 | 12 | 11-12-20-16 | S-32 Light gray, very fine to fine SAND<br>Trace shell fragments |
| 90 | S-33 | 89.0-91.0 | 24 | 20 | 42-81-120 | S-33 Light gray/tan, very fine to fine SAND, trace silt<br>Tan, very fine SAND, little silt |
| 95 | S-34 | 94.0-96.0 | 24 | 11 | 15-21-32-31 | S-34 Tan, fine to medium SAND, little silt<br>Tan, fine SAND, little silt, trace clay<br>Brown clay in nose of spoon, rusty layers |
| 100 | S-35 | 99.0-101.0 | 24 | 16 | 13-12-20-39 | S-35 Light brown, fine SAND, some silt (mica) |
| 105 | S-36 | 104.0-106.0 | 24 | 18 | 6-14-21-26 | S-36 Gray, SILT and CLAY<br>Gray very fine SAND, some silt<br>Gray SILT and CLAY<br>Dark green fine to medium SAND<br>Rusty shell fragments |
| 110 | S-37 | 109.0-111.0 | 24 | 12 | 25-34-44-50 | S-37 Light gray/white fine to medium SAND with shell fragments |
| 115 | S-38 | 114.0-116.0 | 24 | 13 | 9-17-31-52 | S-38 Rusty shell fragments<br>Gray fine SAND, trace medium SAND and SILT |
| | S-39 | 119.0-121.0 | 24 | 13 | 32-61-114 | S-39 Tan to green, very fine to fine SAND, little silt |

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** All soil sample descriptions are based on site representatives interpretation.

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FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-2



| Depth ft | Sample No. | Sample Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | | | | | -120/5" | increasing silt with depth<br>Light greeen very fine SAND & SILT |
| 125 | S-40 | 124.0-126.0 | 24 | 12 | 46-70-97-115 | S-40 Tan, fine to medium SAND, trace silt |
| 130 | S-41 | 129.0-131.0 | 24 | 11 | 50-82-120/5" | S-41 Tan, fine to medium SAND, trace silt |
| 135 | S-42 | 134.0-136.0 | 24 | 12 | 38-58-77-116 | S-42 Gray to green, very fine to fine SAND, trace silt |
| 140 | S-43 | 139.0-141.0 | 24 | 12 | 20-20-37-42 | S-43 Gray to green, very fine to fine SAND, with thin layers of clay |
| 145 | S-44 | 144.0-146.0 | 24 | 18 | 33-38-38-37 | S-44 Dark gray, very fine SAND and SILT, little clay |
| 150 | S-45 | 149.0-151.0 | 24 | 15 | 20-20-37-42 | S-45 Dark gray SILT, trace clay, trace fine sand (more clay in nose of spoon) |
| | | | | | | Bottom of exploration at 151.0'<br>Samples S-1 - S-33 used 3" spoon |
| 155 | | | | | | |
| 160 | | | | | | |

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** All soil sample descriptions are based on site representatives interpretation.

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CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-3

PAGE 1 OF 1

| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/18/04 | SIZE | 4" | 3" | |
| Date Completed: | 11/18/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | P. Majeski | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date Depth
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 22 | 2-2-2-2 | S-1 Dark brown, medium to fine SAND, little to some organic silt, TOPSOIL |
| | S-2 | 2.0-4.0 | 24 | 24 | 2-12-12-9 | S-2 Dark brown, medium to fine SAND, little organic silt, TOPSOIL<br>Reddish/brown GRAVEL, some coarse to medium sand, trace fine sand, trace silt<br>Reddish brown, medium to fine SAND, trace silt |
| 5 | S-3 | 4.0-6.0 | 24 | 10 | 9-10-15-13 | Brown, medium to fine SAND, trace coarse sand, trace gravel<br>S-3 Gray, medium to fine SAND, trace silt |
| | S-4 | 6.0-8.0 | 24 | 19 | 10-10-12-15 | Gray, medium to fine SAND, trace coarse sand, trace gravel<br>S-4 Brown/gray, medium to fine SAND, trace coarse sand, trace gravel |
| | S-5 | 8.0-10.0 | 24 | 12 | 16-7-12-15 | S-5 Brown/gray, medium to fine SAND, trace coarse sand, trace gravel |
| 10 | | | | | | Bottom of exploration at 10.0'<br>Samples obtained with 3" diam. sample |
| 15 | | | | | | |
| 20 | | | | | | |
| 25 | | | | | | |
| 30 | | | | | | |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** All soil sample descriptions are based on site representatives interpretation.

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FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-4



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/18/04 | SIZE | 4" | 3" | |
| Date Completed: | 11/18/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | P. Majeski | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date Depth
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 23 | 2-3-4-2 | S-1 Dark/brown, medium to fine SAND, some organic silt, TOPSOIL<br>Gray/brown, medium to fine SAND, trace organic silt, TOPSOIL<br>Dark brown, medium to fine SAND, little organic silt, TOPSOIL |
| | S-2 | 2.0-4.0 | 24 | 19 | 2-1-5-9 | S-2 Dark brown, medium to fine SAND, some organic silt, TOPSOIL<br>Brown, coarse to fine SAND, some gravel, trace silt |
| 5 | S-3 | 4.0-6.0 | 24 | 12 | 10-9-7-10 | S-3 Brown, coarse to fine SAND and GRAVEL, trace silt; Brown fine SAND, trace silt<br>Brown/gray medium to fine SAND |
| | S-4 | 6.0-8.0 | 24 | 17 | 7-5-6-6 | S-4 Brown/gray medium to fine SAND, trace coarse sand, trace gravel |
| | S-5 | 8.0-10.0 | 24 | 9 | 5-5-7-11 | S-5 Brown/gray medium to fine SAND, trace coarse sand, trace gravel |
| 10 | | | | | | Bottom of exploration at 10.0'<br>Samples obtained with 3" diam. sample |
| 15 | | | | | | |
| 20 | | | | | | |
| 25 | | | | | | |
| 30 | | | | | | |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** All soil sample descriptions are based on site representatives interpretation.

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FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-101



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/18/04 | SIZE | 4" | 2" | |
| Date Completed: | 11/18/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date 11/18/04 ▽ Depth 12.8'
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 23 | 1-8-8-7 | S-1 Dry, loose to medium, tan, fine to coarse SAND, trace of silt, TOPSOIL Brown, fine SAND, trace silt, trace coarse to medium sand |
| 5 | S-2 | 4.0-6.0 | 24 | 8 | 11-16-17-18 | S-2 Wet, dense, tan, fine to coarse SAND |
| 10 | S-3 | 9.0-11.0 | 24 | 10 | 11-11-10-11 | S-3 Wet, medium dense, tan, fine to medium SAND, with 1.5 inch layer of red brown SILT, some fine sand 3" sample |
| | S-4 | 11.0-13.0 | 24 | 11 | 9-6-6-6 | S-4 Wet, medium dense, tan, fine to medium SAND, some gravel, trace of coarse sand ▽ 3" sample |
| | S-5 | 13.0-15.0 | 24 | 0 | 4-4-4-4 | S-5 No Recovery 3" sample |
| 15 | S-6 | 15.0-17.0 | 24 | 8 | 2-3-4-4 | S-6 Wet, loose, tan, fine to medium SAND, trace of gravel |
| 20 | S-7 | 19.0-21.0 | 24 | 2 | 4-2-2-2 | S-7 Wet, loose, tan, fine to medium SAND, trace of coarse sand and gravel |
| 25 | S-8 | 24.0-26.0 | 24 | 1 | 3-3-1-3 | S-8 Similar to S-7 above |
| 30 | S-9 | 29.0-31.0 | 24 | 4 | 2-2-2-2 | S-9 Wet, loose, tan, fine to coarse SAND |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:**

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# Geologic - Earth Exploration, Inc.

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Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-101



| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-10 | 35.0-37.0 | 24 | 8 | 3-3-3-5 | S-10 Similar to S-9 above |
| 40 | S-11 | 39.0-41.0 | 24 | 7 | 3-3-3-3 | S-11 Wet, loose, tan fine to medium SAND, little coarse sand |
| 45 | S-12 | 44.0-46.0 | 24 | 8 | 3-4-6-8 | S-12 Wet, loose, tan, fine to medium SAND, little coarse sand, trace of gravel |
| 50 | S-13 | 49.0-51.0 | 24 | 5 | 4-5-5-5 | S-13 Similar to S-12 above |
| 55 | S-14 | 54.0-56.0 | 24 | 4 | 5-6-4-5 | S-14 Similar to S-12 above |
| 60 | S-15 | 59.0-61.0 | 24 | 5 | 6-7-7-5 | S-15 Similar to S-12 above |
| | | | | | | Bottom of exploration at 61.0' |
| 65 | | | | | | |
| 70 | | | | | | |
| 75 | | | | | | |

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:**

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Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-102



File #: 04291
Date Started: 11/20/04
Date Completed: 11/20/04
Driller: T. Tucker
Site Rep.:

| | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|
| TYPE | HW | SS | |
| SIZE | 4" | 2" | |
| HAMMER | 300# | 140# | — |
| FALL | 24" | 30" | — |

Surface Elevation:
Station:
Groundwater level readings
Date Depth
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 24 | 2-5-5-6 | S-1 Dry, loose, tan to brown, fine to medium SAND, trace of gravel, little silt |
| 5 | S-2 | 4.0-6.0 | 24 | 12 | 6-13-14-12 | S-2 Wet, medium dense, wet, fine to coarse SAND, trace of gravel |
| 10 | S-3 | 9.0-11.0 | 24 | 5 | 5-7-6-7 | S-3 Similar to S-2 above |
| 15 | S-4 | 14.0-16.0 | 24 | 0.5 | 3-5-5-4 | S-4 Similar to S-2 above |
| 20 | S-5 | 19.0-21.0 | 24 | 6 | 3-3-3-3 | S-5 Wet, loose, tan, fine to medium SAND, trace of coarse sand |
| 25 | S-6 | 24.0-26.0 | 24 | 2 | 2-2-3-1 | S-6 Wet, loose, tan, fine to medium SAND, trace of coarse sand and trace gravel |
| 30 | S-7 | 29.0-31.0 | 24 | 2 | 4-3-3-3 | S-7 Similar to S-6 above |
| | S-8 | 34.0-36.0 | 24 | 0 | 4-3-3-4 | S-8 No Recovery |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** Used a plastic bag to keep sample in spoon. Some samples were over drove

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FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-102



| Depth ft | Sample No. | Sample Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| 40 | S-9 | 39.0-41.0 | 24 | 5 | 5-4-5-5 | S-9 Wet, loose, tan, fine to coarse SAND, trace of gravel |
| 45 | S-10 | 44.0-46.0 | 24 | 4 | 5-5-5-5 | S-10 Similar to S-9 above |
| 50 | S-11 | 49.0-51.0 | 24 | 10 | 5-6-6-5 | S-11 Wet, medium dense, tan, fine to medium SAND, trace of coarse sand |
| 55 | S-12 | 54.0-56.0 | 24 | 7 | 7-8-8-10 | S-12 Wet, medium dense, tan, fine to coarse SAND, trace of gravel |
| 60 | S-13 | 59.0-61.0 | 24 | 3 | 8-11-11-9 | S-13 Wet, medium dense, tan, fine to coarse SAND and GRAVEL |
| | | | | | | Bottom of exploration at 61.0' |
| 65 | | | | | | |
| 70 | | | | | | |
| 75 | | | | | | |

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** Used a plastic bag to keep sample in spoon. Some samples were over drove

NEW ADDRESS 04291ET.GPJ GEOLOGIC.GDT 12/15/04

# Geologic - Earth Exploration, Inc.

7 Sherwood Drive
TEL (508) 384-4434
Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-103



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/17/04 | SIZE | 4" | 2" | |
| Date Completed: | 11/17/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | P. Majeski | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date 11/17/04 ▽ Depth 12.3'
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 22 | 2-5-6-10 | S-1 Dark brown medium to fine SAND, little silt, TOPSOIL<br>Brown medium to fine SAND, trace coarse sand, trace gravel |
| 5 | S-2 | 4.0-6.0 | 24 | 11 | 15-13-18-12 | S-2 Brown medium to fine SAND, trace silt<br>Brown coarse to fine SAND, some gravel<br>Brown fine SAND, trace silt |
| 10 | S-3 | 9.0-11.0 | 24 | 8 | 8-9-8-9 | S-3 Gray with rust stains medium to fine SAND, trace coarse sand, trace gravel<br>Gray coarse to fine SAND, little gravel<br>3" sample |
| | S-4 | 11.0-13.0 | 24 | 19 | 7-4-4-5 | S-4 Gray coarse to fine SAND, little gravel<br>▽ Gray with rust stains medium to fine SAND<br>3" sample |
| | S-5 | 13.0-15.0 | 24 | 14 | 2-3-3-5 | S-5 Gray coarse to fine SAND, trace gravel<br>3" sample |
| 15 | S-6 | 15.0-17.0 | 24 | 14 | 3-4-8-8 | S-6 Brown/gray medium to fine SAND, trace coarse sand, trace gravel<br>Brown/gray fine SAND, trace silt |
| 20 | S-7 | 19.0-21.0 | 24 | 0.5 | 5-4-3-6 | S-7 Brown/gray coarse to fine SAND |
| 25 | S-8 | 24.0-26.0 | 24 | 0 | 4-9-11-9 | S-8 No Recovery |
| 30 | S-9 | 29.0-31.0 | 24 | 0.5 | 2-1-2-2 | S-9 Gray coarse to fine SAND, trace gravel<br>poor sample |
| | S-10 | 34.0-36.0 | 24 | 0.5 | 5-7-8-7 | S-10 Gray medium to fine SAND, trace coarse sand, trace gravel |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** All soil sample descriptions are based on site representatives interpretation.

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CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-103



| Depth ft | Sample No. | Sample Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| 40 | S-11 | 39.0-41.0 | 24 | 11 | 3-3-4-5 | S-11 Gray medium to fine SAND, trace coarse sand, trace gravel |
| 45 | S-12 | 44.0-46.0 | 24 | 2 | 2-5-7-9 | S-12 Gray coarse to fine SAND, little gravel |
| 50 | S-13 | 49.0-51.0 | 24 | 0 | 2-3-4-5 | S-13 No Recovery |
| 55 | S-14 | 54.0-56.0 | 24 | 7 | 4-5-5-5 | S-14 Gray coarse to fine SAND, some gravel |
| 60 | S-15 | 59.0-61.0 | 24 | 12 | 2-2-3-5 | S-15 Gray medium to fine SAND |
| | | | | | | Bottom of exploration at 61.0' |
| 65 | | | | | | |
| 70 | | | | | | |
| 75 | | | | | | |

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** All soil sample descriptions are based on site representatives interpretation.

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CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-104



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/19/04 | SIZE | 4" | 2" | |
| Date Completed: | 11/20/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date 11/19/04 ▽ Depth 14.5'
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 17 | 1-2-2-4 | S-1 Dry, loose, tan, fine to medium SAND |
| 5 | S-2 | 4.0-6.0 | 24 | 12 | 6-13-28-27 | S-2 Moist, medium dense to dense, tan, fine to coarse SAND |
| 10 | S-3 | 9.0-11.0 | 24 | 5 | 2-3-3-5 | S-3 Similar to S-2 above |
| 15 | S-4 | 14.0-16.0 | 24 | 3 | 2-3-3-3 | ▽ S-4 Similar to S-2 above |
| 20 | S-5 | 19.0-21.0 | 24 | 0 | 3-4-3-4 | S-5 No Recovery |
| 25 | S-6 | 24.0-26.0 | 24 | 0 | 2-2-2-2 | S-6 No Recovery two times |
| 30 | S-7 | 29.0-31.0 | 24 | 3 | 3-4-5-6 | S-7 Wet, loose, tan fine SAND |
| | S-8 | 34.0-36.0 | 24 | 1 | 6-4-4-4 | S-8 Wet, loose, tan, fine to coarse SAND |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** Used a plastic bag to keep sample in spoon. Some samples were over drove

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FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-104



| Depth ft | Sample No. | Sample Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| 40 | S-9 | 39.0-41.0 | 24 | 4 | 4-3-4-3 | S-9 Wet, loose, tan, fine to medium SAND, trace of coarse sand |
| 45 | S-10 | 44.0-46.0 | 24 | 4 | 5-4-4-4 | S-10 Wet, loose, tan, fine to coarse SAND |
| 50 | S-11 | 49.0-51.0 | 24 | 2 | 1-1-2-2 | S-11 Similar to S-10 above |
| 55 | S-12 | 54.0-56.0 | 24 | 3 | 3-3-3-2 | S-12 Similar to S-10 above |
| 60 | S-13 | 59.0-61.0 | 24 | 10 | 2-2-2-2 | S-13 Similar to S-10 above |
| | | | | | | Bottom of exploration at 61.0' |
| 65 | | | | | | |
| 70 | | | | | | |
| 75 | | | | | | |

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** Used a plastic bag to keep sample in spoon. Some samples were over drove

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FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-105



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/16/04 | SIZE | 4" | 2" | |
| Date Completed: | 11/16/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | P. Majeski | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date Depth
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 20 | 3-3-8-8 | S-1 Dry, loose, brown, fine SAND and trace of medium SAND |
| 5 | S-2 | 4.0-6.0 | 24 | 19 | 7-14-12-11 | S-2 Dry, loose to medium dense, brown, fine SAND, trace of medium to coarse sand, trace of silt |
| 10 | S-3 | 9.0-11.0 | 24 | 7 | 3-3-4-4 | S-3 Wet, loose, tan, fine to coarse SAND, trace gravel |
| 15 | S-4 | 14.0-16.0 | 24 | 5 | 2-3-3-4 | S-4 Wet, loose, tan, fine to coarse SAND, trace gravel |
| 20 | S-5 | 19.0-21.0 | 24 | 3 | 3-2-2-2 | S-5 Wet, loose, tan, medium fine SAND |
| 25 | S-6 | 24.0-26.0 | 24 | 0.5 | 4-4-2-2 | S-6 Similar to S-5 above |
| 30 | S-7 | 29.0-31.0 | 24 | 5 | 2-2-3-2 | S-7 Wet, loose, tan, fine to coarse SAND |
| | S-8 | 34.0-36.0 | 24 | 7 | 4-3-5-4 | S-8 Similar to S-7 above |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:**

NEW ADDRESS 04291ET.GPJ GEOLOGIC.GDT 12/15/04

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Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-105



| Depth ft | Sample No. | Sample Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| 40 | S-9 | 39.0-41.0 | 24 | 0 | 3-2-2-4 | S-9 No Recovery |
| 45 | S-10 | 44.0-46.0 | 24 | 0 | 6-5-7-7 | S-10 No Recovery |
| 50 | S-11 | 49.0-51.0 | 24 | 8 | 2-3-3-2 | S-11 Wet, loose, tan, fine to coarse SAND, trace gravel |
| 55 | S-12 | 54.0-56.0 | 24 | 0 | 5-4-4-5 | S-12 No Recovery |
| 60 | S-13 | 59.0-61.0 | 24 | 3 | 2-2-5-4 | S-13 Wet, loose, tan, fine SAND and some medium to coarse SAND |
| | | | | | | Bottom of exploration at 61.0' |
| 65 | | | | | | |
| 70 | | | | | | |
| 75 | | | | | | |

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:**

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FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-106



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/19/04 | SIZE | 4" | 2" | |
| Date Completed: | 11/19/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date Depth
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 18 | 3-5-7-9 | S-1 Dry, loose to medium dense, brown, fine SAND and SILT |
| 5 | S-2 | 4.0-6.0 | 24 | 5 | 15-19-28-26 | S-2 Moist, dense, tan, fine to medium SAND, trace of coarse sand |
| 10 | S-3 | 9.0-11.0 | 24 | 0 | 3-7-7-7 | S-3 No Recovery |
| 15 | S-4 | 14.0-16.0 | 24 | 3 | 4-3-1-1 | S-4 Wet, loose, tan, fine to medium SAND, trace of coarse sand |
| 20 | S-5 | 19.0-21.0 | 24 | 1 | 3-1-2-2 | S-5 Similar to S-4 |
| | | | | | | Bottom of exploration at 21.0' |
| 25 | | | | | | |
| 30 | | | | | | |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:**

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CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-107



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/20/04 | SIZE | 4" | 2" | |
| Date Completed: | 11/20/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date Depth
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 23 | 3-4-3-3 | S-1 Wet, loose, brown, fine to medium SAND, SILT, trace of coarse sand, trace of gravel |
| 5 | S-2 | 4.0-6.0 | 24 | 10 | 5-11-15-19 | S-2 Wet, medium dense, tan, fine to coarse SAND |
| 10 | S-3 | 9.0-11.0 | 24 | 5 | 10-9-9-6 | S-3 Similar to S-2 above |
| 15 | S-4 | 14.0-16.0 | 24 | 2 | 5-4-4-4 | S-4 Wet, loose, tan, fine to coarse SAND and GRAVEL |
| 20 | S-5 | 19.0-21.0 | 24 | 4 | 2-2-2-2 | S-5 Wet, loose, tan, fine to coarse SAND, trace of gravel |
| 25 | S-6 | 24.0-26.0 | 24 | 3 | 3-1-2-2 | S-6 Wet, loose, tan, fine to coarse SAND and some GRAVEL |
| 30 | S-7 | 29.0-31.0 | 24 | 3 | 2-1-1-2 | S-7 Similar to S-6 above |
| | S-8 | 34.0-36.0 | 24 | 7 | 5-3-3-3 | S-8 Wet, loose, tan, fine to medium SAND, trace of coarse sand |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** Boring drilled 100' west of B-101

NEW ADDRESS 04291ET.GPJ GEOLOGIC.GDT 12/15/04

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TEL (508) 384-4434

Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-107



| Depth ft | Sample No. | Sample Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| 40 | S-9 | 39.0-41.0 | 24 | 6 | 5-6-6-6 | S-9 Wet, medium dense, tan, fine to coarse SAND |
| 45 | S-10 | 44.0-46.0 | 24 | 8 | 2-2-2-3 | S-10 Similar to S-9 above |
| 50 | S-11 | 49.0-51.0 | 24 | 5 | 3-1-3-3 | S-11 Wet, loose, tan, fine to medium SAND, trace of coarse sand and trace gravel |
| 55 | S-12 | 54.0-56.0 | 24 | 3 | 2-5-5-4 | S-12 Similar to S-11 above |
| 60 | S-13 | 59.0-61.0 | 24 | 2 | 2-1-1-2 | S-13 Wet, loose, tan, fine to medium SAND |
| | | | | | | Bottom of exploration at 61.0' |
| 65 | | | | | | |
| 70 | | | | | | |
| 75 | | | | | | |

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** Boring drilled 100' west of B-101

NEW ADDRESS 04291ET.GPJ GEOLOGIC.GDT 12/15/04

# Geologic - Earth Exploration, Inc.

7 Sherwood Drive
TEL (508) 384-4434
Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-108



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/21/04 | SIZE | 4" | 2" | |
| Date Completed: | 11/21/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date 11/21/04 ▽ Depth 12.3'
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| | S-1 | 0.0-2.0 | 24 | 23 | 2-5-5-7 | S-1 Dry, loose, brown, fine to medium SAND, trace of gravel |
| 5 | S-2 | 4.0-6.0 | 24 | 5 | 9-10-18-12 | S-2 Moist, medium dense, tan, fine to coarse SAND |
| 10 | S-3 | 9.0-11.0 | 24 | 5 | 10-7-7-7 | S-3 Wet, medium dense, tan, fine to coarse SAND, trace of gravel |
| 15 | S-4 | 14.0-16.0 | 24 | 3 | 3-2-3-4 | S-4 Similar to S-3 above |
| 20 | S-5 | 19.0-21.0 | 24 | 3 | 3-3-4-3 | S-5 Similar to S-3 above |
| 25 | S-6 | 24.0-26.0 | 24 | 5 | 3-3-3-3 | S-6 Wet, loose, tan, fine to medium SAND, trace of coarse sand and trace of gravel |
| 30 | S-7 | 29.0-31.0 | 24 | 0 | 2-1-2-3 | S-7 No Recovery |
| | S-8 | 34.0-36.0 | 24 | 5 | 9-8-7-9 | S-8 Wet, medium dense, tan, fine to coarse SAND |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** Drilled 100' west of B-102

NEW ADDRESS 04291ET.GPJ GEOLOGIC.GDT 12/15/04

# Geologic - Earth Exploration, Inc.

7 Sherwood Drive
TEL (508) 384-4434

Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: B-108



| Depth ft | Sample No. | Sample Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| 40 | S-9 | 39.0-41.0 | 24 | 0 | 3-3-2-3 | S-9 No Recovery |
| 45 | S-10 | 44.0-46.0 | 24 | 0.5 | 9-10-10-12 | S-10 Wet, medium dense, tan, fine to medium SAND, trace of coarse sand |
| 50 | S-11 | 49.0-51.0 | 24 | 0 | 3-2-4-4 | S-11 No Recovery |
| 55 | S-12 | 54.0-56.0 | 24 | 1 | 2-3-3-3 | S-12 Wet, loose, tan, fine to medium SAND, trace of coarse sand |
| 60 | S-13 | 59.0-61.0 | 24 | 7 | 10-9-8-11 | S-13 Wet, medium dense, tan, fine to coarse SAND and GRAVEL |
| | | | | | | Bottom of exploration at 61.0' |
| 65 | | | | | | |
| 70 | | | | | | |
| 75 | | | | | | |

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** Drilled 100' west of B-102

NEW ADDRESS 04291ET.GPJ GEOLOGIC.GDT 12/15/04

# Geologic - Earth Exploration, Inc.

7 Sherwood Drive
TEL (508) 384-4434
Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: N-3R



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/16/04 | SIZE | 4" | 2" | |
| Date Completed: | 11/16/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | P. Majeski | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date Depth
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| 5 | | | | | | |
| 10 | | | | | | |
| 15 | S-1 | 14.0-16.0 | 24 | 12 | 5-4-5-5 | S-1 Gray, medium to fine SAND |
| 20 | S-2 | 19.0-21.0 | 24 | 14 | 9-16-23-27 | S-2 Reddish/gray medium to fine SAND |
| 25 | S-3 | 24.0-26.0 | 24 | 12 | 19-23-27-25 | S-3 Gray, medium to fine GRAVEL and coarse to fine SAND |
| 30 | S-4 | 29.0-31.0 | 24 | 13 | 31-35-41-49 | S-4 Brownish/gray medium to fine SAND, trace coarse sand, trace gravel |
| | | | | | | Bottom of exploration at 31.0'<br>Installed Groundwater Monitoring Well at 30'<br>10' screen<br>20' riser<br>4" x 2' guard pipe |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:** All soil sample descriptions are based on site representatives interpretation.

NEW ADDRESS 04291ET.GPJ GEOLOGIC.GDT 12/15/04

# Geologic - Earth Exploration, Inc.

7 Sherwood Drive
TEL (508) 384-4434
Norfolk, MA 02056
FAX (508) 384-4452

CLIENT: Earth Tech, Inc.
PROJECT: Nantucket Surfside WWTF
LOCATION: Nantucket, MA

BORING #: N-11A



| | | | CASING | SAMPLER | CORE BARREL |
|---|---|---|---|---|---|
| File #: | 04291 | TYPE | HW | SS | |
| Date Started: | 11/19/04 | SIZE | 4" | 2" | |
| Date Completed: | 11/19/04 | HAMMER | 300# | 140# | — |
| Driller: | T. Tucker | FALL | 24" | 30" | — |
| Site Rep.: | | | | | |

Surface Elevation:
Station:
Groundwater level readings
Date 11/19/04 ▽ Depth 14.0'
Date Depth

| Depth ft | Sample No. | Depth ft | Pen. in | Rec. in | Blows/6" | Sample Description |
|---|---|---|---|---|---|---|
| 5 | | | | | | |
| 10 | S-1 | 9.0-11.0 | 24 | 0.5 | 10-11-7-6 | S-1 Wet, medium dense, tan, fine to medium SAND, some coarse sand, some gravel |
| 15 | S-2 | 14.0-16.0 | 24 | 0 | 5-4-3-2 | S-2 No Recovery |
| 20 | S-3 | 19.0-21.0 | 24 | 4 | 4-5-5-4 | S-3 Wet, loose, tan, fine to medium SAND, trace of coarse sand |
| 25 | S-4 | 24.0-26.0 | 24 | 0.5 | 5-5-4-3 | S-4 Wet, loose, tan, fine to coarse SAND and GRAVEL |
| 30 | | | | | | Bottom of exploration at 26.0'<br>Installed Groundwater Monitoring Well at 25'<br>10' screen<br>15' riser |

Ground Surface to _____ used _____ then _____

| Proportions Used | | Cohesive Consistency Blows/ft | | | | Cohesionless Density Blows/ft | | Sample Type |
|---|---|---|---|---|---|---|---|---|
| Trace | 0 to 10% | 0-2 | Very Soft | 9-15 | Stiff | 0-10 | Loose | UP = Fixed Piston |
| Little | 10 to 20% | 3-4 | Soft | 16-30 | V-Stiff | 10-30 | M-Dense | UT = Shelby Tube |
| Some | 20 to 35% | 5-8 | M-Stiff | 31+ | Hard | 30-50 | Dense | OE = Open End Rod |
| And | 35 to 50% | | | | | 50+ | V-Dense | * = 300# hammer |

**Notes:**
1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.
2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

**Remarks:**

EARTH TECH

# TEST PIT REPORT

| | | | |
|---|---|---|---|
| PROJECT: | Surfside Wastewater Treatment Facility | TEST PIT NO.: | TP-1 |
| LOCATION: | Nantucket, Massachusetts | JOB NO.: | 79862 |
| CLIENT: | Town of Nantucket | GROUND ELEVATION: | |
| CONTRACTOR: | | EXPLORATION DATE: | 11/16/04 |
| LOGGED BY: | Peter Majeski | WEATHER: | Sunny, 40's° |

| SCALE IN FEET | STRATA CHANGE | SAMPLE NUMBER & DEPTH | DESCRIPTION OF MATERIALS |
|---|---|---|---|
| | 0.5 | | Brown MEDIUM to FINE SAND, trace silt with organics |
| 1 | | | Tan brown MEDIUM to FINE SAND, trace silt |
| 2 | | | |
| | 2.7 | | |
| 3 | | | Gray MEDIUM to FINE SAND, slight trace silt |
| | 3.5 | | Brown MEDIUM to FINE SAND, trace silt with organics |
| 4 | | | |
| | 4.3 | | Gray MEDIUM to FINE SAND |
| 5 | | | |
| | 5.3 | | Bottom of Test Pit at 5.3 feet |
| 6 | | | |
| 7 | | | Groundwater at 5.3 feet |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |

| GROUNDWATER | | | PIT DIMENSIONS | |
|---|---|---|---|---|
| DATE | TIME | DEPTH/FT. | LENGTH OF PIT: | WIDTH OF PIT: |
| | | | | |

REMARKS

EARTH TECH

# TEST PIT REPORT

| | | | |
|---|---|---|---|
| PROJECT: | Surfside Wastewater Treatment Facility | TEST PIT NO.: | TP-2 |
| LOCATION: | Nantucket, Massachusetts | JOB NO.: | 79862 |
| CLIENT: | Town of Nantucket | GROUND ELEVATION: | |
| CONTRACTOR: | | EXPLORATION DATE: | 11/16/04 |
| LOGGED BY: | Peter Majeski | WEATHER: | Sunny, 40's° |

| SCALE IN FEET | STRATA CHANGE | SAMPLE NUMBER & DEPTH | DESCRIPTION OF MATERIALS |
|---|---|---|---|
| | 0.5 | | Brown MEDIUM to FINE SAND, trace silt with organics |
| 1 | | | Tan brown MEDIUM to FINE SAND, trace silt |
| 2 | | | |
| 3 | 3.3 | | |
| | | | Brown MEDIUM to FINE SAND, trace silt with organics |
| 4 | 4.2 | | |
| | | | Gray MEDIUM to FINE SAND |
| 5 | 5.5 | | |
| | | | Bottom of Test Pit at 5.5 feet |
| 6 | | | |
| 7 | | | |
| 8 | | | Groundwater at 4.9 feet |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |

| GROUNDWATER | | | PIT DIMENSIONS | |
|---|---|---|---|---|
| DATE | TIME | DEPTH/FT. | LENGTH OF PIT: | WIDTH OF PIT: |
| | | | | |

REMARKS

EARTH TECH

# TEST PIT REPORT

| | | | |
|---|---|---|---|
| PROJECT: | Surfside Wastewater Treatment Facility | TEST PIT NO.: | TP-3 |
| LOCATION: | Nantucket, Massachusetts | JOB NO.: | 79862 |
| CLIENT: | Town of Nantucket | GROUND ELEVATION: | |
| CONTRACTOR: | | EXPLORATION DATE: | 11/16/04 |
| LOGGED BY: | Peter Majeski | WEATHER: | Sunny, 40's° |

| SCALE IN FEET | STRATA CHANGE | SAMPLE NUMBER & DEPTH | DESCRIPTION OF MATERIALS |
|---|---|---|---|
| | 0.5 | | Brown MEDIUM to FINE SAND, trace silt with organics |
| 1 | | | Tan brown MEDIUM to FINE SAND, trace silt |
| 2 | | | |
| 3 | 3.2 | | |
| | | | Brown gray MEDIUM to FINE SAND with thin lenses of brown MEDIUM to FINE SAND, trace silt with organics |
| 4 | | | |
| 5 | 5.0 | | |
| | | | Bottom of Test Pit at 5.0 feet |
| 6 | | | |
| 7 | | | |
| 8 | | | Groundwater at 5.0 feet |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |

| GROUNDWATER | | | PIT DIMENSIONS | |
|---|---|---|---|---|
| DATE | TIME | DEPTH/FT. | LENGTH OF PIT: | WIDTH OF PIT: |
| | | | | |

REMARKS

EARTH TECH

# TEST PIT REPORT

| | | | |
|---|---|---|---|
| PROJECT: | Surfside Wastewater Treatment Facility | TEST PIT NO.: | TP-4 |
| LOCATION: | Nantucket, Massachusetts | JOB NO.: | 79862 |
| CLIENT: | Town of Nantucket | GROUND ELEVATION: | |
| CONTRACTOR: | | EXPLORATION DATE: | 11/16/04 |
| LOGGED BY: | Peter Majeski | WEATHER: | Sunny, 40's° |

| SCALE IN FEET | STRATA CHANGE | SAMPLE NUMBER & DEPTH | DESCRIPTION OF MATERIALS |
|---|---|---|---|
| | 0.5 | | Brown MEDIUM to FINE SAND, trace silt with organics |
| 1 | | | Tan brown MEDIUM to FINE SAND, trace silt |
| 2 | | | |
| 3 | 3.4 | | |
| | | S-1 | Brown MEDIUM to FINE SAND, slight trace silt with organics; also 1 to 2 inch layer of MEDIUM to FINE SAND |
| 4 | | 3.7-4.2 | |
| 5 | 5.0 | | |
| | 5.4 | | Gray MEDIUM to FINE SAND |
| 6 | | | Bottom of Test Pit at 5.4 feet |
| 7 | | | |
| 8 | | | Groundwater at 4.9 feet |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |

| GROUNDWATER | | | PIT DIMENSIONS | |
|---|---|---|---|---|
| DATE | TIME | DEPTH/FT. | LENGTH OF PIT: | WIDTH OF PIT: |
| | | | | |

REMARKS

EARTH TECH

# TEST PIT REPORT

| | | | |
|---|---|---|---|
| PROJECT: | Surfside Wastewater Treatment Facility | TEST PIT NO.: | TP-5 |
| LOCATION: | Nantucket, Massachusetts | JOB NO.: | 79862 |
| CLIENT: | Town of Nantucket | GROUND ELEVATION: | |
| CONTRACTOR: | | EXPLORATION DATE: | 11/16/04 |
| LOGGED BY: | Peter Majeski | WEATHER: | Sunny, 40's° |

| SCALE IN FEET | STRATA CHANGE | SAMPLE NUMBER & DEPTH | DESCRIPTION OF MATERIALS |
|---|---|---|---|
| | 0.5 | | Brown MEDIUM to FINE SAND, trace silt with organics |
| 1 | | | Tan brown MEDIUM to FINE SAND, trace silt with occasional clumps of gray silt, little fine sand. |
| 2 | | | |
| 3 | 3.2 | | Gray MEDIUM to FINE SAND, slight trace silt with layer averaging 3 inches in thickness of medium to fine sand, trace silt with organics |
| 4 | | | |
| 5 | 4.9 | | Bottom of test pit at 4.9 feet |
| 6 | | | Groundwater at 4.9 feet |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |

| GROUNDWATER | | | PIT DIMENSIONS | |
|---|---|---|---|---|
| DATE | TIME | DEPTH/FT. | LENGTH OF PIT: | WIDTH OF PIT: |
| | | | | |

REMARKS

EARTH TECH

# TEST PIT REPORT

| | | | |
|---|---|---|---|
| PROJECT: | Surfside Wastewater Treatment Facility | TEST PIT NO.: | TP-6 |
| LOCATION: | Nantucket, Massachusetts | JOB NO.: | 79862 |
| CLIENT: | Town of Nantucket | GROUND ELEVATION: | |
| CONTRACTOR: | | EXPLORATION DATE: | 11/16/04 |
| LOGGED BY: | Peter Majeski | WEATHER: | Sunny, 40's° |

| SCALE IN FEET | STRATA CHANGE | SAMPLE NUMBER & DEPTH | DESCRIPTION OF MATERIALS |
|---|---|---|---|
| | 0.5 | S-1 0.0 to 0.5 | Brown MEDIUM to FINE SAND, trace silt with organics |
| 1 | | S-2 1.0 to 2.0 | Tan brown MEDIUM to FINE SAND, trace coarse sand, trace gravel, trace silt with occasional clumps of gray silt, little fine sand |
| 2 | | | |
| 3 | 3.0 | S-3 3.0 to 3.7 | Brown MEDIUM to FINE SAND, slight trace silt with organics |
| | 3.7 | | |
| 4 | | | Gray brown MEDIUM to FINE SAND, slight trace silt |
| 5 | 5.0 | | Bottom of test pit at 5.0 feet |
| 6 | | | Groundwater at 5.0 feet |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |

| GROUNDWATER | | | PIT DIMENSIONS | |
|---|---|---|---|---|
| DATE | TIME | DEPTH/FT. | LENGTH OF PIT: | WIDTH OF PIT: |
| | | | | |

REMARKS

EARTH TECH

# TEST PIT REPORT

| | | | |
|---|---|---|---|
| PROJECT: | Surfside Wastewater Treatment Facility | TEST PIT NO.: | TP-7 |
| LOCATION: | Nantucket, Massachusetts | JOB NO.: | 79862 |
| CLIENT: | Town of Nantucket | GROUND ELEVATION: | |
| CONTRACTOR: | | EXPLORATION DATE: | 11/16/04 |
| LOGGED BY: | Peter Majeski | WEATHER: | Sunny, 40's° |

| SCALE IN FEET | STRATA CHANGE | SAMPLE NUMBER & DEPTH | DESCRIPTION OF MATERIALS |
|---|---|---|---|
| | 0.5 | | Dark brown MEDIUM to FINE SAND, trace silt, trace gravel, trace coarse sand with organics |
| 1 | | | Tan brown MEDIUM to FINE SAND, trace silt, trace coarse sand, trace gravel |
| 2 | 2.3 | | Gray MEDIUM to FINE SAND, slight trace silt |
| 3 | | | |
| 4 | 4.2 | | |
| | 4.9 | | Dark brown COARSE to FINE SAND, some silt, trace gravel with organics |
| 5 | | | Dark brown COARSE to FINE SAND and gravel, trace silt with organics |
| | 5.7 | | |
| 6 | | | Bottom of test pit at 5.7 feet |
| 7 | | | Groundwater at 4.1 feet (possibly perched) |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |

| GROUNDWATER | | | PIT DIMENSIONS | |
|---|---|---|---|---|
| DATE | TIME | DEPTH/FT. | LENGTH OF PIT: | WIDTH OF PIT: |
| | | | | |

REMARKS

EARTH TECH

# TEST PIT REPORT

| | | | |
|---|---|---|---|
| PROJECT: | Surfside Wastewater Treatment Facility | TEST PIT NO.: | TP-8 |
| LOCATION: | Nantucket, Massachusetts | JOB NO.: | 79862 |
| CLIENT: | Town of Nantucket | GROUND ELEVATION: | |
| CONTRACTOR: | | EXPLORATION DATE: | 11/16/04 |
| LOGGED BY: | Peter Majeski | WEATHER: | Sunny, 40's° |

| SCALE IN FEET | STRATA CHANGE | SAMPLE NUMBER & DEPTH | DESCRIPTION OF MATERIALS |
|---|---|---|---|
| | 0.6 | | Brown MEDIUM to FINE SAND, trace silt, trace gravel, trace coarse sand with organics |
| 1 | 1.4 | | Tan brown MEDIUM to FINE SAND, trace silt, trace gravel, trace coarse sand |
| 2 | | | Gray MEDIUM to FINE SAND |
| 3 | | | |
| 4 | | | Darker gray bands below 3.7 feet |
| 5 | | | Darker gray below 4.8 feet |
| | 5.5 | | Gray COARSE to FINE SAND, trace gravel |
| 6 | 6.2 | | |
| 7 | | | Bottom of test pit at 6.2 feet<br>Groundwater at 5.1 feet |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |

| GROUNDWATER | | | PIT DIMENSIONS | |
|---|---|---|---|---|
| DATE | TIME | DEPTH/FT. | LENGTH OF PIT: | WIDTH OF PIT: |
| | | | | |

REMARKS

EARTH TECH

# TEST PIT REPORT

| | | | |
|---|---|---|---|
| PROJECT: | Surfside Wastewater Treatment Facility | TEST PIT NO.: | TP-9 |
| LOCATION: | Nantucket, Massachusetts | JOB NO.: | 79862 |
| CLIENT: | Town of Nantucket | GROUND ELEVATION: | |
| CONTRACTOR: | | EXPLORATION DATE: | 11/16/04 |
| LOGGED BY: | Peter Majeski | WEATHER: | Sunny, 40's° |

| SCALE IN FEET | STRATA CHANGE | SAMPLE NUMBER & DEPTH | DESCRIPTION OF MATERIALS |
|---|---|---|---|
| | | | Dark brown, MEDIUM to FINE SAND, little silt, trace coarse sand, trace gravel - TOPSOIL |
| 1 | 1.1 | | Reddish brown MEDIUM to FINE SAND, trace silt, trace coarse sand |
| 2 | | S-1 2.0 to 2.5 | |
| 3 | 3.2 | | Brown gray MEDIUM to FINE SAND, little gravel, trace coarse sand, slight trace silt |
| 4 | | S-2 4.0 to 4.5 | |
| 5 | | | |
| | 5.8 | | Gray FINE SAND, trace silt with two, 2-inch thick layers of coarse to fine sand and gravel, trace silt and one 2-inch thick layer of gravel and coarse to fine sand, trace silt with seam of silt and fine sand |
| 6 | | S-3 6.0 to 6.8 | |
| 7 | | | |
| 8 | 8.0 | | Gray MEDIUM to FINE SAND |
| | 8.8 | | Bottom of Test Pit at 8.8 feet |
| 9 | | | |
| 10 | | | No groundwater encountered. |
| 11 | | | |
| 12 | | | |
| 13 | | | |

| GROUNDWATER | | | PIT DIMENSIONS | |
|---|---|---|---|---|
| DATE | TIME | DEPTH/FT. | LENGTH OF PIT: | WIDTH OF PIT: |
| | | | | |

REMARKS

EARTH TECH

# TEST PIT REPORT

| | | | |
|---|---|---|---|
| PROJECT: | Surfside Wastewater Treatment Facility | TEST PIT NO.: | TP-10 |
| LOCATION: | Nantucket, Massachusetts | JOB NO.: | 79862 |
| CLIENT: | Town of Nantucket | GROUND ELEVATION: | |
| CONTRACTOR: | | EXPLORATION DATE: | 11/16/04 |
| LOGGED BY: | Peter Majeski | WEATHER: | Sunny, 40's° |

| SCALE IN FEET | STRATA CHANGE | SAMPLE NUMBER & DEPTH | DESCRIPTION OF MATERIALS |
|---|---|---|---|
| | 0.8 | | Brown MEDIUM to FINE SAND, little silt, trace coarse sand, TOPSOIL |
| 1 | | S-1 1.5 to 3.0 | Brown MEDIUM to FINE SAND, trace coarse sand, trace gravel, silt content varies from trace to little |
| 2 | | | |
| 3 | | | |
| 4 | 4.3 | | |
| | 4.9 | | Brown COARSE to FINE SAND, some silt (very dense) |
| 5 | | S-2 5.0 to 5.5 | Brown MEDIUM to FINE SAND, trace silt, trace coarse sand, trace gravel |
| 6 | | | |
| | 6.6 | | Brown gray FINE SAND, trace medium sand, trace silt |
| 7 | | | |
| | 7.8 | | |
| 8 | | | Brown gray MEDIUM to FINE SAND |
| | 8.8 | | |
| 9 | | | Bottom of test pit at 8.8 feet<br>No groundwater encountered |
| 10 | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |

| GROUNDWATER | | | PIT DIMENSIONS | |
|---|---|---|---|---|
| DATE | TIME | DEPTH/FT. | LENGTH OF PIT: | WIDTH OF PIT: |
| | | | | |

REMARKS

**GeoTesting**
express

1145 Massachusetts Avenue
Boxborough, MA 01719
978 635 0424 Tel
978 635 0266 Fax

# Geotechnical Test Report

December 14, 2004

# Surfside Wastewater Treatment Facility Project

**Nantucket, MA**

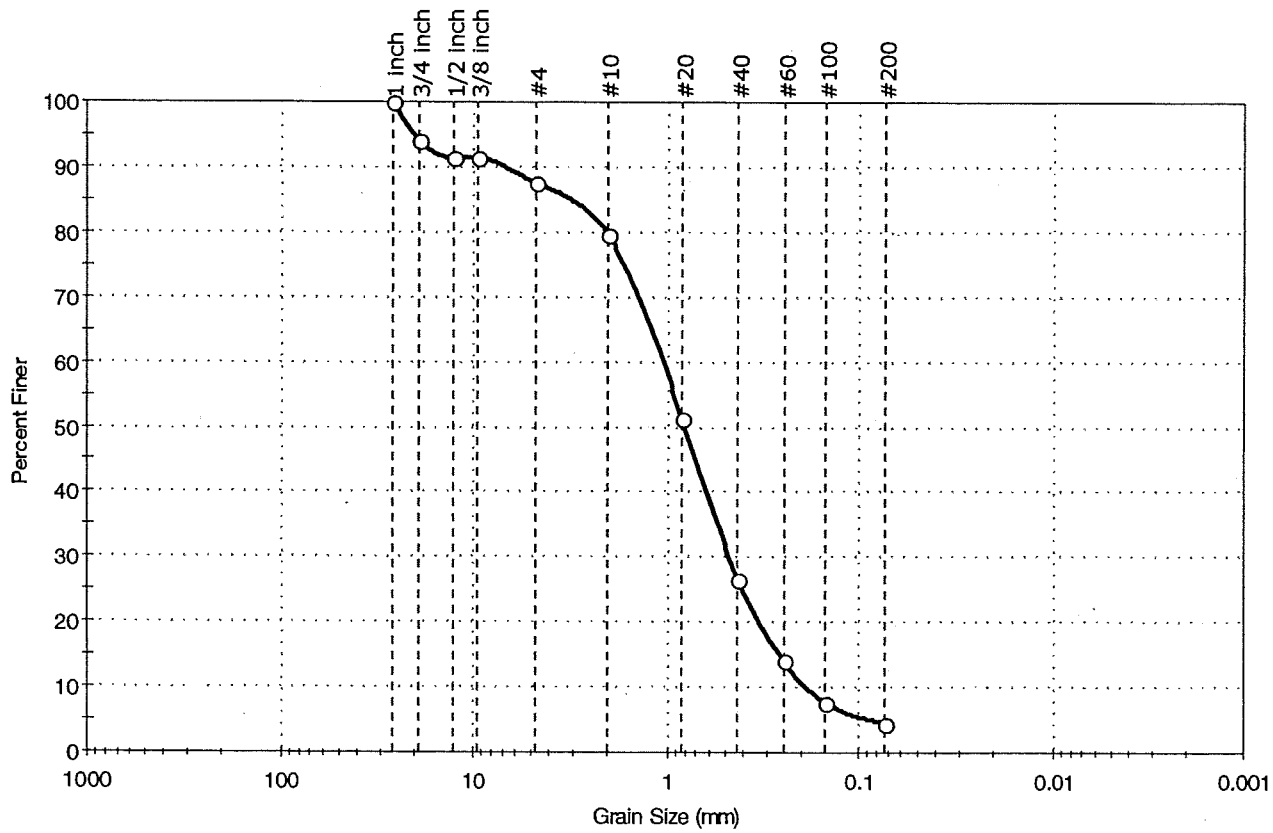
Prepared for:

EARTH TECH

**GeoTesting express**

| | | | |
|---|---|---|---|
| Client: | EarthTech | | |
| Project: | Surfside Wastewater Treament Facility | | |
| Location: | Nantucket, MA | Project No: | GTX-5655 |
| Boring ID: B-2 | Sample Type: bag | Tested By: | ahp |
| Sample ID: S-3 | Test Date: 12/02/04 | Checked By: | jdt |
| Depth : 4.0-6.0 ft. | Test Id: 64556 | | |
| Sample Description: | Moist, light olive brown sand | | |
| Sample Comment: | | | |
| Test Comment: | --- | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 12.5 | 83.0 | 4.5 |

| Sieve Name | Sieve Size (mm) | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1 inch | 25.70 | 100 | | |
| 3/4 inch | 19.00 | 94 | | |
| 1/2 inch | 12.70 | 91 | | |
| 3/8 inch | 9.51 | 91 | | |
| #4 | 4.75 | 87 | | |
| #10 | 2.00 | 80 | | |
| #20 | 0.84 | 51 | | |
| #40 | 0.42 | 27 | | |
| #60 | 0.25 | 14 | | |
| #100 | 0.15 | 8 | | |
| #200 | 0.074 | 4 | | |

**Coefficients**

| | |
|---|---|
| $D_{85}$ = 3.6296 mm | $D_{30}$ = 0.4665 mm |
| $D_{60}$ = 1.0960 mm | $D_{15}$ = 0.2593 mm |
| $D_{50}$ = 0.8091 mm | $D_{10}$ = 0.1793 mm |
| $C_u$ = 6.114 | $C_c$ = 0.199 |

**Classification**

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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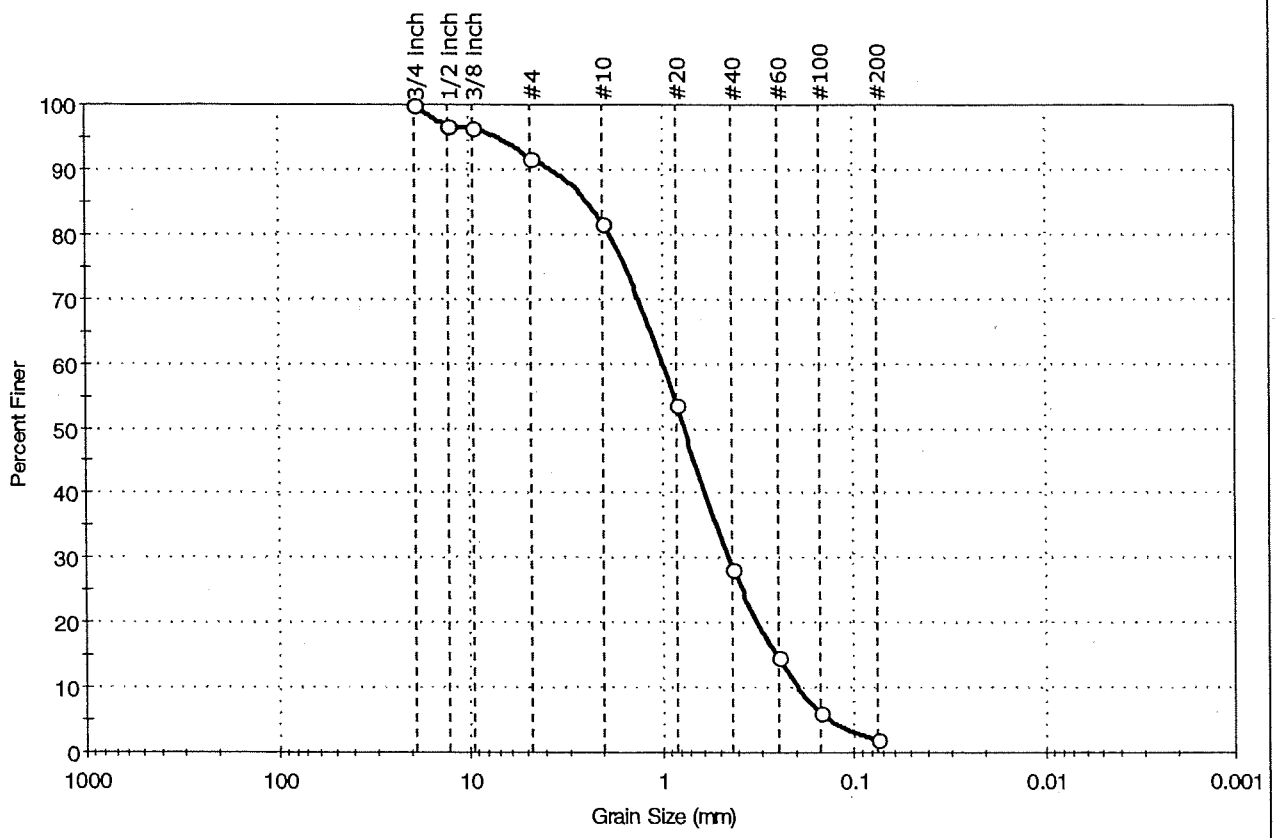
**GeoTesting express**

| | | | | | |
|---|---|---|---|---|---|
| Client: | EarthTech | | | | |
| Project: | Surfside Wastewater Treament Facility | | | | |
| Location: | Nantucket, MA | | | Project No: | GTX-5655 |
| Boring ID: | B-2 | Sample Type: | bag | Tested By: | ahp |
| Sample ID: | S-7 | Test Date: | 12/02/04 | Checked By: | jdt |
| Depth : | 12.0-14.0 ft. | Test Id: | 64552 | | |

Sample Description: Wet, light olive brown sand
Sample Comment:
Test Comment: ---

# Particle Size Analysis - ASTM D 422




| %Cobble | %Gravel | %Sand | %Silt & Clay Size |
|---|---|---|---|
| — | 8.2 | 89.8 | 2.0 |

| Sieve Name | Sieve Size (mm) | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/4 Inch | 19.00 | 100 | | |
| 1/2 Inch | 12.70 | 97 | | |
| 3/8 Inch | 9.51 | 96 | | |
| #4 | 4.75 | 92 | | |
| #10 | 2.00 | 82 | | |
| #20 | 0.84 | 54 | | |
| #40 | 0.42 | 28 | | |
| #60 | 0.25 | 15 | | |
| #100 | 0.15 | 6 | | |
| #200 | 0.075 | 2 | | |

**Coefficients**

$D_{85}$ =2.6710 mm $D_{30}$ =0.4437 mm
$D_{60}$ =1.0205 mm $D_{15}$ =0.2522 mm
$D_{50}$ =0.7594 mm $D_{10}$ =0.1881 mm
$C_u$ =5.425 $C_c$ =0.193

**Classification**

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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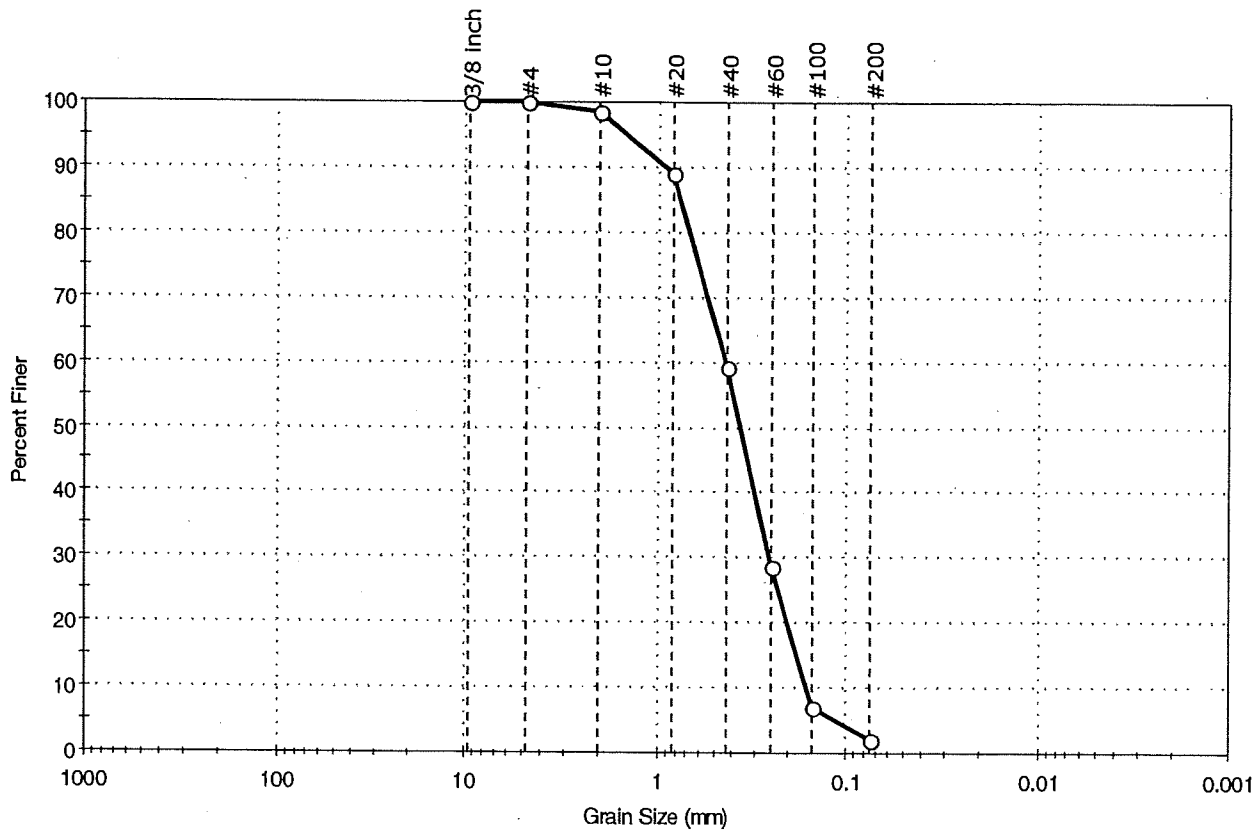
**GeoTesting express**

| | | | |
|---|---|---|---|
| Client: | EarthTech | | |
| Project: | Surfside Wastewater Treament Facility | | |
| Location: | Nantucket, MA | Project No: | GTX-5655 |
| Boring ID: B-2 | Sample Type: bag | Tested By: | ahp |
| Sample ID: S-23 | Test Date: 12/03/04 | Checked By: | jdt |
| Depth : 44.0-46.0 ft. | Test Id: 64553 | | |

Sample Description: Wet, light yellowish brown sand
Sample Comment:
Test Comment: ---

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 0.1 | 97.9 | 2.0 |

| Sieve Name | Sieve Size (mm) | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/8 Inch | 9.51 | 100 | | |
| #4 | 4.75 | 100 | | |
| #10 | 2.00 | 99 | | |
| #20 | 0.84 | 89 | | |
| #40 | 0.42 | 59 | | |
| #60 | 0.25 | 29 | | |
| #100 | 0.15 | 7 | | |
| #200 | 0.075 | 2 | | |

**Coefficients**

$D_{85}$ = 0.7655 mm  $D_{30}$ = 0.2562 mm
$D_{60}$ = 0.4313 mm  $D_{15}$ = 0.1802 mm
$D_{50}$ = 0.3617 mm  $D_{10}$ = 0.1597 mm
$C_u$ = 2.701  $C_c$ = 0.152

**Classification**

ASTM Poorly graded sand (SP)

AASHTO Fine Sand (A-3 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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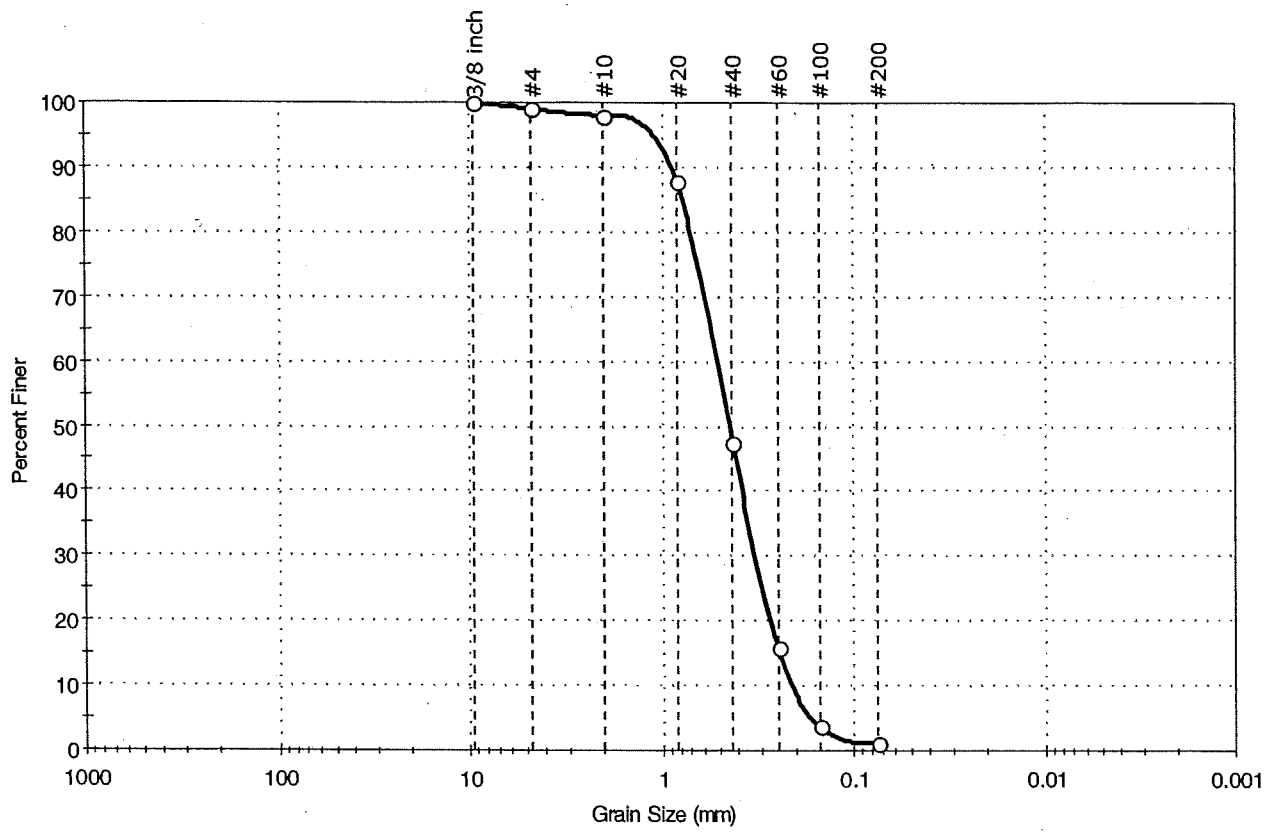
**GeoTesting express**

| | | | |
|---|---|---|---|
| Client: | EarthTech | | |
| Project: | Surfside Wastewater Treament Facility | | |
| Location: | Nantucket, MA | Project No: | GTX-5655 |
| Boring ID: B-2 | Sample Type: bag | Tested By: | ahp |
| Sample ID: S-24 | Test Date: 12/03/04 | Checked By: | jdt |
| Depth : 46.0-48.0 ft. | Test Id: 64554 | | |
| Sample Description: | Wet, light olive brown sand | | |
| Sample Comment: | | | |
| Test Comment: | --- | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 1.0 | 97.8 | 1.2 |

| Sieve Name | Sieve Size (mm) | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/8 inch | 9.51 | 100 | | |
| #4 | 4.75 | 99 | | |
| #10 | 2.00 | 98 | | |
| #20 | 0.84 | 88 | | |
| #40 | 0.42 | 48 | | |
| #60 | 0.25 | 16 | | |
| #100 | 0.15 | 4 | | |
| #200 | 0.075 | 1 | | |

**Coefficients**

$D_{85}$ = 0.8001 mm  $D_{30}$ = 0.3164 mm

$D_{60}$ = 0.5242 mm  $D_{15}$ = 0.2402 mm

$D_{50}$ = 0.4426 mm  $D_{10}$ = 0.1948 mm

$C_u$ = 2.690  $C_c$ = 0.191

**Classification**

ASTM  Poorly graded sand (SP)

AASHTO  Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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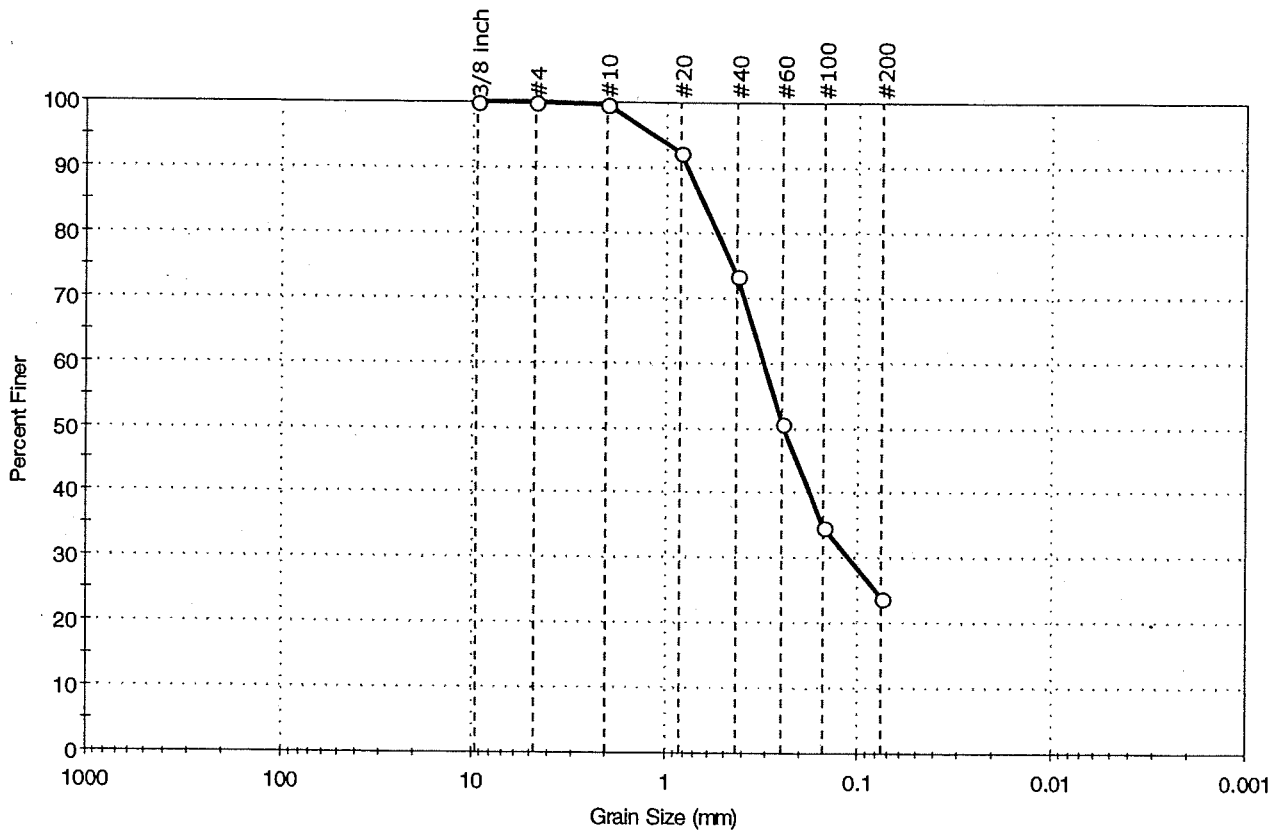
**GeoTesting express**

| | | | |
|---|---|---|---|
| Client: | EarthTech | | |
| Project: | Surfside Wastewater Treament Facility | | |
| Location: | Nantucket, MA | Project No: | GTX-5655 |
| Boring ID: B-101 | Sample Type: bag | Tested By: | ahp |
| Sample ID: S-3 | Test Date: 12/03/04 | Checked By: | jdt |
| Depth : 9.0-11.0 ft. | Test Id: 64555 | | |

Sample Description: Moist, yellowish brown silty sand
Sample Comment:
Test Comment: ---

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| --- | 0.1 | 76.1 | 23.8 |

| Sieve Name | Sieve Size (mm) | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/8 Inch | 9.51 | 100 | | |
| #4 | 4.75 | 100 | | |
| #10 | 2.00 | 100 | | |
| #20 | 0.84 | 92 | | |
| #40 | 0.42 | 73 | | |
| #60 | 0.25 | 51 | | |
| #100 | 0.15 | 35 | | |
| #200 | 0.075 | 24 | | |

**Coefficients**

$D_{85}$ = 0.6460 mm  $D_{30}$ = 0.1107 mm
$D_{60}$ = 0.3105 mm  $D_{15}$ = N/A
$D_{50}$ = 0.2443 mm  $D_{10}$ = N/A
$C_u$ = N/A  $C_c$ = N/A

**Classification**

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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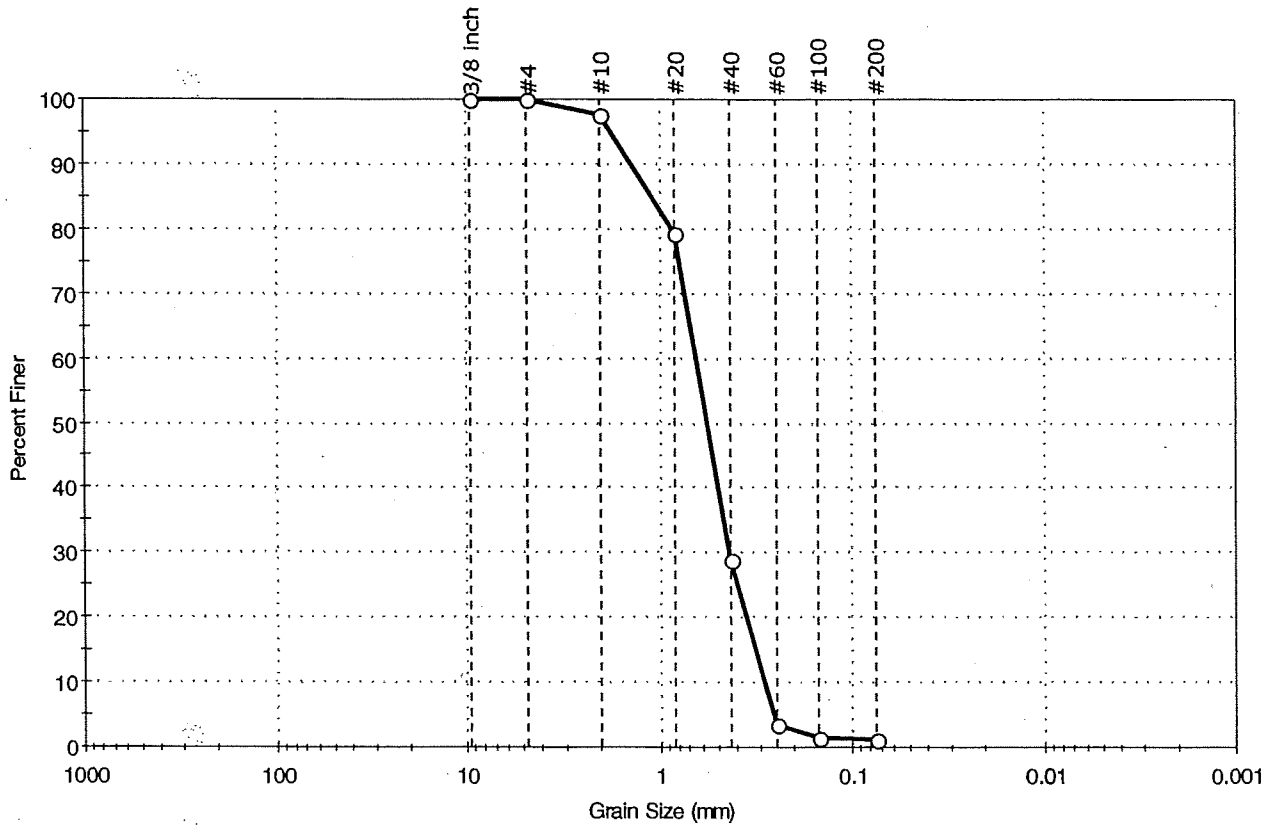
**GeoTesting express**

| | | | |
|---|---|---|---|
| Client: | EarthTech | | |
| Project: | Surfside Wastewater Treament Facility | | |
| Location: | Nantucket, MA | Project No: | GTX-5655 |
| Boring ID: TP-4 | Sample Type: bag | Tested By: | ahp |
| Sample ID: S-1 | Test Date: 12/03/04 | Checked By: | jdt |
| Depth : 3.7-4.2 ft. | Test Id: 64547 | | |
| Sample Description: | Wet, olive brown sand | | |
| Sample Comment: | | | |
| Test Comment: | --- | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| -- | 0.2 | 98.6 | 1.2 |

| Sieve Name | Sieve Size (mm) | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/8 Inch | 9.51 | 100 | | |
| #4 | 4.75 | 100 | | |
| #10 | 2.00 | 98 | | |
| #20 | 0.84 | 79 | | |
| #40 | 0.42 | 29 | | |
| #60 | 0.25 | 3 | | |
| #100 | 0.15 | 2 | | |
| #200 | 0.075 | 1 | | |

**Coefficients**

$D_{85}$ = 1.0989 mm  $D_{30}$ = 0.4316 mm

$D_{60}$ = 0.6473 mm  $D_{15}$ = 0.3182 mm

$D_{50}$ = 0.5655 mm  $D_{10}$ = 0.2867 mm

$C_u$ = 2.258  $C_c$ = 0.288

**Classification**

ASTM  Poorly graded sand (SP)

AASHTO  Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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**GeoTesting express**

| | | | | | |
|---|---|---|---|---|---|
| Client: | EarthTech | | | | |
| Project: | Surfside Wastewater Treament Facility | | | | |
| Location: | Nantucket, MA | | | Project No: | GTX-5655 |
| Boring ID: | TP-4 | Sample Type: | bag | Tested By: | ahp |
| Sample ID: | S-1 | Test Date: | 12/03/04 | Checked By: | jdt |
| Depth : | 3.7-4.2 ft. | Test Id: | 64558 | | |
| Sample Description: | Wet, olive brown sand | | | | |
| Sample Comment: | | | | | |
| Test Comment: | --- | | | | |

# Moisture, Ash, and Organic Matter - ASTM D 2974

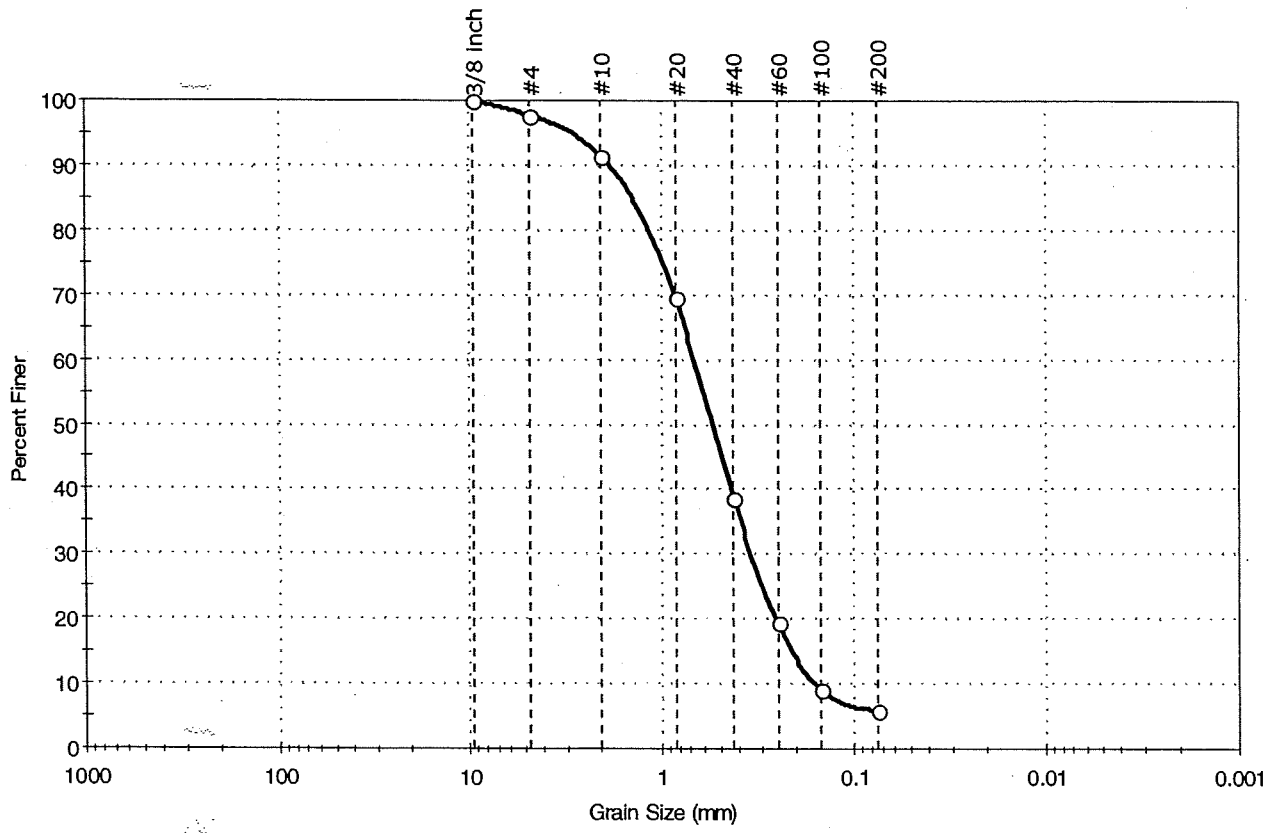
| Boring ID | Sample ID | Depth | Description | Moisture Content,% | Ash Content,% | Organic Matter,% |
|---|---|---|---|---|---|---|
| TP-4 | S-1 | 3.7-4.2 ft. | Wet, olive brown sand | 16 | 99.5 | 0.5 |

Notes: Moisture content determined by Method A and reported as a percentage of oven-dried mass; dried to a constant mass at ter
Ash content and organic matter determined by Method C; dried to constant mass at temperature 440 degrees C.

**GeoTesting express**

| | | | |
|---|---|---|---|
| Client: | EarthTech | | |
| Project: | Surfside Wastewater Treament Facility | | |
| Location: | Nantucket, MA | Project No: | GTX-5655 |
| Boring ID: TP-6 | Sample Type: bag | Tested By: | ahp |
| Sample ID: S-1 | Test Date: 12/03/04 | Checked By: | jdt |
| Depth : 0.0-0.5 ft. | Test Id: 64546 | | |
| Sample Description: | Moist, olive brown sand with silt | | |
| Sample Comment: | | | |
| Test Comment: | --- | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| -- | 2.3 | 91.8 | 5.9 |

| Sieve Name | Sieve Size (mm) | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/8 Inch | 9.51 | 100 | | |
| #4 | 4.75 | 98 | | |
| #10 | 2.00 | 91 | | |
| #20 | 0.84 | 70 | | |
| #40 | 0.42 | 39 | | |
| #60 | 0.25 | 19 | | |
| #100 | 0.15 | 9 | | |
| #200 | 0.075 | 6 | | |

**Coefficients**

$D_{85}$ = 1.5524 mm  $D_{30}$ = 0.3347 mm

$D_{60}$ = 0.6799 mm  $D_{15}$ = 0.2004 mm

$D_{50}$ = 0.5455 mm  $D_{10}$ = 0.1561 mm

$C_u$ = 4.356  $C_c$ = 0.165

**Classification**

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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**GeoTesting express**

| | | | | | |
|---|---|---|---|---|---|
| Client: | EarthTech | | | | |
| Project: | Surfside Wastewater Treament Facility | | | | |
| Location: | Nantucket, MA | | | Project No: | GTX-5655 |
| Boring ID: | TP-6 | Sample Type: | bag | Tested By: | ahp |
| Sample ID: | S-1 | Test Date: | 12/03/04 | Checked By: | jdt |
| Depth : | 0.0-0.5 ft. | Test Id: | 64557 | | |
| Sample Description: | Moist, olive brown sand with silt | | | | |
| Sample Comment: | | | | | |
| Test Comment: | --- | | | | |

# Moisture, Ash, and Organic Matter - ASTM D 2974

| Boring ID | Sample ID | Depth | Description | Moisture Content,% | Ash Content,% | Organic Matter,% |
|---|---|---|---|---|---|---|
| TP-6 | S-1 | 0.0-0.5 ft. | Moist, olive brown sand with silt | 12 | 98.3 | 1.7 |

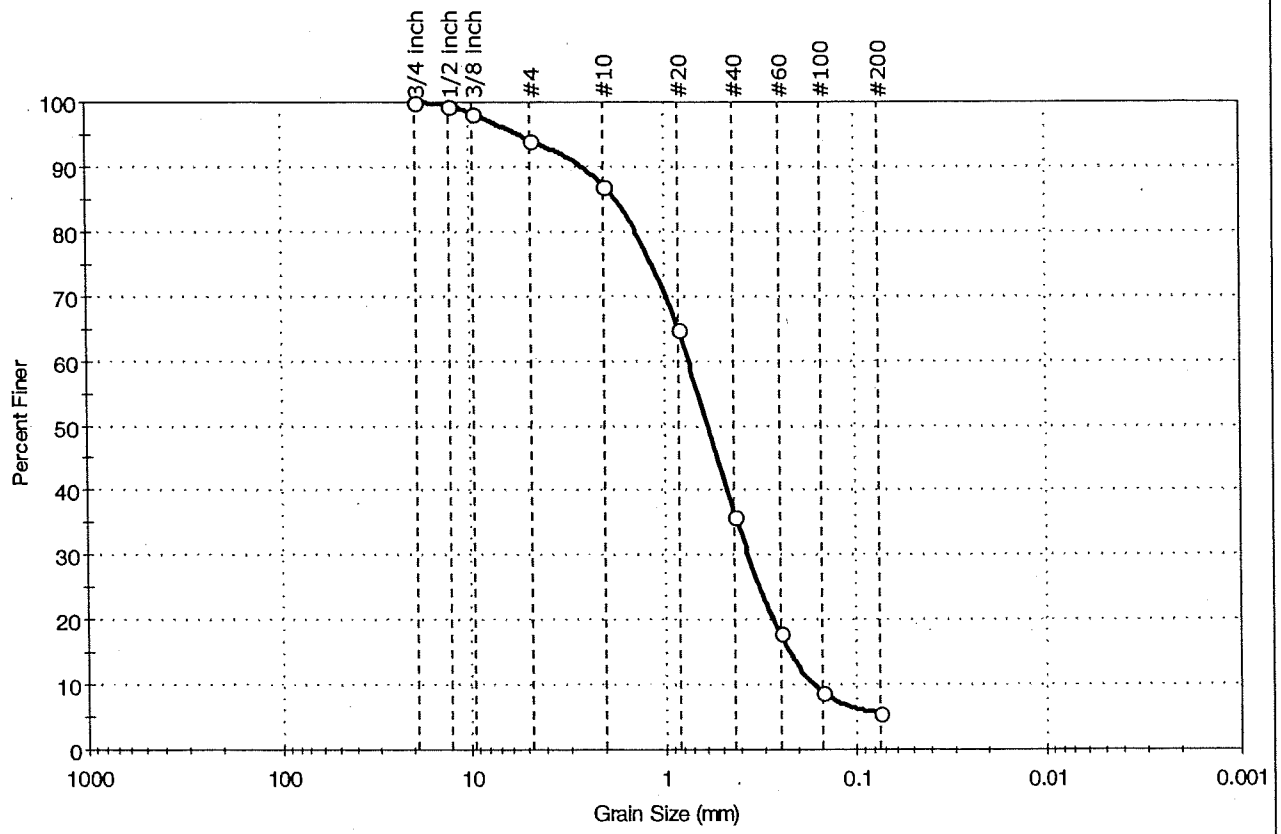
Notes: Moisture content determined by Method A and reported as a percentage of oven-dried mass; dried to a constant mass at ter
Ash content and organic matter determined by Method C; dried to constant mass at temperature 440 degrees C.

**GeoTesting express**

| | | | |
|---|---|---|---|
| Client: | EarthTech | | |
| Project: | Surfside Wastewater Treament Facility | | |
| Location: | Nantucket, MA | Project No: | GTX-5655 |
| Boring ID: TP-6 | Sample Type: bag | Tested By: | ahp |
| Sample ID: S-2 | Test Date: 12/03/04 | Checked By: | jdt |
| Depth : 1.0-2.0 ft. | Test Id: 64548 | | |

Sample Description: Moist, light olive brown sand with silt
Sample Comment:
Test Comment: ---

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 5.9 | 88.5 | 5.6 |

| Sieve Name | Sieve Size (mm) | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/4 inch | 19.00 | 100 | | |
| 1/2 inch | 12.70 | 99 | | |
| 3/8 inch | 9.51 | 98 | | |
| #4 | 4.75 | 94 | | |
| #10 | 2.00 | 87 | | |
| #20 | 0.84 | 65 | | |
| #40 | 0.42 | 36 | | |
| #60 | 0.25 | 18 | | |
| #100 | 0.15 | 9 | | |
| #200 | 0.075 | 6 | | |

**Coefficients**

$D_{85}$ = 1.8436 mm  $D_{30}$ = 0.3563 mm
$D_{60}$ = 0.7482 mm  $D_{15}$ = 0.2122 mm
$D_{50}$ = 0.5909 mm  $D_{10}$ = 0.1596 mm
$C_u$ = 4.688  $C_c$ = 0.170

**Classification**

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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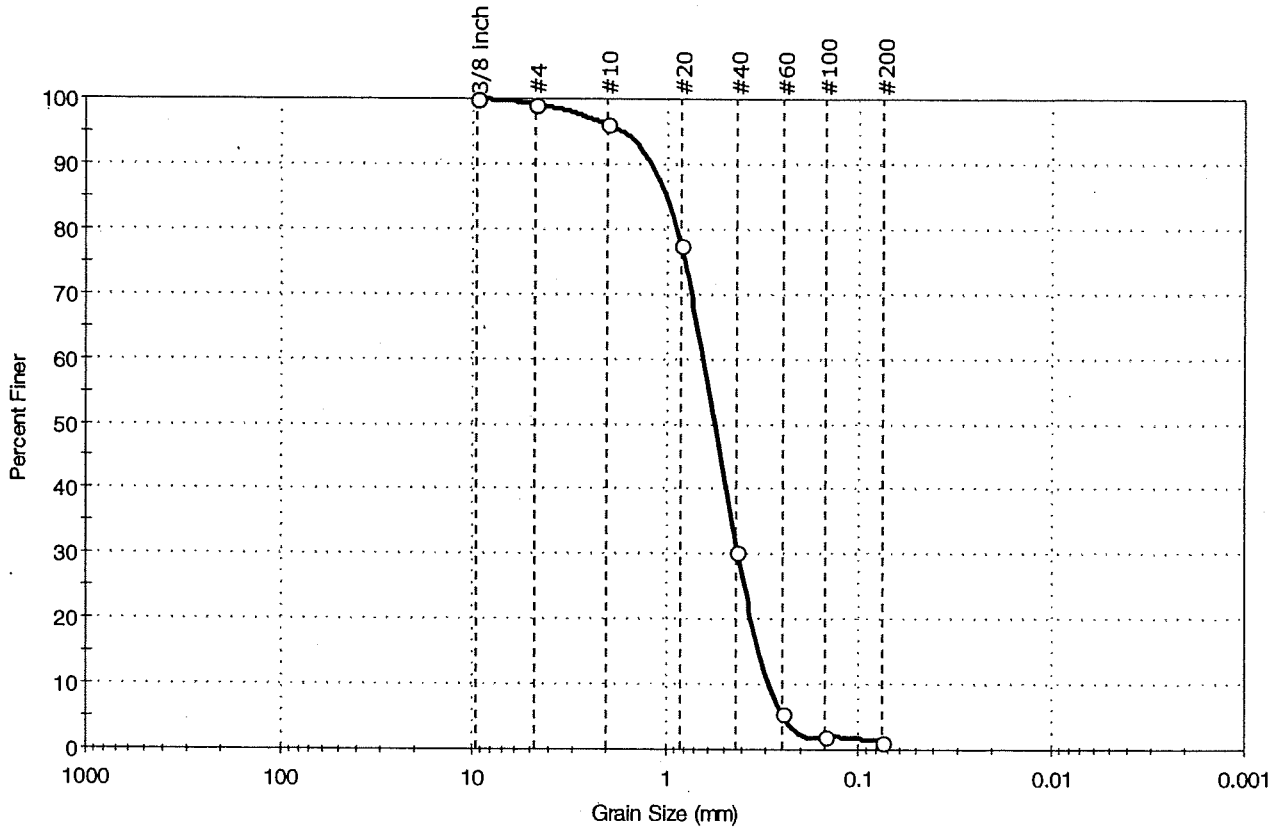
**GeoTesting express**

| | | | |
|---|---|---|---|
| Client: | EarthTech | | |
| Project: | Surfside Wastewater Treament Facility | | |
| Location: | Nantucket, MA | Project No: | GTX-5655 |
| Boring ID: TP-6 | Sample Type: bag | Tested By: | ahp |
| Sample ID: S-3 | Test Date: 12/03/04 | Checked By: | jdt |
| Depth : 3.0-3.7 ft. | Test Id: 64549 | | |
| Sample Description: | Moist, olive brown sand | | |
| Sample Comment: | | | |
| Test Comment: | --- | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 0.8 | 97.9 | 1.3 |

| Sieve Name | Sieve Size (mm) | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/8 Inch | 9.51 | 100 | | |
| #4 | 4.75 | 99 | | |
| #10 | 2.00 | 96 | | |
| #20 | 0.84 | 78 | | |
| #40 | 0.42 | 30 | | |
| #60 | 0.25 | 6 | | |
| #100 | 0.15 | 2 | | |
| #200 | 0.075 | 1 | | |

**Coefficients**

$D_{85}$ = 1.1889 mm  $D_{30}$ = 0.4224 mm

$D_{60}$ = 0.6522 mm  $D_{15}$ = 0.3063 mm

$D_{50}$ = 0.5647 mm  $D_{10}$ = 0.2752 mm

$C_u$ = 2.370  $C_c$ = 0.274

**Classification**

ASTM  Poorly graded sand (SP)

AASHTO  Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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**GeoTesting express**

| | | | | | |
|---|---|---|---|---|---|
| Client: | EarthTech | | | | |
| Project: | Surfside Wastewater Treament Facility | | | | |
| Location: | Nantucket, MA | | | Project No: | GTX-5655 |
| Boring ID: | TP-6 | Sample Type: | bag | Tested By: | ahp |
| Sample ID: | S-3 | Test Date: | 12/03/04 | Checked By: | jdt |
| Depth : | 3.0-3.7 ft. | Test Id: | 64559 | | |
| Sample Description: | Moist, olive brown sand | | | | |
| Sample Comment: | | | | | |
| Test Comment: | --- | | | | |

# Moisture, Ash, and Organic Matter - ASTM D 2974

| Boring ID | Sample ID | Depth | Description | Moisture Content,% | Ash Content,% | Organic Matter,% |
|---|---|---|---|---|---|---|
| TP-6 | S-3 | 3.0-3.7 ft. | Moist, olive brown sand | 10 | 99.4 | 0.6 |

Notes: Moisture content determined by Method A and reported as a percentage of oven-dried mass; dried to a constant mass at ter
Ash content and organic matter determined by Method C; dried to constant mass at temperature 440 degrees C.

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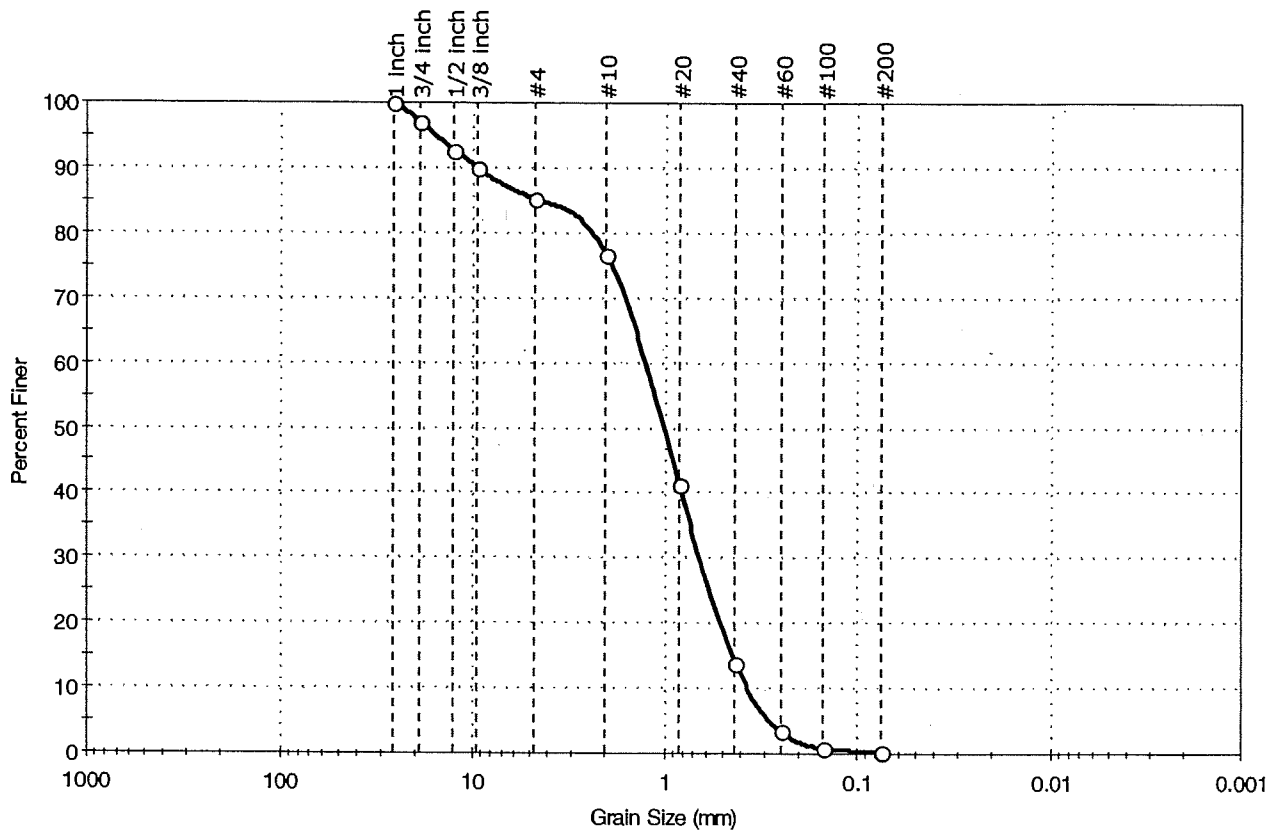
**GeoTesting express**

| | | | |
|---|---|---|---|
| Client: | EarthTech | | |
| Project: | Surfside Wastewater Treament Facility | | |
| Location: | Nantucket, MA | Project No: | GTX-5655 |
| Boring ID: TP-9 | Sample Type: bag | Tested By: | ahp |
| Sample ID: S-2 | Test Date: 12/02/04 | Checked By: | jdt |
| Depth : 4.0-4.5 ft. | Test Id: 64550 | | |
| Sample Description: | Dry, yellowish brown sand | | |
| Sample Comment: | | | |
| Test Comment: | --- | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 14.7 | 85.0 | 0.3 |

| Sieve Name | Sieve Size (mm) | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 1 inch | 25.70 | 100 | | |
| 3/4 inch | 19.00 | 97 | | |
| 1/2 inch | 12.70 | 93 | | |
| 3/8 inch | 9.51 | 90 | | |
| #4 | 4.75 | 85 | | |
| #10 | 2.00 | 77 | | |
| #20 | 0.84 | 41 | | |
| #40 | 0.42 | 14 | | |
| #60 | 0.25 | 3 | | |
| #100 | 0.15 | 1 | | |
| #200 | 0.075 | 0 | | |

**Coefficients**

$D_{85}$ = 4.6185 mm  $D_{30}$ = 0.6337 mm

$D_{60}$ = 1.3270 mm  $D_{15}$ = 0.4363 mm

$D_{50}$ = 1.0388 mm  $D_{10}$ = 0.3479 mm

$C_u$ = 3.815  $C_c$ = 0.303

**Classification**

ASTM  Poorly graded sand (SP)

AASHTO  Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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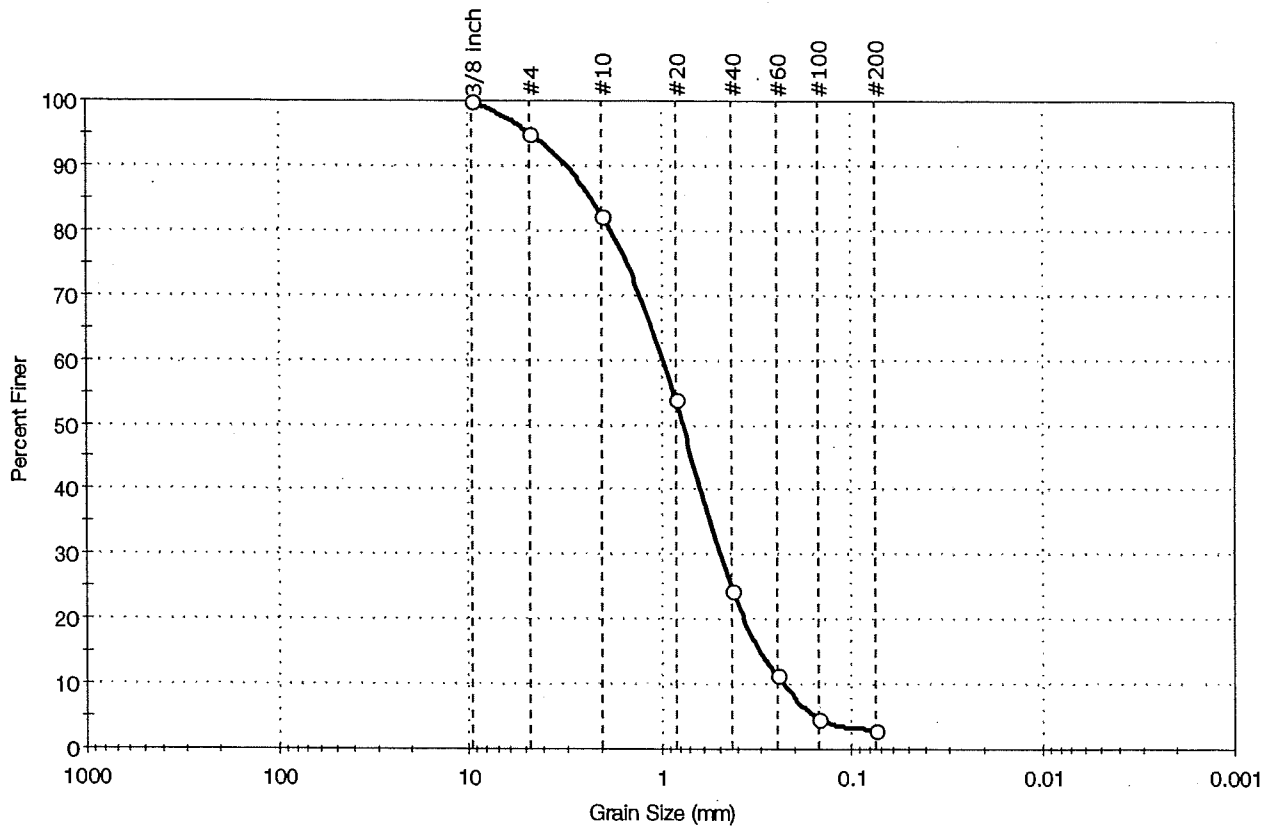
**GeoTesting express**

| | | | |
|---|---|---|---|
| Client: | EarthTech | | |
| Project: | Surfside Wastewater Treament Facility | | |
| Location: | Nantucket, MA | Project No: | GTX-5655 |
| Boring ID: TP-10 | Sample Type: bag | Tested By: | ahp |
| Sample ID: S-1 | Test Date: 12/02/04 | Checked By: | jdt |
| Depth : 1.5-3.0 ft. | Test Id: 64551 | | |
| Sample Description: | Moist, yellowish brown sand | | |
| Sample Comment: | | | |
| Test Comment: | --- | | |

# Particle Size Analysis - ASTM D 422




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 4.9 | 92.0 | 3.1 |

| Sieve Name | Sieve Size (mm) | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 3/8 Inch | 9.51 | 100 | | |
| #4 | 4.75 | 95 | | |
| #10 | 2.00 | 82 | | |
| #20 | 0.84 | 54 | | |
| #40 | 0.42 | 24 | | |
| #60 | 0.25 | 12 | | |
| #100 | 0.15 | 5 | | |
| #200 | 0.075 | 3 | | |

**Coefficients**

$D_{85}$ = 2.4123 mm  $D_{30}$ = 0.4834 mm

$D_{60}$ = 1.0146 mm  $D_{15}$ = 0.2883 mm

$D_{50}$ = 0.7690 mm  $D_{10}$ = 0.2223 mm

$C_u$ = 4.564  $C_c$ = 0.230

**Classification**

ASTM  Poorly graded sand (SP)

AASHTO  Stone Fragments, Gravel and Sand (A-1-b (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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# Appendix D. Laboratory Reports – Groundwater Samples, April 2005

**ALPHA ANALYTICAL LABORATORIES**

**Eight Walkup Drive**
**Westborough, Massachusetts 01581-1019**
**(508) 898-9220 www.alphalab.com**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

# CERTIFICATE OF ANALYSIS

**Client:** Earth Tech

**Address:** 196 Baker Avenue

Concord, MA 01742

**Attn:** Mr. Doug DeNatale

**Project Number:** 79862

**Site:** NANTUCKET WWTP

**Laboratory Job Number:** L0503882

**Date Received:** 13-APR-2005

**Date Reported:** 19-APR-2005

**Delivery Method:** Client

---

**The following questions pertain only to MCP Analytical Methods**

**An affirmative response to questions A,B,C & D is required for "Presumptive Certainty" status**

| | |
|---|---|
| A. Were all samples received by the laboratory in a condition consistent with those described on their Chain-of-Custody documentation for the data set? | YES |
| B. Were all QA/QC procedures required for the specified analytical method(s) included in this report followed, including the requirement to note and discuss in a narrative QC data that did not meet appropriate performance standards or guidelines? | YES |
| C. Does the analytical data included in this report meet all the requirements for "Presumptive Certainty", as described in section 2.0 of the MADEP document CAM VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data"? | YES |
| D. **VPH and EPH methods only:** Was the VPH or EPH method run without significant modifications, as specified in Section 11.3? | NA |

**A response to questions E and F is required for "Presumptive Certainty" status**

| | |
|---|---|
| E. Were all QC performance standards and recommendations for the specified method(s) achieved? | NO |
| F. Were results for all analyte-list compounds/elements for the specified method(s) reported? | NO |

Any answers of NO to the above questions are addressed in the case narrative.

---

I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

---

Authorized by: James Todaro
This document electronically signed

**Laboratory Job Number:** L0503882
**Date Reported:** 19-APR-2005

| ALPHA SAMPLE NUMBER | CLIENT IDENTIFICATION | SAMPLE LOCATION |
|---|---|---|
| L0503882-01 | N-11 | NANTUCKET, MA |
| L0503882-02 | N-1 | NANTUCKET, MA |
| L0503882-03 | N-10 | NANTUCKET, MA |
| L0503882-04 | N-3 | NANTUCKET, MA |

**Laboratory Job Number: L0503882**

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MCP Related Narratives:

Report Submission

In reference to question F, the samples were analyzed only for the compounds specified on the chain of custody.

Extraction methods

Extraction method 3510C was used for the analysis of Pesticides by Method 8081 and PCB by Method 8082.

Pesticides

In reference to question E:

The surrogate % recovery for Decachlorobiphenyl on -01 is below acceptance criteria on both the a-channel and the b-channel. The non-conformance is confirmed by the PCB mcp-8082 analysis for Decachlorobiphenyl on the a-channel and the b-channel.

PCB

The surrogate % recovery for Decachlorobiphenyl on -01 is below acceptance criteria on both the a-channel and the b-channel. The non-conformance is confirmed by the Pesticides mcp-8081 analysis for Decachlorobiphenyl on the a-channel and the b-channel.

The surrogate % recovery for Decachlorobiphenyl on -03 is below acceptance criteria on one channel. The sample was re-analyzed with similar results. Both sets of data were reported.

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503882-01
N-11
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 10:00
**Date Received :** 13-APR-2005
**Date Reported :** 19-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 6-Amber,3-Plastic,2-Vial

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Nitrogen, Ammonia | ND | mg/l | 0.075 | 30 4500NH3-BH | 0418 19:00 | 0419 12:07 | AT |
| Nitrogen, Nitrate | 0.40 | mg/l | 0.10 | 30 4500NO3-F | | 0413 20:17 | DD |
| Nitrogen, Nitrate/Nitrite | 0.40 | mg/l | 0.10 | 30 4500NO3-F | | 0413 20:17 | DD |
| Nitrogen, Total Kjeldahl | 0.92 | mg/l | 0.30 | 30 4500N-C | 0418 17:30 | 0419 11:13 | AT |
| Oil & Grease, Hem-Grav | ND | mg/l | 4.0 | 38 1664 | 0414 11:30 | 0415 10:45 | AT |
| Surfactants, MBAS | ND | mg/l | 0.05 | 30 5540C | | 0415 00:40 | HG |
| Total Metals by MCP 6000/7000 series | | | | 60 6010B | | | |
| Arsenic, Total | ND | mg/l | 0.025 | 60 6010B | 0415 17:00 | 0418 13:39 | MG |
| Arsenic, Total | ND | mg/l | 0.005 | 60 6010B | 0415 17:00 | 0418 13:43 | MG |
| Barium, Total | 0.05 | mg/l | 0.05 | 60 6010B | 0415 17:00 | 0418 13:39 | MG |
| Barium, Total | 0.05 | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 13:43 | MG |
| Cadmium, Total | ND | mg/l | 0.025 | 60 6010B | 0415 17:00 | 0418 13:39 | MG |
| Cadmium, Total | ND | mg/l | 0.005 | 60 6010B | 0415 17:00 | 0418 13:43 | MG |
| Chromium, Total | ND | mg/l | 0.05 | 60 6010B | 0415 17:00 | 0418 13:39 | MG |
| Chromium, Total | 0.02 | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 13:43 | MG |
| Copper, Total | ND | mg/l | 0.05 | 60 6010B | 0415 17:00 | 0418 13:39 | MG |
| Copper, Total | ND | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 13:43 | MG |
| Iron, Total | 9.3 | mg/l | 0.25 | 60 6010B | 0415 17:00 | 0418 13:39 | MG |
| Iron, Total | 9.7 | mg/l | 0.05 | 60 6010B | 0415 17:00 | 0418 13:43 | MG |
| Lead, Total | ND | mg/l | 0.050 | 60 6010B | 0415 17:00 | 0418 13:39 | MG |
| Lead, Total | 0.011 | mg/l | 0.010 | 60 6010B | 0415 17:00 | 0418 13:43 | MG |
| Manganese, Total | 0.23 | mg/l | 0.05 | 60 6010B | 0415 17:00 | 0418 13:39 | MG |
| Manganese, Total | 0.23 | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 13:43 | MG |
| Mercury, Total | ND | mg/l | 0.0002 | 64 7470A | 0414 18:30 | 0415 13:09 | DM |
| Selenium, Total | ND | mg/l | 0.050 | 60 6010B | 0415 17:00 | 0418 13:39 | MG |
| Selenium, Total | ND | mg/l | 0.010 | 60 6010B | 0415 17:00 | 0418 13:43 | MG |
| Silver, Total | ND | mg/l | 0.035 | 60 6010B | 0415 17:00 | 0418 13:39 | MG |
| Silver, Total | ND | mg/l | 0.007 | 60 6010B | 0415 17:00 | 0418 13:43 | MG |
| Zinc, Total | ND | mg/l | 0.25 | 60 6010B | 0415 17:00 | 0418 13:39 | MG |
| Zinc, Total | 0.06 | mg/l | 0.05 | 60 6010B | 0415 17:00 | 0418 13:43 | MG |
| Volatile Organics by MCP 8260B | | | | 60 8260B | | 0415 11:02 | SE |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-01
N-11

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Volatile Organics by MCP 8260B continued | | | | 60 8260B | | 0415 11:02 | SE |
| Methylene chloride | ND | ug/l | 5.0 | | | | |
| 1,1-Dichloroethane | ND | ug/l | 0.75 | | | | |
| Chloroform | ND | ug/l | 0.75 | | | | |
| Carbon tetrachloride | ND | ug/l | 0.50 | | | | |
| 1,2-Dichloropropane | ND | ug/l | 1.8 | | | | |
| Dibromochloromethane | ND | ug/l | 0.50 | | | | |
| 1,1,2-Trichloroethane | ND | ug/l | 0.75 | | | | |
| Tetrachloroethene | ND | ug/l | 0.50 | | | | |
| Chlorobenzene | ND | ug/l | 0.50 | | | | |
| Trichlorofluoromethane | ND | ug/l | 2.5 | | | | |
| 1,2-Dichloroethane | ND | ug/l | 0.50 | | | | |
| 1,1,1-Trichloroethane | ND | ug/l | 0.50 | | | | |
| Bromodichloromethane | ND | ug/l | 0.50 | | | | |
| trans-1,3-Dichloropropene | ND | ug/l | 0.50 | | | | |
| cis-1,3-Dichloropropene | ND | ug/l | 0.50 | | | | |
| 1,1-Dichloropropene | ND | ug/l | 2.5 | | | | |
| Bromoform | ND | ug/l | 2.0 | | | | |
| 1,1,2,2-Tetrachloroethane | ND | ug/l | 0.50 | | | | |
| Benzene | ND | ug/l | 0.50 | | | | |
| Toluene | ND | ug/l | 0.75 | | | | |
| Ethylbenzene | ND | ug/l | 0.50 | | | | |
| Chloromethane | ND | ug/l | 2.5 | | | | |
| Bromomethane | ND | ug/l | 1.0 | | | | |
| Vinyl chloride | ND | ug/l | 1.0 | | | | |
| Chloroethane | ND | ug/l | 1.0 | | | | |
| 1,1-Dichloroethene | ND | ug/l | 0.50 | | | | |
| trans-1,2-Dichloroethene | ND | ug/l | 0.75 | | | | |
| Trichloroethene | ND | ug/l | 0.50 | | | | |
| 1,2-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,3-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,4-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| Methyl tert butyl ether | ND | ug/l | 1.0 | | | | |
| p/m-Xylene | ND | ug/l | 0.50 | | | | |
| o-Xylene | ND | ug/l | 0.50 | | | | |
| cis-1,2-Dichloroethene | ND | ug/l | 0.50 | | | | |
| Dibromomethane | ND | ug/l | 5.0 | | | | |
| 1,2,3-Trichloropropane | ND | ug/l | 5.0 | | | | |
| Styrene | ND | ug/l | 0.50 | | | | |
| Dichlorodifluoromethane | ND | ug/l | 5.0 | | | | |
| Acetone | ND | ug/l | 5.0 | | | | |
| Carbon disulfide | ND | ug/l | 5.0 | | | | |
| 2-Butanone | ND | ug/l | 5.0 | | | | |
| 4-Methyl-2-pentanone | ND | ug/l | 5.0 | | | | |
| 2-Hexanone | ND | ug/l | 5.0 | | | | |
| Bromochloromethane | ND | ug/l | 2.5 | | | | |
| Tetrahydrofuran | ND | ug/l | 10. | | | | |
| 2,2-Dichloropropane | ND | ug/l | 2.5 | | | | |
| 1,2-Dibromoethane | ND | ug/l | 2.0 | | | | |
| 1,3-Dichloropropane | ND | ug/l | 2.5 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-01
N-11

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| **Volatile Organics by MCP 8260B continued** | | | | 60 8260B | | 0415 11:02 | SE |
| 1,1,1,2-Tetrachloroethane | ND | ug/l | 0.50 | | | | |
| Bromobenzene | ND | ug/l | 2.5 | | | | |
| n-Butylbenzene | ND | ug/l | 0.50 | | | | |
| sec-Butylbenzene | ND | ug/l | 0.50 | | | | |
| tert-Butylbenzene | ND | ug/l | 2.5 | | | | |
| o-Chlorotoluene | ND | ug/l | 2.5 | | | | |
| p-Chlorotoluene | ND | ug/l | 2.5 | | | | |
| 1,2-Dibromo-3-chloropropane | ND | ug/l | 2.5 | | | | |
| Hexachlorobutadiene | ND | ug/l | 1.0 | | | | |
| Isopropylbenzene | ND | ug/l | 0.50 | | | | |
| p-Isopropyltoluene | ND | ug/l | 0.50 | | | | |
| Naphthalene | ND | ug/l | 2.5 | | | | |
| n-Propylbenzene | ND | ug/l | 0.50 | | | | |
| 1,2,3-Trichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,2,4-Trichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,3,5-Trimethylbenzene | ND | ug/l | 2.5 | | | | |
| 1,2,4-Trimethylbenzene | ND | ug/l | 2.5 | | | | |
| Ethyl ether | ND | ug/l | 2.5 | | | | |
| Isopropyl Ether | ND | ug/l | 2.0 | | | | |
| Ethyl-Tert-Butyl-Ether | ND | ug/l | 2.0 | | | | |
| Tertiary-Amyl Methyl Ether | ND | ug/l | 2.0 | | | | |
| 1,4-Dioxane | ND | ug/l | 250 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 1,2-Dichloroethane-d4 | 102. | % | 70-130 | | | | |
| Toluene-d8 | 96.0 | % | 70-130 | | | | |
| 4-Bromofluorobenzene | 99.0 | % | 70-130 | | | | |
| Dibromofluoromethane | 99.0 | % | 70-130 | | | | |
| **Polychlorinated Biphenyls by MCP 8082** | | | | 64 8082 | 0414 21:10 | 0418 11:57 | JB |
| Aroclor 1221 | ND | ug/l | 0.255 | | | | |
| Aroclor 1232 | ND | ug/l | 0.255 | | | | |
| Aroclor 1242/1016 | ND | ug/l | 0.255 | | | | |
| Aroclor 1248 | ND | ug/l | 0.255 | | | | |
| Aroclor 1254 | ND | ug/l | 0.255 | | | | |
| Aroclor 1260 | ND | ug/l | 0.255 | | | | |
| Aroclor 1262 | ND | ug/l | 0.255 | | | | |
| Aroclor 1268 | ND | ug/l | 0.255 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 70.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 22.0 | % | 30-150 | | | | |
| **Polychlorinated Biphenyls by MCP 8082** | | | | 64 8082 | 0414 21:10 | 0418 11:57 | JB |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 71.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 19.0 | % | 30-150 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-01
N-11

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Organochlorine Pesticides by MCP 8081A | | | | 64 8081A | 0414 17:30 | 0415 18:37 | BW |
| Delta-BHC | ND | ug/l | 0.020 | | | | |
| Lindane | ND | ug/l | 0.020 | | | | |
| Alpha-BHC | ND | ug/l | 0.020 | | | | |
| Beta-BHC | ND | ug/l | 0.020 | | | | |
| Heptachlor | ND | ug/l | 0.020 | | | | |
| Aldrin | ND | ug/l | 0.020 | | | | |
| Heptachlor epoxide | ND | ug/l | 0.020 | | | | |
| Endrin | ND | ug/l | 0.041 | | | | |
| Endrin ketone | ND | ug/l | 0.041 | | | | |
| Dieldrin | ND | ug/l | 0.041 | | | | |
| 4,4'-DDE | ND | ug/l | 0.041 | | | | |
| 4,4'-DDD | ND | ug/l | 0.041 | | | | |
| 4,4'-DDT | ND | ug/l | 0.041 | | | | |
| Endosulfan I | ND | ug/l | 0.020 | | | | |
| Endosulfan II | ND | ug/l | 0.041 | | | | |
| Endosulfan sulfate | ND | ug/l | 0.041 | | | | |
| Methoxychlor | ND | ug/l | 0.204 | | | | |
| Chlordane | ND | ug/l | 0.204 | | | | |
| Hexachlorobenzene | ND | ug/l | 0.204 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 57.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 26.0 | % | 30-150 | | | | |
| Organochlorine Pesticides by MCP 8081A | | | | 64 8081A | 0414 17:30 | 0415 18:37 | BW |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 60.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 29.0 | % | 30-150 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503882-02
N-1
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 10:40
**Date Received :** 13-APR-2005
**Date Reported :** 19-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 6-Amber,4-Plastic,2-Vial

| PARAMETER | RESULT | UNITS | RDL | REF | METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|---|
| Nitrogen, Ammonia | 2.55 | mg/l | 0.075 | 30 | 4500NH3-BH | 0418 19:00 | 0419 12:08 | AT |
| Nitrogen, Nitrate | ND | mg/l | 0.10 | 30 | 4500NO3-F | | 0413 20:17 | DD |
| Nitrogen, Nitrate/Nitrite | ND | mg/l | 0.10 | 30 | 4500NO3-F | | 0413 20:17 | DD |
| Nitrogen, Total Kjeldahl | 3.0 | mg/l | 0.30 | 30 | 4500N-C | 0418 17:30 | 0419 11:17 | AT |
| Oil & Grease, Hem-Grav | ND | mg/l | 4.0 | 38 | 1664 | 0414 11:30 | 0415 10:45 | AT |
| Surfactants, MBAS | 0.08 | mg/l | 0.05 | 30 | 5540C | | 0415 00:40 | HG |
| Total Metals by MCP 6000/7000 series | | | | 60 | 6010B | | | |
| Arsenic, Total | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 13:47 | MG |
| Barium, Total | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 13:47 | MG |
| Cadmium, Total | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 13:47 | MG |
| Chromium, Total | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 13:47 | MG |
| Copper, Total | 0.02 | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 13:47 | MG |
| Iron, Total | 22. | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 13:47 | MG |
| Lead, Total | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 13:47 | MG |
| Manganese, Total | 0.63 | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 13:47 | MG |
| Mercury, Total | ND | mg/l | 0.0002 | 64 | 7470A | 0414 18:30 | 0415 13:11 | DM |
| Selenium, Total | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 13:47 | MG |
| Silver, Total | ND | mg/l | 0.007 | 60 | 6010B | 0415 17:00 | 0418 13:47 | MG |
| Zinc, Total | 0.07 | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 13:47 | MG |
| Volatile Organics by MCP 8260B | | | | 60 | 8260B | | 0415 11:39 | SE |
| Methylene chloride | ND | ug/l | 5.0 | | | | | |
| 1,1-Dichloroethane | ND | ug/l | 0.75 | | | | | |
| Chloroform | ND | ug/l | 0.75 | | | | | |
| Carbon tetrachloride | ND | ug/l | 0.50 | | | | | |
| 1,2-Dichloropropane | ND | ug/l | 1.8 | | | | | |
| Dibromochloromethane | ND | ug/l | 0.50 | | | | | |
| 1,1,2-Trichloroethane | ND | ug/l | 0.75 | | | | | |
| Tetrachloroethene | ND | ug/l | 0.50 | | | | | |
| Chlorobenzene | ND | ug/l | 0.50 | | | | | |
| Trichlorofluoromethane | ND | ug/l | 2.5 | | | | | |
| 1,2-Dichloroethane | ND | ug/l | 0.50 | | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-02
N-1

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Volatile Organics by MCP 8260B continued | | | | 60 8260B | | 0415 11:39 | SE |
| 1,1,1-Trichloroethane | ND | ug/l | 0.50 | | | | |
| Bromodichloromethane | ND | ug/l | 0.50 | | | | |
| trans-1,3-Dichloropropene | ND | ug/l | 0.50 | | | | |
| cis-1,3-Dichloropropene | ND | ug/l | 0.50 | | | | |
| 1,1-Dichloropropene | ND | ug/l | 2.5 | | | | |
| Bromoform | ND | ug/l | 2.0 | | | | |
| 1,1,2,2-Tetrachloroethane | ND | ug/l | 0.50 | | | | |
| Benzene | ND | ug/l | 0.50 | | | | |
| Toluene | ND | ug/l | 0.75 | | | | |
| Ethylbenzene | ND | ug/l | 0.50 | | | | |
| Chloromethane | ND | ug/l | 2.5 | | | | |
| Bromomethane | ND | ug/l | 1.0 | | | | |
| Vinyl chloride | ND | ug/l | 1.0 | | | | |
| Chloroethane | ND | ug/l | 1.0 | | | | |
| 1,1-Dichloroethene | ND | ug/l | 0.50 | | | | |
| trans-1,2-Dichloroethene | ND | ug/l | 0.75 | | | | |
| Trichloroethene | ND | ug/l | 0.50 | | | | |
| 1,2-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,3-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,4-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| Methyl tert butyl ether | ND | ug/l | 1.0 | | | | |
| p/m-Xylene | ND | ug/l | 0.50 | | | | |
| o-Xylene | ND | ug/l | 0.50 | | | | |
| cis-1,2-Dichloroethene | ND | ug/l | 0.50 | | | | |
| Dibromomethane | ND | ug/l | 5.0 | | | | |
| 1,2,3-Trichloropropane | ND | ug/l | 5.0 | | | | |
| Styrene | ND | ug/l | 0.50 | | | | |
| Dichlorodifluoromethane | ND | ug/l | 5.0 | | | | |
| Acetone | ND | ug/l | 5.0 | | | | |
| Carbon disulfide | ND | ug/l | 5.0 | | | | |
| 2-Butanone | ND | ug/l | 5.0 | | | | |
| 4-Methyl-2-pentanone | ND | ug/l | 5.0 | | | | |
| 2-Hexanone | ND | ug/l | 5.0 | | | | |
| Bromochloromethane | ND | ug/l | 2.5 | | | | |
| Tetrahydrofuran | ND | ug/l | 10. | | | | |
| 2,2-Dichloropropane | ND | ug/l | 2.5 | | | | |
| 1,2-Dibromoethane | ND | ug/l | 2.0 | | | | |
| 1,3-Dichloropropane | ND | ug/l | 2.5 | | | | |
| 1,1,1,2-Tetrachloroethane | ND | ug/l | 0.50 | | | | |
| Bromobenzene | ND | ug/l | 2.5 | | | | |
| n-Butylbenzene | ND | ug/l | 0.50 | | | | |
| sec-Butylbenzene | ND | ug/l | 0.50 | | | | |
| tert-Butylbenzene | ND | ug/l | 2.5 | | | | |
| o-Chlorotoluene | ND | ug/l | 2.5 | | | | |
| p-Chlorotoluene | ND | ug/l | 2.5 | | | | |
| 1,2-Dibromo-3-chloropropane | ND | ug/l | 2.5 | | | | |
| Hexachlorobutadiene | ND | ug/l | 1.0 | | | | |
| Isopropylbenzene | ND | ug/l | 0.50 | | | | |
| p-Isopropyltoluene | ND | ug/l | 0.50 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-02
N-1

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Volatile Organics by MCP 8260B continued | | | | 60 8260B | | 0415 11:39 | SE |
| Naphthalene | ND | ug/l | 2.5 | | | | |
| n-Propylbenzene | ND | ug/l | 0.50 | | | | |
| 1,2,3-Trichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,2,4-Trichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,3,5-Trimethylbenzene | ND | ug/l | 2.5 | | | | |
| 1,2,4-Trimethylbenzene | ND | ug/l | 2.5 | | | | |
| Ethyl ether | ND | ug/l | 2.5 | | | | |
| Isopropyl Ether | ND | ug/l | 2.0 | | | | |
| Ethyl-Tert-Butyl-Ether | ND | ug/l | 2.0 | | | | |
| Tertiary-Amyl Methyl Ether | ND | ug/l | 2.0 | | | | |
| 1,4-Dioxane | ND | ug/l | 250 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 1,2-Dichloroethane-d4 | 108. | % | 70-130 | | | | |
| Toluene-d8 | 96.0 | % | 70-130 | | | | |
| 4-Bromofluorobenzene | 102. | % | 70-130 | | | | |
| Dibromofluoromethane | 105. | % | 70-130 | | | | |
| Polychlorinated Biphenyls by MCP 8082 | | | | 64 8082 | 0414 21:10 | 0415 18:30 | JB |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 69.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 33.0 | % | 30-150 | | | | |
| Polychlorinated Biphenyls by MCP 8082 | | | | 64 8082 | 0414 21:10 | 0415 18:30 | JB |
| Aroclor 1221 | ND | ug/l | 0.260 | | | | |
| Aroclor 1232 | ND | ug/l | 0.260 | | | | |
| Aroclor 1242/1016 | ND | ug/l | 0.260 | | | | |
| Aroclor 1248 | ND | ug/l | 0.260 | | | | |
| Aroclor 1254 | ND | ug/l | 0.260 | | | | |
| Aroclor 1260 | ND | ug/l | 0.260 | | | | |
| Aroclor 1262 | ND | ug/l | 0.260 | | | | |
| Aroclor 1268 | ND | ug/l | 0.260 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 69.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 30.0 | % | 30-150 | | | | |
| Organochlorine Pesticides by MCP 8081A | | | | 64 8081A | 0414 17:30 | 0415 19:06 | BW |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 60.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 41.0 | % | 30-150 | | | | |
| Organochlorine Pesticides by MCP 8081A | | | | 64 8081A | 0414 17:30 | 0415 19:06 | BW |
| Delta-BHC | ND | ug/l | 0.021 | | | | |
| Lindane | ND | ug/l | 0.021 | | | | |
| Alpha-BHC | ND | ug/l | 0.021 | | | | |
| Beta-BHC | ND | ug/l | 0.021 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-02
N-1

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Organochlorine Pesticides by MCP 8081A continued | | | | 64 8081A | 0414 17:30 | 0415 19:06 | BW |
| Heptachlor | ND | ug/l | 0.021 | | | | |
| Aldrin | ND | ug/l | 0.021 | | | | |
| Heptachlor epoxide | ND | ug/l | 0.021 | | | | |
| Endrin | ND | ug/l | 0.042 | | | | |
| Endrin ketone | ND | ug/l | 0.042 | | | | |
| Dieldrin | ND | ug/l | 0.042 | | | | |
| 4,4'-DDE | ND | ug/l | 0.042 | | | | |
| 4,4'-DDD | ND | ug/l | 0.042 | | | | |
| 4,4'-DDT | ND | ug/l | 0.042 | | | | |
| Endosulfan I | ND | ug/l | 0.021 | | | | |
| Endosulfan II | ND | ug/l | 0.042 | | | | |
| Endosulfan sulfate | ND | ug/l | 0.042 | | | | |
| Methoxychlor | ND | ug/l | 0.208 | | | | |
| Chlordane | ND | ug/l | 0.208 | | | | |
| Hexachlorobenzene | ND | ug/l | 0.208 | | | | |

| Surrogate(s) | Recovery | | QC Criteria |
|---|---|---|---|
| 2,4,5,6-Tetrachloro-m-xylene | 57.0 | % | 30-150 |
| Decachlorobiphenyl | 38.0 | % | 30-150 |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503882-03
N-10
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 11:00
**Date Received :** 13-APR-2005
**Date Reported :** 19-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 6-Amber,4-Plastic,2-Vial

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Nitrogen, Ammonia | 1.81 | mg/l | 0.075 | 30 4500NH3-BH | 0418 19:00 | 0419 12:08 | AT |
| Nitrogen, Nitrate | ND | mg/l | 0.10 | 30 4500NO3-F | | 0413 20:18 | DD |
| Nitrogen, Nitrate/Nitrite | ND | mg/l | 0.10 | 30 4500NO3-F | | 0413 23:30 | DD |
| Nitrogen, Total Kjeldahl | 2.2 | mg/l | 0.30 | 30 4500N-C | 0418 17:30 | 0419 11:18 | AT |
| Oil & Grease, Hem-Grav | ND | mg/l | 4.0 | 38 1664 | 0414 11:30 | 0415 10:45 | AT |
| Surfactants, MBAS | 0.08 | mg/l | 0.05 | 30 5540C | | 0415 00:40 | HG |
| Total Metals by MCP 6000/7000 series | | | | 60 6010B | | | |
| Arsenic, Total | ND | mg/l | 0.005 | 60 6010B | 0415 17:00 | 0418 14:04 | MG |
| Barium, Total | 0.01 | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 14:04 | MG |
| Cadmium, Total | ND | mg/l | 0.005 | 60 6010B | 0415 17:00 | 0418 14:04 | MG |
| Chromium, Total | ND | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 14:04 | MG |
| Copper, Total | 0.01 | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 14:04 | MG |
| Iron, Total | 8.1 | mg/l | 0.05 | 60 6010B | 0415 17:00 | 0418 14:04 | MG |
| Lead, Total | ND | mg/l | 0.010 | 60 6010B | 0415 17:00 | 0418 14:04 | MG |
| Manganese, Total | 0.59 | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 14:04 | MG |
| Mercury, Total | ND | mg/l | 0.0002 | 64 7470A | 0414 18:30 | 0415 13:17 | DM |
| Selenium, Total | ND | mg/l | 0.010 | 60 6010B | 0415 17:00 | 0418 14:04 | MG |
| Silver, Total | ND | mg/l | 0.007 | 60 6010B | 0415 17:00 | 0418 14:04 | MG |
| Zinc, Total | 0.06 | mg/l | 0.05 | 60 6010B | 0415 17:00 | 0418 14:04 | MG |
| Volatile Organics by MCP 8260B | | | | 60 8260B | | 0415 12:15 | SE |
| Methylene chloride | ND | ug/l | 5.0 | | | | |
| 1,1-Dichloroethane | ND | ug/l | 0.75 | | | | |
| Chloroform | ND | ug/l | 0.75 | | | | |
| Carbon tetrachloride | ND | ug/l | 0.50 | | | | |
| 1,2-Dichloropropane | ND | ug/l | 1.8 | | | | |
| Dibromochloromethane | ND | ug/l | 0.50 | | | | |
| 1,1,2-Trichloroethane | ND | ug/l | 0.75 | | | | |
| Tetrachloroethene | ND | ug/l | 0.50 | | | | |
| Chlorobenzene | ND | ug/l | 0.50 | | | | |
| Trichlorofluoromethane | ND | ug/l | 2.5 | | | | |
| 1,2-Dichloroethane | ND | ug/l | 0.50 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-03
N-10

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Volatile Organics by MCP 8260B continued | | | | 60 8260B | | 0415 12:15 | SB |
| 1,1,1-Trichloroethane | ND | ug/l | 0.50 | | | | |
| Bromodichloromethane | ND | ug/l | 0.50 | | | | |
| trans-1,3-Dichloropropene | ND | ug/l | 0.50 | | | | |
| cis-1,3-Dichloropropene | ND | ug/l | 0.50 | | | | |
| 1,1-Dichloropropene | ND | ug/l | 2.5 | | | | |
| Bromoform | ND | ug/l | 2.0 | | | | |
| 1,1,2,2-Tetrachloroethane | ND | ug/l | 0.50 | | | | |
| Benzene | ND | ug/l | 0.50 | | | | |
| Toluene | ND | ug/l | 0.75 | | | | |
| Ethylbenzene | ND | ug/l | 0.50 | | | | |
| Chloromethane | ND | ug/l | 2.5 | | | | |
| Bromomethane | ND | ug/l | 1.0 | | | | |
| Vinyl chloride | ND | ug/l | 1.0 | | | | |
| Chloroethane | ND | ug/l | 1.0 | | | | |
| 1,1-Dichloroethene | ND | ug/l | 0.50 | | | | |
| trans-1,2-Dichloroethene | ND | ug/l | 0.75 | | | | |
| Trichloroethene | ND | ug/l | 0.50 | | | | |
| 1,2-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,3-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,4-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| Methyl tert butyl ether | ND | ug/l | 1.0 | | | | |
| p/m-Xylene | ND | ug/l | 0.50 | | | | |
| o-Xylene | ND | ug/l | 0.50 | | | | |
| cis-1,2-Dichloroethene | ND | ug/l | 0.50 | | | | |
| Dibromomethane | ND | ug/l | 5.0 | | | | |
| 1,2,3-Trichloropropane | ND | ug/l | 5.0 | | | | |
| Styrene | ND | ug/l | 0.50 | | | | |
| Dichlorodifluoromethane | ND | ug/l | 5.0 | | | | |
| Acetone | ND | ug/l | 5.0 | | | | |
| Carbon disulfide | ND | ug/l | 5.0 | | | | |
| 2-Butanone | ND | ug/l | 5.0 | | | | |
| 4-Methyl-2-pentanone | ND | ug/l | 5.0 | | | | |
| 2-Hexanone | ND | ug/l | 5.0 | | | | |
| Bromochloromethane | ND | ug/l | 2.5 | | | | |
| Tetrahydrofuran | ND | ug/l | 10. | | | | |
| 2,2-Dichloropropane | ND | ug/l | 2.5 | | | | |
| 1,2-Dibromoethane | ND | ug/l | 2.0 | | | | |
| 1,3-Dichloropropane | ND | ug/l | 2.5 | | | | |
| 1,1,1,2-Tetrachloroethane | ND | ug/l | 0.50 | | | | |
| Bromobenzene | ND | ug/l | 2.5 | | | | |
| n-Butylbenzene | ND | ug/l | 0.50 | | | | |
| sec-Butylbenzene | ND | ug/l | 0.50 | | | | |
| tert-Butylbenzene | ND | ug/l | 2.5 | | | | |
| o-Chlorotoluene | ND | ug/l | 2.5 | | | | |
| p-Chlorotoluene | ND | ug/l | 2.5 | | | | |
| 1,2-Dibromo-3-chloropropane | ND | ug/l | 2.5 | | | | |
| Hexachlorobutadiene | ND | ug/l | 1.0 | | | | |
| Isopropylbenzene | ND | ug/l | 0.50 | | | | |
| p-Isopropyltoluene | ND | ug/l | 0.50 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-03
N-10

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Volatile Organics by MCP 8260B continued | | | | 60 8260B | | 0415 12:15 | SE |
| Naphthalene | ND | ug/l | 2.5 | | | | |
| n-Propylbenzene | ND | ug/l | 0.50 | | | | |
| 1,2,3-Trichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,2,4-Trichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,3,5-Trimethylbenzene | ND | ug/l | 2.5 | | | | |
| 1,2,4-Trimethylbenzene | ND | ug/l | 2.5 | | | | |
| Ethyl ether | ND | ug/l | 2.5 | | | | |
| Isopropyl Ether | ND | ug/l | 2.0 | | | | |
| Ethyl-Tert-Butyl-Ether | ND | ug/l | 2.0 | | | | |
| Tertiary-Amyl Methyl Ether | ND | ug/l | 2.0 | | | | |
| 1,4-Dioxane | ND | ug/l | 250 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 1,2-Dichloroethane-d4 | 116. | % | 70-130 | | | | |
| Toluene-d8 | 98.0 | % | 70-130 | | | | |
| 4-Bromofluorobenzene | 98.0 | % | 70-130 | | | | |
| Dibromofluoromethane | 107. | % | 70-130 | | | | |
| Polychlorinated Biphenyls by MCP 8082 | | | | 64 8082 | 0414 21:10 | 0415 18:58 | JB |
| Aroclor 1221 | ND | ug/l | 0.263 | | | | |
| Aroclor 1232 | ND | ug/l | 0.263 | | | | |
| Aroclor 1242/1016 | ND | ug/l | 0.263 | | | | |
| Aroclor 1248 | ND | ug/l | 0.263 | | | | |
| Aroclor 1254 | ND | ug/l | 0.263 | | | | |
| Aroclor 1260 | ND | ug/l | 0.263 | | | | |
| Aroclor 1262 | ND | ug/l | 0.263 | | | | |
| Aroclor 1268 | ND | ug/l | 0.263 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 64.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 29.0 | % | 30-150 | | | | |
| Polychlorinated Biphenyls by MCP 8082 | | | | 64 8082 | 0414 21:10 | 0415 16:58 | JB |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 64.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 33.0 | % | 30-150 | | | | |
| Polychlorinated Biphenyls by MCP 8082 | | | | 64 8082 | 0414 21:10 | 0418 12:25 | JB |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 66.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 30.0 | % | 30-150 | | | | |
| Polychlorinated Biphenyls by MCP 8082 | | | | 64 8082 | 0414 21:10 | 0418 12:25 | JB |
| Aroclor 1221 | ND | ug/l | 0.263 | | | | |
| Aroclor 1232 | ND | ug/l | 0.263 | | | | |
| Aroclor 1242/1016 | ND | ug/l | 0.263 | | | | |
| Aroclor 1248 | ND | ug/l | 0.263 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-03
N-10

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Polychlorinated Biphenyls by MCP 8082 continued | | | | 64 8082 | 0414 21:10 | 0418 12:25 | JB |
| Aroclor 1254 | ND | ug/l | 0.263 | | | | |
| Aroclor 1260 | ND | ug/l | 0.263 | | | | |
| Aroclor 1262 | ND | ug/l | 0.263 | | | | |
| Aroclor 1268 | ND | ug/l | 0.263 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 64.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 27.0 | % | 30-150 | | | | |
| Organochlorine Pesticides by MCP 8081A | | | | 64 8081A | 0414 17:30 | 0415 19:34 | BW |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 67.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 43.0 | % | 30-150 | | | | |
| Organochlorine Pesticides by MCP 8081A | | | | 64 8081A | 0414 17:30 | 0415 19:34 | BW |
| Delta-BHC | ND | ug/l | 0.021 | | | | |
| Lindane | ND | ug/l | 0.021 | | | | |
| Alpha-BHC | ND | ug/l | 0.021 | | | | |
| Beta-BHC | ND | ug/l | 0.021 | | | | |
| Heptachlor | ND | ug/l | 0.021 | | | | |
| Aldrin | ND | ug/l | 0.021 | | | | |
| Heptachlor epoxide | ND | ug/l | 0.021 | | | | |
| Endrin | ND | ug/l | 0.042 | | | | |
| Endrin ketone | ND | ug/l | 0.042 | | | | |
| Dieldrin | ND | ug/l | 0.042 | | | | |
| 4,4'-DDE | ND | ug/l | 0.042 | | | | |
| 4,4'-DDD | ND | ug/l | 0.042 | | | | |
| 4,4'-DDT | ND | ug/l | 0.042 | | | | |
| Endosulfan I | ND | ug/l | 0.021 | | | | |
| Endosulfan II | ND | ug/l | 0.042 | | | | |
| Endosulfan sulfate | ND | ug/l | 0.042 | | | | |
| Methoxychlor | ND | ug/l | 0.210 | | | | |
| Chlordane | ND | ug/l | 0.210 | | | | |
| Hexachlorobenzene | ND | ug/l | 0.210 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 64.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 40.0 | % | 30-150 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503882-04
N-3
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 11:35
**Date Received :** 13-APR-2005
**Date Reported :** 19-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 6-Amber,4-Plastic,2-Vial

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Nitrogen, Ammonia | 0.097 | mg/l | 0.075 | 30 4500NH3-BH | 0418 19:00 | 0419 12:09 | AT |
| Nitrogen, Nitrate | 3.4 | mg/l | 0.10 | 30 4500NO3-F | | 0413 20:19 | DD |
| Nitrogen, Nitrate/Nitrite | 3.4 | mg/l | 0.10 | 30 4500NO3-F | | 0413 20:19 | DD |
| Nitrogen, Total Kjeldahl | 0.89 | mg/l | 0.30 | 30 4500N-C | 0418 17:30 | 0419 11:19 | AT |
| Oil & Grease, Hem-Grav | ND | mg/l | 4.0 | 38 1664 | 0414 11:30 | 0415 10:45 | AT |
| Surfactants, MBAS | ND | mg/l | 0.05 | 30 5540C | | 0415 00:40 | HG |
| Total Metals by MCP 6000/7000 series | | | | 60 6010B | | | |
| Arsenic, Total | 0.015 | mg/l | 0.005 | 60 6010B | 0415 17:00 | 0418 14:08 | MG |
| Barium, Total | 0.03 | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 14:08 | MG |
| Cadmium, Total | ND | mg/l | 0.005 | 60 6010B | 0415 17:00 | 0418 14:08 | MG |
| Chromium, Total | 0.10 | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 14:08 | MG |
| Copper, Total | 0.02 | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 14:08 | MG |
| Iron, Total | 35. | mg/l | 0.05 | 60 6010B | 0415 17:00 | 0418 14:08 | MG |
| Lead, Total | 0.018 | mg/l | 0.010 | 60 6010B | 0415 17:00 | 0418 14:08 | MG |
| Manganese, Total | 0.53 | mg/l | 0.01 | 60 6010B | 0415 17:00 | 0418 14:08 | MG |
| Mercury, Total | ND | mg/l | 0.0002 | 64 7470A | 0414 18:30 | 0415 13:18 | DM |
| Selenium, Total | ND | mg/l | 0.010 | 60 6010B | 0415 17:00 | 0418 14:08 | MG |
| Silver, Total | ND | mg/l | 0.007 | 60 6010B | 0415 17:00 | 0418 14:08 | MG |
| Zinc, Total | 0.09 | mg/l | 0.05 | 60 6010B | 0415 17:00 | 0418 14:08 | MG |
| Volatile Organics by MCP 8260B | | | | 60 8260B | | 0415 12:52 | SE |
| Methylene chloride | ND | ug/l | 5.0 | | | | |
| 1,1-Dichloroethane | ND | ug/l | 0.75 | | | | |
| Chloroform | ND | ug/l | 0.75 | | | | |
| Carbon tetrachloride | ND | ug/l | 0.50 | | | | |
| 1,2-Dichloropropane | ND | ug/l | 1.8 | | | | |
| Dibromochloromethane | ND | ug/l | 0.50 | | | | |
| 1,1,2-Trichloroethane | ND | ug/l | 0.75 | | | | |
| Tetrachloroethene | ND | ug/l | 0.50 | | | | |
| Chlorobenzene | ND | ug/l | 0.50 | | | | |
| Trichlorofluoromethane | ND | ug/l | 2.5 | | | | |
| 1,2-Dichloroethane | ND | ug/l | 0.50 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-04
N-3

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Volatile Organics by MCP 8260B continued | | | | 60 8260B | | 0415 12:52 | SE |
| 1,1,1-Trichloroethane | ND | ug/l | 0.50 | | | | |
| Bromodichloromethane | ND | ug/l | 0.50 | | | | |
| trans-1,3-Dichloropropene | ND | ug/l | 0.50 | | | | |
| cis-1,3-Dichloropropene | ND | ug/l | 0.50 | | | | |
| 1,1-Dichloropropene | ND | ug/l | 2.5 | | | | |
| Bromoform | ND | ug/l | 2.0 | | | | |
| 1,1,2,2-Tetrachloroethane | ND | ug/l | 0.50 | | | | |
| Benzene | ND | ug/l | 0.50 | | | | |
| Toluene | ND | ug/l | 0.75 | | | | |
| Ethylbenzene | ND | ug/l | 0.50 | | | | |
| Chloromethane | ND | ug/l | 2.5 | | | | |
| Bromomethane | ND | ug/l | 1.0 | | | | |
| Vinyl chloride | ND | ug/l | 1.0 | | | | |
| Chloroethane | ND | ug/l | 1.0 | | | | |
| 1,1-Dichloroethene | ND | ug/l | 0.50 | | | | |
| trans-1,2-Dichloroethene | ND | ug/l | 0.75 | | | | |
| Trichloroethene | ND | ug/l | 0.50 | | | | |
| 1,2-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,3-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,4-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| Methyl tert butyl ether | ND | ug/l | 1.0 | | | | |
| p/m-Xylene | ND | ug/l | 0.50 | | | | |
| o-Xylene | ND | ug/l | 0.50 | | | | |
| cis-1,2-Dichloroethene | ND | ug/l | 0.50 | | | | |
| Dibromomethane | ND | ug/l | 5.0 | | | | |
| 1,2,3-Trichloropropane | ND | ug/l | 5.0 | | | | |
| Styrene | ND | ug/l | 0.50 | | | | |
| Dichlorodifluoromethane | ND | ug/l | 5.0 | | | | |
| Acetone | ND | ug/l | 5.0 | | | | |
| Carbon disulfide | ND | ug/l | 5.0 | | | | |
| 2-Butanone | ND | ug/l | 5.0 | | | | |
| 4-Methyl-2-pentanone | ND | ug/l | 5.0 | | | | |
| 2-Hexanone | ND | ug/l | 5.0 | | | | |
| Bromochloromethane | ND | ug/l | 2.5 | | | | |
| Tetrahydrofuran | ND | ug/l | 10. | | | | |
| 2,2-Dichloropropane | ND | ug/l | 2.5 | | | | |
| 1,2-Dibromoethane | ND | ug/l | 2.0 | | | | |
| 1,3-Dichloropropane | ND | ug/l | 2.5 | | | | |
| 1,1,1,2-Tetrachloroethane | ND | ug/l | 0.50 | | | | |
| Bromobenzene | ND | ug/l | 2.5 | | | | |
| n-Butylbenzene | ND | ug/l | 0.50 | | | | |
| sec-Butylbenzene | ND | ug/l | 0.50 | | | | |
| tert-Butylbenzene | ND | ug/l | 2.5 | | | | |
| o-Chlorotoluene | ND | ug/l | 2.5 | | | | |
| p-Chlorotoluene | ND | ug/l | 2.5 | | | | |
| 1,2-Dibromo-3-chloropropane | ND | ug/l | 2.5 | | | | |
| Hexachlorobutadiene | ND | ug/l | 1.0 | | | | |
| Isopropylbenzene | ND | ug/l | 0.50 | | | | |
| p-Isopropyltoluene | ND | ug/l | 0.50 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-04
N-3

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Volatile Organics by MCP 8260B continued | | | | 60 8260B | | 0415 12:52 | SE |
| Naphthalene | ND | ug/l | 2.5 | | | | |
| n-Propylbenzene | ND | ug/l | 0.50 | | | | |
| 1,2,3-Trichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,2,4-Trichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,3,5-Trimethylbenzene | ND | ug/l | 2.5 | | | | |
| 1,2,4-Trimethylbenzene | ND | ug/l | 2.5 | | | | |
| Ethyl ether | ND | ug/l | 2.5 | | | | |
| Isopropyl Ether | ND | ug/l | 2.0 | | | | |
| Ethyl-Tert-Butyl-Ether | ND | ug/l | 2.0 | | | | |
| Tertiary-Amyl Methyl Ether | ND | ug/l | 2.0 | | | | |
| 1,4-Dioxane | ND | ug/l | 250 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 1,2-Dichloroethane-d4 | 113. | % | 70-130 | | | | |
| Toluene-d8 | 95.0 | % | 70-130 | | | | |
| 4-Bromofluorobenzene | 101. | % | 70-130 | | | | |
| Dibromofluoromethane | 106. | % | 70-130 | | | | |
| Polychlorinated Biphenyls by MCP 8082 | | | | 64 8082 | 0414 21:10 | 0415 19:27 | JB |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 69.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 38.0 | % | 30-150 | | | | |
| Polychlorinated Biphenyls by MCP 8082 | | | | 64 8082 | 0414 21:10 | 0415 19:27 | JB |
| Aroclor 1221 | ND | ug/l | 0.263 | | | | |
| Aroclor 1232 | ND | ug/l | 0.263 | | | | |
| Aroclor 1242/1016 | ND | ug/l | 0.263 | | | | |
| Aroclor 1248 | ND | ug/l | 0.263 | | | | |
| Aroclor 1254 | ND | ug/l | 0.263 | | | | |
| Aroclor 1260 | ND | ug/l | 0.263 | | | | |
| Aroclor 1262 | ND | ug/l | 0.263 | | | | |
| Aroclor 1268 | ND | ug/l | 0.263 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 68.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 34.0 | % | 30-150 | | | | |
| Organochlorine Pesticides by MCP 8081A | | | | 64 8081A | 0414 17:30 | 0415 20:03 | BW |
| Delta-BHC | ND | ug/l | 0.021 | | | | |
| Lindane | ND | ug/l | 0.021 | | | | |
| Alpha-BHC | ND | ug/l | 0.021 | | | | |
| Beta-BHC | ND | ug/l | 0.021 | | | | |
| Heptachlor | ND | ug/l | 0.021 | | | | |
| Aldrin | ND | ug/l | 0.021 | | | | |
| Heptachlor epoxide | ND | ug/l | 0.021 | | | | |
| Endrin | ND | ug/l | 0.042 | | | | |
| Endrin ketone | ND | ug/l | 0.042 | | | | |
| Dieldrin | ND | ug/l | 0.042 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**Laboratory Sample Number:** L0503882-04
N-3

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Organochlorine Pesticides by MCP 8081A continued | | | | 64 8081A | 0414 17:30 | 0415 20:03 | BW |
| 4,4'-DDE | ND | ug/l | 0.042 | | | | |
| 4,4'-DDD | ND | ug/l | 0.042 | | | | |
| 4,4'-DDT | ND | ug/l | 0.042 | | | | |
| Endosulfan I | ND | ug/l | 0.021 | | | | |
| Endosulfan II | ND | ug/l | 0.042 | | | | |
| Endosulfan sulfate | ND | ug/l | 0.042 | | | | |
| Methoxychlor | ND | ug/l | 0.208 | | | | |
| Chlordane | ND | ug/l | 0.208 | | | | |
| Hexachlorobenzene | ND | ug/l | 0.208 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 69.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 46.0 | % | 30-150 | | | | |
| Organochlorine Pesticides by MCP 8081A | | | | 64 8081A | 0414 17:30 | 0415 20:03 | BW |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 71.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 49.0 | % | 30-150 | | | | |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**QUALITY ASSURANCE BATCH DUPLICATE ANALYSIS**

**Laboratory Job Number: L0503882**

| Parameter | Value 1 | Value 2 | Units | RPD | RPD Limits |
|---|---|---|---|---|---|
| Nitrogen, Ammonia for sample(s) 01-04 (L0503621-05, WG199511-4) | | | | | |
| Nitrogen, Ammonia | 0.747 | 0.763 | mg/l | 2 | |
| Nitrogen, Nitrate for sample(s) 01-04 (L0503880-02, WG199019-4) | | | | | |
| Nitrogen, Nitrate | ND | ND | mg/l | NC | 6 |
| Nitrogen, Nitrate/Nitrite for sample(s) 01-04 (L0503302-12, WG199071-4) | | | | | |
| Nitrogen, Nitrate/Nitrite | ND | ND | mg/l | NC | |
| Nitrogen, Total Kjeldahl for sample(s) 01-04 (L0504003-08, WG199512-4) | | | | | |
| Nitrogen, Total Kjeldahl | 2.1 | 2.1 | mg/l | 0 | |
| Oil & Grease, Hem-Grav for sample(s) 01-04 (L0503576-01, WG199162-4) | | | | | |
| Oil & Grease, Hem-Grav | 26. | 28. | mg/l | 7 | |
| Surfactants, MBAS for sample(s) 01-04 (L0503882-02, WG199172-4) | | | | | |
| Surfactants, MBAS | 0.08 | 0.09 | mg/l | 5 | |

**ALPHA ANALYTICAL LABORATORIES**
**QUALITY ASSURANCE BATCH SPIKE ANALYSES**

**Laboratory Job Number: L0503882**

| Parameter | % Recovery | QC Criteria |
|---|---|---|
| Nitrogen, Ammonia LCS for sample(s) 01-04 (WG199511-2) | | |
| Nitrogen, Ammonia | 99 | |
| Nitrogen, Nitrate LCS for sample(s) 01-04 (WG199019-1) | | |
| Nitrogen, Nitrate | 96 | 88-105 |
| Nitrogen, Nitrate/Nitrite LCS for sample(s) 01-04 (WG199071-1) | | |
| Nitrogen, Nitrate/Nitrite | 96 | |
| Nitrogen, Total Kjeldahl LCS for sample(s) 01-04 (WG199512-2) | | |
| Nitrogen, Total Kjeldahl | 102 | |
| Oil & Grease, Hem-Grav LCS for sample(s) 01-04 (WG199162-2) | | |
| Oil & Grease, Hem-Grav | 92 | |
| Surfactants, MBAS LCS for sample(s) 01-04 (WG199172-2) | | |
| Surfactants, MBAS | 102 | |
| Nitrogen, Ammonia SPIKE for sample(s) 01-04 (L0503621-01, WG199511-3) | | |
| Nitrogen, Ammonia | 102 | |
| Nitrogen, Nitrate SPIKE for sample(s) 01-04 (L0503882-03, WG199019-3) | | |
| Nitrogen, Nitrate | 98 | 83-120 |
| Nitrogen, Nitrate/Nitrite SPIKE for sample(s) 01-04 (L0503882-03, WG199071-3) | | |
| Nitrogen, Nitrate/Nitrite | 98 | |
| Nitrogen, Total Kjeldahl SPIKE for sample(s) 01-04 (L0504003-01, WG199512-3) | | |
| Nitrogen, Total Kjeldahl | 101 | |
| Oil & Grease, Hem-Grav SPIKE for sample(s) 01-04 (L0503471-02, WG199162-3) | | |
| Oil & Grease, Hem-Grav | 97 | |
| Surfactants, MBAS SPIKE for sample(s) 01-04 (L0503882-03, WG199172-3) | | |
| Surfactants, MBAS | 120 | |

**ALPHA ANALYTICAL LABORATORIES**
**QUALITY ASSURANCE BATCH LCS/LCSD ANALYSIS**

**Laboratory Job Number: L0503882**

| Parameter | LCS % | LCSD % | RPD | RPD Limit | QC Limits |
|---|---|---|---|---|---|
| Total Metals by MCP 6000/7000 series for sample(s) 01-04 (WG199316-2, WG199316-3) | | | | | |
| Arsenic, Total | 105 | 103 | 2 | 20 | 75-125 |
| Barium, Total | 105 | 100 | 5 | 20 | 75-125 |
| Cadmium, Total | 109 | 107 | 2 | 20 | 75-125 |
| Chromium, Total | 100 | 100 | 0 | 20 | 75-125 |
| Copper, Total | 104 | 104 | 0 | 20 | 75-125 |
| Iron, Total | 99 | 97 | 2 | 20 | 75-125 |
| Lead, Total | 108 | 106 | 2 | 20 | 75-125 |
| Manganese, Total | 104 | 102 | 2 | 20 | 75-125 |
| Selenium, Total | 108 | 108 | 0 | 20 | 75-125 |
| Silver, Total | 100 | 98 | 2 | 20 | 75-125 |
| Zinc, Total | 104 | 102 | 2 | 20 | 75-125 |
| Total Metals by MCP 6000/7000 series for sample(s) 01-04 (WG199218-2, WG199218-3) | | | | | |
| Mercury, Total | 96 | 98 | 2 | 20 | 75-125 |
| Volatile Organics by MCP 8260B for sample(s) 01-04 (WG199222-4, WG199222-5) | | | | | |
| Methylene chloride | 103 | 103 | 0 | 25 | 70-130 |
| 1,1-Dichloroethane | 90 | 93 | 3 | 25 | 70-130 |
| Chloroform | 108 | 108 | 0 | 25 | 70-130 |
| Carbon tetrachloride | 120 | 116 | 3 | 25 | 70-130 |
| 1,2-Dichloropropane | 100 | 100 | 0 | 25 | 70-130 |
| Dibromochloromethane | 94 | 93 | 1 | 25 | 70-130 |
| 1,1,2-Trichloroethane | 89 | 92 | 3 | 25 | 70-130 |
| Tetrachloroethene | 106 | 105 | 1 | 25 | 70-130 |
| Chlorobenzene | 100 | 101 | 1 | 25 | 70-130 |
| Trichlorofluoromethane | 115 | 114 | 1 | 25 | 70-130 |
| 1,2-Dichloroethane | 106 | 106 | 0 | 25 | 70-130 |
| 1,1,1-Trichloroethane | 115 | 115 | 0 | 25 | 70-130 |
| Bromodichloromethane | 100 | 97 | 3 | 25 | 70-130 |
| trans-1,3-Dichloropropene | 91 | 89 | 2 | 25 | 70-130 |
| cis-1,3-Dichloropropene | 94 | 96 | 2 | 25 | 70-130 |
| 1,1-Dichloropropene | 110 | 108 | 2 | 25 | 70-130 |
| Bromoform | 97 | 94 | 3 | 50 | 70-130 |
| 1,1,2,2-Tetrachloroethane | 96 | 93 | 3 | 25 | 70-130 |
| Benzene | 107 | 107 | 0 | 25 | 70-130 |
| Toluene | 100 | 100 | 0 | 25 | 70-130 |
| Ethylbenzene | 103 | 101 | 2 | 25 | 70-130 |
| Chloromethane | 108 | 103 | 5 | 50 | 70-130 |
| Bromomethane | 98 | 97 | 1 | 50 | 70-130 |
| Vinyl chloride | 116 | 113 | 3 | 25 | 70-130 |
| Chloroethane | 100 | 103 | 3 | 25 | 70-130 |
| 1,1-Dichloroethene | 110 | 107 | 3 | 25 | 70-130 |
| trans-1,2-Dichloroethene | 108 | 106 | 2 | 25 | 70-130 |
| Trichloroethene | 104 | 104 | 0 | 25 | 70-130 |
| 1,2-Dichlorobenzene | 104 | 100 | 4 | 25 | 70-130 |
| 1,3-Dichlorobenzene | 107 | 103 | 4 | 25 | 70-130 |
| 1,4-Dichlorobenzene | 103 | 101 | 2 | 25 | 70-130 |
| Methyl tert butyl ether | 87 | 88 | 1 | 25 | 70-130 |

**Laboratory Job Number: L0503882**

**Continued**

| Parameter | LCS % | LCSD % | RPD | RPD Limit | QC Limits |
|---|---|---|---|---|---|
| Volatile Organics by MCP 8260B for sample(s) 01-04 (WG199222-4, WG199222-5) | | | | | |
| p/m-Xylene | 101 | 99 | 2 | 25 | 70-130 |
| o-Xylene | 104 | 102 | 2 | 25 | 70-130 |
| cis-1,2-Dichloroethene | 106 | 104 | 2 | 25 | 70-130 |
| Dibromomethane | 99 | 101 | 2 | 25 | 70-130 |
| 1,2,3-Trichloropropane | 101 | 99 | 2 | 25 | 70-130 |
| Styrene | 102 | 101 | 1 | 25 | 70-130 |
| Dichlorodifluoromethane | 93 | 92 | 1 | 50 | 70-130 |
| Acetone | 92 | 89 | 3 | 50 | 70-130 |
| Carbon disulfide | 106 | 104 | 2 | 25 | 70-130 |
| 2-Butanone | 81 | 80 | 1 | 50 | 70-130 |
| 4-Methyl-2-pentanone | 83 | 78 | 6 | 50 | 70-130 |
| 2-Hexanone | 97 | 94 | 3 | 50 | 70-130 |
| Bromochloromethane | 110 | 107 | 3 | 25 | 70-130 |
| Tetrahydrofuran | 86 | 87 | 1 | 25 | 70-130 |
| 2,2-Dichloropropane | 90 | 95 | 5 | 25 | 70-130 |
| 1,2-Dibromoethane | 95 | 94 | 1 | 25 | 70-130 |
| 1,3-Dichloropropane | 88 | 92 | 4 | 25 | 70-130 |
| 1,1,1,2-Tetrachloroethane | 102 | 100 | 2 | 25 | 70-130 |
| Bromobenzene | 115 | 110 | 4 | 25 | 70-130 |
| n-Butylbenzene | 104 | 98 | 6 | 25 | 70-130 |
| sec-Butylbenzene | 104 | 96 | 8 | 25 | 70-130 |
| tert-Butylbenzene | 102 | 101 | 1 | 25 | 70-130 |
| o-Chlorotoluene | 105 | 101 | 4 | 25 | 70-130 |
| p-Chlorotoluene | 104 | 99 | 5 | 25 | 70-130 |
| 1,2-Dibromo-3-chloropropane | 86 | 93 | 8 | 50 | 70-130 |
| Hexachlorobutadiene | 100 | 101 | 1 | 25 | 70-130 |
| Isopropylbenzene | 105 | 102 | 3 | 25 | 70-130 |
| p-Isopropyltoluene | 105 | 99 | 6 | 25 | 70-130 |
| Naphthalene | 98 | 100 | 2 | 25 | 70-130 |
| n-Propylbenzene | 103 | 100 | 3 | 25 | 70-130 |
| 1,2,3-Trichlorobenzene | 107 | 107 | 0 | 25 | 70-130 |
| 1,2,4-Trichlorobenzene | 108 | 105 | 3 | 25 | 70-130 |
| 1,3,5-Trimethylbenzene | 104 | 101 | 3 | 25 | 70-130 |
| 1,2,4-Trimethylbenzene | 104 | 99 | 5 | 25 | 70-130 |
| Ethyl ether | 94 | 93 | 1 | 25 | 70-130 |
| Isopropyl Ether | 94 | 95 | 1 | 25 | 70-130 |
| Ethyl-Tert-Butyl-Ether | 90 | 91 | 1 | 25 | 70-130 |
| Tertiary-Amyl Methyl Ether | 88 | 89 | 1 | 25 | 70-130 |
| 1,4-Dioxane | 82 | 84 | 2 | 50 | 70-130 |
| Surrogate(s) | | | | | |
| 1,2-Dichloroethane-d4 | 103 | 100 | 3 | | 70-130 |
| Toluene-d8 | 100 | 99 | 1 | | 70-130 |
| 4-Bromofluorobenzene | 103 | 100 | 3 | | 70-130 |
| Dibromofluoromethane | 100 | 100 | 0 | | 70-130 |

**Laboratory Job Number: L0503882**

**Continued**

| Parameter | LCS % | LCSD % | RPD | RPD Limit | QC Limits |
|---|---|---|---|---|---|
| Polychlorinated Biphenyls by MCP 8082 for sample(s) 01-04 (WG199233-2, WG199233-3) | | | | | |
| Aroclor 1242/1016 | 62 | 76 | 20 | 20 | 40-140 |
| Aroclor 1260 | 82 | 84 | 3 | 20 | 40-140 |
| Surrogate(s) | | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 58 | 63 | 8 | | 30-150 |
| 2,4,5,6-Tetrachloro-m-xylene | 58 | 64 | 10 | | 30-150 |
| Decachlorobiphenyl | 45 | 33 | 31 | | 30-150 |
| Decachlorobiphenyl | 45 | 30 | 40 | | 30-150 |
| Organochlorine Pesticides by MCP 8081A for sample(s) 01-04 (WG199173-2, WG199173-3) | | | | | |
| Delta-BHC | 61 | 60 | 2 | 20 | 30-150 |
| Lindane | 71 | 66 | 7 | 20 | 30-150 |
| Alpha-BHC | 70 | 64 | 9 | 20 | 30-150 |
| Beta-BHC | 67 | 60 | 10 | 20 | 30-150 |
| Heptachlor | 67 | 63 | 6 | 20 | 30-150 |
| Aldrin | 61 | 58 | 4 | 20 | 30-150 |
| Heptachlor epoxide | 70 | 68 | 3 | 20 | 30-150 |
| Endrin | 89 | 88 | 1 | 20 | 30-150 |
| Endrin ketone | 78 | 78 | 0 | 20 | 30-150 |
| Dieldrin | 74 | 72 | 2 | 20 | 30-150 |
| 4,4'-DDE | 74 | 72 | 3 | 20 | 30-150 |
| 4,4'-DDD | 87 | 85 | 3 | 20 | 30-150 |
| 4,4'-DDT | 81 | 78 | 3 | 20 | 30-150 |
| Endosulfan I | 68 | 67 | 2 | 20 | 30-150 |
| Endosulfan II | 74 | 72 | 2 | 20 | 30-150 |
| Endosulfan sulfate | 71 | 72 | 2 | 20 | 30-150 |
| Methoxychlor | 89 | 84 | 6 | 20 | 30-150 |
| Hexachlorobenzene | 54 | 49 | 10 | 20 | 30-150 |
| Surrogate(s) | | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 59 | 59 | 0 | | 30-150 |
| 2,4,5,6-Tetrachloro-m-xylene | 59 | 57 | 3 | | 30-150 |
| Decachlorobiphenyl | 56 | 52 | 7 | | 30-150 |
| Decachlorobiphenyl | 56 | 49 | 13 | | 30-150 |

**ALPHA ANALYTICAL LABORATORIES**
**QUALITY ASSURANCE BATCH BLANK ANALYSIS**

**Laboratory Job Number: L0503882**

| PARAMETER | RESULT | UNITS | RDL | REF | METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|---|
| Blank Analysis for sample(s) 01-04 (WG199511-1) | | | | | | | | |
| Nitrogen, Ammonia | ND | mg/l | 0.075 | 30 | 4500NH3-BH | 0418 19:00 | 0419 11:44 | AT |
| Blank Analysis for sample(s) 01-04 (WG199019-2) | | | | | | | | |
| Nitrogen, Nitrate | ND | mg/l | 0.10 | 30 | 4500NO3-F | | 0413 19:30 | DD |
| Blank Analysis for sample(s) 01-04 (WG199071-2) | | | | | | | | |
| Nitrogen, Nitrate/Nitrite | ND | mg/l | 0.10 | 30 | 4500NO3-F | | 0413 19:30 | DD |
| Blank Analysis for sample(s) 01-04 (WG199512-1) | | | | | | | | |
| Nitrogen, Total Kjeldahl | ND | mg/l | 0.10 | 30 | 4500N-C | 0418 17:30 | 0419 11:08 | AT |
| Blank Analysis for sample(s) 01-04 (WG199162-1) | | | | | | | | |
| Oil & Grease, Hem-Grav | ND | mg/l | 4.0 | 38 | 1664 | 0414 11:30 | 0415 10:45 | AT |
| Blank Analysis for sample(s) 01-04 (WG199172-1) | | | | | | | | |
| Surfactants, MBAS | ND | mg/l | 0.05 | 30 | 5540C | | 0415 00:40 | HG |
| Blank Analysis for sample(s) 01-04 (WG199316-1) | | | | | | | | |
| Total Metals by MCP 6000/7000 series | | | | 60 | 6010B | | | |
| Arsenic, Total | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 13:26 | MG |
| Barium, Total | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 13:26 | MG |
| Cadmium, Total | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 13:26 | MG |
| Chromium, Total | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 13:26 | MG |
| Copper, Total | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 13:26 | MG |
| Iron, Total | ND | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 13:26 | MG |
| Lead, Total | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 13:26 | MG |
| Manganese, Total | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 13:26 | MG |
| Selenium, Total | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 13:26 | MG |
| Silver, Total | ND | mg/l | 0.007 | 60 | 6010B | 0415 17:00 | 0418 13:26 | MG |
| Zinc, Total | ND | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 13:26 | MG |
| Blank Analysis for sample(s) 01-04 (WG199218-1) | | | | | | | | |
| Total Metals by MCP 6000/7000 series | | | | | | | | |
| Mercury, Total | ND | mg/l | 0.0002 | 64 | 7470A | 0414 18:30 | 0415 13:04 | DM |
| Blank Analysis for sample(s) 01-04 (WG199222-6) | | | | | | | | |
| Volatile Organics by MCP 8260B | | | | 60 | 8260B | | 0415 10:26 | SE |
| Methylene chloride | ND | ug/l | 5.0 | | | | | |
| 1,1-Dichloroethane | ND | ug/l | 0.75 | | | | | |

**Laboratory Job Number: L0503882**

**Continued**

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Blank Analysis for sample(s) 01-04 (WG199222-6) | | | | | | | |
| Volatile Organics by MCP 8260B continued | | | | 60 8260B | | 0415 10:26 SB | |
| Chloroform | ND | ug/l | 0.75 | | | | |
| Carbon tetrachloride | ND | ug/l | 0.50 | | | | |
| 1,2-Dichloropropane | ND | ug/l | 1.8 | | | | |
| Dibromochloromethane | ND | ug/l | 0.50 | | | | |
| 1,1,2-Trichloroethane | ND | ug/l | 0.75 | | | | |
| Tetrachloroethene | ND | ug/l | 0.50 | | | | |
| Chlorobenzene | ND | ug/l | 0.50 | | | | |
| Trichlorofluoromethane | ND | ug/l | 2.5 | | | | |
| 1,2-Dichloroethane | ND | ug/l | 0.50 | | | | |
| 1,1,1-Trichloroethane | ND | ug/l | 0.50 | | | | |
| Bromodichloromethane | ND | ug/l | 0.50 | | | | |
| trans-1,3-Dichloropropene | ND | ug/l | 0.50 | | | | |
| cis-1,3-Dichloropropene | ND | ug/l | 0.50 | | | | |
| 1,1-Dichloropropene | ND | ug/l | 2.5 | | | | |
| Bromoform | ND | ug/l | 2.0 | | | | |
| 1,1,2,2-Tetrachloroethane | ND | ug/l | 0.50 | | | | |
| Benzene | ND | ug/l | 0.50 | | | | |
| Toluene | ND | ug/l | 0.75 | | | | |
| Ethylbenzene | ND | ug/l | 0.50 | | | | |
| Chloromethane | ND | ug/l | 2.5 | | | | |
| Bromomethane | ND | ug/l | 1.0 | | | | |
| Vinyl chloride | ND | ug/l | 1.0 | | | | |
| Chloroethane | ND | ug/l | 1.0 | | | | |
| 1,1-Dichloroethene | ND | ug/l | 0.50 | | | | |
| trans-1,2-Dichloroethene | ND | ug/l | 0.75 | | | | |
| Trichloroethene | ND | ug/l | 0.50 | | | | |
| 1,2-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,3-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,4-Dichlorobenzene | ND | ug/l | 2.5 | | | | |
| Methyl tert butyl ether | ND | ug/l | 1.0 | | | | |
| p/m-Xylene | ND | ug/l | 0.50 | | | | |
| o-Xylene | ND | ug/l | 0.50 | | | | |
| cis-1,2-Dichloroethene | ND | ug/l | 0.50 | | | | |
| Dibromomethane | ND | ug/l | 5.0 | | | | |
| 1,2,3-Trichloropropane | ND | ug/l | 5.0 | | | | |
| Styrene | ND | ug/l | 0.50 | | | | |
| Dichlorodifluoromethane | ND | ug/l | 5.0 | | | | |
| Acetone | ND | ug/l | 5.0 | | | | |
| Carbon disulfide | ND | ug/l | 5.0 | | | | |
| 2-Butanone | ND | ug/l | 5.0 | | | | |
| 4-Methyl-2-pentanone | ND | ug/l | 5.0 | | | | |
| 2-Hexanone | ND | ug/l | 5.0 | | | | |
| Bromochloromethane | ND | ug/l | 2.5 | | | | |
| Tetrahydrofuran | ND | ug/l | 10. | | | | |
| 2,2-Dichloropropane | ND | ug/l | 2.5 | | | | |
| 1,2-Dibromoethane | ND | ug/l | 2.0 | | | | |

**ALPHA ANALYTICAL LABORATORIES**
**QUALITY ASSURANCE BATCH BLANK ANALYSIS**

**Laboratory Job Number: L0503882**

**Continued**

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Blank Analysis for sample(s) 01-04 (WG199222-6) | | | | | | | |
| Volatile Organics by MCP 8260B continued | | | | 60 8260B | | 0415 10:26 | SB |
| 1,3-Dichloropropane | ND | ug/l | 2.5 | | | | |
| 1,1,1,2-Tetrachloroethane | ND | ug/l | 0.50 | | | | |
| Bromobenzene | ND | ug/l | 2.5 | | | | |
| n-Butylbenzene | ND | ug/l | 0.50 | | | | |
| sec-Butylbenzene | ND | ug/l | 0.50 | | | | |
| tert-Butylbenzene | ND | ug/l | 2.5 | | | | |
| o-Chlorotoluene | ND | ug/l | 2.5 | | | | |
| p-Chlorotoluene | ND | ug/l | 2.5 | | | | |
| 1,2-Dibromo-3-chloropropane | ND | ug/l | 2.5 | | | | |
| Hexachlorobutadiene | ND | ug/l | 1.0 | | | | |
| Isopropylbenzene | ND | ug/l | 0.50 | | | | |
| p-Isopropyltoluene | ND | ug/l | 0.50 | | | | |
| Naphthalene | ND | ug/l | 2.5 | | | | |
| n-Propylbenzene | ND | ug/l | 0.50 | | | | |
| 1,2,3-Trichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,2,4-Trichlorobenzene | ND | ug/l | 2.5 | | | | |
| 1,3,5-Trimethylbenzene | ND | ug/l | 2.5 | | | | |
| 1,2,4-Trimethylbenzene | ND | ug/l | 2.5 | | | | |
| Ethyl ether | ND | ug/l | 2.5 | | | | |
| Isopropyl Ether | ND | ug/l | 2.0 | | | | |
| Ethyl-Tert-Butyl-Ether | ND | ug/l | 2.0 | | | | |
| Tertiary-Amyl Methyl Ether | ND | ug/l | 2.0 | | | | |
| 1,4-Dioxane | ND | ug/l | 250 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 1,2-Dichloroethane-d4 | 104. | % | 70-130 | | | | |
| Toluene-d8 | 98.0 | % | 70-130 | | | | |
| 4-Bromofluorobenzene | 102. | % | 70-130 | | | | |
| Dibromofluoromethane | 96.0 | % | 70-130 | | | | |
| Blank Analysis for sample(s) 01-04 (WG199233-1) | | | | | | | |
| Polychlorinated Biphenyls by MCP 8082 | | | | 64 8082 | 0414 21:10 | 0415 16:07 | JB |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 74.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 47.0 | % | 30-150 | | | | |
| Blank Analysis for sample(s) 01-04 (WG199233-1) | | | | | | | |
| Polychlorinated Biphenyls by MCP 8082 | | | | 64 8082 | 0414 21:10 | 0415 16:07 | JB |
| Aroclor 1221 | ND | ug/l | 0.250 | | | | |
| Aroclor 1232 | ND | ug/l | 0.250 | | | | |
| Aroclor 1242/1016 | ND | ug/l | 0.250 | | | | |
| Aroclor 1248 | ND | ug/l | 0.250 | | | | |
| Aroclor 1254 | ND | ug/l | 0.250 | | | | |
| Aroclor 1260 | ND | ug/l | 0.250 | | | | |
| Aroclor 1262 | ND | ug/l | 0.250 | | | | |

**Laboratory Job Number: L0503882**

**Continued**

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Blank Analysis for sample(s) 01-04 (WG199233-1) | | | | | | | |
| Polychlorinated Biphenyls by MCP 8082 continued | | | | 64 8082 | 0414 21:10 | 0415 16:07 | JB |
| Aroclor 1268 | ND | ug/l | 0.250 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 73.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 42.0 | % | 30-150 | | | | |
| Blank Analysis for sample(s) 01-04 (WG199173-1) | | | | | | | |
| Organochlorine Pesticides by MCP 8081A | | | | 64 8081A | 0414 17:30 | 0415 17:11 | BW |
| Delta-BHC | ND | ug/l | 0.020 | | | | |
| Lindane | ND | ug/l | 0.020 | | | | |
| Alpha-BHC | ND | ug/l | 0.020 | | | | |
| Beta-BHC | ND | ug/l | 0.020 | | | | |
| Heptachlor | ND | ug/l | 0.020 | | | | |
| Aldrin | ND | ug/l | 0.020 | | | | |
| Heptachlor epoxide | ND | ug/l | 0.020 | | | | |
| Endrin | ND | ug/l | 0.040 | | | | |
| Endrin ketone | ND | ug/l | 0.040 | | | | |
| Dieldrin | ND | ug/l | 0.040 | | | | |
| 4,4'-DDE | ND | ug/l | 0.040 | | | | |
| 4,4'-DDD | ND | ug/l | 0.040 | | | | |
| 4,4'-DDT | ND | ug/l | 0.040 | | | | |
| Endosulfan I | ND | ug/l | 0.020 | | | | |
| Endosulfan II | ND | ug/l | 0.040 | | | | |
| Endosulfan sulfate | ND | ug/l | 0.040 | | | | |
| Methoxychlor | ND | ug/l | 0.200 | | | | |
| Chlordane | ND | ug/l | 0.200 | | | | |
| Hexachlorobenzene | ND | ug/l | 0.200 | | | | |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 56.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 50.0 | % | 30-150 | | | | |
| Blank Analysis for sample(s) 01-04 (WG199173-1) | | | | | | | |
| Organochlorine Pesticides by MCP 8081A | | | | 64 8081A | 0414 17:30 | 0415 17:11 | BW |
| Surrogate(s) | Recovery | | QC Criteria | | | | |
| 2,4,5,6-Tetrachloro-m-xylene | 59.0 | % | 30-150 | | | | |
| Decachlorobiphenyl | 53.0 | % | 30-150 | | | | |

## REFERENCES

30. Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WPCF. 18th Edition. 1992.

38. N-Hexane Extractable Material (HEM) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM) by Extraction and Gravimetry (Oil and Grease and Total Petroleum Hydrocarbons), EPA-821-B-94-004, October 1994.

60. Quality Assurance and Quality Control Requirements and Performance Standards for SW-846 Methods. MADEP BWSC. WSC-CAM-IIA (Revision 4), WSC-CAM-V C (Revision 2), WSC-CAM-IIIA (Revision 5). May 2004.

64. Quality Assurance and Quality Control Requirements and Performance Standards for SW-846 Methods. MADEP BWSC. WSC-CAM-IIA (Revision 4), WSC-CAM-V C (Revision 2), WSC-CAM-IIIA (Revision 5). August 2004.

## GLOSSARY OF TERMS AND SYMBOLS

| | |
|---|---|
| REF | Reference number in which test method may be found. |
| METHOD | Method number by which analysis was performed. |
| ID | Initials of the analyst. |
| ND | Not detected in comparison to the reported detection limit. |
| NI | Not Ignitable. |
| ug/cart | Micrograms per Cartridge. |

## LIMITATION OF LIABILITIES

Alpha Analytical, Inc. performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical, Inc., shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical, Inc. be held liable for any incidental consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical, Inc.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding times and splitting of samples in the field.

**ALPHA ANALYTICAL LABORATORIES**
**LOGIN SPECIFIC INFORMATION**

**Laboratory Job Number: L0503882**

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Were project specific reporting limits specified? YES

## Cooler Information

| Cooler | Custody Seal |
|---|---|
| A | Absent |
| B | Absent |
| C | Absent |

## Container Information

| Container ID | Container Type | Cooler | pH | Temp | Pres | Seal | Analysis |
|---|---|---|---|---|---|---|---|
| L0503882-01A | Vial HCl preserved | C | N/A | 4 C | Y | Absent | MCP-8260-04 |
| L0503882-01B | Vial HCl preserved | C | N/A | 4 C | Y | Absent | MCP-8260-04 |
| L0503882-01C | Plastic 500ml H2SO4 preserved | A | <2 | 2.7 C | Y | Absent | NO3/NO2-4500, TKN-4500 |
| L0503882-01D | Amber 1000ml unpreserved | A | =7 | 2.7 C | Y | Absent | MCP-8082-04 |
| L0503882-01E | Amber 1000ml unpreserved | A | =7 | 2.7 C | Y | Absent | MCP-8082-04 |
| L0503882-01F | Plastic 1000ml H2SO4 preserved | B | <2 | 2.9 C | Y | Absent | NH3-4500 |
| L0503882-01G | Plastic 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MBAS-5540, NO3-4500 |
| L0503882-01H | Amber 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MCP-8081-04 |
| L0503882-01I | Amber 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MCP-8081-04 |
| L0503882-01J | Plastic 250ml HNO3 preserved spl | C | <2 | 4 C | Y | Absent | MCP-7470T, MCP-AG-6010T, MCP-AS-6010T, MCP-BA-6010T, MCP-CD-6010T, MCP-CR-6010T, MCP-CU-6010T, MCP-FE-6010T, MCP-MN-6010T, MCP-PB-6010T, MCP-SE-6010T, MCP-ZN-6010T, PREPT |
| L0503882-01K | Amber 1000ml HCl preserved | C | <2 | 4 C | Y | Absent | OG-1664 |
| L0503882-01L | Amber 1000ml HCl preserved | C | <2 | 4 C | Y | Absent | OG-1664 |
| L0503882-02A | Vial HCl preserved | C | N/A | 4 C | Y | Absent | MCP-8260-04 |
| L0503882-02B | Vial HCl preserved | C | N/A | 4 C | Y | Absent | MCP-8260-04 |
| L0503882-02C | Plastic 500ml H2SO4 preserved | A | <2 | 2.7 C | Y | Absent | NO3/NO2-4500, TKN-4500 |
| L0503882-02D | Amber 1000ml unpreserved | A | =7 | 2.7 C | Y | Absent | MCP-8082-04 |
| L0503882-02E | Amber 1000ml unpreserved | A | =7 | 2.7 C | Y | Absent | MCP-8082-04 |
| L0503882-02F | Plastic 1000ml H2SO4 preserved | B | <2 | 2.9 C | Y | Absent | NH3-4500 |
| L0503882-02G | Plastic 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MBAS-5540, NO3-4500 |
| L0503882-02H | Amber 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MCP-8081-04 |
| L0503882-02I | Amber 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MCP-8081-04 |
| L0503882-02J | Plastic 500ml HNO3 preserved | C | <2 | 4 C | Y | Absent | MCP-7470T, MCP-AG-6010T, MCP-AS-6010T, MCP-BA-6010T, MCP-CD-6010T, MCP-CR-6010T, MCP-CU-6010T, MCP-FE-6010T, MCP-MN-6010T, MCP-PB-6010T, MCP-SE-6010T, MCP-ZN-6010T, PREPT |
| L0503882-02K | Amber 1000ml HCl preserved | C | <2 | 4 C | Y | Absent | OG-1664 |

## Laboratory Job Number: L0503882

### Continued

| Container ID | Container Type | Cooler | pH | Temp | Pres | Seal | Analysis |
|---|---|---|---|---|---|---|---|
| L0503882-02L | Amber 1000ml HCl preserved | C | <2 | 4 C | Y | Absent | OG-1664 |
| L0503882-03A | Vial HCl preserved | C | N/A | 4 C | Y | Absent | MCP-8260-04 |
| L0503882-03B | Vial HCl preserved | C | N/A | 4 C | Y | Absent | MCP-8260-04 |
| L0503882-03C | Plastic 500ml H2SO4 preserved | A | <2 | 2.7 C | Y | Absent | NO3/NO2-4500, TKN-4500 |
| L0503882-03D | Amber 1000ml unpreserved | A | =7 | 2.7 C | Y | Absent | MCP-8082-04 |
| L0503882-03E | Amber 1000ml unpreserved | A | =7 | 2.7 C | Y | Absent | MCP-8082-04 |
| L0503882-03F | Plastic 1000ml H2SO4 preserved | B | <2 | 2.9 C | Y | Absent | NH3-4500 |
| L0503882-03G | Plastic 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MBAS-5540, NO3-4500 |
| L0503882-03H | Amber 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MCP-8081-04 |
| L0503882-03I | Amber 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MCP-8081-04 |
| L0503882-03J | Plastic 500ml HNO3 preserved | C | <2 | 4 C | Y | Absent | MCP-7470T, MCP-AG-6010T, MCP-AS-6010T, MCP-BA-6010T, MCP-CD-6010T, MCP-CR-6010T, MCP-CU-6010T, MCP-FE-6010T, MCP-MN-6010T, MCP-PB-6010T, MCP-SE-6010T, MCP-ZN-6010T, PREPT |
| L0503882-03K | Amber 1000ml HCl preserved | C | <2 | 4 C | Y | Absent | OG-1664 |
| L0503882-03L | Amber 1000ml HCl preserved | C | <2 | 4 C | Y | Absent | OG-1664 |
| L0503882-04A | Vial HCl preserved | C | N/A | 4 C | Y | Absent | MCP-8260-04 |
| L0503882-04B | Vial unpreserved | C | N/A | 4 C | Y | Absent | MCP-8260-04 |
| L0503882-04C | Plastic 500ml H2SO4 preserved | A | <2 | 2.7 C | Y | Absent | NO3/NO2-4500, TKN-4500 |
| L0503882-04D | Amber 1000ml unpreserved | A | =7 | 2.7 C | Y | Absent | MCP-8082-04 |
| L0503882-04E | Amber 1000ml unpreserved | A | =7 | 2.7 C | Y | Absent | MCP-8082-04 |
| L0503882-04F | Plastic 1000ml H2SO4 preserved | B | <2 | 2.9 C | Y | Absent | NH3-4500 |
| L0503882-04G | Plastic 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MBAS-5540, NO3-4500 |
| L0503882-04H | Amber 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MCP-8081-04 |
| L0503882-04I | Amber 1000ml unpreserved | B | =7 | 2.9 C | Y | Absent | MCP-8081-04 |
| L0503882-04J | Plastic 500ml HNO3 preserved | C | <2 | 4 C | Y | Absent | MCP-7470T, MCP-AG-6010T, MCP-AS-6010T, MCP-BA-6010T, MCP-CD-6010T, MCP-CR-6010T, MCP-CU-6010T, MCP-FE-6010T, MCP-MN-6010T, MCP-PB-6010T, MCP-SE-6010T, MCP-ZN-6010T, PREPT |
| L0503882-04K | Amber 1000ml HCl preserved | C | <2 | 4 C | Y | Absent | OG-1664 |
| L0503882-04L | Amber 1000ml HCl preserved | C | <2 | 4 C | Y | Absent | OG-1664 |

## Container Comments

| Container ID | Comments |
|---|---|

# CHAIN OF CUSTODY

PAGE 1 OF 1

Eight Walkup Drive Westborough, MA 01581
TEL: 508-898-9220 FAX: 508-898-9193

Date Rec'd In Lab: 4/13/05

ALPHA Job #: L0503882

**Client Information**

Client: EARTH TECH
Address: 196 Baker Ave
Concord, MA. 01742
Phone: 978-371-4000
Fax: 371-2468
Email:

☐ These samples have been previously analyzed by Alpha

**Project Information**

Project Name: Nantucket WWTP
Project Location: Nantucket, MA
Project #: 79862
Project Manager: Doug DeNatale
ALPHA Quote #:

**Turn-Around Time**

☒ Standard ☐ RUSH (only confirmed if pre-approved!)

Date Due: 4/20/05 Time:

**Report Information - Data Deliverables**

☐ FAX ☐ EMAIL
☒ ADEx ☐ Add'l Deliverables

**Billing Information**

☐ Same as Client info PO #: See Quote-Doug D.

**Regulatory Requirements/Report Limits**

| State /Fed Program | Criteria |
|---|---|
| MA/MCP | GW-1 |

**MCP PRESUMPTIVE CERTAINTY - THESE QUESTIONS MUST BE ANSWERED**

☒ Yes ☐ No Are MCP Analytical Methods Required?
☐ Yes ☒ No Are Drinking Water Samples Submitted?
☒ Yes ☐ No Have you met minimum field QC requirements?

Other Project Specific Requirements/Comments/Detection Limits:
TWO Bottles for TKN, — Run Both
~~Two Bottles for MBAS~~ (PA)

**SAMPLE HANDLING**
*Filtration*
☐ Done
☒ Not needed
☐ Lab to do
*Preservation*
☐ Lab to do
(Please specify below)

| ALPHA Lab ID (Lab Use Only) | Sample ID | Collection Date | Collection Time | Sample Matrix | Sampler's Initials | VOC-8260 | TOTAL LF Metals | Oil + Grease | PCB-8082 | Pest-8081 | TKN, Ammonia | Nitrate/MBAS | TKN, $NO_2$ + $NO_3$ | | | | | Sample Specific Comments | TOTAL # BOTTLES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3882.1 | N-11 | 4/13/05 | 10:00 | GW | PA/ES | X | X | X | X | X | X | X | X | | | | | 12 | 9 H |
| 2 | N-1 | ↓ | 10:40 | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | | | | | 12 | H (PA) |
| 3 | N-10 | ↓ | 11:00 | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | | | | | 12 | H |
| 4 | N-3 | ↓ | 11:35 | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | | | | | 12 | H |
| | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Container Type | V | P | A | A | A | P | P | |
| Preservative | B | C | B | — | — | D | — | W/ICE |

**QUESTIONS ABOVE MUST BE ANSWERED FOR PRESUMPTIVE CERTAINTY**

IS YOUR PROJECT MCP ?

| Relinquished By: | Date/Time | Received By: | Date/Time |
|---|---|---|---|
| [signature] | 4/13 05 | [signature] | 4/13/05 15:35 |

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. All samples submitted are subject to Alpha's Payment Terms. See reverse side.

FORM NO: 01-01

# Instructions

Enter Project Information and especially Alpha Quote #

Indicate additional report requirements other than standard mail.

Indicate where bill is to be sent and include PO number.

Where to send the report. Enter phone, fax and email to info here

List regulatory or reporting limits here. Example MA MCP GW-1

Indicate if Standard or Rush Request. Indicate the Date and Time Due!

MCP PROJECTS
**Questions must be answered for Presumptive Certainty**

List Analyses Requested. Be specific Example: 8260 Low EPH Deluxe

Enter Special Instructions such as specific Detection Limits here!

Indicate if Filtration/Preservation is done or is needed and list in comment section below for each sample.

Indicate Sample ID for each sample, date and time collected, matrix type, sampler and check off for each analysis requested.

Matrix/Source Codes:
I= Influent
E= Effluent
DW = Drinking Water
GW = Ground Water
SW = Surface Water
MW = Monitoring Well
RO= Run-off
L= Lake/Pond River
B= Bottom Sediment
S= Soil
SG= Sludge
O= Oil
W=Wipe
X1(other)_____

Enter Container Type and Preservative Code

| Container Code | Preservative Code |
|---|---|
| P= Plastic | A= None |
| A= Amber glass | B= HCl |
| V= Vial | C= $HNO_3$ |
| G= Glass | D= $H_2SO_4$ |
| B= Bacteria cup | E= NaOH |
| C= Cube | F= MeOH |
| O= Other | G= $NaHSO_4$ |
| E= Encore | H = $Na_2S_2O_3$ |
| D= BOD Bottle | I= Ascorbic Acid |
| | J = $NH_4Cl$ |
| | K= Zn Acetate |
| | L= $NH_4Cl$ Phosphate |
| | O= Other |

Signatures, Date & Time when relinquishing or receiving.

**Payment Terms:** By signing this Chain of Custody, Customer hereby authorizes Alpha Analytical to perform all analyses requested. Billing will be in accordance with the Alpha analytical Standard Price Schedule unless quoted separately. Alpha Analytical standard terms of payment are net thirty (30) days from the date of invoice. Interest shall accrue at the rate of one and one half percent (1.5%) per month, or at the maximum rate allowed by law, after 30 days. Any deviation in payment terms must be agreed to in writing. In the event that legal or other action is required to collect unpaid balances or invoices, Customer agrees to pay all costs of collection, including reasonable attorneys' fees, which may be incurred by Alpha Analytical.

**ALPHA ANALYTICAL LABORATORIES**

**Eight Walkup Drive**
**Westborough, Massachusetts 01581-1019**
**(508) 898-9220 www.alphalab.com**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**CERTIFICATE OF ANALYSIS**

**Client:** Earth Tech

**Address:** 196 Baker Avenue

Concord, MA 01742

**Attn:** Mr. Doug DeNatale

**Project Number:** 79862

**Site:** NANTUCKET WWTP

**Laboratory Job Number:** L0503879

**Date Received:** 13-APR-2005

**Date Reported:** 20-APR-2005

**Delivery Method:** Client

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**The following questions pertain only to MCP Analytical Methods**

**An affirmative response to questions A,B,C & D is required for "Presumptive Certainty" status**

A. Were all samples received by the laboratory in a condition consistent with those described on their Chain-of-Custody documentation for the data set? YES

B. Were all QA/QC procedures required for the specified analytical method(s) included in this report followed, including the requirement to note and discuss in a narrative QC data that did not meet appropriate performance standards or guidelines? YES

C. Does the analytical data included in this report meet all the requirements for "Presumptive Certainty", as described in section 2.0 of the MADEP document CAM VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data"? YES

D. **VPH and EPH methods only:** Was the VPH or EPH method run without significant modifications, as specified in Section 11.3? NA

**A response to questions E and F is required for "Presumptive Certainty" status**

E. Were all QC performance standards and recommendations for the specified method(s) achieved? YES

F. Were results for all analyte-list compounds/elements for the specified method(s) reported? NO

Any answers of NO to the above questions are addressed in the case narrative.

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I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

---

Authorized by: James Todaro
This document electronically signed

**Laboratory Job Number:** L0503879
**Date Reported:** 20-APR-2005

| ALPHA SAMPLE NUMBER | CLIENT IDENTIFICATION | SAMPLE LOCATION |
|---|---|---|
| L0503879-01 | N-11 | NANTUCKET, MA |
| L0503879-02 | N-1 | NANTUCKET, MA |
| L0503879-03 | N-10 | NANTUCKET, MA |
| L0503879-04 | N-3 | NANTUCKET, MA |
| L0503879-05 | N-3 COLI | NANTUCKET, MA |
| L0503879-06 | N-10 COLI | NANTUCKET, MA |
| L0503879-07 | N-1 COLI | NANTUCKET, MA |
| L0503879-08 | N-11 COLI | NANTUCKET, MA |

**ALPHA ANALYTICAL LABORATORIES**
**NARRATIVE REPORT**

**Laboratory Job Number: L0503879**

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MCP Related Narratives

Report Submission

In reference to question F, the samples were analyzed only for the compounds specified on the chain of custody.

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503879-01
N-11
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 10:00
**Date Received :** 13-APR-2005
**Date Reported :** 20-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 1-Plastic

| PARAMETER | RESULT | UNITS | RDL | REF | METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|---|
| Solids, Total Dissolved | 55. | mg/l | 10. | 30 | 2540C | | 0419 11:30 | ST |
| Chloride | 21. | mg/l | 1.0 | 1 | 9251 | | 0414 23:57 | DD |
| Fluoride | 0.44 | mg/l | 0.20 | 30 | 4500F-BC | 0420 08:30 | 0420 14:00 | ST |
| Nitrogen, Nitrate | 0.40 | mg/l | 0.10 | 30 | 4500NO3-F | | 0413 20:06 | DD |
| Sulfate | ND | mg/l | 10. | 1 | 9038 | 0415 18:55 | 0415 18:55 | JT |
| Surfactants, MBAS | ND | mg/l | 0.05 | 30 | 5540C | | 0415 00:40 | HG |
| Dissolved Metals by MCP 6000/7000 series | | | | 60 | 6010B | | | |
| Arsenic, Dissolved | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 15:44 | RW |
| Barium, Dissolved | 0.01 | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:44 | RW |
| Cadmium, Dissolved | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 15:44 | RW |
| Chromium, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:44 | RW |
| Copper, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:44 | RW |
| Iron, Dissolved | ND | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0419 08:34 | RW |
| Lead, Dissolved | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 15:44 | RW |
| Manganese, Dissolved | 0.04 | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:44 | RW |
| Mercury, Dissolved | ND | mg/l | 0.0002 | 64 | 7470A | 0414 18:30 | 0415 12:20 | DM |
| Selenium, Dissolved | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 15:44 | RW |
| Silver, Dissolved | ND | mg/l | 0.007 | 60 | 6010B | 0415 17:00 | 0418 15:44 | RW |
| Zinc, Dissolved | ND | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 15:44 | RW |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503879-02
N-1
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 10:40
**Date Received :** 13-APR-2005
**Date Reported :** 20-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 1-Plastic

| PARAMETER | RESULT | UNITS | RDL | REF | METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|---|
| Solids, Total Dissolved | 340 | mg/l | 10. | 30 | 2540C | | 0419 11:30 | ST |
| Chloride | 100 | mg/l | 5.0 | 1 | 9251 | | 0414 23:58 | DD |
| Fluoride | 0.25 | mg/l | 0.20 | 30 | 4500F-BC | 0420 08:30 | 0420 14:00 | ST |
| Nitrogen, Nitrate | ND | mg/l | 0.10 | 30 | 4500NO3-F | | 0413 20:07 | DD |
| Sulfate | 91. | mg/l | 50. | 1 | 9038 | 0415 18:55 | 0415 18:55 | JT |
| Surfactants, MBAS | 0.10 | mg/l | 0.05 | 30 | 5540C | | 0415 00:40 | HG |
| Dissolved Metals by MCP 6000/7000 series | | | | 60 | 6010B | | | |
| Arsenic, Dissolved | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 15:47 | RW |
| Barium, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:47 | RW |
| Cadmium, Dissolved | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 15:47 | RW |
| Chromium, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:47 | RW |
| Copper, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:47 | RW |
| Iron, Dissolved | 12. | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 15:47 | RW |
| Lead, Dissolved | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 15:47 | RW |
| Manganese, Dissolved | 0.50 | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:47 | RW |
| Mercury, Dissolved | ND | mg/l | 0.0002 | 64 | 7470A | 0414 18:30 | 0415 12:22 | DM |
| Selenium, Dissolved | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 15:47 | RW |
| Silver, Dissolved | ND | mg/l | 0.007 | 60 | 6010B | 0415 17:00 | 0418 15:47 | RW |
| Zinc, Dissolved | ND | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 15:47 | RW |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503879-03
N-10
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 11:00
**Date Received :** 13-APR-2005
**Date Reported :** 20-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 1-Plastic

| PARAMETER | RESULT | UNITS | RDL | REF | METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|---|
| Solids, Total Dissolved | 350 | mg/l | 10. | 30 | 2540C | | 0419 11:30 | ST |
| Chloride | 120 | mg/l | 5.0 | 1 | 9251 | | 0415 00:00 | DD |
| Fluoride | 0.21 | mg/l | 0.20 | 30 | 4500F-BC | 0420 08:30 | 0420 14:00 | ST |
| Nitrogen, Nitrate | ND | mg/l | 0.10 | 30 | 4500NO3-F | | 0413 20:08 | DD |
| Sulfate | 63. | mg/l | 20. | 1 | 9038 | 0415 18:55 | 0415 18:55 | JT |
| Surfactants, MBAS | 0.08 | mg/l | 0.05 | 30 | 5540C | | 0415 00:40 | HG |
| Dissolved Metals by MCP 6000/7000 series | | | | 60 | 6010B | | | |
| Arsenic, Dissolved | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 15:50 | RW |
| Barium, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:50 | RW |
| Cadmium, Dissolved | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 15:50 | RW |
| Chromium, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:50 | RW |
| Copper, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:50 | RW |
| Iron, Dissolved | 4.4 | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 15:50 | RW |
| Lead, Dissolved | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 15:50 | RW |
| Manganese, Dissolved | 0.48 | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:50 | RW |
| Mercury, Dissolved | ND | mg/l | 0.0002 | 64 | 7470A | 0414 18:30 | 0415 12:24 | DM |
| Selenium, Dissolved | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 15:50 | RW |
| Silver, Dissolved | ND | mg/l | 0.007 | 60 | 6010B | 0415 17:00 | 0418 15:50 | RW |
| Zinc, Dissolved | ND | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 15:50 | RW |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503879-04
N-3
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 11:35
**Date Received :** 13-APR-2005
**Date Reported :** 20-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 1-Plastic

| PARAMETER | RESULT | UNITS | RDL | REF | METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|---|
| Solids, Total Dissolved | 300 | mg/l | 10. | 30 | 2540C | | 0419 11:30 | ST |
| Chloride | 91. | mg/l | 1.0 | 1 | 9251 | | 0414 22:51 | DD |
| Fluoride | 0.23 | mg/l | 0.20 | 30 | 4500F-BC | 0420 08:30 | 0420 14:00 | ST |
| Nitrogen, Nitrate | 3.4 | mg/l | 0.10 | 30 | 4500NO3-F | | 0413 20:08 | DD |
| Sulfate | 47. | mg/l | 20. | 1 | 9038 | 0415 18:55 | 0415 18:55 | JT |
| Surfactants, MBAS | 0.06 | mg/l | 0.05 | 30 | 5540C | | 0415 00:40 | HG |
| Dissolved Metals by MCP 6000/7000 series | | | | 60 | 6010B | | | |
| Arsenic, Dissolved | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 16:05 | RW |
| Barium, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 16:05 | RW |
| Cadmium, Dissolved | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 16:05 | RW |
| Chromium, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 16:05 | RW |
| Copper, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 16:05 | RW |
| Iron, Dissolved | 0.06 | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 16:05 | RW |
| Lead, Dissolved | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 16:05 | RW |
| Manganese, Dissolved | 0.27 | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 16:05 | RW |
| Mercury, Dissolved | ND | mg/l | 0.0002 | 64 | 7470A | 0414 18:30 | 0415 12:33 | DM |
| Selenium, Dissolved | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 16:05 | RW |
| Silver, Dissolved | ND | mg/l | 0.007 | 60 | 6010B | 0415 17:00 | 0418 16:05 | RW |
| Zinc, Dissolved | ND | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 16:05 | RW |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503879-05
N-3 COLI
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 11:45
**Date Received :** 13-APR-2005
**Date Reported :** 20-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 2-Bacteria

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Coliform, Total (MPN) | 2.0 | MPN/100ml | 2.0 | 30 9221B | | 0413 17:00 | JT |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503879-06
N-10 COLI
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 11:55
**Date Received :** 13-APR-2005
**Date Reported :** 20-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 2-Bacteria

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Coliform, Total (MPN) | 4.0 | MPN/100ml | 2.0 | 30 9221B | | 0413 17:00 | JT |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503879-07
N-1 COLI
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 12:00
**Date Received :** 13-APR-2005
**Date Reported :** 20-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 2-Bacteria

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Coliform, Total (MPN) | <2 | MPN/100ml | 2 | 30 9221B | | 0413 17:00 | JT |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**CERTIFICATE OF ANALYSIS**

**MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE**

**Laboratory Sample Number:** L0503879-08
N-11 COLI
**Sample Matrix:** WATER

**Date Collected:** 13-APR-2005 12:00
**Date Received :** 13-APR-2005
**Date Reported :** 20-APR-2005

**Condition of Sample:** Satisfactory

**Field Prep:** None

**Number & Type of Containers:** 2-Bacteria

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Coliform, Total (MPN) | <2 | MPN/100ml | 2 | 30 9221B | | 0413 17:00 | JT |

Comments: Complete list of References and Glossary of Terms found in Addendum I

**ALPHA ANALYTICAL LABORATORIES**
**QUALITY ASSURANCE BATCH DUPLICATE ANALYSIS**

**Laboratory Job Number: L0503879**

| Parameter | Value 1 | Value 2 | Units | RPD | RPD Limits |
|---|---|---|---|---|---|
| Solids, Total Dissolved for sample(s) 01-04 (L0503879-04, WG199544-2) | | | | | |
| Solids, Total Dissolved | 300 | 300 | mg/l | 0 | 11 |
| Chloride for sample(s) 01-04 (L0503877-05, WG199159-4) | | | | | |
| Chloride | 150 | 160 | mg/l | 6 | 7 |
| Fluoride for sample(s) 01-04 (L0503879-02, WG199132-4) | | | | | |
| Fluoride | 0.25 | ND | mg/l | NC | |
| Nitrogen, Nitrate for sample(s) 01-04 (L0503880-02, WG199019-4) | | | | | |
| Nitrogen, Nitrate | ND | ND | mg/l | NC | 6 |
| Sulfate for sample(s) 01-04 (L0503928-05, WG199273-4) | | | | | |
| Sulfate | 160 | 160 | mg/l | 0 | 14 |
| Surfactants, MBAS for sample(s) 01-04 (L0503882-02, WG199172-4) | | | | | |
| Surfactants, MBAS | 0.08 | 0.09 | mg/l | 5 | |

**ALPHA ANALYTICAL LABORATORIES**
**QUALITY ASSURANCE BATCH SPIKE ANALYSES**

**Laboratory Job Number: L0503879**

| Parameter | % Recovery | QC Criteria |
|---|---|---|
| Solids, Total Dissolved LCS for sample(s) 01-04 (WG199544-3) | | |
| Solids, Total Dissolved | 95 | 72-121 |
| Chloride LCS for sample(s) 01-04 (WG199159-1) | | |
| Chloride | 93 | 84-110 |
| Fluoride LCS for sample(s) 01-04 (WG199132-2) | | |
| Fluoride | 94 | |
| Nitrogen, Nitrate LCS for sample(s) 01-04 (WG199019-1) | | |
| Nitrogen, Nitrate | 96 | 88-105 |
| Sulfate LCS for sample(s) 01-04 (WG199273-2) | | |
| Sulfate | 100 | 84-108 |
| Surfactants, MBAS LCS for sample(s) 01-04 (WG199172-2) | | |
| Surfactants, MBAS | 102 | |
| Chloride SPIKE for sample(s) 01-04 (L0503815-07, WG199159-3) | | |
| Chloride | 100 | 58-140 |
| Fluoride SPIKE for sample(s) 01-04 (L0503879-03, WG199132-3) | | |
| Fluoride | 85 | |
| Nitrogen, Nitrate SPIKE for sample(s) 01-04 (L0503882-03, WG199019-3) | | |
| Nitrogen, Nitrate | 98 | 83-120 |
| Sulfate SPIKE for sample(s) 01-04 (L0503928-09, WG199273-3) | | |
| Sulfate | 97 | 55-147 |
| Surfactants, MBAS SPIKE for sample(s) 01-04 (L0503882-03, WG199172-3) | | |
| Surfactants, MBAS | 120 | |

**ALPHA ANALYTICAL LABORATORIES**
**QUALITY ASSURANCE BATCH LCS/LCSD ANALYSIS**

**Laboratory Job Number: L0503879**

| Parameter | LCS % | LCSD % | RPD | RPD Limit | QC Limits |
|---|---|---|---|---|---|
| Dissolved Metals by MCP 6000/7000 series for sample(s) 01-04 (WG199323-2, WG199323-3) | | | | | |
| Arsenic, Dissolved | 104 | 104 | 0 | 20 | 75-125 |
| Barium, Dissolved | 100 | 100 | 0 | 20 | 75-125 |
| Cadmium, Dissolved | 104 | 104 | 0 | 20 | 75-125 |
| Chromium, Dissolved | 95 | 100 | 5 | 20 | 75-125 |
| Copper, Dissolved | 100 | 100 | 0 | 20 | 75-125 |
| Iron, Dissolved | 96 | 97 | 1 | 20 | 75-125 |
| Lead, Dissolved | 103 | 103 | 0 | 20 | 75-125 |
| Manganese, Dissolved | 98 | 98 | 0 | 20 | 75-125 |
| Selenium, Dissolved | 112 | 110 | 2 | 20 | 75-125 |
| Silver, Dissolved | 101 | 103 | 2 | 20 | 75-125 |
| Zinc, Dissolved | 100 | 100 | 0 | 20 | 75-125 |
| Dissolved Metals by MCP 6000/7000 series for sample(s) 01-04 (WG199216-2, WG199216-3) | | | | | |
| Mercury, Dissolved | 98 | 94 | 4 | 20 | 75-125 |

**ALPHA ANALYTICAL LABORATORIES**
**QUALITY ASSURANCE BATCH BLANK ANALYSIS**

**Laboratory Job Number: L0503879**

| PARAMETER | RESULT | UNITS | RDL | REF | METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|---|
| Blank Analysis for sample(s) 01-04 (WG199544-1) | | | | | | | | |
| Solids, Total Dissolved | ND | mg/l | 10. | 30 | 2540C | | 0419 11:30 | ST |
| Blank Analysis for sample(s) 01-04 (WG199159-2) | | | | | | | | |
| Chloride | ND | mg/l | 1.0 | 1 | 9251 | | 0414 20:17 | DD |
| Blank Analysis for sample(s) 01-04 (WG199132-1) | | | | | | | | |
| Fluoride | ND | mg/l | 0.20 | 30 | 4500F-BC | 0420 08:30 | 0420 14:00 | ST |
| Blank Analysis for sample(s) 01-04 (WG199019-2) | | | | | | | | |
| Nitrogen, Nitrate | ND | mg/l | 0.10 | 30 | 4500NO3-F | | 0413 19:30 | DD |
| Blank Analysis for sample(s) 01-04 (WG199273-1) | | | | | | | | |
| Sulfate | ND | mg/l | 10. | 1 | 9038 | 0415 18:55 | 0415 18:55 | JT |
| Blank Analysis for sample(s) 01-04 (WG199172-1) | | | | | | | | |
| Surfactants, MBAS | ND | mg/l | 0.05 | 30 | 5540C | | 0415 00:40 | HG |
| Blank Analysis for sample(s) 05-08 (WG199383-1) | | | | | | | | |
| Coliform, Total (MPN) | <2 | MPN/100ml | 2 | 30 | 9221B | | 0413 17:00 | JT |
| Blank Analysis for sample(s) 01-04 (WG199323-1) | | | | | | | | |
| Dissolved Metals by MCP 6000/7000 series | | | | 60 | 6010B | | | |
| Arsenic, Dissolved | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 15:15 | RW |
| Barium, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:15 | RW |
| Cadmium, Dissolved | ND | mg/l | 0.005 | 60 | 6010B | 0415 17:00 | 0418 15:15 | RW |
| Chromium, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:15 | RW |
| Copper, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:15 | RW |
| Iron, Dissolved | ND | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 15:15 | RW |
| Lead, Dissolved | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 15:15 | RW |
| Manganese, Dissolved | ND | mg/l | 0.01 | 60 | 6010B | 0415 17:00 | 0418 15:15 | RW |
| Selenium, Dissolved | ND | mg/l | 0.010 | 60 | 6010B | 0415 17:00 | 0418 15:15 | RW |
| Silver, Dissolved | ND | mg/l | 0.007 | 60 | 6010B | 0415 17:00 | 0418 15:15 | RW |
| Zinc, Dissolved | ND | mg/l | 0.05 | 60 | 6010B | 0415 17:00 | 0418 15:15 | RW |

**ALPHA ANALYTICAL LABORATORIES**
**QUALITY ASSURANCE BATCH BLANK ANALYSIS**

**Laboratory Job Number: L0503879**

**Continued**

| PARAMETER | RESULT | UNITS | RDL | REF METHOD | DATE PREP | DATE ANAL | ID |
|---|---|---|---|---|---|---|---|
| Blank Analysis for sample(s) 01-04 (WG199216-1) | | | | | | | |
| Dissolved Metals by MCP 6000/7000 series | | | | | | | |
| Mercury, Dissolved | ND | mg/l | 0.0002 | 64 7470A | 0414 18:30 | 0415 11:59 | DM |

## REFERENCES

1. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates I - IIIA, 1997.

30. Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WPCF. 18th Edition. 1992.

60. Quality Assurance and Quality Control Requirements and Performance Standards for SW-846 Methods. MADEP BWSC. WSC-CAM-IIA (Revision 4), WSC-CAM-V C (Revision 2), WSC-CAM-IIIA (Revision 5). May 2004.

64. Quality Assurance and Quality Control Requirements and Performance Standards for SW-846 Methods. MADEP BWSC. WSC-CAM-IIA (Revision 4), WSC-CAM-V C (Revision 2), WSC-CAM-IIIA (Revision 5). August 2004.

## GLOSSARY OF TERMS AND SYMBOLS

| | |
|---|---|
| REF | Reference number in which test method may be found. |
| METHOD | Method number by which analysis was performed. |
| ID | Initials of the analyst. |
| ND | Not detected in comparison to the reported detection limit. |
| NI | Not Ignitable. |
| ug/cart | Micrograms per Cartridge. |

## LIMITATION OF LIABILITIES

Alpha Analytical, Inc. performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical, Inc., shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical, Inc. be held liable for any incidental consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical, Inc.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding times and splitting of samples in the field.

**ALPHA ANALYTICAL LABORATORIES**
**LOGIN SPECIFIC INFORMATION**

**Laboratory Job Number: L0503879**

Were project specific reporting limits specified? YES

## Cooler Information

| Cooler | Custody Seal |
|---|---|
| D | Absent |

## Container Information

| Container ID | Container Type | Cooler | pH | Temp | Pres | Seal | Analysis |
|---|---|---|---|---|---|---|---|
| L0503879-01A | Plastic 1000ml unpreserved | D | =7 | 0.6 C | Y | Absent | CL-9251, F-4500, MBAS-5540, NO3-4500, PREPS, SO4-9038, TDS-2540 |
| L0503879-01B | Plastic 250ml HNO3 preserved spl | D | <2 | 0.6 C | Y | Absent | MCP-7470S, MCP-AG-6010S, MCP-AS-6010S, MCP-BA-6010S, MCP-CD-6010S, MCP-CR-6010S, MCP-CU-6010S, MCP-FE-6010S, MCP-MN-6010S, MCP-PB-6010S, MCP-SE-6010S, MCP-ZN-6010S |
| L0503879-02A | Plastic 1000ml unpreserved | D | =7 | 0.6 C | Y | Absent | CL-9251, F-4500, MBAS-5540, NO3-4500, PREPS, SO4-9038, TDS-2540 |
| L0503879-02B | Plastic 250ml HNO3 preserved spl | D | <2 | 0.6 C | Y | Absent | MCP-7470S, MCP-AG-6010S, MCP-AS-6010S, MCP-BA-6010S, MCP-CD-6010S, MCP-CR-6010S, MCP-CU-6010S, MCP-FE-6010S, MCP-MN-6010S, MCP-PB-6010S, MCP-SE-6010S, MCP-ZN-6010S |
| L0503879-03A | Plastic 1000ml unpreserved | D | =7 | 0.6 C | Y | Absent | CL-9251, F-4500, MBAS-5540, NO3-4500, PREPS, SO4-9038, TDS-2540 |
| L0503879-03B | Plastic 250ml HNO3 preserved spl | D | <2 | 0.6 C | Y | Absent | MCP-7470S, MCP-AG-6010S, MCP-AS-6010S, MCP-BA-6010S, MCP-CD-6010S, MCP-CR-6010S, MCP-CU-6010S, MCP-FE-6010S, MCP-MN-6010S, MCP-PB-6010S, MCP-SE-6010S, MCP-ZN-6010S |
| L0503879-04A | Plastic 1000ml unpreserved | D | =7 | 0.6 C | Y | Absent | CL-9251, F-4500, MBAS-5540, NO3-4500, PREPS, SO4-9038, TDS-2540 |

## Laboratory Job Number: L0503879

### Continued

| Container ID | Container Type | Cooler | pH | Temp | Pres | Seal | Analysis |
|---|---|---|---|---|---|---|---|
| L0503879-04B | Plastic 250ml HNO3 preserved spl | D | <2 | 0.6 C | Y | Absent | MCP-7470S, MCP-AG-6010S, MCP-AS-6010S, MCP-BA-6010S, MCP-CD-6010S, MCP-CR-6010S, MCP-CU-6010S, MCP-FE-6010S, MCP-MN-6010S, MCP-PB-6010S, MCP-SE-6010S, MCP-ZN-6010S |
| L0503879-05A | Bacteria Cup Na2S2O3 preserved | D | N/A | 0.6 C | Y | Absent | T-COLI-MPN |
| L0503879-05B | Bacteria Cup Na2S2O3 preserved | D | N/A | 0.6 C | Y | Absent | T-COLI-MPN |
| L0503879-06A | Bacteria Cup Na2S2O3 preserved | D | N/A | 0.6 C | Y | Absent | T-COLI-MPN |
| L0503879-06B | Bacteria Cup Na2S2O3 preserved | D | N/A | 0.6 C | Y | Absent | T-COLI-MPN |
| L0503879-07A | Bacteria Cup Na2S2O3 preserved | D | N/A | 0.6 C | Y | Absent | T-COLI-MPN |
| L0503879-07B | Bacteria Cup Na2S2O3 preserved | D | N/A | 0.6 C | Y | Absent | T-COLI-MPN |
| L0503879-08A | Bacteria Cup Na2S2O3 preserved | D | N/A | 0.6 C | Y | Absent | T-COLI-MPN |
| L0503879-08B | Bacteria Cup Na2S2O3 preserved | D | N/A | 0.6 C | Y | Absent | T-COLI-MPN |

## Container Comments

| Container ID | Comments |
|---|---|
| L0503879-02A | This container has not been properly returned to CUSTODY! It was last assigned to JTRAN for department CUSTODY on 04/16/05 00:58 . |

# CHAIN OF CUSTODY

PAGE 1 OF 1

Eight Walkup Drive Westborough, MA 01581
TEL: 508-898-9220 FAX: 508-898-9193

Date Rec'd In Lab: 4/13/05

ALPHA Job #: L0503879

**Client Information**

Client: EARTH TECH
Address: 196 Baker Ave
Concord, MA 01742
Phone: 978-371-4000
Fax: 371-2468
Email:
☐ These samples have been previously analyzed by Alpha

**Project Information**

Project Name: Nantucket WWTP
Project Location: Nantucket, MA
Project #: 79862
Project Manager: Doug DeNatale
ALPHA Quote #:

**Turn-Around Time**

☐ Standard ☐ RUSH (only confirmed if pre-approved!)
Date Due: 4/20/05 Time:

**Report Information - Data Deliverables**

☐ FAX ☐ EMAIL
☒ ADEx ☐ Add'l Deliverables

**Billing Information**

☐ Same as Client info PO #:
See Quote Doug D.

**Regulatory Requirements/Report Limits**

| State /Fed Program | Criteria |
|---|---|
| MA/MCP | GW-1 |

**MCP PRESUMPTIVE CERTAINTY - THESE QUESTIONS MUST BE ANSWERED**

☒ Yes ☐ No Are MCP Analytical Methods Required?
☐ Yes ☒ No Are Drinking Water Samples Submitted?
☒ Yes ☐ No Have you met minimum field QC requirements?

Other Project Specific Requirements/Comments/Detection Limits:
Dissolved LF metals need to be filtered

| ALPHA Lab ID (Lab Use Only) | Sample ID | Collection Date | Collection Time | Sample Matrix | Sampler's Initials | F, TDS, MBAS, Cl | NO3 | DISS LF metals | TOTAL Coliform | Sample Specific Comments | TOTAL # BOTTLES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3879-1 | N-11 | 4/13/05 | 10:00 | GW | RJS | X | X | X | | | 1 |
| 2 | N-1 | | 10:40 | | | | | | | | 1 |
| 3 | N-10 | | 11:00 | | | | | | | | 1 |
| 4 | N-3 | | 11:35 | | | | | | | | 1 |
| 5 | N-3 coli | | 11:45 | | | | | X | | | 1 |
| 6 | N-10 coli | | 11:55 | | | | | X | | | 1 |
| 7 | N-1 coli | | 12:00 | | | | | X | | | 1 |
| 8 | N-11 coli | | 12:00 | | | | | X | | | 1 |

SAMPLE HANDLING
Filtration
☐ Done
☐ Not needed
☒ Lab to do
Preservation
☐ Lab to do
(Please specify below)

| Container Type | P → | P |
|---|---|---|
| Preservative | / → | H |

QUESTIONS ABOVE MUST BE ANSWERED FOR PRESUMPTIVE CERTAINTY

IS YOUR PROJECT MCP ?

| Relinquished By: | Date/Time | Received By: | Date/Time |
|---|---|---|---|
| [illegible] | 4/13/05 | [illegible] | 4/13/05 1535 |

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. All samples submitted are subject to Alpha's Payment Terms. See reverse side.

FORM NO: 01-01

# Instructions

Enter Project Information and especially Alpha Quote #

Indicate additional report requirements other than standard mail.

Indicate where bill is to be sent and include PO number.

Where to send the report. Enter phone, fax and email to info here

CHAIN OF CUSTODY PAGE ____ OF ____

ALPHA

Westborough, MA 01581

FAX: 508-898-9193

Client Information

Client:

Fax:

Email:

☐ These samples have been previously analyzed by Alpha

Project Information

Project Name:

Project Location:

Project #:

Project Manager:

ALPHA Quote #:

Turn-Around Time

☐ Standard ☐ RUSH

Date Due: Time:

Report Information - Data Deliverables

☐ FAX ☐ EMAIL

☐ ADEx ☐ Add'l Deliverables

Billing Information

☐ Same as Client info

ALPHA Job #

List regulatory or reporting limits here. Example MA MCP GW-1

Regulatory Requirements/Report Limits

State /Fed Program | Criteria

Indicate if Standard or Rush Request. Indicate the Date and Time Due!

MCP PRESUMPTIVE CERTAINTY - THESE QUESTIONS MUST BE ANSWERED

☐ Yes ☐ No Are MCP Analytical Methods Required?

☐ Yes ☐ No Are Drinking Water Samples Submitted?

☐ Yes ☐ No Have you met minimum field QC requirements?

**MCP PROJECTS**
**Questions must be answered for Presumptive Certainty**

ANALYSIS

List Analyses Requested. Be specific Example: 8260 Low EPH Deluxe

Other Project Specific Requirements/Comments/Detection Limits:

Enter Special Instructions such as specific Detection Limits here!

Indicate Sample ID for each sample, date and time collected, matrix type, sampler and check off for each analysis requested.

Matrix/Source Codes:
I= Influent
E= Effluent
DW = Drinking Water
GW = Ground Water
SW = Surface Water
MW = Monitoring Well
RO= Run-off
L= Lake/Pond River
B= Bottom Sediment
S= Soil
SG= Sludge
O= Oil
W=Wipe
X1(other)_____

| ALPHA Lab ID (Lab Use Only) | Sample ID | Collection Date | Collection Time | Sample Matrix | Sampler's Initials |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

SAMPLE HANDLING

☐ Done

☐ Not needed

☐ Lab to do

Preservation

☐ Lab to do

(Please specify)

Sample Specific Comments

Indicate if Filtration/Preservation is done or is needed and list in comment section below for each sample.

Enter Container Type and Preservative Code

| Container Code | Preservative Code |
|---|---|
| P= Plastic | A= None |
| A= Amber glass | B= HCl |
| V= Vial | C= $HNO_3$ |
| G= Glass | D= $H_2SO_4$ |
| B= Bacteria cup | E= NaOH |
| C= Cube | F= MeOH |
| O= Other | G= $NaHSO_4$ |
| E= Encore | H = $Na_2S_2O_3$ |
| D= BOD Bottle | I= Ascorbic Acid |
| | J = $NH_4Cl$ |
| | K= Zn Acetate |
| | L= $NH_4Cl$ Phosphate |
| | O= Other |

QUESTIONS ABOVE MUST BE ANSWERED FOR PRESUMPTIVE CERTAINTY

IS YOUR PROJECT MCP ?

Container Type

Preservative

| Relinquished By: | Date/Time | Received By: |
|---|---|---|
| | | |
| | | |
| | | |

Signatures, Date & Time when relinquishing or receiving.

**Payment Terms:** By signing this Chain of Custody, Customer hereby authorizes Alpha Analytical to perform all analyses requested. Billing will be in accordance with the Alpha analytical Standard Price Schedule unless quoted separately. Alpha Analytical standard terms of payment are net thirty (30) days from the date of invoice. Interest shall accrue at the rate of one and one half percent (1.5%) per month, or at the maximum rate allowed by law, after 30 days. Any deviation in payment terms must be agreed to in writing. In the event that legal or other action is required to collect unpaid balances or invoices, Customer agrees to pay all costs of collection, including reasonable attorneys' fees, which may be incurred by Alpha Analytical.

# Appendix E. Administrative Consent Order

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
**DEPARTMENT OF ENVIRONMENTAL PROTECTION**
ONE WINTER STREET, BOSTON, MA 02108 617-292-5500

MITT ROMNEY
Governor

KERRY HEALEY
Lieutenant Governor

ELLEN ROY HERZFELDER
Secretary

ROBERT W. GOLLEDGE, Jr.
Commissioner

November 21, 2003

Finn Murphy, Chairman
Board of Selectmen
Town and County of Nantucket
16 Broad Street
Nantucket, MA 02554

Re: Surfside Wastewater Treatment Facility
ACOP-BO-03-1G002
Groundwater Discharge Permit SE#1-200

Dear Finn:

Thank you for forwarding the corrected Exhibit B for the ACOP-BO-03-1G002. It also came to my attention in making this substitution that Exhibit A, your current permit, was inadvertently omitted from our October 30th mailing. Accordingly, I enclose a complete copy of the Order with both Exhibits for your records. Please note that the substitution of Exhibit B does not alter the effective date of the Order of October 30, 2003, so this date should continue to be used for the purposes of ensuring compliance with deadlines established in the Order.

Please do not hesitate to call if you have any questions.

Very truly yours,

Sharon M. Pelosi, Director
Watershed Permitting Program

cc: David Delorenzo, DEP SERO
Alan Slater, DEP Boston
Jeffrey Willet, Nantucket DPW
Tom Parece, EarthTech

This information is available in alternate format. Call Aprel McCabe, ADA Coordinator at 1-617-556-1171. TDD Service - 1-800-298-2207.

DEP on the World Wide Web: http://www.mass.gov/dep
Printed on Recycled Paper

**COMMONWEALTH OF MASSACHUSETTS**
**EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS**
**DEPARTMENT OF ENVIRONMENTAL PROTECTION**

| | | |
|---|---|---|
| IN THE MATTER OF:<br><br>Surfside Wastewater Treatment Facility<br>Town of Nantucket | ) | RE: ADMINISTRATIVE CONSENT ORDER<br>FILE NO. ACOP-BO-03-1G002 |

RECEIVED
OCT 30 2003
Watershed Management

## I. THE PARTIES

1. The Department of Environmental Protection (hereinafter, the "Department") is a duly constituted agency of the Commonwealth of Massachusetts. The Department maintains a primary office at One Winter Street, Boston, Massachusetts 02108, and a regional office located at 20 Riverside Drive, Lakeville, Massachusetts 02347. The Department is empowered to enforce the Massachusetts Clean Water Act (M.G.L. c. 2), §§ 26-53) and regulations issued thereunder, including 314 CMR 5.00 through 12.00. The Department is authorized to assess Civil Administrative Penalties by G.L., C.21A S.16 and regulations promulgated thereunder at 310 C.M.R. 5.00.

2. The Town of Nantucket ("Nantucket") is a body politic and division of the Commonwealth of Massachusetts. It is represented by its Board of Selectmen. Its offices are located at 16 Broad Street, Nantucket, Massachusetts 02554. Nantucket receives and treats sewage from residential and commercial establishments at the Surfside Wastewater Treatment Plant (hereinafter, the Facility).

## II. STATEMENT OF FACT AND LAW

3. Nantucket owns, operates and maintains a sewage treatment facility ("Facility") at South Shore Road, Nantucket, Massachusetts, which was permitted pursuant to 314 CMR 5.00 and Groundwater Discharge Permit SE #1-200 dated March 4, 1992.

4. In 2000, 2001, 2002 and 2003, the Department alleges that Nantucket's Facility exceeded the limits of its existing permit (#1-200) on numerous occasions as more particularly described in the Discharge Monitoring Reports on file with the Department. The Department alleges that Nantucket failed to report these violations to the Department. Although Nantucket has managed to reduce flows in the last twenty-four months through removal of Infiltration/Inflow ("I/I"), the Department alleges that there have still been exceedances of the permitted flow limit. Nantucket disagrees with the Department's allegations in that, based on the permit requirements, Nantucket reported the required flow data in its Monthly Discharge Monitoring

Reports, and has not exceeded the limits of the existing permit. The parties have been involved in a dispute regarding the meaning and interpretation of the existing permit.

5. Nantucket is preparing a Comprehensive Wastewater Management Plan/Environmental Impact Report ("CWMP/EIR").

6. The alleged violations of permit effluent limits and monitoring requirements of permit #1-200, enumerated above, if true, entitle the Department to relief.

7. Without admitting the existence of any violations, but for the purpose of resolving this matter between Nantucket and the Department as expeditiously as possible, Nantucket enters into this Administrative Consent Order with Penalties (hereinafter, Order or Consent Order) with the Department, acknowledges the Department's authority to issue this Order and waives all rights it may have to administrative or judicial review of the issuance of this Order.

## III. ORDER

8. Now therefore, this Order is issued by the Department under the authorities set forth above:

9. Nantucket shall immediately take steps to comply with all of the terms and conditions of Permit #1-200. The Permit is attached as Exhibit A to this Order and its terms and conditions are incorporated by reference herein. Violations of the permit by Nantucket are actionable by the Department under the Administrative Penalty Act or through other independent enforcement actions as set forth in Section IV of this Order. The mutual goal of the parties is to re-write the Permit to meet the 20 year planning period conditions predicted in the CWMP/EIR.

10. Except as authorized by this Order, the Town shall not authorize or allow any new connections to or extensions of its sewer system except those for which the Town Board of Health has found and certified to the Department, or the Department has itself determined, are necessary to abate an imminent hazard to public health or the environment caused by inadequate sewage disposal.

11. No further connections shall be made to the Facility until or unless a new Facility is operational as set forth in Paragraph 12 below except as follows:

    a. Sewer permit applications #:W028741 - "Sturgis Pines Nominee Trust" with a flow of 11,550 gallons per day (gpd) and dated 6/13/02; 205488 - "Cliff Acquisitions Inc." with a flow of 21,810 gpd and dated 7/24/02; W030009 - "Nantucket Public Schools" with a flow of 2,530 and dated 8/16/02 ; W030737 - "Sherburne Commons Inc." with a flow of 16,260 gpd and dated 8/27/02; W032136 - "Nantucket Electric Co." with a flow of 22,550 gpd and dated 11/6/02; W032340 - "Duane Jones" with a flow of 2,200 gpd and dated 11/4/02; W032361 - "Beezer Trust" with a flow of

5,280 gpd and dated 11/27/02; W035152 - "Great Point partners LLC" with a flow of 7,195 gpd and dated 7/28/03; W041324 - "Nantucket Homes for People, Inc." with a flow of 9,240 gpd and dated 8/6/03; and W206432 - "Donald Holdgate" with a flow of 3,960 gpd and dated 9/8/03 will be issued and flows there from connected to the Facility, subject to concurrence from all state and local agencies exercising jurisdiction over the sewer permit applications and formal notice to the Department of such connections when they occur;

b. Within 30 days of the effective date of this Order, the Town shall submit to the Department, for its review and approval, a plan for the establishment and implementation of a sewer bank to allow the town to issue permits for new sewer connections or extensions or authorize increases in flow from existing sewer connections or extensions. The plan for this sewer bank shall include a program to restrict connections to the sewer system as described in paragraph (iv) below, as well as quarterly reporting to the Department, in accordance with the notice provisions of the Order set forth below, of all connections and extensions which withdraw flow from the sewer bank balance based on the method set forth in 314 CMR 7.15. If it is not practicable to calculate sewage flow from any particular parcel in this manner, the Town must state why and may estimate such flow using metered water use for that property. The sewer bank will be apportioned as follows:

i. Initial flow balance of 20,000 gallons per day.

ii. Notwithstanding the sewer bank, upon submission to the Department of a copy of an executed contract with a notice to proceed with a Massachusetts Registered Professional Engineer for the preparation of plans and specifications to upgrade the Facility to Class I discharge standards, as outlined in Paragraph 12 below, the Town may issue sewer permits for the sewage flows originating from the Nantucket Harbor Watershed Overlay District as further described on the maps attached to this Order as Exhibit B. These flows shall be in addition to the sewer bank balance allowed under paragraphs 11(b)(i),(iii) and (iv).

iii. Upon submission to the Department of a copy of an executed construction contract with a notice to proceed with an authorized construction contractor for the construction of a Facility to meet Class I discharge standards, as outlined in Paragraph 12 below, the sewer bank balance established in Paragraph 11.b.i. will be increased by an additional 90,520 gallons per day.

iv. Except as specifically identified and authorized by this Order, no further connections shall be made to the Facility until or unless a new

Facility is operational as set forth in Paragraph 12 below except as follows: The Town shall submit to the Department for its review and approval a program for restricting connections to the sewer system. At a minimum, the program shall provide for the removal of two gallons of infiltration and inflow for each additional gallon of wastewater that will be discharged to the sewer system. Thereafter, the Town shall implement the program as approved by the Department. Proof of removal in a form consistent with standard engineering practices and acceptable to the Department shall be submitted in accordance with the notice provisions of the Order set forth below. Failure to implement the program will be a violation of this Order.

12. Construction Of Upgraded Wastewater Treatment To Meet Class I Discharge Standards Pursuant to 314 CMR 5.00 and 6.00.

a. By 9/30/03, the Town shall submit to the Department and to the MEPA Office ("MEPA") of the Massachusetts Executive Office of Environmental Affairs for review and comment a Draft CWMP/EIR that shall include a recommendation for upgrading wastewater treatment to Class I discharge standards.

b. By 3/30/04, the Town shall submit to the Department and to MEPA for review and approval a Final CWMP/EIR that shall include a recommendation for upgrading wastewater treatment to Class I discharge standards.

c. By 7/1/04, the Town shall commence preparation of plans and specifications for the wastewater treatment facilities identified in the Final CWMP/EIR as approved by the Department and MEPA.

d. By 7/1/05, the Town shall submit to the Department a complete groundwater permit application pursuant to 314 CMR 5.00 for the wastewater treatment facilities identified in the Final CWMP/EIR as approved by the Department and MEPA.

e. By 7/1/05, the Town shall submit to the Department final plans and specifications for the wastewater treatment facilities identified in the Final CWMP/EIR as approved by the Department and MEPA.

f. By 4/1/06, the Town shall commence construction of the wastewater treatment facilities identified in the Final CWMP/EIR as approved by the Department and MEPA.

g. By 4/1/08, the Town shall complete construction of the wastewater treatment facilities identified in the Final CWMP/EIR as approved by the Department and MEPA.

h. By 6/30/08, the Town shall achieve full operation of the wastewater treatment facilities identified in the Final CWMP/EIR as approved by the Department and MEPA in accordance with all applicable regulations and permits.

Failure to construct the wastewater treatment facilities identified in the Final CWMP/EIR as approved by the Department in accordance with the above schedule shall be a violation of this Order.

13. By January 1, 2004, Nantucket shall submit to the Department evidence of the existence of a locally adopted regulation or bylaw designed to minimize the introduction of toxic substances and other pollutants to the Facility and encouraging the reduction of flow to the Facility, together with a program for enforcing these local laws.

14. Failure to complete the Facility by the time specified may shall result in penalties or a modification by the Department to this Order imposing additional terms and conditions necessary to treat the existing flow and to prevent damage to the environment.

15. Should the Department determine that Nantucket is making inadequate progress under the terms of this Consent Order towards the completion of a Facility capable of treating effluent to Class I Standards by April 1, 2008, it may issue an order forbidding further connections to the existing facility and require such other actions as are necessary to insure protection of the ground and surface waters of the Commonwealth.

16. For the purposes of determining compliance with the Consent Order, the Department shall be permitted access to the Property and to any connections thereto as needed for the duration of this Consent Order.

17. This Consent Order does not constitute a permit under 314 CMR 5.00 or 314 CMR 7.00. The Town shall apply for and obtain all permits and approvals required to accomplish the objectives set forth in this Consent Order. Nantucket's failure to identify and obtain needed permits or the failure to obtain outside financial assistance shall not be a basis for extending time periods set forth hereunder or excusing nonperformance unless delay is caused by the Department.

18. Within 30 days of the effective date of this order, Nantucket shall submit a maintenance and monitoring plan to the Department's Southeast Regional Office for review and approval ("Maintenance and Monitoring Plan"). This Plan includes a plan of action for maintaining the Existing System prior to the implementation of an upgraded wastewater treatment facility in accordance with paragraph 12 above. Once approved, the Maintenance and Monitoring Plan will be attached as Appendix B, and the terms and requirements thereof, will be incorporated by reference into this

Consent Order. Violations of said Plan are subject to stipulated penalties in accordance with Paragraph 23 below.

19. Nantucket shall submit quarterly reports to the Department beginning three (3) months after the Effective Date of this Consent Order. The report shall detail the efforts undertaken to achieve compliance with this Consent Order over the prior three (3) month period. Reports shall include: for each separate sewer bank, identification and flow amount of any new connections to the existing Facility, identification of specific locations and efforts to reduce infiltration and inflow to the Facility's sewer system, a written summary of actions taken under Appendix B of this Consent Order, a discussion of impediments Nantucket encountered and progress made towards completing a Class I Facility, and a description of what Nantucket plans to accomplish over the next three (3) month period

20. Prior to the Compliance Date, Nantucket may continue to discharge sewage to the Facility subject to the conditions set forth above.

21. Nantucket shall inform the Department in writing whenever it has reason to believe that any deadlines set forth in this Order will not be met, or permit violations or permit excursions occur, setting forth the reasons for the delay and the length of additional time required to complete the action. By written amendment to this Consent Order, the Department may, in its discretion, extend any time period set forth herein, which extension shall not be unreasonably withheld.

## IV. PENALTY ASSESSMENT

22. For the alleged violations set forth in Section II, Nantucket shall pay a penalty in the amount of twenty thousand dollars ($20,000). In consideration of Nantucket's agreement to abide by the terms and conditions of this order, and most particularly the construction deadlines contained in Section III(12) above, this penalty shall be suspended subject to compliance with this order. The Department shall not seek additional civil administrative penalties for the violations alleged in this Order that occurred before the effective date of this Order. Nantucket reserves its rights to challenge any such future actions by the department.

23. If Nantucket materially fails to comply with any of the actions or deadlines established by this Consent Order or incorporated by reference herein, or otherwise materially violates any of the terms or conditions of this Consent Order, Nantucket agrees to pay a stipulated penalty in the amount of **$1,000** per violation for each day, or any portion thereof, that such violation continues. Per day amounts shall double on the thirtieth (30th) consecutive day of noncompliance, treble on the sixtieth (60th) consecutive day of noncompliance, and quadruple on and thereafter the ninetieth (90th) consecutive day of noncompliance, with the maximum per day penalty not to exceed $25,000.00 per day, per offense. All penalties shall begin to accrue the day after performance is due or the day a material violation occurs, and shall continue to accrue through the final day of the

correction of the violation or completion of the activity. Nantucket reserves its rights to challenge any such future actions by the department.

24. The stipulated penalties set forth herein shall not preclude the Department from electing to pursue alternative remedies or alternative civil penalties which may be available by reason of Nantucket's failure to comply with the requirements of this Consent Order. In the event the Department collects alternative civil administrative penalties, Nantucket shall not be required to pay stipulated penalties pursuant to this Consent Order. Nantucket reserves its rights to challenge any such future actions by the department.

25. All payments of penalties shall be made by certified check, cashier's check or money order, payable to the "Commonwealth of Massachusetts". The name Nantucket, its Federal Employer Identification Number ("FEIN") and the Consent Order file number, **ACOP-BO-03-1G002**, should be clearly printed on the face of the check or money order. All penalty payments shall be sent to the following address:

    Commonwealth of Massachusetts
    Department of Environmental Protection
    P.O. Box 3584
    Boston, MA 02241-3584
    Attn: Director, Watershed Permitting Program

26. Other than as noted above, the Department reserves all of its rights to enforce against violations that occur after the date of this Consent Order through an independent action and Nantucket reserves its rights to challenge any such future actions.

## V. ADDITIONAL PROVISIONS

27. The Department shall have the power to extend or waive any deadline, time period, term, or condition contained herein as the Department, in its sole discretion, may deem fit, provided such extension or waiver shall not be unreasonably withheld, provided also that no extension or waiver will be effective which contravenes any provision of any applicable statute or regulation

28. This Order shall apply to and bind Nantucket and its officers, employees, agents, successors and assigns. Nantucket shall not violate this Order, nor suffer or allow its employees, agents, or contractors to violate this Order.

29. Nothing in this Order shall be construed as, or operate as, barring diminishing, adjudicating, or in any way affecting any legal or equitable right of the Department to issue any future Order with respect to the subject matter covered by this Order, or in any way affecting any other claim, action, or demand which the Department may have with respect thereto.

30. This order does not constitute a permit and is not and shall not be interpreted to be a modification of the existing permit, issued pursuant t0 314 CMR 5.00; nor shall it in any way relieve Nantucket of its obligation to obtain any permits and comply with the requirements of any applicable permits or with any other federal or state law or regulation. Nantucket shall comply with all conditions and effluent limitations of its existing groundwater discharge permit and any modification or renewal thereof.

31. Except where otherwise specified, each submittal required by this Order shall be made to:

Department of Environmental Protection
Division of Water Pollution Control
20 Riverside Drive
Lakeville, Massachusetts 02347
Attention: Jeffrey E. Gould

And

Department of Environmental Protection
Watershed Permitting Program
One Winter Street, Floor 6
Boston, MA 02108
Attn: Alan D. Slater, P.E.

32. This Order is issued on the date it is signed by the Department.

DEPARTMENT OF ENVIRONMENTAL PROTECTION

DATE: 10/30/03 BY _____
Glenn S. Haas, Director
Division of Watershed Management

DATE: 10/22/03 BY: _____

DATE: Oct 22, 03 BY: _____

DATE: 10/22/03 BY: _____

DATE: _____ BY: _____

DATE: _____ BY: _____

For the Nantucket Board of Selectmen

EXHIBIT A

# DISCHARGE PERMIT

Name and Address of Applicant: Nantucket Dept. of Public Works
P.O. Box 239, Nantucket, Mass 02554

Date of Application: 1-3-91

Application/Permit No. 1-200

Date of Issuance: March 4, 1992

Date of Expiration: March 3, 1997

## AUTHORITY FOR ISSUANCE

Pursuant to authority granted by Chapter 21, Sections 26-53 of the Massachusetts General Laws, as amended, the following permit hereby issued to The Nantucket Department of Public Works (hereinafter called "the permittee") authorizing discharges from the Surfside Wastewater Treatment Plant to the ground

such authorization being expressly conditional on compliance by the permittee with all terms and conditions of the permit hereinafter set forth.

This permit shall become effective on the date of the Director's signature and shall expire on March 3, 1997.

Brian Donahoe
Brian Donahoe, Director
Division of Water Pollution Control

March 4, 1992
Date

## I. SPECIAL CONDITIONS

### A. Effluent Limits

The permittee is authorized to discharge into the ground from the groundwater treatment facilities for which this permit is issued a treated effluent whose characteristics, within one month after start-up of the facilities and continuing thereafter, shall not exceed the following values:

| Effluent Characteristics | Discharge Limitations Average | Discharge Limitations Maximum |
|---|---|---|
| Flow, gallons per day | 1,800,000 | 5,800,000 |
| BOD, 5-day, 20°C | 215 mg/l | 230 mg/l |
| Total Suspended Solids | 225 mg/l | 250 mg/l |
| Oils & Grease | 15.0 mg/l | |

a) the pH of the effluent shall not be less than 6.5 nor greater than 8.5 at any time.

b) The discharge of the effluent shall not result in violations of the SA water quality limits established for the surface waters downgradient of the discharge.

c) When the effluent discharged for a period of 90 consecutive days exceeds 80 percent of the permitted flow limitations, the permittee shall submit to the permitting authorities projected loadings and a program for maintaining satisfactory treatment levels consistent with approved water quality management plans.

B. Monitoring and Reporting

1) The permittee shall monitor and record the quality and quantity of effluent prior to discharge to the filter beds according to the following schedule and other provisions.

| Parameter | Minimum Frequency of Analysis | Sample Type |
|---|---|---|
| Flow | Daily | Average-Maximum |
| pH | Weekly | Grab |
| BOD | Weekly | 8-hour composite |
| TSS and Total Solids | Weekly | 8-hour composite |
| Oil & Grease | Weekly | Grab |

2) The permittee shall Monitor, record and report the quality of water in both the Class III compliance wells and the discharge permit wells, previously installed (CB-1, CB-2, CB-3, CB-4; N-3, N-9, N-1, N-10), according to the following schedule and other provisions:

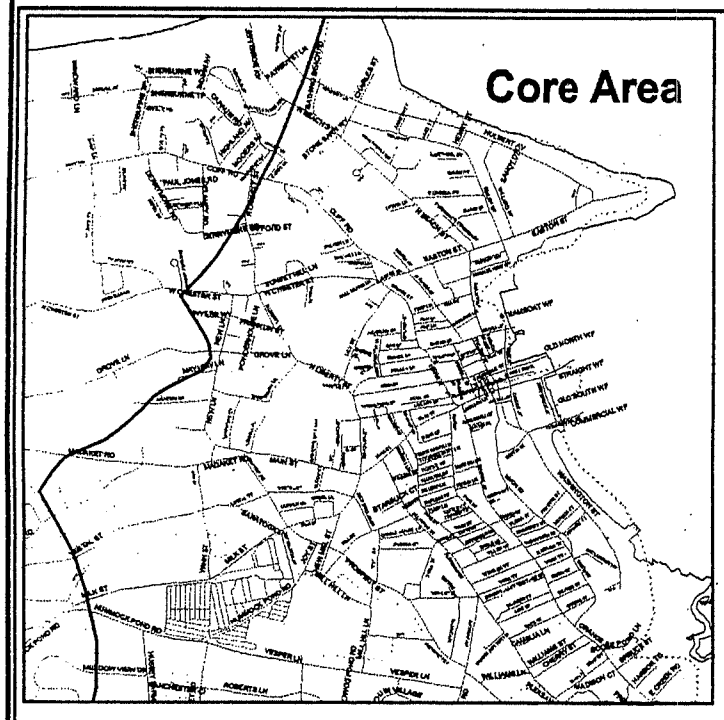
| | |
|---|---|
| Ammonia | 1 x quarterly |
| Surfactants | " |
| Nitrate Nitrogen | " |
| Total Nitrogen | " |
| Total Coliform | " |
| Static Water Level | " |

3) Any grab sample or composite sample required to be taken less frequently than daily shall be taken during the period of Monday through Friday inclusive. Eight hour composites and grab samples shall be taken between 8:00 a.m. and 6:00 p.m. All composite samples shall be taken over the operating day.

The permittee shall submit all reports on an acceptable form, properly filled and signed, on the last day of every month, beginning thirty days after the issuance of this permit, to the Regional Director, Department of Environmental Protection, Southeast Regional Office, Lakeville Hospital, Lakeville, Mass 02346 and to the Director, Department of Environmental Protection, Division of Water Pollution Control, One Winter Street, Boston, MA 02108.

BD/CW/yg
wp8:nantucket.pmt

# Nantucket Harbor Watershed Overlay District




Legend

Town of Nantucket
GIS Mapsheet

1 inch equals 1,300 feet

N

11/20/2003

# TABLE 1
# GROUNDWATER QUALITY SUMMARY
# APRIL 13, 2005 MONITORING
# SURFSIDE WASTEWATER TREATMENT PLANT
# NANTUCKET, MASSACHUSETTS

| Parameter | Units | Reporting Limit | N-1 | N-3R | N-10 | N-11A |
|---|---|---|---|---|---|---|
| pH | Std. Unit | NA | 6.2 | 6.2 | 6.3 | 6.5 |
| Specific Conductance | umho/cm | NA | 670 | 560 | 680 | 130 |
| Surfactants, MBAS | mg/L | 0.05 | 0.10 | 0.06 | 0.08 | ND |
| Total Dissolved Solids | mg/L | 10 | 340 | 300 | 350 | 55 |
| Chloride | mg/L | 1.0, 5.0 | 100 | 91 | 120 | 21 |
| Oil & Grease | mg/L | 4.0 | ND | ND | ND | ND |
| Fluoride | mg/L | 0.20 | 0.25 | 0.23 | 0.21 | 0.44 |
| Sulfate | mg/L | 10., 20., 50. | 91. | 47. | 63. | ND |
| Total Nitrogen | mg/L | NA | 3.0 | 4.29 | 2.2 | 1.32 |
| Total Kjeldahl Nitrogen | mg/L | 0.30 | 3.0 | 0.89 | 2.2 | 0.92 |
| Ammonia-Nitrogen | mg/L | 0.075 | 2.55 | 0.097 | 1.81 | ND |
| Nitrite-Nitrogen | mg/L | NA | ND | ND | ND | ND |
| Nitrate-Nitrogen | mg/L | 0.1 | ND | 3.4 | ND | 0.40 |
| Arsenic, Total | mg/L | .005 | ND | .015 | ND | ND |
| Arsenic, Dissolved | mg/L | .005 | ND | ND | ND | ND |
| Barium, Total | mg/L | .01 | ND | .03 | .01 | .05 |
| Barium, Dissolved | mg/L | .01 | ND | ND | ND | .01 |
| Cadmium, Total | mg/L | .005 | ND | ND | ND | ND |
| Cadmium, Dissolved | mg/L | .005 | ND | ND | ND | ND |
| Chromium, Total | mg/L | .01 | ND | 0.10 | ND | .02 |
| Chromium, Dissolved | mg/L | .01 | ND | ND | ND | ND |
| Copper, Total | mg/L | .01 | .02 | .02 | .01 | ND |
| Copper, Dissolved | mg/L | .01 | ND | ND | ND | ND |
| Iron, Total | mg/L | .05 | 22. | 35. | 8.1 | 9.7 |
| Iron, Dissolved | mg/L | .05 | 12. | .06 | 4.4 | ND |
| Lead, Total | mg/L | .010 | ND | .018 | ND | .011 |
| Lead, Dissolved | mg/L | .010 | ND | ND | ND | ND |
| Manganese, Total | mg/L | .01 | 0.63 | 0.53 | 0.59 | 0.23 |
| Manganese, Dissolved | mg/L | .01 | 0.50 | 0.27 | 0.48 | .04 |
| Mercury, Total | mg/L | .0002 | ND | ND | ND | ND |
| Mercury, Dissolved | mg/L | .0002 | ND | ND | ND | ND |
| Selenium, Total | mg/L | .010 | ND | ND | ND | ND |
| Selenium, Dissolved | mg/L | .010 | ND | ND | ND | ND |
| Silver, Total | mg/L | .007 | ND | ND | ND | ND |
| Silver, Dissolved | mg/L | .007 | ND | ND | ND | ND |
| Zinc, Total | mg/L | .05 | .07 | .09 | .06 | .06 |
| Zinc, Dissolved | mg/L | .05 | ND | ND | ND | ND |
| Total Coliform | Col/100ml | 2 | <2 | 2.0 | 4.0 | <2 |
| Pesticides/PCBs | µg/L | Various | ND | ND | ND | ND |
| VOCs | µg/L | Various | ND | ND | ND | ND |

NA = not applicable
ND = not detected
VOC = Volatile Organic Compounds
µg/L = microgram per liter
µmho/cm = micromho per centimeter
mg/L = milligram per liter
Col/100ml = colonies per 100 ml
pH and Specific Conductance measured in field, April 13, 2005

| Geographic NAD 1927 | X | Y |
|---|---|---|
| WWTF Buildings | -70.1069302 | 41.24474514 |
| Discharge Beds | -70.1074359 | 41.24281374 |

JUNE 2005 Source: USGS quads scanned by MassGIS.

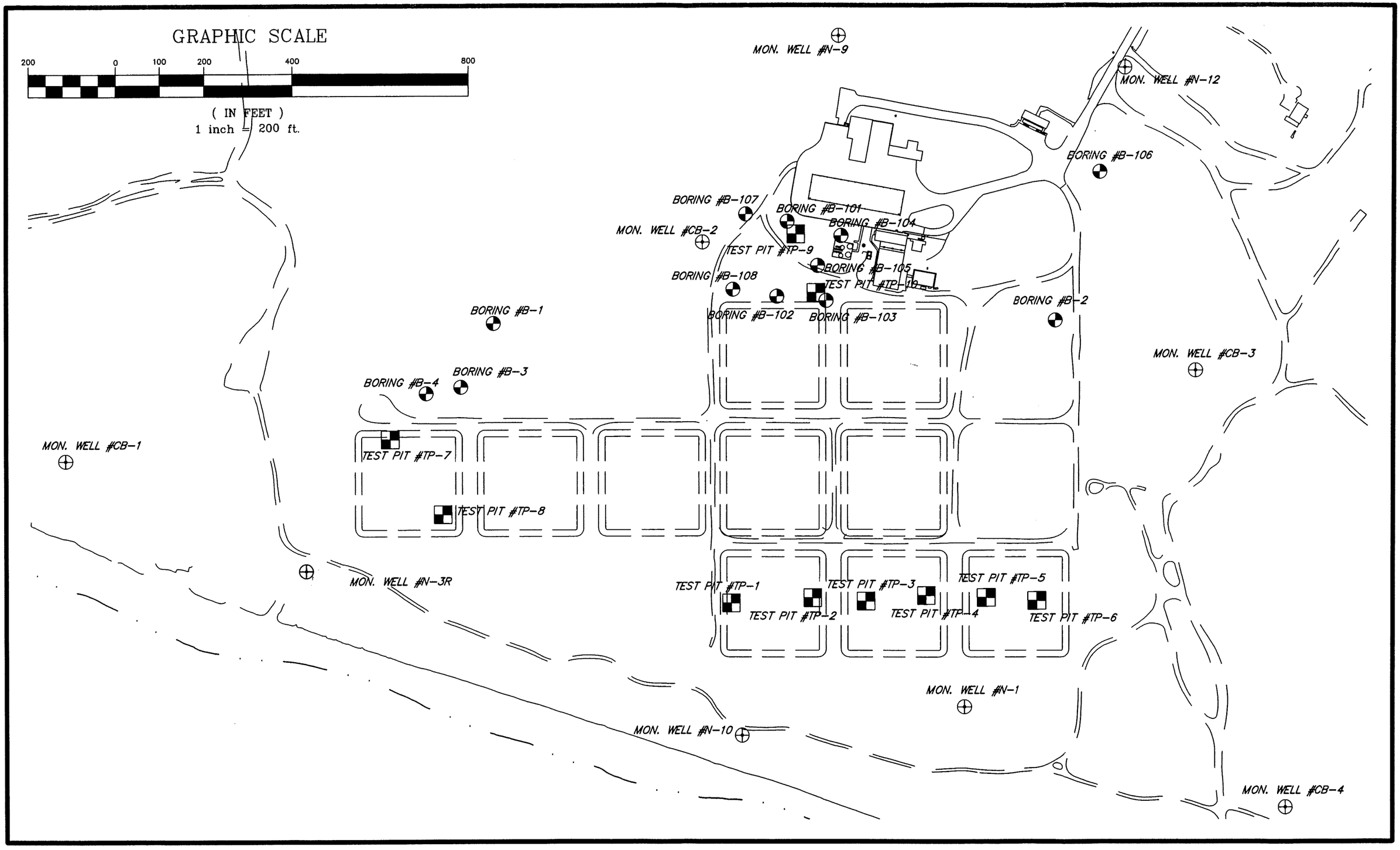
N W E S

SCALE 1:25,000

0 1,000 2,000 Feet

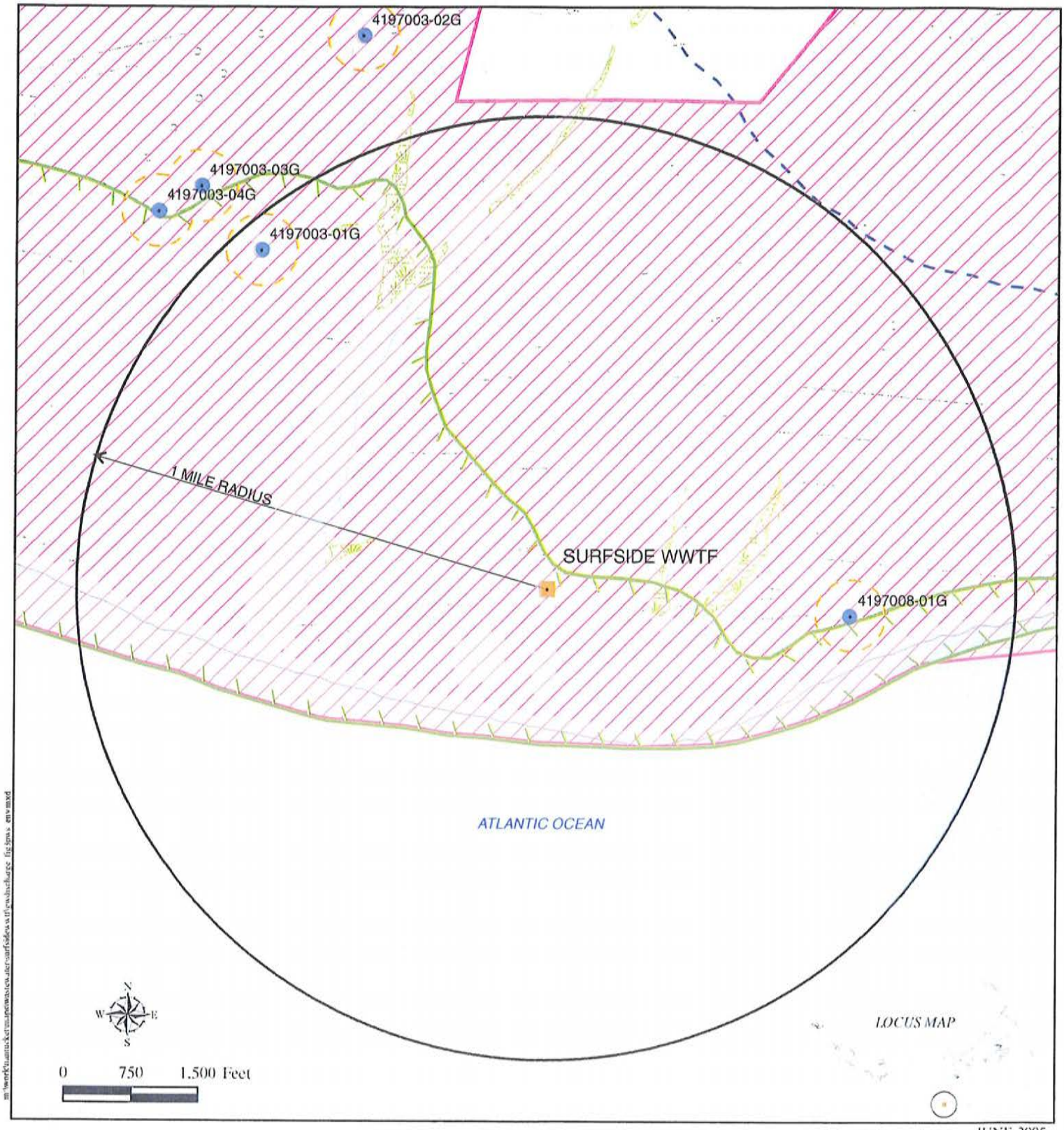
FIGURE 1
SITE LOCUS
SURFSIDE WASTEWATER
TREATMENT FACILITY
NANTUCKET, MASSACHUSETTS

EarthTech




EarthTech
A Tyco International Ltd. Company

FIGURE 2
SITE PLAN AND GROUNDWATER MONITORING WELLS
SURFSIDE WWTF, NANTUCKET, MASS.




JUNE 2005

Legend

- Public Water Supply Well
- NHESP 2003 Massachusetts Certified Vernal Pools
- Surfside WWTF
- 1 mile radius
- Zone I
- Road

Surface Water

- Wetland
- Area of Critical Environmental Concern
- NHESP 2003 Priority Habitats for State-Protected Rare Species
- NHESP 2003 Estimated Habitats for Rare Wildlife: For Use with the MA Wetlands Protection Act Regulations (310 CMR 10)
- Zone II

FIGURE 3
PUBLIC WATER SUPPLY WELLS
AND ENVIRONMENTAL RESOURCES
SURFSIDE WASTEWATER
TREATMENT FACILITY
NANTUCKET, MASSACHUSETTS

EarthTech

JUNE 2005

LEGEND

- Surfside WWTF
- 1/4 Mile Radius around Surfside WWTF
- Private Water Supplies
- Building
- Unpaved Road
- Paved Road

0 150 300 Feet

SCALE 1 INCH = 300 FEET

N

EarthTech

FIGURE 4
PRIVATE WATER SUPPLIES
SURFSIDE WASTEWATER TREATMENT FACILITY
NANTUCKET, MASSACHUSETTS

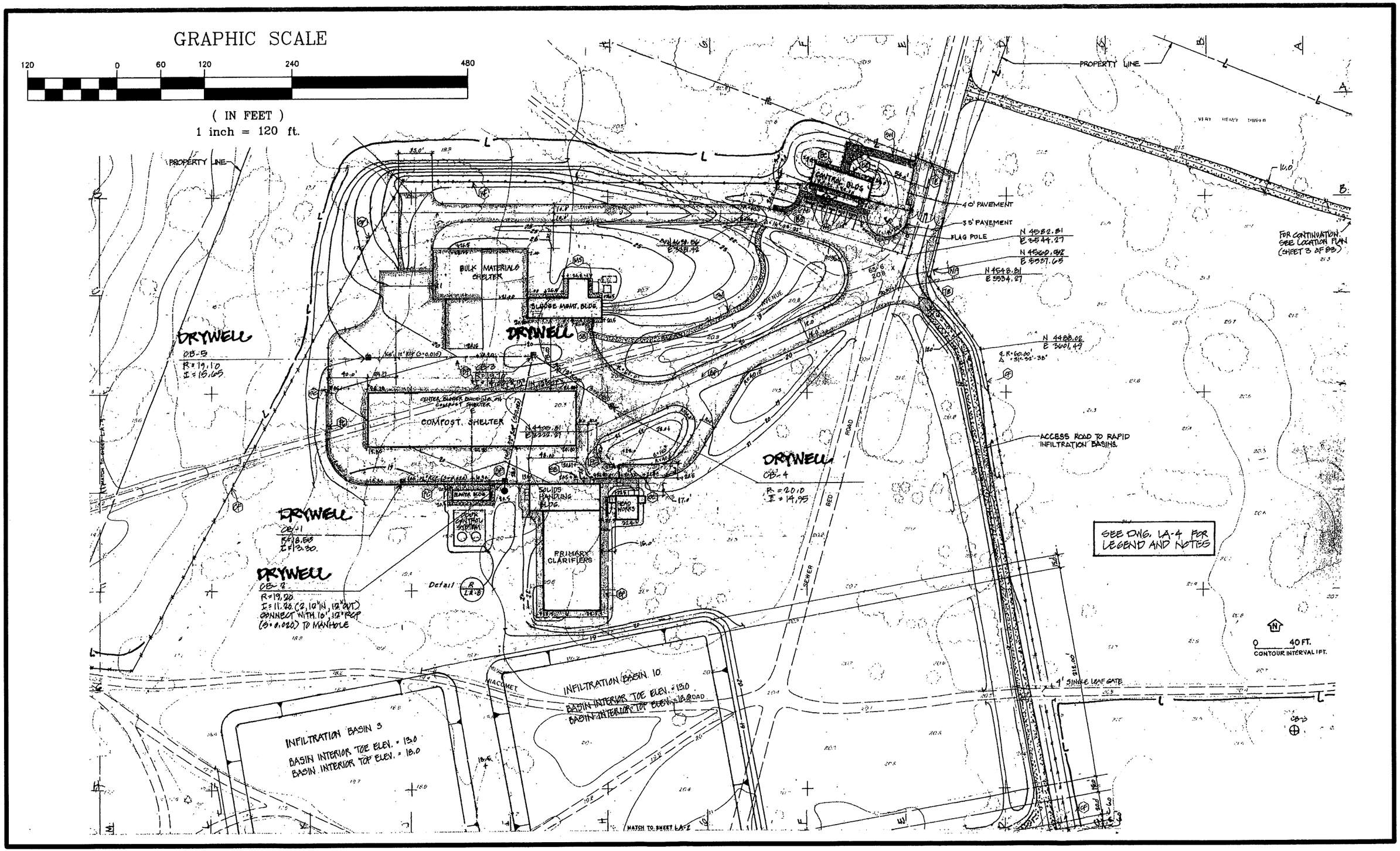



FIGURE 5A
EXISTING PIPING, PLUMBING AND SUBSURFACE UTILITIES
SURFSIDE WWTF, NANTUCKET, MASS.

EarthTech
A Tyco International Ltd. Company

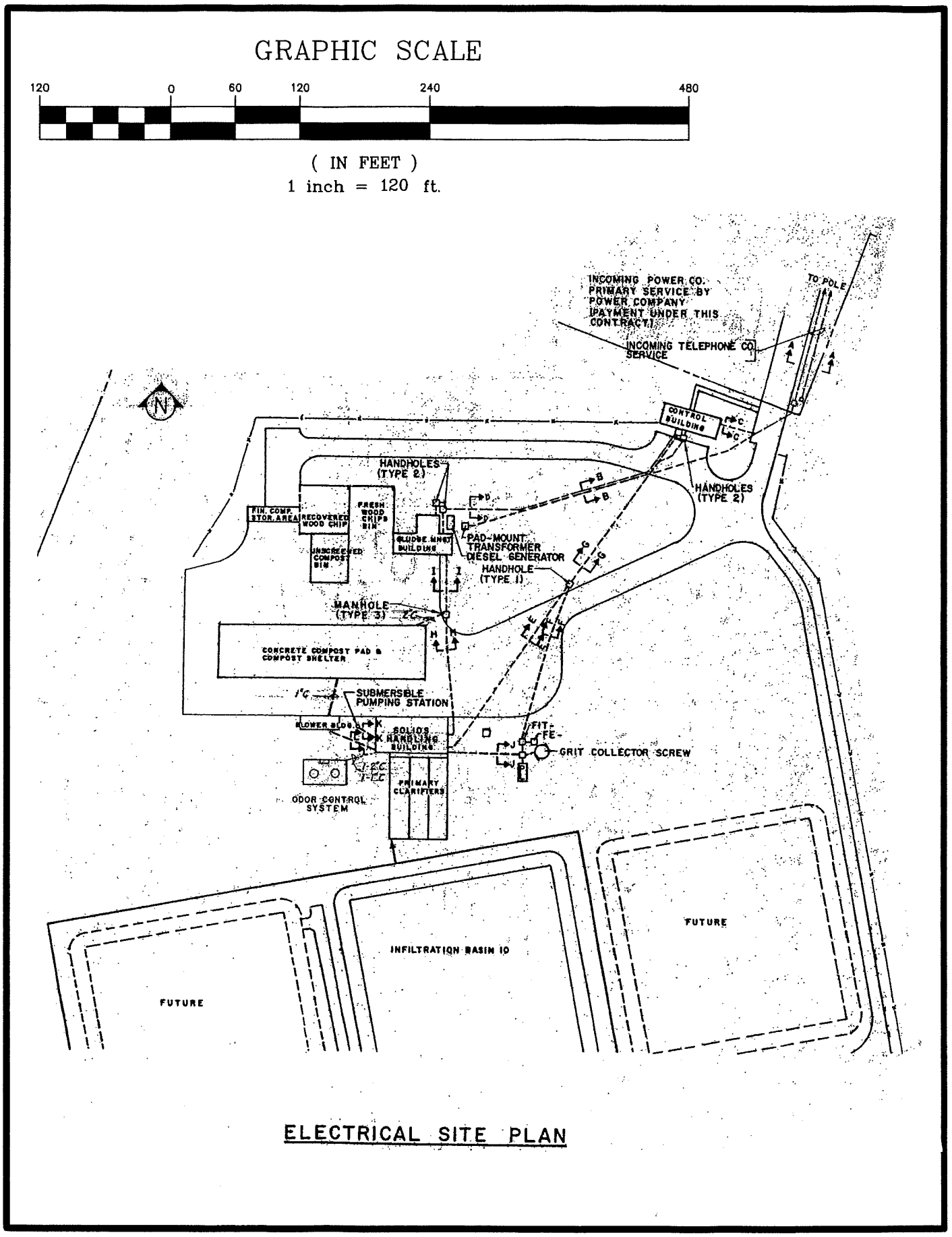


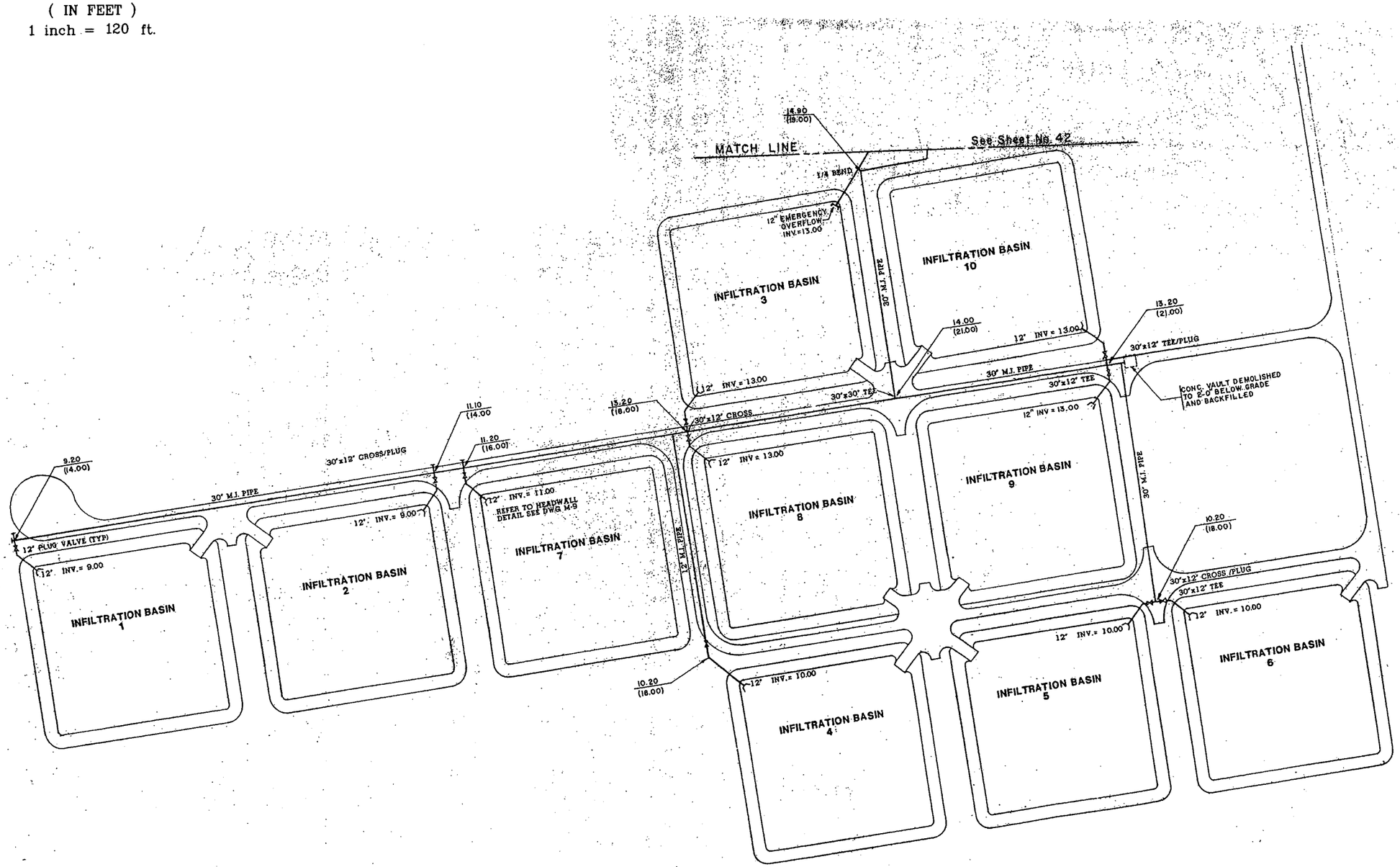

FIGURE 5D
EXISTING PIPING, PLUMBING AND SUBSURFACE UTILITIES
SURFSIDE WWTF, NANTUCKET, MASS.

EarthTech
A Tyco International Ltd. Company

GRAPHIC SCALE

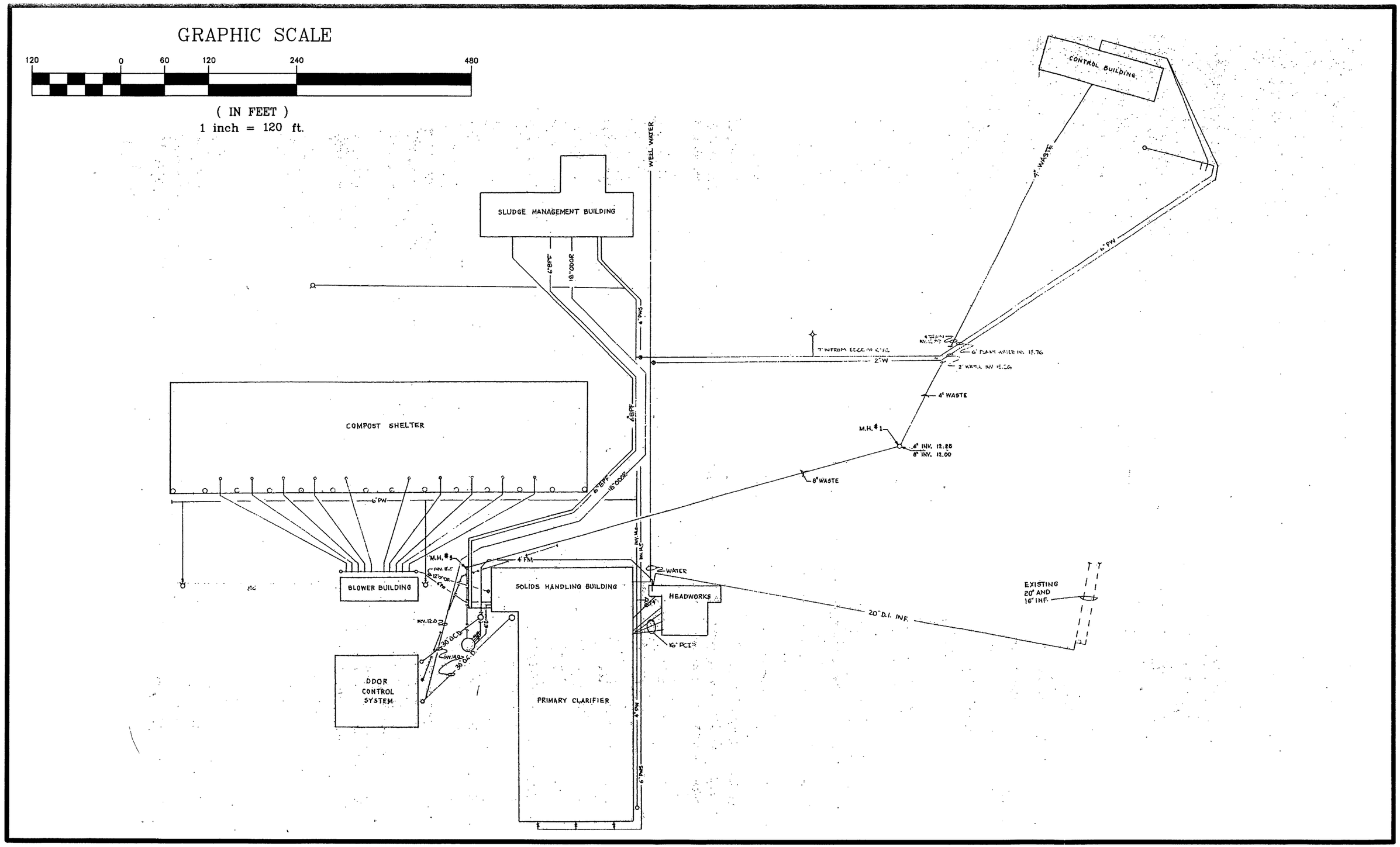
120 0 60 120 240 480

( IN FEET )
1 inch = 120 ft.




EarthTech
A Tyco International Ltd. Company

FIGURE 5B
EXISTING PIPING, PLUMBING AND SUBSURFACE UTILITIES
SURFSIDE WWTF, NANTUCKET, MASS.

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A Tyco International Ltd. Company

FIGURE 5C
EXISTING PIPING, PLUMBING AND SUBSURFACE UTILITIES
SURFSIDE WWTF, NANTUCKET, MASS.

# APPENDIX D: APPENDIX A SURFSIDE O & M MANUAL DESIGN SPECIFICATIONS

# APPENDIX A – BASIC DESIGN DATA

| Description | Remark / Value |
|---|---|
| **Flows and Loadings** | |
| Design Average Daily Flow (mgd) | 3.50 |
| $BOD_5$ Concentration (mg/l) | 341 |
| TSS Concentration (mg/l) | 466 |
| TKN Concentration (mg/l) | 40 |
| $NH_4$-N Concentration (mg/l) | 25 |
| Total P Concentration (mg/l) | 9 |
| WWTFDesign Flow Average Day, Peak Month (mgd) | 3.50 |
| WWTF Max. Day, Peak Month (mgd) | 5.25 |
| Design Flow Peaking Factor | 2.4 |
| WWTF Design Instantaneous Max. Flow (mgd) | 7.71 |
| Design $BOD_5$ Load Average Day, Peak Month (lbs/day) | 9,946 |
| Design TSS Load Average Day, Peak Month (lbs/day) | 13,589 |
| Design TKN Load Average Day, Peak Month (lbs/day) | 1,155 |
| Design $NH_4$-N Load Average Day, Peak Month (lbs/day) | 730 |
| Design Total P Load Average Day, Peak Month (lbs/day) | 270 |
| Headworks | |
| Type of Unit | In-Channel Grinder |
| Number of Units | 1 |
| Capacity, each (mgd) | 7.70 |
| Motor Horsepower (hp) | 5 |
| Type of Unit | Bar Rack |
| No. of Units | 1 |
| Bar Opening (in.) | 2¼ |
| Type of Unit | Parshall Flume |
| No. of Units | 1 |
| Flume Size (in.) | 12 |
| Max. Capacity (mgd) | 5.80 |
| Type of Unit | Aerated Grit Chamber |
| No. of Units | 1 |
| Chamber Length (ft. & in.) | 15’-0” |
| Chamber Width (ft. & in.) | 17’-0” |
| Sidewater Depth (ft. & in.) | 14’-10” |
| Detention Time @ Max. Cap.(min.) | 3.9 |
| Grit Screw Drive Protection | Shear Pin |
| Screw Drive Motor Horsepower (hp) | 1.0 |
| Screw Conveyor Dia. (in.) | 6 |
| Air Diffuser System | Single Pipe Header |
| Type of Unit | Air Blowers |
| No. of Air Blowers | 2 |
| Air Blower Cap. (icfm) | 120 |
| Blower Discharge Pressure (psig) | 5 |
| Intake/Discharge Size (in) | 2/2 |

# APPENDIX E: COMPLETE 2004 CWMP AND O & M MANUAL

*Report*

# Phase III – Comprehensive Wastewater Management Plan and Final Environmental Impact Report

# Nantucket, Massachusetts

## Volume I of III

*Prepared for:*

Nantucket Department of Public Works
188 Madaket Road
Nantucket, Massachusetts 02554-2623

*Prepared by:*

Earth Tech, Inc.
196 Baker Avenue
Concord, Massachusetts 01742-2167

*March 2004*

*27355*

# Phase III - Comprehensive Wastewater Management Plan and Final Environmental Impact Report

## Nantucket, Massachusetts

## Volume I of III

*Prepared for:*

Nantucket Department of Public Works
188 Madaket Road
Nantucket, Massachusetts 02554-2623

*Prepared by:*

Earth Tech, Inc.
196 Baker Avenue
Concord, Massachusetts 01742-2167

03/25/04

COMMONWEALTH OF MASSACHUSETTS
THOMAS E. PARECE
CIVIL
No. 34463
REGISTERED PROFESSIONAL ENGINEER

*March 2004*

March 31, 2004

Dear Project Reviewer:

Enclosed please find one copy of the report entitled "Comprehensive Wastewater Management Plan and Final Environmental Impact Report Phase III (Phase III Report) completed in accordance with the Massachusetts Department of Environmental Protection's "Guide to Wastewater Management Planning" dated January 1996. The review of the Comprehensive Wastewater Management Plan (CWMP)/Environmental Impact Report (EIR) will be through the submission of three documents including: (1) Phase I Report; (2) Phase II CWMP/Draft EIR; and (3) Phase III CWMP/Final EIR.

This Phase III Report is consistent with the general requirements of the MEPA regulations including being circulated per MEPA regulations at 301 CMR 11.16 (3). In addition, six (6) copies will be available for public review at the Selectmen and Town Clerk's Offices in the Town Hall, Department of Public Works, Nantucket Land Council, Nantucket Planning and Economic Development Commission and at the Antheneum (Public Library). The complete Report can also be accessed through the Town's website at www.nantucket-ma.gov. The circulation list is included in Section 7 of the Phase III Report.

A public hearing on the Phase III Report will be initiated by a notice of availability for review in the Environmental Monitor. A responsiveness Summary will be completed as a result of the Public Hearing and included in the permanent record.

If you have questions regarding this project, please do not hesitate to contact the MEPA office at 617-626-1000.

Very truly yours,
Earth Tech, Inc.

Thomas E. Parece, P.E.
Senior Program Director

enclosures

# Table of Contents

# TABLE OF CONTENTS

Section Page

LETTER OF TRANSMITTAL
EXECUTIVE SUMMARY ..... ES-1
LIST OF FIGURES ..... v
LIST OF TABLES ..... vi

1.0 INFORMATION UPDATE REQUEST OF THE PHASE I MEPA CERTIFICATE

A. NEEDS ANALYSIS DISCUSSION UPDATE ..... 1-1
1. Introduction ..... 1-1
2. First Stage Analytical Approach - Rating Criteria Matrix ..... 1-1
3. Second Stage Analytical Approach - Soils, Groundwater and Age/Lot Evaluation ..... 1-3
4. Results of Needs Analysis ..... 1-8

B. WASTEWATER FLOW UPDATE ..... 1-26

C. DISPOSAL SITE ALTERNATIVES ..... 1-29

D. WATER SUPPLY ..... 1-29

E. PLANNING FOR GROWTH (EXECUTIVE ORDER #385) ..... 1-29

2.0 IDENTIFY AND DISCUSS ALTERNATIVES FOR WASTEWATER DISPOSAL

A. INTRODUCTION ..... 2-1

B. OPTIMIZE OPERATION AND MAINTENANCE OF EXISTING ON-SITE SYSTEMS ..... 2-1
1. Repair/Upgrade Existing On-Site Systems ..... 2-2
2. Conventional Title 5 System ..... 2-4

C. WASTEWATER COLLECTION, TREATMENT AND DISPOSAL ALTERNATIVES ..... 2-6
1. Flow and Waste Reduction ..... 2-6
2. Decentralized Facilities ..... 2-12
3. Analysis of On-Site Alternatives ..... 2-34
4. Configurations and Alternative Sewer Systems ..... 2-37
5. Wastewater Treatment, Disposal, Reuse and Land Applications ..... 2-41
6. Existing Wastewater Infrastructure ..... 2-63
7. Existing Wastewater Treatment Facilities ..... 2-71
8. Potential Reuse Opportunities ..... 2-95
9. Residuals Disposal and Reuse ..... 2-98

Section Page

D. WASTEWATER REUSE FOR ARTIFICIAL RECHARGE ..... 2-107
1. General ..... 2-107
2. General Requirements for Wastewater Usage for Artificial Recharge ..... 2-107
3. Wastewater Treatment Levels and Technologies ..... 2-110
4. Wastewater Recharge/Drinking Water Reuse Experience ..... 2-117

E. STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE INITIATIVES ..... 2-124

F. SHORT LIST OF ALTERNATIVES ..... 2-125
1. General ..... 2-125
2. Technical Considerations ..... 2-127
3. Environmental Benefits ..... 2-130
4. Economic Considerations ..... 2-131
5. Water Balance Impacts ..... 2-132

3.0 SCREENING OF SITES FOR TREATMENT AND/OR DISPOSAL

A. CRITERIA DEVELOPMENT ..... 3-1

B. SITE IDENTIFICATION ..... 3-12
1. General ..... 3-12
2. Surfside Wastewater Treatment Facility ..... 3-16
3. FAA Site – Massasoit Bridge Road ..... 2-16
4. UMASS Site ..... 3-17
5. Quidnet – No. 1 Site ..... 3-17
6. Quidnet – No. 2 Site ..... 3-17
7. Pocomo Road Site ..... 3-17
8. Milestone Road – “Clear-Cut Site” ..... 3-17
9. Tom Nevers – Naval Station Site ..... 3-18
10. Siasconset WWTF Site ..... 3-18
11. Airport Site ..... 3-18
12. Wauwinet Road Site ..... 3-18
13. Wauwinet – Quidnet Roadways ..... 3-18
14. State Forest Site ..... 3-18
15. Madaket – Warren’s Landing Area Roadways ..... 3-19

C. PRELIMINARY SITE SCREENING ..... 3-19
1. Environmentally Sensitive Areas ..... 3-19
2. Archaeological and Historical Resources ..... 3-19
3. MCP Phase I Site Assessment ..... 3-20
4. Soil Suitability and Geologic Evaluation ..... 3-20
5. Sensitive Receptors ..... 3-20
6. Hydrogeologic Evaluations ..... 3-20
7. Historical Shoreline Analysis at Surfside WWTF ..... 3-22

Section Page

D. IDENTIFICATION OF FEASIBLE SITES BASED ON SCREENING ANALYSIS ..... 3-22

E. SUMMARY ..... 3-25

4.0 EVALUATION OF SHORT LISTED ALTERNATIVES

A. ENVIRONMENTAL EVALUATION ..... 4-1
1. Introduction ..... 4-1
2. Evaluation ..... 4-1
3. Recommendations based on Environmental Evaluation Criteria ..... 4-6

B. EVALUATION OF COSTS ..... 4-9
1. Project Costs ..... 4-9
2. Operation and Maintenance Costs ..... 4-13
3. Wastewater Treatment Facilities Alternative Costs ..... 4-15
4. Collection and Transmission Alternative Costs ..... 4-16

C. INSTITUTIONAL ARRANGEMENTS ..... 4-26
1. General ..... 4-26
2. Institutional and System Management Procedures ..... 4-28

D. RESIDUALS DISPOSAL ..... 4-31

E. LOCATION OF FACILITIES ..... 4-31
1. Madaket WWTF – FAA Site ..... 4-31
2. Surfside WWTF Expansion ..... 4-32
3. Needs Areas ..... 4-32

F. PHASED CONSTRUCTION ..... 4-33

G. FLEXIBILITY AND RELIABILITY ..... 4-34

H. IMPLEMENTATION CAPABILITY ..... 4-34

I. REGULATORY, DESIGN AND RELIABILITY REQUIREMENTS ..... 4-35

5.0 RECOMMENDED PLAN

A. DETAILED RECOMMENDED PLAN ..... 5-1
1. Introduction ..... 5-1
2. Study Areas ..... 5-1
3. Wastewater Treatment Facilities ..... 5-15
4. Existing Pump Stations ..... 5-42
5. Evaluation and Mapping Project ..... 5-43

B. INSTITUTIONAL IMPACTS ..... 5-47

Section Page

C. ENVIRONMENTAL IMPACTS ..... 5-47
1. General ..... 5-47
2. Historical, Archaeological, Cultural, Conservation and Recreation ..... 5-47
3. Wetlands, Flood Plains and Agricultural Lands ..... 5-48
4. Zones of Contribution of Existing and proposed Water Supply Sources ..... 5-48
5. Surface and Groundwater Resources Including Nantucket and Madaket Harbor Watersheds ..... 5-48
6. Displacement of Households, Businesses and Services ..... 5-48
7. Noise Pollution, Air Pollution, Odor and Public health Issues Associated with Construction and Operation ..... 5-49
8. Violation of Federal, State or Local Environmental and Land Use Statues or Regulations and Plans Imposed by Such Statutes and Regulations ..... 5-49
9. Changes if Development and Land Use Patterns
10. Pollution Stemming from Changes in Land Use ..... 5-49
11. Damage to Sensitive Ecosystems ..... 5-49
12. Socioeconomic for Expansion ..... 5-49

D. CAPITAL, OPERATION AND MAINTENANCE COSTS ..... 5-50
1. Capital Costs ..... 5-50
2. Operation and Maintenance Costs ..... 5-53

E. IMPLEMENTATION PLAN ..... 5-55

6.0 FINAL ENVIRONMENTAL IMPACT REPORT

A. PROJECT DESCRIPTION ..... 6-1
1. General ..... 6-1
2. Summary ..... 6-1
3. Needs Areas ..... 6-2
4. Disposal Site Alternatives ..... 6-2
5. Threshold Exceedances ..... 6-2

B. WATER SUPPLY ..... 6-2
1. General ..... 6-2
2. Existing Conditions ..... 6-2
3. Proposed Water Use ..... 6-3

C. MITIGATION MEASURES ..... 6-6

D. EXECUTIVE ORDER 385/PLANNING FOR GROWTH ..... 6-7

Section Page

7.0 REVIEW OF PUBLIC PARTICIPATION PROGRAM

A. GENERAL ..... 7-1
B. PUBLIC MEETING ..... 7-2
C. RESPONSIVENESS SUMMARIES ..... 7-4
D. SUMMARY OF PUBLIC COMMENTS RECEIVED DURING THE MEPA PROCESS ..... 7-4
E. CIRCULATION LIST ..... 7-5

8.0 SRF GRANT/LOAN ADMINISTRATION ..... 8-1

## LIST OF FIGURES

**Figure** **Page**

1-1 Typical Lot Configuration ..... 1-6
2-1 Conventional Title 5 System ..... 2-5
2-2 Typical STEP System ..... 2-14
2-3 Subsurface Cluster System ..... 2-15
2-4 Recirculating Sand Filter ..... 2-20
2-5 Amphidrome™ Process ..... 2-22
2-6 Bioclere™ System ..... 2-24
2-7 Cromaglass® System ..... 2-26
2-8 RUCK® System ..... 2-29
2-9 Single Home FAST® ..... 2-30
2-10 Typical Grinder Pump Unit ..... 2-39
2-11 Surfside WWTF Flows and Precipitation ..... 2-78
2-12 Watershed Sub-Basins ..... 2-140
3-1 Potential Wastewater Treatment and/or Disposal Sites ..... 3-13
3-2 Natural Resources and Environmentally Sensitive Areas ..... 3-15
5-1 Madaket Study Area ..... 5-3
5-2 Warren's Landing Study Area ..... 5-5
5-3 Somerset Study Area ..... 5-6
5-4 Shimmo Study Area ..... 5-11
5-5 Monomoy Study Area ..... 5-13
5-6 Wastewater Treatment Facility Locations ..... 5-17
5-7 Surfside WWTF Site Location ..... 5-19
5-8 Surfside WWTF Process Layout ..... 5-20
5-9 Siasconset WWTF Site Location ..... 5-30
5-10 Siasconset WWTF Process Layout ..... 5-31
5-11 Madaket WWTF Site Location ..... 5-36
5-12 Madaket WWTF Process Layout ..... 5-37
5-13 Capital Improvement Program – FY 2004-2014 ..... 5-49

## LIST OF TABLES

**Table** **Page**

1-1 Rating Criteria Points Per Developed Lot ..... 1-4
1-2 Rating Criteria ..... 1-9
1-3 Study Area Long Term Wastewater Disposal Option ..... 1-27
1-4 Estimated Wastewater Flows by Study Area ..... 1-28
1-5 Estimated Wastewater Flows by Wastewater Treatment Facility ..... 1-29
2-1 Summary of Monitoring Results Versus Treatment Requirements ..... 2-32
2-2 Summary of Water Quality Criteria For Class B Streams ..... 2-44
2-3 Proposed Effluent Limitations ..... 2-47
2-4 Class 1 Groundwater Permit Standards ..... 2-48
2-5 Areas Required For Surface Application of Treated Effluent ..... 2-49
2-6 Areas Required For Subsurface Application of Treated Effluent ..... 2-49
2-7 Wastewater Pumping Stations Survey Summary ..... 2-66
2-8 Massachusetts Groundwater Discharge Permit No. 1-200 Limits ..... 2-74
2-9 Surfside WWTF Design Data ..... 2-75
2-10 Surfside WWTF Wastewater Flows (1999 through 2002) ..... 2-77
2-11 Surfside WWTF Performance – 1999 ..... 2-80
2-12 Surfside WWTF Performance – 2000 ..... 2-81
2-13 Surfside WWTF Performance – 2001 ..... 2-82
2-14 Surfside WWTF Performance – 2002 ..... 2-83
2-15 Surfside WWTF Serviceability Ratings ..... 2-84
2-16 Surfside WWTF Evaluation of Process Equipment – Headworks ..... 2-85
2-17 Surfside WWTF Evaluation of Process Equipment – Primary Clarifiers ..... 2-85
2-18 Surfside WWTF Evaluation of Process Equipment – Solids Handling Building ..... 2-87
2-19 Surfside WWTF Evaluation of Process Equipment – Sludge Management Building ..... 2-88
2-20 Surfside WWTF Evaluation of Process Equipment – Odor Control ..... 2-90
2-21 Surfside WWTF Evaluation of Process Equipment – CEPT Building ..... 2-91
2-22 Surfside WWTF Evaluation of Process Equipment – Miscellaneous ..... 2-92
2-23 Alternative Summary ..... 2-126
2-24 Water Withdrawals ..... 2-134
2-25 Water Balance Impacts - 2001 Annual ..... 2-135
2-26 Water Balance Impacts - 2001 Summer ..... 2-136
2-27 Water Balance Impacts- 2025 Annual ..... 2-137
2-28 Water Balance Impacts - 2025 Summer ..... 2-138
3-1 Criteria Description ..... 3-2
3-2 Existing Conditions and Site Features ..... 3-14
3-3 Results of Preliminary Screening ..... 3-23
3-4 Wastewater Treatment and/or Disposal Sites ..... 3-26
4-1 Innovative/Alternative System Evaluation ..... 4-7
4-2 Connection to the Existing System Evaluation ..... 4-8
4-3 Communal System Evaluation ..... 4-10
4-4 Surfside WWTF Alternatives - Estimated Construction Costs ..... 4-15
4-5 Madaket Study Area Alternatives - Estimated Project Costs, Operation and Maintenance Costs and Present Worth Costs ..... 4-18

**Table** **Page**

4-6 Monomoy Study Area Alternatives - Estimated Project Costs, Operation and Maintenance Costs and Present Worth Costs ..... 4-19
4-7 Somerset Study Area Alternatives - Estimated Project Costs, Operation and Maintenance Costs and Present Worth Costs ..... 4-21
4-8 Shimmo Study Area Alternatives - Estimated Project Costs, Operation and Maintenance Costs and Present Worth Costs ..... 4-23
4-9 Warren's Landing Study Area Alternatives - Estimated Project Costs, Operation and Maintenance Costs and Present Worth Costs ..... 4-25
5-1 Summary of Recommended Plan ..... 5-15
5-2 Typical WWTF Effluent Permit Requirements ..... 5-16
5-3 Surfside WWTF Wastewater Flows ..... 5-25
5-4 Surfside WWTF Design Criteria ..... 5-26
5-5 Siasconset WWTF Design Criteria ..... 5-33
5-6 Madaket WWTF Wastewater Flows ..... 5-39
5-7 Madaket WWTF Design Criteria ..... 5-40
5-8 Summary of Estimated Project Costs For CWMP/FEIR Recommendations ..... 5-50
5-9 Summary of Estimated Project Costs For Evaluation and Mapping Recommendations ..... 5-51
5-10 Estimated Operation and Maintenance Costs For CWMP/FEIR Recommendations ..... 5-54
5-11 Estimated Operation and Maintenance Costs For Evaluation and Mapping Recommendations ..... 5-55
5-12 Capital Improvement Plan For CWMP/FEIR Recommendations ..... 5-56
5-13 Capital Improvement Plan For Evaluation and Mapping Recommendations ..... 5-57
6-1 Warren's Landing Study Area Water Use Design Conditions ..... 6-4
6-2 Somerset Study Area Water Use Design Conditions ..... 6-4
6-3 Shimmo Study Area Water Use Design Conditions ..... 6-5
6-4 Monomoy Study Area Water Use Design Conditions ..... 6-6

# Executive Summary

# EXECUTIVE SUMMARY

In 1998, the Nantucket Department of Public Works retained Earth Tech, Inc. to prepare an Island-wide Comprehensive Wastewater Management Plan/Environmental Impact Report (CWMP/EIR) to identify areas within the Island with sub-surface wastewater disposal problems and to develop a plan to mitigate or eliminate the problems. The Town established a special procedure for the review of this major and complicated project. This special procedure is a three-phase process during which the scope of future phases is based largely on the results of the preceding phase. The process consists of filing three documents: (1) Phase I, Needs Analysis; (2) Phase II, Alternatives and Site Identification and Draft Environment Impact Report; and (3) Phase III, Comprehensive Wastewater Management Plan and Final Environmental Impact Report. The results of the three-phase plan are included in this Document. This Document provides the basis for the design and ultimate implementation of the approved plan.

This Document contains the results of extensive efforts by Earth Tech, Inc. and the Town of Nantucket to evaluate the available options for improving the existing on-site wastewater disposal systems. In order to obtain as much information as possible on the existing and projected land use, demographic conditions and population, Earth Tech Inc., coordinated efforts with the Nantucket Planning and Economic Development Commission (NP&EDC) and the Massachusetts Estuary Project (MEP). The goals of the NP&EDC's, "The Nantucket Comprehensive Plan", coupled with the on-going Massachusetts Estuary Project (MEP) have been utilized in evaluations and analyses for the community presented in this Document and have been an integral force in the formation of the final recommendations herein.

The MEP is currently gathering data in the Nantucket Harbor and Sesachacha Pond areas in order to provide technical data relative to the maximum amount of nitrogen (nitrogen threshold) that each estuary can tolerate without adversely changing its character and use. Madaket Harbor is also being studied but at a different target date than the above-mentioned areas. MEP will set the target to be achieved in order to protect and restore the health of the estuaries. Study areas affected by the MEP include Wauwinet, Quidnet, Pocomo, and Polpis. Until the MEP data is completed, these areas are recommended to continue using on-site wastewater disposal systems managed under a Septage Management Plan. Once the MEP data is complete, these areas will be further evaluated for long-term recommendations.

A recommended solution is being made for Madaket in this Report, which has been classified as a Need Area based on multiple criterion identified in the Phase I Report. The MEP in the Madaket Harbor area will further define the need for reducing nitrogen loadings to the estuaries here. This could mean redefining the wastewater treatment level necessary to meet the goals of the MEP in Madaket. The CWMP/EIR is an evolving and acquiescent process. It is recommended that the Town continue the coordination of efforts on Island with the MEP.

Other agencies utilized for information and considered herein are U.S. Soils Conservation Services, U.S. Department of Agriculture, U.S. Coast Guard, local planning officials, the Nantucket Historic Commission, the Natural Heritage Program, and local Town boards including Assessors, Building Department, Board of Health, Public Works Department, Zoning Officials, Conservation Commission and Nantucket Planning and Economic Development Commission.

The Phase I, Needs Analysis was completed and filed with MEPA in August 2001. An Environmental Notification Form (ENF) was filed with MEPA in October of 2001. The Phase I Document determined the areas on Island incapable of sustaining long-term, on-site wastewater disposal systems throughout and beyond the 20-year planning period. There were ten Study Areas identified as Needs Areas:

| | |
|---|---|
| Madaket | Shimmo |
| Monomoy | Pocomo |
| Pocomo | Polpis |
| Polpis | Warrens Landing |
| Quidnet | Wauwinet |

See the map at the end of this Executive Summary for a description of the challenges and solutions for each of the ten identified Study Areas.

The Phase II, Alternatives and Site Identification, was completed and filed with MEPA in September 2003. The Phase II Document analyzed the selected alternatives in accordance with the revised scope that was issued by the Secretary of EOEA and comments received on the Phase I CWMP/EIR document.

The Phase II CWMP/DEIR document contains the preliminary investigation into the viability of siting wastewater treatment facility(s) and/or highly treated wastewater effluent disposal facilities on Nantucket. Site selection, for both the wastewater treatment facilities (WWTFs), and the effluent disposal field(s) is the most difficult to resolve. The screening criteria presented in this section were developed to assess the

viability of 14 sites identified within Nantucket as potential wastewater treatment facility and/or wastewater disposal facility sites. The screening criteria used to evaluate these potential project sites were based upon eleven environmental criterion. The environmental screening criteria were chosen based upon review by the Project Proponent and upon comments received by the Proponent in the Secretary of the Executive Office of Environmental Affairs Certificate on the ENF dated October 2001. It was determined that by applying the screening criteria to the 14 identified sites a short list of selective potential sites would be established for additional evaluation through field testing. The screening criteria chosen to evaluate the potential project sites are: (1) wetlands; (2) soils; (3) drinking water supply - wellhead protection areas (Zone I and Zone II); (4) fisheries (including shellfish areas); (5) waterbodies (distance from surface water); (6) floodplains; (7) sensitive habitats; (8) park lands; (9) recreational resources;
(10) agricultural/historical interests; (11) shoreline change data; and (12) in or adjacent to an Area of Critical Environmental Concern.

Wastewater treatment options were evaluated based on four levels of criteria. The first criterion, Technical Factors, included flow and loading, land/site requirements, suitability for groundwater discharge, climate, sludge disposal and ease of operation. The second criterion, Environmental Factors, included groundwater and permitting impacts. The third criterion, Institutional Factors, included community acceptance, regulatory and legal issues. The fourth criterion, Economic Factors, included construction cost and operations cost. Various wastewater treatment technologies were evaluated based on the above criteria and the Town of Nantucket's goals regarding the operation and maintenance of the facilities.

The Phase II CWMP/DEIR document presents recommendations for wastewater management in the above-mentioned ten identified areas of the Town of Nantucket where existing on-site wastewater disposal systems are shown to be inadequate for long-term wastewater disposal. Specific recommendations by Study Area have taken into account the appropriateness of utilizing: (1) innovative alternative systems; (2) communal systems; and (3) local wastewater collection, treatment, and disposal facilities. The Phase II CWMP/DEIR document evaluated the environmental impacts, technical design, institutional factors, and project costs associated with each alternative and recommends the appropriate solution to the wastewater disposal problems in the Town of Nantucket on a long term basis, with the exception of those areas included in the MEP Study Areas.

The Phase II CWMP/DEIR document recommends that the Town of Nantucket upgrade the existing Surfside Wastewater Treatment Facility, construct a new Madaket Wastewater Treatment Facility and provide sanitary sewer via low pressure sewers and/or gravity sewers to five needs areas (Madaket, Monomoy, Shimmo, Somerset and Warrens Landing), and to prepare a Septage Management Plan for the remainder of the Island. The recommended plan is the most environmentally sound and cost-effective alternative, and insures the sustainability of Nantucket's water resources for centuries to come. The recommended plan is proposed to be designed and constructed over a twelve-year period and has been divided into seven construction phases. The construction phases were developed based on: (1) the need of an area to be serviced; (2) funding constraints; and (3) minimizing construction related disruptions within the Town. The capital cost of the recommended plan is estimated at $92.1 million and includes construction, engineering (design and construction), legal, fiscal, administrative, and contingency costs for providing sanitary sewerage to the five needs areas, and the construction of the Surfside WWTF upgrade and Madaket WWTF. The CWMP/EIR is a dynamic and flexible long-term planning document, therefore, the Town has the opportunity to incorporate any additional information that is developed by Federal, State and/or Local authorities and/or private entities prior to the implementation of the recommendations, if appropriate.

The Secretary issued the MEPA Certificate for the Phase II, EOEA Number 12617, on December 1, 2003.

After filing the Phase II CWMP/DEIR on October 30, 2003, the Town of Nantucket entered into an Administrative Consent Order (ACO), ACOP-BO-03-1G002, with the DEP in the matter of the Surfside Wastewater Treatment Facility. The implementation schedule contained in this Phase III Document coincides with the schedules detailed in the ACO. The complete ACO is included in Appendix A.

In addition to the CWMP/EIR, the Town has been involved with an Evaluation and Mapping project for its wastewater and stormwater infrastructures. The project involves the review, investigation and mapping of the infrastructures and recommended rehabilitation/upgrades required based on existing and future needs. The capital cost of the recommended plan is estimated at $83.4 million and includes construction, engineering (design and construction), legal, fiscal, administrative, and contingency costs over a 20-year planning period. One of the major parts of the Evaluation and Mapping project is the initial investigation of infiltration/inflow within the existing wastewater infrastructure and recommendations to reduce excessive groundwater from entering the wastewater collection system. Since the Evaluation and Mapping project is scheduled to be completed in the Summer of 2004, adjustments to the recommendations and associated estimated capital costs may be necessary.

This Phase III, Comprehensive Wastewater Management Plan and Final Environmental Impact Report (CWMP/FEIR) is the final result of all comments received on the Phase II Report through the MEPA process as well as comments received during multiple public informational meetings and workshops held on the Island and incorporates the provisions contained in the Surfside ACO. The Phase III, CWMP/FEIR, contains the final recommended plan for long-term wastewater collection, treatment and disposal as well as all associated costs for users and non-users. A Septage Management Plan is completed in draft form for those areas on Island determined to be long-term sustainable with on-site wastewater disposal systems.

These projects have spearheaded the Town's efforts to develop a long-term Capital Improvement Program that incorporates not only the recommendations from the CWMP/EIR and Evaluation and Mapping projects, but other Town Department budget expenditures as well. This proactive agenda will allow the Town to act fiscally responsible and ensure the long-term sustainability of the Island while protecting the environment and sole source aquifer at the same time both of which are direct goals the State's Watershed Initiative.

In summary, both the CWMP/EIR and Evaluation and Mapping projects are dynamic and flexible long-term planning documents that leave opportunities open to modifications by the Town to incorporate any additional information that is developed by Federal, State and/or Local authorities and/or private entities prior to the implementation of the recommendations, if appropriate.

**Challenge:**
*Evaluate alternatives for a 20-year solution to wastewater collection, treatment and disposal needs of the Town.*

**Solution:**
*An Island-wide study to maintain and/or improve environmental conditions while determining costs, benefits for long-term sustainability, protection of the sole source aquifer and public health, and preservation of Nantucket Harbor, Madaket Harbor, Polpis Harbor and Sesachacha Pond.*

**Area of Wastewater Disposal Need Based on Wellhead Overlay Protection Zone**

**Town WPZ**
**Challenge**
- Wellhead Protection Zone
- Private Water Supply & Wastewater Disposal

**Solution**
- Connect into Existing Wastewater System

**Area of Wastewater Disposal Need Based on Harbor Watershed Line**

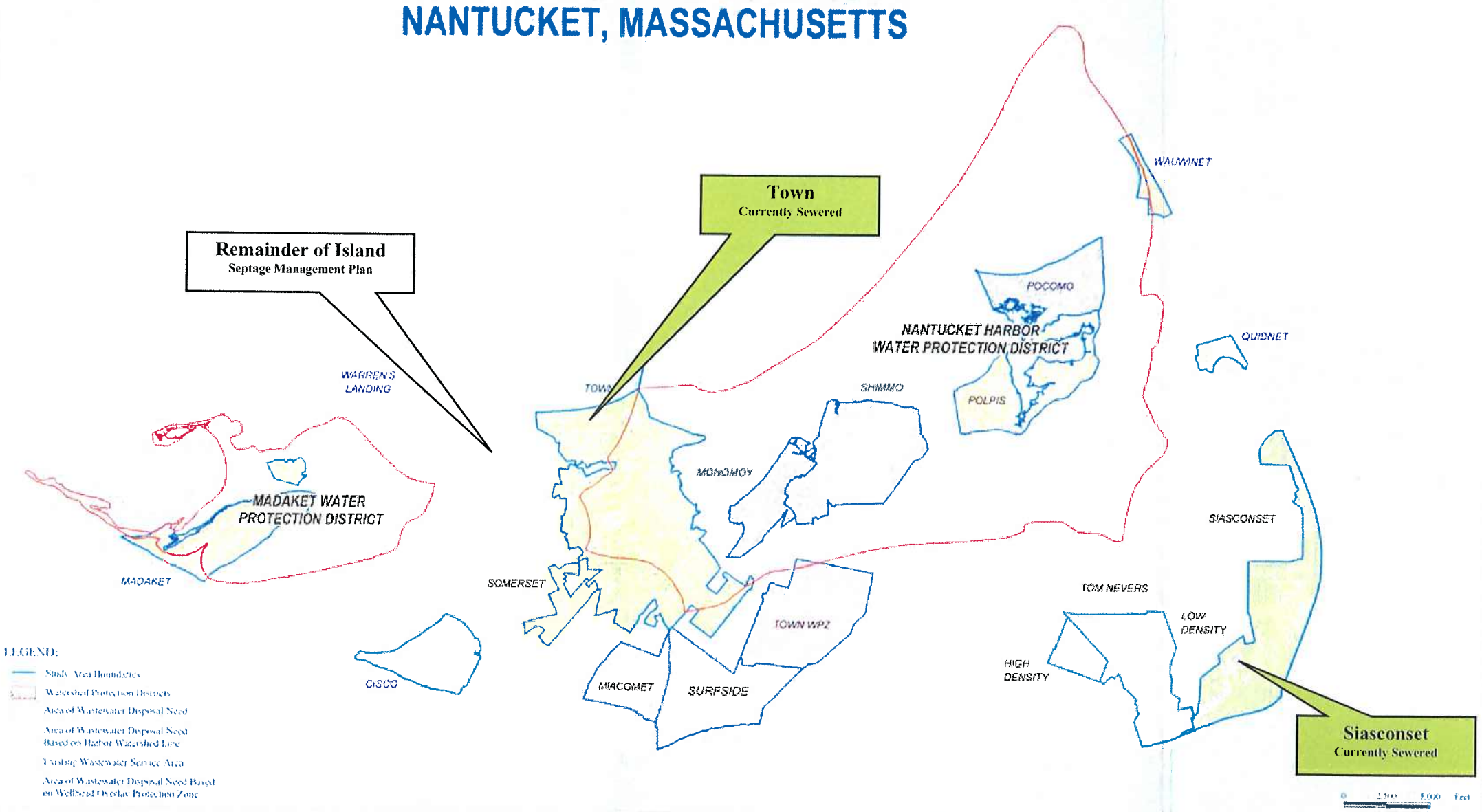
**Pocomo**
**Challenge**
- Nantucket Harbor Watershed
- High Groundwater
- Private Water Supply & Wastewater Disposal

**Solution**
- Septage Management Plan

**Monomoy**
**Challenge**
- Nantucket Harbor Watershed
- Private Water Supply & Wastewater Disposal

**Solution**
- Connect into Existing Wastewater System

# COMPREHENSIVE WASTEWATER MANAGEMENT PLAN NANTUCKET, MASSACHUSETTS




**Area of Wastewater Disposal Need**

**Shimmo**
**Challenge**
- Nantucket Harbor Watershed
- Private Water Supply & Wastewater Disposal

**Solution**
- Connect into Existing Wastewater System

**Madaket**
**Challenge**
- Small Dense Lots
- Madaket Harbor Watershed
- Private Water Supply & Wastewater Disposal

**Solution**
- Decentralize Wastewater Treatment

**Polpis**
**Challenge**
- Nantucket Harbor Watershed
- Degradation of Polpis Harbor
- High Groundwater
- Private Water Supply & Wastewater Disposal

**Solution**
- Septage Management Plan

**Quidnet**
**Challenge**
- Topography
- Small Dense Lots
- Private Water & Wastewater Disposal

**Solution**
- Septage Management Plan

**Somerset**
**Challenge**
- Small Dense Lots
- Private Water & Wastewater Disposal

**Solution**
- Connect into Existing Wastewater System

**Warrens Landing**
**Challenge**
- Madaket Harbor Watershed
- Small Dense Lots
- Private Wastewater Disposal

**Solution**
- Decentralize Wastewater Treatment

**Wauwinet**
**Challenge**
- Small Dense Lots
- Private Water Supply & Wastewater Disposal

**Solution**
- Septage Management Plan


Prepared For: Town of Nantucket, Department of Public Works, 188 Madaket Road, Nantucket, MA 02554
For Additional Information Contact: Mr. Jeffrey Willett, Director, Department of Public Works, 508-228-7244
Prepared By: Earth Tech, Inc., 196 Baker Avenue, Concord, MA 01742, Contact: Mr. Thomas Parece, P.E., 978-371-4142


Date Prepared: June 2003 (Revised: March 2004)

# Section 1.0

## Information Update Request of the Phase I MEPA Certificate

# 1.0 INFORMATION UPDATE REQUEST OF THE PHASE I MEPA CERTIFICATE

## A. NEEDS ANALYSIS DISCUSSION UPDATE

### 1. Introduction

A Town wide Needs Analysis was performed to determine whether or not conventional Title 5 on-site systems will be effective in disposing of wastewater within a given study area throughout and beyond the 20 year planning period. A "Needs Area" is defined as a Study Area where a majority of the developed or developable properties located within the Study Area will not be able to utilize a conventional Title 5 septic system to effectively dispose of wastewater throughout and beyond the 20-year planning period. Data obtained from Board of Health records, Assessor's files, and soil surveys of Nantucket performed by the U.S. Department of Agriculture were used to ascertain current land uses, associated soil and groundwater conditions, and to identify wastewater disposal problem areas. The objective of the Needs Analysis was to determine the specific Study Areas where conventional Title 5 wastewater disposal systems are inadequate or conversely, where existing on-site wastewater disposal systems can remain and be effective for wastewater disposal.

A comprehensive two stage approach was utilized in the analysis consisting of: (1) a rating criteria matrix created to establish or eliminate a Study Area as a need area (community provided data); and (2) an evaluation of each Study Area based only on predominant soils classification, seasonally high groundwater level, and a combination of system age and lot size (disposal system constraint data). This type of data is specifically used when designing an on-site conventional Title 5 wastewater disposal system and is used in this study to confirm or eliminate a Study Area as a need area as determined in the First Stage Analytical Approach-Rating Criteria Matrix.

### 2. First Stage Analytical Approach - Rating Criteria Matrix

During the first stage, a rating criteria matrix was developed to evaluate the entire Island, which was broken down into eighteen Study Areas. The matrix consists of four levels of criteria that are assigned rating points. The information gathered in this first stage is the "Community" information or data on file within the community such as Board of Health Records (Title 5 reports, system repairs, system pumping records, percolation test information), Assessor records (lot size, age, density of properties, resale records,

locations to wetlands and surface water bodies) and Water Department records (aquifer protection districts, proximity to wellheads, billing records for water use). The more comprehensive data that exists on file in the community, the more detailed the first stage analysis becomes and vice versa.

The highest rating is given to actual failures compiled from Board of Health records. The second highest rating is given to categorical failures based on current Title 5 regulations. The third highest rating is given to on-site systems that are at risk for failure/noncompliance, which are on-site systems that: (1) have severe groundwater limitations; (2) have severe soil limitations; (3) have on-site systems that were built before 1978; (4) are constructed on a lot size of one-half acre or less; and/or (5) have two or more septic tank pump-outs occurring within a calendar year. The fourth highest criteria is given to on-site systems that have health/water quality issues associated with on-site systems located: (1) in a Study Area with a density of on-site systems greater than two per acre; (2) within 100 feet of a surface water body; wetland or stream; (3) located within a 100 year flood plain; and (4) within a Zone II aquifer recharge area; and (5) located within either the Nantucket Harbor Watershed or Nantucket Harbor Watershed as defined by Chapter 99 of the Town By-Laws.

This “Community” data was compiled for each delineated Study Area and criteria points were established based on the sum of this information from the matrix. For each study area, the total criteria points were divided by the number of unsewered-developed lots. This in effect “normalized” the criteria points on a per lot basis and formed a rating number for each Study Area.

A “breakpoint” in the rating numbers is established from the tabulation of all of the Study Area “rating numbers”. The “breakpoint” for Nantucket is 7.33 based on the First Stage Analytical Approach-Rating Criteria Matrix.

The breakpoint was established by listing the corresponding rating number for each Study Area and calculating the difference between subsequent values. The largest differences were then studied. After reviewing this data, the 7.33 breakpoint value was selected because it best represented a threshold between specific conditions in Study Areas that are currently sewered, and thus warranted the construction of sewers in the past in Nantucket, and Study Areas that are currently unsewered.

All Study Areas with rating numbers that are greater than 7.33 were determined to be "Need Areas". The lower criteria point totals tend to reflect areas sustainable on current on-site systems whereas the highest criteria point totals tend to reflect areas that require a solution other than current on-site system. Refer to Table 1-1, Rating Criteria Points per Developed Lots. The table shows, the differences in the points per developed lots and that the breakpoint of 7.33 occurs in the Quidnet Study Area. As indicated in the preceding paragraph, review of the differences helps to set the breakpoint. The larger differences in points per developed lots represent a break in which one study area ranks significantly higher than the preceding study area listed. This break was determined to be significant in that, for example, Quidnet has more constraints in utilizing Conventional Title 5 Systems for on-site wastewater disposal than areas such as Miacomet or Surfside for example. The 7.33 break point was used to delineate the Study Areas into "No Need Areas" and "Need Areas". A second stage analytical approach was used to validate the break point assumption. Refer to Table 3D-1 from the Phase I Report.

**3. Second Stage Analytical Approach - Soils, Groundwater and Age/Lot Evaluation**

During the second stage of the analysis, each Study Area was evaluated based on predominant soil classification, groundwater levels, and a combination of system age and lot size or in total "disposal system constraint data". The three qualifying criteria are: (1) 50 percent or more of the lots within the Study Area meeting the age/lot size criteria (built before 1978 and a lot size of one-half acre or less); (2) 30 percent or more of the Study Area having severe soils limitations (hardpan, bedrock, slope, flooding and wetness); and (3) 20 percent or more of the Study Area having severe groundwater limitations (seasonally high water table at the surface to 2 feet deep). If two of these three criteria are met, then the Study Area is determined to be a need area.

**TABLE 1-1**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**RATING CRITERIA POINTS PER DEVELOPED LOT**

| Study Area | Points Per Developed Lot | Difference In Points Per Developed Lot |
|---|---|---|
| Miacomet | 1.990 | --- |
| Surfside | 2.263 | 0.273 |
| Tom Nevers Low-Density | 3.238 | 0.974 |
| Other | 3.720 | 0.482 |
| Shimmo | 4.168 | 0.448 |
| Tom Nevers High-Density | 4.475 | 0.307 |
| Siasconset | 4.519 | 0.044 |
| Town - WPZ | 4.597 | 0.078 |
| Town | 5.077 | 0.480 |
| Pocomo | 5.111 | 0.034 |
| Cisco | 5.161 | 0.050 |
| Monomoy | 6.170 | 1.009 |
| **Quidnet** | **7.333** | **1.163** |
| Somerset | 7.404 | 0.070 |
| Warren's Landing | 8.088 | 0.685 |
| Polpis | 8.186 | 0.098 |
| Madaket | 8.400 | 0.214 |
| Wauwinet | 9.260 | 0.860 |

A thorough side by side comparison of the results of the above referenced two stage evaluation methods is made to determine: (1) if a given Study Area shows consistent need; and (2) areas where there is a conflict in need (e.g. areas that show a need in one evaluation approach and no need in the other), which are then further evaluated in order to identify the real need. This comparison identifies small Sub-Study Areas, which are evaluated based on the second stage criteria, which include soils classification, groundwater levels, and a combination of system age and lot size. Utilizing these two steps provides a comprehensive approach to determine not only areas that require something other than the current on-site system, but also those areas that can sustain with their current on-site systems as a long-term wastewater solution.

**On-Site Wastewater Disposal System Age**

On-site wastewater disposal systems built before 1978 have a very high likelihood of failure due to the lack of design and construction controls placed on these systems prior to this date. If a developed lot had an on-site wastewater disposal system that was built before 1978, the system today would most likely fail a current Title 5 inspection. In 1978, Title 5 Regulations were promulgated by DEP and the local Boards of Health were required to enforce these regulations. The significance of this date is that prior to 1978, there were rules pertaining to the design and construction monitoring of on-site wastewater disposal systems, but these requirements were significantly less stringent and enforcement by the State Department of Public Health was ineffective.

**Lot Size**

Lot size will have a direct affect on whether or not a failed on-site wastewater disposal system can be repaired to meet current Title 5 criteria. It is a reasonable assumption that under less than ideal soil and groundwater conditions, all lots of one-half acre or less in an area would, as a minimum, require a variance to Title 5 in order to repair the on-site wastewater disposal system.

To better describe how lot size will affect the ability to repair an existing failed on-site wastewater disposal system, consider the following scenario: a one-half acre lot with typical dwelling, property line and structure setbacks along with Title 5 setbacks is shown in Figure 1-1. If the soils and groundwater levels are not problematic there is about 9,150 square feet available for a soil absorption system. A typical soil absorption system servicing a four-bedroom single-family residence generating 440 gallon per day of wastewater being disposed into the ground with a percolation rate of 10 minutes per inch will require about 2,500 square feet. If an on-site wastewater disposal system under the same general conditions has to be mounded, due to high groundwater, the land area required to build this system is about 4,400 square feet.

- If 30 percent of the one-half acre lot has severe soil limitations (hardpan, bedrock, etc.) the useable land for a new on-site system is reduced to less than 2,500 square feet.

- If 20 percent of the one-half acre lot has severe groundwater limitations (seasonally high groundwater level at the surface to 2 feet below grade) the useable land for a new on-site system is reduced to less than 4,400 square feet.

**Insert Figure 1-1**

**Combination Age and Lot Size Criteria**

If 50 percent or more of the properties within a study area have an on-site system that was built before 1978 and a lot of one-half acre or less, then the age/lot size criteria has been met. The percentage was chosen as it represents that the majority of the study area has a small lot size and an outdated on-site wastewater disposal system.

**Severe Soils Criteria**

If 30 percent or more of the soils within a study area classified as having severe limitations (hardpan, bedrock, slope, high permeability sands, flooding and wetness) the severe soils criteria has been met. The percentage represents the maximum amount of severe soils that can be present on a lot and still construct a conventional Title 5 system. Soil types were obtained from the Soil Survey Report by the U.S. Department of Agriculture.

**Severe Groundwater Criteria**

If 20 percent or more of a study area is classified as having a "moderately shallow" to "shallow" (high water table at the surface to 2 feet deep) seasonally high groundwater level the severe groundwater criteria has been met. The percentage represents the maximum amount of severe groundwater that can be present on a lot and still construct a conventional Title 5 system. High groundwater levels were obtained from the Soil Survey Report by the U.S. Department of Agriculture.

**Need Determination**

As per the Second Stage Analytical Approach, if two of the three criteria are met then the study area qualifies as a "Need Area". As previously discussed, the three criteria are: (1) having 50 percent or more of the properties within the study area meeting the age/lot size criteria (built before 1978 and a lot size of one-half acre or less); (2) having 30 percent or more of the study area with severe soils limitations (hardpan, bedrock, slope, high permeability sands, flooding and wetness); and (3) having 20 percent or more of the study area with severe groundwater limitations (seasonally high water table at the surface to 2 feet below grade).

If this hypothetical one-half acre lot had an on-site wastewater disposal system that failed and the property was developed before 1978 and the lot has either 30 percent severe soils or 20 percent high groundwater, the existing system could not be repaired using a conventional Title 5 system.

The options for a solution for this system would be either: (1) allowing variances to the conventional Title 5 system; (2) on-site innovative-alternative systems;(3) communal wastewater treatment and disposal; (4) local wastewater treatment and (5) regional wastewater treatment. Of these alternatives, the recommended solution for each study area with wastewater disposal needs will be presented in Phase II of the CWMP, based on comprehensive technical, environmental, and financial considerations.

Refer to Table 1-2 for a summary of the results from the rating criteria matrix for the entire Town from the Phase I Report on the next few pages. This shows all the criteria used for evaluation and exactly how it applied to each of the eighteen Study Areas in Town.

## 4. Results of Needs Analysis

The final results are summarized below for each study area.

### Madaket

This study area is comprised of 394 acres of which approximately 232 acres are currently developed. There are 435 developed lots located in this study area. The average age of the residential units is 30 years. This study area is about 50 percent developed. About 22 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 30 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade). Approximately 435 systems fall within 3,600 feet of Madaket Harbor.

Between 1972 and 1999, there were 105 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 44 percent, based on 70 resales.

**TABLE 1-2**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**RATING CRITERIA**

**TABLE 1-2 (cont)**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**RATING CRITERIA**

**TABLE 1-2 (cont)**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**RATING CRITERIA**

This study area has a criteria point rating of 8.40 per developed lot, which is above the threshold of 7.33. The properties within this study area have the following characteristics: approximately 46 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 22 percent have poor soils; and approximately 30 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

**Warren's Landing**

This study area is comprised of 49 acres of which approximately 26 acres are currently developed. There are 68 developed lots located in this study area. The average age of the residential units is 10 years. This study area is about 69 percent developed. Approximately 53 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and 221 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade). Approximately 34 systems fall within 3,600 feet of Madaket Harbor.

Between 1973 and 1999, there were 6 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 21 percent, based on 19 resales.

This study area has a criteria point rating of 8.08 per developed lot, which is above the threshold of 7.33. The properties within this study area have the following characteristics: no properties were developed before 1978 and had a lot size of one-half acre or less; approximately 53 percent have poor soils; and approximately 21 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

**Cisco**

This study area is comprised of 355 acres of which approximately 143 acres are currently developed. There are 143 developed lots located in this study area. The average age of the residential units is 19 years. This study area is about 70 percent developed. About 50 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 8 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 18 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 30 percent, based on 27 unsewered resales.

This study area has a criteria point rating of 5.16 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 9 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 50 percent have poor soils; and approximately 8 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's Septage Management Plan.

**Somerset**

This study area is comprised of 151 acres of which approximately 103 acres are currently developed. There are 161 developed lots located in this study area. The average age of the residential units is 12 years. This study area is about 78 percent developed. About 64 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 5 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 29 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 73 percent, based on 30 resales.

This study area has a criteria point rating of 7.40 per developed lot, which is above the threshold of 7.33. The properties within this study area have the following characteristics: approximately 1 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 64 percent have poor soils; and approximately 5 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

**Miacomet**

This study area is comprised of 296 acres of which approximately 197 acres are currently developed. There are 101 developed lots located in this study area. The average age of the residential units is 14 years. This study area is about 79 percent developed. About 51 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 3 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 14 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 53 percent, based on 15 resales.

This study area has a criteria point rating of 1.99 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 1 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 51 percent have poor soils; and approximately 3 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's Septage Management Plan.

**Surfside**

This study area is comprised of 685 acres of which approximately 363 acres are currently developed. There are 281 developed lots located in this study area. The average age of the residential units is 19 years. This study area is about 67 percent developed. About 16 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 7 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 48 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 48 percent, based on 44 resales.

This study area has a criteria point rating of 2.26 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 9 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 16 percent have poor soils; and approximately 7 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's Septage Management Plan.

**Tom Nevers – High Density**

This study area is comprised of 129 acres of which approximately 63 acres are currently developed. There are 255 developed lots located in this study area. The average age of the residential units is 8 years. This study area is about 73 percent developed. About 47 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 21 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 2 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 8 percent, based on 26 resales.

This study area has a criteria point rating of 4.48 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 1 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 47 percent have poor soils; and approximately 21 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's Septage Management Plan.

**Tom Nevers – Low Density**

This study area is comprised of 653 acres of which approximately 374 acres are currently developed. There are 122 developed lots located in this study area. The average age of the residential units is 15 years. This study area is about 63percent developed. About 44 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 5 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 28 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 27 percent, based on 48 resales.

This study area has a criteria point rating of 3.24 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 3 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 44 percent have poor soils; and approximately 5 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's Septage Management Plan.

**Siasconset**

This study area is comprised of 1,012 acres of which approximately 349 acres are currently developed. There are 664 developed lots located in this study area of which 127 are currently unsewered. The average age of the residential units is 56 years. This study area is about 63 percent developed with approximately 81 percent of the developed lots connected to the existing wastewater collection system. About 47 percent of the soils

in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 29 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 18 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 11 percent, based on 27 resales of unsewered developed lots.

This study area has a criteria point rating of 4.52 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 53 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 47 percent have poor soils; and approximately 29 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area since a majority of the study area is currently provided with wastewater collection, treatment and disposal.

**Quidnet**

This study area is comprised of 68 acres of which approximately 45 acres are currently developed. There are 45 developed lots located in this study area. The average age of the residential units is 47 years. This study area is about 58 percent developed. About 28 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 32 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 20 reported on-site wastewater disposal system upgrades or repairs in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 78 percent, based on 9 resales.

This study area has a criteria point rating of 7.33 per developed lot, which is at he threshold of 7.33. The properties within this study area have the following characteristics: approximately 36 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 28 percent have poor soils; and approximately 32 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented after the results of the Massachusetts Estuary Project is completed and will be based on comprehensive technical, environmental, and financial considerations.

**Wauwinet**

This study area is comprised of 61 acres of which approximately 51 acres are currently developed. There are 50 developed lots located in this study area. The average age of the residential units is 46 years. This study area is about 74 percent developed. About 15 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 47 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade). Approximately 50 systems are within the Harbor Watershed Line.

Between 1972 and 1999, there were 14 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 Regulations came into effect on March 31, 1995, the failure rate in this study area is 100 percent, based on 3 resales.

This study area has a criteria point rating of 9.26 per developed lot, which is above the threshold of 7.33. The properties within this study area have the following characteristics: approximately 10 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 15 percent have poor soils; and approximately 47 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented after the results of the Massachusetts Estuary Project is completed and will be based on comprehensive technical, environmental, and financial considerations.

**Pocomo**

This study area is comprised of 457 acres of which approximately 297 acres are currently developed. There are 81 developed lots located in this study area. The average age of the residential units is 24 years. This study area is about 58 percent developed. About 36 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 35 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade). Approximately 81 systems are within the Harbor Watershed Line.

Between 1972 and 1999, there were 15 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 55 percent, based on 11 resales.

This study area has a criteria point rating of 5.11 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 6 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 36 percent have poor soils; and approximately 35 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area since the study area abuts the Town Harbor and is entirely located within the Harbor Watershed Area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these

alternatives, the recommended solution for this study area will be presented after the results of the Massachusetts Estuary Project is completed and will be based on comprehensive technical, environmental, and financial considerations.

**Polpis**

This study area is comprised of 583 acres of which approximately 395 acres are currently developed. There are 59 developed lots located in this study area. The average age of the residential units is 44 years. This study area is about 59 percent developed. About 64 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 56 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade). Approximately 59 systems are within the Harbor Watershed Line.

Between 1972 and 1999, there were 22 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area is 100 percent, based on 10 resales.

This study area has a criteria point rating of 8.19 per developed lot, which is above the threshold of 7.33. The properties within this study area have the following characteristics: approximately 15 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 64 percent have poor soils; and approximately 56 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented after the results of the Massachusetts Estuary Project is completed and will be based on comprehensive technical, environmental, and financial considerations.

**Town**

This study area is comprised of 1,922 acres of which approximately 1,333 acres are currently developed. There are 3,943 developed lots located in this study area of which 890 are currently unsewered. The average age of the residential units is 64 years. This study area is about 83 percent developed with approximately 77 percent of the developed lots connected to the existing wastewater collection system. About 56 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 22 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade). Approximately 1972 systems are within the Harbor Watershed Line.

Between 1972 and 1999, there were 142 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 40 percent, based on 108 resales of unsewered developed lots.

This study area has a criteria point rating of 5.08 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 47 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 56 percent have poor soils; and approximately 22 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area since a majority of the study area is currently provided with wastewater collection, treatment and disposal.

**Town - WPZ**

This study area is comprised of 744 acres of which approximately 313 acres are currently developed. This area encompasses the Wellhead Protection Overlay Zone. There are 524 developed lots located in this study area of which 315 are currently unsewered. The average age of the residential units is 15 years. This study area is about 71 percent developed with approximately 40 percent of the developed lots connected to the existing wastewater collection system. About 43 percent of the soils in this study area are

classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 1 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 47 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 62 percent, based on 37 resales of unsewered developed lots.

This study area has a criteria point rating of 4.60 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 6 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 43 percent have poor soils; and approximately 1 percent have high groundwater.

Conventional Title 5 septic systems will be considered as the long-term wastewater disposal solution for portions of this study area as this study area is located within the Wellhead Protection Overlay Zone and approximately 40 percent is of the study area is currently provided with wastewater collection, treatment and disposal. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations. For those areas with on-site wastewater disposal systems, they will continue to be the recommended long-term solution for this study area. This study area should be maintained in accordance with the Town's Septage Management Plan.

**Shimmo**

This study area is comprised of 881 acres of which approximately 380 acres are currently developed. There are 137 developed lots located in this study area. The average age of the residential units is 21 years. This study area is about 48 percent developed. About 26 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope,

high permeability sands, flooding and wetness) and about 19 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade). Approximately 103 systems are located within the Harbor Watershed Line.

Between 1972 and 1999, there were 26 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 43 percent, based on 21 resales.

This study area has a criteria point rating of 4.17 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 1 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 26 percent have poor soils; and approximately 19 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area since the study area abuts the Town Harbor and approximately 75 percent is located within the Harbor Watershed Area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

**Monomoy**

This study area is comprised of 276 acres of which approximately 218 acres are currently developed. There are 184 developed lots located in this study area of which 178 are currently unsewered. The average age of the residential units is 29 years. This study area is about 70 percent developed with approximately 3 percent of the developed lots connected to the existing wastewater collection system. About 54 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands,

flooding and wetness) and about 16 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade). Approximately 184 systems are located within the Harbor Watershed Line.

Between 1972 and 1999, there were 47 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 90 percent, based on 19 resales of unsewered developed lots.

This study area has a criteria point rating of 6.17 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 14 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 54 percent have poor soils; and approximately 16 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area since the study area abuts the Town Harbor and is entirely located within the Harbor Watershed Area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

**Remaining Island**

This study area is comprised of 21,863 acres of which approximately 5,422 acres are currently developed. There are 818 developed lots located in this study area of which 812 are currently unsewered. The average age of the residential units is 26 years. This study area is about 32 percent developed with approximately 1 percent of the developed lots connected to the existing wastewater collection system. About 35 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability

sands, flooding and wetness) and about 24 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade). Approximately 161 systems are located within the Harbor Watershed Line.

Between 1972 and 1999, there were 170 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 53 percent, based on 114 resales of unsewered developed lots.

This study area has a criteria point rating of 3.72 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 5 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 35 percent have poor soils; and approximately 24 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's Septage Management Plan.

Of the eighteen studies areas, seven study areas have been identified as having a need or are currently located within the existing service are, while the remaining study areas can be maintained in accordance with the Town's Septage Management Plan. Refer to Table 1-3 for a summary of the Needs Analysis.

## B. WASTEWATER FLOW UPDATE

In the Phase I Report, wastewater flows were estimated for each study area for both the initial and design years. The estimates are based on the number of developed lots and undeveloped parcels within each study area based on the Assessor's information. The design wastewater flow for each study area was calculated from the undeveloped parcel and acreage data to determine the design number of developed lots.

**TABLE 1-3**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**STUDY AREA LONG TERM WASTEWATER DISPOSAL OPTION**

| | Long Term Wastewater Disposal Option | |
|---|---|---|
| Study Area | On-site Innovative Alternative Systems, Local or Satellite WWTF | Septage Management Plan |
| Miacomet | | X |
| Surfside | | X |
| Tom Nevers Low-Density | | X |
| Other | | X |
| Shimmo | X | |
| Tom Nevers High-Density | | X |
| Siasconset | X | |
| Town - WPZ | | X |
| Town | X | |
| Pocomo | | X |
| Cisco | | X |
| Monomoy | X | |
| Quidnet | | X |
| Somerset | X | |
| Warren's Landing | X | |
| Polpis | | X |
| Madaket | X | |
| Wauwinet | | X |

The wastewater flow estimates have been expanded to include future flows from second dwellings. Nantucket bylaws allow for a second dwelling to be built on buildable lots. The wastewater flow estimates assumes that it is possible to build second dwellings on two thirds of the current developed and undeveloped buildable lots. Refer to Table 1-4 for a summary of the updated flows for each Need Area.

**TABLE 1-4**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**ESTIMATED WASTEWATER FLOWS BY STUDY AREA**

| Study Area | Design Flows without Second Dwellings (gpd) | | Design Flows with Second Dwellings (gpd) | |
|---|---|---|---|---|
| | Winter | Summer | Winter | Summer |
| Madaket | 101,715 | 175,730 | 169,516 | 293,007 |
| Warrens Landing | 16,465 | 28,480 | 27,497 | 47,562 |
| Somerset | 38,225 | 65,700 | 63,139 | 108,794 |
| Siasconset | 163,340 | 280,230 | 268,945 | 462,899 |
| Quidnet | 9,620 | 16,640 | 16,065 | 27,789 |
| Wauwinet | 11,250 | 19,250 | 18,439 | 31,685 |
| Pocomo | 20,980 | 36,185 | 34,862 | 60,198 |
| Polpis | 15,245 | 26,265 | 25,285 | 43,631 |
| Town | 883,710 | 1,470,245 | 1,378,766 | 2,326,559 |
| Town-WPZ | 147,920 | 237,115 | 215,845 | 354,606 |
| Shimmo | 34,300 | 59,225 | 57,107 | 98,675 |
| Monomoy | 42,295 | 72,740 | 69,936 | 120,551 |
| Total Design Flows | 1,485,065 | 2,487,805 | 2,345,402 | 3,975,955 |

Note:

1. Estimated Wastewater Flows do not include an allowance for infiltration/inflow.

The estimated design flows were then assigned to existing water treatment facilities or future wastewater treatment facilities. The assigned flows were used to as design flows for the evaluation of short listed alternatives. Refer to Table 1-5 for a summary of the updated flows by wastewater treatment facility. The design flows for Quidnet, Wauminet, Pocomo, and Polpis will be managed with a Septage Management Plan.

**TABLE 1-5**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**ESTIMATED WASTEWATER FLOWS BY**
**WASTEWATER TREATMENT FACILITY**

| Study Area | Flow – Design Summer (gpd) | Wastewater Treatment Facility Flow – Design Summer (gpd) | | |
|---|---|---|---|---|
| | | Surfside | Siasconset | Madaket |
| Madaket | 293,007 | | | 293,007 |
| Warrens Landing | 47,562 | | | 47,562 |
| Somerset | 108,794 | 108,794 | | |
| Siasconset | 210,175 | | 210,175 | |
| Town | 2,326,559 | 2,326,559 | | |
| Town-WPZ | 354,606 | 354,606 | | |
| Shimmo | 98,675 | 98,675 | | |
| Monomoy | 120,551 | 120,551 | | |
| Total Design Flows | | 3,009,185 | 210,175 | 340,568 |

Notes:

1. The estimated wastewater flow for Siasconset has been adjusted based on the approved Facility Plan dated December 1997 which calculated the future summer season sewered population being 75 percent of the future summer season total population.
2. Estimated Wastewater Flows do not include an allowance for infiltration/inflow.

## C. DISPOSAL SITE ALTERNATIVES

The CWMP/FEIR Phase III Document in its entirety addresses this topic.

## D. WATER SUPPLY

Section 6 of the CWMP/FEIR Phase III Document addresses this topic.

## E. PLANNING FOR GROWTH (EXECUTIVE ORDER #385)

The CWMP/FEIR Phase III Document in its entirety addresses this topic.

# Section 2.0

## Identify and Discuss Alternatives for Wastewater Disposal

# 2.0 IDENTIFY AND DISCUSS ALTERNATIVES FOR WASTEWATER DISPOSAL

## A. INTRODUCTION

A variety of wastewater alternatives were investigated during the Phase III CWMP/FEIR to determine the appropriate wastewater facilities that will meet the needs of Nantucket. The wastewater alternatives that were investigated include: (a) the continued use of existing on-site wastewater disposal systems; (b) replacement of existing wastewater disposal systems with Title 5 systems; (c) replacement of existing wastewater disposal systems with on-site innovative/alternative options; (d) replacement of existing wastewater disposal systems with cluster systems consisting of a pressure system and communal subsurface disposal; and (e) replacement of existing wastewater disposal systems with a conventional sewer collection system, either: (1) connection into the existing collection system; (2) gravity sewers and pump station, (3) pressure sewers and grinder pumps, or (4) a combination thereof. Each wastewater alternative was evaluated based on environmental and technical design criteria and on site-specific data such as subsurface conditions, topography, and existing septic system performance. The CWMP/FEIR Phase III document evaluated the environmental, technical design and institutional cost associated with each alternative and recommends the appropriate solution to the wastewater disposal problems for the Town of Nantucket in order to reach a long-term solution to the wastewater needs of the Island.

## B. OPTIMIZE OPERATION AND MAINTENANCE OF EXISTING ON-SITE SYSTEMS

One alternative considered is optimizing the performance of the existing on-site wastewater disposal systems, which includes optimizing septage management plans, maintenance, and repair and upgrade of current on-site systems. If this alternative were pursued Island-wide, all developed lots currently not in a sewer service area, would remain dependent on their existing on-site wastewater disposal systems. As documented in the Phase I CWMP/EIR Document, there are substantial documented failures and disposal systems with eminent problems in Nantucket. This alternative looked at each individual Study Area identified in the Phase I Document and evaluate the potential for remaining on the current on-site wastewater disposal systems under a Septage Management Plan. Assessments of various levels of compliance, including maximum feasible compliance will be made. The potential effects on surface water quality, coordinating efforts with the State Estuary Project in the Nantucket Harbor, Sesachacha Pond and Madaket Harbor areas, will be discussed. Additional assessments were made on groundwater quality and the protection of the sole source aquifer, growth in the planning area as it relates to Executive

Order 385, land use limitations and socioeconomic factors such as residential and industrial development and public health issues. Economic and legal impacts to the Town and all regulatory requirements of the State Department of Environmental Protection (DEP) and the Federal Environmental Protection Agency (EPA) were considered and discussed.

The Town of Nantucket has recently embarked on a study to develop a Septage Management Plan (SMP) for the Island. The SMP will be completed in coordination with the final recommendations of this Phase III CWMP/FEIR document in order to provide a long-term solution to those areas on Island evaluated and recommended for this alternative.

**1. Repair / Upgrade Existing On-Site Systems**

One alternative considered for the areas of wastewater disposal need on the Island is continued use of existing systems with emphasis on optimizing the performance of the existing on-site wastewater disposal systems. This includes optimizing septage management plans, maintenance, and repair and upgrade of on-site systems.

Failing on-site wastewater disposal systems contribute to the degradation of water quality of groundwater, wetlands and surface water. The surface waters bordered by areas of wastewater disposal need on the Island are: Tom Nevers Pond, Sesachacha Pond, The Creeks, Miacomet Pond, Shimmo Creek, Hither Creek, Long Pond, No Bottom Pond, and Reed Pond. The swamps and/or wetlands bordered by areas of wastewater disposal need are: Pocomo Meadow, Squam Swamp, Rolgers Marsh, Millbrook Swamp, Brunt Swamp, and Madaket Ditch. The harbors bordered by areas of wastewater disposal need on the Island are: Nantucket Harbor, Madaket Harbor, and Polpis Harbor. These water bodies and water ways are located adjacent, within, and downstream of the areas of wastewater disposal need and are threatened by existing on-site wastewater disposal systems (both properly operating as well as malfunctioning systems depending on the soils present and groundwater table) which will eventually contribute to water quality degradation due to contamination of groundwater.

As time passes, the non-conforming on-site wastewater disposal systems that do not meet current Title 5 rules and regulations will become less adequate and will contribute to the degradation of groundwater, wetlands and surface water. These sub-standard on-site wastewater disposal systems combined with soils with severe limitations for subsurface

sewage disposal and high groundwater levels are a potential health hazard. With increased system age combined with these environmental issues, it is expected that property owners will experience future operating nuisances and eventually failures. If the water quality of surface water bodies continues to decline, Nantucket will potentially lose a very important recreational resource. Declining water quality of Miacomet Pond, Hither Creek, Long Pond, Nantucket Harbor, Madaket Harbor, and Polpis Harbor may reach such unacceptable levels that swimming could be prohibited.

As more on-site wastewater disposal systems fail, individual property owners will be required to upgrade their systems to a conventional or innovative/alternative Title 5 system. If this cannot be accomplished due to the physical site conditions, a tight tank would be required and would only be approved by the DEP to eliminate a failed system. The cost of frequently pumping these tight tanks will be a financial burden for the property owners. Property owners would not be able to expand their homes and/or even fully use their existing facilities. In this scenario, property values would decline.

With the increased potential of the degradation of both the water quality in the surface water bodies and the drinking water supply from the sole source aquifer, Nantucket is obligated to provide for acceptable wastewater disposal for the areas of need. Continued use or repair/upgrade of the existing on-site disposal systems in the areas of need is not recommended as the wastewater disposal solution for the entire area of need due to the likelihood that not all existing systems could be repaired or upgraded to conform to Title 5. Continued operation of poor or substandard disposal systems poses public health hazards, environmental degradation and is a real threat to the sole source aquifer.

If it is recommended that the existing on-site wastewater disposal systems in specified Study Areas will continue to be used, then, at a minimum, these systems need to be operated and maintained under a septage management plan. The purpose of a septage management plan is to maintain the operation of septic systems that will protect the groundwater and reduce the expansion of the areas of wastewater disposal need, which require structural solutions such as treatment facility and collection system. The recommended septage management plan should include such items as recommended septage pump-out frequencies and maintenance of on-site wastewater disposal systems.

Public education concerning the importance of proper maintenance of on-site wastewater disposal systems is a beneficial means of prolonging the life of these systems, and will be included as part of the recommended septage management plan.

**2. Conventional Title 5 System**

This wastewater alternative entails replacing the existing on-site septic systems with Title 5 systems for wastewater management within the wastewater disposal need areas of the Island. Under this option, the systems that do not meet the requirements of Title 5 would be replaced with new Title 5 systems. The remaining septic systems would be upgraded or replaced when it becomes necessary such as when the system fails.

The Massachusetts Environmental Code, 310 CMR 15.000, effective March 31, 1995 govern Title 5 systems. The standard components of a Title 5 system are a building sewer, septic tank, distribution box, soil absorption system, and reserve area. Wastewater exits the building through its building sewer and enters the septic tank where solids are settled and retained. The septic tank effluent flows through the distribution box and to the soil absorption system where it is distributed and treated prior to discharge to appropriate subsurface soils. A schematic of this system is shown on Figure 2-1.

The Title 5 state code dictates certain requirements for the soil absorption system. For instance, the minimum vertical separation distance from the bottom of the stone underlying the soil absorption system to the top of the seasonally high groundwater table is 4 feet in soils where the percolation rate is greater than 2 minutes per inch (mpi) and 5 feet in soils where the percolation rate is less than or equal to 2 mpi. In addition, there must be at least 4 feet of naturally occurring pervious soil below the entire area of the soil absorption system and the reserve area. Title 5 requires a reserve area to be located on the property such that it can be used in case the primary soil absorption system fails. No building, driveway or other physical improvement can be made to the reserve area; it must remain in its pristine state. Setback requirements are also given in the Title 5 code, which identifies the minimum horizontal separation required between the soil absorption system and items such as a drinking water well, property lines and wetlands.

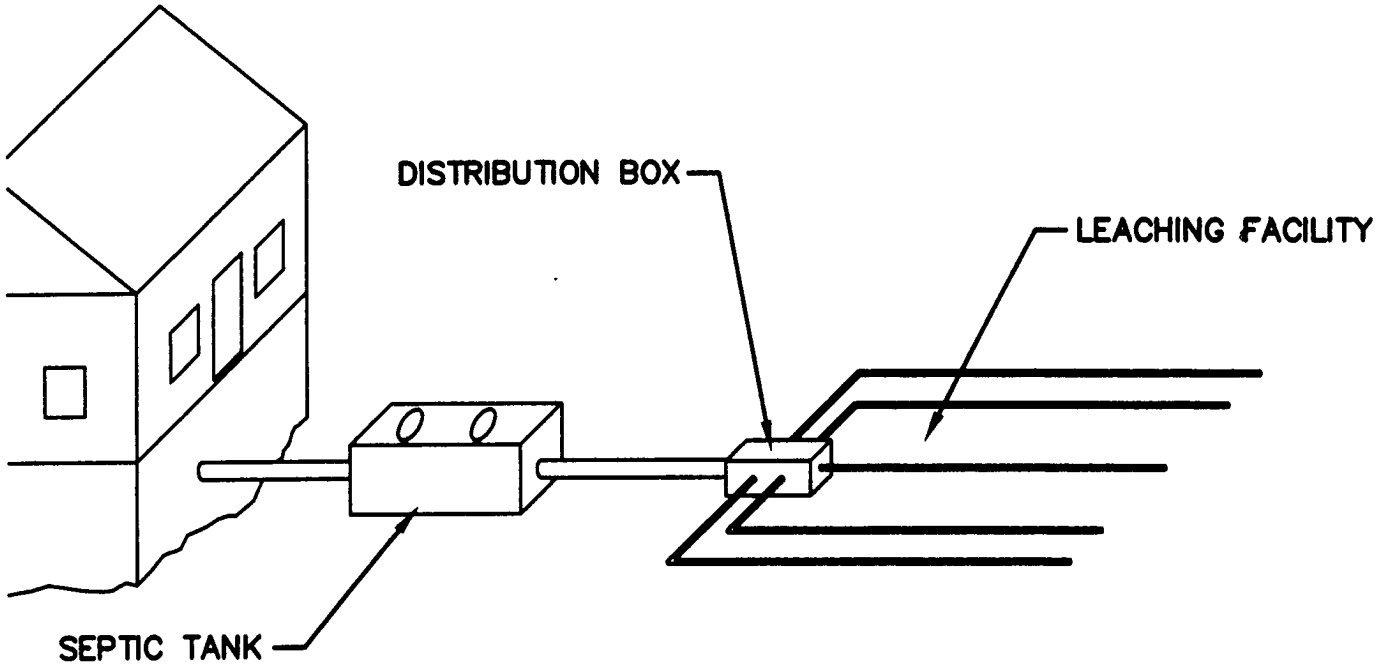



Figure 2-1
Conventional Title 5 System

In order to assess the suitability of replacing existing on-site wastewater disposal systems with new Title 5 systems, several critical criteria need to be addressed. The most common reasons that on-site septic systems fail (including Title 5 systems) is due to overloading, poor construction, and poor maintenance. Assuming the systems are properly constructed and maintained, the remaining issue to address is overloading of the system. Several ways in which a soil absorption system can be overloaded are (1) hydraulically overloading the soil, (2) pollutants clogging within the soil, and (3) insufficient depth of naturally occurring pervious soil that results in improper treatment of the effluent. Standard design practices should deal with each of these issues. The most difficult condition to overcome is subsurface conditions including shallow depth to groundwater and insufficient depth of naturally occurring pervious soil.

Variances from Title 5 code may be granted for septic systems that are unable to meet the groundwater separation distance, depth to impervious layer, or other provisions of Title 5. These systems are referred to as Title 5 Systems with Variances. In these cases, a mounded system would be constructed. A mounded system is not a conventional Title 5 system. Mounded systems are sited in areas where there are slowly permeable soils, shallow permeable soils over creviced or porous bedrock, or permeable soils with high water tables.

## C. WASTEWATER COLLECTION, TREATMENT AND DISPOSAL ALTERNATIVES

### 1. Flow and Waste Reduction

The entire Island relies on public and private water supply wells, which draw from a groundwater supply or aquifer. There are two public water supply companies on the Island; (1) Wannacomet Water Supply Company and (2) Siasconset Water Company. There is also a small drinking water supply well servicing approximately 15 homes in the Wauwinet area of the Island. The private drinking water wells on Island fall under the jurisdiction of the Nantucket Board of Health.

The Town of Nantucket understands the significance of reducing its wastewater flows. One of the ways to ensure this minimization is to implement water conservation measures to reduce water use. In the development of the septage management plan, a significant effort will be devoted to water conservation measures. At this point in time, any efforts have been suggestive in nature due to the jurisdictional issues.

Varieties of water conservation options have been presented by the DEP in the "1992 Water Conservation Standards for the Commonwealth of Massachusetts". These options are discussed below.

**Public Education**

Public education involves the dissemination of information and getting public support by providing a basic understanding of sound water resources management. One of the three main areas of emphasis that should be included in an educational program is explaining to water users the various costs that are associated with providing water. These costs include planning, engineering, construction, operation, maintenance, treatment, wastewater facilities costs, piping, leak detection, infiltration/inflow reduction measures, compliance costs, salaries and benefits, protection costs, training, and public education. Other areas of emphasis include providing water system users with tangible evidence of the cost savings and environmental benefits that can be attained through water conservation. Materials for education programs may be sought from the Massachusetts Water Works Association, the New England Water Works Association and other organizations, and funded by local water and sewer revenues.

The "1992 Water Conservation Standards" makes the following suggestions for developing a successful public education program: (1) the largest users should be targeted early on to realize the greatest potential savings; (2) public education should reach to the schools to get the children involved; (3) water bills should include a worksheet to enable customers to track water use and conservation, and figure the dollar savings; (4) publicly advertise water conservation successes (and failures) / public service announcements; (5) joint advertising with hardware stores to promote household conservation devices; and (6) provide information on landscaping, gardening, and lawn care practices that promote water conservation.

The Wannacomet Water Supply Company has developed an aggressive public education program through effective communication with its customers and partnerships with the business and school communities on Island. The *Annual Water Quality Report* for 2001 and 2002 details the efforts the Wannacomet Water Supply Company has expended to reach out to the community.

In the Spring of 2001, Wannacomet Water Supply Company joined the Mid-Island Partnership, which is a group of local businesses working together to improve the Island. Wannacomet Water Supply Company also collaborates regularly with the Nantucket Rotary Club.

Each year for the last three years, Wannacomet Water Supply Company participated in the annual Cottage Hospital Health Fair providing information about water quality, the sole source aquifer and water conservation.

Wannacomet Water Supply Company also participates in the education of the youth on Island, working with the elementary, middle and high schools with various programs, including the importance of water conservation. It has developed a "School-to-Career Program" with the local high school to provide internships to seniors. In addition to the Annual Water Quality Report, Wannacomet Water Supply Company distributes various literature for public education on water quality and conservation. Refer to Appendix B for copies.

**Leak Detection and Repair**

Leak detection and repair is intended to reduce the amount of water lost via leaks in the water distribution system. This maintenance activity is considered most important in older water systems. Leak detection programs can vary but should be carried out regularly by the water suppliers.

**Metering**

Complete system metering lets customers know how much water they are using, provides Nantucket with valuable knowledge of customer use patterns, assists in demand management programs, and enables Nantucket to bill the customer accurately. With accurate knowledge about current demand, Nantucket can more effectively identify potential water savings, assist specific users to implement water saving measures, determine unaccounted for water, and thereby provide the opportunity to reduce overall system demand and plan efficiently for system growth. Metering costs should be recovered through water rates, and include not only the costs for the metering equipment, but also the costs associated with reading the meters regularly.

In 2002, Wannacomet Water Supply Company transitioned from quarterly to monthly billings for themselves as well as the Siasconset Water Company. This decision was based on three objectives: (1) the need to obtain more accurate water accountability data; (2) improve cash flow; and (3) have the ability to detect potential problems or leaks in the customer's service line and interior plumber sooner rather than later.

In 2002, Wannacomet Water Supply Company completed the implementation of the Automated Meter Reading System. All water meters in the system are now read via a mobile reading systems that is much more accurate than done manually. In order to convert to this automated service, all accounts had to be reviewed and a new meter installed.

**Pricing**

Full-cost pricing refers to price levels that recover all the direct and indirect costs associated with providing water. For all sectors of water use, knowing the costs associated with providing water and sewer services creates an appreciation of the importance of conserving water and promotes greater understanding of the direct relationship and environmental implications of individual water use and community water resources, especially during seasonal or drought shortages. The pricing structure for water should include the complete cost to run the system. These costs include pumping, maintenance, electricity/fuel, treatment, distribution system operation and maintenance, watershed/well site purchase/protection, capital replacement fund, capital depreciation account, and debt service, purchase and installation of water conservation retrofit equipment, public education program, staff and benefits, and leak detection and repair.

The Nantucket Water Commission held a public informational hearing in 2001 to discuss adopting new water rates, which had not been increased in over ten years. In 2002, the commission adjusted the fees for meter and service installations. A basic rate is charged for water, including the seasonal properties that shut off water for the winter, even if there is zero usage. This charge covers annual operating expenses, debt service, insurance costs, production and distribution system maintenance, billing and customer support services.

**Residential Water Use**

Residential water use from Massachusetts' public water suppliers amounts to about 450 million gallons per day. Increasing efficiency of use and implementing conservation measures can realize significant savings for consumers and suppliers, both in energy and water costs. Residential users should be encouraged to use the following water saving devices: low-flow showerheads, faucet aerators, toilet displacement devices and/or low-flow toilets, toilet leak detection kits and moisture detectors on underground irrigation systems.

**Public Sector Water Use**

Public municipal and state buildings and facilities should serve as demonstrations of water saving techniques and concepts. The public should be aware that the state and municipalities are not only doing their part, but also leading the way. Public facilities (schools, hospitals, public offices, etc.) should be built or retrofitted with water conservation devices such as faucet aerators, low flow shower heads, toilet displacement devices or low-flow toilets, and self-closing faucets. Other public sector policies should include charging contractors for using fire hydrants for pipe flushing and other construction purposes.

**Industrial, Commercial, and Institutional Water Use**

The bulk of industrial, commercial, and institutional water use is for heating, cooling, and processing, but often includes an appreciable sanitary and landscaping component. Conservation measures must be tailored to reflect the type of water use and characteristics of individual facilities. A reduction in facility water uses as well as a reduction in pollutant discharge often accompany the implementation of source reduction programs. Water conservation can be built into an industry's strategy to comply with sewer and discharge requirements and often results in monetary savings following short payback periods. All industrial, commercial, and institutional water users should be required to develop and implement a written water policy addressing at a minimum demand management, leak detection and repair, a program of preventive maintenance, and a program of employee education.

They should also be required to perform water audits to determine the location and amount of water used for heating, cooling processing, sanitary use, and outdoor use. This information could then be used to determine areas to conserve water. Industrial, commercial, and institutional users should also be required to install water saving sanitary devices.

Industrial, Commercial, and Institutional Water Use is relatively small, accounting for approximately five percent of the land use on Island. As previously mentioned, Wannacomet has partnered with business groups on Island and the Rotary Club working towards Island sustainability.

**Water Supply System Management**

The Nantucket Water Commission and more specifically the Wannacomet Water Supply Company has taken advantage of many options for improving the efficiency of its operations, educating the public and encouraging water conservation by consumers. The public education to date developed by Wannacomet Water Supply Company provides a framework for implementing these standards and establishing long-term priorities and plans for system maintenance, source protection, and, as necessary, new source development.

On April 12, 1999 at annual Town Meeting, Article 68, Nantucket adopted a set of Conservation Bylaws, which were approved August 10, 1999 defining the public water supply use restrictions on Island. Included in this bylaw under Chapter 114 are the following:

- Authority;
- Purpose;
- Definitions;
- Declaration of a State of Water Supply Conservation;
- Restricted water uses;
- DEP and Public Notification of a State of Water Supply Conservation;
- Termination of Water Supply Conservation notice;
- State of Water Supply Emergency/DEP compliance; and
- Penalties.

## 2. Decentralized Facilities

The Study Areas of wastewater disposal need identified in the Phase I Document are currently relying on individual on-site wastewater disposal systems for wastewater treatment and disposal. A majority of these systems are substandard, provide a low level of treatment, and do not comply with the requirements of Title 5. The Phase I Document identified eleven study areas that were determined to need some sort of upgraded wastewater disposal, whether it be a stringent septage management plan, sewage collection system, cluster systems serving a limited number of homes, or on-site innovative/alternative disposal systems. This section will discuss the option of providing each property that has an existing on-site wastewater disposal system with an on-site or decentralized innovative/alternative wastewater disposal system. The systems considered include (1) STEP/Cluster Systems; (2) Small-scale Wastewater Treatment Plants; and (3) On-Site Innovative/Alternative Systems.

This alternative will be fully discussed and analyzed in those areas on Island affected with an embayment included in the State Estuary Project. A coordination of efforts with the Estuary Project will ensure long-term on-site wastewater disposal in compliance with the final results or Total Maximum Daily Load (TMDL) of this project in the Nantucket Harbor, Sesachacha Pond and Madaket Harbor areas.

A Title 5 system achieves only a nominal level of treatment in terms of Biochemical Oxygen Demand ($BOD_5$) and Total Nitrogen removal. Based on the compilation of various studies and DEP data, typical effluent concentrations from a conventional Title 5 septic tank are as follows: the effluent $BOD_5$ concentration is 170 mg/L; the effluent Total Suspended Solids (TSS) concentration is 60 mg/L; and the effluent Total Nitrogen concentration is 42 mg/L with the majority of this total being ammonia nitrogen. Comparing these effluent concentrations with the influent concentrations noted during the evaluation of Title 5, ($BOD_5$ = 300 mg/L, TSS = 300 mg/L, and TN = 45 mg/L), the conventional system can achieve about 43 percent removal of $BOD_5$, about 80 percent removal of TSS and only 6 percent removal of Total Nitrogen. These influent concentrations to individual septic tanks were found to be higher than those of a medium strength wastewater. According to “Wastewater Engineering: Treatment, Disposal, Reuse” by Metcalf and Eddy, a medium strength wastewater has a Biochemical Oxygen Demand ($BOD_5$) of 220 milligrams per liter (mg/L), a Total Suspended Solids (TSS) of

220 mg/L, and a Total Nitrogen (TN) concentration of 40 mg/L. A typical wastewater treatment facility will remove 85 percent of the $BOD_5$ and TSS and 60 to 80 percent of the Total Nitrogen. These parameters are used in this section only to show the removal efficiency of the Title 5 system. Title 5 systems do not adequately remove nutrients from the wastewater before it enters the leaching field. From this it can be concluded that even a properly installed and operating Title 5 septic system will still discharge levels of pollutants which impact the quality of the receiving groundwater, in cases where the groundwater enters the bottom of the soil absorption area.

**STEP/Cluster Systems**

One decentralized treatment alternative to a Title 5 system considered was the Septic Tank Effluent Pump (STEP) System which pumps septic tank effluent through a pressurized sewer to a small-scale, off-site subsurface disposal cluster system or treatment facility. This system consists of a septic tank that concentrates and collects the solids from the wastewater and a pump, which pumps the septic tank effluent to a cluster subsurface disposal system or treatment facility. Schematics of a typical STEP System and Subsurface Cluster System are shown on Figure 2-2 and Figure 2-3, respectively.

Based on Title 5 requirements, a maximum flow of 10,000 gallons per day is allowed to be discharged to a subsurface trench disposal system before a sewage treatment plant is required. A treatment facility may or may not be required depending on the specific wastewater flow from each of the individual need areas. The land area required for a trench system for 10,000 gallons per day (about 45 residential/ commercial units) is about 17,800 square feet, assuming an optimal percolation rate of less than 5 minutes per inch with Class I soils (sands, loamy sands) equaling 0.74 GPD/SF (based on Title 5 requirements).

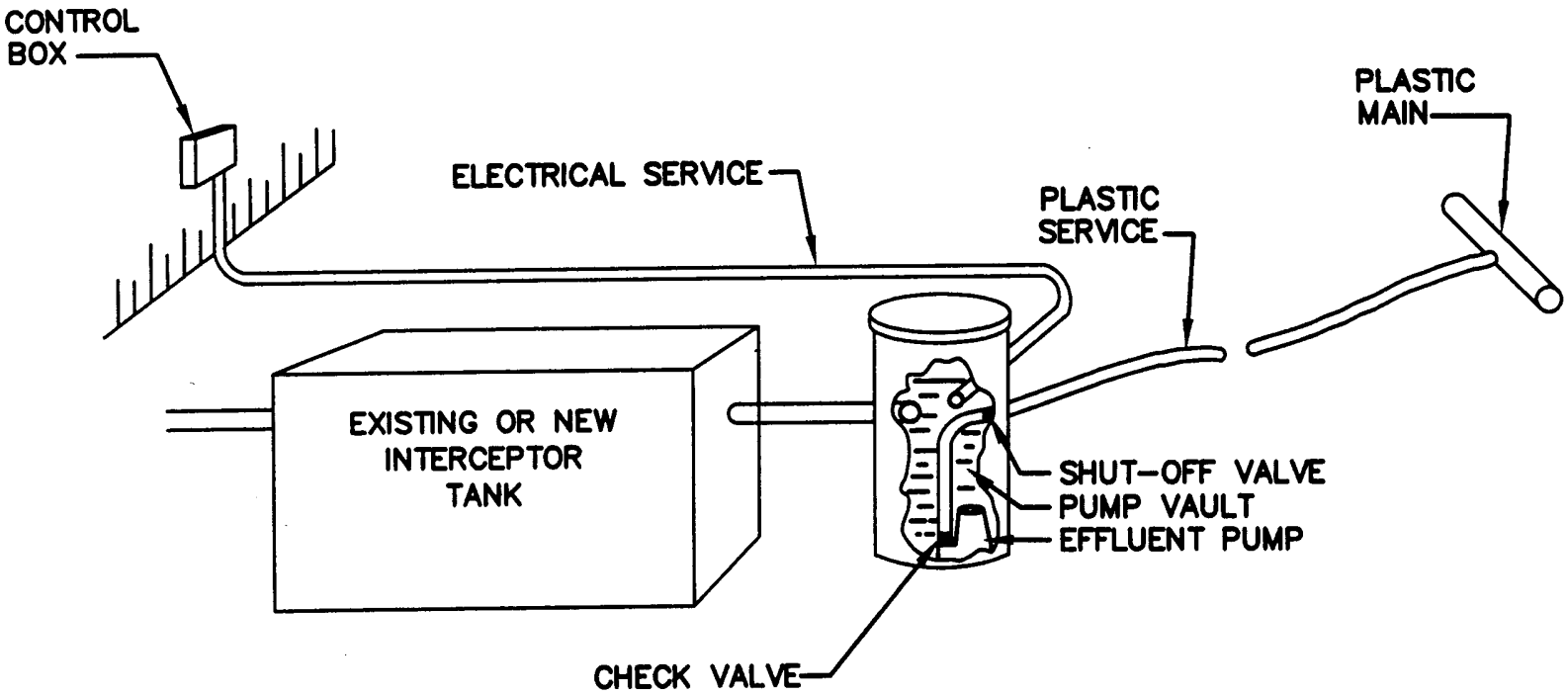



Figure 2-2
Typical STEP System

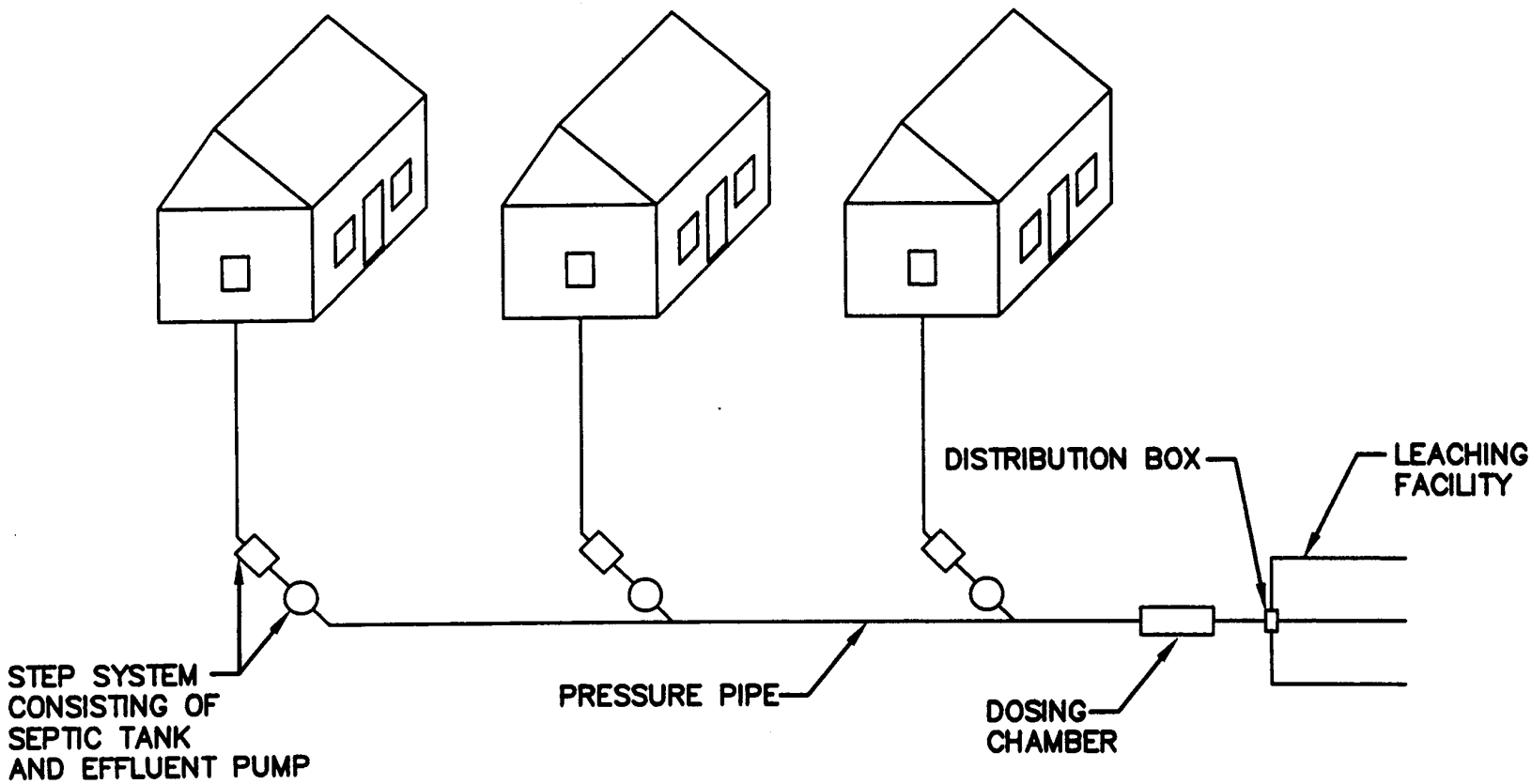



Figure 2-3
Subsurface Cluster System

For the purpose of this calculation, it was assumed that each trench is 2 feet wide by 2 feet deep and 100 feet long, and that there is 6 feet between trenches. Title 5 also requires space to be set aside for a reserve area in the event of system failure; however, it allows the space between trenches to be used as the reserve. Therefore, the total area required for 10,000 gallons per day is 17,800 square feet (approximately 0.4 acres), which represents the minimum size of any one system based on the above assumptions. This area only includes the area needed for the subsurface disposal system itself, and does not include required setbacks from property lines, water bodies, buildings, slopes, etc. The land area required due to setback limitations can only be determined when an appropriate disposal area has been identified and designated, but an additional 50 percent would not be excessive. Hence 0.6 acres would be appropriate. Although the foregoing space requirements are needed to meet all of the setback limits of Title 5, it is quite common for septic systems to be sited within smaller spaces and still function well.

STEP systems can be used to pump the effluent from individual residences through a pressurized sewer to a small-scale treatment facility. As with a conventional Title 5 system, the septic tanks must be routinely pumped to remove solids.

**Small-Scale Wastewater Treatment Plants**

If more than 10,000 gallons per day is to be treated, a subsurface disposal system will no longer be adequate and a treatment plant will be required. A typical plant consists of an enclosed building which would include: anoxic pretreatment, primary settling and a sludge storage tank; a flow equalization and pump chamber in order to normalize flow over 24-hour periods; an aerobic biological process for organics reduction and nitrification; a secondary clarifier; an anoxic denitrification process; sand filtration and disinfection. The building would also typically include a laboratory, office and a utility and equipment room. The amount of land required for the plant itself and related site items varies with the capacity of the plant. The size of the disposal fields, however, is based directly upon the flow and according to the "Guidelines for the Design, Construction, Operation and Maintenance of Small Sewage Treatment Facilities with Land Disposal," January 1988 (as published by the Massachusetts Department of Environmental Quality Engineering, Division of Water Pollution Control), a reserve area tested and shown to be sufficient to replace the capacity of the original leaching area would be required. Again, assuming an optimal percolation rate with good soils, open

sand beds can treat 5.0 gallons per day/square feet and a subsurface trench system can treat 2.5 gallons per day/square feet (based upon "Guidelines for the Design, Construction, Operation and Maintenance of Small Sewage Treatment Facilities with Land Disposal"). For the open sand bed alternative, this would consequently result in a much smaller field of 2,000 square feet. Including 2,000 square feet for a reserve area, the total land area required for the open sand bed alternative would be 4,000 square feet (about 0.1 acre) for the equivalent wastewater flow of 10,000 gallons per day. Assuming trenches that are 2 feet wide by 2 feet deep by 100 feet long and a 6 foot wide area between trenches, a subsurface trench disposal system would occupy 5,000 square feet. The area between the trenches can be used as the reserve area. Therefore, the total area required for the equivalent 10,000 gallons per day flow utilizing a subsurface trench system would be 5,000 square feet to over 100,000 square feet depending upon the percolation rate of the soil.

**On-Site Innovative/Alternative (I/A) Systems**

Title 5 allows for the use of Innovative/Alternative (I/A) technologies with DEP approval. Periodically, the DEP issues an updated memorandum entitled: "Title 5 I/A Technologies Approved for use in 310 CMR 15.000 Massachusetts". This memorandum provides a description and status for a variety of innovative and alternative technologies. A number of these I/A technologies provide enhanced wastewater treatment with nitrogen reduction. Of these technologies, the on-site alternative systems that will be evaluated for use in each of the areas or wastewater disposal need are the Recirculating Sand Filter, Amphidrome™ Process, Bioclere™ System, Cromaglass®, RUCK® System, and the Single Home FAST®.

According to Title 5, "alternative systems, when properly designed, constructed, operated and maintained, may provide enhanced protection of public health, safety, welfare and the environment." I/A systems are recommended for use in areas where a conventional Title 5 system cannot be sited. Title 5 details an approval process which proponents of each respective innovative/alternative technology must adhere to in order to gain approval of their alternative system. DEP approves the I/A technologies under four main categories: Approval for Piloting; Provisional Approval; Certification for General Use; and Approval for Remedial Use. These categories are described in the following paragraphs:

- Piloting Approval, which is addressed in 310 CMR 15.285, allows for controlled field testing and technical demonstration of I/A technologies. Pilot systems can only be built where the establishment to be serviced has access to a sewer system or a conventional Title 5 system to which it can be connected if the alternative system fails. If the I/A technology is approved for piloting it can be implemented at a maximum of fifteen locations. A minimum of 18 months of environmental monitoring must be performed at each facility. Piloting is considered successful when at least 75 percent of the systems perform satisfactorily over 12 months.

- Provisional Approval, which is addressed in 310 CMR 15.286, provides for broader field testing of the I/A technologies which appear to be technically capable of providing equivalent levels of environmental protection as a conventional Title 5 system. Under the provisional approval testing, it will be determined if the technology is technically capable of providing this level of treatment over a broader use than the pilot, and whether any further conditions regarding operation, maintenance, or monitoring are necessary to ensure such environmental protection. Provisional approval is contingent on successful completion of the piloting program. Systems that have completed two (2) years of general use in another state will also be considered for provisional approval. A three (3) year performance evaluation must be performed on the first fifty (50) systems. As with piloting, establishments to be serviced by provisional systems must be capable of connecting to a sewer system or a conventional Title 5 system, if the alternative should fail.

- Certification for General Use, which is addressed in 310 CMR 15.288, facilitates the use of I/A technologies which have shown that they provide the level of environmental protection which is offered by a conventional Title 5 on-site system. In order for an I/A technology to be Certified for General Use, it must have a success rate during the provisional process of 90 percent. The DEP also establishes nutrient removal credits for I/A technologies that are more effective than a conventional Title 5 system in removing nitrates.

- Remedial Approval, which is addressed in 310 CMR 15.284, provides for rapid approval of I/A technologies needed to upgrade currently failing or non-conforming systems. In order for the technology to be considered for remedial approval, it must have at least one year of general use in a state with climate conditions similar to Massachusetts. Remedial approval is a “stopgap measure”. It is not intended that the data collected for a remedial use approval will be used to support an application for piloting, provisional or general certification.

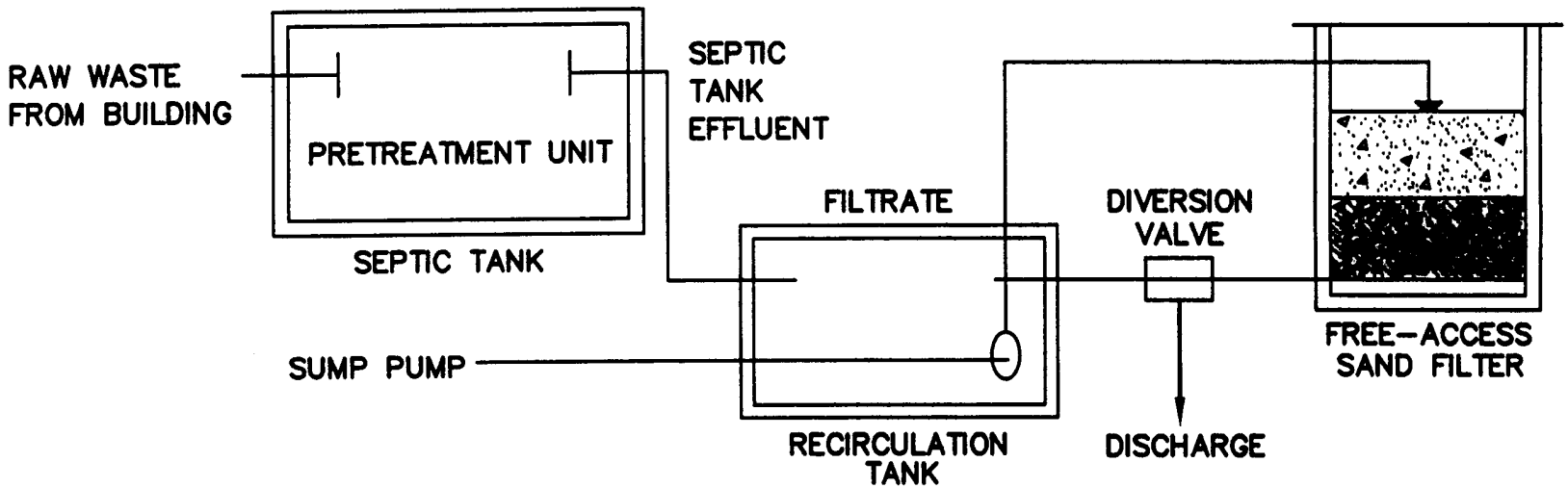
**Recirculating Sand Filter**

The Recirculating Sand Filter (DEP approval March 1995) is an alternative treatment system, which consists of a septic tank, a recirculation tank and pump, a sand filter with underdrains, and a soil absorption system. The wastewater flows from the building through its building sewer to a septic tank where solids are settled and retained. Effluent from the septic tank flows by gravity and is collected in the recirculation pump chamber. Within the recirculation pump chamber, the effluent from the septic tank and the effluent,

which is returned from the sand filter, are mixed. This mixture is then periodically pumped and evenly distributed over the sand filter bed surface. After percolating through the sand filter, the effluent is collected by underdrains and either recirculated back by gravity flow to the recirculation pump chamber or, if the chamber is full, discharged to a soil absorption system. A typical schematic of this system is shown on Figure 2-4.

The Recirculating Sand Filter was issued a Certification for General Use and Remedial Use Approval by DEP in March 1995. The Recirculating Sand Filter must meet secondary treatment standards of 30 mg/L $BOD_5$ and 30 mg/L TSS with a minimum removal of 85 percent of the influent $BOD_5$ and TSS. The effluent Total Nitrogen concentration must not exceed 25 mg/L and the system shall remove a minimum of 40 percent of the influent total nitrogen concentration.

Generally, the Recirculating Sand Filter achieves a higher level of treatment compared to a conventional Title 5 system. A variety of papers and studies have been written on Recirculating Sand Filters showing very high levels of treatment. Some of these studies show that typical $BOD_5$ and TSS removals are greater than 90 and 85 percent, respectively. Typical $BOD_5$ and TSS effluent concentrations have been less than 15 mg/L. These studies also show that the Recirculating Sand Filter is capable of obtaining high levels of Total Nitrogen removal of up to 75 percent. The effluent Total Nitrogen concentration has been recorded to be as low as 10 mg/L. The Recirculating Sand Filter is the I/A technology that is specifically covered in Title 5. The treatment capabilities of all I/A technologies are compared to the Recirculating Sand Filter. In discussions with DEP, the Recirculating Sand Filter does not always meet the effluent standards required, however, due to DEP's familiarity with the process and the majority of the data, which they have reviewed, it is their opinion that the Recirculating Sand Filter is capable of enhanced wastewater treatment compared to a conventional Title 5 system. DEP is confident of the system's treatment capabilities and ability to protect public health and the environment.




SOURCE: EPA MANUAL, WASTEWATER TREATMENT/DISPOSAL FOR SMALL COMMUNITIES

Figure 2-4
Recirculating Sand Filter

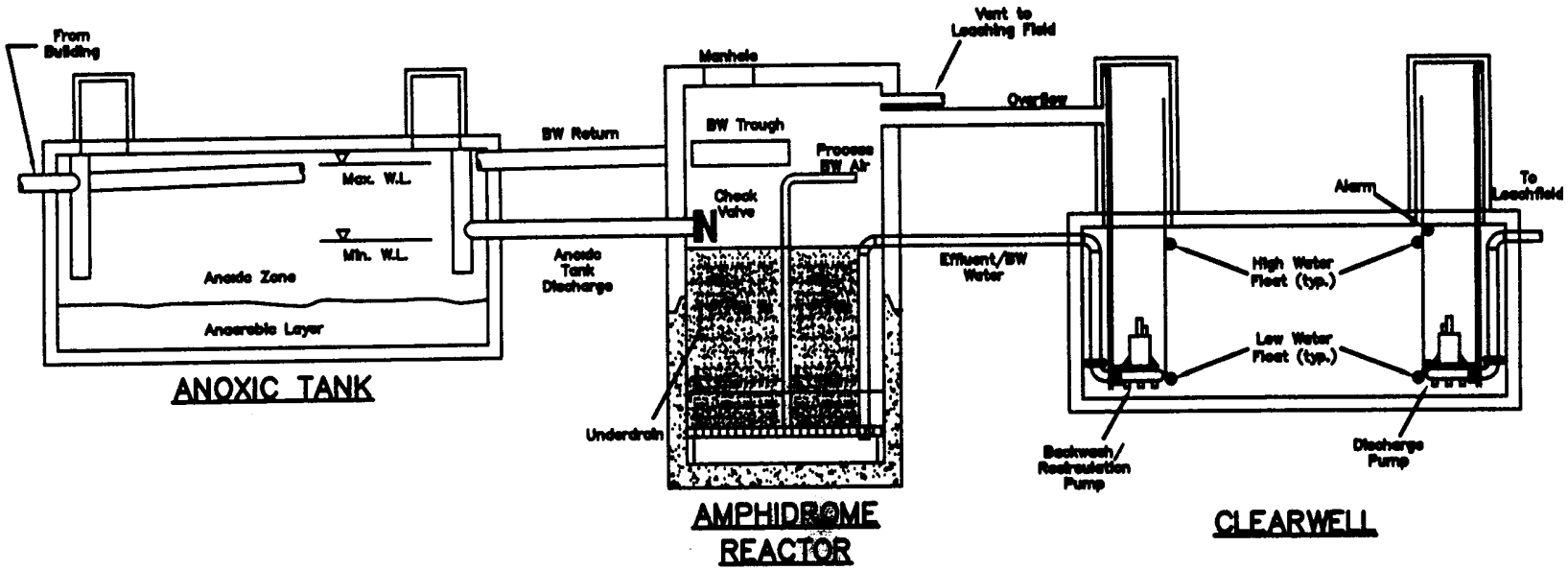
**Amphidrome™ Process**

The Amphidrome™ (DEP piloting approval June 1995) system is a fixed film, sequencing batch biological filter. The Amphidrome™ primarily consists of an anoxic equalization tank, the Amphidrome™ reactor/sand filter, and a clearwell. As with a conventional Title 5 system, a soil absorption system is also required. Wastewater flows from the building through its building sewer, combines with recycle flow from the clearwell and enters the anoxic equalization tank. From the equalization tank, the wastewater flows to the anoxic pretreatment/sludge storage area. The equalization tank stores flow prior to treatment through the biological filter. The anoxic pretreatment/sludge storage area settles solids, provides denitrification for the recycled flow using the new flow as the carbon source, and stores and digests sludge.

A batch of wastewater flow is sent by gravity from the anoxic equalization tank, down through the filter, to the clearwell. This flow of wastewater is then reversed by pumping from the clearwell, up through the filter, back to the equalization tank. This cycle is repeated several times until the required level of treatment is achieved. The cycles are alternated between aerobic and anoxic modes. The wastewater flows through the filter to the clearwell. The purpose of the clearwell is to provide storage for the flow to be recycled or to be used as backwash. Once the degree of treatment is obtained, the effluent is discharged to a soil absorption system. A schematic of this system is shown on Figure 2-5.

The Amphidrome™ Process was issued Piloting Approval by DEP in June 1995. It is approved to be piloted as an equivalent technology to a Recirculating Sand Filter. The Amphidrome™ Process must meet secondary treatment standards of 30 mg/L $BOD_5$ and 30 mg/L TSS and a minimum of 85 percent of the influent $BOD_5$ and TSS must be removed. The system must also meet the nitrogen loading design standards as follows:

- For residential systems, the effluent total nitrogen concentration shall not exceed 19 mg/L and the system shall remove a minimum of 55 percent of the influent total nitrogen concentration.
- For non-residential systems, the effluent total nitrogen concentration shall not exceed 25 mg/L and the system shall remove a minimum of 40 percent of the influent total nitrogen concentration.




SOURCE: F.R. MAHONEY & ASSOCIATES, INC.

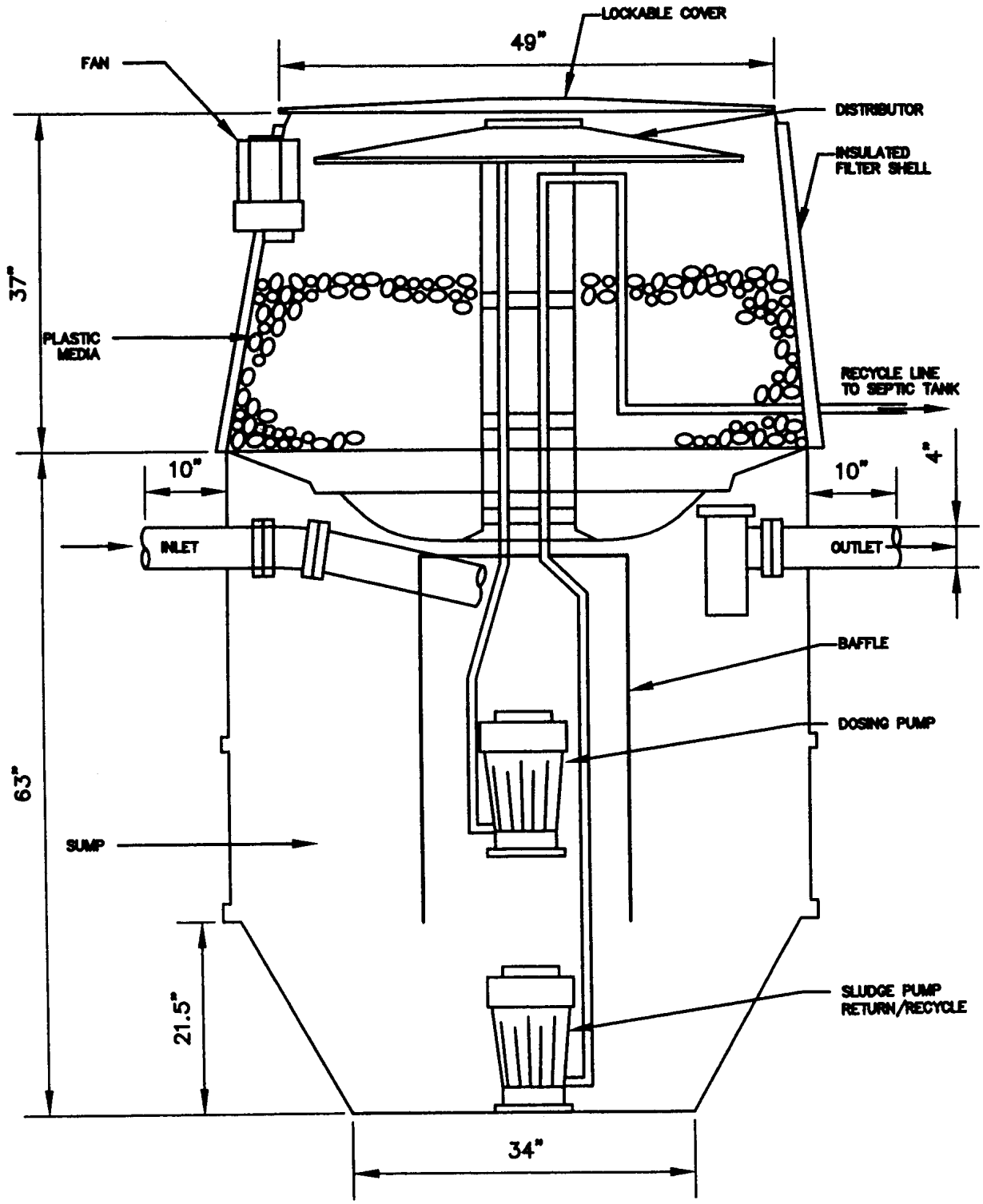
Figure 2-5
Amphidrome™ Process

DEP requires that the influent and effluent parameters for this technology be monitored monthly for the first year of operation. The proponent of this system is seeking to show that the effluent total nitrogen concentration does not exceed 10 mg/L and that the system removes a minimum of 76 percent of the influent Total Nitrogen. Therefore, the ultimate goal of the Amphidrome™ Process is to achieve an effluent with a Total Nitrogen concentration of less than 10 mg/L.

**Bioclere™ System**

The Bioclere™ (DEP general remedial and provisional approval March 1995) is essentially a modified tricking filter, which can be added to a Title 5 system between the septic tank and the soil absorption area. Wastewater flows from an establishment through its building sewer, into a standard Title 5 septic tank in which primary settling occurs. Effluent from the septic tank then flows by gravity to the baffled sump portion of the Bioclere™. A dosing pump within this sump intermittently pumps the effluent up to the top of the media bed for distribution. The wastewater trickles through this bed of highly permeable plastic media and then mixes with the wastewater in the bottom of the Bioclere™. This mixture is then recirculated to the top of the media bed in a continuous cycle. Sloughed biomass and particles not removed through the septic tank or the filter settle out in the base of the Bioclere™ unit from where a portion of the effluent sludge is pumped back to the septic tank. The remaining portion of the effluent from the Bioclere™ is discharged to a conventional leaching area. A schematic of this system is shown on Figure 2-6.

The Bioclere™ was issued a Certification for General Use, Provisional Use Approval and Remedial Use Approval by DEP in March 1995. The Bioclere™ must meet secondary treatment standards of 30 mg/L $BOD_5$ and 30 mg/L TSS with a minimum removal of 85 percent of the influent $BOD_5$ and TSS. The system must also meet the nitrogen loading design standards as follows:




SOURCE: BIOCLERE – RHODE ISLAND ON-SITE WASTEWATER TRAINING PROGRAM

Figure 2-6
Bioclere™ System

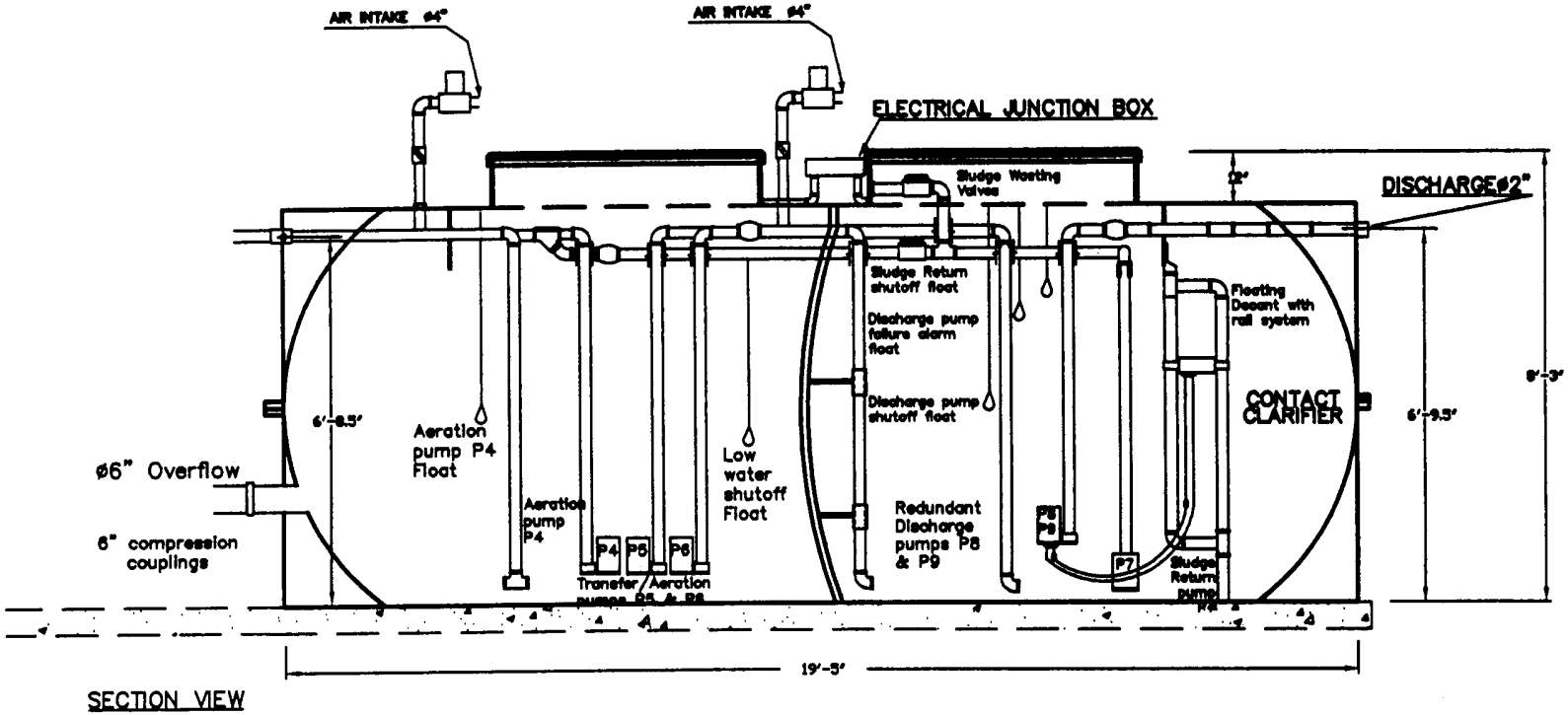
- For residential systems, the effluent total nitrogen concentration shall not exceed 19 mg/L and the system shall remove a minimum of 55 percent of the influent total nitrogen concentration.

- For non-residential systems, the effluent total nitrogen concentration shall not exceed 25 mg/L and the system shall remove a minimum of 40 percent of the influent total nitrogen concentration.

A variety of papers and studies have been written on the Bioclere™ system showing high levels of treatment. Some of these studies show that typical $BOD_5$ and TSS removals are about 85 and 70 percent, respectively. Typical $BOD_5$ and TSS concentrations are about 50 and 70 mg/L, respectively. They also show that the Bioclere™ is capable of obtaining high levels of Total Nitrogen removal of up to 25 percent above that of a conventional Title 5 system. The effluent Total Nitrogen concentration has been recorded to be less than 30 mg/L.

**Cromaglass®**

The Cromaglass® (DEP general piloting use approval September 1995) system is composed of a fiberglass tank, which is separated into three chambers and operates as a Sequencing Batch Reactor (SBR). Wastewater flows from the building through its building sewer and enters into the first chamber of the Cromaglass® unit. Within the first chamber, which is referred to as the "Solids Retention Section", large inorganic particles are retained. Wastewater, with smaller particles and broken organic solids, flow through the grit screen into the second chamber. This chamber is referred to as the "Aeration Section" where biological treatment by aeration occurs. New inflow is continuously mixed with the existing activated sludge, which is maintained in this chamber and aeration lasts for several hours. In this chamber, an anoxic period is also provided for denitrification. After the anoxic period, a batch of treated wastewater is transferred at preset intervals to the third chamber for clarification. This chamber is called the "Clarification Section," and is filled until the mixed liquor overflows the weir back into the Aeration Section. The chamber is then isolated allowing solids separation to occur by settling under quiescent conditions for about one hour. The sludge, which collects at the bottom of the chamber, is either recycled by pump to the Aeration Section or transferred to a sludge collection tank. After clarification, a batch of treated wastewater effluent is discharged to the soil absorption system. A schematic of the Cromaglass® system is shown on Figure 2-7.




SOURCE: CROMAGLASS CORPORATION

Figure 2-7
Cromaglass® System

The Cromaglass® system was issued a Certificate for General Use and Piloting Approval by DEP in September 1995. Under the General Use category, the Cromaglass® system must meet the environmental protection requirements of a conventional Title 5 system. It is also approved to be piloted as an equivalent technology to a Recirculating Sand Filter. The Cromaglass® must meet secondary treatment standards of 30 mg/L $BOD_5$ and 30 mg/L TSS and a minimum of 85 percent of the influent $BOD_5$ and TSS must be removed. The system must also meet the nitrogen loading design standards as follows:

- For residential systems, the effluent total nitrogen concentration shall not exceed 19 mg/L and the system shall remove a minimum of 55 percent of the influent total nitrogen concentration.
- For non-residential systems, the effluent total nitrogen concentration shall not exceed 25 mg/L and the system shall remove a minimum of 40 percent of the influent total nitrogen concentration.

DEP requires that the influent and effluent parameters for this technology be monitored monthly for the first year of operation. As with the Amphidrome™ Process, the proponent of the Cromaglass® is seeking to show that the effluent Total Nitrogen concentration does not exceed 10 mg/L and that the system removes a minimum of 76 percent of the influent Total Nitrogen.

**RUCK® System**

The RUCK® (DEP general use approval March 1995) system is referred to as a passive nitrogen removal system. The components of the RUCK® system consist of two parallel septic tanks, the nitrifying RUCK® filter, and a conventional subsurface leaching area. One septic tank receives blackwater, which is the waste from toilets and drains equipped with garbage grinders such as a kitchen sink; the other tank receives graywater, which is the waste from showers, washing machines, dishwashers and other sinks, also called washwater. These wastes must be separated at the source, therefore an establishment will need to have the appropriate dual plumbing system or make plumbing changes to make this possible. Blackwater flows from the establishment through the blackwater designated building sewer to the blackwater septic tank where solids settle. The effluent from this blackwater tank is then passed through the single pass aerobic RUCK® sand filter. After the wastewater passes through this filter, it is collected at the bottom of the filter, and is transferred to the graywater septic tank. Effluent from the RUCK® filter is

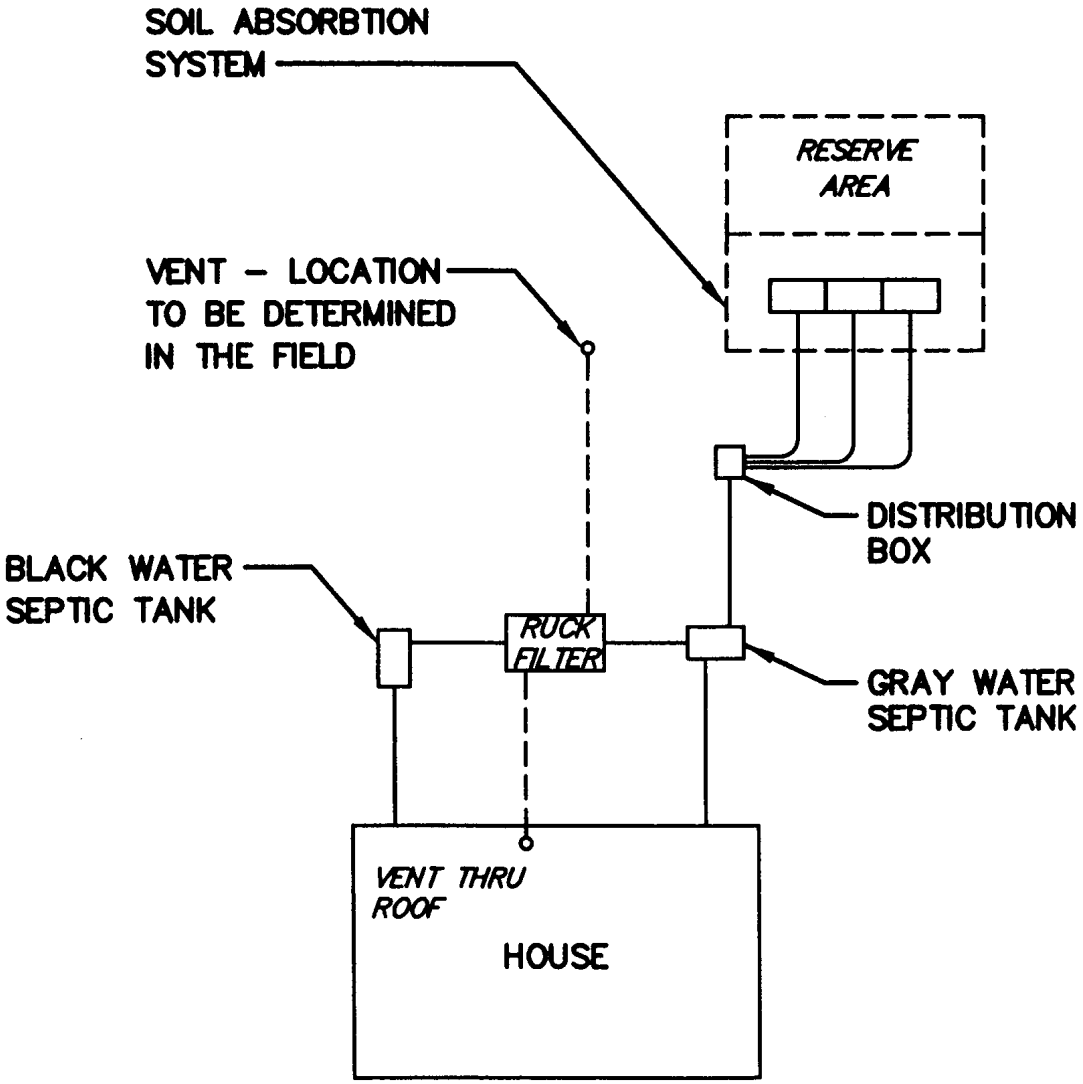
combined with graywater from the establishment in the graywater septic tank. The denitrified effluent from this tank is then transferred to a conventional soil absorption system. A schematic of this system is shown on Figure 2-8.

The RUCK® System was issued a Certification for General Use Approval by DEP in March 1995. The RUCK® must meet secondary treatment standards of 30 mg/L $BOD_5$ and 30 mg/L TSS with a minimum removal of 85 percent of the influent $BOD_5$ and TSS. The effluent Total Nitrogen (TN) concentration must not exceed 19 mg/L and the system shall remove a minimum of 55 percent of the influent TN concentration. The proponent of the system has indicated that the RUCK® system has achieved between 60 to 85 percent removal of $BOD_5$ and TSS and has achieved better than 55 percent removal of Total Nitrogen. DEP requires sampling at three points in the process: the blackwater effluent (septic tank effluent); graywater influent; and the distribution box (final effluent) to the soil absorption system.

**Single Home FAST®**

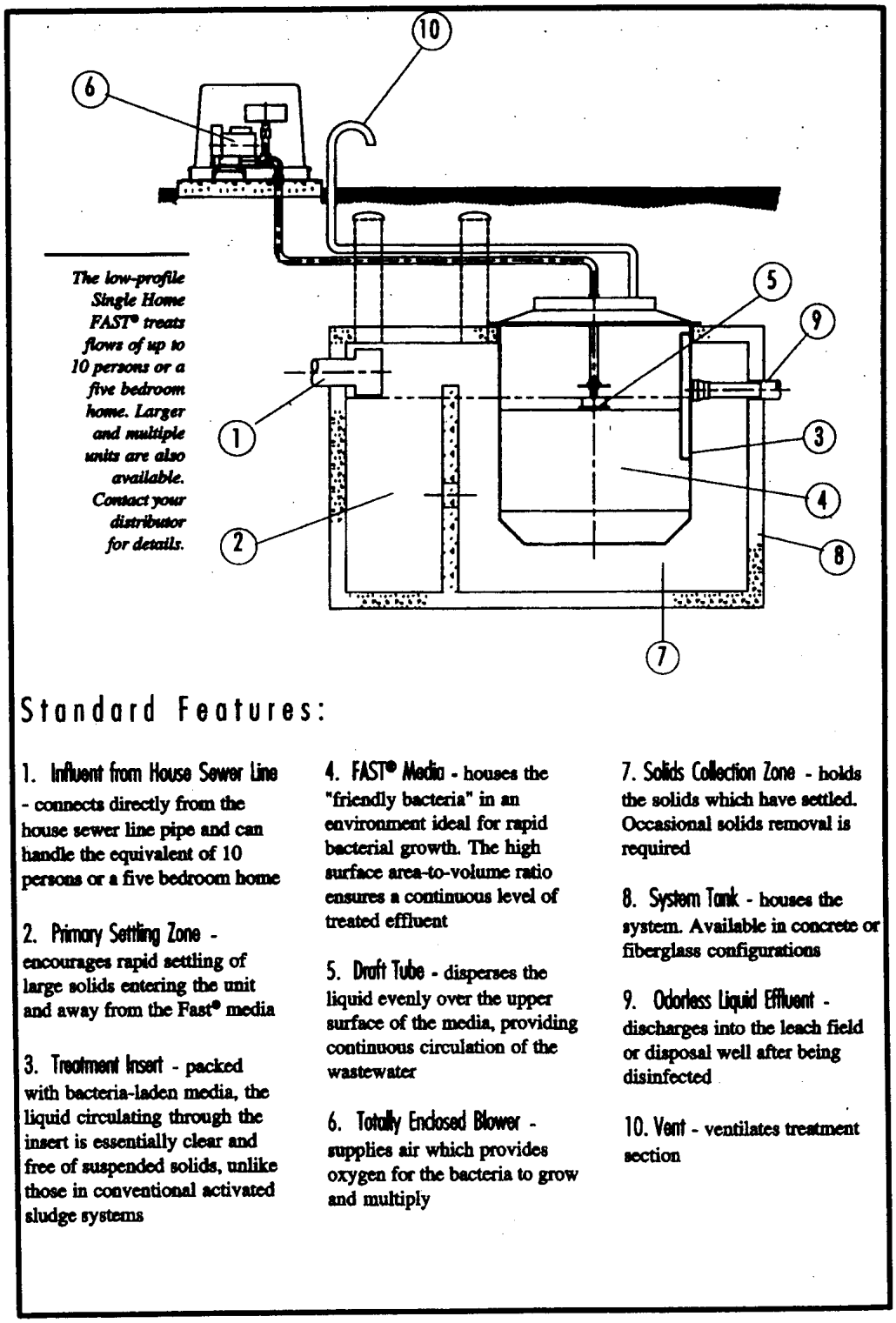
The Single Home FAST® (DEP general, provisional and remedial use approval March 1995) system is a Fixed Activated Sludge Treatment (FAST) system. The FAST® Process consists of two zones -- a primary settling zone and an aerobic biological zone. The FAST® unit is essentially a fixed film media bed, which is inserted into a 1,500 to 2,000 gallon septic tank. A schematic of this system is shown on Figure 2-9.

The FAST® System was issued a Certification for General Use, Provisional Use Approval and Remedial Use Approval by DEP in March 1995. The FAST® System must meet secondary treatment standards of 30 mg/L $BOD_5$ and 30 mg/L TSS with a minimum removal of 85 percent of the influent $BOD_5$ and TSS. The system must also meet the nitrogen loading design standards.




SOURCE: INNOVATIVE RUCK SYSTEMS, INC.

Figure 2-8
RUCK® System




SOURCE: SMITH & LOVELESS, INC.

Figure 2-9
Single Home FAST®

The proponent of this system is seeking to show that the effluent Total Nitrogen concentration does not exceed 15 mg/L and that the system removes a minimum of 64 percent of the influent Total Nitrogen. Therefore the ultimate goal of the FAST® System is to achieve an effluent with a Total Nitrogen concentration of less than 15 mg/L. DEP has recognized that the FAST® unit is capable of 90 to 95 percent reduction in $BOD_5$ and TSS. The effluent concentrations of $BOD_5$ and TSS are reported to be less than 30 mg/L. It is also recognized that the unit can reduce the Total Nitrogen entering the system to 19 mg/L.

- For residential systems, the effluent total nitrogen concentration shall not exceed 19 mg/L and the system shall remove a minimum of 55 percent of the influent total nitrogen concentration.
- For non-residential systems, the effluent total nitrogen concentration shall not exceed 25 mg/L and the system shall remove a minimum of 40 percent of the influent total nitrogen concentration.

Monitoring results for the six Innovative/Alternative (I/A) Technologies discussed above were compiled and are summarized in Table 2-1. This Table shows the average effluent concentrations and percent removals for several systems in operation for each I/A technology. Also, shown on this Table is the DEP requirements and goals set for each system. The monitoring results are variable in that not all technologies were sampled and tested under the same conditions. Variable influent and effluent concentrations were recorded depending on the source, day and time of day each sample was taken. Also, different methods of sampling and testing were used for each technology. Although the monitoring methods and results were different for each system and cannot be used to rank the technologies, the results were helpful in evaluating the technologies in terms of whether or not the technology achieved the effluent requirements set by DEP. In summary, the monitoring results show that all of the technologies have the capability of achieving enhanced treatment over that of a conventional Title 5 system. Of the systems and monitoring results analyzed, the Recirculating Sand Filter, the Amphidrome™ Process, the Cromaglass® and the FAST® system achieved their respective DEP effluent and removal requirements more frequently than the other technologies. These systems achieve a higher degree of wastewater treatment than can be achieved by a Conventional Title 5 system.

# TABLE 2-1
# TOWN OF NANTUCKET
# CWMP/FEIR
# SUMMARY OF MONITORING RESULTS VERSUS TREATMENT REQUIREMENTS

| I/A TECHNOLOGY | Average Monitoring Results | | | | | | DEP Treatment Requirements | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $BOD_5$ | | TSS | | Total Nitrogen | | $BOD_5$ | | TSS | | Total Nitrogen | |
| | Effluent Concentration (mg/L) | Percent Removal (%) | Effluent Concentration (mg/L) | Percent Removal (%) | Effluent Concentration (mg/L) | Percent Removal (%) | Effluent Concentration (mg/L) | Percent Removal (%) | Effluent Concentration (mg/L) | Percent Removal (%) | Effluent Concentration (mg/L) | Percent Removal (%) |
| **Recirculating Sand Filter** | | | | | | | 30 | 85 | 30 | 85 | 25 | 40 |
| Colburn Street - Gloucester, MA | 7.0 | 96.5 | 12.0 | 82.3 | 60.8 | 39.2 | | | | | | |
| Langsford Street - Gloucester, MA | 11.0 | 93.3 | 15.0 | 77.0 | 78.6 | 44.6 | | | | | | |
| Anne Arudel County - Maryland | | | | | | | | | | | | |
| System A | 4.0 | 98.1 | 8.0 | 88.9 | 22.0 | 59.3 | | | | | | |
| System B | 2.0 | 98.4 | 5.0 | 91.1 | 17.0 | 62.2 | | | | | | |
| System C | 8.0 | 97.8 | 10.0 | 89.7 | 21.0 | 70.4 | | | | | | |
| Chart House Restaurant - Chester, CT | 4.0 | 99.1 | 7.0 | 96.5 | 11.9 | 73.5 | | | | | | |
| **Amphidrome Process** | | | | | | | 30 | 85 | 30 | 85 | Residential -- 19 | 55 |
| Stuart's Mall - Swansea, MA | 9.2 | 95.0 | 9.9 | 68.5 | 14.5 | 67.5 | | | | | Nonresidential -- 25 | 40 |
| | | | | | | | | | | | Goal – 10 | 76 |
| **Bioclere** | | | | | | | 30 | 85 | 30 | 85 | Residential -- 19 | 55 |
| High Street - Gloucester, MA | 29.0 | 78.4 | 33.0 | 62.3 | 26.9 | 39.8 | | | | | Nonresidential -- 25 | 40 |
| Vale Court - Gloucester, MA | 51.0 | 83.6 | 42.0 | 66.3 | 29.3 | 47.4 | | | | | | |
| NSF Testing | 13.0 | 82.4 | 17.0 | 63.8 | 22.3 | 20.5 | | | | | | |
| 391 Atlantic Avenue - Cohasset. MA | 7.3 | 87.6 | 8.9 | 64.0 | 12.3 | 11.1 | | | | | | |
| Stop & Shop - Yarmouth, MA | 112.0 | 81.1 | 86.0 | 50.4 | 43.7 | 35.3 | | | | | | |
| Mercury Drive - S. Yarmouth, MA | 50.0 | 63.9 | 79.0 | 63.5 | 24.0 | 21.7 | | | | | | |

## TABLE 2-1 (cont)
## TOWN OF NANTUCKET
## CWMP/FEIR
## SUMMARY OF MONITORING RESULTS VERSUS TREATMENT REQUIREMENTS

| I/A TECHNOLOGY | Average Monitoring Results | | | | | | DEP Treatment Requirements | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $BOD_5$ | | TSS | | Total Nitrogen | | $BOD_5$ | | TSS | | Total Nitrogen | |
| | Effluent Concentration (mg/L) | Percent Removal (%) | Effluent Concentration (mg/L) | Percent Removal (%) | Effluent Concentration (mg/L) | Percent Removal (%) | Effluent Concentration (mg/L) | Percent Removal (%) | Effluent Concentration (mg/L) | Percent Removal (%) | Effluent Concentration (mg/L) | Percent Removal (%) |
| **Cromaglass** | | | | | | | 30 | 85 | 30 | 85 | Residential -- 19 | 55 |
| Meadowbrook Christian School -- Milton, PA | | | | | | | | | | | Nonresidential -- 25 | 40 |
| Phase I | 11.1 | 92.1 | 19.2 | 86.2 | 12.9 | 29.7 | | | | | Goal – 10 | 76 |
| Phase II | 7.5 | 95.8 | 11.9 | 93.1 | 4.7 | 78.7 | | | | | | |
| NSF Testing | 42.0 | 82.3 | 39.0 | 84.2 | -- | -- | | | | | | |
| **RUCK** | | | | | | | 30 | 85 | 30 | 85 | Residential -- 19 | 55 |
| Highway Inspection Facility -- Truckee, CA | 9.7 | 80.9 | -- | -- | 60.3 | 57.0 | | | | | | |
| Porter's Orchard Lot No. 5 -- Colchester, VT | 51.2 | 75.7 | 156.0 | 48.2 | 142.7 | 27.5 | | | | | | |
| Porter's Orchard 8 Home Composite | 47.8 | -- | 63.1 | -- | 5.7 | -- | | | | | | |
| **Single Home FAST** | | | | | | | 30 | 85 | 30 | 85 | Residential -- 19 | 55 |
| NSF Testing | 9.0 | 93.8 | 7.0 | 96.4 | 9.3 | 73.2 | | | | | Nonresidential -- 25 | 40 |
| Florida Keys -- Owners Demonstration | 4.6 | 95.7 | 8.0 | 92.2 | 13.0 | 64.5 | | | | | Goal – 15 | 64 |
| 140 Beach Street -- Cohasset, MA | 20.1 | -- | 6.2 | -- | 12.2 | -- | | | | | | |
| Coonamesett Inn -- Falmouth, MA | 14.8 | -- | 18.5 | -- | 6.6 | -- | | | | | | |

I/A technologies can potentially overcome site and environmental constraints but at a premium cost to the property owner. In remedial situations, I/A technologies with nitrogen reduction allow for either a 50 percent reduction in leaching area; a two foot reduction in the groundwater separation requirement; or a two foot reduction in the depth of naturally occurring soil under the leach field. Since the treatment capabilities as well as the cost of the I/A technologies are similar, one technology, Single Home FAST® System, was selected in order to evaluate the wastewater disposal alternatives for the areas of wastewater disposal needs. The costs of the I/A technologies are similar and all are capable of achieving enhanced treatment over that of a conventional Title 5 system.

## 3. Analysis of On-site Alternatives

### General

A brief on-site alternatives analysis to determine the optimal wastewater treatment and disposal options for the areas of wastewater disposal needs is presented below. The analysis considers each of the need areas as a single entity. To determine the optimal wastewater treatment and disposal option for each need area, technical and environmental factors were considered. The purpose of this evaluation is to determine which of the on-site, cluster, and/or I/A options presented are feasible, if any, for the ten (10) wastewater disposal Need Areas identified in Nantucket.

### Conventional Title 5 Septic Systems

Conventional Title 5 septic systems would be a feasible option if all the existing developed properties within the Need Areas are capable of siting a soil absorption system according to Title 5 code. Without conducting site specific field investigations for each property in each of the need areas, and based solely on the subsurface soil and groundwater information gathered from Board of Health data, it is anticipated that some of the identified need areas will not be able to meet Title 5 regulations for the soil absorption system and pose a greater risk to the environment in other areas. Thus, continued use of existing and use of conventional Title 5 septic systems are not considered feasible for all of the need areas identified in the Phase I Document.

**Variances to Conventional Title 5 Septic Systems**

Conventional Title 5 septic systems with a variance would also be a feasible option if all of the existing developed properties within the need areas were capable of siting a soil absorption system with either a variance from the Title 5 regulations or Town By-law. The criteria used to determine whether variances to conventional Title 5 systems are feasible for a need area are: lot size, soils, and groundwater. If the need area has an average lot size of less than or equal to one-half acre but does not have either severe soil or groundwater limitations, the area could potentially use variances to conventional Title 5 systems. If a need area has an average lot size less than or equal to one-half acre with either severe soil or groundwater limitations, then variances to conventional Title 5 systems are not an option. Since all the properties within the need areas are not larger than one-half acre in size, Title 5 systems with variances are a potential option for a portion of each of the need areas, but not for all of each of the identified need areas. Hence, this is not a feasible option for an entire need area. Each property would need to be evaluated on a case-by-case basis in order to determine which properties could effectively utilize Title 5 systems with variances. This option will be evaluated in those Needs Areas recommended for long-term sustainable with on-site wastewater disposal systems and managed under a Septage Management Plan.

**STEP/Cluster Systems**

STEP/Cluster systems would be a feasible option if a soil absorption system can be sited within the area of wastewater disposal need or within close proximity to the need area. The STEP/Cluster System consists of a septic tank effluent pump on each property and a small scale, off-site subsurface cluster disposal system. The disposal system for this type of facility is similar to a conventional Title 5 soil absorption system, except that it is larger in scale and is located off-site from the wastewater source. As previously discussed, at a minimum, approximately 0.4 acres are required for the disposal system, assuming good soils and not including setback requirements from property lines, wells, etc. If reasonable setback limits are included, 0.6 acres is typically required for the disposal system.

The disposal system could be located either on an undeveloped parcel in the need area, on an undeveloped parcel just outside of the need area, or on a portion of an existing developed parcel in the need area. The property would need to be either purchased by the Town or an easement on the existing property would need to be obtained from the property owner by the Town. It is unlikely that a property owner would be willing to sell a portion of their property or grant an easement on their property to site a subsurface disposal system. In addition, there would need to be enough area on the property with adequate soils, depth to groundwater, depth of naturally occurring soil, and depth to ledge to accommodate such a system. One of the major limiting factors in the Needs Areas is insufficient land area so, thus STEP / Cluster systems are most likely not a viable option for wastewater treatment and disposal in the identified areas of wastewater disposal need.

**On-site Innovative Alternative Wastewater Treatment and Disposal Systems**

On-site Innovative/Alternative (I/A) systems would be a feasible option if the existing developed properties could accommodate innovative alternative systems (e.g. recirculating sand filter, Amphidrome™ Process, Bioclere™ System, Single Home FAST, etc.) to effectively treat and dispose of wastewater. Like a conventional Title 5 system, these I/A systems require a soil absorption area. As previously mentioned, an I/A system can potentially overcome site and environmental constraints but at a premium cost to the property owner. In remedial situations, I/A technologies with nitrogen reduction allow for either a 50 percent reduction in leaching area; a two foot reduction in the groundwater separation requirement; or a two foot reduction in the depth of naturally occurring soil under the leach field. If a property has either severe soil limitations or high groundwater, the area could potentially use I/A wastewater treatment and disposal systems. However, if a property has both severe soil limitations and high groundwater, then I/A wastewater treatment and disposal systems are not an option. I/A systems will be considered in those Needs Areas that can accommodate such systems and will be offered as a recommendation if appropriate in order to comply with the recommendations of the Estuary project. This option will also be included in the development of the Island-wide septage management planning.

## 4. Configurations and Alternative Sewer Systems

### Gravity Sewer System

A gravity sewer system consists of sewer lines that allow residential, commercial, and industrial customers to discharge into a sanitary system consisting of gravity pipes, which flow downhill and are not pressurized. Gravity sewer systems operate by collecting the wastewater via continuously sloped pipe, typically eight inches minimum diameter, and transport the wastewater to local low points in the collection system. The design of a gravity sewer system is dependent on the velocity of the wastewater within the pipes. Minimum velocities are set to assure that suspended matter does not settle out in the conduit, while maximum velocities are set to prevent erosion of pipe material. Extremely flat or hilly terrain poses problems to gravity sewer installation since the gravity sewers must continually slope downward. This results in the sewer becoming increasingly deep or the need for a pump station. Pump stations are located at the local low points to collect and pump the wastewater to the next high point in the collection system, where the process continues.

### Low Pressure Sewer System

A low-pressure sewer system has proven to be a viable alternative to gravity sewer systems. A low-pressure sewer system includes small diameter pressure sewers fed by individual grinder pumps at each source or can be configured so that the pump system may also serve multiple sources. A pressure sewer system makes use of small diameter piping, ranging in size from 1-¼ to 4 inches in diameter, buried at a shallow depth following the profile of the ground. The pressure main and service pipe are generally manufactured from polyvinyl chloride (PVC) or high density polyethylene (HDPE). The pressure sewer mains and laterals are buried just below the depth of frost penetration following the contour of the ground.

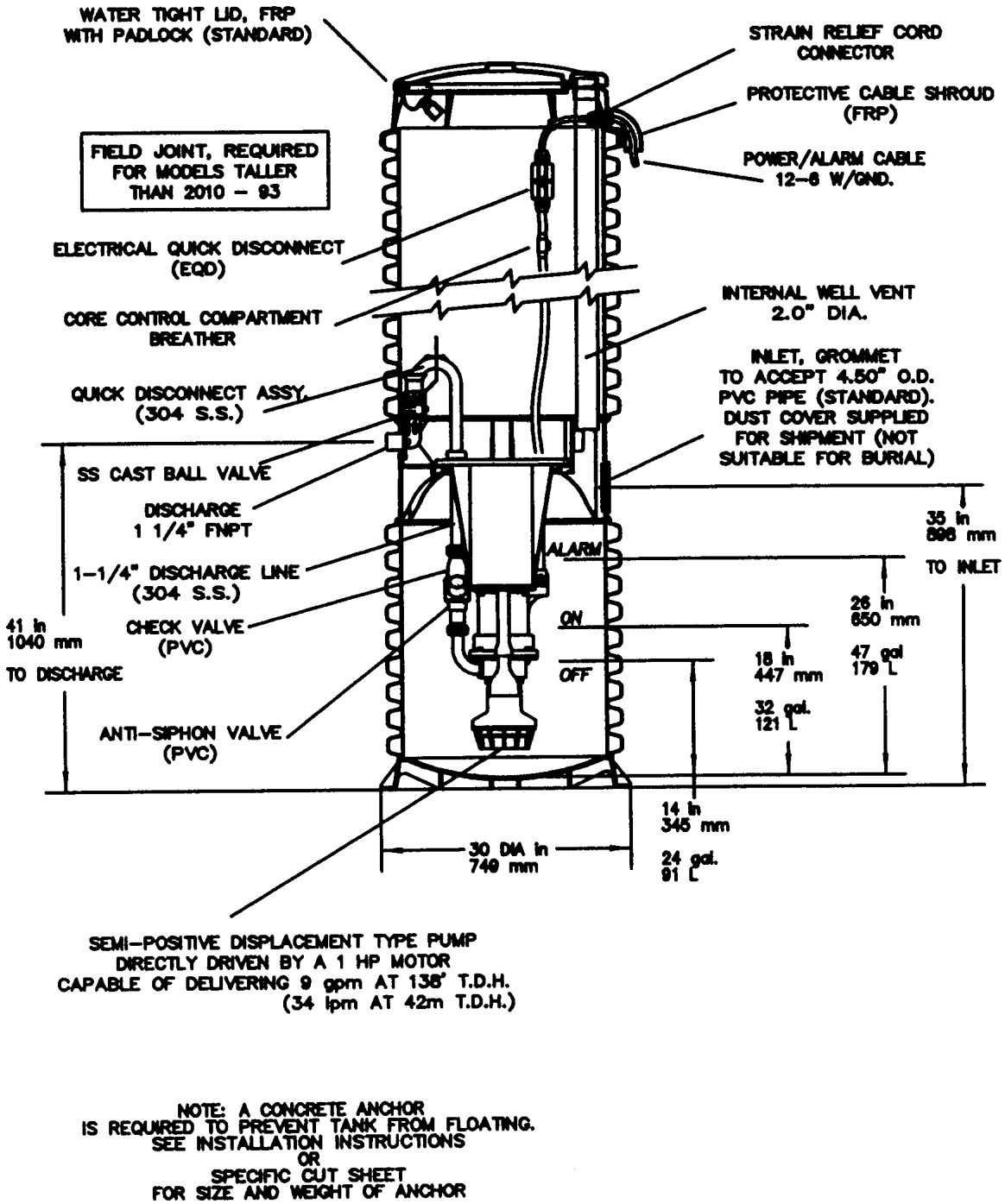
The pressure sewer system is separated into branches of sewers of different sizes depending on the number of connections to each branch. Standard manholes are not required in a pressure sewer system. Instead, flushing connections/drain manholes are installed at the end of branches and where major changes in direction or size of pipe occurs. Air relief/vacuum valve manholes are installed at high points in the system to allow trapped air to escape. Each source will utilize a grinder pump for discharge of sewerage into the main. Each grinder pump unit is equipped with a grinder pump, check

valve, tank and all necessary controls. The units can be located outdoors close to each source's existing septic tank or cesspool so that the connection to the existing service pipe exiting the building can be made easily. The units can also be located inside the building. The grinder pump macerates the solids present in the wastewater to a slurry in a manner that is similar to a kitchen sink garbage grinder and discharges wastewater to the pressure sewer collection pipes. If a malfunction occurs, a high liquid level alarm is activated. This alarm may be a light mounted on the outside of the building or an audible alarm, which can be silenced by the customer. The customer will then notify the Town or a Town approved technician or contractor to come and make the necessary repair. Figure 2-10 shows a schematic of a typical grinder pump unit.

A low-pressure sewer system collects and transports the wastewater from each customer located in low points to the nearest gravity sewer. Each customer would provide the service pipe from their building to the grinder pump, the grinder pump, and service pipe to the property line. The Town would provide the service pipe and appurtenances from the property line to the low-pressure sewer. Within the right-of-way, air relief manholes with air and vacuum valves would be installed at all high points and terminal flushing drain manholes would be installed at all low points. In addition, cleanouts would be installed every 1,000 feet. As an option the Town may consider to purchase and install the grinder pump units within the roadway right-of-way.

**Vacuum Sewer System**

Like the low-pressure sewer system, the vacuum sewer system is used where gravity sewer systems are impractical and/or not economically feasible. The vacuum collection system consists of three main components: (1) services, (2) collection mains, and (3) the vacuum station. As with pressure sewers, the materials used for the collection mains and service pipe are typically PVC or HDPE. The pipe diameter for the collection mains range from a minimum of 4 to 10 inches. The service lines have a minimum diameter of 3 inches. The service lines consist of a vacuum valve, auxiliary vents, valve pit/sump or buffer tank. The valve pit/sump accepts the waste from the customer. Included within the valve pit is a vacuum valve, which provides the interface between the vacuum in the collection piping and the atmospheric air in the building sewer, and a controller, which regulates the vacuum cycle frequency.




SOURCE: ENVIRONMENT ONE CORPORATION

Figure 2-10
Typical Grinder Pump Unit

When the vacuum valve is closed, system vacuum within the collection piping is maintained; when it is open, the system vacuum evacuates the contents of the sump. An auxiliary vent is installed on the customer's service lateral and is necessary to provide the volume of air that will follow the wastewater into the main. Buffer tanks are also used as holding tanks to collect and regulate large flows such as those flows from apartment buildings, schools and other large users, and are required when gravity flow switches to vacuum flow.

Vacuum systems can be buried at a shallow depth due to the high velocity (15 to 18 feet per second) of sewage, which keeps the lines from freezing. The collection mains can follow the profile of the ground as long as there are small elevation changes. The collection lines need to have a minimum slope of 0.2 percent toward the vacuum station. Uphill liquid transport or temporary increases in elevation can be accomplished by the insertion of lifts (vertical profile changes) along the sloped route to the station. These lifts can consist of two 45-degree elbows connected by a straight piece of pipe and are limited to a length of three feet. The collection mains are all connected to a vacuum station located in the center of the service area. The vacuum created by the system pulls sewage to the vacuum station and pumps it to its ultimate disposal point in the downstream collection system. This station has a collection tank and a vacuum tank. The wastewater is stored in the collection tank until a sufficient volume accumulates and it is then evacuated. In addition to the collection and vacuum tanks, the vacuum station includes: vacuum pumps to create the vacuum for wastewater transport; wastewater pumps to transfer the wastewater which is pulled into the collection tank by the vacuum pumps to the disposal point in the downstream collection system; controls; motor control center; chart recorder; and a fault monitoring system to alert the operator of irregularities such as low vacuum levels. Therefore, the vacuum station requires an electrical connection, however, electrical connections at each user are not necessary. A standby generator is required for this station so that the system can continue to operate in the event of a power failure.

## 5. Wastewater Treatment, Disposal, Reuse and Land Applications

As previously discussed, alternatives were presented for discharge of sewage from Nantucket's need areas to various decentralized facilities. In this section, the alternative of treating Nantucket's sewage at a new wastewater treatment facility, at the Siasconset Wastewater Treatment Facility that is currently under construction, and/or at the Surfside Wastewater Treatment Facility was explored. The alternative required a detailed look at process requirements, cost impacts, land requirements, structure sizing, treatment ability, as well as, looking into the existing treatment facilities and disposal systems capacities.

In general, the new treatment facility alternative consists of providing an appropriate level of sewerage treatment that allows treated effluent discharge on the Island of Nantucket. As such, the treatment technologies analyzed must be capable of producing an effluent that meets DEP criteria. The following issues were discussed in this section: (1) Effluent discharge options; (2) Proposed effluent limitations; (3) Four general treatment categories: suspended growth biological process, fixed film biological processes, physical/chemical processes and natural systems processes; (4) Existing Surfside and Siasconset wastewater treatment facilities; (5) Evaluation criteria; and (6) Potential Reuse Opportunities.

The treatment categories and technologies described in this section do not represent all of the treatment processes necessary only the central processes which accomplish most of the treatment needed to meet proposed effluent limitations. It is assumed that all treatment technologies will need preliminary screening of large objects, grit removal and disinfection. The need for primary clarification will depend on the specific technology involved, but it is assumed that many will require it. These issues will be addressed in detail once the treatment technologies have been screened.

**Effluent Discharge Options**

**Surface Water Discharges**

The discharge of treated wastewater to surface waters was evaluated as an option for disposal in Nantucket. Surface waters also include wetland areas adjacent to streams and waterbodies. This disposal option involves discharging highly treated effluent from a treatment facility directly to a surface water body, stream or wetland system. For purposes of this discussion, the location of the discharge is considered independent of the location of the treatment facility since the treated effluent could be transmitted along a pipeline.

The discharges of pollutants to surface waters is regulated by DEP under the Surface Water Discharge Permit Program (314 CMR 3.00) and the Massachusetts Clean Water Act (MGL c.21, s.26-53). The point source discharge of pollutants is regulated by the National Pollutant Discharge Elimination System (NPDES) permit program administered by the EPA under Section 402 of the Clean Water Act. EPA is the lead agency in NPDES permitting using compliance with water quality standards set under the DEP state Surface Water Discharge Permit Program (314 CMR 3.00). The DEP cosigns the issued permit, if it is determined that water quality standards will be met, a 401 Water Quality Certificate is issued.

The Surface Water Discharge and NPDES Permit Program have been established to limit or prohibit discharges of pollutants to surface waters to assure that surface water quality standards of receiving waters are protected, maintained or attained. The antidegradation provision of the Surface Water Quality Standards (314 CMR 4.04) requires that in all cases existing uses shall be maintained and protected.

The Massachusetts Division of Marine Fisheries designates the following surface waters and harbors in Nantucket as shellfish growing areas:

| | |
|---|---|
| Polpis Harbor | Sesachacha Pond |
| Nantucket Harbor West and East | Nantucket Southeast Coastal |
| Head of the Harbor | Madaket Harbor |
| Coskata Pond | Northwest Coastal |
| Nantucket East Coastal | Nantucket Northeast Coastal |
| Nantucket Southwest Coastal (Hummock Pond and Clark Cove) | |

The effluent parameter of concern for a surface water discharge is phosphorus, which, even at relatively low concentrations, can increase the growth of aquatic plants, and produce algal blooms. Such conditions reduce the aesthetic and recreational utility of receiving waters. Lakes, ponds, and small or slow moving streams are most sensitive to increases in phosphorus and other nutrient loadings, due to their low flow through rates. Table 2-2 outlines the minimum criteria for Class B waters, the anticipated designation of receiving waters, as well as additional minimum criteria for surface waters.

Although EPA has stated that discharges to local surface waters should be considered, they have expressed concerns that the local surface waters provide little or no dilution. The larger surface waterbodies and streams in Nantucket include: Sesachacha Pond, Long Pond, Tom Nevers Pond, Miacomet Pond, Coskata Pond, Hither Creek, and Gibbs Pond.

In addition, the larger harbors include: Nantucket Harbor, and Madaket Harbor. These surface water bodies are either insufficient in size, predisposed to seasonal flooding, suffering from poor water quality, used for recreational purposes or their locations limit their use. The harbors are used for shellfish harvesting, which would represent an incompatible use. In addition, it is doubtful that the U.S. Environmental Protection Agency and/or Massachusetts Department of Environmental Protection would approve a surface water discharge for Nantucket, as the waterways have already experienced declining water quality due to elevated nutrient levels. As such a surface water discharge to these ponds and harbors is not being considered further. The two existing wastewater treatment facilities on the Island discharge to rapid infiltration basins.

As was previously stated in this Phase II Document, the stringent regulatory requirements facing the surface water discharge and the unavailability of suitable surface waters on Island preclude this disposal option as a reliable alternative and therefore a detailed evaluation of this discharge option has not been developed for this document. Additionally, as was previously discussed in the preceding section, the Massachusetts Ocean Sanctuaries Act prohibits discharge of municipal wastewater off Nantucket. The only purpose of presenting any type of surface water discharge in this document is to address the opportunities and constraints associated with wastewater disposal.

**TABLE 2-2**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SUMMARY OF WATER QUALITY CRITERIA FOR CLASS B STREAMS**

| CLASS B WATERS (Minimum Criteria) | Description |
|---|---|
| Dissolved Oxygen | Shall not be less than 6.0 mg/L in cold water fisheries and 5.0 mg/L in warm water fisheries |
| Temperature | Shall not exceed 68°F in cold water fisheries and 83°F in warm water fisheries |
| pH | Shall be in a range of 6.5 through 8.3 standard units and not more than 0.5 units outside of the background range |
| Fecal Coliform Bacteria | Shall not exceed the geometric mean of 200 organisms per 100 ml, not shall mare than 10 percent of samples exceed 400 organisms per 100 ml |
| Solids | Free from floating, suspended and settleable solids |
| Color and Turbidity | Free from color and turbidity in concentrations or combinations that are objectionable |
| Oil and Grease | Free from oil , grease and petrochemicals that produce a visible film on the surface of the water, impart an oily taste |
| Taste and Odor | None in such concentrations or combinations that are aesthetically objectionable |
| Additional Minimum Criteria for All Surface Waters | All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits, float as debris, scum or other matter to form nuisances |
| Bottom Pollutants or Alterations | All surface waters shall be free from pollutants in concentrations or combinations, or from alterations that adversely effect the physical or chemical nature of the bottom |
| Nutrients | Shall not exceed site-specific limits necessary to control accelerated growth of algae and other plants. |
| Radioactivity | Free from radio-active substances in concentration or combinations that would be harmful |
| Toxic Pollutants | Free from pollutants in concentrations or combinations toxic to humans, aquatic life or wildlife |

**Groundwater Discharges**

The discharge of treated wastewater to groundwater was evaluated as an option for disposal in Nantucket. This disposal option involves the discharge of highly treated effluent from a wastewater treatment facility into an infiltration bed designed to handle the estimated discharge. For discussion purposes, the location of the discharge is considered independent of the location of the treatment facility since the treated effluent could be transmitted along a pipeline to the infiltration system.

The requirements for groundwater discharge of wastewater are outlined in the Groundwater Discharge Permit Program (314 CMR 5.00 and 6.00). The principal constituent of concern for groundwater discharges is nitrates, a primary component of treated wastewater. Potential sites for use as a groundwater disposal site must be comprised of sandy or gravely soils that exhibit medium infiltration rates. Sites that contain poor soil permeability, high groundwater levels, and ledge, inhibit the downward flow of water and are generally unacceptable. Soil properties can be amended by excavating and amending the soils in the discharge area or mounding the infiltration beds. This approach may be infeasible for larger systems designed for large wastewater flows but may be appropriate for small systems.

The most difficult of these physical constraints to overcome is the shallow depth to bedrock. Title 5 requires that 4 feet of naturally occurring pervious material be located beneath the bottom of the leaching facility. In areas where bedrock is 4 feet or less from the natural ground surface, a system cannot be installed in accordance with Title 5. Soils with slight or moderate limitations for wastewater disposal are considered acceptable for effluent beds. The groundwater discharge options within Nantucket are also restricted by discharge standards that prohibit anti-degradation. The Nantucket County Soil Survey Report by the U.S. Department of Agriculture indicates that soil classifications having severe soil limitations to septic disposal represent approximately 14.2 percent and the soil classifications having severe groundwater limitations to septic disposal represent approximately 18.3 percent of the total land are of Nantucket.

**Proposed Effluent Limitations**

Effluent limitations are dependent upon the method and location of treated effluent discharge. As discussed above, there are two ultimate effluent discharge options: surface water and groundwater discharge. A surface water discharge would involve discharging treated effluent to a stream, pond, lake or wetland area. A groundwater discharge would involve the discharge of treated effluent to the ground and percolation through the soil to the groundwater. Groundwater discharge can be accomplished by discharging the treated effluent to rapid infiltration sand basins; using spray irrigation or overland discharge; or to subsurface disposal beds similar to Title 5 septic systems. Another groundwater discharge method would be to utilize subsurface injection through wells.

A stream, pond or lake surface water discharge was determined to be infeasible in Nantucket because of the more stringent effluent requirements associated with small, intermittent low flow streams and primarily groundwater fed ponds. While a properly sited system with highly treated effluent discharged to a surface water body through a constructed wetland offers a high degree of treatment, it likely will not be able to meet water quality requirements regarding metals where there is little or no dilution. Accordingly, surface water discharges have been eliminated from further consideration.

For Nantucket, it was determined that groundwater discharge would be the most feasible means of effluent discharge. The requirements for groundwater discharges can be found in 314 CMR 5.00. According to these regulations, the minimum effluent limitations for a Nantucket treatment facility are shown in Table 2-3.

Beneficial reuse of wastewater typically is associated with the application and reuse of water for irrigation. In this context reuse also applies to discharging treated wastewater into the ground to recharge the aquifer used for supplying drinking water. The technology exists, through the use of micro-filtration and membrane technologies, if necessary, to produce very clean effluent to meet most reuse needs.

Reuse of the wastewater effluent as seasonal irrigation at golf courses could reduce water use at the course as well as minimize the summer loadings to adjacent waterbodies during the critical spring-to-fall growing season.

**TABLE 2-3**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**PROPOSED EFFLUENT LIMITATIONS**

| Parameter | Open Beds Proposed Limits (1) | Subsurface/Spray Irrigation Proposed Limits (2) |
|---|---|---|
| Biochemical Oxygen Demand ($BOD_5$) | 30 mg/L | 10 mg/L |
| Total Suspended solids (TSS) | 30 mg/L | 10 mg/L |
| Total Nitrogen | 10 mg/L | <10 mg/L |
| Fecal Coliform | 200 mpn/100 ml | 200 mpn/100 ml |
| Oil and Grease | 15 mg/L | 15 mg/L |

(1) 314 CMR 5.00
(2) Proposed limits for subsurface disposal to prevent plugging of disposal area and to eliminate the need for a reserve area.
Note: mg/L = milligrams per liter; mpn/100 ml = most probable number per 100 milliliters

This irrigation reuse is considered a secondary disposal option since a permanent effluent disposal solution will still be required in the off months when the golf courses are not operating. A more detailed discussion of Reuse follows in this section. DEP's opinion is that a properly planned and sited discharge that has received a high level of treatment can be sited in a Zone II and still protect the environment and public health, although DEP strongly recommends that discharges of highly treated wastewater to the groundwater outside of a Zone II be considered first.

Based on the Interim Guidance on Reclaimed Water Use issued by DEP (Draft, September 1, 1998), new discharges from wastewater treatment plants within aquifer recharge areas (Zone IIs) must meet the discharge and treatment standards as shown in Table 2-4. These standards apply to the reclaimed water at the point of discharge from the treatment facility, unless otherwise noted. Siting a wastewater disposal site within a Zone II is normally a prohibited use unless all other feasible alternatives have been explored. The EPA New England Region has expressed concerns regarding the groundwater discharge of wastewater within the Zone II. The concerns expressed by the EPA include the reliability of the treatment facilities and adequacy of the water supply monitoring programs for detecting potential health risks associated with contaminants in the wastewater. Based on these concerns, EPA is not recommending discharge within a Zone II as a preferred option.

**TABLE 2-4**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**CLASS 1 GROUNDWATER PERMIT STANDARDS**

| Parameter | Standard |
|---|---|
| pH | 6 to 9 |
| BOD | ≤ 10 mg/L or ≤ 30 mg/L |
| Turbidity | ≤ 2 NTU or ≤ 5 NTU |
| Fecal Coliform | median of 0 colonies/100 ml over continuous, running 7 day sampling periods, not to exceed 14/100 ml or 200 colonies/100 ml |
| TSS | 5 mg/L or 10 mg/L |
| Total Nitrogen | < 10 mg/L |

**Required Land Areas**

The land area required for each alternative is the sum of the area required for the actual treatment facility and the area required for effluent disposal. The land area required for the actual facility is dependent upon the size of the treatment plant as well as the treatment technology chosen. This is a highly variable parameter, thus it will be discussed in general in the following subsection (Treatment Technologies and Evaluation Criteria) as it relates to the specific technologies, which will be defined more precisely in the screening process and subsequent detailed analyses of the prospective alternatives.

Land areas required for effluent disposal are dependent upon the soil characteristics of the site and the method of disposal. Effluent disposal can be achieved through surface or subsurface application. Table 2-5 and Table 2-6 include approximate land area requirements for surface and subsurface disposal assuming a percolation rate of 5 to 10 minutes per inch and an application rate of 4 and 2.5 gallons per day/square feet, respectively. These areas will have to be tailored to the specific facility and site once screening is complete and soil characteristics have been determined.

**TABLE 2-5**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**AREAS REQUIRED FOR SURFACE APPLICATION OF TREATED EFFLUENT**

| Surface Application (Open Sand Beds) Application Rate: 4 gpd/ft$^2$ (1) | | | | | | |
|---|---|---|---|---|---|---|
| Average Daily Flow | Leaching Area | | Reserve Area | | Total Area | |
| gpd | ft$^2$ | Acres | ft$^2$ | Acres | ft$^2$ | Acres |
| 200,000 | 50,000 | 1.15 | 50,000 | 1.15 | 100,000 | 2.30 |
| 400,000 | 100,000 | 2.30 | 100,000 | 2.30 | 200,000 | 4.59 |
| 600,000 | 150,000 | 3.44 | 150,000 | 3.44 | 300,000 | 6.89 |
| 800,000 | 200,000 | 4.59 | 200,000 | 4.59 | 400,000 | 9.18 |
| 1,000,000 | 250,000 | 5.74 | 250,000 | 5.74 | 500,000 | 11.48 |

(1) Based on recommendations in the "Guidelines for the Design, Construction, Operation, and Maintenance of Small Sewage Treatment Facilities with Land Disposal."

**TABLE 2-6**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**AREAS REQUIRED FOR SUBSURFACE APPLICATION OF TREATED EFFLUENT**

| Surface Application (Open Sand Beds) Application Rate: 2.5 gpd/ft$^2$ (1) | | | | | | |
|---|---|---|---|---|---|---|
| Average Daily Flow | Leaching Area | | Reserve Area | | Total Area | |
| gpd | ft$^2$ | Acres | ft$^2$ | Acres | ft$^2$ | Acres |
| 200,000 | 44,600 | 1.02 | 133,200 | 3.06 | 177,800 | 4.08 |
| 400,000 | 89,000 | 2.04 | 266,400 | 6.12 | 355,400 | 8.16 |
| 600,000 | 133,400 | 3.06 | 399,600 | 9.17 | 533,000 | 12.23 |
| 800,000 | 177,800 | 4.08 | 532,800 | 12.23 | 710,600 | 16.31 |
| 1,000,000 | 222,400 | 5.11 | 666,600 | 15.30 | 889,000 | 20.41 |

(1) Based on recommendations in the "Guidelines for the Design, Construction, Operation, and Maintenance of Small Sewage Treatment Facilities with Land Disposal".
(2) According to the "Guidelines," the area between the leaching facilities can be used as the reserve area.

**Treatment Technologies**

In this section, a total of 14 treatment technologies are described. These treatment technologies discussed can be broken down into four broad categories as follows:

- **Suspended Growth Biological Processes**

  Conventional Activated Sludge/Extended Aeration
  Pure Oxygen Activated Sludge
  Sequencing Batch Reactors
  Oxidation Ditch
  A/O Systems

- **Fixed Film Biological Processes**

  Trickling Filters
  Rotating Biological Contactors
  Activated Biofilters

- **Physical/Chemical Processes**

  Chemical Coagulation
  Granular Activated Carbon
  Zimpro PACT

- **Natural Systems Processes**

  Aquaculture
  Constructed Wetlands
  Solar Aquatics™

The 14 wastewater treatment alternatives listed above are described in the following paragraphs:

**Suspended Growth Biological Treatment**

Suspended growth treatment is a biological process that consists of microorganisms in suspension feeding on organic pollutants in the wastewater. This process is accomplished aerobically and therefore outside air is added. The added air serves two purposes in that it provides microorganisms with their needed supply of oxygen and also maintains the suspension of biomass. Within the suspended growth biological processes category, a total of five alternatives will be considered. These treatment alternatives do not need to be proceeded by primary treatment units in order to meet the proposed $BOD_5$ and TSS effluent requirements. Suspended growth processes are capable of producing an effluent that meets 10 mg/L $BOD_5$, 10 mg/L TSS, 19 mg/L $NO_3$ and 1 mg/L $NH_3$.

**Conventional Activated Sludge/Extended Aeration**

In the Conventional Activated Sludge (CAS) process, treatment is accomplished by microorganisms in suspension. The process usually consists of a rectangular shaped aeration tank and a final clarifier that separates out the biomass for either wasting or recycling. Since in colder climates, an older sludge age is required to achieve the required $BOD_5$ effluent levels, extended aeration, which is a variation of the activated sludge process, is commonly used. With extended aeration, aeration time is up to 4 times longer than with the typical CAS system. Using longer aeration times allows the facility to operate over a wider range of flows and loads. However, such systems are usually limited to relatively low organic loads and therefore are generally applicable to flows less than 1 MGD. Sludge generated in the process is recycled and aerobically digested; therefore, very little sludge is wasted compared to the typical CAS system. The extended aeration system achieves better than secondary levels of treatment and can generally reduce $BOD_5$ and TSS to 10 mg/L, $NO_3$ to 19 mg/L and $NH_3$ to 1 mg/L. Some biological nitrogen removal occurs as a consequence of periodic high waste load-low oxygen and low wasteload-high oxygen cycles creating a suitable environment for the appropriate bacteria. However, it is not anticipated that the levels of total nitrogen removal required will be achieved without modification of the normal extended aeration process or without additional treatment processes.

Although CAS/Extended Aeration Systems have been used successfully in this country for over 70 years and it has been proven to be a flexible and reliable process which produces year-round secondary treatment quality effluent, it has been known to require relatively complex process monitoring and control, and the process is subject to shock loadings and solids washout during flow surges. Another drawback of the process is that it produces a sludge that is difficult to thicken and dewater. Perhaps a more serious drawback to the use of this treatment technology is that without added treatment units, the process cannot reliably reduce nitrogen to required levels. This is an issue when considering groundwater discharge. Climate is also an issue because extended aeration cycles in cold weather hinder treatment performance. The use of extended aeration may also have regulatory and legal implications because of its inability to meet required effluent limitations.

Construction and operation costs for CAS/Extended Aeration are usually not especially high, although operation costs are higher than other treatment processes because of the relatively complex operational requirements. Electric power usage of Extended Aeration facilities tend to be high as a result of long aeration times and therefore these facilities generally have higher operation costs.

**Pure Oxygen Activated Sludge**

Pure Oxygen Activated Sludge is a variation of CAS in which pure oxygen is added to the aeration tank rather than air. Pure oxygen systems are used when it is an advantage to keep aeration tank volumes and sizes small. Pure oxygen activated sludge tanks are smaller (about one third (1/3) the volume) than CAS tanks because more oxygen is available and therefore less time and volume are needed to degrade organic pollutants. Due to the smaller footprint size, this process is commonly used for treatment facilities with severe site constraints. Like CAS/extended aeration systems, pure oxygen systems achieve better than secondary levels of treatment and can generally reduce $BOD_5$ and TSS to 10 mg/L, $NO_3$ to 19 mg/L and $NH_3$ to 1 mg/L. The pure oxygen process is not capable, however, of reducing total nitrogen to required levels without additional treatment processes.

Pure Oxygen Activated Sludge has many of the same benefits and drawbacks as the CAS Process. The capital costs are about the same: the savings due to the smaller tankage are comparable to the additional costs of the sophisticated oxygen generation equipment. Additional drawbacks of Pure Oxygen Activated Sludge are that it tends to cost more to operate than CAS due to the oxygen required. The principle consideration, here and with CAS/extended aeration, is the inability of the process to reliably reduce nutrients to required levels.

**Sequencing Batch Reactors**

Sequencing Batch Reactors (SBR's) are a variation of activated sludge biological treatment. In the SBR process, the mixing, aeration and settling takes place in one basin, not in separate basins typical of CAS processes. SBR's operate on a fill-and-draw principle in which wastewater flows into a basin and is mixed and aerated using mechanical and/or diffused aeration. When a basin is full, flow is

diverted to a parallel basin while mixing and aeration continues in the full basin. After a period of time, mixing and aeration is stopped and the tank contents are allowed to settle. Excess sludge is removed from the bottom of the tank while the treated effluent is decanted from the top. The SBR process achieves better than secondary levels of treatment and can generally reduce $BOD_5$ and TSS to 10 mg/L, $NO_3$ to 19 mg/L and $NH_3$ to 1 mg/L. An added advantage of the SBR process is that nitrogen can be reduced to required levels without additional equipment and tankage. If the SBR is run with an anoxic cycle, it can reduce total nitrogen to 10 mg/L. If phosphorus removal is required, the SBR process can be run with both an anaerobic cycle and anoxic cycle reducing the phosphorous levels to about 1.5 mg/L.

The Sequencing Batch Reactor is used in relatively low flow, space-limited applications. A particular advantage of the SBR is that it can handle shock and variable flow and load. Another advantage of the SBR is that no secondary clarifiers are required. There may be some community acceptance issues as a result of the relatively large tankage involved with the SBR process. The SBR combines the settling and aeration steps into one tank that limits the size of the footprint of the facility. SBR's can be built above-ground with exposed tank walls or can be constructed at grade level depending on the terrain of the site. The above-ground tankage is a possible aesthetic concern. Enclosing the above-ground tankage in a building is an option; however, it would drive the cost of the SBR alternative up.

**Oxidation Ditch**

The oxidation ditch is a variation of the extended aeration process in which oxygen is imparted to the wastewater through mechanical surface aerators. In the other types of suspended growth systems described so far, the oxygen is usually provided by diffused aeration. The oxidation ditch is characterized by its distinctive "race track", oval shape. Like extended aeration, the oxidation ditch achieves better than secondary levels of treatment and can generally reduce $BOD_5$ and TSS to 10 mg/L, $NO_3$ to 19 mg/L and $NH_3$ to 1 mg/L. The oxidation ditch is not capable, however, of reducing total nitrogen to required levels without additional treatment processes.

An oxidation ditch is a special type of extended aeration process, and as a result, its utilization will raise many of the criteria issues raised with CAS/extended aeration. The only notable difference is the configuration used and community acceptance issues that might surface as a result. The "race track" type configuration employed takes up more space than typical extended aeration layouts. The larger space required would cost more to purchase land and to build, and the layout does not lend itself well to a building enclosure. Residents in the area may find a large, unenclosed "race track" shape in their area unsightly.

**Anaerobic/Anoxic/Oxic Systems**

For the purposes of this report, Anaerobic/Anoxic/Oxic Systems are defined as those processes that utilize a combination of anaerobic, anoxic and oxic (aerobic) stages to reduce nitrogen and phosphorus. The removal of nitrogen occurs in a two step process. The first step is done aerobically and involves the biological oxidation of ammonia-nitrogen to nitrate-nitrogen. The second step is done in an anoxic basin and reduces nitrate-nitrogen to nitrogen gas. The first step is known as nitrification and the second step is known as denitrification.

Systems designed to remove nitrogen, A/O Systems, generally consist of an anoxic stage followed by an aerobic stage, and a final clarifier that recycles settled sludge to the anoxic zone. Nitrification occurs in the aerobic zone and denitrification occurs in the anoxic zone. The anoxic zone is strategically placed ahead of the aerobic zone in order to take advantage of influent organics that aid in denitrification. The A/O System can generally reduce $BOD_5$, TSS and Total Nitrogen to 10 mg/L.

A variation of this process is the $A^2O^2$ process that consists of four sequential stages: an anoxic stage, aerobic stage, anoxic stage, and aerobic stage. This $A^2O^2$ process can reduce $BOD_5$ and TSS to 10 mg/L, and Total Nitrogen to about 4 mg/L.

Systems designed to remove phosphorus and nitrogen, $A^2O$ Systems, utilize anaerobic, anoxic and aerobic stages. Most biological wastewater treatment processes can reduce phosphorus by 10 to 20 percent. Phosphorus is reduced in wastewater treatment because it is an essential nutrient for biological cell growth.

Placing the anaerobic stage first followed by anoxic and aerobic stages can enhance the amount of phosphorus removal. Placement of the anaerobic stage first and following it with an aerobic stage causes a type of bacteria to predominate, which takes up, more than the standard amount of phosphorus. These bacteria accomplish the needed phosphorus reduction. Nitrogen is removed in the anoxic-aerobic stages, as discussed in the previous paragraphs.

Typically $A^2/O$ systems can remove phosphorus to levels below 3 mg/L and nitrogen to levels below 10 mg/L. Phosphorous removal, however, is typically not required for groundwater disposal unless the location for the groundwater discharge is in close proximity to a sensitive surface waterbody. The levels of treatment obtained by all three of the Anaerobic/Anoxic/Oxic systems discussed above are consistent with effluent limitations required for this study.

Many of the treatment technologies discussed in the previous paragraphs were not able to meet proposed nutrient effluent discharge requirements. An A/O system, with one of the above technologies as the aerobic component, will result in proposed effluent requirements being met. The following treatment technologies could serve as a component of the A/O system: extended aeration, pure oxygen activated sludge, and oxidation ditch. Sequencing batch reactors were not considered because they have the ability to meet nitrogen requirements without the addition of an A/O system.

Of the treatment technologies available, extended aeration offers the most benefits when used in conjunction with an A/O process. Pure oxygen activated sludge tends to be more expensive than extended aeration due to the cost of purchasing and generating the oxygen. The oxidation ditch tends to take up more space, would be more costly to build and would be faced with community acceptance issues as well.

**Fixed Film Biological Processes**

Fixed Film Biological Processes are like suspended growth biological processes in that they rely on microorganisms to accomplish reduction of organic pollutants. The difference between the two is the medium in which the microorganisms thrive. With suspended growth systems, the biological population is kept in suspension in a tank. With fixed film processes, microorganisms grow on a surface and wastewater is applied to the surface or the surface is applied to the wastewater. These treatment alternatives need to be preceded by primary clarifiers in order to meet the required $BOD_5$ and TSS effluent requirements. Depending on the fixed film biological process implemented, secondary treatment levels or better can be achieved. A total of three fixed film biological processes will be considered.

**Trickling Filters**

With Trickling Filters, organic pollutant removal is accomplished by passing wastewater over a collection of loosely packed media. Microorganisms grow on the surface of the media and feed on the organic matter in the wastewater. With time, the biological growth falls off the media and flows out of the trickling filter tank with the treated wastewater. Air, needed by the microorganisms to degrade organics, is entrained in the wastewater as it falls though the media. The typical process also employs a secondary clarifier to separate biological matter from treated wastewater. Trickling filters can accomplish secondary levels of treatment and can generally reduce $BOD_5$ and TSS to 30 mg/L. Trickling Filters are not capable of consistently achieving $BOD_5$ and TSS levels of 10 mg/L in colder climates. In warmer climates a two stage Trickling Filter can generally reduce $BOD_5$ and TSS to 10 mg/L, $NO_3$ to 19 mg/L and $NH_3$ to 1 mg/L. Nitrification (i.e., oxidation to convert ammonia into nitrate) is also possible, but total nitrogen removal is not feasible using trickling filters.

Trickling Filters can't remove nitrogen to required levels. The nature of the Trickling Filter is such that it must be covered to perform properly. As such, it will not be able to operate in Nantucket's climate without this protection.

Another option is to enclose the Trickling Filter in a building, however this is not recommended due to the ventilation requirements of the filters. Covering of the treatment process is assumed to be necessary for community acceptance, however it will add to the construction cost of the facility.

**Rotating Biological Contactors**

Similar to Trickling Filters, Rotating Biological Contactors (RBC's) involve growing bacteria on media. However, RBC's utilize large moving disks that rotate through the wastewater rather than stationary media, which has wastewater, passed over it. The rotating disk causes the microorganisms to be exposed to cycles of air and wastewater (organics). The rotating action also causes shear forces to slough off the bacterial growths. A final clarifier captures the sloughed-off biological material. The principles involved are essentially the same for RBC's and Trickling Filters. The advantage of RBC's is that they tend to be more reliable and less susceptible to shock loading. Aerobic RBCs can generally reduce $BOD_5$ and TSS to 10 mg/L, $NO_3$ to 19 mg/L and $NH_3$ to 1 mg/L. A two stage RBC with both an anoxic and oxic stage combined with the addition of methanol can economically reduce $BOD_5$, TSS and Total Nitrogen to 10 mg/L. With the use of RBCs, sludge thickening is not required.

Wastewater treatment using rotating biological contactor technology is a compact, relatively simple and reliable process that can easily be designed to remove nitrogen. The nature of the RBC is such that it must be covered to perform properly. Covering of the treatment process is also necessary for community acceptance. Another option is to enclose the RBC in a building, however this is not recommended due to access issues for operation and maintenance and the high cost to provide proper lighting and ventilation.

**Activated Biofilters**

An Activated Biofilter (ABF) is a dual biological process that employs both suspended growth and fixed film processes. In its typical arrangement, a fixed film process (such as a trickling filter) is placed in series with a suspended growth process (such as conventional activated sludge). The media used in the ABF process is commonly redwood boards because the return activated sludge is

mixed with the influent flow upstream of the trickling filter. The two systems are usually combined in the Activated Biofilter arrangement in order to take advantage of the strengths of each process. They are resistance to shock loads and ease of maintenance for trickling filters and the flexibility and high-quality effluents of conventional activated sludge. This type of system is capable of nitrification, however removal of total nitrogen is not feasible with this process. The ABF is capable of reducing $BOD_5$ and TSS to 10 mg/L, $NO_3$ to 19 mg/L and $NH_3$ to 1 mg/L.

The Activated Biofilter is a treatment technology, which utilizes both, suspended growth and fixed film systems. These types of systems can not remove nitrogen to required levels. While also taking advantage of the best features of suspended growth and fixed film systems, Activated Biofilters also suffer similar criteria problems for each type of system as described in the previous sections.

**Physical/Chemical Processes**

Physical/Chemical Processes are those processes that involve removal of pollutants solely through the use of gravity settling and chemical addition and/or the addition of particles that attract pollutants to surfaces. Biological activity is not intended to be the principal pollutant-reduction mechanism in physical/chemical treatment. The following three physical/ chemical alternatives will be discussed:

**Chemical Coagulation**

In general, particles in wastewater do not have an affinity for one another and do not have a great tendency to agglomerate. Chemical coagulation involves the addition of chemicals to increase particle affinity and therefore the tendency for agglomeration. The overall process is usually accomplished in three steps: coagulation, flocculation and sedimentation. In the coagulation step, chemicals such as aluminum sulfate or iron salts are added to the wastewater and mixed rapidly to destabilize solids. In the next step, flocculation, the destabilized solids are mixed slowly to encourage agglomeration. In the last step, the destabilized, agglomerated particles are settled out in a sedimentation tank. Chemical coagulation can remove $BOD_5$, TSS, insoluble organic nitrogen and phosphorus, but is not effective in removing total nitrogen to the required levels.

Chemical coagulation is not well suited to surges in flow and load, as chemical dosages would constantly require adjustment to match influent conditions. Complicated process control, large tankage and flow equalization would be required.

Chemical coagulation can remove $BOD_5$, TSS and phosphorus, but is not effective in removing total nitrogen to the required levels. As such, treated effluent will not be suitable for groundwater discharge that would raise regulatory and legal issues. Other issues include the cost of the chemicals, and the large quantity of chemical sludges produced.

**Granular Activated Carbon**

Treatment using granular activated carbon relies on the principle of adsorption. Adsorption is a physical/chemical process by which materials accumulate on surfaces. Since adsorption is a surface-active phenomenon, the larger the surface the greater the tendency for adsorption to occur. Activated carbon is a popular substance for adsorption because of its large surface area. Granular activated carbon is typically not used in wastewater treatment because of the size and amount of solids in the waste stream. It would not be effective in removing nitrogen and phosphorus. It is better suited for removal of small particles and residual organics. The Granular Activated Carbon process would not be very effective without significant process addition and modification. The drawbacks to the use of this process as a treatment technology are identical to chemical coagulation. In addition there are additional operation and maintenance cost issues due to the need to regenerate the carbon.

**Zimpro PACT**

Zimpro PACT is a patented process in which powdered activated carbon (PAC) is added to the aeration tank of the conventional activated sludge process. DuPont developed the process in the early 1970's, but Zimpro/Passavant currently holds the patent. Once in the aeration tank, the bacteria and the PAC work together to reduce organic material. The bacteria degrade most of the organics and the PAC handles the remaining portion. In the conventional arrangement, sludge and PAC are settled out in a clarifier and then returned to

the aeration tank or wasted. When the PAC becomes spent, it must be replaced or regenerated. Wastewater treatment facilities employing the PACT process can achieve effluent $BOD_5$ and TSS of 10 mg/L, but have not achieved effluent total nitrogen and phosphorous concentrations to low levels that may be required for a facility in Nantucket.

As with Granular Activated Carbon, Zimpro PACT is usually used for the removal of small particles and residual organic matter. Zimpro PACT would not be very effective without significant process addition and modification and the drawbacks to its use as a treatment technology are identical to chemical coagulation. Zimpro PACT is commonly used for industrial discharge; however, it is generally more cost effective for industries to use some form of pretreatment rather than the PACT process. The PACT process also creates more sludge and operating costs due to the addition of PAC than the previously mentioned technologies.

**Natural Systems Processes**

Natural Systems Processes involve utilization of naturally occurring plants and animals for wastewater treatment. These types of systems consist of some tankage, but mostly consist of large basins, ponds and wetlands. A total of three Natural Systems Processes will be discussed.

**Aquaculture**

The Aquaculture process for treating wastewater generally consists of a series of greenhouses and wetlands. Influent first passes through the headworks, where grit and large objects are removed. From there, wastewater flows to a greenhouse, which houses a series of solar tanks and solar ponds. Here, aquatic and non-aquatic plants, bacteria and aquatic animals provide treatment. Next, wastewater flows to clarifiers, sand filters and constructed wetlands. The clarifiers separate biological solids from the water and the sand filters remove residual solids prior to reaching the constructed wetland. The purpose of the

constructed wetland is to accomplish the last phase of nitrogen removal. Aquaculture treatment systems are capable of reducing $BOD_5$ and TSS to secondary treatment standards (30 mg/L). Nitrogen and phosphorus removals are also reported to be feasible.

**Constructed Treatment Wetlands**

Constructed treatment wetlands are essentially man-made systems designed to provide biological and chemical conditions that mimic natural wetlands systems. However, unlike a traditional treatment facilities, these treatment wetland systems offer many additional advantages, including longer service life, low O&M costs, and a variety of aesthetic values. Treatment wetlands are comprised of rooted vascular plants within shallow flooded or saturated soils that provide conditions effective for wastewater treatment. The two types of treatment systems include surface-flow wetland systems (SF) and subsurface-flow wetland systems (SSF). The SF wetland systems consist of an excavated lined basin containing a shallow substrate that supports emergent wetland vegetation. Treatment in the SF wetland occurs primarily in the rhizomes of the plant material. The SSF wetland systems use a bed of soil or gravel media for the growth of plants. Wastewater in the SSF wetland systems flows by gravity horizontally through the media were most of the treatment occurs from interaction with aquatic microorganisms. Typical plants used in these treatment wetland systems include common reed (Phragmites communis), cattail (Typha spp.) and bulrushes (Scirpus spp.).

Wetlands have been incorporated into wastewater treatment systems for more than 25 years and have become a popular waste treatment alternative for communities in both the U.S. and Europe. Recent estimates have identified approximately 1,000 constructed wetlands are currently operating, ranging from treatment for single-family homes to large-scale municipal systems. Cities and towns such as Marion, MA, Minoa, NY, Iselin, PA; Arcata, CA; Orlando, FL; PA; Monterey, VA and Columbia, MO have combined conventional treatment technologies with treatment wetland systems to achieve discharge requirements. The EPA issued a design manual (1988) formally recognizing constructed wetland technology, and site-specific guidelines for their design have been developed in many states. This Design Manual, “Constructed Wetlands and

Aquatic Plant Systems for Municipal Wastewater Treatment Disposal" is currently being updated by EPA to address the advances in technology and understanding of these systems.

The effectiveness of these treatment wetland systems is based largely on the level of pre-treatment, conservative estimates of constituent and hydraulic loading rates, monitoring and operational strategies. Design parameters for the size of these systems vary according to the treatment goals, estimated wastewater volumes, effluent characteristics and hydraulic loading. General sizing for approximately 1 MGD with a basin depth of 3 feet and a detention time of 6 days would require approximately 6 acres.

Relatively elevated concentrations of trace metals can be found naturally occurring in the streams and waterbodies in Nantucket. These metal concentrations (i.e.: copper and lead) are found in groundwater within the aquifer. Treatment wetlands can be effective at reducing metal concentrations. Reduction of metals within the treatment wetlands can be accomplished through immobilization in the surface soils or assimilation by plants and animals. The reduction of metals is largely correlated to the inflow concentrations and detention times. Specific performance data on the removal of trace metals from treatment wetlands is limited.

Treatment wetlands systems are generally designed for the reduction of levels of conventional pollutants including, nitrates, fecal coliform, Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS). The treatment wetland systems should be viewed as a component in optimizing the overall wastewater treatment process rather than a means to reduce trace metals. The use of these wetland systems for this purpose is considered speculative. The applicability of using treatment wetlands for wastewater disposal in Nantucket is viewed as a final component in the treatment process prior to a direct discharge to surface water or groundwater infiltration system. The option of discharging treated

wastewater to surface waters/wetlands is not feasible in Nantucket due to the lack of dilution potential offered by the low flow streams. However, the implementation of a treatment wetland system could function as a buffer by providing a "polishing" component in the treatment process.

In summary, the treatment wetland system could be used as part of a surface water discharge in functioning to minimize the potential impacts to natural wetland systems. Properly constructed treatment wetlands could control the quality and quantity of the discharge, reduce channelized flow and assimilate nutrient levels. The implementation of treatment wetland system as a component of the wastewater plan would require site-specific characterization of the receiving waters and development of discharge parameters.

**Solar Aquatics™**

The Solar Aquatics™ treatment process, a proprietary design, is characterized as a natural system by its developer. It utilizes elements of natural wetland systems, such as plants, subsurface wetland media and sand filtration with more conventional treatment elements such as diffused aeration and settling tanks. The Solar Aquatics™ process is housed in a greenhouse structure, which provides light for photosynthesis of its plant life, the ability to grow plants year-round, as well as provide an attractive appearance. Several Solar Aquatics™ facilities are currently operating in the region. Solar Aquatic™ systems are capable of reducing $BOD_5$ and TSS to secondary treatment standards (30 mg/L). Designs are available which are reported to reduce $BOD_5$, TSS and Total Nitrogen to 10 mg/L. Phosphorus removals are also reported to be feasible.

## 6. Existing Wastewater Infrastructure

The Town is currently undertaking an evaluation and mapping program for the entire collection system. The evaluation and program consists of the following: (1) visual inspection to identify materials of construction, system configuration, depth of structure, and identification of defects; (2) topographic survey to locate the existing manhole

structures and obtain rim elevation; (3) creation of a system map compatible with the Town's existing GIS system; and (4) provide the Town with priorities for system repairs and/or modifications. Nantucket's existing wastewater Infrastructure is divided into two service areas.

The first service area collects, transmits, treats and disposes of wastewater generated from the Town area of the Island. The service area consists of approximately 34 miles of sewer, 6 pumping stations, and a 2.24-mgd advanced primary wastewater treatment facility (WWTF). The Surfside WWTF is located on South Shore Road in the Southwest region of the Island. The facility is currently permitted to discharge 1.80 mgd of advanced primary treated effluent during the summer months into 10 rapid infiltration basins. The service area encompasses approximately 2,000 acres of land out of a total 30,580 acres on the Island. The Surfside WWTF serve approximately 4,000 residential and commercial customers.

The second service area collects, transmits, and disposes of wastewater generated from the Siasconset area of the Island. The service area consists of approximately 5 miles of sewer, and a 0.12-mgd discharges raw wastewater into six infiltration basins. The Siasconset WWTF is located on Low Beach Road in the Southeast region of the Island. Over the last decade, the Town has been in the process of planning, design and permitting an advanced wastewater treatment facility. The Siasconset WWTF is design for advanced treatment of the wastewater with an average daily flow of 0.22-mgd and discharge limits of 10 mg/L $BOD_5$, 10 mg/L TSS and 5 mg/L Total N. Currently the proposed facility is under construction and consists of the following components: (1) Influent Flow Measurement; (2) Primary Clarifiers; (3) Sequencing Batch Reactors; (4) Post Equalization; (6) Effluent Filtration; (6) Ultraviolet Disinfection; (7) Effluent Flow Measurement; (8) Sludge Holding Tanks; (9) Scum Holding Tank; (10) Odor Control System; and (11) Rehabilitation of the Existing Rapid Infiltration Basins. The service area encompasses approximately 1,012 acres of land out of a total 30,580 acres on the Island. The Siasconset WWTF will serve approximately 700 residential and commercial customers.

**Collection System Tributary to the Surfside WWTF**

The sewer collection system tributary to the Surfside WWTF consists of approximately 34 miles of sewer. The size of sewer pipes range from 4 to 30 inch in diameter. The average pipe diameter in the system is 6 and 8 inches. The majority of the sewer system flows by gravity and the most common pipe material is VC with oakum-mortar joints. The manholes are generally round brick or concrete block construction with cast-iron frames and covers. Most manholes are without steps and range between 2 to 17 feet in depth, with an average depth between 6 and 8 feet.

The gravity sewers discharge to a pumping station on Sea Street where the sewage is pumped through either of two force mains to the Surfside filter beds; a 20-inch ductile force main installed in 1981, or a 20-inch cast-iron force main relined with 16-inch polyethylene liner pipe installed in 1984. The total distance from the pumping station to the ten slow sand filter beds on the south shore of the Island is about 17,800 feet. The pumping station, the original force main, and original seven filter beds were built in 1929. Beginning at the pumping station, 5,300 feet of force main was repaired in 1959 and during the period repairs were in progress, an emergency force main bypass discharging to the ocean at Brant Point was constructed and placed in service to permit the repairs. The emergency bypass has been taken out of service.

**Collection System Tributary to the Siasconset WWTF**

The sewer collection system tributary to the Siasconset WWTF consists of approximately 5 miles of sewer. The size of sewer pipes range from 4 to 12 inch in diameter. The average pipe diameter in the system is 6 and 8 inches. The sewer system flows by gravity to the existing rapid infiltration basins and the most common pipe material is VC with oakum-mortar joints. The manholes are generally round brick or concrete block construction with cast-iron frames and covers. Most manholes are without steps and range between 2 to 15 feet in depth, with an average depth between 6 and 8 feet.

**Wastewater Pumping Stations**

There are six pump stations located throughout the Town that convey the Town's wastewater to Surfside WWTF. The stations types consist of two submersible pump stations, two suction lift pump stations, one air injection pump station and one custom built station. Refer to Table 2-7 for a summary of the pumping stations.

**TABLE 2-7**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**WASTEWATER PUMPING STATIONS SURVEY SUMMARY**

| ID | Pump Station Name | Type of Station | Year Built | Year Upgrade | Pumping System Design Capacity | Pumping System No. | Pumping System Miscellaneous | Pumping System HP | Station Alarms (Y / N) | Emergency Generator (Y / N) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Airport Pump Station | Submersible | 1989 | None | 300 GPM<br>48' TDH<br>1750 RPM | 2 | ABS<br>AF60-4<br>4 inch Discharge | | Y (Phone) | N | • Pump Run Times: 7,698 hours and 6,412 hours<br>• Float controlled<br>• Feeds Old South Road Pump Station<br>• No flow measuring device<br>• Control Panel needs to be replaced due to corrosion.<br>• One pump overhauled |
| 2 | Cato Lane Pump Station | Submersible | 1964 | 2003 | 85 GPM<br>13' TDH<br>1750 RPM | 2 | ITT/Flygt<br>CP3085-440<br>4 inch Discharge | 3 | Y | N | • Ejector Station Replaced in 2003<br>• Feeds Surfside Pump Station<br>• No Flow measuring device |
| 3 | Old South Road (South Valley) Pump Station | Suction Lift | 1989 | None | 980 GPM<br>81' TDH<br>1765 RPM | 3 | Gorman Rupp<br>T6A3-B<br>12 3/8th inch impeller | 40 | N | Y | • DMT Corp. Generator: 100kW, 125kVa, 150 amps, 277/430 V, 3 ph, 60 Hz<br>• Generator run time = 65 hours<br>• Pump Run Times: 250 hours, 215 hours, and 223 hours<br>• Structure condition good<br>• Control Panel parts have been discontinued.<br>• Town Maintained from 1989 to 1991 and 2001 to present.<br>• Air bubbler controlled<br>• Flow measurement device by Polysonics<br>• Flow to station is much lower than design capacity. |

**TABLE 2-7 (cont)**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**WASTEWATER PUMPING STATIONS SURVEY SUMMARY**

| ID | Pump Station Name | Type of Station | Year Built | Year Upgrade | Pumping System Design Capacity | Pumping System No. | Pumping System Miscellaneous | Pumping System HP | Station Alarms (Y / N) | Emergency Generator (Y / N) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Pine Valley Pump Station | Submersible | 1989 | None | 458 GPM<br>47' TDH<br>1150 GPM | 2 | ABS<br>AFP/N-15 | | Y (Phone) | N | • Floats used for controls<br>• 8" gravity in, 4" FM out<br>• No flow data<br>• Feeds Surfside Pump Station |
| 5 | Sea Street Pump Station | Custom Building | 1930 | 1994 | 1800 GPM<br>86' TDH<br>VFD | 3 | Worthington<br>6MF17FR6<br>Westinghouse Motor<br>460V, 3ph, 60Hz,<br>1170 RPM | 75 | Y | Y | • Screen Motor: Underwriters Laboratories, FAB239175, 3 hp, 3ph, 1725 rpm, 230/408V<br>• Grinder Motor = Underwriters Laboratories, SZ541361, 3 hp, 233V, 1725 rpm, 60 cycles, 3ph<br>• Kohler Generator: 3ph, 60Hz, 277/480V, 230 kW, 288kVa, 346 Amps, 185 hrs. |
| | | | | | 1900 GPM<br>78' TDH<br>VFD | | Clow Yeomans<br>5k6404AS308<br>GE Motor<br>460V, 3ph, 60Hz,<br>1190 RPM | 60 | | | |
| 6 | Surfside Pump Station | Suction Lift | 1987 | None | 980 GPM<br>68' TDH<br>1400 RPM | 2 | Gorman Rupp<br>T5A3-B | 40 | Y | Y | • Pump Run Times – 5,721 hours and 4,672 hours<br>• Flow measurement device by Polysonics<br>• Allen Bradley Control Panels, parts difficult to obtain<br>• Generator only capable of running 1 pump.<br>• Superior Generator: 75 kW, 93.75 kVa, 112 amps, 3ph, 60Hz, 277/480V |

**Pine Valley Pump Station**

The Pine Valley Pump Station was constructed in 1989 and utilizes submersible pumps as the mean to convey wastewater. The station is privately owned and maintained. The station does not have a flow measurement device, on-site emergency generator or capability of alarm transmission to the Surfside WWTF. Wastewater flows from Pine Valley Pump Station are pumped into the collection system that is tributary to the Surfside Road Pump Station.

**Airport Pump Station**

The Airport Pump Station was constructed in 1989 and utilizes submersible pumps as the mean to convey wastewater. The Town has only maintained the Airport Pump Station since early 2000 when it took control of the station from the Nantucket Inn. The Airport Pump Station's control panels are badly corroded and are in need of replacement. The station does not have a flow measurement device, on-site emergency generator or capability of alarm transmission to the Surfside WWTF. Wastewater flows from Airport Pump Station are pumped into the collection system that is tributary to the Old South Road Pump Station.

**Cato Lane Pump Station**

At the beginning of this project, the Cato Lane Pump Station was the only air injection station and was in poor condition as its structure was in need of an upgrade. This ejector station lacked suitable access for proper operation and maintenance, did not have a flow measurement device, on-site emergency generator or capability of alarm transmission to the Surfside WWTF. During 2003, the Cato Lane Pump Station was completely replaced with a submersible pumping station as part of the Siasconset WWTF project. Wastewater flows from Cato Lane Pump Station are pumped into the collection system that is tributary to the Surfside Pump Station.

**Old South Road Pump Station**

Old South Road Pump Station (also known as South Valley Pump Station) utilizes suction lift pumps as the mean to convey wastewater. The Town maintained Old South Road Pump Station from 1989 to 1991. The South Valley Subdivision Community took over the maintenance of the pump station from

1991 to 2001. In February of 2001, the Town took back the responsibility to maintain the Old South Road Pump Station. Flow to this station is much lower than design capacity and therefore has created some operational problems. The station does not have an on-site emergency generator or capability of alarm transmission to the Surfside WWTF. Wastewater flows from Old South Road Pump Station are pumped directly to the Surfside WWTF.

**Surfside Road Pump Station**

Surfside Road Pump Station utilizes suction lift pumps as the mean to convey wastewater. The Surfside Road Pump Station is in need of a new generator since the existing generator is capable of only running one pump, which reduces the flexibility and redundancy of the station. Wastewater flows from Surfside Road Pump Station are pumped directly to the Surfside WWTF.

**Sea Street Pump Station**

Sea Street Pump Station is the largest pump station located in a custom building in the center of the downtown area. This is the oldest station dating back to around 1930. The station has gone through two major upgrades, the most recent in 1994. The Town is planning to replace the existing comminutor with a bar screen. Currently the station has experienced a problem with excessive grease in the collection system that accumulates in the station's wetwell. In addition, the Town has also experience problems with the variable frequency drives at Sea Street. Wastewater flows from Sea Street Pump Station are pumped directly to the Surfside WWTF utilizing either a 20-inch diameter force main or 16-inch diameter force main.

The Sea Street pumping station was built in the 1930s and consists of a one-story superstructure, 30 feet by 32-feet in plan partitioned into two sections comprising of an 11-foot by 32-foot wet well extending below grade along the rear of the building and a ground level control room with a below-grade dry well occupying the remaining space on the street side.

In the 1970s a headworks facility consisting of a comminutor and by-pass bar rack was constructed to replace the manually cleaned screen cages. In addition, an emergency generator was added to maintain operation of the station in the event of a power outage. This equipment was installed in a new building located directly behind the existing superstructure and was constructed adjacent to the existing wetwell.

In the early 1990s, the pump station was upgraded to include the installation of a channel grinding mechanism, chemical addition storage and feed equipment for the force main and wetwell, activated carbon odor control system, ozone generation and wetwell distribution equipment, separation of a large wetwell into two compartments to facilitate cleaning, replacement of 2 pumps and the additional of variable speed drives.

**Portable Generator**

For the three pump stations that do not have an on-site emergency generator, the Town utilizes a portable generator during normal power failures. The portable generator is currently stored at the Surfside WWTF. The portable generator is covered with rust and requires some minor repairs.

**Infiltration/Inflow**

An infiltration/inflow (I/I) study was initiated on the Island of Nantucket in March of 1988. A previous study had been conducted in 1973. The objective of the I/I investigation was to identify the portions of Nantucket's wastewater collection system that contribute excessive I/I to the local wastewater facility and to develop a list of cost effective recommendations for the elimination or reduction of these I/I sources.

The sewer system in the Town of Nantucket was divided into seven Mini-systems, M1, M2, M3, N1, N2, N3 and N4. Mini-system M1 was reported with excessive infiltration with approximately 157,000 gpd. While mini-systems M1, M2, M3, N1 and N2 were noted to incur 87 percent of the total inflow. In 1987 State Guidelines suggested that mini-systems that account for at least 80 percent of the total system inflow must be subjected to a Sewer Service Evaluation Survey (SSES).

The SSES was performed to identify the specific locations of I/I sources, to quantify the amount of I/I, to identify the method of rehabilitation to eliminate I/I, and to justify rehabilitating each defined I/I source. Included in the SSES was flow isolation, manhole inspections, private source inflow questionnaires, internal building inspections, smoke testing, and dyed-water testing. The SSES was completed in 1989 and submitted to and approved by the Massachusetts DEP in 1991. Final conclusions and recommendations from the report include:

- Total removable design peak inflow amounted to 1.978 mgd, of which approximately 1.68 mgd is attributable to private inflow sources;
- Approximately 160,000 gpd of infiltration was identified of which approximately 20,000 gpd was found to be cost effective to be removed;
- Rehabilitate sewer lines and manholes identified in the cost-effective analysis;
- Perform a testing and sealing program of identified leaking service connections;
- Remove illegal connections to sewer system;
- Develop a regular maintenance program including flushing the sewer lines to minimize the build up of debris and to maintain hydraulic capacity; and
- Correct collapsed pipes and broken inverts, and remove heavy root intrusion that contribute to heavy infiltration.

After the completion of the 1991 Town of Nantucket Infiltration/Inflow Analysis and Sewer System Evaluation Survey, the Town has taken a number of steps to remove I/I from its sewer system. Amongst the steps taken are the following:

- Removal of illegal connections;
- Removal of suspect catch basins;
- Purchased equipment to aid in locating and repairing broken lines and potential I/I sources;
- Developed an Operation and Maintenance program that includes two full time staff dedicated to the maintenance of the collection system;
- Manhole repairs and installation with an average of 10 manholes repaired per year and 6 manholes replaced installed per year; and
- Replacement of the Washington Street Area interceptor that was identified as a line that: (1) was a source of several surcharging events per year; (2) was a source of significant infiltration; (3) created a maintenance problem caused by a continual build-up of debris; and (4) had various structure defects.

## 7. Existing Wastewater Treatment Facilities

### Background

Earth Tech provided wastewater master planning services, including facilities planning and EIR completion, for the Town of Nantucket. These services included the planning, design and construction of the Surfside Wastewater Treatment Facility and the Siasconset Wastewater Treatment Facility. The Surfside Wastewater Treatment Facility was

completed in 1991. Severe storms caused significant erosion that postponed construction of the coastal Siasconset Wastewater Treatment Facility. Shortly thereafter, Earth Tech evaluated short-term measures to be utilized as interim solutions for the Siasconset wastewater disposal issue. The final result was only minor modifications being made to the existing infiltration basins in 1991. In July 2002, an updated Coastal Erosion Report was completed at the Surfside WWTF site. The Woods Hole Group completed this and the former coastal erosion report done in July 1999 under subcontract with Earth Tech. The reports summarize the fact that erosion is not an issue at this site. A copy of both these erosion reports are included in Appendix C.

**Surfside Wastewater Treatment Facility**

The Surfside Wastewater Treatment Facility treats flow generated from the Center of Nantucket and has a design capacity of 2.24 MGD. The Surfside Wastewater Treatment Facility consists of a septage receiving tank, aerated grit chamber, three primary clarifiers that utilize ferric chloride and polymer for enhanced treatment, ten rapid infiltration basins, three aerated sludge holding tanks, one aerated septage equalization tank, and process support systems. Sludge and septage are dewatered with belt filter presses and can be mixed with wood chips in a portable mixer using aerated static pile method to produce a product that meets DEP Standards for a Type I sludge or composted with municipal solid waste. Currently, the Town transports the dewatered solids to the Town landfill for co-composting in a privately operated facility. The facility has been in operation since 1991 and underwent improvements in 1992 for odor control and improved primary treatment.

A key element of the facility's design is the odor control system, which treats odorous air from the sludge dewatering area, grit dewatering area, sludge storage, septage equalization, and the compost operation. The 4-stage odor control system utilizes a water cooling chamber for the compost pile off gases, an acid wash chamber for ammonia odors, a sodium hypochlorite and sodium hydroxide scrubber for hydrogen sulfide, and an activated carbon chamber for volatile organics. The process also includes chemical addition to the sludge and septage holding tanks and to the sludge suction of the belt filter press feed pumps as a back up to the air scrubbing system.

In addition, the Surfside Wastewater Treatment Facility is designed to receive an average of 11,200 gallons per day of septage. The septage can be processed using several methods: (1) Pumping to the Headworks; (2) Pumping to the Cyclone Grit Classifier; or (3) Pumping to the Aerated Sludge Holding Tanks for Belt Press Dewatering.

The Nantucket Surfside WWTF provides primary settling for biochemical oxygen demand ($BOD_5$) removal and total suspended solids (TSS) removal. The Town's wastewater flows through a 12-inch Parshall flume where it is screened before continuing through an aerated grit chamber, primary clarifiers with the final effluent discharged into one of 10 rapid infiltration basins. Chemically enhanced primary treatment occurs during the summer months by the addition of chemicals are various injection points. Wastewater solids are stored in three aerated sludge holding tanks prior to dewatering utilizing belt filter presses. Although the facility has the capability to stabilize the dewatered wastewater sludge, using aerated static pile composting, the facility discontinued composting operations in 1997 and the dewatered sludge is transported to an on-island municipal solid waste composting facility that is privately operated. The following is a summary of the unit process:

- One Aerated Grit Chamber with a dimension of 12 feet by 14 feet with sidewater depth of 10 feet.
- One Septage Holding Tank with dimensions of 16.25 feet by 18 feet with a total storage of approximately 19,700 gallons.
- Three Primary Clarifiers with dimensions of 81.5 feet by 18 feet with a side water depth of 7 feet.
- Three Aerated Sludge Holding Tanks with varying dimensions of 16.25 feet by 18 feet for Tank No. 1 and Tank No. 2, and 13 feet by 25 feet for Tank No. 3.
- Two 1.0 meter Belt Filter Presses.
- Ten Rapid Infiltration Basins each 1.02 acres with a maximum loading depth of 2.5 feet.
- Multi-stage odor control system consisting of cooling chamber, acid wash chamber, mist chambers followed by activated carbon chambers.
- Chemical storage and feed systems for chemically enhanced primary treatment.

The Nantucket Surfside Wastewater Treatment Facility (WWTF) was designed in 1987 for expected conditions up to the summer of 2007 and is currently permitted to discharge 1.80 mgd. Although the Surfside WWTF is designed for 2.24-mgd, it currently has a Class III Groundwater Discharge Permit issued by the Massachusetts DEP for only 1.80 mgd. Table 2-8 provides the limits imposed by the DEP Class III Groundwater Discharge Permit issued March 4, 1992. A complete copy of the permit is included in

Appendix D. Over the last few summers, the facility has approached its permitted flow limit. The DEP has refused the Town's application to increase its discharge permit limits to its capacity of 2.24 mgd.

Since the filing of the Phase II Report in September 2003, the Town entered into an Administrative Consent Order (ACO), ACOP-BO-03-1G002, with the Massachusetts Department of Environmental Protection on October 22, 2003 in the matter of the Surfside Wastewater Treatment Facility. The ACO encompasses alleged permit limit violations, establishment of a sewer bank, infiltration/inflow analysis and system rehabilitation, deadlines for the upgrading of the WWTF to meet Class I Discharge standards and various milestones to be accomplished with regards to the permitting, operating and maintaining of the WWTF. A Preliminary Design Report (PDR) is been completed, which will enable the Town to meet the ACO deadline for a new Surfside WWTF. Refer to Appendix A for the complete ACO. The schedule of recommendations from this CWMP/FEIR are being revised in order to coordinate and comply with the provisions of the ACO.

**TABLE 2-8**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**MASSACHUSETTS GROUNDWATER**
**DISCHARGE PERMIT No. 1-200 LIMITS**

| Effluent Characteristics | Units | Discharge Limitation | |
|---|---|---|---|
| | | Average Daily | Maximum Daily |
| Flow | mgd | 1.80 | 5.80 |
| $BOD_5$ | mg/L | 215 | 230 |
| TSS | mg/L | 225 | 230 |
| Oil & Grease | mg/L | 15.0 | |
| pH | --- | 6.5 – 8.5 | |

The detailed design criteria for the existing Surfside WWTF is included in Table 2-9.

Peak flow on the Island is in the summer months between June and September and has averaged 1.63 mgd as shown on Table 2-10 and Figure 2-11. The off-peak season on the island records lower flows during the months of October through May, with an average of 1.05 mgd. The quantity of wastewater into the wastewater system is influenced heavily by the summer months, of which includes tourist season and an increase in the residential population.

**TABLE 2-9**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SURFSIDE WWTF DESIGN DATA**

| Criteria | Initial Year (1987) | Future Year (2007) |
|---|---|---|
| **Design Loading Data** | | |
| Population | 12,225 | 20,100 |
| Flow (mgd) | | |
| Average Daily | 1.6 | 2.24 |
| Domestic | 1.5946 | 2.2288 |
| Septage | 0.0054 | 0.0112 |
| Peak Daily | 4.8 | 6.68 |
| Biochemical Oxygen Demand (lbs/day) | 3,729 | 5,871 |
| Domestic | 3,387 | 5,264 |
| Septage at 15,000 mg/L | 293 | 607 |
| Suspended Solids (lbs/day) | 3,729 | 6,426 |
| Domestic | 3,056 | 5,025 |
| Septage at 15,000 mg/L | 673 | 1,401 |
| **Process Design Data** | | |
| Aerated Grit Chamber | | |
| Number | 1 | |
| Dimension, Each (feet) | 12 x 14 | |
| Side Water Depth (feet) | 10 | |
| Grit Screw Horsepower, Each | ¾ | |
| Air Requirements, Each | | |
| Flow (cfm) | 50 to 80 | |
| Pressure (psi) | 9 | |
| Grit Washer | | |
| Number | | |
| 12-inch Cyclone | 1 | |
| 10-inch Classifier | 1 | |
| Horsepower | ½ | |
| Aerated Septage Holding Tank | | |
| Number | 1 | |
| Size, Each (feet) | 16.25 x 18 | |
| Mixing Type | Diffused Air | |

**TABLE 2-9 (cont)**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SURFSIDE WWTF DESIGN DATA**

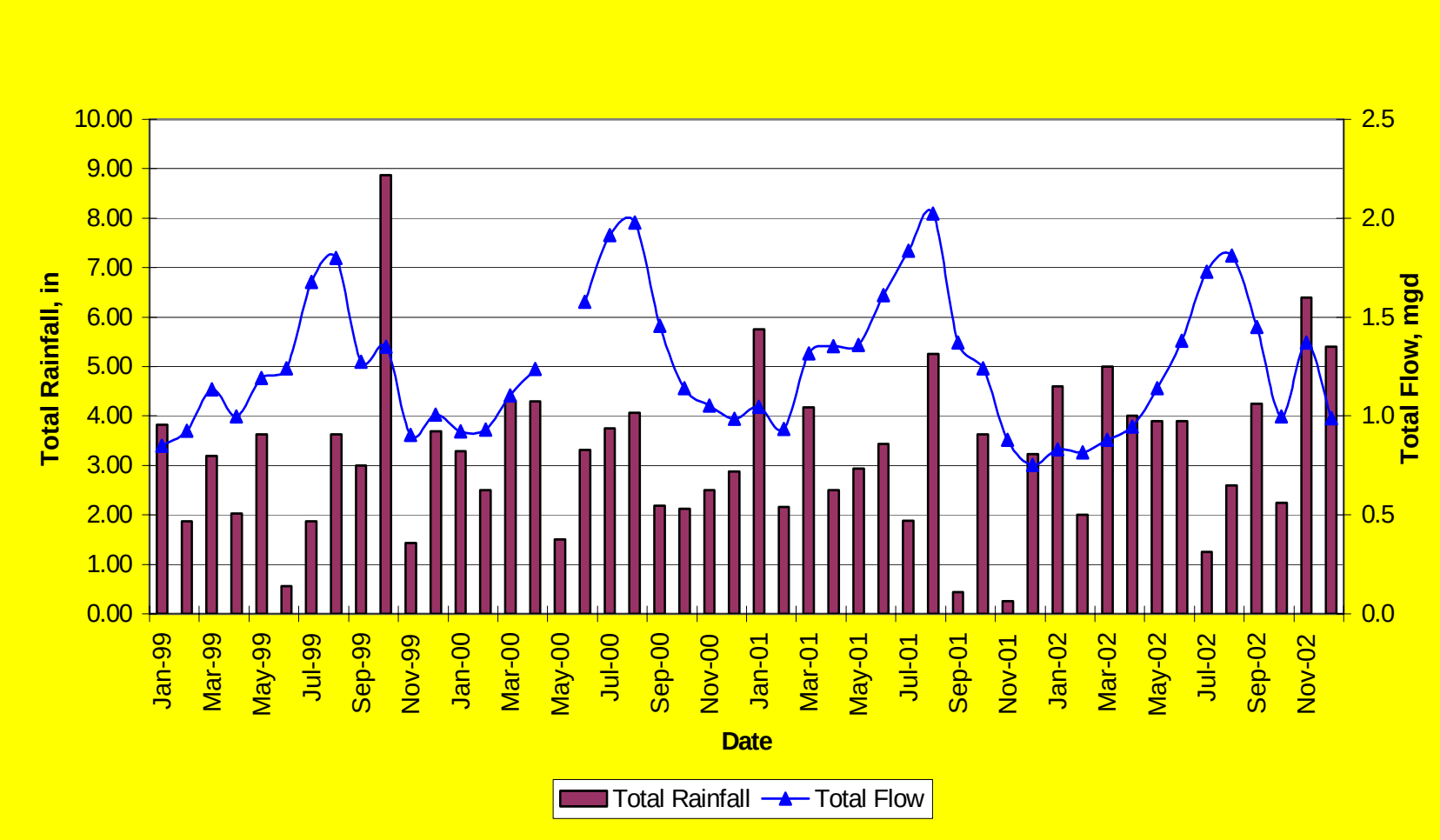
| Criteria | Initial Year (1987) | Future Year (2007) |
|---|---|---|
| Air Requirements | | |
| SCFM Per 1,000 CF | 30 | |
| Per Diffuser (scfm) | 12 | |
| Total Storage, Each (gallons) | 19,690 | |
| Primary Clarifiers | | |
| Number | 3 | |
| Size, Each (feet) | 81.5 x 18 | |
| Side Water Depth (feet) | 7 | |
| Effective Surface Area, Each (square feet) | 1,467 | |
| Volume, Each (gallons) | 76,812 | |
| Overflow Rate (gpd/sq. ft.) | | |
| Average Daily Flow | 364 | 509 |
| Peak Daily Flow | 2,576 | 1,518 |
| Loading Rate (gpd/lf of weir) | 16,667 | 23,336 |
| BOD Removal (%) | 60 | |
| Effluent SS (lbs/day) | 1,492 | 2,570 |
| Rapid Infiltration Basins | | |
| Number Provided | 10 | |
| Average Loading Rate (gpd/sq. ft.) | 4 | |
| Loading Depth (ft) | 2.5 | |
| Basin Area (acres) | 1.02 | |
| Aerated Sludge Holding Tanks | | |
| Number | 3 | |
| Size, Ea. (ft) | | |
| Tanks 1 and 2 | 16.25 x 18 | |
| Tank 3 | 13 x 25 | |
| Depth, Ea. (ft) | 9 | |
| Volume Ea. (cu. ft.) | | |
| Tanks 1 and 2 | 5,265 | |
| Tank 3 | 2,981 | |
| Total | 8,246 | |
| Mixing Type | Diffused Air | |
| Air Requirements | | |
| SCFM per 1,000 CF | 20 | |
| Per Diffuser (scfm) | 12 | |
| Total Storage at 4 percent solids (gal) | 61,680 | |
| Total Storage at 4 percent solids (days) | 9.2 | 5.34 |
| Belt Filter Presses | | |
| Number | 2 | |
| Size, Ea. (meter) | 1 | |
| Sludge Feed (lbs. D.S./wk) | 15,662 | 26,990 |
| Unit Capacity | | |
| Dry Solids (lbs/hr) | 1,000 | |
| Liquid Feed (gpm at 4 percent D.S.) | 50 | |
| Washwater Requirements | | |
| Flow (gpm) | 65 | |
| Pressure (psi) | 85 | |
| Unit Horsepower | 7.5 | |
| Operations (hrs/wk/unit) | 11.17 | 17.83 |
| Sludge Cake, Min (% D.S.) | 25 | |
| Polymer Required (lbs./ton D.S.) | 5 to 10 | |

**TABLE 2-10**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SURFSIDE WWTF WASTEWATER**
**FLOWS (1999 through 2002)**

| Month | Average Flows (mgd) | | | |
|---|---|---|---|---|
| | 1999 | 2000 | 2001 | 2002 |
| January | 0.85 | 0.92 | 1.05 | 0.83 |
| February | 0.93 | 0.93 | 0.93 | 0.82 |
| March | 1.14 | 1.10 | 1.31 | 0.88 |
| April | 1.00 | 1.24 | 1.35 | 0.95 |
| May | 1.19 | N/A | 1.36 | 1.14 |
| June | 1.24 | 1.58 | 1.61 | 1.38 |
| July | 1.68 | 1.91 | 1.83 | 1.73 |
| August | 1.80 | 1.98 | 2.02 | 1.81 |
| September | 1.27 | 1.45 | 1.37 | 1.45 |
| October | 1.35 | 1.14 | 1.24 | 1.00 |
| November | 0.90 | 1.05 | 0.88 | 1.37 |
| December | 1.00 | 0.99 | 0.75 | 0.99 |
| **Annual Average** | **1.20** | **1.30** | **1.31** | **1.20** |
| **Peak Season Average** | **1.50** | **1.73** | **1.71** | **1.59** |
| **Off-Peak Season Average** | **1.05** | **1.05** | **1.11** | **1.00** |

Although the Town continues to experience a high growth rate, the Town's efforts to reduce infiltration/inflow is reflected in the fact that the average for the last four years is only 1.25 mgd, considerable below the permit limit annual average of 1.80 mgd. The average daily discharge flow in 1999 was 1.20 mgd with a maximum flow of 1.80 mgd. The flow increased in 2000 with an average of 1.30 mgd with a maximum of 1.98 mgd. The flow in 2001 increased yet again to an average of 1.31 mgd with a maximum of 2.02. The average flow in 2002 dropped to 1.20 mgd with a maximum of 1.81 mgd.

**FIGURE 2-11**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SURFSIDE WWTF FLOWS AND PRECIPITATION**



Refer to Table 2-11, Table 2-12, Table 2-13 and Table 2-14 for design loading data and process design data for the calendar years 1999, 2000, 2001 and 2002, respectively. The Nantucket Surfside Wastewater Treatment Facility is permitted to discharge an effluent $BOD_5$ of 215 mg/L. Over the last four years the facility's maximum effluent $BOD_5$ was 119 mg/L or approximately 55 percent of the permitted limit. The average effluent $BOD_5$ in 1999 was 89 mg/L, the average effluent $BOD_5$ in 2000 was 95 mg/L, and the average effluent $BOD_5$ in 2001 was 93 mg/L, and the average effluent $BOD_5$ in 2002 was 101 mg/L.

The Nantucket Surfside Wastewater Treatment Facility is permitted to discharge an effluent TSS of 225 mg/L. Over the last four years the facility's maximum effluent TSS was 34 mg/L or only 15 percent of the permitted limit. The average TSS discharge in 1999 was 34 mg/L, the average TSS effluent discharge in 2000 was 34 mg/L, the average TSS effluent discharge in 2001 was 35 mg/L, and the average TSS effluent discharge in 2002 was 40 mg/L.

# TABLE 2-11
# TOWN OF NANTUCKET
# CWMP/FEIR
# SURFSIDE WWTF PERFORMANCE - 1999

| | | | Influent Quality | | | Effluent Quality | | | | | Sludge | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Avg. Flow (mgd) | Oil & Grease | BOD (mg/L) | TSS (mg/L) | Total Solids (mg/L) | pH | Temp. (C) | BOD (mg/L) | TSS (mg/L) | Total Solids (mg/L) | Gals. (x 1000 gal) | Lbs (x 1000 lbs) | Feed Solids (%) | Cake Solids (%) |
| January | .85 | 15.8 | 174 | 122 | 1950 | 7.00 | 9.6 | 99 | 41 | 899 | 25.9 | 14.6 | 2.0 | 29.7 |
| February | .93 | 19.9 | 128 | 96 | 983 | 6.87 | 9.5 | 119 | 62 | 696 | 19.1 | 13.1 | 2.7 | 29.5 |
| March | 1.14 | 14.0 | 126 | 82 | 590 | 6.92 | 9.5 | 81 | 50 | 497 | 22.8 | 13.5 | 1.8 | 30.8 |
| April | 1.00 | 29.4 | 148 | 96 | 556 | 6.85 | 12.0 | 102 | 45 | 461 | 23.6 | 13.6 | 1.7 | 28.6 |
| May | 1.19 | 7.4 | N/A | N/A | N/A | 6.89 | 17.9 | 83 | 35 | 948 | 27.7 | 17.6 | 2.7 | 27.3 |
| June | 1.24 | 6.2 | 260 | 238 | 650 | 6.79 | 19.4 | 75 | 18 | 535 | 32.1 | 19.9 | 2.7 | 29.0 |
| July | 1.68 | 8.0 | 218 | 226 | 687 | 6.78 | 22.6 | 87 | 17 | 471 | 37.6 | 21.5 | 2.9 | 31.4 |
| August | 1.80 | 9.6 | N/A | N/A | N/A | 6.81 | 23.5 | 91 | 16 | 514 | 40.6 | 22.4 | 2.7 | 29.8 |
| September | 1.27 | 7.8 | 233 | 282 | 652 | 6.75 | 21.5 | 77 | 15 | 451 | 33.3 | 17.3 | 2.2 | 28.5 |
| October | 1.35 | 9.8 | 177 | 184 | 550 | 6.83 | 18.1 | 59 | 26 | 373 | 28.1 | 13.0 | 2.3 | 28.5 |
| November | .90 | 41.5 | 141 | 119 | 390 | 6.69 | 15.1 | 97 | 45 | 419 | 16.9 | 8.3 | 2.3 | 29.3 |
| December | 1.00 | 18.1 | 118 | 100 | 450 | 6.79 | 11.7 | 98 | 41 | 491 | 13.8 | 9.3 | 2.9 | 29.0 |
| **Total[1]** | **14.35** | | | | | | | | | | **321.2** | **184.1** | | |
| Average | 1.20 | 15.6 | 172 | 154 | 746 | 6.83 | 15.8 | 89 | 34 | 563 | 26.8 | 15.3 | 2.4 | 29.3 |
| Minimum | 0.85 | 6.2 | 118 | 82 | 390 | 6.69 | 9.5 | 59 | 15 | 373 | 13.8 | 8.3 | 1.7 | 27.3 |
| Maximum | 1.80 | 41.5 | 260 | 282 | 1950 | 7.00 | 23.5 | 119 | 62 | 948 | 40.6 | 22.4 | 2.9 | 31.4 |

N/A- Not Available
[1]The average, minimum, maximum under total are based on the monthly values reported in this table.

# TABLE 2-12
# TOWN OF NANTUCKET
# CWMP/FEIR
# SURFSIDE WWTF PERFORMANCE - 2000

| | | | Influent Quality | | | Effluent Quality | | | | | Sludge | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Avg. Flow (mgd) | Oil & Grease | BOD (mg/L) | TSS (mg/L) | Total Solids (mg/L) | pH | Temp. (C) | BOD (mg/L) | TSS (mg/L) | Total Solids (mg/L) | Gals. (x 1000 gal) | Lbs (x 1000 lbs) | Feed Solids (%) | Cake Solids (%) |
| January | .92 | 19.6 | 128 | 106 | 1782 | 6.8 | 9.5 | 90 | 42 | 491 | 19.5 | 11.3 | 2.3 | 30.6 |
| February | .93 | 20.7 | 127 | 163 | 917 | 6.9 | 8.1 | 103 | 43 | 488 | 13.0 | 5.2 | 2.4 | 26.5 |
| March | 1.10 | 17.3 | 104 | 107 | 1465 | 6.9 | 10.8 | 84 | 44 | 767 | 21.3 | 12.1 | 2.1 | 31.2 |
| April | 1.24 | 21.0 | N/A | N/A | N/A | 6.7 | 12.1 | 89 | 50 | 409 | 28.6 | 16.9 | 3.0 | 31.0 |
| May | N/A | 15.8 | N/A | N/A | N/A | 6.8 | 15.6 | 99 | 47 | 443 | 24.3 | 15.2 | 2.7 | 31.9 |
| June | 1.58 | 11.0 | 191 | 113 | 635 | 7.0 | 19.1 | 75 | 18 | 406 | 28.2 | 23.9 | 3.1 | 26.9 |
| July | 1.91 | 8.7 | 209 | 185 | 774 | 7.0 | 21.5 | 98 | 11 | 552 | 40.2 | 28.1 | 2.4 | 28.4 |
| August | 1.98 | 11.8 | 257 | 305 | 723 | 7.1 | 21.4 | 96 | 20 | 480 | 42.2 | 23.6 | 2.1 | 29.3 |
| September | 1.45 | 37.1 | 153 | 76 | 615 | 6.9 | 20.5 | 89 | 27 | 604 | 36.3 | 17.8 | 1.9 | 28.9 |
| October | 1.14 | 20.0 | N/A | N/A | N/A | 7.0 | 18.5 | 96 | 30 | 587 | 38.7 | 19.3 | 2.4 | 28.5 |
| November | 1.05 | 23.0 | N/A | N/A | N/A | 7.0 | 14.0 | 110 | 33 | 526 | 27.0 | 16.6 | 1.6 | 29.3 |
| December | .99 | 23.6 | N/A | N/A | N/A | 7.0 | 10.3 | 113 | 38 | 841 | 22.2 | 15.7 | 2.8 | 29.0 |
| **Total[1]** | **14.30** | **229.4** | | | | | | | | | **341.8** | **205.7** | | |
| Average | 1.30 | 19.1 | 167 | 151 | 987 | 7.0 | 16.4 | 95 | 34 | 549 | 28.5 | 17.1 | 2.4 | 29.3 |
| Minimum | 0.92 | 8.7 | 104 | 76 | 615 | 6.7 | 8.1 | 75 | 11 | 406 | 13.0 | 5.2 | 1.6 | 26.5 |
| Maximum | 1.98 | 37.1 | 257 | 305 | 1782 | 7.1 | 21.5 | 113 | 50 | 841 | 42.2 | 28.1 | 3.1 | 31.9 |

N/A- Not Available
[1]The average, minimum, maximum under total are based on the monthly values reported in this table.

# TABLE 2-13
# TOWN OF NANTUCKET
# CWMP/FEIR
# SURFSIDE WWTF PERFORMANCE - 2001

| | | | Influent Quality | | | Effluent Quality | | | | | Sludge | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Avg. Flow (mgd) | Oil & Grease | BOD (mg/L) | TSS (mg/L) | Total Solids (mg/L) | pH | Temp. (C) | BOD (mg/L) | TSS (mg/L) | Total Solids (mg/L) | Gals. (x 1000 gal) | Lbs (x 1000 lbs) | Feed Solids (%) | Cake Solids (%) |
| January | 1.05 | 18.0 | 145 | 90 | 1116 | 7.06 | 8.6 | 104 | 44 | 1162 | 30.0 | 11.2 | 1.3 | 28.2 |
| February | 0.93 | 22.8 | 116 | 88 | 383 | 7.07 | 8.2 | 93 | 36 | 973 | 23.4 | 15.5 | 3.0 | 27.0 |
| March | 1.31 | 24.2 | 133 | 139 | 497 | 7.02 | 8.5 | 83 | 52 | 687 | 19.3 | 13.3 | 2.7 | 28.4 |
| April | 1.35 | 14.9 | 129 | 99 | 419 | 7.08 | 11.0 | 101 | 39 | 381 | 36.0 | 23.9 | 3.4 | 30.3 |
| May | 1.36 | 18.4 | 141 | 166 | 565 | 7.08 | 16.4 | 72 | 26 | 427 | 35.6 | 21.4 | 3.5 | 28.1 |
| June | 1.61 | 7.0 | 251 | 277 | 742 | 7.13 | 19.6 | 92 | 39 | 479 | 39.2 | 23.0 | 3.2 | 25.4 |
| July | 1.83 | 10.0 | 210 | 215 | 814 | 7.17 | 22.5 | 103 | 26 | 535 | 37.6 | 26.1 | 3.3 | 27.2 |
| August | 2.02 | 8.6 | 233 | 225 | 684 | 7.01 | 22.8 | 96 | 17 | 451 | 39.3 | 25.3 | 2.7 | 28.5 |
| September | 1.37 | 19.2 | 209 | 245 | 757 | 6.87 | 20.9 | 81 | 19 | 564 | 31.4 | 15.9 | 2.4 | 28.0 |
| October | 1.24 | 13.7 | 190 | 190 | 617 | 6.93 | 19.2 | 92 | 33 | 507 | 25.6 | 14.4 | 2.9 | 27.8 |
| November | 0.88 | 25.7 | 166 | 165 | 581 | 6.95 | 15.5 | 129 | 47 | 518 | 21.0 | 14.1 | 1.9 | 29.5 |
| December | 0.75 | 21.0 | 150 | 94 | 741 | 6.97 | 12.4 | 145 | 54 | 643 | 13.0 | 8.0 | 2.5 | 29.4 |
| **Total[1]** | **15.70** | | | | | | | | | | **351.4** | **212.1** | | |
| Average | 1.31 | 17.0 | 173 | 166 | 660 | 7.02 | 15.5 | 99 | 36 | 611 | 29.3 | 17.7 | 2.7 | 28.2 |
| Minimum | 0.75 | 7.0 | 116 | 88 | 383 | 6.87 | 8.2 | 72 | 17 | 381 | 19.3 | 26.1 | 1.3 | 25.4 |
| Maximum | 2.02 | 25.7 | 251 | 277 | 1116 | 7.17 | 22.8 | 145 | 54 | 1162 | 39.3 | 8.0 | 3.5 | 30.3 |

[1]The average, minimum, maximum under total are based on the monthly values reported in this table.

# TABLE 2-14
# TOWN OF NANTUCKET
# CWMP/FEIR
# SURFSIDE WWTF PERFORMANCE - 2002

| | | | Influent Quality | | | Effluent Quality | | | | | Sludge | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Avg. Flow (mgd) | Oil & Grease | BOD (mg/L) | TSS (mg/L) | Total Solids (mg/L) | pH | Temp. (C) | BOD (mg/L) | TSS (mg/L) | Total Solids (mg/L) | Gals. (x 1000 gal) | Lbs (x 1000 lbs) | Feed Solids (%) | Cake Solids (%) |
| January | 0.83 | 29.5 | 120 | 91 | 560 | 7.09 | 9.20 | 106 | 46 | 508 | 16.8 | 11.1 | 2.6 | 27.4 |
| February | 0.82 | 21.0 | 117 | 158 | 660 | 7.08 | 9.15 | 107 | 75 | 851 | 12.4 | 9.1 | 5.1 | 26.8 |
| March | 0.88 | 11.9 | 120 | 104 | 658 | 6.82 | 10.65 | 94 | 55 | 554 | 16.8 | 11.7 | 3.0 | 25.2 |
| April | 0.95 | 22.8 | 113 | 87 | 441 | 6.65 | 12.73 | 116 | 47 | 379 | 24.8 | 16.1 | 3.5 | 28.9 |
| May | 1.14 | 27.6 | 145 | 129 | 541 | 6.64 | 15.42 | 91 | 37 | 426 | 33.3 | 16.8 | 4.5 | 30.4 |
| June | 1.38 | 8.0 | 172 | 163 | 719 | 6.83 | 18.73 | 89 | 27 | 544 | 30.6 | 17.5 | 3.4 | 27.0 |
| July | 1.73 | 9.6 | 207 | 193 | 770 | 6.70 | 22.95 | 120 | 28 | 560 | 36.4 | 28.7 | 3.4 | 27.4 |
| August | 1.81 | 4.5 | 176 | 124 | 665 | 6.71 | 23.04 | 115 | 18 | 496 | 30.3 | 21.7 | 3.1 | 27.5 |
| September | 1.45 | 9.1 | 173 | 147 | 583 | 6.62 | 20.9 | 86 | 16 | 538 | 21.9 | 16.3 | 3.1 | 27.1 |
| October | 1.00 | 15.6 | 153 | 116 | 533 | 6.70 | 18.12 | 96 | 37 | 486 | 22.3 | 14.4 | 3.3 | 28.4 |
| November | 1.37 | 38.0 | 110 | 99 | 554 | 6.74 | 13.88 | 94 | 51 | 602 | N/A | 8.2 | 3.0 | 31.8 |
| December | 0.99 | 18.8 | 130 | 88 | 485 | 6.73 | 10.23 | 111 | 46 | 409 | 11.5 | 12.2 | 5.5 | 32.7 |
| **Total**[1] | **14.35** | | | | | | | | | | **257.1** | **183.8** | | |
| Average | 1.20 | 17.9 | 147 | 127 | 599 | 6.75 | 16.0 | 101 | 40 | 531 | 26.3 | 17.6 | 3.5 | 28.1 |
| Minimum | 0.82 | 4.5 | 110 | 87 | 441 | 6.62 | 9.15 | 86 | 16 | 379 | 11.5 | 8.2 | 2.6 | 25.2 |
| Maximum | 1.81 | 38.0 | 207 | 193 | 770 | 7.09 | 23.04 | 120 | 75 | 851 | 36.4 | 28.7 | 5.5 | 32.7 |

[1]The average, minimum, maximum under total are based on the monthly values reported in this table.

**Evaluation of Process Equipment**

The condition of all of the process equipment at the Surfside WWTF was evaluated. The equipment evaluation is based on a site visits, discussions with the WWTF staff and review of maintenance records. The serviceability rating is based on the following qualitative rankings show in Table 2-15.

**TABLE 2-15**
**TOWN OF NANTUCKET, MASSACHUSETTS**
**CWMP/FEIR**
**SURFSIDE WWTF SERVICEABILITY RATINGS**

| Rating | Description |
|---|---|
| 3 | Good |
| 2 | Fair |
| 1 | Poor |
| 0 | Inoperative |

**Headworks**

The Bar Rack, Parshall Flume and Aerated Grit Chamber are located in the Headworks. An evaluation of the Headworks equipment found of a badly corroded grit collector screw and retrievable aeration piping in need of replacement, and the need for aluminum plates instead of the grating currently in place. Currently a grating system is in place that allows odors to escape into the air while using aluminum plates would contain the odors and allow the odorous air stream to be treated in the existing odor control system. Table 2-16 shows the summary of equipment in the Headworks.

**Solids Handling Building**

Grit Dewatering System, Grit Pump, Septage Pump, Primary Sludge Pumps, Belt Filter Press Feed Pumps, Odor Control Equipment including Chemical Feed System and Air Compressor are located in the Solids Handling Building. The investigation of the Solids Handling Building concluded that the Cyclone Dewatering System and grit and septage pumps are in need of rehabilitation or replacement due to severe corrosion. Table 2-17 shows the summary of process equipment in the Solids Handling Building.

## TABLE 2-16
## TOWN OF NANTUCKET, MASSACHUSETTS
## CWMP/FEIR
## SURFSIDE WWTF EVALUATION OF PROCESS EQUIPMENT – HEADWORKS

| Description | Qty | Manufacturer | Run Time (hrs) | Serviceability Rating | Nameplate | Comments |
|---|---|---|---|---|---|---|
| Flow Measuring Device | 1 | Sigma 950 | | 3 | --- | - Primary measuring device is a 12” Parshall Flume |
| Grit Pump | 1 | Hayward Gordon | 2,092 | 2.5 | 3” | |
| Retrievable Piping | 1 | | | 0 | --- | - Located in Grit Chamber<br>- Used for Air Distribution<br>- Out of Service<br>- Needs Replacement<br>- Manufactured by Schloss |
| Grit Collector Screw | 1 | | | 1 | --- | - Badly Corroded |
| Floor Grates | --- | --- | --- | 1 | --- | - Needs aluminum plate to replace grating covered by plywood for odor containment. |

## TABLE 2-17
## TOWN OF NANTUCKET, MASSACHUSETTS
## CWMP/FEIR
## SURFSIDE WWTF EVALUATION OF PROCESS EQUIPMENT – PRIMARY CLARIFIERS

| Description | Qty | Manufacturer | Run Time (hrs) | Serviceability Rating | Nameplate | Comments |
|---|---|---|---|---|---|---|
| Clarifier Drives | 3 | FMC | Min: 57,205<br>Max: 86,000 | 2 | --- | - Replace Flights, Sprockets and Chains as part of Upgrade |
| MCC | 1 | --- | --- | 2 | --- | - Exterior of cabinets beginning to corrode |

**Sludge Management Building**

Belt filter presses and ancillary equipment, plant water system and emergency generator are located in or near the Sludge Management Building. The location of the plant water system in the Sludge Management Building creates an unfavorable suction condition due to its significant distance from the water supply. This condition has caused the pumps to periodically become air bound. The belt filter presses are in very poor condition due to the significant amount of corrosion in the control panels, the frame, and the ancillary mechanical components. The air compressor is ongoing maintenance issue, and the tracking system requires frequent maintenance.

The WWTF generator is adjacent to the sludge management building and also faces minor corrosion of the base and frame. Do to the limited sludge storage capacity, longer dewatering operations will be required in the short term when the additional sludge from the Siasconset WWTF is processed at the facility. Table 2-18 shows the summary of equipment in the Sludge Management Building.

**Odor Control System**

The evaluation of process equipment pertaining to odor control identified the same problem as other equipment. The air purification towers contain electrical controls and fan motors that are severely corroded. The prechlorination pumps are also corroding. Table 2-19 shows the summary of equipment for Odor Control. At this time, the Nantucket WWTF does not use a SCADA system. SCADA would be beneficial to this facility as a way of monitoring operations and alarms at the WWTF as well as at the remote pump stations.

It is evident that the Nantucket WWTF has a corrosion problem with most of its above ground equipment. The most likely cause of this problem is the salt water blowing off the ocean. In process areas (such as the Sludge Management Building) the presence of hydrogen sulfide is also contributing to the problems with corrosion. In any means, it is necessary to rehabilitate or replace this equipment**.**

**TABLE 2-18**
**TOWN OF NANTUCKET, MASSACHUSETTS**
**CWMP/FEIR**
**SURFSIDE WWTF EVALUATION OF PROCESS EQUIPMENT – SOLIDS HANDLING BUILDING**

| Description | Qty | Manufacturer | Run Time (hrs) | Serviceability Rating | Nameplate | Comments |
|---|---|---|---|---|---|---|
| Cyclone | 1 | Krebs | 2,092 | 1 | --- | - Located in Grit Room<br>- Supplied by Schloss<br>- Corroded |
| Inplant Pump Station | 1 | Hydromatic | --- | 1.5 | 5 hp | - Heavily corroded |
| Septage Pumps | 1 | Hayward Gordon | Grit Rml: 2,092<br>Septage: 1,256 | 2.5 | 200 gpm@24'<br>5 hp | - Dual purpose pump<br>- Variable speed<br>- Used for grit and septage |
| Sludge Pumps (Primary Sludge) | 3 | Penn Valley | Min: 2,425<br>Max: 2,872 | 2.5 | 300 rpm<br>80 gpm | - Double Disc |
| Sludge Pumps (Belt Press Feed) | 2 | US Motor | Min: 2,897<br>Max: 12,903 | 2 | --- | - Progressing Cavity<br>- Variable speed |
| De-Humidifier | 1 | Dryomatic | --- | 2.5 | --- | - Currently in use<br>- Possible location for plant water |
| Blowers (Aerated Sludge Holding) | 2 | Dresser | Min: 24,380<br>Max: 56,860 | 2.5 | --- | |

**TABLE 2-19**
**TOWN OF NANTUCKET, MASSACHUSETTS**
**CWMP/FEIR**
**SURFSIDE WWTF EVALUATION OF PROCESS EQUIPMENT – SLUDGE MANAGEMENT BUILDING**

| Description | Qty | Manufacturer | Run Time (hrs) | Serviceability Rating | Nameplate | Comments |
|---|---|---|---|---|---|---|
| Plant Water Pumps | 3 | Systecon | 1: 10,806<br>2: 6,320<br>3: 4,097 | 2 | --- | - Pumps periodically become air bound due to unfavorable suction conditions |
| Polymer Feed System | 2 | Milton Roy/ Acrison | --- | 2 | 100 gph | - 6,000 lb/yr |
| Belt Filter Presses | 2 | Roedigger | --- | 1 | 1.0 meter | - Control panels badly corroded<br>- Air compresser for tracking system requires frequent maintenance<br>- Frame and ancillary mechanical components corroded. |
| Plant Generator | 1 | Kohler | 777 | 2.5 | 92 hp | - Some corrosion on base and frame |

Table 2-20 shows the summary of Primary Clarifier equipment. Table 2-21 shows the summary of equipment in the CEPT Building. Table 2-22 shows the summary of all miscellaneous equipment.

**Siasconset Wastewater Treatment Facility**

The existing Siasconset sewerage system, which dates back in part as far as 1914 and serves the densely built up area of the village along the easterly end of the island. It extends to Sankaty Head Lighthouse on the north, Front Street on the east, Ocean Avenue on the south, and Burnell Street on the west. The system discharges all wastewater to four rapid sand infiltration basins located off of Low Beach Road via a 12-inch diameter gravity sewer. Currently, all wastewater flow from the Siasconset area passes through a flow-metering manhole, abandoned screening chamber and a settling tank prior to discharge at the basins. The flow metering equipment consists of a parshall flume and level element retrofitted into a manhole.

The United State Coast Guard (USCG) also has existing wastewater disposal facilities in the same area as the existing Town facilities. The USCG sewer infrastructure consists of gravity sewer on USCG property, which services the main buildings off the end of Low Beach Road, and the housing on Silver Street (cul-de-sac off of Low Beach Road). All wastewater is discharge to two rapid sand infiltration basins via a 10-inch diameter gravity sewer that runs from Low Beach Road cross-country to the basins.

The existing effluent beds noted above have been improved, however untreated wastewater is still being discharged to the ground through the rapid infiltration basins due to abandonment of the Siasconset WWTF project in 1990 because of coastal erosion concerns.

**TABLE 2-20**
**TOWN OF NANTUCKET, MASSACHUSETTS**
**CWMP/FEIR**
**SURFSIDE WWTF EVALUATION OF PROCESS EQUIPMENT – ODOR CONTROL**

| Description | Qty | Manufacturer | Run Time (hrs) | Serviceability Rating | Nameplate | Comments |
|---|---|---|---|---|---|---|
| Hypochlorite Storage Tanks | 2 | Poly Processing | --- | 3 | --- | - Tanks hold 3,000 gallons each<br>- Delivery time is once every two weeks<br>- 50 gpd used for scrubbers<br>- 250 gpd used for prechlorination<br>- Hypochlorite only used between 5/15-11/15 |
| Scrubbers | 2 | Quad | --- | 2.5 | Chemtact | - Consists of 50 hp compressed air system manufactured by Sull Air |
| Air Purification Towers | 2 | Calgon | --- | 2 | --- | - Vessels appear to be in good condition<br>- Electrical controls and fan motors are severely corroded |
| Mist Chamber Fans | 2 | Hartzell | --- | 2 | -- | |
| Carbon Filtration Fans | 2 | New York Blowers | --- | 2 | 20 hp | - Odor control for Composting not in use<br>- Odor control for sludge management system is in use |
| Potassium Permanganate | | --- | --- | 2 | --- | - 25,000 lbs used per year |
| Prechlorination Pumps | 2 | Hydroflo | --- | 1.5 | 20 gph | - One pump for each scrubber<br>- Exterior of pumps are corroding |

**TABLE 2-21**
**TOWN OF NANTUCKET, MASSACHUSETTS**
**CWMP/FEIR**
**SURFSIDE WWTF EVALUATION OF PROCESS EQUIPMENT – CEPT BUILDING**

| Description | Qty | Manufacturer | Run Time (hrs) | Serviceability Rating | Nameplate | Comments |
|---|---|---|---|---|---|---|
| Cationic Polymer System | 1 | Acrison | --- | 2.5 | --- | - Not in Use |
| Anionic Polymer System | 1 | Acrison | --- | 2.5 | --- | - Amount used for chemically enhanced primary treatment is 25 lbs/yr<br>- Amount used for de-watering is 6,000 lbs/yr |
| Polymer Pumps | 3 | Milton Roy | --- | 2.5 | --- | - One pump for each system and one for standby use |
| Potassium Permanganate Tank | 1 | Poly Processing | --- | 2.0 | --- | - 2,000 gallons of storage available<br>- 0.5% solution is used<br>- Venturi system used for mixing |
| Aluminum Salt Tanks | 2 | Poly Processing | --- | 2.5 | --- | - Tank 1 capacity is 3,000 gallons<br>- Tank 2 capacity is 1,000 gallons<br>- Tank 1 stores Aluminum Salts<br>- Tank 2 originally used to store Sodium Hydroxide, currently used to store Aluminum Salts<br>- Approximately five deliveries per year (mid May, mid June, mid July, late August & late September)<br>- Usage: 25,000 gallons/ year |
| Aluminum Salt Pumps | 3 | Milton Roy | --- | 2.5 | #1 & 2: 8.8 gph<br>#3: 5.2 gph | - Pump 3 was originally used for Sodium Hydroxide |

**TABLE 2-22**
**TOWN OF NANTUCKET, MASSACHUSETTS**
**CWMP/FEIR**
**SURFSIDE WWTF EVALUATION OF PROCESS EQUIPMENT – MISCELLANEOUS**

| Description | Qty | Manufacturer | Run Time (hrs) | Serviceability Rating | Nameplate | Comments |
|---|---|---|---|---|---|---|
| Compost Blowers | 10 | Dayton | Min: 1,652<br>Max: 7,891 | 2 | Model: 4C329 | - Not In Use<br>- High Pressure Direct Drive Blowers |
| Screener | 1 | LinDig | --- | 1.5 | --- | - Was used for composting<br>- Out Of Service |
| Sludge Mixer | 1 | SSI | -- | 2 | --- | - Was used for composting<br>- Not In Use |
| SCADA | --- | --- | --- | --- | --- | - Not currently in place<br>- Could be useful at this facility<br>- Current alarm and indication panel uses relays and indicator lights. |

As noted above severe storms caused significant erosion that postponed construction of the coastal Siasconset Wastewater Treatment Facility and only minor modifications being made to the existing infiltration basins in 1991. Several years after the minor modifications, Earth Tech was engaged by the Town of Nantucket to evaluate the alternatives for providing wastewater treatment and disposal for the Siasconset area of the Island.

As part of the Plan, a Needs Analysis was conducted to investigate existing conditions and to project future needs. Evaluations of topography, watersheds, natural resources, surficial geology, soils, existing land use and populations trends (sewered versus non-sewered, seasonal versus year round), water supply systems and wastewater conveyance and treatment systems were conducted and future wastewater flows were projected. It was concluded that in the year 2022, a projected peak seasonal population of 3,500 individuals would require a facility with a design average flow of about 220,000 gpd. It was also projected that the facility would meet effluent limit concentrations of 10 mg/L for $BOD_5$, TSS, and Total Nitrogen.

Feasible options for regional wastewater treatment and disposal at the existing Surfside Wastewater Treatment Facility were also evaluated. These options included the investigation of force main routes, pumping station requirements, environmental issues, and an analysis of existing versus projected wastewater flows at the Surfside Wastewater Treatment Facility. One of the major elements evaluated in the Facilities Plan was the alternative of treatment and disposal of wastewater within the Siasconset Planning area versus the transport of wastewater to the Surfside Wastewater Treatment Facility for treatment and disposal. Significant issues included site availability within the planning area, environmental impacts, and costs. The EIR addressed specific environmental issues, including rare and endangered species, and coastal erosion. The EIR also included detailed cost analyses of the treatment facility and sewering options.

On-site treatment and disposal was selected as the solution for the Siasconset. Sequencing Batch Reactors (SBR) were selected as the secondary treatment process for the facility. Multiple basins will be installed to allow the Operator

flexibility in the number of basins to be operated during each particular season. It is anticipated that two or three larger volume basins will be operated during summer months and one or two smaller volume basins operated during winter months. The process has been designed not only to treat the projected future summer flows and loadings, but also to adequately treat the initial winter low flow and loadings.

The entire project includes construction of an influent pumping station, wastewater treatment facility and infiltration basins. The influent pumping station is located near the basins and will pump all of the wastewater to the new wastewater treatment facility. The raw wastewater will pass through a channel grinder prior to entering the pump station. Wastewater will then flow through the following processes: influent metering structure, primary clarifiers, SBRs, post equalization, effluent filters, UV disinfection system and an effluent metering structure. All treated wastewater is then discharged to the infiltration basins.

The design includes a totally covered process in order to maximize odor control at the facility. A biofilter system for treatment of the odorous air stream was chosen due to the fact that it has a low profile (below grade organic bed) and does not require any chemicals for operation.

The system has been designed to provide complete treatment without the use of chemicals. This was a requirement of the Town because of the fact that the facility is located on an island and will not be fully manned. The Siasconset Wastewater Treatment Facility will be operated as a satellite facility to the existing Surfside Wastewater Treatment Facility. A supplemental alkalinity (sodium bicarbonate) chemical feed system has been included as a safety measure for the secondary treatment process, but it is not anticipated that this system will be needed for normal operation of the process.

The groundbreaking for this facility occurred in November 2002 with an estimated completion date of July 2004.

## 8. Potential Reuse Opportunities

As discussed previously in this section, typically treated effluent is discharged either to a surface water body or to the ground with percolation through the soil to the groundwater. A third option, discussed in this section, is to reuse the wastewater for non-potable needs. Some communities, throughout the United State, have adopted policies on wastewater reuse in an effort to conserve valuable water resources and provide a means for the disposal of treated effluent. A properly developed wastewater reclamation program can provide valuable benefits to both the municipality and the water/wastewater system users. Fee structures can be developed whereby consumers pay a flat fee or no fee at all for unlimited use of reclaimed wastewater for lawn irrigation and other non-potable uses. If such a structure includes fees based on usage for potable water, consumers can realize an economic benefit by using reclaimed wastewater for irrigation purposes rather than potable water. Such a pricing scheme would also encourage water conservation.

The agricultural, industrial, and commercial consumers can realize similar economic benefits. With proper treatment, reclaimed wastewater demonstrates few health risks, while providing the community with a solution to their wastewater disposal problem.

The Water Environment Federation explored water reuse issues at their Annual Conference and Exposition in October 1998. Specifically, water reuse innovations and alternatives were presented as they applied to numerous Florida communities. Such technologies include water reuse for landscaping, agricultural uses, and fire protection. Following is a discussion of these alternatives, and commercial/industrial water reuse applications as they may be applied to the Town of Nantucket.

### Landscaping

Reclaimed wastewater has been successfully used as irrigation water for residential, commercial, and industrial applications. Reclaimed water has several advantages over the use of potable water for irrigation. In St. Petersburg, Florida, it was shown that the application of 1½ inches of reclaimed water per

week provided approximately 50 percent of the nitrogen, phosphorus, and potassium requirements for horticultural and agricultural purposes. This resulted in reduced fertilizing costs to the consumer. A study completed by St. Petersburg indicated that when chloride levels in the reclaimed wastewater were kept below 400 mg/L, plants being irrigated with reclaimed water showed significantly more growth than those plants irrigated with water from the city's potable water system.

**Agricultural Uses**

The City of Orlando, Florida has achieved success in wastewater reuse through the implementation of Water Conserv II, a comprehensive program whereby water is reused in agricultural irrigation systems and aquifer recharge. In areas with a significant agricultural industry, wastewater reuse can substantially reduce the amount of wastewater to be disposed of by traditional surface or subsurface application procedures. Depending on demand, reclaimed wastewater can be given to agricultural consumers free of charge or for a nominal fee, thereby providing an incentive to farmers by decreasing costs and providing an alternative for wastewater disposal. Benefits from the nutrient enriched reclaimed wastewater are similar to those cited for wastewater reuse for landscaping purposes.

**Fire Protection**

The use of reclaimed wastewater for fire protection involves unique construction, permitting, and regulatory limitations. For such a system to be developed, the Town of Nantucket would have to work closely with local, state, and federal environmental and regulatory groups to develop a policy for the design of a facility utilizing reclaimed wastewater in its fire protection system. Initial design considerations would include delineating the potential uses of the facility for which the fire protection system is being designed (food preparation, retail outlet, industrial, etc.), examining construction constraints, and addressing regulatory concerns (for example, would building occupants be required to sign an agreement prohibiting them from salvaging certain items in the event of a fire). Development of this alternative could require substantial investment of time and resources, as this technology is relatively new.

**Commercial/Industrial Uses**

Commercial/Industrial consumers can use reclaimed wastewater for process water and other non-potable applications within their facilities, and for irrigation outside their facilities as described above. Commercial/Industrial consumers could also prove instrumental in the implementation of reclaimed wastewater in fire protection systems. The specific nature of any given industrial application would require that the industrial water reuse program be tailored to meet the specific needs of each facility.

Health concerns of the public will need to be addressed to promote acceptance of a reclaimed wastewater system. St. Petersburg, Florida, has had no reported cases of illness or disease resulting from the use of reclaimed water since the inception of their reuse program in the 1970s. This fact is significant in that homeowners have control over their use of reclaimed water, and many of the residents of St. Petersburg are elderly and thus more susceptible to disease. The specific health risks associated with the wastewater produced in the Town of Nantucket would have to be studied and addressed as part of the development of a wastewater reclamation program.

The drawbacks of reclaimed water use can be mitigated through careful planning. If demand is anticipated to exceed supply, the Town may consider installing metering devices and developing a rate structure so that usage can be monitored and controlled. The Town would need to develop the rate structure in conjunction with the potable water rate structure to ensure that incentives are still present to encourage consumers to use reclaimed wastewater for their non-potable water needs. Should the supply of reusable water exceed the demand, the Town would have to implement other wastewater disposal alternatives to supplement reuse activities. Consumers would have to be educated as to the benefits and proper use of a reclaimed wastewater system. For example, use of reclaimed water is not recommended for car washing, as the high mineral content in the wastewater will leave a mineral deposit on vehicles. Such educational objectives could be included in the water conservation plan.

Finally, construction costs must be minimized. Installing a new reclaimed wastewater distribution system in an area can be quite costly due to restoration costs associated with installing the necessary piping. However, if construction is coordinated with other projects, such as the construction of a wastewater collection system, economic benefits could be realized. If such construction activities can be coordinated, it may make economic sense to install dry lines in areas of new development to accommodate the reclaimed water supply when it becomes available.

## 9. Residuals Disposal and Reuse

In this section, technologies are reviewed for possible application in meeting the Town of Nantucket's sludge management needs if a new wastewater treatment facility is constructed. A description of each technology option is presented, focusing on the process, products and/or sidestreams, relative advantages and disadvantages. Some of these, such as dewatered sludge landfilling, are considered to be "disposal" technologies because sludge, as a waste material, is being disposed. Others are often referred to as "beneficial-use" technologies because they result in a product form of sludge that can be recycled for beneficial purposes. For example, composting processes sludge into humus-like material that contains plant nutrients and is an excellent soil conditioner. Some technologies, such as incineration, have both disposal and beneficial aspects. Ash, the end product of incineration, is usually disposed in a landfill. However, heat produced during combustion can also be recovered and is sometimes used to generate electricity. Methane recovery from sludge digestion will not be considered since it would only be provided with anaerobic digestion facilities. These facilities are typically not economical for smaller wastewater treatment facilities with flows less than 5.0 MGD.

### Incineration with Ash Landfilling

Incineration reduces sludge to ash and gases, decreasing the volume for disposal by approximately 95 percent. Sludge ash is a sterile, inorganic, non-odorous powdery material that is typically conditioned with water to minimize blow-away

during handling and landfilling. Incineration exhaust gas contains pollutants, which must be treated with emissions control equipment prior to release to the atmosphere.

Federal and state regulations govern both ash handling and air pollution controls. The ash must meet the standards set forth in the RCRA toxicity characteristic leaching procedure (TCLP) prior to landfilling. Exhaust gases must meet Federal New Source Performance Standards (NSPS), National Emissions Standards for Hazardous Air Pollutants (NESHAP) and the 40 CFR Part 503 regulations with respect to emissions of hazardous air pollutants, plume capacity and flue gas temperature and oxygen content.

Advantages of incineration as a sludge management technology are that it is a well-established and proven technology; the resultant ash is sterile and odor-free and requires minimal landfill volume; large quantities can be processed and disposed of on a continuous basis; and storage and transport requirements are minimal.

Disadvantages are that: it is a relatively complex technology requiring skilled operators; capital and operating costs, including costs for emission control, are high; and two sidestreams are produced, ash and emissions, which require additional treatment and handling. Odor production is often associated with the use of this technology due to the relatively low temperature combustion practiced at many existing incinerator facilities. However, combustion at high temperatures will be required to comply with future emissions standards, which should largely eliminate odor releases.

**Heat-Drying with Distribution and Marketing**

Heat-drying is a beneficial-use technology which uses heat from either flue gases or steam heat exchangers to evaporate moisture from dewatered sludge and produce an organic fertilizer/soil conditioner for distribution and marketing. A sidestream of exhaust gases is also produced which must be treated by emissions control equipment before discharge to the atmosphere.

Both the heat-dried product and the emissions resulting from the process are subject to federal and state regulations relating to land application of sludge. The Federal NSPS, the NESHAP, 40 CRF Part 503 regulations, and state regulations would regulate the release of exhaust gases from heat drying.

The main advantage of heat drying is that it produces a beneficial, marketable product which is less bulky and potentially more valuable than compost because of its higher nutrient content. Thus, transportation to more distant markets is sometimes practical. In addition to local marketing of the product, it can be distributed through brokers to large users such as citrus growers and tree farmers. Heat-dried product can be used as a substitute for chemical fertilizers and has numerous landscaping and horticultural applications.

Disadvantages are that it is a relatively complex and expensive technology that requires skilled operators, strict emissions/odor control, and efficient storage/handling/and marketing of a product with primarily a seasonal demand. Another factor to consider is competition from heat-dried products produced outside of the Town of Nantucket (e.g. Boston, New York City and possibly some other communities that formerly relied on ocean dumping).

**Composting with Distribution and Marketing**

**C**omposting is a beneficial-use technology, which accelerates the biological decomposition of dewatered sludge through aeration and the addition of volatile organic material to produce a humus-like soil conditioner for distribution and marketing. The composting process generates two sidestreams which require treatment: a liquid sidestream consisting of condensate and leachate and an exhaust air sidestream which must be treated with odor control equipment.

Compost can be marketed to various industries and users. Compost can be used for the following:

Greenhouse, Nursery, and Turfgrass Use: To provide a growing medium and soil amendment in a mix with other media for potting non-food chain plants, for growing and transplanting nursery stock, and for soil enhancement prior to new seeding and maintenance.

Golf Courses and Landscaping: To provide organic matter during maintenance and fertilizing of the grasses, and as a soil amendment.

Landfills: As an amendment to soil used for final cover material and for subsequent slope management.

Topsoil and Land Reclamation: As a soil amendment to improve the growing ability, nutrient content, and water retention of poor, sandy, gravel type soils.

The main advantages of composting are the relative simplicity of the technology, the fact that it produces a beneficial and marketable product from sludge waste, and that it can aid in meeting solid waste management needs by utilizing tree trimmings and other yard wastes in the sludge composting process.

Disadvantages include potential difficulties with odor control, dependence on a successful marketing and distribution program, and substantial storage/handling requirements for a bulky product with a primarily seasonal demand. Additional factors to consider include availability of suitable land for compost application and competition for a limited market.

**Alkaline Stabilization**

Alkaline stabilization is a beneficial-use technology which uses exothermic (heat producing) reactions resulting from mixing alkaline materials with dewatered sludge to evaporate moisture and kill pathogens and odor-causing bacteria, while fixating (chemically binding) metals to produce an organic soil conditioner/soil

substitute. Alkaline-stabilized sludge can be used for agricultural, landscaping, and land reclamation purposes. Alkaline stabilized sludge is different than compost. The chief difference is that it has a much higher inert solids content due to the chemicals added during processing.

The main advantages of alkaline stabilization are that it is a relatively simple technology and that it produces a usable material without generating sidestreams. Disadvantages are the need for a continuous supply of alkaline material, substantial storage and handling requirements, and reliance on dependable outlets for product distribution.

**Agricultural or Non-Agricultural Land Application**

Land application is a beneficial-use technology in which liquid or dewatered sludge is applied directly to the land to promote agricultural or non-agricultural plant growth. Land application can also be a sludge disposal technology, when sludge is applied at higher than agronomic rates to dedicated sites. Land-applied sludge is usually pretreated for pathogen reduction and stabilized by lime conditioning or aerobic or anaerobic digestion. If the sludge is applied properly, potential sidestream problems (i.e. odors, surface run-off, and leachate) can be averted.

Advantages of land application are that it is a simple technology based on beneficial-use and little capital investment is required. Disadvantages are that: large usable land areas must be available; operation is weather- and season-dependent, necessitating provisions for sludge storage; and careful application and monitoring are required to control problems with odors, surface runoff, and leachate.

**Dewatered Sludge Landfilling (Monofilling)**

Monofilling is the disposal of sludge by burial in a dedicated sanitary landfill. Preprocessing typically consists of dewatering and may include anaerobic digestion or chemical treatment for stabilization. Proper design and operation is required to control leachate, volatile organics emissions, and methane gas seepage. Landfilling of dewatered sludge is regulated by the RCRA toxicity

characteristic leaching procedure (TCLP), 40 CFR Part 257 requirements for landfills, and by state regulations governing landfilling. Sludge rarely fails the TCLP test and so is usually classified as non-hazardous.

Advantages of monofilling include simple operation, minimal processing and low costs. The overwhelming disadvantage is the need for suitable landfill sites to place the dewatered sludge.

**Co-Disposal**

Co-disposal is the treatment and/or disposal of sludge in conjunction with municipal solid waste (MSW). Possibilities include co-incineration, co-composting, and landfill co-disposal. While co-incineration has been successfully practiced in other countries, there are only two large-scale operations in the United States – one located in the Western Connecticut region at Stamford, the other in Duluth, Minnesota. Western Connecticut also has a very small co-incinerator located in New Canaan. Typically, dry sludge solids are burned at a rate of 1 dry pound for every 5 to 8 pounds of MSW; the Stamford facility operates at a 1 to 20 ratio.

Advantages of co-incineration are the reduction in combined costs of incinerating sludge and MSW separately and the process efficiency, which allows complete burning of both materials without the use of auxiliary fossil fuels (and provides an excess of heat for steam generation if desired). Disadvantages are the dependence on a supply of MSW and coordination of sludge quantities with MSW quantities during the co-incineration process.

Co-composting sewage sludge with MSW is a co-treatment technology which has had limited acceptance in the United States in the past, but is beginning to receive interest. The process requires presorting and pulverization of MSW before mixing it with liquid sludge containing 5 to 12 percent solids. A 2 to 1 ratio of solid waste to sludge is the recommended minimum. Although beneficial product results, the quality of the compost is inconsistent and generally inferior to compost made from sewage sludge alone.

The most common co-disposal practice is sanitary landfilling, which is advantageous because of the complimentary absorption characteristics of the solid waste and the soil conditioning characteristics of the sludge. Co-disposal costs are typically lower than the costs of a dedicated sludge landfill due to the economy of scale. Disadvantages of utilizing a co-disposal site include operational problems associated with mixing refuse and sludge, increased leachate and odor potential, and site capacity concerns.

The Town of Nantucket dewaters sludge at the Surfside Wastewater Treatment Facility. Although the facility has the capability to compost the dewatered sludge using the aerated static pile method, the Town is currently hauling it to a Municipal solid waste composting facility located at the Department of Public Works in Madaket. The municipal solid waste composting facility in a privately owned and operated under a 25-year contract.

**Contract Disposal Alternatives**

An alternative to the Town of Nantucket disposing its own sludge is to have the material transported to a private contract disposal facility. The sludge could be transported in cake form, with a dump truck or a container truck using watertight bodies. Dump trucks typically have a normal capacity of approximately 12 cubic yards, though smaller and larger sizes are available. Container capacities typically average approximately 30 cubic yards, though smaller and larger sizes are also available. Containers can be custom made in different sizes, shapes, and dumping configurations to suit the needs of a specific location.

The sludge could also be thickened and pumped into a tank truck in liquid form for disposal at a facility, which accepts liquid sludge. The liquid sludge is transported in tank trucks, which typically hold approximately 6,500 gallons (though smaller and larger capacities are available).

Various facilities are available throughout the New England area. Wastestream Environmental (WSE), with facilities located in Fitchburg, Upper Blackstone, Mattabassett, and Hartford; New England Treatment Company (NETCO), located in Woonsocket, Rhode Island; Waste Management, Inc. in Rochester,

New Hampshire; and Naugatuck Treatment Company in Naugatuck, Connecticut are all contract disposal facilities in the New England region. Costs at these facilities depend on how the sludge is transported (in liquid or solid form), and the sludge has to meet various criteria established by each facility. The cost will be dependent on the specific characteristics of the sludge, but typically range from $0.10 to $0.20 per gallon for liquid sludge and $90 to $100 per wet ton for dewatered sludge. This fee typically covers the tipping fee at the facility but does not cover the transportation costs from the Island.

**Innovative Technologies**

"Innovative technologies" is the generic term applied to a range of unconventional sludge disposal technologies. In general, these technologies have been demonstrated on a pilot scale or small facility basis, but have not seen widespread use. End products range from a compost-like material to a concrete aggregate substitute.

The following technologies are some of the more widely known, if not widely practiced innovative technologies.

**Aggregate Production**

This type of process is available in various forms and is generally similar to conventional incineration in that sludge volatiles are burned, leaving only the inert fraction. In one of the process variations, sludge is burned in a special furnace at very high temperatures to induce slag formation. Instead of ash, liquid slag is removed from the bottom of the furnace and dropped into a quenching medium, such as water, forming a stable, fused, glassy solid, suitable for reuse as aggregate. This process is being marketed by World Envirotech, and is used at a wastewater facility in Monticello, New York.

**Earthworm Conversion, or Vermiculture**

This is a stabilization process by which earthworms consume the organic material in municipal wastewater sludge. The product of Vermiculture (i.e., the worm castings) may be used as a soil conditioner, similar to compost. This technology is still in the experimental stage. There are no significant facilities in the United States.

**Fuel from Sludge**

The conversion of sludge solids to oil and char under pressure has been proven technically feasible under laboratory conditions. However, commercialization and scale-up have been estimated to be prohibitively expensive.

**Deep Well Oxidation**

This process uses conventional oil well drilling technology to position an annular reactor in a vertical position up to one mile below grade. The process takes advantage of the great hydraulic head generated by the liquid column, along with the application of head and oxygen, to oxidize the sludge organics. A small prototype facility was constructed and operated with mixed results in Longmont, Colorado early in the 1980's. Privatized facilities using modifications to the original concept are under evaluation in Houston and Detroit. Chief disadvantages of the process are corrosion or scaling of the reactor surfaces and generation of a side stream with a high soluble organics content, which requires additional treatment. The main advantages are the generation of a relatively inert ash-like product, with low land area requirement.

As with the conventional technologies described previously, any innovative technology would also be subject to corresponding federal and state regulations governing processing and distribution. For example, the aggregate production process would be regulated in a manner similar to incineration, focusing on air quality impacts.

Each of the innovative technologies described above has its unique advantages. For example, the aggregate production process solves the problem of ash disposal resulting from conventional incineration, assuming a market for the aggregate material is found.

The major disadvantage of all innovative technologies is that they are untried and unproven on a large scale in the United States. High costs and operational problems are generally incurred in operating a facility based upon a new unproven process.

A prime example of this is the difficulties experienced by the City of Los Angeles with its innovative oil-based sludge drying system used at the Hyperion Treatment Plant, which represented the first large-scale adaptation of this technology for wastewater sludge in the U.S.

## D. WASTEWATER REUSE FOR ARTIFICIAL RECHARGE

### 1. General

This section provides an overview of salient aspects, generally of a technical nature, applicable to wastewater reuse for artificial recharge. Legal, institutional, and economic aspects are not a part of this discussion. These aspects include (a) desirable wastewater treatment levels, and (b) treatment technologies that represent components of process train(s), which will produce effluent suitable for artificial ground water recharge. This chapter also provides brief descriptions of relevant representative projects currently in operation, which produce wastewater effluents for artificial recharge or potable water reuse.

### 2. General Requirements For Wastewater Usage For Artificial Recharge

National Research Council's report on Ground Water Recharge Using Waters of Impaired Quality (1994) has extensively researched the aspects of wastewater usage for artificial recharge. The following pertinent information is summarized using the material presented in that report.

Based on current information, wastewater used to recharge the ground water must receive a sufficiently high degree of treatment (minimum secondary treatment) prior to recharge so as to minimize the extent of any degradation of native ground water quality, as well as to minimize the need for and extent of additional treatment at the point of extraction. After proper treatment, the wastewater is ready for recharge, either through surface spreading and infiltration through the unsaturated zone or by direct injection into ground water. Recharge by infiltration takes advantage of the natural treatment processes, such as biodegradation of organic chemicals that occurs as water moves through soil. The quality of the water prior to recharge is of interest in assessing the possible risks associated with human exposures to chemical toxicants and pathogenic microorganisms that might be present in the source water. Although one can reasonably expect that such constituents will often be reduced during filtration through the soil, as well as subsequently in the aquifer, a conservative approach to risk assessment would assume that toxicants and microorganisms are not completely removed and some are affected only minimally prior to subsequent extraction and use. Thus when recharge water is withdrawn later for another purpose, it may require some degree of post treatment, depending on its intended use.

There are several operational issues that must be addressed on a site-specific basis. These concerns are related to project sustainability, treatment needs, public health impacts, and economic and institutional constraints. In the short-term, project sustainability is controlled by operating and managing the system so as to prevent or control clogging. Long-term sustainability is dependent on finding the best combination of pretreatment, soil-aquifer treatment, and post treatment for determining whether the wastewater used for recharge will exceed the treatment and removal capacity of the soil-aquifer treatment system.

Constituents of concern in municipal wastewater include organic compounds, nitrogen species, pathogenic organisms, and suspended solids. Treatment processes are readily available and have been used successfully to treat municipal wastewater effluent to levels acceptable for various recharge applications. However, even when treated to a very high degree, disinfection of the effluent

with chlorine results in the formation of disinfection by-products (DBPs) with the residual organic compounds. These DBPs are of concern if the recovered ground water is to be used for potable purposes. Raw municipal wastewater may include contributions from domestic and industrial sources, infiltration and inflow from the collection system, and, in the case of combined sewer systems, urban stormwater runoff.

The occurrence and concentration of pathogenic microorganisms in raw wastewater depend on a number of factors, and it is not possible to predict with any degree of assurance what the general characteristics of a particular wastewater will be with respect to infectious agents.

Healthy individuals do not normally excrete viruses for prolonged periods, and the occurrence of viruses in municipal wastewater fluctuates widely. Viral concentrations are generally highest during the summer and early autumn months. Viruses as a group are generally more resistant to environmental stresses than many of the bacteria, although some viruses persist for only a short time in municipal wastewater.

Dissolved inorganic solids (total dissolved solids or salts, TDSs) are not altered substantially in most wastewater treatment processes. In some cases, they may increase as a result of evaporation in lagoons or storage reservoirs. Therefore, unless wastewater treatment processes specifically intended to remove mineral constituents are employed, the composition of dissolved minerals in treated wastewater used for ground water recharge can be expected to be similar to the composition in the raw wastewater.

Based on the information collected by numerous researchers, the following treatments for the two types of ground water recharge methods are considered desirable: (1) If the wastewater is indirectly discharged to the aquifer, the wastewater should receive secondary treatment followed by nitrification/denitrification, sand filtration, and disinfection; and (2) If the wastewater is used for direct injection to the aquifer, the wastewater should receive secondary treatment followed by sand filtration, a membrane process

(such as micro-filtration/reverse osmosis, or similar treatment), and disinfection. It is assumed that if a membrane process is used, nitrification/denitrification will not be required because the membrane process will remove nitrogen compounds present in the wastewater.

## 3. Wastewater Treatment Levels and Technologies

### General

Wastewater treatment levels are generally classified as preliminary, primary, secondary, tertiary, and advanced. The nature of each level of treatment is discussed in the following sections.

#### Primary Treatment

The first step in treatment, sometimes referred to as preliminary treatment, generally consists of the physical processes of screening, or comminution, and grit removal.

Past this initial screening, primary treatment consists of physical processes to remove settleable organic and inorganic solids by sedimentation and floating materials by skimming. These also remove some of the organic nitrogen, organic phosphorus, and heavy metals. Primary treatment, together with preliminary treatment, typically removes 50 to 60 percent of the suspended solids and 30 to 40 percent of the organic matter. Primary treatment does not remove the soluble constituents of the wastewater. Primary treatment has little effect on the removal of most biological species present in wastewater. However, some protozoa and parasite ova and cysts will settle out during primary treatment, and some particulate-associated microorganisms may be removed with settleable matter. Primary treatment does not reduce the level of viruses in municipal wastewater.

While primary treatment by itself generally is not considered adequate for ground water recharge applications, primary effluent has been successfully used in soil-aquifer treatment systems at some spreading sites where the extracted water is to be used for non-potable purposes.

A disadvantage of using primary effluent is that infiltration basin hydraulic loading rates may be lower because of higher suspended solids and weaker biological activity on and in the soil of the infiltration system. Also, too much organic carbon in the recharge water can have adverse effects on processes that occur in the soil and aquifer systems. In most cases, wastewater receives at least secondary treatment and disinfection, and often tertiary treatment by filtration, prior to augmentation of non-potable aquifers by surface spreading.

**Secondary Treatment**

Secondary treatment is intended to remove soluble and colloidal biodegradable organic matter and suspended solids (SS). In some cases, nitrogen and phosphorus also are removed. Treatment consists of an aerobic biological process whereby microorganisms oxidize organic matter in the wastewater. Several types of aerobic biological processes are used for secondary treatment, including activated sludge, trickling filters, rotating biological contactors (RBCs), and stabilization ponds. Generally, primary treatment precedes the biological process; however, some secondary processes are designed to operate without sedimentation; e.g., stabilization ponds and aerated lagoons.

**Tertiary Treatment**

The treatment of wastewater beyond the secondary or biological stage is sometimes called tertiary treatment. The term normally implies the removal of nutrients such as phosphorus and nitrogen, and a high percentage of suspended solids. However, the term tertiary treatment is now being replaced in most cases by the term advanced wastewater treatment, which refers to any physical, chemical, or biological treatment used to accomplish a degree of treatment greater than that achieved by secondary treatment.

**Advanced Wastewater Treatment**

Advanced wastewater treatment processes are designed to remove suspended solids and dissolved substances, either organic or inorganic in nature. Advanced wastewater treatment processes generally are used when a high-quality reclaimed water is necessary, such as for direct injection into potable aquifers. The major advanced wastewater treatment processes associated with ground water recharge are coagulation-sedimentation, filtration, nitrification-denitrification, phosphorus removal, carbon adsorption, and reverse osmosis.

**Coagulation-Sedimentation**

Chemical coagulation with lime, alum, or ferric chloride followed by sedimentation removes suspended solids, heavy metals, trace substances, phosphorus, and turbidity. Viral inactivation under alkaline pH conditions can be accomplished using lime as a coagulant, but pH values of 11 to 12 are required before significant inactivation is obtained.

**Filtration**

Filtration is a common treatment process used to remove particulate matter prior to disinfection. Filtration involves the passing of wastewater through a bed of granular media, which retain the solids. Treatment of biologically treated secondary effluent by chemical coagulation, sedimentation, and filtration has been demonstrated to remove more than 99 percent of seeded poliovirus. This treatment chain reduces the turbidity of the wastewater to very low levels, thereby enhancing the efficiency of the subsequent disinfection process.

The primary purpose of the filtration step is not to remove viruses, but to remove protozoa and helminth eggs and other suspended matter that may contain adsorbed or enmeshed microorganisms, thereby making the disinfection process more effective.

Chemical coagulation and filtration, followed by disinfection, can remove or inactivate 5 logs (99.999 percent) of seeded polio virus and bacteria through these processes alone; and subsequent to conventional biological secondary treatment, can produce effluent essentially free of measurable levels of bacterial and viral pathogens.

**Nitrification**

Nitrification is the biological conversion of ammonia nitrogen sequentially to nitrite nitrogen and nitrate nitrogen. Nitrification does not remove significant amounts of nitrogen from the effluent: it merely converts it to another form.

**Denitrification**

Denitrification removes nitrate nitrogen from the wastewater. As with ammonia removal, denitrification is usually done biologically for most municipal applications. In biological denitrification, nitrate nitrogen is used by a variety of heterotrophic bacteria as the terminal electron acceptor in the absence of dissolved oxygen (anaerobic conditions). In the process, nitrate nitrogen is converted to nitrogen gas, which escapes to the atmosphere. The bacteria in these processes require a carbonaceous food source (e.g., carbonaceous BOD, methanol).

**Phosphorus Removal**

Phosphorus can be removed from wastewater by either chemical or biological methods, or a combination of the two.

**Carbon Adsorption**

One of the most effective advanced wastewater treatment processes for removing biodegradable and refractory organic constituents is the use of granular activated carbon (GAC). GAC can reduce the levels of synthetic organic chemicals in wastewater by 75 to 85 percent. The basic mechanism of removal is by adsorption of the organic compounds onto the carbon. Carbon adsorption preceded by conventional secondary treatment and filtration can produce an effluent with a Biochemical

Oxygen Demand (BOD) of 0.1 to 5.0 mg/L, Chemical Oxygen Demand (COD) of 3 to 25 mg/L, and Total Organic Compound (TOC) of 1 to 6 mg/L.

**Reverse Osmosis**

Reverse Osmosis (RO) is used mainly as a wastewater treatment process to remove suspended and dissolved solids (including microorganisms), either organic or inorganic. Removal is accomplished by the passage of wastewater through a semi-permeable membrane. The size, shape, chemical characteristics, and concentration of the chemical species, as well as the physical and chemical characteristics of the feed wastewater and type of RO unit employed influence constituent removal. Because of the nature of the RO process, feed wastewater must be of a fairly high quality (low suspended solids content) to prevent membrane clogging and deterioration.

**Emerging Hybrid Technology**

Membrane bioreactor (MBR) is an emerging technology, which combines an activated sludge reactor with a membrane filtration unit. The end result is an effluent that is similar to the one that is produced by a process train consisting of a secondary treatment followed by tertiary treatment and advanced treatment. MBR process essentially eliminates the tertiary treatment step. The MBR effluent is considered suitable for aquifer recharge.

**Disinfection**

The most important process for the destruction of microorganisms is disinfection. Although the most common disinfectant is chlorine, ozone ($O_3$) and ultraviolet (UV) radiation are other prominent disinfectants used at wastewater treatment plants. Other disinfectants, such as gamma radiation, bromine, iodine, and hydrogen peroxide, have been considered for the disinfection of wastewater, but are not generally used because of economical, technical, operational, or disinfection efficiency considerations. Membrane processes (e.g., micro-filtration, ultrafiltration, and reverse osmosis) have been shown to be effective in

removing microorganisms, including viruses, from municipal wastewater, but again are not commonly used. The strategy in the selection and use of disinfectants for source waters prior to recharge should recognize the possibility that the nature and quantities of the disinfection by-products (DBPs) that may be formed are different from those in conventional water treatment. For example, both chlorine and ozone react in wastewater with organic precursors, which are likely to be greater in number and concentration than in freshwater sources of drinking water, to form DBPs. Accordingly, treatment of water for potable purposes is being modified to minimize the use of oxidizing disinfectants. However, in the treatment of wastewater for non-potable purposes, the numbers and concentration of DBPs are of less concern because long-term ingestion is not an issue.

**Chlorine**

The efficiency of disinfection with chlorine depends on the water temperature, pH, degree of mixing, time of contact, presence of interfering substances, concentration and form of chlorinating species, and the nature and concentration of the organisms to be destroyed. In general, bacteria are less resistant to chlorine than viruses, which in turn are less resistant than parasite ova and cysts.

The chlorine dosage required to disinfect a wastewater to any desired level is greatly influenced by the constituents present in the wastewater. Secondary effluent can be disinfected with chlorine to achieve very low levels of coliform bacteria, although complete destruction of pathogenic bacteria and viruses is unlikely to occur. Chlorination of secondary effluent that has received further treatment to remove suspended matter can produce wastewater that is essentially free of bacteria and viruses. Chlorine, at the normal concentrations used in wastewater treatment, may not destroy helminth eggs, Giardia lamblia, and Crypto sporidium species.

**Ozone**

Ozone is a powerful disinfecting agent and a powerful chemical oxidant in both organic and inorganic reactions. Due to the instability of ozone, it must be generated on site from air or oxygen carrier gas. Ozone destroys bacteria and viruses by means of rapid oxidation of the protein mass, and disinfection is achieved in a matter of minutes. Some disadvantages are that the use of ozone is relatively expensive and energy intensive, ozone systems are more complex to operate and maintain than chlorine systems, and ozone does not maintain a residual in water. Ozone is a highly effective disinfectant for advanced wastewater treatment plant effluent, and it removes color and contributes dissolved oxygen. It also breaks down recalcitrant organic compounds into more biodegradable compounds, which is advantageous for ground water recharge and soil-aquifer treatment.

**Ultraviolet Radiation**

Irradiation of wastewater with ultraviolet radiation for disinfection is potentially a desirable alternative to chemical disinfection, owing to its inactivating power for bacteria and viruses, affordable cost, and the absence of chemical disinfection by-products. Exposure of microorganisms to the appropriate amount of electromagnetic (EM) radiation disrupts the cells' genetic material and interferes with the reproduction process. Some bacteria have repair enzyme systems that are activated by similar EM energies, and thus these particular bacteria may repopulate disinfected waters after disinfection when exposed to light. UV disinfection for water and wastewater is the newest of the disinfection technologies and therefore, valuable large-scale field applications are still under study. However, the trend is toward more use of UV disinfection.

## 4. Wastewater Recharge/Drinking Water Reuse Experience In The U.S.A.

### General

There are approximately 1,900 wastewater reuse projects currently operating throughout the USA (approximately 34 states have such projects). Only a very small number (probably less than 10) of those projects use direct wastewater recharge into an aquifer. In most cases, the wastewater is used (after proper treatment) for irrigation of urban landscapes and agricultural land or industrial purposes.

Within the United States, wastewater reuse is most common in Florida, California and Arizona. Prominent projects of wastewater reuse for drinking water or ground water recharge are as follows:

**Water Factory 21 in Orange County, California**

The Orange County Water District (OCWD) has been injecting high quality reclaimed water into selected coastal aquifers to establish a saltwater intrusion barrier. Seawater intrusion was first observed in municipal wells during the 1930s as a consequence of basin overdraft. Over-drafting of the ground water continued into the 1950s. Over-pumping of the ground water resulted in seawater intrusion as far as 3.5 miles inland from the Pacific Ocean by the 1960s.

OCWD began pilot studies in 1965 to determine the feasibility of injecting effluent from an advanced wastewater treatment (AWT) facility into potable water supply aquifers. Construction of an AWT facility, known as Water Factory 21, began in 1972 in Fountain Valley, and injection of the treated municipal wastewater into the ground began in 1976.

Water Factory 21 accepts activated-sludge secondary effluent from the adjacent County Sanitation Districts of Orange County wastewater treatment facility. The 15 MGD water reclamation plant processes consist of: lime clarification for removal of suspended solids, heavy metals, and dissolved minerals; re-carbonation for pH control; mixed-

media filtration for removal of suspended solids; activated carbon absorption for removal of dissolved organic compounds; reverse osmosis for demineralization and removal of other constituents; and chlorination for disinfection and algae control.

Prior to injection, the product water is blended 2:1 with deep well water from an aquifer not subject to contamination. The blended water is chlorinated in a blending reservoir before it is injected into the ground. Depending on conditions, the injected water flows toward the ocean, forming a seawater barrier; inland to augment the potable ground water supply; or in both directions. On average, well over 50 percent of the injected water flows inland. It is estimated that this injected water makes up no more than 5 percent of the water supply for area residents who rely on ground water.

**County Sanitation Districts of Los Angeles County Ground Water Recharge Projects**

Since 1962, the Whittier Narrows Water Reclamation Plant (WRP) has used reclaimed water along with surface water and storm water to recharge ground water in the Montebello Forebay area of Los Angeles County by surface spreading of the reclaimed water. The reclaimed water makes up a portion of the potable water supply for the area residents that rely on ground water. From 1962 until 1973, the Whittier Narrows WRP was the sole provider of reclaimed water in the form of disinfected secondary effluent for recharge. Some surplus effluent from a third treatment plant, the Pomona WRP, is released to the San Jose Wash, which ultimately flows to the San Gabriel River and becomes an incidental source for recharge in the Montebello Forebay.

The WRPs start their wastewater treatment with primary and secondary biological treatment. In 1978, all three WRPs added tertiary treatment with mono- or dual-media filtration and chlorination/dechlorination to their treatment regimes.

After leaving the reclamation plants, the reclaimed water is conveyed to one of several spreading areas (either specially prepared spreading grounds or dry river channels or washes). In the process of ground water recharge, the water percolated through an unsaturated zone of soil ranging in average thickness from about 10 to 40 feet before reaching the ground-water table. The usual spreading consists of five days of flooding, during which water is piped into the basins and maintained at a constant depth. The flow is then discontinued. The basins are then allowed to drain and dry out for 16 days. This wet and dry cycle maintains the proper conditions for the percolation process.

**Denver's Direct Potable Water Reuse Demonstration Project**

In 1968, the Environmental Protection Agency (EPA) allowed Denver to divert water from the Blue River on the west side of the Continental Divide on the condition that it examine a range of alternatives to satisfy projected future demands of a growing metropolitan area. The Direct Potable Water Reuse Demonstration Project was designed to examine the feasibility of converting secondary effluent from a wastewater treatment plant to water of potable quality that could be piped directly into the drinking water distribution system. In 1979, plans were developed for the construction of a demonstration facility to examine the cost and reliability of various treatment processes. The 1.0 MGD treatment plant began operation in 1985, and during the first three years, many processes were evaluated. Data from the evaluation period was used to select the optimum treatment sequence, which was used to produce samples for a two-year animal feeding health- effect study. Comprehensive analytical studies defined the product water quality in relation to existing standards and to Denver's current potable supply. The project water exceeded the quality of Denver's drinking water for all chemical, physical, and microbial parameters tested except for nitrogen, and alternative treatment options were demonstrated for nitrogen removal. The final health-effect study demonstrated no health effects associated with either water. The raw water supply for the reuse plant was unchlorinated secondary effluent (treated biologically) from the metropolitan Denver wastewater

treatment facility. Advanced treatment included high-pH lime treatment, single- or two-stage re-carbonation, pressure filtration, selective ion exchange for ammonia removal, two-stage activated carbon adsorption, ozonation, reverse osmosis, air stripping, and chlorine dioxide disinfection. Side stream processes included a fluidized bed carbon reactivation furnace, vacuum sludge filtration, and selective ion exchange regenerant recovery.

**San Diego's Total Resource Recovery Project**

San Diego, California imports virtually all of its water supply from other parts of the state. New sources of imported water are not readily available; the availability of existing supplies is diminishing. The city is thus actively investigating advanced water treatment technologies for reclaiming municipal wastewater that is presently being discharged to the Pacific Ocean. Preliminary experiments were conducted at the bench-scale (20,000 gallons per day) Aqua I facility in Mission Valley from 1981 to 1986. The pilot-scale (300,000 gallons per day secondary, 50,000 gallons per day advanced) treatment Aqua II Total Resource Recovery facility operated at Mission Valley from 1984 through 1992. The full-scale demonstration Aqua III facility (1.0 MGD secondary, 500,000 gallons per day advanced) was constructed in Pasqual Valley and began full-time operation in October 1994.

The Aqua II pilot facility uses channels containing water hyacinths for secondary treatment followed by a 50,000 gal/day advanced treatment system designed to upgrade the secondary effluent water to a quality equivalent to raw water for potable reuse. A technical advisory committee in conjunction with the city selected the tertiary and advanced process trains in 1985. Tertiary treatment to produce a low-turbidity water suitable for reverse osmosis feedwater was provided by a package water treatment plant, with ferric chloride coagulation, flocculation,

sedimentation, and multimedia filtration. The system included ultraviolet light disinfection, cartridge filtration, chemical pretreatment, reverse osmosis using thin-film composite membranes, aeration tower decarbonation, and carbon adsorption. The final process train produces water that meets U.S. drinking water standards.

**Tampa Water Resource Recovery Project**

The Tampa Water Resource Recovery Project was developed to satisfy the future water demands of both the City of Tampa and the West Coast Regional Water Supply Authority. The proposed project involves the supplemental treatment of the Hookers Point Advanced Wastewater Treatment (AWT) Facility effluent to achieve acceptable quality for augmentation of the Hillsborough River raw water supply. In 1993, a pilot plant was designed, constructed, and operated to evaluate supplemental treatment requirements, performance, reliability, and quality.

Source water for the pilot plant was withdrawn downstream from AWT Facility denitrification filters prior to chlorination. The pilot plant facility evaluated four unit process trains, all of which included preaeration, lime treatment and recarbonation, and gravity filtration, followed by either (1) ozone disinfection, (2) reverse osmosis and ozone disinfection, (3) ultrafiltration and ozone disinfection, or (4) granular activated carbon (GAC) adsorption and ozone disinfection. The process train including GAC adsorption and ozone disinfection was selected for design.

The City of Tampa's industrial base is mostly food oriented. Inputs to the wastewater system were confirmed by a "vulnerability analysis." Tampa has an active pretreatment program, and there has been no interference with the plant's biological process since startup in 1978.

The design of the advanced treatment plant allows for rejection of water at any level of treatment and diversion back to the main plant. The use of a bypass canal for storage and mixing provides a large storage capacity and constant dilution of product water with canal and river water. Water can be diluted from the aquifer when river water is not available. Flood control gates allow the canal to be flushed if a problem is detected. Canal water can be drawn through a "linear well field" along the canal to provide further ground water dilution. Five miles of canal and river provide additional natural treatment prior to the intake for the drinking water treatment plant.

**Public Health Issues of Wastewater Effluent Recharge**

The following material is derived from the information provided in the National Research Council's Report on Ground Water Recharge Using Waters of Impaired Quality (1994).

A major consideration in the use of wastewater effluent for artificial recharge is the possible presence of chemicals in the effluent that may be hazardous to human health. At the present time, according to the National Research Councils Committee Report on Ground Water Recharge Using Waters of Impaired Quality, on the basis of available information, there is no indication that the health risks from using reclaimed wastewater are greater than those from using existing water supplies or that the concentrations of chemicals, with several exceptions, or microorganisms are higher than those established in drinking water standards set by the EPA.

Studies have been made of the chemical and microbiological characteristics of recovered water, although they are limited in number and scope. Several studies have shown that the recovered water can meet drinking water standards, even when the recharge source is treated municipal wastewater. Such findings lead some experts to the conclusion that these extracted waters are as acceptable as water supplied from traditional sources. Other experts strongly disagree; saying that water originating from an impaired source is inherently more risky. For instance, disinfection of the recharge waters may develop a different mix of

disinfection by-products (DPBs), often unidentified, from those found in conventional water supplies. Also, the characterizations of the organic material and the full range of microbiological constituents are incomplete. In addition, source waters of impaired quality and recharge water withdrawn from the aquifer at the point of use may contain some contaminants at higher concentrations than are likely to be present in conventional water supplies. And throughout the whole process, there is increased reliance on technology and management, leaving open the door for errors. Thus, the question arises whether drinking water standards developed for conventional water supply systems are sufficiently protective of human health when ground water is recharged with waters of impaired quality. There is a substantial amount of uncertainty principally related to the presence of synthetic organic chemicals, inorganic chemicals, disinfection by-products, and pathogenic organisms.

The assessment of health risks associated with recharge using wastewater effluent is far from definitive because there are limited chemical and toxicological data and inherent limitations in the available toxicological and epidemiological methods. The limited data and extrapolation methodologies used in toxicological assessments provide a source of limitations and uncertainties in the overall risk characterization.

Similarly, epidemiological studies suffer from the need for very long time periods required, because cancers have latency periods of 15 year or more. Also, such studies require large populations to uncover the generally low risks associated with low concentrations of toxicants. Past studies of the possible adverse health effects from reclaimed water have tended to be limited in terms of toxicological characterization and have focused only on those chemicals for which drinking water standards exist.

**Summary and Conclusions**

Many communities currently use water sources of varying quality, including sources that receive significant upstream discharges of wastewater. In this sense, cities upstream of drinking water intakes are already providing water reclamation in their wastewater treatment facilities; for they treat the water, then release it into the raw water supply used by downstream communities.

A small but growing number of communities include the use of highly treated wastewater to augment water supply. Projects currently operating in the United States generally produce reclaimed water that meets or exceeds the quality of the raw waters those systems would use otherwise, as measured by current standards established by the Safe Drinking Water Act. Current potable reuse projects and studies have demonstrated that technology exists to produce reclaimed water of excellent measurable quality and to ensure system reliability.

Assessment of health risks associated with recharge using wastewater effluent is far from definitive because there are limited chemical and toxicological data and inherent limitations in the available toxicological and epidemiological methods.

## E. STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE INITIATIVES

The implementation of infiltration measures as part of stormwater management will increase the annual recharge to groundwater. One method of improving the groundwater infiltration may be creating improvements to developed subdivisions were stormwater management was never applied. Some of the recharge potential in these subdivisions could be restored by retrofitting the existing drainage systems to encourage infiltration. The incorporation of infiltration trenches and basins, dry wells and water quality swales are some of the measures that could be utilized. This stormwater management initiative would be a large undertaking and potentially expensive to accomplish.

The Town began addressing its drainage and stormwater in 1999 with a project consisting of an evaluation and mapping of limited areas of wastewater and drainage infrastructure on Island. There have been numerous amendments to the original contract, adding additional phases and the complete wastewater infrastructure area to the project.

Extensive inspections have been performed on approximately 3,300 wastewater and drainage manholes, drainage catch basins and drainage out-flow structures in Town. Since 1999, additional work has been done not only inspections but also topographical surveys, GIS mapping, and database developing for the Town. The most recent work completed provides the Town with detailed horizontal and, more importantly, vertical elevations of the entire wastewater and drainage infrastructures and an evaluation of the 14 outfalls that discharge into Nantucket Harbor. Work to be completed includes individual catch basin watershed analysis and pipe system analysis.

## F. SHORT LIST OF ALTERNATIVES

### 1. General

The CWMP/EIR Phase I and Phase II Documents identified a variety of alternative wastewater disposal options to be evaluated for each area of wastewater disposal need. These alternatives, which include: (1) the continued use of existing on-site wastewater disposal systems; (2) replacement of existing wastewater disposal systems with Title 5 systems; (3) replacement of existing wastewater disposal systems with on-site innovative/alternative (I/A) systems; (4) replacement of existing wastewater disposal systems with cluster systems consisting of a pressure system and communal subsurface disposal; (5) replacement of the existing wastewater disposal system with a conventional sewer collection system by, either: (a) connection into the existing collection system at Surfside or Siasconset, (b) gravity sewers and pump station(s), (c) pressure sewers and grinder pumps, or (d) a combination thereof.

Section 4.0 of this Document evaluates the costs associated with each of the short-listed alternatives and plan selection and Section 5.0 of this Document details the final recommended plan.

The CWMP/EIR Phase I Document determined study areas where conventional Title 5 wastewater disposal systems are inadequate for long-term sustainability and study areas where existing on-site systems can remain and be effective for wastewater disposal. The Phase II Document evaluated the alternatives listed above for each of the identified Need Areas. The alternatives that were further evaluated for each of the areas of wastewater disposal need are shown in Table 2-23.

**TABLE 2-23**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**ALTERNATIVE SUMMARY**

| Study Area | On-Site | I/A | Communal | Local |
|---|---|---|---|---|
| **1-Madaket** | | | **X** | **X** |
| **2-Warren's Landing** | | | **X** | **X** |
| 3-Cisco | X | | | |
| **4-Somerset** | | | **X** | **X** |
| 5-Miacomet | X | | | |
| 6-Surfside | | | | |
| 7-Tom Nevers Low Density | X | | | |
| 7H-Tom Nevers High Density | X | | | |
| **8-Siasconset** | | | | **X** |
| **9-Quidnet** | **X** | **X** | **X** | **X** |
| **10-Wauwinet** | **X** | **X** | **X** | **X** |
| **11-Pocomo** | **X** | **X** | **X** | **X** |
| **12-Polpis** | **X** | **X** | **X** | **X** |
| **13-Town** | | | | **X** |
| **14-Town-WPZ** | | | | **X** |
| **15-Shimmo** | | | **X** | **X** |
| **16-Monomoy** | | | **X** | **X** |
| 17-Remainder of Island | X | | | |

Note: Bold text indicates Study Area is a "Need Area"

The continued use of existing on-site disposal systems was evaluated for all Study Areas on Island. This evaluation was based on existing on-site systems and with replacement Title 5 systems. Local wastewater treatment and disposal systems were evaluated for all areas of need since this is a viable alternative. Communal wastewater treatment and disposal systems was evaluated only for those areas of need in which there is a site or sites available for treated wastewater effluent disposal within that specific Study Area. Innovative Alternative wastewater treatment and disposal systems were evaluated for those areas of need, which meet the severe soil limitations and high groundwater criteria necessary for proper operation and maintenance.

An analytical approach was utilized to assess the viability of each alternative for each of the individual Study Areas. The alternatives were evaluated based on technical considerations, environmental benefits, and economic feasibility. A screening process was used, which rejected options that do not meet the physical constraints of the planning area, such as climate, soils, and topography. Options were rejected if they were not compatible with air and water quality. Only options that which appear to provide the greatest environmental, technical, financial and institutional benefits have been short-listed. Other factors used in the screening process include reliability, complexity, ease of implementation as well as capital and operating costs.

## 2. Technical Considerations

### On-Site Wastewater Disposal

On-site wastewater disposal was evaluated based on the ability of existing systems to perform to current Title 5 standards. This includes optimizing Septage Management Plans, maintenance and repair and upgrade of on-site systems.

**Innovative/Alternative Wastewater Treatment and Disposal Systems**

I/A treatment was evaluated based on the ability of the process to perform under existing conditions. The review consists of answering "Yes" or "No" to the following three questions: (1) Is a majority of the lot sizes within the Study Area greater than one-third acre; (2) Do suitable soils exist for more than 70 percent of the Study Area?; and (3) Do suitable groundwater conditions exist for more than 80 percent of the Study Area?

**Is a majority of the lot sizes within the Study Area greater than one-third acre?**

Lot size has a direct effect on whether or not a failed on-site wastewater disposal system can be repaired to meet Title 5 criteria with the use of I/A technologies. It is assumed that under ideal soil and groundwater conditions, all lots of one-third acre or less with an on-site wastewater disposal system would, as a minimum, require a variance to Title 5 in order to be repaired. A one-third acre lot size is the absolute minimum lot size, which is feasible for an upgrade of an existing on-site wastewater disposal system.

Another contributing factor utilized in the screening process were the results of the effect of the water balance in each of the 14 drainage sub-basins on the Island, which is included in this section.

Based on all these factors, a short list of alternatives has been developed to meet Nantucket's long-term wastewater needs. Refer to Table 2-23 for the short-list of alternatives.

**Do suitable soils exist for more than 70 percent of the study area?**

If 30 percent or less of the soils within a study area were classified as having severe limitations (hardpan, bedrock, slope, flooding and wetness) the severe soils criteria has been met. Soil types were obtained from the Nantucket County Soil Survey Report by the U.S. Department of Agriculture.

If the question is answered "Yes", then I/A treatment is considered a feasible alternative for existing areas of wastewater disposal need. If the question is answered "No", then the evaluation would continue and the next question which must be answered "Yes" in order for I/A treatment to be considered a feasible alternative for existing areas of wastewater disposal need.

**Do suitable groundwater conditions exist for more than 80 percent of the study area?**

If 20 percent or less of a study area is classified as having a moderately shallow to shallow (high water table at the surface to 2 feet deep) seasonally high groundwater level, the severe groundwater criterion has been met. The U.S. Department of Agriculture obtained high groundwater levels from the Nantucket County Soil Survey Report.

If the question is answered "Yes", then I/A technologies are considered a feasible alternative for existing areas of wastewater disposal need. If the question is answered "No" and the previous question was answered "No" then I/A technologies are not considered a feasible alternative for existing areas of wastewater disposal need.

If it is determined that the alternative is technically feasible then the alternative will be reviewed for environmental benefits and economic considerations.

**Local Wastewater Collection, Transmission, Treatment and Disposal System**

The local wastewater collection, transmission, treatment and disposal system alternative was evaluated based on the availability of site(s) for wastewater treatment facilities and treated wastewater effluent disposal sites located within the Town of Nantucket. The evaluation consists of answering "Yes" or "No" to the following four questions: (1) Is there available capacity in either the Siasconset Wastewater Treatment Facility or the Surfside Wastewater Treatment Facility for additional flows from Needs Areas; (2) If capacity is available, is it technically, economically and/or politically feasible to direct flow to either of these WWTFs; (3) If necessary, are sites available for the construction of wastewater treatment facilities?; and (4) Are sites available for treated

wastewater effluent disposal via groundwater discharge?. All questions must be answered "Yes" in order for local wastewater collection, transmission, treatment and disposal system alternative to be considered a feasible alternative for two or more designated areas of wastewater disposal need.

If it is determined that this alternative is technically feasible then this alternative will be reviewed for environmental benefits and economic considerations.

**Communal Wastewater Collection, Transmission, Treatment and Disposal System**

The communal wastewater collection, transmission, treatment and disposal system alternative was evaluated based on the availability of site(s) for a wastewater treatment facilities and treated wastewater effluent disposal sites located within a given area of need. The evaluation consists of answering "Yes" or "No" to the following two questions: (1) Is a site available for construction of a wastewater treatment facility?; and (2) Is a site available for treated wastewater effluent disposal via groundwater discharge?. Both questions must be answered "Yes" in order for the communal wastewater collection, transmission, treatment and disposal system alternative to be considered a feasible alternative for a designated area of wastewater disposal need.

If it is determined that this alternative is technically feasible then this alternative will be reviewed for environmental benefits and economic considerations.

**3. Environmental Benefits**

Each technically feasible alternative was further evaluated for its ability to meet the following environmental goals: maintain stream flows, recharge Zone II aquifers, and reduce pollutant loadings to preserve aquatic habitats. The evaluation consisted of answering "Yes" or "No" to the following three questions: (1) Does the alternative maintain stream flows?, (2) Does the alternative recharge a Zone II aquifer area?, and (3) Does the alternative reduce pollutant loadings?.

**Does the alternative maintain stream flows?**

This question would be answered "Yes" if the treated wastewater effluent from the alternative discharges into a location that would maintain stream flows within the Town of Nantucket. A "Yes" answer would be indicative of an environmental benefit. This question would be answered "No" if the effluent from the alternative discharges into a location that would not maintain stream flows within the Town of Nantucket. A "No" answer would indicate that the alternative has no environmental benefit in maintaining stream flows.

**Does the alternative recharge a Zone II aquifer area?**

This question would be answered "Yes" if the treated wastewater effluent from the alternative discharges into a Zone II aquifer, and therefore results in an environmental benefit. Likewise, this question would be answered "No" if the treated wastewater effluent from the alternative does not discharge into a Zone II aquifer area and therefore would not result in an environmental benefit as recharge.

**Does the alternative reduce pollutant loadings?**

This question would be answered "Yes" if the treated wastewater effluent from the alternative reduces pollutant loadings to a higher degree than a conventional Title 5 system. Since all of the alternatives being considered will reduce pollutant loadings to a higher degree than a conventional Title 5 system, this question will be answered "Yes" for all of the alternatives. Therefore, all of the alternatives will reduce pollutant loadings and are environmentally beneficial.

**4. Economic Considerations**

All technically feasible and environmentally beneficial alternatives were further evaluated with regard to estimated project costs and estimated annual operation and maintenance costs. The estimated project costs include costs for construction, engineering services, fiscal, legal, administrative, land acquisitions, easements and police details. The estimated operation and maintenance costs were converted to a present worth value based on the interest rate of 7 percent and the expected life cycle of the alternative. Capital construction and operation and maintenance costs were computed for each feasible alternative by designated

area of need. The total present worth value (capital construction and operation and maintenance) for each feasible alternative was divided by the number of users serviced in order to normalize the costs on a per user basis.

**5. Water Balance Impacts**

Water balance can be described as replacing whatever groundwater is removed via potable sources and the elimination of groundwater recharge through the use of on-site wastewater disposal systems with groundwater recharge by means of treated effluent discharge into the ground.

Maintenance of water balance within the drainage sub-basins was a consideration in the evaluation of alternatives. The cause and effects of alternative wastewater treatment on the water balance in each sub-basin was reviewed for impacts. Efforts to recharge the groundwater in any need areas whose water balance has been affected by alternative wastewater treatment and disposal takes precedence. Every attempt was made to be able to locate disposal of highly treated effluent within sub-basins experiencing or proposed to experience stress due to the removal of on-site wastewater system recharge. This was not always possible due to a number of environmental factors that far outweighed any recharge benefits. Many of the Study Areas have been identified as a "Need Area" due to the "severe" soil and groundwater conditions, which would preclude the discharge of larger quantities of treated effluent. Section 4.0 of this Document details the alternatives reviewed for each need area and the effect, if any, on the water balance in the drainage sub-basin. The Report, "Nantucket Water Resources Management Plan", completed by Horsely and Witten in May 1980, states that "it is the precipitation that falls onto the Island's sandy permeable soils, upwards of 30 billion gallons per year, that actually recharge the underground aquifer". While this CWMP/EIR evaluation looked at the more finite goal of recharging individual sub-basins with the location of effluent discharge, the overall goal of recharging the major basin will be accomplished. Refer to Table 2-24 through Table 2-28 for the Island-wide effects on the water balance.

**Background**

The Commonwealth of Massachusetts Watershed Initiative is a collaborative effort of state and federal agencies, conservation organizations, municipal officials and other interested parties working towards protecting and restoring natural resources and ecosystems on a watershed basis. Because watersheds are defined by natural hydrology, they represent the most logical basis for managing water resources. The primary goals of the Watershed Initiative are to:

- Improve water quality;
- Restore natural flows to rivers;
- Protect and restore sensitive habitats;
- Improve public access and balance resource use;
- Improve local abilities to protect water resources; and
- Promote shared responsibility for watershed protection and management.

A significant change in the Commonwealth's approach to managing the state's water resources occurred in 1993 with the adoption of the Watershed Initiative, a strategy to implement integrated, watershed-based resource management by establishing collaborative efforts among individuals, groups, municipalities and agencies with local, regional, state and federal agencies in each watershed. The watershed is the primary focus for coordinating and resolving resource management issues such as water supply shortages, stream flows, fisheries and wildlife protection and wastewater assimilation.

The 1996 update of the Massachusetts Water Supply Policy Statement recommends that action be coordinated with the watershed approach to strengthen local capability to develop and implement water resource management programs. In addition, the 1996 statement advocates that: (1) communities recognize the interconnection of groundwaters and surface waters in water supply management and planning; (2) local and regional integration of planning and management of water supplies and wastewater treatment; (3) aggressive implementation of water conservation measures; (4) watershed protection to ensure both ground and surface water quality are protected and improved; (5) reduce the need for out of basin resources ("keep it local"); and (6) the updating of local zoning bylaws to protect and preserve the natural resources capacity while seeking to provide adequate water supply and wastewater treatment.

## TABLE 2-24
## TOWN OF NANTUCKET
## CWMP/FEIR
## WATER WITHDRAWALS

| Name | Subbasin | Registered Volume (MGD)[1] | Permitted Volume (MGD)[1] | Days[2] | Actual Pumpage [1] 2001 (MGD) | Volume Distributed 2001[3] (MGD) | Summer Useage 2001[4] (MGD) | Volume Distributed Summer 2001 (MGD) | Estimated Useage 2025[5] (MGD) | Volume Distributed 2025 (MGD) | Estimated Summer Useage 2025 [4,5] (MGD) | Volume Distributed Summer 2025 (MGD) | Over Usage Volume[6] (MGD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wannacomet Water Company (3 Wells) | | 0.610 | 0.62 | 365 | | | | | | | | | 0.71 |
| | Harbor | | | | 0.125 | 0.13 | 0.44 | 0.44 | 0.20 | 0.20 | 0.71 | 0.71 | 0.00 |
| | Harbor | | | | 0.674 | 0.67 | 0.85 | 0.85 | 1.08 | 1.08 | 1.36 | 1.36 | 0.00 |
| | Ocean | | | | 0.458 | 0.46 | 1.05 | 1.05 | 0.74 | 0.74 | 1.69 | 1.69 | 0.00 |
| Siasconset Water Department (4 wells) | | 0.110 | 0.00 | 365 | | | | | | | | | 0.21 |
| | Ocean | | | | 0.030 | 0.03 | 0.05 | 0.05 | 0.05 | 0.05 | 0.08 | 0.08 | 0.00 |
| | Ocean | | | | 0.030 | 0.03 | 0.05 | 0.05 | 0.05 | 0.05 | 0.08 | 0.08 | 0.00 |
| | Ocean | | | | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Ocean | | | | 0.140 | 0.14 | 0.33 | 0.33 | 0.22 | 0.22 | 0.52 | 0.52 | 0.00 |
| Miacomet Golf Course | Miacomet | 0 | 0.146 | 210 | 0.000 | 0.00 | 0.00 | 0.00 | 0.146 | 0.00 | 0.248 | 0.00 | 0.00 |
| Wauwinet House | Harbor | N/A | N/A | N/A | 0.002 | 0.00 | 0.013 | 0 | 0.002 | 0 | 0.013 | 0 | 0.00 |
| Surfside Beach | Ocean | N/A | N/A | N/A | 0.000 | 0.0000 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Westender Restaurant | Madaket | N/A | N/A | N/A | 0.0004 | 0.0004 | 0.0011 | 0 | 0.0004 | 0 | 0.0011 | 0 | |
| Nantucket Golf Club | Ocean | 0 | 0.19 | 240 | 0.1047 | 0.09 | 0.18 | 0 | 0.19 | 0 | 0.32 | 0 | 0.00 |
| Nantucket Conservation Foundation | Ocean | 2.420 | 0 | 365 | 1.8800 | 0.94 | 1.8800 | 0.94 | 0 | 0 | 0 | 0 | 2.52 |
| Ocean View Farm | Long | 0.420 | 0 | 150 | 0.0800 | 0.04 | 0.16 | 0.08 | 0.42 | 0.21 | 0.84 | 0.42 | 0.46 |
| Sankaty Head Golf Course | Ocean | 0.130 | 0 | 183 | 0.1400 | 0.00 | 0.24 | 0 | 0.13 | 0 | 0.22 | 0 | 0.18 |
| **TOTAL** | | 3.690 | 0.956 | | 3.664 | 2.526 | 5.243 | 3.794 | 3.230 | 2.552 | 6.103 | 4.879 | 4.081 |

Notes:
1. Listing from DEP printout entitled "Actual Water Use – 2001". DEP lists withdrawals over the permitted period. Actual Usage numbers were adjusted for the whole year.
2. Days reflect approved number of days of operation.
3. Volume distributed reflects the volume of water, which flows to surface water or groundwater. Agricultural lands are calculated to have a 50% consumption rate and a 50% recharge rate. Golf courses, commercial, and industrial withdrawal are calculated to have a 100% loss. Industrial losses are assumed to be 100% since they discharge to the municipal WWTF and are included in the municipal collection calculations.
4. Summer usage assumes that the days of operation include July and August.
5. Estimated Usage is the registered or permitted withdrawal amount adjusted for the whole year.
6. Water Withdrawal Registrations issued before the Water Management Act include a clause which allows the Withdrawal Volume to exceed the Registered Volume by 100,000 gallons per day of operation. In subsequent tables, future water withdrawals are based on maximum permitted amount. Over usage volumes are shown here to illustrate a possible worst case scenario.

**TABLE 2-25**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**WATER BALANCE IMPACTS - 2001 ANNUAL**

| Subbasin | (-) Amount Withdrawn (mgd) | (-) Amount Distributed (mgd) | (-) Amount Collected (mgd) | (+) Amount Discharged (mgd) | Water Balance Impact (mgd) | Groundwater Recharge (mgd) |
|---|---|---|---|---|---|---|
| Capaum | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Harbor | 0.80 | 0.57 | 0.77 | 0.00 | -1.01 | -0.21 |
| Hummock | 0.00 | 0.06 | 0.09 | 0.00 | -0.02 | -0.02 |
| Long | 0.08 | 0.04 | 0.00 | 0.00 | -0.04 | 0.04 |
| Madaket | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Maxcy | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Miacomet | 0.00 | 0.21 | 0.29 | 0.00 | -0.08 | -0.08 |
| Ocean | 2.78 | 1.50 | 0.65 | 1.80 | -0.13 | 0.86 |
| Sesachacha | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Tom Nevers | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Washing | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **3.66** | **2.386** | **1.80** | **1.80** | **-1.28** | **0.59** |

**TABLE 2-26**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**WATER BALANCE IMPACTS - 2001 SUMMER**

| Subbasin | (-) Amount Withdrawn (mgd) | (-) Amount Distributed (mgd) | (-) Amount Collected (mgd) | (+) Amount Discharged (mgd) | Water Balance Impact (mgd) | Groundwater Recharge (mgd) |
|---|---|---|---|---|---|---|
| Capaum | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Harbor | 1.30 | 1.05 | 1.06 | 0.00 | -1.32 | -0.01 |
| Hummock | 0.00 | 0.12 | 0.12 | 0.00 | 0.00 | 0.00 |
| Long | 0.16 | 0.08 | 0.00 | 0.00 | -0.08 | 0.08 |
| Madaket | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Maxcy | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Miacomet | 0.00 | 0.40 | 0.40 | 0.00 | 0.00 | 0.00 |
| Ocean | 3.78 | 1.82 | 0.89 | 2.47 | -0.38 | 0.93 |
| Sesachacha | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Tom Nevers | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Washing | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **5.24** | **3.468** | **2.47** | **2.47** | **-1.78** | **0.99** |

**TABLE 2-27**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**WATER BALANCE IMPACTS - 2025 ANNUAL**

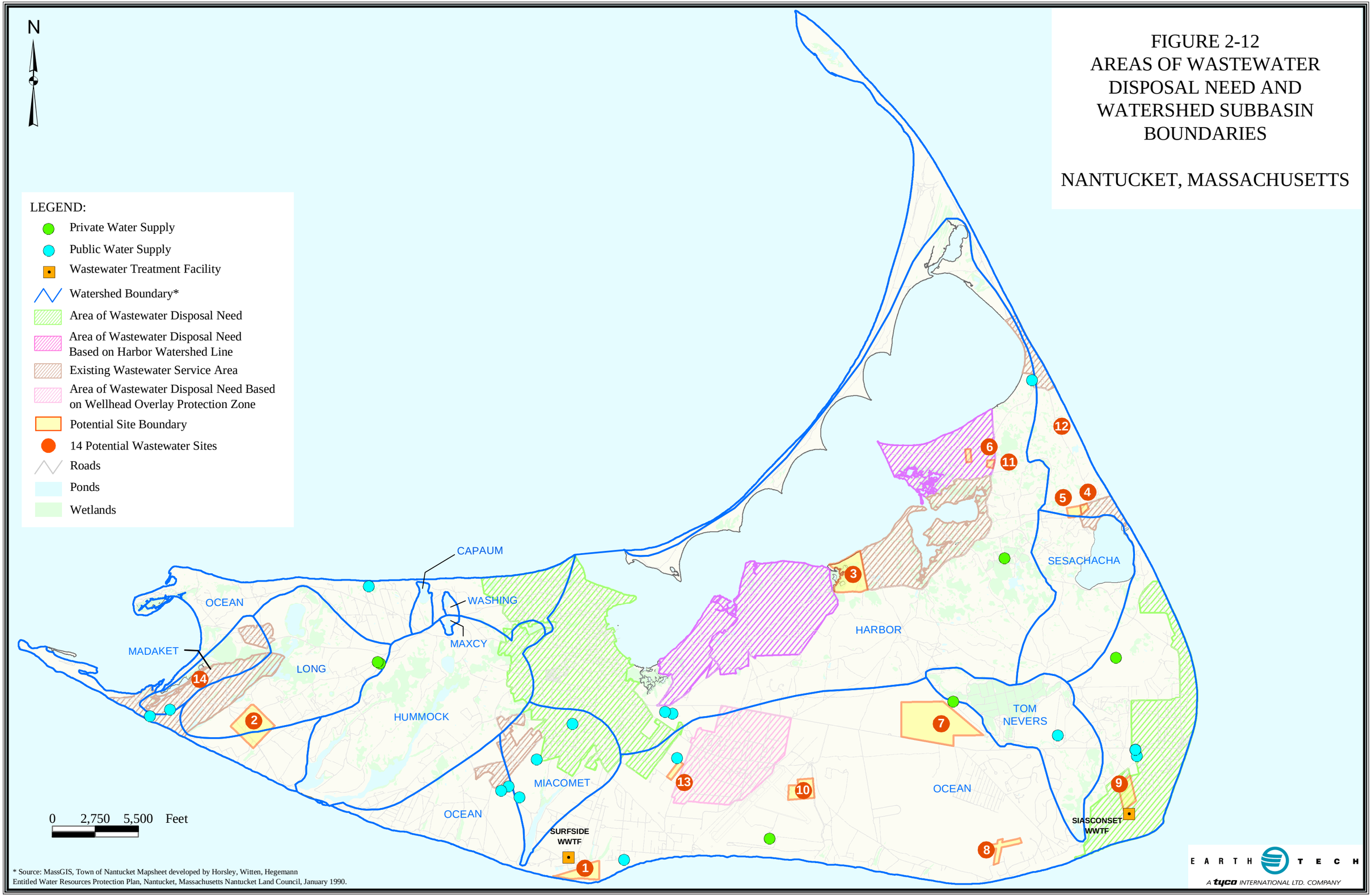
| Subbasin | (-) Amount Withdrawn (mgd) | (-) Amount Distributed (mgd) | (-) Amount Collected (mgd) | (+) Amount Discharged (mgd) | Water Balance Impact (mgd) | Groundwater Recharge (mgd) |
|---|---|---|---|---|---|---|
| Capaum | 0.00 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 |
| Harbor | 1.29 | 1.051 | 1.15 | 0.00 | -1.39 | -0.10 |
| Hummock | 0.00 | 0.120 | 0.09 | 0.00 | 0.03 | 0.03 |
| Long | 0.42 | 0.000 | 0.10 | 0.00 | -0.52 | -0.10 |
| Madaket | 0.00 | 0.000 | 0.11 | 0.00 | -0.11 | -0.11 |
| Maxcy | 0.00 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 |
| Miacomet | 0.15 | 0.397 | 0.33 | 0.00 | -0.08 | 0.07 |
| Ocean | 1.38 | 0.879 | 0.91 | 2.71 | 1.30 | -0.03 |
| Sesachacha | 0.00 | 0.000 | 0.01 | 0.00 | -0.01 | -0.01 |
| Tom Nevers | 0.00 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 |
| Washing | 0.00 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **3.23** | **2.448** | **2.71** | **2.71** | **-0.78** | **-0.26** |

**TABLE 2-28**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**WATER BALANCE IMPACTS - 2025 SUMMER**

| Subbasin | (-) Amount Withdrawn (mgd) | (-) Amount Distributed (mgd) | (-) Amount Collected (mgd) | (+) Amount Discharged (mgd) | Water Balance Impact (mgd) | Groundwater Recharge (mgd) |
|---|---|---|---|---|---|---|
| Capaum | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Harbor | 2.09 | 1.85 | 1.58 | 0.00 | -1.82 | 0.27 |
| Hummock | 0.00 | 0.15 | 0.13 | 0.00 | 0.02 | 0.02 |
| Long | 0.84 | 0.59 | 0.14 | 0.00 | -0.40 | 0.44 |
| Madaket | 0.00 | 0.18 | 0.15 | 0.00 | 0.02 | 0.03 |
| Maxcy | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Miacomet | 0.25 | 0.53 | 0.46 | 0.00 | -0.17 | 0.08 |
| Ocean | 2.93 | 1.46 | 1.25 | 3.72 | 1.01 | 0.21 |
| Sesachacha | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| Tom Nevers | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Washing | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **6.10** | **4.769** | **3.72** | **3.72** | **-1.34** | **1.05** |

It is these principles that form the foundation of the Commonwealth of Massachusetts Watershed Initiative, which support the "watershed approach" to environmental planning and decision making in order to guarantee the citizens and inhabitants of the Commonwealth sufficient quantity and quality of water resources for the long-term.

An initiative of this CWMP/EIR is to evaluate the potential positive effects of the disposal of highly treated wastewater effluent, as groundwater recharge, within the various watershed subbasins on Nantucket, in offsetting groundwater withdrawals as water supply and/or the replacement of on-site wastewater disposal facilities with sewers. The primary focus of the evaluation centers on areas of Town that are currently sewered or are a designated "Needs Area" where there is a potential for sewers. The result of the water balance analysis is a definitive identification of the watershed subbasins where the volume of groundwater removed as water supply is greater than, equal to or less than the volume of groundwater recharge through wastewater disposal. Potential discharge sites for the disposal of highly treated wastewater effluent will be given a priority within stressed watershed subbasins. Again, while this evaluation looked at the more finite goal of recharging individual sub-basins, the overall goal of recharging the major basin will be accomplished through the final recommended plan and as previously stated, it is the precipitation that falls onto the Island's sandy permeable soils, upwards of 30 billion gallons per year, that actually recharge the underground aquifer. While it is the precipitation that recharges the aquifer, the on-site wastewater systems currently utilized in Nantucket add to the recharge. The Water Balance completed as part of this Document, is an exercise that will identify those areas that will experience a groundwater recharge deficit due only to the removal of on-site wastewater disposal systems. These areas will still continue to receive the major benefits of aquifer recharge through annual precipitation. The watershed subbasins and Study Areas where sewers exist or may exist in the future are shown on Figure 2-12.

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SEPTEMBER 2003

The water balance is calculated by sub basin. The sub basins are delineated by Horsely, Witen, Hegemann Entitled Water Resources Protection Plan, Nantucket Massachusetts, Nantucket Land Counsel, January 1990.

The water balance is calculated using the following formula:

Water Balance = **(–)** Amount withdrawn **(+)** Amount distributed
**(–)** Amount collected

The groundwater recharge is calculated by the following formula:

Groundwater Recharge = **(+)** Amount distributed **(–)** Amount collected

**Amount Withdrawn**

The total amount of water withdrawn from each subbasin is the sum of the water withdrawn from the municipal water supply sources and all non-municipal water withdrawals by commercial/industrial entities that are required to report such data to the DEP. The municipal withdrawal volume data is from the Department of Environmental Protection's *2001 Public Water Supply Annual Statistical Report.* The non-municipal withdrawal volume data is from the DEP's *2001 Actual Water Withdrawal Report*. Additional water withdrawals from small capacity private wells that may be located within certain watersheds are assumed to be negligible.

The actual municipal withdrawal volumes, non-municipal withdrawal volumes and the DEP registered and/or permitted withdrawal volumes for the year 2001 along with the projected 2025 volumes of withdrawal from these sources are shown in Table 2-24. Each registered and/or permitted water supply source was placed in its respective subbasin based on its longitude and latitude and confirmed with the data included in the DEP Water Management Act permit for each source.

The summer withdrawals for 2001 and estimated summer withdrawals for 2025 are shown in Table 2-24. The summer withdrawals for 2001 are the average of the water withdrawals on the Island for the months of July and August. The non-municipal withdrawals for 2001 are the actual withdrawals from DEP and assume that the days of operation include the moths of July and August. The 2025 summer non municipal withdrawals are the maximum permitted amount and assume that the days of operation include the months of July and August.

The projected water withdrawal from existing municipal water supply sources in 2025 is based on the analysis performed for the Comprehensive Wastewater Management Plan. It is projected that the average daily withdrawal volume will increase by approximately 2 percent each year from 2002 to 2025. It is assumed in this analysis that the increase in withdrawal volume will be shared equally by all existing water supply sources and that no new water supply sources will be developed before 2025. The estimate of 2025 non-municipal withdrawals is assumed to be the maximum permitted amount.

**Amount Distributed**

The amount distributed is the volume of water dispersed throughout the entire water system. The amount distributed is calculated by using the water use quantities for the entire Island. The Island withdrawal quantities are then distributed across the area of water service in each sub basin.

The current amount of municipal water distributed in Nantucket was reported to DEP in the 2001 Public Water Supply Annual Statistical Report. The amount of water distributed over each subbasin is estimated from the recorded volume of water reported to DEP, as metered, to each category of municipal water customer. The difference between the volume of water delivered through the municipal water system infrastructure and the amount of water withdrawn at each supply source is unaccounted-for-water. The unaccounted-for-water component is distributed proportionally across the entire area of Town serviced by the municipal water system. Non-municipal withdrawals are added to the amount distributed in their respective subbasins. The water balance assumes that agricultural resources recharge the sub basins by 50 percent of their irrigation rate.[1]

**Amount Collected**

The amount of water collected is calculated by using the estimated quantity of wastewater delivered to the municipal sewer system. The amount collected the calculated quantity of wastewater pumped accepted at the Surfside WWTF in 2001 and the estimated amount of wastewater accepted at Surfside WWTF in 2025. The total collections are then distributed over the sewered area of the sub basins.

[1] Viessmaen, Jr., Warren, Hammer, Mark J., Water Supply and Pollution Control, Fifth Edition, HarperCollins College Publishers, 1993, pg. 32.

The annual total uses the discharge quantity from 2001, and the summer total uses the average 2001 discharge quantity for the months of July and August. This data is taken from the Phase I report. The 2025 total annual discharge assumes that the wastewater treatment plants discharge the estimated flow for the design year as calculated in the Phase I Report. The 2025 summer discharge is proportional to 2001 summer discharge. The 2025 collection area includes the Needs Areas.

**Summary**

The baseline water balance impact analysis for the calendar year 2001 is presented in Table 2-25 and Table 2-26. The result of this analysis shows that water withdrawals exceed groundwater recharge in 5 of the 11 subbasins located within the Nantucket. These subbasins and the effective negative recharge are summarized as follows: (a) Harbor; (b) Ocean; (c) Miacomet; (d) Long; and (e) Hummock.

The major cause of negative recharge in these subbasins is the municipal water supply. The Town's existing groundwater supply sources are located within the subbasins with the most impact, Harbor and Ocean. The effect of collecting potential recharge through the existing sewer system is minimal with respect to the withdrawal of groundwater supply from the municipal water supply system.

The projected water balance impact analysis for the calendar year 2025 is presented in Table 2-27 and Table 2-28. The result of this analysis shows that water withdrawals continue to exceed groundwater recharge in 5 of the 11 subbasins identified. Some of the subbasins have changed due to proposed water withdrawal changes. The projected effective negative recharge by subbasin for the calendar year 2025 are summarized as follows: (a) Harbor; (b) Long; (c) Madaket; (d) Miacomet; (e) Sesachacha.

If it is assumed that the recommended Town-wide wastewater management plan will include sewering as a long-term solution for wastewater disposal in the identified Needs Areas, then the amount of potential recharge from on-site wastewater disposal systems will be reduced accordingly. As is the case presently, the effect of collecting potential recharge through a proposed sewer system for the identified Needs Areas is minimal with respect to the withdrawal of groundwater supply from the municipal water supply system.

The primary goal of the Commonwealth of Massachusetts Watershed Initiative is to keep water local thereby maintaining more constant stream flows and recharging aquifer areas. The identified potential subsurface wastewater disposal sites, located throughout the Island of Nantucket will be evaluated for their ability to receive highly treated wastewater effluent from existing and/or potential wastewater treatment facilities.

The result of the water balance analyses confirms that in certain watershed subbasins the volume of groundwater removed as water supply is greater than the volume of groundwater recharge through on-site wastewater disposal systems. Potential subsurface wastewater disposal sites for highly treated wastewater effluent will be given a priority within the five identified stressed watershed subbasins for the design year of 2025. Recharge from stormwater will be considered for the Harbor subbasin during the evaluation and mapping project and recharge from a wastewater treatment facility will be considered for the Long and Madaket subbasins. The major and most important groundwater aquifer recharge to all these areas continues through annual precipitation.

# Section 3.0

## Screening of Sites for Treatment and/or Disposal

# 3.0 SCREENING OF SITES FOR TREATMENT AND/OR DISPOSAL

## A. CRITERIA DEVELOPMENT

The screening criteria presented in this section was developed to assess the viability of 14 sites identified within Nantucket as potential wastewater treatment facility and/or wastewater disposal facility sites. The screening criteria used to evaluate these potential project sites was based upon eleven environmental criteria. The environmental screening criteria were chosen based upon review by the Project Proponent and upon comments received by the Proponent in the Secretary of the Executive Office of Environmental Affairs Certificate on the ENF dated October 2001. It was determined that by applying the screening criteria to the 14 identified sites a short list of selective potential sites would be established for additional evaluation through field testing. The screening criteria chosen to evaluate the potential project sites are: (1) wetlands; (2) soils; (3) drinking water supply - wellhead protection areas (Zone I and Zone II); (4) fisheries (including shellfish areas); (5) waterbodies (distance from surface water); (6) floodplains; (7) sensitive habitats; (8) park lands; (9) recreational resources; (10) agricultural/historical interests; (11) shoreline change data; and (12) in or adjacent to an Area of Critical Environmental Concern. A description of each screening criteria is given below and presented on Table 3-1.

The criteria was also developed with respect to whether or not there was an existing "Opportunity" or environmental "Constraint" for the site to be utilized for a treatment facility and/or disposal facility for Nantucket's wastewater.

The designation of an "Opportunity" within the screening criteria reflects the positive aspects of the environment that could be used in a beneficial manner in siting treatment and/or disposal facilities. Similarly, the designation of environmental "Constraints" within the screening criteria reflects aspects of the site and environment that would not be beneficial in siting these facilities. The "Constraints" are identified as "Minimal", "Moderate", and "Severe" depending on the extent and nature of the obstacles to developing each site. All sites were potentially located to avoid directly impacting any of the screening criteria.

# TABLE 3-1
# TOWN OF NANTUCKET
# CWMP/FEIR
# CRITERIA DESCRIPTION

| Screening Criteria | Facility | Surface water Discharge | Groundwater Discharge |
|---|---|---|---|
| **Wetlands** [a] | **Opportunity**-N/A<br>**No Constraint**-if greater than 200 feet from wetlands<br>**Minimal Constraint**-if within 200 feet of wetlands<br>**Moderate Constraint**-if within 100 feet of wetlands<br>**Severe Constraint**-if within wetland | **Opportunity** if wetlands present adjacent to Site<br>**No constraint** if within 200 feet of wetlands<br>**Minimal constraint** if between 200 and 400 feet from wetlands<br>**Moderate constraint** if between 400 and 1000 feet from wetlands<br>**Severe constraint** if greater than 1000 feet from wetlands | **Opportunity** - N/A<br>**No constraint** if greater than 1000 feet from wetland<br>**Minimal constraint** if between 400 and 1000 feet from wetlands<br>**Moderate constraint** if between 100 and 400 feet from wetland<br>**Severe constraint** if within 100 ft of wetland |
| **Soils** | **Opportunity**-N/A<br>**No Constraint**-based on mapped soil type<br>**Minimal Constraint**- based on mapped soil type<br>**Moderate Constraint**- based on mapped soil type<br>**Severe Constraint**-if within known documented hazardous soil area | **No opportunity, minimal, or moderate constraint** based on mapped soil type<br>**Severe constraint** if within known hazardous area | **Opportunity** if mapped within sand/gravel deposits<br>**No constraint** - N/A<br>**Minimal constraint** - N/A<br>**Moderate constraint** - if mapped within till/bedrock<br>**Severe constraint** if mapped within known hazardous area |
| **Drinking Water Supply** | **Opportunity** - N/A<br>**No constraint** if outside Zone II<br>**Minimal constraint** if within Zone II<br>**Moderate constraint** - N/A<br>**Severe constraint** - N/A | **Opportunity** - N/A<br>**No constraint** if greater than 1000 feet from Zone II<br>**Minimal constraint** - N/A<br>**Moderate constraint** if within Zone II and greater than 1000 feet from public well<br>**Severe constraint** if within Zone II and within 1000 feet from public well | **Opportunity** - N/A<br>**No constraint** if greater than 1000 feet from Zone II<br>**Minimal constraint** - N/A<br>**Moderate constraint** if within Zone II and greater than 1000 feet from public well<br>**Severe constraint** if within Zone II and within 1000 feet from public well |
| **Fisheries and Shell Fish Beds** | **Opportunity**-N/A<br>**No constraint** if facility is downstream or greater than 1000 feet of fish stocking area<br>**Minimal constraint** if facility is located within 400 feet from fish stocking area<br>**Moderate constraint** if facility is located within 200 feet fish stocking area<br>**Severe constraint** if facility is located directly in fish stocking area | **Opportunity** - N/A<br>**No constraint** if discharge is downstream or greater than 1000 feet of fish stocking area<br>**Minimal constraint** if discharge within 400 feet from fish stocking area<br>**Moderate constraint** if discharge within 200 feet fish stocking area<br>**Severe constraint** if discharge directly into fish stocking area | **Opportunity** - N/A<br>**No constraint** if discharge downstream or greater than 1000 feet of fish stocking area<br>**Minimal constraint** if discharge within 400 feet from fish stocking area<br>**Moderate constraint** if discharge within 200 feet fish stocking area<br>**Severe constraint** -N/A |
| **Waterbodies** [a] | **Opportunity**-N/A<br>**No Constraint**-if greater than 200 feet from water body<br>**Minimal Constraint**-if within 200 feet of water body<br>**Moderate Constraint**-if within 100 feet of water body<br>**Severe Constraint**-if within wetland | **Opportunity** if adjacent waterbody present<br>**No constraint** if within 200 feet of waterbody<br>**Minimal constraint** if between 200 and 400 feet from waterbody<br>**Moderate constraint** if greater than 400 feet from waterbody<br>**Severe constraint** if greater than 1000 feet from waterbody | **Opportunity** - N/A<br>**No constraint** if greater than 1000 feet from waterbody<br>**Minimal constraint** if between 200 and 1000 feet from waterbody<br>**Moderate constraint** if within 200 feet from waterbody<br>**Severe constraint** - N/A |
| **Floodplains** [a] | **Opportunity** - N/A<br>**No constraint** if outside of floodplain<br>**Minimal constraint** -N/A<br>**Moderate constraint** - if within floodplain<br>**Severe constraint** N/A | **Opportunity** - N/A<br>**No constraint** if outside of floodplain<br>**Minimal constraint** -N/A<br>**Moderate constraint** - N/A<br>**Severe constraint** if within floodplain | **Opportunity** - N/A<br>**No constraint** if outside of floodplain<br>**Minimal constraint** -N/A<br>**Moderate constraint** - N/A<br>**Severe constraint** if within floodplain |
| **Sensitive Habitat** [a] | **Opportunity** - N/A<br>**No constraint** if outside of sensitive habitat<br>**Minimal constraint** - N/A<br>**Moderate constraint** if within sensitive habitat and greater than 100 feet from wetland<br>**Severe constraint** if within sensitive habitat and within 100 feet from wetland | **Opportunity** - N/A<br>**No constraint** if greater than 200 feet from sensitive habitat<br>**Minimal constraint** if within 200 feet of sensitive habitat<br>**Moderate constraint** if within sensitive habitat and greater than 100 feet from wetland<br>**Severe constraint** if within sensitive habitat and within 100 feet from wetland | **Opportunity**- N/A<br>**No constraint** if greater than 200 feet from sensitive habitat<br>**Minimal constraint** if within 200 feet of sensitive habitat<br>**Moderate constraint** if within sensitive habitat and greater than 100 feet from wetland<br>**Severe constraint** if within sensitive habitat and within 100 feet from wetland |
| **Park Lands** | **Opportunity** - N/A<br>**No constraint** if greater than 200 feet from park lands<br>**Minimal constraint** if abutting park lands<br>**Moderate constraint** - N/A<br>**Severe constraint** if within park lands | **Opportunity** - N/A<br>**No constraint** if greater than 200 feet from park lands<br>**Minimal constraint** if abutting park lands<br>**Moderate constraint** if within park lands<br>**Severe constraint** - N/A | **Opportunity**- N/A<br>**No constraint** if greater than 200 feet from park lands<br>**Minimal constraint** if within 200 feet of park lands<br>**Moderate constraint** if within park lands<br>**Severe constraint** - N/A |
| **Recreation Resources** | **Opportunity** - N/A<br>**No constraint** if greater than 200 feet from recreation resource<br>**Minimal constraint** if within 200 feet of recreation resource<br>**Moderate constraint** if within recreation resource area<br>**Severe constraint** - N/A | **Opportunity** - N/A<br>**No constraint** if greater than 200 feet from recreation resource[b]<br>**Minimal constraint** if within 200 feet of recreation resource<br>**Moderate constraint** if within recreation resource<br>**Severe constraint** - N/A | **Opportunity** - N/A<br>**No constraint** if greater than 200 feet from recreation resource<br>**Minimal constraint** if within 200 feet of recreation resource<br>**Moderate constraint** if within recreation resource<br>**Severe constraint** - N/A |
| **Agricultural/Historic Interests** | **Opportunity** - N/A<br>**No constraint** if greater than 200 feet from historic interest<br>**Minimal constraint** if within 200 feet of historic interest<br>**Moderate constraint** if directly abutting historic interest<br>**Severe constraint** if within historic interest | **Opportunity** - N/A<br>**No constraint** if greater than 200 feet from historic interest<br>**Minimal constraint** if within 200 feet of historic interest<br>**Moderate constraint** if directly abutting historic interest<br>**Severe constraint** if within historic interest | **Opportunity** - N/A<br>**No constraint** if greater than 200 feet from historic interest<br>**Minimal constraint** if within 200 feet of historic interest<br>**Moderate constraint** if directly abutting historic interest<br>**Severe constraint** if within historic interest |
| **Shoreline Change Data** | **Opportunity** - N/A<br>**No constraint** outside of area of documented erosion<br>**Minimal constraint** if within 200 feet of **documented erosion**<br>**Moderate constraint** if directly abutting **documented erosion**<br>**Severe constraint if within area of documented erosion** | **Opportunity** - N/A<br>**No constraint** outside of area of documented erosion<br>**Minimal constraint** if within 200 feet of **documented erosion**<br>**Moderate constraint** if directly abutting **documented erosion**<br>**Severe constraint if within area of documented erosion** | **Opportunity** - N/A<br>**No constraint** outside of area of documented erosion<br>**Minimal constraint** if within 200 feet of **documented erosion**<br>**Moderate constraint** if directly abutting **documented erosion**<br>**Severe constraint if within area of documented erosion** |
| **Area of Critical Environmental Concern (ACEC)**[a] | **Opportunity** - N/A<br>**No constraint** if outside of ACEC<br>**Minimal constraint** -N/A<br>**Moderate constraint** - N/A<br>**Severe constraint** if within ACEC | **Opportunity** - N/A<br>**No constraint** if outside of ACEC<br>**Minimal constraint** -N/A<br>**Moderate constraint** – N/A<br>**Severe constraint** if within ACEC [a] | **Opportunity** - N/A<br>**No constraint** if outside of ACEC<br>**Minimal constraint** -N/A<br>**Moderate constraint** – N/A[a]<br>**Severe constraint** if within ACEC [a] |
| **Nantucket and Madaket Harbor Watersheds** | **Opportunity** - N/A<br>**No constraint** if outside of Watershed Delineation<br>**Minimal constraint** -N/A<br>**Moderate constraint** - N/A<br>**Severe constraint**-N/A | **Opportunity** - N/A<br>**No constraint** if outside of Watershed Delineation<br>**Minimal constraint** -N/A<br>**Moderate constraint** - N/A<br>**Severe constraint**-N/A | **Opportunity** - N/A<br>**No constraint** if outside of Watershed Delineation<br>**Minimal constraint** -N/A<br>**Moderate constraint** - N/A<br>**Severe constraint**-N/A |

(a) Based on available information, potential sites were located to avoid directly impacting wetlands, floodplains, ACEC (Site specific), sensitive habitat (Site specific) and waterbodies and are at least 100 feet removed.

For those sites large enough to locate a facility or groundwater discharge site outside of any environmental criteria onsite, either a "No Constraint" or "Opportunity" rating was given due to the overall site size and availability of land outside of any environmental constraints.

- "Opportunity": the positive attributes associated with the criteria that could be a benefit to siting the facility (positive).
- "Constraint": the nature of the obstacles associated with the criteria that could negatively affect the siting of the facility.

    1. "No Constraint": the criteria does not have any positive attributes or impose any obstacles to the siting of the facility (neutral).
    2. "Minimal Constraint": the criteria imposes the lowest degree of obstacles in the siting the facility.
    3. "Moderate Constraint": the criteria imposes average obstacles to the siting the facility.
    4. "Severe Constraint": the criteria does impose extremely difficult obstacles to overcome in the siting the facility.

For the purposes of this report, it is presumed that treated effluent from any proposed facilities will be discharged to land, as the Massachusetts Ocean Sanctuaries Act prohibits ocean discharge of municipal wastewater off Nantucket. Although the Ocean Sanctuaries Act permits municipalities to apply for a waiver from its requirements, the Department of Environmental Protection would most likely deny the consideration of ocean discharge as an option, as it did during the Siasconset Facilities Planning Process. The Island is designated a Sole Source Aquifer, by the Environmental Protection Agency under the auspices of the Safe Drinking Water Act (Section 1424e) and gives the EPA the authority to review and restrict federal funding for projects that represent threats to the aquifer. Although "Surface Water Discharge" is defined in Table 3-1, any surface water discharges have been eliminated from consideration due to stringent regulatory requirements and the lack of suitable surface waters located on the Island. The surface fresh water bodies on Island are derived entirely from precipitation. Approximately 57 percent of the precipitation is returned to the atmosphere by evaporation and transpiration by plants. Significant amounts of this precipitation infiltrates the permeable sandy soils and recharge the underground aquifer. A limited amount results in surface water runoff directly into the Island's few streams ponds, and wetland areas. A perfunctory review of these streams, ponds and wetland areas located on Island identifies them as unsuitable for any treated effluent discharge due to not

only their size but locations as well. The water resources for the Town are unique in that the fragile ecosystem survives on a system whereby fresh groundwater floats on top of salt water due to the density difference between salt and fresh. Surface water flow and the runoff from the land area is directly related to the topography of the Island's land area. Water moves from the higher to the lower elevations, which in Nantucket's case, is from center Island towards the shoreline. Ultimately this groundwater movement discharges to the ponds, wetland areas, and harbors or eventually in some areas to the open ocean.

At times of high groundwater, typically the spring months, many of these surface water bodies are flooded by the natural cause of events. For this reason alone, these surface water bodies cannot handle additional flow in the form of treated effluent.

**Wetlands**

The wetlands screening criteria is considered an important factor in siting both the treatment facilities and effluent disposal facilities. It was determined that "No Opportunities" exist for constructing treatment facilities or effluent disposal facilities in wetlands. These facilities would need to be constructed in upland areas to avoid filling or alternation of wetlands. The wetland related "Constraints" are based on distances from the wetland. The wetland screening criteria is developed with the assumption that the potential facilities will be greater than 100 feet away from wetland areas.

The wetlands criteria for surface water discharge facilities is considered more constrained the further removed from the wetland, since the discharge of the treated effluent ideally should be directly into the receiving water body. Those sites located within 100 feet of a wetland are considered to present "Minimal Development Constraints" because the proximity of the treatment facility and the length of the treated wastewater effluent discharge piping is minimized. Sites located distant (greater than 400 feet) from the wetland/surface water would pose "Moderate" and "Severe Constraints" since access to the discharge point is restricted.

**Soils**

Soil type is considered to have a greater influence on the selection of an effluent disposal/groundwater discharge site than on the selection of a treatment facility site due to the variable infiltration properties of soils. However, soil type is not as critical in selecting a treatment facility or surface water disposal site since construction is predominantly above ground.

The only "Constraint" associated with soil type for the construction of treatment facilities or surface water discharge facilities is the presence of known hazardous materials on site. The soil properties and the presence of hazardous material on site is considered primary to the selection of potential groundwater discharge sites.

To ensure proper function of an effluent disposal facility, a suitable site must have a soil permeability high enough to allow percolation of the effluent into the soil profile at a rate that will properly treat the effluent. Suitable soil types were determined by review of the Nantucket County Soil Survey Reports, developed by the U.S. Department of Agriculture's Soil Conservation Service. Soil types with slight or moderate limitations for sewage disposal will be considered to present "No Constraint" (slight) or "Minimal Constraint" (moderate) with regards to locating a subsurface effluent disposal/groundwater discharge system. Soil types with severe limitations for sewage disposal or soils mapped within hazardous areas will be considered to present "Severe Constraints" with regards to locating a subsurface effluent disposal/groundwater discharge system.

The soils within the Town of Nantucket are generally of four types. These soil types are listed below in descending order of the soil's suitability for potential groundwater discharge of treated effluent.

- Soil Type 1: Sand and Gravel Deposits – 0 to 50 feet deep
- Soil Type 2: End Moraines
- Soil Type 3: Till or Bedrock
- Soil Type 4: Landfill

Sites located within areas, which are comprised of Soil Type 1, are considered to provide the greatest "Opportunity". Soil Types 2, 3 and 4 are not considered suitable for effluent disposal, therefore, sites with these soil types are considered to have "Severe Constraints".

**Floodplains**

Construction within 100-year floodplains is constrained by regulatory restrictions on development within floodplain areas for protection of flood storage and for protection of the constructed facility to flood hazards. This criteria was considered to present "Moderate Developmental Constraints" with regard to siting of treatment facilities if located within a floodplain, and "No Constraint" if located outside of a floodplain.

Potential groundwater discharge sites located within the 100-year floodplain are restricted from being located in velocity zones and floodways in accordance with DEP regulations (310 CMR 15.213(2)). A facility in the 100-year flood plain would also be more susceptible to flooding during major storm events. Therefore, the floodplain site selection criterion was considered to present "Severe Developmental Constraints" for groundwater disposal facilities if the potential site is located within the floodplain. If the disposal site is outside the floodplain then "No Constraints" are present to development of a groundwater discharge facility. The 100-year flood plain was identified through review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps for Nantucket, Community-Panel Numbers 250230 0001-0020. Sites with insufficient buildable area outside the flood plain were deemed unacceptable and were eliminated from consideration.

Surface water discharge facilities located within a floodplain are a concern since the discharge flow would represent additional flow that would have to be accommodated during the 100-year flood event. Most of the primary streams in Nantucket are associated with a floodplain. Therefore, potential flooding impacts could be buffered by the capability of the stream to handle slight increases in flow. Therefore, surface water discharges within a floodplain were eliminated from the evaluation as previously stated. If the disposal site is outside the floodplain then "No Constraints" are present to development

**Waterbodies (Distance from Surface Water)**

Although surface water discharges have been eliminated from consideration as previously mentioned, the following information regarding surface water discharges describe the usual process for evaluation and is for discussion purposes only.

Proximity to waterbodies is considered a factor in the siting of surface water and groundwater discharge locations. The location and construction of treatment facilities should not impact waterbodies if the facility is located greater than 100 feet from the waterbodies. The screening criteria for waterbodies is not considered to present "Developmental Constraints" on treatment facility sites regardless of the location outside the resource.

Surface water discharge sites are required to be located proximate to a surface waterbody. Therefore, this site selection criteria is accorded substantial weight in the surface water discharge site selection process when being considered. Those sites located proximate to surface waterbodies are considered to present an "Opportunity" for development. Those sites, which are not located proximate to a waterbody, are considered to present extensive "Developmental Constraints" regarding the surface water discharge site selection process.

Groundwater discharge sites should be located a sufficient distance from a surface water to ensure the facility does not affect the water quality of the surface water. The proposed subsurface disposal of effluent may result in the creation of a groundwater "mound" beneath the disposal field. The system should be sited such that the outer edges of the mound do not significantly influence the hydrology or water quality of the adjacent surface water body. Therefore, it was conservatively assumed that a groundwater discharge effluent bed should be at least 500 feet from a surface water body to provide an adequate margin of safety to ensure preservation of surface water quality. Potential groundwater discharge sites located at least 500 feet from a surface water body are considered to present an "Opportunity" for development. If within 500 feet, the site is considered to present "Moderate Constraints" for groundwater disposal.

**Drinking Water Supply - Wellhead Protection Areas (Zone I and II)**

The Town of Nantucket has an overlay district, the Public Wellhead Recharge District, designed to protect the Town's groundwater resource to ensure a safe and healthy public water supply (Nantucket Code Section 139-12B). Siting a wastewater treatment facility or an effluent disposal discharge in this overlay district is strictly prohibited. For this siting study, only sites with suitable area outside of the public wellhead protection district will be considered viable options.

Treatment facility sites, without an associated discharge on site, located in Zone II areas are not scrutinized the same as treatment facility sites with a groundwater discharge since the potential impacts to drinking water quality are minimal. Due to the importance of the Zone II resource areas, treatment facility sites located in Zone II areas are considered to present "Minor Developmental Constraints" while those located outside these areas are considered to present "No Constraints".

The proximity of surface water and groundwater discharge sites to public drinking water supplies is a significant criterion in the screening process due to the stringent regulatory restrictions which apply to siting these facilities within Zone I and II areas. This criterion is not given the same significance with respect to the siting of the treatment facilities since construction of a treatment facility does not necessarily include an effluent discharge. The screening criteria were developed to coincide with the requirements of the Nantucket Code (Zoning Overlay District), Massachusetts Drinking Water Regulations and the designation of Zone I (for wells with a yield of greater than 100,000 gpd, the Zone I is assumed to be 400 feet in radius) and Zone II (contributes to the well under severe pumping and recharge conditions).

Siting an effluent discharge is prohibited within a Zone I area. The location of a surface water or groundwater discharge within a Zone II area and greater than 1,000 feet from a public well is considered a "Moderate Constraint". In order to conservatively protect the Zone II areas, which are nitrogen sensitive, more stringent nitrogen discharge limitations have been established by DEP. Discussions with regulatory agencies regarding this matter suggest that an effluent discharge should not be considered unless all alternative options have been exhausted and a risk/benefit analysis has been performed. Current DEP policy allows for a wastewater discharge within Zone II's. Due to the higher levels of treatment and public concerns placed on siting wastewater discharge facilities within Zone II's, a "Severe Constraint" is identified for a discharge within 1,000 feet of a drinking water supply well within the Zone II. Location of a facility outside of the Zone II is viewed as having "No Constraint" for either a treatment facility or a discharge facility. Zone II areas were determined from the MASS GIS database and Town maps entitled "Public Wellhead District, Siasconset," prepared by Horsely, Witten and Heggemann, Inc. for the Siasconset Wellfield and "Public Wellhead Recharge District: Town" for the Wannacomet Wellfield.

**Fisheries (Including shellfish beds)**

The proximity of the potential facility site to fisheries resources, which includes shellfish beds, and adjacent waterbodies is a factor in siting surface water and groundwater discharge facilities. It was assumed that the location and construction of treatment facilities would not impact fisheries, if the facility is located greater than 100 feet from the waterbodies supporting the fisheries. The screening criteria for fisheries is considered to present "No Constraints" to development on treatment facility sites regardless of the location outside the resource.

Surface water discharge facilities pose the greatest threat to the fishery resources since the discharge of treated wastewater is directly into the waterbodies, which support the fisheries. Therefore, this criteria is considered to present a "Moderate Developmental Constraints" for a facility if it is located within 100 feet of a fish stocking area. If a site is located downstream or greater than 1,000 feet from a fish stocking area the site is considered to present "No Constraint" for the facility.

While groundwater discharges may impact fisheries, there is less risk of impact because the discharge is not directly into the surface water body, which contains the fisheries. Therefore, the criteria is only considered to present a "Minimal Constraint" for sites located within 400 feet of the fish stocking areas, and "No Constraint" for sites located greater than 1,000 feet from fish stocking areas. It was considered to be a "Moderate Constraint" if the facility site was located within 200 feet of the fisheries.

**Sensitive Habitats**

Sensitive habitats considered in the screening criteria include Estimated Habitats of Rare Wildlife, Certified Vernal Pools, Priority Sites of Rare Species Habitats and Exemplary Natural Communities, and Areas of Critical Environmental Concern. These habitats are sensitive to changes in the environment and are protected in both DEP Wetland Protection and Surface Water Quality Regulations. These regulations impose restrictions on development of any kind within the boundaries of these mapped habitats, and thus, for sites located within sensitive habitats, there is a "Severe Constraint" to development. Therefore, the "Constraints" to treatment facilities, surface water and groundwater disposal facilities is viewed to be equally restricted. The criteria identifies a "Severe Constraint" for those sites located within a sensitive habitat area, a "Minimal Constraint" if outside of, but abutting a sensitive habitat area, and "No Constraint" for those sites located a sufficient distance outside of a sensitive habitat area. Other sensitive habitats include park lands, recreational resources, and historical interests.

**Park Lands and Recreational Resources**

Land developed for recreational use or as park lands should be avoided in siting treatment facilities and disposal facilities (groundwater or surface water). If the existing land use of the potential site involves park or conservation lands or other recreational resources, construction of a treatment facility and/or disposal facility would represent an incompatible use conflict. Therefore, the presence of a park, conservation, or recreation land poses a "Severe Constraint" to

development of a treatment facility. If the potential treatment facility site is located on property directly abutting the resources, then a "Minimal Development Constraint" exists on the site. If located greater than 200 feet from theses resource areas, the criteria is considered to present "No "Constraints" to development.

Groundwater and surface water discharge facilities do not impact these resources to the same extent the buildings and above ground structures associated with a treatment facility would. Therefore, these wastewater disposal facilities are only considered to present "Moderate Developmental Constraints" for sites located within the resource areas, and "Minimal Constraints" if the sites are located outside the resource areas and "No Constraints" to development if located greater than 200 feet from these resource areas.

**Agricultural/Historical Interests**

The proximity of the potential facilities (wastewater treatment facility and/or wastewater disposal facility) to historic resources is a factor that will be considered in siting the facilities. The Massachusetts Historical Commission State Register of Historic Places 2001 was consulted to determine the existence of historic resources within Nantucket. In addition to the presence of historic resources, the Massachusetts Historical Commission (MHC) has commented that there are many areas throughout the Island that could contain archaeological resources. The Massachusetts Historical Commission has noted that Nantucket has one of the highest densities of known archaeological sites in the Commonwealth.

In screening the potential project sites, it is considered desirable to select sites that do not impact these resources. The Massachusetts Historical Commission (MHC) is the jurisdiction notified of details regarding proposed projects in designated historic areas as well as the Nantucket Historic District Commission (NHDC). The MHC will then determine whether State Register properties exist within a project's area of potential impact. If it is determined that the proposed project will have an adverse effect, the applicant will be required to present a comprehensive analysis of alternatives. By eliminating these sites, the project will preserve the resources and avoid potential administrative and regulatory burdens associated with development in these areas. Since the developmental regulatory "Constraints" associated with these resources apply with equal force to either treatment facilities or disposal facilities, independent of any specific characteristics associated with the facilities, this screening criterion is considered to present the same "Constraints" for each facility. The criterion presents a "Severe Constraint" for those sites

located within a historic resource area, a "Moderate Constraint" if directly abutting the site, a "Minor Constraint" if within 200 feet a historic resource area and "No Constraint" for those sites located greater than 200 feet outside of these resource areas.

**Shoreline Change Data**

The proximity of the potential or existing facilities to the Nantucket shoreline is a factor considered. The purpose of this parameter is to quantify the changes in shoreline position using the most accurate data sources and compilation procedures available and to characterize any areas of erosion and accretion. This criteria was utilized specifically for the current Surfside Facility.

An "Historical Shoreline Change Analysis for the Surfside, Nantucket Coastline", which is an evaluation of the existing and potential erosion at the Surfside disposal bed area was conducted in 1999 and again in 2002 in order to determine the useful disposal area available at this specific site. The Woods Hole Group performed both studies, which looked at shoreline changes from 1846 to 2002. Refer to Appendix C for the complete reports.

In screening the potential for this type of site, it was considered desirable to select sites that are not affected with shoreline changes due to historical erosion. The criteria presents a "Moderate to Severe Constraint" for those sites located within an area of erosion and "No Constraint" for those sites outside of any erosion areas.

**Nantucket and Madaket Harbor Watersheds**

The proximity of the potential or existing facilities to the Nantucket Harbor Watershed, as described in a technical report entitled, "Nantucket Water Resource Management Plan," 1990, by Horsley, Whitten & Hegemenn, Inc. and as delineated on a map entitled "Nantucket Harbor Watershed," Nantucket GIS, dated January, 1999 and the Madaket Harbor Watershed area, of which the Horsley, Whitten & Hegemenn, Inc. plan was the principal source and was adopted by reference at the 2003 Town Meeting, are both factors that have been considered.

This site development criteria presents a unique environmental/sensitive receptor for each site based on the siting of a wastewater treatment facility and/or treated wastewater disposal facility. The designation of an "Opportunity" within the screening criteria reflects the positive aspects of the existing land use that could be used in a beneficial manner in the siting of any facilities. Similarly, the designation of environmental/sensitive receptor "Constraints" within the screening

criteria reflect aspects of the site that would not be beneficial in the siting of these facilities. The siting of any facilities within these designated areas will be evaluated using the most stringent criteria and efforts will be made to avoid or minimize direct impacts to the screening criteria. Evaluations will be made depending on the nature and extent of any obstacles in the potential development of the site(s). In the context of the direct goals of this Project, the removal of problem and failing on-site wastewater disposal systems within any designated watershed area(s) to new wastewater treatment facilities, designed to treat and dispose of a highly treated wastewater effluent that is located within the boundaries of these designated areas, would be rated as an "Opportunity" as an environmental benefit would be achieved.

## B. SITE IDENTIFICATION

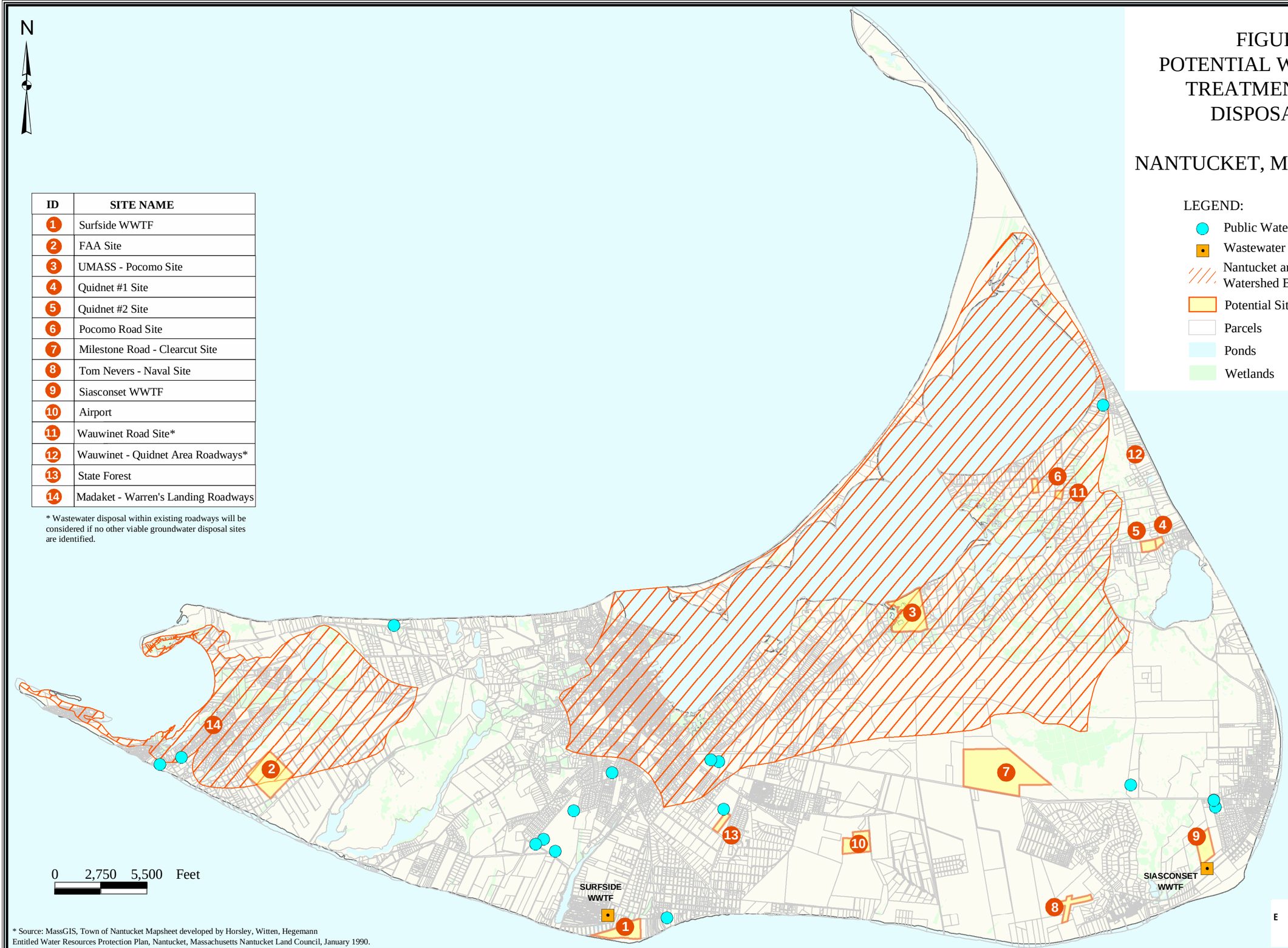
### 1. General

The following section provides a description of the 14 sites identified as potential locations for local or centralized treatment facilities and/or groundwater treated effluent disposal locations. Refer to Figure 3-1 for site locations. The identification of sites in this section includes both properties and sites within larger parcels. Existing conditions and site features for each site are presented in Table 3-2, with respect to the screening criteria. Information used in the description of the sites was obtained from MassGIS data layers, Nantucket Master Plan, Nantucket Assessor records and USGS topographic maps. The information used to characterize the environmental conditions of these sites is viewed as conservative and appropriate for planning and screening purposes. Most of the sites screened in this analysis have been visited in the field and information gathered during these inspections is reflected in the details of the site. The information was supplemented by a field reconnaissance of the potential site locations with the existing conditions as represented on Figure 3-2.

The discussion describes the sites in terms of their location, the primary land use associated with the sites, and the significant site features and conditions. The search for potential sites involved a variety of previously described environmental parameters and also parcel size. Size is important to the type of facility proposed such as: (1) Centralized Treatment – undeveloped land of generally five acres or larger; and (2) Satellite Treatment-undeveloped land of generally one to two acres located within identified Need Area neighborhoods. The existing conditions for all 14 potential project sites were characterized based on the screening criteria previously outlined.

# FIGURE 3-2
# POTENTIAL WASTEWATER TREATMENT AND/OR DISPOSAL SITES

## NANTUCKET, MASSACHUSETTS




| ID | SITE NAME |
|---|---|
| 1 | Surfside WWTF |
| 2 | FAA Site |
| 3 | UMASS - Pocomo Site |
| 4 | Quidnet #1 Site |
| 5 | Quidnet #2 Site |
| 6 | Pocomo Road Site |
| 7 | Milestone Road - Clearcut Site |
| 8 | Tom Nevers - Naval Site |
| 9 | Siasconset WWTF |
| 10 | Airport |
| 11 | Wauwinet Road Site* |
| 12 | Wauwinet - Quidnet Area Roadways* |
| 13 | State Forest |
| 14 | Madaket - Warren's Landing Roadways |

* Wastewater disposal within existing roadways will be considered if no other viable groundwater disposal sites are identified.

* Source: MassGIS, Town of Nantucket Mapsheet developed by Horsley, Witten, Hegemann
Entitled Water Resources Protection Plan, Nantucket, Massachusetts Nantucket Land Council, January 1990.

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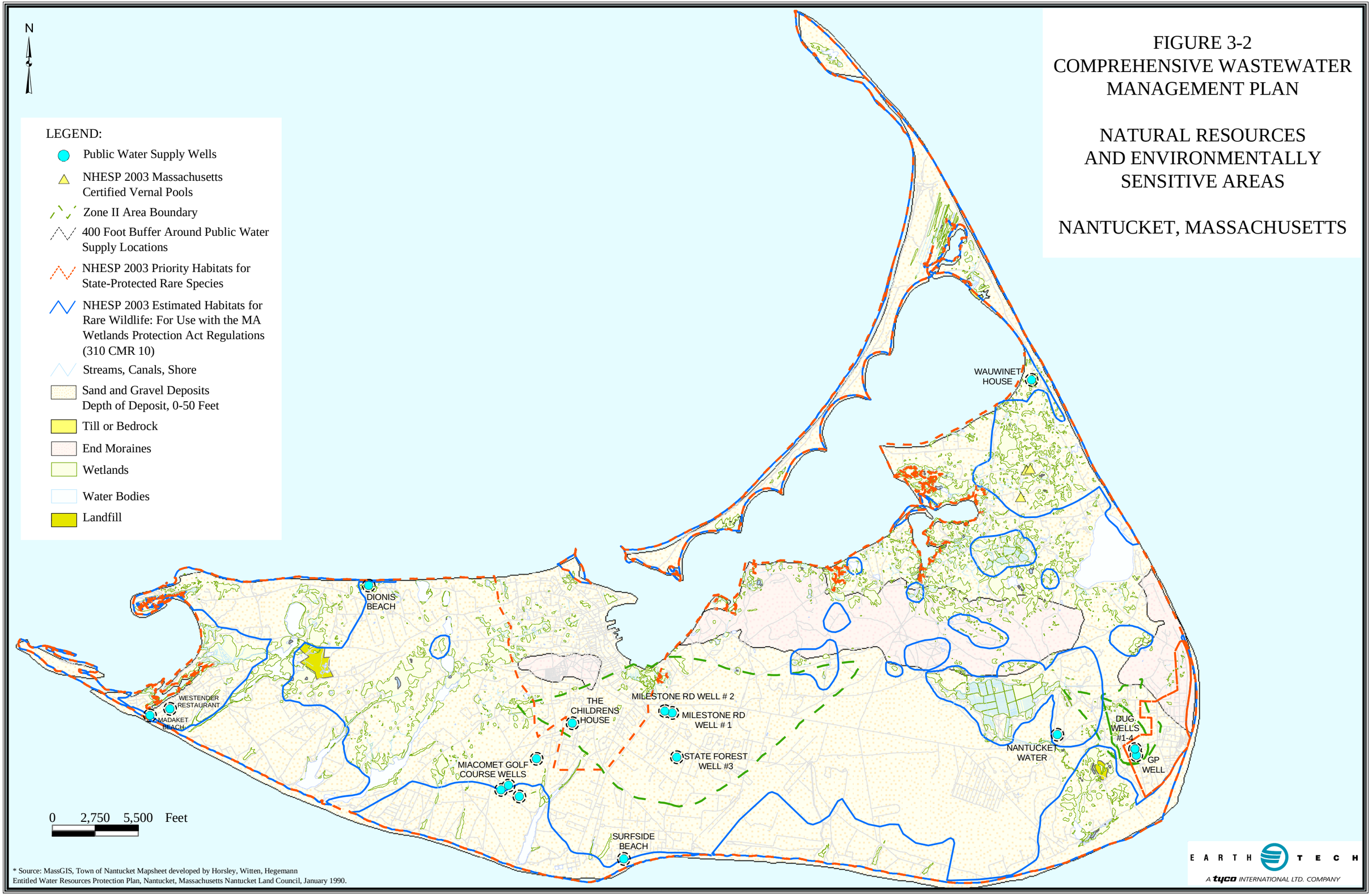
SEPTEMBER 2003

**TABLE 3-2**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**EXISTING CONDITIONS AND SITE FEATURES**

| Site Map/Parcel | Wetlands | Soils | Drinking Water Supply | Fisheries And Shell Fish Beds | Waterbodies | Floodplains | Sensitive Habitat | Park Lands | Recreation Resources | Agricultural/ Historic Interests | Shoreline Change Data | Nantucket and Madaket Harbor Watersheds |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. Surfside WWTF 87-87*** | No Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | Ocean Nearby | Outside of Flood Plain | No Sensitive Habitat Nearby | None Located Within or Proximate | None Located Within or Proximate | None Documented Step 1 Review | No Erosion Data Reported | Outside of Harbor Watershed Delineations |
| **2. FAA Site 63-9** | No Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | Ocean Nearby | Outside of Flood Plain | No Sensitive Habitat Nearby | None Located Within or Proximate | None Located Within or Proximate | None Documented Step 1 Review | No Erosion Data Reported | Portions Within Harbor Watershed Delineations |
| **3. UMass Site 26-1** | Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | Ocean Nearby | Portions Within Flood Plain | Sensitive Habitat Nearby | None Located Within or Proximate | None Located Within or Proximate | None Documented Cursory Review | No Erosion Data Reported | Within Nantucket Harbor Watershed Delineation |
| **4. Quidnet Area-1 21-36** | No Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | No Waterbodies Nearby | Outside of Flood Plain | No Sensitive Habitat Nearby | None Located Within or Proximate | None Located Within or Proximate | None Documented Cursory Review | No Erosion Data Reported | Outside of Harbor Watershed Delineations |
| **5. Quidnet Area-2 21-53** | No Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | No Waterbodies Nearby | Outside of Flood Plain | No Sensitive Habitat Nearby | None Located Within or Proximate | None Located Within or Proximate | None Documented Cursory Review | No Erosion Data Reported | Outside of Harbor Watershed Delineations |
| **6. Pocomo Area 14-72** | No Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | No Waterbodies Nearby | Outside of Flood Plain | Sensitive Habitat Nearby | None Located Within or Proximate | None Located Within or Proximate | None Documented Cursory Review | No Erosion Data Reported | Outside of Harbor Watershed Delineations |
| **7. Milestone Road 70-2** | No Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | No Waterbodies Nearby | Outside of Flood Plain | Within Sensitive Habitat | Within or Proximate | Conservation Land | Potential Within | No Erosion Data Reported | Outside of Harbor Watershed Delineations |
| **8. Tom Nevers Site 91-109** | No Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | Ocean Nearby | Outside of Flood Plain | No Sensitive Habitat Nearby | None Located Within or Proximate | Proximate to Park | None Documented Cursory Review | No Erosion Data Reported | Outside of Harbor Watershed Delineations |
| **9. Siasconset WWTF 74-52*** | No Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | Ocean Nearby | Outside of Flood Plain | No Sensitive Habitat Nearby | None Located Within or Proximate | None Located Within or Proximate | None Documented Cursory Review | No Erosion Data Reported | Outside of Harbor Watershed Delineations |
| **10. Airport Site** | No Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | No Waterbodies Nearby | Outside of Flood Plain | Sensitive Habitat Nearby | None Located Within or Proximate | None Located Within or Proximate | None Documented Cursory Review | No Erosion Data Reported | Outside of Harbor Watershed Delineations |
| **11. Wauwinet Road Area 14-29** | Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | No Waterbodies Nearby | Outside of Flood Plain | Within Sensitive Habitat | None Located Within or Proximate | None Located Within or Proximate | None Documented Cursory Review | No Erosion Data Reported | Outside of Harbor Watershed Delineations |
| **12. Wauwinet-Quidnet Roadways** | No Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | Wetlands and Ocean Nearby | Portions Within Flood Plain | Within Sensitive Habitat | None Located Within or Proximate | None Located Within or Proximate | None Documented Cursory Review | No Erosion Data Reported | Portions Within Harbor Watershed Delineations |
| **13. State Forest Sites** | No Wetlands Onsite | Sand and Gravel Deposits | Within Zone II | No Fish Stocking Nearby | No Waterbodies Nearby | Outside of Flood Plain | Within Sensitive Habitat | Within or Proximate | Within or Proximate | Potential Within | No Erosion Data Reported | Outside of Harbor Watershed Delineations |
| **14. Madaket-Warren's Landing Roadways** | No Wetlands Onsite | Sand and Gravel Deposits | Outside of Zone II | No Fish Stocking Nearby | Wetlands and Ocean Nearby | Portions Within Flood Plain | Within Sensitive Habitat | None Located Within or Proximate | None Located Within or Proximate | None Documented Cursory Review | No Erosion Data Reported | Portions Within Harbor Watershed Delineations |

*-Multiple Parcels
Notes: "Proximate to wetlands" is defined as within 400 feet, but greater than 100 feet
"Removed from wetlands" is defined as greater than 400 feet
"Proximate to stream/waterbody" is defined as within 200 feet

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SEPTEMBER 2003

**1. Surfside Wastewater Treatment Facility - Assessor Map 87 and Multiple Parcels**

This site is located on the southern tip of the Island directly east of Miacomet Pond and municipally owned. The site is the current location of the Town's main Wastewater Treatment Facility as well as nine open sand beds for discharge of the wastewater treated at this location. The Surfside Wastewater Treatment Facility currently treats flow from the center of Nantucket and has a design capacity of 2.24 MGD (the current DEP permitted flow is 1.8 MGD). The Surfside Wastewater Treatment Facility consists of a septage receiving tank, aerated grit chamber, three primary clarifiers that utilize ferric chloride and polymer for enhanced treatment, ten rapid infiltration basins, three aerated sludge holding tanks, one aerated septage equalization tank, and process support systems. Sludge and septage are dewatered with belt filter presses and can be mixed with wood chips in a portable mixer using aerated static pile method to produce a product that meets DEP Standards for a Type I sludge or composted with municipal solid waste.

The Town is currently working on a Preliminary Design Report for the upgrade and expansion of this Facility in order to handle additional flows based on the results of the Phase I CWMP/EIR. A hydrogeologic evaluation of the facility and discharge beds has been completed for this site and is included in Appendix E.

**2. FAA Site - Massasoit Bridge Road - Assessor Map 63 and Parcel 9**

This site is located east of Long Pond and west of Hummock Pond in the southwest corner of the Island, south of the Town department of Public Works and currently owned by the Federal Government. The site consists of a large open area, approximately 100 acres in size where the Federal Aviation Administration has maintained a tower with the land area covered in steel mesh to aid in the tower's reception. The site is large enough to accommodate buffers to the remote residential parcels in the area. The site immediately abuts land under the Nantucket Conservation Foundation. Evaluations at this site for soils and groundwater have been positive for the discharge of highly treated effluent and for the location of a package wastewater treatment facility.

A hydrogeologic evaluation of this site for the design and construction of a wastewater treatment facility and discharge beds for highly treated effluent has been completed and is included in Appendix F.

**3. UMASS Site - Assessor Map 26, Parcel 1**

This site is located on Polpis Road west of Polpis Harbor abutting Folgers Marsh. This site consists of approximately 100 acres and owned by the University of Massachusetts, Boston Campus. The school maintains the site and buildings located within the property. The property consists of large wetland areas on the westerly side, dry upland areas to the south and borders Polpis Harbor to the north.

**4. Quidnet - No. 1 Site - Assessor Map 21, Parcel 53**

This site is located within the village of Quidnet on Polpis Road northwest of Sesachacha Pond. This site consists of approximately five acres and is privately owned. The current land use for this parcel is identified in Town Assessor records as Accessory Land with Improvement. The property is fairly level and dry.

**5. Quidnet - No. 2 Site - Assessor Map 21, Parcel 36**

This site is located within the village of Quidnet on Polpis Road northwest of Sesachacha Pond. This site consists of approximately 13 acres and is privately owned. The current land use for this parcel is identified in Town Assessor records as Vacant Residential. The property is fairly level and dry.

**6. Pocomo Road Site - Assessor Map 14, Parcel 72**

This site is located off of the Wauwinet Road area on Pocomo Road just south of the Wauwinet Study Area. This site consists of approximately six acres and is privately owned. The current land use for this parcel is identified in Town Assessor records as Vacant Residential. The property is fairly level and dry.

**7. Milestone Road - "Clear-cut Site" - Assessor Map 70, Parcel 2**

This site is located directly on Milestone Road and is sometimes referred to as the "Clear-Cut" land. This site consists of approximately 223 acres and is owned and maintained by the Nantucket Conservation Foundation. The current land use for this parcel is identified in Town Assessor records as Tax Exempt. The property is level and dry.

**8. Tom Nevers - Naval Station Site - Assessor Map 91, Parcel 109**

This site is located in the village of Tom Nevers in the southeast shore of the Island just east of the village of Siasconset. This site consists of approximately 29 acres and is Town owned. The current land use for this parcel is identified in Town Assessor records as Municipal. The property is fairly level and dry.

**9. Siasconset WWTF Site - Assessor Map 74, Parcel 52**

This site is located within the village of Siasconset on property formerly under the jurisdiction of the United States Coast Guard. The new wastewater treatment facility is presently under construction at this site, with a design capacity of 0.22-mgd. There are 4 open sand beds located across the street on Low Beach road where the treated effluent is discharged.

**10. Airport Site - Assessor Map 78, Parcel 3**

This site is located on Town-owned property adjacent to the Nantucket Municipal Airport. The site consists of approximately 42 acres of undeveloped land and is fairly level and dry.

**11. Wauwinet Road Site - Assessor Map14, Parcel 29**

This site is located in the northeastern portion of the Island in the direction of the village of Pocomo. The site consists of approximately four acres and is privately owned. The current land use for this parcel as identified by Town Assessor records is Vacant Residential.

**12. Wauwinet - Quidnet Area Roadways**

This site includes the unpaved roadways in the villages of Wauwinet and Quidnet adjacent to the identified areas of need.

**13. State Forest Site - Assessor Map 68, Parcel 70**

This site is the Sate Forest parcel located near the center of the Island off of Old South Road. The site consists of approximately 39 acres of undeveloped land and is under the state's jurisdiction.

### 14. Madaket - Warren's Landing Area Roadways

This site includes the unpaved roadways in the villages of Madaket and Warrens Landing adjacent to the identified areas of need.

## C. PRELIMINARY SITE SCREENING

### 1. Environmentally Sensitive Areas

Environmentally sensitive areas such as wetlands, flood plains, depth to groundwater, wellhead recharge/Zone Is/Zone IIs, surface waters, sensitive habitats and existing land use on each of the above sites was assessed. Any wetland/flood plains on site will be delineated according to appropriate federal and state guidelines. The functional value of the wetland as well as the potential to avoid or minimize impacts on, wetlands was determined. Wellhead recharge/Zone I/Zone II areas were delineated. The proximity of each site to these areas and the impacts of siting wastewater facilities was assessed. The characteristics of the groundwater at each site has been described. The effect, if any, on the groundwater at each site has been described. The effect of the project on groundwater quality has been assessed. Based upon groundwater investigations at the site, the surface waters potentially receiving flow from land application on the site have been identified. Each surface water body has been described in terms of existing conditions, use, and water quality issues. Impacts on surface waters from the wastewater discharge have been assessed to determine the level of treatment necessary at each site. Any area potentially affected by the activity, including downstream surface waters receiving groundwater from the site(s), has been surveyed for the presence of sensitive natural resources and receptors. This was accomplished by: (1) review of resource maps; (2) discussion with state, local and federal agency personnel; (3) field reconnaissance; and (4) review of readily available information. With the utilization of windshield surveys, existing maps, and discussions with appropriate local planning officials, and the availability of the EOEA Build-Out Analysis, the current and future land use at each site has been assessed.

### 2. Archaeological and Historical Resources

A review of existing information and the potential for significant historic and archaeological resources has been evaluated. The Massachusetts Historical Atlas/Register was reviewed for pertinent information on each identified site. A copy of the Project Notification Form (PNF) filed with MHC, which includes the Step 1 archaeological survey for the two short-listed sites is included in Appendix G.

**3. MCP Phase I Site Assessment**

A review of the Massachusetts Bureau of Waste Site Cleanup has been performed in order to determine the location of any hazardous materials on any of the identified sites. A complete listing can be found in Appendix H and at http://www.state.ma.us/cgi-bin/dep/wscreport.cgi.

**4. Soil Suitability and Geologic Evaluation**

Soil permeability and geologic conditions have been assessed at each site using existing data and maps such as the USDA Soil Conservation Services surficial geology maps and soil survey reports. Local Board of Health records were also used where applicable. Additionally, field testing was performed at each site to determine the ability of the soil at to allow percolation of wastewater effluent into the soil at a rate to properly treat the effluent. Depth to groundwater and site specific soil conditions have been assessed through field testing.

**5. Sensitive Receptors**

Sensitive receptors, which include the location of developed residential areas, schools, hospitals, nursing homes and commercial/industrial parcels within 500 feet of each site has been delineated. The potential impacts of odors, noise, traffic and visual aesthetics of construction and operation of any wastewater facilities to be located on each identified site in relation to the identified sensitive receptors have been assessed.

**6. Hydrogeologic Evaluations**

**FAA Site**

The following is a summary of the hydrogeological results of the FAA Site. Refer to Appendix F for the complete hydrogeological report as well as all tables and figures cited in this summary. The high groundwater conditions described in Section 3 and listed in Table 3-2 were used for all of the model simulations to predict the groundwater mound under discharge conditions. The proposed discharge area is approximately 340,000 square feet as shown in Figure 2-1. The proposed discharge rate is 351,000 gallons per day. The simulated groundwater mound at this discharge rate is shown in Figure 4-1.

The maximum groundwater mound is approximately 1.8 feet. The highest water table elevation beneath the discharge area is predicted to be approximately 5.8 feet. The lowest ground elevation at the site is currently about 17 feet. The groundwater modeling indicates that the proposed discharge can be easily accommodated at the site and still maintain the required separation distance of four feet from the top of the mound.

The three-dimensional groundwater flow model was coupled with a particle tracking model called PATH3D (Zheng, 1991) in order to illustrate the potential movement of groundwater over time and to predict the ultimate discharge of effluent-impacted groundwater generated at the site. Four particles were seeded at each of the 130 nodes representing the discharge area. The particles were tracked forward for a period of 30 years. The results of the particle tracking analysis are shown in Figure 4-2. The model predicts that approximately 76 percent of the effluent-impacted groundwater will discharge to the ocean. The remainder will discharge to Long Pond.

**Surfside WWTF**

The following is a summary from the hydrogeological report on the Surfside WWTF Site. Refer to Appendix E for the complete hydrogeological report as well as all tables and figures cited in this summary.

The high groundwater condition described Section 2 and listed in Table 2-1 was used for all of the model simulations to predict the groundwater mound under discharge conditions. The initial model runs indicated that the existing bed configuration would not be able to accommodate significantly greater flows while still maintaining a four-foot separation between the top of the mound and the bottom of the beds. Since there is sufficient land area for the construction of additional beds at the site, it was decided to use those potential beds in the maximum discharge simulation.

**7. Historical Shoreline Analysis at Surfside Wastewater Treatment Facility**

The Woods Hole Group performed historical shoreline analyses in the vicinity of the Surfside Wastewater Treatment Facility in 1999 and again in 2002. The completed reports and maps can be accessed in Appendix C.

## D. IDENTIFICATION OF FEASIBLE SITES BASED ON SCREENING ANALYSIS

The screening criteria previously presented was applied to the 14 sites identified above. The preliminary screening of sites involved applying the 12 environmental criteria: (1) wetlands; (2) soils; (3) drinking water supply - wellhead protection areas (Zone I and Zone II); (4) fisheries (including shellfish areas); (5) waterbodies (distance from surface water); (6) floodplains; (7) sensitive habitats; (8) park lands; (9) recreational resources; (10) agricultural/historical interests; (11) shoreline change data; and (12) in or adjacent to an Area of Critical Environmental Concern. Each site was screened with respect to the potential for construction of a treatment facility and/or location of a groundwater discharge site.

As previously mentioned, the designation of an "Opportunity" within the screening criteria reflects the positive aspects of the environment that could be viewed as a benefit in siting these facilities. Similarly, the designation of environmental "Constraints" within the screening criteria reflects aspects of the site and environment that would pose limitations in siting the treatment and/or disposal facilities. The "Constraints" are identified as "Minimal", "Moderate", and "Severe" depending on the extent and nature of the obstacles to developing each site.

The feasible site or sites to accommodate the recommended wastewater facilities were identified upon the completion of the detailed screening described in the previous tasks. The results of this preliminary screening are presented in Table 3-3. This Table presents a rating of each site based on the application of the screening criteria. The sum of the opportunities and various "Constraints" are reflected in a rating of low, moderate or high potential for siting of a facility or disposal site. The rationale for the ratings is as follows:

- ○ High Potential = predominately "Opportunities" and "No Constraints"; may have a "Minimal" or "Moderate Constraint".
- ◒ Moderate Potential = characterized by more than 1 "Moderate" and 1 "Minimal Constraint".
- ● Low Potential = presence of a least one "Severe Constraint" plus a minimal, "Moderate" or additional "Severe Constraint".

**TABLE 3-3**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**RESULTS OF PRELIMINARY SCREENING**

| Site No. | Site Name | Wetlands | Soils | Drinking Water Supply | Fisheries | Waterbodies | Floodplains | Sensitive Habitat | Park Lands | Recreation Resources | Agricultural/ Historic Interests | Shoreline Change Data | Nantucket and Madaket Harbor Watersheds | Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **Surfside WWTF, 87-87*** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| **2** | **FAA Site, 63-9** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| **3** | **UMass Site, 26-1** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | Minimal | Minimal | Minimal | No Constraint | No Constraint | No Constraint | No Constraint | Minimal | ◒ |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | Minimal | Minimal | Minimal | No Constraint | No Constraint | No Constraint | No Constraint | Minimal | ◒ |
| **4** | **Quidnet Area, 21-36** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| **5** | **Quidnet Area, 21-53** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| **6** | **Pocomo Area, 14-72** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| **7** | **Milestone Road, 70-2** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | Minimal | Severe | Severe | No Constraint | No Constraint | ● |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | Minimal | Severe | Severe | No Constraint | No Constraint | ● |
| **8** | **TomNevers-US Navy,91-109** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| | Groundwater Discharges | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| **9** | **Siasconset WWTF, 74-52*** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |

○ High potential alternative

◒ Moderate potential alternative

● Low potential alternative

**TABLE 3-3 (cont)**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**RESULTS OF PRELIMINARY SCREENING**

| Site No. | Site Name | Wetlands | Soils | Drinking Water Supply | Fisheries | Waterbodies | Floodplains | Sensitive Habitat | Park Lands | Recreation Resources | Agricultural/ Historic Interests | Shoreline Change Data | Nantucket and Madaket Harbor Watersheds | Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | **Airport-78-1, 78-2, 78-3** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ○ |
| **11** | **Wauwinet Area, 14-29** | | | | | | | | | | | | | |
| | Treatment Facility | Minimal | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ◒ |
| | Groundwater Discharge | Minimal | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ◒ |
| **12** | **Wauwinet –Quidnet Roadways** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | Minimal | Minimal | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ◒ |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | Minimal | Minimal | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ◒ |
| **13** | **State Forest Sites-Multiple Parcels** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | Severe | Severe | Severe | Minimal | No Constraint | No Constraint | ● |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | Severe | Severe | Severe | Minimal | No Constraint | No Constraint | ● |
| **14** | **Madaket-Warren's Landing Roadways** | | | | | | | | | | | | | |
| | Treatment Facility | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | Minimal | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ◒ |
| | Groundwater Discharge | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | Minimal | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | No Constraint | ◒ |

○ High potential alternative

◒ Moderate potential alternative

● Low potential alternative

The rating for each potential site, presented in the preliminary screening table, only considers the environmental factors that can influence the siting of a wastewater treatment and/or disposal facility. Engineering design considerations, constructability and/or political decisions may also influence final site selection.

As stated previously, all 14 sites identified as potential wastewater treatment and/or groundwater discharge sites are situated on a parcel of land or contiguous parcels of land that have an area greater than that needed for siting of these type facilities. In most cases, this allowed for the potential treatment facilities and/or groundwater discharge site(s) to be sited with the maximum available buffer from any of the 11-screening criterion. This enabled more potential sites to rate either a "No Constraint" or "Opportunity" designation due mainly to the overall area of the parcel(s) and availability of usable land within the parcel(s), which minimizes or eliminates potential environmental and/or other constraints.

## E. SUMMARY

The Study Areas on Island rated as Need Areas, namely Wauwinet, Quidnet, Pocomo, Polpis, which are included in the study being completed by The Massachusetts Estuaries Project (MEP), will be evaluated further when the results of the Study are complete. At this point in time, we are recommending that these areas be managed under the Island's Septage Management Plan. The MEP is in the process of addressing the issue of nitrogen loading in the Nantucket Harbor and Sesachacha Pond areas on Island and will develop the maximum amount of nitrogen (nitrogen threshold) that each estuary can tolerate without adversely changing its character or present use. When this final data is released from the MEP, a thorough evaluation of the MEP data will be made and a final recommendation will follow for these Study Areas.

Based on the preliminary screening criteria for those Needs Areas outside of the above-referenced, two of the 14 proposed groundwater disposal sites and proposed wastewater treatment facility sites rated favorably and are recommended for use as wastewater treatment facilities as well as groundwater disposal of the treated effluent: (1) Surfside Wastewater Treatment Facility; and (2) FAA Site.

Detailed evaluations including field-testing, of these two short list of favorable sites have been completed and are included in Appendices E and F. The number of wastewater treatment and/or groundwater disposal sites considered for detailed evaluation have been predicated on the land area required by the recommended wastewater management plan to support the treatment and disposal of wastewater in Nantucket. The detailed evaluation considers technical feasibility, economic viability and the most efficient use of the identified sites for the recommended wastewater management plan. Table 3-4 summarizes the sites considered the most favorable for siting of a wastewater treatment facility and/or groundwater disposal facility Island-wide with those in the MEP Study Areas, identified in Table 3-4 with Italics, being delayed from further review.

**TABLE 3-4**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**WASTEWATER TREATMENT AND/OR DISPOSAL SITES**

| Site Number | Site Description | Groundwater Disposal | Wastewater Treatment Facility |
|---|---|---|---|
| 1 | Surfside WWTF - 87-87 (multiple parcels) | X | X |
| 2 | FAA Site - 63-9 | X | X |
| 3 | *Umass - 26-1* | *X* | *X* |
| 4 | *Quidnet Area - 21-36* | *X* | *X* |
| 5 | *Quidnet Area - 21-53* | *X* | *X* |
| 6 | Pocomo Area - *14-72* | *X* | *X* |
| 7 | Milestone Road - 70-2 | X | |
| 8 | Tom Nevers-US Navy - 91-6 | X | |
| 9 | Siasconset WWTF - 74-52 | X | X |
| 10 | Airport - 78-1 (multiple parcels) | X | |
| *11* | *Wauwinet Area - 14-29* | *X* | *X* |
| 12 | Wauwinet-Quidnet Roadways | X | |
| 13 | State Forest Site | X | |
| 14 | Madaket-Warrens Landing Roadways | X | |

# Section 4.0

## Evaluation of Short Listed Alternatives

# 4.0 EVALUATION OF SHORT LISTED ALTERNATIVES AND PLAN SELECTION

## A. ENVIRONMENTAL EVALUATION

### 1. Introduction

The three alternatives (Innovative/Alternative systems, connecting to the existing system, and communal systems) for the five Need Areas, whose evaluations were completed with this Report, were screened for direct and indirect impact. The direct and indirect impacts of the short listed alternatives were screened for building a new Madaket wastewater treatment facility at the FAA site, expanding the existing Surfside wastewater treatment facility, and providing sewer service to Madaket, Warren's Landing, Somerset, Shimmo, and Monomoy.

### 2. Evaluation

**General**

The alternatives were evaluated for the following direct impacts: (a) Historical, Archaeological, Cultural, Conservation and Recreation; (b) Wetlands, Flood Plains, and Agricultural Lands; (c) Zones of Contribution of Existing and Proposed Water Supply Sources; (d) Surface and Groundwater Resources Including Nantucket and Madaket Harbor Watersheds; (e) Displacements of Households, Businesses and Services; (f) Noise or Air Pollution or Odor and Public Health Issues Associated with Construction and Operation; (g) Violation of Federal, State or Local Environmental and Land Use Statutes.

In addition, the alternatives were evaluated for the following indirect impacts: (a) Changes in Development and Land Use Patterns; (b) Pollution Stemming from Changes in Land; (c) Damage to Sensitive Ecosystems; and (d) Socioeconomic Pressures for Expansion.

The following is a summary of each of the evaluation criteria.

**Direct Impacts**

**Historical, Archaeological, Cultural, Conservation and Recreation**

There are no known impacts to historical, archeological, cultural, conservation or recreational resources for any of the alternatives. A Step I Historical and Archeological Survey was conducted for the FAA site and the proposed

expansion area of the Surfside Wastewater Treatment Facility. The survey showed that there would be no impacts on those sites. Refer to Appendix G for a copy of the Project Notification Form filed with the Massachusetts Historical Commission on these two sites.

While there are no known impacts, connecting the Madaket Needs Area and the Warren's Landing Needs Area to the existing wastewater treatment facility would have the most potential for impact. Due to the considerable distance, if sewers were installed from these Needs Areas to the existing wastewater infrastructure, it would make the Island more vulnerable to impacts to historical and archeological impacts.

It is possible that there would be impacts associated with the installation of I/A systems in all of the areas of need, but the individual property owners would install the systems and would be required to review the impact on the installation of the systems on any Historical, Archaeological, Cultural, Conservation and Recreation resources.

A review of the Massachusetts Natural Heritage Atlas (11$^{th}$ Edition) indicates that the proposed FAA and Surfside expansion sites are within areas designated as Priority and Estimated Habitat for rare wildlife and plant species. Earth Tech requested data on rare, threatened, and endangered species in the project area from the Massachusetts Natural Heritage and Endangered Species Program (MNH&ESP). In January 2004, MNH&ESP responded with a list of plant and animal species know to occur in the vicinity of each site.

In August of 2003, botanists from Buckley Botanical Consultants completed a preliminary investigation of each site. At that time no rare plants were discovered. Once final site designs are chosen, the Town of Nantucket will work with MNH&ESP to develop a plan to complete an extensive survey of each site to determine the occurrence and likely impact to any rare, threatened, or endangered species.

**Wetlands, Flood Plains, and Agricultural Lands**

There is a potential for temporary impacts to wetlands from each of the alternatives. All three alternatives potentially impact the 100-foot wetland buffer zone. The impacts would be temporary and associated with the construction of sewer infrastructure. Any impacts would be mitigated by erosion control during construction. The Conservation Commission and the DEP will review all erosion control measures during the Notice of Intent process.

**Zones of Contribution of Existing and Proposed Water Supply Sources**

None of the treatment alternatives will impact the Zones of Contribution. The contribution zones for the water supply sources do not fall into the areas of any of the alternatives.

**Surface and Groundwater Resources Including Nantucket and Madaket Harbor Watersheds**

The I/A systems would have a negative impact in all of the proposed sewered areas. While the I/A systems provide a higher level of treatment than current on-site wastewater disposal systems, the I/A systems do not provide the same level of treatment as an advanced wastewater treatment facility. Since some of the areas have close proximities to the Nantucket and Madaket Harbor Watersheds it will be required that any wastewater treatment system achieve a high level of treatment. Communal systems in Somerset, Shimmo and Monomoy would have negative impact on water resources because of the constraints on available land and high volume of wetland areas. There are no available parcels of land in these areas that would provide for the required buffer zones around water resources.

**Displacements of Households, Businesses and Services**

Communal systems in the Somerset, Shimmo and Monomoy areas would have a severe constraint regarding displacement of households, businesses and services. There are currently no available land parcels in these areas that would meet the requirements for communal systems. If communal system were required in these areas, then parcels would have to be taken by Eminent Domain and would displace residential property owners.

**Noise Pollution, Air Pollution, Odor and Public Health Issues Associated with Construction and Operation**

There will be some temporary construction noise associated with all of the alternatives. Limiting the hours and the days of construction will mitigate the construction noise impacts. There may be additional noise impacts associated with expanding the Surfside Wastewater Treatment Facility due to the additional treatment processes. Additionally, the residential areas are so dense in Somerset, Shimmo and Monomoy that communal systems would cause impacts associated with noise pollution, air pollution, and odor issues. Any impacts associated with these alternatives will be mitigated in the final design.

**Violation of Federal, State or Local Environmental and Land Use Statutes or Regulations and Plans Imposed by Such Statutes and Regulations**

None of the alternatives would violate any of the Federal, State or Local Environment and/or Land Use Statutes or Regulations and plans imposed by any of the statutes and regulations.

**Indirect Impacts**

**Changes in Development and Land Use Patterns**

Connecting the proposed sewer infrastructure to the existing wastewater treatment facility would impact land use and development patterns in Madaket and Warren's Landing. These areas are not in close proximity to the existing facility. A connection would have to be across open space and several buildable parcels. An expansion of this magnitude would open up these areas and the areas along the way to significant development.

Building a communal system on the FAA site would have positive impact to the Madaket and Warren's Landing area. The parcel has the potential for high density development with the current zoning and land use. This kind of development would cause a long-term negative change in development and land use patterns.

Communal systems in Somerset, Shimmo and Madaket would have a negative impact to the areas in regards to land use patterns. Currently, there are no parcels available for development of a communal system in these area, the Town would have to change the land use of several parcels in order to accommodate a communal system.

**Pollution Stemming from Changes in Land Use**

Connecting the proposed sewer infrastructure to the existing wastewater treatment facility would impact land use and development patterns in Madaket and Warren's Landing. These changes in development and land use would cause noise pollution, impacts to historical and cultural resources, impacts to water resources, and impacts to Long Pond and Madaket Harbor Watershed.

Building a communal system on the FAA site would have positive impact to land use in the Madaket and Warren's Landing area. New, high density development on this site would have a negative environmental impact on Long Pond and Madaket Harbor Watershed.

Land Use patterns would have to be changed for communal systems in Somerset, Shimmo. Communal systems in dense residential areas could have negative impact on noise pollution, odor pollution and the water resources, such as wetlands.

**Damage to Sensitive Ecosystems**

I/A systems would negatively impact the sensitive ecosystems of all of the proposed sewer expansion areas. I/A systems do not treat wastewater to as high of a level of treatment as wastewater treatment facilities. The wastewater effluent from I/A systems has the potential to negatively impact wetlands, and harbor watershed areas.

Connecting Madaket and Warren's Landing to the existing wastewater treatment facility at Surfside would include construction along a significant distance. This construction would go through an increased amount of wetland buffer zone areas.

There are currently no available parcels in Somerset, Shimmo and Monomoy for communal systems. If a communal system was built on one of the available parcels, it would negatively impact sensitive ecosystems, such as wetlands and harbor watersheds because of the poor soils and shallow depth to groundwater.

**Socioeconomic Pressures for Expansion**

Socioeconomics would not be affected by I/A systems or communal systems because these systems would be designed to treat only the exiting systems. Connecting Madaket and Warren's Landing to the exiting facilities may affect Socioeconomics. The expansion could cause increased development and negatively impact the socioeconomics in regard to several factors associated with development, such as increased budget need for items such as school systems, maintenance of roadways, fire protection and other Town services. The Town and its consultant are working to develop a plan that will not promote nor deny growth. Low-pressure sewers and the establishment of "Sewer Districts" are both being considered at this time. The Town will have regulations in place before any recommendation is implemented in order to ensure the Island's future sustainability.

## 3. Recommendations Based on Environmental Evaluation Criteria

Table 4-1 summarizes the evaluation of the environmental criteria with regards to Innovative/Alternative Systems for the five Need Areas. The evaluation indicates that Innovative/Alternative Systems for all of the Study Areas have an equal number of impacts and therefore is not considered a high potential alternative. Innovative/Alternative System would not impact the existing Surfside WWTF nor require the construction of the Madaket WWTF and therefore is not applicable to this evaluation.

Table 4-2 summarizes the evaluation of the environmental criteria with regards to Connection to the Existing System for the five Need Areas and Surfside WWTF Expansion. The evaluation indicates that a Connection to the Existing System for Mononoy, Somerset, and Shimmo Study Areas has the least impacts and therefore is considered the highest potential alternative. Connection to the Existing System would not require the construction of the Madaket WWTF and therefore is not applicable to this evaluation.

# TABLE 4-1
# TOWN OF NANTUCKET
# CWMP/FEIR
# INNOVATIVE/ALTERNATIVE SYSTEM EVALUATION

| | Direct Impacts | | | | | | | Indirect Impacts | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Description | Historical, Archaeological, Cultural, Conservation and Recreation | Wetlands, Flood Plains, and Agricultural Lands | Zones of Contribution of Water Supply Sources | Surface and Groundwater Resources | Displacements of Households, Businesses and Services | Construction and Operation Pollution | Violation of Land Use Statutes | Changes In Land Use Patterns | Pollution Stemming from Changes in Land | Damage to Sensitive Ecosystems | Socioeconomic Pressures for Expansion |
| Madaket WWTF at FAA Site | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** |
| Surfside WWTF Expansion | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** |
| Madaket | ○ | ◒ | ○ | ◒ | ○ | ◒ | ○ | ○ | ○ | ◒ | ○ |
| Monomoy | ○ | ◒ | ○ | ◒ | ○ | ◒ | ○ | ○ | ○ | ◒ | ○ |
| Shimmo | ○ | ◒ | ○ | ◒ | ○ | ◒ | ○ | ○ | ○ | ◒ | ○ |
| Somerset | ○ | ◒ | ○ | ◒ | ○ | ◒ | ○ | ○ | ○ | ◒ | ○ |
| Warren's Landing | ○ | ◒ | ○ | ◒ | ○ | ◒ | ○ | ○ | ○ | ◒ | ○ |

○ High potential alternative, no impact

◒ Moderate potential alternative, minimal constraints

● Low potential alternative, severe constraints

# TABLE 4-2
# TOWN OF NANTUCKET
# CWMP/FEIR
# CONNECTION TO THE EXISTING SYSTEM EVALUATION

| | Direct Impacts | | | | | | | Indirect Impacts | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Description | Historical, Archaeological, Cultural, Conservation and Recreation | Wetlands, Flood Plains, and Agricultural Lands | Zones of Contribution of Water Supply Sources | Surface and Groundwater Resources | Displacements of Households, Businesses and Services | Construction and Operation Pollution | Violation of Land Use | Changes In Land Use Patterns | Pollution Stemming from Changes in Land | Damage to Sensitive Ecosystems | Socioeconomic Pressures for Expansion |
| Madaket WWTF at FAA Site | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** |
| Surfside WWTF Expansion | ○ | ○ | ○ | ○ | ○ | ◒ | ○ | ○ | ○ | ○ | ○ |
| Madaket | ◒ | ◒ | ○ | ○ | ○ | ○ | ○ | ◒ | ◒ | ◒ | ◒ |
| Monomoy | ○ | ◒ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Shimmo | ○ | ◒ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Somerset | ○ | ◒ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Warren's Landing | ◒ | ◒ | ○ | ○ | ○ | ○ | ○ | ◒ | ◒ | ◒ | ◒ |

○ High potential alternative, no impact

◒ Moderate potential alternative, minimal constraints

● Low potential alternative, severe constraints

Table 4-3 summarizes the evaluation of the environmental criteria with regards to the Communal System for the five Need Areas, Surfside WWTF Expansion, and Madaket WWTF Construction. The evaluation indicates that a Communal System for Madaket and Warren's Landing Study Areas has the least impact and therefore is considered the highest potential alternative.

The analysis of impacts indicates that the best alternative for wastewater disposal problems in the Madaket and Warren's Landing Study Areas is to construct a communal WWTF at the FAA site, and the best alternative for wastewater disposal problems in the Somerset, Shimmo and Monomoy Study Areas is to connect to the existing Surfside WWTF.

## B. EVALUATION OF COSTS

### 1. Project Costs

Cost estimates have been prepared for the various alternatives for the areas of wastewater disposal need. The presentation of costs is preliminary in nature and contains construction, construction contingencies, administrative, legal, design engineering, and construction engineering. Construction costs are based upon present day, competitively bid construction work prices and on an Engineering News Record (ENR) Construction Cost Index of 6741 for September 2003. We recommend that budget costs be updated periodically prior to each construction phase.

# TABLE 4-3
# TOWN OF NANTUCKET
# CWMP/FEIR
# COMMUNAL SYSTEM EVALUATION

| | Direct Impacts | | | | | | | Indirect Impacts | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Description | Historical, Archaeological, Cultural, Conservation and Recreation | Wetlands, Flood Plains, and Agricultural Lands | Zones of Contribution of Water Supply Sources | Surface and Groundwater Resources | Displacements of Households, Businesses and Services | Construction and Operation Pollution | Violation of Land Use | Changes In Land Use Patterns | Pollution Stemming from Changes in Land | Damage to Sensitive Ecosystems | Socioeconomic Pressures for Expansion |
| Madaket WWTF at FAA Site | ○ | ○ | ○ | ○ | ○ | ◒ | ○ | ○ | ○ | ○ | ○ |
| Surfside WWTF Expansion | ○ | ○ | ○ | ○ | ○ | ◒ | ○ | ○ | ○ | ○ | ○ |
| Madaket | ○ | ◒ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Monomoy | ○ | ◒ | ○ | ◒ | ● | ◒ | ○ | ◒ | ◒ | ◒ | ○ |
| Shimmo | ○ | ◒ | ○ | ◒ | ● | ◒ | ○ | ◒ | ◒ | ◒ | ○ |
| Somerset | ○ | ◒ | ○ | ◒ | ● | ◒ | ○ | ◒ | ◒ | ◒ | ○ |
| Warren's Landing | ○ | ◒ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

○ High potential alternative, no impact

◒ Moderate potential alternative, minimal constraints

● Low potential alternative, severe constraints

**Costing of Off-Site Wastewater Disposal Alternatives**

For the areas of wastewater disposal need where off-site wastewater disposal alternatives are being considered, the project costs for conventional gravity sewers with pumping stations versus low-pressure sewers were estimated. The estimated project costs are based on the following:

- Collector and Interceptor Sewers and appurtenances are estimated to be $275 per linear foot for pipes ranging in size from 8 inches to 12 inches;
- Pumping Stations are estimated to be $750,000 per pumping station;
- Force Mains and appurtenances are estimated to be $200 per linear foot for pipes ranging in size from 3 inches to 6 inches;
- Low Pressure Sewers and appurtenances are estimated to be $175 per linear foot for pipes ranging in size from 1-1/2 inches to 3 inches;
- Low Pressure Sewer Pumping System estimated at $12,500 each and includes the purchase and installation of the pumping unit, control panel, piping and abandonment of the existing on-site wastewater disposal system;
- Design Engineering is estimated to be ten (10) percent of Construction Cost;
- Construction Engineering is estimated to be ten (10) percent of Construction Cost;
- Administrative, Fiscal and Legal Costs are estimated to be five (5) percent of Construction Cost;
- Land Takings for pumping stations are estimated at $250,000 per acre and that ½ acre of land is required for each pumping station. The cost estimates assumes that no other Land Takings and/or Easement are required;
- Sub-Total of Project Cost includes all items listed above;
- Contingency is estimated to be twenty (20) percent of the Construction Cost; and
- Total Estimate Project Cost includes Sub-Total Project Cost plus Contingency.

**Costing of On-Site Innovative/Alternative Systems**

Since the treatment capabilities as well as the costs of the innovative/alternative (I/A) technologies are similar, one on-site I/A technology, FAST® System, was selected in order to evaluate the wastewater disposal alternatives for the areas of wastewater disposal need. The Single Home FAST® System can accommodate flows up to 440 gallons per day (gpd). The site conditions on each property play a major role in the costing of I/A systems. It has been assumed that each property has enough usable land to accommodate its existing septic tank, a FAST® system, pump chamber, necessary piping, distribution box, and a rectangular leaching area. The areas of wastewater disposal need where I/A systems are being considered have either 30 percent or more of the study area with severe soil limitations (hardpan, bedrock, slope, flooding and wetness) or 20 percent or more of the study area with severe groundwater limitations (seasonally high water table at the surface to 2 feet deep). These site conditions contribute to the construction cost of the

I/A system. For the areas of wastewater disposal need where on-site I/A systems are being considered, the construction costs of two different FAST® systems have been estimated. The effluent loading rates, leaching area requirements, and I/A system credits are based on the requirements/provisions of Title 5. These systems are described in the following paragraphs.

**Case 1: Single Home FAST® System**

**Design Flow of 440 gpd, Poor Soils, Suitable Depth to Groundwater**

This system includes the existing septic tank, a Single Home FAST® System, piping, distribution box and leaching trenches. It has been assumed that the poor soils within the study area have a percolation rate of 60 minutes per inch (mpi), which as per Title 5, require an effluent loading rate of 0.15 gpd/SF. It has been assumed that the effective leaching area of each trench includes the bottom of the trench (2 feet) and a maximum of 2 feet of each sidewall. Therefore each trench provides 6 SF of leaching area per linear foot of trench. Title 5 allows a credit of a 50 percent reduction in leaching area with the use of an I/A system. Based on these requirements, each system requires 245 linear feet of leaching trench. Therefore, this system includes a 72-foot by 36-foot leaching area consisting of four 62-foot long leaching trenches with a distance of 6 feet between trenches. The area between the trenches is the designated reserve area.

**Case 2: Single Home FAST® System**

**Design Flow of 440 gpd, Suitable Soils, Poor Depth to Groundwater**

These systems include the existing septic tank, a Single Home FAST® System, a pump and pump chamber, piping, distribution box and mounded leaching trenches. It has been assumed that the suitable soils within the study area have a percolation rate of 10 mpi, which as per Title 5, require an effluent loading rate of 0.60 gpd/SF. It has been assumed that the effective leaching area of each trench includes the bottom of the trench (2 feet) and a maximum of 2 feet of each sidewall. Therefore each trench provides 6 SF of leaching area per linear foot of trench. Since this system is located in an area with shallow depth to groundwater, the leaching area needs to be raised in order to meet Title 5 requirements. A pump chamber is required to pump the FAST® System

effluent to the elevated leaching trenches. Title 5 allows a credit of a 2-foot reduction in depth to groundwater with the use of an I/A system. This system requires a 2-foot mound to provide adequate separation between the bottom of the leaching area and groundwater. Based on these requirements, each system requires 123 linear feet of leaching trench. Therefore, this system includes a 41-foot by 36 foot leaching area consisting of four 31-foot long leaching trenches with a distance of 6 feet between trenches. The area between the trenches is the designated reserve area.

The estimated construction costs for the FAST® systems are estimated at $50,000 each. The estimated construction cost is based on the following:

- Single Home FAST® System requires a 2,000 gallon tank and/or pump chamber;
- Single Home FAST® System requires 4 days for installation;
- Filter fabric and washed stone are used within leaching trenches;
- Site will be loam and seeded after construction of I/A system;
- Contractor's payroll burden is approximately 50 percent of labor cost;
- Contractor's overhead and profit is approximately 15 percent of material, equipment and labor cost; and
- Construction contingency is approximately 20 percent of the total construction cost.

## 2. Operation and Maintenance Costs

### Operation and Maintenance Costs for Off-Site Wastewater Alternative

The annual operation and maintenance (O&M) costs for the design year has been estimated and is assumed to be approximately the same for each alternative. The costs include estimated manpower, electrical power, supplies, equipment and maintenance for the gravity sewers, pump stations, force mains, wastewater treatment facilities and groundwater disposal sites. In order to maximize the life of the system, particularly the pumping stations and wastewater treatment facilities, a comprehensive O&M program is recommended. This will require a full time operating staff that will perform daily, weekly and monthly tasks in order to achieve this goal. Therefore, the largest factor in the O&M costs for each of the alternatives is labor. It has been assumed that other Town resources will be used to aid in the operation of the system including billing, and sharing of equipment and manpower during emergencies. The O&M costs are based on the following:

- Operating Staff
  - Staff for WWTFs, pumping stations and wastewater infrastructure has been estimated to include: 1 superintendent, 1 administrative assistant, 1 clerical staff, 1 laboratory technician, 4 operators and 4 laborers
  - Staff for Septage Management Plan has been estimated to include: 1 superintendent, 1 administrative assistant
  - Staffing Cost estimated at an average of $27.50 per hour per person including benefits
- Power Cost estimated at $0.15 per kilowatt hour with each system/pump operating for 6 hours per day
- Yearly cost for supplies, spare parts, lubrication and calibration of measurement
  - Wastewater Treatment Facilities estimated at $52,500 per year
  - Pumping Stations estimated at $10,000 per station
- Compliance Monitoring and Testing
  - Wastewater Treatment Facilities Management Plan at $40,000 per year
  - Pumping Stations at $5,000 per station
  - Septage Management Plan at $1,000 per week.
- Maintenance Contract including yearly inspection, supplies, spare parts, and lubrication for Low Pressure System Pumping Unit estimated at $500 per unit
- O&M costs include items such as chemicals, telephone, postage, permit fees, legal, accounting, insurance, taxes and assessments, principal and interest on loans, and fuel
- Present Worth Cost based on 20 years at 7 percent interest (10.594).

**Operation and Maintenance Costs for On-Site Innovative/Alternative Systems**

Operation and maintenance of the FAST® System includes septic tank pumping, blower maintenance, periodic inspections, and electrical costs. Depending on the approval and permit issued by DEP, water quality testing may also be required. Septic tank pumping should be performed on a regular basis such as once every two to three years. The cost of this service is about $200 per pump-out. Yearly maintenance service contracts may be obtained through the manufacturer's representative of the FAST® System. The service contract includes the four service visits, which are required by DEP. The estimated costs of the service contracts for the Single Home FAST® System is estimated $500 per year. Water quality testing is required on a quarterly basis and is estimated at $250 per year. Annual electrical cost for a Single Home FAST® System is estimated at about $25 a month or approximately $300 per year. Therefore the total annual operation and maintenance cost for a Single Home FAST® System is estimated $1,150.

### 3. Wastewater Treatment Facilities Alternative Costs

An estimated construction cost was developed for two of the alternatives for the Surfside WWTF. Table 4-4 presents the estimated construction cost for the Surfside WWTF.

**TABLE 4-4**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SURFSIDE WWTF ALTERNATIVES**
**ESTIMATED CONSTRUCTION COSTS**

| Alternative Number | Description | Estimated Construction Cost |
|---|---|---|
| 1 | Modified Ludzack Ettinger | $24,000,000 |
| 2 | Sequencing Batch Reactors (SBRs); | $22,500,000 |

Cost comparisons for the Surfside facility were calculated for Modified Ludzack Ettinger (MLE) process and Sequencing Batch Reactors (SBRS). Costs for these two processes are very similar. The detailed cost comparison is calculated in the Surfside Preliminary Design Report. Trickling filters and Rotating Biological Contactors were not considered because they require chemical addition, which is not consistent with the Town's goals for minimal use of hazardous chemicals. In addition, both RBCs and Trickling Filters require a downstream process for nitrogen removal.

The cost comparisons for the treatment alternatives for Madaket were based on the Facilities Plan for the Siasconset Wastewater Treatment Facility. The comparisons for the Siasconset Facility detailed that SBRs were the most cost effective alternative. The Town decided to use the same treatment process in Madaket because operation and maintenance costs are cheaper for the Town if the same treatments processes are used.

## 4. Collection and Transmission Alternatives Costs

Various alternatives were evaluated for addressing the areas of wastewater disposal need in the Town of Nantucket. The three alternatives are: (a) Convention Gravity Sewer with Pumping Stations and Force Mains and connection to the existing system; (b) Low Pressure Sewers with connection to the existing system; and (c) Innovative/Alternative Systems with on-site disposal. An estimated project cost, estimated operation and maintenance cost, and present worth cost was developed for each of these alternatives for the five needs areas (Madaket, Monomoy, Somerset, Shimmo, and Warren's Landing) identified in Phase I. The present worth analysis for the collection and transmission alternatives is based on the cost to both the Town and the individual homeowner.

### Madaket Study Area

Alternative No. 1 consists of the installation of approximately 38,150 l.f. of gravity sewers, 16,320 l.f. of force mains and 6 pumping stations. All gravity sewers and force mains would be located in existing roadways while each of the pumping stations would required the purchase of land. The approximate 293,007 gpd of wastewater generated in the Madaket Study Area would be transported and treated at the proposed Madaket Wastewater Treatment Facility.

Alternative No. 2 consists of the installation of approximately 39,930 l.f. of low pressure sewers. All low-pressure sewers would be located within existing roadways. The approximate 293,007 gpd of wastewater generated in the Madaket Study Area would be transported and treated at the proposed Madaket Wastewater Treatment Facility.

Alternative No. 3 consists of the installation of approximately 549 innovative/alternative systems. The approximate 293,007 gpd of wastewater generated in the Madaket Study Area would be treated and disposed locally.

Table 4-5 presents the estimated project cost, operation and maintenance cost and present worth for each of the three alternatives for this study area.

**Monomoy Study Area**

Alternative No. 1 consists of the installation of approximately 19,830 l.f. of gravity sewers, 9,500 l.f. of force mains and 5 pumping stations. All gravity sewers and force mains would be located in existing roadways while each of the pumping stations would required the purchase of land. The approximate 120,551 gpd of wastewater generated in the Monomoy Study Area would be transported and treated at the proposed Monomoy Wastewater Treatment Facility.

Alternative No. 2 consists of the installation of approximately 19,270 l.f. of low pressure sewers. All low-pressure sewers would be located within existing roadways. The approximate 120,551 gpd of wastewater generated in the Monomoy Study Area would be transported and treated at the proposed Monomoy Wastewater Treatment Facility.

Alternative No. 3 consists of the installation of approximately 227 innovative/alternative systems. The approximate 120,551 gpd of wastewater generated in the Monomoy Study Area would be treated and disposed locally.

Table 4-6 presents the estimated project cost, operation and maintenance cost and present worth for each of the three alternatives for this study area.

**TABLE 4-5**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**MADAKET STUDY AREA ALTERNATIVES**
**ESTIMATED PROJECT COSTS, OPERATION AND MAINTENANCE COSTS AND PRESENT WORTH COSTS**

| Alternative Number | Description | Quantity | Unit | Unit Price | Extended Total | Estimated Project Cost | Estimated O&M Cost | Present Worth Cost |
|---|---|---|---|---|---|---|---|---|
| 1 | Gravity Sewers | | | | | | | |
| | Gravity Sewer | 38,150 | L.F | $275 | $10,491,250 | | | |
| | Pumping Station | 6 | Each | $750,000 | $4,500,000 | | | |
| | Force Main | 16,320 | L.F | $200 | $3,264,000 | | | |
| | Land Acquisition | 6 | Each | $125,000 | $750,000 | $19,005,250 | $189,200 | $21,009,635 |
| 2 | Low Pressure Sewer | | | | | | | |
| | Low Pressure Sewer | 39,930 | L.F | $175 | $6,987,750 | | | |
| | Grinder Pumps and Appurtenances | 549 | Each | $10,000 | $5,490,000 | $12,477,750 | $278,281 | $15,425,862 |
| 3 | Innovative/Alternative | 549 | Each | $50,000 | $27,450,000 | $27,450,000 | $631,350 | $34,138,522 |

**TABLE 4-6**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**MONOMOY STUDY AREA ALTERNATIVES**
**ESTIMATED PROJECT COSTS, OPERATION AND MAINTENANCE COSTS AND PRESENT WORTH COSTS**

| Alternative Number | Description | Quantity | Unit | Unit Price | Extended Total | Estimated Project Cost | Estimated O&M Cost | Present Worth Cost |
|---|---|---|---|---|---|---|---|---|
| 1 | Gravity Sewers | | | | | | | |
| | Gravity Sewer | 19,830 | L.F | $275 | $5,453,250 | | | |
| | Pumping Station | 5 | Each | $750,000 | $3,750,000 | | | |
| | Force Main | 9,500 | L.F | $200 | $1,900,000 | | | |
| | Land Acquisition | 5 | Each | $125,000 | $625,000 | $11,728,250 | $167,200 | $13,499,567 |
| 2 | Low Pressure Sewer | | | | | | | |
| | Low Pressure Sewer | 19,270 | L.F | $175 | $3,372,250 | | | |
| | Grinder Pumps and Appurtenances | 227 | Each | $10,000 | $2,270,000 | $5,642,250 | $115,325 | $6,864,001 |
| 3 | Innovative/Alternative | 227 | Each | $50,000 | $11,350,000 | $11,350,000 | $261,050 | $14,115,564 |

**Somerset Study Area**

Alternative No. 1 consists of the installation of approximately 19,970 l.f. of gravity sewers, 7,115 l.f. of force mains and 3 pumping stations. All gravity sewers and force mains would be located in existing roadways while each of the pumping stations would required the purchase of land. The approximate 108,794 gpd of wastewater generated in the Somerset Study Area would be transported and treated at the proposed Somerset Wastewater Treatment Facility.

Alternative No. 2 consists of the installation of approximately 19,970 l.f. of low pressure sewers. All low-pressure sewers would be located within existing roadways. The approximate 108,794 gpd of wastewater generated in the Somerset Study Area would be transported and treated at the proposed Somerset Wastewater Treatment Facility.

Alternative No. 3 consists of the installation of approximately 205 innovative/alternative systems. The approximate 108,794 gpd of wastewater generated in the Somerset Study Area would be treated and disposed locally.

Table 4-7 presents the estimated project cost, operation and maintenance cost and present worth for each of the three alternatives for this study area.

**TABLE 4-7**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SOMERSET STUDY AREA ALTERNATIVES**
**ESTIMATED PROJECT COSTS, OPERATION AND MAINTENANCE COSTS AND PRESENT WORTH COSTS**

| Alternative Number | Description | Quantity | Unit | Unit Price | Extended Total | Estimated Project Cost | Estimated O&M Cost | Present Worth Cost |
|---|---|---|---|---|---|---|---|---|
| 1 | Gravity Sewers | | | | | | | |
| | Gravity Sewer | 19,970 | L.F | $275 | $5,491,750 | | | |
| | Pumping Station | 3 | Each | $750,000 | $2,250,000 | | | |
| | Force Main | 7,115 | L.F | $200 | $1,423,000 | | | |
| | Land Acquisition | 3 | Each | $125,000 | $375,000 | $9,539,750 | $123,200 | $10,844,931 |
| 2 | Low Pressure Sewer | | | | | | | |
| | Low Pressure Sewer | 19,970 | L.F | $175 | $3,494,750 | | | |
| | Grinder Pumps and Appurtenances | 205 | Each | $10,000 | $2,050,000 | $5,544,750 | $104,391 | $6,650,669 |
| 3 | Innovative/Alternative | 205 | Each | $50,000 | $10,250,000 | $10,250,000 | $235,750 | $12,747,536 |

**Shimmo Study Area**

Alternative No. 1 consists of the installation of approximately 26,315 l.f. of gravity sewers, 5,000 l.f. of force mains and 5 pumping stations. All gravity sewers and force mains would be located in existing roadways while each of the pumping stations would required the purchase of land. The approximate 98,675 gpd of wastewater generated in the Shimmo Study Area would be transported and treated at the proposed Shimmo Wastewater Treatment Facility.

Alternative No. 2 consists of the installation of approximately 26,315 l.f. of low pressure sewers. All low-pressure sewers would be located within existing roadways. The approximate 98,675 gpd of wastewater generated in the Shimmo Study Area would be transported and treated at the proposed Shimmo Wastewater Treatment Facility.

Alternative No. 3 consists of the installation of approximately 185 innovative/alternative systems. The approximate 98,675 gpd of wastewater generated in the Shimmo Study Area would be treated and disposed locally.

Table 4-8 presents the estimated project cost, operation and maintenance cost and present worth for each of the three alternatives for this study area.

**TABLE 4-8**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SHIMMO STUDY AREA ALTERNATIVES**
**ESTIMATED PROJECT COSTS, OPERATION AND MAINTENANCE COSTS AND PRESENT WORTH COSTS**

| Alternative Number | Description | Quantity | Unit | Unit Price | Extended Total | Estimated Project Cost | Estimated O&M Cost | Present Worth Cost |
|---|---|---|---|---|---|---|---|---|
| 1 | Gravity Sewers | | | | | | | |
| | Gravity Sewer | 26,315 | L.F | $275 | $7,236,625 | | | |
| | Pumping Station | 5 | Each | $750,000 | $3,750,000 | | | |
| | Force Main | 5,000 | L.F | $200 | $1,000,000 | | | |
| | Land Acquisition | 5 | Each | $125,000 | $625,000 | $12,611,625 | $167,200 | $14,382,942 |
| 2 | Low Pressure Sewer | | | | | | | |
| | Low Pressure Sewer | 26,315 | L.F | $175 | $4,605,125 | | | |
| | Grinder Pumps and Appurtenances | 185 | Each | $10,000 | $1,850,000 | $6,455,125 | $94,992 | $7,461,470 |
| 3 | Innovative/Alternative | 185 | Each | $50,000 | $9,250,000 | $9,250,000 | $212,750 | $11,503,874 |

**Warren's Landing Study Area**

Alternative No. 1 consists of the installation of approximately 7,400 l.f. of gravity sewers, 3,925 l.f. of force mains and 2 pumping stations. All gravity sewers and force mains would be located in existing roadways while each of the pumping stations would required the purchase of land. The approximate 47,562 gpd of wastewater generated in the Warren's Landing Study Area would be transported and treated at the proposed Warren's Landing Wastewater Treatment Facility.

Alternative No. 2 consists of the installation of approximately 8,000 l.f. of low pressure sewers. All low-pressure sewers would be located within existing roadways. The approximate 47,562 gpd of wastewater generated in the Warren's Landing Study Area would be transported and treated at the proposed Warren's Landing Wastewater Treatment Facility.

Alternative No. 3 consists of the installation of approximately 89 innovative/alternative systems. The approximate 47,562 gpd of wastewater generated in the Warren's Landing Study Area would be treated and disposed locally.

Table 4-9 presents the estimated project cost, operation and maintenance cost and present worth for each of the three alternatives for this study area.

**TABLE 4-9**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**WARREN'S LANDING STUDY AREA ALTERNATIVES**
**ESTIMATED PROJECT COSTS, OPERATION AND MAINTENANCE COSTS AND PRESENT WORTH COSTS**

| Alternative Number | Description | Quantity | Unit | Unit Price | Extended Total | Estimated Project Cost | Estimated O&M Cost | Present Worth Cost |
|---|---|---|---|---|---|---|---|---|
| 1 | Gravity Sewers | | | | | | | |
| | Gravity Sewer | 7,400 | L.F | $275 | $2,035,000 | | | |
| | Pumping Station | 2 | Each | $750,000 | $1,500,000 | | | |
| | Force Main | 3,925 | L.F | $200 | $785,000 | | | |
| | Land Acquisition | 2 | Each | $125,000 | $250,000 | $4,570,000 | $101,200 | $5,642,113 |
| 2 | Low Pressure Sewer | | | | | | | |
| | Low Pressure Sewer | 8,000 | L.F | $175 | $1,400,000 | | | |
| | Grinder Pumps and Appurtenances | 89 | Each | $10,000 | $890,000 | $2,290,000 | $45,258 | $2,769,459 |
| 3 | Innovative/Alternative | 89 | Each | $50,000 | $4,450,000 | $4,450,000 | $102,350 | $5,534,296 |

### 5. Recommendations Based on Evaluation of Cost

The evaluation of costs indicates that the best alternative for wastewater disposal problems for each of the Study Areas is the installation of a Low Pressure Sewer System and to use Sequencing Batch Reactors for the Expansion of the Surfside WWTF Expansion and new Madaket WWTF.

## C. INSTITUTIONAL ARRANGEMENTS

### 1. General

The Town of Nantucket Department of Public Works is presently governed by its Board of Selectmen. The Town presently owns and operates two municipal sewer systems, one that currently collects, treats and disposes of wastewater at the Surfside Wastewater Treatment Facility and another smaller collection system located in Siasconset. At present, the Siasconset WWTF is undergoing a major upgrade with the design and construction of a state of the art wastewater treatment facility to provide Class I discharge standards as required by Federal and State law. The Town has completed a Preliminary Design Report to upgrade and expand its Surfside Wastewater Treatment Facility to Class I discharge standards as required by Federal and State law. All areas presently not connected to either of these two systems rely on individual on-site wastewater disposal systems, which are under the jurisdiction of the local Board of Health under state Title 5 rules and regulations at "310 CMR 15.000 - The State Environmental Code, Title 5: Standard Requirements for the Siting, Construction, Inspection, Upgrade and Expansion of On-Site Sewage Treatment and Disposal Systems and for the Transport and Disposal of Septage, Effective 3/31/95." Historically the Town of Nantucket Board of Health has adopted requirements for design and construction of on-site systems that augmented the state requirements.

In early 1997, the Town of Nantucket retained Earth Tech, Inc. to prepare a Facilities Plan for Wastewater Disposal and Treatment for the Village of Siasconset. The report entitled "Siasconset Facilities Plan for Wastewater Treatment and Disposal," Nantucket Massachusetts, dated December 31, 1997, (Siasconset Facilities Plan) detailed a solution for the Siasconset Wastewater Infiltration Beds and the lack of wastewater treatment achieved by the infiltration beds. The facilities plan report met the requirements of the Administrative Consent Order between the Town of Nantucket and the Department of Environmental Protection.

In early 1998, the Town of Nantucket retained Earth Tech, Inc. to prepare an Island-wide Comprehensive Wastewater Management Plan/Environmental Impact Report (CWMP/EIR). In general, the objective of a CWMP/EIR is to identify areas within the Town with subsurface wastewater disposal problems and to develop a plan to mitigate or eliminate the problems. The wastewater treatment solutions presented in the Siasconset Facilities Plan are considered in this CWMP/EIR.

The Town of Nantucket established a special procedure for review of this major and complicated project. The special procedure consists of a three phase review of the CWMP/EIR Document. The Document has been delineated into three phases, where the scope of future phases is based in part on the results of the preceding phase. The first phase, Phase I, included the Needs Analysis. The Phase II Report contained the Alternatives and Site Identification and Draft Environmental Impact Report (DEIR) and in this Phase III includes the Final Environmental Impact Report (FEIR). The scope of the Island-wide CWMP/EIR is twofold: (1) to determine the areas on the Island with wastewater disposal problems that cannot be solved with a conventional Title 5 wastewater disposal system; and (2) evaluate and make recommendations on the most viable solution for wastewater disposal in each study area based on environmental, technical, and economic considerations. With the filing of this Phase III Report, all of these scope items have been determined and a recommended plan has been established.

The currently recommended plan for new and expanded wastewater collection, transmission and treatment facilities have been evaluated, and are proposed to be designed and constructed under the guidance and direction of the Town of Nantucket Department of Public Works and Board of Selectmen.

In order to manage and operate the proposed wastewater collection, transmission and treatment facilities, the Town will need to implement institutional and system management procedures, which are briefly described in the following paragraphs.

## 2. Institutional and System Management Procedures

### Establishment of Sewer and Septic Overlay Districts

In order to legally identify the boundaries of and set policy relating to, sewer and septic overlays need to be delineated. This will allow the Town to distinguish which properties have the right to hook into the municipal sewers system and, also, those that will be managed under the Town's Septage Management Program. This will involve acceptance at the Town's level. The primary purposes of the establishment of "Sewer Districts" are to preserve the existing wastewater infrastructure capacity for the residents/businesses located adjacent to the existing collection system and for residents/businesses located within the areas of wastewater disposal need as identified in the CWMP/EIR Document.

### Review of the Current Sewer Use Rules and Regulations

A thorough review of the current Sewer Use Rules and Regulations needs to be completed in order to set the minimum requirements for all users of the Town's wastewater collection, transmission and treatment facilities. This will enable the Town to continue to comply with all applicable state and federal laws as well as the requirements of the receiving treatment facilities. Included in these regulations will be the provisions for sewer connections and extensions, building sewers, infiltration/inflow, construction requirements, regulation of wastewater discharges, pretreatment of industrial wastewater, permit applications and issuance, reporting requirements, compliance monitoring, enforcement proceedings, service charges and fees. The main purpose of these regulations is to prevent the introduction of undesirable pollutants and to provide standard requirements for all users discharging into the sewer system. These regulations must be in accordance with those of the receiving treatment facilities accepting Nantucket's wastewater. The rules and regulations will be administered by the Director of Public Works.

### Cost Recovery Plan

Cost Recovery Program will need to be developed in order to recover the capital costs of new and expanded wastewater collection, transmission and treatment facilities. Nantucket will need to address the problem of how to equitably apportion the capital costs among its system's users. The cost recovery for the planning, design, construction and implementation of Nantucket's wastewater facilities and the cost(s) of capital outlay could potentially be by a combination of property taxes and betterments. An equitable

means of recovering these costs could be: to recover the cost of any portion of the project that provides a general benefit to the entire community through municipal property taxes; and to recover the cost of public improvements which are of specific benefit to a particular area in the community by betterments. Nantucket must arrive at a financing solution that is fair, equitable and politically acceptable. A cost recovery plan will be formulated, reviewed, and adopted by the Town prior to the start of construction of the Project.

**Review of Current Sewer User Charge System**

A review of the current sewer user charge system will need to be completed and, reviewed and any changes adopted by the Town which meets the requirements of the state regulations in order to recover the costs required to operate, maintain and replace the wastewater collection, transmission and treatment facilities. In the Fall of 2003, the Town of Nantucket completed a Sewer Rate Study. A copy of the study can be found in Appendix I.

**Sewer System Expansion Control Policy**

A Sewer System Expansion Control Policy will need to be developed and adopted by the Board of Selectmen that deals with issues concerning the expansion of the sewer collection system outside of the finalized "Needs Areas" approved in the CWMP/EIR. The expansion of the sewer service areas within Town will need to be controlled in order for the Town to stay within its allotted flow allowances at the receiving wastewater treatment facilities. This policy should address issues such as:

- The number of service connections allotted to large parcels of undeveloped land that have frontage on a sewer line in a designated area;
- Connections to force mains;
- Sewer service to back lots which do not have frontage on a street that has sewers;
- The possibility of establishments not in a designated sewer service area connecting into a gravity main that services a designated sewer area;
- Sewer system extension outside the "Needs Areas" as identified and approved in the CWMP/EIR;
- Title 5 failures outside of the designated sewer areas;
- Policy to service the first floor of a structure by gravity and exceptions to this rule;
- Connections to interceptors outside of the designated service area; and
- Establishment of "Low Flow Sewer Systems".

This policy should address the above issues and, when implemented, will prioritize the concerns for the Town to include in any future expansion plans for the sewer system if there is adequate capacities remaining within their wastewater flow allowances at the receiving wastewater treatment facilities.

**Review of Sewerage System Staffing and Operations Plan**

A review of the current and projected Sewerage System Staffing and Operations Plan will need to be completed. It is recommended that this plan be developed during the design phases of the proposed Surfside WWTF upgrade and Madaket WWTF. This plan will review and estimate the current and proposed tasks, responsibilities and staffing requirements for each aspect of the operation and maintenance of the current and proposed wastewater collection, transmission and treatment facilities. The relative merits to Town staff versus contract operations should be evaluated.

**Review of Current System Construction Standards**

In order to maintain consistency Island-wide, there should be a review and discussion on construction standards for the Town. Included in this review would be facility design (for spare part redundancy and general O & M) and manhole design.

**Septage Management Plan**

Proactive in its approach to the CWMP/EIR, the Town of Nantucket began the process of developing a Septage Management Plan for the areas of Town not included in the current and proposed municipal sewer service area. The goal of this Septage Management Plan (SMP) is to protect and maintain public health, ensure protection of surface and groundwater quality, provide sustainability of the Island's single-source aquifer, maintain water resources as recreational, aesthetic and economic assets, improve the environment and prevent its deterioration, preserve and retain local control of on-site wastewater disposal systems without regulatory intervention and to protect private investments with regards to residential property values that is not only accepted locally but in accordance with all regulatory requirements. The successful long-term sustainability of on-site wastewater disposal systems is dependent on proper operation and maintenance in order to prevent adverse health and environmental impacts. It is the intent of this SMP to operate in conjunction with the Town's municipal wastewater collection systems in the proper collection and disposal of septage on Nantucket.

The Town has reviewed the form of government to regulate and oversee the Septage Management Plan and has elected to have the current Board of Health administer the institutional requirements set forth in the final approved SMP that is now being evaluated.

**Water Conservation Program**

It is recommended that an overall water conservation program be implemented in order to reduce the amount of water consumed and discharged into both the existing on-site wastewater disposal systems and the proposed wastewater collection, transmission and treatment facilities. The Town will be limited as to how much wastewater it can send to the receiving wastewater treatment facilities. Not only will the implementation of water conservation devices and programs result in lower operational costs to each user, but it will also result in reserve capacity at the receiving treatment facilities should future areas of Need arise in Town. This is presently being undertaken by the Wannacomet Water Company. It is recommended that the Department of Public Works, in conjunction with the Water Company work to promote a public education program in order to achieve maximum benefit.

## D. RESIDUALS DISPOSAL

The Town leases the property for the Municipal Compost facility. A private contractor operates the facility. According to the facility operator, the composting facility can handle the proposed additional residuals disposal. The recommended plan is to continue this operation. No other alternatives were reviewed because this alternative is already established and permitted.

## E. LOCATION OF FACILITIES

### 1. Madaket WWTF – FAA Site

The Madaket WWTF is proposed to be located on the current FAA site. The WWTF will be at least 1,000 feet away from residential areas and located outside of any environmentally sensitive areas. This will minimize any potential aesthetic issues with the facility.

The hydrogeological study for the FAA site will serve to help situate the disposal beds on this site in the area of least consequence. In addition, the wastewater effluent is proposed be treated to a much higher degree than the current Title 5 systems in this area. This will help minimize any impacts to Long Pond or Madaket Harbor. The hydrogeological report for this site is included in Appendix F.

The WWTF will be designed to meet the guidelines of the Nantucket Historic District Commission (NHDC) as detailed in, "Building with Nantucket in Mind." The guidelines detail strict design requirements, such as building color, building outline, and the use of native species in landscaping. The final design will be reviewed by the NHDC during their building permit process.

**2. Surfside WWTF Upgrade and Expansion**

The proposed Surfside WWTF project will be an upgrade from primary to secondary treatment as required in ACO NO. ACOP-BO-03-1G002 and an expansion of the existing facility. Since the site has been previously disturbed and is currently used and permitted for wastewater treatment, the project will have minimal effect on the area. The hydrogeological report is included in Appendix E and the ACO is included in Appendix A.

The design will be similar to the existing facility and will be designed to meet the guidelines of the Nantucket Historic District Commission (NHDC) as detailed in, "Building with Nantucket in Mind." The guidelines detail strict design requirements, such as building color, building outline, and the use of native species in landscaping. The final design will be reviewed by NHDC during their building permit process.

**3. Needs Areas**

Madaket, Monomoy, Somerset, Shimmo, and Warren's Landing Study Areas are recommended to receive sewer expansion. The sewer lines will be constructed in existing roadways. This will minimize aesthetic problems. No new pumping stations in these areas are proposed.

This new infrastructure will be located outside of environmentally sensitive areas, since it is proposed to be located primarily in previously disturbed locations. Removing theses areas from failing Title 5 systems and connecting them to a municipal sewer system will serve to remove many pollutants from the Nantucket and Madaket Harbors and other local water bodies.

## G. PHASED CONSTRUCTION

A phased construction will be used for the construction of the selected alternative. A phased construction will allow the Town to spread out the cost of design, construction, and implementation of the selected alternative through several fiscal years. In addition, the selected capital improvement will be reviewed with the Town departments and committees, such as the Department of Public Works, Board of Selectmen and Finance Committee to determine the financial impacts of the recommended plans along with any other improvement projects such as roadway improvements and school. The Town is also in the process of determining the financing methods necessary to implement the recommendations detailed herein.

At this time, the Town has determined that the highest priority is to continue investigation of infiltration/inflow within the existing collection system, begin rehabilitation of the existing infrastructure located within the Brant Point Area, and to begin the design phase for the upgrade and expand the existing Surfside WWTF from primary to secondary treatment as required in ACO. The Town has included warrant articles for these three projects for action at the Spring 2004 Town Meeting. Over the next few months, the Town will be developing the remaining financial options best suited for the Town to implement the remaining recommendations contained in this Document.

In addition, since the CWMP/EIR is a long-term planning document, the Town has the opportunity to incorporate any additional information that is developed by Federal, State and/or Local authorities and/or private entities prior to the implementation of the recommendations and adjust the phased construction, if appropriate

## H. FLEXIBILITY AND RELIABILITY

The wastewater treatment alternatives will be design to be flexible and reliable so that any unforeseen circumstances can be dealt with in a timely manner. All infrastructure and wastewater treatment will be designed in accordance with the New England Interstate Water Pollution Control Commission's "Guide for the Design of Wastewater Treatment Works." The guide details how to number and arrange units so that the componet parts of plants are arranged for the greatest operating convenience, flexibility, and economy and for the installation of future units. The design and layout of the treatment facilities will include provisions for future expansion or future upgrades.

The facilities will be designed and constructed with the following project goals in mind that have been identified by the Town: (1) Use the Existing Surfside WWTF Site; (2) Use the Existing FAA property; (3) Low Maintenance; (4) Operate without the Use or with a Limited Use of Chemicals; (5) Capture and Treat Odors; (6) Meet High Discharge Limits; and (6) Ensure Community Acceptance.

In addition, the facilities will be similarly designed so that the operation and maintenance of the facilities on the Island will be standardized. All three of the wastewater treatment facilities on the Island will utilize SBRs and be standardized on other unit processes, such as pumping equipment. The standardized design will maximize efficiency and the ability to minimize the impacts from unforeseen equipment problems.

## I. IMPLEMENTATION CAPABILITY

Each of the recommended alternatives will be reviewed by the applicable federal, state and local governmental units for ability to implement via appropriate permitting agencies. As part of the MEPA process, Nantucket is required to provide the Secretary of Environmental Affairs and the public with a 30-day public review period, during which comments are solicited by the Secretary, reviewed and applied appropriately in the MEPA Certificate. In addition to the MEPA process, all of the plans and specifications for this project will be reviewed by the Department of Environmental Protection and will be subject to all required permitting regulations.

The Town of Nantucket is prepared to bear its local share of the cost of the selected alternatives through local appropriations, Town Meeting action, and through the user tax base. Currently the Town has one WWTF in operation and one WWTF under construction both of which fall under the Department of Public Works jurisdiction. Other recommended institutional arrangements are discussed in this Document and the Town has indicated will be in place before any plan is implemented.

## J. REGULATORY, DESIGN AND RELIABILITY REQUIREMENTS

As part of the MEPA process, Nantucket is required to file an EIR. The Secretary issued a Certificate containing a scope that provides a description of alternatives to be considered in the EIR, environmental impacts to be analyzed, and techniques to be used in the analysis. EIRs are subject to 30 days of agency and public comment after publication in the Environmental Monitor. This project is also subject to the rules and regulations of the State Revolving Fund (SRF). Plans and Specifications will be reviewed and approved by the Department of Environmental Protection and the project will be evaluated and subject to all required permitting regulations.

All of the recommended plans in this Document have been formally approved on the federal, state and local level. This plan will not implement any new technologies that have not already been approved by MEPA and the SRF program. The Town of Nantucket has worked closely with the DEP and MEPA in this process.

# Section 5.0

## Recommended Plan

# 5.0 RECOMMENDED PLAN

## A. DETAILED RECOMMENDED PLAN

### 1. Introduction

In previous sections of this Report, each Study Area determined by the Phase I Report to be a "Needs Area" or an area unsustainable with current on-site wastewater disposal systems, was looked at in terms of possible solutions for wastewater need. This section of the Report highlights the recommended plan for each Study Area as well as associated institutional impacts, environmental impacts, capital costs, and operation and maintenance costs.

### 2. Study Areas

In Phase I of the CWMP, the Island was delineated into eighteen (18) Study Areas based on geographic location. All of these areas were analyzed for the need for wastewater disposal beyond the use of Conventional Title 5 on-site wastewater disposal systems. Once an area was determined to be a Needs Area, several alternatives were analyzed in order to determine a solution for each area's needs. The four options analyzed for each area were: (1) Conventional Gravity Sewers with Pump Stations and Forcemains; (2) Low Pressure Sewers; (3) I/A systems; and (4) On-Site Wastewater Disposal Systems with the implementation of a Septage Management Plan (SMP).

Each Needs Area was first evaluated for the possibility of connecting to an existing collection system to be treated at either the Siasconset Wastewater Treatment Facility or the Surfside Wastewater Treatment Facility. This was not a feasible option for Madaket, Warren's Landing, Polpis, Pocomo, Wauwinet, and Quidnet due to their distance from either Wastewater Treatment Facility (WWTF). The costs incurred with attempting to tie these areas into existing facilities due to the length of pipe needed to connect these areas as well as operation and maintenance costs would be prohibitive.

The next alternative evaluated was the construction of a local treatment facility or communal/cluster treatment for each Need Area Land availability or lack thereof, and the abundance of wetlands, harbor watersheds proximity, and other water bodies posed as major obstacles on the Island and therefore became difficult scenarios for numerous Needs Areas. Constructing a local treatment facility, combined with ground water

discharge of treated effluent necessitates acres of land, which combined with the above mentioned water and wetland issues, eliminated this option in many areas on Island. With the development of a SMP to be implemented by the Town, on-site Conventional Title 5 wastewater disposal systems became a sensible solution for those areas on Island that lack sufficient and suitable land area and where other alternatives became cost-prohibitive. The following is a discussion of each Study Area and the recommended plan based on the afore-mentioned criteria.

**Study Area 1 – Madaket**

The Madaket Study Area was evaluated in the Phase I Report as long-term unsustainable with the current on-site wastewater disposal systems or simply a "Needs Area". Out of the four options evaluated in the Phase III Report as a solution for this Needs Area, the most feasible is Option No. 2, Low Pressure Sewers.

The recommended plan consists of the installation of 39,930 linear feet of low-pressure sewer with sizes ranging from 1-1/4 to 4 inch diameter pipe. Approximately 1,400 linear feet of the total 39,930 linear feet will be used for connection to a future satellite wastewater treatment facility. All low-pressure sewers will be located in the roadways and end at the new satellite wastewater treatment plant in-plant pump station. Refer to Figure 5-1 for the proposed Madaket Collection System.

A parcel located in close proximity to the Madaket Study Area will be able to accommodate the collection, treatment and disposal of wastewater for this Area making this the most feasible option. The Federal Aviation Administration currently owns the parcel where the new Madaket Wastewater Treatment facility is proposed to be located and is in the process of surplusing the property through the General Services Administration. Nantucket has begun the legal process through required channels in order to acquire the property.

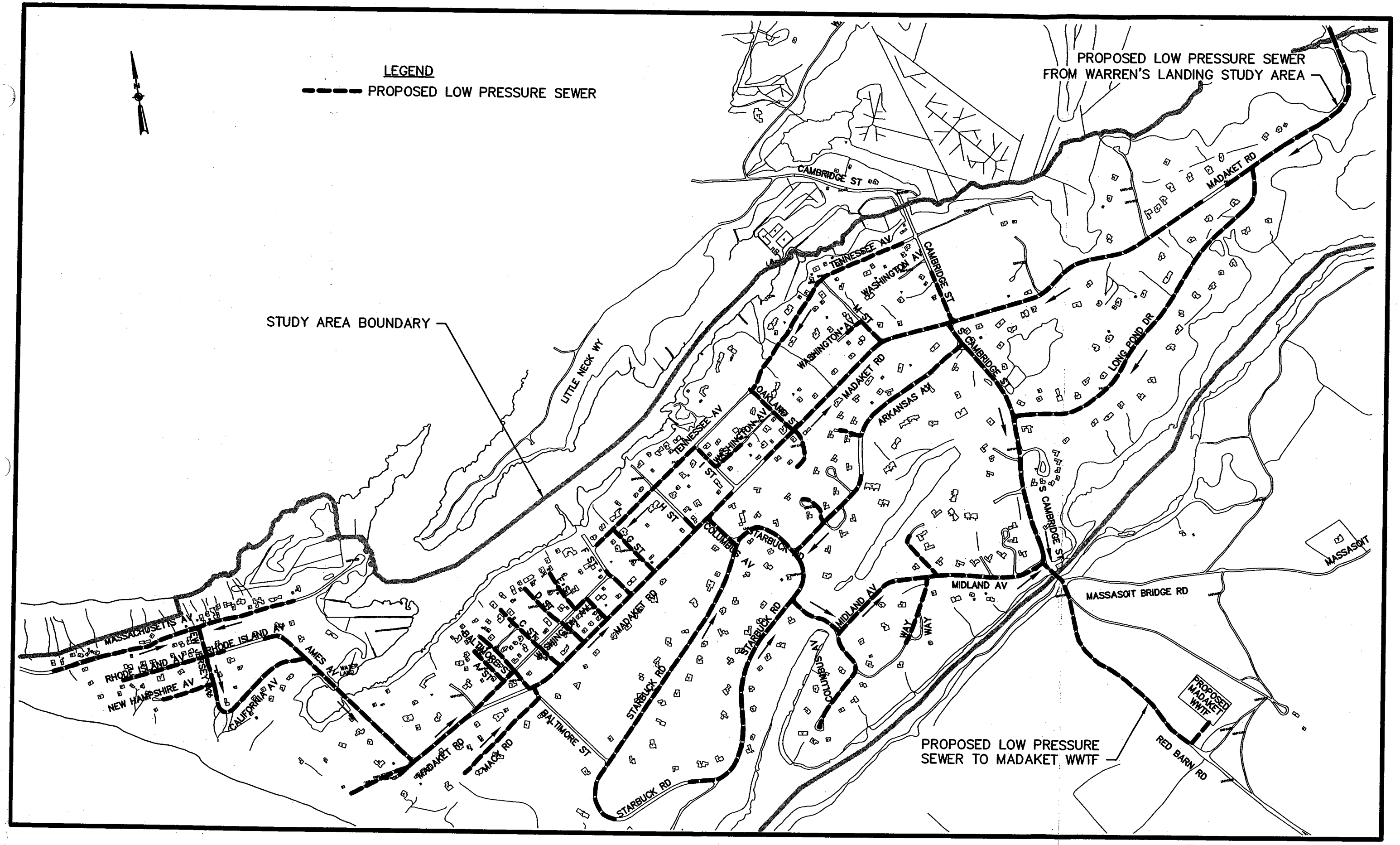



FIGURE 5-1
TOWN OF NANTUCKET
CWMP/FEIR
MADAKET STUDY AREA
NOT TO SCALE

EARTH TECH

**Study Area 2 – Warren's Landing**

The Warren's Landing Study Area was evaluated in the Phase I Report as long-term unsustainable with the current on-site wastewater disposal systems or simply a "Needs Area". Out of the four options evaluated in the Phase III Report as a solution for this Needs Area, the most feasible is Option No. 2, Low Pressure Sewers.

The recommended plan consists of installation of 8,000 linear feet of low-pressure sewer with sizes ranging from 1-1/4 to 4 inch diameter pipe. All low-pressure sewers will be located in the roadways and connected to the Madaket collection system via Madaket Road. Refer to Figure 5-2 for the proposed Warren's Landing Collection System. A parcel located in close proximity to the Madaket Study Area will be able to accommodate the collection, treatment and disposal of wastewater for the Warren's Landing Study Area, making this the most feasible option. The Federal Aviation Administration currently owns the parcel where the new Madaket Wastewater Treatment facility is proposed to be located and is in the process of surplusing the property through the General Services Administration. Nantucket has begun the legal process through required channels in order to acquire the property.

**Study Area 3 – Cisco**

The Cisco Study Area was evaluated in the Phase I Report as long-term sustainable with the current on-site wastewater disposal systems. Therefore, the recommended plan is Option No. 4, continued use of on-site wastewater disposal systems with oversight from the Town under a Septage Management Plan.

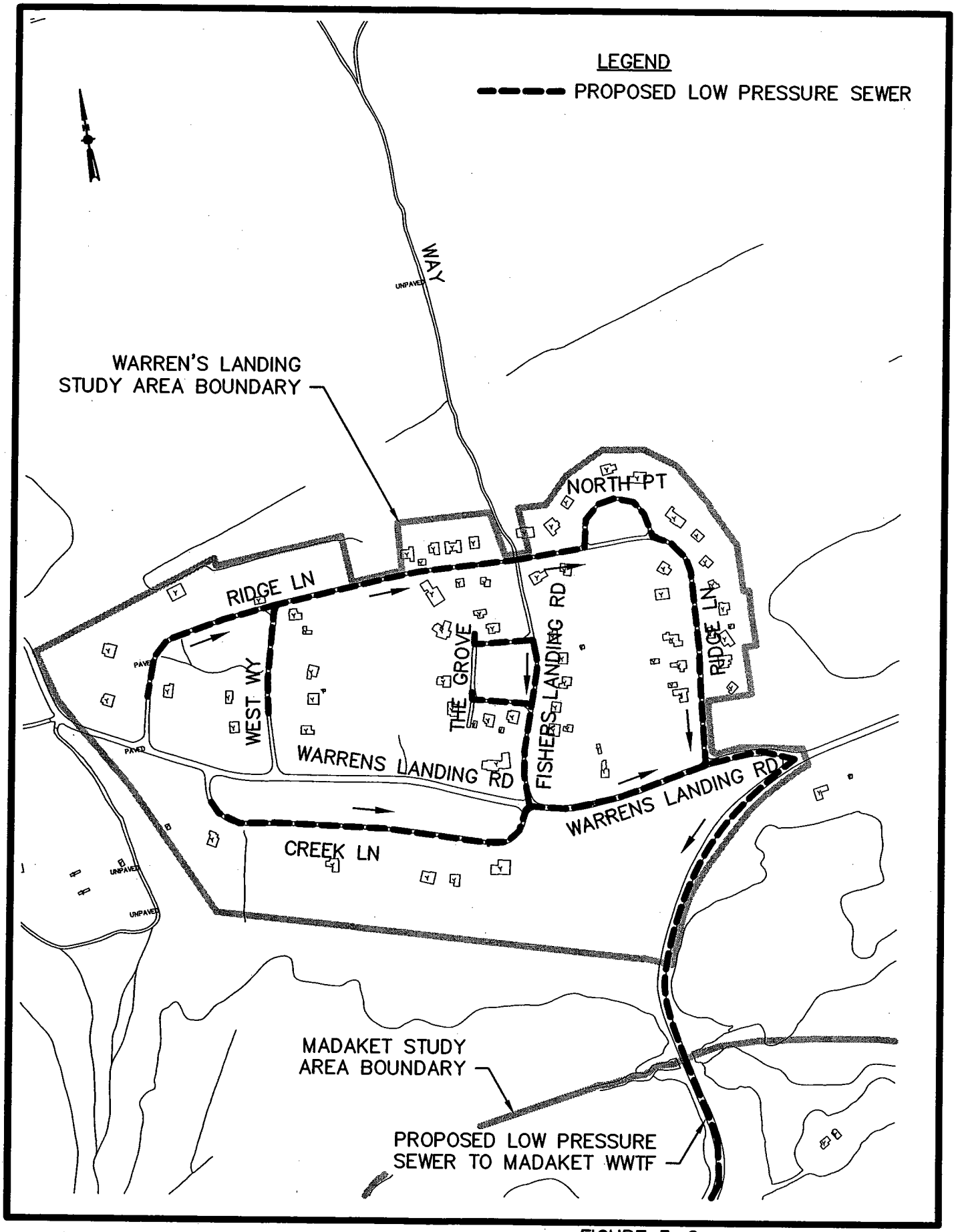



FIGURE 5–2
TOWN OF NANTUCKET
CWMP/FEIR
WARREN'S LANDING STUDY AREA

NOT TO SCALE

EARTH TECH

**Study Area 4 – Somerset**

The Somerset Study Area was evaluated in the Phase I Report as long-term unsustainable with the current on-site wastewater disposal systems or simply a "Needs Area". Out of the four options evaluated in the Phase III Report as a solution for this Needs Area, the most feasible is a combination of Option No. 1, Conventional Gravity Sewers and Option No. 2, Low Pressure Sewers.

The recommended plan consists of the installation of 12,850 linear feet of gravity sewer with sizes ranging from 4 to 8 inch diameter pipe and 7,115 linear feet of low-pressure sewer. Refer to Figure 5-3 for the proposed Somerset Collection System.

Of the 12,850 linear feet of gravity sewer, 1,000 linear feet will be used to connect to the Town's existing gravity sewer via Bartlett Road to Surfside Road, which will convey the wastewater to the Sea Street Pump Station located in the Town Area of Nantucket. The Sea Street Pump Station will pump the wastewater flow to the Surfside Wastewater Treatment Facility for treatment and disposal. All sewers will be located in the roadways.

**Study Area 5 – Miacomet**

The Miacomet Study Area was evaluated in the Phase I Report as long-term sustainable with the current on-site wastewater disposal systems. Therefore, the recommended plan is Option No. 4, continued use of on-site wastewater disposal systems with oversight from the Town under a Septage Management Plan.

**Study Area 6 – Surfside**

The Surfside Study Area was evaluated in the Phase I Report as long-term sustainable with the current on-site wastewater disposal systems. Therefore, the recommended plan is Option No. 4, continued use of on-site wastewater disposal systems with oversight from the Town under a Septage Management Plan.

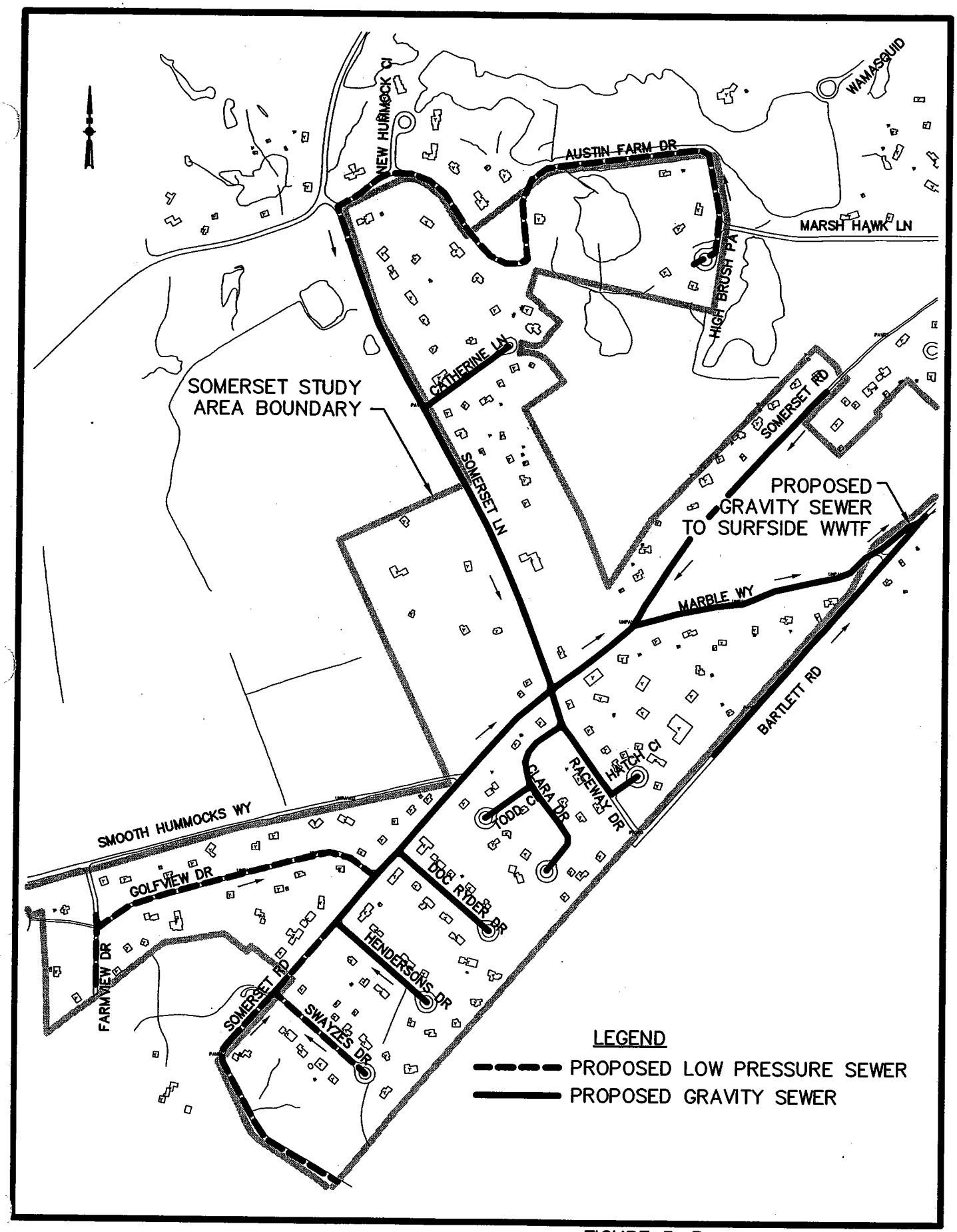



FIGURE 5-3
TOWN OF NANTUCKET
CWMP/FEIR
SOMERSET STUDY AREA

NOT TO SCALE

EARTH TECH

**Study Area 7 – Tom Nevers – Low Density**

The Tom Nevers-Low Density Study Area was evaluated in the Phase I Report as long-term sustainable with the current on-site wastewater disposal systems. Therefore, the recommended plan is Option No. 4, continued use of on-site wastewater disposal systems with oversight from the Town under a Septage Management Plan.

**Study Area 7H – Tom Nevers-High Density**

The Tom Nevers-High Density Study Area was evaluated in the Phase I Report as long-term sustainable with the current on-site wastewater disposal systems. Therefore, the recommended plan is Option No. 4, continued use of on-site wastewater disposal systems with oversight from the Town under a Septage Management Plan.

**Study Area 8 – Siasconset**

The Siasconset Study Area was evaluated in the Phase I Report as long-term unsustainable with the current on-site wastewater disposal systems or simply a "Needs Area". However, the Siasconset Study Area is currently being addressed with the design and construction of the Siasconset Wastewater Treatment Facility due to be completed with construction in spring of 2004. The facility is located in the Siasconset area on United States Coastguard property. The Town is currently considering the establishment of this Study Area as a "Sewer District".

**Study Area 9 – Quidnet**

The Quidnet Study Area was evaluated in the Phase I Report as long-term unsustainable with the current on-site wastewater disposal systems or simply a "Needs Area". The Quidnet Area is a high priority in terms of requiring attention due its location in proximity to and potential impact to Sesachacha Pond from the high number of failing on site wastewater disposal systems. Sesachacha Pond is currently listed on the State's 303(d) list for having high Nitrogen levels.

However, due to the work being completed in this area by the Massachusetts Estuaries Project (MEP), the recommended plan under Option No. 4, consists of maintaining the current on-site wastewater disposal systems until the MEP is

completed and efforts at solutions can be coordinated. The Town, under the auspices of the Septage Management Plan, will monitor all on-site wastewater disposal systems and at the completion of the MEP, will be reevaluated for a long-term wastewater solution in accordance with the guidelines of the MEP. Refer to the Executive Summary for an explanation of the MEP.

**Study Area 10 – Wauwinet**

The Wauwinet Area was evaluated in the Phase I Report as long-term unsustainable with the current on-site wastewater disposal systems or simply a "Needs Area". The Wauwinet Area is a high priority in terms of requiring attention due its location in proximity to and potential impact to Nantucket Harbor from the on site wastewater disposal systems.

However, due to the work being completed in this area by the Massachusetts Estuaries Program (MEP), the recommended plan, under Option No. 4, consists of maintaining the current on-site wastewater disposal systems until the MEP is completed and efforts at solutions can be coordinated. The Town, under the auspices of the Septage Management Plan, will monitor all on-site wastewater disposal systems and at the completion of the MEP, will be reevaluated for a long-term wastewater solution in accordance with the guidelines of the MEP. Refer to the Executive Summary for an explanation of the MEP.

**Study Area 11 – Pocomo**

The Pocomo Study Area was evaluated in the Phase I Report and determined to be a Needs Area based on the Area's proximity to and potential impact to the Nantucket Harbor Watershed.

However, the recommended plan for the Pocomo Study Area, under Option No. 4, consists of maintaining on-site wastewater disposal systems until the MEP is completed and efforts at solutions can be coordinated.. The Town, under the auspices of the Septage Management Plan, will monitor all on-site wastewater disposal systems and at the completion of the MEP, will be reevaluated for a long-term wastewater solution in accordance with the guidelines of the MEP. Refer to the Executive Summary for an explanation of the MEP.

**Study Area 12 – Polpis**

The Polpis Study Area was evaluated in the Phase I Report as long-term unsustainable with the current on-site wastewater disposal systems or simply a "Needs Area". The Polpis Study Area is a high priority in terms of requiring attention due its location in proximity to and potential impact to Nantucket Harbor from the on site wastewater disposal systems.

However, due to the work being completed in this area by the Massachusetts Estuaries Program (MEP), the recommended plan, under Option No. 4, consists of maintaining the current on-site wastewater disposal systems until the MEP is completed and efforts at solutions can be coordinated. The Town, under the auspices of the Septage Management Plan, will monitor all on-site wastewater disposal systems and at the completion of the MEP, will be reevaluated for a long-term wastewater solution in accordance with the guidelines of the MEP. Refer to the Executive Summary for an explanation of the MEP.

**Study Area 13 – Town**

The Town was evaluated in the Phase I Report as long-term unsustainable with the current on-site wastewater disposal systems or simply a "Needs Area". This was due not only to its proximity in relation to the Nantucket Harbor Watershed delineation, but, also, based on qualifying criteria as detailed in the Phase I Report. The majority of the Town's Area properties are currently connected to the Town's municipal sewer system at Surfside. Gravity sewers and pump stations collect and convey the wastewater to the Surfside Wastewater Treatment Facility for treatment and disposal. The recommended plan under Option No. 1, is for the remaining unsewered lots to be connected to the existing collection system at Surfside.

**Study Area 14 – Town WPZ**

The Town Wellhead Protection Zone (WPZ) is a Needs Area based on vicinity to the Town well water. The majority of the WPZ is connected via gravity sewers to the existing Surfside Collection System and is treated and disposed of at the Surfside Wastewater Treatment Facility. The remaining Town WPZ Study Area

is serviced through on-site wastewater disposal systems. At this time, the recommended plan under Option No. 4, is for the Town, under the auspices of the Septage Management Plan. However, the Town should not allow any type of variances to current Title 5 rules and regulations and should established a stringent monitoring program of all on-site wastewater disposal systems in this Study Area to determine if any potential negative impacts to the Town's water supply. If it is determined that the public water supply is being or could be compromised, it is recommended that all the remaining unsewered lots to be connected to the existing collection system at Surfside.

**Study Area 15 – Shimmo**

The Shimmo Study Area was evaluated in the Phase I Report and determined to be a Needs Area based on the Area's proximity to and potential impact to the Nantucket Harbor Watershed. The recommended plan, under Option No. 2, consists of the installation of 26,315 linear feet of low pressure sewer with sizes ranging from 1-1/4 to 4 inch diameter pipe. The Shimmo collection system will tie in directly to the gravity sewer in the Monomoy Study Area via Polpis Road. Figure 5-4 provides a layout for the proposed Shimmo Collection System.

Both the proposed Monomoy and Shimmo collection systems will discharge to the existing Town collection system at Milestone Road, which will convey the wastewater to the Sea Street Pump Station. The Sea Street Pump Station will then pump the wastewater flows to the Surfside Wastewater Treatment Facility for treatment and disposal.

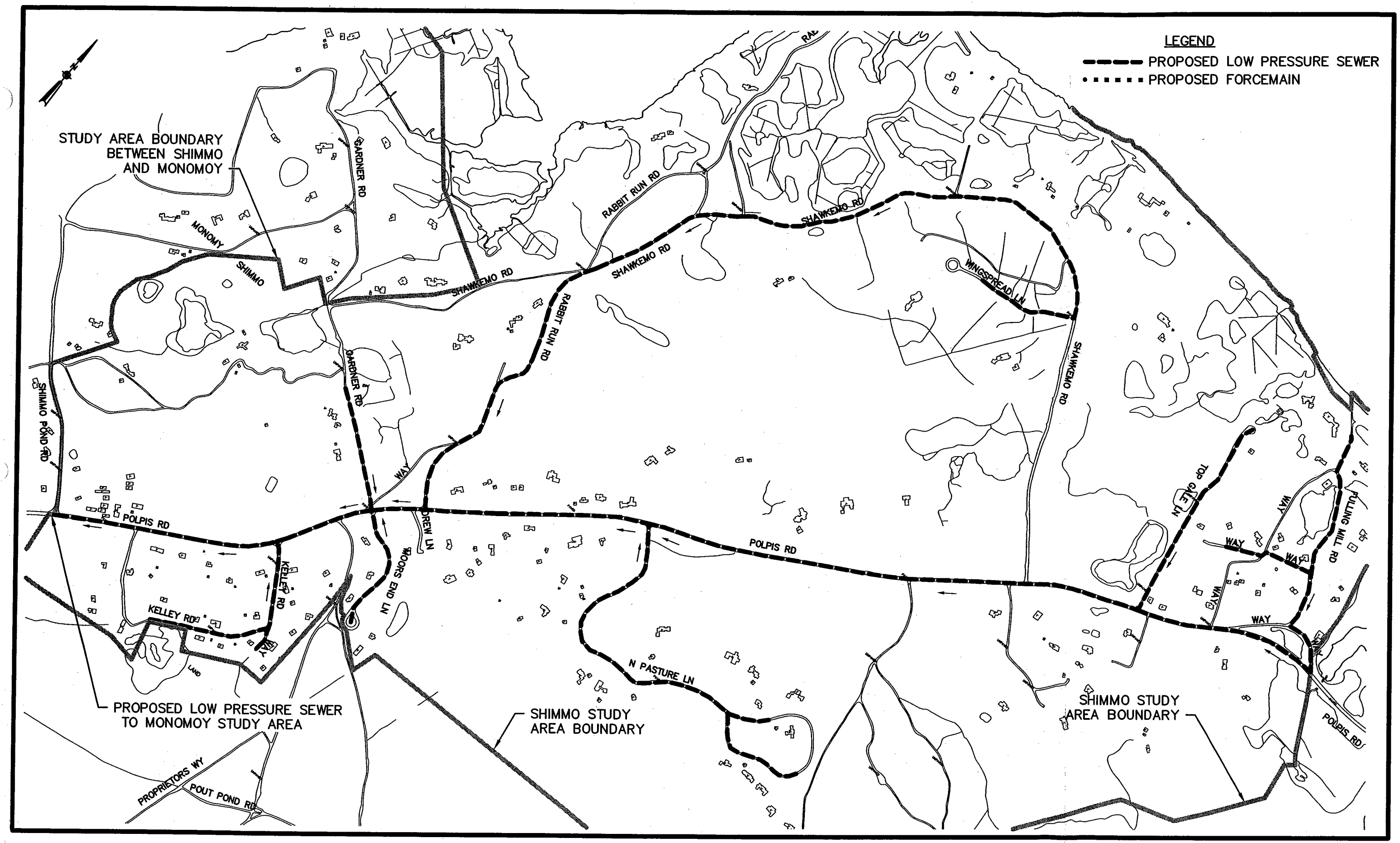



FIGURE 5-4
TOWN OF NANTUCKET
CWMP/FEIR
SHIMMO STUDY AREA
NOT TO SCALE

EARTH TECH

**Study Area 16 – Monomoy**

The Monomoy Area is a Needs Area based on the proximity to and potential impact to the Nantucket Harbor Watershed. Currently, there are approximately three-percent of the developed lots connected to the Town collection system that conveys wastewater to the Surfside Wastewater Treatment Facility. The recommended plan, under a combination of Option No. 1 and Option No. 2, consists of connecting the remaining Monomoy Study Area to the same collection system via 14,540 linear feet of low-pressure sewer with sizes ranging from 1-1/4 to 4 inch diameter pipe. The collection system also includes 4,730 linear feet of 8-inch gravity sewer that will travel down Polpis Road to Milestone Road, thereby connecting the Monomoy and Shimmo Collection Systems to the Town Collection System. This whole system would connect to the Sea Street Pump Station to be conveyed for treatment and disposal at the Surfside Wastewater Treatment Facility. All sewers will be located in the roadways. Refer to Figure 5-5 for the proposed layout of the Monomoy Collection System.

**Study Area 17 – Remaining Island**

The Remaining Island Area was evaluated in the Phase I Report as long-term sustainable with the current on-site wastewater disposal systems. Therefore, the recommended plan is Option No. 4, continued use of on-site wastewater disposal systems with oversight from the Town under a Septage Management Plan.

Refer to Table 5-1 for a summary of the recommend plan.

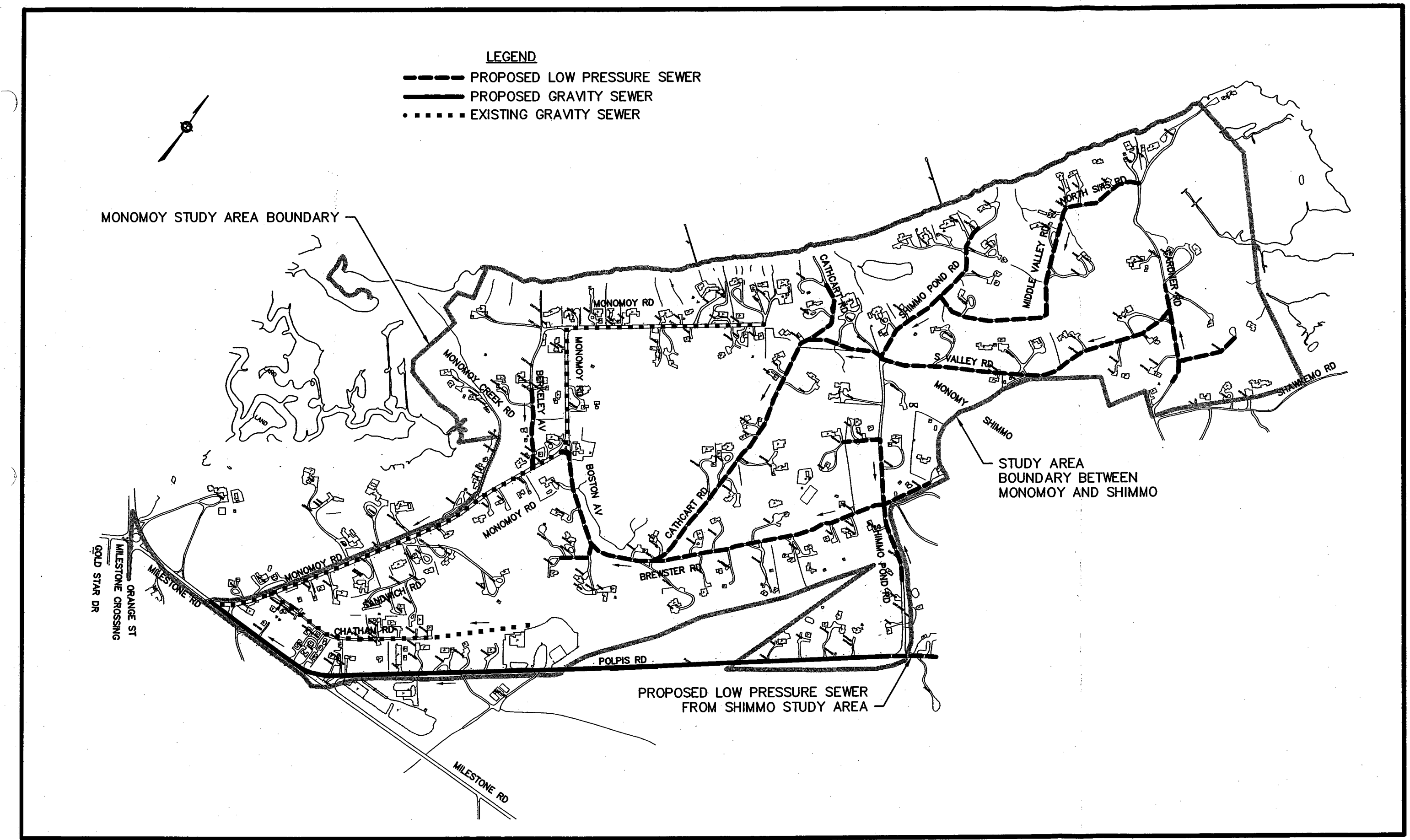



FIGURE 5–5
TOWN OF NANTUCKET
CWMP/FEIR
MONOMOY STUDY AREA
NOT TO SCALE

EARTH TECH

# TABLE 5-1
# TOWN OF NANTUCKET
# CWMP/FEIR
# SUMMARY OF RECOMMENDED PLAN

| Study Area | Recommended Plan |
|---|---|
| Madaket | • Needs Area Based on Matrix<br>• 39,930 LF Low Pressure Sewer<br>• Treatment at Madaket WWTF |
| Warren's Landing | • Needs Area Based on Matrix<br>• 8,000 LF Low Pressure Sewer<br>• Connection to Madaket Collection System<br>• Treatment at Madaket WWTF |
| Cisco | • Long-term sustainable with the current on-site wastewater disposal systems<br>• Monitored by Septage Management Plan |
| Somerset | • Needs Area Based on Matrix<br>• 12,850 LF Gravity Sewer<br>• 7,115 LF Low Pressure Sewer<br>• Connection to Town Collection System<br>• Treatment at Surfside WWTF |
| Miacomet | • Long-term sustainable with the current on-site wastewater disposal systems<br>• Monitored by Septage Management Plan |
| Surfside | • Long-term sustainable with the current on-site wastewater disposal systems<br>• Monitored by Septage Management Plan |
| Tom Nevers – Low Density | • Long-term sustainable with the current on-site wastewater disposal systems<br>• Monitored by Septage Management Plan |
| Tom Nevers – High Density | • Long-term sustainable with the current on-site wastewater disposal systems<br>• Monitored by Septage Management Plan |
| Siasconset | • Needs Area Based on Matrix<br>• Treatment at Siasconset WWTF (Currently Under Construction) |
| Quidnet | • Needs Area Based on Matrix<br>• Continued Use of On-Site Systems<br>• Monitored by Septage Management Plan<br>• Reevaluated After Completion of The Massachusetts Estuaries Project |
| Wauwinet | • Needs Area Based on Matrix<br>• Continued Use of On-Site Systems<br>• Monitored by Septage Management Plan<br>• Reevaluated After Completion of The Massachusetts Estuaries Project |
| Pocomo | • Needs Area Based on Harbor Watershed<br>• Continued Use of On-Site Systems<br>• Monitored by Septage Management Plan<br>• Reevaluated After Completion of The Massachusetts Estuaries Project |
| Polpis | • Needs Area Based on Matrix<br>• Continued Use of On-Site Systems<br>• Monitored by Septage Management Plan<br>• Reevaluated After Completion of The Massachusetts Estuaries Project |
| Town | • Needs Area Based on Matrix<br>• Connect All Unsewered Lots to Town Collection System<br>• Treatment at Surfside WWTF |
| Town Wellhead Protection Zone | • Needs Area Based on Well Protection Zone<br>• Continued Use of On-Site Systems<br>• Monitored by Septage Management Plan than Connect All Unsewered Lots to Town Collection System, if necessary<br>• Treatment at Surfside WWTF |
| Shimmo | • Needs Area Based on Harbor Watershed<br>• 26,315 LF of Low Pressure Sewer<br>• Connection to Monomoy Collection System<br>• Treatment at Surfside WWTF |
| Monomoy | • Needs Area Based on Matrix<br>• 14,540 LF of Low Pressure Sewer<br>• 4,730 LF of Gravity Sewer<br>• Connection to Town Collection System<br>• Treatment at Surfside WWTF |
| Remaining Island | • Long-term sustainable with the current on-site wastewater disposal systems<br>• Monitored by Septage Management Plan |

### 3. Wastewater Treatment Facilities

The Island of Nantucket currently operates one wastewater treatment facility, the Surfside Wastewater Treatment Facility (WWTF). The Island's second wastewater treatment facility is currently being constructed in the Siasconset Area. The recommended plan includes the construction of a third wastewater treatment facility in the Madaket Area of the Island. Figure 5-6 shows the locations of three wastewater treatment facilities. Table 5-2 shows the Typical WWTF Effluent Requirements.

**TABLE 5-2**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**TYPICAL WWTF EFFLUENT PERMIT REQUIREMENTS**

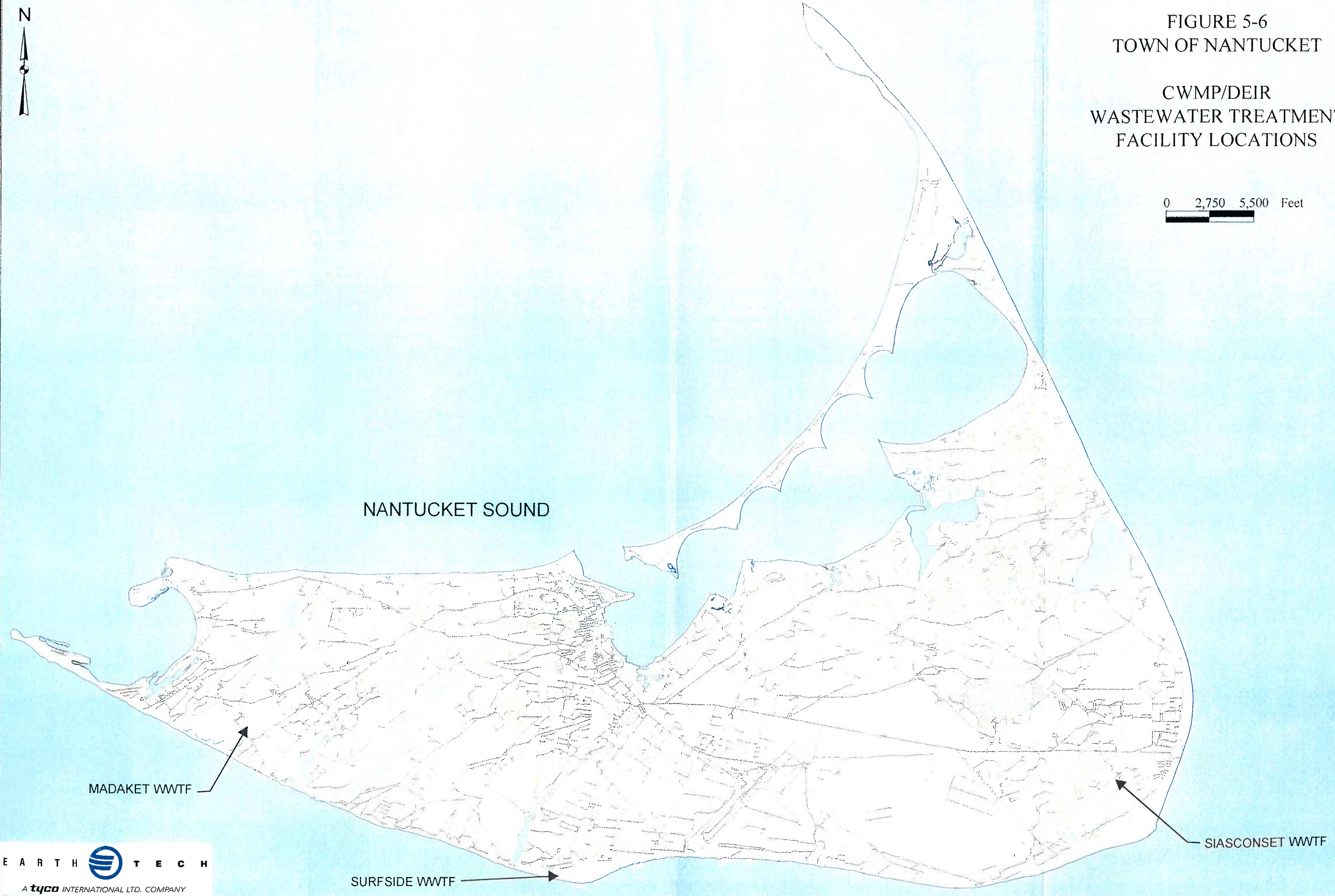
| Effluent Permit Parameter | Monthly Average | Weekly Average | Daily Maximum |
|---|---|---|---|
| $BOD_5$ (mg/L) | 10 | 15 | 20 |
| TSS (mg/L) | 10 | 15 | 20 |
| Settleable Solids (ml/L) | 0.1 | -- | 0.3 |
| Fecal Coliform Bacteria (#/100ml) | -- | -- | 200 |
| Total Residual Chlorine (mg/L) | < 1.0 | -- | 1 |
| Toxicity - LC50 (% survival) | -- | -- | ≥ 50 |
| pH | -- | -- | 6.0 to 8.5 |
| Total Nitrogen | 10 | -- | -- |
| $NO_3$ | < 10 | -- | -- |
| Total Phosphorous | -- | -- | -- |
| Oil and Grease | 15 | -- | -- |

**Surfside WWTF**

The Surfside WWTF, located on South Shore Road in the Southwest region of the Island is currently permitted to discharge 1.80 mgd of advanced primary treated effluent during the summer months into 10 rapid infiltration basins. The service area encompasses approximately 2,000 acres of land out of a total 30,580 acres on the Island. The Surfside WWTF serves approximately 4,000 residential and commercial customers. The Surfside WWTF was built in 1991 and is in dire need of rehabilitation.

FIGURE 5-6
TOWN OF NANTUCKET

CWMP/DEIR
WASTEWATER TREATMENT
FACILITY LOCATIONS




EARTH TECH
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SEPTEMBER 2003

The Town of Nantucket has already begun the next step of upgrading and expanding the existing Surfside WWTF. Earth Tech prepared a Preliminary Design Report (PDR) to identify and develop the necessary upgrades at the WWTF. The PDR includes expanding and improving the headworks, providing secondary treatment for the removal of BOD, TSS and nitrogen, expansion of the effluent disposal beds, sludge processing improvements, septage receiving improvements, and odor control. The PDR was developed with the following project goals in mind that have been identified by the Town:

- Maximize Use of the Existing Site;
- Low Maintenance;
- Operation Without the Use or a Limited Use of Chemicals;
- Capture and Treat Odors;
- Meet High Discharge Limits; and
- Community Acceptance.

The Town requested that the PDR include a cost-effective review of alternatives for providing secondary treatment with biological processes, furnishing expanded sludge dewatering capabilities, and improving the existing odor control facilities. As such, the following alternatives were evaluated:

- Biological Unit Process Alternatives included: (a) Modified Ludzack Ettinger; (b) Sequencing Batch Reactors (SBRs); (c) Trickling Filters; and (d) Rotating Biological Contactors.

- Sludge Processing Alternatives included: (a) High performance Belt Filter Presses, (b) Centrifuges; and (c) Rotary Presses.

- Odor Control Alternatives included: (a) Packed bed scrubbers; (b) Mist chamber scrubbers; and (c) Bio-Filters.

Of these alternatives, SBRs were selected for providing biological secondary treatment, Centrifuges were selected for providing sludge dewatering, and Packed Bed Scrubbers were selected to provide odor control. A recommended plan, including these selected alternatives, was presented in the PDR, and is discussed below and shown on Figure 5-7 and Figure 5-8.

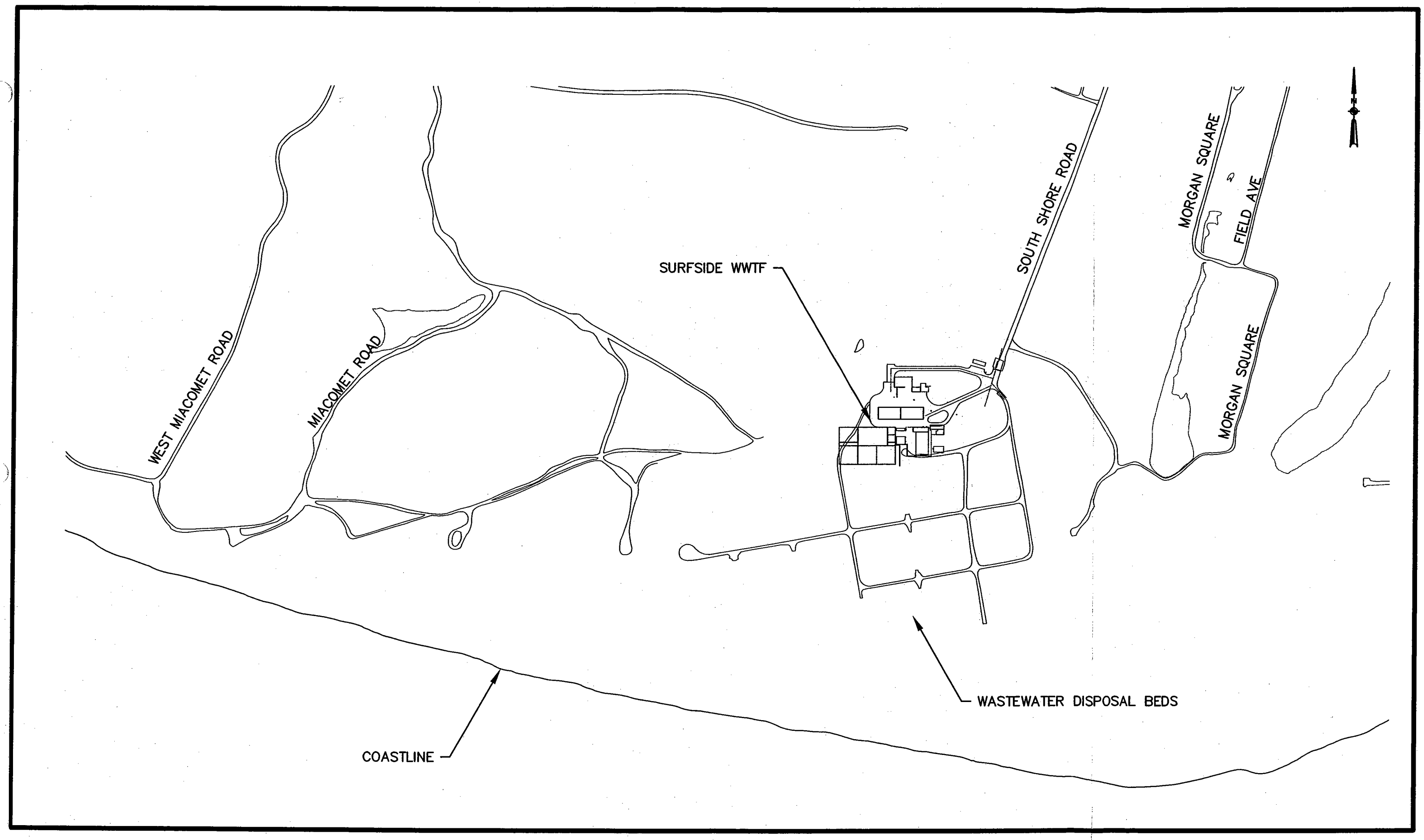


FIGURE 5–7
TOWN OF NANTUCKET
CWMP/FEIR
SURFSIDE WWTF SITE LOCATION
NOT TO SCALE

EARTH TECH

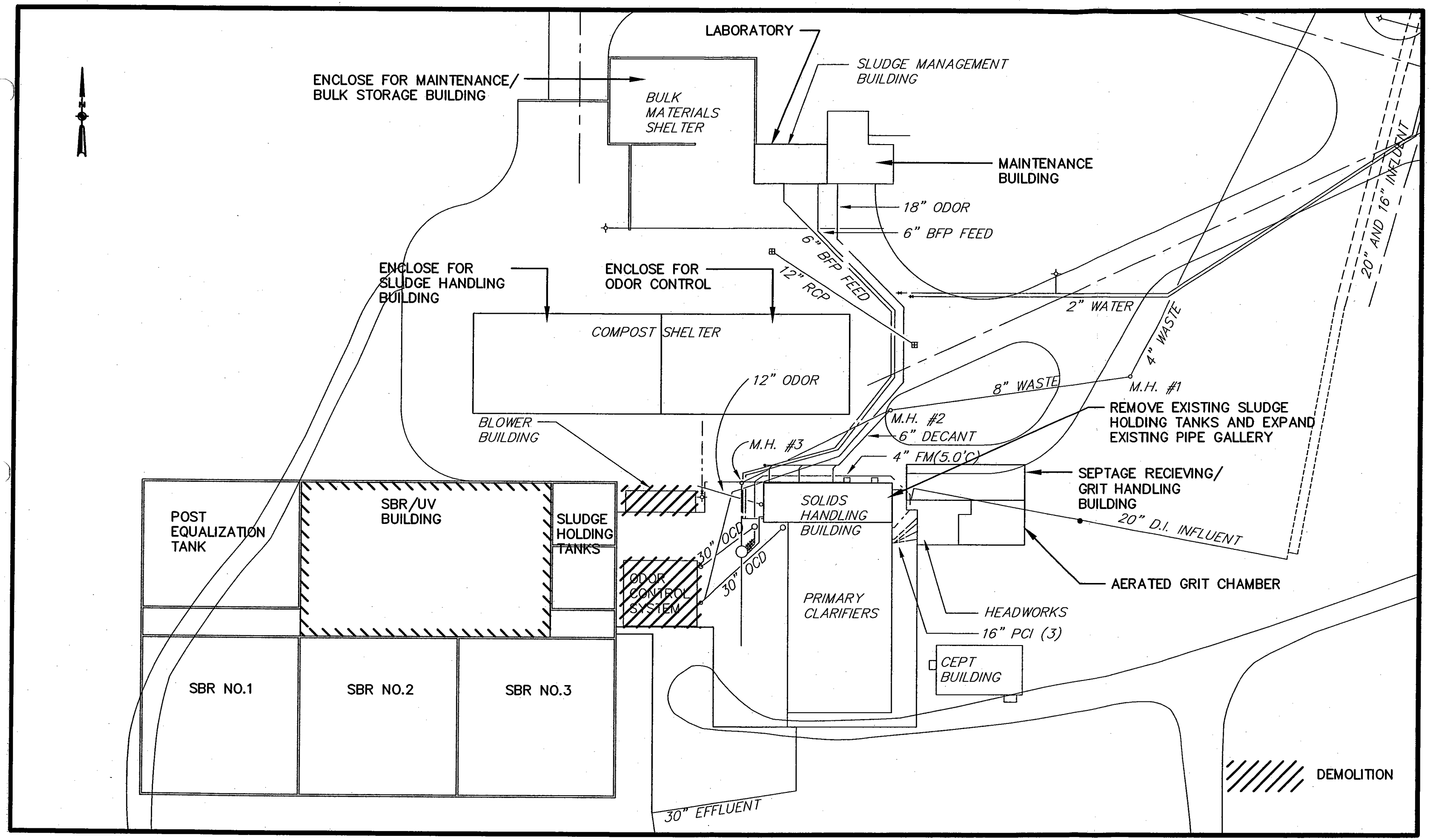


FIGURE 5-8
TOWN OF NANTUCKET
CWMP/FEIR
SURFSIDE WWTF PROCESS LAYOUT
SCALE: 1" = 50'

EARTH TECH

**Grit Removal**

It is recommended that the existing aerated grit chamber be expanded to provide for a new aerated grit chamber. An additional chamber would allow for operational flexibility, particularly for maintenance. In addition, it is recommended that a building be constructed adjacent to the aerated grit chamber. The new building will be provided with automated grit processing equipment. In addition, the recommendation is for the building to serve as a new septage receiving area. Providing housing around the septage receiving area will prevent the escape of odors. Finally, it is recommended that the aerated grit chambers be covered with aluminum plates and that new ductwork be provided for odor control.

**Primary Clarification**

The existing rectangular clarifiers have the necessary capacity to handle the design flow, therefore it is recommended that they be kept in service for primary clarification prior to secondary treatment. In addition, it is recommended that the sludge removal equipment, including mechanical drives and pumps, be refurbished and that aluminum covers with ducts for odor control be provided.

**Solids Handling Building**

It is recommended that the Solids Handling Building be modified by relocating the sludge holding tanks. The existing pipe gallery, which is currently severely congested, could then be expanded into what is now the sludge holding tank area.

**Biological Unit Processes**

Of the four alternatives evaluated (SBRs, MLE Process, RBCs, and Trickling Filters), SBR's are the recommended alternative for providing secondary treatment. Both RBCs and Trickling Filters are not recommended because they require chemical addition, which is not consistent with the Town’s goals for minimal use of hazardous chemicals. In addition, both RBCs and Trickling Filters require a downstream process for nitrogen removal.

In the evaluation, it was determined that the MLE Process, is a suitable alternative capable of providing the same level of treatment and operation

flexibility at approximately the same cost as SBRs. SBRs are recommended because the Siasconset WWTF (currently under construction) is a SBR facility and the proposed Madaket WWTF is anticipated to be an SBR facility. Therefore, SBRs are recommended because it is anticipated that there will be an overall cost savings to the Town and a simplification of operation realized by providing essentially the same treatment process and process equipment at all three facilities.

**Effluent Disinfection**

Disinfection of the WWTF effluent through the use of an ultraviolet (UV) system using medium-pressure quartz vapor lamps is the recommended method of effluent disinfection. The ultraviolet process is capable of destroying all types of pathogens in clear liquids without the addition of chemicals or heat. UV disinfection is consistent with the Town's goals for minimal use of hazardous chemicals. Most other disinfection alternatives require the use of chemicals.

**Effluent Disposal Bed Expansion**

The current means of disposing of the treated effluent is through groundwater infiltration by rapid infiltration basins. In order to expand the facility to treat and dispose of the 3.5 MGD future design wastewater flow, an analysis was needed to determine the required infiltration basin capacity. For this determination, a preliminary groundwater model was developed. The model indicated that the existing bed configuration would not be able to accommodate the significantly greater flows being proposed. Since there is sufficient land area for the construction of additional beds at the site, it was decided to use those potential beds in the maximum discharge simulation. Model runs to evaluate the use of additional beds, found that the expanded 3.5 MGD flow could be disposed of through the construction of 5 additional disposal beds. Although additional model simulations may be required in order optimized disposal bed configurations, the site is capable of handling the additional discharge being proposed.

**Sludge and Septage Dewatering and Disposal**

Of the three alternatives evaluated, belt filter presses, centrifuges, and rotary presses, the recommended alternative for sludge dewatering is centrifuges. An

annual cost evaluation, presented in the PDR determined that BFP's and centrifuges are close in cost and that rotary presses are more expensive. Centrifuges are recommended for sludge dewatering because they require less space than belt filter presses and reduce the quantity of odorous air required to be processed in the odor control system.

The sludge dewatering facilities at Surfside will need to have capacity to dewater primary sludge, waste sludge from the SBR's and primary and waste sludge that is hauled from the Siasconset WWTF. In addition, it is recommended that the centrifuges be sized such that they could handle sludge from the planned Madaket WWTF, in an emergency situation. In this manner, the sludge dewatering facilities at Madaket could be smaller because there would be no need for a redundant backup. If dewatering equipment at that Madaket facility needed to be repaired, the sludge could be hauled to the Surfside WWTF. It is recommended that the existing Compost Shelter be enclosed and modified to house the centrifuges. In addition, it is recommended that the layout be designed such that the trucks used to haul the dewatered sludge, could park and load within the renovated sludge building. In this manner, odorous air could be contained and therefore minimize odor problems at the facility.

As was previously discussed, it is recommended that a new building be constructed to house both the grit processing equipment and septage receiving. Having the septage hauling trucks park and unload septage within an enclosed building will allow for capturing the odorous air and therefore reduce odor problems at the facility.

**Odor Control**

A packed media scrubber system is recommended to "scrub" odorous air generated at the WWTF. Although the biofilter alternative does not require hazardous chemical, the volume of air requiring treatment makes the biofilter cost prohibitive.

**Building Renovations**

There are several building renovations being recommended. As previously discussed, it is recommended that the sludge holding tanks be relocated so that the pipe gallery in the existing Solids Handling Building could be expanded to relieve congestion. It is recommended that the existing Compost Shelter be enclosed and used as a Sludge Handling Building. It is recommended that the existing Sludge Management Building be renovated to use part of the building as a laboratory and part of the building as a maintenance building. In this manner, a much needed enclosed maintenance work area will be provided and the Administrative Building that now houses the Laboratory could become more of a true Administration Building. Finally, it is recommended that the existing Bulk Material Shelter be enclosed and used for large equipment maintenance and bulk storage. This would provide a much needed area, out of the elements, for storage and maintenance. Table 5-3 presents the wastewater flow components and Table 5-4 shows the Surfside WWTF Design Criteria for Future Design Summer 2025.

# TABLE 5-3
# TOWN OF NANTUCKET
# CWMP/FEIR
# SURFSIDE WWTF WASTEWATER FLOWS

| | Wastewater Flow (MGD) - Winter | | | Wastewater Flow (MGD) - Summer | | |
|---|---|---|---|---|---|---|
| Flow Component | Existing | Initial | Design | Existing | Initial | Design |
| (a) Average Daily Residential | 1,239,875 | 1,353,275 | 1,591,000 | 1,526,000 | 2,340,800 | 2,752,160 |
| (b) Average Daily Industrial | - | - | - | - | - | - |
| (c) Average Daily Commercial | 221,325 | 179,400 | 193,700 | 293,680 | 238,050 | 257,025 |
| (d) Average Daily Institutional/Special | - | - | - | - | - | - |
| (e) Average Daily Intermunicipal | - | - | - | - | - | - |
| (f) Septage | 5,400 | 25,000 | 25,000 | 11,200 | 40,000 | 40,000 |
| Average Daily Total [1] | 1,466,600 | 1,557,675 | 1,809,700 | 1,830,880 | 2,618,850 | 3,049,185 |
| Peaking Factor | 2.80 | 2.77 | 2.70 | 2.70 | 2.53 | 2.47 |
| Peak Wastewater [2] | 4,112,673 | 4,321,969 | 4,890,374 | 4,937,481 | 6,631,035 | 7,516,558 |
| Average Daily Infiltration [3 & 4] | 900,000 | 450,000 | 450,000 | 450,000 | 225,000 | 225,000 |
| Maximum Monthly Infiltration | 1,800,000 | 900,000 | 900,000 | 900,000 | 450,000 | 450,000 |
| Maximum Peak Inflow | 1,150,000 | 575,000 | 575,000 | 575,000 | 287,500 | 287,500 |
| Average Annual Flow [5] | 2,366,600 | 2,007,675 | 2,259,700 | 2,280,880 | 2,843,850 | 3,274,185 |
| Maximum Monthly Average Flow [6] | 3,266,600 | 2,457,675 | 2,709,700 | 2,730,880 | 3,068,850 | 3,499,185 |
| Maximum Daily Flow [7] | 4,416,600 | 3,032,675 | 3,284,700 | 3,305,880 | 3,356,350 | 3,786,685 |
| Maximum Hourly Flow [8] | 7,062,673 | 5,796,969 | 6,365,374 | 6,412,481 | 7,368,535 | 8,254,058 |

Notes:

[1] Sum of components a through f

[2] Average Daily Total multiplied by peaking factor

[3] Initial Infiltration based on approximately 5,070 connections at 35 linear feet of service pipe per connection and 300 gpdidm plus 34 miles of pipe and 1,000 gpdidm

[4] Design Infiltration based on approximately 9,346 connections at 35 linear feet of service pipe per connection and 300 gpdidm plus 34 miles of pipe and 1,000 gpdidm

[5] Average Daily Total plus Average Daily Infiltration

[6] Average Daily Total plus Maximum Monthly Infiltration

[7] Average Daily Total plus Maximum Monthly Infiltration plus Maximum Inflow

[8] Peak Wastewater plus Maximum Monthly Infiltration plus Maximum Inflow

**TABLE 5-4**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SURFSIDE WWTF DESIGN CRITERIA**

| Description | Future Design Summer 2025 |
|---|---|
| **A. Flows and Loadings** | |
| Flow (mgd) | 3.5 |
| $BOD_5$ Concentration (mg/l) | 300 |
| TSS Concentration (mg/l) | 200 |
| TKN Concentration (mg/l) | 40 |
| $NH_4$-N Concentration (mg/l) | 25 |
| Total P Concentration (mg/l) | 10 |
| WWTF Design Flow Average Day, Peak Month (mgd) | 3.500 |
| WWTF Max. Day, Peak Month (mgd) | 5.250 |
| Design Flow Peaking Factor | 2.20 |
| WWTF Design Instantaneous Maximum Flow (mgd) | 7.700 |
| **B. Primary Treatment** | |
| No. of Units | 3 |
| Type | Rectangular |
| Length Each (ft.) | 81.5 |
| Width Each (ft.) | 18 |
| Sidewater Depth each (ft.) | 7 |
| Overflow Rate at Design Flow (gpd/ft$^2$) | 795 |
| Overflow Rate at Maximum Day Flow (gpd/ft$^2$) | 1193 |
| Overflow Rate at Instantaneous Peak Flow (gpd/ft$^2$) | 1750 |
| Detention Time at Design Flow (hrs.) | 1.6 |
| **C. SBR System** | |
| Length, feet | 87 |
| Width, feet | 87 |
| Maximum Depth, feet | 16 |
| Volume (MG) | 0.906 |
| Total No. of Units (each) | 3 |
| No. of Cycles (per day/basin) | 5 |
| Cycle Duration (hours/cycle) | 4.8 |
| Hydraulic Retention Time (Day) at design flow | 0.776 |
| **D. Post Equalization** | |
| No. of Units | 1 |
| Maximum Sidewater Depth, ft | Varies |
| Volume, MG (Each) | 1.8120 |
| Detention Time at Average Flow (hrs.) | 12.4 |
| Detention Time at Instantaneous Maximum Flow (hrs.) | 8.3 |

**TABLE 5-4 (cont)**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SURFSIDE WWTF DESIGN CRITERIA**

| Description | Future Design Summer 2025 |
|---|---|
| **E. Ultra - Violet Disinfection** | |
| Type of Unit | Medium Pressure |
| Type of Structure | Open Channel |
| Number of Units (each) | 2 |
| Number of Modules Per Unit (each) | 4 |
| Number of Lamps per Module (each) | 24 |
| Total Number of Lamps Per Unit | 96 |
| U.V. Dosage, each unit (Microwatts-sec/cm^2) | 51,640 |
| U.V. Transmission (percent) | 65 |
| Channel Water Depth (inches) | 42 |
| **F. Sludge Holding** | |
| No. of Raw Sludge Tanks | 2 |
| Storage Volume (gal), each | 130,000 |
| Estimated Daily Sludge Quantity (lbs/day) | 10,073 |
| **G. Odor Control System** | |
| Type of System | Single-Stage |
| Method of Treatment | Packed Tower |
| Inlet $H_2S$, ppm | 20 |
| Estimated Air Flow - Grit Chambers (cfm) | 300 |
| Estimated Air Flow - Headworks Building | 3,600 |
| Estimated Air Flow - Primary Clarifiers | 2,700 |
| Estimated Air Flow - SBRs (cfm) | 20,500 |
| Estimated Air Flow - Post Equalization Tanks (cfm) | 5,300 |
| Estimated Air Flow - Sludge Management Building (cfm) | 1,200 |
| Estimated Air Flow-Sludge Holding Tanks (cfm) | 1,400 |
| Estimated Total Air Flow - (cfm) | 35,000 |
| Equivalent H2S Concentration (ppm) | 20 |
| **H. Sludge Dewatering** | |
| Type of System | Centrifuges |
| Number of Units | 2 |
| Throughput (gpm each) | 110 |
| Run Time (hours per week) | 37 |
| Dry Solids (lbs/day) | 10,700 |

**Siasconset WWTF**

Since the abandonment of the Siasconset WWTF project in 1990, the existing effluent beds have been improved, however untreated wastewater is still being discharged to the ground through rapid infiltration basins in violation of the Town's Administrative Order, Docket No. 782 dated June 6, 1989 from Massachusetts DEP. The Order required completion of construction and commencement of operation of the Siasconset treatment facility by June 1, 1991. The Town does have a Class 3 Discharge License (# 0-201) for this site. Due to the abandonment of the proposed site for the treatment facility, the Town proceeded with a Facilities Plan in July 1994 to find a solution to its wastewater problems in the Siasconset area. The Town and DEP negotiated Administrative Consent Order No. SE-97-1006 signed November 1997, with a revised schedule for this project that provides for completion of an approved treatment facility and the cessation of the discharge of untreated sewage by May 2002. A copy of this Administrative Consent Order is in Appendix A.

The Department of Environmental Protection requested that the Town of Nantucket file an Environmental Notification Form (ENF) under the Massachusetts Environmental Policy Act (MEPA) to ensure a thorough and coordinated review of the project by all permitting authorities. An ENF for the proposed project (EOEA No. 11460) was submitted to the MEPA Unit of the Massachusetts Executive Office of Environmental Affairs for the January 15, 1998, filing date. Following publication in the *Environmental Monitor*, staff of the MEPA Unit conducted a public consultation session on February 13, 1998. The Secretary of Environmental Affairs issued a *Certificate on the ENF* on February 24, 1998, requiring the preparation of an EIR and establishing a Special Procedure under Section 11.12 of the MEPA Regulations. This Special Procedure requires the submittal of a Phase I Screening Report to screen the set of alternatives to a reasonable number of alternatives for detailed review. The subsequent filing of a Draft Environmental Impact Report/Facilities Plan (EIR/FP) and a Final EIR/FP was also required.

In accordance with the Secretary's decision on the ENF, a Phase 1 Environmental Report – Screening of Alternative Sites - was submitted to the MEPA unit on July 15, 1998. The Secretary of Environmental Affairs issued a *Certificate on the Special Procedure: Phase I Report, Screening Alternatives* on August 28, 1998. The Secretary determined that the Phase I report fulfilled the requirements set forth in the Phase I report scope outlined in the ENF Certificate.

The Draft Environmental Impact Report/Facilities Plan was submitted to the MEPA unit on December 23, 1998. A 30-day public comment period was initiated by a notice of the Draft EIR/FP's availability for review in the *Environmental Monitor* that was published on January 10, 1999. On February 16, 1999, the Secretary of Environmental Affairs issued a *Certificate on the Special Procedure: Phase II Report, Draft Environmental Impact Report/Facilities Plan* stating that the DEIR/FP adequately and properly complies with MEPA and with its implementing regulations. The Administrative Consent Order stated that a FEIR/FP was to be filed within 120 days of the approval of the DEIR/FP. The initial FEIR/FP was filed with MEPA on June 16, 1999. On July 30, 1999, the Secretary of Environmental Affairs issued a *Certificate on the Special Procedure: Phase III Report, Final Environmental Impact Report/Facilities Plan* stating that the FEIR/FP adequately and properly complies with MEPA and with its implementing regulations. Modifications were made to the *Special Procedure*, which allowed for the submission of a Supplemental FEIR/FP covering the effluent disposal portion of this Project. The PDR is based on the initial Facilities Plan, ENF, DEIR/FP, and FEIR/FP which were all submitted to and approved by MEPA through the Special Procedure under Section 11.12 of the MEPA Regulations.

The Siasconset Wastewater Treatment Facility Project consists of a new WWTF, Influent Pumping Station and modifications to the existing rapid infiltration basins. The new Influent Pumping Station will be remote from the WWTF and located off the basin gravel access road just South of Low Beach Road. The new facilities will be designed to treat a future summer average daily flow of 0.22 mgd and an instantaneous maximum flow of 1.039 mgd. Refer to Figure 5-9 for the Siasconset WWTF location and to Figure 5-10 for the Process Layout.

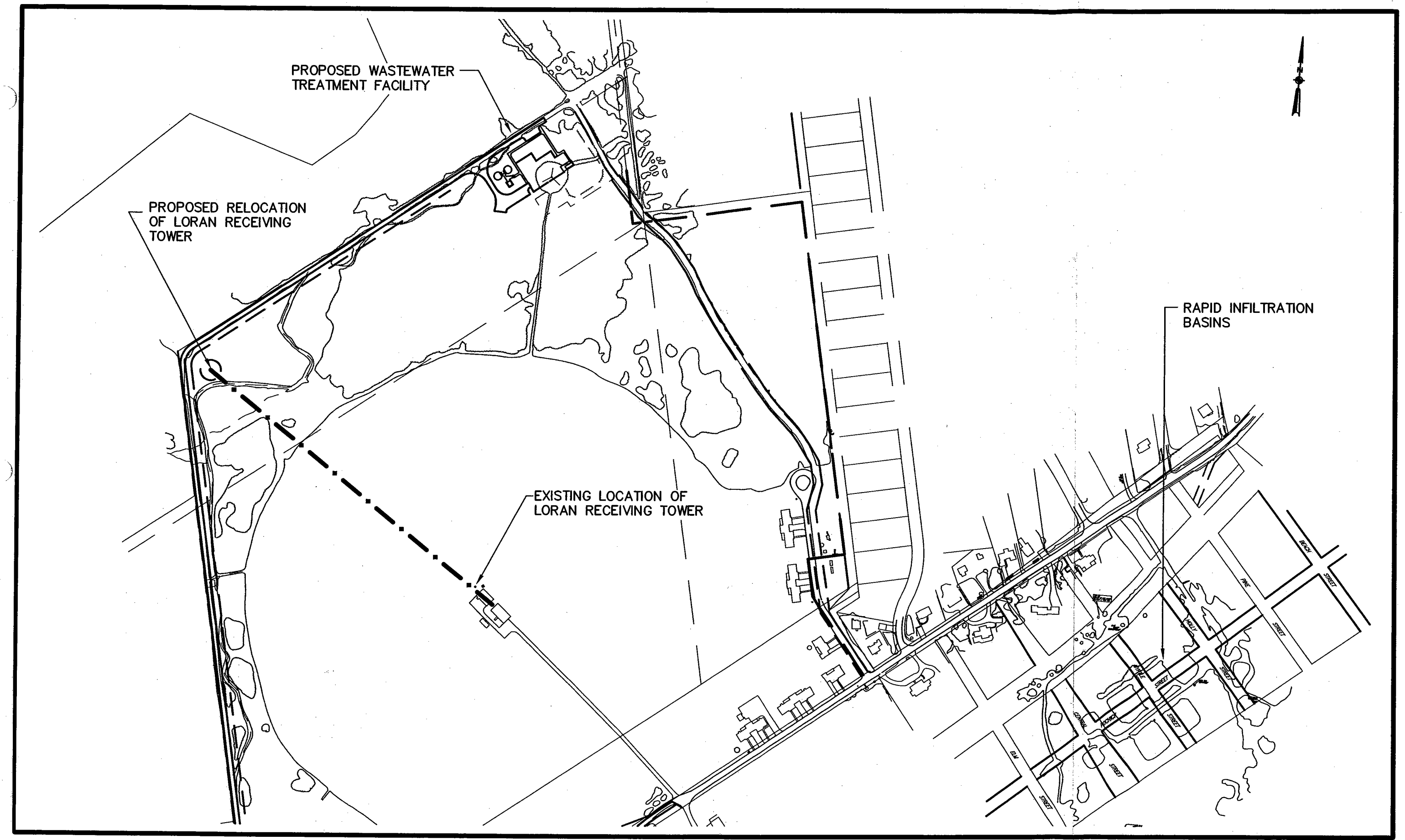


FIGURE 5-9
TOWN OF NANTUCKET
CWMP/FEIR
SIASCONSET WWTF SITE LOCATION
NOT TO SCALE

EARTH TECH

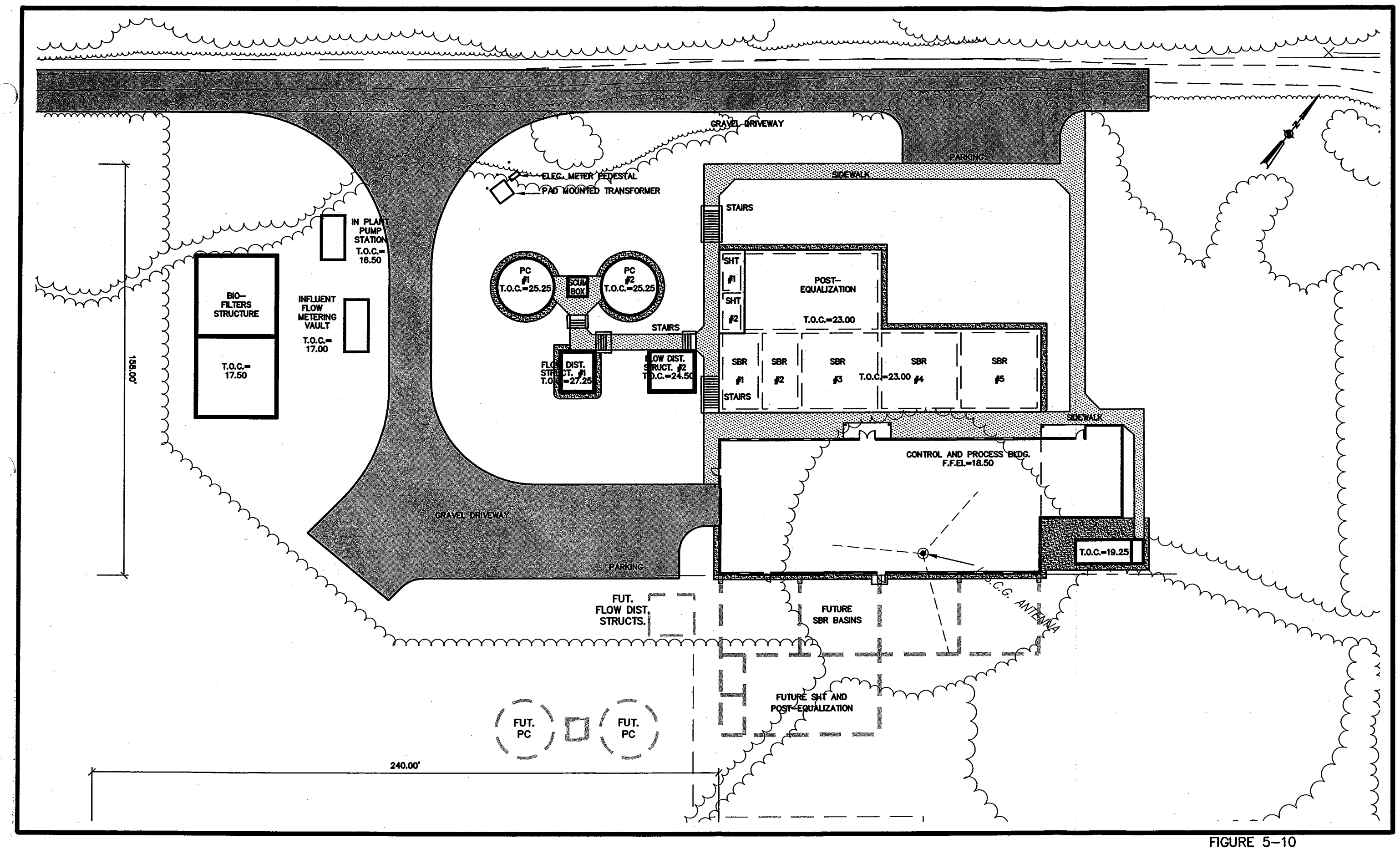


FIGURE 5-10
TOWN OF NANTUCKET
CWMP/FEIR
SIASCONSET WWTF PROCESS LAYOUT
NOT TO SCALE

EARTH TECH

Refer to Table 5-5 for the Siasconset WWTF Design Criteria. The WWTF will be designed to remove conventional pollutants (BOD and TSS) and to significantly reduce the amount of total nitrogen in the WWTF effluent to the basins. The following is a summary of the major treatment components of the new Siasconset WWTF:

- Wastewater Treatment Facility Control and Process Building;
- One influent pumping station;
- One influent flow metering structure;
- Two primary clarifiers with scum collection;
- Five sequencing batch reactor secondary treatment process systems;
- One sodium bicarbonate ($NaHCO_3$) chemical feed system to provide supplemental alkalinity to the SBR system if needed;
- One post-equalization tank with coarse bubble aeration and effluent pumping;
- Two sludge-holding tanks with mechanical mixing and decant equipment;
- Two cloth disk type effluent filters to provide tertiary treatment of the SBR Effluent;
- Two ultraviolet disinfection units providing final treatment prior to disposal via the rapid infiltration basins;
- One effluent sump for effluent reuse via plant water and effluent filter high pressure wash systems;
- One plant water system;
- One effluent flow metering structure;
- Six rapid infiltration basins for final WWTF effluent disposal. The six basins will consist of modifications to the four existing Town rapid infiltration basins and modifications to the two existing Coast Guard basins;
- WWTF effluent piping to the rapid infiltration basins; and
- Two bio-filter type odor control system cells and exhaust fan to treat odorous air exhausted from the primary clarifiers, sequencing batch reactors, sludge holding tanks, post-equalization tank and the sludge pumping truck.

The proposed site for the Siasconset WWTF will be approximately five acres, located on two parcels of land owned by the United States Coast Guard.

**TABLE 5-5**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SIASCONSET WWTF DESIGN CRITERIA**

| Description | Future Design Summer 2022 |
|---|---|
| **A. Flows and Loadings** | |
| Residential/Commercial Flow (gpd) | 208,500 |
| Infiltration/Inflow (gpd) | 11,500 |
| $BOD_5$ Concentration (mg/L) | 376 |
| TSS Concentration (mg/L) | 345 |
| TKN Concentration (mg/L) | 40 |
| Ammonia-Nitrogen Concentration (mg/L) | 25 |
| WWTF Design Flow Average Day, Peak Month (mgd) | 0.220 |
| Design Flow Peaking Factor | 4.93 |
| WWTF Design Instantaneous Maximum Flow (mgd) | 1.039 |
| Design BOD5 Load Average Day, Peak Month (lbs./day) | 691 |
| Design TSS Load Average Day, Peak Month (lbs./day) | 634 |
| Design TKN Load Average Day, Peak Month (lbs./day) | 73 |
| Design Ammonia-Nitrogen Load, Average Day, Peak Month (lbs./day) | 46 |
| **B. Primary Treatment** | |
| No. of Units | 2 |
| Type | Circular |
| Diameter (each, feet) | 20 |
| Sidewater Depth each, (feet) | 12 |
| $BOD_5$ Removal | 30% |
| TSS Removal | 60% |
| Overflow Rate at Monthly Average Flow (gpd/ft$^2$) | 384 |
| Overflow Rate at Instantaneous Maximum Flow (gpd/ft$^2$) | 1,655 |
| Weir Loading at Monthly Average Flow (gpd/ft) | 1,920 |
| Weir Loading at Instantaneous Maximum Flow (gpd/ft) | 8,271 |
| **C. SBR System** | |
| Number of Reactor Basins – Large Units | 3 |
| Length of Reactor Basins (feet) | 29 |
| Width of Reactor Basins (feet) | 29 |
| Depth of Reactor Basins (feet) | 20 |
| Maximum Volume (each, Mgal) | 0.126 |
| Total No. of Decanters | 3 |
| Maximum Decant Rate (each, gpm) | 969 |
| Number of Reactor Basins – Small Units | 2 |
| Length of Reactor Basins (feet) | 29 |
| Width of Reactor Basins (feet) | 14.5 |
| Depth of Reactor Basins (feet) | 20 |
| Maximum Volume (each, Mgal) | 0.063 |
| Total No. of Decanters | 2 |
| Maximum Decant Rate (each, gpm) | 475 |

**TABLE 5-5 (cont)**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SIASCONSET WWTF DESIGN CRITERIA**

| Description | Future Design Summer 2022 |
|---|---|
| **D. Post Equalization** | |
| No. of Tanks | 1 |
| Tank Width (feet) | 29 |
| Tank Length (feet) | 65 |
| Tank Sidewater Depth (feet) | 8 |
| Effective Tank Volume (gals) | 112,800 |
| **E. Filtration** | |
| Type of Treatment | Cloth Media Filter |
| Number of Filter Units (each) | 2 |
| Number of Filter Disks per Unit (each) | 6 |
| Average Flow to Filters (gpm) | 164 |
| Maximum Flow to Filters (gpm) | 300 |
| **F. Ultra-Violet Disinfection** | |
| Type of Disinfection | Ultraviolet |
| Type of Structure | S.S. Channel |
| Number of Units | 2 |
| Capacity per Unit (gpd) | 500,000 |
| Channel Length, each, including transition boxes (feet) | 13.6 |
| Channel Width (feet) | 1.25 |
| Channel Depth (inches) | 23 |
| Channel Water Depth (inches) | 11.5-12.5 |
| U.V. Transmission (percent) | 65 |
| **G. Sludge Holding** | |
| No. of Tanks | 2 |
| Tank Length (feet) | 14 |
| Tank Width (feet) | 12 |
| Sidewater Depth (feet) | 10 |
| Total Storage Volume (gal.) | 25,130 |
| Estimated Sludge Quantity including decant (lbs./day) | 662 |
| Estimated Sludge Volume including decant (gpd) | 1,600 |
| Design Storage Time (days) | 15.7 |

**TABLE 5-5 (cont)**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SIASCONSET WWTF DESIGN CRITERIA**

| Description | Future Design Summer 2022 |
|---|---|
| **H. Odor Control System** | |
| Type | BioFilter |
| Arrangement | Air Upflow |
| Media Type | Organic Mixture |
| Media Support Type | 1- 1/2" Gravel |
| Estimated Air Flow (cfm) | 4,500 |
| Retention Time (sec) | 72 |
| Media Depth (feet) | 3 |
| **I. Effluent Discharge Beds** | |
| Total Number of Beds | 4 |
| Beds in Use | 4 |
| Length of Bed, each (feet) | 100 |
| Width of Bed, each (feet) | 100 |
| Design Loading Rate (gpd/ft$^2$) | 4 |
| Effective Loading Rate | 3.7 |

**Madaket WWTF**

The proposed Madaket Wastewater Treatment Facility (WWTF) will be located on a parcel currently owned by the Federal Aviation Administration, located near the Madaket Study Area. Wastewater treatment, consisting of tanks, equipment and an access road will encompass approximately four acres of land. The groundwater discharge site will encompass approximately six and a half acres. The Madaket Wastewater Treatment Facility will consist of an Influent Pumping Station, which will receive wastewater flow from the Madaket and Warren's Landing Study Areas, treatment equipment including sequencing batch reactors (SBRs), and Infiltrators for groundwater discharge. The new facilities will be designed to treat a future summer average daily flow of 0.35 MGD. The WWTF will be designed to remove conventional pollutants such as BOD, TSS and Total Nitrogen. Refer to Figure 5-11 for the Madaket WWTF location and Figure 5-12 for the Process Layout.

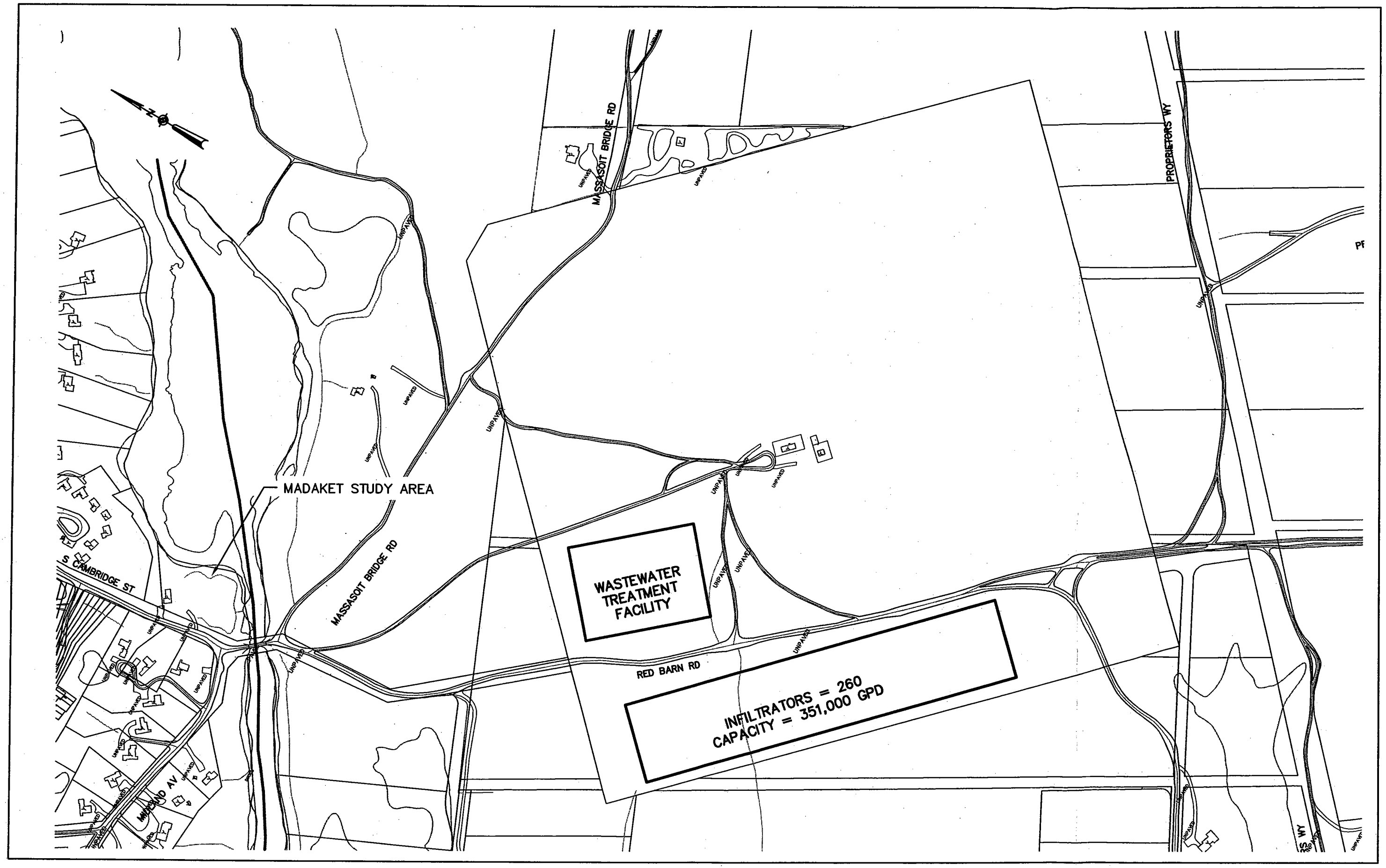


FIGURE 5–11
TOWN OF NANTUCKET
CWMP/FEIR
MADAKET WWTF SITE LOCATION
NOT TO SCALE

EARTH TECH

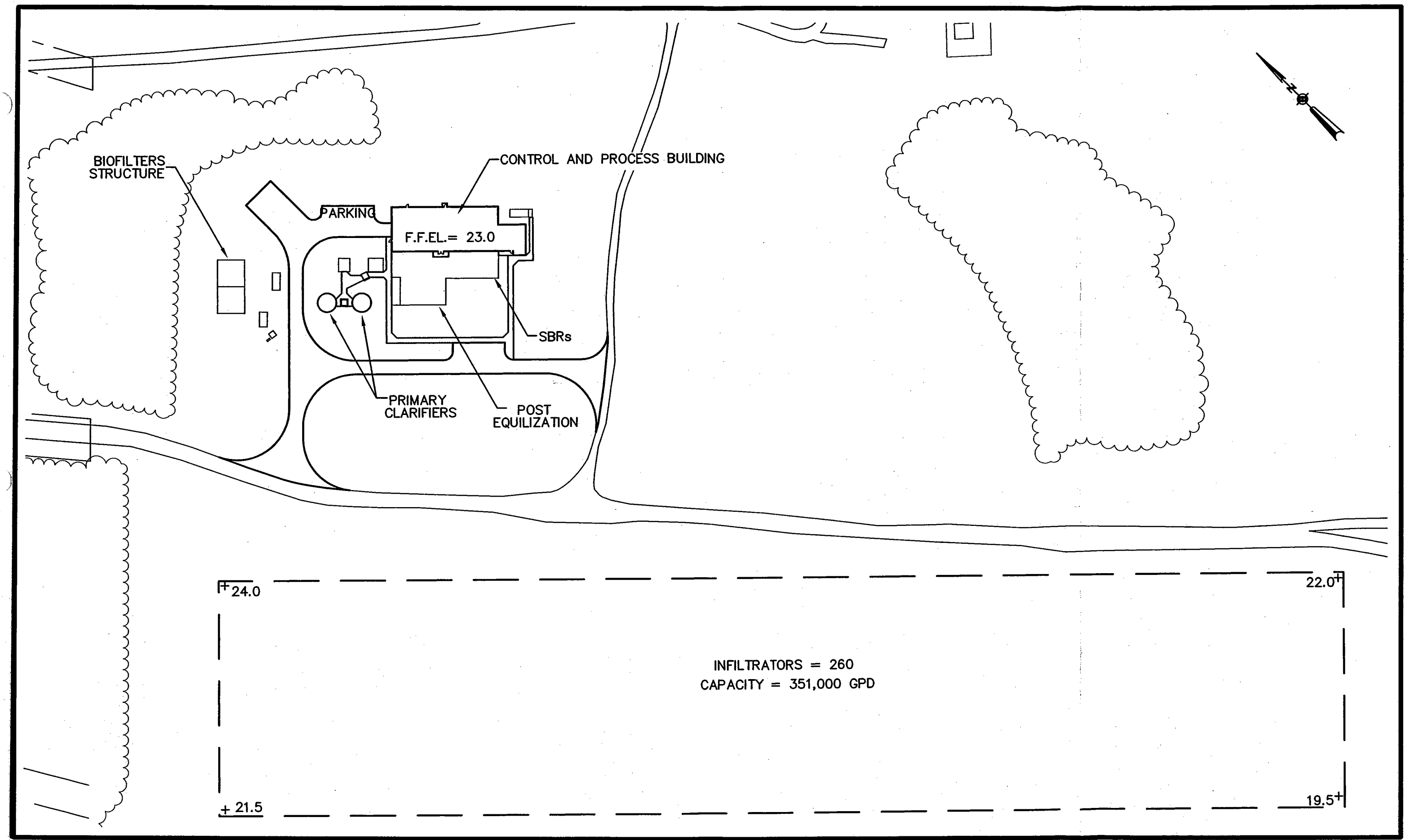


FIGURE 5–12
TOWN OF NANTUCKET
CWMP/FEIR
MADAKET WWTF PROCESS LAYOUT
NOT TO SCALE

EARTH TECH

Refer to Table 5-6 presents the wastewater flow components and Table 5-7 for the Madaket WWTF Design Criteria for Future Design Summer 2025. The WWTF will be designed to remove conventional pollutants (BOD and TSS) and to significantly reduce the amount of total nitrogen in the WWTF effluent to the groundwater site. The following is a summary of the major components of the Madaket WWTF:

- Wastewater Treatment Facility Control and Process Building;
- WWTF Influent Pumping Station;
- One influent flow metering structure;
- Two primary clarifiers with scum collection;
- Two sequencing batch reactor (SBR) secondary treatment process systems;
- Two post-equalization tanks with coarse bubble aeration and effluent pumping;
- Two sludge-holding tanks with mechanical mixing and decant equipment;
- Two cloth disk type effluent filters to provide tertiary treatment of the SBR Effluent;
- Two ultraviolet disinfection units providing final treatment prior to disposal;
- One effluent sump for effluent reuse via plant water and effluent filter high pressure wash systems;
- One plant water system;
- One effluent flow metering structure;
- 260 Infiltrators for final WWTF effluent disposal;
- One centrifuge for dewatering of sludge produced during treatment; and
- Two bio-filter odor control system cells and an exhaust fan to treat odorous air exhausted from the primary clarifiers, sequencing batch reactors, sludge holding tanks, post-equalization tank, sludge pumping truck, and the centrifuge area.

# TABLE 5-6
# TOWN OF NANTUCKET
# CWMP/FEIR
# MADAKET WWTF WASTEWATER FLOWS

| Flow Component | Wastewater Flow (MGD) - Winter | | | Wastewater Flow (MGD) - Summer | | |
|---|---|---|---|---|---|---|
| | Existing | Initial | Design | Existing | Initial | Design |
| (a) Average Daily Residential | - | 156,430 | 185,470 | - | 270,580 | 320,800 |
| (b) Average Daily Industrial | - | - | - | - | - | - |
| (c) Average Daily Commercial | - | 520 | 520 | - | 690 | 690 |
| (d) Average Daily Institutional/Special | - | - | - | - | - | - |
| (e) Average Daily Intermunicipal | - | - | - | - | - | - |
| (f) Septage | - | - | - | - | - | - |
| Average Daily Total [1] | - | 156,950 | 185,990 | - | 271,270 | 321,490 |
| Peaking Factor | - | 4.52 | 4.36 | - | 4.01 | 3.86 |
| Peak Wastewater [2] | - | 709,972 | 810,246 | - | 1,086,859 | 1,240,446 |
| Average Daily Infiltration [3 & 4] | - | 9,000 | 17,000 | - | - | - |
| Maximum Monthly Infiltration | - | 18,000 | 34,000 | - | - | - |
| Maximum Peak Inflow | - | - | - | - | - | - |
| Average Annual Flow [5] | - | 165,950 | 202,990 | - | 271,270 | 321,490 |
| Maximum Monthly Average Flow [6] | - | 174,950 | 219,990 | - | 271,270 | 321,490 |
| Maximum Daily Flow [7] | - | 174,950 | 219,990 | - | 271,270 | 321,490 |
| Maximum Hourly Flow [8] | - | 727,972 | 844,246 | - | 1,086,859 | 1,240,446 |

Notes:
[1] Sum of components a through f
[2] Average Daily Total multiplied by peaking factor
[3] Initial Infiltration based on approximately 540 connections at 50 linear feet of service pipe per connection and 300 gpdidm
[4] Design Infiltration based on approximately 1,000 connections at 50 linear feet of service pipe per connection and 300 gpdidm
[5] Average Daily Total plus Average Daily Infiltration
[6] Average Daily Total plus Maximum Monthly Infiltration
[7] Average Daily Total plus Maximum Monthly Infiltration plus Maximum Inflow
[8] Peak Wastewater plus Maximum Monthly Infiltration plus Maximum Inflow

**TABLE 5-7**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**MADAKET WWTF DESIGN CRITERIA**

| Description | Future Design Summer 2025 |
|---|---|
| **A. Flows and Loadings** | |
| Residential Flow (mgd) | 0.35 |
| $BOD_5$ Concentration (mg/l) | 300 |
| TSS Concentration (mg/l) | 200 |
| TKN Concentration (mg/l) | 40 |
| $NH_4$-N Concentration (mg/l) | 25 |
| Total P Concentration (mg/l) | 10 |
| WWTF Design Flow Average Day, Peak Month (mgd) | 0.350 |
| WWTF Max. Day, Peak Month (mgd) | 0.875 |
| Design Flow Peaking Factor | 4.20 |
| WWTF Design Instantaneous Maximum Flow (mgd) | 1.470 |
| **B. Primary Treatment** | |
| No. of Units | 2 |
| Type | Circular |
| Diameter (ft.) | 18 |
| Sidewater Depth each (ft.) | 10 |
| Overflow Rate at Design Flow (gpd/ft2) | 688 |
| Overflow Rate at Maximum Day Flow (gpd/$ft^2$) | 1,719 |
| Overflow Rate at Instantaneous Peak Flow (gpd/$ft^2$) | 2,888 |
| Detention Time at Design Flow (hrs.) | 2.6 |
| **C. SBR System** | |
| Length, feet | 36 |
| Width, feet | 36 |
| Maximum Depth, feet | 18 |
| Volume (MG) | 0.174 |
| Total No. of Units (each) | 2 |
| No. of Cycles (per day/basin) | 5 |
| Cycle Duration (hours/cycle) | 4.8 |
| Hydraulic Retention Time (Day) at design flow | 0.797 |
| **D. Post Equalization** | |
| No. of Units | 2 |
| Maximum Sidewater Depth, ft | 10 |
| Volume, MG (Each) | 0.046 |
| Detention Time at Average Flow (hrs.) | 6.3 |

**TABLE 5-7 (cont)**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**MADAKET WWTF DESIGN CRITERIA**

| Description | Future Design Summer 2025 |
|---|---|
| **E. Filtration** | |
| Type of Unit | Cloth Media Filter |
| Design Flow, mgd | 0.700 |
| Number of Units | 2 |
| Hydraulic Loading Rate, gpm per $ft^2$ | 3.25 |
| Filter Area, $ft^2$ | 107.6 |
| **F. Ultra-Violet Disinfection** | |
| Type of Unit | Medium Pressure |
| Type of Structure | Open Channel |
| Design Flow (mgd) | 0.350 |
| Design Maximum Day Flow (mgd) | 0.875 |
| Number of Units (each) | 1.0000 |
| Number of Modules Per Unit (each) | 7 |
| Number of Lamps per Module (each) | 4 |
| Total Number of Lamps Per Unit | 28 |
| U.V. Transmission (percent) | 65 |
| Channel Water Depth (inches) | 21 |
| **G. Sludge Holding** | |
| No. of Raw Sludge Tanks | 2 |
| Storage Volume (gal), each | 210,000 |
| Estimated Daily Sludge Quantity (lbs/day) | 16,025 |
| **H. Odor Control System** | |
| Type of System | Biofilter |
| Inlet $H_2S$, ppm | 20 |
| Estimated Air Flow, cfm | 8,000 |
| Number of Cells | 2 |
| Ave. Loading Rate, cfm/$ft^2$ | 2.50 |
| Area per Cell, $ft^2$ | 1,600 |
| **I. Sludge Dewatering** | |
| Type of System | Centrifuge |
| Number of Units | 1 |
| Throughput (gpm each) | 50 |
| Run Time (hours per week) | 16 |

### 4. Existing Pump Stations

The Town of Nantucket currently operates and maintains six wastewater pumping stations. All six pump stations convey flow to the existing Surfside Wastewater Treatment Facility. The recommended plan does not include any new pump stations and recommends rehabilitating the six current pumping stations. The following are the recommended upgrades:

- **Airport Pump Station** – (a) Replace the station's badly corroded control panels with a epoxy-coated corrosion-resistant housing; and (b) Install flow-measuring instrument.

- **Cato Lane Pump Station** – (a) Due to the poor condition of the entire station, demolish and install a submersible pump station in its place. The replacement of the Cato Lane Pump Station has been incorporated into the Siasconset Wastewater Treatment Facility Project. As of the submission of this report, the Cato Lane Pump Station has been totally replace and put into operation.

- **Old South Road Station** – (a) Perform a detailed hydraulic analysis of the station to determine the efficiency of the existing pumps. Current and future wastewater flows should be taken into consideration; (b) Replace the control panel due to inaccessible replacement parts; and (c) Install an alarm system.

- **Pine Valley Pump Station** – (a) Install flow measuring equipment.

- **Sea Street Pump Station** – (a) Install an alarm system; and (2) Update the VFD's. Minimization of the grease entering the station would reduce operation and maintenance costs. Therefore, investigation of the cause of the consistent grease problems in the area should be undertaken and addressed.

- **Surfside Pump Station** – (a) Install an alarm system; (b) Replace the control panel due to inaccessibility to obtain replacement parts; and (c) Replace the generator with a generator that is capable of handling both pumps.

- **Portable Generator** - (a) Sandblast housing of the generator to remove rust and apply a protected epoxy-based corrosion-resistant coating system.

## 5. Evaluation and Mapping Project

In addition to the recommendations outlined above, various recommendations have been developed as part of the on-going Evaluation and Mapping Project, complimenting the work being completed by the CWMP/EIR.. In general, this project consists of investigation and mapping of the Town's wastewater and stormwater infrastructures, inspection of the infrastructure manholes and catch basins, and infiltration/inflow analysis of the Brant Point wastewater collection system. The existing wastewater collection system consists of sewers ranging in size from 4 to 30 inches in diameter and a total length of approximately 34 miles or approximately 180,000 linear feet. Most sewers are vitrified clay with oakum-mortar joints. The existing stormwater collection system consists of pipes ranging is size from 8 to ## inches in diameter and a total length of approximately ## miles or approximately ## linear feet with approximately outfalls discharge stormwater into Nantucket Harbor and various other surface water bodies and wetlands. The following is a summary of the work completed to date, including recommendations, and proposed work to be completed:

### Wastewater Infrastructure

Since an Infiltration/Inflow (I/I) and Sewer System Evaluation Survey (SSES) report was completed in February 1991, the Town has implemented most of the recommendations, including: notifying property owners with illegal connections to remove such connections, replacement of sewer lines, developing a flushing program of the entire system to minimize buildup of debris and maintain hydraulic capacity, manhole and sewer line rehabilitation, and requiring restaurants to install grease traps. In addition, the Town is currently removing catch basins, sump pumps and roof leaders from the sanitary sewers. Although the Town has continued in its efforts to identify and reduce or eliminate sources of infiltration/inflow, the Town has experienced excessive infiltration/inflow particularly during and after major storm events. Therefore, the Town determined that it was necessary to further eliminate and/or reduce infiltration/inflow in order to gain additional capacity out of the existing system to allow growth in the Town. In addition, infiltration/inflow analysis is a major part of the Administrative Consent Order (ACO), ACOP-BO-03-1G002, that the Town entered into with DEP on October 30, 2003.

**Phase 1 – Mini-System M1**

The Town elected to begin a new round of investigations in one mini-system (M1) already identified by the previous I/I and SSES Report located in the Brant Point Area. This one system accounts for about 10-percent of the total length of the Town's system. In general, the scope of work consisted of performing flow isolation, television inspection, and smoke testing. The results of the investigations are summarized below. Refer to Appendix K for a copy of the report.

Based on the Flow Isolation and Television Inspection results, the recommended repairs include removing and replacing sewer lines due to excessive sags, spot repairs for short stretches of sags and cracked joints, and capping open clean outs. For Minisystem M1 there is a total amount of 28 linear feet of spot repairs, 4,146 linear feet of pipe to be removed and replaced, 1,646 linear feet of pipe to be tested and sealed, and capping four open cleanouts.

Based on the smoke testing results, the recommended repairs for specific pipelines located within Minisystem N1, include disconnecting roof leaders, one catch basin, and a driveway drain, and re-routing the connections into the stormwater system. The other recommendations are to raise one depressed manhole cover and to cap previously disconnected roof leaders. For Minisystem N1 there is a total 20 roof leaders that require disconnection and re-routing to the stormwater system. About 45.5 percent of the illegitimate inflow is from roof leaders in this minisystem. The most critical of these roof leaders is the four roof leaders located at No. 19 Liberty Street. These roof leaders provide a peak inflow rate of about 74,353 gallons per day or approximately 27 percent of the total inflow found in the minisystem. The other large contributor to excessive inflow is one catch basin located at No. 3 Hiller Lane. Indications are that this catch basin was added over the existing sewer to offer relief from street flooding during times of large storm events. This one catch basin is contributing more than 50 percent of the total inflow found coming into the Minisystem N1.

**Phase 2 – Remainder of the System**

Based on the results of the infiltration/inflow analysis performed in Phase 1, the Town has elected to continue with the new round of investigations for the reminder of the system. The study will follow the scope of work performed in Phase 1 and in accordance with "Guidelines for Performing Infiltration/Inflow Analyses and Sewer System Evaluation Survey dated January 1993, a publication of the Massachusetts Department of Environmental Protection (DEP). Evaluation of the reminder of the wastewater infrastructure will lead to completion of an I/I and SSES Report with recommendations to rehabilitate the problem sources.

**Stormwater Infrastructure**

The Town of Nantucket proposed to provide water quality improvements (sediments from first flush events) to the existing outfalls, discharging into Nantucket Harbor, of their drainage system in the downtown area. The ongoing project will entail proposed infiltration of stormwater in the upper reaches of these watershed areas; offline detention where available in the watershed; and near the outfall, the installation of a vortechnic type water treatment structure for treatment of the first flush, with by-pass of the larger storm events. This project will determine the calculation of the flow at the outlet pipes, and conceptual plans for water quality treatment within the individual watershed areas. A later work effort, not included in this project, will be an individual catch basin watershed analysis and pipe system analysis report to be provided during the final design of the water quality treatment for the drainage systems.

**Geographic Information System (GIS) Mapping**

In order to properly operate and maintain the wastewater and stormwater infrastructures, and to plan for necessary upgrades and expansion of the infrastructures, detailed mapping becomes a key component. Therefore, the Town of Nantucket elected to develop wastewater and stormwater maps that accurately depict the location, sizes, materials of construction, and condition of the wastewater and stormwater infrastructures. The following summarizes the two phases of this project:

**Phase 1 - Mapping**

Performed topographic survey of the existing and drainage manholes and catch basins in order to determine the elevations of each manhole rim, manhole invert, and inverts of accessible inlet and outlet pipes.

Performed visual inspections of wastewater and drainage manholes. Prepared inspection reports for manholes that included the following: size of manhole, material of construction of the manhole, general physical condition of manhole, location of inlet and outlet pipes, sizes of inlet and outlet pipes. Digital photos of each manhole and structure were taken.

Performed visual inspections of existing catch basins. Prepared inspection reports for each located catch basin that included the following: size of catch basin, material of construction of the catch basin, general physical condition of catch basin, location of inlet and outlet pipes, sizes of inlet and outlet pipes. Digital photos of each catch basin were taken.

Created specific GIS data layers of all information obtained which will be incorporated into the overall Island-wide GIS Database. The following GIS data layers created consist of the location of pipeline, manholes, catch basins and outfalls for the existing wastewater infrastructure and the existing drainage infrastructure.

**Phase 2 – Attribute Enhancements**

Phase 2 of the Evaluation and Mapping Project will consist of adding attribute enhancements to the mapping created in Phase 1. In general, these attribute enhancements are anticipated to consist of: (a) pipe size, material and condition; (b) manhole size, material and condition; (c) catch basin size, material and condition; (d) rim and invert elevations; and (e) recommended wastewater infrastructure improvements, and recommended drainage infrastructure improvements.

## B. INSTITUTIONAL IMPACTS

The recommended wastewater collection, transmission and treatment facilities are currently being planned, designed and constructed under the guidance and direction of the Nantucket Board of Selectmen and Department of Public Works. In order to manage and operate the recommended wastewater collection, transmission and treatment facilities, the Town will need to implement several institutional and system management procedures. The first being the designation and delineation of sewer and septic overlay districts on Island in order to define service areas. The recommended institutional arrangements recommended for implementation are as follows and were previously detailed in Section 4.0 of this report:

- Establishment of Sewer and Septic Overlay Districts;
- Review of the Current Sewer Use Rules and Regulations;
- Cost Recovery Plan;
- Review of Current Sewer User Charge System;
- Review of Sewer System Expansion Control Policy;
- Review of Sewerage System Staffing and Operations Plan;
- Review of Current System Construction Standards;
- Development of a Septage Management Plan; and
- Water Conservation Program.

## C. ENVIRONMENTAL IMPACTS

### 1. General

When determining the recommended plan for each Study Area, it is important to take into consideration and identify and mitigate any environmental impacts. The following environmental impacts were noted:

### 2. Historical, Archaeological, Cultural, Conservation and Recreation

There are no known impacts to historical, archeological, cultural, conservation or recreational resources for any of the study areas. A Step I Historical and Archeological Survey was conducted for the FAA site and the proposed expansion area of the Surfside Wastewater Treatment Facility. The survey showed that there would be no impacts on those sites. A Project Notification Form (PNF) has been filed with the Massachusetts Historical Commission for these two areas. Refer to Appendix G for a copy.

Since, the Administrative Consent Order issued by the Massachusetts Department of Environmental Protection dated October 30, 2003, requires that the Phase III CWMP/FEIR document by completed by March 30, 2004, and that archaeological reviews cannot be conducted once the ground is frozen, the Town was not able to obtain the necessary permits to conduct the intensive archaeological review prior to the filing of the Phase III CWMP/FEIR document. Therefore, the Town will conduct an intensive archaeological review, according to the regulations, as part of the design phases of the Surfside WWTF Upgrade and FAA property.

**3. Wetlands, Flood Plains, and Agricultural Lands**

All Study Areas will temporarily impact wetlands. Construction of all collection systems will potentially impact the 100-foot wetland buffer zone. The impacts would be temporary and associated with the construction of sewer infrastructure. Any impacts would be mitigated by erosion control during construction. The Conservation Commission and the DEP will review all erosion control measures during the Notice of Intent process.

**4. Zones of Contribution of Existing and Proposed Water Supply Sources**

None of the recommended plans will impact the Zones of Contribution.

**5. Surface and Groundwater Resources Including Nantucket and Madaket Harbor Watersheds**

None of the recommended plans will negatively impact surface and groundwater resources.

**6. Displacements of Households, Businesses and Services**

None of the recommended plans will cause displacement of households or businesses.

**7. Noise Pollution, Air Pollution, Odor and Public Health Issues Associated with Construction and Operation**

There will be some temporary construction noise associated with any construction involved with the recommended plan. Limiting the hours and the days of construction will mitigate the construction noise impacts. Any impacts associated with these alternatives will be mitigated in the final design.

**8. Violation of Federal, State or Local Environmental and Land Use Statutes or Regulations and Plans Imposed by Such Statutes and Regulations**

None of the recommended plans will violate any of the Federal, State or Local Environment and/or Land Use Statutes or Regulations and plans imposed by any of the statutes and regulations.

**9. Changes in Development and Land Use Patterns**

Building a communal system on the FAA site would have positive impact to the Madaket and Warren's Landing area. The parcel has the potential for high-density development with the current zoning and land use patterns in place since the parcel contains approximately 100 acres. Deducting for roadways and dividing the resultant by the 2-acre zoning results in about 40 residential house lots. This analysis does consider the potential for the property to be used for a Chapter 40B development that would results in a much higher density development. This kind of development would cause a long-term negative change in development and land use patterns and potential impacts to the environment, drinking water supplies, wastewater disposal, schools, and Town services.

**10. Pollution Stemming from Changes in Land Use**

There will be no pollution stemming from changes in land use.

**11. Damage to Sensitive Ecosystems**

There will be no damage to sensitive ecosystems as part of the recommended plans for any of the Study Areas.

**12. Socioeconomic Pressures for Expansion**

Socioeconomics would not be affected by the recommended plan.

## D. CAPITAL, OPERATION AND MAINTENANCE COSTS

### 1. Capital Costs

The estimated Capital Cost for the recommended plan contained in this CWMP/FEIR is $92.1 million (Present Day Cost). As detailed, this capital cost includes furnishing and installing gravity sewer pipes, low pressure sewer pipes, excavation and backfill, ledge removal, paving; dewatering, loam and seeding, pumping stations, upgrade to the Surfside WWTF, Madaket WWTF, engineering (design and construction), legal, fiscal, administrative, and contingency costs. Refer to Table 5-8 for estimated Capital Costs for the Recommended Plan.

**TABLE 5-8**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SUMMARY OF ESTIMATED PROJECT COSTS**
**FOR CWMP/FEIR RECOMMENDATIONS**

| Project Description | Estimated Project Cost |
|---|---|
| Study Area | |
| Madaket | $11,150,000 |
| Warren's Landing | $1,830,000 |
| Somerset | $7,620,000 |
| Shimmo | $7,340,000 |
| Monomoy | $6,130,000 |
| Wastewater Treatment Facilities | |
| Surfside WWTF | $32,630,000 |
| Siasconset WWTF | Currently Funded |
| Madaket WWTF | $25,380,000 |
| Total | $92,080,000 |

The estimated Capital Cost for the recommended plan contained in the Evaluation and Mapping Project is $83.4 million (Present Day Cost). As detailed, this capital cost includes wastewater infrastructure rehabilitation for the Brant Point Area, infiltration/inflow study for the remainder of the wastewater collection system, wastewater rehabilitation for the remaining wastewater collection system, stormwater outfall rehabilitations and upgrades, stormwater infrastructure rehabilitation and

upgrades, and attributes enhancements to the GIS mapping. Construction projects include furnishing and installing pipes, excavation and backfill, ledge removal, paving; dewatering, loam and seeding, engineering (design and construction), legal, fiscal, administrative, and contingency costs. Engineering projects include legal, fiscal, administrative, and contingency costs. Refer to Table 5-9 for estimated Capital Costs for the Recommended Plan.

**TABLE 5-9**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SUMMARY OF ESTIMATED PROJECT COSTS**
**FOR EVALUATION AND MAPPING RECOMMENDATIONS**

| Project Description | Estimated Project Cost |
|---|---|
| Wastewater | |
| Infiltration/Inflow – Phase 1 | |
| Study | Currently Funded |
| Rehabilitation | $2,140,000 |
| Infiltration/Inflow – Phase 2 | |
| Study | $1,100,000 |
| Rehabilitation | $30,870,000 |
| Infrastructure Improvements | $9,570,000 |
| Stormwater | |
| Outfalls | |
| Study | Currently Funded |
| Rehabilitation | $27,840,000 |
| Infrastructure | |
| Study | Currently Funded |
| Rehabilitation | $11,750,000 |
| GIS Mapping | |
| Phase 1 | Currently Funded |
| Phase 2 | $50,000 |
| Total | $83,320,000 |

The most user-friendly funding option for this project is public financing through the State Revolving Fund (SRF) Loan program which would finance the eligible capital cost. The SRF Loan Program is a modified continuation of prior Massachusetts Department of Environmental Protection (DEP) financial assistance programs (grants) and allows communities to receive low interest loans with a payback period of up to 20 years.

This Program is financed through the Massachusetts Water Pollution Abatement Trust (Trust), which was established by Chapter 275 of the Acts of 1989 (The Hayes Act), as amended (Chapter 29C). Under Chapter 29C financial assistance is offered to public entities for eligible projects at one-half market rate. Currently, the General Court has authorized additional funding (contract assistance) to be paid to the Trust to buy down the interest to 2 percent. The present market rate for AA municipal bonds of approximately 5.5 percent. For wastewater treatment and collection projects, the actual planning and design engineering costs are not eligible for the SRF loan. Each year the DEP's Division of Municipal Services canvasses all of the state's, cities, towns, and districts for projects with a potential to receive financial assistance.

The Town of Nantucket must address the equitable apportionment of the capital costs amongst the either the general pollution, the system users and/or a combination of the two. Typically, there are limited financial resources available to enable a community to undertake such projects. The following sources are frequently used in combination to arrive at a financing solution:

- Federal and/or state funding through grants and/or loans;
- Betterment assessments based on the fixed uniform rate (linear foot frontage and/or property area) or the uniform unit method (number of existing/potential sewer units). Currently the Town of Nantucket bylaw develops betterments based on either total square footage of the lot or linear foot frontage;
- Special assessments such as connection charges, capacity reserve charges, privilege fees, interest, and fines;
- User charges; and
- Property taxes.

**Betterment Assessment**

A betterment is a tax or charge that is permitted where properties within a limited area receive a special benefit or advantage, other than the general advantage to the community, from the construction of a public improvement which results in an enhancement of the value or use of those properties.

**User Fee**

A user fee charge is permitted for properties that are connected into the wastewater infrastructure who pay for the cost for the operation and maintenance of the system. Currently, the Town of Nantucket takes the total cost of operation and maintenance of the wastewater infrastructure, wastewater pumping stations and wastewater treatment facilities and divides it equally among the approximately 4,200 users. The Town of Nantucket completed an update of its user fee in December 2001. Refer to Appendix I for a copy of the report.

**Funding Scenarios**

As of the filing of this Document, the Town of Nantucket had not determined how to finance the recommendations of the CWMP/FEIR and Evaluation and Mapping Project. However, the Town has determined that four projects are needed to be placed on the Spring 2004 Town Meeting. These projects consist of the: (1) design phase of the Surfside WWTF Upgrades; (2) Brant Point Rehabilitation; (3) Infiltration/Inflow Study; and (4) the establishment of the Town and Siasconset Sewer Districts. These projects will be paid for through bonds debt service cost, which will be recovered through property taxes. In order to reduce the financial burden to the tax payers, the Town applied for SRF funding for the Brant Point Rehabilitation and Infiltration/Inflow Study Projects. Discussions with the DEP have indicated that both of these projects have been accepted to receive low-interest loans through the program.

## 2. Operation and Maintenance Costs

In addition to the capital cost for designing and constructing the recommend plan contained in the CWMP/FEIR, there will also be an annual cost for the Town to both operate and maintain the system. The estimated Operation and Maintenance Cost for the recommended plan is $2.73 million (Present Day Cost). The operation and maintenance cost associated with the system primarily consists of costs to operate and maintain the wastewater

collection system, pumping stations, force mains, maintenance on the mechanical pumping equipment, annual replacement costs, power costs, and WWTFs. In areas where low pressure sewers are part of the recommend plan, the Town has elected to have the individual homeowners operate and maintain the individual grinder pump units. Therefore, the homeowners will be required to handle all future service issues and associated costs. Refer to Table 5-10 for estimated Operation and Maintenance Cost for the Recommended Plan.

**TABLE 5-10**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**ESTIMATED OPERATION AND MAINTENANCE COSTS**
**FOR CWMP/FEIR RECOMMENDATIONS**

| Description | Estimated Operation and Maintenance Cost |
|---|---|
| Wastewater Treatment Facilities | |
| Surfside | $1,290,000 |
| Siasconset | $270,000 |
| Madaket | $400,000 |
| Infrastructure | $520,000 |
| Septage Management Plan | $250,000 |
| Total | $2,730,000 |

In addition to the capital cost for designing and constructing the recommend plan contained in the Evaluation and Mapping Project, there will also be an annual cost for the Town to both operate and maintain the system. The estimated Operation and Maintenance Cost for the recommended plan is $44,000 (Present Day Cost). The operation and maintenance cost associated with the system consists of costs to operate and maintain the stormwater collection system and to update the wastewater and stormwater mapping.

**TABLE 5-11**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**ESTIMATED OPERATION AND MAINTENANCE COSTS**
**FOR EVALUATION AND MAPPING RECOMMENDATIONS**

| Description | | Estimated Operation and Maintenance Cost |
|---|---|---|
| Wastewater Infrastructure | | Included Above |
| Stormwater Infrastructure | | $29,000 |
| GIS Mapping | | $15,000 |
| | Total | $44,000 |

## E. IMPLEMENTATION PLAN

The recommended plan is estimated to be designed and constructed over a twelve-year period. The recommended plan has been divided into seven construction phases. The construction phases were developed based on: (1) the need of an area to be serviced as identified in the CWMP/EIR Phase I Document; (2) funding constraints; (3) recommended on-site solutions; (4) recommended off-site solutions; and (5) minimizing construction related disruptions to the Town. Table 5-12 and Table 5-13 summarizes the recommended on-site solutions, recommended off-site solutions, length of time, estimated costs under each recommended solution and area of construction phase as well as funding mechanisms required under the Capital Improvement Program FY 2004-2014 for Wastewater and Stormwater Infrastructure presented to the Town. Once the Town, regulatory and non-regulatory agencies and the public approve the recommended plan, the recommendations can by further broken down into construction contracts.

# TOWN OF NANTUCKET
## DEPARTMENT OF PUBLIC WORKS
## CAPITAL IMPROVEMENT PROGRAM FY 2004-2014
## FOR CWMP/FEIR RECOMMENDATIONS

| | | | | Estimated Project Cost (As of 09/03) | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | Remainder |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Comprehensive Wastewater Management Plan | On-Site Solution | Septage Management Plan | Cisco | | | | | | | | | | | | | |
| | | | Miacomet | | | | | | | | | | | | | |
| | | | Surfside | | | | | | | | | | | | | |
| | | | Tom Nevers High Density | | | | | | | | | | | | | |
| | | | Tom Nevers Low Density | | | | | | | | | | | | | |
| | | | Town-WPZ | | | | | | | | | | | | | |
| | | | Remainder of Island | | | | | | | | | | | | | |
| | | | Pocomo* | | | | | | | | | | | | | |
| | | | Polpis* | | | | | | | | | | | | | |
| | | | Quidnet* | | | | | | | | | | | | | |
| | | | Wauwinet* | | | | | | | | | | | | | |
| | Off-Site Solution | Wastewater Treatment Facility | Surfside WWTF | $ 32,630,000 | $ 2,250,000 | | $ 32,230,000 | | | | | | | | | |
| | | | Siasconset WWTF | | | | | | | | | | | | | |
| | | | Madaket WWTF | $ 25,380,000 | | $ 1,800,000 | | $ 25,820,000 | | | | | | | | |
| | | Infrastructure Expansion | Madaket | $ 11,150,000 | | $ 790,000 | | | $ 11,680,000 | | | | | | | |
| | | | Monomoy | $ 6,130,000 | | | | | | $ 490,000 | | $ 3,840,000 | | | | |
| | | | Somerset | $ 7,620,000 | | | | | $ 590,000 | | $ 8,470,000 | | | | | |
| | | | Shimmo | $ 7,340,000 | | | | | | | $ 600,000 | | $ 8,660,000 | | | |
| | | | Warren's Landing | $ 1,830,000 | | $ 130,000 | | | | $ 1,980,000 | | | | | | |
| | | | | $ 92,080,000 | $ 2,250,000 | $ 2,720,000 | $ 32,230,000 | $ 25,820,000 | $ 12,270,000 | $ 2,470,000 | $ 9,070,000 | $ 3,840,000 | $ 8,660,000 | $ - | $ - | |

* Wastewater disposal recommendation(s) for these study areas to be based on the results of the on-going MA DEP Estuaries Project.

Legend

- Project Currently Funded
- Project Required By ACO
- Project Recommended
- Town Meeting Appropriation for Design Phase
- Town Meeting Appropriation for Construction Phase
- Construction Duration

EARTH TECH

September 22, 2003

# TOWN OF NANTUCKET
## DEPARTMENT OF PUBLIC WORKS
## CAPITAL IMPROVEMENT PROGRAM FY 2004-2014
## FOR EVALUATION AND MAPPING RECOMMENDATIONS

| | | | | Estimated Project Cost (As of 09/03) | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | Remainder |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Evaluation & Mapping | Wastewater | Infiltration/Inflow | Study - Area M-1 | | | | | | | | | | | | | |
| | | | Construction | $ 2,140,000 | | $ 150,000 | | $ 2,180,000 | | | | | | | | |
| | | | Study - Remainder | $ 1,100,000 | $ 1,100,000 | | | | | | | | | | | |
| | | | Construction | $ 30,870,000 | | | $ 2,260,000 | | $ 2,810,000 | $ 2,900,000 | $ 2,990,000 | $ 3,070,000 | $ 3,170,000 | $ 3,260,000 | $ 3,360,000 | TBD |
| | | Infrastructure Improvements | | $ 9,570,000 | | | | $ 720,000 | | $ 10,330,000 | | | | | | |
| | Stormwater | Outfalls | | $ 27,840,000 | | | | | $ 2,160,000 | | $ 2,990,000 | $ 3,070,000 | $ 3,170,000 | $ 3,260,000 | $ 3,360,000 | TBD |
| | | Infrastructure | | $ 11,750,000 | | | | | $ 910,000 | | $ 13,060,000 | | | | | |
| | GIS Mapping | Phase I | | | | | | | | | | | | | | |
| | | Phase II | | $ 50,000 | $ 50,000 | | | | | | | | | | | |
| | | | | $ 83,320,000 | $ 1,150,000 | $ 150,000 | $ 2,260,000 | $ 2,900,000 | $ 5,880,000 | $ 13,230,000 | $ 19,040,000 | $ 6,140,000 | $ 6,340,000 | $ 6,520,000 | $ 6,720,000 | |
| | | | | $ 175,400,000 | $ 3,400,000 | $ 2,870,000 | $ 34,490,000 | $ 28,720,000 | $ 18,150,000 | $ 15,700,000 | $ 28,110,000 | $ 9,980,000 | $ 15,000,000 | $ 6,520,000 | $ 6,720,000 | |

Legend

- Project Currently Funded
- Project Required By ACO
- Project Recommended
- Town Meeting Appropriation for Design Phase
- Town Meeting Appropriation for Construction Phase
- Construction Duration

This type of program needs to be completed over many years. Based on the scope of work and the financial commitment required for this recommended plan and other Town projects, it is recommended that be completed over a 10 to 20-year period. The following is a list of specific tasks for implementation for each year of the recommended plan in chronological order:

- Appropriate project funds at the Annual April Town meeting for the Design Phase;
- Execute a design phase engineering contract and proceed with the engineering design in mid-July;
- Prepare and submit a Project Evaluation Form (PEF) to the DEP. Currently, PEF's are due to the DEP by August 15 of each year. The PEF should include documentation that the Town has appropriated funds for the design and construction. The submittal of the PEF will allow the DEP to review and assign priority points to get the project on the calendar year "Priority List" for funding on January 1. Submittal of this CWMP to the DEP for approval will result in a higher rating for each project;
- Appropriate project funds at the Annual April Town meeting for the Construction Phase;
- Execute a construction phase engineering contract and proceed with the SRF Loan funding application in July;
- Prepare and submit SRF Loan funding application and contract documents (plans and specifications) for construction of the project. Currently, loan applications and contract documents are due to the DEP by October 15;
- Submit required Permit Applications by October 15. Permits and environmental determinations should be in hand within 2 to 3 months from the date of submittal, depending on the review and approval by regulatory agencies. It is anticipated that a Conservation Commission Notice of Intent will be required for each project. In addition, it should be noted that completed contract documents are required for most permit applications;
- DEP approves the SRF application for funding and contract documents by December 31;
- Receive approval from DEP to advertise and publicly bid the project by February 1;
- Advertise and publicly bid the project (typically six to ten weeks depending upon on the size and type of project);
- Receive bids and prepare a SRF Part B for the project (typically two to four weeks to prepare Part B depending upon the size of project and completeness of the contractor information);
- Submit Part B to DEP for review and approval. Receive approval from DEP to award the project (typically up to six to eight weeks for DEP review and approval);
- Award to contractor (typically up to two months after bid opening dependent on DEP

review and approval);

- Construction of project and SRF monthly draw-downs; and
- Complete record plans and do DEP SRF Closeout; (typically up to two months depending upon size of the project).

# Section 6.0

## Final Environmental Impact Report

# 6.0 FINAL ENVIRONMENTAL IMPACT REPORT

## A. PROJECT DESCRIPTION

### 1. General

This Final Environmental Impact Report (FEIR) presents an analysis of the impacts associated with the construction of the recommend wastewater treatment plan for the Town of Nantucket. This FEIR has been prepared in order to satisfy the procedural requirements of the Massachusetts Environmental Policy Act (MEPA). The file number issued for the Project by the Executive Office of Environmental Affairs (EOEA) is EOEA No. 12617.

The Secretary's Certificate on the ENF and Phase I Report was issued on October 10, 2001 by the Secretary of Environmental Affairs (Secretary). The complete MEPA Certificate and the responses to the comment letters are included in Appendix L. Section 1.0 is devoted in its entirety to addressing the comments received from the Secretary in the MEPA Certificate and in a letter dated May 17, 2002, which is also included in Appendix L.

The Secretary's Certificate on the Phase II Report was issued on December 1, 2003 by the Secretary of Environmental Affairs (Secretary). The complete MEPA Certificate and the responses to the comment letters are included in Appendix M.

### 2. Summary

The recommended plan for the Town of Nantucket is detailed in Section 5.0 of this report. The plan includes the upgrade and expansion of the existing Surfside Wastewater Treatment Facility, and the design and construction of a new wastewater treatment facility in Madaket. The new facility in Madaket will be located on the FAA site. The new facility will include the treatment and disposal of wastewater for the Madaket and the Warren's Landing needs areas. The recommended plan also includes the treatment of the wastewater for the Needs Areas of Shimmo, Somerset, and Monomoy to be treated within the existing roadways.

### 3. Needs Areas

The Needs Areas are detailed in Sections 1.0 and 5.0 of this Report and include the following Study Areas:

| | |
|---|---|
| Madaket | Shimmo |
| Monomoy | Somerset |
| Pocomo | Town WPZ |
| Polpis | Warren's Landing |
| Quidnet | Wauwinet |

### 4. Disposal Site Alternatives

The entire Phase III Document details the disposal site alternatives.

### 5. Threshold Exceedances

The proposed project required the FEIR due to exceedance of the MEPA regulation Section 11.03 (5) a3 dealing with the construction of more than 10 miles of new sewer. The proposed project includes approximately 22 miles of sewer main in the areas of Madaket, Warren's Landing, Shimmo, Somerset, and Monomoy.

## B. WATER SUPPLY

### 1. General

The Secretary's Certificate requests more information concerning the water supply to the Town and how the existing and projected water use fits with the Water Management Act (WMA) approval for the Town. This is detailed in the Water Balance completed for the Island, which is included in Section 2.0 of this Report. This review shows the effects of the selected alternative on the Water Management Act.

### 2. Existing Conditions

The water supply on the Island is from groundwater sources withdrawn for the sole source aquifer. The water is withdrawn through seven wells on the Island and is distributed by two municipal water companies. The existing water use is detailed in the Water Balance contained in Section 2 of this Report.

### 3. Proposed Water Use

The proposed water use is calculated to show only the effects of the build out of the Needs Areas that are proposed to be sewered. The build out is based on current buildable lots as defined by current zoning and state land use codes from the Town assessor database. The proposed water use for the Needs Areas is assumed to be a worst-case scenario with the build out of the area.

**Madaket**

In the Madaket Study Area the current water supply comes from individual private water wells. The future potential water use is assumed to come from private water supplies and will not impact the Water Management Act. If municipal water use is extended to these areas at some point in the future, the DEP and other state agencies would review the expansion in accordance the Water Management Act.

**Warren's Landing**

Table 6-1 shows the current water supply for Warren's Landing Study Area as the initial yearly average flow. The initial yearly average flow for the Warren's Landing Study Area is 12,765 gpd. The design yearly average flow was calculated based on the build out of current buildable lots and was calculated to be 23,140 gpd. The water demand in Warren's Landing Study Area may increase by up to a yearly average 10,375 gpd.

**Somerset**

Table 6-2 shows the current water supply for Somerset Study Area as the initial yearly average flow. The initial yearly average flow for the Somerset Study Area is 30,325 gpd. The design yearly average flow was calculated based on the build out of current buildable lots and was calculated to be 88,740 gpd. The water demand in Somerset Study Area may increase by up to a yearly average 58,415 gpd.

**TABLE 6-1**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**WARREN'S LANDING STUDY AREA**
**WATER USE DESIGN CONDITIONS**

| Design Condition | Unit Type | Unit Number | Unit Flow (gpd) | Total Flow (gallons) Off Season | Total Flow (gallons) Peak Season | Total Flow (gallons) Year | Average (gpd) |
|---|---|---|---|---|---|---|---|
| Initial | Residential | 69 | 185 | 3,893,325 | 765,900 | 4,659,225 | 12,765 |
| | Commercial | 0 | 320 | 0 | 0 | 0 | 0 |
| | | | | | | | 12,765 |
| Design | Residential | 89 | 260 | 7,057,700 | 1,388,400 | 8,446,100 | 23,140 |
| | Commercial | 0- | 345 | 0 | 0 | 0 | 0 |
| | | | | | | | 23,140 |
| | | | | | | Difference | 10,375 |

**TABLE 6-2**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SOMERSET STUDY AREA**
**WATER USE DESIGN CONDITIONS**

| Design Condition | Unit Type | Unit Number | Unit Flow (gpd) | Total Flow (gallons) Off Season | Total Flow (gallons) Peak Season | Total Flow (gallons) Year | Average (gpd) |
|---|---|---|---|---|---|---|---|
| Initial | Residential | 157 | 185 | 8,858,725 | 1,742,700 | 10,601,425 | 29,045 |
| | Commercial | 4 | 320 | 390,400 | 76,800 | 467,200 | 1,280 |
| | | | | | | | 30,325 |
| Design | Residential | 336 | 260 | 26,644,800 | 5,241,600 | 31,886,400 | 87,360 |
| | Commercial | 4 | 345 | 420,900 | 82,800 | 503,700 | 1,380 |
| | | | | | | | 88,740 |
| | | | | | | Difference | 58,415 |

**Shimmo**

Table 6-3 shows the current water supply for the Shimmo Study Area as the initial yearly average flow. The initial yearly average flow for the Shimmo Study Area is 25,295 gpd. The design yearly average flow was calculated based on the build out of current buildable lots and was calculated to be 80,165 gpd. The water demand in Shimmo Study Area may increase by up to yearly average 54,870 gpd.

**TABLE 6-3**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**SHIMMO STUDY AREA**
**WATER USE DESIGN CONDITIONS**

| | Unit | | | Total Flow (gallons) | | | |
|---|---|---|---|---|---|---|---|
| Design Condition | Type | Number | Flow (gpd) | Off Season | Peak Season | Year | Average (gpd) |
| Initial | Residential | 135 | 185 | 7,617,375 | 1,498,500 | 9,115,875 | 24,975 |
| | Commercial | 1 | 320 | 97,600 | 19,200 | 116,800 | 320 |
| | | | | | | | 25,295 |
| Design | Residential | 307 | 260 | 24,345,100 | 4,789,200 | 29,134,300 | 79,820 |
| | Commercial | 1 | 345 | 105,225 | 20,700 | 125,925 | 345 |
| | | | | | | | 80,165 |
| | | | | | | Difference | 54,870 |

**Monomoy**

Table 6-4 shows the current water supply for the Monomoy Study Area as the initial yearly average flow. The initial yearly average flow for the Monomoy Study Area is 34,580 gpd. The design yearly average flow was calculated based on the build out of current buildable lots and was calculated to be 98,100 gpd. The water demand in Monomoy Study Area may increase by up to yearly average 63,520 gpd.

**TABLE 6-4**
**TOWN OF NANTUCKET**
**CWMP/FEIR**
**MONOMOY STUDY AREA**
**WATER USE DESIGN CONDITIONS**

| Design Condition | Unit Type | Unit Number | Unit Flow (gpd) | Total Flow (gallons) Off Season | Total Flow (gallons) Peak Season | Total Flow (gallons) Year | Average (gpd) |
|---|---|---|---|---|---|---|---|
| Initial | Residential | 180 | 185 | 10,156,500 | 1,998,000 | 12,154,500 | 33,300 |
| | Commercial | 4 | 320 | 390,400 | 76,800 | 467,200 | 1,280 |
| | | | | | | | 34,580 |
| Design | Residential | 372 | 260 | 29,499,600 | 5,803,200 | 35,302,800 | 96,720 |
| | Commercial | 4 | 345 | 420,900 | 82,800 | 503,700 | 1,380 |
| | | | | | | | 98,100 |
| | | | | | | Difference | 63,520 |

**Impacts to the Water Management Act**

If the Needs Areas are built out according to current zoning and land uses, then the water demand from these areas may increase by up to a total of 187,180 gpd. The total amount of water that the Island is allowed to withdraw according to the Water Management Act is 1.54 million gallons per day (mgd). In the year 2001, the Town withdrew an average of 1.317 mgd. The potential increase based on the design flow selected alternative would only increase the withdrawal rate by up to 1.50 mgd. This increase would not exceed the current Water Management Act approval.

## C. MITIGATION MEASURES

The Town is proactive concerning any potentially negative impacts from the selected alternatives for this project. The majority of temporary negative impacts will come from construction work. Any temporary construction impacts will be required to be mitigated in the construction contract. The contract will include mitigation measures that would not allow any construction in roadways during the summer months, holidays. Construction would not be allowed during key Town events, such as the Christmas Stroll and Daffodil Weekend.

## D. EXECUTIVE ORDER 385/PLANNING FOR GROWTH

The Town of Nantucket has a Planning and Economic Development Commission (NP&EDC). The NP&EDC has created a planning document titled, "Charting the Future: The Nantucket Comprehensive Community Plan." The Town agencies have worked together to find a recommended solution for the future planning and growth in Nantucket. The recommended solution takes into account the "Charting the Future: The Nantucket Comprehensive Community Plan" and Executive Order 385. The Community Plan's goal is not to end growth, nor accelerate it but rather to develop alternatives in order to manage it, and to keep it at a pace and level where the Island is still able to:

- Protect the working community of Nantucket and provide for the housing needs of those whose choose to live on the Island;
- Protect the open spaces and natural resources;
- Enhance the ability of Nantucketers to live and work on the Island;
- Protect the historical integrity of the land and buildings;
- Maintain the strong tourism-based economy;
- Maintain access to the beaches; and
- Provide a healthy environment for the residents.

The Phase III document has taken into consideration Executive Order 385 in its recommended wastewater collection, treatment and disposal plans for the Island. For example, the recommended solution for the Madaket and Warren's Landing Study Areas incorporates low-pressure sewers instead of gravity sewers. This system is designed as a calculated flow base system for existing developed lots and those designated as buildable in the future according to the current state land use codes and local zoning. This will require local approval, special legislation and the development of new zoning overlays delineating sewer and septic districts. While the introduction of sewer infrastructure in itself does not serve to promote or deny growth, the local zoning and by-laws will. The intent of this CWMP/FEIR is to solve the problems of the existing development while at the same time not serving to promote sprawl or unchecked development in more rural, less dense areas on Island. Section 4.0 details the recommended measures to be taken by the Town in order to conform to not only Executive Order 385 but its own Community Plan goals as well.

As an additional proactive approach to keep unwarranted growth in check, the Town has recently completed a Septage Management Plan (SMP) for those areas on Island currently recommended for long-term sustainability with their current on-site wastewater disposal systems. Once implemented, this SMP will serve prevent the Town of Nantucket from having to finance the high cost of extending municipal sewers into additional areas in the future. A well managed SMP has the potential to provide the means with which to prevent areas on Island from over development due to the construction of infrastructure and utilities in areas previously not serviced by such as well as preserving the community structure that originally attractive residents to the Island.

# Section 7.0

## Review of Public Participation Program

# 7.0 REVIEW OF PUBLIC PARTICIPATION PROGRAM

## A. GENERAL

As part of the scope of this Comprehensive Wastewater Management Plan/Environmental Impact Report (CWMP/EIR), the Town of Nantucket has conducted an extensive public education program. The purpose of this public education/participation program is to inform the public of the scope and progress of the planning study, to describe the results of the wastewater needs analysis and siting alternatives selection process, and to encourage public input throughout the entire planning process.

Earth Tech, along with the Town Administration, Town of Nantucket Department of Public Works and Nantucket Planning and Economic Development Commission, undertook a comprehensive public participation campaign in order to educate and inform all interested parties on the Island of all the on-going CWMP/EIR work. A presentation of the CWMP/EIR was made to the annual meeting of the Nantucket Civic League on June 2, 2003. This organization represents members of each Island village/community. Through this initial meeting with the Nantucket Civic League, a number of additional, individual community meetings were recommended and arranged. A CWMP/EIR presentation was made at the annual meeting of the Tristam's Long Pond Association in Madaket on August 9, 2003. The CWMP/EIR was also on the annual meeting agenda at the Quidnet-Squam Association on August 11, 2003. The Nantucket Civic League held another presentation at the close of the Phase II CWMP/DEIR on November 3, 2003. Through continued communication with these member groups, this effort will continue.

Additional meetings and presentations have been held with Island groups including the Nantucket Land Council on August 8, 2003. As a result of this meeting, an additional Depository has been established at the Land Council's Ash Lane office.

A meeting with the Nantucket Conservation Foundation resulted in the cooperative efforts of soil and groundwater testing in the Madaket area.

Earth Tech, in conjunction with the Department of Public Works, has also initiated a poster campaign to educate both citizens and visitors to the Island about the Comprehensive Wastewater Management Plan. Posters have been distributed to the Planning and Economic Development Department, Town Hall, the Office of Marine Fisheries, the Department of Public Works, and the Library and have been posted in the Steamship Authority and the Airport. Tri-fold brochures have also been distributed through the Department of Public Works. A copy of the poster and tri-fold brochure can be found in Appendix L.

In addition to the six Depositories located on Island, the Phase I and II Reports have been posted on the Town's website under the Department of Public works and can be accessed at http://www.nantucket-ma.gov/.

## B. PUBLIC MEETINGS

Throughout the development of the CWMP/EIR, the Town of Nantucket and Earth Tech have been proactive in providing timely and informative information to the residents. All meetings held with Town Officials have been posted as required in Town Hall and have been advertised in the local newspaper(s). The following is a summary of the meetings and workshops that have been held regarding this project.

1. The Public Informational Meeting was held on July 29, 1999 to present the results of the Phase I CWMP/EIR Document. The Public Informational Meetings were widely publicized and posted in the Town Hall.

2. A public meeting was held with the Nantucket Planning and Economic Development Commission on September 4, 2001.

3. A Public Informational Meeting was held on October 21, 2003 to present the results of the Phase II CWMP/DEIR Document. The Public Informational Meetings were widely publicized and posted in the Town Hall.

4. At the conclusion of this last and final phase, Phase III, Final CWMP/EIR, a public hearing will be scheduled and held on Island to present the final recommended plan.

5. A Capital Improvement Plan Workshop, which outlined the financial aspects of the CWMP/EIR, was held with Town Officials on September 22, 2003, with the public in attendance.

6. A workshop on the build-out analysis contained in the CWMP/EIR Documents was held with the Board of Selectmen, the NP&EDC and other Town Officials on January 12, 2004.

7. Forum on Wastewater and Solid Waste Management sponsored by the Alliance of Nantucket's Working Community on November 20, 2003. Presentations were made by the Board of Health, Department of Public Works and Earth Tech, Marine Department, Conservation Commission, Wannacomet water Company and Waste Options.

8. Regularly scheduled meetings have been held with the Nantucket Board of Selectmen and the Department of Public Works. Earth Tech presented a workshop with the Board of Selectmen and all Town Department Heads on the progress of the CWMP/EIR on October 7, 2002. There are also, regularly scheduled meetings with state and federal regulators, including the DEP and representatives from the EOEA Nantucket Watershed Team and the Massachusetts Estuary Project.

9. A Madaket Harbor Quality Workshop was held on January 29, 2004 with the following members participating:
   - Town of Nantucket Department of Public Works
   - Town of Nantucket Board of Selectmen
   - The Alliance for Nantucket's Working Community
   - Nantucket Marine and Coastal Resources Department
   - Town of Nantucket Board of Health
   - Town of Nantucket Conservation Commission
   - Massachusetts Department of Environmental Protection
   - Massachusetts Estuaries Program

- Madaket Area Plan Work Group
- Nantucket Planning and Economic Development Commission
- Earth Tech

10. In addition to the above meetings and workshops, the Town of Nantucket and Earth Tech have prepared and presented the results of the CWMP/EIR Documents to various special interest groups such as but not limited to the NP&EDC, Quidnet/Squam Association, Madaket Long Pond Association, Wannacomet Water Company, Tristam's Long Pond Association in Madaket, Nantucket Land Council, Nantucket Civic League, and Nantucket Marine and Coastal Resources Department.

A copy of all of the public participation literature can be found in Appendix Q.

A newsletter titled, "Understanding Our Wastewater" was developed with the Town Administration and Department of Public Works, which was mailed directly to Nantucket households. The Newsletter summarizes the wastewater planning efforts to date, federal, state and local regulations driving the effort, additional on-going state planning projects and costs associated with the CWMP/EIR. A copy of the newsletter can be found in Appendix R.

## C. RESPONSIVENESS SUMMARIES

Earth Tech will prepare and distribute responsiveness summaries after the public hearing. These responsiveness summaries will identify the public participation activities and document significant questions, comments, concerns and suggestions by the public and responses by Town staff and Earth Tech. The responsiveness summaries will be distributed to the depositories, active participants and the mailing list.

## D. SUMMARY OF PUBLIC COMMENTS RECEIVED DURING THE MEPA PROCESS

The Town of Nantucket submitted an Environmental Notification Form (ENF) to MEPA on October 1, 2001. The 30-day comment period for the ENF ended on November 1, 2001 and on November 16, 2001, the Executive Office of Environmental Affairs (EOEA) determined that the project required an Environmental Impact Report (EIR) and established a special procedure for review of the required EIR.

The MEPA Certificate (EOEA No. 12617), issued by the Secretary of Environmental Affairs to the Town of Nantucket, requires the preparation of a Comprehensive Wastewater Management Plan/Environmental Impact Report (CWMP/EIR) for the Town and establishes a special procedure for review of this project. The special procedure is a phased review during which the scope for future phases is based in large part on the results of the preceding phase. A project description was included in the MEPA certificate. The Phase II scope is the "Alternatives and Site Identification and Draft Environmental Impact Report (DEIR)" and was finalized upon the completion of Phase I. A MEPA Certificate was issued by the Secretary of Environmental Affairs on December 1, 2003. The Phase III scope is the "Final CWMP/Environmental Impact Report (FEIR)" was finalized upon the completion of Phase II. Each phase of this project is distributed for review according to MEPA regulations. The MEPA Regulations allow for a 30 day review and public comment period following the filing of each report. The filing is advertised in the Environmental Monitor and is also widely publicized through local media, including the Inquirer and Mirror on Island. Therefore, there were ample opportunities for the appropriate public comment period for all interested parties to contribute to the outcome of this project. A copy of the MEPA Certificates and the responses to comments on the Phase I and Phase II Reports are attached in Appendix L and Appendix M, respectively.

In addition to the MEPA public comments allowed under the MEPA process, the Town initiated a "Letter Campaign" based on subsequent public meetings outside of the MEPA Process. This further enabled all interested parties to have their comments heard and questions answered with a direct response. Copies of letters and responses can be viewed in Appendix S.

## E. CIRCULATION LIST

Secretary of Environmental Affairs
Executive Office of Environmental Affairs
Attn: MEPA Office
100 Cambridge Street, Suite 900
Boston, MA 02114
(Three Copies)

Department of Environmental Protection
Boston Office
Attn: Ron Lyberger
One Winter Street, 5th Floor
Boston, MA 02108
(Two Copies)

Nantucket Department of Public Works
188 Madaket Road
Nantucket, MA 02554
(Two Copies plus Depository)

Nantucket Board of Selectmen
Town Hall
16 Broad Street
Nantucket, MA 02554
(Six Copies plus Depository)

Department of Environmental Protection

Nantucket Planning & Economic

South East Regional Office
Attn: Frank Mezzacappa
20 Riverside Drive
Lakeville, MA 02347
(Four Copies)

Development Commission
Attn: John Pagini
4 North Water Street
Nantucket, MA 02554
(One Copy plus Depository)

Nantucket Conservation Commission
Attn: Michael Glowacki, Chairman
Town Hall Annex
37 Washington Street
Nantucket, MA 02554

Nantucket Board of Health
Attn: Richard Ray
Town Hall Annex
37 Washington Street
Nantucket, MA 02554

Nantucket Division of Marine Fisheries
Attn: Dave Fronzuto
38 Washington Street
Nantucket, MA 02554

Wannacomet Water Company
Attn: Robert Gardner
One Milestone Road
Nantucket, MA 02554

Massachusetts Historical Commission
Attn: Brona Simon
Massachusetts Archives Building
220 Morrissey Boulevard
Boston, MA 02125

Nantucket Land Council, Inc.
Attn: Linda Holland, Executive Director
Six Ash Lane
P.O. Box 502
Nantucket, MA 02554
(One Copy plus Depository)

Massachusetts Estuary Project
c/o SMAST – Center for Marine
Science & Technology
Attn: Dr. Brian Howes
706 South Rodney French Boulevard
New Bedford, MA 02744-1221

Massachusetts Estuary Project
c/o SMAST – Center for Marine
Science & Technology
Attn: Roland Samimy
706 South Rodney French Boulevard
New Bedford, MA 02744-1221

Division of Marine Fisheries
Attn: Neil Churchill
50A Portside Drive
Pocassett, MA 02559

Coastal Zone Management, Suite 800
Attn: Mr. Todd Callahan
251 Causeway Street
Boston, MA 02114

MassWildlife
Natural Heritage and Endangered
Species Program
1 Rabbit Hill Road
Westborough, MA 01581

Mass. Department of Food & Agriculture
Attn: Marcia Starkey
251 Causeway Street, Suite 500
Boston, MA 02114

CZM Cape Cod & Islands Regional Office
Attn: Truman Henson/Stephen McKenna
P.O. Box 220
Barnstable, MA 02630-0220

Division of Marine Fisheries
Attn: Dr. Jack Schwartz
30 Emerson Avenue
Gloucester, MA 01930

Nantucket Community Association
Attn: Dale Stoodly

Nantucket Civic League
Attn: John W. Atherton, Jr.

917 North Rodney Street
Wilmington, DE 14806

Nantucket Community Association
Attn: William K. Tell, Jr.
660 Steamboat Road
Greenwich, CT 06830

Nantucket Community Association
Attn: Duncan Sutphen
1155 Bowline Drive
Vero Beach, FL 32963

Madaket Conservation Association
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55 Tennessee Avenue
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Nantucket, MA 02554

# Section 8.0

## SRF Grant/Loan Administration

# 8.0 SRF GRANT/LOAN ADMINISTRATION

## A. GENERAL

As part of the scope of this Town-wide Comprehensive Wastewater Management Plan/Environmental Impact Report (CWMP/EIR), Earth Tech submitted to the Massachusetts Department of Environmental Protection (DEP) a Calendar Year (CY) 2000 Project Priority List/Intended Use Plan (IUP) Project Evaluation Form (PEF) on June 30, 1999.

The "Calendar Year 2000 Intended Use Plan and Project Priority List" was finalized on November 12, 1999 by the Massachusetts Department of Environmental Protection, and the Town-wide Comprehensive Wastewater Management Plan Project was identified on the Intended Use Plan as a project (DEP/BRM Project Number CWSRF 625) eligible for financial assistance from the State Revolving Fund effective January 1, 2000.

On October 13, 2000 Earth Tech prepared and submitted two copies of the Town's SRF Application for the Comprehensive Wastewater Management Plan/Environmental Impact Report for DEP Division of Municipal Services and Water Pollution Abatement Trust review and approval.

A Restricted Project Approval Certificate (PAC) was issued for this project on January 29, 2001. The PAC was restricted until all of the Special Conditions in Exhibit C were satisfied. On November 16, 2001 the Department of Environmental Protection approved the revised Comprehensive Wastewater Management Plan/Environmental Impact Report scope and lifted the restriction. Refer to Appendix T for a copy of the approved Scope of Work.

Grant/Loan administration services are being provided in accordance with DEP financial assistance guidelines and procedures. Liaison among the Town, DEP officials and Earth Tech, and contract administration, are being carried out. Earth Tech is assisting the Town in submitting (on average) monthly SRF drawdown requests to the DEP for reimbursement for costs incurred to undertake the study. Upon completion of the project, the Town and Earth Tech will prepare and submit the required loan closeout documents.

The Town will then be responsible to budget for debt service payments to the Water Pollution Abatement Trust over the 20-year payoff period for this loan.

*Report*

# Phase III - Comprehensive Wastewater Management Plan and Final Environmental Impact Report

# Nantucket, Massachusetts

## Volume II of III

*Prepared for:*

Nantucket Department of Public Works
188 Madaket Road
Nantucket, Massachusetts 02554-2623

*Prepared by:*

Earth Tech, Inc.
196 Baker Avenue
Concord, Massachusetts 01742-2167

*March 2004*

*27355*

# Phase III - Comprehensive Wastewater Management Plan and Final Environmental Impact Report

## Nantucket, Massachusetts

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196 Baker Avenue
Concord, Massachusetts 01742-2167

*March 2004*

## LIST OF APPENDICES


| Appendix | Description |
|---|---|
| A | Administrative Consent Order entitled "Surfside Wastewater Treatment Facility ACOP-BO-03-1G002, Groundwater Discharge Permit SE#1-200" |
| B | Wannacomet Water Company Literature |
| C | Coastal Erosion Reports for 1999 and 2002 |
| D | Surfside WWTF DEP Class III Groundwater Discharge Permit |
| E | Hydrogeological Report for Surfside WWTF Site |
| F | Hydrogeological Report for FAA Site |
| G | Project Notification Form for Massachusetts Historical Commission - Step 1 Archaeological Survey |
| H | Massachusetts Bureau of Waste Site Clean Up |
| I | Town of Nantucket, Sewer Rate Study dated December 2001 |
| J | Siasconset WWTF Administrative Consent Order |
| K | Town of Nantucket, Infiltration/Inflow Report dated December 2003 |

*Report*

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*March 2004*

## LIST OF APPENDICES


| Appendix | Description |
|---|---|
| L | CWMP/EIR Phase I MEPA Certificate and Response to Comments |
| M | CWMP/DEIR Phase II MEPA Certificate and Response to Comments |
| N | Town of Nantucket Surfside Wastewater Treatment Plant Erosion Emergency Plan |
| O | NP&EDC Partial Update of 1997 Nantucket Buildout Analysis And Comparison of Buildout Potential of Town Overlay district, Earthtech CWMP Boundaries, and Sewered Area Boundaries |
| P | Earth Tech letter to CZM and DEO dated January 21, 2004 transmitting proposed infrastructure (roadway pipes, pump stations, etc.) superimposed on FEMA paper maps and Earth Tech letter to CZM dated March 10, 2004 transmitting Marine and Coastal Department Erosion Data |
| Q | Public Participation Literature |
| R | Town of Nantucket, Board of Selectmen "Understanding Our Wastewater – Volume 1, Issue 1" dated March 2004 |
| S | Town of Nantucket, Board of Selectmen CWMP/EIR Letter Campaign |
| T | CWMP/EIR Scope of Work |

Volumes II and III, Appendices can be reviewed at Depositories

# OPERATION AND MAINTENANCE MANUAL

## NANTUCKET, MASSACHUSETTS

## SURFSIDE WASTEWATER TREATMENT FACILITY

**Prepared For:**

Town of Nantucket
Surfside Wastewater Treatment Facility
South Shore Road
Nantucket, MA 02554

**Prepared By:**

AECOM
300 Baker Avenue, Suite 290
Concord, MA 01742

**January 2010**

# PURPOSE AND USE OF THIS MANUAL

This Operations and Maintenance (O&M) manual is intended to serve as a guide for efficient and economical operation of the Surfside Wastewater Treatment Facility (WWTF) located in Nantucket, Massachusetts. Contained herein are specific details relating to various functions and equipment as well as recommended operational procedures. Periodically, information gained as a result of WWTF operation should be incorporated into the manual.

This O&M manual has been prepared with a general overview of the operation and maintenance requirements for the facility. The operators must rely on the specific O&M data provided by the equipment suppliers and manufacturers.

This O&M manual included various figures and tables have been provide for general reference only. operators must rely on the record drawings and specific O&M data provided by the equipment suppliers and manufacturers.

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**TABLE OF CONTENTS**

**Section .....Page No.**

PURPOSE AND USE OF THIS MANUAL ..... 1
TABLE OF CONTENTS ..... i
1 - INTRODUCTION ..... 1
1.1 PURPOSE ..... 1
1.2 OPERATIONAL RESPONSIBILITY ..... 1
1.3 RESPONSIBILITY OF THE TOWN ..... 1
1.4 RESPONSIBILITY OF THE LICENSED OPERATOR ..... 2
1.5 DISCHARGE LICENSE ..... 3
1.6 DESCRIPTION OF THE FACILITY ..... 3
1.7 STAFFING PLAN ..... 6
2 - HEADWORKS ..... 1
2.1 GENERAL ..... 1
2.2 IN-CHANNEL GRINDER ..... 3
2.2.1 Description ..... 3
2.2.2 Operation and Control ..... 3
2.2.3 Equipment Maintenance ..... 4
2.3 INFLUENT FLOW MEASUREMENT ..... 5
2.3.1 Description ..... 5
2.3.2 Operation and Control ..... 6
2.4 INFLUENT SAMPLER ..... 7
2.4.1 Description ..... 7
2.4.2 Operation and Control ..... 7
2.5 GRIT COLLECTION AND REMOVAL ..... 8
2.5.1 Description ..... 8
2.5.2 Operation and Control ..... 9
2.6 GRIT CHAMBER BLOWERS ..... 11
2.6.1 Description ..... 11
2.6.2 Operation and Control ..... 12
2.7 GRIT PUMP ..... 13
2.7.1 Description ..... 13
2.7.2 Operation and Control ..... 14
2.7.3 Equipment Maintenance ..... 14

2.8 SEPTAGE RECEIVING STATION ..... 15
2.8.1 Description ..... 15
2.8.2 Operation and Control ..... 16
2.9.3 Equipment Maintenance ..... 18
2.10 SEPTAGE/SLUDGE HOLDING TANKS AND PUMPING ..... 20
2.10.1 Description ..... 20
2.10.2 Operation and Control ..... 22
3 - PRIMARY CLARIFIERS ..... 1
3.1 GENERAL ..... 1
3.2 SLUDGE COLLECTION EQUIPMENT ..... 2
3.2.1 Description ..... 2
3.2.2 Operation and Control ..... 5
3.3 SLUDGE PUMPS AND GRINDERS ..... 6
3.3.1 Description ..... 6
3.3.2 Operation and Control ..... 7
3.4 SCUM COLLECTION AND WITHDRAWAL ..... 8
3.5 SLUDGE WITHDRAWAL ..... 9
3.6 PRIMARY CLARIFIER TANK DEWATERING ..... 11
3.7 EQUIPMENT MAINTENANCE (Primary Tank and Collection Equipment) ..... 12
3.7.1 Inspections ..... 12
3.7.2 Troubleshooting ..... 13
4 - ADVANCED TREATMENT PROCESS ..... 1
4.1 GENERAL ..... 1
4.2 DISTRIBUTION BOX ..... 10
4.3 PRE-ANOXIC TANKS ..... 11
4.3.1 Description ..... 11
4.3.2 Submersible Mechanical Mixers ..... 12
4.3.3 Submersible Aeration Lift Pumps ..... 13
4.3.4 Operation and Control ..... 13
4.4 AERATION TANKS ..... 14
4.4.1 Description ..... 14
4.4.2 Aeration Tank Blowers ..... 15
4.4.3 Operation and Control ..... 16
4.5 MEMBRANE BIOREACTORS (MBR'S) ..... 17
4.5.1 Description ..... 17
4.5.2 MBR Blowers ..... 19
4.5.3 MBR Permeate/Backpulse Pumps ..... 20

4.5.4 MBR Cleaning System ....22
4.5.5 WAS Pumps ....24
4.5.6 DO Analyzers (AE/AIT-7338, A-1,2,3/B-1,2,3) ....24
4.5.7 Turbidimeters (AE/AIT-3537, 1/2/3/4) ....25
4.5.8 Instrumentation and Control System ....25
4.5.9 Operation and Control ....27
4.6 TANK DRAIN SYSTEM ....36
4.6.1 Description ....36
4.6.1 Operation and Control ....36
4.7 PLANT WATER SYSTEM ....37
4.7.1 Description ....37
4.7.1 Operation and Control ....37
5 - ULTRAVIOLET DISINFECTION .... 1
5.1 GENERAL ....1
5.2 ULTRAVIOLET DISINFECTION SYSTEM DESCRIPTION ....3
5.3 OPERATION AND CONTROL ....4
5.3.1 Automatic Cleaning System ....5
5.3.2 Module Removal Mechanism ....6
5.3.3 Operator Interface Terminal ....6
5.3.4 General Control Requirements ....7
5.3.5 Bank Cycling ....7
5.3.6 Module Control ....7
5.3.7 Lamp Control and Monitoring ....8
5.3.8 Wiper Control and Monitoring ....8
5.3.9 UV Intensity ....9
5.3.10 Bank Control ....9
5.3.11 Alarms ....9
5.3.12 Operator Interface ....10
5.3.13 Electrical System ....10
5.4 EFFLUENT SAMPLER ....11
5.4.1 Description ....11
5.4.2 Operation and Control ....12
5.5 EQUIPMENT MAINTENANCE ....12
6 - EFFLUENT DISPOSAL .... 15
6.1 RAPID INFILTRATION BASINS ....15
6.2 RAPID INFILTRATION BASIN OPERATION ....17
6.3 INFILTRATION BASIN MAINTENANCE ....20

6.4 GROUNDWATER MONITORING WELLS .....20
7 - SOLIDS PROCESSING ..... 1
7.1 INTRODUCTION.....1
7.2 OVERVIEW OF SLUDGE PROCESSING SYSTEM .....4
7.3 PRIMARY SLUDGE/SEPTAGE HOLDING TANKS .....5
7.3.1 Description .....5
7.3.2 Operation and Control.....6
7.4 ADVANCED TREATMENT BUILDING SLUDGE HOLDING TANKS.....9
7.4.1 Description .....9
7.4.2 Operation and Control.....9
7.5 SLUDGE TRANSFER AND PUMPING SYSTEMS .....13
7.5.1 Description - Septage/Primary Sludge Pumping System .....13
7.5.2 Description - WAS Pumping System.....14
7.5.3 Operation and Control.....15
7.6 ROTARY PRESS FEED SYSTEM.....16
7.6.1 Description .....16
7.6.2 Operation and Control.....16
7.7 ROTARY PRESS DEWATERING SYSTEM.....18
7.7.1 Description .....18
7.7.2 Polymer Feed System.....23
7.7.3 Principles of Operation.....25
7.7.4 Operation and Control.....28
7.8 SCREW CONVEYORS AND DISPOSAL .....37
7.8.1 Description .....37
7.8.2 Operation and Control.....39
7.9 LIQUID SLUDGE RECEIVING STATION.....39
7.9.1 Description .....39
7.9.2 Operation and Control.....40
7.10 GRIT DEWATERING SYSTEM (HYDROGRITTER).....40
7.10.1 Description .....40
7.10.2 Operation and Control.....40
7.10.3 Equipment Maintenance .....43
8 - IN-PLANT PUMPING STATION..... 1
8.1 GENERAL .....1
8.2 OPERATION AND CONTROLS .....2
8.3 MAINTENANCE SUMMARY.....4
9 – CHEMICALLY ENHANCED PRIMARY TREATMENT ..... 1

9.1 BACKGROUND - 2008 UPGRADE ....1
9.2 GENERAL ....1
9.3 REMAINING EQUIPMENT ....1
9.3.1 Polymer Systems ....1
9.3.2 Ferric Chloride System ....2
9.3.3 Sodium Hydroxide System ....2
9.3.4 Potassium Permanganate ....2
10 - ODOR CONTROL SYSTEM .... 1
10.1 GENERAL ....1
10.1.1 Description ....1
10.1.2 Principle of Operation ....4
10.2 OPERATION RECORDS ....7
10.3 CHEMICAL HANDLING ....7
10.4 OPERATION AND CONTROL ....8
10.5 START-UP AND OPERATION ....9
10.6 SYSTEM SHUT DOWN ....10
10.7 EQUIPMENT MAINTENANCE ....11
10.8 SCRUBBER PACT CLEANING PROCEDURE ....12
10.9 MIST ELIMINATOR CLEANING PROCEDURE ....13
10.10 PREPARATION OF CLEANING SOLUTIONS ....14
11 - HVAC/PLUMBING SYSTEMS .... 1
11.1 GENERAL ....1
11.2 HVAC EQUIPMENT MAINTENANCE ....1
11.3 HVAC AND PLUMBING EQUIPMENT ....2
11.3.1 Administration Building ....2
11.3.2 Process Analysis Building ....3
11.3.3 Equipment Storage Building ....6
11.3.4 Sludge Processing Building ....7
11.3.5 Primary Treatment Building ....11
11.3.6 Advanced Treatment Building ....13
11.3.7 Chemically Enhanced Primary Treatment (CEPT) Building ....16
12 - ELECTRICAL SYSTEMS .... 1
12.1 INTRODUCTION ....1
12.1.1 On-site Power Distribution ....1
12.1.2 Available Voltages ....1
12.1.3 Direct Current Power ....1
12.1.4 On site Power Generation. ....2

12.1.5 Other Electrical References. ....2
12.2 MAINTENANCE ....2
12.3 SAFETY ....4
12.4 480 VOLT SYSTEMS ....5
12.4.1 480 Volt Motor Control Centers ....5
12.4.2 Power Distribution Panels (DP's) ....5
12.4.3 Engine Generator ....5
12.5 120/208/240 VOLT SYSTEMS ....6
12.5.1 Lighting Panelboards ....6
12.5.2 Lighting ....7
12.6 FIRE ALARM SYSTEM ....7
12.7 SECURITY ALARM SYSTEM AND TELECOMMUNICATIONS SYSTEM ....10
12.7.1 Security and Alarm System ....10
12.7.2 Telecommunication System ....12
13 - SCADA/INSTRUMENTATION & CONTROL SYSTEMS .... 1
13.1 INSTRUMENTATION ....1
13.1.1 General ....1
13.1.2 Supervisory Control and Data Acquisition (SCADA) System ....2
13.1.3 Instrument Panels ....4
13.1.4 Instrument Equipment ....5
13.1.5 Maintenance ....6
13.2 MONITORING INSTRUMENTS AND ALARM CONDITIONS ....6
13.2.1 Turbidity Monitoring ....6
13.2.2 pH Monitoring ....7
13.2.3 Dissolved Oxygen Monitoring ....8
13.3 SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA) ....9
13.3.1 General ....9
13.3.2 Data Logs and Graphic Displays ....11
13.3.3 Trending ....11
13.3.4 Report Generation ....11
13.4 PROCESS CONTROL ABBREVIATED LOOP DESCRIPTIONS ....11
13.4.1 General ....11
13.4.2 General Overall Wastewater Treatment Facility Control ....12
14 - LABORATORY .... 1
14.1 GENERAL ....1
14.2 LABORATORY SAFETY ....1
14.3 TYPES OF SAMPLES ....2

14.3.1 Grab Samples ....2
14.3.2 Composite Samples ....2
14.4 RECORDS ....3
14.5 INFLUENT AND EFFLUENT QUALITY MONITORING AND TESTING ....5
14.6 TEST PURPOSE AND DESCRIPTION ....5
14.6.1 Dissolved Oxygen ....5
14.6.2 Biochemical Oxygen Demand ....7
14.6.3 Total Suspended Solids ....7
14.6.4 Total Solids ....9
14.6.5 Dissolved Solids ....9
14.6.6 Percent Solids (Sludge) ....9
14.6.7 Volatile Suspended Matter ....10
14.6.8 Chemical Oxygen Demand ....10
14.6.9 Hydrogen Ion Concentration (pH) ....10
14.6.10 Coliform Bacteria ....11
14.6.11 Total Kjeldahl Nitrogen (TKN) ....12
14.6.12 Ammonia ....13
14.7 CHEMICALS USED IN THE LAB ....13
15 - PREVENTATIVE MAINTENANCE .... 1
15.1 INTRODUCTION ....1
15.2 MAINTENANCE PROGRAM ....1
15.2.1 Overview ....1
15.2.2 Equipment Maintenance Records ....1
15.2.3 Inventory Cards ....2
15.3 ROUTINE MAINTENANCE ....3
15.3.1 Lockout/Tagout ....4
15.3.2 Tools, Equipment and Supplies ....4
15.3.3 Housekeeping Schedule ....4
15.3.4 Maintenance Contracts ....5
15.3.5 Greasing ....5
15.3.6 Grease and Lubricant Storage ....6
15.3.7 Cleaning Un-mounted Bearings ....6
15.3.8 Equipment Rotation ....7
15.3.9 Plant Library ....7
15.4 ELECTRICAL MAINTENANCE ....7
15.4.1 General ....7
15.4.1 Ampmeter/Troubleshooting ....8

16 - PERSONNEL ..... 1
16.1 GENERAL ..... 1
16.2 CERTIFICATIONS ..... 1
16.3 ATTENDANCE ..... 3
16.4 STAFF REQUIREMENTS ..... 3
16.4 JOB DESCRIPTIONS ..... 5
17 - SAFETY ..... 1
17.1 GENERAL ..... 1
17.2 MANAGEMENT RESPONSIBILITIES ..... 1
17.3 GAS HAZARDS ..... 2
17.4 CONFINED SPACE ENTRY ..... 3
17.5 FALLS AND FALLING OBJECTS ..... 4
17.6 CHEMICAL HAZARDS ..... 5
17.7 ELECTRICAL EQUIPMENT ..... 5
17.8 MECHANICAL EQUIPMENT ..... 7
17.9 SAFETY EQUIPMENT ..... 7
17.10 WASTEWATER BORNE DISEASES ..... 8
17.10.1 Work Precautions ..... 9
17.10.2 Personal Hygiene ..... 9
17.10.3 Personal Protective Equipment ..... 10
17.10.4 Housekeeping ..... 10
17.10.5 Vaccinations ..... 11
17.11 SAFETY EDUCATION AND TRAINING ..... 11
18 - CHEMICAL HANDLING ..... 1
18.2 INTRODUCTION ..... 1
18.3 DESCRIPTION ..... 1
18.3.1 Chemical Delivery ..... 1
18.2.2 Chemical Feed Pumps ..... 3
18.2.3 Chemical Uses ..... 4
18.3 OPERATION AND CONTROL ..... 8
18.3.1 At the Local Control Panel Chemical Feed Pumps ..... 8
18.3.2 At the Polymer Feed System local Control Panels ..... 9
18.3.3 At The Polymer Pump Local Control Panel ..... 9
18.3.4 At the SCADA System HMI ..... 10
19 - EMERGENCY OPERATION ..... 1
19.1 GENERAL ..... 1
19.2 MUNICIPAL AID AGREEMENTS ..... 2

19.3 FIRES ....3
19.4 PERSONNEL INJURY ....4
19.5 CONTAMINATION OF WATER SUPPLY ....4
19.6 NATURAL DISASTERS ....4
19.6.1 Flooding ....5
19.6.2 Hurricanes and Wind Storms ....5
19.6.3 Earthquake and Pipe Ruptures ....6
19.7 SPILLS INTO THE FACILITY ....7
19.8 SPILLS FROM THE FACILITY ....7
19.8.1 Wastewater Spills ....7
19.8.2 Chemical Releases ....8
19.9 RESPONSE COURSE OF ACTION ....8
20 - FACILITY RECORDS AND REPORTING .... 1
20.1 GENERAL ....1
20.2 DAILY LOGS ....1
20.3 LABORATORY RECORDS ....1
20.4 SCADA SYSTEM GENERATED REPORTS ....2
20.5 MASSACHUSETTS DEP REPORTING ....2
20.6 ANNUAL REPORT ....3
20.7 RECORD KEEPING REQUIREMENTS ....3
20.8 LIST OF FORMS ....4

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# 1 - INTRODUCTION

## 1.1 PURPOSE

This Operation and Maintenance Manual is intended to serve as a guide for the safe and effective operation of the Surfside Wastewater Treatment Facility (WWTF). Refer to **Appendix A – Basic Design Data** for the Surfside WWTF. This manual contains a comprehensive description of the various facility functions and recommended methods of operation. This manual is intended, for use by a trained operator, to show how the wastewater treatment facility operates and how individual items of equipment operate in conjunction with each other to pump and treat wastewater. Additional information gained "on-the-job" should be attached to this manual as it becomes available. Also, Standard Operating Procedures (SOPs) should be developed during the first year of operation.

The use of this manual does not preclude the responsibility of the operator to faithfully review and understand the information contained in the manufacturer's equipment and system operation and maintenance manuals.

## 1.2 OPERATIONAL RESPONSIBILITY

The Town of Nantucket, Massachusetts is the legal owner of the Surfside WWTF and the Commonwealth of Massachusetts Department of Environmental Protection (MassDEP) the permittee. The Town is required to operate and maintain the Surfside WWTF, so as to comply with the MassDEP groundwater discharge permit and Nantucket Health Department regulations.

The Town is required to staff the facility with a fully certified Grade VI (chief) operator in accordance with the MassDEP. The MassDEP also requires a backup operator possessing a valid Grade VI license. The licensed operator shall be responsible for supervising maintenance personnel on matters related to discharges into the sewer and preparation of the required monthly monitoring reports. The reports shall be submitted within the first 15 days of the reporting month in accordance with the MassDEP groundwater discharge permit. Any non-compliance that may endanger health or the environment should be reported within 24 hours or as otherwise required by the groundwater discharge permit.

## 1.3 RESPONSIBILITY OF THE TOWN

The Town of Nantucket, Massachusetts, through its Department of Public Works, is the Owner of the Surfside WWTF and is responsible for complying with the MassDEP groundwater discharge permit. The Town should provide all necessary labor, materials, power, chemicals, laboratory

testing, equipment, and supplies required to operate and maintain the Surfside WWTF in good working condition. The Town should employ an individual or contract operator with the required MassDEP Grade VI Wastewater Certification to supervise the operation and maintenance of the Surfside WWTF. The Town is the MassDEP Permittee. An authorized representative of the Town is required to sign the required monthly report in accordance with the conditions of the MassDEP permit.

## 1.4 RESPONSIBILITY OF THE LICENSED OPERATOR

The licensed operator is responsible for supervising the operation and maintenance of the Surfside WWTF, preparing the monthly reports, presenting the monthly report to the Town for signature by the authorized representative, submitting the executed monthly report, and notifying his/her superiors from the Town of any necessary labor, materials, power, chemicals, laboratory tests, equipment and supplies necessary for proper operation and maintenance of the Surfside WWTF to maintain compliance with the MassDEP permit.

The licensed operator is responsible for the sampling and testing program required for the MassDEP permit. The licensed operator is responsible for sample collection and analysis, delivery of samples to a certified testing laboratory when required, maintaining records of the sample test results performed in house and by the certified testing laboratory, and recording the results on the monthly report.

The operator should have a thorough understanding of all facility functions and the intention of these functions. In the event of an alarm condition or equipment malfunction, the operator should have the knowledge and ability to take whatever measures are necessary to restore the facilities to normal operation.

The licensed operator must show evidence of continuing education through approved training courses in order to renew his or her license. Training courses must be approved by the MassDEP. Training and renewals of licenses are through the New England Interstate Water Pollution Control Commission (NEIWPCC) NEIWPCC is leading a consortium of training organizations that is assuming responsibility for Massachusetts' wastewater operator certification and training program. Training courses are offered at the Millbury training center in Millbury, MA or online. For a schedule of upcoming courses contact NEIWPCC at (978) 323-7929 or via email at training@neiwpcc.org.

## 1.5 DISCHARGE LICENSE

The MassDEP permit for this facility is SE #-200-2. The permittee is the Town of Nantucket, Massachusetts. The permittee shall submit all reports on an acceptable form, properly filled and signed. The report shall be submitted within the first 15 days of the reporting month, beginning thirty days after the issuance of this permit, to the following:

| | | |
|---|---|---|
| Town of Nantucket<br>Board of Health<br>37 Washington Street<br>Nantucket, MA 02554 | MassDEP<br>Watershed Permitting Program<br>One Winter Street<br>Boston, MA 02108 | MassDEP SERO<br>Bureau of Resource Protection<br>Watershed Chief<br>20 Riverside Drive<br>Lakeville, MA 02347 |

The current permit is effective for a period of five calendar years. The application for permit renewal must be filed 180 calendar days prior to the date of expiration. Refer to **Appendix B – MassDEP Groundwater Discharge Permit.** Where applicable throughout the manual, monitoring schedules have been suggested for process control purposes. Refer to the permit for the mandatory analyses.

## 1.6 DESCRIPTION OF THE FACILITY

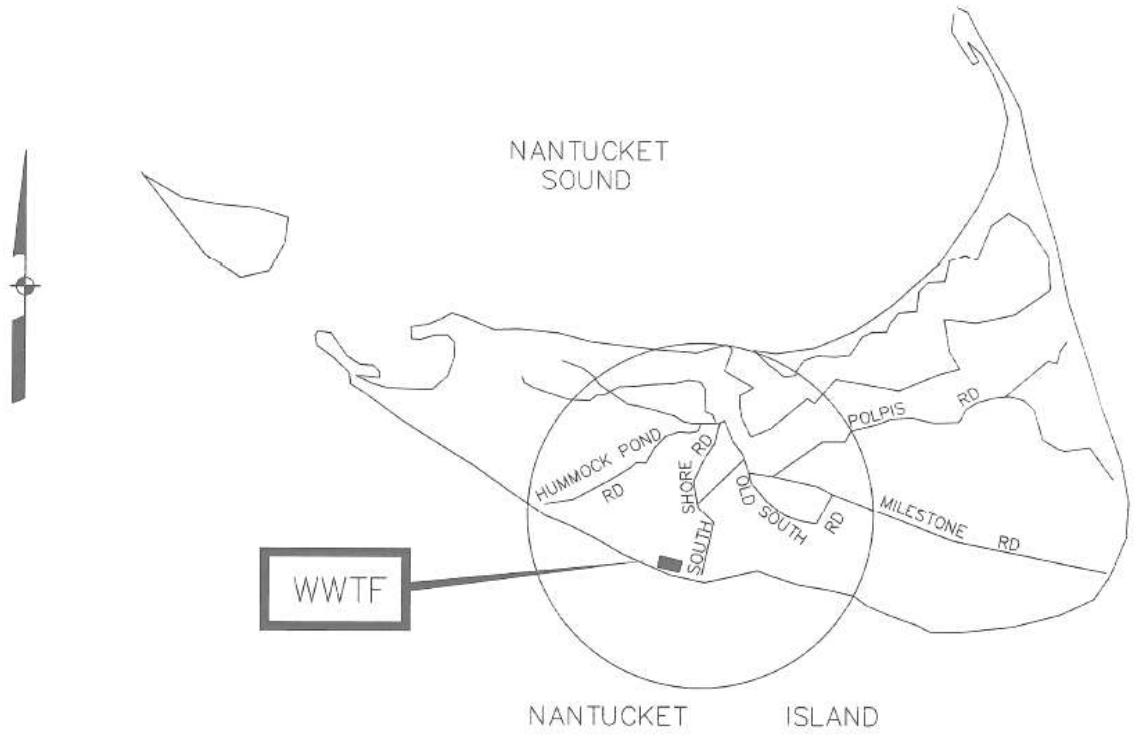
The Surfside WWTF is located off of South Shore Road on the south coast of Nantucket Island. Refer to **Figure 1.1 – Locus Plan**. Wastewater from the Town Sewer District is collected and conveyed to the Surfside WWTF through a series of 9 pumping station and over 75 miles of pipelines. Flow enters the WWTF through the headworks via a 20” DI force main (refer to chapter 2 for the headworks operation). Wastewater flow is then distributed to one of three primary clarifiers to settle out the solids (refer to chapter 3 for Primary Clarifier Operations). Once flow has passed the primary clarifiers it enters advanced treatment through pre-anoxic tanks, aeration tanks and filtering through Membrane Bioreactors (MBR) (refer to chapter 4 for MBR operation). Finally treated wastewater is disinfected using UV light tubes and discharged via rapid infiltration basins into the groundwater.

Solids removed from the wastewater are stored in sludge holding tanks prior to transfer by the rotary press feed pumps to the three rotary presses for dewatering. The rotary press filtrate is returned to the Headworks via the in-plant pump station and the dewatered sludge solids are hauled to the Town’s solid waste landfill facility for composting with municipal solid waste.

The Surfside WWTF consists of the following:

- Headworks – in-channel grinder and bypass bar rack;
- Parshall Flume to measure influent flow;

**FIGURE 1.1 – LOCUS PLAN**



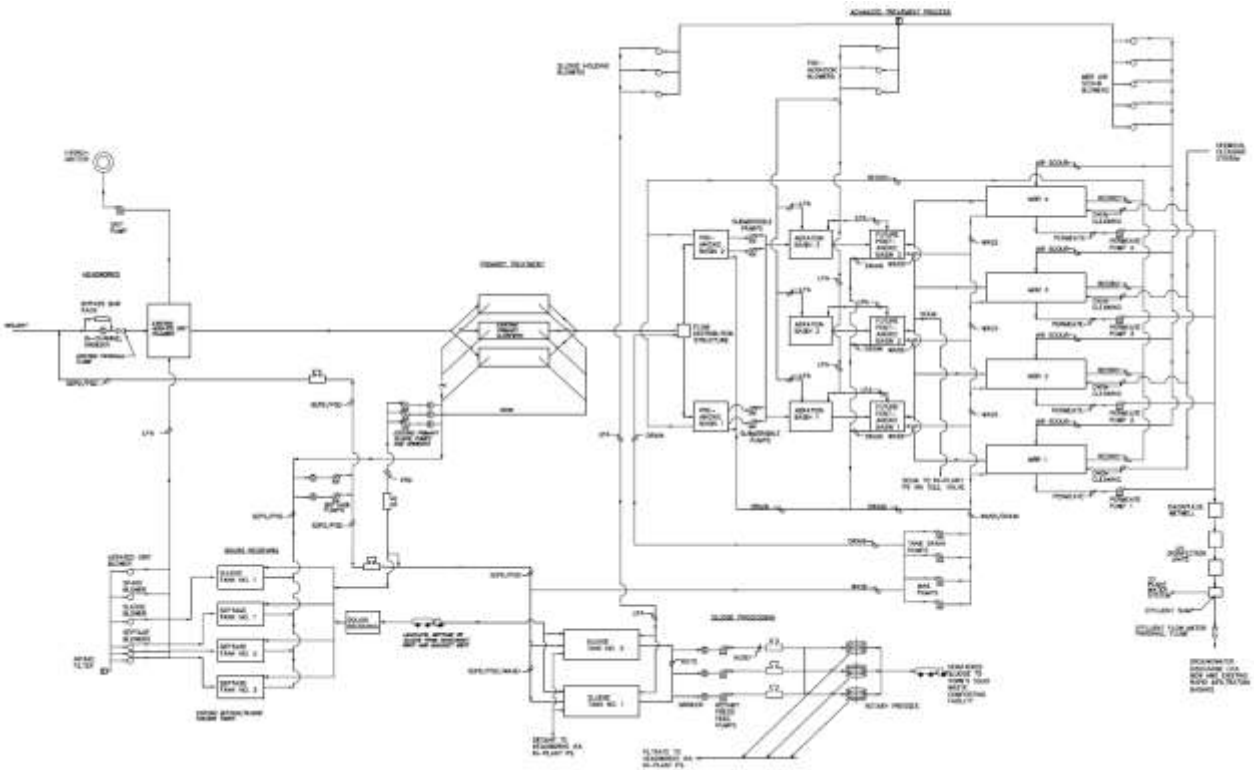

- Aerated Grit Chamber, grit pump, hydro-gritter;
- Three Primary Clarifiers, three primary sludge pumps and grinders;
- Scum collection system;
- Two pre-anoxic basins with four mechanical mixers;
- Four aeration tank lift pumps;
- Three Aeration basins with blowers;
- Three future post-anoxic basins;
- Four MBR tanks with blowers and chemical cleaning system;
- One ultraviolet disinfection system;
- Plant water system;
- Parshall flume to measure effluent flow;
- Chemical storage and feed systems;
- Two sludge holding tanks adjacent to Advanced Treatment Building with three blowers;

- Four Septage/Sludge Tanks adjacent to Primary Treatment building with four blowers and a common spare;
- Three sludge grinders, rotary press pumps, and rotary presses for dewatering;
- Odor control system;
- Rapid infiltration basins for effluent disposal;
- One septage receiving system; and
- One liquid sludge station.

Refer to **Figure 1.2 - Site Layout** and **Figure 1.3 - Process Flow Schematic.**

**FIGURE 1.2 – SITE LAYOUT PLAN**

**FIGURE 1.3 – PROCESS FLOW SCHEMATIC**



## 1.7 STAFFING PLAN

The Owner shall employ sufficient personnel to ensure the proper operation of the facility. At a minimum, the owner shall employ a chief operator with the qualifications outlined below. An assistant operator shall be available to perform plant duties in the absence of the chief operator. Either the chief operator or his/her assistant shall be at the facility at least five days each week or as otherwise required by the MassDEP groundwater discharge permit. The chief operator or his/her assistant shall be on call 24 hours a day, seven days a week, in the event of an emergency.

The Surfside WWTF should be staffed by individuals who must devote part of their time to general attention of plant process operations, daily report requirements, and routine housekeeping and maintenance chores. The majority of the operator's time will be spent conducting laboratory sampling, equipment maintenance and repair, and general plant process attention. In order to provide proper and efficient operation of the Surfside WWTF, it is necessary to have sufficient and qualified personnel on staff. Refer to **Chapter 15 – Personnel**.

The chief operator of the Surfside WWTF must be certified by the State Board of Certification of Operators of Wastewater Treatment Plants in accordance with the requirements of 257 CMR 2.00 and shall have the following qualifications:

- Grade: Commonwealth of Massachusetts Grade VI Wastewater Treatment Plant operator's license. A backup operator possessing a Grade VI license must also be designated; and

- Experience: At least 1 year as a Grade VI Operator working under the supervision of an operator with a license grade greater than VI.

All other personnel employed at the facility shall be familiar with the operations of wastewater treatment facilities. Such personnel shall work under the direction and supervision of the chief operator or backup operator.

Every effort should be made to provide continuing education and training for all Surfside WWTF personnel. Operators should take advantage of those courses offered in the Commonwealth of Massachusetts. Subscription to trade magazines and membership in New England Water Works Association, the local chapter of Water Environment Federation will also aid in providing continuing education. The advantages of training courses for wastewater treatment plant operators are obvious. This training, along with experience, will provide the operators with the technical background necessary to properly operate the plant and to retain the required operator's certification license.

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# 2 - HEADWORKS

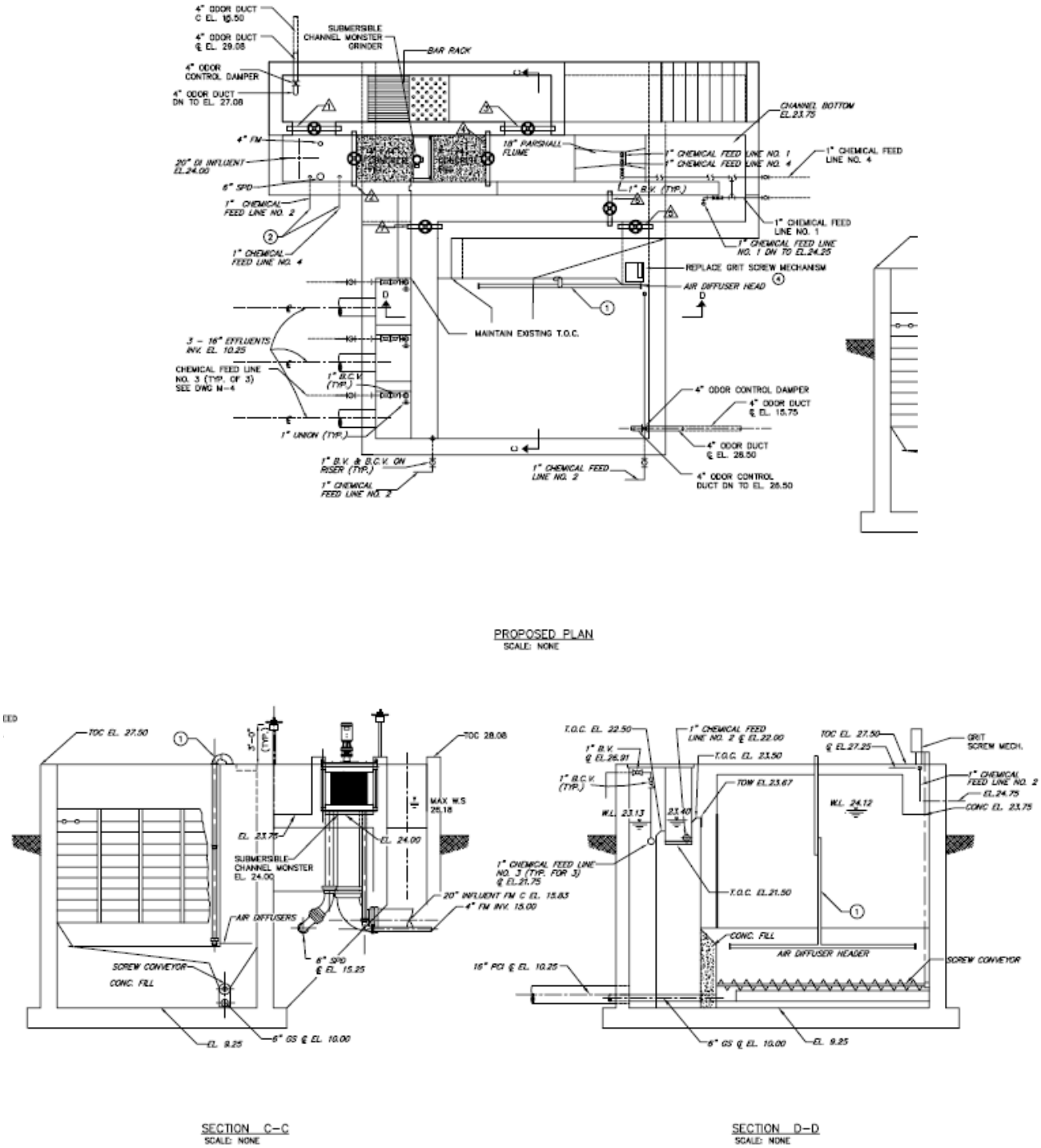
## 2.1 GENERAL

The first step for all wastewater entering the WWTF is to pass through the headworks system. The headworks system includes in-line grinder, bypass coarse bar rack, flow measurement, grit aeration system, grit pump, septage receiving, and septage treatment. Wastewater enters the headworks structure via three influent lines. The main influent line is a 20-inch ductile iron force main from the Sea Street Pumping Station. The other two influent lines include the 4-inch ductile iron force main from the in-plant pump station and a 4-inch ductile iron septage discharge line. All three lines discharge to the influent channel prior to the in-channel grinder and bypass coarse bar rack. The wastewater normally flows through the in-channel grinder, 18-inch Parshall Flume and into the aerated grit chamber. Grit settles out in this chamber and is removed using a grit screw and grit pump. Wastewater mixing in the grit chamber is performed using a single diffused air header and scum is retained by the wooden scum baffle. The settled grit is pumped by the grit pump to the grit dewatering system for processing. The appropriate slide gates can be manually opened and closed in the influent channel to by-pass either the in-channel grinder and/or the aerated grit chamber for maintenance or repair. Refer to **Figure 2.1 - Headworks Plan and Sections.**

Any large objects, rags and debris will be ground into smaller manageable solids by the in-channel grinder. If the in-channel grinder is out of service the slide gates are repositioned to direct the wastewater influent through the bypass bar rack. The bypass bar rack sits at a 45 degree angle from horizontal and has 2-1/2-inch x 3/8-inch bars spaced 2-1/4-inches on center. Periodically debris is raked up the rack onto the aluminum platform. The platform has 3/4-inch diameter holes spaced 3 inches each way to allow any wastewater to drip back into the influent channel.

Rakings should be allowed to dry on this platform and then be placed in rubber barrels lined with trash bags and covered until disposal at the Town's municipal solid waste facility. The rakings should not be allowed to dry on the drip platform for extended periods of time as this may promote the generation of odors from the headworks area. Disposal of rakings to the Town's municipal solid waste facility can be scheduled along with the disposal of grit. Excessive numbers of barrels full of rakings should be avoided at the Headworks.

**FIGURE 2.1 – HEADWORKS PLAN AND SECTIONS**



The bar rack should be raked a minimum of once early in the morning and again in the late afternoon, with additional rakings throughout the day, as required. Frequent raking of the bar rack will prevent excessive buildup of rags and debris and avoid backup of grit/solids and debris into the incoming 4-inch, 6-inch, and 20-inch force mains (thus reducing the chance of clogging these pipes).

## 2.2 IN-CHANNEL GRINDER

### *2.2.1 Description*

Influent wastewater screening and grinding is accomplished by an In-Channel Grinder, which will grind and screen any large solids that may be in the influent flow. The double-drum screening and grinding system will operate continuously. The system includes the guide plate, frame, end housing, covers, shafts, reducer, cutters, spacers, bearings, seals, drums, grinder, motor, and local controller. The double rotating drums direct all influent solids toward and into the dual counter-rotating shaft grinder. Drums on each side of the grinder are driven by the drive mechanism and motor. The drum screen is made of a stainless steel spiral coil drum. The coil stock diameter is ¼ -inch with ¼ -inch spacing. The drum support is constructed of Type 304 stainless steel. The drum shaft is made of Type 304 stainless steel and has a diameter of 1½ -inches. The radial loads of the drum shafts are borne by two sealed oversized Conrad-Type ball bearings. The motor is a 5 hp, 1725 rpm, 460 volt, 60 hertz, 3-phase, and is a TEFC design. If at any time the In-Channel Grinder is not operating, the operator must redirect the influent flow to the adjacent channel containing the bypass bar rack for screening of the incoming wastewater. This is accomplished by opening Gates No. 1 and 3 and closing Gate No. 4. Gates No. 1-4 are 44” x 24” high. Refer to **Figure 2.1 - Headworks Plan and Sections** for Gate locations.

### *2.2.2 Operation and Control*

The In Channel Grinder local Control Panel located in the Primary Treatment Building on the first floor has the following controls:

- Local operation of the Grinder is through a HAND/OFF/AUTO” selector switch at the VFD. When in “AUTO” position, remote control is by the SCADA System;
- Grinder “ON” indicating light (White);
- Grinder “Run” Indicator Light (Green);
- “Trip” Indicator Light (Red) (Flashes on motor overload);
- “Forward” and “Reverse” Indicator Lights (Amber);
- “Seal Fail” Indicator Light (Red); and

- "Start" and "Stop" Pushbuttons.

The control logic restricts resetting an overload condition from the SCADA System. Resetting an overload condition must be done from the local control panel. Refer to **Figure 2.2 - In-Channel Grinder Local Control Panel.**

If the grinder encounters a jam condition, the motor controller stops the grinder and drum, it then reverses their rotation to clear the obstruction. If the jam is cleared, the controller returns the grinder and drum to normal operation. If the jam condition remains, the controller goes through two additional reversing cycles within 30 seconds before signaling a grinder overload condition. Upon a grinder overload condition, the controller will shut down the grinder and drum and activate a "FAIL" condition. If a power failure occurs while the grinder is running, the grinder will resume running when the power is restored. If the grinder is stopped due to an overload condition and a power failure occurs, the overload indicator will reactivate when the power is restored.

The SCADA System displays the following status and alarm signals:

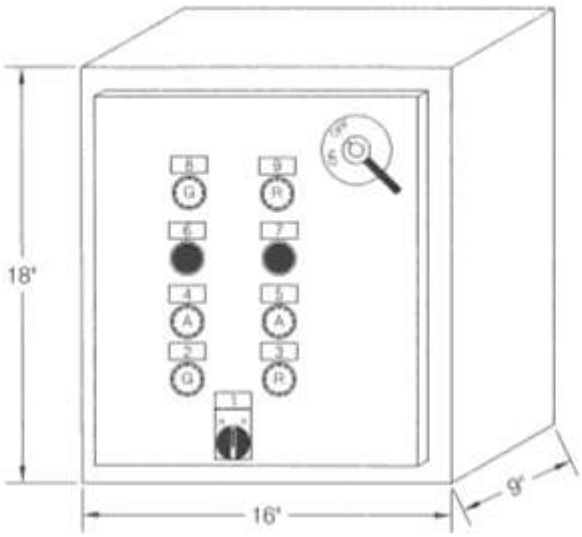
- In-Channel Grinder RUN Status (YI-100);
- In-Channel Grinder FAILURE ALARM (YA-100); and
- Elapsed run time meters (KQI-100).

### *2.2.3 Equipment Maintenance*

The following information defines the preventive maintenance required for the In-Channel Grinder unit. Correct lubrication procedures are essential for the operation of this equipment. Time periods are based on normal operation usage and should be adjusted by the operator based on the specific usage and operational environment. More frequent inspections are recommended if the unit is operating in a harsh environment.

- Visual Cutter Inspection – Semi-Annually. Inspect the cutters for signs of excessive wear or rounding of the edges. If wear is noticeable, the cutters need sharpening or replacement;
- Gear Lubrication – Annually. The gears must be lubricated with Dow Corning 1122 grease. Used grease must be removed from the space under the gears. This should be done when the unit is having the yearly seal inspection;
- Seal Inspection – Annually. Inspect the seal assembly every 12-months to ensure there is no leakage; and
- Fasteners – Quarterly. Inspect the fasteners once every 3-months and tighten as necessary.

**FIGURE 2.2 - IN-CHANNEL GRINDER LOCAL CONTROL PANEL**




Legend

1. "HAND-OFF/RESET-AUTO " LOCKABLE SELECTOR SWITCH
2. "RUN" INDICATOR LIGHT (GREEN)
3. "TRIP" (FLASHING ON MOTOR OVERLOAD) PILOT LIGHT (RED)
4. "FORWARD" PILOT LIGHT (AMBER)
5. " REVERSE" PILOT LIGHT (AMBER)
6. "START" PUSH BUTTON (GREEN)
7. "STOP" PUSH BOTTOM (RED)
8. "POWER ON" INDICATOR LIGHT (WHITE)
9. "SEAL FAIL" INDICATOR LIGHT (RED)

## 2.3 INFLUENT FLOW MEASUREMENT

### *2.3.1 Description*

After passing through the in-channel grinder, the wastewater flows through the 18 inch Parshall Flume for flow measurement. A Magnetrol Ultrasonic, non-contact continuous level sensor and transmitter measures the water depth in the flume. The sensor directs an ultrasonic pulse to the wastewater surface level and detects the returning echo/signal. The microprocessor amplifies and converts this signal into a digital representation of the level. The flow can be read at the locally mounted digital readout. The local display is calibrated to readout the influent flow in million gallons per day (mgd). The signal is also

sent to the Main Control Room in the Sludge Processing Building where it is displayed at the Foxboro flow recorder and totalizer and the SCADA System. The flow recorder utilizes a 12-inch circular chart divided into hourly periods. The flow rate is determined by multiplying the chart reading by the chart multiplier. For example, if the flow recorder is calibrated to measure flow in gallons per hour and the chart multiplier is 100, the flow rate for a chart reading of 26 is (26)x(100) =2600 gph. The SCADA System will show the flow rate and totalized daily flow.

The influent is totalized in gallons, which can be read at the Foxboro control panel or the SCADA System located in the Main Control Room. The flow recorder charts need to be changed daily and stored in a safe, dry place. The operators should only perform the maintenance and troubleshooting tasks clearly outlined in the Magnetrol and Foxboro O&M Manuals, while any specialized calibration and maintenance tasks should be reserved for trained manufacturers' representatives.

### *2.3.2 Operation and Control*

The Local Display Panel can display the following:

- Plant Influent Ultrasonic Flow Element (FE-110-2);
- Plant Influent Flow Indicating Transmitter (FIT-110);
- Plant Influent Flow Rate Indicating Recorder (FIR-110); and
- Influent Channel High Level Float Switch (LSH-110).

Daily checks should be made by the operators of the digital readout at the headworks, the flow recorder, and totalizer at the SCADA System, and the ultrasonic depth sensor at the Parshall Flume. The recorder pens should be checked, the depth sensor should be free of dirt and debris and cleaned as needed, the depth should be manually checked to verify calibration of depth at the throat of the flume, and the flows should be checked and mentally compared to expected values for that particular time of week, day, etc. Careful attention geared to the entire flow measurement process will result in accurate valuable data for present and future evaluations.

The following SCADA System controls are provided:

- Flow rate is indicated, trended, and recorded at the SCADA System (FIR-110);
- Non-resettable flow total (FQI-110-1;
- Current day flow total (FQI-110-3), automatically reset at midnight;

- Previous day flow total (FQI-110-2);
- Current Month flow total;
- Current Year flow total;
- Resettable flow total (FQI-110-4); and
- Influent Channel high and Low level alarms (LAH-110.

## 2.4 INFLUENT SAMPLER

### *2.4.1 Description*

The refrigerated influent sampler is designed to operate outdoors in ambient temperatures without an enclosure. The sampler is self-defrosting and suited for sequential and composite sampling. In the sequential mode, the sampler is capable of collecting discrete samples in 24 sample bottles. In the composite mode, the sampler is capable of being converted to use a single 2½ gallon glass or polyethylene container. All samples are stored in the refrigerated enclosure. The refrigerator has a hinged, reinforced fiberglass controller cover capable of being locked. The refrigerator door has hasps capable of accepting padlocks to prevent unauthorized tampering.

Samples are collected using a peristaltic pump typically producing a line velocity of 5.1 fps in a ¼ -inch suction line, or 2.5 fps in a 3/8-inch suction line at 3 feet of head. Before and after each sample is collected, the pump air purges the suction line. Pre-purges and post-purges are automatically controlled, and no pre-calibration adjustments are required. A weighted polypropylene strainer with a debris deflector is provided to prevent clogging. Samplers have impact resistant ABS plastic pH sensors for detecting and transmitting data to the SCADA System.

### *2.4.2 Operation and Control*

The sampling program is established using a 24 position sealed keypad and a 2 line, 40 character liquid crystal display. The display continually communicates the sampler's status. The sampler has 2 programming modes, "Basic" and "Extended". The basic programming mode allows the operator to easily set-up typical sampling routines. The extended mode expands the versatility of the sampler by providing options to allow the operator to create complex sampling routines.

The sampler has software capable of storing up to 3 sampling routines identified by number. The internal lithium battery provides the sampler with continuous memory. The basic and extended modes allow the operator to program the sampler to collect either

sequential or composite samples at user definable time intervals (time pacing or flow pacing). In the extended programming mode, a third type of sample pacing known as STORM pacing is available. The STORM pacing mode provides for both time and flow paced samples to be collected in separate bottle sets during a single program.

The Influent Sampler Local Control Panel is equipped with the following controls;

- pH Relay (AY-120); and
- Flow Rate Relay (FY-120).

The following Influent Sampler SCADA System Controls are provided:

- The influent sampler receives a 4-20 mA DC influent flow rate signal from the SCADA System (FY-120);
- All influent sampler related alarms are indicated at the SCADA System (HMI); and
- The influent flow pH (AY-120) is indicated at the SCADA System.

## 2.5 GRIT COLLECTION AND REMOVAL

Following the Parshall Flume, wastewater enters the aerated grit chamber. Air is diffused into the chamber agitating the wastewater in such a way as to separate the lighter organic matter from the heavier grit and inorganic solids. The chamber is designed to provide approximately 3.0 minutes of detention time at the design summer peak daily flow of 7.6 mgd.

### *2.5.1 Description*

Wastewater influent flow can be directed through the in-channel grinder or bypass bar rack by opening and closing the various 7 manual slide gates at the Headworks Facility. By closing Gate No. 6 and Gate No. 7 and opening Gate No. 5, the wastewater is fed into the aerated grit chamber. Closing Gate No. 5 and opening Gate No. 6 and Gate No. 7, the wastewater will by-pass the grit chamber and flow directly into the primary clarifiers. Gate No. 1, Gate No. 2, Gate No. 3, and Gate No. 4 are 44-inches wide by 24-inches high and Gate No. 5, Gate No. 6, and Gate No. 7 are 26-inches wide by 24-inches high. Refer to **Figure 2.1 - Headworks Plan and Sections** for Gate locations

Diffused air, introduced at the bottom of the tank, imparts a roll to the wastewater in the grit chamber. The lighter organic and colloidal matter is kept in suspension while the heavier grit falls to the bottom of the sloped tank floor. The rolling motion in the tank and the sloped bottom causes the grit to be continually deposited into the screw collector trough. Accumulated grit is then directed to the suction sump by the action of the screw auger. A diffused air pressure of approximately 5 psig is required to maintain an adequate roll in the grit chamber.

The grit screw mechanism includes a 1 hp drive motor, gear reducer, drive chain and sprockets, and a 12-inch diameter by 12 foot – 6-inch long screw with shaft wall attachments. The grit screw drive motor is protected from an overload condition by a shear pin assembly. If the pin shears, a small arm will spring out and contact a micro switch, which will send an alarm to the Main Control Room in the sludge Processing Building. Following the normal grit removal and dewatering operations will avoid overloading the grit removal screw auger and minimize the occurrence of breaking the auger drive shear pin.

### *2.5.2 Operation and Control*

Certain aspects of the grit collection and removal system can be operated from the Local Control Panel, however the primary operation of this system is from the SCADA System HMI.

The Grit Screw Central Operation is at MCC-4 located on the first floor of the Primary Treatment Building and has the following features.

- Grit screw motor high temperature alarm (TAH-130A);
- Grit screw “HAND/OFF/AUTO” switch (YI-130A-1);
- Grit screw “RUN” status (YI-130A-2);
- Grit screw “START/STOP” pushbutton (YS-130A);
- Grit Screw Reset pushbutton;
- Grit Screw elapsed run time meter (KQI-130A); and
- Lockout at the MCC-4 to prevent remote start-up while repairs or maintenance is being performed.

The following status and alarm signals are displayed at the SCADA System HMI:

- Grit screw in “AUTO” (YI-130A-1);

- Grit screw “RUN” status (YI-130A-2);
- Grit screw motor high temperature alarm (TAH-130A);
- Grit Screw motor disagreement alarm; and
- Grit screw elapsed time meters (KQI-130A).

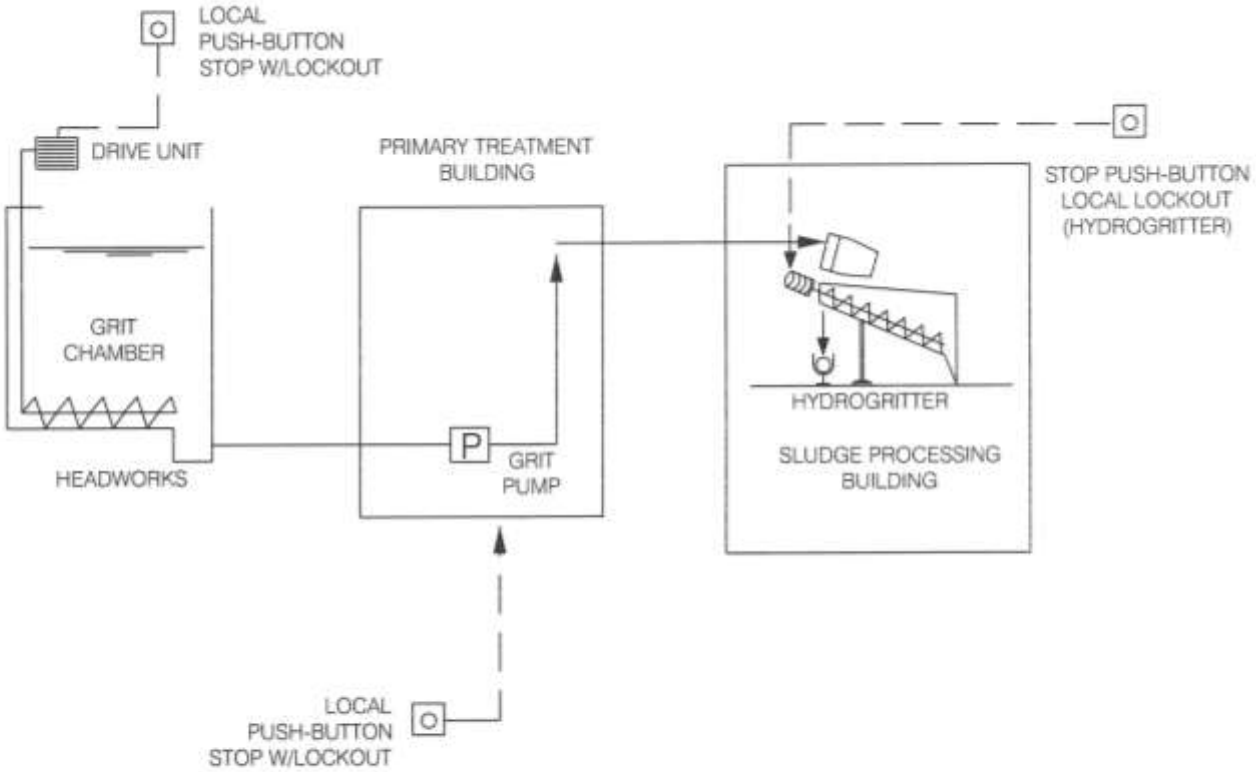
In addition, a motor status disagreement alarm is displayed at SCADA if the called state of the motor and the run status contacts do not agree after a preset adjustable time. The disagreement alarm is enabled if the H/O/A switches are in the “AUTO” position. The disagreement alarm must be manually reset through the SCADA before Remote Automatic Control is enabled. Remote Automatic Control: The grit collection system will automatically operate from cycle timer (KC-130) with adjustable on-state and off-state durations.

The Horizontal Screw Conveyor HC-1, Hydrogritter, and Grit pump must be started in order and confirmed running before the grit screw can be started. Refer to **Figure 2.3 - Grit Removal and Dewatering Schematic.**

A wooden scum baffle is used in the aerated grit chamber to retain scum and other "floatables". The baffle is located just prior to the weir and runs the width of the chamber. Two stainless steel hinges allow a 21 -inch top section of the scum release gate to be opened and scum manually removed. The scum layer in this chamber should be visually observed a minimum of once daily and skimmed off as needed.

The diffused air-drop leg-header assembly is provided with a portable manual hoist to enable the operator to crank up the assembly for maintenance or repair. Be aware that the hoist must be engaged with the anchor clip prior to hoisting the assembly. Failure to anchor the hoist could cause equipment damage or personal injury. The assembly should be raised and pipes and air diffusers cleaned every 4 months, or as needed. The “knee” in the middle of the drop leg-header assembly should always be kept straight (no bend at all) to maximize the roll of wastewater in the grit chamber imparted by the diffused air hitting the sloped concrete ceiling directly above the header.

**FIGURE 2.3 – GRIT REMOVAL AND DEWATERING SCHEMATIC**




## 2.6 GRIT CHAMBER BLOWERS

### *2.6.1 Description*

The grit chamber diffused air system is served by an Aerzan positive displacement blower, which is located in the Primary Treatment Building. The blower has a capacity of 120 CFM at a speed of 2,370 rpm and produces a maximum operating pressure of 5 psi. The blower is belt driven by 5 hp variable speed 480 volts, 60 hertz, three phase motors with variable speed drives. Belts are matched cogged type V-belts with automatic tension adjustment. The blowers have noise attenuation enclosures and 2-inch side intake and discharge ports.

### *2.6.2 Operation and Control*

Certain aspects of the grit chamber blower operation can be controlled from the Local Control Panel; however the primary control of this system is from the SCADA System HMI. The Grit Chamber Blower Local Control Panel is located in the Primary Treatment Building on the first floor at the variable frequency drive unit and has the following features:

- Local operation of the blowers is through a HAND/OFF/AUTO" selector switch at the VFD. When in "AUTO" position, remote manual control is by the SCADA System;
- Blower manual speed control (SC-140);
- Blower speed indication (SI-140);
- Blower motor over temperature alarm (TAH-140-1) and Reset Pushbutton;
- Blower discharge high pressure switch alarm (PAH-140-2) and Reset Pushbutton;
- Blower high vibration switch alarm (VAH-140) and Reset Pushbutton;
- Blower "Local"/Remote" switch (SS-140-1);
- VFD "ON" indicating light (Red);
- VFD "OFF" indicating light (Green); and
- Elapsed run time meter (KQI-140).

The following status and alarm signals are displayed at the SCADA HMI:

- "HAND/OFF/AUTO" selector switch position (YI-140-1);
- Blower motor over temperature alarm (TAH-140-1);
- Blower high vibration alarm (VAH-140);
- Blower high discharge pressure alarm (PAH-140-2);
- VFD fault alarm (YA-140-1);
- Speed indication (SI-140);
- Elapsed run time meters (KQI-140);
- Motor state disagreement alarm (YA-140-2); and
- Remote manual START/STOP (YS-140) and speed control (SC-140).

## 2.7 GRIT PUMP

The grit pump is located in the pipe gallery of the Primary Treatment Building. It is a WEMCO, 3x3 Model–C, horizontal recessed impeller torque flow pump. The grit pump withdraws grit from the aerated grit chamber and discharges it to the grit dewatering system located in the Sludge Processing Building for dewatering and disposal.

### *2.7.1 Description*

The grit pump is constant speed and fitted with a 13-7/8 inch diameter recessed impeller. The impeller is "recessed" from the flow to minimize wear and tear of the impeller from the grit and sand. As with the typical end suction centrifugal pumps, mechanical energy is transferred to the water as velocity head. Since water is very cohesive, it tends to twist in the same way that a rag gripped at one point and twirled will twist. This action is referred to as "developing torque" in the water.

The twirling action causes the water to move out of the pump discharge, leaving a partial vacuum at the center of the impeller. This partial vacuum, plus the vortex action of the water causes particles to move up the suction line. The particles then enter the fast moving vortex within the pump housing and are thrown by centrifugal force to the outer edge of the pump case and then exit through the discharge.

This pump is capable of passing a 3-inch diameter sphere through the pump and out the discharge. Refer to **Table 2.1 - Grit Pump Operating Data**. From the WEMCO certified pump curves, the grit pump will pump 220 gpm against a 30 foot total dynamic head (TDH) at a speed of 1,800 rpm. Typically, this pump will be operating at a lesser head, thus achieving increased flow output.

**TABLE 2.1 - GRIT PUMP OPERATING DATA**

| Description | Value |
|---|---|
| Number of Pumps | 1 |
| Total Dynamic Head (feet) | 30.0 |
| Capacity (gpm) | 220 |
| Impeller Diameter (inches) | 13-7/8 |
| Motor | 7.5 HP<br>1800 RPM Constant Speed<br>V-belt Drive<br>TEFC Enclosure |

### *2.7.2 Operation and Control*

Central operation of the grit pump can be from MCC-4 located on the first floor of the Primary Treatment building but the grit pump is primarily from the SCADA System in the Main Control Room in the Sludge Processing Building. The Grit Pump Operation at MCC-4 has the following controls:

- Grit Pump "HAND/OFF/AUTO" switch (YI-130B-1);
- Grit Pump "START/STOP" pushbutton (YS-130B);
- Grit Screw Reset pushbutton; an
- Lockout at the MCC-4 to prevent remote start-up while repairs or maintenance is being performed.

The following status and alarm signals are displayed at the SCADA System:

- Grit pump in "AUTO" (YI-130B-1);
- Grit pump "RUN" status (YI-130B-2);
- Grit pump seal leak alarm (YA-130B-1);
- Grit pump motor high temperature alarm (TAH-130B);
- Grit pump motor disagreement alarm; and
- Elapsed time meters (KQI-130B).

Remote Automatic Control - The grit pump will automatically operate from cycle timer (KC-130) with adjustable on-state and off-state durations.

The Hydrogritter and Inclined Screw Conveyor HC-2 must be started in order and confirmed running before the grit screw can be started.

### *2.7.3 Equipment Maintenance*

The Grit Pump requires preventive maintenance on a regular basis to maintain the pump's efficiency and prevent breakdowns. Below is a summary of the maintenance recommended for the Grit Pump. For more specific information refer to the manufacturer's standard maintenance manual.

- Inspect Pump for Proper Operation – Daily. Clean and clear as needed
- Check Bearing Housing Oil Level – Weekly. Fill as required;
- Change Bearing Housing Oil – Annually. Drain old oil. Add required quantity of new oil;
- Check Sheave Belt Tension – Semi-Annually. Adjust if necessary;

- Inspect Sheaves for Proper Operation – Semi-Annually. Check Alignment and Belt for Wear;
- Check Motor for Proper Operation – Daily. Clean and Clear as Required; and
- Motor Lubrication – Semi-Annually. Lube as Required.

## 2.8 SEPTAGE RECEIVING STATION

### *2.8.1 Description*

Septage from cesspools and septic tanks is discharged to the WWTF at the septage receiving station located in the Sludge Processing Building. Vacuum pumping septage trucks discharge their contents (normally 1,000 to 2,500 gallons) under pressure into the septage receiving tank. A four-inch inlet pipe with a four-inch male quick-connect coupling is used to allow the vacuum pumping septage trucks to connect to and discharge septage into the receiving tank.

The trucks are required to pull completely into the septage bay and close the overhead door before making their connection to the inlet and beginning discharge. The concrete floor in this area is sloped to a floor drain to allow any septage spillage, overflow and clean-up water to be collected and discharged to the building's drainage system.

The septage station basically consists of a 504 gallon receiving tank and a fine screen and solids dewatering screw conveyor. The receiving tank is a pass through container, which allows the fine screen and screw conveyor to remove and dewater the septage solids. The dewatered solids are discharged into a manually operated holding cart and the liquid septage passes through the tank, out the outlet, and flows through underground piping to the below ground septage holding tank.

The package septage receiving system was supplied by Lakeside Equipment Corp., Bartlett, IL. The major components of the system include the following;

- Outer tube and trough;
- Screen basket;
- Rake arm and rake assembly;
- Screw;
- Brush assembly;
- Scraper comb assembly;
- Dewatering chamber assembly;

- Drive assembly;
- Septage acceptance tank (504 gal.);
- Ultrasonic level sensor on tank;
- Tank cover switch;
- Water supply line;
- Solenoid valves;
- Tank vent and hinged cover;
- Spray wash system;
- Magnetic flow meter on inlet;
- Water operated pinch valve on inlet;
- Main control panel; and
- 4-inch diameter inlet and 8-inch diameter outlet.

### *2.8.2 Operation and Control*

The operation of the septage receiving station is from the Local Operator Interface Control Panel located on the unit itself and Main Control Panel located on the south wall of the Septage Receiving Bay. There are currently five septage haulers in Nantucket that transport septage to the WWTF. Each hauler access to the septage receiving bay via a town issued garage door remote. Once the truck has pulled into the Septage Receiving Bay, the door must be closed completely before the Septage Receiving Station can be activated.

The septage haulers of the town are also issued given a company specific code, as well as truck specific codes that are required to activate the Septage Receiving Station. After the station receives the truck's load of septage, it creates a receipt is dispersed for the hauler and sends the information to is recorded through the SCADA system for billing. The individual septage haulers should be required to spray down the septage receiving area themselves after each discharge. Septage discharge coupons should be monitored and logged in at the treatment facility for each and every septage hauler discharge. If problems occur with septage receiving processes, the operators should require all septage haulers to discharge septage during normal weekday working hours.

There is no remote operating capability of this equipment. The septage received by the haulers flows into the acceptance tank and the open end of the screenings basket, through the bars, and continues through the tank. As screenings are held back by the bars, the free flow area in the screen is restricted causing the upstream liquid level to rise. At a preset level or time period, a cleaning cycle is started. The rake is attached to the transport screw and rotates with the screw. The teeth of the rake, which pass through the bars of the screen, collect the screenings on rotation. The screenings are dropped into the screw conveyor trough as the rake reaches the topmost position.

The screenings are washed and dewatered upon deposit in the feed trough. Spray jets direct wash water at the screenings. The screw in the feed trough turns synchronously with the rake arm transporting the screenings through further washing zones and into a dewatering zone. In the dewatering zone, the screenings are compressed and the water released. The water either flows back down the transport tube or passes through drain holes located in the tube into a dewatering chamber. A moist plug of screenings forms and is discharged into a collection container as additional screenings are transported into the dewatering zone. The screenings are then transferred by the treatment plant staff to the Town's Municipal Solid Waste Facility.

Organics are removed from the screenings with the wash water. The jet action of the water and mechanical rotation of the screw act to break down the organics as the screenings progress through the various stages of the fine screen. The wash water is drained from the screenings and is returned to the tank. The bottom of the septage receiving tank should be visually observed after septage "dumps". Any grit, stones and debris that collected on the bottom of the tank should be removed, as needed. The receiving tank should be sprayed down with plant water after use to keep it clean and reduce odors

The Local Control Panel (MC-1) has the following features:

- Allen-Bradley SLC500 PLC with a 5/05 processor;
- Power "ON" pilot light (White);
- Screen "RUNNING" pilot light (Green);
- Overload Shutdown pilot light (Red);
- Screen "Fault" pilot light (Red);

- Screen “STANDBY” pilot light (Blue);
- Screen Drive “HAND/OFF/AUTO” selector switch;
- Dewatering Screw “HAND/OFF/AUTO” selector switch;
- Screenings Spray Wash System “HAND/OFF/AUTO” selector switch;
- Screen “FORWARD/OFF/REVERSE selector switch;
- Lower Wash System “HAND/OFF/AUTO” selector switch;
- Tank Wash System “HAND/OFF/AUTO” selector switch;
- Emergency Stop, “E – STOP” pushbutton; and
- Elapsed Time Meter.

Refer to **Figure 2-4 - Septage Acceptance Plant Main Control Panel** and **Figure 2-5 - Operator Interface Control Panel.**

### *2.9.3 Equipment Maintenance*

The Septage Receiving Station requires preventive maintenance on a regular basis to maintain the unit’s efficiency and prevent breakdowns. A summary of the maintenance recommended for the unit is below. For more specific information refer to the manufacturer’s standard maintenance manual.

- Equipment – Daily. Clean and check for proper operation.
- Remove Trapped Debris from Rake, Comb, and Basket – Weekly. Shut down unit and remove all debris;
- Check Operation of Solenoid Valves – Weekly. Solenoid valves should open and close quickly without hesitation;
- Check Alignment Between Rake Teeth and Basket Bars – Weekly. Realign as needed;
- Check Alignment Between Rake Teeth and Cleaning Comb – Weekly. Realign as needed;
- Check for Oil Seepage & Gear Noise, Gearbox – Monthly. Check gaskets and oil levels;
- Clean Wash water Y-Strainer – Monthly. Remove all debris;
- Flush Dewatering Chamber – Quarterly. Remove all debris;
- Clean Spray Nozzle Orifices Frequently - Remove all debris;
- Check Function of Tank Wash Nozzle – Weekly. Clean as Required;

**FIGURE 2.4 - SEPTAGE ACCEPTANCE PLANT MAIN CONTROL PANEL**

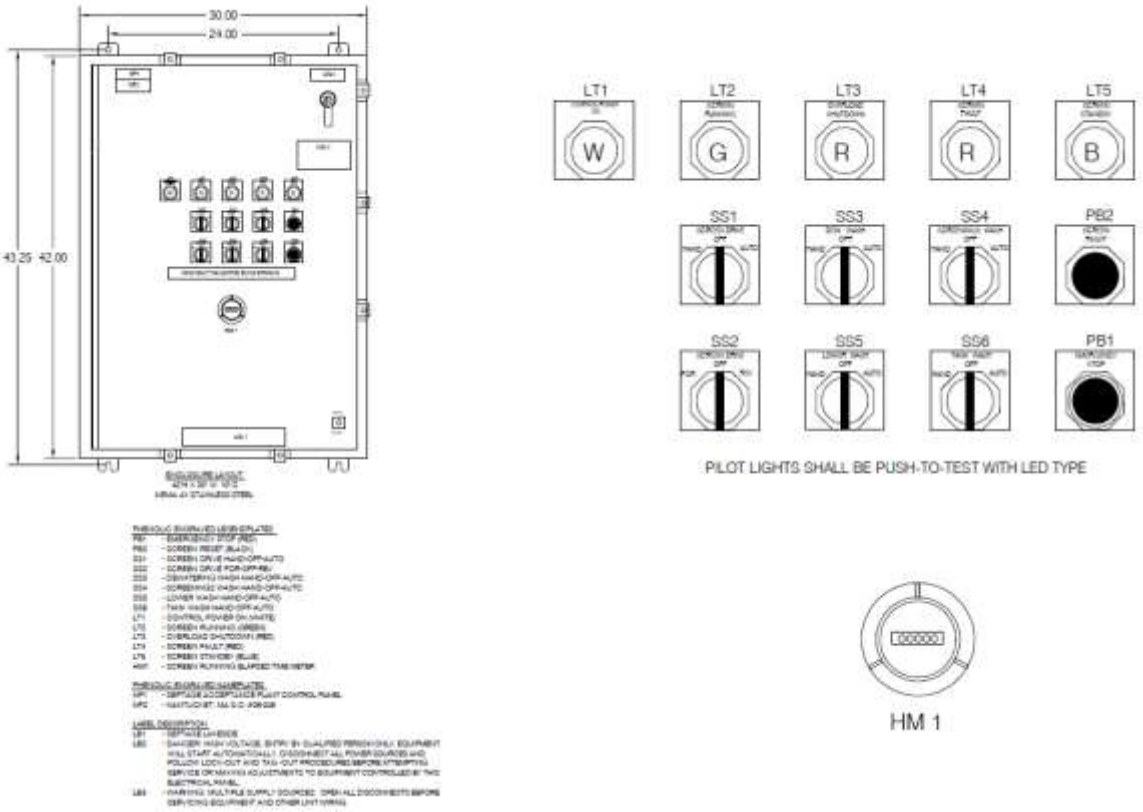
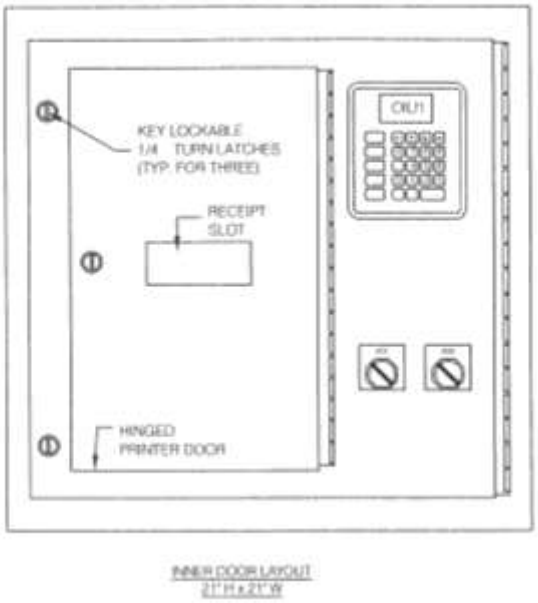



**FIGURE 2.5 - SEPTAGE OPERATOR INTERFACE CONTROL PANEL**



- Lower Rake Arm Bearing – Semi-Annually. Check for wear; and
- Replace Lube Oil in Gearbox – Semi-Annually. Use proper grade of oil.

## 2.10 SEPTAGE/SLUDGE HOLDING TANKS AND PUMPING

### *2.10.1 Description*

Approximately 40,000 gallons per day of septage was anticipated to be discharged to the facility in the design year of 2029. The design septage BOD loadings anticipated at the facility are approximately 2,335 pounds per day. Previous design summer septage suspended solids (SS) loadings are anticipated to be about 5,004 pounds per day. Refer to **Table 2.2 - Typical Septage Characteristics**.

**TABLE 2.2 - TYPICAL SEPTAGE CHARACTERISTICS**

| Parameters | Average Values |
|---|---|
| Total solids, mg/l | 11,600 |
| Total volatile solids, mg/l | 8,170 |
| Total suspended solids, mg/l | 9,500 |
| Volatile suspended solids, mg/l | 7,650 |
| BOD., mg/l | 5,890 |
| COD, mg/l | 19,500 |
| TKN, mg/l | 410 |
| Ammonia-N, mg/l | 100 |
| Total phosphorus, mg/l | 190 |
| Alkalinity, mg/l as CaCO | 610 |
| Grease, mg/l | 3,850 |
| pH | 6.5 |

Source: Journal Water Pollution Control, November 1980 by Burton A. Segall, Charles R. Ott, Pp. 6655-6665, University of Lowell.

Note: Average Chemical characteristics for more than 50 samples taken from trucks and holding tanks.

From the characteristics listed in **Table 2.2 - Typical Septage Characteristics**, it can be seen that septage has very high concentrations of solids, BOD, COD and grease. In fact, domestic septage is often close to 50 times as strong as domestic

wastewater for several pollutant parameters. On average, a 2 percent addition of septage to a wastewater stream will double the solids and organic loading of the treatment facility for the duration of the septage addition.

Shock loading of septage could place a severe demand upon a secondary treatment plant's biological treatment processes. Since the Surfside Facility is designed for primary and advanced biological treatment of wastewater, slug loads of septage should not significantly hinder expected suspended solids and BOD removals.

The primary clarifiers should do a satisfactory job of absorbing the shock effect of slug septage loading. Ideal septage addition should be done in gradual increments ("bled") during high flow conditions (early morning or early evening), if possible.

When processing septage, it is recommended to utilize the following steps:

- Aerate the septage holding tanks beginning when the septage level is approximately 1 foot above the 4" diffuser header;
- Aerate the septage as long as possible before pumping septage to the sludge processing system; and
- Pump sodium hypochlorite (NaOCL solution) into the septage holding tank to control the generation of odors (as needed). Odors released from the septage by agitation from the diffused air are typically controlled using the odor control system.

Once the discharged septage in a given tank exceeds the “On” set point, typically a level of 2 feet, the aeration system will be activated and the intensity will be varied between the lower and upper level set points. If the septage is drawn below the “Off” set point, the aeration system will automatically be deactivated. The septage level in the holding tank should be monitored by the operator through SCADA HMI in the Main Control Room and septage processing initiated, when required

The automatic timer should be set to "bleed" septage to the Headworks in approximately 10-15 minute intervals approximately every 100 minutes. The timer should be adjusted by the operators to meet the incoming septage schedules. The septage can also be pumped to the ATB sludge holding tanks if needed, but intermittent septage pumping is recommended. When the septage in the septage holding tank reaches the “off” set point for the septage pumps, the pumps are stopped. Typical operation of the septage pumps and grinders will be in the automatic position allowing for ease of control through SCADA.

When septage holding tank draw down is nearing completion, the septage level in the tank should be drawn down below the "low level" so that there is about 6 to 8-inches left on the bottom. This will reduce odors generated from septage sitting in the tank and aid in washing down the tank walls. Based on the amount of septage expected at the treatment plant, the septage holding tank should be cleaned every two weeks. The locally mounted stop pushbutton can be used to shut down the septage pump(s) and stop septage transfer.

### *2.10.2 Operation and Control*

The operation and control of the septage holding tank level system, septage/sludge holding tank blowers and septage/sludge pumps through the SCADA system HMI, but can also be done through the Local Control Panels located in the primary treatment building. The appropriate septage/sludge pump suction and discharge valves must be opened or closed to accommodate septage discharge to the proper location.

The Local Control Panels for the above mentioned equipment has the following features:

- Septage/Sludge Holding Tank Blower System VFD Controls
  - Pump H-O-A Switch in “AUTO” (YI-220A-1, etc.)
  - Blower Manual Speed Control (SC-220A, etc.)(0% to 100%)
  - Blower Speed Indication (SI-220A, etc.)(0% to 100%)
  - Blower Motor Over Temperature Alarm (TAH-220A, etc.)(Reset PB)
  - Blower Discharge High Pressure Alarm (PAH-220A, etc.) (Reset PB)
  - Blower High Vibration Alarm (VAH-220A, etc.) (Reset PB)
  - Blower “Local/Remote” switch (SS-220A-1,etc.)
  - VFD “ON” indicating light (Red)
  - VFD “OFF” indicating light (Green)
  - Elapsed run time meter (KQI-220A, etc.)

- Septage/Sludge Pump VFD Controls
  - Pump High Discharge Pressure Alarm (PAH-230A, etc.) and Reset Pushbutton
  - Pump Low Suction Pressure Alarm (PAL-230A, etc.) and Reset Pushbutton
  - Pump Hand-Off-Auto Switch (YI-230A-1, etc.)
  - Pump Run Status Display (YI-230A-2, etc.)
  - VFD “On/Off” Pushbuttons (YS-230A, etc.)
  - Local / Remote Selector Switch
  - Elapsed run time meter (KQI-230A, etc.)

- Septage/Sludge Grinders:
  - Grinder “ON” indicating light (White)
  - Grinder “Run” Indicator Light (Green)
  - “Forward” and “Reverse” Indicator Lights (Amber)
  - “Seal Fail” Indicator Light (Red)
  - “Start” and “Stop” Pushbuttons

- Grinder Hand-Off-Auto Selector Switch

At the SCADA System for the above mentioned equipment are the following features:

Septage/Sludge Holding Tanks #1 - #4 Level Systems:

- Level is indicated, trended, and recorded at the SCADA HMI (LIR-210A, etc.);
- ”Low Low,” “Low”, “High” and “High High” Level Alarms (LAH-210A, etc.); and
- Tank Level set points Control for Pumps/Grinders and Blowers.

Septage/Sludge Holding Tank Blower Systems:

- When Local H-O-A Switch is in “AUTO” remote automatic and manual control via SCADA HMI is enabled;
- VFD Speed Indication (SI-220A, etc.) ;
- H-O-A switch in “AUTO” position (YI-220A-1, etc.);
- Run Status Indication (YI-220A-2, etc.);
- VFD Fault Alarm (YA-220A-1, etc.) ;
- Motor Over Temperature Alarm (TAH-220A-1, etc.);
- High Vibration Alarm (VAH-220A, etc.);
- Discharge High Temperature Alarm (TAH-220A-2, etc.);
- Elapsed Run Time Meters KQI-220A, etc.); and
- Motor State Disagreement Alarm (YA-220A-2, etc.).

Septage/Sludge Pumping/Grinder System:

- Grinder/Pump In “AUTO” (YI-230A-1, etc.);
- Pump Run Status (YI-230A-2, etc.);
- Low Suction Pressure Alarm displayed (PAL-230A, etc.);
- High Discharge Pressure displayed (PAH-230A, etc.);
- Grinder Run Status displayed (YI-230A-3, etc.);
- Grinder Failure Alarm (YA-230A-1, etc.);
- Grinder Motor State disagreement alarm (YA-230A-2, etc.); and

- Elapsed Time Meter displayed at SCADA HMI (KQI-230A-1)(KQI-230A-2, etc.).

Septage Pump Flow to Headworks Metering:

- Flow Rate indicated, trended, and recorded at SCADA HMI (FIR-240);
- Non-Resettable flow total (FQI-240-1);
- Current Day flow total (FQI-240-3);
- Previous Day flow total (FQI-240-2);
- Current Month flow total;
- Current Year flow total; and
- Resettable Flow total (FQI-240-4).

For More information on the Septage/Sludge Pumps and Grinders see **chapter 7 – Solids Processing.**

# 3 - PRIMARY CLARIFIERS

## 3.1 GENERAL

Wastewater flows by gravity over the weirs at the headworks grit chamber to equalize the flow and then through three 16-inch pipes from the headworks to the Primary Clarifiers. Three rectangular clarifiers are used at this facility for solids settling and removal. The WWTF was designed to have three primary clarifiers in operation during the summer months and two clarifiers in operation during the winter months. The actual number of clarifiers used during summer and winter months will be determined based on actual wastewater flow to the WWTF. Refer to **Table 3.1 – Primary Clarifier Basic Design Data.**

The three Primary Clarifiers are identical in size with an effective surface area of 1,467 square feet and volume of 76,812 gallons. With the three primary clarifiers in operation, the detention time will be approximately 1.5 hours at the average summer flow of 3.50 mgd. Each individual clarifier will have a detention time of 0.51 hours at this same flow.

**TABLE 3.1 - PRIMARY CLARIFIER DESIGN DATA**

| Description | Value |
|---|---|
| Number | 3 |
| Size, each, L x W (feet) | 81.5 by 18.0 |
| Side Water Depth (feet) | 7 |
| Effective Surface Area each (sq. ft.) | 1,467 |
| Volume, each (gallons) | 76,812 |
| Overflow Rate at Average Daily Flow (gpd/sq. ft.) | 795 |
| Overflow Rate at Peak Daily Flow (gpd/sq. ft.) | 1,752 |
| Loading Rate (gpd/linear foot of weir) | 24,297 |
| BOD Removal (percent) | 30 |
| BOD Removed (lbs/day) | 3,076 |
| TSS Removal (percent) | 60 |
| TSS Removed (lbs/day) | 8,700 |

During the wastewater detention time in the clarifier(s), approximately 30 percent of the BOD and 60 percent of the suspended solids will be removed. A decrease in BOD and SS removals in the clarifiers will also likely occur during peak or increased flow periods. Momentary losses of solids over the effluent weirs in the clarifiers may also be attributed to peak flow conditions and/or "shock" solids loading. A continual decrease in solids capture efficiency is often an indication of hydraulic and/or solids overload. Under normal flow and solids loading conditions, typical BOD and SS removals will range from 25 to 35 percent and 55 to 65 percent, respectively.

Each primary clarifier can be isolated from the treatment process by closing the desired self contained slide gate at the headworks grit chamber. Under normal summer operating conditions, the self contained slide gates should be open to allow for three tank operation. During winter months, any two desired clarifiers can be operated using the appropriate valves. The two clarifier stop planks should normally be left in position to allow flow direction to be controlled from the three self contained slide gates at the headworks. This also allows uniform flow distribution to be controlled from the Headworks effluent weirs.

Solids that settle to the bottom of the clarifiers are directed toward the sumps near the solids handling building. Solids are directed to the sumps by the chain-driven collection equipment installed in each clarifier. Mounted to the chains are tank-wide flights that continuously direct solids to the sumps by scraping the bottom of the tank. The flights are spaced ten feet apart and are fitted with wearing shoes to decrease wear of the flights.

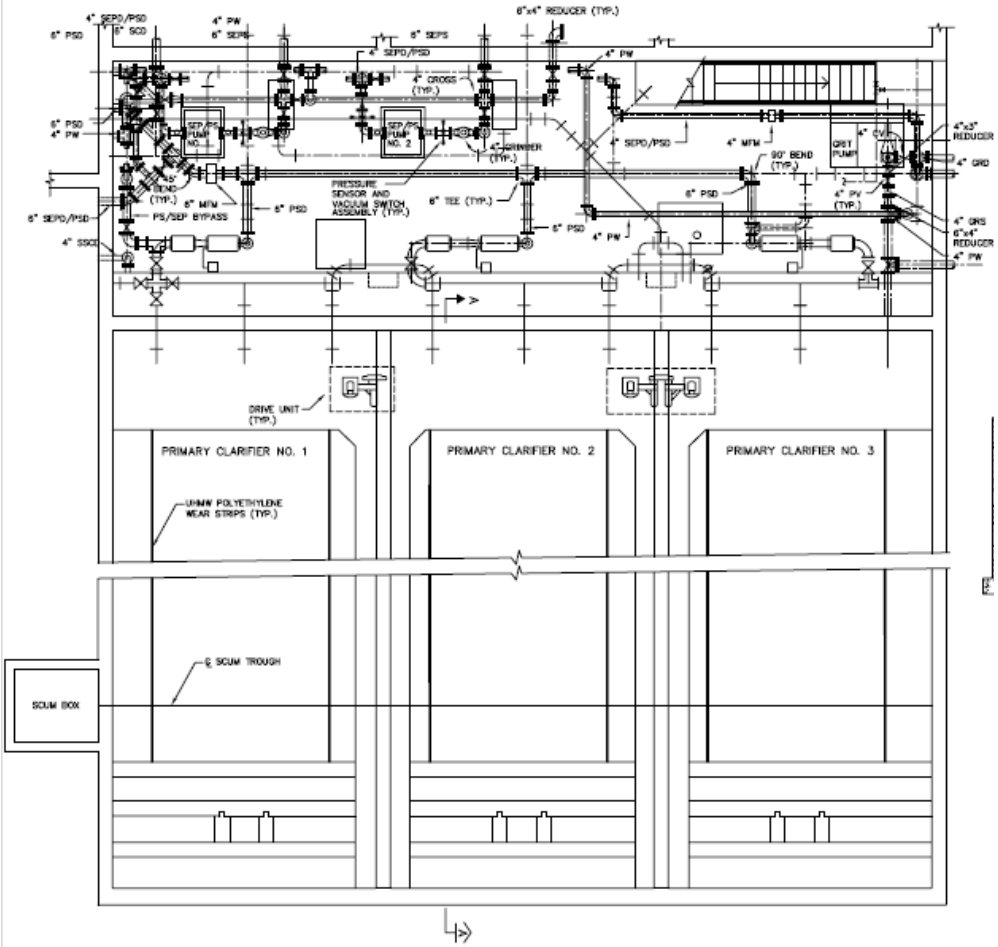
Solids collected in the sumps are pumped to the sludge holding tanks to await processing. Refer to the Sludge Withdrawal section of this chapter for information on this process. Scum and floatables are removed from the primary clarifiers via the manual rotating collector troughs. Weirs are located at the end of each clarifier to allow the wastewater to flow uniformly to the effluent trough and channel and on to the secondary process. Refer to **Figure 3.1 - Primary Treatment Building and Clarifiers.**

## 3.2 SLUDGE COLLECTION EQUIPMENT

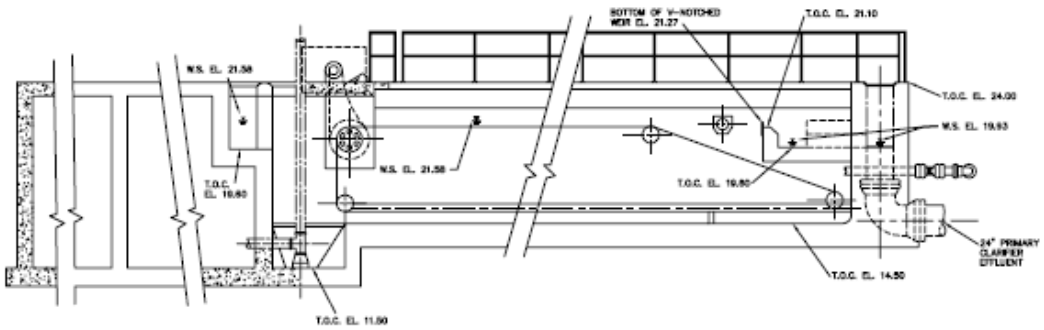
### *3.2.1 Description*

The primary collection equipment in each clarifier is made by Allied-Lock Industries of Dixon, IL. Each collector mechanism is driven by a motor, gear reducer assembly and drive sprocket. The drive sprockets are provided with shear pin hubs and limit switches for overload protection.

**FIGURE 3.1 - PRIMARY TREATMENT BUILDING AND CLARIFIERS**




PLAN




SECTION A

The shear pin makes the connection between the motor drive shaft and the drive sprocket. When to great a torque is realized at this connection, the pin is "sheared" off and the motor shaft spins freely while the collector mechanism stops. This system protects the motor from burning out under high torque situations.

A limit switch assembly has been installed on each of the three primary clarifier collector drive units. These switches were installed to sense when the shear pin is broken and relay an alarm to the SCADA System in the Main Control Room. When the shear pin breaks, a lever on the motor shaft is pushed out, this in turn pushes the limit switch lever enough to initiate an alarm condition. The SCADA System will show a blinking light for the clarifier drive with the broken shear pin. The operator should push the acknowledge button at the SCADA System (light stops blinking but is still shining) and go to the solids handling building and shut down the clarifier drive at MCC-4. When the situation is remedied (shear pin replaced) the alarm should be "reset" at MCC-4 and the SCADA System.

Excessive torque situations on the sludge collection equipment are most often caused by jamming of the flights, chain or sprockets by large objects such as sticks, wood planks or even rakes. Should an alarm condition occur (shear pin break) at a collector mechanism, the tank will probably have to be drained and the problem identified and alleviated. See **Section 3.6** for more information on dewatering the Primary Clarifiers. The correct size shear pins should always be used and monthly greasing of pins should be performed.

Each primary clarifier has a single drive unit with one ½ hp electric motor connected to adjacent gearboxes through flexible coupling. The drive units have a worm or helical gear type speed reducer that produces a sludge collector speed of 2 feet per minute at the 1,800 rpm motor speed. The chain drives above the operating platform have removable metal cover guards. Sprocket assemblies are polyethylene of the two segment, split construction, hunting type.

Non-metallic main chains are made of glass fiber, reinforced thermoplastic polyester alloy with barrel and sidebars integrally molded to insure squareness of the links. Sludge collector flights are made of fiberglass reinforced isothalic polyester resin and are 3-inches by 6-inches nominal size. Each is provided with ½ -inch thick UHMW wear shoes designed to run on the return track and floor wear strips, respectively.

Scum troughs for each tank are located in the downstream end of the clarifiers, just before the overflow weir. Each scum trough consists of a 10-inch diameter by 1/4–inch wall thickness pipe. Each pipe has longitudinal slots 30-inches long with 1-inch uncut bands between the slots to act as stiffeners. The scum troughs are manually rotated in cast iron flanged wall bearings using a hand lever. The operator should rotate the trough just enough to allow the scum floating on the surface to enter the trough. The scum troughs in each tank operate independently allowing the scum to flow through to the scum box. The primary sludge pumps transfer the scum to the two (2) primary sludge holding tanks.

The sludge collection equipment should be run continuously for all on-line clarifiers. The horizontal travel velocity of the flights is approximately two feet per minute (2 fpm) giving one complete tank revolution in about 1.475 hours.

### *3.2.2 Operation and Control*

Central operation of the three primary collector drives is at MCC-4 in the Primary Treatment Building and at the SCADA System in the main control room. MCC-4 has the following features:

- “On/Trip/Off - Reset” selector level;
- MCC-4 has a “RUN/STOP” indicating lamp;
- Elapsed time meter and “RESET” pushbutton;
- Locally mounted pushbuttons may also be used to “START, STOP, and LOCKOUT” each collector mechanism;
- High Torque Alarm (WAH-300A, etc.); and
- Run Status (YI-300A-2, etc.).

The SCADA System HMI displays the following status and alarm signals:

- Sludge Collector Drive run status (YI-300A-2, etc.);
- Sludge Collector Drive torque overload alarm (WAH-300A, etc.); and
- Elapsed run time meters (KQI-300A, etc.).

Plant operators should check to make sure that each on-line clarifier sludge collector mechanism is operating the first thing in the morning and at regular intervals throughout each working day. The quality of clarifier effluent should also be checked each morning and as needed throughout the day.

## 3.3 SLUDGE PUMPS AND GRINDERS

### *3.3.1 Description*

Three constant speed Penn Valley neoprene double disc diaphragm pumps are used to remove sludge from the primary clarifiers. Each pump delivers approximately 80 gpm at 15 feet of TDH. Local controls are provided to stop and lockout the primary sludge pumps. Refer to **Table 3.2 – Primary Sludge Pump Basic Design Data**

**TABLE 3.2 – PRIMARY SLUDGE PUMP DESIGN DATA**

| Description | Value |
|---|---|
| Number of Pumps | 3 |
| Total Dynamic Head (feet) | 15.0 |
| Capacity (gpm) | 280 |
| Pump Speed (RPM) | 300 |
| Pump Size (inches) | 4 |
| Motor | 5 HP<br>3 Phase, 60 Hertz<br>480 Volts |

A Franklin Miller grinder is provided just prior to each primary sludge pump to protect the units from large solids. The grinders have two counter rotating shafts capable of grinding 250 gallons of thickened wastewater sludge a minute. Each grinder is furnished with its own local control panel. If the grinder jams, it will reverse direction. This cycle is repeated up to three times, if necessary. If the jam clears, the grinder will return to normal operation. If the grinder does not clear, a failure light will illuminate on the controller and the associated sludge pump will shut down. The grinders receive power from Power Distribution Panel No. 1, which in turn receives power from MCC-4.

When servicing the pumps and grinders, make sure the units are electrically and hydraulically isolated. The water level in the clarifiers is several feet higher than the pumps. Removing a pump or grinder without closing the proper valves could result in flooding the pump room.

The quality and quantity of sludge withdrawn from primary clarifiers may vary widely. Variations may depend on: composition and freshness; flow into the clarifier; and management of sludge removal. Granular particles, such as inorganic sand and silt not completely removed in the headworks, settle at a constant velocity independent of one another and without change in size, weight, or shape. Temperature of the wastewater

will also influence the degree of settling. Water viscosity changes with varying ambient temperatures. A warmer (less viscous) wastewater will settle quicker and more efficiently.

### *3.3.2 Operation and Control*

The Primary Sludge Pumps are controlled through MCC-4 while the Grinders are controlled through local control panels. Local operation of the Grinders is through a HAND/OFF/AUTO" selector switch at the LCP, when in "AUTO" position, remote control is by the SCADA System.

The Grinder local Control Panels located on the first floor of the Primary Treatment Building have the following controls:

- HAND/OFF/AUTO" selector switch;
- Grinder "ON" indicating light (White);
- Grinder "Run" Indicator Light (Green);
- "Trip" Indicator Light (Red) (Flashes on motor overload);
- "Forward" and "Reverse" Indicator Lights (Amber);
- "Seal Fail" Indicator Light (Red); and
- "Start" and "Stop" Pushbuttons.

The control logic restricts resetting an overload condition from the SCADA System. Resetting an overload condition must be done from the local control panel

The Primary Sludge Pump Central Operations is at MCC-4 located on the first floor of the Primary Treatment Building and has the following features.

- "HAND/OFF/AUTO" Selector Switch ( YI-310A-1, etc.);
- Pump "On" and "Off" Indicator Lights;
- Pump high discharge pressure alarm (PAH-310A, etc.);
- Pump low suction pressure alarm (PAL-310A, etc.);
- H-O-A switch in "AUTO" (YI-310A-1, etc.);
- Pump elapsed run time meter (KQI-310A-1, etc.); and
- Pump "Reset" pushbutton.

The operator must be sure that the valves are set up properly before activating the pump. Operation of a positive displacement pump against a closed suction or discharge valve will cause damage to the pump.

The SCADA System displays the following controls and status and alarm signals for the Primary Sludge Pumps and Grinders:

- Pump HAND/OFF/AUTO selector switch position, (YI-310A-1, etc.);
- Pump run status (YI-310A-2, etc.);
- Pump low suction pressure alarm (PAL-310A, etc.);
- Pump high discharge pressure alarm (PAH-310A, etc.);
- Grinder in “AUTO” (YI-310A-3) etc.);
- Grinder run status (YI-310A-4, etc.);
- Grinder failure alarm (YA-310A-1, etc.);
- Elapsed run time meters for each pump and grinder (KQI-310A-1, KQI-310a-2, etc.);
- Motor disagreement alarm (YA-310A-2, etc.); and
- Pump/grinder tank Selector Switch.

Primary Sludge Flow Metering:

- The sludge flow rate is indicated, trended, and recorded at the SCADA HMI (FIR-320);
- Non-resettable flow total (FQI-320-1);
- Current day flow total (FQI-320-3), automatic reset at midnight;
- Current month flow total;
- Current year flow total;
- Previous day flow total (FQI-320-2);
- Resettable flow total (FQI-320-4); and
- High and Low flow alarms (LAH-330-1, LAH-330-2).

## 3.4 SCUM COLLECTION AND WITHDRAWAL

Primary Clarifier Nos. 1, 2, and 3 are all equipped with 10-inch revolving scum troughs for scum collection. Primary scum and other floatables in the clarifiers are directed to the scum troughs by the sludge collector flights moving along the water surface toward the trough. After a

significant quantity of scum has accumulated near the troughs, the manual operating lever should be used to rotate the scum trough towards the scum, allowing scum and some wastewater to enter the trough. Scum and wastewater are collected in the trough flow by gravity to the square concrete scum box adjacent to Primary Clarifier No. 1. When all the scum for a particular clarifier has been collected, the scum trough should be manually rotated back to the vertical position so no wastewater enters the trough. The operators should be careful to turn the scum trough slowly when collecting scum and position it so as not to allow too large a volume of wastewater to enter the trough with the scum.

Scum can be held in the scum box and removed by a vacuum-pumping haul truck. However, Sludge Pump No. 1 should be primarily used for withdrawal of scum from the scum box and discharged to a hauler. The plug valves located on the 8-inch primary scum suction and 6-inch sludge suction lines must be properly positioned for scum to be drawn from the scum box and discharged to the haul truck. All six-inch plug valves on the primary sludge suction lines must be closed and the appropriate discharge valves set to allow primary scum discharge to the haul truck. The primary scum discharge pipe connection is located outside of sludge holding tank No. 2 next to the six-inch sludge receiving connection. The scum can be discharged to the truck using any of the three sludge pumps or the grit pump (as long as the required valves are properly set). Scum may also be discharged to any sludge holding tank. Scum pumped to the sludge holding tanks may cause problems during dewatering procedures and should be discontinued if any problems arise. Previous operation experience has found that scum pumping to the sludge holding tanks and eventual dewatering with accumulated sludge has not caused any unusual problems. If scum discharge to the sludge holding tanks in the future causes adverse conditions, scum should be separately removed by vacuum haulers as described previously. Scum may be discharged to any sludge holding tank from any of the three sludge pumps using the appropriate valuing scenario. The operator has wide flexibility with scum pump selection and discharge location.

Scum collection and removal should be performed by plant operators as scum buildup dictates. The primary clarifiers should be checked every weekday morning for scum accumulation and as needed during the day. The scum troughs and box should always be hosed down after use.

## 3.5 SLUDGE WITHDRAWAL

The quality and quantity of sludge removed from the primary clarifiers may vary widely. Variations may depend on; composition and freshness; flow into the clarifier; and management of sludge removal. Granular particles, such as inorganic sand and silt not completely removed in the headworks, settle at a constant velocity independent of one another and without change

in size, weight, or shape. The temperature of the wastewater will also influence the degree of settling. Water viscosity changes with varying ambient temperatures. A warm (less viscous) wastewater will settle quicker and more efficiently. Operators should strive for proper sludge removal management. At the WWTF, a 3 to 5 percent solids concentration in the primary sludge underflow is desirable.

The laboratory total solids test is the only accurate method for determining exact solids content. This is a time consuming test and cannot be used routinely for the control of sludge pumping. It should, however, be done weekly to check the validity of your sludge pumping cycles. On a daily basis, the operator should check the inventory of primary sludge by the use of a sludge judge. The sludge inventory should be checked at the same time each day and in the same location of each clarifier.

Sludge withdrawal can be accomplished automatically at any predetermined time of the day or night. Programmable timers associated with each primary sludge pump can be used to activate any of the three sludge pumps and the grit pump.

By using the laboratory test for suspended solids and percent solids, the operator can gauge how much sludge to remove from the primary clarifiers. Efficient operation of any treatment facility must include knowing where the solids are, what condition the solids are in, and how to manage them for further treatment.

Sludge withdrawal can also be performed manually by using the "Hand" position of the H-O-A selector switches at MCC-4. The operator can remove sludge manually from the clarifiers instead of using the automatic timer, but should only run the sludge pump(s) as long as the solids concentration of sludge being pumped is approximately 3 to 5 percent. This can be monitored by watching the ultrasonic flow meters. When the flow rate "jumps" up significantly while pumping, the pumping should be ceased for that particular clarifier hopper. The sampling valve on the sludge pump discharge piping can also be used to visually check the solids content of sludge being pumped to the holding tanks. Manual sludge pumping should be done for each individual clarifier hopper (9 total) until the solids content of sludge being pumped instantly drops off. Previous primary sludge pumping experience indicates that manual pumping 3 times daily and automatic pumping the remainder of the day, night and weekends is satisfactory. Automatic pumping cycles should be adjusted to meet varying conditions. Decanting of the sludge holding tanks should be performed if needed to provide a thicker sludge for dewatering.

The appropriate Primary Sludge Holding Tank (tank 1 or 2) selector switch should always be set with the appropriate sludge pump at the sludge pump tank selector panel for high tank level sensors. This control panel provides an alarm when a particular tank has reached a "high" tank level. Sludge withdrawal from any clarifier and discharge to any holding tank can be performed with any sludge pump, or the grit pump, as long as the appropriate suction and discharge valves are properly positioned.

If a blockage occurs in the sludge suction piping during sludge withdrawal, the 4-inch quick-connect pipe risers (one for each clarifier suction pipe, nine total) can be used to hook-up a water pressure hose from a yard hydrant to "blow" the blockage free. Blockage can also be removed using the air connection on the suction piping. The most likely place for blockage will be the tee in the piping near the 6-inch sludge shoes.

The solids receiving arrangement is two (2) Primary Sludge Holding Tanks, and two (2) Septage Holding Tanks. Each holding tank has a “HIGH” and “HIGH-HIGH” level alarm to notify the operator the alarmed tank is full and cannot receive any additional sludge. At this point the operator must transfer sludge from the Primary Sludge Holding Tank to the Advanced Treatment Sludge Holding Tanks using one of the two Septage/Sludge Pumps. The operator can also transfer the primary sludge to one of the Septage Holding Tanks until the Advanced Treatment Sludge Holding Tanks becomes available.

## 3.6 PRIMARY CLARIFIER TANK DEWATERING

The individual clarifiers must be dewatered if a clarifier is being taken offline for maintenance, including is the sludge collector mechanism is jamming.

The preferred method of Tank dewatering is to draw down the particular clarifier using the grit pump. Using this pump will discharge the wastewater back to the influent channel of the headworks structure. To dewater a clarifier the following manual steps should be taken;

- Turn off septage pumps;
- Isolate the grit chamber from the Primary Clarifier Trunk Line using valve Gr -001;
- Close valve GR-004; and
- Close Valve Sep-19;
- Isolate Clarifier to be drained.

## 3.7 EQUIPMENT MAINTENANCE (Primary Tank and Collection Equipment)

### *3.7.1 Inspections*

Daily Inspections

- Inspect the operation of the collection mechanism for a jerking motion or for flights not riding perpendicular to the guide rails. Either condition may indicate that a chain tension problem exists; and

- Inspect the sludge pit for excessive build up and clean as required.

Monthly Inspections

- Drive unit shear pins should be removed and carefully inspected. Replace any damaged material. While shear pin is removed, verify that the shear pin hub rotates freely from the drive sprocket. Re-grease shear pin prior to reassembly; and

- Check gear reducer oil levels. Note that double/triple reduction gear units have two/three independent gear housings. Oil levels in each housing should be checked.

Semi-Annually Inspections

Clarifier tanks should be dewatered to ensure the longevity of the system. The following steps should be followed:

- Grease all wall bearings immediately upon dewatering. Lubrication with grease is required under non-submerged conditions to avoid seizure;

- All equipment should be washed down and all debris removed from the tank. Avoid high pressure water directed at drive unit or limit switch assembly;

- Check all flight, sprocket, and track hardware for proper tightness;

- Ensure all anchor bolts are properly tightened. Ensure anchor bolts are still properly anchored to the concrete surface;

- Inspect the collector chain sprockets for excessive wear. If wear is discovered on the sprocket teeth, reverse sprocket hubs to lengthen the sprocket life;

- Inspect all collector chain and attachment links for unusual wear or cracks or breaks. Wear along the inside chain side bar is an indication of sprocket misalignment. Broken links must be replaced;

- Inspect carry and return wear shoes for wear. If wear shoes are less than ¼ inch thick, it is recommended the shoes be reversed or replaced. All wear shoes are reversible to allow for double life;

- Measure wear strips and if wear strip thickness is less than ¼ inch thick or mounting hardware protrudes above the wear strip it is recommended the wear strips should be replaced;

- Check for sprocket alignment and be sure that hardware is secure;

- Check the idler sprockets to make sure they turn freely on the shaft. If not, remove the sprocket and check both bearing surfaces. Clean both surfaces and return sprocket to shaft. Clearance between set collar and sprocket should be 1/16 inch; and

- Change oil in reducer as described in the manufacturers' manual.

### *3.7.2 Troubleshooting*

Refer to **Table 3.3 – Primary Clarifier Troubleshoot Guide.**

**TABLE 3.3 - PRIMARY CLARIFIER TROUBLESHOOTING GUIDE**

| Observation | Probable Cause | Monitor | Solutions |
|---|---|---|---|
| Floating sludge in clarifier(s) | 1a. Sludge decomposing in tank | 1a. Tank water surface of cycle | 1a. Remove sludge more frequently by increasing duration of cycle |
| | 1b. Flights worn or damaged | 1b. Inspect flights | 1b. Repair or replace flights as required |
| | 1c. Sludge withdrawal suction line plugged | 1c. Sludge pump discharges and suction gages | 1c. Clean suction line by flushing through 4-inch connect riser piping |
| Black and odorous wastewater in clarifier(s) | 2a. Improper sludge removal pumping cycles | 2a Sludge density | 2a. Increase frequency and duration of pumping cycles until sludge density decreases |
| | 2b. Inadequate pretreatment | 2b. Pretreatment operation | 2b. Pre-aerate septage longer if possible. Add Sodium Hypochlorite to bring up the pH of the septage before pumping to the municipal flow. Lime may also be added |
| Erratic operation of Sludge unit trips off | 3a. Excessive sludge inventory | 3a. Sound bottom of tanks. Dewater tank (only if absolutely necessary) | 3a. Increase frequency of tank pumping to waste |
| | 3b. Foreign object dropped in tank | 3b. Sound bottom of tanks. Dewater tank (only if absolutely necessary) | 3b. Dewater tank and remove object |
| Scum overflow in effluent | 4a. Heavy industrial/ commercial contributions of grease | 4a. Influent waste | 4a. Control industrial waste contributions |
| | 4b. Collector not working | 4b. Collector | 4b. Adjust or repair collector (flights). Make sure the lines are free to the holding tanks |
| | 4c. Scum trough improperly positioned or clogged | 4c. Scum trough | 4c. Adjust trough |
| Undesirably low solids content in sludge | 5a. Over-pumping of sludge | 5a. Frequency and duration of sludge pumping, solids concentration and pump duration | 5a. Reduce frequency and duration of pumping cycles |

# 4 - ADVANCED TREATMENT PROCESS

## 4.1 GENERAL

The advanced treatment process at the Surfside WWTF is a modification of the Activated Sludge Process known as the Modified Ludzack-Ettinger Process (MLE) followed by the Membrane Bioreactor (MBR) Process. The MLE Process is a two stage, single sludge, nitrification/denitrification process that includes a pre-anoxic stage followed by an aerobic stage with an internal recycle from the aerobic stage back to the anoxic stage with provisions for a future post-anoxic stage. The membrane bioreactors take the place of clarifiers typically used in a conventional plant; however they provide a process similar to ultra-filtration.

The advanced treatment system consists of distribution box, followed by two mechanically mixed pre-anoxic basins, each discharging to three aeration basins. Two aeration lift pumps lift the effluent from each of the two pre-anoxic basins into the aeration basin influent channel that distributes the flow equally into the three aeration basins. Each aeration basin utilizes a fine bubble air diffuser system to aerate the mixed liquor and keep it in suspension. The aeration basin effluent flows through open wall ports into the future post-anoxic basins. The post-anoxic basin effluent flows into the MBR basin influent channel that distributes the flow into the four MBR basins. Each MBR tank is equipped with an ABS Submersible pump to pump RAS to an elevation at which it will then be recycled by gravity back to the pre-anoxic basins. Other components of the advanced treatment system include the waste sludge pumping system, explained in **Chapter 7.0 – Solid Processing**. The advanced treatment system including distribution box, the pre-anoxic tanks, aeration tanks, post-anoxic tanks, and the MBR tanks can be found on **Figure 4.1 – Location Plan** and **Figure 4.2 – Plan Layout**.

The treatment process provided is a modified activated sludge suspended growth process, which achieves BOD, TSS, and nitrogen removal by utilizing microorganisms in suspension. The process utilizes rectangular tanks, which are separated by weirs into a pre-anoxic stage (devoid of oxygen) followed by an aerobic stage. The aerobic stage is accomplished by using diffused air aeration. The pre-anoxic/aerobic tanks are followed by the future post-anoxic tanks for future nitrogen removal then by the MBR system, which separate out the biomass for wasting or for recycling back to pre-anoxic tanks.

**FIGURE 4-1 – LOCATION PLAN**

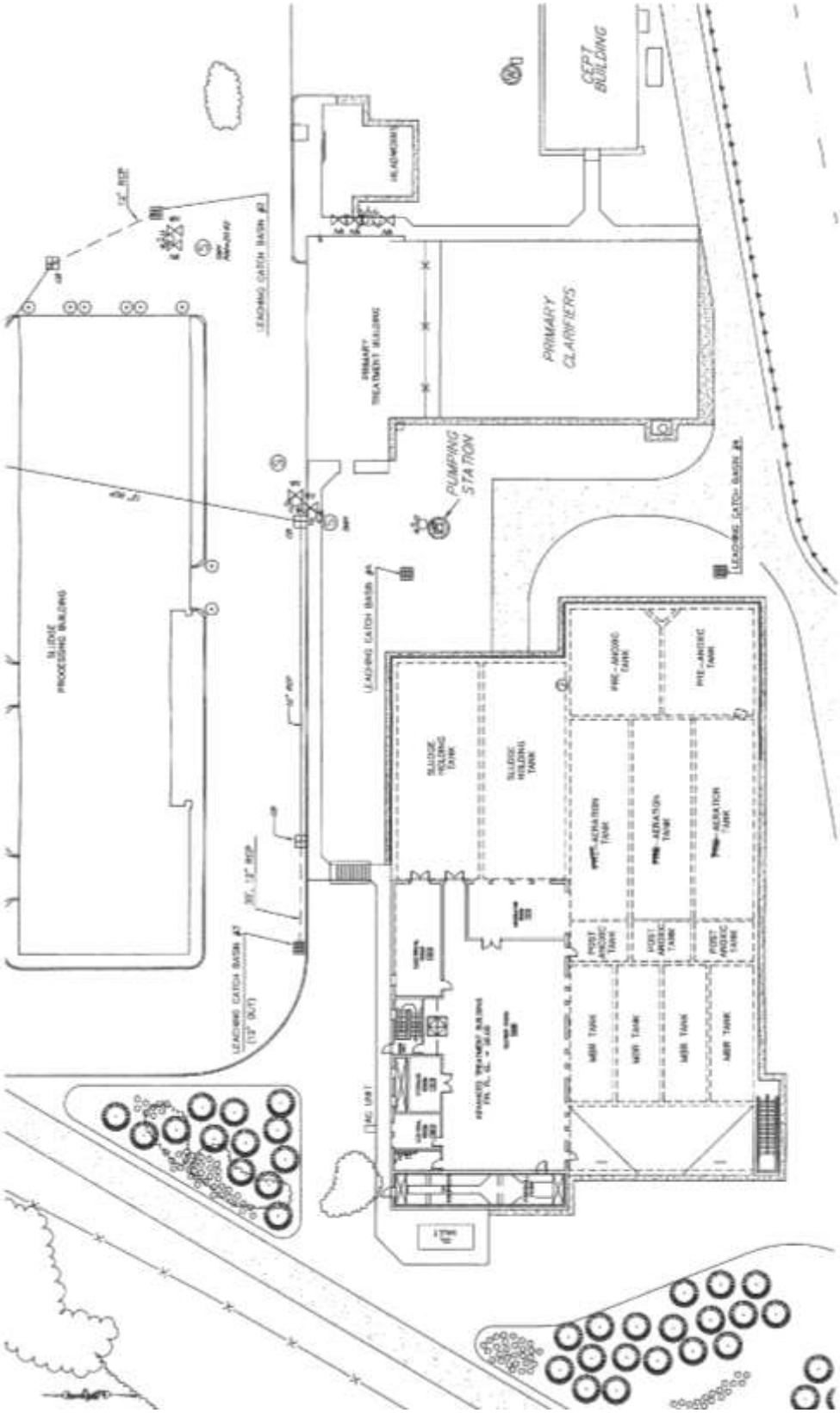
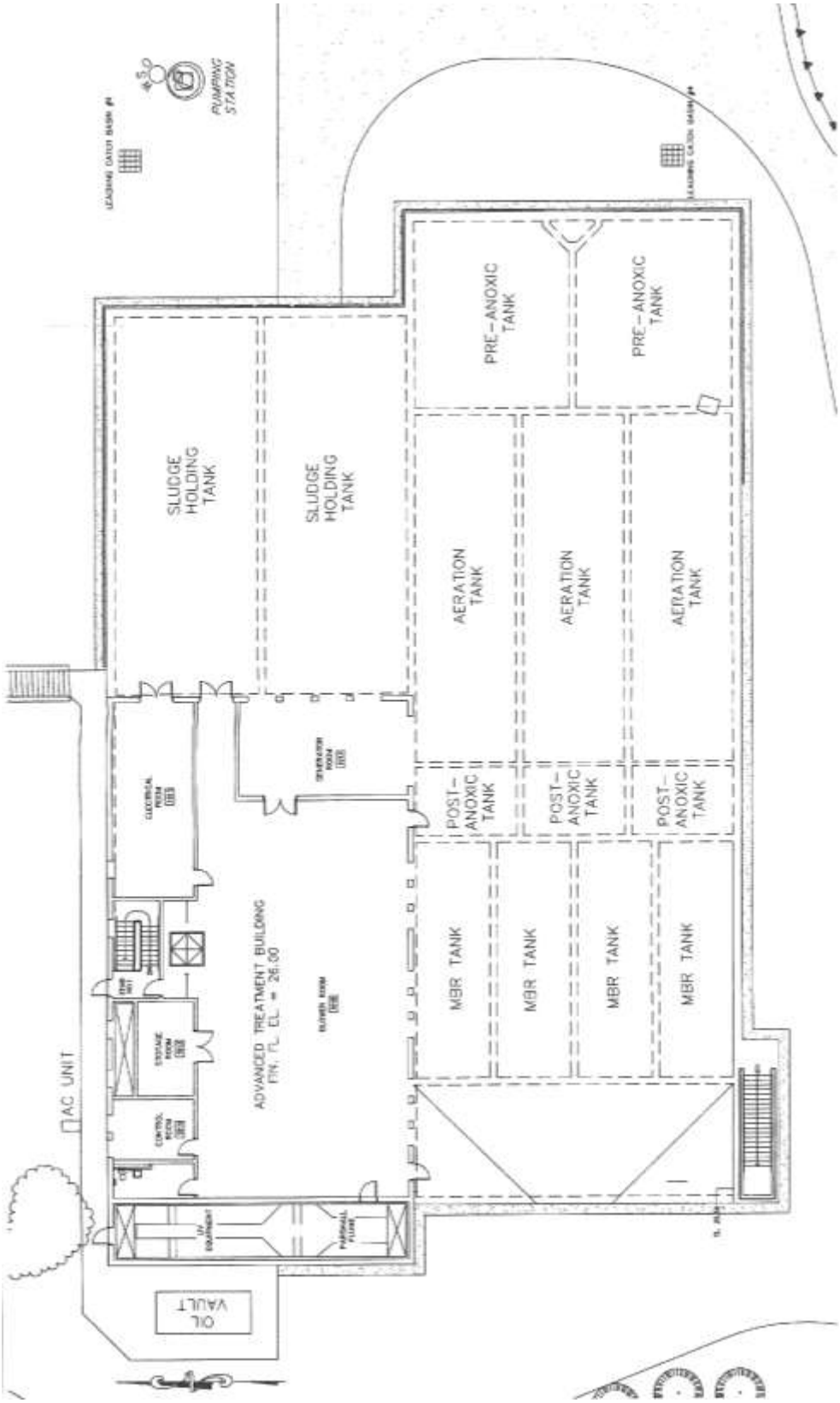


**FIGURE 4-2 – PLAN LAYOUT**



The removal of BOD and TSS occurs primarily in the aerobic stage of the process. The combination of pre-anoxic and aerobic stages is used for the removal of nitrogen. The first step is done aerobically and involves the biological oxidation of ammonia-nitrogen to nitrate-nitrogen. The second step is done in the pre-anoxic basins and reduces nitrate-nitrogen to nitrogen gas. The first step is known as nitrification and the second step is known as denitrification. Although the typical order of nitrogen treatment is to provide nitrification followed by denitrification, the stages are reversed in the process provided at the Surfside WWTF. The reason for this is to provide the organic material from the primary wastewater effluent for the pre-anoxic stage where it is needed as a food source for the microorganisms used to treat the wastewater. The microorganisms are kept mixed and in suspension along with the wastewater throughout the aeration and post-anoxic tanks. This combination of the microorganisms and wastewater is what makes up the mixed liquor.

Primary effluent enters the pre-anoxic tanks from the distribution box and supplies carbon to the microorganisms in the mixed liquor. The microorganisms in the absence of dissolved oxygen will utilize oxygen in the nitrate-nitrogen, releasing nitrogen gas to the atmosphere. This process is known as denitrification. The wastewater then travels to the aeration tanks where the mixed liquor is aerated and mixed. The microorganisms in the mixed liquor in the aeration tank treat the wastewater, stabilizing its organic matter. As a result, the biodegradable $BOD_5$ is oxidized as the microorganisms utilize the organic matter as a food source to grow new cells, and ammonia is converted to nitrate through the action of a specialized group of microorganisms known as nitrifiers. This process is known as nitrification.

An internal pumping system is utilized to return the nitrified wastewater from the MBR stage to the pre-anoxic stage for denitrification. Excess mixed liquor created from cellular growth is wasted from the MBR Tanks to the sludge holding tanks and then dewatered. The function of the internal recycle is to return the nitrates formed in the aeration tank back to the pre-anoxic tank to undergo denitrification. The internal recycle is typically 400% to 600% of the influent flow rate. The mixed liquor then flows from the aeration tanks through the post-anoxic tanks and on to the MBR System. In the MBR System the activated sludge (sludge with microorganisms) is removed from the effluent flow by drawing the wastewater through the ZeeWeed Membrane hanging hollow tubes using the Permeate/ Backpulse Pumps. The effluent is discharged to the groundwater through the Rapid Infiltration Basins via the Backpulse Wet Well, the UV Disinfection System, the Effluent Sump, and through Parshall Flume for flow measurement.

During nitrification, alkalinity is consumed at the rate of 7.2 mg of Alkalinity as $CaCO_3$ per mg of ammonia nitrified. However, during the denitrification process, there is an alkalinity return of 3.6 mg as $CaCO_3$ per mg nitrate reduced. This payback helps to maintain the pH of the advanced wastewater treatment process around neutral (7.0) where the process can run efficiently. The post-anoxic tanks also act as a natural selector for filament control. Even though it is commonly thought that a low DO environment will encourage the growth of filaments, filamentous organisms do not proliferate in the rapidly changing environment created by the pre-anoxic/aerobic treatment process.

For equipment specific operation and maintenance information, please refer to the manufacturer's Operation and Maintenance Manuals. Refer **to Table 4.1 - Advanced Treatment Process Design Data.**

**TABLE 4.1 - ADVANCED TREATMENT PROCESS DESIGN DATA**

| Equipment | Design |
|---|---|
| **Process Conditions** | |
| Average Daily Flow (mgd) | 3.50 |
| Maximum Daily Flow (mgd) | 5.25 |
| $BOD_5$ Load Average Day, Peak Month (lbs/day) | 7,176 |
| Total SS Load Average Day Peak Month (lbs/day) | 5,800 |
| TKN Load Average Day Peak Month (lbs/day) | 1,095 |
| $NH_4$-N Load Average Day Peak Month (lbs/day) | 784 |
| Total P Load Average Day Peak Month (lb/day) | 209 |
| $SBOD_5$ Load Average Day Peak Month (lbs/day) | 4,306 |
| Effluent $BOD_5$ (mg/l) | 5 |
| Effluent TSS (mg/l) | 5 |
| Effluent $NH_3$-N (mg/l) | 1.0 |
| Effluent $NO_3$-N (mg/l) | 7.0 |
| Effluent Organic N (mg/l) | 2.0 |
| Effluent TN (mg/l) | 10.0 |
| Effluent TP (mg/l) | 3.0 |
| MLSS (mg/l) | 4,000 |

**TABLE 4.1 - ADVANCED TREATMENT PROCESS DESIGN DATA**

| Equipment | Design |
|---|---|
| MLSS under Aeration (lb) | 56,105 |
| **Distribution Box No. 1** | |
| Number of Weir Gates (ea) | 2 |
| Width of gate (ft) | 6 |
| **Pre-Anoxic Tanks** | |
| Number of Tanks (ea.) | 2 |
| Sidewater Depth (ft) | 11.50 |
| Width (ft.)(each) | 29.33 |
| Length (ft.)(each) | 36.50 |
| Unit Volume (gal) | 90,000 |
| Total Volume (gal) | 180,000 |
| Detention Time @ ADF (hrs) | 5.58 |
| Number of Submersible Pumps | 4 |
| Pump Type | Submersible Propeller |
| Pump Propeller Diameter (in.) | 20 |
| Pump Propeller Speed (variable)(rpm) | 565 |
| Pump Motor Horsepower (HP) | 7.64 |
| Submersible Pump Capacity (gpm) | 4165 |
| Pump Head (FT.) | 3.86 |
| Pump Drive | Direct |
| Number of Mechanical Mixers (each) | 4 |
| Mixer Type | Submersible Propeller |
| Mixer Propeller Diameter (in.) | 11.8 |
| Mixer Propeller Speed (rpm) | 1111 |
| Mixer Motor Horsepower (HP) | 2.3 |
| Mixer Flowrate (gpm) | 2600 |
| Mixer Drive | Direct |
| **Aeration Basins** | |
| Number of Basins | 3 |
| Width (ft) | 19.08 |

**TABLE 4.1 - ADVANCED TREATMENT PROCESS DESIGN DATA**

| Equipment | Design |
|---|---|
| Length (ft) | 15.69 |
| Side Water Depth (ft) | 15.06 |
| Basin Volume (gal.)(each) | 148,000 |
| Total Volume (gal.) | 444,000 |
| Detention Time (hrs) | 3.05 |
| **Air Diffuser Systems** | |
| Aeration Tank Nos. | 1 – 3 |
| Zone Nos. | 1 – 2 |
| Grids per Tank | 2 |
| Distributor Legs per Grid | 10 |
| Diffuser Elements per Distributor | 26 |
| Diffuser Elements per Grid | 260 |
| All Diffusers | 9” EPDM Membrane Discs |
| **Air Blower System** | |
| Number of Blowers (ea.) | 3 |
| Speed @ Max. Capacity (rpm) | 2967 |
| Max. Inlet Cap. (icfm) | 1040 |
| Max. Operating Pressure (psig) | 9 |
| Max. Horsepower | 60 |
| Number of Blowers | 3 |
| Blower Intake/Discharge Port Size (in.) | 6/6 |
| Drive Type | Variable Speed |
| Noise Attenuation | Yes |
| **Post-Anoxic Basins** | |
| Number of Basins (ea) | 3 |
| Side Water Depth (ft) | 15.95 |
| Width (ft) | 19.08 |
| Length (ft) | 13.17 |
| Unit Volume (gal.) | 30,000 |
| Total Volume (gal) | 90,000 |

**TABLE 4.1 - ADVANCED TREATMENT PROCESS DESIGN DATA**

| Equipment | Design |
|---|---|
| Detention Time (hrs) | 0.62 |
| **Air Diffuser System** | |
| Post-Anoxic Tanks Nos. | 1 - 3 |
| Zone No. | 3 |
| Grids per Tank | 1 |
| Distributor Legs per Grid | 7 |
| Diffuser Elements per Distributor | 9 |
| Diffuser Elements per Grid | 63 |
| All Diffusers | 9” EPDM Membrane Discs |
| **Air Blower System (Shared Aeration Blowers)** | |
| Number of Blowers | 3 |
| Speed @ Max. Cap. (rpm) | 2967 |
| Max. Inlet Cap. (icfm) | 1040 |
| Max. Operating Pressure (psig) | 9 |
| Max Horsepower (HP) | 60 |
| Blower Intake/Discharge Port Size (in.) | 6/6 |
| Drive Type | Variable Speed |
| Noise Attenuation | Yes |
| **Membrane Bioreactors (MBRs)** | |
| Number of Basins | 4 |
| Sidewater Depth (ft) | 15.5 |
| Width (ft) | 14.0 |
| Length (ft) | 42.0 |
| No. of Cassetts per Basin | 5 |
| Total No. of Cassetts | 20 |
| **MBR Blowers** | |
| Number | 5 |
| Type | Rotary Lobe (PD) |
| Inlet Capacity (scfm) | 1728 |

**TABLE 4.1 - ADVANCED TREATMENT PROCESS DESIGN DATA**

| Equipment | Design |
|---|---|
| Discharge Pressure (psig) | 8.00 |
| Buildout Inlet Capacity (scfm) | 1728 |
| Buildout Discharge Pressure (psig) | 8.00 |
| Blower (HP) | 100 |
| Blower Speed (rpm) | 2778 |
| No. of MBR Cassettes (per Basin) | 5 |
| Total No. of MBR Cassettes | 20 |
| **MBR Permeate/Backpulse Pumps** | |
| Number | 4 |
| Type | Positive Displacement |
| Flow Rate (gpm) | 375 – 1605 |
| Discharge Pressure (TDH) (psig) | 16 – 25 |
| Motor Horsepower | 50 |
| Motor Speed (rpm) | 540 |
| Drive Type | Variable Speed |
| **MBR Chemical Cleaning System** | |
| Number | 4 |
| Pumps Used | Permeate/Backpulse |
| Backpulse Flow Rate (gpm) | 683 – 1365 |
| Backpulse Discharge TDH (ft.) | 16 – 25 |
| Chemical #1 Injected | Citric Acid |
| Chemical #2 Injected | Sodium Hypochloride |
| **Waste Activated Sludge Pumps** | |
| Number | 2 |
| Type | Double Disc |
| Port Size (in) | 4 |
| Speed (rpm) | 232 |
| Flow Rate (gpm) | 80 |
| Discharge TDH (ft.) | 25 |
| Horsepower | 5 |

**TABLE 4.1 - ADVANCED TREATMENT PROCESS DESIGN DATA**

| Equipment | Design |
|---|---|
| Drive Type | Variable Speed |
| **DO Analyzer /Transmitter** | |
| Number of units (ea) | 6 |
| Manufacturer | HACH-Danfoss-Evita |
| Model No. Sensor | PT#OXY1100 |
| Model No. Transmitter | PT#OXY4100 |
| Model No. Converter | PT#OXY7000 |
| Range | 0-10 mg/l |
| Sensor Mounting | Floating ball |

## 4.2 DISTRIBUTION BOX

After primary treatment the wastewater flows by gravity into a distribution box, which combines it with Sodium Hydroxide for pH control and splits the flow into two equal streams for advanced treatment. The wastewater flow enters the distribution box through a 30-inch diameter gravity pipeline. Sodium Hydroxide enters through 1-inch diameter pipeline through the headwall. The Sodium Hydroxide is controlled by Milton Roy metering pumps located on the ground floor of the Advanced Treatment Building. An 8-inch diameter drain pump force main can also be discharged into the distribution box through the headwall if one of the Pre Anoxic or aeration basins is being dewatered. The drain pumps are located in the basement of the Advanced Treatment Building.

The primary effluent, drain pump, and sodium hydroxide discharges combine and pass through the two slide gates and flow into the two pre-anoxic tanks. When both slide gates are open, the flow is equally distributed between the two pre-anoxic tanks.

A pre-anoxic tank may be taken off-line by closing its respective distribution box, aeration lift pump, and recycle line slides gates. At least one of the two pre-anoxic tanks must remain on line at all times. Once the initial operating position of the slide gates are selected slide gate changes are only required if tanks are taken off-line for inspection or maintenance.

## 4.3 PRE-ANOXIC TANKS

### *4.3.1 Description*

Flow from the distribution box discharges directly into the adjacent pre-anoxic tank(s). Recycled mixed liquor, originating from the MBR tanks, flows directly into the pre-anoxic tanks by gravity. Thus, the flow through the advanced treatment process is equal to the influent flow plus the internal recycle flow. There are two tanks, Pre-Anoxic Tank No. 1 and No.2. Each pre-anoxic tank has two (2) submerged mechanical mixers to keep the mixed liquor in suspension and maintain a homogenous tank volume. Each pre-anoxic tank has two (2) submerged propeller type aeration lift pumps to lift and discharge the tank's effluent into the Aeration Tank's influent channel, which serves all three (3) Aeration Tanks. Thus, if one of the Pre-Anoxic Tanks is taken out of service, the online Pre-Anoxic Tank can feed all the downstream process units.

The pre-anoxic stage is designed to achieve efficient denitrification. Denitrification requires an anoxic environment, which does not contain dissolved oxygen but does contain nitrates. In this environment, facultative bacteria present in the mixed liquor use the oxygen from the nitrates as a replacement for dissolved oxygen for metabolism, releasing nitrogen into the atmosphere as a gas. The bacteria simultaneously utilize carbon from the BOD to fuel cell growth and energy needs. The internal recycle stream brings the nitrate formed in the aeration tanks back into the anoxic zone to undergo denitrification.

Internal recycle into the pre-anoxic tanks from the MBR tanks flows through a 20" diameter underground pipeline running along the outer wall of the advanced treatment process units, discharging into the influent end of the pre-anoxic tanks. The recycle flow rate is measured by four 8" diameter magnetic flow meters and controlled by the differential head between the MBR Tanks and the Pre-Anoxic Tanks. The internal recycle system is designed to provide a recirculation rate of up to 100% of the plant's influent flow. For this process, it is suggested that the recirculation rate be set to its highest value initially. Adjustments can be made after this initial setting. A manual operator and mud valve has been provided on the bottom of each Pre-Anoxic Tank for dewatering.

Each anoxic tank is also equipped with an Oxidation Reduction Potential (ORP) probe. The ORP probe provides continuous information to the operator through the MBR Control Panel and the SCADA System concerning the state of the pre-anoxic zone. The value of the oxidation-reduction potential is an indication as to whether the pre-anoxic zone is anoxic, anaerobic or aerobic. With this information the operator can adjust the DO

control system and the recirculation rate to optimize the pre-anoxic zone environment. Indication of ORP may be viewed at the local transmitters on the Pre-Anoxic Tanks, at the MBR Control Panel, and at the SCADA System.

### *4.3.2 Submersible Mechanical Mixers*

Four Pre-Anoxic Tank Submersible Mechanical Mixers are used to mix the mixed liquor in the tanks. There are two mixers per tank: Mixers Nos. 1A and 1B are in Pre-Anoxic Tank No.1 and Mixers Nos. 2A and 2B are in Pre-Anoxic Tank No. 2. These mixers are constant speed submersible type axial flow propeller mixers. Each mixer pumps at the rate of 2,600 gpm and is driven by a 2.3-Hp constant speed direct drive electric submersible motor. Ancillary equipment for the pre-anoxic mixers include:

- Local Control Panel – Red LED Indicating Light – Oil Chamber Seal Alarm;
- Local Control Panel – Red LED Indicating Light – Motor Overtemp Alarm;
- Local Control Panel – Overtemp Reset Pushbutton;
- Set of “Form C” contacts for remote monitoring of above alarms; and
- Portable hoist and guide rail system.

Each of the mixer motors is equipped with an over temperature protection system that will automatically shut down the mixers and send an alarm due to a motor over-temperature. Similarly, a seal leak detection system wired to the mixer control panel will shut down the mixer if a leak is detected. Both of these alarms will be indicated at MCC-10 as well as at the MBR Control Panel and the SCADA System. After detection, the alarms must be reset at MCC-10 before the mixer will restart.

Power for each mixer is supplied by MCC-10, which is located in the Advanced Treatment Building. At MCC-10 are the run and alarm status lights. Run and alarm conditions are transmitted from MCC-10 to the MBR Control Panel and the SCADA System. At each mixer, there is a local Pushbutton On/Off Lockout Station. There are no mixer controls in the SCADA system.

Each mixer is mounted on a portable hoist guide rail system to facilitate its installation, mixing optimization, and removal. The guide rail system allows the mixer position to be adjusted to optimize its flow and mixing energy. A Davit crane has been provided for each mixer, used to remove the mixers from the tanks.

### *4.3.3 Submersible Aeration Lift Pumps*

Each pre-anoxic tank discharge is pumped by two (2) submersible aeration lift pumps (located inside the pre-anoxic tank) into a common aeration tank influent channel. The full height common channel runs across the width of the three (3) aeration basins allowing for free flow within the channel and equal distribution into the three aeration tanks The common aeration tank influent channel allows one pre-anoxic tank to serve all three aeration tanks, if a pre-anoxic tank is out of service. The submersible aeration lift pumps are low head, high volume units. Each of these units can pump 4,165 gpm at a TDH of 3.86 ft. The motors are 7.64 horsepower and operate at a maximum speed of 565 rpm. The four (4) submersible aeration lift pumps are powered from Switchboard-10 (SWBD-10).

### *4.3.4 Operation and Control*

The pre-anoxic tanks are equipped with level transmitters, which monitor the liquid level in each tank. A low level alarm registers if the tank level falls below a set point level for a set duration, which causes the submersible aeration lift pumps to stop operating.

The four (4) submersible mixers should typically operate continuously because these mixers handle the entire plant flow as well as the flow from the internal recycle. The operation of the four (4) submersible aeration lift pumps can vary. At all times, at least one submersible pump operates in each pre-anoxic tank. The second submersible pump starts and stops in response to flow demand triggers.

The four (4) pre-anoxic mixers (2-each) are monitored and controlled through the Zenon MBR System control panel and the SCADA System. The following controls are available to the operator:

At the Local Control Panel:

- Refer to the manufacturer's O & M Manual for detailed information.

At the SCADA System:

- Refer to Loop Description #440A.

The submersible aeration lift pumps (4-each) are monitored and controlled through the Zenon MBR System control panel and the SCADA System. The following controls are available to the operator:

At the Local Control Panel

- Refer to the manufacturer's O & M Manual, Section - A for detailed information.

At the SCADA System

- Refer to Loop Description #425A.

## 4.4 AERATION TANKS

### *4.4.1 Description*

From each Pre-Anoxic Tank, mixed liquor is pumped into the aeration tank common influent channel and flows into each of the aeration tanks, under normal operating conditions. There are three aeration tanks, Tank Nos. 1, 2, and 3. Each aeration tank is configured as a deep rectangular basin. The aeration tanks utilize a fine bubble air diffuser system to provide the oxygen necessary for BOD removal and nitrification. The air diffuser system also provides for agitation to maintain the mixed liquor in suspension while the flowing through the tank. The diffuser rows are equally spaced across the bottom of the tank to keep the entire volume of mixed liquor in suspension. Aeration tank zone #1 and zone #2 has ten (10) diffuser rows, each 30.40 ft. long. The post -anoxic tank zone #3 has seven (7) diffuser rows, each 11.67 ft. long.

The mixed liquor effluent from each aeration tank flows through rectangular openings in the bottom of the common wall between the aeration tanks and the future post-anoxic tanks. At plant startup, the post-anoxic tanks will be aerated and act as an extension (zone #3) of the aeration tanks. In the future, the aeration tank effluent will flow over weirs that are located at the downstream end of the tank and direct the nitrate rich mixed liquor into the post-anoxic tank, which will be mixed with mechanical mixers.

In the aeration basins, dissolved oxygen from the aeration system removes any BOD remaining in the flow from the pre-anoxic basin. It also oxidizes ammonia nitrogen ($NH_3$-N) in the influent wastewater to nitrate ($NO_3$-N). The nitrate is then recirculated back to the pre-anoxic basin to undergo denitrification, which will reduce the nitrate to nitrogen gas, thus reducing the total nitrogen in the wastewater effluent. The effluent overflowing from the future post anoxic tanks will always minimal nitrates present. The level of nitrates remaining is a function of the internal recirculation rate, wastewater, etc. Returning more nitrate to the pre-anoxic basin for denitrification lowers the levels of nitrogen present in the effluent. However. too high of a recirculation rate will result in washing nitrates through the pre-anoxic basin, resulting in higher levels of effluent nitrate. Also, there must be an adequate supply of carbon from the BOD in the pre-anoxic basin and the level of dissolved oxygen must be as close to zero as practical.

Each aeration basin is equipped with two Dissolved Oxygen (DO) probes. One is located in zone #1 and the second is located in zone #2. The DO probes are utilized to control the speed of the aeration blowers through an algorithm in SCADA. Indication of dissolved oxygen can be viewed at the local transmitters, at MBR Control Panel, and at the SCADA System.

### *4.4.2 Aeration Tank Blowers*

Two (2) active and one (1) standby positive displacement air blowers supply compressed air to the submerged air diffuser systems in the aeration tanks. Blower duty is alternated according to an operator entered run time. The blowers' capacity is 1040 icfm at a differential head of 9 psi, operating at 2967 rpm. Each blower is driven by 60 hp motor operating at 1800 rpm. The blower package system includes an inlet filter and silencer, a discharge silencer, a blower unit, a motor, multiple v-belts with guards, , a fabricated metal skid, a pressure relief valve, butterfly valves, and check valves The entire unit is enclosed in a sound attenuating enclosure limitng the noise level three (3) feet from the unit to less than 75 dbA. The blower output is regulated by variable frequency drives, which vary motor speed based on a DO sensor signal from the aeration tanks and the DO set point.

The impellers are of the straight two-lobe involute type and are center timed to permit rotation in either direction. The impellers are timed by a pair of carburized and ground steel spur gears. Each impeller and shaft is supported by oversized anti-friction bearings. Each bearing housing includes a positive lip type Viton oil seal. Each Blower has a side inlet, a side discharge and is driven by a motor mounted on the unit's common base with guarded belts. The Matched cogged type V-belts are tensioned automatically. Motors are premium efficiency, continuous duty and suitable for inverted duty. These three blowers also serve the Post-Anoxic Tanks.

Each blower is equipped with a temperature switch, which will automatically shut the blower down and alarm in the event of a high temperature. The blowers are equipped with thermometers to measure the inlet and discharge temperature. Vacuum and pressure gauges measure the inlet and discharge pressure of the air. Inlet and discharge expansion joints are provided on each blower and the discharge expansion joint has control rods to restrict joint movement. Spring type large nozzle bronze relief valves are located in the discharge silencer for pressure relief, if needed. Butterfly valves are provided on the suction and discharge piping, and wafer style check valves are provided on the discharge lines.

### *4.4.3 Operation and Control*

The average concentration of dissolved oxygen in the aeration tanks is used to control the speed of the aeration blowers. At a regular frequency, (e.g. every 5 minutes), the average DO is compared to an operator entered DO set point to control the blower output. When the DO is near the set point and within a specific deadband, (e.g. +/- 0.2 mg/l), the speed of the blowers is not changed. When the DO is outside of the deadband, the blower speed is changed by a fixed percentage, to change the airflow to the aeration tanks. The total airflow from the aeration tank blowers is controlled by step changes of blower speed. The blower speed step changes are hard coded in the PLC and are not adjustable by the operator. A dissolved oxygen (DO) analyzer/indicator measures the amount of dissolved oxygen in each tank. A low oxygen level alarm or a high oxygen level alarm registers whenever the tank oxygen level is at or above, or at or below, respectively, an operator entered set point for a pre-set duration.

The Aeration Tank Blowers can be monitored and controlled from the MBR System VFD local control panel and from SCADA System as follows:

At the Local Control Panel

- Speed Control (SC-430A, etc.);
- Speed Indication (SI-430A, etc.);
- Motor Over Temperature Alarm (TAH-430A-1, etc.);
- Discharge High Temperature Alarm (TAH-430A-2, etc.);
- High Vibration Alarm (VAH-430A, etc.);
- VFD Fault Alarm (YA-430A, etc.);
- H-O-A Switch in “Auto” (YI-430A-1, etc.);
- Run Status (YI-430A-2, etc.); and
- Start/Stop (YS-430A, etc.).

At the SCADA System

- Blower H-O-A in “Auto” (YI-430A-1, etc.);
- Blower run status (YI-430A-2, etc.);
- Blower speed indication (SI-430A, etc.);
- Blower VFD fault alarm (YA-430A, etc.);

- Motor over temperature alarm (TAH-430A-1, etc.);
- Blower high vibration alarm (VAH-430A, etc.);
- Blower discharge high temperature alarm TAH-430A-2, etc.); and
- Elapsed run time meter (KQI-430A, etc.).

## 4.5 MEMBRANE BIOREACTORS (MBR'S)

### *4.5.1 Description*

The Membrane Reactor System is also known as the "ZeeWeed Wastewater Treatment System" by the manufacturer GE Water & Process Technologies of Oakville, Ontario, Canada. The manufacturer's operation and maintenance manual provides detailed procedures that must be followed in order to ensure optimal system performance. All operators and supervisors working on the system must have read the manual completely and understand how the entire system is designed to operate. Operation of the system outside the limits described in the manufacturer's operation and maintenance manual may impair system performance and invalidate the warranty.

The MBR System is an Ultrafiltration Process where water (permeate) is extracted from the mixed liquor prior to disinfection and effluent discharge. Membrane filtration includes the separation of dissolved solids in liquid streams, including the removal of various materials ranging from salts to microorganisms. The membrane separation process can be categorized in three general ways: pore size, molecular weight cutoff (MWCO), and operating pressure. As the pore size gets smaller, the pressure applied to the membrane for separation generally increases. Surfside WWTF uses ultra filtration with "loose" membranes, refering to membranes that have relatively large pore sizes ranging from 0.005 to 0.2 micrometers.

The ZeeWeed filtration surface is a neutral, strong polymeric membrane cast on the outside surface of a porous support fiber. The wastewater being treated can pass through the membrane as clean filtrate (permeate), while the membrane rejects the MLSS. The ZeeWeed filtration system uses a turbulent flow pattern along the exterior of membrane fibers with the use of low pressure air to keep the filtration surface from fouling, which would cause a reduction in the efficiency of the unit. The filtrate (permeate) is pulled through the membrane surface from the Mixed Liquor by a partial vacuum created inside the membrane fibers. Periodically, the membranes are back-pulsed by pumping a small amount of the filtrate through the membrane fibers, forcing

flow in the reverse direction through the fiber. The reverse flow expels fouling material from the surface of the membrane and back into the basin contents.

The Surfside WWTF is provided with ZeeWeed 500d modules consisting of many hollow fibers that run vertically between top and bottom permeate headers in the MBR Tank. The membrane modules are grouped into frame-mounted cassettes containing up to 48 ZeeWeed membrane modules each. The permeate is drawn into the fibers and collected in headers at the top of the cassette. Air is periodically required to scour clean the membrane fibers is and is supplied to each module through air headers at the bottom of the cassette. The airflow creates bubbles, which rise from the aerator located at the bottom of the modules, upward past the membrane fibers, helping to remove solids from the membrane surface. The ZeeWeed 500d membrane modules have a nominal pore size of 0.04 micrometers and will reject all particles and suspended solids larger than this. The ZeeWeed Wastewater Treatment System provided at the Surfside WWTF is designed for an average daily (summer) flow of 3.50 mgd. The system includes the following:

- Two (2) pre-anoxic zone;
- Three (3) aeration zones;
- Recirculation system;
- Three (3) biological process aeration blowers;
- Four (4) ZeeWeed membrane trains, each with five (5) cassettes of ZW-500d modules, a dedicated permeate/backpulse pumping system, and related instruments;
- Five (5) membrane aeration blowers;
- Two (2) waste activated sludge pumps;
- Two (2) drain pumps;
- A compressed air system including two (2) air compressors, compressed air tanks, and refrigerated dryers; and
- Clean in place (CIP) equipment.

The Membrane System Design Data is listed in **TABLE 4.2 - MBR SYSTEM DESIGN DATA.**

**TABLE 4.2 - MBR SYSTEM DESIGN DATA**

| Primary Effluent | Winter Values | Summer Values | Units |
|---|---|---|---|
| Average Daily Flow | 1.80 | 3.50 | MGD |
| Maximum Daily Flow | - | 5.25 | MGD |
| Peak Hour Flow | - | 7.70 | MGD |
| $BOD_5$ | 4278 | 6695 | lb/day |
| TKN-N | 652 | 1021 | lb/day |
| *Membrane System Design Requirements* | | | |
| **Design Flow** | **Values** | **Units** | |
| Net Average Daily Flow | 12 | GFD* | |
| Net Max. Daily Flow | 18 | GFD* | |
| Net Peak Hour Flow | 26 | GFD* | |
| *Physical Parameters* | | | |
| TSS | 5 | mg/l | |
| Turbidity | <0.5 | NTU | |
| $BOD_5$ | 5 | mg/l | |
| TKN-N | 3.0 | mg/l | |
| $NO_3$ - N | 7.0 | mg/l | |
| Total N | 10 | mg/l | |

* GFD = Gallons per square foot per day

### *4.5.2 MBR Blowers*

The air blower equipment for the MBR Tanks is located on the ground level of the Advanced Treatment Building. There are five (5) rotary lobe positive displacement blowers (4-duty & 1-standby) that alternate service providing air scouring to the membrane modules in the MBR Tanks. Each blower is powered by a 100 horsepower motor and can deliver 1213 scfm at 7.5 psig to the tank's aeration system.

During normal operation, air bubbles provide a coarse scour for cleaning the outside of the membranes. The mixed liquor circulates around the membranes because of the mixing pattern generated by the airflow through the cassettes. The blower duty time is alternated according to an operator entered run time.

The blowers supply low-pressure air into a common air header for all of the trains. This common header then divides into multiple air headers leading to the membrane tanks. The blowers operate at constant speed. The PLC will start and stop the blowers as necessary based on demand. Each train operates under cyclic aeration meaning valves will cycle air within a train, reducing the air required to run the system. When trains are not in service, the aeration frequency will change according to the “aeration chart”. Cyclic aeration can be deactivated for a train by the PLC if there is a valve failure.

Typically, three trains are in 10/30 aeration and the fourth train is in 10/10 aeration. The 10/30 sequential aeration is accomplished by aerating a given membrane module for 10 seconds, then not aerating for 30 seconds The train with the highest priority to go to standby is the 10/10 aeration train.. The MBR control system automatically determines which trains should run in the 10/10 aeration and 10/30 aeration based on the system performance. The reduction in aeration is made possible by monitoring the condition of membranes and determining the level of fouling on the membranes. When the membranes are clean, the trains will operate in the 10/30 aeration. If the membranes become fouled, the aeration is returned to the 10/10 aeration in order to increase airflow, increasing the shear on the membranes to remove any solids accumulation. Typically, with a relatively clean membrane, a high wastewater flow will require 10/10 aeration and a low flow of 10/30 aeration.

A low airflow switch is located on the discharge of each blower for blower protection. If the switch is activated, the control panel PLC will change the lead to the next available blower. If there is no other blower available, the PLC will shutdown all trains and an alarm will sound.

### *4.5.3 MBR Permeate/Backpulse Pumps*

There are four (4) MBR positive displacement permeate/backpulse pumps located on the lower level of the Aeration Treatment Building. Each pump is driven by a variable speed 50 horsepower motor and can pump a maximum flow of 1605 gpm at a TDH of 25 psig. Each MBR train has a dedicated permeate/backpulse pump, which provides the suction necessary to draw the permeate through the membranes. The MBR control panel PLC calculates a plant flow demand based on the influent flow signal. As the influent flow increases, the plant flow demand increases, causing the pumps to speed up. To prevent standby and overflow conditions, the level in the pre-anoxic tanks is used to trim the plant permeate pump demand.

Level control is accomplished through Proportional-Integral-Derivative (PID) control. This is carried out through calculations in the PLC. The plant flow demand is the net permeate flow rate required from the MBR System and does not include additional permeate the system produces for non-production operations, such as Backpulseing.

Recovery is defined as the proportion of the feed to a system that is recovered as treated water - Recovery = Treated Water /Feed Water.

The PLC maintains the calculated production flow rate, or the operator entered production flow rate, up to a maximum Trans Membrane Pressure (TMP). As the membranes become fouled, the TMP becomes more negative for a given permeate flow rate, and the speed of the permeate pump must increase in order to maintain the production flow rate. To protect the integrity of the membranes, there is a limit beyond which the TMP is not allowed to decrease. At this point, the speed of the pump is controlled to maintain this value for TMP, rather than to maintain a permeate flow rate.

The permeate/backpulse pumps are also used for the backpulse sequence, which is the reversal of permeate through the membranes to dislodge and prevent the buildup of contaminants on the membrane surface. The backpulse slightly expands the membrane pores and dislodges any particles that may be trapped or that have adhered to the membrane surface. This procedure helps in maintaining stable TMP. Only one train can be in the backpulse mode at a time. Membranes are backpulsed using the permeate/backpulse pumps. When a backpulse is initiated, permeating stops and the valves are throttled as described in the Operations Sequence Chart (OSC) in the manufacturer's O & M Manual. The pumps then restart to draw permeate back through the membranes for the preset backpulse duration. The pump then stops, the valves realign and the train returns to normal production.

"Relax" control is an alternative to backpulsing. If a backpulse failure occurs and no pump is available, the PLC places the trains into the "Relax" mode. For a backpulse to be initiated, at least two trains must be in "Production" mode. If not, a "Relax" is initiated. During "Relax" mode, the membranes will sit for an operator specified duration without permeation before resuming production. During this time membrane aeration will disperse the solids that have concentrated around the membranes.

### *4.5.4 MBR Cleaning System*

#### *4.5.4.1 Maintenance Cleanings*

The membranes require periodic cleaning to maintain peak performance. There are two types of cleaning, Maintenance Clean and Recovery Clean. Maintenance Cleanings are scheduled by the operator through the MBR control panel HMI and are automatically initiated by the PLC based on a 24-hour clock. The operator should select to perform one scheduled Maintenance Clean per train per day. The operator can select to perform the Maintenance Clean using either sodium hypochlorite or citric acid. Maintenance cleaning involves backpulsing a solution of permeate and a cleaning chemical through all the membranes of a specific train.

When the PLC determines the time to perform a Maintenance Clean, the control system compares the current plant demand with the available capacity of the plant if one MBR train is taken out of service. If the plant demand exceeds this capacity, then scheduled Maintenance Cleans are skipped but the request remains active and will be started when the demand is lower. When the Maintenance Clean is skipped or aborted, an alarm occurs to inform the operator of the situation.

If the plant demand will not exceed the reduced capacity when it is time to start the Maintenance Clean, the train will complete its current production cycle before starting the cleaning procedure. If a train is in Standby, it will go directly into the Maintenance Clean sequence.

The default steps for Maintenance Clean are as follows:

- Aerate the membrane tank;
- Initial chemically enhanced pulse to all cassettes;
- Relaxation period for all cassettes;
- Chemically enhanced pulse to all cassettes;
- Relaxation period for all cassettes;
- Steps 4 and 5 are repeated for a number of iterations;
- Non-chemically enhanced pulse to all cassettes; a
- Proceeds to Standby.

The detailed procedure for the Maintenance Cleaning can be found in the manufacturer's O & M Manual, Appendix – A, Control Documentation, Control Narrative.

#### *4.5.4.2 Recovery Cleanings*

Recovery Cleaning becomes necessary when the membranes become fouled to the extent that the TMP has increased is affecting system performance. The recommended recovery cleaning frequency for this system is twice yearly. Recovery cleaning is performed using two types of cleaning chemicals, sodium hypochlorite for removal of organic compounds, and citric acid for scale removal. Both types of cleaning involve the injection of cleaning chemicals into the permeate header. Two sodium hypochlorite diaphragm metering pumps are available for transferring the chemical from the storage tank to the membrane. Two citric acid diaphragm metering pumps are available for transferring this chemical from the storage tank to the membrane. The citric acid storage tank has a mechanical mixer for chemical make-up.

Recovery Cleaning can only be carried out for a train if it is in the "R-Clean" mode. The operator is required to turn the train "OFF" and place the train into "R.Clean" for the cleaning cycle to begin. During Recovery Clean there are several control panel prompts, which the operator must address. Thus, the operator must remain at the control panel during this procedure to respond in a timely manner to the PLC prompts.

Recovery Clean can be done with either or both sodium hypochlorite and/or citric acid depending on which cleaning chemical the operator selects at the beginning of the sequence. The detailed procedure for the Recovery Cleaning can be found in the manufacturer's O & M Manual, Appendix – A, Control Documentation, Control Narrative. It should be noted here that this procedure is a time consuming, multi-step process that involves emptying and filling the tank to be cleaned.

Each ZeeWeed train has separate mode buttons on the control panel. There are several possible operating modes for each train. The following modes are available:

- Off;
- Standby;

- Backpulse;
- Relax;
- Production;
- Maintenance Clean;
- Recovery Clean; and
- Neutralization.

Refer to the manufacturer's O & M Manual, Section 5, System Operations, Paragraph 5.6, Cleaning the ZeeWeed Membranes.

### *4.5.5 WAS Pumps*

There are two WAS double disc positive displacement pumps (1-duty/1-standby) located on the lower level of the Aeration Treatment Building. Each pump is driven by a 5 horsepower variable speed motor and can pump a maximum flow of 80 gpm at a TDH of 25 ft. In order to maximize advanced process performance, sludge is wasted from the membrane tanks daily, at a preset time and volume. The operator enters run time and speed of the pump on the MBR control panel HMI. When the preset start time arrives, sludge wasting is initiated.

To confirm sludge wasting is needed, the operator should analyze the MBR sludge to ensure that the mixed liquor concentration is less than 10,000 mg/l, for example. Two drain pumps can operate on a similar basis, if needed. The waste sludge is discharged into one of the sludge holding tanks. A flow magmeter monitors the flow of waste sludge to the sludge holding tank and indicates the volume of sludge that has been wasted.

### *4.5.6 DO Analyzers (AE/AIT-7338, A-1,2,3/B-1,2,3)*

Each of the three (3) aeration basins are fitted with two Dissolved Oxygen Analyzers to monitor and regulate the dissolved oxygen levels within the basins. Each monitoring system includes a HACH, Danfoss-Evita PT #OXY1100, Dissolved Oxygen Sensor. The Clark sensor is easily replaceable and can operate in 0 to 50 degrees centigrade media. Each monitoring system includes a HACH, Danfoss-Evita PT #OXY4100 Ball Float type Transmitter with a range of DO from 0 to 10 ppm using a 4 to 20 mA output signal. Each monitoring system includes a HACH, Danfoss-Evita Pt #USC 7000 Converter, which has an IP67 enclosure and can run up to 15 transmitters. It has four 4 to 20 mA outputs, five SPST Relay Outputs, and has an LCD Display. The heart of the DO monitoring system

is the oxygen sensor. The transmitter converts the measurements of the sensor into a current signal and at the same time performs the required calculations and corrections. The signal converter is the display and programming unit and offers additional outputs. At the Surfside WWTF the Converter output signal is sent to the VFD's, which regulate the speed of the aeration system blowers.

### *4.5.7 Turbidimeters (AE/AIT-3537, 1/2/3/4)*

Each of the four (4) MBR Basins are served by a Permeate/Backpulse Pump, which provides the negative pressure (vacuum) to draw the permeate through the MBR membrane units. The membrane units filter out the MLSS and provide a relatively clear wastewater effluent stream. To monitor turbidity of this relatively clear effluent stream, the permeate pump discharge line has a ½ -inch diameter side-stream line that discharges to a turbidimeter analyzer element and analyzer indicator transmitter. Each permeate pump discharge line includes a HACH PT #60101-00 on-line turbidimeter including a 1720E sensor and controller having a range of 0 to 100 NTU's. The analyzer indicator transmitter sends a turbidity signal to the operator via the associated HMI and PLC, which shows one of the following levels:

- HIGH HIGH;
- HIGH;
- LOW; and
- LOW LOW.

### *4.5.8 Instrumentation and Control System*

The MBR main instrumentation and control system components are described in this section of the manual. The Allen Bradley Control Panel (CP-01), which includes the Panelview Plus 1250 Human Machine Interface (HMI), Programmable Logic Controller (PLC), and the L61 Processor make up the central control panel and controls the operation of the system. The system process is controlled by the instructions stored in the PLC's programmable memory. The operator interfaces with the HMI, which communicates with the PLC, which in turn controls the advanced treatment processes. The MBR central control panel is located on the outside wall of the Electrical Room, which is on the ground level of the Advanced Treatment Building.

The central control panel houses switches and selectors to control the system in both manual and automatic modes via the HMI keypad and touch screen. All advanced treatment activities can be carried out from this control panel. Alarms and operations are accessed through the HMI. All motor starters and breakers for the equipment are located

in the MCC-10 and MCC10A panels. All the information generated by the system is displayed on the programmed screens that operate the system. The HMI is a touch screen, and operator discipline must be exercised when adjusting set points or starting and stopping motors.

For security purposes, the HMI has different accounts and passwords set up for different user types. Without entering a password, the operator has access to the major screens and the horn silence button. There is no access to the Acknowledge Alarm Button. The user can log in from any major screen.

For the MBR System, the operator user name is “OPER” and the password is “500401”. The operator privileges include:

- Navigation of all HMI screens (set points cannot be changed);
- Access to set points pop-ups (view only);
- All operator selections, including starting and stopping the trains;
- Resetting of alarms; and
- Auto control of pumps and valves.

The supervisor’s user name is “SUPER” and the password is available only to the supervisor. The supervisor privileges include:

- All operator access privileges;
- Access to change set points;
- Manual control of pumps and valves; and
- Manual control of PIDs.

If the user enters the password incorrectly, there is no limit to the number of times that password can be attempted. The user is logged out of the HMI after four hours and must log in again to navigate the screens. The screen saver blanks the screen and goes into screen saver mode after 30 minutes of continuous idle time. Move the mouse to deactivate screen saver mode. For more information on the operation of the MBR System from the central control panel, refer to the manufacturer’s O & M Manual.

The MBR main control panel (CP-01) is a 6 ft. high by 5 ft. wide, self-standing, double door, operator interface terminal, which has the following HMI features.

- Allen Bradley Panel View Plus 1250, color touch screen and keypad;
- PL-1, Normal Power “ON” white light indication;

- PL-2, UPS Power “ON” white light indication; and
- DS-1, Power Disconnect Selector Switch.

The operator can monitor and control the Advanced Treatment Facility via the Panel View Plus 1250 color touch screen, which is the HMI. This control panel monitors the following parameters:

- Dissolved Oxygen Levels; and
- Tank Liquid Levels.

This control panel monitors and controls the following equipment items:

- Membrane Aeration Blowers/ Air Flow Rate, etc.;
- Permeate/Backpulse Pumps/ Running Forward/Reverse/Speed, etc.;
- Biological Aeration Blowers/ Air Flow Rate/Speed, etc.;
- WAS Pump Flow Rate/Speed/ Suction/Discharge Pressure, etc.;
- Aeration Lift Pump /Speed/ Auto/Hi-Temp/Seal Leak, etc.; and
- Drain Pump /Running, etc.

The MBR Main Control Panel interfaces with the SCADA System Control Panel, which is located in the adjacent Control Room.

### *4.5.9 Operation and Control*

#### *4.5.9.1 Process Description*

The pre-anoxic and aeration tanks are designed to remove BOD to levels of 30 mg/l and total nitrogen to levels of 5.0 to 6.0 mg/l in the plant effluent. Biological nitrogen removal is a two-stage process. In the pre-anoxic stage, the nitrates are reduced first back to nitrites and then to nitrogen gas by heterotrophic bacteria under anoxic conditions. The nitrogen gas escapes into the atmosphere, removing nitrogen from the wastewater. This process is known as denitrification. In the aeration stage, ammonia and organic nitrogen are oxidized first to nitrite and then to nitrate by autotrophic nitrifying bacteria (Nitrosomonas and Nitrobacter) under aerobic conditions. This process is known as Nitrification. Nitrification and Denitrification can be expressed by the following simplified equations:

Nitrification

$2NH^+_4 + 3O_2 \rightarrow 2NO_2 + 4H^+ + 2H_2O$

$2NO^-_2 + O_2 \rightarrow 2NO^-_3$

Denitrification

$NO^-_3 \rightarrow NO^-_2 \rightarrow NO \rightarrow N_2O \rightarrow N_2$

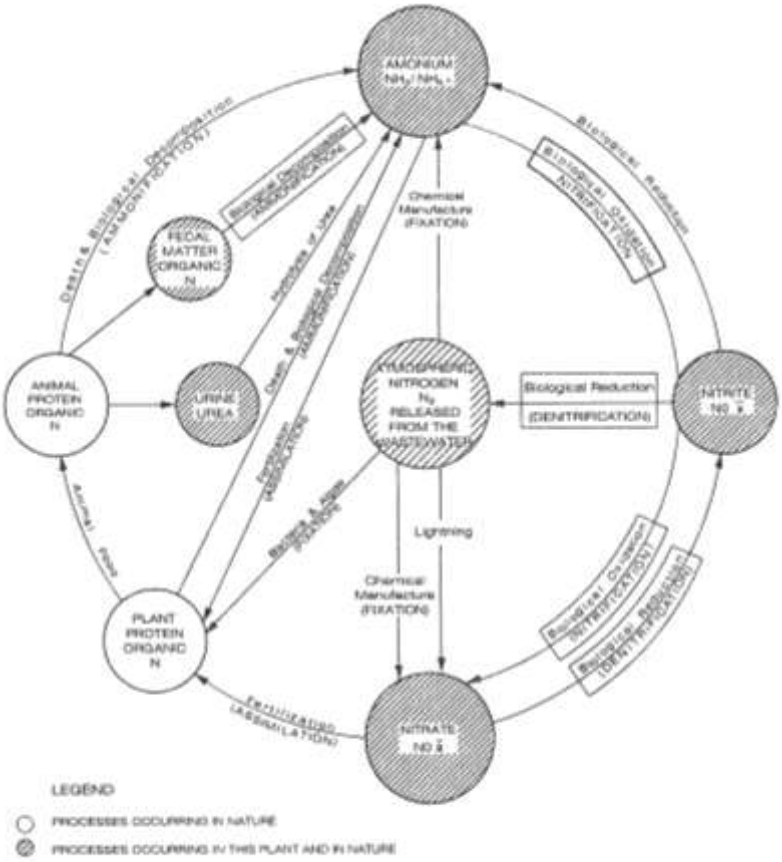
Biological nitrification and denitrification are naturally occurring processes, which are part of the nitrogen cycle, as shown in **Figure 4-3 - The Nitrogen Cycle**.

For nitrification to occur, a sufficient population of nitrifying bacteria must be present with an adequate supply of oxygen. The nitrification reaction consumes approximately 4.6 pounds of oxygen for every pound of ammonia nitrogen converted to nitrate. The optimum pH for nitrification is between 7 and 8. The nitrification reaction consumes alkalinity at the rate of approximately 7.14 pounds of $CaCO_3$ per pound of ammonia nitrogen converted and can lower the pH of the wastewater below the optimum pH range if sufficient alkalinity is not present in the influent wastewater.

For denitrification to take place a sufficient source of readily biodegradable carbon must be present in an anoxic environment. At the Surfside Facility, carbon is available in the form of BOD in the influent wastewater. An anoxic environment can be defined as a DO concentration less than 0.5 mg/l. In the absence of oxygen, the heterotrophic bacteria utilize oxygen from the nitrate for metabolism. The denitrification reaction generates alkalinity at the rate of 3.57 pounds per pound of nitrate nitrogen reduced and recovers 2.86 pounds of oxygen per pound of nitrate nitrogen reduced. The process is designed to take advantage of both of these processes.

The alkalinity generated partially offsets alkalinity consumed in nitrification, and the oxygen recovered reduces the need for aeration in the aeration basin, lowering energy requirements.

**FIGURE 4.3 – NITROGEN CYCLE**




After supplying the carbon for denitrification, the wastewater travels to the aeration tanks where the remaining BOD is removed, the organic nitrogen is converted to ammonia and ammonia undergoes nitrification to form nitrates. This process configuration allows for removal of total nitrogen to levels of 5.0 to 8.0 mg/l in the effluent without the need to add supplemental carbon (such as methanol) and usually without the need to add supplemental alkalinity. Alkalinity should be adequate for this process; however, an annual check of the alkalinity in the effluent is advised. Effluent alkalinity should be at least 50 mg/l total alkalinity for the process to have sufficient alkalinity to operate efficiently. If it is found that alkalinity is deficient, the addition of sodium hydroxide to the recirculation pipeline is available to increase the alkalinity.

The process is a variation of the two-stage MLE process. Logically, one would think that the anoxic basin should follow the aeration basin, since nitrification takes place in the aeration basin and denitrification takes place in the anoxic basin. In the MLE process, the anoxic basin is placed first, so that the carbon from the BOD in the primary effluent is available for the denitrification reaction. This requires that nitrate rich mixed liquor be recirculated from the aeration basin back to the anoxic basin to make the nitrates available for the denitrification reaction. After supplying the carbon for denitrification, the wastewater travels to the aeration tank where the remaining BOD is removed, the organic nitrogen is converted to ammonia, and the ammonia undergoes nitrification to form nitrates.

The anoxic tank also acts as a natural selector for control of filamentous bacteria. Even though it is commonly thought that a low DO environment and low F/M ratios will encourage the growth of filamentous bacteria, filamentous organisms do not proliferate in the rapidly changing environment created by an anoxic/aerobic treatment process.

The MBR Air Scour Blowers are monitored and controlled from the MBR Local Control Panel and from the SCADA System HIM as follows:

At the Local Control Panel

- Speed control (SC-450A, etc.);
- Speed indication (SI-450A, etc.);
- Motor over temperature alarm (TAH-450A-1, etc.);
- Discharge high temperature alarm (TAH-450A-2, etc.);
- High vibration alarm (VAH-450A, etc.);
- H-O-A switch in “Auto” (YI-450A-1, etc.);
- Run status (YI-450A-2, etc.); and
- Start/Stop (YS-450A, etc.).

At the SCADA System

The following status and alarm signals are displayed at the SCADA System HMI:

- H-O-A switch in “Auto” (YI-450A-1, etc.);
- Run status (YI-450A-2, etc.);

- Motor over temperature alarm (TAH-450A-1, etc.);
- High vibration alarm (VAH-450A, etc.);
- Discharge high temperature alarm (TAH-450A-2, etc.);
- Speed indication (SI-450A, etc.); and
- Elapsed run time meter (KQI-450A, etc.).

The MBR Permeate/Backpulse Pumps are monitored and controlled from the MBR Local Control Panel and from the SCADA System HIM as follows:

At the Local Control Panel

- Refer to the G. E. Zenon O & M Manual

At the SCADA System

The following status and alarm signals are displayed at the SCADA System HMI:

- Refer to the G. E. Zenon O & M Manual

The MBR Cleaning System is monitored and controlled from the MBR Local Control Panel and from the SCADA System HIM as follows:

At the Local Control Panel

- Refer to the G. E. Zenon O & M Manual

At the SCADA System:

The following status and alarm signals are displayed at the SCADA System HMI:

- Refer to the G. E. Zenon O & M Manual

The WAS Pumps are monitored and controlled from the MBR Local Control Panel and from the SCADA System HIM as follows:

At the Local Control Panel

- Low suction pressure (PAL-460A, etc.);
- Speed control (SC-460A, etc.);
- Speed indication (SI-460A, etc.);
- H-O-A switch in “Auto” (YI-460A-1, etc.);

- Run status (YS-460A-2, etc.); and
- Start/Stop (YS-460A, etc.).

At the SCADA System

The following status and alarm signals are displayed at the SCADA System HMI:

- H-O-A switch in “Auto” (YI-460A-1, etc.);
- Run status (YI-460A-2, etc.);
- Low suction pressure alarm (PAL-460A, etc.);
- High discharge pressure alarm (PAH-460A, etc.);
- Speed indication (SI-460A, etc.); and
- Elapsed run time meter (KQI-460A, etc.).

#### *4.5.9.2 Process Control*

It is the operator’s responsibility to maintain the activated sludge process such that the quality of the effluent meets the discharge permit’s requirements. This is done by adjusting the mixed liquor suspended solids and the solids retention time (SRT) with respect to the BOD and TKN loadings to the aeration tank. In the process utilized, it also includes adjusting the internal recirculation rate to achieve the optimum nitrogen removal and adjusting the aeration system to maintain the optimum DO in both the aeration tanks and the anoxic tanks. Design parameters for operation are presented in **Table 4.3 – Advanced Treatment Process Design Parameters**. Operators can use this information to develop target SRTs and Mixed Liquor Suspended Solids for the current loadings. Operators should also review the Process Manual Provided by the manufacturer.

Operation of a Two-Stage, Single Sludge Denitrification-Nitrification Activated Sludge Process is very similar to a conventional Activated Sludge Facility. Operators must determine the best SRT, MLSS, and F/M ratio that works for their facility and then maintain those operating conditions. At 10 degrees C, the minimum SRT to achieve nitrification is 10 days. Therefore, it is recommended that an initial SRT of 16 days be used as presented in the design data. Adjustments to improve performance and reliability can be made from this point.

**TABLE 4.3 - ADVANCED TREATMENT PROCESS DESIGN PARAMETERS**

| Parameter | Average Annual | Maximum Moth |
|---|---|---|
| Temperature ($^oC$) | 10 | 10 |
| BOD/TKN | 5 | 5 |
| MLSS (mg/l) | 4,000 | 4,000 |
| MLSS under aeration (lb) | 56,100 | 56,100 |
| MVLSS/MLSS | 0.7 | 0.7 |
| F/M Ratio (avg) | 0.18 | 0.21 |
| SRT (day) | 16 | 13 |
| Internal Recirculation Rate | 400% - 600% | 400% - 600% |

Note that seasonal process changes will be required to maintain the performance of the system. Wastewater temperatures do affect the activated sludge process. Nitrification rates are considerably lower at colder temperatures. As a result, SRTs may need to be increased to achieve the desired percent removals in the winter months. SRTs may also be lowered in summer months, as the minimum SRT to achieve nitrification is 4 days at 20 degrees C. Mixed liquor suspended solids monitoring in the aeration basins provide a continuous indication of MLSS as an aid to process control.

For the efficient operation of the aeration tanks, the dissolved oxygen concentration must be maintained at concentrations above 1.5 mg/L in the aeration zone. Because the DO sensors are located ahead of the aeration zone, it should be set up to maintain a DO of about 0.5 mg/L at all times. When done properly, the DO Control System will automatically regulate the blowers to ensure that sufficient air is provided at all times, while saving electrical costs.

- It is important not to provide too much aeration because some of the excess DO will travel to the pre-anoxic zone with the recirculation flow.
- It is important to maintain the pre-anoxic zone with as close to zero DO as is possible.

If the DO measured at the DO sensor is maintained at 0.5 mg/l, the DO in the anoxic basin should be maintained in an acceptable range. ORP sensors in the pre-anoxic tanks can be utilized to determine a more accurate representation of

the anoxic environment. Refer to the O&M Manual supplied with the ORP sensor for more information on interpretation of the ORP values. There is an option to operate the blowers on a timed schedule during the nighttime hours at fixed speeds. At least one blower per operating basin should be in operation at all times. In addition to aeration, the air diffusers also provide mixing of the tank contents. The movement of the wastewater is also necessary to obtain the MLSS in suspension.

The recirculation of mixed liquor from the aeration tanks (via the MBR Tanks) to the pre-anoxic tanks is controlled by the head differential between the two tanks. The system is designed to provide a recirculation rate of up to 600% of the influent flow to the pre-anoxic basin. The operator will need to experiment to find the recirculation rate that results in the lowest effluent nitrate concentration. If the differential head is too great and the recirculation rate is too high, the flow will wash through the pre-anoxic basin too fast with insufficient detention time and the nitrates will be too high. If the differential head is too little and the recirculation rate is too low, not enough nitrate will be returned to the pre-anoxic basin for denitrification and the effluent nitrates will also be high. Changes in recirculation rate should be made in small increments. The Operator should take samples of the plant effluent and test for nitrates during different rates of recirculation flow to find the differential head that works best under varying flow conditions. It may be necessary to increase the differential head during the colder winter months.

$BOD_5$:TKN ratios of the pre-anoxic tank Influent greater than 3:1 are considered adequate for the denitrification process. However, ratios greater than 5:1 are considered favorable. Operators should regularly measure the pre-anoxic tank influent's $BOD_5$: TKN ratio. Although denitrification will still be achieved at the ratios less then 5:1, the rate of denitrification may be hindered thus reducing the amount of denitrification that will be achievable in the pre-anoxic zone.

If pre-anoxic tank influent $BOD_5$: TKN ratios of less than 5:1 are encountered on a regular basis, it may be advantageous to by-pass some or all of the flow around primary treatment. When bypassing primary clarification, the primary anoxic zone influent $BOD_5$: TKN ratio will increase.

Daily process control is required in order to maintain a good operating system. Some of the process parameters that operators should routinely monitor are as follows:

- DO Concentrations;
- MLSS Concentration (each tank);
- Aeration Tank Solids Inventory;
- BOD Loadings;
- TKN Loadings;
- $BOD_5$: TKN ratios;
- Food/Mass ratios;
- Recirculation Rate;
- Wasting Rate;
- Sludge Retention Time;
- 30 Minute Settling Test; and
- Sludge Volume Index.

It is recommended that MBR effluent sampling be conducted according to **Table 4.4 - MBR Effluent Sampling**.

**TABLE 4.4 - MBR EFFLUENT SAMPLING**

| Parameter | Unit | Conditions |
|---|---|---|
| $BOD_5$ | mg/l | Monthly Average of at least four 24-hr. composite samples. |
| TKN-N | mg/l | Monthly Average of at least four 24-hr. composite samples. |
| $NO_3$-N | mg/l | Monthly Average of at least four 24-hr. composite samples. |
| TN-N | mg/l | Monthly Average of at least four 24-hr. composite samples. |

## 4.6 TANK DRAIN SYSTEM

### *4.6.1 Description*

A tank drain system has been provided for the pre-anoxic, aeration, post-anoxic, and MBR tanks. Two Tank Drain Pumps, located on the basement level of the Advanced Treatment Building, have been provided for draining any one of these tanks. The tank drain suction pipelines from all the tanks are manifolded together and run under the respective tanks back to the Tank Drain Pumps, which also connect to the two Waste Activated Sludge (WAS) Pumps. An 8-inch plug valve separates the Drain Pumps from the WAS Pumps. The Tank Drain Pumps and WAS Pumps discharge pipelines are manifolded together and this flow is monitored by an inline flow meter. Downstream of the flow meter, the Tank Drain Pumps can discharge to the following points by regulating the pneumatic plug valves, which are provided on the discharge pipeline.

- The Primary Treatment System;
- The Advanced Treatment Distribution Box; and
- Sludge Holding Tanks #1 and #2 (typically used for WAS pump discharge).

In order to drain either of the two pre-anoxic tanks, the three aeration tanks, or the three post-anoxic tanks, the respective mud valve on the bottom of the tank to be drained must be manually opened using the valve operator and the valves at the pump must be adjusted. To drain any of the three MBR tanks, which have an open pipeline from the bottom of each tank, only the valves at the drain pump need to be adjusted.

Typically, the drain flow would be directed to either the primary treatment system or the advanced treatment system distribution box. Primarily the WAS pumps would discharge to the sludge holding tanks prior to transfer to the rotary presses for sludge dewatering. In the unlikely event both drain pumps are out of service, the WAS pumps can be used to drain any one of the above mentioned tanks if the valves on the suction manifold are properly adjusted.

### *4.6.1 Operation and Control*

The operation and control of the tank drain system is totally manual because this is not a treatment process procedure. Prior to draining any process tank the influent and effluent flow must be stopped and isolated. All equipment must be shutdown and aeration stopped. Proper valves must be opened and closed so that the tank to be drained has an opened suction pipeline and the drain pump discharge is directed to the proper discharge point. Once the decision has been made to drain a tank, the draining operation should proceed as soon as possible to prevent sludge from settling on the bottom of the tank.

## 4.7 PLANT WATER SYSTEM

### *4.7.1 Description*

The Plant Water System provided is a skid-mounted package pumping system supplied by SyncroFlo Pumping System Solutions Model #3P230E362PM, of Norcross, GA. The system is located on the lower level of the Advanced Treatment Building and delivers treated wastewater for various uses throughout the facility. The three pump unit consists of two full capacity, close coupled, end suction centrifugal pumps driven by 10 hp motors that individually can deliver 150 gpm at 143 ft TDH and a jockey type, vertical multistage pump driven by a 3 hp motor that can deliver 50 gpm at 143 ft TDH. The pumps draw their suction from the UV Disinfection System effluent channel upstream of the Parshall Flume. The total combined capacity of the package pumping system is 230 gpm at a minimum variable system pressure of 60 psig. The piping system includes a 6-inch suction manifold and a 4 x 6-inch discharge manifold. The hydrocumulator tank is rated for a capacity of 180 gallons and a pressure of 200 psig

### *4.7.1 Operation and Control*

The package pumping system includes a NEMA-4, local control panel, which has the following features:

- 3 – motor disconnect switches;
- 3 – pump run indicating lights;
- 3 – pump run HOA selector switches;
- 1 – low system pressure alarm light;
- 1 – irregular power alarm light;
- 1 – control power indicating light;
- 1 – alarm silencer/reset push button;
- 1 – alarm horn;
- 3 – pump failure alarm lights;
- 1 – digital flow meter/totalizer; and
- 3 – elapsed run time meters.

The control system has a set of SCADA System interface outputs for remote monitoring the system's operation. The sequence of operation is as follows:

- 0 to 50 gpm = Pump #1;
- 0 to 150 gpm = Pump#2; and
- 0 to 230 gpm = Pumps #1 & #2.

For more detailed information on the Plant Water System, refer to the manufacturer's O & M Manual.

# 5 - ULTRAVIOLET DISINFECTION

## 5.1 GENERAL

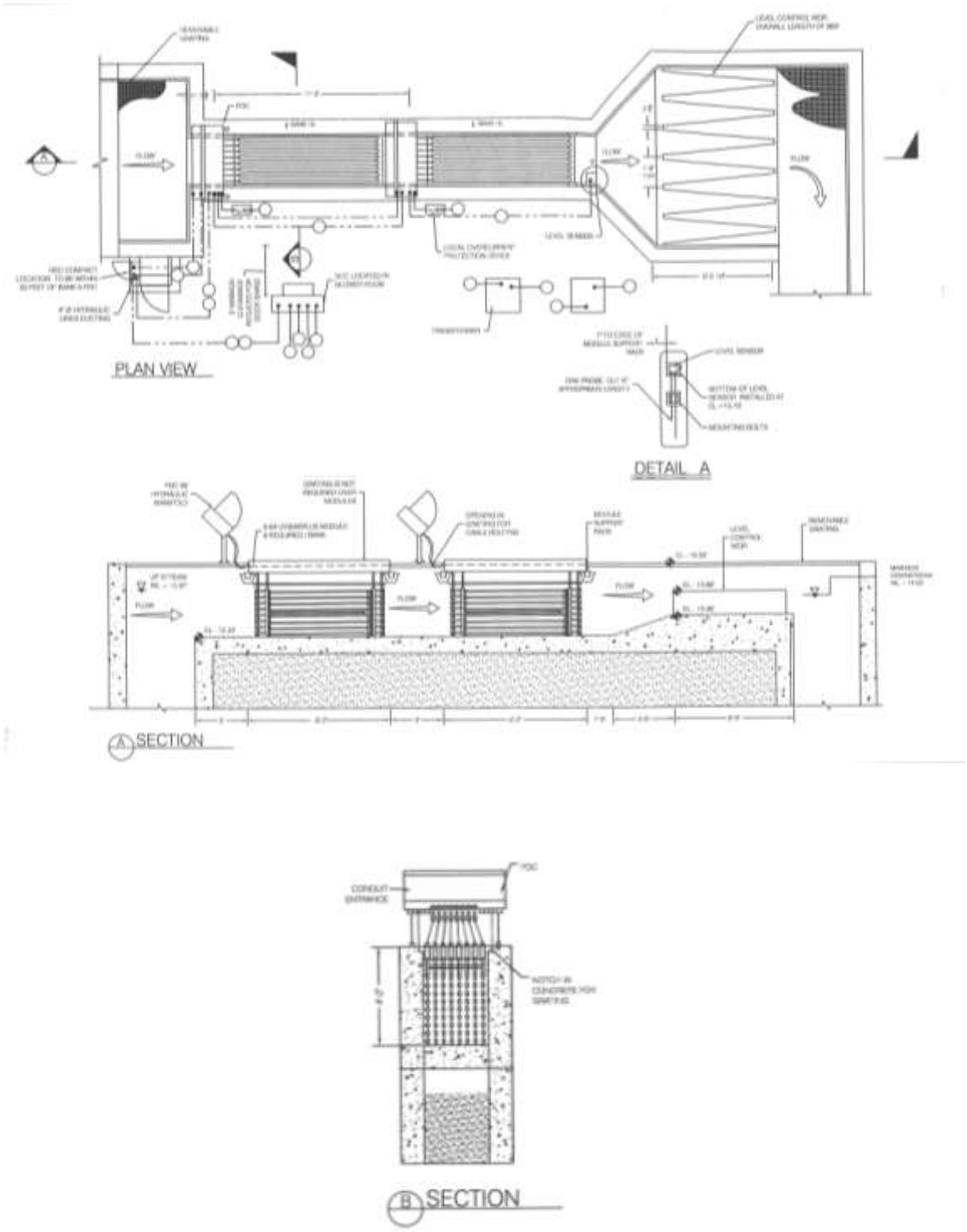
The permeate/backpulse pumps transfer the membrane bioreactor's effluent to the backpulse wet well located in the UV area. The backpulse wet well effluent then flows by gravity to the UV Disinfection System where the flow is disinfected. Refer to **Figure 5.1 - UV Disinfection System, Plan and Sections** for additional information.

Ultraviolet (UV) light is the portion of the electromagnetic spectrum with wavelengths between 100 and 400 nanometers (nm). Germicidal wavelengths are located in the spectral region of 200 nm to 300 nm. The low pressure mercury lamp radiation is essentially monochromatic with its output at 253.7 nm. The medium pressure mercury lamp is polychromatic with germicidal output spread over different wavelengths.

Disinfection is the reduction of pathogens (disease causing microorganisms) to non-infectious levels, whereas sterilization is the total inactivation of all living cells and viruses. The wastewater microorganisms are inactivated by UV light as a result of photochemical damage to nucleic acids. The amount of cell damage depends on the dose of UV energy absorbed by the microorganisms and their resistance to UV. Most bacteria and viruses require relatively low UV doses for inactivation. The dose of UV light available to kill the pathogens is measured in microwatt-seconds/cm$^2$, which is equivalent to the product of the light intensity and the duration of exposure, or retention time. Any factor that affects light intensity or duration of exposure to the light will affect the systems performance.

One such factor which affects light intensity or duration of exposure is flow rate. Increasing the rate of effluent flow over the UV lamps decreases the duration of exposure, resulting in a lower disinfection. Another important factor is effluent quality. The two aspects of effluent quality that most affect disinfection performance are ultraviolet light transmission and the amount of suspended solids. The ultraviolet light transmission of a water sample is defined as the percentage of UV light not absorbed after passing through 1 cm of water. UV transmission depends on dissolved and suspended matter in the water. High quantities of dissolved and suspended matter reduce UV transmission, lowering the intensity reaching the pathogens or bacteria, resulting in a decreased disinfection.

**FIGURE 5.1 - UV DISINFECTION SYSTEM, PLAN AND SECTIONS**



The visual clarity of a water sample is not always a good indicator of its UV transmission since water that is clear to visible light may absorb invisible ultraviolet wavelengths.

Water treated by UV Disinfection is chemically unchanged by the treatment. That is, there is no increase in toxicity to humans or to the natural environment.

## 5.2 ULTRAVIOLET DISINFECTION SYSTEM DESCRIPTION

The Ultraviolet Disinfection System is a Model No. UV 3000 Plus manufactured by Trojan Technologies, Inc. of London, Ontario, Canada. The number and configuration of the lamps is based on the effluent quality, flow rate, and the required level of disinfection. When the UV Disinfection System is operating at maximum capacity, it can disinfect a peak flow of 7.71 mgd.

The UV Disinfection System designed for the Surfside WWTFis based on the following:

- Peak Effluent Flow = 7.71 mgd;
- Average Effluent Flow = 3.5 mgd;
- Minimum Effluent Flow = 0.9 mgd;
- Suspended Solids = equal or less than 10 mg/l based on a 30 day average;
- Percent Transmittance = 65% minimum at 253.7 nm; and
- Disinfection Standards equal or less than 200 fecal coliform / 100 ml based on a 30 day geometric mean.

The UV Disinfection System consists of the following major system components:

- UV Modules – Each Module is the support structure for the UV lamps, enclosed in quartz sleeves, and for the ActiClean$^{tm}$ Cleaning System. The module enclosure contains the ballasts, module control boards, and wiring from each ballast to each lamp. All ballast and lamp wiring runs inside the module frame to shield the wiring from the harsh wastewater effluent environment and exposure to UV light. The module is 6P rated (air and water tight), to ensure all components are protected from the harsh environment. Two modules are installed in the 23 ft. 10 in. long by 4.17 ft. deep open channel, parallel to the flow direction. A series of modules placed side by side into the channel defines a bank or reactor. The Surfside WWTF is supplied with 8 lamp modules having a 4-inch lamp spacing. There are two banks (Bank 1A and 1B) of 8 modules located in the UV Channel.

- System Control Center (SCC) – The SCC includes all of the hardware required to control the UV Disinfection System. It includes a PLC, Operator Interface Terminal, input/output connections, and communications hardware. The SCC is also equipped with an extensive alarm reporting system to ensure fast and accurate diagnosing of system process and maintenance alarms. The SCC is located in the blower room of the Advanced Treatment Building

- Power Distribution Center (PDC) – The PDC powers each bank of modules and spans the width of the channel. The PDC distributes power from the main electrical service out to the modules in each bank. It contains the communication and control equipment for each bank of modules.

- ActiClean Cleaning System (ACS) and Hydraulic System Center (HSC) – When the ACS is used, a magnetically coupled submersible wiper drive is supplied on each module. This drives a wiper carriage assembly with attached wiper canisters along the UV modules. The wiper canisters surround each quartz lamp sleeve and are filled with a cleaning agent. The cleaning fluid in the wiper canisters contacts the lamp sleeves between the two wiper seals and maintains the sleeve UV light transmittance to ensure proper wastewater effluent disinfection. Cleaning is achieved mechanically with the scraping action of the wiper seals and chemically by the chemical reaction between the cleaning agent and the build-up of material on the sleeves. The periodic cleaning takes place while the lamps are submerged and operating. All the lamp sleeves within each bank are cleaned simultaneously. The frequency of cleaning is operator adjustable at the operator interface terminal on the SCC. The ACS is hydraulically actuated by the HSC, which is located adjacent to the channel. The HSC contains the pump, valves, and reservoir for the ACS.

- UV Sensor(s) – Measures the UV intensity and reports that value back to the SCC.

- Water Level Sensor – The water level sensor is located on the channel wall downstream of Bank 1B. It is a two-probe unit to ensure all lamps are submerged.

- Water Level Controller – The water level is controlled by a fixed “saw tooth” type weir that maintains the proper module submergence in the upstream UV Channel.

- Module Support Rack – Supports UV Module Banks within the channel.

## 5.3 OPERATION AND CONTROL

The UV Disinfection System is designed to operate automatically. The operation of the UV Disinfection System is managed at the SCC by its Allen Bradley SLC 5/05 PLC controller, which continuously monitors and controls the system’s functions. The PLC controller is the brain of the UV Disinfection System and communicates with the Operator Interface, PDC, and HSC. The Operator Interface on the SCC allows complete control and monitoring of the system.

The UV Disinfection System operates using an automatic dose paced system that ensures the disinfection requirements are continuously achieved for the current wastewater effluent flow conditions while conserving power. The power of the UV lamps is automatically adjusted in response to analog inputs from the effluent flow meter and manually entered UV Transmittance taken from the Photometer. These inputs are continuously monitored in the SCC and the power setting for each bank of UV lamps is adjusted (i.e. turned up/down or on/off) in response to changes in flow or effluent quality. As the lamps age, power is also increased to make sure that the required dose is continuously met. The SCC acts as the brain of the system as it receives input from all the system monitoring devices and enables the lamps to respond accordingly.

A wastewater effluent level control device is positioned downstream of Bank 1B to maintain the correct submergence over the lamps at all flows.

Each bank (Bank 1A & 1B) uses a Communications Control Board (CCB) to control and monitor the lamps, ballast, and bank status. The CCB is located within the PDC. The SCC polls each CCB in sequence to continually update the status of the modules and ballasts. The messages are decoded by the controller and checked for errors prior to displaying the data on the status screen.

Alarm history and alarm summary screens provide the operator with an indication of system faults as they occur. An auto answer modem located in the SCC permits off-site manufacturer's personnel to monitor system performance and assist in diagnosing problems.

Note: Unprotected exposure to ultraviolet light can cause sever burns to eyes and skin.

### *5.3.1 Automatic Cleaning System*

To minimize operator maintenance, the UV Disinfection System has an automatic lamp cleaning mechanism, which can be programmed for periodic operation without the need for system shutdown or loss of disinfection. Each module is fitted with specialized hydraulic cylinders and a two-way solenoid control valve, which moves the wiper collar assembly in alternate liner motion over the length of the lamps. The wiper collar assembly is powered from a hydraulic pump complete with an integral four-way valve and fluid reservoir located within the hydraulic system center. The hydraulic pump delivers the fluid from the reservoir to the hydraulic cylinder. The operator should check the levels in the reservoir periodically. A pressure gauge is located on the discharge side of the pump. The operator should also check the hydraulic system's pressure to ensure proper operation of the system. The system pressure ranges are as follows:

- Operating Pressure = 150 to 200 psi;
- Low Pressure = 100 psi; and
- High Pressure = 230 psi.

Control system pressure sensors continuously monitor the hydraulic system. If the pressure is too low or too high, an alarm will be indicated on the control panel. Lamp cleaning is accomplished mechanically, by the scraping action of the wiper seals, and chemically, by the action of the acid cleaning solution contained in the wiper collar's seals. After months of wiping the quartz sleeves, the acid solution will be consumed or possibly lose its strength. At that time, it will be necessary to refill or change the cleaning

solution. The time interval between cleaning solution refills or changes will vary depending on the nature of the effluent and related sleeve fouling characteristics. The system manufacturer recommends changing the cleaning solution at the regularly scheduled lamp changes, or whenever it appears a coating is forming on the outside of the quartz sleeves.

When operating in the remote mode, the PLC Processor controls the mechanical cleaning frequency. This unit initiates the cleaning cycle by controlling one module at a time in sequence, then repeating the cycle at regular intervals pre-selected by the operator. When operating in the manual mode from the control panel, the operator must place the wiper selector switch in the local position. Then, placing the second wiper selector switch in the sequence position will start the cleaning cycle one module at a time. The return and extend positions are primarily used for performing maintenance on the module when it is in the raised position.

### *5.3.2 Module Removal Mechanism*

The module removal mechanism is a lifting sling, which attaches to the module frame and can be can be used to remove the module from the UV Disinfection Channel when lamp replacement or other maintenance is required. Before removing any UV module from the channel, make sure the electrical power to that unit has been turned off and locked out.

Routine maintenance of the removed module includes the following:

- Lubricate the stainless steel cable as required;
- Inspect the stainless steel cable for signs of fraying. Replace if necessary;
- Inspect the sling for signs of strain or damage. Replace if necessary; and
- Check to make sure electric cables are in good condition.

### *5.3.3 Operator Interface Terminal*

The Operator Interface Terminal consists of a Panelview 1000 color graphic active matrix touch-screen display located on the SCC door. It allows the operator to monitor and control all UV system functions. The UV Disinfection System is designed to operate in the automatic mode (the PLC monitors and controls the UV dosage produced by the banks) or in the manual mode (the operator selects the UV dosage level). When the ActiClean Cleaning System (ACS) is used, the PLC also controls the wiper system when in the automatic mode. The Panelview 1000 communicates information to the PLC using Allen Bradley Ethernet/IP network protocol. The Ethernet network port is used to communicate with the Panelview 1000, the plant SCADA System, and connect to a

programming PC. Each SCC panel is equipped with an Ethernet switch to allow interconnection of the PLC, HMI, and SCADA network. This switch is also equipped with a dial-in modem/router to allow the manufacturer's off-site personnel to access the SCC for monitoring and troubleshooting purposes. A dedicated telephone line must be made available to connect to the modem for this feature.

Additionally local override switches are available on the PDC enclosure to control each bank. To allow local control of each UV bank, bypass the PLC controller by placing the bank mode selector switch(es) on the PDC(s) in the Local ON or OFF position.

A detailed description of the operation using the Panelview 1000 screen is provided in the manufacturer's O & M Manual.

### *5.3.4 General Control Requirements*

The following are the general control requirements for the UV Disinfection System:

- In the "AUTO" mode and under normal operating conditions, at least one (1) bank is always on-line, regardless of the total effluent flow signal;
- In the unlikely event of a power failure at the PLC, the battery backup will retain the control program in memory;
- The selection of banks to be energized will be based on the UV bank with the least amount of run time hours and the requirements to minimize bank cycling;
- All set points are field adjustable; and
- All alarms have an adjustment time delay from 1 to 60 minutes to avoid nuisance alarms.

### *5.3.5 Bank Cycling*

To facilitate even ware on the banks of lamps, a "lead bank rotation" timer is provided such that the lead bank will rotate service each cycle. To avoid unnecessary cycling of banks, an adjustable "bank time OFF delay" timer is provided so that when the dose increases above a bank's set point, no bank will turn off until the bank time off delay timer elapses (normally 1 – 300 minutes).

### *5.3.6 Module Control*

Each module is controlled individually through a soft ON/OFF control integral to the lamp ballast. The module control circuitry is electrically interlocked with a module mercury limit switch to prevent lamps from being energized when out of the channel.

Note: This feature is not intended to be used as a "LOCK-OUT" means during operational maintenance. The bank's power should always be locked out electrically prior to removing modules from the channel or working on the electrical system.

When switched on, lamps are initially energized to their high power setting for a warm-up period regardless of mode. After the warm-up period has expired, the lamps are automatically switched to the required power level. However, once the module has been switched off through either hand or automatic mode, it will not re-energize until a "module restart" timer has expired.

### *5.3.7 Lamp Control and Monitoring*

The following summarizes the lamp control and monitoring features:

- Power settings are variable from 30 to 100 percent per bank;
- For power settings, each bank will respond to a 4-bit power level signal, which will adjust the lamp ballast to the correct power level as determined by the PLC;
- Each lamp is controlled directly from the lamp ballast, which is fully modulated between 30 and 100 percent;
- Specially designed current setting circuits detect lamp ON/OFF status. The status of each individual lamp is displayed via the "Bank Control" screen at the Panelview 1000. Faulted lamps are indicated by specific address;
- Specially designed Equipment Protection Devices (EPD) for ballast secondary circuits detect leakage to ground for remote indication of module fault. The EPD located on each ballast secondary circuit de-energizes the module when a current leakage to ground occurs, which may damage the equipment; and
- The first EPD indication of a module fault starts the "module fault delay" timer (normally preset to 30 minutes).

The PLC will automatically attempt to restart the module with every scan of the module restart timer (normally set to 5 minutes). If the module lamps turn on before the module fault delay timer expires, then this delay is reset. Once the module fault delay timer expires, a module fault is considered present and an alarm will be sounded.

### *5.3.8 Wiper Control and Monitoring*

The following summarizes the wiper control and monitoring features:

- Modules are cleaned one at a time. A complete wipe sequence to clean all modules may be initiated either manually or automatically via the "Wiper Control" screen at the Panelview 1000;
- In "AUTO" mode, the interval between wiping sequences is determined by the "Wiper Sequence" timer, which is preset at 24 hours and adjustable from 1 to 500 hours;

- Each module wiper is controlled by an individual solenoid. At the start of extension, the solenoid is energized and a “wiper stroke” timer is initiated. The wiper stroke timer is preset at 20 seconds, adjustable from 1 to 60 seconds;

- When the “wiper stroke” timer expires, the solenoid is de-energized and the “wiper stroke” timer is then re-initiated;

- When the “wiper stroke” timer expires, the next module wiper is extended; and

- The automatic wiper sequence is disabled for flows greater than 90 percent of peak flow.

### *5.3.9 UV Intensity*

One UV Intensity Sensor is provided per bank. The sensor signal is amplified to 4020 mA and integrated into the serial communications string to the PLC. The range is 0 to 300 mW/cm$^2$. The maximum set point is adjustable from 1 to 999 mW/cm$^{2.}$

### *5.3.10 Bank Control*

The following summarizes the bank control features:

- A three-position selector switch, one per bank, is provided at each PDC for ON/OFF/REMOTE control of the UV Disinfection Equipment;

- Individual banks will energize when placed in the “ON” or “HAND” mode of operation at the Panelview 1000;

- Dose pacing will be applied to banks in the “AUTO” mode only;

- In the “AUTO” mode, the lead bank will initially energize at 100 percent power level. Once the “bank warm up delay” timer expires, the lead bank will stage down to its required power level;

- As the UV demand increases, the power level of the lead bank will automatically increase accordingly. When the lead bank reaches a preset power level of 58 percent, the lag bank will energize;

- As the UV demand continues to increase, the lamp power of the lag bank will continue to increase accordingly to provide the appropriate UV dose; and

- The PLC will use the flow and UV Transmission signals to calculate the theoretical dose for all possible points. These calculations then form the basis for automatic dose pacing.

### *5.3.11 Alarms*

All alarms generated by the UV Disinfection System PLC will be logged and displayed on the Panelview 1000. Each alarm will be time and date stamped when it occurs.

The following critical alarms are included in the system:

- Low UV Dose;
- Hydraulic Max Exceeded;
- Not Enough Healthy UV Equipment Channels Available;
- Flow Meter Fault;
- Channel XX Not Enough Healthy Banks; and
- Bank XX Low Water Level Shutdown.

Other Major Alarms are listed and described in the manufacturer's O&M Manual.

### *5.3.12 Operator Interface*

The Panelview 1000 consists of a touch/keypad screen, which communicates with the PLC via the Data Highway. The operator can monitor and control the entire UV Disinfection System via this screen. A touch screen and keypad are available for system control and monitoring. The information available to the operator is presented on the following screens:

- Bank Settings
- UVI Settings
- Wiper Settings
- Dose Settings
- Flow Settings
- General Settings
- UVT Settings (Manual Input Only)
- Channel Settings

For more detailed information on the screen settings refer to the manufacturer's O&M Manual.

### *5.3.13 Electrical System*

The Power Distribution Center (PDC) spans the top of the channel and distributes electrical power from the main service to the UV modules in a bank of modules. Power distribution is achieved through receptacles on the PDC(s) to allow for local connection of UV modules. Power distribution centers are UL approved with a rating of Type 4X. One PDC is provided per bank of lamps. Each UV module has a cable with a plug that mates with a receptacle on the PDC.

The PDC consists of the following:

- PDC Enclosure;
- Module Power Distribution;
- Relays & Over-current Protection For Modules;
- 24VDC Control and Communication Equipment;
- Communication Control Board (CCB);
- Low Level Sensor Module; and
- Hydraulic Manifold.

A Bank Module Selector switch on the PDC switches between OFF, REMOTE, and ON operation of the bank.

Note: Local over current protection is provided for the three-phase power supply and the single-phase mechanical service.

## 5.4 EFFLUENT SAMPLER

### *5.4.1 Description*

The refrigerated effluent sampler, base mounted in the UV Room, is designed to operate indoors or outdoors in ambient temperatures without an enclosure.

The sampler is self-defrosting and suited for sequential and composite sampling. In the sequential mode the sampler is capable of collecting discrete samples in 24 sample bottles. In the composite mode the sampler is capable of being converted to use a single 2½ gallon glass or polyethylene container. All samples are stored in the refrigerator enclosure. The refrigerator has a hinged, reinforced fiberglass controller cover capable of being locked. The refrigerator door has a hasp capable of accepting padlocks to prevent unauthorized tampering.

Samples are collected using a peristaltic pump typically producing a line velocity of 5.1 fps in a ¼ inch suction line, or 2.5 fps in a 3/8-inch suction line at 3 feet of head. Before and after each sample is collected, the pump air purges the suction line. Pre-purges and post-purges are automatically controlled and no pre-calibration adjustments are required. A weighted polypropylene strainer with a debris deflector is provided to prevent clogging. Samplers have impact resistant ABS plastic pH sensors for detecting and transmitting instantaneous pH data to the SCADA System.

### *5.4.2 Operation and Control*

The sampling program is established using a 24 position sealed keypad and a 2 line, 40 character liquid crystal display. The display continually communicates the sampler's status. The sampler has two (2) programming modes, "BASIC" and "EXTENDED". The "basic" programming mode allows he operator to easily setup typical sampling routines. The "extended" programming mode expands the versatility of the sampler by providing options to allow the operator to create complex sampling routines.

The sampler has software capable of storing up to three (3) sampling routines identified by number. The internal lithium battery provides the sampler with continuous memory. The "basic" and "extended" modes allow the operator to program the sampler to collect either sequential or composite samples at user definable time intervals (time pacing or flow pacing). In the "extended" programming mode, a third type of sample pacing known as STORM pacing is available. The STORM pacing mode provides for both time and flow paced samples to be collected in separate bottle sets during a single program.

The Effluent Sampler Local Control Panel is equipped with the following controls:

- pH Relay (AY-120); and
- Flow Rate (FY-120).

The following Effluent Sampler SCADA System Controls are provided:

- The Effluent Sampler receives a 4 – 20 mA DC effluent flow rate signal from the SCADA System (FY-120);
- All Effluent Sampler related alarms are indicated at the SCADA System HMI;
- The Effluent flow pH (AY-120) is indicated at the SCADA System HMI.

## 5.5 EQUIPMENT MAINTENANCE

Trojan Technologies, Inc. the manufacturer of the UV Disinfection System has supplied a comprehensive Operation & Maintenance Manual, which covers all aspects of their equipment. The "System Maintenance" section provides seven categories of maintenance frequency from daily to every two years (includes four pages). Below is a summary of the daily, weekly, and monthly maintenance requirements. For more maintenance information refer to the Vendor's O&M Manual.

- Daily (SCC)
  - Record "Lamp Hours" from the bank section of the "System Overview" screen.
  - Check Wiper Control Screen to ensure all wiper groups are in REMOTE AUTO.
  - Check Alarm Status screen for new faults and record new alarms.

- Check Alarm History screen for an overview of past faults.
- Check Bank Control screen to ensure all banks are in REMOTE AUTO.
- Check Bank Mode selector switches to ensure they are in REMOTE.
- Check Wiper Control switches to ensure they are in RET, and the remaining switches are set to REMOTE.
- Visual walk through inspection.

- Monthly
  - Check that the hydraulic system pressure is within range.
  - Check the hydraulic fluid level.
  - Inspect for hydraulic leaks.
  - Inspect WW effluent level in channel during flow & no flow to ensure top lamp is staying submerged.
  - Clean debris & algae from module.
  - Check that all sleeve nuts are tight.
  - Inspect sleeve cleanliness
  - Check low water level sensor rod(s) for debris, algae, damage.
  - Clean
  - Level Sensor – Clean as required
  - Channel - Inspect and clean as required.

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# 6 - EFFLUENT DISPOSAL

## 6.1 RAPID INFILTRATION BASINS

The Surfside WWTF discharges all treated effluent to the groundwater via rapid infiltration basins. The rapid infiltration basins use sand as the percolation medium. All basins are fed by a gravity effluent discharge. Refer to **Figure 6.1 - Rapid Infiltration Basin Layout**.

Fifteen infiltration basins provide final effluent treatment and disposal at the Surfside WWTF. Each basin has an effective surface area of approximately 1.05 acres or approximately 45,800 square feet. The total effective infiltration basin surface area is therefore approximately 15.75 acres (686,000 square feet). The Surfside WWTF is designed to use fifteen (15) infiltration basins during the design year summer operations. The basic design data for the rapid infiltration basins is listed in **Table 6.1 - Design Data for Rapid Infiltration Basins.**

**TABLE 6.1 - DESIGN DATA FOR RAPID INFILTRATION BASINS**

| | Initial Year | | Design Year | |
|---|---|---|---|---|
| Description | Winter | Summer | Winter | Summer |
| Number of Basins Provided | 15 | 15 | 15 | 15 |
| Infiltration Basin Area, Each (acres) | 1.05 | 1.05 | 1.05 | 1.05 |
| Average Loading Depth (inches) | 12 | 12 | 12 | 12 |
| Average Daily Flow (mgd) | 1.0 | 2.0 | 2.0 | 3.5 |
| Average Loading Rate (gpd/sq. ft.) | 5 | 5 | 5 | 5 |
| Number of Basins Required | 5 | 9 | 9 | 15 |

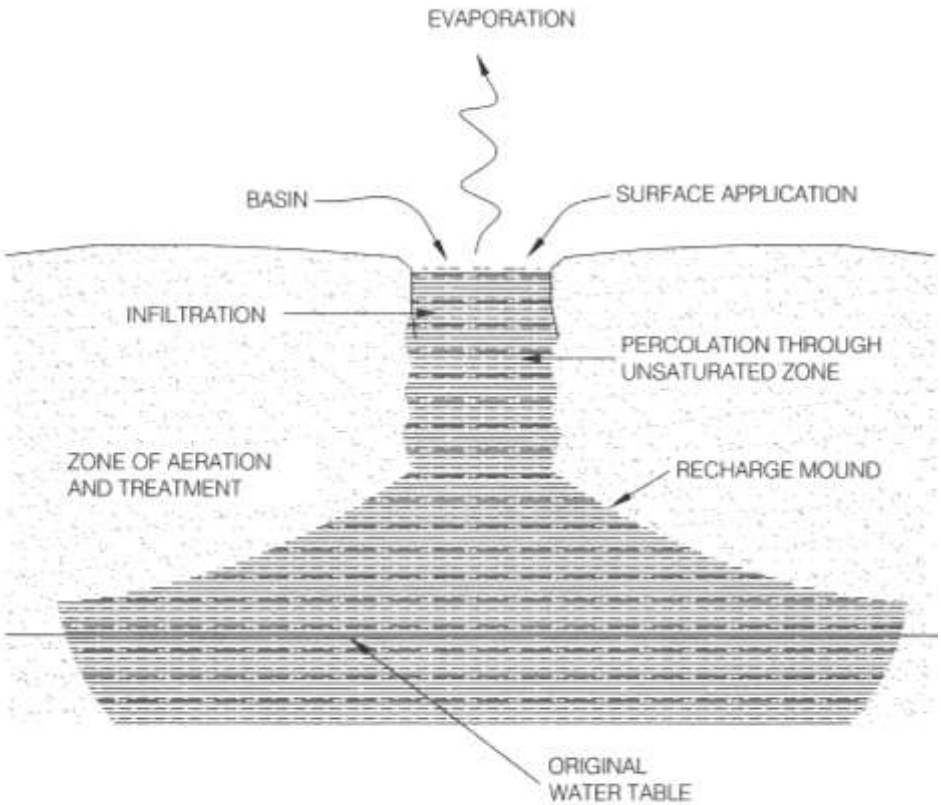
**FIGURE 6.1 - RAPID INFILTRATION BASIN LAYOUT**

The sand for all infiltration basins has an effective size of between 0.3 and 0.6 mm for a minimum depth of 36-inches (top layer). The existing soil stratum beneath this sand is a mixture of fine to coarse sand with some silt, depending on the location.

Wastewater applied to the basins will percolate through an unsaturated zone where filtration of any remaining solids takes place. A zone of aeration and biological treatment also exists at the infiltration basins. This zone is located above the recharge mound and below the sand berm surface of the basins. Aeration occurs in this zone as well as BOD removal.

The filtered wastewater finally reaches the original groundwater table and a recharge mound in the shape of a dome is formed. Evaporation at the wastewater surface of the basins occurs and is a continuous process. Obviously, greater evaporation will occur in the summer time due to warmer temperatures. Strong winds will also increase the rate of evaporation from the basins. Refer to **Figure 6.2 - Rapid Infiltration Basin Percolation Schematic**.

**FIGURE 6.2 - RAPID INFILTRATION BASIN PERCOLATION SCHEMATIC**




## 6.2 RAPID INFILTRATION BASIN OPERATION

Operation of the rapid infiltration basins is performed by simply allowing the wastewater to flow into each basin through the gravity effluent discharge network at the facility. Wastewater flows to individual basins typically one or perhaps two at a time. Any individual basin can be isolated from facility effluent flow by closing the appropriate 12-inch, butterfly valve.

Advanced treatment effluent is discharged to the basins through a 36-inch high density polyethylene interceptor and fifteen 12-inch service lines of the same material. Effluent enters each basin through the 12-inch pipe located at the influent headwall structure. The 12-inch influent inverts and basin elevations above mean sea level (MSL) range from approximately 10.00 to 11.00 feet.

Plant effluent should be discharged to one or two infiltration basins at a time in a logical predetermined sequence. The on-line basin(s) should be filled to a depth no greater than 2.5 feet for a period of time determined by operator experience, flow conditions, and solids loading. The

dosing period will probably be in the one to two day range. Longer dosing periods will increase the solids loading per basin and may increase the potential generation of odors from the basins. Once this period is over, the effluent should be diverted to the next basin(s) in sequential order. The previously used basin(s) should be allowed to dry and then be raked and fine graded.

Previous operating experience of the basins included dosing one or two basins simultaneously and then switching to one or two basins located at the opposite end of the basin layout. One to two days has been the initial average basin drying time. The butterfly valves for the off-line basins should be left in the closed position. **Table 6.2 - Rapid Infiltration Basin Operating Data Sheet** should be used to track and record basin operation and performance.

Under peak flow conditions or extenuating circumstances, more than one basin can be used for a certain period of time. The number of basins required for such a situation can easily be determined using the incoming flow data and the 4 gpd/sq. ft. basin loading rate. As the basins become older, the sand and soil void spaces will fill up and slow down the percolation rate. Operators should be aware of this, as basins will fill up faster and tend to pond more readily. Proper adjustments should be made for this.

Efficient operation of the Surfside WWTF is important considering that the better quality of final effluent, the better condition of basin surfaces for effluent percolation and disposal. A higher degree of treatment will reward the operator with less frequent cleaning intervals. For each basin or system of basins dosed, record the total gallons applied, number of days dosed, and the suspended solids (mg/l) concentration. This information can be obtained by monitoring suspended solids levels in the Surfside WWTF effluent. As an example, consider a winter flow to Basin No. 1 of 1.0 mgd. If the effluent solids concentration is 10 mg/L, the total pounds of solids to the basin can be calculated.

Example:

1.0 mgd x 8.34 x 10 mg/L = 83.4 lbs/day

Area of Basin No. 1 = 44,431 $ft^2$

83.4 lbs / 44,431 $ft^2$ = 0.0019 $lbs/ft^2$ per day

Therefore, a dosing of 1.0 mgd with a solids concentration of 10 mg/L will deposit 0.0019 $lbs/ft^2$ per day on Basin No. 1.

**TABLE 6.2 - RAPID INFILTRATION BASIN OPERATING DATA SHEET**

**Date:** _____

| Basin Number | Total Flow to Basin (gpd) | Time Flow Started | Time Flow Stopped | Basins Dry (Y / N) | Basin Raked (Y / N) | Time (hours) | | | Dosing Rate (gpd/sq.ft.) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Dosing | Drying | Total | |
| | | | | | | | | | |
| **1** | | | | | | | | | |
| **2** | | | | | | | | | |
| **3** | | | | | | | | | |
| **4** | | | | | | | | | |
| **5** | | | | | | | | | |
| **6** | | | | | | | | | |
| **7** | | | | | | | | | |
| **8** | | | | | | | | | |
| **9** | | | | | | | | | |
| **10** | | | | | | | | | |
| **11** | | | | | | | | | |
| **12** | | | | | | | | | |
| **13** | | | | | | | | | |
| **14** | | | | | | | | | |
| **15** | | | | | | | | | |
| | | | | | | | | | |

From this example, it is obvious that infiltrations can be alternately dosed for moderate periods of time before drying and cleaning is undertaken as a part of regular basin maintenance. Keeping accurate records of the total gallonage dosed, the duration of the percolation, and drying periods and the solids concentration applied will aid in determining roughly when to dry and clean the basins.

## 6.3 INFILTRATION BASIN MAINTENANCE

The Surfside WWTF uses advanced treatment with an MBR Ultra-filtration Process, which will significantly reduce the level of effluent suspended solids. Thus, the loading on the rapid infiltration basins will be only a fraction of the previous loading. However, the infiltration basins will still need periodic maintenance.

Thus, depending upon the Surfside WWTF's operating performance relative to effluent suspended solids levels, the sand surface should be cleaned as required to avoid ponding. Ponding is one of the first indicators of a blinding problem, which will result in reduced basin percolation efficiency. Do not scarify and reintroduce solids back into the sand bottom when raking and grading infiltration basins. Plugging of the basin surface will result from mixing effluent solids with filter sand (scarifying). Basin maintenance should be scheduled, if possible, in March to May, or September to November, to take advantage of good weather and low seasonal flows.

The basin should be manually raked by the operators or raked with a light tractor and drag-rake assembly. The top layer of solids should be completely scraped off the basin surface using either method and disposed of at the Town's municipal Solid Waste Facility. A small layer of sand will be removed when manually raking the basins. The operator should try to minimize the sand removal (1/2 inch or less) when raking the beds. Careful basin maintenance and uniform distribution of the basin operation will allow the basin sand medium to last the majority of the Surfside WWTF design life.

Keep the basin surface area and lower basin berm free of weeds and grass. Grass and weeds can be partially controlled by keeping the surrounding grass area cut or pruned to minimize natural airborne seeding. Operators should visually observe the on-line basins at least once a day. Depth measurements should be made and recorded for each on-line basin once a day.

## 6.4 GROUNDWATER MONITORING WELLS

Groundwater monitoring wells are installed up gradient and down gradient of the infiltration basins. Eight groundwater monitoring wells (CB-1 thru CB-4, N-1, N-3, N-9, and N-10) are used at the facility for groundwater quality monitoring. Monitoring wells N-9 and N-10 are north of the Surfside WWTF. All other monitoring wells are between the Surfside WWTF and the shoreline.

Each well consists of a 2-inch scheduled 40 PVC pipe, slotted well screen, and a guard casing with locking cap. The slotted well screens are 15-feet long and located at the bottom of the well pipe. The well screens are a minimum of 10-feet below the water table (at the time of installation)

for each well site. The depth of each well varies depending on location and groundwater elevation. The groundwater table migration pattern is generally toward the Atlantic Ocean. Refer to **Figure 6-3 - Groundwater Monitoring Well Detail**. The MassDEP Groundwater Discharge Permit requires groundwater sampling of each well. Sampling is required quarterly for the following parameters:

- Static water level;
- Specific Conductance;
- pH;
- Total Phosphorous;
- Orthophosphate;
- V.O.C.;
- Ammonia;
- Surfactants;
- Nitrate Nitrogen;
- Total Nitrogen; and
- Total Coliform.

Refer to **Table 6.3 - Groundwater Monitoring Well Sampling Report**.

The groundwater discharge permit lists the sampling frequency, sample type, and pollutant parameters for the groundwater monitoring wells. Refer to **Appendix B - MassDEP Groundwater Discharge Permit** which includes the groundwater monitoring requirements for the Surfside WWTF.

Groundwater monitoring sampling laboratory results should be recorded quarterly and kept on file for reference. Quarterly sampling laboratory data taken prior to the completion of the secondary treatment facilities should be maintained at the facility and can be used as baseline data for comparison to groundwater quality data obtained after completion of the Advanced Treatment Facilities.

A standard set of procedures should be follow when sampling from the groundwater monitoring wells. Refer to **Appendix C - Groundwater Sampling Procedures.**

**FIGURE 6.3 - GROUNDWATER MONITORING WELL DETAIL**

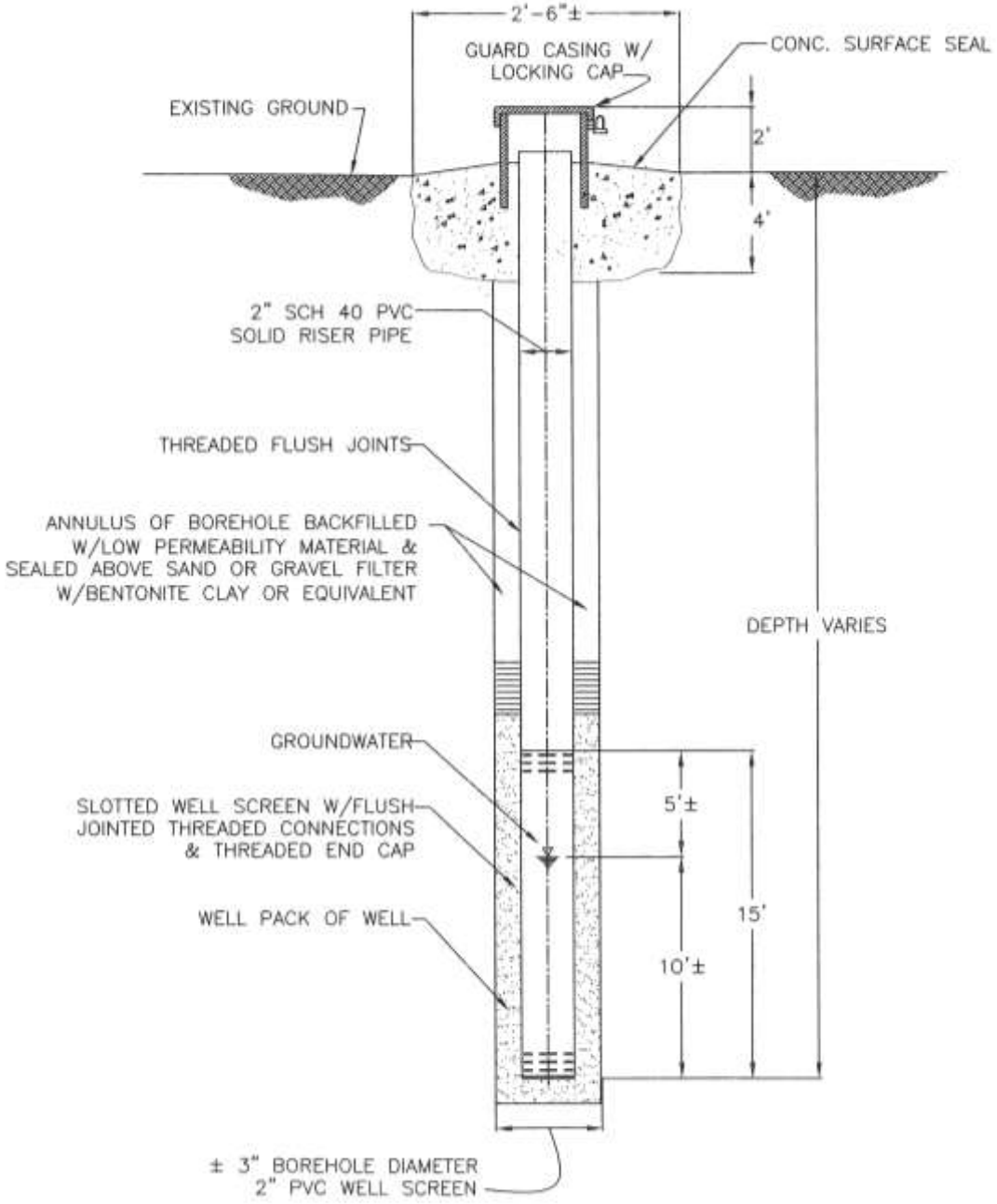


**TABLE 6.3 - GROUNDWATER MONITORING WELL SAMPLING REPORT**

Sample Collection Date: _____

Groundwater Analysis Results

| | Well Number | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | CB-1 | CB-2 | CB-3 | CB-4 | N-1 | N-3 | N-9 | N-10 |
| | | | | | | | | |
| Static Water Level (feet) | | | | | | | | |
| Specific Conductance (Mho) | | | | | | | | |
| Acidity (pH) | | | | | | | | |
| Total Phosphorous (mg/L) | | | | | | | | |
| Orthophosphate (mg/L) | | | | | | | | |
| V.O.C (mg/L) | | | | | | | | |
| Nitrate Nitrogen (mg/L) | | | | | | | | |
| Total Nitrogen (mg/L) | | | | | | | | |
| | | | | | | | | |

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# 7 - SOLIDS PROCESSING

## 7.1 INTRODUCTION

A basic function of the Nantucket WWTF is to separate the solids from the liquid portion of the wastewater. Thus, sludge is a byproduct of the wastewater treatment process. This chapter deals with processing the solids originating from the liquid treatment train. The previous chapters described many aspects of solids handling as it affects control of the wastewater treatment systems. The objective of this chapter is to discuss and explain the processing of solids for disposal purposes. The goal of this processing is to manage the sludge solids volumes in an efficient manner, dewater the sludge solids thus reducing its volume, and facilitate its disposal to the Town's Municipal Solid Waste Facility.

The successful operation of the sludge processing facilities requires plant personnel to also be familiar with the wastewater treatment facilities. An understanding of the factors that influence sludge characteristics and sludge processing, together with a thorough knowledge of the equipment and controls, contributes greatly to optimum performance of this portion of the plant's processes.

The problems of dealing with wastewater sludge can be complicated, particularly with waste activated sludge. These problems primarily revolve around the following factors:

- Sludge is composed of substances responsible for the offensive character of untreated sewage;
- Sludge is primarily organic and subject to biological decomposition. Unstabilized or raw sludge is thus likely to produce offensive odors; and
- Only a small fraction of the sludge is solid matter. The volume of sludge is largely made up of water.

While these factors generally apply to all sludges, differences exist between specific types. The characteristics of sludge depend on its origin, its age, and the type of processing it has undergone.

Primary sludge is chiefly composed of organic settleable solids found in the influent wastewater. Primary sludge may become septic quickly if it is allowed to stagnate. Generally, the heavier inorganic settleable solids are removed in the aerated grit chamber. The lighter organic settable solids are removed in the primary clarifiers.

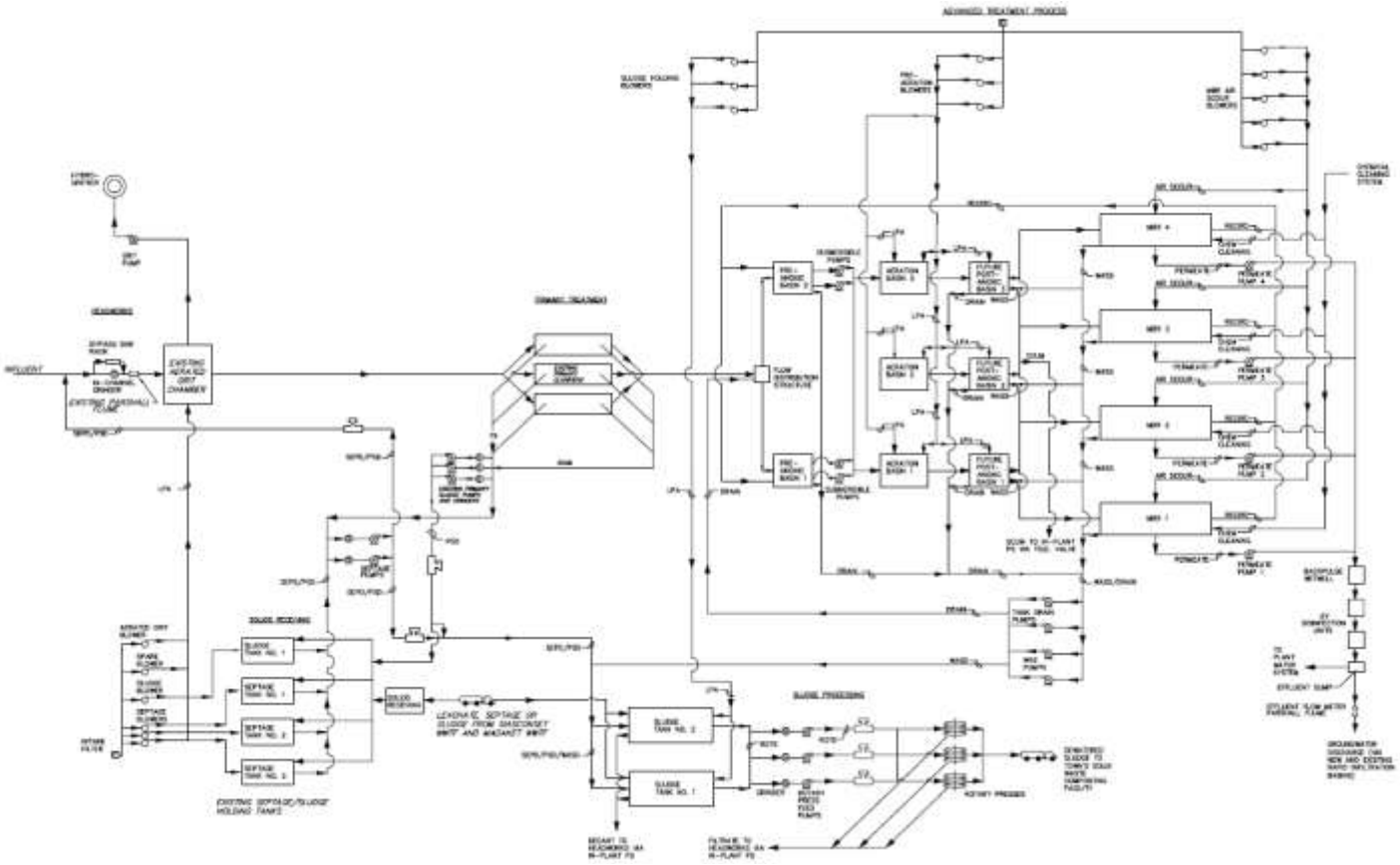
"Pure" waste activated sludge (WAS) has a brown, fluffy appearance. If the color is black, the sludge is approaching a septic condition. If the color is lighter than usual, the sludge is under oxidized and may have a tendency to bulk and settle slowly. Activated sludge is apt to become septic quickly in the final MBR Tanks if the process is not properly controlled.

The sludge processing facilities at the Surfside WWTF include the following facilities:

- One (1) Grit Tank and Blower (Common Spare);
- One (1) Grit Pump and Grit Dewatering System;
- Two (2) Septage/Primary Sludge Pumps with Grinders;
- Three (3) Primary Clarifiers and Sludge Pumps with Grinders;
- One (1) Septage Receiving Station;
- Three (3) Sludge Flow Meters;
- Four (4) Primary Sludge/Septage Holding Tanks;
- Five (5) Primary Sludge/Septage Holding Tank Blowers (1-common spare);
- Two (2) ATB Sludge Holding Tanks;
- Three (3) ATB Sludge Holding Tank Blowers (1-common spare);
- Two (2) WAS Pumping Systems;
- Three (3) Flow Meters;
- Two (2) Polymair Polymer Mixing Systems (for sludge conditioning);
- Three (3) Rotary Press Feed Pumps and Grinders;
- Three (3) Rotary Press Chemical Feed Systems;
- Three (3) Rotary Press Dewatering Systems;
- Sludge Screw Conveyors for Cake Disposal via truck to Town Landfill; and
- Liquid Sludge Receiving Station (for accepting Siasconset Sludge and sludge from future Madaket WWTF).

Refer to **Appendix-A - Basic Design Data** for the sizing of the Solids Processing System. Refer to **Figure 7.1 - General Sludge Flow Schematic** shows the major sludge flow streams. For a more detailed understanding of the sludge handling systems, the operator is advised to examine the Piping and Instrumentation Drawings prepared by the construction contractor and the related shop drawings.

**FIGURE 7.1 - GENERAL SLUDGE FLOW SCHEMATIC**



Sludge processing represents a significant portion of both operating costs and initial capital cost of the WWTF. Sludge processing facilities must be effectively and efficiently operated to maintain the best possible performance. Inefficient operation will result in wasted chemicals, energy, and disposal cost. The staff must be aware that a change in the operation of one system within the plant often affects the operation of another system located downstream in the flow train. Because the characteristics of the sludge and wastewater vary daily, and even hourly, staff must be alerted to those changes and adjust the system operations accordingly.

Debris and grit often cause operational and maintenance problems in the sludge processing equipment. For this reason, it is essential that the primary treatment facilities such as the aerated grit chamber and grinders be properly operated and maintained.

Detailed operating and maintenance instructions are included in the manufacturer's Operation and Maintenance Manuals for the respective pieces of equipment. All equipment and systems listed above have manufacturer's O&M Manuals.

## 7.2 OVERVIEW OF SLUDGE PROCESSING SYSTEM

There are two types of sludge processed by the Sludge Processing System at the Surfside WWTF. The sludge types are:

- Primary Treatment Sludge; and
- Waste Activated Sludge (WAS).

The quantity and quality of the sludge inventory is a function of flow conditions, seasons, and process quality. The grit, septage, and primary sludge originate from the Headworks Facility, Septage Receiving Station, and the Primary Treatment Facility. The Headworks Facility includes an In-Channel Grinder that screens and grinds the influent solids and discharges that flow through the Parshall Flume, Aerated Grit Chamber, and on to Primary Treatment.

The Aerated Grit Chamber removes the heavier solids from the wastewater by aerating the volume, causing the heavier solids to settle to the bottom of the tank and the lighter organic solids to remain in the wastewater. The Primary Treatment Facility separates the primary sludge from the wastewater influent flow and pumps that sludge into the adjacent sludge holding tank for further processing. The septage and sludge in the two (2) Primary Sludge Holding Tanks and in the two (2) Primary Septage Holding Tanks are kept mixed and fresh by four (4) blowers that aerate the septage/sludge. Sludge from the Primary Sludge Holding Tanks is transferred to the ATB Sludge Holding Tanks for further processing by the Two (2) septage/sludge grinders and pumps. Under normal operations, the septage/sludge grinders and pumps also discharge the septage from the Primary Septage Holding Tanks to the wastewater influent pipeline upstream of the Headworks Facility. Optionally, the septage/sludge pumps can discharge septage from the Primary Septage Holding Tanks to the ATB Sludge Holding Tanks.

The Waste Activated Sludge (WAS) is withdrawn from the Advanced Treatment Process, specifically the two (2) Pre-Anoxic Tanks, three (3) Post Anoxic Tanks and the four (4) Membrane Bioreactor (MBR) Tank. WAS is pumped from one of the advanced treatment process tanks by one of the two (2) WAS pumps located in the pump room of the ATB and discharged into the ATB sludge holding tanks The ATB Sludge Holding Tanks have the capability to concentrate the sludge by settling and decanting. The ATB Sludge Holding Tanks are kept mixed and fresh by three (3) blowers that aerate the sludge.

The sludges generated at the Siasconset WWTF and the future Madaket WWTF are transported to the Surfside WWTF and discharged at the Liquid Sludge Station and into the ATB Sludge Holding Tanks for storage and future pumping and dewatering by the Rotary Presses. For more information of liquid sludge receiving see section 7.9.

Periodically, the concentrated sludge is removed from ATB Sludge Holding Tanks, passed through one of three (3) grinders, pumped by one of three (3) Rotary Press Feed Pumps to one of three (3) flocculators, where the sludge is conditioned by a polymer, and finally to one of three (3) Rotary Presses for dewatering. The polymer is used to promote coagulation and aggregation of the sludge solids and the release of entrained water. The Rotary Presses discharge a sludge cake consisting of about 18 to 30 percent solids, measured by dry weight.

The sludge cake is discharged into a series of screw conveyors to an elevated level in the truck loading bay where the cake discharges into an open truck, which will transport and discharge the dewatered sludge into the Town's Landfill.

## 7.3 PRIMARY SLUDGE/SEPTAGE HOLDING TANKS

### *7.3.1 Description*

Primary Sludge, Septage, and Grit Filtrate are stored in four sludge/septage holding tanks adjacent to the Primary Treatment Building. The recent designation states there are two (2) Primary Sludge Holding Tanks and two (2) Septage Holding Tanks. There are four on-line blowers and one standby blower that can serve any of the four (4) holding tanks. These blowers are located on the first floor of the Primary Treatment Building. Each of the two Primary Septage Tanks and one of the Primary Sludge Holding Tanks has dimensions of 13-feet by 25-feet and 9-foot sidewall depth. The tank surface area per foot of depth is 2,431 gallons and the total tank capacity is 21,879 gallons. One of the Primary Sludge Holding Tank has dimensions of 16.25-feet by 18-feet and a 9-foot side wall depth. Each tank surface area per foot of depth is 2,188 gallons and individual tank capacities are 19,691 gallons. The total storage capacity of the four holding tanks is 80,952 gallons.

The sludge is mixed and aerated in each holding tank by a Sanitare coarse bubble diffused aeration system. Air is supplied by Aerzen positive displacement blowers located on the ground level of the Primary Treatment Building. Refer to **Table 7.1 - Primary Sludge/Septage/Grit Filtrate, Holding Tanks and Air Blower Design Data**.

**TABLE 7.1 - PRIMARY SLUDGE/SEPTAGE HOLDING TANKS AIR BLOWER DESIGN DATA**

| Description | Value |
|---|---|
| Blower Manufacturer | Aerzen USA Corp. |
| Model No. | GM-7L |
| Number of Units | 4 + 1-Spare |
| Inlet Capacity | 120 icfm |
| Blower Speed | 2370 rpm |
| Max. Operating Pressure | 5 psig |
| Motor Horsepower | 5 hp |
| Drive Type | Variable Speed |
| Intake & Discharge Size | 3-inches |
| Noise Attenuation | Yes |

The blowers are floor mounted and supply air to the holding tanks through a four inch drop-leg and four inch diffuser header. Air is discharged from each header through 6.0-inch diameter coarse bubble Air Seal Diffusers. Each diffuser is designed to pass 10 cfm of air with a head loss of 10 -inches of water. This air rate will provide sufficient mixing and minimize diffuser clogging.

Since this system is designed for primary sludge, aeration is provided predominantly for mixing and minimal oxygen transfer to the sludge is anticipated. All four holding tanks are served by a Duall single-stage, packed scrubber odor control system that has been installed to minimize odors from the holding tanks and other sources. The Duall Odor Control System is located in the sludge processing building.

### *7.3.2 Operation and Control*

By increasing the concentration of septage and sludge in the holding tanks the overall storage capacity is increased and the dewatering efficiency of the Rotary Presses is enhanced. For these reasons, provisions have been made to facilitate decanting. A 6-inch telescoping valve has been provided in each holding tank. The operating range of each tank is 3-feet.

To decant from a holding tank, the operator should shut off the air to that tank and allow the solids to settle. The operator should then open the aluminum access hatch to view the top of the telescoping valve, and then slowly lower the valve into the top clear liquid to be removed. When all the clear liquid has been removed and the top of the valve reaches the level of the settled solids, the valve should be raised to its upper position and the air should be turned back on. If a layer of floating solids forms on the top of the holding tanks, a sludge blanket level detector such as a “sludge judge” should be used to determine the level of clear liquid that can be removed.

The tanks should be decanted weekly or as needed to concentrate the sludge and maximize the holding capacity of the tanks. The decanted liquid from the holding tanks drains by gravity to the in-plant pumping station. The in-plant pumping station discharges the decant back to the headworks.

Daily monitoring of sludge depth or “blanket” should be performed using the “sludge judge”. Samples taken from the “sludge judge” should be taken to the laboratory for analysis of the solids concentration in the sludge holding tanks. This information should be used to determine sludge feed pumping schedules and rates. Refer to the following example of how to calculate sample solids concentrations:

Basic Formulas to use:

1. $\frac{\text{Loss in weigh}}{\text{Weight of Wet Sludge}} \times 100 = \text{Percent Moisture in sludge}$

2. 100 - Percent Moisture = Solids Concentrate

Given:

| | |
|---|---|
| Weight of dish and wet sludge | 58.12g |
| Weight of dish | 33.75g |
| Weight of dish and dry sludge | 34.73g |

Calculation

1. Weight of Wet Sludge
   58.12g-33.75g = 24.37g

2. Weight Lost
   58.12g-34.73g = 23.39

3. Percent moisture in sludge

$$\frac{23.39g \text{ (Loss of Weight)}}{24.37g \text{ (Weight of Wet Sludge}} \times 100 = 95.98\%$$

4. Solids Concentration in sludge

100.00 – 95.98%( percent moisture in sludge) = 4.02%

Each Primary Septage and Sludge Holding Tanks' liquid level is monitored by an ultrasonic level element and indicating transmitter (LE/LIT-700A&B), which can operate over a range of 0-ft. to 20-ft. Each of Primary Septage and Sludge Holding Tanks has a secondary level monitoring float switch (LSH-700A&B), which is utilized to signal sludge level alarms. The tank volume can be easily calculated knowing the effective tank surface area. The ultrasonic level sensors and transmitters should be recalibrated and checked out by a qualified technician according to the schedule suggested in the manufacturer's O&M Manual. The liquid level can be visually checked in each holding tank through each aluminum hatch.

The liquid level is monitored through SCADA and controls four operator set alarms, "Low Low,' "Low," "High," "High High." The Low and Low Low level alarms should be set to approximately 1.0' and 0.5' respectively while the High and High High alarms should be set to approximately 9.0' and 9.5' respectively. The High High alarm is tied into the two the three Primary Sludge Pumps discharging into the Primary Septage and Sludge Holding Tanks, locking out the pumps when the alarm is activated. Conversely, the Low Low Level alarm is tied into the septage/sludge pumps, locking out the pumps when the alarm is activated.

The Primary Septage and Sludge Holding Tanks have "On" and "Off" set points that control the activate and deactivate the aeration system. The Intensity of the aeration is varied between the "lower" and "Upper" level set-points. The liquid sludge should be added and withdrawn within an operating level between 1.5' and 7.0' to allow for continuous aeration and odor control. The level should only be dropped below this level to service an air header, inlet or outlet piping, or the tank itself. The air should be shut off to the particular tank being serviced using the appropriate eight inch butterfly valve located on the eight inch air supply line in the basement of the Advanced Treatment Building

Common operational problems with the air blowers and tank aeration system include maintaining adequate air flow in the holding tank to maintain a well mixed, homogenous sludge concentration for dewatering. Operators should monitor blower discharge pressure gauges and visually observe (through an open hatch) that adequate solids mixing and suspension in each holding tank is maintained. The hand adjustable butterfly valves on the aeration piping can be easily positioned to allow the proper flow to each holding tank and grit chamber. Remember, air will always follow the path of least resistance. The operators should also draw the Primary Septage/Sludge Holding Tanks down routinely to clean aeration piping and remove any rags or debris that may accumulate around the diffusers.

## 7.4 ADVANCED TREATMENT BUILDING SLUDGE HOLDING TANKS

### *7.4.1 Description*

The Advanced Treatment Building Sludge Holding Tanks are two underground tanks located east of the Advanced Treatment Building and north of the Advanced Treatment Process Tankage. These tanks have hopper bottoms and are covered to allow the odor control withdrawal piping to remove odorous air from the “head space” in each tank and transfer that odorous air to the plant’s odor control scrubber system for treatment. Each tank has two roof hatches for access. Each tank is 71 ft. – 8 in. long by 26 ft. – 11 in. wide and has a side water depth of approximately 19 ft. – 0 in. Refer to **Table 7.2 - ATB Sludge Holding Systems Basic Design Data.**

Under normal operating conditions, sludge from the Primary Sludge Holding Tanks is pumped to the ATB Sludge Holding Tanks before being transferred to the sludge dewatering system.

### *7.4.2 Operation and Control*

Increasing the concentration of septage and sludge in the holding tanks will increase overall storage capacity and enhance the dewatering efficiency of the Rotary Presses. For these reasons, provisions have been made to facilitate decanting. An 8-inch telescoping valve has been provided in each holding tank. The operating range of each tank is 5-feet with a high water level of el. 19.58 and a low water level of el 14.58.

To decant from a holding tank, the operator should shut off the air to that tank and allow the solids to settle. The operator should then open the aluminum access hatch to view the top of the telescoping valve, then slowly lower the valve into the sludge to allow the top clear liquid to be removed. When all the clear liquid has been removed and the top of

the valve reaches the level of the settled solids, the valve should be raised to its upper position and the air should be turned back on. If a layer of floating solids forms on the top of the holding tanks, a sludge judge should be used to determine the level of clear liquid that can be removed.

**TABLE 7.2 - ATB SLUDGE HOLDING SYSTEM BASIC DESIGN DATA**

| Description | Value |
|---|---|
| No. of Sludge Tanks | 2 |
| Storage Volume (gal.) each | 200,000 |
| Estimated Daily Sludge Quantity (lbs/day) | 15,314 |
| Estimated Sludge Concentration (mg/l) | 17,984 |
| Estimated Daily Raw Sludge Flow – Surfside (gpd) | 101,304 |
| Estimated Daily Raw Sludge Flow – Siasconset (gpd) | 800 |
| Total Estimated Daily Raw Sludge Flow (gpd) | 102,104 |
| Estimated Sludge Holding Time (days) | 4.0 |
| Type of Sludge Mixing | Air |
| Mixing Rate (scfm/1,000 $ft^3$) | 30 |
| Air Quantity (icfm) | 1040 |
| No. of Blowers (each) | 3 |
| Blower Capacity at High Speed (icfm) | 1,040 |
| Blower Capacity at Low Speed (icfm) | 650 |
| Blower Design Pressure (psig) | 9 |
| Type of Blower Drive | VFD |
| Blower Motor Min. (HP) | 60 |
| Type of Diffuser | Coarse Bubble |
| Quantity of Diffusers (each tank) | 152 |
| Diffuser Submergence (ft.) | 16 |
| Diffuser Headloss (inches of $H_2O$) | 12 |

The tanks should be decanted weekly or as needed to concentrate the sludge and maximize the holding capacity of the tanks. The decant liquid from the holding tanks drains by gravity to the In-Plant Pumping Station. The In-Plant Pumping Station discharges the decanted liquid to the Headworks.

Daily monitoring of sludge depth or “blanket” should be preformed using the “sludge judge”. Samples taken from the “sludge judge” should be taken to the laboratory for analysis of the solids concentration in the sludge holding tanks. This information should be used to determine sludge feed pumping schedules and rates.

Each ATB Sludge Holding Tank liquid level is monitored by an ultrasonic level element and indicating transmitter (LE/LIT-700A&B), which can operate over a range of 0-ft. to 20-ft. Each ATB Sludge Holding Tank has a secondary level monitoring float switch (LSH-700A&B), which is utilized to signal sludge level alarms. The tank volume can be easily calculated knowing the effective tank surface area. The ultrasonic level sensors and transmitters should be recalibrated and checked out by a qualified technician according to the schedule suggested in the manufacturer’s O&M Manual. The liquid level can be visually checked in each holding tank through each aluminum hatch.

The liquid level is monitored through SCADA and controls four operator set alarms, “Low Low,’ “Low,” “High,” ”High High.” The Low and Low Low level alarms should be set to approximately 1.0’ and 0.5’ respectively while the High and High High alarms should be set to approximately 9.0’ and 9.5’ respectively. The High High alarm is tied into the two sludge/septage pumps, the two WAS pumps discharging into the ATB Sludge Holding Tanks, locking out the pumps when the alarm is activated. Conversely, the Low Low Level alarm is tied into the rotary press feed pumps, locking out the pumps when the alarm is activated.

The ATB Sludge Holding Tanks have “On” and “Off” set points that control activation and deactivation the aeration system. The Intensity of the aeration is varied between the “lower” and “Upper” level setpoints. The liquid sludge should be added and withdrawn within an operating level between 1.5’ and 7.0’ to allow for continous aeration and odor control. The level should only be dropped below this level to service an air header, inlet or outlet piping, or the tank itself. The air should be shut off to the particular tank being serviced using the appropriate eight inch butterfly valve located on the eight inch air supply line in the basement of the Advanced Treatment Building

Common operational problems with the air blowers and tank aeration system include maintaining adequate air flow in the holding tank to maintain a well mixed, homogenous sludge concentration for dewatering. Operators should monitor blower discharge pressure gauges and visually observe, through an open hatch, that adequate solids mixing and suspension in each holding tank is maintained. The hand adjustable butterfly

valves on the aeration piping can be easily positioned to allow the proper flow to each holding tank. Remember, air will always follow the path of least resistance. The operators should also draw the solids holding tanks down routinely to clean aeration piping and remove any rags or debris that may accumulate around the diffusers.

The ATB Holding Tanks also receive WAS from the Advanced Treatment Process. The sludge generated by the Advanced Treatment Process must be periodically wasted in order to maintain the proper mixed liquor concentration in the tanks. Waste Activated Sludge Pumps withdraw sludge from either the Pre Anoxic, Future Post Anoxic or the Membrane Bioreactor Tanks and discharge to the ATB Holding Tanks. This sludge has a very high water content, which makes decanting the ATB Holding Tanks a necessity.

The ATB Sludge Holding Tank Level Panel includes the following:

- Tank Level System (LIR-700A, etc.); and
- Tank High Level Alarm (LAH-700A, etc.).

The ATB Holding Tank Blower Local Control Panel is located in the Advanced Treatment Building on the first floor at the variable frequency drive unit and has the following features: Blower Control & Alarm System at the VFD:

- Local operation of the blowers is through a HAND/OFF/AUTO" selector switch at the VFD. When in "AUTO" position, remote manual control is by the SCADA System;
- Blower manual speed control (SC-710);
- Blower speed indication (SI-710);
- Blower motor over temperature alarm (TAH-710-1) and Reset Pushbutton;
- Blower discharge high pressure switch alarm (PAH-710-2) and Reset Pushbutton;
- Blower high vibration switch alarm (VAH-710) and Reset Pushbutton;
- Blower "Local"/Remote" switch (SS-710-1);
- VFD "ON" indicating light (Red);
- VFD "OFF" indicating light (Green); and
- Elapsed run time meter (KQI-140).

At the SCADA System:

Tank Level System

- Level is indicated, trended, and recorded at the SCADA HMI (LIR-700A, etc.);
- ”Low Low,” “Low”, “High” and “High High” Level Alarms (LAH-700A, etc.); and
- Tank Level set points Control for Rotary Press Feed Pumps/Grinders and Blowers.

Blower Control & Alarm System

- When VFD H-O-A switch is in “AUTO” remote manual and automatic control at SCADA HMI is enabled;
- VFD speed Indication (SI-710A, etc.)
- “HAND/OFF/AUTO” switch in “AUTO” position (YI-710A-1, etc.);
- Run status indication (YI-710A-2, etc.);
- VFD Fault Alarm (710A-1, etc.);
- Motor over temperature alarm (TAH-710A-1, etc.);
- High vibration alarm (710A, etc.);
- Blower high discharge temperature alarm (710A-2, etc.);
- Elapsed run time meters (KQI-710A, etc.); and
- Motor state disagreement alarm displayed at SCADA HMI (YA-710A-2, etc.).

## 7.5 SLUDGE TRANSFER AND PUMPING SYSTEMS

### *7.5.1 Description - Septage/Primary Sludge Pumping System*

Sludge is withdrawn from the two primary sludge holding tanks by the two (2) septage/sludge grinders and double disc pumps and will normally be transferred into the two ATB Sludge Holding Tanks before being sent to the sludge dewatering system. The septage is withdrawn from the two primary septage holding tanks by the two (2) septage/sludge grinders and double disc pumps and will normally be transferred to the Headworks Facility and discharged into the plant influent flow upstream of the in-channel Franklin Miller grinder and/or bypass bar rack. Alternately, septage can also be pumped directly to the ATB Sludge Holding Tanks for further processing. Refer to **Table 7.3 - Septage/Sludge Pumping Systems Basic Design Data**.

**TABLE 7.3 - SEPTAGE/SLUDGE PUMPING SYSTEMS BASIC DESIGN DATA**

| Description | Value |
|---|---|
| Manufacturer | Penn Valley Pumps |
| Type of Sludge Pump | Double Disc |
| No. Sludge Pumps (ea.) | 2 |
| Suction Size (inches) | 4 |
| Discharge Size (inches) | 4 |
| Flow Rate (gpm) each | 80 |
| TDH (ft.) | 25 |
| Motor Horsepower (each) | 5 |
| Pump Speed (rpm) | 200 |
| Drive Type | VFD |

The sludge in the two ATB Sludge Holding Tanks is periodically transferred through Rotary Press Feed Pumps and Grinders to the sludge dewatering system. For more information on the Primary and ATB Sludge Storage and Pumping Systems refer to **Chapter 2.0 – Headworks**.

### *7.5.2 Description - WAS Pumping System*

Two Waste Activated Sludge (WAS) Pumps are utilized to withdraw ATB Sludge from either the MBR Tanks, Pre Anoxic or the Post-Anoxic Basins and discharged into the ATB Sludge Holding Basins. The WAS Pumps are located in the basement level of the ATB. The purpose of these pumps is to withdraw a sufficient volume of mixed liquor from the ATB Process to maintain mixed liquor concentration required by the ATB Process. The WAS pumps are double disc pumps that utilize a suction disc and a discharge disc to provide a double acting, non clogging pumping action. This pumping action allows large solids and rags to be passed with no loss of pumping action. The basic design data for the WAS Pumps is indicated below in **Table 7.4 - Waste Activated Sludge Pumps Basic Design Data**.

**TABLE 7.4 - WASTE ACTIVATED SLUDGE PUMPS BASIC DESIGN DATA**

| Description | Value |
|---|---|
| Manufacturer | Penn Valley Pumps |
| Type of Sludge Pump | Double Disc |
| No. of Sludge Pumps | 2 |
| Suction Size (inches) | 3 |
| Discharge Size (inches) | 3 |
| Flow Rate (gpm each) | 40 |
| TDH (ft.) | 20 |
| Motor Horsepower (each) | 3 |
| Pump Speed (rpm) | 174 |
| Drive Type | VFD |

### *7.5.3 Operation and Control*

These pumps are typically controlled through the Zenon MBR system. The Local Control Panel for the WAS Pumps is mounted on the east wall of the Blower Room on the ground level of the ATB. These WAS Pumps can also be controlled from the SCADA System, which is located in the control room on the ground level of the Advanced Treatment Building.

At the Local Control Panel:

- Pump High Discharge Pressure Alarm (PAH-460A, etc.) and Reset Pushbutton;
- Pump Low Suction Pressure Alarm (PAL-460A, etc.) and Reset Pushbutton;
- Pump Hand-Off-Auto Switch (YI-460A-1, etc.);
- Pump Run Status Display (YI-460A-2, etc.);
- VFD “On/Off” Pushbuttons (YS-460A, etc.);
- Local / Remote Selector Switch; and
- Elapsed run time meter (KQI-460A, etc.).

The following status and alarm signals are displayed at the SCADA System:

- WAS Pump “RUN” status (YI-460A, etc.);
- WAS Pump “low suction pressure” alarm (PAL-460A, etc.);
- WAS Pump “high discharge pressure” alarm (PAH-A, etc.);
- Speed Indication (SI-460A, etc.);
- Elapsed time meters (KQI-460A, etc.); and
- WAS flow rate is indicated, trended, and recorded (FIR-465). Flow alarms are indicated at the SCADA HMI.

## 7.6 ROTARY PRESS FEED SYSTEM

### *7.6.1 Description*

The Rotary Press Grinders and Feed Pumps transfer the sludge from the ATB Sludge Holding Tank(s) through the in-line flow meter(s) on to the Rotary Press Dewatering Unit(s). The Rotary Press Grinders and Pumps are located in the basement of the Advanced Treatment Building. The sludge discharge piping leaves the Advanced Treatment Building through the North basement wall and runs underground to the Sludge Processing Building. There are three feed systems serving the three (3) Rotary Presses. The suction piping and discharge piping are manifolded together such that any feed system can pump from any sludge holding tank and serve any of the three Rotary Presses. Refer to **Table 7.5 - Rotary Press Grinders and Feed Pumps Basic Design Data**.

### *7.6.2 Operation and Control*

The operation and control of the Rotary Press Grinders and Feed Pumps can be from the Local Control Panels, but is primarily controlled through the Fornier Control panel in the control room of the Sludge Processing Building. The Rotary Press Grinder local control panel for each grinder is located adjacent to the unit in the basement of the Advanced Treatment Building. The Rotary Press Pump VFD control panel for each pump is located in Electrical Room #1011, which is on the ground level of the Advanced Treatment Building.

**TABLE 7.5 - ROTARY PRESS GRINDERS AND FEED PUMPS BASIC DESIGN DATA**

| Description | Value |
|---|---|
| Rotary Press Grinders | |
| Manufacturer | Franklin Miller |
| Quantity | 3 |
| Pipe Size (inches) | 6 |
| Maximum Headloss (psig) | 0.91 |
| Minimum Flow (gpm) | 600 |
| Minimum Speed (rpm) | 1725 |
| Motor Horsepower | 3 |
| Drive Type | Constant Speed |
| Rotary Press Feed Pumps | |
| Manufacturer | Penn Valley Pumps |
| Quantity | 3 |
| Type | Double Disc |
| Pipe Size (inches) | 6 |
| Maximum Speed (rpm) | 230 |
| Flow (gpm) | 175 |
| TDH (ft) | 60 |
| Minimum Horsepower | 10 |
| Drive Type | VFD |

The Local Control Panel for the Rotary Press Feed Pumps and Grinders has the following features:

- Rotary Press Feed Grinders
  - “Grinder “ON” indicating light (White)
  - Grinder “Run” Indicator Light (Green)
  - “Forward” and “Reverse” Indicator Lights (Amber)
  - “Seal Fail” Indicator Light (Red)
  - “Start” and “Stop” Pushbuttons
  - Grinder Hand-Off-Auto Switch

- Rotary Press Feed Pumps VFD Control
  - Pump High Discharge Pressure Alarm (PAH-720A, etc.) and Reset Pushbutton
  - Pump Low Suction Pressure Alarm (PAL-720A, etc.) and Reset Pushbutton
  - Pump Hand-Off-Auto Switch (YI-720A-1, etc.)
  - Pump Run Status Display (YI-720A-2, etc.)
  - VFD "On/Off" Pushbuttons (YS-720A, etc.)
  - Local / Remote Selector Switch
  - Elapsed run time meter (KQI-720A, etc.)

The SCADA System HMI displays the following information.

- Rotary Press Feed Grinders
  - Rotary Press Feed Grinder in "AUTO" (YI-720A-3, etc.)
  - Run status (YI-720A-4, etc.)
  - Failure alarm (YA-720A-2, etc.)
  - Elapsed run time meters (KQI-720A-2, etc.)
  - Hard-wired interlock between pump circuit and grinder circuit:
    - When called to start – grinder start for preset time before pump start.
    - When called to stop – grinder run for preset time after pump stopped.
    - Pump stop on grinder fault
    - Pump/grinder must be manually restarted if stopped on failure.

- Rotary Press Feed Pumps
  - "HAND/OFF/AUTO" switch in "AUTO" (YI-720A-1, etc.)
  - Run status (YI-720A-4, etc.)
  - Low Suction Pressure Alarm (PAL-720A, etc.)
  - High Discharge Pressure Alarm (PAH-720A, etc.)
  - Speed indication (SI-720A, etc.)
  - VFD fault alarm (YA-720A-1, etc.)
  - Hard-wired interlock between pump circuit and grinder circuit:
    - When called to start – grinder start for preset time before pump start.
    - When called to stop – grinder run for preset time after pump stopped.
    - Pump stop on grinder fault
    - Pump/grinder must be manually restarted if stopped on failure.

Each of the Rotary Press Feed Pump discharge piping system has a dedicated pressure gauge and flow meter that measures the sludge flow rate and can totalize the flow volume for a given time period. The 3-inch diameter magnetic meters supplied by Endress & Hauser, Model No. 50FH80, have a capability of measuring flow between 0 and 175 gpm. The flow meters are designated FIR-725A, 725B, and 725C.

## 7.7 ROTARY PRESS DEWATERING SYSTEM

### *7.7.1 Description*

The Rotary Press Grinders and Feed Pumps transfer the sludge from the ATB Sludge Holding Tanks to the three (3) Flocculators and three (3) Rotary Presses located in the Sludge Processing Building. Each Rotary Press has four (4) channels and the capability of adding two (2) additional channels if additional dewatering capacity is needed in the

future. Each Rotary Press is served by a flocculator, which is used to condition the sludge by mixing it with polymer. The Rotary Presses are Fournier Model No. 900/6000CV. Each of 3 zone, 4 channel Rotary Presses are driven by a 20 HP Lesson motor. The Flocculators are Fournier Model No. 5-300-900. Each Flocculator has a 21 gallon reservoir with a variable speed agitator driven by a 1 HP Nord motor. The Rotary Presses dewater the sludge before it is conveyed to a truck for disposal at the Town's Municipal Solid Waste Facility.

The flocculator consists of a 21 gallon reservoir that contains a mixture of sludge and polymer fed through an inlet at the top of the unit. An electric motor and gear reducer drive an agitator located inside the reservoir near the inlet. The agitator ensures proper mixing of the sludge and the polymer and speeds up the flocculation process. The speed of the agitator may be changed to accommodate a change in the sludge's nature. The flocculator's outlet is located at the bottom of the reservoir. The conditioned sludge can be directed towards the sampler or the Rotary Press. Refer to **Table 7.6 - Rotary Press Dewatering System Basic Design Data**, **Figure 7.2 - Rotary Press Schematic Diagram** and **Figure 7.3 – Sludge Processing Building Partial Plan.**

If the sludge is inadequately flocculated when it enters the Rotary Press, a large portion of the solids contained in the sludge will pass through the filtering elements and clog them. When this occurs, the Rotary Press must be shut down. The system will have to be flushed out before it can be started again. An air bleed is located at the top of the flocculator. It allows gases trapped in the flocculator to escape through the drain. The valve between the evacuation line and the drain must always be open, except when the air bleed is being washed.

The Rotary Press Feed Pumps feed the raw sludge to the flocculator where a pre-set ratio of polymer solution is injected into the sludge at the flocculator inlet. A short period of rapid agitation takes place within the flocculator and transforms this mixture into a high quality "floc". A sampler, which is attached to the flocculator, allows the operator to sample the conditioned sludge (floc) for either visual inspection or laboratory analysis.

The conditioned sludge then enters the manifold and is directed to each Rotary Press channel. The dewatering process begins as soon as the conditioned sludge passes the channel's inlet. Water is extracted through filtering elements and exits the channel while the dewatered sludge is retained, becoming progressively denser as it advances in the channel.

**TABLE 7.6 - ROTARY PRESS DEWATERING SYSTEMS BASIC DESIGN DATA**

| Description | Value |
|---|---|
| Flocculator | |
| Quantity | 3 |
| Model No. | 05-300-900 |
| Maximum Volume | 21 Gallons |
| Design Pressure of Vessel | 60 lb./po |
| Inlet | Top Side |
| Rotation Speed | Variable 0 – 450 rpm |
| Agitator Diameter | 10-inches |
| Gear Motor | Nord, Hollow Shaft 434 rpm, 1 hp, |
| Model | SK0282NBAFBVL-80LH/4 |
| Rotary Press | |
| Quantity | 3 |
| Model No. | 4(6)-900/6000CV |
| Total No. of Channels | 12 |
| Surface of Filtration | 1.0 M2 / channel |
| Gear Motor | Leeson 20- hp, SF 125 |
| Speed Reducer | Moventas 20 hp, D5R SF60 - 623.1 |

A restrictor, located at the channel outlet, further removes moisture from the sludge by compressing it until it is transformed into a sludge cake. The sludge cake falls from the outlet by force of gravity and drops into the screw conveyor below.

**FIGURE 7.2 - ROTARY PRESS SCHEMATIC DIAGRAM**

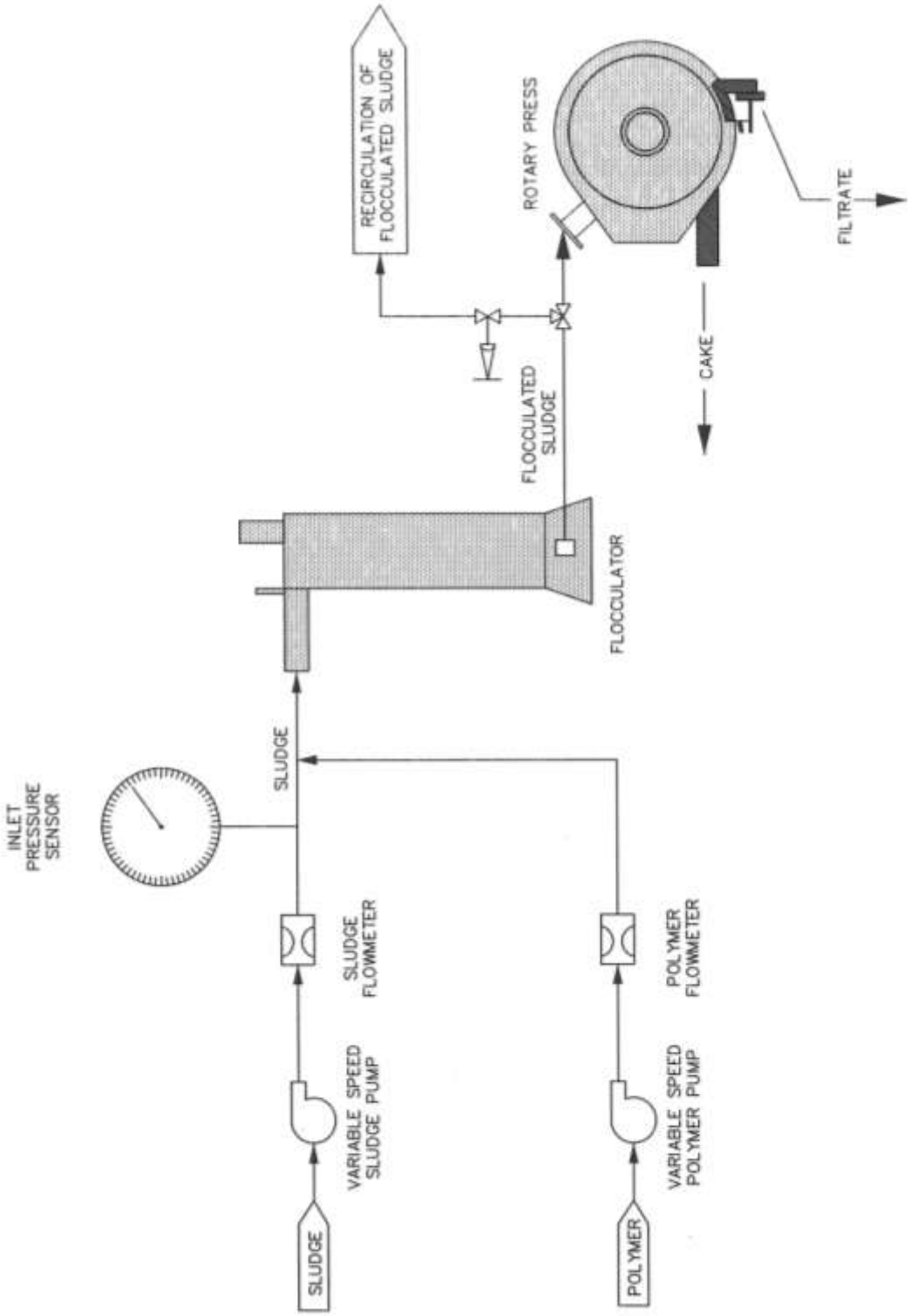
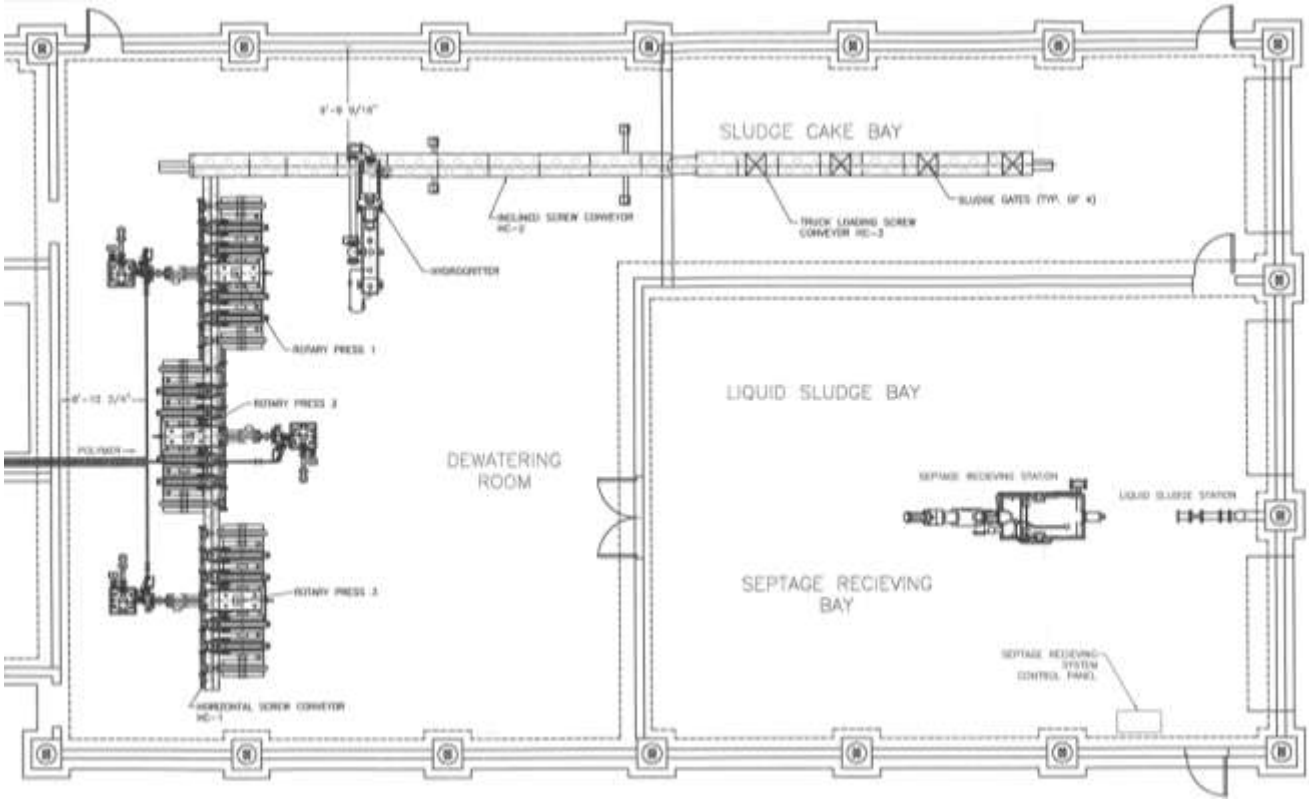


**FIGURE 7.3 – SLUDGE PROCESSING BUILDING PARTIAL PLAN**



### *7.7.2 Polymer Feed System*

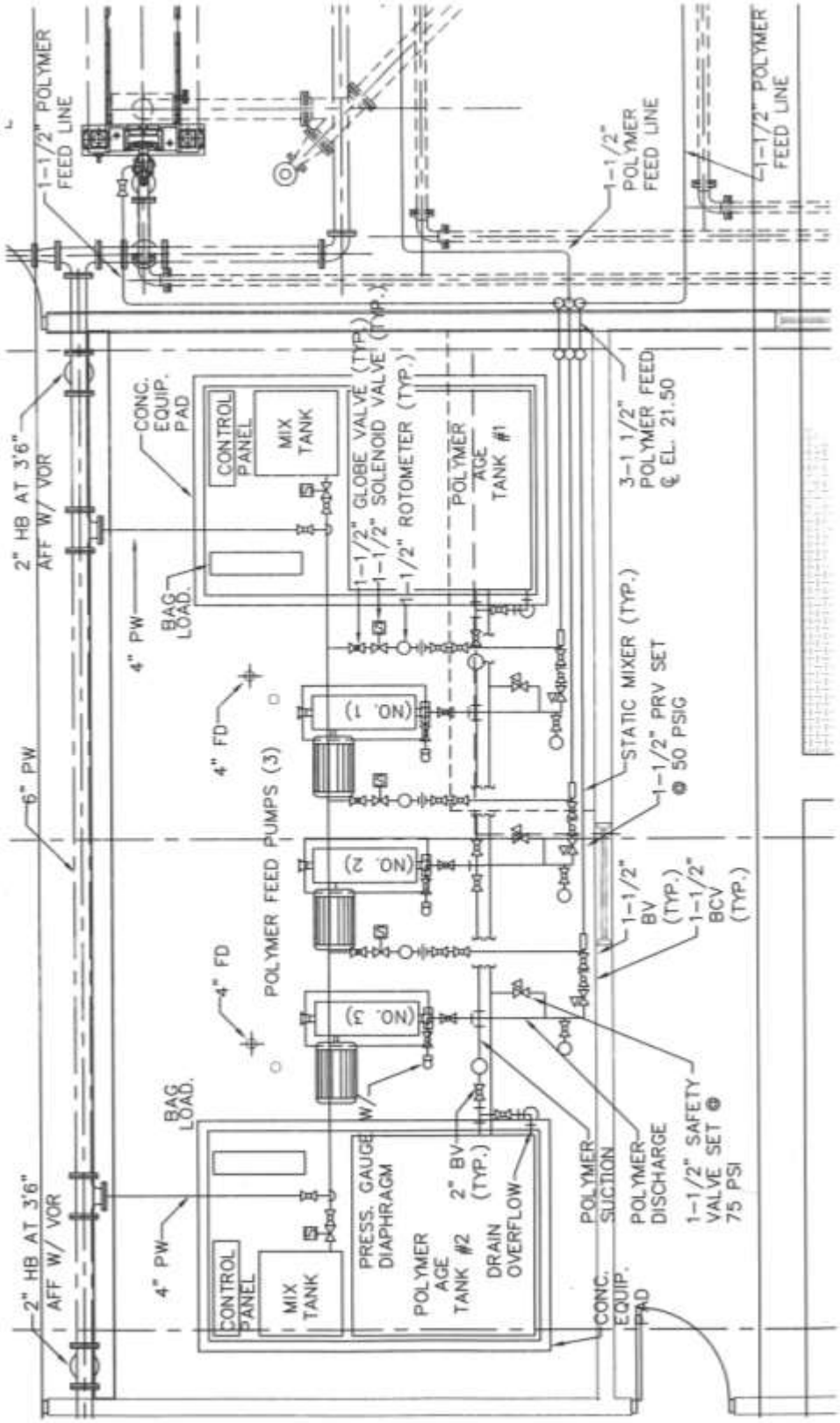
A dual polymer storage and feed system serves the three (3) Rotary Presses via the Flocculators and is located in the Sludge Processing Building. The Acrison Polymer System consists of the following components:

- Feed Hopper;
- Volumetric Feeder;
- Air Dryer;
- Atomizer;
- Cyclone Wetting Chamber;
- Mixing Tank;
- Mechanical Mixer;
- Exhaust Blower;
- Air Scrubber;
- Three (3) Level Probes;
- Two (2) Solenoid Valves;
- Transfer Valve;
- Aging Tank; and
- Liquid Polymer Pump.

The dry polymer is manually loaded into the feed hopper and then accurately metered at an operator preset rate by the volumetric feeder. The metered polymer is pneumatically dispersed with pre-dried air by the atomizer and simultaneously conveyed into the cyclone wetting chamber. The atomized polymer impinges into a continuously flowing water cyclone, where it is thoroughly wetted without clumping or agglomeration. Refer to **Figure 7.4 - Polymer System Plan Layout.**

The completely wetted polymer then drops into the mixing tank where a slow speed mechanical mixer facilitates dissolving the dry polymer into solution without damaging the polymer chains. The air scrubber exhaust blower assures a positive downdraft at the inlet of the wetting chamber. This prevents even the smallest atomized particle from escaping to the atmosphere. The mixing tank level probe automatically closes the water supply solenoid valve at high water level and opens the water supply solenoid valve at low water level.

**FIGURE 7.4 - POLYMER SYSTEM PLAN LAYOUT**



The mixing tank level probe also closes the mixing tank discharge valve when the mixing tank is empty. The aging tank level probe opens the mixing tank discharge valve to ensure a continuous supply of polymer to the aging tank. Aged polymer is fed to the Flocculator by Milton Roy Milroyal B Drive Metering Pumps, which in-turn feeds the Rotary Presses. The entire polymer batch should be used within two (2) or three (3) days.

The Milroyal pumps are reciprocating controlled volume pumps, designed to move specific volumes of liquids against pressure difference. The chemical metering pumps are each driven by a 3 phase, 2 HP Baldor motor running at 1725 rpm. The Local Control Panel for the three polymer pumps is located in the control room of the Sludge Processing Building and has the following features for each pump:

- "VFD ON"(Green) and "VFD OFF" (Red) indicating lights;
- Hand – Off – Auto Selector Switch;
- Variable Speed Control Knob;
- Pump System Display; and
- Elapsed Run Timer.

For further information about the Chemical Metering Pumps, see the Manufacture's O&M Manual.

Alternately, Liquid Polymer can also be feed to the polymer feed pumps by the liquid polymer pump. This pump is controlled through Polymer Feed System 1. For further information about using the liquid polymer pump, see the Manufacture's O&M Manual. The operators should be aware that polymer could be a dangerous product to handle. Polymer is a toxic product and needs to be handled with care including wearing gloves and safety glasses.

### *7.7.3 Principles of Operation*

Each Rotary Press channel is delimited by filtering elements on each side and by inner and outer spacers at the top and bottom.

Each outer spacer contains two (2) openings:

- The channel inlet allows sludge to enter the channel; and
- The channel outlet allows sludge cake to be discharged.

A deflector separates the inlet from the discharge and prevents the conditioned sludge from mixing with the sludge cake. The restrictor controls the flow of sludge through the channel and keeps the channel full.

Each channel has three (3) sludge dewatering zones: the filtration zone, the pressing zone, and the restriction zone. The three zones are described below:

- Filtration Zone: During the first phase of the dewatering cycle, water leaves the channel through the filtering elements. This portion of the channel is known as the filtration zone. In this zone, scrapers in continuous contact with the filtering elements remove the film of sludge particles captured during water evacuation.

- Pressing Zone: Further along in the channel, the sludge enters a second phase. The channel's moving wheel drives the sludge forward by force of friction while the restrictor at the channel outlet generates an opposite force, extending the time the sludge remains in the channel. The sludge thus thickens gradually to become a sludge cake.

In this section of the channel, known as the pressing zone, the pressure that the cake exerts on itself increases the friction between the sludge and the filtering elements increases. The pressure increases exponentially as the cake moves toward the discharge outlet. The cake is subject to sliding and shearing forces. As more liquid is drawn out, the forming cake starts to slip against the channel walls.

- Restriction Zone: The extent of the filtration zone, as well as that of the pressing zone, is affected by the speed of the wheel, the sludge feed pressure, the discharge pressure, and nature of the sludge being treated.

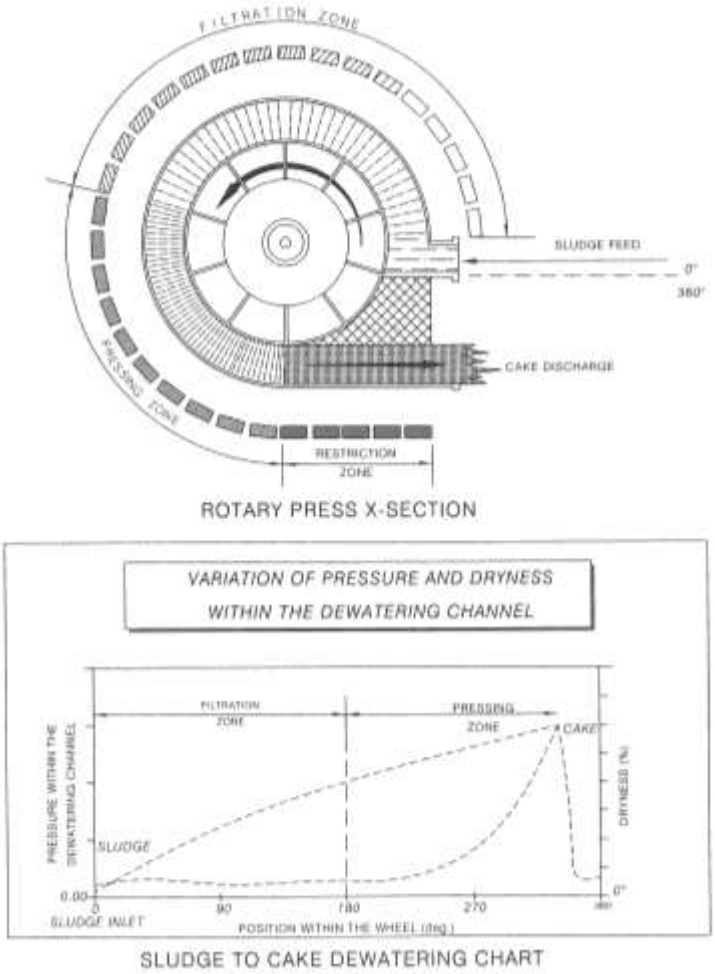
Refer to **Figure 7.5 - Rotary Press Operating Zones,** which depicts the three zones shown on a typical cross section of the Rotary Press. Also, shown on this figure is the "Sludge to Cake Dewatering Chart", which depicts the filtration and pressing zones, and the curve plot of the liquid sludge proceeding through the channel, increasing in solids concentration to a sludge cake consistency.

The speed of the wheel's rotation affects the cake's dryness and production rate. As the speed of the wheel increases, cake dryness decreases. An increase in wheel speed leads to an increase in cake production up to a point beyond which the production rate starts to decline. The optimum wheel speed varies with the nature of the sludge and the proportion of sticky materials it contains.

A progressive increase in sludge feed pressure can result in the following:

- Reduction in cake dryness;
- Reduction in cake production; and
- Reduction in capture rate.

**FIGURE 7.5 - ROTARY PRESS OPERATING ZONES**




The feed pressure significantly affects the operation of the Rotary Press. Increasing the feed pressure beyond a certain point not only reduces the production rate but randomizes the results and makes control of the dewatering process difficult. Therefore, the Rotary Press should only operate at low feed pressures. It is better to control cake dryness and cake production rate by changing either the wheel speed or the discharge pressure.

A progressive increase in discharge pressure will increase cake dryness. However, cake dryness cannot increase indefinitely. At some point, the cake dryness will level off. Also, an increase in discharge pressure reduces the cake production rate. The Rotary Press discharges a second liquid filtrate stream, which flows by gravity to the In-Plant Pumping Station. The In-Plant Pumping Station then discharges its flow to the Headworks treatment.

**Polymer Dosage:** To obtain optimum operation, the sludge has to be properly flocculated with polymer before it enters the Rotary Press. An insufficient quantity of polymer makes the floc too small and too fragile. As the floc enters the channel, particles break up and pass through the filtering elements while larger particles are captured by the filtration elements, which will cause the cake to be extremely dry. On the other hand, excess polymer reduces the production rate by causing too much slippage between the compressed sludge and the filtering elements. The correct dosage results in a strong floc and good friction properties.

**Sampler Operation:** Samples are taken manually in Recirculation or Dewatering mode. While selected in Recirculation mode, assure the inlet pressure is positive and above 1 psi. In case the inlet pressure is too low, the sample tube will not fill up completely. To correct this situation, create a positive pressure in the flocculator tank by partially shutting off the drain valve installed after the 3-way valve. To let the sludge enter inside the clear sample tube, open the bottom valve. Sludge will slowly start to fill up the tube but will be restrained by the air trapped inside the tube. To let the air bleed out, open the sampler top valve. This same valve is used to regulate the fill up speed. Shut it off to stop the sludge from entering inside the tube. Shut the bottom valve.

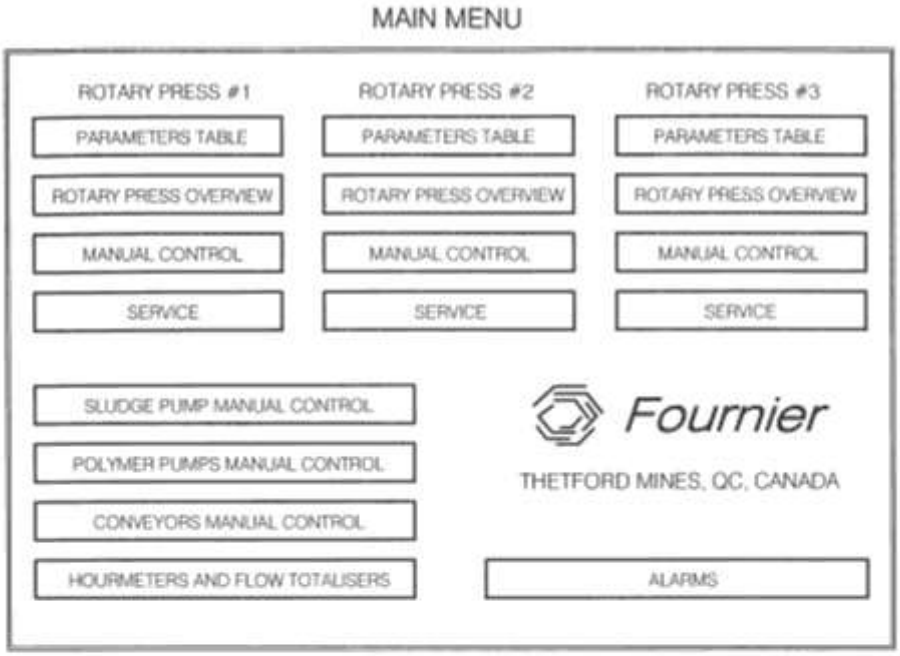
After observing the sample, drain it out from the clear tube by opening the valve at the bottom of the sampler. To accelerate the drainage, open the bleeder valve at the top of the sampler. When finished sampling, rinse out the side glass using the wash water valve. Refer to the manufacturer's O&M Manual for more details.

### *7.7.4 Operation and Control*

The operation and control of the Rotary Press Process Equipment is managed through the Local Control Panel's Allen Bradley "PanelView" Plus 1000 in the Main Control Room of the Sludge Process building, and monitored through the SCADA System HMI. Refer to **Figure 7.6 - Main Menu HMI Screen, Figure 7.7 - Rotary Press #1 - Parameters HMI Screen, Figure 7.8 - Rotary Press #1 – Manual Control HMI Screen, Figure 7.9 - Sludge Pumps Manual Control HMI Screen, Figure 7.10 - Polymer Pumps Manual Control HMI Screen,** and **Figure 7.11 - Conveyor Manual Control HMI Screen.**

The operation and control of the Rotary Press System is operated through the PanelView Plus 1000 seven operator interface terminal screens. Refer to Figures 7-6 through 7-12 for PanelView screens. The automatic mode is used for normal operation of the Rotary Presses and their related devices. The must be polymer present in the polymer tank and the ATB Sludge holding tanks must be at a minimum level prior to starting a cycle

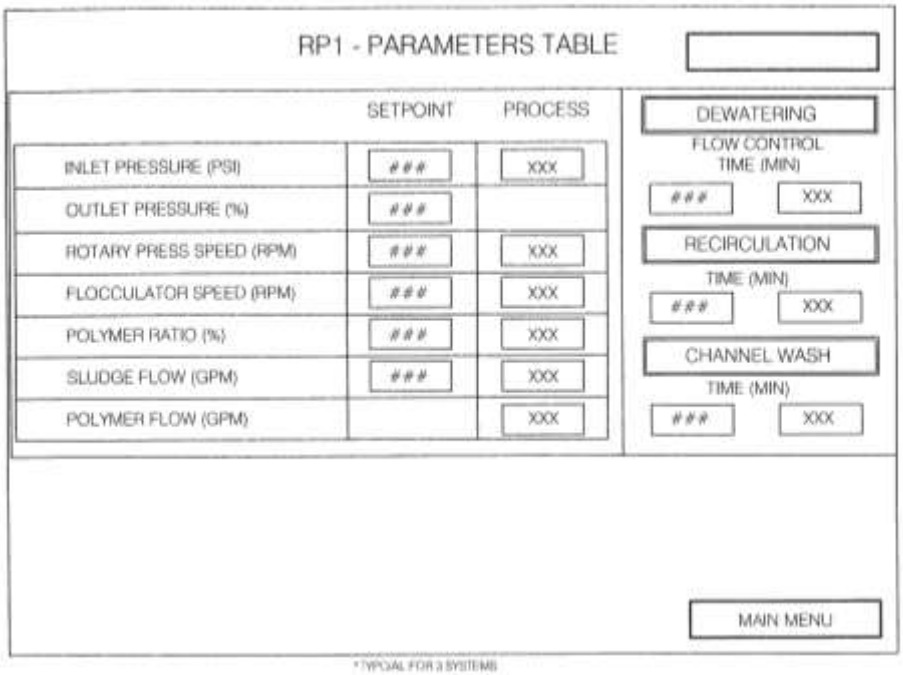
**FIGURE 7.6 - MAIN MENU HMI SCREEN**




*This page is used to access other pages.

| If you want to: | Press: |
|---|---|
| - Start the recirculation cycle, the dewatering cycle or the channel wash cycle or change/adjust automatic parameters | "PARAMETERS TABLE" button |
| - Have a general overview of the rotary press status | "ROTARY PRESS OVERVIEW" button |
| - See/change the status of the rotary press and the flocculator or operate the dewatering valve and the wash valve manually | "MANUAL CONTROL" button |
| - See/change the status of the speed of the sludge pump | "SLUDGE PUMPS MANUAL CONTROL" button |
| - See/change the status of the speed of the polymer pump and the polymer system | "POLYMER PUMPS MANUAL CONTROL" button |
| - See/change the status of the conveyors | "CONVEYORS MANUAL CONTROL" button |
| - See the hourmeters of the rotary press and the flocculator or see/reset the sludge and the polymer flow totaliser | "HOURMETERS AND FLOW TOTAL" button |
| -Turn one or more channels ON/OFF or change the channel wash mode | "SERVICE" button |
| - Acknowledge or see the alarms and go to the Panel View configuration screen (date & hour) | "ALARMS" button |

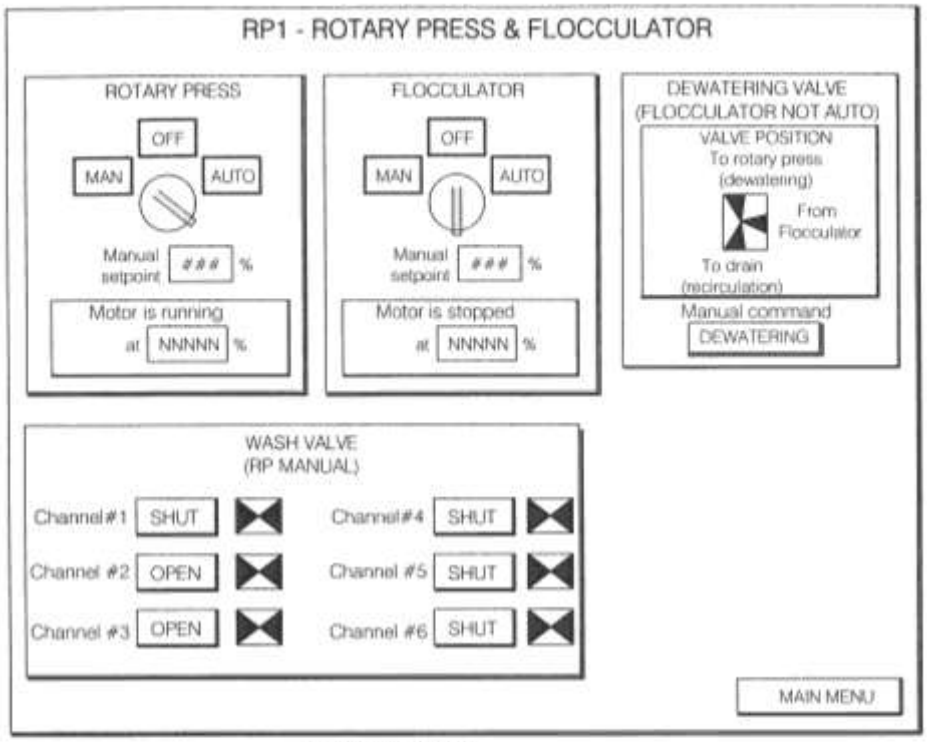
**FIGURE 7.7 - ROTARY PRESS #1 - PARAMETERS HMI SCREEN**




* TYPICAL FOR 3 SYSTEMS

| If you want to: | Press: |
|---|---|
| - Start or stop the dewatering process | "DEWATERING" button (When the process is ON, the inside of the rectangle become green. When the process is OFF, the inside of the rectangle is gray) |
| - Start or stop the recirculation process | "RECIRCULATION" button (When the process is ON, the inside of the rectangle become green. When the process is OFF, the inside of the rectangle is gray) |
| - Start or stop the channel wash cycle | "CHANNEL WASH" button (When the process is ON, the inside of the rectangle become green. When the process is OFF, the inside of the rectangle is gray) |
| - Change the recirculation time | The recirculation time setpoint box (then enter setpoint 0-20 min) |
| - Change the flow control time | The flow control time setpoint box (then enter setpoint 0-30 min) |
| - Change the channel wash time | The channel wash setpoint box (then enter setpoint 1-30 min) |
| - Change the setpoint of the inlet pressure | The inlet pressure setpoint box (then enter setpoint 0-10 PSI) |
| - Change the setpoint of the outlet air control | The outlet air control setpoint box (then enter setpoint (0-100 PSI) |
| - Change the speed of the rotary press | The rotary press speed setpoint box (then enter setpoint 0-2.5 RPM) |
| - Change the speed of the flocculator | The flocculator speed setpoint box (then enter setpoint 0-450 RPM) |
| - Change the polymer ratio | The polymer ratio setpoint box (then enter setpoint 0-50%) |
| - Change the setpoint of the sludge flow | The sludge flow setpoint box (then enter sepoint 0-100 GPM) |
| - Go to Main menu | "MAIN MENU" button |

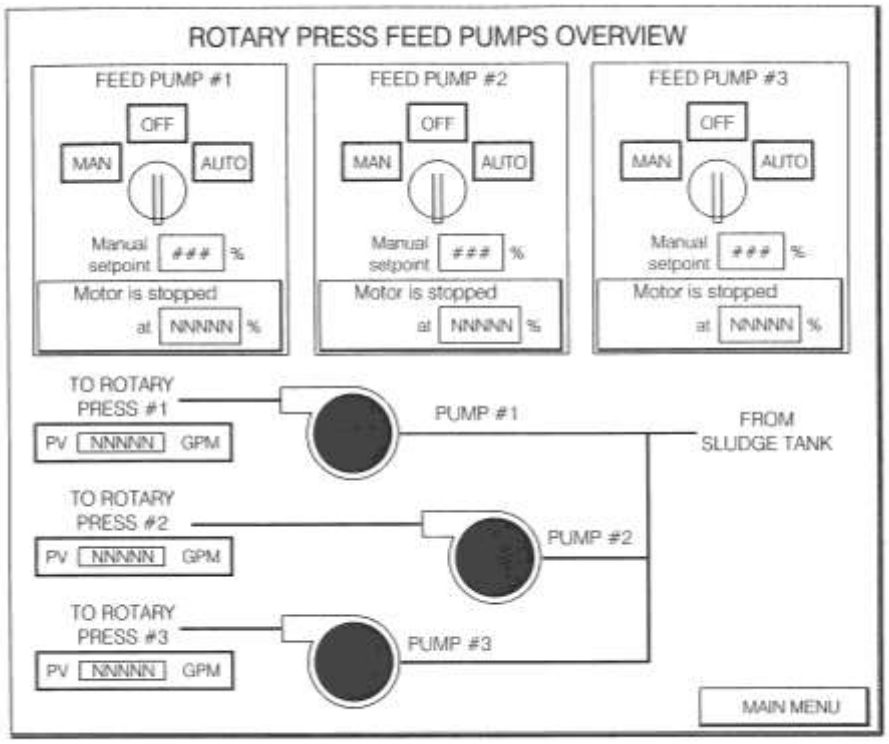
- **FIGURE 7.8 - ROTARY PRESS #1 – MANUAL CONTROL HMI SCREEN**




*Typical for 3 systems.

| If you want to: | Press: |
|---|---|
| - Start the rotary press manually | "MAN" button of the rotary press selector |
| - Turn OFF the rotary press | "OFF" button of the rotary press selector |
| - Set the rotary press to the AUTOMATIC mode | "AUTO" button of the rotary press selector |
| - Change the speed of the rotary press in manual mode | The rotary press speed setpoint box (then enter setpoint 0-100%) |
| - Start the flocculator manually | "MAN" button of the flocculator selector |
| - Turn OFF the flocculator | "OFF" button of the flocculator selector |
| - Set the flocculator to the AUTOMATIC mode | "AUTO" button of the flocculator selector |
| - Change the speed of the flocculator in manual mode | The flocculator speed setpoint box (then enter setpoint (0-100%) |
| - Open a wash valve manually (the rotary press must not be in AUTO) | The corresponding button (when the valve is closed, the button is gray and when the valve is open the button is green.) |
| - Operate the dewatering valve manually (flocculator must not be in AUTO) | "DEWATERING/RECIRCULATION" button (when the valve is in recirculation position, the rectangle is gray. When the valve is in dewatering position the rectangle is green.) |
| - Go to Main menu | "MAIN MENU" button |

**FIGURE 7.9 - SLUDGE PUMPS MANUAL CONTROL HMI SCREEN**




| If you want to: | Press: |
|---|---|
| - Start the sludge pump manually | 'MAN' button of the sludge pump selector |
| - Turn Off sludge pump | 'OFF' button of the sludge pump selector |
| - Set a sludge pump to the AUTOMATIC mode | 'AUTO' button of the sludge pump selector |
| - Change the speed of a sludge pump in manual mode | The sludge pump speed setpoint box (then enter setpoint 0-100%) |
| - Go to Main menu | 'MAIN MENU' button |

**FIGURE 7.10 - POLYMER PUMPS MANUAL CONTROL HMI SCREEN**

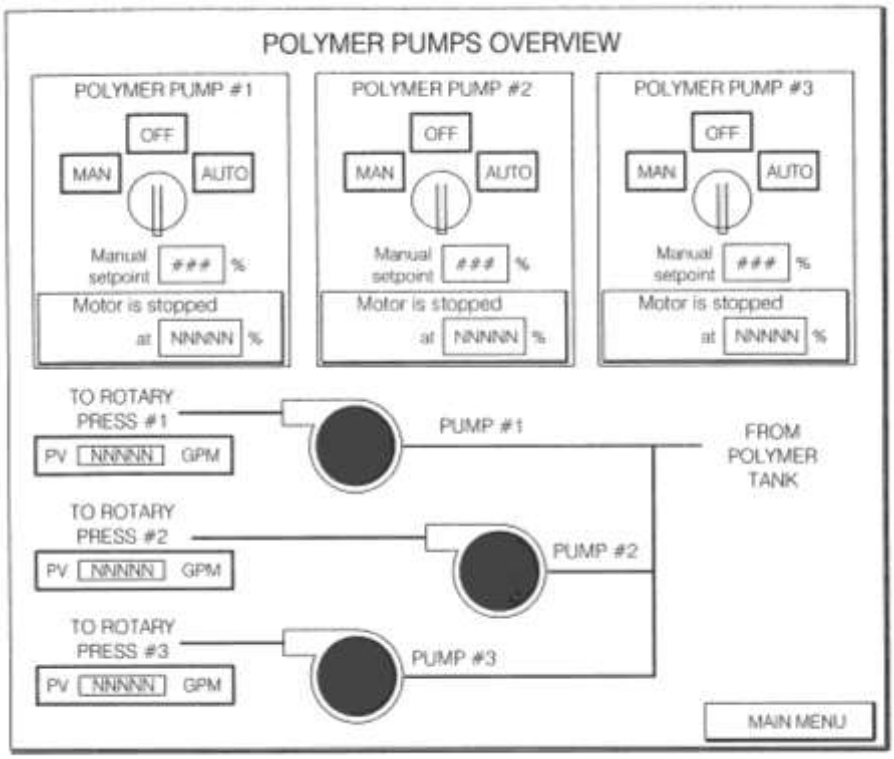
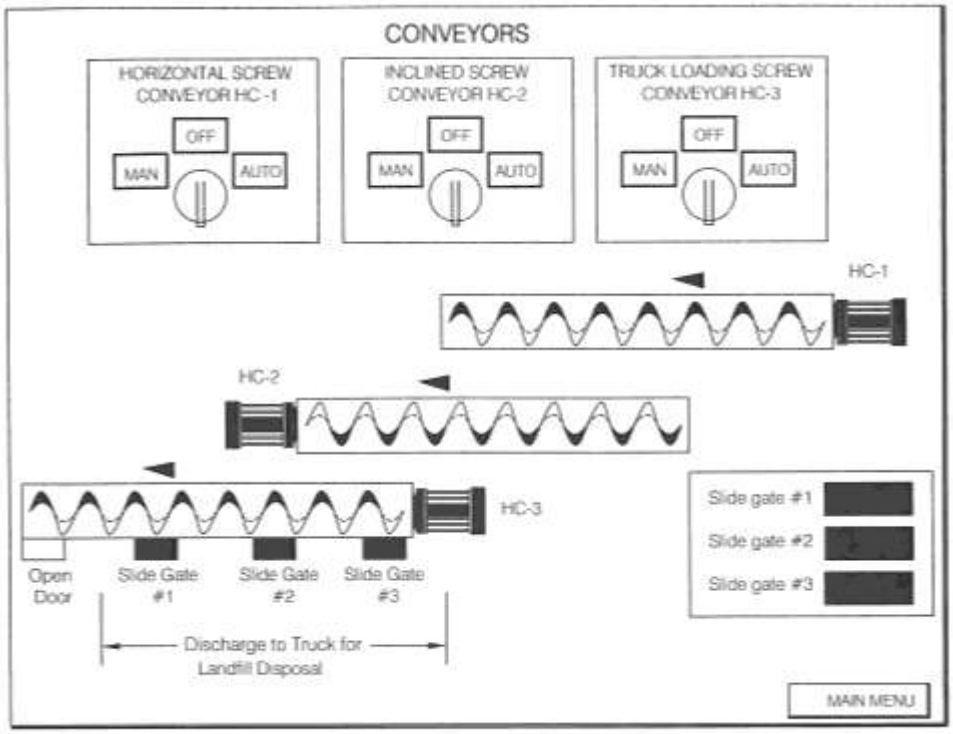



**FIGURE 7.11 - CONVEYOR MANUAL CONTROL HMI SCREEN**



- **Polymer Dosage Control**: The polymer dosage is calculated as a percentage (%) of the sludge flow, which in turn is measured by a flow meter located near the flocculator. The necessary quantity of polymer is calculated from the flow meter reading and a signal is sent to the polymer pump controller to adjust the speed of the pump accordingly.

- **Outlet Pressure Control**: An air regulator with a pressure relief feature will control the outlet restrictor. The operator manually sets a pressure to close the channel outlet. When the cake is hard enough to push, it will open the restrictor and the pressure will be released from the air regulator to keep the same set point. If the cake becomes too soft, the door restrictor will compress the cake to close the channel outlet to avoid splashing. This can be done with an I/P controller via the HMI or manually on the press. The load cell reading is only there to read the channel torque as an option but is not required to control the channel restrictor.

The Automatic mode is used for three different cycles - Dewatering Cycle, Recirculation Cycle and Channel Wash Cycle.

**Dewatering Cycle**

Sludge flow control is used at the very beginning of each dewatering cycle. A constant flow, which is pre-set by the operator, will feed the channels, without being controlled or affected by the inlet pressure readings. Sludge flow control is used to fill up channels with a relatively low constant flow, which allows the unit to build up a good dry cake plug at the outlet of each channel. Sludge flow control is on a timer and the operator could preset a value from 1 to 30 minutes.

Once time runs out, the press gets in Pressure Control Mode. The sludge flow will be adjusted in order to maintain a constant pressure at the inlet of the flocculator. The pressure valve has to be entered by the operator to a range of (3 to 7 psi) pressure and is continuously read by the sensor located on the flocculator. As the pressure varies, a 4 – 20 mA signal is sent to the rotary press feed pump to speed up or slow down to maintain a constant inlet pressure. This mode allows the unit to overcome variations in the sludge (% TS), in order to maintain a constant inlet pressure. This mode remains for all the rest of the dewatering cycle.

The basic steps required to start the dewatering cycle are as follows:

- Step No. 1
  From Main Menu HMI Screen, go to Rotary Press #1 - Parameters HMI Screen

- Step No. 2
  Adjust the operating set point to the desired value. To do this, press on the set point box of the desired parameter to be changed.
  - Inlet Pressure (0 – 8 psi)
  - Flocculator Speed (0 – 450 rpm)

- Rotary Press Speed (0 – 2.5 rpm)
- Polymer Ratio (0 – 50%)
- Sludge Flow (0 – 100 gpm)

- Step No. 3
  Make sure all equipment is in “AUTO” and that no alarms are present.

- Step No. 4
  From the Rotary Press #1 Parameters HMI Screen, Press on Dewatering to start the cycle. During this cycle the operator can:
  - Stop the cycle by pressing the Dewatering button again
  - Modify each operation set point

When running, the dewatering cycle commands the following equipment:

- Rotary Press Feed Pumps;
- Polymer Feed Pumps;
- Flocculators;
- Rotary Presses;
- Dewatering Valves; and
- Screw Conveyors.

While the dewatering cycle is running, the operator can adjust all parameters (set points) to have an optimal production, quality (filtrate and cake dryness), of the Rotary Press.

**Recirculation Cycle**

The rotary press feed pumps operates in a fixed flow mode during recirculation, at the flow level set by the operator at the operator interface terminal. This value simulates the normal flow to the Rotary Press during the dewatering cycle. A magnetic flow meter continuously measures the flow of sludge at the flocculator inlet. The measured flow is compared to the set point value. A signal is sent to the sludge pump to adjust its speed accordingly.

Set the inlet pressure to approximately the same level as during the dewatering cycle by slightly closing the manual valve near the recirculation sludge pipe. The recirculation time will vary with the type of sludge being dewatered.

The recirculation cycle can be used when it is necessary to create a build up of solids in case there is not enough solids for a proper dewatering cycle, see vender O&M for more information on when it is necessary to run a recirculation cycle.

The operator must verify the quality of the floc in the sampler, while the timer is not done, to make sure that it will run properly.

The basic steps required to start the Recirculation cycle are as follows

- Step No. 1
  From Main Menu HMI Screen, go to Rotary Press #1 – Manual Control HMI Screen.

- Step No. 2
  Adjust the operation set point to the desired value. To do this, press on the set point box of the desired parameter to be changed.
  - Flocculator Speed (0 – 450 rpm)
  - Polymer Ratio (0 – 50%)
  - Recirculation Time (1 – 20 min.)
  - Sludge Flow (0 – 100 gpm)

- Step No. 3
  Make sure that all the equipment items are in “AUTO” and that no alarms are on.

- Step No. 4
  From the Parameters Screen, press on “RECIRCULATION” to start the cycle. The cycle is running as long as the recirculation timer is not done. While this cycle is running, the operator can:
  - Stop the cycle by pressing the “RECIRCULATION” button again.
  - Increase or decrease the recirculation time by setting a new set point

When running, the recirculation cycle commands the following equipment:

- Sludge Pump;
- Polymer Pump; and
- Flocculator.

At the end of the cycle, the system starts the dewatering cycle automatically.

**Channel Wash Cycle**

When the Rotary Press is in operation, the control system automatically cleans the wash pipes for three (3) seconds every hour. The Rotary Press activates the channel washing cycle at the end of each day of operation or at a minimum sequence of 5 minutes per 24 hours of operation.

The channel wash cycle can be manually activated, when necessary, to wash the filtering screens and the exterior of the wheels of the Rotary Press. The following situations can tell the necessity of a manual channel wash:

- Cake Lost, bad production;

- Filtrate abnormally dirty; and
- Rotary Presses current abnormally high.

The basic steps required to start the Channel Wash Cycle are as follows**:**

- Step No. 1
  From the Main Menu Screen, go to the Parameters Screen.
- Step No. 2
  Adjust the operating set point to the desired value. To do this, press on the set point box of the desired parameter to be changed.
  - Rotary Press Speed (0 – 2.5 rpm)
  - Channel Wash Time (0 – 30 min.)
- Step No. 3
  From the Parameters Screen of the Dewatering System, press on Channel Wash to start the cycle. The cycle is running as long as the timer is not done.

When running, the channel wash cycle commands the following equipment:

- Rotary Press;
- The opening/closing of the wash valve for each channel; and
- Conveyor.

While the Channel Wash Cycle is running, the system can be stopped by pressing "Channel Wash" on the Parameters Screen. Otherwise, the cycle will stop at the end of the timed cycle.

The Rotary Press should discharge a sludge cake of 18 percent and 30 percent solids concentration depending upon the type and concentration sludge in order for the sludge to be used as compost at the town landfill.

## 7.8 SCREW CONVEYORS AND DISPOSAL

### *7.8.1 Description*

The dewatered sludge discharges by gravity from the Rotary Presses directly into the screw conveyor system, which transfers it to the sludge cake bay where it is loaded into an open truck bed for transport and discharge into the Town's Municipal Solid Waste Facility. A total of three (3) conveyors located in the Solids Processing Building make up the total conveyor system. Horizontal Screw Conveyor HC-1 is the inlet conveyor that collects the dewatered sludge from the three (3) Rotary Presses, and transfers and discharges it into Inclined Screw Conveyor HC-2. The Inclined Screw Conveyor transfers and lifts the sludge up to the Truck Loading Screw Conveyor HC-3, which has four bottom openings, three (3) with flanged electric actuated slide gates to allow the sludge

to drop from the conveyor into a open truck bed below. The complete conveyor system was provided by JDV Equipment Corp., Dover, NJ, 07801. The conveyor equipment is capable of transporting a maximum capacity of 300 cu.ft./hr. of dewatered sludge. Refer to **Table 7.7 - Sludge Screw Conveyors Basic Design Data.**

Each conveyor has a wear liner fabricated of ultra high molecular weight polyethylene impregnated with a lubricating agent. Each conveyor is driven by a constant speed integral gear reducer/motor drive unit mounted to an adapter flange mounted to the end plate of the conveyor. All gear reducers are AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings.

Each conveyor drive unit is equipped with a motion failure alarm unit. Motion sensors of the non-contacting type are used with a probe having a pre-amplifier and main electronic assembly. Each conveyor is furnished with an emergency pull cord (E–Stop) and safety switch that runs the full length of the conveyor. If pulled, the trip switch will immediately stop all conveyors.

**TABLE 7.7 - SLUDGE SCREW CONVEYORS BASIC DESIGN DATA**

| Description | Unit No. 1<br>Horizontal Screw Conveyor HC–1 | Unit No. 2<br>Inclined Screw Conveyor HC–2 | Unit No. 3<br>Truck Loading Screw Conveyor HC–3 |
|---|---|---|---|
| Model No. | U320 B/SS | U320 B/SS | U320 B/SS |
| Capacity | 300 cu.ft./hr. @ 20 rpm | 300 cu.ft./hr. @ 23 rpm | 300 cu.ft./hr. @ 23 rpm |
| Length | 42 ft. approx. | 42 ft. approx. @ 14 degrees | 26 ft. approx. |
| Drive Location | Inlet End Inlet Location: | Inlet End | Discharge End |
| Inlet Location | Top from Rotary Presses thru 18 openings | Side from Unit No. 1<br>Top from Hydrogritter discharge | End from Unit No. 2 |
| Discharge Location | Axial into Unit No. 2 | Axial into Unit No. 3 | Bottom thru four (4) openings, three (3) with electric slide gates. |
| Drive Unit | 5.0 HP constant speed | 7.5 HP constant speed | 5.0 HP constant speed |

### *7.8.2 Operation and Control*

The screw conveyor system is controlled through the Fournier Control Panel located in the Control Room of the Solids Processing Building

The following status and alarm signals are displayed at the SCADA HMI:

- Horizontal Screw Conveyer HC-1 run status (YI-740A etc);
- Horizontal Screw Conveyer HC-1 common alarm (YA-740A etc);
- Inclined Screw Conveyer HC-2 and horizontal screw conveyor hc-3 can be remotely “STARTED/STOPPED” (YS-74-A etc) when the Grit Collection System is started;
- Elapsed run time meter displayed at SCADA HMI for screw conveyors (KQI-740A etc); and
- Screw motor disagreement Alarm.

Once the truck is loaded with sludge cake it will transport that load to the Town’s Municipal Solid Waste Facility for proper disposal. It is important to note that the sludge loading bay door shall remain closed at all times to minimize odors.

Refer to the JDV Equipment Corp. O&M Manual for more detailed information on the Screw Conveyor System, including Start-Up and Shut Down, Maintenance Requirements, and Troubleshooting.

## 7.9 LIQUID SLUDGE RECEIVING STATION

### *7.9.1 Description*

The Liquid Sludge Receiving Station is a 4-inch valved quick connection and piping system located on the South side of the Liquid Sludge Bay in the Sludge Processing Building. The sludge trucks from the Siasconset WWTF and future Madaket WWTF pull into the bay make the flexible hose connection, open the horizontal valve and one of the vertical valves, and discharge their load. The discharged sludge passes through the horizontal 6-inch valve and pipeline and drops into one of two 6-inch vertical valved pipelines, which lead to either the Primary Sludge Holding Tanks or the ATB Sludge Holding Tanks.

Once the entire sludge truck is empty, the flexible hose is disconnected, the horizontal valve is closed, and the below ground 6-inch sludge lines leading to the selected sludge holding tank should be flushed out using the 4-inch plant water line. The plant water

flushing step is important because it clears the 6-inch underground pipeline of any residual sludge, which could over time cause a blockage.

The truck driver is responsible for flushing off any sludge that was spilled on the floor while discharging the load. A plant water hose connection is provided adjacent to the Liquid Sludge Station for that purpose, and the floor in that area is slopped to a 4-inch trough drain to accommodate the flushing.

### *7.9.2 Operation and Control*

The entire Liquid Sludge Station procedure is a manual operation completed by the truck driver. There are not manual or automatic controls associated with this procedure. However, it should be noted that sludge should not be discharged when the ATB sludge holding tanks are in a “High” or “High High” alarm state.

## 7.10 GRIT DEWATERING SYSTEM (HYDROGRITTER)

### *7.10.1 Description*

Grit is drawn from the grit chamber sump by the grit pump and discharged to the grit dewatering system located in the Sludge Processing Building for dewatering. The slurry is first run through the Wemclone or cyclone. The spinning action in the cyclone separates the grit from the water. The grit is collected at the bottom of the U-trough (classifier) while the water flows out the discharge of the cyclone to the In-Plant Pump Station. The grit is retained in the trough by the adjustable weir assembly. Water that overflows the adjustable weirs is caught by the overflow pan and discharged through a 1-1/2 inch equipment drain to the 6-inch drain and to the In-Plant Pump Station.

The collected grit is guided up the classifier by the 12-inch diameter screw auger and drops out the 3-inch by 5½ inch square discharge opening onto the Inclined Screw Conveyor HC-2. The Inclined Screw Conveyor conveys the grit to the Truck Loading Screw Conveyer HC-3. The dewatered grit drops through one of the open slide gates into a dump truck, which will properly dispose of the grit at the Town landfill on a regular basis.

### *7.10.2 Operation and Control*

The manufacturer recommends operating the cyclone at a pressure drop of 5 psi. It is recommended that the grit pump be set at approximately 220 gpm to pump grit to the grit dewatering system.

The grit collector screw, grit pump, hydrogritter, and screw conveyors must be run simultaneously. The frequency of grit removal and dewatering operations should be determined simply by plant operation experience and amount of grit entering the WWTF. Large quantities of grit should be expected at the WWTF from infiltration/inflow and the condition of the existing collection system. Heavy rainfalls and spring thaws may cause increased quantities of grit to be discharged to the plant. Slug loads of grit can be expected in the aerated grit chamber when septage is being pumped from the septage holding tank. When grit is no longer being emitted from the cyclone at the dewatering system, the grit removal and dewatering operations are complete. The operators should continuously adapt process schedules to meet the actual on-site grit removal and dewatering demand.

The grit removal and dewatering operation at the WWTF should be initiated and shut down according to the following steps:

START-UP

- After the unit has been bumped to confirm proper rotation, the classifier must be bedded in clean sand. This is accomplished by first filling the tank with water and then, with the unit running, loading it with sand in the pool area until sand is discharged by the conveyor at the upper end of the classifier;

- The bedding of the unit accomplishes two goals: first, it establishes a bed for the spiral to work against, and second, it eliminates the possibility of stagnant grit filling the void between the spiral and the tank; and

- The water connection at the top end of the classifier tank provides a means of keeping the channel free of grit. During operation, as the grit is augured up to the discharge point, free water drains into this channel and back into the pool area. Small particles of grit are carried into the channel by the draining action. If this grit is not washed back into the pool area and allowed to build up and restrict free drainage back to the pool, a much wetter end product will result. A solenoid valve is usually wired to the drive control circuit to provide control of this water supply so water is consumed only while the unit is in operation. Also, a manual valve is provided for flow control.

SHUTDOWN

- Manually stop grit screw in grit chamber;

- Allow grit pump to continue operating for an additional 5 to 10 minutes to make sure grit suction and discharge piping is free of grit. Stop the grit pump;

- Stop the dewatering system; and

- Allow for Screw Conveyors HC-2 and HC-3 to run for several minutes after the hydrogritter is stopped to prevent any remaining grit from staying the screw conveyors.

Previous grit removal operation experience also revealed that increased grit loads or "slugs" will occur at the plant during heavy rain events. Under these circumstances the grit removal operation could be operated continously until normal conditions prevail, or the grit removal operation could be initiated prior to a storm-related grit "slug" reaching the aerated grit chamber.

The primary operation of this system is from the SCADA System HMI. However the Central Control is through MCC-4 and has the following features:

- “HAND/OFF/AUTO” selector switch (YI-130C-1);
- “Pump On” (Green) and “Pump Off” (Red) indicator lights; and
- Lockout to prevent remote start-up while repairs or maintenance are being performed.

The following status and alarm signals are displayed at the SCADA System:

- Grit dewatering in “AUTO” (YI-130C-1);
- Grit dewatering “RUN” status (YI-130C-2);
- Grit dewatering “MOTOR HIGH TEMP” alarm (TAH-130C);
- Elapsed time meters (KQI-130C);
- Motor state disagreement alarm (YA-130C); and
- Remote Automatic Control: Grit collection system automatically operates from a cycle timer (KC-130) with adjustable “ON” and “OFF” durations. After The Inclined screw conveyor, HC-2 is started (YS-740A) and confirmed running (YI-740A) for a preset time, the Hydrogritter is called to start (YS-130C).

In addition, a motor status disagreement alarm is displayed at SCADA if the called state of the motor and the state of the run status contact do not agree after a preset adjustable time. The disagreement alarm is enabled if the H/O/A switches are in the “AUTO” position. The disagreement alarm must be manually reset through the SCADA before Remote Automatic Control is enabled.

Remote Automatic Control - The grit dewatering will automatically operate from cycle timer (KC-130) with adjustable on-state and off-state durations.

The Screw Conveyors HC-2 and HC-3 must be started and confirmed running before the grit screw can start

### *7.10.3 Equipment Maintenance*

The Hydrogritter requires preventive maintenance on a regular basis to maintain the unit's efficiency and prevent breakdowns. A summary of the maintenance recommended for the unit is below:

- Equipment – Daily. Clean and clear as needed. Inspect for Proper Operation;
- Lower Bearing – Annually. Check or Replace Toric Rings in Seal. Refer to Manufacturer's O&M Manual for detail procedure;
- Lower Bearing – Annually. Change Oil and Fill to Capacity;
- Check Sheave Belt Tension – Semi-Annually. Adjust if necessary; and
- Check Sheave for Proper Operation – Semi-Annually. Check Alignment and belt for Wear.

For more specific information refer to the manufacturer's standard maintenance manual

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# 8 - IN-PLANT PUMPING STATION

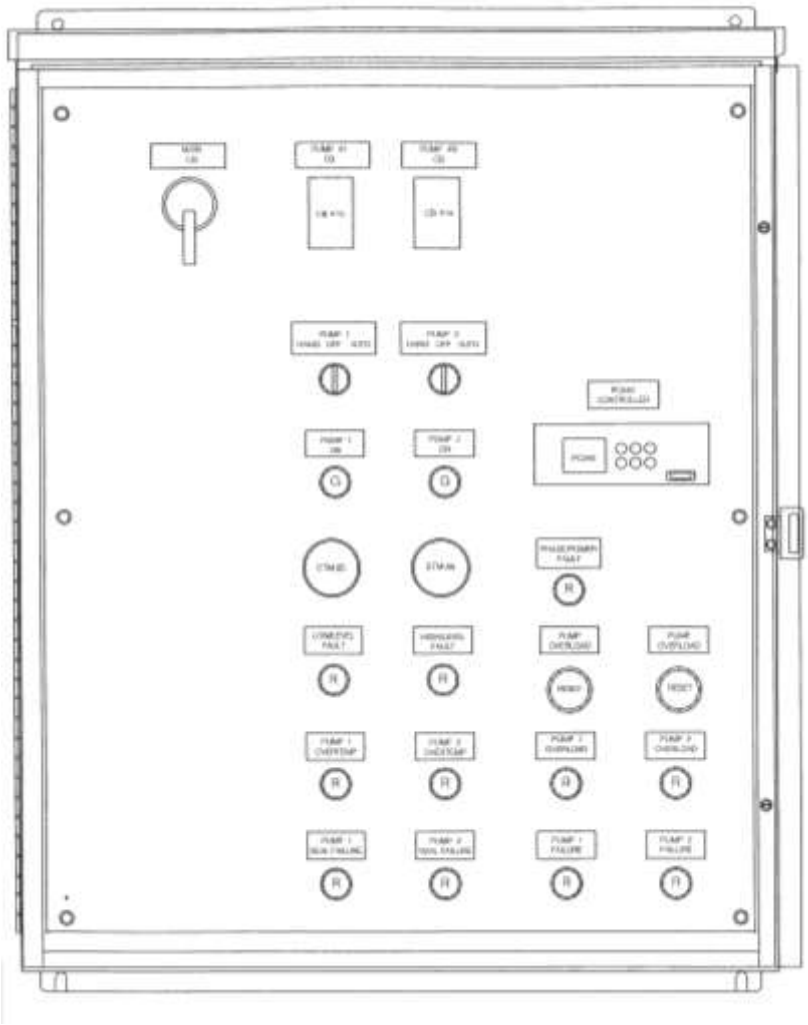
## 8.1 GENERAL

The In-Plant Pumping Station is located in an open area of the site between the Primary Clarifiers and the Advanced Treatment Building. It is a self-contained, in-the-ground package pumping station, which collects wastewater and other flows, which include lavatory sewage, laboratory wastes, floor and equipment drain discharges from the Administration Building, Primary Treatment Building, Process Analysis Building, Sludge Processing Building, and Advanced Treatment Building. Wastewater collected at the pumping station is discharged to the influent channel at the Headworks Facility through a four-inch diameter force main to combine with the Surfside WWTF influent stream.

The In-Plant Pumping Station consists of a eight-foot diameter precast concrete wet well containing two ABS Pumps, Inc., Model AFPK 1047 M70/6 submersible sewage pumps with 9.39 hp motors, mounted on a side rail, quick disconnect, lift assembly system. The side rail, quick disconnect, lift assembly system allows the operator to raise the pump and motor up out of the wet well for inspection and maintenance. Each pump is rated for 525 gpm at 37 feet total dynamic head. The submersible pumps are centrifugal type, double shrouded multi-vane, non-clog with recessed impellers, and are capable of passing three-inch solids. The submersible motors are direct coupled to the pumps through an oil filled watertight sealed chamber. An electric probe leakage sensor is provided for detecting the presence of water and an over temperature sensor is provided to protect the windings, either of which will shut off the motor and initiate an alarm.

The pumps are operated from a completely self-contained control panel mounted in the first floor of the Primary Treatment Building. The control panel enclosure is a hinged, gasketed, deadfront design panel of fiberglass, having NEMA Type 4 construction. A three pole 480 volt main circuit breaker is provided. Each pump is provided with a 150 VA 480-120 volt control transformer, NEMA rated combination motor circuit protector and full voltage, non-reversing motor starter. Refer to **Figure 8.1 - In-Plant Pumping Station, Local Control Panel.**

**FIGURE 8.1 - IN-PLANT PUMPING STATION, LOCAL CONTROL PANEL.**



## 8.2 OPERATION AND CONTROLS

The In-Plant Pumping Station is operated from the local control panel located in the first floor of the Primary Treatment Building. An automatic alternator with manual override switch is provided within the control panel to manually select the lead pump duty between the two-pumps on successive cycles. Once set, the elecro-mechanical alternator will alternate the lead pump duty between the two-pumps on successive cycles. A selector switch is also provided to bypass the alternator and select either pump as the continuously operating lead pump. A non-resetable elapsed time meter is provided for each pump to indicate the time of operation from 0 to 99,000 hours.

The pump controls located in the control panel operate the pumps to maintain the liquid level in the wet well between adjustable operating limits. Starting and stopping of each pump is accomplished when so signaled by submersible diaphragm pressure transducers on high and low wet well levels. The pumps will operate in parallel if the wet well level rises above the "Pump #2 - ON" level. A redundant float type level switch, encapsulated within a solid polyurethane float ball is provided for high water level alarm sensing.

Normal pump operation is selected by placing the automatic alternator switch in the "AUTO" position so that the lead pump alternates between Pump #1 and Pump #2 for each pump cycle. This will allow equal wear on the pumps and their motors. Placing the individual pump alternator switch in either the "LEAD #1/LAG #2" or "LEAD #2/LAG #1" position will set Pump #1 or Pump #2 as the lead pump. This mode of operation should be used only if the operator has justification to minimize the use of one pump, or if one pump is out of service for maintenance or repair.

The LOCAL and SCADA System In-Plant Pumping Station controls are as follows:

At the Local Control Panel:

- Utility Power low voltage/phase reversal alarm (EA-900);
- Utility Power normal power failure alarm (JAL-900);
- Wet well high level alarm (LAH-900);
- Wet well low level alarm (LAL-900);
- Wet well level value (LIR-900);
- Pump #1 and #2 motor over temperature alarm (TAH-900A and B);
- Pump #1 and #2 motor overload alarm (YA-900A-1 and B-1);
- Pump #1 and #2 seal leak alarm (YA-900A-2 and B-2);
- "HAND/OFF/AUTO" switch not in "AUTO" (YI-900A-1 and B-1) and
- Pump #1 and #2 run status (YI-900A-2 and B-2).

At the SCADA System:

- Pump #1 and #2 "HAND/OFF/AUTO" switch not in "AUTO" (YI-900A-1 and B-1);
- Pump run status (YI-900A-2 and B-2);
- Wet well level (LIR-900);
- High wet well level (LAH-900);

- Low wet well level (LAL-900);
- Pump #1 and #2 motor overload (YA-900A-1 and B-1);
- Pump #1 and #2 motor over temperature (TAH-900A and B);
- Pump #1 and #2 seal leak YA-900A-2 and B-2);
- Low voltage/phase reversal (EA-900);
- Normal power failure (JAL-900); and
- Elapsed run time meter displayed (KQI-900A and B).

## 8.3 MAINTENANCE SUMMARY

Refer to **Table 8.1** - **Summary of Equipment Maintenance** of the In-Plant Pump Station.

**TABLE 8.1 – SUMMARY OF EQUIPMENT MAINTENANCE**

| Maintenance Operation | Frequency |
|---|---|
| Wash Down Unit | Every 6 months |
| Jog Idle Pump | Every Month |
| Check Seal Oil for Contamination | Every 12 Months |
| Check Mechanical Seals | If Oil is Contaminated or if Seal Failure Light is "ON" |
| Inspect Cable for Chafing, Cuts, or Abrasions | Every 3 Months |
| Inspect Impeller for Wear | If Pump Performance has Decreased |
| Inspect Lift Chains | Every 3 Months |
| Check Motor Performance (amp draw) | Every 6 Months |
| Check Bearing for Wear | Regular Inspection Not Required |

# 9 – CHEMICALLY ENHANCED PRIMARY TREATMENT

## 9.1 BACKGROUND - 2008 UPGRADE

The 2008 upgrade of the Surfside WWTF effectively replaced the need for any Chemically Enhanced Primary Treatment (CEPT). That being said, the CEPT building and equipment are not being removed at the request of the town to provide a backup treatment system for unforeseen circumstances. The exterior of the building was renovated in 2008 in match the new and upgraded buildings on site.

## 9.2 GENERAL

The equipment in the CEPT building allows for the use of cationic and anionic polymers and ferric chloride for chemical enhancement, sodium hydroxide for pH control and Potassium Permanganate for odor control. The CEPT system is designed to use ferric chloride and cationic polymer as coagulant and use anionic polymer as a flocculating agent. The ferric chloride is used to as a coagulant to provide cations to reverse the negative charge of the suspended particles of wastewater while the cationic polymer is used to absorb the destabilized particles, binding the smaller particles together. Anionic polymer is used as a flocculating agent to form larger settleable floc. The proper dosages should be determined through jar testing, often done free by chemical suppliers.

## 9.3 REMAINING EQUIPMENT

### *9.3.1 Polymer Systems*

Two complete Acrison Polymer Batching Systems remain in the CEPT building to prepare and age the polymer solutions. One unit is dedicated to the preparation of anionic polymer, and other unit is dedicated to the preparation of cationic polymer. These polymer systems function similarly to the Acrison polymer systems described in **Chapter 7.0 – Solids Processing**.

Three polymer metering pumps are provided to pump the polymer to the headworks. The pumps are located between the two Acrison units. Pumps 1 and 3 will be dedicated to one of the Acrison units, will pump 2 will serve as a standby for either system. Each 1 Hp pump is capable of pumping 190 gph. Each pump has a dilution water solenoid valve to provide plant water to dilute the concentration of the polymer solution when needed. Refer to the manufacture's Operation and Maintenance Manual for further information of the systems capacities and its operation.

### *9.3.2 Ferric Chloride System*

Up to 38 percent Ferric Chloride is stored in a 3,000 gallon storage tank in the CEPT Building. Two ferric chloride pumps are provided to pump the Ferric Chloride to the headworks. Each pump is capable of pumping 8.8 gph and can be calibrated to flow at specific rates depending on the influent flow rate. Plant water connections are provided to flush the discharge lines as required. Refer to the Manufacture's Operation and Maintenance Manual for further information of the pumps capacities and operations.

### *9.3.3 Sodium Hydroxide System*

Up to 50 percent Sodium Chloride is stored in a 1,000 gallon storage tank in the CEPT Building. A chemical metering pump is provided to pump the NaOH to the headworks when needed for pH control. The pump is capable of pumping 5.2 gph and like the ferric chloride pumps can be calibrated to flow at specific rates depending on the influent flow rate. Refer to the Manufacture's Operation and Maintenance Manual for further information of the pumps capacities and operations.

### *9.3.4 Potassium Permanganate*

One Acrison volumetric dry chemical feeder is provided to supply Potassium Permanganate to various points throughout the Surfside WWTF for odor control. The Acrison unit combines dry potassium permanganate and potable water. The unit is driven by a 1/2 hp motor and can be completely controlled through the attached Acrison control panel. Refer to the manufacture's Operation and Maintenance Manual for further information of the systems capacities and its operation.

# 10 - ODOR CONTROL SYSTEM

## 10.1 GENERAL

The package odor control system employed at the Surfside WWTF controls odors originating from various process units, tanks and areas in the facility. The odor control system is located on a concrete equipment pad in the odor control room of the Sludge Processing Building. Adjacent to the odor control system are the sodium hydroxide and sodium hypochlorite storage and feed systems, positioned inside a concrete curbed containment area. Refer to **Table 10.1 - Odor Control System Removal Design Efficiencies**.

**TABLE 10.1 – ODOR CONTROL SYSTEM REMOVAL DESIGN EFFICIENCIES**

| Inlet Gas Stream | Outlet Gas Stream |
|---|---|
| Less than 5 ppm $H_2S$ | 0.25 ppm $H_2S$ or less |
| 5 to 30 ppm | Greater than 98 percent $H_2S$ removal |
| Less than 1,000 odor units $ED_{50}$ | Less than 200 odor units $ED_{50}$ |
| Greater than 1,000 odor units $ED_{50}$ | Greater than 90 percent odor removal |

The odor control duct system collects various quantities of odorous air derived from the entire facility. Refer to **Figure 10.1 - Odor Piping Schematic**.

### *10.1.1 Description*

Contaminated air is introduced to the Met-Pro Corporation/Duall Division, Model f110-157 S.C. single stage odor control system designed to remove hydrogen sulfide, mercaptans, aldehydes, ketones, and other organic odors normally occurring in domestic wastewater and sludge. Refer to **Figure 10.2 - Odor Control Plan Layout.**

As the odorous air travels through the scrubber it mixes with the chemically treated scrubbing solution, which falls by gravity from the top of the bed. Within the scrubber, odorous aerosols and vapors are transferred to the scrubbing liquid in accordance with various chemical and mechanical principles. Cleaner air is exhausted to the atmosphere, while the scrubbing liquid is either discharged into the wastewater treatment system (if its absorptive capacity has been exhausted) or recycled.

**FIGURE 10.1 - ODOR PIPING SCHEMATIC**

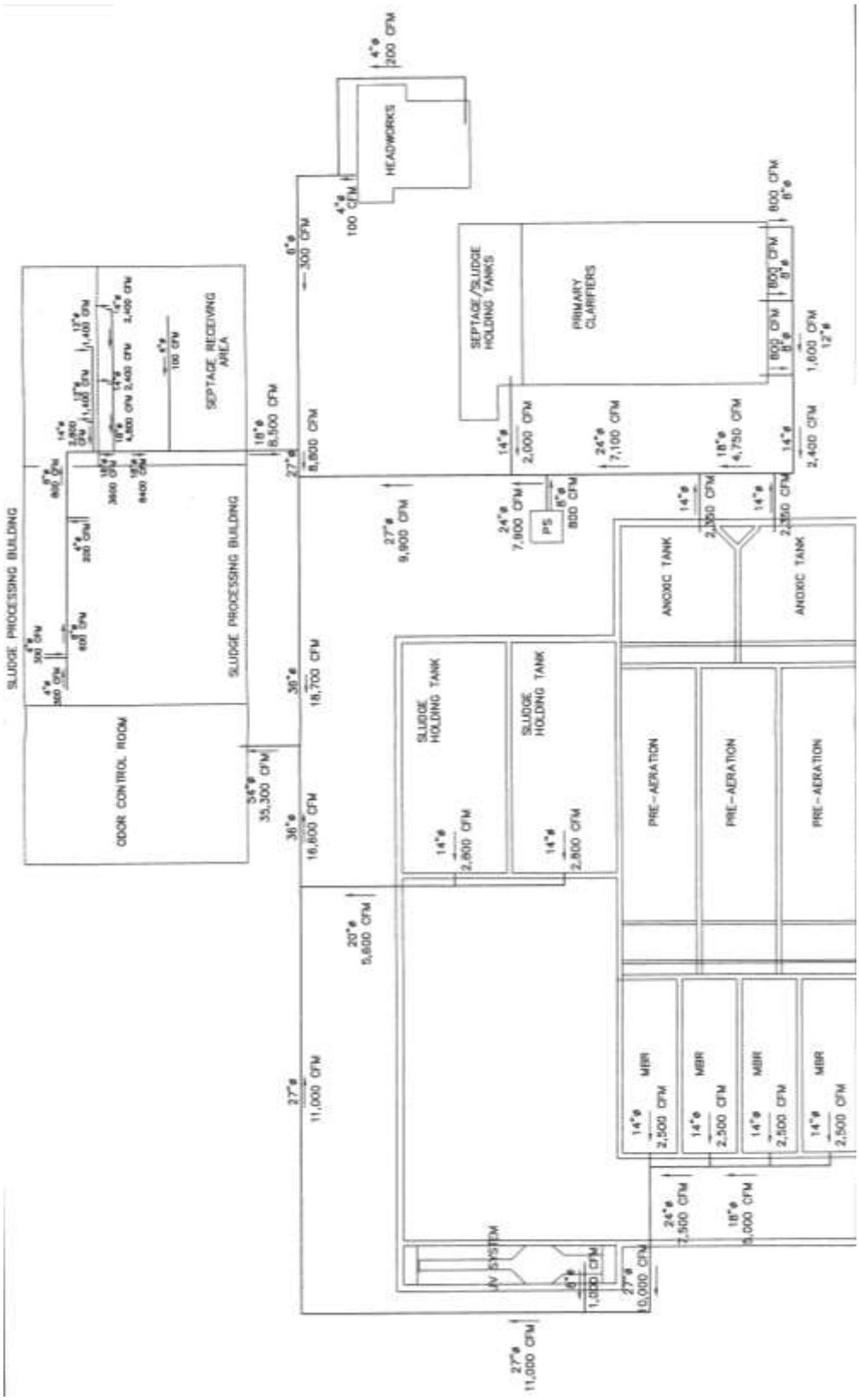
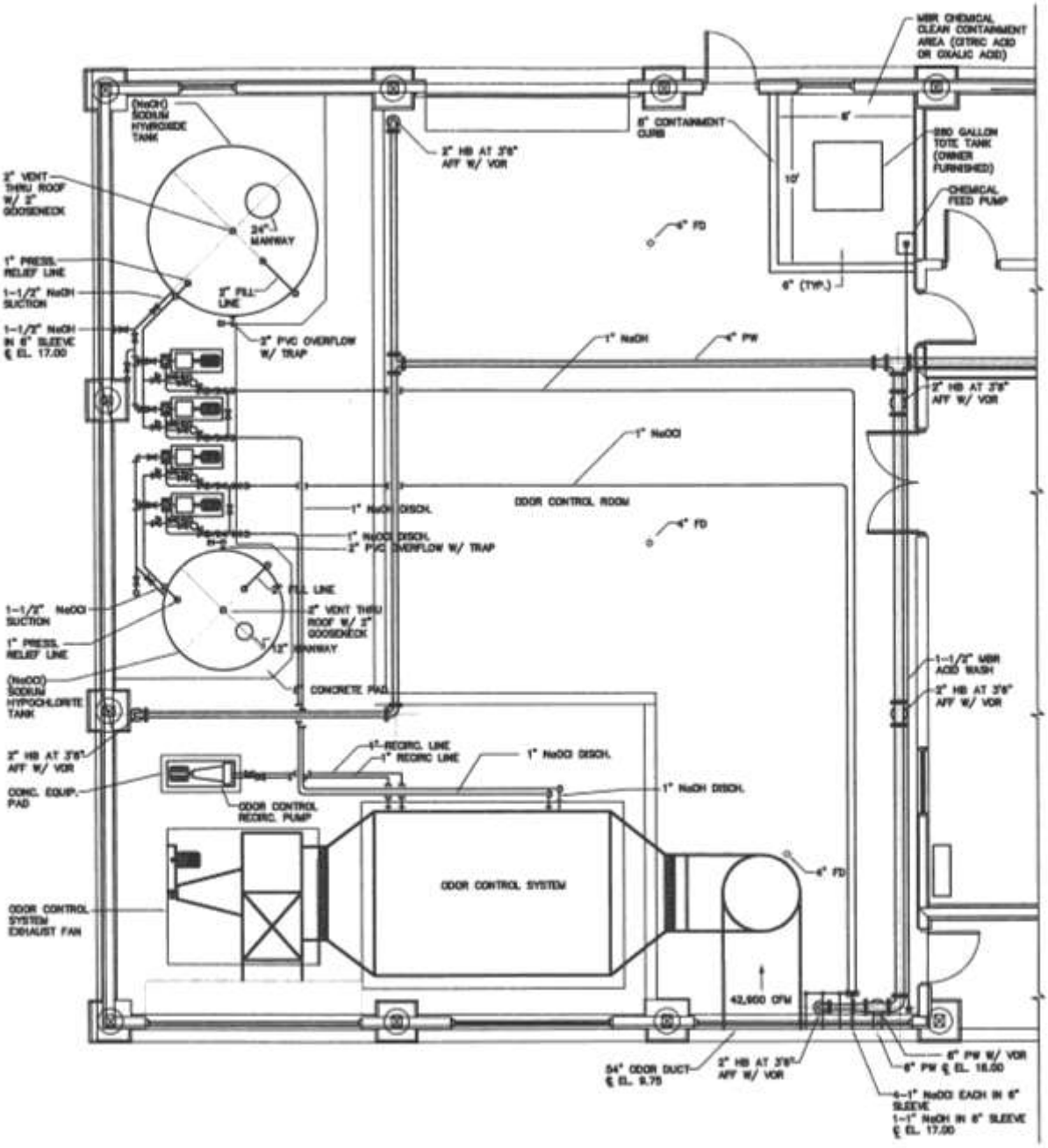


**FIGURE 10.2 - ODOR CONTROL SYSTEM, PLAN LAYOUT**



The design basis and major components of the Odor Control System are as following:

- Met-Pro Corp./ Duall Division Model F110-157 S.C. The scrubber shall be a horizontal, modular, cross-flow, packed bed type. Internals include an entrainment separator, internal spray piping, packing, packing supports, manholes, lifting and hold down lugs, and nozzles;
- Met-Pro Corp./ Duall Division Model NH-98 Leeson two-speed, two-winding, 60/27 hp motor, serving a V-belt driven, horizontal, right angle, side inlet, front discharge centrifugal fan unit having an air flow capacity of 39,200 cfm;
- Design Air Temperature – 100 Degrees F;
- Pressure Drop Across the Unit – 1.5 to 2.0 inches of water column;
- Sodium Hydroxide storage and feed system;
- Sodium Hypochlorite storage and feed system;
- Recirculation Pump is a direct coupled, single stage, end suction, horizontal, back pullout type, centrifugal pump with a capacity – 850 gpm at 175 psi TDH, driven by a 20 hp motor;
- Packing Material – 3½-inch Jaeger Tri-Pack PP (1,200 cu. ft.);
- Mist Eliminator Packing Material – G.B. Special Mesh Pad;
- Weir Liquid Distributor – Bete TF48-150 PP (39.3 gpm @ 6.86 psi);
- Front Liquid Distributor – Bete NCM070W PP (8 gpm @ 9.26 psi);
- Differential Pressure Indicator – Dwyer Magnehelic Gauge 2004;
- Flow Meter – DwyerRMC-144-SSV;
- Misc. level switches and level alarms;
- ORP and pH analyzers and alarms;
- Pressure gauges;
- Flow switches;
- Misc. piping and valves; and
- Control Panel.

### *10.1.2 Principle of Operation*

Aerosols are removed from the air stream by impact with the packing material. Water or aqueous solution flushes the packing to keep it clean. Removal efficiency is dependent on particulate size and density as well as the velocity of the air passing through the scrubber.

The rate of transfer of a vapor from air to water is dependent on several factors. Counter current operation maximizes the difference in concentration of the contaminated compounds between air and water. This difference, which is called the concentration gradient, is the driving force for the transfer. In cross-current flow, the gradient varies both in direction of flow and in a radial direction.

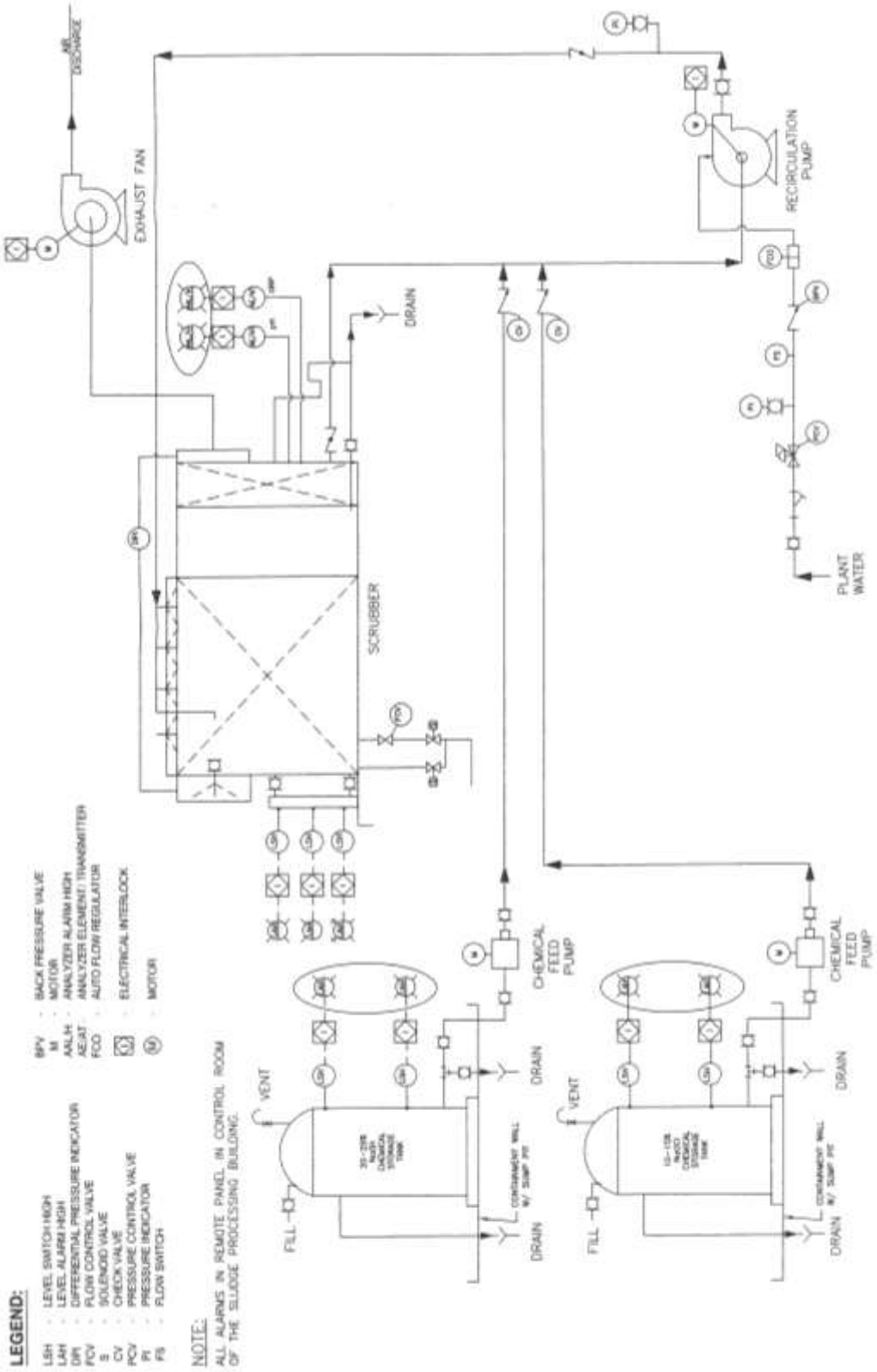
The reaction between the absorbed vapor and chemicals in the scrubbing solution transforms the vapor into a species that does not inhibit further adsorption of that vapor. This action increases the capacity of the scrubbing solution to absorb the vapor and allows recirculation of the solution. Failure to produce a reaction makes it necessary to use larger volumes of water on a once through basis. In order to facilitate occurrence of the reactions mentioned above, it is usually important that the proper type and amount of chemical are added to the scrubbing solution. This can be done automatically or by manual control.

Fresh water is typically added to the scrubbing solution in order to replace water lost by evaporation and to prevent excessive accumulation of any absorbed vapors or products of the reaction. The resultant wastewater generally has relatively high concentrations of various salts. It may also have high or low pH because of treatment chemicals it contains.

The odorous air coming into the scrubber is usually not saturated with water vapor, but the treated air exhaust will be saturated with water vapor. This water loss requires water to be added to the recycle tank either continuously or on a periodic basis. Continuous addition with overflow is preferred because it helps to maintain a more steady solution chemistry. If the purge rate is properly balanced, no more water is used than if the scrubbing solution is discharged and made-up periodically.

When batch treatment is used, all or part of the solution is released periodically and that volume is replaced with fresh water and chemical. This make-up process can be done either manually or automatically. The make-up water is added by means of a float valve, or a differential level control assembly. Also, fresh water is required to flush certain types of mechanical seals to protect the seals from excessive heat and chemical attack. This water is supplied when the recycle pump is running, and it could replace a small part of the make up water. A solenoid valve can be used to interlock the addition of seal water to the recycle pump. Refer to **Figure 10.3 - Odor Control Scrubber System Schematic Diagram.**

**FIGURE 10.3 - ODOR CONTROL SCRUBBER SYSTEM SCHEMATIC DIAGRAM**



## 10.2 OPERATION RECORDS

It is recommended that the operator maintain a continuous record of all operating data in order to facilitate troubleshooting and ensure proper maintenance is accomplished at regular intervals. The frequency of these observations should be at least weekly. The operator should record the following:

- Air flow rate (velometer reading)
- Air differential pressure reading
- Pump recirculation flow rate
- Fresh water make up rate or usage
- Chemical composition of scrubbing solutions (pH and ORP analyzers)
- Chemical usage (FIT for Sodium Hydroxide and Sodium Hypochlorite)
- Comments regarding operation or changes in procedure
- General quality of stack emissions (opacity, acidity, misting, etc.)
- Record date and time of these observations

## 10.3 CHEMICAL HANDLING

The chemicals being added to the scrubbing solution may (especially in their concentrated form) irritate or burn skin, eyes, and mucous membranes, and may stain or destroy clothing. A Material Safety Data Sheet (MSDS) for each chemical should be obtained from the chemical supplier. Observe all recommended handling practices listed on the MSDS sheets.

The following are general suggested practices:

- Wear safety glasses or goggles, gloves, and protective clothing when working with the chemicals or equipment, which contains or transports them.
- Do not add water to concentrated chemical solutions. Dilution is accomplished by adding the chemical to water. Since a great deal of heat may be released by this action, take care to control the rate of chemical addition to allow the heat generated to dissipate.
- Do not add acids to solutions of hypochlorite. Chlorine vapors may be released. Use caustic to maintain solution pH.
- Do not mix strong acids with strong alkali. Heat of reaction could cause the solution to boil.
- Do not mix strong oxidizing agents with organic chemicals. Explosive reactions may result.
- When disposing of chemicals, treat them as hazardous wastes.

## 10.4 OPERATION AND CONTROL

The odor control system supplier provided control panel includes all the features required to operate the system locally and from the SCADA System. The control panel includes a main 480-volt circuit breaker, motor starters, pH and ORP indicator/controllers, HAND/OFF/AUTO switches, programmable controllers/analyzers for chemical feed controls, status lights, lock-out stop push buttons, alarm lights, and step down transformers for low voltage power. The following specific control panel items are provided:

- Motor starters with running time meters and lock-out STOP push-buttons
  - Recirculation Pump – 71/2 hp, interlocked with seal water solenoid valve
  - Sodium Hypochlorite Pump – 1/3 hp motor
  - Sodium Hydroxide Pump – 1/4 hp motor
  - Motor operated ball valves on water supply
  - Exhaust fan with 2-speed motor 20 hp

- Programmable controller/analyzers
  - pH
  - ORP

- Switches
  - Recirculation pump H-O-A
  - Sodium hypochlorite pump H-O-A
  - Sodium hydroxide pump H-O-A
  - Exhaust fan H-O-A
  - Exhaust fan speed selector HIGH – LOW
  - Motorized ball valve OPEN-CLOSE-AUTO

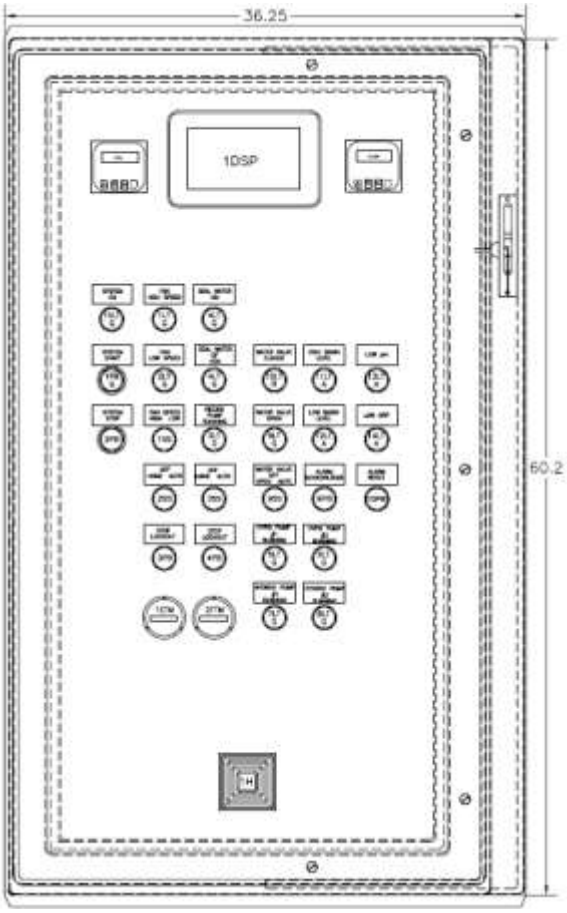
- Status lights (red running, light off when not in service)
  - Exhaust fan HIGH SPEED
  - Exhaust fan LOW SPEED
  - Recirculation Pump
  - Sodium Hypochlorite Pump
  - Sodium Hydroxide Pump
  - pH Power
  - ORP Power
  - Level Sensor Power
  - Motor Operated Ball Valve OPEN
  - Motor Operated Ball Valve CLOSED

- Alarm Functions
  - High Sump Level
  - Low Sump Level
  - Low pH
  - Low ORP
  - High Hydrogen Sulfide in Outlet Flow
  - Acknowledge and Reset buttons for each alarm

- Start stop buttons
  - Scrubber system

Refer to **Figure 10.4 - Odor Control Panel Operator Interface Terminal.**

**FIGURE 10.4 - ODOR CONTROL PANEL OPERATOR INTERFACE TERMINAL**




| ODOR CONTROL PANEL LEGEND | |
|---|---|
| CALL | DESCRIPTION |
| 11-14LT | PILOT LIGHT, AMBER, 120VAC |
| 1-9, 15L | PILOT LIGHT, GREEN, 120VAC |
| 10L | PILOT LIGHT, RED, 120VAC |
| 9, 10PB | PUSH-BUTTON, FL HD BLACK, NO |
| 2-4PB | PUSH-BUTTON, EX HD, RED, NC |
| 2-4PB | LOCKING ATTACHMENT |
| 1PB | PUSH-BUTTON, FL HD, GREEN, NO |
| 1SS | SEL SWITCH, 2 POS, MAINTAINED, OX |
| 2-4SS | SEL SWITCH, 3 POS, MAINTAINED, XOX |
| 1, 2ETM | ELAPSED TIME METER, 120VAC, NEMA 4 |
| 1DSP | DISPLAY, COLOR, 5.7" |
| 1H | ALARM HORN, 120VAC |
| 1PH | pH METER/CONTROLLER |
| 1ORP | ORP METER/CONTROLLER |
| PANEL INTERNAL COMPONENTS | |
| 1PS | 24VDC POWER SUPPLY, 2A |
| 1PLC | BRICK PLC, 20 IN/16 OUT |
| 1PLC | 4 CH. ANALOG INPUT CARD |
| 2M | STARTER, SIZE 2, OPEN, 120 VOLT COIL |
| 2M | HEATER PACK 23.5 - 38.5 |
| 1M | STARTER, 2 SPEED, 120 VOLT COIL |
| 1M | HEATER PACK 62.2 -84.6 |
| 1PT | PRESSURE TRANSDUCER |

## 10.5 START-UP AND OPERATION

The operator must follow the procedures listed below when starting up the odor control system:

- Shut the drain valve and fill the scrubber sump to the level of the overflow with fresh water;

- Calibrate and install pH and ORP probes. Adjust set points to control the operation of the chemical pumps. The instructions for calibration and adjustment of the set points are found in the equipment manuals. Chemical analysis is required in order to identify the correct ORP setting for a particular application;

- Place selector switches for all chemical pumps in “AUTO” position. The pumps will not operate unless the recycle pump is operating;

- Open all valves on the recirculation loop. If the recycle pump has a water flushing seal, start seal water flow and verify that there are no system leaks. The seal water should be flowing whenever the pump is running. Consult the pump manual for the required flushing rates and pressures;

- Start the recycle pump with the discharge valve close or nearly closed. As the pump comes up to speed slowly open the discharge valve. This procedure will prevent damage to the liquid distributor that could be caused by water hammer. Check for proper operation and verify that there are no leaks. Avoid pressure drops above 5 to 10 psig in order to prevent excessive carryover;

- Open dampers in the exhaust system and start the fan. Check to ensure fan is running properly. Adjust dampers to produce the desired flow rate. A velometer (pitot tube with MagnOehelic differential pressure gauge) indicates the air flow rate according to the following formula: Flow Rate (CFM) = Velocity (FPM) x Duct Area (sq. ft.);

- Start fresh water discharge into the scrubber sump. The water level must be kept at the level of the overflow connection, either by continuous addition of purge water or by periodic addition of make up water;

- Check for exhaust stack misting. If misting is occurring, immediately turn off the unit and contact the manufacturer; and

- The scrubber is now ready to begin treating the contaminated air. This assumes written verification has already been provided from the manufacturer that the system has been properly installed and previously started up. Failure to do so will void all warranties.

## 10.6 SYSTEM SHUT DOWN

The operator must follow the procedures listed below when shutting down the odor control system:

- Turn off fan and pump; and

- Shut off seal water and make up water.

If the system is to be out of service for an extended period (2 to 4 weeks or longer), follow these additional steps:

- Remove probes and cover them with protective caps in which they were shipped. To prevent damage due to dehydration of the sensing elements, place a few drops of water in the cap before the probe is covered. The probes must not be subject to freezing. Store above 32 deg. F;

- Flush the chemical lines and chemical feed pumps with clean water and then drain the entire chemical feed system. Fill the pump housing with antifreeze, if appropriate;

- Drain the scrubber sump completely and then fill the sump to the overflow level with clean water. Recirculate the clean water for approximately 5 to 10 minutes. Drain the scrubber sump. Do not drain the scrubber without first verifying that an atmospheric vent is provided. If the inlet or outlet ducting is open to the atmosphere, this will provide adequate venting;

- Fill the recycle pump housing with antifreeze, if appropriate. Drain seal water lines, if applicable; and

- Shut off power to the control panel and/or motor control center.

## 10.7 EQUIPMENT MAINTENANCE

Except for components that need periodic lubrication, preventive maintenance is not required for the odor control system. Daily inspection of the system is strongly recommended so that corrective maintenance, as outlined below, is accomplished in a timely manner. The operator must perform the following inspections and corrective maintenance on a regular basis as recommended below:

Liquid Distributor - Spray nozzles should be inspected after the first week of operation and monthly thereafter. The spray pattern should be uniform and cover a full 360-degree arc in order to prevent problems related to poor liquid distribution. Also, inspect nozzles for accumulation of scale or slime. To correct a defective spray pattern, stop flow to the unit, remove the header and clean each affected nozzle. Depending on the condition of the nozzle, chemical or mechanical cleaning may be required. Replace the header and resume operation, making sure that the defects are corrected.

Packing - Inspect the packing each month for accumulations of sludge, scale, and slime. Differential pressure drop increases when the packing becomes fouled. Packing should be cleaned before the pressure drop exceeds the clean-pack pressure drop by 50 percent or more, or when visual inspection indicates that cleaning in necessary. It is usually possible to clean the unit by recirculating a cleaning solution instead of the normal scrubbing solution. All other chemical feeds must be turned off during cleaning. Before attempting to clean the unit, analyze the material causing the problem in order to determine its nature.

Mist Eliminator - Inspect the mist eliminator each month for accumulation of sludge, scale, and slime. It should be cleaned before the pressure drop exceeds that which existed on the clean unit by ¼ -inch w.g., or when visual inspection indicates that cleaning is necessary. The mist eliminator cleaning procedure is outlined in Section 9.9.

Recycle Pumps - Periodic lubrication of bearings, and inspection of the pump for leakage around the shaft and for excessive vibration is required monthly. Mechanical seals should not leak, but a steady drip rate is required when packing is used. Adjust the packing gland per the manufacturer's instructions. Follow maintenance instructions, which are included in the vendor O&M Manual. Since the pump impeller can become fouled by solids or by formation of scale, it may be necessary to clean the pump interior as well as the packing. This is easily accomplished since the recycle pump is generally used during cleaning of the packing, and it is exposed to the same cleaning chemicals. In the worst case, it may be necessary to open the pump casing and remove the solids.

Exhaust Fan - Check for excessive vibrations and excessive bearing temperature. Periodic lubrication of bearings is required. Inspect drive belts for proper tension and for wear. Follow maintenance instructions, which are included in the vendor O&M Manual.

Chemical Metering Pumps - Chemical feed diaphragm pumps do not require more than periodic inspection. Check at one month intervals to confirm that the pumping rate is per design. In addition to these procedures, chemical feed pumps must be checked for proper oil level, and the lubricant must be replaced in accordance with the manufacturer's instructions, which are found in the vendor O&M Manual. Most failure to pump problems involve plugging or otherwise non-functional check valves, or failure to maintain prime. If check valves must be removed in order to inspect and clean them, be sure to follow the maintenance instructions and the procedures for proper handling of chemicals, which are found in the vendor's O&M Manual.

Sensors and Probes - Probes must be checked periodically in order to ensure they are giving accurate readings. This should be done on a weekly basis. The easiest way to check accuracy of the readings is to perform an independent chemical analysis of the scrubbing solution and compare the results to those of the system controller. If this cannot be done, or if the results do not compare, it will be necessary to recalibrate the analyzer. Consult the pH or ORP control section of the vendor O&M Manual for details.

Before removing probes from a pipe or tank, be sure that all valves are closed and the pressure has been relieved in order to prevent loss of chemical and possible injury. Reading instability can be introduced by ground loops, air bubbles flowing past the sensor, and by improper wiring methods.

Odor Control Duct - The odor control duct system has a low point located just to the south of the Sludge Processing Building prior to connecting to the odor control system. This low point has a value box which allows for inspection and removal of condensate from the odor control duct system. This should be done on a bi-monthly basis.

## 10.8 SCRUBBER PACT CLEANING PROCEDURE

The procedure for cleaning the scrubber packing in place is as follows:

- Take the scrubber unit off line. Shut down the recycle pump;
- Open the scrubber sump drain and discharge the entire contents of the sump to a suitable wastewater treatment or disposal system;

- Rinse the sump once by filling it with clean water, running the recycle pump for at least one half hour and, then, draining the sump. This liquid should also be discharged to a suitable wastewater treatment or disposal system;

- Close the drain valve and fill the sump with the cleaning solution as described in section 9-10. Start the recycle pump;

- Recirculate this solution through the scrubber for at least 3 to 4 hours, although 8 to 10 hours is preferred for best results;

- Stop the recycle pump, drain the sump, and inspect the packing. If the packing still needs cleaning, repeat the above procedure;

- If the packing is clean, refill the sump with fresh water and run the recycle pump for a few minutes in order to rinse the unit. Drain the sump and repeat with fresh water. Finally, drain the sump again; and

- Inspect the sump and remove any foreign matter that may have accumulated. The unit is now ready for start up.

If the packing must be removed for cleaning, proceed as follows:

- Take the unit off-line. Shut down the pump;

- Open the drain and discharge the entire contents of the scrubber sump to a suitable wastewater treatment or disposal system;

- Rinse the packing material once by recirculating fresh water;

- Prepare a cleaning solution as outlined in section 9-10 and in the vendor's O&M Manual;

- Open access doors and remove the packing media, placing the elements into a clean tank;

- Flood the tank with cleaning solution and let it stand for 3 to 4 hours, although 8 to 10 hours is preferred for best results. During this time, maintain concentration in the solution by adding chemical as needed. Agitation of the solution is helpful;

- When the elements are clean, drain the cleaning tank and refill with fresh water in order to rinse the media. Repeat with fresh water. Finally, drain the cleaning tank again; and

- Remove the media from the cleaning tank and place it in the scrubber. The unit is now ready for normal operation.

## 10.9 MIST ELIMINATOR CLEANING PROCEDURE

Mist eliminators are manufactured with a variety of media elements. The mist eliminator provided is a G. B. special mash pad in two pieces. Each pad has a 1½ inch thick grating attached to the outlet side and a 1 inch thick grating attached to the inlet side with Kynar thread. Grating I-beams are positioned vertically. Pad dimensions are 82 inches wide by 72 inches high. Grating dimensions are 81½ inches wide and 71½ inches high.

## 10.10 PREPARATION OF CLEANING SOLUTIONS

Prepare a volume of solution to fill the sump to its normal liquid level, or fill a cleaning tank. The temperature of this solution should not exceed 120 degrees F. Dilute acid will remove scale or sludge caused by elements that form insoluble carbonates, sulfates, or hydroxides. The cleaning solution should have a pH below 3 during the cleaning cycle.

- A Citric acid solution should be predominately used. It is prepared by first filling the cleaning solution containor with water followed by adding 50% citric acid until the pH reaches a 2.5-3 range. The pH is determined by using the pH equipment that is supplied with the odor control unit.

- Sulfamic, Hydrochloric and Sulfuric acids can also be used.
  - A 20 percent solution of sulfamic acid ($HSO_3NH_2$) is prepared by dissolving 1.8 pounds of dry sulfamic acid per gallon of solution.
  - Hydrochloric (muriatic) and Sulfuric acids are prepared by adding 2 gallons of 30 percent acid per 100 gallons of solution.

- A chlorine solution will remove deposits caused by growth of microorganisms (slime). Chlorine gas may be released if the pH of the solution is lowered.
  - A 2 percent solution of hypochlorite is prepared by adding 13 gallons of 15 percent hypochlorite per 100 gallons of solution.
  - Other cases than those mentioned above will require individual analysis. It will be necessary to select a cleaning agent that is compatible with the materials of construction, in order to be effective for the particular foulant and safe to use.

Note: Refer to the manufacturer's O&M Manuals for Troubleshooting and other detailed information on the Odor Control System.

# 11 - HVAC/PLUMBING SYSTEMS

## 11.1 GENERAL

The heating, ventilating, air conditioning, and plumbing systems at the Surfside WWTF consist of various units and systems located in the several buildings and structures associated with the WWTF.

The seven (7) major buildings at the site include the following:

- Administration Building (Building No. 1);
- Primary Treatment Building (Building No. 4);
- Process Analysis Building (Building No. 5);
- Sludge Processing Building (Building No. 6);
- Equipment Storage Building (Building No. 7);
- Advanced Treatment Building ( Building No. 10); and
- Chemically Enhanced Primary Treatment Building (CEPT Building).

The other structure that would have minor plumbing related facilities is the Headworks Facility. This is an open structure and, thus, has no HVAC System.

## 11.2 HVAC EQUIPMENT MAINTENANCE

Efficient operation of all the heating, ventilating, air conditioning, and plumbing equipment and systems is dependent on good preventive maintenance programs. Many conditions such as hours of operation, cleanliness, etc., contribute to frequency of required maintenance service.

The following items require regular attention:

- Lubricate equipment as recommended by the manufacturers;
- Change filters as required to clean the air and maintain adequate air flow;
- Check and adjust or replace belts as required;
- Clean coils and drains as required;
- Maintain free access to all equipment;
- Protect equipment from improper operation, freezing, negligence, abuse, and misuse; and

- Minimize down time and eliminate unnecessary service calls by checking to be sure power is on, then restart the system. If system still fails to operate, call for service person.

## 11.3 HVAC AND PLUMBING EQUIPMENT

### *11.3.1 Administration Building*

The existing Control Building was retrofitted inside the structure to act as the new Administration Building. The retrofitted building includes the following rooms and areas:

- Office;
- Women's Lavatory;
- Men's Lavatory;
- Utility Room;
- Mechanical Room;
- Conference and Lunch Room; and
- Corridors.

The HVAC equipment and systems installed in the Administration Building includes:

- Exhaust Fan #1 – In-Line Centrifugal, 300 cfm, located in toilet and utility room;
- Electric Baseboard Heaters - #1 - #10, with a 500 to 2000 watt capacity, including thermostat, located along the outside walls of the building;
- Air Cooled Condensing Unit #1 & #2;
- Fan Coil Unit #1 & #2; and
- Exhaust Grill – 3 each.

The Plumbing units and systems installed in the Administration Building includes:

- Hot and cold water piping;
- Men's and Women's Lavatories with Showers;
- Electric hot water heater;
- Water Coolers;
- Backflow Preventor, etc.;
- Floor drains and cleanouts; and
- 4" sanitary sewer discharge and associated piping.

HVAC Operation and Controls

Hot Water Unit Heater - Upon a drop below space temperature set point (55 degrees F adjustable) as sensed by a 2-position direct acting room thermostat, the unit heater fan will start. Upon a rise above set point, the unit heater fan will stop. Upon a drop below hot water return temperature set point (100 degrees F adjustable) as sensed by a strap-on aqua stat, the fan will be prevented from starting.

Lavatories - Toilet room fans are controlled by a manual switch. When the switch is placed in the "ON" position, the 2-position exhaust air motor-operated damper will open, after which the exhaust fan will start. When the switch is placed in the "OFF" position, the reverse will occur.

Note: Refer to the manufacturer's O&M Manual(s) for more detailed information.

### *11.3.2 Process Analysis Building*

The Process Analysis Building was a pre-existing building retrofitted to include the laboratory and office space. The retrofitted building includes the following rooms and areas on the first floor:

- Tool room;
- Electrical room;
- Service bay; and
- Corridor.

On the mezzanine there are the following rooms:

- Two offices;
- Lavatory;
- Laboratory; and
- Toilets.

The HVAC equipment and systems installed in the Process Analysis Building includes:

- Finned tube radiators;
- Unit heaters;
- Electric unit heaters;
- Fan coil units;

- Exhaust fans;
- Fume hood fans;
- Supply fans;
- Heating coils;
- Air cooled condensing unit;
- Motor operated louvers;
- Cabinet unit heaters;
- Supply diffusers; and
- Backdraft dampers.

HVAC Operation and Controls

Finned Tube Radiation - Upon a drop below space temperature set point (70 degrees F adjustable) as sensed by a 2-position direct acting room thermostat, the unit heater fan will start. Upon a rise above set point, the reverse will occur.

Hot Water Unit Heaters - Upon a drop below space temperature set point (55 degrees F adjustable) as sensed by a 2-position direct acting room thermostat, the unit heater fan will start. Upon a rise above set point, the unit heater fan will stop. Upon a drop below hot water return temperature set point (100 degrees F adjustable) as sensed by a strap-on aquastat, the fan will be prevented from starting.

Fume Hood System - Upon turning on a manual switch mounted on the exterior of the fume hood, the outside air 2-position mod will open, after which both the fume hood supply fan (5SF-1) and the exhaust fan (5EF-1) will start. Upon turning off the manual switch, the reverse will occur. The supply air hot water coil (5HC-1) discharge temperature as sensed by a duct-mounted temperature sensor will be maintained at 50 degrees F (adjustable) by mounting a 3-way control valve at the hot water coil.

Lab Air Conditioning System - An electronic programmable room thermostat is provided for setting the user selected occupied/unoccupied time periods and for following control sequences.

Occupied Mode - Outside air 2-position motor-operated damper will be open and supply fan will run continuously. In the heating mode, space temperature as sensed by the room thermostat will be maintained at 68 degrees F (adjustable) by modulating a 3-way control valve at the hot water coil. In the cooling mode, space temperature as sensed by the room thermostat will be maintained at 68 degrees F (adjustable) by cycling “ON/OFF” the air-cooled condensing unit.

Unoccupied Mode - Outside air 2-position mode will be closed, supply fan will be “OFF”, and 3-way control valve will be fully open through the hot water coil. In the heating mode, space temperature as sensed by the room thermostat will be maintained at 55 degrees F (adjustable) by cycling “ON/OFF” the supply fan. The cooling mode will be disabled. Upon a drop in hot water and a coil discharge air temperature below 40 degrees F (adjustable) as sensed by a unit mounted freezestat, the system will turn off.

Humidifier - Humidifier controls will be enabled whenever the 5FCU-1 supply fan is running and the associated electronic programmable room thermostat is in the heating mode. Humidifier controls will be disabled under all other circumstances. With humidifier controls enabled, relative humidity will be maintained at 50% RH set point (adjustable) as sensed by a space relative humidity sensor, wall-mounted 5’ – 0” above the finished floor at a location in the room representative of average space humidity conditions. Humidifier will not be permitted to run when hi-limit relative rises above 90% RH set point (adjustable) as sensed by the duct relative humidity sensor located in the supply duct. Humidifier will not be permitted to run when there is no airflow as sensed by the supply duct-mounted sail switch located between the supply fan and the humidifier dispersion tube assembly.

Toilet Fans - Toilet room fans are controlled by a manual switch. When the switch is placed in the “ON” position, the 2-position exhaust air motor-operated damper will open, after which the exhaust fan will start. When the switch is placed in the “OFF” position, the reverse will occur.

Note: Heating and cooling units are thermostatically controlled.

The Plumbing units and systems installed in the Process Analysis Building include:

- Oil fired domestic water heater;
- Hot water supply & return;

- Toilets and sinks;
- Two (2) 40 gal. Potable water well tanks;
- Floor drains and cleanouts;
- Lab. Cup sinks & Lab. Sinks;
- 55 gal. Acid neutralization tank;
- Dishwasher;
- Water hammer arrestor;
- Mixing valves;
- Humidifier;
- Emergency shower and eye wash located in the Laboratory; and
- Gasoline/oil interceptor manhole serving the repair shop.

Note: Refer to the manufacturers' O&M Manuals for more detailed information.

### *11.3.3 Equipment Storage Building*

The Equipment Storage Building was recently constructed in the approximate location of the original Bulk Materials Shelter. Thus, this is an existing structure newly enclosed with new HVAC equipment and systems. The Equipment Storage Building interior is a completely open area without wall partitions or walls for the storage of large vehicles and equipment.

The following HVAC equipment and systems were installed in the Equipment Storage Building:

- Exhaust fan assembly with a 36" x 36" fixed louver and carbon monoxide control unit. (Capacity = 3850 cfm w. ½ hp motor);
- Carbon Monoxide (CO) Control System (7EF-1): The system will be controlled by an H-O-A switch located beside the "CO" control unit. When the switch is placed in the "AUTO" position, the exhaust fan will be interlocked with, and controlled by, the "CO" control unit. When the switch is placed in the "HAND" position, the exhaust fan will be "ON". When the switch is placed in the "OFF" position the exhaust fan will be "OFF". The "HAND" and "OFF" positions, will not bypass the "CO" control unit "Audible Alarm/Visual Alarm circuit;
- When the exhaust fan is called upon to turn "ON", the two-position exhaust air motor-operated damper will open, after which the exhaust fan will start. When the exhaust fan is called upon to turn "OFF", the exhaust fan will turn off after which the damper will close; and

- Refer to the Manufacture's O & M Manual(s) for the "CO" unit's control sequence. "FAN ON" set point will be 25 ppm "CO" (adjustable) with 3 minute (adjustable) minimum "FAN ON" time. "Audible Alarm/Visual Alarm" set point will be 50 ppm "CO" (adjustable). Disable routine fan cycling feature (Periods when "CO" is below "Fan ON" set point).

Note: This building has no plumbing, heating or air conditioning equipment or systems.

### *11.3.4 Sludge Processing Building*

The Sludge Processing Building was recently constructed in the location of the original Compost Shelter. This building is a major component of the WWTF and handles all the sludge, scum, and septage from both the Surfside and Siasconset WWTFs.

The building includes the following rooms and areas:

- Septage Receiving Station;
- Liquid Sludge Receiving Station;
- Sludge Cake Bay;
- Dewatering Room;
- Chemical Feed Room;
- Control Room;
- Electrical Room;
- Lunch Room;
- Lavatory;
- Odor Control Room with Chemical Feed System; and
- Various Corridors.

Thus, this is a totally new building including all the HVAC and Plumbing equipment and systems.

The HVAC major equipment and systems installed in the Sludge Processing Building include the following:

- Centrifugal In-Line Fans. (3 ea.)(Cap.= 2020 – 4760 cfm);
- Centrifugal Ceiling Exhaust Fans (1 ea.)(Cap. = 75 cfm);
- Destratification Prop. (5 ea.)(Cap. = 27,500 cfm);

- Electric Unit Heater (1 ea.)(Cap. = 650 cfm/7.5 KW); and
- Domestic Water Heater (1 ea.)(Cap. = 400 MBH/Oil).

HVAC Operation and Controls

Septage Receiving Area Ventilation System - When the Odor Control Unit is “ON”; the two-position outdoor air motor-operated damper will open. When the Odor Control Unit is “OFF”, the reverse will occur. Note: The Odor Control Unit is in the Odor Control Room.

Dewatering Room Ventilation System - System will be controlled by an “H-O-A” switch located in the motor control center (MCC) area. When the switch is place in the “AUTO” position, the system will be interlocked with the Odor Control Unit and will be “ON” only when the Odor Control Unit is “ON”. When the switch is placed in the “HAND” position, the system will be “ON”. When the switch is placed in the “OFF” position, the system will be “OFF”. When the system is “ON”, the two-position outdoor air motor-operated damper will open, after which the air handling unit supply fan will start. When the switch is placed in the “OFF” position, the reverse will occur. The air handling unit hot water coil discharge temperature of 55 degrees F (adjustable) as sensed by a duct-mounted temperature sensor will be maintained by modulating the air handling unit face and bypass damper. Upon detection of smoke as sensed by a supply duct mounted smoke detector, the system will turn off. A signal will be sent to the fire alarm control panel. Upon drop in hot water coil discharge temperature below 40 degrees F (adjustable) as sensed by a unit mounted freezestat, the system will turn off.

Chemical Feed Room Ventilation System - System will be controlled by a manual switch. When the switch is placed in the “ON” position, both the two position outdoor air motor-operated damper and the two position exhaust air motor-operated damper will open, after which the exhaust fan and the air handling unit supply fan will start. When the switch is placed in the “OFF” position, the reverse will occur. The air handling unit hot water coil discharge temperature as sensed by a duct mounted temperature sensor and will be maintained at 55 degrees F (adjustable) by modulating the air handling unit face and bypass damper. Upon drop in hot water coil discharge air temperature below 40 degrees F (adjustable) as sensed by a unit mounted freezastat, the system will turn off.

Control Room Air Conditioning System (F) - In the heating mode, space temperature as sensed by an electronic programmable room thermostat will be maintained at 72 degrees F (adjustable) by cycling ("ON/OFF") the supply fan and electric heating coil in unison. In the cooling mode, space temperature as sensed by the electronic programmable space thermostat will be maintained at 75 degrees F (adjustable) by cycling ("ON/OFF") the supply fan and air-cooled condensing unit in unison. Upon detection of smoke as sensed by a supply duct mounted smoke detector, the system will turn off. A signal will be sent to the fire alarm control panel.

SCADA System - Activation of Control Room high temperature alarm (78 degrees F, adjustable) signal will be taken from a space temperature sensor located inside the Control Room. Activation of the space heating plant "Boiler B-1 Failure" and/or "Boiler B-2 Failure" alarm signals will be taken from control lockout relay located on the burner of each boiler.

Activation of the "Main Fuel Oil Tank Overfill" alarm signal will be taken from tank 10 ft –1 electronic tank level and overfill prevention system control panel. The control panel is located outdoors on Building #10 east wall.

Activation of space heating plant "Pump P-1 Failure" and/or "Pump P-2 Failure" alarm signals will be taken from differential pressure switch connected to suction and discharge of each pump. Alarm signal will not be available from an inactive pump when either pump is placed in the inactive mode.

Activation of space heating plant "Pump P-3 Failure" and/or "Pump P-4 Failure" alarm signals will be taken from differential pressure switch connected to the suction and discharge of each pump.

Activation of space heating plant "Pump FP-1 Failure" alarm signal will be taken from the pump failure audible alarm circuit in the fuel oil pump set control panel. The alarm signal will not be available from an inactive pump when pump is placed in the inactive mode.

Activation of Engine Generator "Pump Failure" alarm signal will be taken from pump failure audible alarm circuit in the fuel oil pump set control panel. Alarm signal will not be available from inactive pump when pump is placed in the inactive mode.

Electrical Rooms Heating Removal Systems - Upon a rise above space temperature set point (90 degrees F adjustable) as sensed by a two position reverse acting thermostat, both the two position outdoor air motor-operated damper and the two position exhaust air motor-operated damper will open, after which the exhaust fan will start. Upon a drop below the set point, the reverse will occur.

Toilet Room Fans - Toilet room fans are controlled by a manual switch. When the switch is placed in the "ON" position, the 2-position exhaust air motor-operated damper will open, after which the exhaust fan will start. When the switch is placed in the "OFF" position, the reverse will occur.

Odor Control Room Ventilation System - System will be controlled by a manual switch. When the switch is placed in the "ON" position, both the two position outdoor air motor-operated damper and the two position exhaust air motor-operated damper will open, after which the exhaust fan and the air handling unit supply fan will start. When the switch is placed in the "OFF" position, the reverse will occur.

The air handling unit hot water coil discharge temperature as sensed by a duct-mounted temperature sensor will be maintained at 55 degrees F (adjustable) by modulating the air handling unit face and bypass damper. Upon a drop in hot water coil discharge air temperature below 40 degrees F (adjustable) as sensed by a unit mounted freezestat, the system will turn off.

Upon detection of smoke as sensed by a supply duct mounted smoke detector, the system will turn off. A signal will be sent to the fire alarm control panel.

Hot Water Unit Heaters - Upon a drop below space temperature set point (55 degrees F adjustable) as sensed by a 2-position direct acting room thermostat, the unit heater fan will start. Upon a rise above set point, the unit heater fan will stop. Upon a drop below hot water return temperature set point (100 degrees F adjustable) as sensed by a strap-on aquastat, the fan will be prevented from starting.

Note: This building has a full complement of HVAC equipment and systems as shown on the record drawings and in the manufacturer's O&M Manuals.

The Plumbing equipment and systems located in the Sludge Processing Building include the following:

- Floor drains and floor cleanouts;
- Hot and cold water supply;
- Domestic water heater (1 ea.)(Cap. = 176 gal./400 MBH);
- Lavatory;
- Water hammer arrestor;
- Kitchen facilities;
- Water Cooler;
- (2) Emergency shower and eye wash stations located in the chemical feed room and the odor control room; and
- Backflow preventor.

Note: This building has a full complement of Plumbing equipment and systems as shown on the record drawings and in the manufacturer's O&M Manuals.

### *11.3.5 Primary Treatment Building*

The Primary Treatment Building was formally designated as the Solids Handling Building and served much the same function as it now serves, however it has been upgraded with new HVAC equipment and Plumbing.

The building is a major component of the WWTF and houses equipment and systems supporting the Headworks operation, the Sludge Holding Tank operation, and the Primary Clarifiers.

The Ground Level of the building houses the following rooms, equipment, and systems:

- Blower Room;
- Storage Room;
- Electrical Room;
- Equipment Room;
- Aerated Grit Chamber Blowers (2 ea.);
- Sludge Holding Tank Blowers (4 ea.); and
- Process Air Piping Systems.

The Basement Level of the building houses the following rooms, equipment, and systems:

- Pipe Gallery;
- Primary Clarifier Sludge Withdrawal Pumps (3 ea.);
- Grit Pump serving the Aerated Grit Chamber;
- Septage/Primary Sludge Pumps (2 ea.);
- In-Line Grinders (2 ea.); and
- Process piping for the above mentioned pumping units and adjacent Tankage.

The HVAC major equipment and systems installed in the Primary Treatment Building include the following:

- Basement Level:
  - Unit Heaters (3 ea.)
  - Hot Water Supply and Return Piping
  - Dehumidifier
  - Exhaust Fan (1 ea.)

- Ground Level:
  - Unit Heaters (3 ea.)
  - Hot Water Supply and Return Piping
  - Electric Unit Heaters (2 ea.)
  - Motor Operated Louvers
  - Exhaust Fan and Duct System

HVAC Operation and Controls

Hot Water Unit Heaters - Upon a drop below space temperature set point (55 degrees F adjustable) as sensed by a 2-position direct acting room thermostat, the unit heater fan will start. Upon a rise above set point, the unit heater fan will stop. Upon a drop below hot water return temperature set point (100 degrees F adjustable) as sensed by a strap-on aquastat, the fan will be prevented from starting.

Electric Room Heat Removal System - Upon a rise above space temperature set point (90 degrees F adjustable) as sensed by a two position reverse acting thermostat, both the two position outdoor air motor-operated damper and the two position exhaust air motor-operated damper will open, after which the exhaust fan will start. Upon a drop below the set point, the reverse will occur.

Building Heat Removal System - The system will be controlled by an "H-O-A" switch located in the motor control center (MCC). In the "HAND" position, all the two position outdoor air motor-operated dampers and the two position exhaust air motor-operated damper will open, after which the exhaust fan will start. In the "OFF" position, the exhaust fan will turn off, after which all dampers will close. In the "AUTO" position, upon a rise above space temperature set point (90 degrees F (adjustable) as sensed by either of two 2-position reverse acting room thermostats (one in the blower room and one in the electrical room), the system will turn "ON". When the system turns "ON", all the two position outdoor air motor-operated dampers and the two position exhaust air motor-operated dampers will open, after which the exhaust fan will start. Upon a drop below set point by both room thermostats, the reverse will occur.

Note: This building has a full complement of HVAC equipment and systems as shown on the record drawings and in the manufacturer's O&M Manuals.

The Plumbing equipment and systems originally provided for in the existing two story building remain in service. No new plumbing was required.

### *11.3.6 Advanced Treatment Building*

The Advanced Treatment Building was constructed on the former site of the original Blower Building. The Advanced Treatment Building houses the following equipment and systems that support the secondary and tertiary process units:

- Basement Level
  - Pump Area
  - Mechanical Room
  - Plant Water Wet well
  - Backpulse Wet well

- Ground Level
  - Generator Room
  - Electrical Room
  - Blower Room
  - Storage Room
  - Control Room
  - Lavatory
  - UV Disinfection Room
  - Permeate/Backpulse Pump Area
  - Corridors and Stairs

The HVAC equipment and systems provided in the Advanced Treatment Building include the following:

- Ground Level
  - Unit Heaters (5 ea.)
  - Emergency Generator and support equipment
  - HVAC Control Panel
  - Electric Unit Heaters
  - Motor Operated Louvers
  - Exhaust Fans (3 ea.)
  - Supply Fan
  - Fintube Radiators (2 ea.)
  - Fan Coil Condensing Unit
  - Cabinet Unit Heater

- Basement Level
  - Unit Heaters (5 ea.)
  - Expansion Tanks (2 ea.)
  - Recirculation Pumps (4 ea.)
  - Boilers (2 ea.)
  - Fuel Pumps (2 ea.)
  - Motor Operated Louvers
  - Air Separator
  - Destratification Fans (3 ea.)
  - Hot Water Supply & Return Piping
  - Supply Fans

HVAC Operation and Controls

Space Heating Plant - When the outdoor air temperature falls below set point (55 degrees F adjustable), the active secondary hot water pump (P-1 or P-2) will start, the boilers fuel oil pump set (FP-1) will start (wired through “AUTO” position of FP-1 H-O-A switch, and the boiler controls will be enabled. A duct-mounted outdoor air temperature sensor and a hot water supply temperature sensor will, through the return temperature control package supplied by the boiler manufacturer, modulate each boiler diverting valve. The hot water supply temperature will be reset between 170 to 210 degrees F (adjustable) in a ratio to outside temperature as it varies from 55 to 0 degrees F (adjustable). Upon a call for either boiler burner to operate, the combustion air two position motor-operated dampers will open, after which the boiler/burner(s) will start. When operating set points of both boilers/burners are satisfied, the reverse will occur. Selection of active/inactive secondary hot water pump will be by manual switch located on the wall-mounted boiler control panel face.

Refer to the boiler manufacturer’s return temperature control installation and maintenance manual for boiler control sequence using return temperature control package. The package includes return water temperature sensor, three way diverting valve, 24 VAC valve actuator, and controller all supplied by the

manufacturer. "Boiler Min" minimum return water temperature set point will be 135 degrees F (adjustable). All other control package set points not specified in this space heating plant control sequence will be as recommended by the boiler manufacturer.

Hot Water Unit Heaters - Upon a drop below space temperature set point (55 degrees F adjustable) as sensed by a 2-position direct acting room thermostat, the unit heater fan will start. Upon a rise above set point, the unit heater fan will stop. Upon a drop below hot water return temperature set point (100 degrees F adjustable) as sensed by a strap-on aqua stat, the fan will be prevented from starting.

UV Room Ventilation System - When the Odor Control Unit is "ON", the two position outdoor air motor-operated damper will open. When the Odor Control Unit is "OFF", the reverse will occur.

Blower Room Heat Removal System - Upon a rise above space temperature set point (90 degrees F Adjustable) as sensed by a two position reverse acting room thermostat, both the two position outdoor air motor-operated damper and the two position exhaust air motor-operated damper will open, after which both the supply fan and exhaust fan will start. Upon a drop below set point, the reverse will occur.

Pipe Gallery Heat Removal System - The system will be controlled by an H-O-A switch located in the motor control center (MCC). In the "HAND" position, both the two position outdoor air motor-operated damper and the two position relief air motor-operated damper will open, after which the supply fan will start at high speed. In the "OFF" position, the supply fan will turn off after which both dampers will close. In the "AUTO" position, upon a rise in space temperature above 90 degrees F (adjustable) as sensed by the first stage of a two position two stage reverse acting thermostat, both the two position outdoor air motor-operated damper and the two position relief air motor-operated damper will open, after which the two speed supply fan will start and run at low speed. Upon a further rise in space temperature above 94 degrees F (adjustable) as sensed by the second stage of the two position two stage reverse acting thermostat, the two speed supply fan will go to high speed. Upon a drop below set points, the reverse will occur.

Toilet Room Fans - Toilet room fans are controlled by a manual switch. When the switch is placed in the "ON" position, the 2-position exhaust air motor-operated

damper will open, after which the exhaust fan will start. When the switch is placed in the "OFF" position, the reverse will occur.

Electrical Room Heat Removal System - Upon a rise above space temperature set point (90 degrees F adjustable) as sensed by a two position reverse acting thermostat, both the two position outdoor air motor-operated damper and the two position exhaust air motor-operated damper will open, after which the exhaust fan will start. Upon a drop below the set point, the reverse will occur.

Note: This building has a full complement of HVAC equipment and systems as shown on the record drawings and in the manufacturer's O&M Manuals.

The Plumbing equipment and systems provided in the Advanced Treatment Building include the following

- Ground Level
  - Electric Water Heater
  - Lavatory
  - Floor Drains

- Basement Level
  - Floor Drains & Cleanouts
  - Sanitary Drains
  - Cold Water make-up water piping
  - Water Meter
  - Backflow Preventor

### *11.3.7 Chemically Enhanced Primary Treatment (CEPT) Building*

The CEPT Building is an existing facility that was principally used prior to the installation of the Advanced Treatment Facilities. This building will be maintained to be used when necessary in unforeseen and/or emergency situations. It will also function as a storage building.

The HVAC and Plumbing equipment and systems originally provided for in the existing CEPT Building remain in service. No new HVAC or plumbing was required.

# 12 - ELECTRICAL SYSTEMS

## 12.1 INTRODUCTION

The electrical utility company serving the Surfside WWTF is the Nantucket Electric Company – National Grid (NGRID). NGRID primary electrical power enters the facility underground from South Shore Road. Primary electrical power then enters a pad mounted transformer located in the northeast corner of the Sludge Processing Building. The pad mounted transformer delivers 277/480 volts, 3-phase, 4-wire, 60-hertz power underground into the Main Switch Board #1 (MSB-1) located in the electrical room of the Sludge Processing Building. MSB-1 is also the switchboard housing the main breaker for the entire facility, metering equipment, and the automatic transfer switch. In Emergency contact, National Grid at 1-800-465-1212

### *12.1.1 On-site Power Distribution*

Power (277/480) is distributed from Main Switch Board – 1, (MSB-1) to MCC-6, DP-6 and DP-6A in the Sludge Processing Building. Power from MCC-6 is sent to other electrical facilities outside of the Sludge Processing Building via underground plastic conduits encased in concrete. Power is distributed from MCC-6 to MCC-10, MCC-10A, DP-10, DP-10A, and SWBD-10 all located in the Advanced Treatment Building. Power from MCC-6 supplies power to MCC-4 and DP-4 located in the Primary Treatment Building. Power from MCC-6 is sent to DP-5 in the Process Analysis Building. Power from MCC-6 is sent to LP-1 located in the Administration Building. Power from MCC-6 is sent to the CEPT Building through power distribution panel PDP-2, and lighting panelboard LP-1.

### *12.1.2 Available Voltages*

In addition to 480 volt power, other (ac) voltages are used in this facility. Two hundred seventy seven (277) volt power is available but not used. One hundred twenty and two hundred forty (120-240) volts-single phase, and 208 volt-three phase power are produced from 480 volts through dry type transformers located throughout the facility. Power from these transformers feeds lighting panelboards, which provide branch circuits for various 120, 208, and 240 volt electrical operated equipment.

### *12.1.3 Direct Current Power*

Certain items of equipment operate on direct current (dc), which is derived from alternating current (ac) through rectifiers or is produced by batteries (the engine generator starting system, for example).

#### *12.1.4 On site Power Generation.*

In case of a MEC power failure, the engine generator set, located on the ground level in the south west corner of the Advanced Treatment Building, will automatically start and be automatically connected by the automatic transfer switch (ATS) to the Sludge Processing Building distribution system including MCC-6, DP-6, and DP-6A. The ATS is located in the Main Switch Board (MSB) in the Sludge Processing Building.

Refer to **Figure 12.1 - Simplified Single-Line Diagram** of power distribution system and voltage levels throughout the facility. This shows electrically how 480 and 240, 208, and 120 volt power is delivered throughout the facility.

#### *12.1.5 Other Electrical References.*

The electrical system involves the above referenced distribution system and a great many other items. In addition to this manual, there are contract drawings (from which the facility was built), manufacturer's shop drawings (manufacturer's data on components of the facility), and technical manuals (supplied with the equipment) available for reference.

## 12.2 MAINTENANCE

Personnel responsible for the operation and maintenance of the electrical systems should be thoroughly familiar with all aspects of the equipment involved. All maintenance of exposed electrical conductors and connections should be performed by a licensed electrician. However, there is a limited amount of electrical operation and maintenance that can be performed by facility personnel. The basic rules of electrical maintenance are:

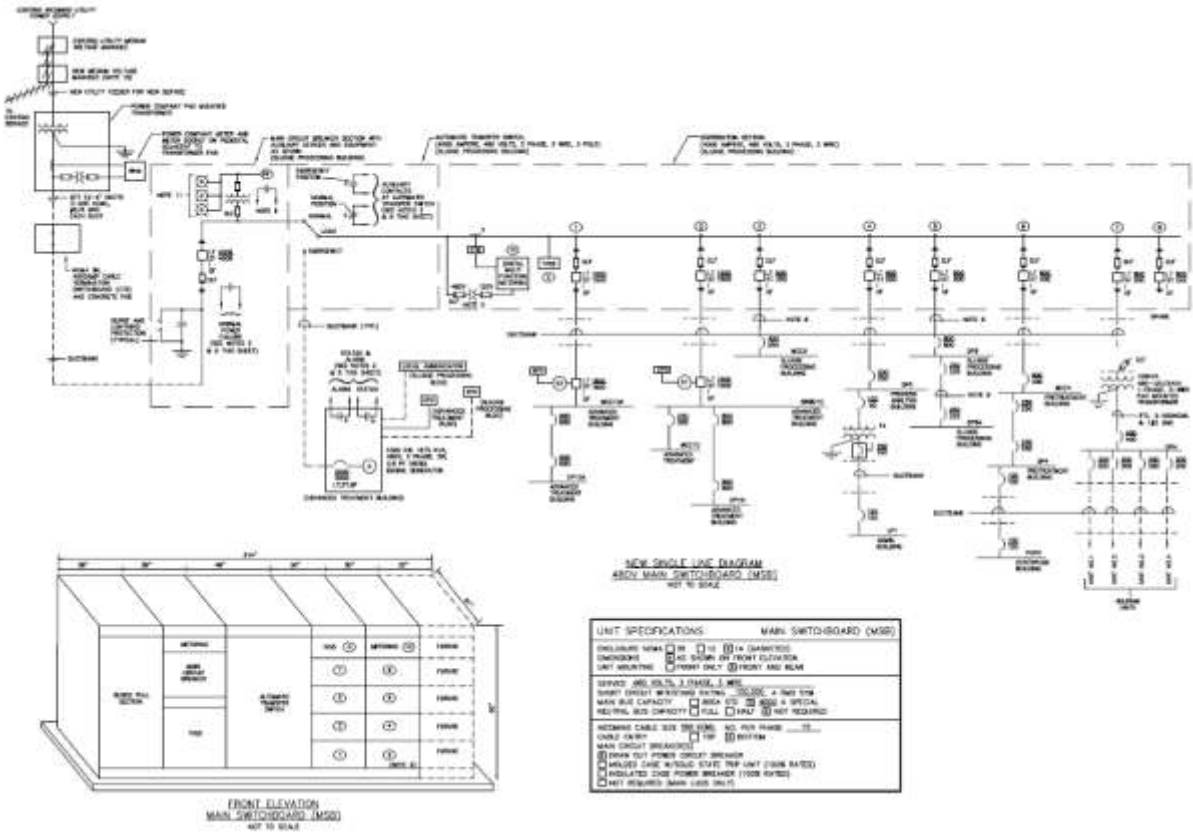
- "be careful";
- "keep equipment clean"; and
- "maintain adequate ventilation and maintenance clearances".

Following is a list of some of the items of electrical work to be preformed by the operators:

- Switch panelboard branch circuit breakers to operate some minor equipment (e.g. heaters, fans, etc.). The main reason for these circuit breakers is to detect and automatically disconnect equipment when an electrical malfunction occurs. However, these breakers can also be used to switch power "ON" and "OFF".

- Push "RESET" buttons for "tripped" motor over current protectors (called heaters) at MCCs and other starter locations. If the "RESET" button does not hold, the heater has not had enough time to cool off (requires up to 15 minutes). After resetting, restart equipment as if normally starting. If repeated tripping occurs, an electrician should be called to thoroughly check the motor and controls before the motor is restarted.

**FIGURE 12.1 - SINGLE LINE DIAGRAM**




Some equipment is started by pushing a momentary (spring return) pushbutton. A momentary outage of the electrical service will often cause the momentary pushbutton operated controls to drop out of service and stop the equipment. The equipment must be restarted in the normal manner. A list should be posted at the motor control centers or control consoles of the desired “ON-OFF” status of all equipment, or tags should be hung at each cubicle to indicate intended status.

- Replace blown low voltage (120) volt) cartridge fuses for motor starter and indicating light control circuits.
- Replace faulty indicating light bulbs.
- Reset circuit breakers. Tripped position may look similar to “ON” position. To reset, first put breaker operator in the “OFF” position, then to the “ON” position. If repeated tripping occurs, an electrician should be called to thoroughly check the equipment before the system is re-energized.
- The identifying number and amperage rating for motor starter heaters and 120 volt control circuit breakers should be posted inside each motor starter cubicle. Keep spare circuit breakers on hand. This will expedite replacement when necessary.

## 12.3 SAFETY

All electrical installations and equipment should be maintained in accordance with the provisions of the National Electrical Code (NEC). The purpose of the code is the practical safeguarding of personnel and property. Only qualified and authorized personnel should be allowed to work on electrical system and equipment. If the facility has no licensed electrician on staff, a local outside electrician should be contracted to do emergency electrical work at the facility. Electrical work done on equipment by unauthorized personnel may invalidate warrantees or insurance claims and may be dangerous.

For routine work on electrically operated equipment, it is good practice to assign two qualified maintenance personnel to work on electrical equipment that has not been completely isolated from the power source.

When operating equipment, be prepared for the unexpected. Know the locations of power disconnects for each piece of electrically operated equipment.

At the beginning of each shift, check to see if anyone in your area of responsibility is working on electrical equipment. Check to insure that equipment reported as being out of service has been disconnected and locked out.

Think twice before energizing a piece of equipment. First, assure yourself that you understand the equipment's function, especially at that instant in time prior to placing it on-line. Secondly, make sure that there is no possibility that another plant personnel could be injured by operation of the equipment. It doesn't take much time to follow these basic principles of thought, yet avoiding them could result in serious injury.

If a motor or piece of electrical apparatus is to be taken out of service, a lockout/tagout procedure should be taken to insure that the equipment is not accidentally started:

- Disconnect the power source by opening the circuit breaker feeding the apparatus;
- Install padlock or locks on disconnect handles;
- Attach signs to the power disconnecting devices and the equipment indicating that the equipment is out of service; and
- Notify the proper supervisory personnel.

## 12.4 480 VOLT SYSTEMS

The highest voltage level inside the buildings and structures of this facility is 480 volts. As shown in **Figure 12-1**, the 480 volt output of the NEC transformer enters the Main Switch Board located in the Sludge Processing Building. The MCCs in all the buildings have 480 volt power and so do the distribution panels and switchboards.

### *12.4.1 480 Volt Motor Control Centers*

Motor control centers at this facility are manufactured by Eaton, Corp./Cutler Hammer, Inc. Motor Control Centers distribute 480 volt power to 480 volt motors, to dry type transformers for serving low voltage systems such as lighting panelboards, to 480 volt space heaters, and to other 480 volt loads. Each load served from a motor control center is protected from short circuits by a circuit breaker (or motor circuit protector), which is manually operable from the front of the MCC. Nameplates on the front of MCCs identify each load. Operation is covered under the GENERAL section of this electrical chapter.

The MCC also has running motor overcurrent protection and motor controlling devices for 480 volt motors. An unusual condition or a low level malfunction will cause the motor over current protector to “trip”. The “RESET” procedure for this protector is covered under the “GENERAL” section of this electrical chapter.

### *12.4.2 Power Distribution Panels (DP’s)*

Power distribution panels are groupings of circuit breakers mounted in a panel serving 480 volt loads. Like motor control centers power distribution panels include control circuits and devices such as VFD’s and control panels. There are seven (7) power distribution panels located at various locations at this facility:

- DP-4 and 4A – Primary Treatment Building;
- DP-5 – Process Analysis Building;
- DP-6 and 6A – Sludge Processing Building; and
- DP-10 and 10A – Advanced Treatment Building.

Lighting panels are served from power distribution panels.

### *12.4.3 Engine Generator*

A Cummins, Model 1500 DQGAB engine generator is available to supply 480 volt power to the WWTF in case of loss of normal (power company) power. This unit is rated at 1500 KW, 1875 KVA, and can provide adequate power for the facility’s electrical load.

The engine generator can be started manually or be set to start automatically. In the automatic mode, when normal power is lost for more than a few seconds (adjustable), the engine generator is started.

Automatic starting is due to a signal sent from the automatic transfer switch (ATS) in the Main Switchboard. The ATS has the following effect on the automatic operation of the engine generator.

- Starts engine on sustained loss of power (adjustable 0.5 to 3.0 seconds at ATS);
- Transfers load to engine generator when engine reaches full speed and power is available, and after time delay (adjustable 1 to 300 seconds at ATS);
- Transfers load back to normal when normal power is available (after adjustable 0 to 25 minute time delay); and
- Provides that the engine runs for a minimum of 5 minutes after re-transfer to normal power.

The status of the ATS (normal or emergency) is indicated at the ATS. Engine generator power is transferred to the Main Circuit Breaker in the Main Switchboard through the ATS from where power is distributed throughout the facility.

Operation and maintenance of the engine generator is detailed in the manufacturer's O&M Manual. Important items of maintenance for the engine generator include weekly operation for a minimum of 30 minutes, monthly operation under load for one hour, normal engine oil and filter changes, lubrication, and battery maintenance once each year. The battery charger should be connected and energized at all times. The engine block heater and antifreeze condition should also be checked regularly.

## 12.5 120/208/240 VOLT SYSTEMS

### *12.5.1 Lighting Panelboards*

Lighting Panelboards are operated at the voltage levels normally encountered in home electrical systems (120/240 volt, single phase). In this facility, 120 and 240 volt-single phase, and 208 volts-three phase power is produced from the 480 volt system through dry type transformers. Power from the transformers feed lighting panelboards, which provide branch circuits for lighting, receptacles, and other 120, 208, and 240 volt equipment.

Each panelboard has a directory indicating which branch circuit breaker feeds which piece of equipment. The available voltage at each panelboard is indicated on the record contract drawings. **Table 12.1 – Lighting Panel Board** indicates important information about each panelboard:

### *12.5.2 Lighting*

Lighting fixtures should be kept clean. Burned out tubes and bulbs should be replaced immediately. Special care should be taken to check the battery liquid levels in the emergency lighting battery units. This should be done according to the manufacturer's instructions in the O&M Manual, but at a minimum of once every year.

## 12.6 FIRE ALARM SYSTEM

The WWTF has been provided with a National Fire & Security, Inc. Gamewell-FCI 7100 multiprocessor-based analog/addressable fire alarm system, which has control panels and equipment in all buildings and areas throughout the facility. **Refer to Figure 12.2 - Fire Alarm Riser Diagram.** The fire alarm control panels have been designated as indicated in **Table 12.2 – Fire Alarm Control Panel Designations. M**omentary or sustained overloads or short circuits may cause circuit breakers to trip.

**TABLE 12.1 - LIGHTING PANEL BOARD**

| Lighting Panelboard | Location | Location of Transformer |
|---|---|---|
| LP1 | Administration Building | Administration Building |
| LP1A | Administration Building | Administration Building |
| LP4 | Primary Treatment Building | Primary Treatment Building |
| LP4A | Primary Treatment Building | Primary Treatment Building |
| LP5 | Process Analysis Building | Process Analysis Building |
| LP5A | Process Analysis Building | Process Analysis Building |
| LP6 | Sludge Processing Building | Sludge Processing Building |
| LP6A | Sludge Processing Building | Sludge Processing Building |
| LP6B | Sludge Processing Building | Sludge Processing Building |
| LP7 | Equipment Storage Building | Equipment Storage Building |
| LP10 | Advanced Treatment Building | Advanced Treatment Building |
| LP10A | Advanced Treatment Building | Advanced Treatment Building |
| LP10B | Advanced Treatment Building | Advanced Treatment Building |
| LP10C | Advanced Treatment Building | Advanced Treatment Building |

**TABLE 12.2 – FIRE ALARM CONTROL PANEL DESIGNATIONS**

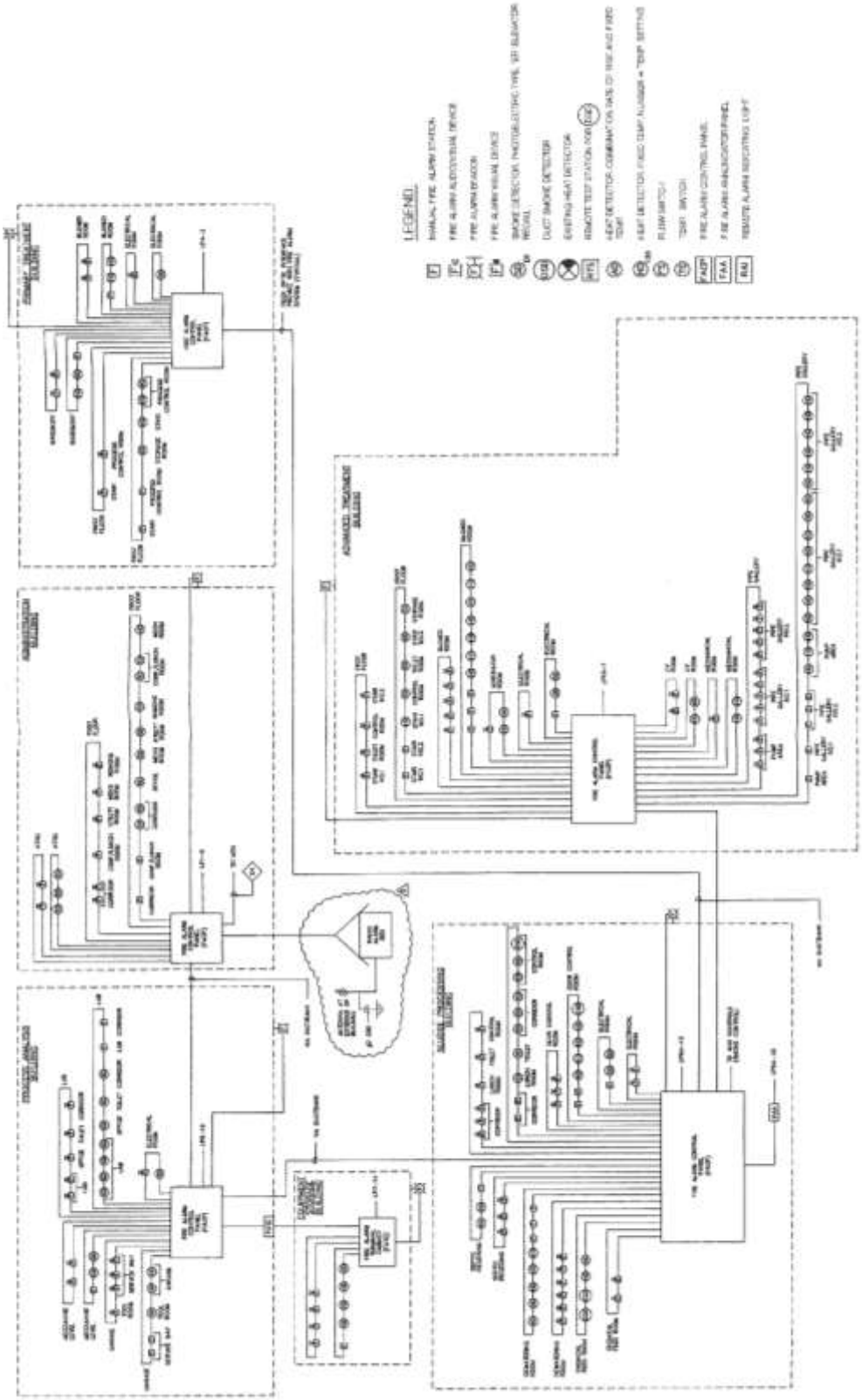
| Location | Panel Title | Panel Number |
|---|---|---|
| Process Analysis Bldg. | Fire Alarm Control Panel | LP5 – 19 |
| Administration Bldg. | Fire Alarm Control Panel | LP1 - 9 |
| Primary Treatment Bldg. | Fire Alarm Control Panel | LP4 - 2 |
| Equipment Storage Bldg. | Fire Alarm Terminal Cabinet | LP7 - 14 |
| Sludge Processing Bldg. | Fire Alarm Control Panel | LP6A - 10 |
| Advanced Treatment Bldg. | Fire Alarm Control Panel | LP10 - 7 |

The activation of any manual fire alarm pull station, or the automatic actuation of any thermal detector, smoke detector, or other alarming indicating device will immediately result in the following:

- Alarm signals sent to the Town of Nantucket Fire Department by means of a Master Box. All trouble and alarm signals will be sent to the SCADA System;
- Each Fire Alarm Control Panel will identify and address the location of the alarm by area and type of alarm. All audible and visual alarm signals will operate continuously only at the building where the initiating device has caused the alarm until the system has been manually silenced by an ALARM-OFF Switch or until the initiating device and control unit have been restored to the normal condition; and
- During an alarm condition the associated supervised indicator of the building and type of alarm will be illuminated on each control panel and the main Annunciator panel. In addition, a red strobe lamp will be energized at the building, which is in alarm.

The control panels will perform auxiliary control functions on a common or zoned basis. All alarm indicating circuits and Annunciator circuits are supervised against the occurrence of a break or ground fault condition in the field wiring. These conditions will cause a trouble buzzer to sound in the control panel until manually silenced by the buzzer silencing switch. Tripping of the smoke detector supply circuit breaker or a burned out zone lamp will also energize the trouble circuit. The trouble circuit is arranged for ring back operation to prevent switch disagreement during normal supervisory conditions. The system also has the capability of indicating the specific alarm initiating device in the trouble condition.

**FIGURE 12.2 - FIRE ALARM RISER DIAGRAM**



The fire alarm control panel has been designated YA-940.

- At the Local Control Panels:
  - Alarm Acknowledge
  - Trouble Acknowledge
  - Signal Silence
  - System Reset/Lamp Test
  - Programming Buttons:
    – Menu/Back
    – Back Space/Edit
    – OK
  - 12 Button Keypad

- LED Indicators:
  - AC Power "ON" (green)
  - Alarm (red)
  - Supervisory (yellow)
  - System Trouble (yellow)
  - Power Fault (yellow)
  - Ground Fault (yellow)
  - NAC 1 Silence (yellow)
  - NAC 2 Silence (yellow)
  - System Silence (yellow)

- Audible Sounder:
  - An Alarm/Trouble sounder is located on the Basic System Module (BSM)

- At the SCADA System:
  - A fire alarm from a dry contact in the Fire Alarm Control Panel (FACP) in the Sludge Processing Building will be displayed at the SCADA System HMI (YA-940).

## 12.7 SECURITY ALARM SYSTEM AND TELECOMMUNICATIONS SYSTEM

The Surfside WWTF has been provided with a National Fire & Security, Inc. GEM-P1632 eight zone Security System and a Telecommunications System, which is depicted on **Figure 12.3 - Communications System Riser Diagram.**

### *12.7.1 Security and Alarm System*

Actuation of any door magnetic switch security alarm device will:

- Actuate the respective zone alarm lamp in the control panel. One zone lamp has been provided for each door; and

- After an adjustable time period, actuate discrete remote alarm via an isolated contact as indicated on **Figure 12.3 - Communications System Riser Diagram**, and actuate a weatherproof building strobe.

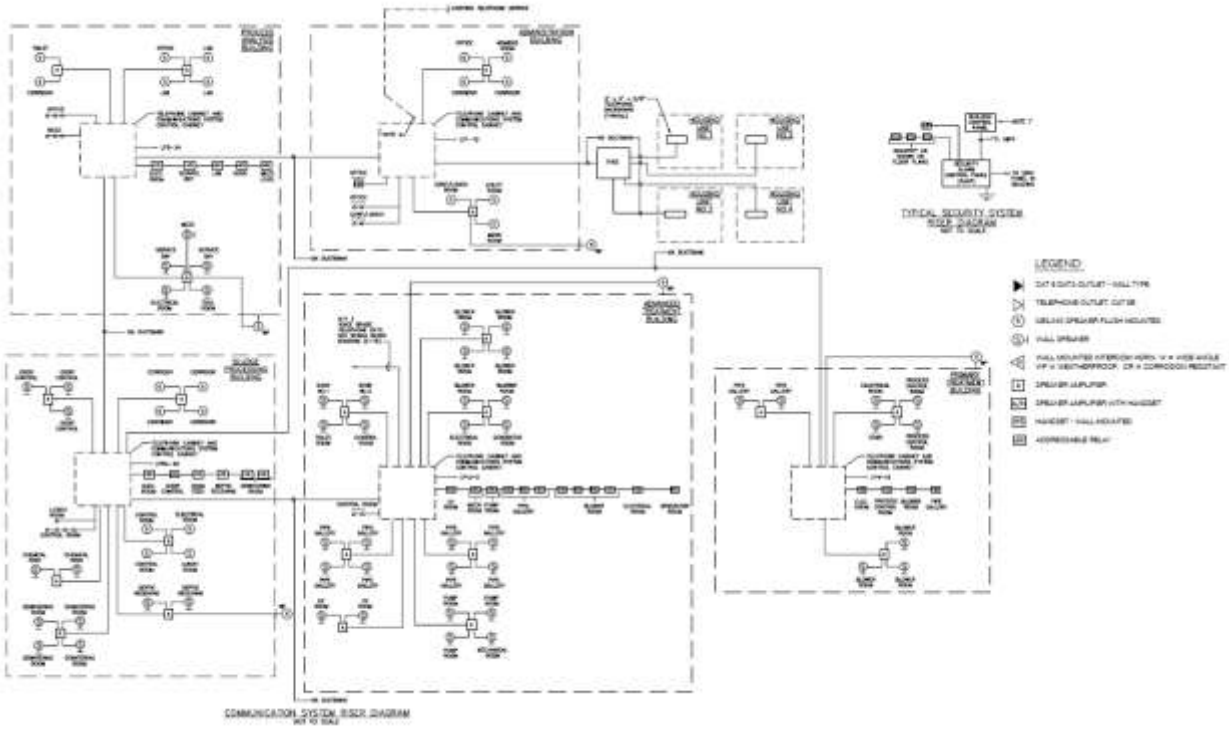
Each building control panel is furnished with a timed exit/entry control to allow access to the building without tripping the alarm. Authorized personnel entering the building and entering a code at the keypad will have up to 5 minutes to de-activate the alarm system prior to sending an alarm output signal.

The Security Alarm Control Panels (SACP) are powered by the following panelboards:

- Administration Building SACP – Panelboard LP-1;
- Primary Treatment Building SACP – Panelboard LP-4;
- Process Analysis Building SACP – Panelboard LP-5;
- Sludge Processing Building SACP – Panelboard LP-6A; and
- Advanced Treatment Building SACP – Panelboard LP-10.

A Security Alarm Control Panel with built-in keypad is located near each exit/entry door and is completely accessible to the operators. If the Security Alarm System is maintained in the active mode, the operators will have to “ARM” and “DISARM” the system with every entrance and exit. Refer to the manufacturer’s O & M Manual for specific operating instructions.

**FIGURE 12.3 - COMMUNICATIONS SYSTEM RISER DIAGRAM**



Opening, grounding, or tampering occurring in the zone monitoring circuit during the bypass or secure mode of operation will cause a trouble signal. To clear a trouble signal transmission, the trouble must be corrected and the system will automatically return to its normal state of operation. To restore the device actuating the alarm, the alarm must be secure to its normal position and the system reset switch operated. A trouble signal on an individual zone monitor circuit will not interfere with the automatic transmission of an alarm signal on another zone monitor circuit occurring during the same period.

### *12.7.2 Telecommunication System*

The telecommunication system was provided by Signet Electronic Systems, Inc. of Norwell, MA. A complete surge protected digital telephone and paging system has been provided, which interfaces with the local telephone company. The system provides direct dialing, full duplex private telephone communication between all stations equipped with administrative or staff telephones. The system has the capability for distinctive ringing to enable the receiving party to distinguish between internal and external calls. The system will allow paging from any offsite touchtone telephone via an incoming Telco line. Only authorized individuals may use this feature by dialing the dedicated trunk number and then dialing the system function.

The Multi-Line Digital Telephones have the following features:

- Two direct station select “speed dial” keys (buttons) for automatic dialing. These buttons can be initially programmed for line access;
- LCD display for incoming caller identification;
- Full hands-free speaker phone; and
- Message waiting indication.

The Digital Single Line Staff Telephones have the following features:

- Flash key;
- Message waiting light;
- Ringer volume control;
- Wall or desk mounted;
- Access to all system functions; and
- In wet (NEMA-4 or NEMA4X) areas phones within a fiberglass hinged enclosure have been provided.

For a complete detailed understanding of the telecommunication system provided at the Surfside WWTF refer to the Signet Electronic Systems, Inc. Operation & Maintenance Manual.

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# 13 - SCADA/INSTRUMENTATION & CONTROL SYSTEMS

## 13.1 INSTRUMENTATION

### *13.1.1 General*

This section is presented to detail the operation and control of the instrumentation equipment associated with the process control loops for the Surfside WWTF. It will supplement the information on process systems described in the previous chapters of this manual. It should also assist the operator in better understanding the instrumentation equipment, which controls the various process systems. The following O & M Manual sections will detail the process control loops and relate them to the operation and control of particular process systems.

The alarm and instrumentation system at the WWTF consists of the following:

- A Supervisory Control And Data Acquisition (SCADA) System;
- Process Instrumentation Panels; and
- Main Instrumentation Panel.

There are five (5) process control panels mounted at various locations within the WWTF, which receive and transmit control alarm and monitoring signals for the different process systems. Refer to **Table 13.1 - Process Control Panels** for list of control panels, their designations, descriptions, location, mounting details, and UPS status:

**TABLE 13.1 – PROCESS CONTROL PANELS**

| Designation | Abbreviation | Location | Mounting | UPS Status |
|---|---|---|---|---|
| Administration Bldg. Control Panel | ABCP | Admin. Bldg. Office Room | Wall | Has UPS |
| Advanced Treat. Bldg. Control Panel | ATBCP | Advanced Treat. Bldg. | Floor | Has UPS |
| Process Analysis Bldg. Control Panel | PABCP | Process Analysis Bldg. | Wall | Has UPS |
| Primary Treat. Bldg. Control Panel | PTBCP | Primary Treat. Bldg. | Wall | Has UPS |
| Sludge Processing Bldg. Control Panel | SPBCP | Sludge Processing Bldg. Control Room | Floor | Has UPS |

The SCADA System provides the following functions:

- Equipment Operating Status;
- Alarm Annunciation and Indication; and
- Instrument and Process Control.

The following manual sections will detail the primary instrument equipment and will provide an overview of particular process systems. The information being furnished is intended to supplement material discussed in previous chapters. The operator should thoroughly read all volumes of the SCADA O & M Manual and become familiar with the instrumentation equipment in order to gain a clear understanding of the equipment functions and operations.

### *13.1.2 Supervisory Control and Data Acquisition (SCADA) System*

The SCADA system hardware, manufactured by Allen Bradley, includes the Programmable Logic Controllers (PLCs), and eight Remote SCADA Stations. Refer to **Table 13.2 – Remote SCADA Stations.**

**TABLE 13.2 – REMOTE SCADA STATIONS**

| Node Name | Location | Software Type | Operating System |
|---|---|---|---|
| SCADA #1 | Sludge Processing Bldg. Control Rm. | Server/Full Development | Windows XP Professional |
| SCADA #2 | Sludge Processing Bldg. Control Rm. | Server | Windows XP Professional |
| SCADA #3 | Laptop | Operator | Windows XP Professional |
| SCADA #4 | Process Analysis Bldg. (Maintenance) | Operator | Windows XP Professional |
| SCADA #5 | Process Analysis Bldg. (Lab.) | Operator | Windows XP Professional |
| SCADA #6 | Administration Bldg. | Operator | Windows XP Professional |
| SCADA #7 | Advanced Treatment Bldg. | Operator | Windows XP Professional |
| SCADA #8 | Primary Treatment Bldg. | Operator | Windows XP Professional |

The SCADA System in the Main Control Room of the Sludge Processing Building serves the entire WWTF and has access to the Remote Terminal Units at the following locations.

- Siasconset WWTF – Administration Building;
- Airport Pumping Station;
- Cato Lane Pumping Station;
- South Valley Pumping Station;
- Sea Street Pumping Station;
- Pine Valley Pumping Station;
- Surfside Pumping Station;
- Monomoy North Pumping Station; and
- Monomoy South Pumping Station.

The Main Control Panel's PLC is a control and data acquisition instrument designed specifically for SCADA System applications. All analog and discrete data signals, transmitted and received by remote instrumentation, are respectively received and transmitted by the PLC. A software program, which is loaded within the PLC, allows it to communicate with the SCADA System's computers by placing the data in the Network Dynamic Data Exchange (NETDD). All SCADA System's computers are equipped with a software package called Intellution iFIX/FIX HMI/SCADA Version 3.5, which allows the operators to access and look at the data on customized, interactive graphic displays.

The Instrumentation and Control equipment provides the following functions:

- Data Acquisition System (DAS);
- Equipment Status Indication;
- Alarm Indication and Annunciation; and
- Process Control.

**Data Acquisition System**

All control and data acquisition functions at the WWTF are performed through the SCADA System. The system is required to and has the capability of indicating, storing, and annunciating the process, status, and alarm data on a continuous basis. It also allows the operator to control process functions directly from the PCs and to use the data received in a customized way to evaluate, tabulate, and trend the data.

**Equipment Status Indication**

Equipment status is continuously monitored by the SCADA System and the present status (ON/OFF) of all process equipment in the WWTF is indicated on graphic screen displays, usually by a green display representing an "ON" status and a red display for an "OFF" status. Also, all changes in equipment status conditions will be printed on a dedicated alarm and equipment status printer.

**Alarm Indication and Annunciation**

All alarm conditions throughout the WWTF are continuously monitored by the SCADA System. They can be generated either by an external contact, which is received by the PLC, or by an internal software contact generated when an analog value received by the PLC exceeds or falls below a software set point value. When an alarm condition is received, it is announced by a horn on the building Process Control Panel or other equipment control panels. It is indicated by a red flashing signal on the computer screen. The alarm must be acknowledged with the computer mouse by clicking the "Acknowledge" button on the screen. Some alarm conditions must also be acknowledged on the specific equipment's local control panel. All alarm conditions are stored by the SCADA System. In addition, the status of all alarm conditions will be printed on a dedicated alarm and equipment status printer. If multiple alarms occur, each must be acknowledged separately.

### *13.1.3 Instrument Panels*

Each of the five major WWTF buildings has a Process Control Panel as shown in **Table 13.1 - Process Control Panels**. Each of the five major WWTF buildings has at least one **Remote SCADA Station** as shown on **Table 13.2 – Remote SCADA Stations**. Most process units have local control panels that report to the building's Process Control Panel. The building's Process Control Panels report all data to the building's SCADA System, which is the operator's HMI.

In previous chapters, the individual process control panels have been shown in detail to assist the operator in understanding the options available when operating the specific process.

### *13.1.4 Instrument Equipment*

The main instrument system consists of process sensing, indicating, and controlling equipment located on or within instrument panels as software based equipment within the SCADA System or in the field. The equipment receives and/or sends either analog or digital signals to and from various processes. The operator utilizes this equipment to control and monitor the WWTF operation. This equipment can be categorized as follows:

- Flow Elements FE
- Flow Indicating Transmitters FIT
- Flow Indicating Controllers FIC
- Level Elements LE
- Level Indicating Transmitters LIT
- Level Indicating Controllers LIC
- Pressure Elements PE
- Pressure Indicating Transmitters PIT

A brief description of the main instrument equipment follows. The operator should refer to the manufacturer's instructions located in the SCADA O & M Manual for the specific operation of each instrument.

**Flow Elements, Flow Transmitters, and Flow Indicating Transmitters – FE, FT, FIT**

Flow monitoring is accomplished using magnetic and Parshall Flume flow meters (FE) and flow indicating transmitters (FIT). The flow elements sense the flow and generate either an electrically induced signal (magnetic flow meter) or a level signal (Parshall Flume), which are proportional to the square of the flow or flow level. The flow indicating transmitters convert the flow signals received from the flow elements to 4 – 20mA output signals, which are proportional to flow, and transmits these signals to either the individual process control panel PLC or to the SCADA System.

**Level Elements and Level Indicating Transmitters – LE and LIT**

There are two types of level element used at the WWTF. All liquid levels at the WWTF are measured and indicated by an ultrasonic type level element or by a submersible pressure transducer using a piezoresistive pressure sensor with a transmitter. The ultrasonic type measures the time that it takes for the signal to return to the element after being transmitted to and reflected off a liquid surface. The pressure transducer

measures the direct water pressure on the sensor head based on the depth of the unit in the water. The level signals are transmitted to indicators and/or process controllers, which use the signals to control the process variables.

**Flow and Level Indicating Controllers – FIC and LIC**

Computer software generated flow and level indicating controllers are utilized by the PLC processors to maintain constant flow and constant level conditions in all areas of the WWTF. By definition, an indicating controller is an instrument utilized in conjunction with other devices to automatically control a "process variable" at a predetermined "set point". In this case, the "process variable" is either flow or level. The controller receives a "process variable" signal (4 – 20mA flow signal) from a remote flow or level indicating transmitter or from some other type of measuring/transmitting device for the process. The controller compares this process signal with a process "set point" signal, which may be either locally or remotely generated. The controller then transmits a corrective output signal, which is proportional to the deviation between the process variable and the set point signal.

### *13.1.5 Maintenance*

Maintenance must be performed on the instrumentation equipment periodically to insure maximum equipment life and efficient operation. The operators should become thoroughly familiar with each volume of the SCADA O & M Manual, in order to perform all required inspection and maintenance procedures.

## 13.2 MONITORING INSTRUMENTS AND ALARM CONDITIONS

### *13.2.1 Turbidity Monitoring*

Four HACH Model 1720E Turbidimeters (AE/AIT-3537-1/2/3/4) have been provided at the Surfside WWTF to continuously monitor the turbidity of the treated wastewater before it enters the UV Disinfection System. The turbidity analyzer indicating transmitters have been programmed to display the turbidity locally at the transmitters on a scale of 0 – 100 NTUs. A 4-20mA output signal proportional to the actual turbidity is sent by the analyzer indicating transmitters to the MBR System Control Panel and SCADA System located on the ground floor level of the Advanced Treatment Building. Each permeate/backpulse pump discharge line includes a ½ -inch diameter P.E. tubing side stream that contains a ½ inch diameter solenoid valve, ½ inch diameter check valve, and a ½ inch needle valve before the flow enters the turbidity analyzer indicating transmitter.

The sample water flow rate to the analyzer should range from 3.2 to 11.9 gph depending on sample pressure. Sample water is channeled through an internal bubble trap to allow entrained bubbles to escape and vent from the turbidimeter body. Once the sample flow rate is established, it should then be kept constant.

The 1720E Turbidimeter is a continuous-reading nephelometric unit designed for low-range turbidity monitoring. This unit is capable of measuring turbidity from 0.001 to 100.0 NTU. Calibration is based on formazin, the primary turbidity reference standard adopted by the APHA Standard Methods for the Examination of Water and Wastewater and the U.S. Environmental Protection Agency (EPA).

The 1720E Turbidimeter measures turbidity by directing a strong beam of collimated light from the sensor head assembly down into the sample in the turbidimeter body. Light scattered at 90 degrees relative to the centerline of incident light by suspended particles in the sample is detected by the submerged photocell. The amount of light scattered is proportional to the turbidity of the sample. If the turbidity of the sample is negligible, little light will be scattered and detected by the photocell and the turbidity reading will be low. High turbidity, on the other hand, will cause a high level of light scattering and result in a high reading.

The turbidimeter operator interface is the controller, which has a keypad with eight keys and a display window. The display window shows sensor name and status of relays, turbidity reading, output signal, energized relay indicator, warning icon, and units measured.

Standardized maintenance procedures should also be performed monthly to insure the integrity of the analyzer's results. Before operating the turbidity monitoring system, the operator must read and understand the HACH sc100tm 1720E Analyzer System Instrument Manual Volume #1 of the G.E. Water & Process Technologies O & M Manual #500401.

### *13.2.2 pH Monitoring*

The WWTF influent and effluent flows are monitored for high and low pH. The influent and effluent automatic samplers analyze these two flows and report the pH values. Both pH values are indicated locally and transmitted to the SCADA System. Alarm set points have been established for high and low pHs.

### *13.2.3 Dissolved Oxygen Monitoring*

Six Danfoss-Evita Model PT#OXY 1100 dissolved oxygen analyzers (sensors) and analyzer indicating transmitters (AE/AIT-7338-A-1/B-1, A-2/B-2, and A-3/B-3) have been provided at the Surfside WWTF to continuously monitor the oxygen level of the aerated wastewater in the three (3) Aeration Basins. The Oxygen OXY Sensor sends a signal to the OXY 4100 Ball Float Transmitter, which has been programmed to signal the oxygen level locally on the Universal Signal Converter (USC) #7000 IP 67 on a scale of 0 to 10 mg/l. A 4–20 mA output signal proportional to the actual oxygen concentration is sent by the converter to MBR System Control Panel and SCADA System located on the ground floor level of the Advanced Treatment Building.

The sensor and transmitter are suspended in the wastewater on the end of a PVC pipe, which is held in place by a hinged mounting bracket attached to an adjacent handrail or wall. The oxygen sensor unit is mounted on the bottom of the ball float and is submerged in the aerated wastewater. The USC #7000 Converter is mounted vertically on a handrail or wall adjacent to the monitoring unit and is accessible to the operator.

The USC #7000 Converter unit has a 6-item keypad and display window. The display window shows the oxygen concentration value in ppm, the parameter being measured “oxygen”, and the transmitter number. By using the keypad, the display window can show the following:

- Temperature;
- Calibration;
- No. of Alarms;
- Rem. Lifetime;
- Reset Lifetime; and
- Last Calibration in Days.

The Evita OXY sensors must be calibrated in atmospheric air every six (6) months. During calibration the OXY 1100 Sensor must not be exposed to direct sunlight. Before operating the dissolved oxygen monitoring system the operator must read and understand the EVITA OXY User Manual from HACH/LANGE contained in Volume #1 of the G. E. Water & Process Technologies O & M Manual #500401

## 13.3 SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA)

### *13.3.1 General*

A “real time” Supervisory Control and Data Acquisition (SCADA) System has been provided at the Surfside WWTF, which will receive and store 4 – 20mA analog input signals (i.e., analyzer and flow signals), discrete inputs (i.e., alarm signals) and equipment operation signals. A PLC/SCADA Network Diagram is provided on the following page to graphically indicate each building system and show how the various systems interact. The system is equipped with an Allan Bradley programmable logic controller (PLC), which is the primary control and data acquisition instrument used in the system. It uses Allan Bradley software, and an Intellution iFIX/FIX HMI software program, which allows operator interface by communicating with operator workstations.

The system is capable of performing the following functions:

- Pump control, including chemical feed;
- Pump alternation;
- Equipment interlocking;
- Start/Stop set points;
- Run time accumulation on pumps;
- Totalizing of flow rates;
- Loading cycling (minimum and maximum on/off times);
- Time of day control with lockout and level override;
- Digital alarms;
- Delays;
- Math functions;
- Local operations;
- Analog and digital valve controllers; and
- PID controller.

The Allan Bradley PLC has the following alarm features:

- Displays for current and historical alarm information;
- Automatic logging of alarm information on the designated printer;

- Digital outputs for alarm annunciation and indication;
- Four priority alarm levels;
- Delay for analog alarms (to account for momentary spikes);
- Alarm grouping; and
- Periodic logging.

The Allan Bradley PLC has historical logging capabilities including:

- Logging of digital as well as analog data points;
- A user-definable dead-band for determining when alarms are logged;
- Display of recently recorded data; and
- Graph of a point's value for the last three hours.

The system is provided with Microsoft Windows XP, Intellution IFIX/FIX HMI software program, Microsoft Excel (a spreadsheet program), and Microsoft Word (a word processing program). All of these provide the additional capabilities of storing, analyzing, comparing, averaging, trending, and reporting the data collected in a variety of numerical and graphic hard copy modes. The system also allows the user to run a large variety of commercially available business and engineering software. The software (stored on the personal computer's hard disk) provides a set of high resolution graphic displays. These include alarm, summary, trending, and interactive plan view displays (refer to the SCADA Installation O & M Manual). The interactive plan view displays produce animated color graphic layouts of the plant which provide:

- Real-time process data or status indication;
- Alarm indication; and
- Process control.

Access to all the display functions is made by either clicking the speed buttons or points on the displays with the computer's mouse. The system is configured as a data highway on the personal computers at the plant and provides backup capabilities to each other. Since the computers are linked on a data highway, there is no need for a lead or secondary computer. Instead, all operational functions and report generation may be performed from any computer and the others will be immediately updated. Since the software is all stored on the computer's hard drive, it is highly recommended that a complete backup of the hard drive be made and stored in a safe location. Also, on a periodic basis, all new or changed data should be backed up onto a compact disk.

### *13.3.2 Data Logs and Graphic Displays*

The SCADA System gathers analog and discrete remote data signals, which are logged and displayed as real time and historical process signals on the graphic displays. Each display is accessed by using the computer's mouse. The SCADA System displays plant performance data such as flow, level, pH, etc. as well as hours of running for motors and other operational data. This data is stored on the computer's hard drive; however it should be archived to a compact disk on a monthly basis.

### *13.3.3 Trending*

Real time and historical trending of user specified data may be performed. The SCADA System has the capability to create four trends each on each display. The operator has the ability to select, which data points are to be trended. These are selected with the mouse by clicking speed buttons on the trending display and then selecting the desired data to trend.

### *13.3.4 Report Generation*

Daily and monthly reports can be generated from data stored by the SCADA System using the Microsoft Excel software package. Using Excel, reports can be automatically generated by linking data cells on the spreadsheet program directly with the SCADA System via the system's Network Dynamic Data Exchange (NETDDE). The operator can also create a variety of daily and monthly reports of all plant processes by manually entering data into a pre-configured Excel spreadsheet program.

## 13.4 PROCESS CONTROL ABBREVIATED LOOP DESCRIPTIONS

### *13.4.1 General*

The Surfside WWTF is designed so that the treated wastewater meets the quality and quantity required by the groundwater discharge permit. This is accomplished through a combination of manual operations carefully performed by the WWTF operators and automatic operations performed by the process control loops which monitor the tank levels, process flow rates, and analyzer data and compair set point values. This insures a nearly constant level in the process tankage and a relatively constant flow rate through the WWTF, which consistently manages the incoming wastewater flow and satisfies the groundwater permit requirements. The flow through the WWTF will vary in accordance with the seasonal population and the infiltration/inflow entering the collection system.

The process begins with the operator deciding on the expected wastewater flow into the plant and placing the proper number of process units online. The operator will also adjust specific flow rate controllers and set the advanced process units to satisfy that flow rate. After that is done, the flow control loops will automatically adjust the process units to satisfy the demand of the incoming wastewater flow.

Control loops are also used at the WWTF to automatically control the following functions:

- Analyzers;
- Chemical Feeds;
- Telemetering;
- MLSS Concentration;
- DO Concentration;
- MBR Module Cleaning; and
- WAS Pumping.

These and other process control loops will be described in the section. The less complex control loops, which require minimum operator control, are not described in this section. The operator should refer to the SCADA O & M Manual for complete information on all control loops except for the control loops for the Advanced Treatment System. For information on the Advanced Treatment System loops the operator should refer to the G. E. Water & Process Technologies, Zenon Membrane System O & M Manuals, Volume I, II, and III.

### *13.4.2 General Overall Wastewater Treatment Facility Control*

When the WWTF is operated automatically, the flow through the plant will determine the number of process units online. During the summer months the plant should be in full operation with all units operating. During the winter months the lower wastewater flow rate should allow some of the process units to be manually put on standby. This is done by restricting the wastewater flow to the online units by closing gates and valves discharging to the offline units. This will also require changes to the SCADA System so it only recognizes the online units. The units that are taken offline should be cleaned and inspected for possible deficiencies and made ready for future summer operation. Also, the manufacturer's O & M Manual should be checked for instructions on standby process unit status.

For example, taking one or more MBR tanks offline will be cost effective by saving operating and maintenance cost and energy costs. However, the following specific steps should be taken when removing a train from service:

- Drain the MBR tank completely to remove all solids;
- Pressure wash the interior of the tank and the membranes to remove all the residue;
- Fill the tank with clean water up to the normal water level;
- During freezing weather (i.e. temperatures below 32 degrees F), operate the air diffuser system at low volume to keep the clean water from freezing; and
- The operator should check the tank daily, especially during extremely cold weather, to make sure sufficient diffused air is being fed to the tank to prevent any ice from forming.

This procedure is necessary to keep the Zenon module media from drying out and degrading by being exposed to the natural environmental elements.

**Loop 100 – In-Channel Grinder**

Wastewater from the Surfside collection system enters the WWTF via a 20-inch diameter force main and flows in the influent channel to the in-channel grinder, which reduces large size solids to a maximum of ¼-inch. The operation of the grinder is controlled automatically through the vendor furnished local control panel. The following status and alarm signals are displayed at the SCADA System HMI:

- In-channel grinder run status (YI-100);
- In-channel grinder failure alarm (YA-100); and
- Elapsed run time meter (KQI-100).

**Loop 110 – Influent Flow Rate Metering**

Wastewater flow continues in the channel and passes through the 12-inch Parshall Flume where the wastewater flow rate is metered. The plant influent flow rate is indicated and recorded locally at the Primary Treatment Building. The flow rate is indicated, trended, and recorded at the SCADA System HMI. Flow alarms are indicated at the SCADA System HMI. The following influent flow information is displayed at the SCADA HMI:

- Non-resettable flow total (FQI-110-1);
- Previous day flow total (FQI-110-2);
- Current day flow total (FQI-110-3), automatically reset at midnight;

- Resettable flow total (FQI-110-4); and
- Influent Channel high level (LAH-110).

**Loop 120 – Influent Sampler**

The influent sampler, located at the Headworks Facility, is capable of sequential and composite sampling, and the wastewater pH is immediately relayed to and alarmed at the SCADA System HMI (AY-120). The influent sampler receives a 4-20 mA DC influent flow rate signal from the SCADA System (FY-120). The influent sampler receives its 120 VAC power from the Primary Treatment Building Control Panel.

**Loop 130 – Grit Collection System**

The operation of Grit System equipment including Grit Screw, Grit Pump, Hydrogritter, and Inclined and Horizontal Screw Conveyors 2 and 3(see Loop 740) is controlled automatically via the SCADA System HMI. The Grit Screw, Grit Pump, and Hydrogritter have H-O-A selector switches at the local control panels. When all H-O-A switches are in "Auto" remote, automatic control via the SCADA System HMI is enabled.

The following status and alarm signals are displayed at the SCADA System HMI:

- Grit Screw, Grit Pump, and Hydrogritter H-O-A in "Auto" (YI-130A, etc.);
- Grit Screw, Grit Pump, and Hydrogritter run status (YI-130A-2, etc.);
- Grit Screw, Grit Pump, and Hydrogritter Motor high temperature alarm (TAH-130A, etc.);
- Grit Pump seal leak alarm (YA-130B-1);
- Grit Screw, Grit Pump, and Hydrogritter non-resettable elapsed time meters (KQI-130A, etc.);
- Grit System motor state disagreement alarm displayed at SCADA System HMI if state of motor and run status do not agree after a preset time (YA-130-A, YA-130B-2, YA-130 C). If disagreement, systems shut down; and
- Remote Automatic Control: The Grit System will automatically operate from a cycle timer (KC-130) with adjustable "On-State" and "Off State" durations. The conveyor must start first, the hydrogritter second, the grit pump third, and the grit screw fourth for the Grit System to be considered successfully operating and under Remote Automatic Control.

**Loop 140 – Aerated Grit Chamber Blower**

Two aerated grit chamber blowers, one online and one standby, are located in the Primary Treatment Building on the ground level. The Primary Treatment Building local control panel controls can control blower speed and Start/Stop functions. The local control panel monitors speed, motor temperature, discharge temperature, vibration, VFD fault, switch in "Auto", and run status.

The following status and alarm signals are displayed at the SCADA System HMI:

- H-O-A switch in "Auto" (YI-140-1, etc.);
- Run status indication (YI-140-2, etc.);
- Alarms for motor temperature (TAH-140-1), high vibration (VAH-140), high discharge temperature (TAH-140-2), and VFD fault (YA-140-1);
- Speed indication (SI-140);
- Elapsed run time meter (KQI-140);
- Motor disagreement alarm (YA-140-2); and
- Remote Manual Control: Blower manually started/stopped (YS-140) and speed controlled (SC-140) at SCADA System HMI.

**Loop 200 - Septage Receiving System**

The Septage Receiving System is monitored and controlled by the vendor's Local Control Panel and Operator Interface Control Panel. There is no SCADA System HMI interface.

**Loops 210A, 210B, and 210C – Existing Septage Holding Tanks**

The three existing septage holding tanks are monitored for level (LIR-210A, etc.) and alarmed for high level (LAH-210A, etc.) at the local control panel.

The following status and alarm signals are displayed at the SCADA System HMI:

- Liquid level indicated, trended, and recorded at SCADA HMI (LIR-210A, etc.);
- High level alarms are displayed at the SCADA System HMI (LAH-210A, etc.); and
- Tank levels are interlocked to control Septage Pumps, Grinders, and Blowers, refer to their respective loops.

**Loop 210D – Existing Sludge Holding Tank**

The existing sludge holding tank is monitored for level (LIR-210D) and alarmed for high level (LAH-210D) at the local control panel.

The following status and alarm signals are displayed at the SCADA System HMI:

- Liquid level indicated, trended, and recorded at SCADA HMI (LIR-210D, etc.);
- High level alarms are displayed at the SCADA System HMI (LAH-210D, etc.); and
- Tank levels are interlocked to control Septage Pumps, Grinders, and Blowers. Refer to their respective loops.

**Loop 220A, 220B, 220C, and 220D – Existing Septage Holding Tanks Blowers/Existing Sludge Holding Tank Blowers**

The existing septage holding tank blowers and existing sludge holding tank blowers are located in the Primary Treatment Building on the ground level. The Primary Treatment Building local control panel controls can control blower speed and Start/Stop functions. The local control panel monitors speed, motor temperature, discharge temperature, vibration, VFD fault, switch in “Auto”, and run status.

The following status and alarm signals are displayed at the SCADA System HMI:

- H-O-A switch in “Auto” (YI-140-1, etc.);
- Run status indication (YI-140-2, etc.);
- Alarms for motor temperature (TAH-140-1), high vibration (VAH-140), high discharge temperature (TAH-140-2), and VFD fault (YA-140-1);
- Speed indication (SI-140);
- Elapsed run time meter (KQI-140);
- Motor disagreement alarm (YA-140-2);
- Remote Manual Control: Blower manually started/stopped (YS-140) and speed controlled (SC-140) at SCADA System HMI; and
- Remote Automatic Control: Blower auto started (YS-220A, etc.) when level exceeds preset point (LS-220A-1, etc.). Blower auto stopped when level drops below set point (LS-2220A-2, etc.).

**Loops 230A and 230B – Septage-Sludge Pumps/Grinders**

The two sets of Septage-Sludge Pumps and Grinders are located in the Primary Treatment Building on the lower level. The local control panel will indicate an alarm condition for high pump discharge pressure, low pump suction pressure, and grinder failure. The local control panel indicates HOA switch in “Auto”, Pump run status, and Start/Stop controls. The local control panel has H-O-A switches for septage/sludge pump and grinder controls.

The following status and alarm signals are displayed at the SCADA System HMI:

- Alarms for low pump suction pressure (PAL-230A, etc.), high pump discharge pressure (PAH-230A, etc.), grinder failure (YA-230A-1, etc.), and motor disagreement (YA-230A-2, etc.);
- Monitoring of H-O-A switch in "Auto" (YI-230A-1, etc.), pump run status (YI-230A-2, etc.), grinder run status (YI230A-3, etc.), and elapsed run time for pumps and grinders (KQI-230A-1 and KQI230A-2, etc.); and
- Refer to loop descriptions in the contract documents for more instrument and control information.

**Loop 240 – Septage Flow Metering**

The Septage Receiving Station located in the Sludge Processing Building has two local control panels mounted on the unit. The unit has a 4-inch Rosemount Model 8732C magnetic flow meter mounted on the inlet pipeline. The flow meter monitors the influent flow rate and totalizes the discharge from each tank truck at the main control panel (FIR-240). The main control panel sends a 4-20 mA analog flow signal to the SCADA System. The operator can monitor these flow values at the SCADA HMI.

The following status signals are displayed at the SCADA HMI:

- The septage flow rate can be indicated, trended, and recorded at the SCADA System HMI (FIR-240);
- Non-resettable flow total (FQI-240-1);
- Previous day flow total (FIQ-240-2);
- Current day flow total (FQI-240-3), automatically reset at midnight; and
- Resettable flow total (FQI-240-4).

**Loops 300A, 300B and 300C – Primary Clarifier Sludge Collector Drive**

The Sludge Collector Drive units are located on the deck adjacent to the Primary Clarifier Tanks. The local control for the collector drives is at MCC-4, which is in the electric room of the Primary Treatment Building on the ground level. MCC-4 has an "ON/OFF" selector switch for local control of the equipment.

The following status and alarm signals are displayed at the SCADA System HMI:

- Sludge Collector Drive run status (YI-300A-2, etc.);
- Sludge Collector Drive torque overload alarm (WAH-300A, etc.);
- Elapsed run time meter (KQI-300A, etc.).

**Loop 310 - Primary Sludge Pumps & Grinders**

The Primary Sludge Pumps and Grinders are located in the pump room of the Primary Treatment Building on the lower gallery level. The local control panels for these units are located in the Process Control Room above, at ground level (PSPCP-1, 2 and 3). The three local control panels have H-O-A selector switches for local operation of each pump and each grinder. When switch is in “Auto”, remote control is enabled.

The following status and alarm signals are displayed at the SCADA System HMI:

- Primary Sludge Pump H-O-A switch in “Auto” (YI-310A-1, etc.);
- Primary Sludge Pump run status (YI-310A-2, etc.);
- Primary Sludge Pump low suction pressure alarm (PAL-310AA, etc.);
- Primary Sludge Pump high discharge pressure alarm (PAH-310A, etc.);
- Grinder H-O-A switch in “Auto” (YI-310A-3, etc.);
- Grinder run status (YI-310A-4, etc.);
- Grinder failure alarm (YA-310A-1, etc.);
- Elapsed run time meter for each pump and grinder (KQI-310A-1, KQI-310A2, etc.);
- Motor state disagreement alarm (YA310A-2, etc.);
- Sludge Pump and Grinder software hand switch to manually designate which pump and grinder serves which Sludge Holding Tank (HS-310A, etc.);
- Remote Manual Control: Pumps and grinders manually started/stopped via SCADA HMI (YS-310A, etc.); and
- Remote Automatic Control: Pumps and grinders automatically started/stopped based on a cycle timer YS-310A, etc.) and Sludge Holding Tank level interlock signals to keep tank level in the operating range (LS310A-1) and LH-310A-2).

**Loop 320 – Primary Sludge Flow Metering**

The Primary Sludge Flow Meter is located on the Primary Sludge Pump discharge piping, which is on the lower gallery level of the Primary Treatment Building. The flow meter measures and indicates (FE-320 & FIT-320) the flow at the unit. The flow indicating transmitter sends a 4-20 mA signal proportional to the flow rate to the SCADA System.

The following status and alarm signals are displayed at the SCADA System HMI:

- The Primary Sludge Flow rate can be indicated, trended, and recorded at the SCADA System HMI (FIR-320);

- Non-resettable flow total (FQI-320-1);
- Previous day flow total (FQI-320-2);
- Current day flow total (FQI-320-3); and
- Resettable flow total (FQI-320-4).

**Loop 330 – Primary Treatment Building Sump Level Alarms**

There are two floor sumps with ¾ hp sump pumps located on the lower gallery level of the Primary Treatment Building. The water level in each sump is monitored by a float switch for a high level event. The float switches (LSH-330-1 and LSH-330-2) signal a high level alarm at the SCADA System HMI.

**Loop 400 – MBR System**

The MBR System is connected to the plant SCADA System. Monitored process variables, equipment status, and alarms are reported to the MBR Control Panel and forwarded to the SCADA System. Refer to the MBR manufacturer's (G. E. Water & Process Technologies, Zenon Membrane System O & M Manuals, Volume I, II, and III) O & M Manual for the instrumentation and control details of the MBR System.

**Loop 420, etc. – Submersible Aeration Lift Pumps**

The four Submersible Aeration Lift Pumps, two in each Pre-Anoxic Tank, transfer the WWTF flow from the Pre-Anoxic Tanks to the Aeration Tank Influent Channel, which distributes the flow to the individual Aeration Tanks. Each pump is monitored and controlled through the MBR System Control Panel located on the outside wall of the control room on the ground level of the Advanced Treatment Building or the SCADA System located inside the above mentioned control room. The pump's flow rate is regulated by the Pump's VFDs based on the liquid level in the Pre-Anoxic Tanks.

The following status and alarm signals are displayed at the MBRCP and the SCADA System HMI:

- Pump H-O-A in "Auto" (YI-420A-1, etc.);
- Pump run status (YI-420A-2, etc.);
- Motor over temperature alarm (TAH-420A-1, etc.);
- Pump VFD fault Alarm (YA-420A, etc.)(Change to add Speed etc.);
- Elapsed run time meter (KQI-420A, etc.);
- Speed indication (SI-420A, etc.); and

- Speed control (SC-420A, etc.).

**Loop 430A, etc. – Aeration Tank Blowers**

The three Aeration Tank Blowers are located in the blower room on the ground level of the Advanced Treatment Building. These blowers aerate the three aeration tanks and their air output/speed is controlled by dedicated VFDs based on the mixed liquor DO concentration measured in the aeration tanks. Each blower is monitored and controlled through the MBR System Control Panel and/or the SCADA System.

The following status and alarm signals are displayed at the SCADA System HMI:

- Blower H-O-A in “Auto” (YI-430A-1, etc.);
- Blower run status (YI-430A-2. etc.);
- Blower speed indication (SI-430A, etc.);
- Blower VFD fault alarm (YA-430A, etc.);
- Motor over temperature alarm (TAH-430A-1, etc.);
- Blower high vibration alarm (VAH-430A, etc.);
- Blower discharge high temperature alarm (TAH-430A-2, etc.); and
- Elapsed run time meter (KQI-430A, etc.).

**Loop 440A, etc. – Pre-Anoxic Tank Mixers**

There are four Submerged Mechanical Mixers, two in each Pre-Anoxic Tank. The Pre-Anoxic Tank Mixers are monitored and controlled through the MBR System Control Panel and/or the SCADA System. Both tank mixers should run if both tanks are operating.

The following status and alarm signals are displayed at the MBRCP and the SCADA System HMI:

- Mixer H-O-A in “Auto” (YI-440A-1, etc.);
- Mixer run status (YI-440A-s, etc.);
- Motor over temperature (TAG-440A, etc.);
- Mixer motor seal leak alarm (YA-440A, etc.); and
- Elapsed run time meter (KQI-440A, etc.).

**Loop 450. etc. – Air Scour Blowers**

The five air scour blowers are located in the blower room on the ground level of the Advanced Treatment Building. These blowers serve the MBR modules and help keep the media from fouling. They are constant speed blowers that operate 'ON" and "OFF" based on a PLC program. The blowers are monitored and controlled through the MBR System Control Panel and/or the SCADA System.

The following status and alarm signals are displayed at the SCADA System HMI:

- Blower H-O-A in "Auto" (YI-450A-1, etc.);
- Blower run status (YI-450A-2, etc.);
- Motor over temperature alarm (TAH-450A-1, etc.);
- High vibration alarm (VAH-450A, etc.);
- Blower discharge high temperature alarm (TAH-450A-2, etc.);
- Speed indication (SI-450A, etc.); and
- Elapsed run time meter (KQI-450A, etc.).

**Loop 460A, etc. – WAS/Scum Pumps**

The two WAS/Scum Pumps are located in the pump room on the basement level of the Advanced Treatment Building. They are variable speed pumps operating through VFDs #23 and #24. The WAS pumps alternate duty based on run times. The pump's speed and run time are operator entered set points based on a maximum mixed liquor concentration in the MBR tanks. The WAS Pumps are monitored and controlled through the MBR System Control Panel and/or the SCADA System.

The following status and alarm signals are displayed at the SCADA System HMI:

- Pump H-O-A in "Auto" (YI-460A-1, etc.);
- Pump run status (YI-460A-2, etc.);
- Pump low suction pressure alarm (PAL-460A, etc.);
- Pump high discharge pressure alarm (PAH-460A, etc.);
- Pump speed indication (SI-460A, etc.);
- Pump speed control (SC-460A, etc.); and
- Elapsed run time meter (KQI-460A, etc.).

**Loop 465 – WAS Flow Metering**

The 4-inch diameter ABB Magmaster MFE Series magnetic flow meter is located on the WAS pump and Tank Drain Pump common discharge line. WAS Pump flow rate is indicated, trended, and recorded at the MBR System control panel and at the SCADA System (FIR-465).

The following flow totals are displayed at the SCADA System HMI:

- Non-resettable flow total (FQI-465-1);
- Previous day flow total (FQI-465-2);
- Current day flow total (FQI-465-3) automatically reset at midnight; and
- Resettable flow total (FQI-465-4).

**Loop 470A, 470B, 470C, 470D – MBR System Effluent Flow Rate Metering**

The MBR effluent flow is monitored by an 8-inch diameter magnetic flow meter mounted on each of the four permeate pump pipelines. The permeate flow rate is primarily regulated by the plants influent flow signal. As the plant's influent flow increases or decreases the permeate pump speed increases or decreases. The level in the Pre-Anoxic Tanks is used to trim the permeate pump flow. As the tank level increases or decreases above or below a set point, the trim signal causes the permeate pump speed to ramp up or ramp down, accordingly. The MBR effluent flow is indicated, trended, and recorded at the SCADA System HMI (FIR-470A, etc.).

The following flow totals are displayed at the SCADA System HMI:

- MBR Train #1, #2, #3, #4 Effluent low flow alarm (FAL-470A, B, C, D);
- MBR Train #1, #2, #3, #4 Effluent high flow alarm (FAH –470A, B, C, D);
- Non-resettable flow total (FQI-470A-1, etc);
- Previous day flow total (FQI-470A-2, etc.);
- Current day flow total (FQI-470A-3, etc.); and
- Resettable flow total (FQI470A-4, etc.).

**Loop 480 – Advanced Treatment Building. Sump Level Alarms**

High level building sump alarms are displayed at the SCADA System HMI (LAH-480-1, LAH-480-2, LAH-480-3, LAH-480-4).

**Loop 600 – UV System**

The UV Disinfection System, which is located on the basement level of the Advanced Treatment Building, disinfects the wastewater prior to its discharge to the rapid infiltration basins. The system's local control panel controls the system and monitors process variables, equipment status, and alarms, which are presented at the SCADA System HMI. Refer to the UV Disinfection System manufacturer's O & M Manual for more information.

**Loop 605 – Plant Effluent Flow Rate Metering**

The plant Parshall Flume, which is located on the basement level of the Advance Treatment Building, measures the plant effluent flow rate. The flow rate is indicated, trended, and recorded at the vendor furnished local control panel and at the SCADA System HMI (FIR-605).

The following flow alarms and flow totals are displayed at the SCADA System HMI:

- Effluent low flow alarm (FAL-605);
- Effluent high flow alarm (FAH-605);
- Non-resettable flow total (FQI-605-1);
- Previous day flow total (FQI-605-2);
- Current day flow total (FQI-605-3) automatically reset at midnight; and
- Resettable flow total (FQI-605-4).

**Loop 610 – Effluent Sampler**

The plant effluent sampler, which is located on the basement level of the Advanced Treatment Building, samples the wastewater effluent flow to confirm that the discharge satisfies the plant's groundwater permit requirements. To obtain a flow proportional sample, the unit receives a 4-20mA DC effluent flow rate signal from the SCADA System HMI (FY-605).

The following monitoring signals and alarms are displayed at the SCADA System HMI:

- The pH low level alarm (AAL-610);
- The pH high level alarm (AAH-610); and
- Sample pH relay (YA-610).

**Loop 620 – Plant Water System**

The Plant Water System, which is located on the lower level of the Advanced Treatment Building, is a package unit that draws treated wastewater from the plant effluent channel upstream of the Parshall Flume. The Plant Water System supplies non-potable water for various uses throughout the plant. The Plant Water System package unit includes a vendor furnished local control panel that controls the operation of the Plant Water System.

The following status and alarm signals are displayed at the SCADA System HMI:

- Pump #1, #2, and #3 run status (YI-620A, B, C);
- Pump #1, #2, and #3 failure alarm (YA-620A, B, C);
- Low system pressure (PAL-620-1);
- Low suction pressure (PAL-620-2);
- Irregular power alarm (JA-620);
- Flow rate (FI-620); and
- Elapsed run time meter for each pump (KQI-620A, etc.).

**Loop 700A and 700B – Sludge Holding Tanks**

The two ATB Sludge Holding Tanks act as sludge storage reservoirs that receive and hold both primary and advanced treatment sludge prior to their being dewatered by the Rotary Press System. The level in each of the two sludge holding tanks is indicated, trended, and recorded at the SCADA System HMI (LIR-700A & 700B).

The following status and alarm signals are displayed at the SCADA System HMI:

- Tank #1 and #2 high level alarm (LAH-700A & B); and
- Tank #1 and #2 liquid level (LIR-700A & B) used for control interlocks on Blowers and Rotary Press Feed Pumps/Grinders.

**Loop 710A, B, & C – Sludge Holding Tank Blowers**

The three Sludge Holding Tank Blowers are located on the ground level of the Advanced Treatment Building. Two Blowers operate constantly to maintain a homogeneous volume and prevent the sludge from turning septic. The Blower VFDs have H-O-A selector switches for local operation. When the switch is in the Auto position, remote automatic and remote manual control via the SCADA System HMI is enabled.

The following status and alarm signals are displayed at the SCADA System HMI:

- VFD speed indication (SI-710A, etc.);
- H-O-A selector switch in “Auto” (YI-710A, etc.);
- Run status indication (YI-710A-2, etc.);
- VFD fault alarm (YA-710A-1, etc.);
- Motor over temperature alarm (TAH-710A-1, etc.);
- High vibration alarm (VAH-710A, etc.);
- Blower discharge high temperature alarm (TAH-710A-2, etc.);
- Elapsed run time meter (KQI-710A, etc.); and
- Motor state disagreement alarm (YA-710A-2, etc.).

**Loop 720A, B, and C – Rotary Press Feed Pumps/Grinders**

The three Rotary Press Feed Pumps/Grinders are controlled and monitored through the Variable Frequency Drive Unit’s 10VFD-#6, #7, and #8. These three VFD units are located in the electric room on the ground level of the Advanced Treatment Building.

The following control, status, and alarm signals are displayed at the SCADA System HMI:

- Pump H-O-A in “Auto” (YI-720A-1, etc.);
- Pump run status (YI-720A-2, etc.);
- Pump/Grinder Start/Stop (YS-720A, etc.);
- Pump low suction pressure alarm (PAL-720A, etc.);
- Pump high discharge pressure (PAH-720A, etc.);
- Pump speed indication (SI-720A, etc.);
- Pump speed control (SC-720A, etc.);
- Pump VFD fault alarm (YA-720A-1, etc.);
- Grinder H-O-A switch in “Auto” (YI-720A-3, etc.);
- Grinder run status (YI-720A-4, etc.);
- Grinder failure alarm (YA-720A-2, etc.); and
- Elapsed run time meter (KQI-720A-1 & 2, etc.).

**Loop 725A, 725B & 725C – Rotary Press Feed Flow Metering**

The Rotary Press Feed flow rate is measured by three 6-inch diameter ABB Magmaster MFE Series magnetic flow meters located on each pump's discharge line. The feed flow rate is indicated, trended, and recorded at the SCADA System HMI (FIR-725A, etc.).

The following alarms and flow totals are indicated at the SCADA System HMI:

- Flow alarm low (FAL-725A, etc.);
- Flow alarm high FAH-725A, etc.);
- Non-resettable flow total (FQI-725A-1, etc.);
- Previous day flow total FQI-725A-2, etc.);
- Current day total (FQI-725A-3, etc.); and
- Resettable flow total (FQI-725A-4, etc.).

**Loop 730A, 730B, and 730C – Rotary Presses (E. T. to review/approve description)**

The Rotary Press System is located in the dewatering room of the Sludge Processing Building. The Rotary Presses and related equipment are controlled by four local control panels. The local control panels monitor the process variables, equipment status, and alarms associated with the Rotary Presses and related equipment and transmit that information to the SCADA System. The operator's access to that information is through the SCADA System HMI.

Detailed instrumentation and control information is provided in the Fournier Industries, Inc. Operating and Maintenance Manual for Dewatering Equipment (Rotary Press Model 4(6)-900/6000CV) Instrumentation and Control three ring binder Rev. 00 – June 2007.

**Loop 740A, 740B & 740C – Sludge Conveyors**

The operation of the Sludge Conveyors is controlled through the Rotary Press System control panel. The control panel includes a common alarm, run status, and Start/Stop controls.

The following status and alarm signals are displayed at the SCADA System HMI:

- Conveyor Trains A B and C run status (YI-720A, etc.);
- Conveyor Trains A B and C common alarm (YA-740A, etc.)
- Elapsed run time meters (KQI-740A, etc.)

- Conveyor Trains A, B, and C are remotely Started/Stopped (YS-740A, etc.) when the Grit Collection System is Started/Stopped.

**Loop 750A and 750B – Polymer Feed Systems**

The operation of the two polymer feed systems is controlled through the Rotary Press System control panel. Refer to Loop #730.

The following alarm signals are displayed at the SCADA System HMI:

- Polymer feed system #1 common alarm (YA-750A); and
- Polymer feed system #2 common alarm (YA-750B).

**Loop 760 – Odor Control System**

The Odor Control System is located in the Odor Control Room of the Sludge Processing Building. The operation of the Odor Control System is controlled through the vendor furnished local control panel located in the electrical room. The local control panel includes a low pH alarm, high outlet hydrogen sulfide concentration, a low ORP alarm, a high sump alarm, and a low sump alarm.

The following status and alarm signals are displayed at the SCDAC System HMI:

- High sump level alarm (LAH-760);
- 
- Low sump alarm (LAL-760A);
- Low pH alarm (AAL-760-1);
- Low ORP alarm (AAL-760-2); and
- High outlet $H_2S$ alarm (AAH-760).

**Loop 765 – Chemical Storage Tanks**

There are two chemical storage tanks located in the Odor Control Room of the Solids Processing Building. One chemical storage tank contains sodium hypochlorite and the other storage tank contains sodium hydroxide. Both chemicals are used in the Odor Control System as well as other various process systems.

The following status and alarm signals are displayed at the SCADA System HMI:

- The sodium hypochlorite chemical storage tank level is indicated, trended, and recorded (LIR-765A) and alarmed (LAH-765A)(LAL-765A);
- The sodium hydroxide chemical storage tank level is indicated, trended, and recorded (LIR-765B) and alarmed (LAH-765B)(LAL-765B); and

- The chemical storage tank containment area spill alarm (LAH-765).

**Loop *00 Series**

The loops in the 800 series cover the chemical systems located in the Chemically Enhanced Primary Treatment Building, which was used prior to the 2008 upgrade and are not covered in this O & M Manual.

**Loop 900 – In-Plant Pump Station**

The Surfside Treatment Facility's internal wastewater flows by gravity to the In-Plant Pumping Station located in the yard area between the Primary Treatment Facilities and the Advanced Treatment Facilities. The wastewater collected at the station is pumped to the plant's influent channel at the Headworks Facility.

The following status and alarm signals are displayed at the SCADA System HMI:

- Pump #1 H-O-A switch not in "Auto" (YI-900A-1);
- Pump #2 H-O-A switch not in "Auto" (YI-900B-1);
- Pump #1 run status (YI-900A-2);
- Pump #2 run status (YI-900B-2);
- Wet Well level (LIR-900);
- High Wet Well level (LAH-900);
- Low Wet Well level (LAL-900);
- Pump #1 motor overload (YA-900A-1);
- Pump #2 motor overload (YA-900A-1);
- Pump #1 motor over temperature (TAH-900A);
- Pump #2 motor over temperature (TAH-900B);
- Pump #1 seal leak (YA-900A-2);
- Pump #2 seal leak (YA-900B-2);
- Low voltage/phase reversal (EA-900);
- Normal power failure (JAL-900); and
- Elapsed run time meter for each pump (KQI-900A, etc.).

# 14 - LABORATORY

## 14.1 GENERAL

The majority of plant process testing will be performed at the Surfside WWTF is equipped with a modern wastewater laboratory. Effective use of laboratory data is an important requirement for the operation of the Surfside WWTF. Efficiency of the treatment process will depend upon the quality control maintained in the laboratory. Justification for process control decisions will be based upon the accuracy of lab determinations. Developing problems will be identified by lab tests and corrective action will be taken long before serious operational upsets can occur. The surfside WWTF shall employ one (1) Laboratory Technician. The technician is required by the EPA to demonstrate competency in the analysis he/she performs, as demonstrated through their training and education. The technician is also encouraged to receive the NEWEA Laboratory Analyst Certification, refer to the NEWEA website for more information.

To be of value, laboratory data must be obtained regularly and the interpretation of the results must be known and thoroughly understood. For these reasons, the services of an EPA certified, experienced Contract Laboratory should be arranged and maintained for proper facility operation. Testing requirements are outlined in some of the previous chapters. A summary of this information follows. Actual work experience may lead to modification of the monitoring frequency.

## 14.2 LABORATORY SAFETY

Any personnel working in the laboratory should be aware of the potential dangers. The major threats to lab personnel are:

- Infectious Materials
  - Wash hands often
  - Observe rules of personal hygiene
  - Do not eat in the lab

- Corrosive Chemicals, Acids and Bases
  - Know the location of the emergency shower and eye wash station
  - When the lab emergency shower or eyewash is used, an alarm is activated at the alarm indicator panel in the Process Building. Emergency medical phone numbers should be clearly posted near a phone for immediate use.
  - Do not mouth pipette anything
  - Remember! When working with acid - "if you do what you oughta, add the acid to the water (wata)."
  - Wear gloves
  - Use goggles
  - Use the fume hood when required
  - Wear a lab apron
  - Remember to periodically check the status of the neutralizing chips in the polypropylene acid neutralization tank.

- Toxic, Explosive or Flammable Material
  - Avoid inhaling fumes and use the fume hood.
  - Be careful around open flames.
  - Do not smoke in the lab or anywhere else in the building.

- Broken Equipment
  - Do not use broken or cracked equipment.
  - Dispose of broken glass properly.

- Handling Chemicals
  - Check labels and be sure you have the proper chemical for the job.
  - All chemicals and bottles should be clearly labeled.
  - Do not handle chemicals with your bare hands. Wear gloves and use a spatula, spoon or tongs.

## 14.3 TYPES OF SAMPLES

### *14.3.1 Grab Samples*

Grab samples can be taken to represent the flow of wastewater at one given time. Take great care to obtain samples that are truly representative. Be sure to record when the sample was taken, the location, the date, the name of person doing the sampling and the volume.

Refer to this chapter under the section detailing sampling requirements. This will alert you to the volume required to do the analysis, what type of container to use, how long the sample can be held and what preservative to use.

### *14.3.2 Composite Samples*

Composite samples usually refer to a mixture of grab samples collected at the same location over a period of time. It is absolutely a must, that all sample lines and bottles used in a composite sampler be clean. Composite samples are not normally required to be flow proportioned for a small facility with flow equalization.

Influent and effluent wastewater samplers are provided to sample from Headworks and UV Channel outlet with the samplers located at Headworks and in the UV Room, respectively. The sampler automatically collects wastewater in bottles, which are then collected by the operator at predetermined time intervals. These samples are taken to the laboratory for testing or storage for shipment to the certified laboratory. After the sampler collects the samples using a peristaltic pump, it preserves the samples using refrigeration.

The Operator should review the discharge permits for any composite sampling requirements. The influent samples will be proportioned to the 4-20 mA signal from the influent magnetic flow meter and the effluent samples will be proportioned to the 4-20 mA signal from the effluent Parshall Flume. The Operator simply must connect the appropriate cables to the influent and/or effluent sampler and program the sampler using the sampler manufacturer's guidelines. The refrigerated wastewater samplers must be in maintained in order to keep the samples at 4°C.

**Table 14.1 - Recommended Methods For Sampling and Preservation** shows a list of laboratory tests and the required preservation technique. Be sure to coordinate preservation requirements and maximum allowable holding times with the Laboratory.

## 14.4 RECORDS

A log book should be maintained by the Lab Technician at the Surfside WWTF to record all sampling information including the time and date of the sample, type of sample, preservation used, and the sampler's initials. Some tests are required to be taken on a daily basis, others on a monthly or weekly basis. Individual records of test results will be needed to fill out State and Federal discharge forms that must be sent in to the regulatory agency no later than the fifteenth day of each following month. All lab records at the Laboratory must be up to date, accurate and filed properly. In addition to laboratory data, accurate records must be kept for plant operational data such as flows, blanket depths, and amount of sludge pumped.

Laboratory test data, which requires computation, should be recorded on preprinted bench sheets. Following this method will insure that all required information is obtained. The use of the bench sheets will also aid the Technician in checking computations since the figures will be organized. From these reports the Technician can be informed as to the performance of the facility and where adjustment will be needed.

It is helpful to put each test in perspective and plot trends of the lab results. Such a method may aid in pinpointing when a problem first arose and possible causes for the deviation. Laboratory bench sheets are included at the end of this Section, to be used as master sheets to produce working copies. It is very important to be able to "back-up" your data by keeping the bench sheets used to generate the final, reporting figure. Always remember that generation of data is meaningless unless you can defend how it was obtained via bench sheets. Keeping good records is just as important as conducting the analysis properly.

**TABLE 14.1 - RECOMMENDED METHODS FOR SAMPLING AND PRESERVATION ACCORDING TO MEASUREMENT**

| Measurement | Vol. Req. (ml) | Container* | Preservative | Holding Time |
|---|---|---|---|---|
| Alkalinity | 100 | P or G | Cool, 4°C | No Holding |
| BOD | Varies | P or G | Cool, 4°C | 48 hrs after final sample |
| COD | 50 | P or G | $H_2SO_4$ to pH 2 | 7 days |
| Coliform, Fecal | 100 | P or G (Sterile) | Cool, 4°C | 8 hrs. |
| Dissolved Oxygen Uptake | 300 | G only | Det. on site | No Holding |
| Winkler D.O. | 300 | G only | Fix on site | No Holding |
| Nitrogen | | | | |
| Ammonia | 100 | P or G | Cool, 4°C, $H_2SO_4$ to pH 2 | 28 Days |
| Kjeldahl | 25-300 | P or G | Cool, 4°C, $H_2SO_4$ to pH 2 | 28 Days |
| Nitrate | 100 | P or G | Cool, 4°C, $H_2SO_4$ to pH 2 | 48 hrs. |
| Nitrite | 50 | P or G | Cool, 4°C, $H_2SO_4$ to pH 2 | 28 Days |
| Oil & Grease | Up to 1000 | Brown G only | Cool, 4°C, $H_2SO_4$ to pH 2 | 28 Days |
| pH | 25 | P or G | Cool, 4°C, Det. on site | No Holding |
| Phosphorus, Ortho-phosphate | | | | |
| Dissolved | 50 | P or G | Filter on site, Cool, 4°C | 24 hrs. |
| Hydrolyzable | 50 | P or G | Cool, 4°C, $H_2SO_4$ to pH 2 | 24 hrs. |
| Total | 50 | P or G | Cool, 4°C, $H_2SO_4$ to pH 2 | 24 hrs. |
| Total Dissolved Residue | 50 | P or G | Filter on site, Cool, 4°C | 24 hrs. |
| Filterable | 1000 | P or G | Cool, 4°C | 7 days |
| Non-filterable (TSS) | 1000 | P or G | Cool, 4°C | 7 days |
| Total | 100 | P or G | Cool, 4°C | 7 days |
| Volatile | 100 | P or G | Cool, 4°C | 7 days |
| Settleable Matter | 1000 | P or G | None Req. | 24 hrs. |

*(P) Plastic and (G) Glass

The required sampling parameters and sampling locations are outlined in the MassDEP Groundwater Discharge Permit which is attached as Appendix B.

Maintain a file in the lab, on all testing done. In most areas, it would be a good choice to keep this file in chronological order and store the records for three years before you throw out the bench sheets. Always retain your reporting values.

It is most helpful to plot all the data on a graph. Presenting data in this way will give a quick overview of the data and allow you to judge the direction of trends.

## 14.5 INFLUENT AND EFFLUENT QUALITY MONITORING AND TESTING

Monitoring and recording of the quality of influent and effluent is required by the MassDEP Groundwater Discharge Permit. The parameters are to be monitored in the influent, primary clarifier effluent, pre-aeration system, MBR system effluent, final effluent, and groundwater monitoring wells. Refer to **Table 14.2** - **Influent and Effluent Quality Monitoring and Testing.** Those parameters required by MassDEP are indicated.

## 14.6 TEST PURPOSE AND DESCRIPTION

Laboratory procedures to be followed for the various tests may be found in the most recet edition of "Standard Methods for the Examination of Water and Wastewater". Process control using "Standard Methods" as a guide, insures proper methodology needed for testing samples required under the permits. At the completion of each test, you should get into the habit of cleaning the work area, reshelving all equipment and chemicals, and cleaning all used equipment before they move onto the next test.

Following is a discussion of the purpose, application and character of each of the laboratory tests to be performed. These discussions were taken in part, from the process control manual for "Aerobic Biological Wastewater Treatment Facilities." E.P.A., Municipal Operations Branch, March, 1977. Not all the tests described are required by permits. However, as potential tools that could be used by the Lab Technician, these tests have been addressed in this section.

### *14.6.1 Dissolved Oxygen*

Dissolved oxygen (DO) is that oxygen dissolved in liquid and is usually expressed as milligrams per liter (mg/L). There are various types of tests to determine the DO content of water. Generally, the isometric methods and the membrane electrode (DO probe) are best suited for the domestic wastewater application.

**TABLE 14.2 - INFLUENT AND EFFLUENT QUALITY MONITORING AND TESTING**

| Process | Parameter | Sample Type | Frequency |
|---|---|---|---|
| Influent [1 and 2] | $BOD_5$ [1,2] | 24 Hr Composite | Weekly |
| | Total Suspended Solids [1,2] | 24 Hr Composite | Weekly |
| | Ammonia-Nitrogen [2] | 24-Hr Composite | Weekly |
| | ph[1,2] | Grab | Daily |
| Primary Clarifier Effluent [1] | $BOD_5$ | 8 Hr Composite | Weekly |
| | Suspended Solids | 8 Hr Composite | Weekly |
| | Settleable Solids | Grab | Daily |
| | Temperature | Grab | Daily |
| | Alkalinity | Grab | Daily |
| | ph | Grab | Daily |
| | Total Solids | 8 Hr Composite | Weekly |
| | Oil and Grease | Grab | Weekly |
| MBR System Effluent [1] | Settleability | Effluent Grab | Weekly |
| | ph | Effluent Grab | Daily |
| | Suspended Solids | Effluent Grab | Weekly |
| | VSS | Mixed Liquor | Weekly |
| | Microscope Analysis | Mixed Liquor | Daily |
| | DO | Mixed Liquor | Daily |
| | MLSS | Mixed Liquor | Daily |
| | Sludge Volume Index | Mixed Liquor | Daily |
| | Oxygen Uptake Rate | Mixed Liquor | Daily |
| Final Effluent [2] | $BOD_5$ [2] | 24 Hr Composite | Weekly |
| | Total Nitrogen [2] | 24 Hr Composite | Monthly |
| | Total Dissolved Solids [2] | Grab | Monthly |
| | ph[2] | Grab | Daily |
| | Total Suspended Solids [2] | 24 Hr Composite | Weekly |
| | Nitrate-Nitrogen | 24 Hr Composite | Monthly |
| | Fecal Coliform | Grab | Monthly |
| | Oil and Grease [2] | 24 Hr Composite | Monthly |
| | Volatile Organic Compounds [2] | Grab | Quarterly |
| | Total Phosphorous | 24 Hr Composite | Quarterly |
| | Orthophosphate | 24 Hr Composite | Quarterly |
| Groundwater Monitoring Wells [2 and 3] | Specific Conductance [2] | Grab | Quarterly |
| | ph | Grab | Quarterly |
| | Nitrate Nitrogen [2] | Grab | Quarterly |
| | Total Nitrogen [2] | Grab | Quarterly |
| | Volatile Organic Compounds [2] | Grab | Quarterly |
| | Volatile Organic Compounds [2] | Grab | Quarterly |
| | Total Phosphorous | 24 Hr Composite | Quarterly |
| | Orthophosphate | 24 Hr Composite | Quarterly |

[1] Samples shall be gathered and tested concurrently with effluent samples so removal percentages can be determined.

[2] MassDEP required testing.

[3] Refer to Appendix C - Groundwater Sampling Procedures.

The Azide modification of the iodometric method (also known as the Winkler Method) is recommended for most wastewater and stream samples. When determining the DO in biological flocs, which have high oxygen utilization rates, the membrane electrode method is popular because of its speed, ease of operation, and adaptability to process control instrumentation. The membrane electrodes must be properly maintained and calibrated on a daily basis to ensure that their measurements are accurate and usable for process control. Calibration against a Winkler is sometimes done, however air calibration is quicker.

The significance of the DO test in process control is in its measurement of the dissolved oxygen available for and essential to aerobic decomposition of the organic matter; otherwise, anaerobic decomposition may occur with the possible development of nuisance conditions.

When performing the DO test, use extreme caution in handling the chemical reagents to avoid injury. Wear protective clothing. Sulfuric acid and alkaline iodide acids are strong chemicals. Do not agitate or trap any air bubbles in the sample during the test. Perform the test immediately following collection of the samples. Standard Methods, most current edition, gives the procedure to follow.

### *14.6.2 Biochemical Oxygen Demand*

The Biochemical Oxygen Demand (BOD) is an index of the amount of oxygen that will be consumed by the decomposition of the organic matter in a water or wastewater sample. The analysis consists of measuring the initial dissolved oxygen concentration, incubation for five days at 20$^{o}$C, and measuring the final dissolved oxygen. The BOD test is related to both the organic loading upon the biological process as well as the removal efficiency of the process. A properly conducted BOD analysis will have organic matter as the growth limiting substance. If oxygen is limiting, the analysis is not meaningful.

Note: In the summer, the use of a nitrification inhibitor may be required. Review Standard Methods for more information. Consult with the State Regulating Authority before using a nitrification inhibitor. If allowed, be sure to label your results as "N inhibitor used" on the State monthly report forms.

### *14.6.3 Total Suspended Solids*

The suspended solids test refers to the solids in suspension that can be removed by standard filtering laboratory procedures. The suspended matter is determined by filtering a known volume of sample through a weighed glass fiber or membrane filter disc in an appropriate filtering apparatus. The filter with the entrapped solids is oven-dried at 103$^{o}$

to 105$^{o}$ C and then cooled in a desiccator and subsequently weighed. The increase in filter weight represents the suspended matter. (Consult the most current edition of Standard Methods.

The significance of the suspended matter test is generally dependent on the type of treatment process and the location of measurement within the process application. Results of the test have the following uses in process control:

- Evaluating the organic strength of the wastewater;
- Evaluating the clarifier solids loading;
- Calculating tank and treatment efficiencies; and
- Judging the required primary sludge removal in gallons.

See the following sample equation:

Basic Formulas:

1. Solids Captured x Flow x Density of Water = Lbs Solids Captured per day

2. $$\frac{\text{LBS Sludge capture per day}}{(\text{\% Solid Sludge x Density of Water})} = \text{Gallons of Sludge per Day}$$

Given:

Flow = 1.0 mgd
S.S. in influent = 250 mg/L
S.S. in effluent = 150 mg/L
Dry solids in sludge = 5%.

Calculations

1. Dry solids capture:
   250 mg/L (Influent S.S) - 150 mg/L (Effluent S.S.) = 100 mg/L

2. Pounds of Solids Captured
   1 mgd x 8.34 lbs/gal x 100 ppm = 834 lbs./day

3. Gallons of Sludge to be Pumped
   $$\frac{8.34 \text{ lbs /gal}}{(0.05 \text{ X } 8.34 \text{ lbs. / gal})} = 2{,}000 \text{ gpd}$$

When performing the suspended matter test, follow procedures outlined by Standard Methods. Other tips for accuracy are:

- Mix the entire sample before taking a portion for testing;
- Use a graduated cylinder to ensure all solids in the sample portion will be tested;
- Solids in the sample that 'stuck on' to the side of the cylinder wall must be rinsed through the filter using distilled water;

- Monitor the drying temperature: $103^{o}$ to $105^{o}$ C;
- Be sure to properly seat the filter paper;
- Use large samples to reduce weighing errors; and
- Be consistent in the time allowed for the filter apparatus and paper to cool in the desiccator.

### *14.6.4 Total Solids*

The total amount of solid material in wastewater is a significant factor in defining its strength and the extent of treatment, which should be applied to it. In applying this test, both the total solids content of the sample and the organic solids concentration, or those solids, which volatilize by ignition, should be measured. This test is used in assessing the character and strength of sewage as well as the efficiencies of treatment operations. Remember the following tips when doing this determination:

- Calibrate the balance to absolute zero;
- Make sure the drying oven is set at $98^{o}$ C when using the oven to evaporate the sample. This will prevent boiling and splattering;
- Once the sample has evaporated, dry it in a drying oven at $103^{o}$ C to $105^{o}$ C for one hour; and
- Cool thoroughly before placing on the analytical balance.

### *14.6.5 Dissolved Solids*

The total solids minus the suspended solids will equal the dissolved solids. Results of the test are an indication of the treatment load on secondary processes.

### *14.6.6 Percent Solids (Sludge)*

This test is a measure of all material present in sludge, both in suspension and in solution. Unlike total solids in wastewater, which is expressed in mg/L, total solids in sludge are expressed in terms of percent by weight of the total amount of solids. Conversely, percent moisture of a sludge sample can be found. Determining efficiencies of dewatering units is one application of this test. All weight determinations must be performed quickly. Wet samples tend to lose weight by evaporation. After drying, the residues are often hygroscopic (similar to a dry sponge) and rapidly absorb moisture from the air. Consult Standard Methods for a discussion of this analysis.

Note: To reduce pumping costs, it is generally desirable to minimize moisture content, as a 4 percent sludge (96 percent water) has half the volume of a 2 percent sludge (98 percent water).

### *14.6.7 Volatile Suspended Matter*

The volatile suspended solids test is performed by volatilizing (burning) the non-filterable residue from the total suspended solids test. The volatilization is done by burning in a furnace at about 55$^{o}$C. The results of this test indicate the amount of volatile and nonvolatile solids contained in the sample. Consult Standard Methods for a discussion of this analysis.

### *14.6.8 Chemical Oxygen Demand*

The COD is an estimate of the total oxygen demand that results from the degradable organic matter. The analysis consists of oxidizing the organic matter with potassium dichromate in a heated, strongly acidic solution. This analysis suffers from the disadvantage that it does not measure the rate or biodegradability of the organic matter.

When performing the COD test, the following procedures should be followed in conjunction with those outlined in Standard Methods.

- Use a wide tip pipette to ensure that a representative sample is taken;
- Glassware used for the COD analyses must be washed with hydrochloric acid, hot washed, and rinsed three times with distilled water;
- Safety precautions should be observed when handling the chemical reagents for the test. Goggles, a rubberized apron and asbestos gloves are essential equipment;
- If a sample turns green during or immediately following the heating period, the analysis is not valid and should be re-examined in a more dilute sample; and
- A primary standard consisting of potassium (hydrogen acid), phthalate (KHP 500 mg/L) should be analyzed on a weekly basis to ensure that the analyses are consistent. Remember to use volumetric pipettes when analyzing reagents.

### *14.6.9 Hydrogen Ion Concentration (pH)*

The intensity of acidity or alkalinity of a solution is numerically expressed by its pH. A pH value of 7.0 is neutral, while values 7 to 14 are alkaline and values 0 to 7 are acid. pH can be measured calorimetrically or electrometrically. The electrometric method (pH meter) is preferred in all applications because it is not as subject to interference by color, turbidity or colloidal matter. The pH measurements are valuable in process control because pH is one of the environmental factors that affect the activity and health of microorganisms. Generally, the pH of a secondary effluent will be close to 7.0. To conduct this test:

- Grab samples should be used;

- Do not contaminate the buffer by pouring used buffer solution back into the buffer container;
- Calibrate the meter daily;
- Adjust the meter for temperature changes; and
- Keep the electrodes clean.

Consult Standard Methods for a discussion of this analysis.

#### *14.6.10 Coliform Bacteria*

The purpose of the routine bacteriological examination of wastewater effluent is to determine the efficiency of the chlorination process and the impact of potential health hazards discharged to the receiving water. The total coliform group can be subgrouped as fecal and non-fecal coliforms. The fecal coliform subgroup is derived from feces of human and other warm blooded animals. Pathosene: (*E.Coli*) is a member of the fecal coliform subgroup. Non-fecal organisms are frequently found on vegetation and in the soil.

Organisms of the non-fecal subgroup tend to survive longer in water than do the fecal subgroup. Non-fecal coliforms also tend to be somewhat more resistant to chlorination than the fecal coliform group or the commonly occurring intestinal bacterial pathogens. For this reason, a good bacterial kill (total coliform 99% and higher) indicates a near complete destruction of pathogens.

The presence of (*E.Coli*) organisms indicates recent fecal pollution. The presence of non-fecal coliform suggests less recent pollution. In domestic sewage, the F.C. density may constitute 30 to 40 percent of the total coliform density. Consult Standard Methods for a discussion of this analysis.

Reporting Colonies Counted - Fecal Coliform Monthly Results Using an Electronic Calculator Procedure:

- Enter the colony count in the calculator. Press the log button;
- Record this value;
- Sum of the values;
- Divide this sum value by the total number of counts, including zeros, for the monthly period;
- Find the antilog of the average log sums;

- If any coliform counts are listed as TNTC (Too Numerous To Count), no value for the geometric mean should be reported. Instead, simply list all the values individually in the order they were obtained; and

- Specify that the monthly figure is a Geometric Mean.

Notification of the use of a geometric mean first appeared in the Federal Register, Volume 38, No. 159, 8/17/73.

Example:

| Week Number | Fecal Coliforms per 100 ml | Log |
|---|---|---|
| 1 | 300 | 2.47712 |
| 2 | 2400 | 3.38021 |
| 3 | 0 | 0 |
| 4 | 160 | 2.20412 |
| | TOTAL | 8.06145 |

Average = 8.06145 / 4 = 2.01536. The Antilog of 2.01536 is equal to 104. This is the figure to use for monthly reporting purposes.

### *14.6.11 Total Kjeldahl Nitrogen (TKN)*

TKN is a measurement of the ammonia and organic nitrogen present in the waste sample. It does not take into consideration the nitrite or nitrate nitrogen. Consult Standard Methods for a discussion of this analysis. Due to the fact that strong acids, bases and heat are used in the execution of this test, great care must be followed throughout. The entire digestion and distillation process must be completed under the fume hood. After the digestion process, acids are left in the bottom of the flask (800 ml Kjeldahl). Prior to the distillation step, the contents of the flask has its pH elevated with a sodium hydroxide-thiosulfate (BASIC) solution. You must dilute the digestate first with distilled water before the base is added or a violent reaction will take place that could easily cause damage or injury. Consult Standard Methods for a discussion of this analysis.

#### *14.6.12 Ammonia*

Depending upon the concentration, the titrimetric and the Nesslerization method should be used for analysis of ammonia concentration. The choice of method depends upon the concentration of ammonia found in the sample. Low concentrations, (5 mg/L or less), should use the Nesslerization Method, and higher values should be analyzed using the titrimetric method. Selection of method is strictly a matter of the level of concentration. Both methods should require a preliminary distillation step.

Note: An ammonia selective electrode can be used with or without preliminary distillation. The range of operation for the probe is 0.03 to 1,400 mg/L ammonia. Sterilize the probe prior to use.

## 14.7 CHEMICALS USED IN THE LAB

**Table 14.3 - Recommended Laboratory Chemical Inventory** is a list of chemicals and quantities recommended for the startup of the facility. This list is being presented to enable the staff to keep the chemical inventory up to proper operating standard. Refer to **Table 14.4 - Common Preservatives and Application**. It is up to the laboratory staff to update this list with respect to change laboratory requirements. It should be further noted that all the chemicals presented in this list are of Certified Reagent Grade or better. All should meet the standards as set forth by the American Chemical Society.

**TABLE 14.3 - RECOMMENDED LABORATORY CHEMICAL INVENTORY**

| Description and Specification | Quantity | Description and Specification | Quantity |
|---|---|---|---|
| Acetic Acid | 500 ml | Potassium Dihydrogen Phosphate | 500 g |
| Boric Acid | 500 g | Dipotassium Hydrogen Phosphate | 500 g |
| Hydrochloric Acid | 6 lb | Potassium Sulfate | 500 g |
| Sulfuric Acid | 5 pt | Potassium Iodide | 500 g |
| Sulfuric Acid 0.02 N. | 6 x 1L | Potassium Iodide Solution | 6 x 40 oz |
| Ethanol, absolute denatured | 1 gal | Sodium Tetraborate | 500 g |
| Alkaline Iodide Sodium Azide Solution | 1 L | Sodium Chloride | 500 g |
| Ammonium Chloride | 500 g | Electolyte Tablets | 500 g |
| Calcium Chloride | 500 g | Sodium Carbonate Anhydrous | 500 g |
| Colbaltous Chloride | 100 g | Ethylenediamine Tetraacetic Acid Disodium Salt | 500 g |
| Ferric Chloride | 1/4 lb | Sodium Hydroxide | 500 g |
| Magnesium Sulfate | 500 g | Disodium Hydrogen Phosphate | 500 g |
| Manganese Sulfate | 6 lb | Sodium Sulfite | 500 g |
| Mercuric Oxide | 1/4 lb | Sodium Thiosulfate | 500 g |
| Methyl Red Hydrochloride | 25 g | Buffer, pH 4.0 | 6 x 4 oz |
| Methylene Blue | 1/4 lb | Buffer, pH 7.0 | 6 x 16 oz |
| N-(1-Naphthyl) Ethylenediamine dihydrochloride | 25 g | Buffer, pH 4.0 | 1 L |
| Phenolphthalein | 25 g | Buffer, pH 7.0 | 500 ml |
| Potassium Dichromate | 500 g | Buffer, pH 10.0 | 500 ml |
| Potassium Biodate | 1/4 lb | Phenylarsine Oxide | 6 x 16 oz |
| Potassium Biphthalate | 100 g | Starch Solution | 1 qt |
| Potassium Hydroxide | 500 g | M-Endo Les Broth (Ampoule) | 1 Box |
| Potassium Nitrate | 500 g | M-FC Broth (Ampoule) | 1 Box |
| Potassium Nitrite | 500 g | | |

Note: Refer to MSDS sheets for further detailed information on Laboratory Chemicals.

**TABLE 14.4 - COMMON PRESERVATIVES AND APPLICATION**

| Preservative | Action | Applicable to |
|---|---|---|
| HgC12 | Bacterial Inhibitor | Nitrogen forms,<br>Phosphorous forms |
| Acid (HNO3) | Metals solvent,<br>prevents precipitation | Metals |
| Acid (H2S)4) | Bacterial Inhibitor | Organic samples<br>(COD, oil & grease organic carbon) |
| | Salt formation with volatile compounds | Ammonia, amines |
| Alkali (NaOH) | Salt formation with volatile compounds | Cyanides, organic acids |
| Refrigeration | Bacterial Inhibitor | Acidity-alkalinity, organic materials,<br>BOD, color, odor, organic P,<br>organic N, carbon, etc.,<br>biological organism (coliform, etc.) |

*In summary, refrigeration at temperatures near freezing or below is the best preservative technique available, but it is not applicable to all types of samples.

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# 15 - PREVENTATIVE MAINTENANCE

## 15.1 INTRODUCTION

A total maintenance program, which combines preventative maintenance and corrective maintenance, must be developed for the Surfside WWTF. The development of a maintenance program is essential for continuous trouble-free operations. The program should contain equipment information, scheduled preventative and corrective maintenance tasks, maintenance logs, inventory management, information to help solve regularly occurring maintenance problems, and record data for preparing maintenance cost analysis.

Refer to **Table 15.1 – Preventative Maintenance Program, Table 15.2 – Preventative Maintenance Record, Table 15.3 – Service Record** and **Table 15.4 – Schedule of Inspections and Preventive Maintenance** at the end of this chapter for examples of record keeping forms.

## 15.2 MAINTENANCE PROGRAM

### *15.2.1 Overview*

A total maintenance program should be developed incorporating the following:

- Preventative Maintenance;
- Repair and Maintenance;
- Recommended Special Tools and Equipment List;
- Master Equipment List; and
- Repair Parts Data List.

### *15.2.2 Equipment Maintenance Records*

#### *15.2.2.1 Operational Readings*

Hour meter readings and gauge readings should be recorded on rounds sheets to track equipment operation and aid in scheduling preventative maintenance tasks. This data can be compared to previous readings to observe changes in equipment operation.

#### *15.2.2.2 Preventative Maintenance Schedules and Work Orders*

The program should provide scheduling of regular preventative maintenance for the facilities which will prevent process shut down, reduce wear and tear, and extend the life of all equipment and structures. Work orders should be

issued that will instruct operators in preventative maintenance tasks. These could include instructions for periodic inspections, servicing, lubrication, alignment, calibration, and adjustment. A well-implemented preventative maintenance program will curtail the total labor used for "emergency breakdowns".

#### *15.2.2.3 Repair and Corrective Maintenance Records*

A record should be maintained of corrective maintenance tasks done for all equipment needing such maintenance.

### *15.2.3 Inventory Cards*

A detailed inventory of all equipment and spare parts should be maintained as part of a preventative maintenance program.

#### *15.2.3.1 Tools and Test Equipment List*

An inventory of tools and testing equipment should also be maintained. Tools should be identified by their name, manufacturer, part number, characteristic, and application. In order to perform the maintenance tasks required, these tools must be readily available. To effectively keep track of the plant tool inventory, a tool access system with check-out cards should be kept at the location where the tools are stored.

#### *15.2.3.2 Master Equipment List*

All the equipment associated with the wastewater collection and treatment facilities should be accounted for on the Master Equipment List (MEL). Equipment used for specific treatment processes or areas of the facilities should be grouped together on the list. Each piece of equipment should be identified by what system or process it is a part of, and its location, nameplate data, manufacturer, service representative, model number, equipment ID numbers, and quantity.

#### *15.2.3.3 Repair Parts Data List*

The ability to perform emergency and routine maintenance depends on the availability of spare parts. An inventory of the spare parts available to support the equipment should be maintained. All parts usage rates should be estimated yearly and the inventory should be regularly updated to avoid any prolonged shutdowns.

An alphanumeric index of all manufacturer's names, addresses, and telephone numbers is included in the Repair Parts Data List. Where applicable, the true source of the equipment is also provided.

For each part, the O&M instructions, figure, and parts list from where it was obtained should be referenced. Also, all necessary ordering information, including procurement lead-time and estimated unit price, should be listed.

## 15.3 ROUTINE MAINTENANCE

The most important factor in determining the service life and reliability of equipment, structures and related facilities is an effective preventative maintenance program. Maintenance should be carried out as outlined in the Manufacturers' factory service manuals, and in a manner, which prevents emergencies or unscheduled shutdowns. The comments and recommendations in this section form the basis for a good preventative maintenance program. Experience, incentives, and time devoted to this program will determine its effectiveness at the facility.

It is recommended that maintenance for outside equipment, be scheduled for spring and fall when weather may be more favorable and seasonal changes in lubrication required. Also, all outside cleanouts, manholes, valves and appurtenances should be located with ties or stakes so they can be found under snow. All outside tanks should be drained yearly and inspected for defects, and worn and broken parts. All mechanical equipment should be painted above and below the water line, as recommended by the manufacturer. The rapid infiltration basins slope stability should be monitored and repaired annually, or more frequently if required to prevent erosion.

Equipment, especially outside equipment with gear systems lubricated by an oil bath, frequently can accumulate water from condensation. The oil in these systems should be removed periodically. This can be done by removing the drain plug and draining a small quantity of liquid to eliminate any water or foreign matter that may have collected. The lubricant should be restored to the proper operating level.

Preventative Maintenance Schedules should be developed which alert the staff to impending maintenance needs and allow them to plan their time accordingly. The time periods between maintenance requirements should be viewed as approximate values, which may need to be adjusted depending on actual hours of operation and operating conditions. Continuously starting and stopping equipment will add wear and tear and, thus, will result in more maintenance.

### *15.3.1 Lockout/Tagout*

The Surfside WWTF has been designed with controls that allow every piece of equipment to be de-energized and locked out of service. This must be done whenever any maintenance is required that could endanger an operator if the equipment starts. A tag should also be used to alert other personnel as to the reason for the lockout. In general, the person who installed the lock and tag should be required to remove the tag when the equipment is returned to service. Never remove another person's lock or tag without his permission. An example of a proper tag is included at the end of the chapter.

### *15.3.2 Tools, Equipment and Supplies*

To maintain and repair equipment, it is fundamental that the facility has the proper tools and equipment. Accordingly, mechanics tools, gate valves, plug valves, and the portable pumps, etc., must always be on hand and immediately available.

It is the responsibility of the Operator to continuously stock the plant with sufficient spare parts, lubricants, packings and other supplies necessary for routine repairs and maintenance. The Operator must be sure that seasonal equipment, such as a lawnmower and a snow blower, is stored and maintained properly when not in use. Also, all tools and equipment should be cleaned, as required.

Items, which cannot be obtained quickly through normal channels, should be stocked at the plant, if recommended by the manufacturer. If an item is frequently used during routine maintenance or requires frequent replacement, the Operator should see that it is replaced immediately if withdrawn from stock.

### *15.3.3 Housekeeping Schedule*

To many people, the performance of the staff and effectiveness of a treatment plant depends mainly on the general appearance and condition of the treatment plant. Practically speaking, neat and orderly facilities reflect the attitude of the Operator and provide safer, more pleasant working conditions. The Operator is responsible for the appearance of the work environment and safety of all staff. The Surfside WWTF should be kept neat and orderly. To maintain a clean, safe work environment, the plant manager should create a housekeeping plan and schedule. The housekeeping tasks should include both inside and outside work.

- Inside maintenance work includes cleaning floors, windows, doors, railings, gratings, and miscellaneous metal coverings. Fire extinguishers and other safety equipment should be inspected to confirm it is in good working order and is available, if needed.

- Outside maintenance work includes regular hosing and/or scrubbing tank walls and channels and removing accumulated material from aeration tanks and weirs. Seasonally, such items as grass cutting, trimming shrubbery and snow removal will be periodically required. The roofs, paint, railings, fences and lights should be periodically inspected for repair or replacement requirements.

### *15.3.4 Maintenance Contracts*

Since the wastewater facilities utilizes a substantial amount of complex electrical and instrumentation control equipment, a maintenance service contract may be useful to provide fast service for the repair of malfunctioning equipment or controls and to provide for regular maintenance of this equipment. With such a contract, the reliability and performance of the facility's instrumentation will be greatly increased and, in the long run, the total overall cost may be reduced. A maintenance service contract for the boilers and other heating and ventilating equipment may also be desirable.

### *15.3.5 Greasing*

More equipment is damaged by improper lubrication than any other single means. Over-lubrication can be as detrimental as under-lubrication, making maintenance records invaluable. Follow the nine rules below when greasing pumps and motors:

- Shut off, tag and lock out the unit being greased so the equipment will not start unexpectedly;
- Use the proper grease;
- Remember: Excessive grease will cause the bearings to slide rather than rotate, increasing friction and heat buildup;
- Make sure the grease gun tip is clean;
- Clean the grease fitting to be greased with a clean rag. If a plug is to be removed, clean area around plug before removing plug and inserting grease fitting;
- Remove any relief plug before pumping in grease;
- Pump the proper amount of grease as indicated by information obtained in manufacturer's instructions. This information is sometimes included (along with frequency of greasing) on a service tag attached to the specific corresponding equipment;
- Wipe off all excessive grease around unit;
- Clean vent before replacing vent plug to allow for expansion of grease and to allow excess grease to work out of bearing; and
- Be sure to note in the maintenance records, the time, date of the preventative maintenance, initials of the person servicing and what was done to the equipment.

### *15.3.6 Grease and Lubricant Storage*

When handling or storing greases and oils, some special precautions must be followed. Make sure the storage area does not create a fire hazard. Post "NO SMOKING" signs around the immediate storage area.

When storing lubricants, wipe any spills and make sure that all the lids are tight on their containers. A partially-used container of oil should not be allowed to be contaminated with dirt. Contaminated oil could ruin a piece of equipment.

Grease and lubricants are to be stored in three separate locations. All grease and lubricants used in the Sludge Processing Building will be stored in a fire retardant drum in the Dewatering Room. All grease and lubricants used in the Advanced Treatment Building will be stored in a fire retardant drum in the storage room of the Advanced Treatment Building. All spent grease and lubricants will be stored in the Equipment Storage Building.

### *15.3.7 Cleaning Un-mounted Bearings*

To clean un-mounted bearings, place the bearings in a basket and suspend the basket in a container of clean, cold petroleum solvent or kerosene and soak the bearing, preferably overnight. Light transformer oils, spindle oils or automatic flushing oil are suitable for cleaning bearings. Any oil heavier than light motor oil (SAE-1O) is not recommended. Do not use gasoline to clean bearings!

CAUTION: Petroleum solvents must be used with the usual precautions associated with fire hazards. The use of chlorinated solvents is not recommended for bearing cleaning because of the rust hazard involved.

To determine if a piece of equipment is too noisy, place your ear against a screwdriver, one end of which is firmly pressed against the bearing housing, or use a mechanic's stethoscope. If a rumbling or unevenness is noticed, it may be due to dirt. A whistling sound usually means improper lubrication. Unusual noises should be investigated immediately and the condition corrected.

NOTE: When pressing ball bearings onto the shafts, apply force to the inner race only. To remove a bearing, also apply force to the inner bearing race.

### *15.3.8 Equipment Rotation*

Standby equipment has been provided to prevent facility shutdown due to equipment malfunction. It is the Operator's responsibility to verify that this equipment is always working and available.

Regular exercising of the standby equipment should be equal to one-fourth to three-fourths of the run time of the primary equipment. Routine exercising makes certain that the lubrication is properly distributed and provides the Owner with the confidence that the standby equipment will function in an emergency situation.

Duplicate pieces of primary equipment should be started up on a staggered schedule or rotated with the standby to prevent identical run times. Two identical pieces of equipment with the same elapsed run time will require the same maintenance on the same time schedule. By staggering the run times, corrective maintenance tasks requiring equipment shut down can be performed one piece at a time. Two pieces of equipment should have a maintenance schedule offset by one-half, three pieces by one-third, four pieces by one-fourth, and so on. Equipment should never stand idle for more than a week. If the equipment cannot be put on line or exercised, it should be manually rotated several times per week to help distribute the oils and lubricants.

### *15.3.9 Plant Library*

A plant library, which includes a complete set of record plans, specifications, MassDEP permits, and the facility O&M Manual should be maintained at the Facility Office Area. All manufacturers' equipment instructions should be kept on file for quick reference. For the convenience of the operating staff, each manufacturer's equipment instructions should be indexed.

## 15.4 ELECTRICAL MAINTENANCE

### *15.4.1 General*

Personnel responsible for the operation and maintenance of the electrical systems should be thoroughly familiar with all aspects of the equipment involved. All maintenance of exposed electrical conductors and connections should be performed by a licensed electrician. There is, however, a limited amount of electrical maintenance that can be performed by operating personnel.

- The basic rules of electrical maintenance are:
  - Be Careful
  - Keep Equipment Clean
  - Maintain Adequate Ventilation and Maintenance Clearances

- The operators must perform the following work:
  - Switch panelboard branch circuit breakers to operate some minor equipment (e.g., unit heaters and fans). The main reason for these circuit breakers is to detect and automatically disconnect equipment when an electrical malfunction occurs. However, these breakers can also be used to switch power on and off.
  - Push "RESET" buttons for "tripped" motor over current protectors (called "heaters") at MCC's and other starter locations. If the "RESET" button does not hold, the heater has not had enough time to cool (up to 15 minutes). After resetting, restart equipment as normally done. If repeated tripping occurs, an electrician should thoroughly check the motor and controls before the motor is restarted.
  - Some equipment is started by pushing a momentary (spring return) pushbutton. A momentary outage of the electrical service will often cause the momentary pushbutton operated controls to drop out and stop the equipment. Restart the equipment in the normal manner. Post a list of the desired ON-OFF status of all equipment in the control and electrical rooms.
  - Replace blown low voltage (120 volts) cartridge fuses for motor starter and indicating light control circuits.
  - Replace faulty indicating light bulbs.
  - Reset circuit breakers. Tripped position may look similar to ON position. To reset, first put breaker operator in OFF position, then to ON position. If repeated tripping occurs, an electrician should thoroughly check the equipment before the system is re-energized.
  - Post the identifying number and amperage rating for motor starter heaters and 120-volt control circuit fuses inside each motor starter cubicle. Keep spare fuses on hand. This will expedite replacement when necessary.

### *15.4.1 Ampmeter/Troubleshooting*

Normally, the manufacturers of treatment equipment will provide the expected maximum running amps for their units. The running amperage is the normal amp draw under normal load. Invariably, the control panel circuit breaker will trip at some point above the maximum running amps to avoid problems relating to motor burnout or overheating.

The application of an ammeter when used regularly to record current drawn (records must be kept of the values) will detect variations from normal or initial values. As an example, the horsepower demand for a pump will diminish as the capacity of the pump decreases. Similarly, the horsepower demand grows as the pump capacity increases.

Once the operator has recorded the normal running amperage for the pump under operating conditions, it will be safe to assume the following:

- If the pump current is measured and found less than normal, possibly there is:
  - A plugged line
  - A closed valve on the discharge side of the pump

- If the pump amperage is greater than normal and there is no broken line, possibly there is:
  - A badly plugged pump

  - A pump with drag on the impeller, such as stringy material wrapped around the shaft or impeller

- If the pump amperage is greater than normal and the pump is vibrating or cavitating, it could be caused by:
  - Rotation in the wrong direction

- If the pump is drawing less than normal amperage and cavitation is present, it could be caused by:
  - A restricted suction

Ammeters can also be used to test the condition of bearings in motor drives. Impending bearing failure will draw more amperage and, if detected by an ammeter, will expedite replacement and/or repair and reduce shutdown time.

A hand-held ammeter, with the half circle prongs placed around the lead wire, is all that is needed. Accurate tabulations, date, etc., is also needed to keep the information valuable. Place the prongs around the lead and hold the ammeter perpendicular to the lead. If the ammeter is not held perpendicular, inaccurate readings will be generated. BE ABSOLUTELY SURE NOT TO TOUCH THE LEADS AS THEY ARE 'LIVE'.

The Surfside WWTF employs a qualified electrician who should record amp readings on all pieces of equipment in the plant yearly. Keep in mind that the readings are taken at the MCC for convenience and will not reflect the actual conditions at the motor terminals.

Impeding motor burnout can also be detected by taking voltage or amperage readings on each of the three phases. A 3.5 percent voltage imbalance will cause an approximate 25 percent increase in temperature. Excessive heat breaks down windings in the stator when the insulation deteriorates. When deterioration begins, leakage to ground takes place creating high amperage problems and more heat, which leads to burnout of the motor.

As a rule of thumb, a voltage imbalance of 1 percent and an amperage imbalance of 5 percent is cause for concern. Below is a formula for determining the percent of imbalance for voltage or amperage.

Maximum Deviation From Average X 100 = % Imbalance Average Of The 3 Readings.

Example: The voltage between terminals is as follows:

L1 - L2 = 234V
L2 - L3 = 230V

L1 - L3 = 223V

1. The average voltage = 687 / 3 = 229V
2. The maximum deviation from this average = 229V - 223 = 6V
3. Voltage imbalance = (6 x 100) / 229 = 2.62

| TABLE 15.1 - PREVENTATIVE MAINTENANCE PROGRAM | |
|---|---|
| Equipment | Electrical Equipment |
| | |
| Item No.: | Equipment: |
| Name: | Make: |
| Serial No.: | Serial No.: |
| Machine No.: | Type: |
| Vendor: | Voltage: Amps RPM: |
| Model: | Phase: Frame: hp: |
| Belt Size No.: | |
| | |

| Item No. | Work To Be Done | Frequency | Date |
|---|---|---|---|
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**TABLE 15.2 - PREVENTATIVE MAINTENANCE RECORD**

| Preventative Maintenance Program<br>Equipment Description | Equipment Record No.:<br>Electrical or Mechanical Data |
|---|---|
| Name: | Size: |
| Serial No.: | Model: |
| Vendor: | Type: |
| Vendor Address: | Initial Amp. Draw: |
| | |
| Vendor Rep.: | Phone No.: |
| Initial Cost: | |

| Work To Be Done | Frequency | Time |
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**TABLE 15.3 - SERVICE RECORD**

| Date | Work Done | Signed | Date | Work Done | Signed | Date | Work Done | Signed |
|---|---|---|---|---|---|---|---|---|
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**TABLE 15.4 - SCHEDULE OF INSPECTIONS AND PREVENTIVE MAINTENANCE**

| TYPE OF EQUIPMENT | MAINTENANCE TASK | FREQ. |
|---|---|---|
| | | |
| Pumps | 1. Inspect all units | M |
| | 2. Check Vibration Level | M |
| | 3. Check Mechanical Seal | M |
| | 4. Lubricate Line Shaft | M |
| | 5. Lubricate Motor Bearings | Q |
| | 6. Lubricate Mag-Drive | M |
| | 7. Check for Leaks from Seals | W |
| | 8. Check Level and Condition of Lube-Oil | W |
| | 9. Check Foundation Bolts-Attachment/Corrosion | S |
| | | |
| Sump Pumps | 1. Clean Sumps and Hose Down Pumps | A |
| | 2. Inspect Cable & Rail Removal Systems | W |
| | | |
| Chemical Metering Pumps | 1. Change Oil in Main Housing | S |
| (Milton Roy Type) | 2. Replace Check Valves | A |
| | 3. Replace PTFE Diaphragm | A |
| | 4. Replace Relief Valve Poppet | A |
| | | |
| Electric Unit Heaters | 1. Vacuum off Heater | S |
| | 2. Replace Grease | Q |
| | 3. Check for Excessive Noise or Vibration | W |
| | | |
| Ventilation Fans | 1. Check Belts Periodically for Wear and Tightness | A |
| | | |
| WWTF Alarm Systems | Test All Process and Intrusion Alarms | M |
| | | |
| Backflow Preventer(s) | Dismantle and Refurbish | A |
| | | |
| Diesel Engine Generator | 1. Inspect Genset | D |
| | 2. Check Coolant Heater | D |
| | 3. Check Oil Level | D |
| | 4. Check Coolant Level | D |
| | 5. Check Fuel Level | D |
| | 6. Check Charge Air Piping | D |
| | 7. Check Air Cleaner | W |
| | 8. Check Battery Charging System | W |
| | 9. Drain Water/Sediment from Fuel Tank | W |
| | 10. Drain Exhaust Condensate Trap | M |
| | 11. Check Starting Batteries | M |
| | 12. Check Fan Belt | M |
| | 13. Check Radiator Hoses for Wear & Cracks | S |
| | 14. Change Air Cleaner Element | A |
| | 15. Perform Polarization Index Test | A |
| | 16. Perform Cooling System Maintenance | A |
| | 17. Change Fan Belt | 2-yrs |
| | 18. Lubricate Fan Bearings (two) | 2-yrs |
| | 19. Check Generator Output Lug Torques | 2-yrs |
| | 20. Grease Generator Bearings (P7)(MV7) | 2-yrs |

| TABLE 15.4 - SCHEDULE OF INSPECTIONS AND PREVENTIVE MAINTENANCE (CONT.) | | |
|---|---|---|
| TYPE OF EQUIPMENT | MAINTENANCE TASK | FREQ. |
| | | |
| Diesel Engine Generator (continued) | 21. Drain Fuel Filter(s) | See Owners Manual |
| | 22. Check Anti-Freeze and DCA Concentration | See Owners Manual |
| | 23. Change Engine Oil and Filter | See Owners Manual |
| | 24. Change Coolant Filter | See Owners Manual |
| | 25. Clean Crankcase Breather | See Owners Manual |
| | 26. Change Fuel Filters | See Owners Manual |
| | 27. Clean Cooling System | See Owners Manual |
| | | |
| Frequency Legend:<br>D=Daily<br>W=Weekly<br>M=Monthly<br>Q=Quarterly<br>S=Semi-Annually<br>A=Annually | | |
| | | |

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# 16 - PERSONNEL

## 16.1 GENERAL

In this Chapter, personnel requirements are described for the proper, efficient, and economical operation and maintenance of the Surfside WWTF. The recommendations made in this Chapter should be considered flexible, allowing for adjustments to be made for changes in conditions and in the capabilities of personnel available.

These recommendations are made based on the anticipation that outside skilled trade's people, such as electricians, motor and engine mechanics, and instrumentation service people will be retained when needed to perform specialized maintenance and repair, which is beyond the capabilities of the permanent Plant staff.

## 16.2 CERTIFICATIONS

The Commonwealth of Massachusetts has specific regulations prepared by the "Board of Registration of Operators of Wastewater Treatment Facilities" regulations 257 CMR 2.00, entitled "Certification of Operators of Wastewater Treatment Facilities", that pertain to the certification of WWTF Operators. An operator desiring to be certified shall file an application with the Board, on an application form provided by the Board, not later than one month proceeding the date of the examination. The operator must pass an examination prepared by the Board, which is used to determine the knowledge, ability, and judgment of the applicant. Upon satisfactory fulfillment of all requirements, the Board will issue a suitable certificate designating the person's competency. The certification will indicate the Class of treatment plant for which the operator is qualified to operate and the current renewal date.

The regulation states that each "Each municipal wastewater treatment facility shall be classified by the Board as either 1M, 2M, 3M, 4M or 5, 6, or 7 for large or complex facilities.....The increasing numerical class indicates increasing complexity of operation and a higher level of training, knowledge, and experience required for operation." In addition, "The class of a facility shall be established by adding together all rating values reflecting the complexity of operation for units which are present in the facility….". The WWTF classification is based on the sum of the "rating values" given for each operating unit/process. Refer to **Table 16-1 – Surfside WWTF Certification Rating**.

**TABLE 16-1 – SURFSIDE WWTF CERTIFICATION RATING**

| Unit | Rating |
|---|---|
| Aeration - Diffused air greater than 0.5 MGD | 10 |
| $BOD_5$ Removal = (9,946*0.8)/1,000 | 8 |
| Chemical Addition - 2 points per chemical (ferric, polymer, and hypo) | 6 |
| Comminution (grinder) | 1 |
| Flow Measurement | 1 |
| Grit Chamber, Aerated | 2 |
| Hydrocyclones (grit removal) | 3 |
| Instrumentation | 2 |
| Laboratory | 3 |
| Membrane Filtration | 4 |
| Nitrification | 10 |
| Odor Control | 3 |
| Primary Settling; mechanical sludge removal | 5 |
| Pumping (in plant) | 3 |
| Pumping stations under operator's control | 1 |
| Septage Facilities | 3 |
| Sludge Storage | 2 |
| Rotary Presses | 8 |
| Ultraviolet Disinfection | 3 |
| Total | 78 |

Refer to **Table 16-2 – WWTF Cumulative Rating Value** Based on the cumulative rating value each WWTF is classified as follows:

**TABLE 16-2 – WWTF CUMULATIVE RATING VALUE**

| Class | Cumulative Rating Value |
|---|---|
| Class 1 (M or I) | 1 to 7 |
| Class 2 (M or I) | 8 to 20 |
| Class 3 (M or I) | 21 to 30 |
| Class 4 (M or I) | 31 to 50 |
| Class 5 (C) | 51 to 65 |
| Class 6 (C) | 66 to 80 |
| Class 7 (C) | 81 or more |

Therefore, based on the rating analysis and classification table, the Surfside WWTF is classified as Class 6; and, as such, the certification for the Chief Operator and Assistance Chief Operator are required to be equal to the grade of the facility.

## 16.3 ATTENDANCE

As is the case with all municipal wastewater treatment plants, the Surfside WWTF must operate 24 hours per day, 365 days per year. The proposed staff monitors the operation of both the Surfside and Siasconset WWTF and 8 remotely controlled pumping stations on a daily basis. The eight pump stations include the Surfside, Airport, Sea Street, Cato Lane, South Valle, Pine valley and Monomoy North and South pump stations. The nine (9) staff members will cover the operation of both Plants and the pumping stations with an eight (8) hour day shift arrangement. The second and third shifts will be continuously monitored by the WWTF's Control System. Should an alarm condition occur, the WWTF's Control System automatically "dials-up" the "on-call" operator who will immediately visit the alarmed location and correct the problem.

## 16.4 STAFF REQUIREMENTS

Using the Board of Registration of Operators of WWTF methodology for establishing staffing requirements, a total potential staff of 9 staff capable of performing the routine operating, testing, and maintenance duties should be adequate for these two plants and the associated collection system. **Table 16.3 – Surfside WWTF Recommended Staffing Level** presents a summary of

the recommended staffing requirements, including grade of the wastewater treatment facility operator.

**TABLE 16-3 – SURFSIDE WWTF RECOMMENDED STAFFING LEVEL**

| Title | Recommended Staffing Level | Grade of Wastewater Treatment Facility Operator |
|---|---|---|
| Chief Operator [1] | 1 | 6 |
| Assistant Chief Operator [2] | 1 | 6 |
| Dewatering Operator | 1 | 4 to 6 |
| Mechanic/Electrician | 2 | 4 to 64 |
| Laboratory Manager | 1 | Not Required |
| Operator | 3 | Not Required |
| Totals | 9 | |

[1] Primarily located at the Surfside WWTF

[2] Primarily located at the Siasconset WWTF

Complete and accurate job descriptions are dependent on the qualifications and skills of the personnel selected to operate the Surfside WWTF. Regardless of the care that goes into the design and construction of the facilities, the full capabilities of the facilities cannot be realized without qualified personnel in adequate numbers available for the required operation and maintenance. Up-to-date training for operators and maintenance personnel is stressed as being of utmost importance in the proper functioning of the facilities. This type of training will not only protect the equipment and systems from damage and deterioration but also maintain the quality of the Surfside WWTFs effluent at a reasonable cost.

General job descriptions and duties of the recommended staff as presented later in this Chapter. However, with a staff of this size, there should be a complete interchange of duties, insofar as practical and thus no rigid job classification should be established. It is strongly recommended that all operators be encouraged to obtain the highest degree of certification possible for their experience level and to take advantage of any operator training courses, which may be available.

The administration should also consider providing incentives to encourage personnel to voluntarily obtain certification and/or additional schooling. This increased knowledge would be expected to result in a higher level of performance, more competent operation of the facilities, and more flexible staff better able to meet and solve problems.

## 16.4 JOB DESCRIPTIONS

General duties and responsibilities, supervision received, and exercised, and qualifications and entrance requirements of the typical types of personnel commonly employed for the operation and maintenance functions of conventional wastewater treatment facilities are listed. These descriptions include, but are not limited to, the responsibilities indicated. The suggested duties, qualifications, and experience explained in these Position Descriptions should be used as a guide only. The need for manpower requirements, based on individual capabilities, will vary with the municipality's ability to recruit suitable employees.

- Chief Operator: Responsible for all phases of treatment plant operations at both treatment plants to ensure that the DEP discharge permits are met. The chief operator reports to the Director of the Department of Public Works.

- Assistant Chief Operator: Lead operator of the Siaconset Treatment Plant and capable of assuming the responsibilities of the chief operator is his absence. The Assistant Chief Operator Reports to the Chief Operator.

- Laboratory manager/Process Control: Responsible for all sampling and the analysis at the surfside plant as well as analysis at the Siasconset plant that are performed in the surfside laboratory. Responsible for all maintenance and Quality Assurance and Quality Control (QA/QC) pertaining to the lab. Required to provide selective samples to be tested off-island by a certified lab for QA/QC purposes Recommends needed daily processes and changes for both facilities, and responsible for implementing such changes. The Lab manager reports to the Asst. Chief Operator and the Chief Operator.

- Mechanic/Electrician: Responsible for all preventative and corrective maintenance at both facilities and oversees maintenance of existing pump stations. These personnel should hold wastewater licenses and be capable of operating both facilities. The Mechanics report to the Asst. Chief Operator and the Chief Operator.

- Dewatering Operator: Responsible for all dewatering operations including: calculations and implantation of sludge characteristic and blending, transporting sludge from Siasconset to Surfside, maintaining operation of the septic receiving station, hauling sludge cake to the Materials Receiving facility and working with the mechanics to ensure proper maintenance and operation of all equipment. Should have CDL/Tanker licenses in addition to a minimum level 4 wastewater license. The Dewatering Operator reports to the Asst. Chief Operator and the Chief Operator.

- Operators: Works with plant staff to ensure proper operation of both facilities. Responsibilities include monitoring pump station operations, monitoring and performing all duties associated with primary and secondary treatment under the supervision of the chief operator, maintain rapid infiltration beds at both facilities, maintain grounds and buildings both inside and out as well as assisting the assistant chief operator with any functions needed at Siasconset.

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# 17 - SAFETY

## 17.1 GENERAL

By their very nature wastewater treatment facilities are potentially hazardous places to work. Mechanical and electrical equipment, walkways, ladders, laboratory equipment, and chemicals all present opportunities for injury. Items of equipment such as lockouts on electrical equipment, ventilating fans, and panic hardware have been incorporated into the plant in an effort to reduce the chance of injury. These features are useless, however, if they are removed, do not operate properly, cannot be found when needed, or personnel are not familiar with there use.

A major, desirable quality to be found in treatment plant operators is the ability to carry out work assignments safely. This is reflected by the condition of tools and equipment, and the attitude towards fellow workers. It is the responsibility of the Chief Plant Operator to instill good safety practices in the plant personnel. Training seminars, films, and regular informal training courses offered by the MassDEP and other agencies will prove invaluable in a planned, conscientious, safety program.

Reports from WWTF monitoring agencies show that the water pollution control industry has a very poor safety record. Considering such a poor national record, operators at the wastewater treatment plant should be concerned with doing their job safely. Where negligence and casual attitudes exist, an accident will follow.

A few safety precautions are fairly obvious, such as locking the buildings and gates when areas are unattended to prevent unauthorized entry or vandalism. Other areas merit further comment and are discussed in this Chapter. This discussion is not to be considered all-inclusive, however. Safety is everyone's business and it is the operator's staff's responsibility to educate them and expand upon the information presented in this Chapter.

## 17.2 MANAGEMENT RESPONSIBILITIES

Management provides the place to work and should make the facility as safe as practicable by initiating safety maintenance procedures. Management selects, hires, and places employees and should; therefore, choose personnel by a logical system, mindful of ability, aptitude, and health records. Management trains its employees and should supply or make available, the best chance for education. The ultimate success or failure of any safety program rests squarely with management.

It is the obligation of employees to obey all safety regulations set forth by management. Managerial personnel can help encourage safety conscious work habits among the personnel by:

- Initiating employee safety activities such as meetings, inspections, investigations, evaluations, and analysis;
- Maintaining an active safety policy and competent safety supervision;
- Incorporating a separate safety performance rating in the evaluation of individual performance;
- Supporting reasonable disciplinary action for failure to follow established safe practices, and even more important, implementing a recognition or reward system for an outstanding safety record;
- Holding every person accountable for safety;
- Conducting effective safety training programs;
- Placing the same emphasis on accident prevention, as on personnel performance;
- Directing operating personnel to consult safety representatives on difficult safety considerations;
- Establishing and supporting a joint safety committee composed of representatives from management and the operating personnel;
- Encourage operating personnel to take a course on safety; and
- Instituting a monthly testing program of all the plant alarm devices in the form of a drill.

## 17.3 GAS HAZARDS

Gas hazards are a very special problem in the wastewater industry and should be realized, as such, while working in the plant. Three basic types of gas dangers are:

- Poisonous or toxic gases;
- Explosive gases; and
- Oxygen deficient atmospheres.

In any enclosed space at the wastewater treatment plant, be mindful of hazardous gases and dangerous atmospheres.

The following is a list of some of the more common gasses found in the industry:

- Methane (CH3) is lighter than air and is one of the most combustible gases encountered. It is produced from decomposing organic matter in the wastewater. When the methane content of the atmosphere is between 5 and 15 percent, it presents an explosive hazard.

- Hydrogen Sulfide ($H_2S$) has the characteristic smell of “rotten eggs”. It is generated by anaerobic decomposition of organic matter and will collect toward the bottom of enclosed tanks and manholes. When the hydrogen sulfide content of the air is 12 percent, death will result in a few minutes. This gas also represents an explosive hazard. After exposure to hydrogen sulfide, the human nose becomes desensitized. The gas may still be present, and it can kill you or make you dizzy enough to stumble and hit your head causing injury. Always test the atmosphere with a gas/explosive meter BEFORE entering a manhole or other confined space. Remember; use TWO people above while one works below in a harness.

- Sewer gas is a combination of carbon dioxide, methane, hydrogen, and hydrogen sulfide. It accumulates as a result of fermentation and decomposition of organic matter.

Normal ambient air contains 20.8 percent oxygen. Atmospheres containing less than this amount are considered oxygen deficient. Oxygen deficiencies may occur when less desirable gases physically displace the ambient air in a given area. Another way this problem comes about is by depletion of the oxygen source biochemically, as a result of decomposition of organic matter.

Explosive atmospheres may arise from a gas service line rupturing and leaking gas into the collection system or siphon structure. If you believe such a condition exists, do not hesitate to contact the gas company. Gasoline accidentally spilled into the system may also cause a hazardous condition. A cigarette or spark from a tool may trigger an explosion. Always test the atmosphere before proceeding with any work.

Manholes and other wastewater structures are normally closed which may encourage the accumulation of gases and vapors. After opening these structures, allow enough time for venting or operate an exhaust fan or blower before entering. Anyone entering a manhole or other below ground structure should use a safety harness. Two people strong enough to easily lift the belowground person should remain at grade, hold the safety harness rope, and be ready to help. The end of the safety harness rope should always be secure so that it cannot fall out of reach.

## 17.4 CONFINED SPACE ENTRY

Many operators are hurt each year working in confined spaces, and some are killed. Injury and death can be avoided if a few simple rules are followed:

- Obtain a Confined Space Entry Permit prior to entry. An example of such a permit is in **Appendix D – Confided Space Regulations.**

- Do not enter a confined space unless it is absolutely necessary. Determine if work can be done from outside of the confined space;

- Before entry check the air quality. The oxygen content should be between 19.5 and 22.5 percent;

- Check the atmosphere for flammable gases. The safe level for entry is less than 10 percent of the lower explosive limit;

- Check the atmosphere for $H_2S$;

- Assure that the proper number of employees are available in order to allow one worker to enter the confined space with at least two workers topside;

- The person going into the confined space should be wearing the following:
  - Safety harness.
  - Rope, long enough to be easily managed by the workers topside.
  - Hard hat.
  - Overalls.
  - Gloves.

- Provide ventilation equipment. Ventilate the space continuously;

- Monitor the atmosphere in the confined space while the worker is below; and

- If the entry to the confined space is in the street, protect the crew topside from traffic with proper signs, flags, etc. The local police can advise proper methods of traffic control.

Never enter a confined space if the atmosphere is oxygen deficient or toxic or explosive gases are present.

Be aware, manholes are not the only confined spaces found in wastewater treatment systems. Wet-wells, septic tanks, flow equalization tanks, sludge storage tanks, filters, effluent distribution boxes, and clearwells, etc., all qualify as confined spaces. In fact, any structure that was not designed for habitation, has one entrance, and has poor or no ventilation, can be considered a confined space. Refer to **Appendix D – Confided Space Regulations** for more information.

## 17.5 FALLS AND FALLING OBJECTS

At the WWTF, the possibility of an accidental fall should always be on the operator's mind as that person enters a manhole or tank. Regardless of their depth, manholes, and other underground structures demand respect.

The following situations are common reasons for falls at treatment facilities:

- Trying to find your footing on the top rung of the ladder while entering a manhole is, at times, a problem;

- Steps or rungs may, over a period of years, become weakened and may be unable to support your weight;

- Slimes and growths on these steps or rungs may also cause problem due to their slippery nature; and

- Wet surfaces, icy surfaces or snow accumulation.

To avoid problems while working in manholes, be sure to always use a safety harness. Use it properly at all times. Two people must remain topside holding one end of the safety harness rope while the third person goes below ground.

Snow accumulations should be promptly removed from the entrance and all access paths around the WWTF. Ample supplies of sand and salt should be kept at the plant to aid in providing a safe and slip free work area at the WWTF.

Falling objects are also a danger. Do not purposefully drop or throw tools to a worker in a manhole or underground structure. Your aim and the worker's catch may be poor, which could result in a serious injury. Above ground keep the area immediately around the manhole opening free from clutter. A hammer or other tool accidentally kicked into the manhole could fall and hit the worker below. Hard hats should always be worn to help avoid serious injuries from falling objects.

## 17.6 CHEMICAL HAZARDS

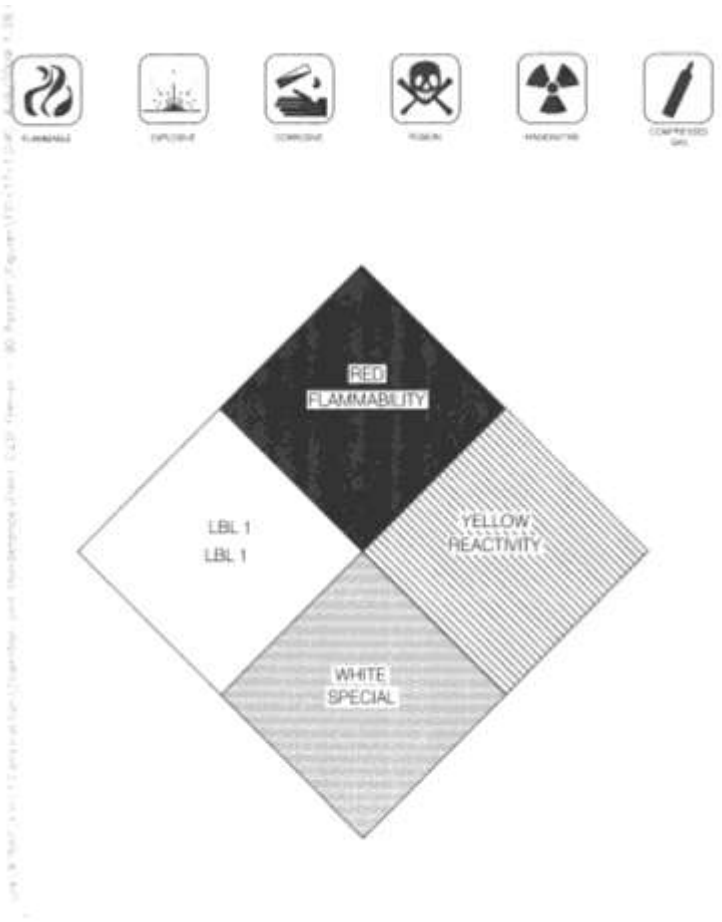
The primary chemical hazards encountered by treatment plant workers will be associated with the chemicals used for the various processes and in the laboratory. WWTF workers should always wear the proper protection when working with chemical storage and handling facilities. Refer to **Chapter 17 – Chemical Handling** for more specific chemical handling and safety procedures.

OSHA Standard 29 CFR 1910.1200 and Right-to Know Laws protect an employee's right to be informed about hazardous chemicals in the workplace. These laws require employees to make MSDS sheets available to all employees. Chemical containers must be labeled to identify potential hazards. Refer to **Figure 17.1 - Chemical Hazard Label**. Refer to **Appendix E – Material Safety Data Sheets** and **Appendix F - OSHA Right-to-Know Regulations**.

## 17.7 ELECTRICAL EQUIPMENT

All electrical installations and electrical equipment should be made, installed, and maintained in accordance with the provisions of the National Electric Code. The purpose of the Code is the practical safeguard of employees, buildings, and their contents from hazards arising from the use of electricity for lighting, heating, power, radio, signaling, and other purposes. Review **Chapter 11 - Electrical Systems** for more detailed information.

**FIGURE 17.1 - CHEMICAL HAZARD LABEL**




Only qualified and authorized personnel should be allowed to work on electrical equipment and systems. The Surfside WWTF employs a professionally licensed electrician however, it is recommended that outside professional help be contracted to do all the electrical work at the plant if a licensed electrician is not available. Aside from jeopardizing personnel safety, electrical work done on equipment by unauthorized personnel will invalidate the warranty or any insurance claims should damage result.

To extinguish fires in electrical equipment, use only non-conducting extinguishing agents to minimize shock hazard to the operator. Use those extinguishing agents, which do not permanently damage the equipment. Carbon Dioxide extinguishers are preferred to dry chemical extinguishers. If feasible, de-energize the electrical equipment before attempting to extinguish a fire. This will eliminate the possibility of electrical shock or death hazard in case of accidental contact with electrical conductors.

Before working on any electrical power machinery, shut down the power to the unit at the MCC and inform all other plant operators what is being done. Use the lockout device on each motorized unit and secure it in place by a lock, wire, or other suitable means. Use insulated or non-sparking tools when servicing storage batteries and avoid smoking or open flames near batteries. Storage batteries can emit hydrogen and oxygen gases which, when combined, can be highly explosive.

Use properly sized electrical overload devices that will function when an overload or short circuit occurs.

Make sure electrical tools are in good condition before using them. Never use a tool that has a frayed cord or other damage. Never use electrical tools while standing in water.

When work requires the use of extension cords, use a ground fault interrupter between the tool and the extension cord to reduce the risk of shock.

## 17.8 MECHANICAL EQUIPMENT

There are similar rules for working on both electrical and mechanical equipment. Only authorized, qualified personnel should be allowed to work on mechanical equipment. The operator must know exactly what has to be done and how to go about it before attempting to do the job. Always remember, much of the equipment at the wastewater treatment facility starts and stops automatically, without warning.

Make sure that when the equipment is running, all belt guards and protective covers are securely in place. Do not wear loose clothing near rotating equipment or moving parts. Be sure that after a maintenance job is complete, all tools used for the service work are removed from the area.

Practice good housekeeping around all equipment.

- Use positive lockout mechanism and tagging procedures at MCC's BEFORE working on any mechanical equipment;
- Use the proper tools for the job, not improvised modifications;
- Institute a preventive maintenance program for all machinery; and
- Use earplugs and/or earmuffs when working in excessively noisy areas.

## 17.9 SAFETY EQUIPMENT

Safety equipment is useless unless the operator knows where the equipment is, has it in good working condition, and is well trained in its use. Detailed instructions on the use of safety

equipment, from the manufacturer's literature, should be thoroughly understood by all operators. Training drills and instructions should be provided by management and repeated periodically.

Signs warning of dangerous conditions such as high voltage and high-pressure plant water are intended more for the visitor's benefit than for operating personnel familiar with the facility. Visitors should not be discouraged from touring the plant, nor should they be allowed to wander throughout the plant unescorted. Posting a sign at the main gate requesting all visitors to report to the office is a common safety precaution.

Safety equipment must be placed in a convenient location and must be in perfect working order. Safety harnesses, nylon securing lines, gas detection equipment, and fire extinguishers all should be checked for integrity of service and be properly maintained and stored. During an emergency is not the time to go looking around for equipment that is needed in a hurry.

At least monthly, all safety equipment such as alarms should be tested. Do not place tools and equipment in front of fire extinguishers or other safety devices. Periodically give a plant tour to the local fire department (upon the request of the Chief Plant Operator). There are two benefits that could result. First, the fire department could provide the operating staff with useful tips on fire prevention. Secondly when the fire/rescue squad is familiar with the facility, it reduces their response time and makes their actions more effective in an emergency.

Periodically, bring the self-contained breathing apparatus to the local fire department to have the unit checked for serviceability. The air should be changed and filled at least every six months. Most local fire departments will fill the tanks with air at no charge.

## 17.10 WASTEWATER BORNE DISEASES

Because domestic wastewater contains millions of microorganisms, the potential exists for employees to be exposed to waterborne diseases. Pathogenic organisms can be found in both raw wastewater and the treated effluent, in mists and aerosols found in turbulent areas, in sludges, and on equipment. Although the incidence of waterborne diseases among treatment plant workers is not common, new employees often have a higher than average rate of gastrointestinal or upper respiratory illnesses. Following good hygiene practices reduces this risk.

Infections can be caused by three different types of microorganisms: bacteria, viruses, and parasites. Some of these diseases that can be caused by wastewater-borne bacteria and viruses include; the common cold, upper respiratory infection, dysentery, gastroenteritis, typhoid fever,

tetanus, gas gangrene, Asiatic cholera, conjunctivitis (eye infection), aseptic meningitis, infectious hepatitis, poliomyelitis, and myocarditis. Parasites that are carried in wastewater include Giardia, roundworms, hookworms, and tapeworms. Some of the pathogenic (disease-causing) organisms mentioned can be found even in disinfected effluent.

Organisms can enter the body in three ways; through the skin via a cut or abrasion, through the lungs after breathing contaminated mists or aerosols, or through ingestion, the most common route of infection among wastewater workers. Ingestion occurs when organisms are accidentally swallowed because of splashing or unsafe practices.

Some of the tasks that have the potential for contact with wastewater include cleaning and hosing tanks, pumps, and equipment maintenance, sampling, and laboratory work. Any operations that require hosing down tanks or equipment can produce mists or aerosols that contain pathogens. Cleaning out obstructions from pumps can be dangerous because of the possibility of sharp objects, such as needles, being part of the obstruction. It is important to thoroughly wash hands and other exposed areas of the body prior to leaving work at the WWTF.

### *17.10.1 Work Precautions*

Employees should adopt universal precautions in all areas of the facility. In other words, they should assume that all wastewater, sludge, and equipment contain biohazards. The following practices will reduce the risk of infections:

- Do not pick up sharp objects by hand. Use a broom and dust pan, if possible;
- Use caution and always wear gloves when working on equipment to avoid cuts and needle sticks;
- Hands should not be used to remove obstructions in plugged lines or pumps. Use a tool instead, and wear durable gloves when performing equipment maintenance to avoid cuts and scrapes; and
- When possible, use automatic samplers. Grab samples should be taken in a manner that will minimize the chance of splashing and splattering. If splattering cannot be avoided, a face shield should be worn to minimize the chance of wastewater splashing a worker in the face. Gloves should always be worn while taking and handling samples of sludge or wastewater. Sample containers should be leak-proof and properly labeled.

### *17.10.2 Personal Hygiene*

The risk of ingestion can be greatly reduced by following a few simple hygiene procedures:

- Wash hands and face with soap and water before eating, drinking, smoking, handling contact lenses, or applying lip balm or cosmetics, after removing gloves, after contact with wastewater, and at the end of each shift, using the sink in the

WWTF. Instant hand sanitizer should be carried in the facility vehicles to allow employees to clean their hands when they are away from the plant;

- Do not touch your face or hands while working with wastewater or sludge. Keep your hands below your collar;
- Immediately wash with soap and water any skin or mucous membranes that come in contact with wastewater or sludge;
- Eating, drinking, and smoking should not be permitted in areas where wastewater or sludge contamination may be present;
- Clean and treat cuts and abrasions immediately;
- Never pipet anything by mouth; and
- Do not drink water from the tap or hose bib at the WWTF. These fixtures may have been contaminated during routine use.

### *17.10.3 Personal Protective Equipment*

Gloves should be worn at all times when working with wastewater or sludge, performing maintenance or repairs on equipment that has come into contact with wastewater, sampling and conducting testing such as pH or dissolved oxygen readings. Disposable gloves should not be reused. Utility gloves should be cleaned as often as is practical. When the possibility of splashing exists, goggles or a face shield should be worn. Workers should also wear goggles and a surgical mask or respirator when working around aerosols or mists for a prolonged period.

Rain gear and boots are provided when direct contact with wastewater is necessary. A lab coat or apron and goggles should be worn when working in the laboratory.

### *17.10.4 Housekeeping*

Although it is impossible to maintain the facility in a sterile manner, every effort should be made to reduce the number of pathogens in the work environment. Work areas should be cleaned every day with a disinfectant. Sample buckets and automatic samplers should be cleaned with a detergent or bleach solution weekly or as needed. Clean up spills immediately. Equipment that needs servicing by an outside service must be decontaminated, if possible. When decontamination is not feasible, notify the servicing agency of the contamination.

Soiled clothing should be bagged and laundered. Do not wear or carry home any soiled clothing or shoes. Employees should wear gloves when handling soiled clothing. If a professional laundry or uniform service is used, they should be notified of the potential hazard involved with wastewater contamination.

#### *17.10.5 Vaccinations*

Immunizations for diphtheria and tetanus should be current. Tetanus boosters are required every 10 years, but in case of a dirty wound, a booster is recommended if more than 5 years have elapsed since the last booster. Employees should also be immunized against polio and typhoid fever. There is no consensus among medical professionals concerning the need for wastewater operators to be immunized against Hepatitis B. Some municipalities require the vaccine, and some physicians refuse to give it to wastewater employees. Questions about this and other vaccines that are recommended for the general public should be addressed to the worker's physician.

The local hospital should be asked to notify treatment plant staff of any outbreaks of infectious diseases in the community.

A physician should be consulted as soon as possible if a worker is exposed directly to wastewater splashes to the mouth or mucous membranes, wastewater in an open wound, or if the employee receives a needle stick. OSHA mandates that employees who have been exposed in this manner have the right to a medical evaluation and follow-up at the employee's expense. The physician or hospital should be notified about the materials that the worker may have come into contact with at the WWTF.

## 17.11 SAFETY EDUCATION AND TRAINING

Plant management has the responsibility to address safety issues associated with the wastewater collection and treatment system. This can be done by conducting seminars or renting videos from the Water Environment Federation (WEF). The most important thing is that a program be established and the subject matter presented.

Training (safety) is most important for new employees. Management should document the date, subject matter presented, and who attended. This information should be kept on file and be available to regulatory agencies. All special training in safety should be job related.

By offering scheduled safety meetings, safety awareness is kept high in people's minds and communication is kept open.

The following are some suggested topics that could be used at a safety meeting:

- Safe chemical handling;
- Laboratory safety;

- Confined space entry;
- Electrical maintenance and safety;
- CPR course;
- General first aid;
- Fire prevention, the types of fires, and fire extinguishers;
- Use of SCBA;
- Employee Right-to-Know; and
- Safe lifting techniques.

You are encouraged to involve your local fire and police departments as well as hospital staff in organizing these meetings.

WEF regularly publishes safety information in the wastewater industry. The information is usually free and can be obtained by writing WEF Technical Services Manager, 601 Wythe St., Alexandria, VA 22314 or visit http://www.wef.org.

Be sure to stress to all new employees the fact that much of the equipment installed at the WWTF starts and stops automatically. All equipment has been provided with stop/lockout buttons mounted locally at the equipment. Prior to doing work on a piece of equipment, it should be locked out at the disconnect and shut off at the Control Panel and at the local controller.

It should be stressed that safety programs are not enough to stem accidents. Concepts used or taught in safety seminars must be applied to the actual working environment. The transition from classroom to field is, for some reason, difficult. By continually pushing safety, this transition is made easier.

Management should take an active interest in safety issues. This may include assigning funds for needed pieces of safety equipment or allowing operators to attend safety seminars. Reluctance by management to support safety programs will result in unsafe working conditions at the WWTF.

# 18 - CHEMICAL HANDLING

## 18.2 INTRODUCTION

The WWTF has five (5) chemical handling systems serving various primary, secondary and advanced process systems, the solids processing and odor control systems and the emergency CEPT systems. This section briefly describes the chemicals, which can be fed, and the feed systems used for feeding them. Operators should refer to the Material Safety Data Sheets (MSDS) in **Appendix E – Material Safety Data Sheets** and **Appendix G – DOT Regulations for Loading and Unloading** Chemicals for the recommended safety precautions to be used when handling these chemicals.

It is generally the responsibility of the Chief Plant Operator to determine the chemicals to be used for optimum performance as well as the specific chemical dosages that are required to obtain this efficiency. WWTF operators are responsible for determining and maintaining the correct chemical dosages to operate the WWTF. In the absence of the Chief Plant Operator, it may occasionally be necessary for the WWTF operators to independently make slight adjustments in dosages to maintain the desired treatment. A record should be kept of the reasons for such adjustments, as well as the degree of adjustment, and the associated results of the treatment.

The Five chemicals utilized at the WWTF are as follows:

- Sodium Hypochlorite (NaOCL);
- Sodium Hydroxide (NaOH);
- Citric Acid;
- Polymers; Cationic for dewatering and Anoxic for CEPT; and
- Potassium Permanganate in CEPT Building.

Sodium Hypochlorite, Sodium Hydroxide, and prepared citric acid are all stored in tanks located in the odor control room of the Sludge Processing Building. The dry bags of citric acid and polymer are stored on pallets in the Polymer Feed Room. Chemicals pertaining to CEPT are stored in the CEPT Building.

## 18.3 DESCRIPTION

### *18.3.1 Chemical Delivery*

Refer to **Table 18.1 – Chemical Information** for a listing of the chemicals available at the WWTF. This table identifies each chemical by its chemical and common name, by its

delivery form, and how the chemical is stored. It should be noted that WWTF operators are encouraged to experiment with alternative treatment chemicals (in conjunction with chemical suppliers and equipment manufacturers), in a continued effort to improve treatment, optimize processes, reduce overall treatment costs, and reduce sludge production.

**TABLE 18.1 - CHEMICAL INFORMATION**

| Chemical | Form | Type of Delivery | Type of Storage |
|---|---|---|---|
| **Sludge Processing Building** | | | |
| Sodium Hypochlorite (NaOCL – "Hypo") | Liquid @ 12.5 % | Tank Truck | 6,100 gal. Tank |
| Sodium Hydroxide (NaOH – Caustic Soda) | Liquid @ 35 % | Tank Truck | 2,000 gal. Tank |
| Citric Acid (Acid) | Liquid @ 50 % | Bags - Truck | Dry Bag Storage / 400 gal. Tank |
| Cationic Polymer ("Poly") [1] | Dry | Bags - Truck | Dry Bag Storage |
| **CEPT Building** | | | |
| Potassium Permanganate | Dry | Bags - Truck | Dry Bag Storage |
| Ferric Chloride | Liquid @ 38 % | Tank Truck | 3,000 gal. Tank |
| [1]Anionic Polymer | Dry | Bags - Truck | Dry Bag Storage |
| [1]Cationic Polymer | Dry | Bags - Truck | Dry Bag Storage |

[1] The polymer feed systems includes a separate pump for liquid polymer if needed.

The sodium hypochlorite is distributed to the following locations:

- Headworks;
- Primary Treatment Building - Sludge/Septage Holding Tanks;
- Advanced Treatment Building - Recirculation Line, MBR System as a membrane cleaning agent and Sludge Holding Tanks; and

- Sludge Processing Building - Odor Control Scrubber.

The sodium hydroxide is distributed to the following locations:

- Headworks;
- Flow Distribution Structure;
- Sludge Processing Building - Odor Control Scrubber; and
- CEPT Building – pH Control.

The Cationic Polymer is distributed to the following locations:

- Rotary Press No. 1;
- Rotary Press No. 2;
- Rotary Press No. 3; and
- CEPT Building – Coagulant.

The Anionic Polymer is distributed to the following locations:

- CEPT Building – Flocculating agent.

The citric acid is distributed to the following locations:

- Advance Treatment Building - MBR System as a membrane cleaning agent; and
- Sludge Processing Building – Odor Control System as a scrubber cleaning agent.

The Potassium Permanganate is distributed to various locations throughout the Surfside WWTF.

### *18.2.2 Chemical Feed Pumps*

The various chemicals are delivered to their application point by various type pumps depending on the chemical being delivered and the delivery point characteristics.

- Sodium hypochlorite is delivered to the various application points (except the MBR System) by two (2) Milton Roy, Milroyal Model MGH-282 metering pumps with 1 hp, 460 volt, 3 phase, 60 Hz inverted duty motors having variable speed drives. These metering pumps have a pumping range of 20 to 130 gph at 100 psig;
- Sodium hypochlorite is delivered to the MBR System for chemical cleaning by two (2) diaphragm air actuated chemical metering pumps having a capacity range of 0.00 to 23.0 gpm;
- Sodium hydroxide is delivered to the various application points by two (2) Milton Roy, mRoy–A metering pumps with 1/3 hp. 460 volt, 3 phase, 60 Hz inverted duty motors having variable speed drives. These metering pumps have a pumping range of 0.38 to 3.8 gph at 200 psig;

- Polymer is delivered to the various Rotary Presses by three (3) Milton Roy, Milroyal B metering pumps with 2 hp., 460 volt, 3 phase, 60 Hz inverted duty motors having variable speed drives. These metering pumps have a pumping range of 50 to 500 gph at 150 psig; and

- Citric Acid is delivered to the MBR System by two (2) diaphragm chemical metering pumps with a capacity range of 0.00 to 23 gpm. These pumps are reciprocating controlled volume pumps. Since the citric acid is only utilized in the recovery cleaning, only one flow rate is required. The recovery flow rate for citric acid is from 252 to 318 gph.

The Milton Roy metering pumps have a very wide pumping range because the speed ratio is 5:1 and the stroke ratio is 10:1. These two metering pump adjustments give these pumps the capability of pumping in a range of 50 to 1.

See Chapter 9 for more information of the CEPT buildings chemical feed pumps.

### *18.2.3 Chemical Uses*

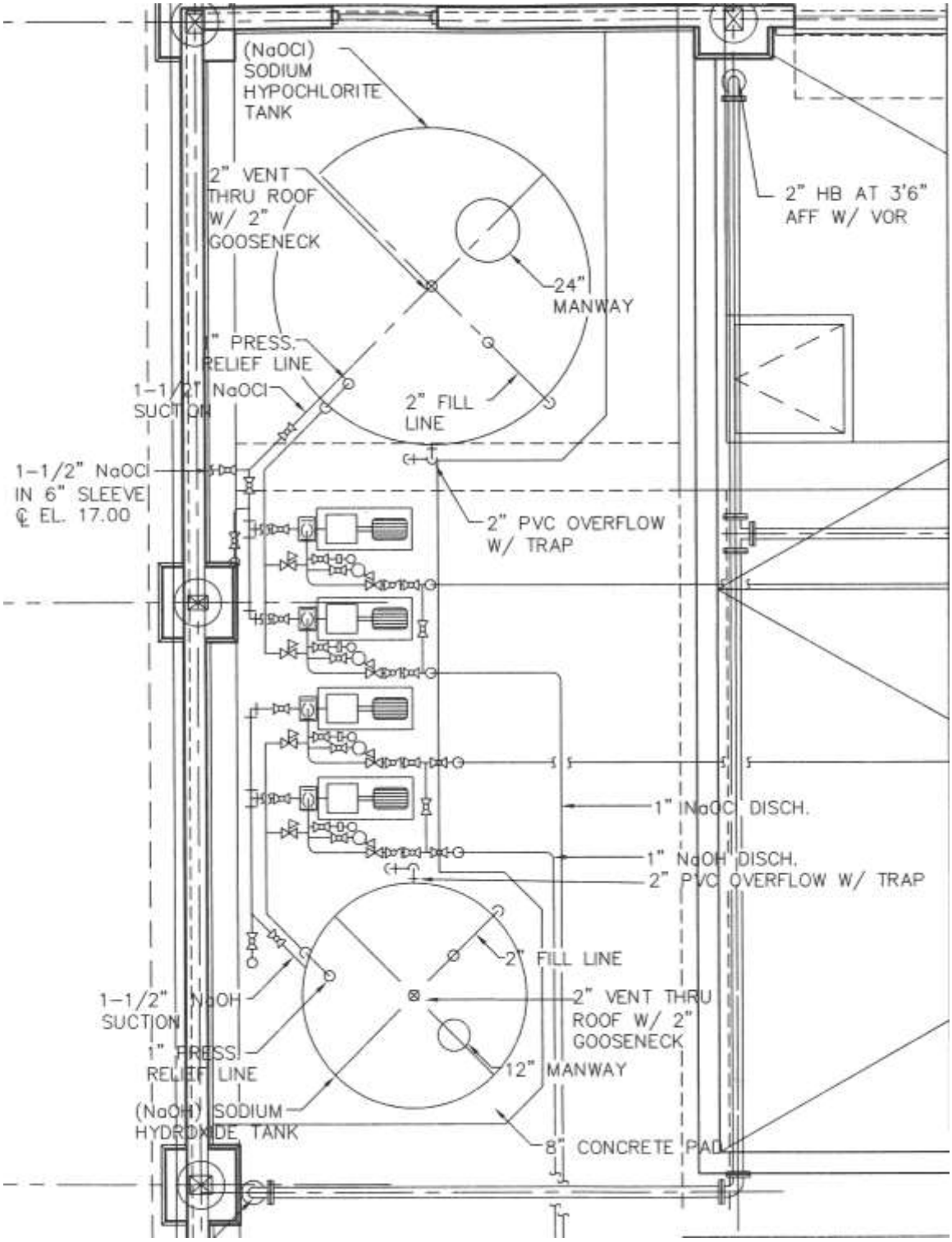
- Sodium Hypochlorite – Odor Control, MBR Cleaning and Process Control
  Sodium Hypochlorite is pumped from the 6,100 gallon storage tank to the Headworks Facility, Advanced Treatment Building, Primary Sludge Holding Tanks, ATB Sludge Holding Tanks and the Odor Control Scrubber. At the Headworks Facility, Primary and ATB Sludge Holding Tanks, it is used as an alternate form of odor control.

  At the Advanced Treatment Building, it is discharged into the recirculation pumped flow and discharged into the permeate/backpulse pump discharge pipeline when the pump is operating in the backpulse mode. The backpulse pump flow carrying the hypochlorite is forced back through the MBR membranes and assists in their maintenance and recovery cleaning. In addition, at the Advanced Treatment Building, Sodium Hypochlorite is discharged into the Return Activated Sludge discharge line for process control of filamentous bacteria.

  At the Odor Control Scrubber, it is used to assist in scrubbing the odorous air along with Sodium Hydroxide. When these chemicals are added to the scrubbing solution, a reaction between the absorbed vapor and chemicals in the scrubbing solution transforms the vapor into a species that allows further adsorption of the odors. This action increases the capacity of the scrubber solution to absorb the odorous vapor and allows recirculation of the solution. The sodium hypochlorite solution also prevents the build up of any slime on the scrubber packing.

  When the operator is working with a system utilizing sodium hypochlorite solution, protective clothing (gloves, long pants, and shirts with long sleeves) and eye protection should always be worn. This chemical will bleach clothing white and will seriously burn eyes and cuts, if carelessly handled. Contact with heat and acids should be avoided when working with sodium hypochlorite. The concentration of sodium hypochlorite used at this facility is approximately 15 to 20 percent. This is about 3 to 8 times stronger than normal household bleach. Refer to the MSDS sheet for detailed hypochlorite data. Refer to **Figure 18.1 - Sodium Hypochlorite and Sodium Hydroxide Storage and Feed System Schematic.**

**FIGURE 18.1 - SODIUM HYPOCHLORITE AND SODIUM HYDROXIDE STORAGE AND FEED SYSTEM SCHEMATIC**



- Sodium Hydroxide – ph Adjustment and Neutralization
  Sodium hydroxide is used at this facility to control the pH of the scrubbing solution in the Odor Control System and adjust the pH of the wastewater to facilitate optimum treatment. If the pH of the Odor Control scrubbing solution becomes too low, chlorine gas could form and be discharged with the clean air.

  Full protective clothing and eye protection should always be worn when working with caustic soda. Skin and eye contact with this chemical will cause burns. Affected areas must be immediately flushed with water. The concentration of caustic soda to be used in the Odor Control System is approximately 30%. Refer to the MSDS sheet for safety information and detailed characteristics.

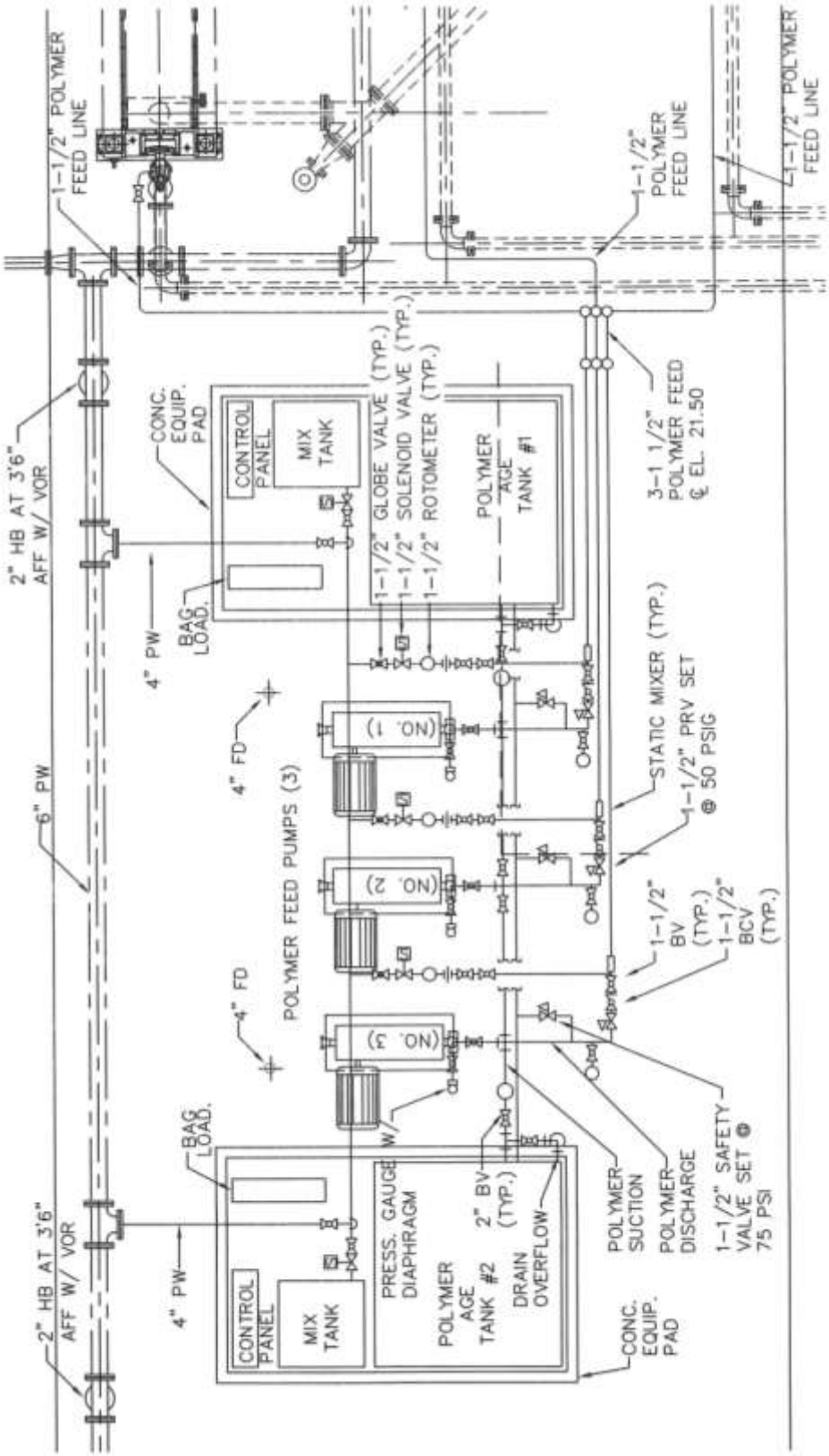
- Polymer (cationic) – Sludge Conditioner
  To obtain the optimum dewatering operation, the sludge has to be properly flocculated before it enters the Rotary Press. An insufficient quantity of polymer makes the floc too small and too fragile. An electric motor and gear reducer drives an agitator located inside the reservoir near the inlet. As it enters the Rotary Press channel, particles break up and pass through the filtering elements while larger particles are captured by the filtration elements, which will cause that cake to be extremely dry. On the other hand, excess polymer reduces the production rate by causing too much slippage between the compressed sludge and the filtering elements. The correct dosage results in a strong floc and good friction properties.

  The flocculator positioned inline before the Rotary Presses facilitates the proper mixing of the sludge and the polymer. The flocculator is a 21 gallon reservoir that contains a mixture of sludge and polymer fed through an inlet at the agitator properly mixes the sludge and polymer and speeds up the flocculation process. The speed of the agitator can be changed to accommodate a change in the sludge's nature. The flocculator's outlet is located at the bottom of the reservoir. The conditioned sludge discharge can be directed towards the side mounted sampler or the Rotary Press. Refer to the Rotary Presses manufacturer's OandM Manual for more information on using the sampler to obtain a floc sample and perform jar tests to evaluate the proper sludge/polymer mixture.

  The polymer dosage is calculated as a percentage of the sludge flow, which in turn is measured by the sludge flow meter. The necessary quantity of polymer is computed from the flow meter reading and a signal is sent to the polymer pump controller to adjust the speed of the metering pump accordingly. Polymer dosages will typically be less than 18 pounds of polymer per ton of dry sludge solids when dewatering a blend of raw primary sludge and waste activated sludge. The dewatered sludge cake output concentration for the blended type sludge typically ranges from 25 to 30 percent solids. Refer to **Figure 18.2 - Polymer System Storage and Feed System Schematic**.

- Citric Acid - MBR Membrane Cleaning Agent
  The Citric Acid System was designed and provided at the WWTF by the MBR Membrane System provider Zenon Membrane Solutions, which is a subsidiary of G.E. Water and Process Technologies. The Citric Acid is utilized along with Sodium Hypochlorite to clean the "ZeeWeed" membrane units when the headless across the train becomes excessive. This cleaning is a periodic event rather than a continuous process. Since the head loss across the train (or unit) cannot be measured, the operator will determine when the cleaning cycle should begin by observing the water level in the respective tank. The concentration of acid used in this process is approximately 50 percent.

**FIGURE 18.2 - POLYMER SYSTEM STORAGE AND FEED SYSTEM SCHEMATIC**



Citric Acid is also used as a cleaning agent on the Odor Control Units Scrubber. The OCU cleans itself automatically and uses a diluted concentration of citric acid.

Full protective clothing and eye goggles should always be worn when working with this chemical. Refer to the MSDS sheet for the acid properties and spill and disposal procedures. Refer to the Zenon Membrane Solutions O&M Manual and the Odor Control Units O&M for more detailed information on these systems.

- CEPT Systems (only to be used as backup during unforeseen circumstances)
  - Ferric Acid: The CEPT process uses Ferric Acid as a coagulant. It is delivered to the headworks through a one inch drop pipe and provides cations to destabilize the negative charged fine particles of wastewater.
  - Cationic Polymer: The CEPT process uses cationic polymer as a coagulation agent. It is delivered to the headworks through a one inch diffuser. The cationic polymer is used to absorb the particles that the ferric chloride has destabilized, binding the smaller particles together.
  - Anionic Polymer: The CEPT process uses anionic polymer as a flocculating agent. The polymer can be delivered to the aerated grit chamber or directly to the three primary clarifiers. The anionic polymer is used to create larger floc that settles easier.
  - Potassium Permanganate: Backup odor control can be achieved by adding Potassium Permanganate to various points throughout the facility.

## 18.3 OPERATION AND CONTROL

The chemical systems can be monitored and controlled from every respect at the Local Control Panels. The chemical systems can be monitored and partially controlled from the SCADA System HMI. The details are explained as follows:

### *18.3.1 At the Local Control Panel Chemical Feed Pumps*

- Sodium Hydroxide Pump motor over temperature/failure alarm (YA-835);
- Sodium Hydroxide Pump run status (YI-835);
- Sodium Hydroxide Pump “START/STOP” pushbutton (YS-835);
- Sodium Hydroxide Pump No. 1 and No. 2, VFD Manual Speed Control;
- Sodium Hydroxide Pump No. 1 and No. 2, VFD HAND/OFF/AUTO Switch (SS-825A, etc.);
- Sodium Hydroxide Pump No. 1 and No. 2, VFD “ON” indicating light (Red);
- Sodium Hydroxide Pump No. 1 and No. 2, VFD “OFF” indicating light (Green);
- Sodium Hydroxide Pump No. 1 and No. 2, VFD “START/STOP” pushbuttons (YS-825A, etc.);
- Sodium Hydroxide Pump No. 1 and No. 2, VFD Speed Indication;

- Sodium Hydroxide Pump No. 1 and No. 2, VFD Elapsed run time meter;
- Sodium Hypochlorite Pump motor over temperature/failure alarm (YA-835);
- Sodium Hypochlorite Pump motor run status (YI-835);
- Sodium Hypochlorite Pump “START/STOP” pushbutton (YS-835);
- Sodium Hypochlorite Pump No. 1 and No. 2, VFD Manual Speed Control;
- Sodium Hypochlorite Pump No. 1 and No. 2, VFD HAND/OFF/AUTO Switch (SS-825A, etc.);
- Sodium Hypochlorite Pump No. 1 and No. 2, VFD “ON” indicating light (Red);
- Sodium Hypochlorite Pump No. 1 and No. 2, VFD “OFF” indicating light (Green);
- Sodium Hypochlorite Pump No. 1 and No. 2, VFD “START/STOP” pushbuttons (YS-825A, etc.);
- Sodium Hypochlorite Pump No. 1 and No. 2, VFD Speed Indication; and
- Sodium Hypochlorite Pump No. 1 and No. 2, VFD Elapsed run time meter.

### *18.3.2 At the Polymer Feed System local Control Panels*

- Dry Polymer System Age Tank low level alarm (LAL-800);
- Dry Polymer System failure alarm (YA-800-1);
- Dry Polymer System hopper low/water fail alarm (YA-800-2);
- Dry Polymer System “ON” (YI-800);
- Polymer pacing signal (FY-820); and
- Polymer Make-Up System No. 1 and No. 2 low level shutdown alarm (LAL-820-1 and 2).

### *18.3.3 At The Polymer Pump Local Control Panel*

- Polymer Pump No. 1, No. 2 and No. 3 motor over temperature/failure alarm (YA825A, B and C);
- Polymer Pump No. 1, No. 2 and No. 3 run status (YI-825A, B, and C);
- Polymer Pump No. 1, No. 2 and No. 3 “START.STOP” pushbuttons (YS-825A, B, and C);
- Polymer Pump No. 1, No. 2 and No. 3 VFD Manual Speed Contro;
- Polymer Pump No. 1, No. 2 and No. 3 VFD HAND/OFF/AUTO Switch (SS-825A, etc.);
- Polymer Pump No. 1, No. 2 and No. 3 VFD “ON” indicating light (Red);

- Polymer Pump No. 1, No. 2 and No. 3 VFD “OFF” indicating light (Green);
- Polymer Pump No. 1, No. 2 and No. 3 VFD “START/STOP” pushbuttons (YS-825A, etc.);
- Polymer Pump No. 1, No. 2 and No. 3 VFD Speed Indication; and
- Polymer Pump No. 1, No. 2 and No. 3 VFD Elapsed run time meter.

The backup CEPT Chemical systems are controlled through their respective local control panels in the CEPT building. See the individual manufactures’ O&M Manuals or previous surfside O&M manuals for further information.

#### *18.3.4 At the SCADA System HMI*

Local operation of the two polymer chemical feed systems’ equipment is controlled through the Rotary Press System control panel. The following status and alarm signals are displayed at the SCADA HMI:

- Polymer Feed System No. 1 common alarm (YA-750A);
- Polymer Feed System No. 2 common alarm (YA-750B);
- Sodium hypochlorite storage tank level is indicated, trended, and recorded (LIR-765A) at the SCADA HMI. Level alarms are displayed at the SCADA HMI;
- Sodium Hydroxide storage tank level is indicated, trended, and recorded (LIR-765B) at the SCADA HMI. Level alarms are displayed at the SCADA HMI; and
- Hypochlorite and Hydroxide chemical containment area spill alarm (LAH-765) is displayed at the SCADA HMI.

Refer to G. E. Water and Process Technologies, Inc. O&M Manual, Volume II, No. 500401, Section No. 5, “System Operations”” for information on the MBR Chemical Systems and Equipment for feeding the cleaning agents Sodium Hypochlorite and Citric Acid.

# 19 - EMERGENCY OPERATION

## 19.1 GENERAL

Plant processes and equipment, which are the most vulnerable during emergencies, must be identified so that consideration may be given to the alternate or emergency modes of operation available. This can be done by the development of a “Vulnerability Analysis”, which includes the selection of several high-risk emergency situations and estimating the effects that each of these situations could have on individual components of a treatment system.

The treatment system components that would be out of service during several types of emergencies and are vital to the operation of the WWTF are the most vulnerable system components. Special attention should be given to the maintenance, repair and emergency operation of these system components.

The following measures should be considered to reduce component and system vulnerability:

- The formation and execution of an optimum preventative maintenance and equipment testing program;
- Complete familiarization with alternative modes of system operation;
- Maintenance of reserve and emergency equipment in good working order;
- Keeping an adequate supply of chemicals in stock;
- Training regular and auxiliary personnel in emergency operation procedures; and
- Conducting emergency operation exercises routinely.

The WWTF personnel should formulate an Emergency Response Plan for the facility and create checklists for the procedures to be followed in anticipated emergencies. Individual emergency response cards should outline each person’s duties under different major emergency situations. The emergency response cards should tell the individual where and to whom he/she is to report, his/her duties, and phone numbers he/she can call for instructions or assistance.

Steps should be taken to equip the emergency administration center, stock and inventory reserve supplies and spare parts, and inform all staff members of basic emergency procedures. It is important in the beginning that it be clear exactly who will give orders in case of an emergency so that the response program will run as smoothly as possible.

Accurate record keeping is also important to a well organized response program. When an emergency occurs, there should be up-to-date records so that repair teams can locate the problem area. Inventory should be restocked as soon as possible so that reserve supplies are on hand when needed.

Once an emergency response program has been set up, it is important that it be ready to go into action at a moment's notice. Therefore, a schedule should be established which will give certain prescribed times when reserve equipment will be tested and reserve supplies inventoried.

WWTF staff should be drilled routinely on emergency response procedures. During emergency drills, all personnel should report to their posts and proceed as they would in an actual emergency. Those aspects of the WWTF that require the cooperation of other organizations (such as the fire department) should also be reviewed periodically with key personnel from those organizations, particularly after Plant updates.

The objectives of emergency response planning may be identified as follows:

- To eliminate or minimize adverse effects from emergency situations affecting the treatment system;
- To develop procedures for properly responding to emergencies;
- To provide instruction for system personnel to ensure that they understand their responsibilities during emergency situations; and
- To provide inventories of available emergency equipment and outline existing mutual aid agreements and contracts with outside organizations for specialized assistance.

## 19.2 MUNICIPAL AID AGREEMENTS

Agencies and businesses within the community may be helpful during an emergency due to the type of personnel they employ or the services they offer. Written mutual aid agreements should be made with agencies and businesses to help during emergencies. Some examples of these groups follow:

- Industrial firms;
- Construction companies;
- Electrical, gas, and telephone utilities;
- Local fire and police departments;
- Civil defense organizations;
- Health departments; and

- Rescue squads.

Mutual assistance programs with the above organizations can provide the following:

- Emergency equipment and supplies;
- Spare and/or repair parts;
- Specialized maintenance skills;
- Auxiliary operating personnel; and
- Chemists, environmental and civil engineers and/or wastewater engineers.

## 19.3 FIRES

Dry type fire extinguishers should be provided for use at the Facility. Those extinguishers should be stored on the wall of the Administration Building and have a ten-pound-capacity. The fire extinguishers should be checked regularly for serviceability and kept easily accessible. Access to the units should never be blocked with tools or equipment. Fire extinguisher should only be used for small manageable fires. Let the fire department handle all significant fires!

Emergency lighting units are provided in all interior areas of the Surfside Wastewater Treatment Facility. This allows emergency escape if power goes out. All WWTF personnel should familiarize themselves with the location of the entrance/exits of the buildings.

All the buildings and major structures within the Plant's fenced perimeter are easily reached by fire apparatus and rescue equipment. The WWTF roadways provide direct access should any structure need to be approached by emergency vehicles. It is recommended that police, fire, and rescue workers be periodically given a tour of the facility.

During the tour of the facility, these professionals should be introduced to the location of access points, gates, doors, location of stored chemicals, and location of available fire and yard hydrants. At the time of the tour, it would be useful to give copies of Material Safety Data Sheets (MSDS) information for all chemicals stored at the facility to the fire department representatives. The M.S.D.S. information should also be kept in the Administration Building and Process Analysis Building.

The fire department has a key for the main entrance gate and a master key for the buildings. This allows the fire department to respond as quickly as possible should the operator not be available.

During periods of heavy snowfall, the road to the facility and path to the main gate should be kept plowed and easily passable. Make sure all walkways are cleared of snow to allow fast entrance to or exit from any building.

## 19.4 PERSONNEL INJURY

In the event of personnel injury, remove the injured worker from any recurring danger. Make the worker as safe, warm, and comfortable as possible. Aside from administering artificial respiration, cardiopulmonary resuscitation (CPR), or stopping severe bleeding, Emergency Response Personnel should be contacted immediately to provide medical attention until the victim can be transported to a hospital. The emergency phone number is 911 and it should be posted within each building at the WWTF.

## 19.5 CONTAMINATION OF WATER SUPPLY

The buildings within the facility are protected from contamination of the potable water supply by placement of backflow preventors on the potable water feed line.

Although unlikely, potable water contamination could take place within the buildings after the backflow preventor. If this occurs, the feed line will need to be flushed to the nearest hydrant or blow-off. The use of chlorine bleach may be required as part of the line flushing process. These materials should be brought in on an “as needed” basis, and only stored and handled in accordance to the chemical suppliers’ recommendations.

Any flushing and chlorination of potable water supply lines should be done under the supervision of Water Department personnel. Never use Plant Water in the facility for drinking. Fixtures could be contaminated resulting in severe gastrointestinal illness. These fixtures have been provided solely for maintenance activities and cleanup before leaving the facility. Signs shall be maintained warning against drinking this water.

## 19.6 NATURAL DISASTERS

In Nantucket, the primary natural threat is from a blizzard, ice storm or hurricane. The threat of a earthquake is also a possibility. Problems associated with these types of natural disasters include flooding, freezing, pipe ruptures, etc. A response plan for all these situations should be in place for the treatment facility. The possible effects of each disaster should be listed along with the immediate precautions to be taken which will either eliminate or counteract each effect. For example, one of the possible effects of a blizzard or ice storm would be blockage of the plant access road. A hurricane could cause wind or water damage.

Refer to **Table 19.1 - Emergency Response Program During Natural Disasters** which lists a suggested response procedure for the most commonly suffered disaster effects. This table should be expanded by the Licensed Operator so that it provides an up-to-date reference for all plant personnel.

The following are some considerations for developing an emergency response plan.

### *19.6.1 Flooding*

There is a possibility of flood conditions at the WWTF given proximity to the ocean. The entire WWTF is constructed above the nearest 100 year flood elevation however, there is a possibility of flooding in lower elevations at the facility, such as pump rooms, from hurricanes, windstorms, or pipe ruptures.

The major hazard with flooding is the danger of electrical shock. Do not enter a flooded area without first isolating the power. Do not use an internal combustion engine inside an enclosed area to pump out water. Use an electric pump with power from an outside source. After heavy rains, the slopes of the infiltration basins should be checked for damage and erosion. If identified, repairs and re-seeding should be implemented.

### *19.6.2 Hurricanes and Wind Storms*

The most obvious consideration facing the facility during hurricanes and windstorms is the loss of normal power. All power to and within the WWTF is delivered via an underground feed cables however, the main service from South Shore Road is from above ground poles and wires.

The single biggest problem associated with a hurricane is the high winds and the amount of rainfall that accompanies these storms. These may cause problems accessing the site or structural damage to the various structures. If damage occurs, the area should be protected from further damage and it should be evaluated by a licensed Engineer with experience evaluating these types of problems and recommend solutions implemented as soon as possible.

**TABLE 19.1 - EMERGENCY RESPONSE PROGRAM DURING NATURAL DISASTERS**

| Natural Disaster | Effect | Response |
|---|---|---|
| FLOOD | Submerged equipment, or electrical lines | (1) Notify licensed operator<br>(2) Shut off electrical current to all submerged lines or equipment<br>(3) Dewater area (use portable pump to aid in dewatering)<br>(4) Do not enter flooded areas alone or without checking for gas and oxygen deficiency.<br>(5) Clean up area<br>(6) Assess damage and begin repairs<br>(7) Use portable radio, battery powered lighting equipment, and emergency drinking water. |
| HURRICANES | Doors blown in, damage to outside equipment by wind, accumulation of debris, flooding | (1) Notify licensed operator and personnel at plant<br>(2) Secure, if possible, doors with boards, nails, masking tape and rope<br>(3) Keep personnel clear of damaged areas<br>(4) Protect any exposed equipment<br>(5) Shut off electrical current to damaged equipment and repair after storm<br>(6) Provide first aid and secure medical care for injured<br>(7) Make sure all hatches are secure. |
| FIRE | Personnel injuries, property damage | (1) Call fire department and notify licensed operator<br>(2) Evacuate all personnel and equipment<br>(3) Use fire extinguishers, yard hydrants, and water hoses to Administration fire<br>(4) DO NOT USE WATER ON ELECTRICAL OR OIL FIRES<br>(5) Provide first aid and secure medical care for injured |
| EXPLOSION | Fire, flooding, power outage, release of gases, personnel injuries | (1) Notify licensed operator and Fire Department<br>(2) Evacuate all personnel and equipment<br>(3) Shut down all electrical equipment in area<br>(4) Ventilate area<br>(5) Provide first aid and secure medical care for injured |
| NATURAL DISASTER FREEZING | Equipment damage, blockage | (1) Notify licensed operator<br>(2) Apply supplemental temporary heat<br>(3) Remove ice after shutting down unit<br>(4) Assess damage and repair |

### *19.6.3 Earthquake and Pipe Ruptures*

The occurrence of this type of natural disaster is rare in this geographic area. Emergency management of this type of situation would entail providing medical treatment to injured personnel.

Breakage of lines at the treatment facility, caused by an earthquake, would require that the affected lines within the buildings and at the tanks be isolated. In most cases, valves are provided that will stop flow from within the buildings and at the tanks. Structural damage should be reviewed as soon as possible, since most of the mechanical equipment requires proper alignment to function properly.

## 19.7 SPILLS INTO THE FACILITY

As part of emergency response planning, a list should be compiled of any sources where spills might occur that would affect plant operation. Take an inventory of all potentially dangerous substances that could enter the sewerage system. Notify all departments using hazardous substances that they must notify the treatment plant immediately, by telephone or in person, if any accident (spill) occurs.

When faced with a spill of gasoline or fuel oil, plant personnel should immediately notify the Fire Department and the appropriate official to call in a licensed hazardous waste containment/cleanup crew. Any enclosed area where the spill may have reached (e.g., tank or manhole), must be vacated. Personnel should be kept well away from all smoking material, open flames, and other heat sources.

## 19.8 SPILLS FROM THE FACILITY

### *19.8.1 Wastewater Spills*

In case of a spill of raw or inadequately treated wastewater from the WWTF to the local area, the following agencies must be notified:

- MassDEP - Emergency Response: 508-946-2850

An Accidental Spill Report should be filled with MassDEP. The report should contain the following information:

- Reason for spill;
- Description of the discharge;
- Anticipated time the spill will continue;
- Duration of spill, if already corrected; and
- Steps taken to prevent such a spill from occurring again or plans which will be implemented within a stated period to prevent such a condition from recurring.

Refer to **Table 19.2 –Spill Report** which can be used to help compile the information.

### *19.8.2 Chemical Releases*

In the event of a release of a small amount of chemical, the chemical should be cleaned up according to the instructions given on the manufacturer's MSDS. Pay particular attention to the recommendations for personal protective equipment.

For larger releases, the local Fire Department should be called for assistance.

- Fire Department: 911 or 508-228-2324

To request assistance for a hazardous material incident, contact:

- MassDEP: 888-304-1133

## 19.9 RESPONSE COURSE OF ACTION

Emergency situations can be varied and require a different response to fit the conditions encountered. In the text, we have detailed responses to floods, hurricanes, fire, explosions, and freezing. Each response will require that a well-thought-out plan be initiated to minimize the impact of the situation. It has been our intent to make plant operators aware of potential problems and guide them in the direction that will aid in addressing the situation. This does not complete the operator's obligation to initiate a set of step-by-step procedures that will be used to address emergency impact situations. Such a step-by-step plan is best formulated by the community most familiar with local conditions relative to available manpower, agencies, and talent.

**TABLE 19.2 - SPILL REPORT**

Name of Facility: Surfside Wastewater Treatment Facility

County: Nantucket City / Town: Nantucket, MA

Spill Location: _____

Date: _____ Time: _____

Reason For The Problem: _____

Corrective Action Taken: _____

Estimated Time To Complete _____

Remarks: _____

Reported By: _____ Telephone No. _____

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# 20 - FACILITY RECORDS AND REPORTING

## 20.1 GENERAL

Operation, maintenance, and financial records provide important documentation for any wastewater treatment facility. Operating cost records are essential in the preparation of budgets, and accurate operational records provide a history and any trends in individual processes. Records should be kept neat and stored in a safe place, input into a computer, and backed up on disc.

## 20.2 DAILY LOGS

The operator shall maintain a daily log of plant operations, process changes, and equipment maintenance. Copies of the daily logs shall be kept at the facility at all times. At a minimum, the following information should be recorded in the facility's log:

- Results of daily and monthly influent and effluent monitoring as required in the discharge permit;
- Results of daily and monthly monitoring or other wastewater samples;
- Date and quantity of sludge removed from the facility;
- Physical changes in the biological status in the Aeration and MBR Systems;
- Process changes;
- Equipment maintenance records;
- Equipment failures and replacements; and
- Emergency situations.

## 20.3 LABORATORY RECORDS

Daily, weekly, monthly, and quarterly laboratory test results should be recorded on laboratory worksheets and laboratory reports. A sample laboratory report for the WWTF is included at the end of this Chapter along with laboratory bench sheets for the following:

- Total Suspended Solids;
- Total, Volatile, and Fixed Suspended Solids;
- Solids in Sludge;
- $BOD_5$ Test;
- COD Determination;
- Oil and Grease Analysis;

- Alkalinity Determination;
- Ammonia, Nitrogen Determination; and
- TKN Determination.

## 20.4 SCADA SYSTEM GENERATED REPORTS

The SCADA system has the ability to control, monitor, report and store a variety of WWTF processes. The SCADA system automatically collects and stores a variety of measured process variable data, and also accepts operator-entered data to automatically generate daily, weekly, monthly, and annual hard copy text reports and selected graphic reports. The SCADA system software (Graphical User Interface) is provided under FIX DYNAMICS for Windows by Intellution. The software provides the following features:

- Data acquisition and control;
- Alarming and alarm management;
- Historical trending;
- Security;
- Application integration; and
- Cross-platform integration.

The SCADA system is designed to collect, process, store and report process variable data and user entered data, and automatically load such data into specifically designed Microsoft Excel spreadsheet files and/or pre-designed numerical and graphical templates.

## 20.5 MASSACHUSETTS DEP REPORTING

The operator shall also report any of the following to the Massachusetts Department of Environmental Protection (MassDEP), Division of Water Pollution Control, Southeastern Regional Office, Lakeville, Massachusetts Office (SERO):

- Planned physical alterations and additions to the facility;
- Anticipated non-compliance;
- Occurrence of a facility non-compliance (reported within 24 hours); and
- Any proposed sewer connections or changes of a present sewer user.

All facility record keeping and reporting shall meet the requirements of the Groundwater Discharge Permit Program (314 CMR 5.00).

## 20.6 ANNUAL REPORT

The Chief Plant Operator should prepare an annual report at the end of each fiscal year for the operation of the WWTF. The report generally consists of three sections, a Management Data Section, Operating Data Section and General Data Section.

In addition, the following data should be provided in the annual report if possible:

- Management Data
  - Total Historical Capital Cost
  - Total Historical Capital Cost Depreciated
  - Replacement Cost
  - Replacement Cost Depreciated

- Operation Data
  - All costs exclusive of debt service
  - All costs including debt service

- General (Information for last 10 years)
  - Average daily flow for each month
  - Average daily flow for year
  - Project curve for next five years
  - Total Unit Cost for the year

## 20.7 RECORD KEEPING REQUIREMENTS

Record keeping and reporting on the operation of the WWTF and related appurtenances must also conform to the provisions of 314 CMR 12.07. Specifically, monthly operating records shall be maintained by the plant operator in accordance with the most recent edition of the MassDEP, Division of Water Pollution Control's publication entitled, "Directions for Completing Monthly Report Forms for Wastewater Treatment Plants" and submitted on forms supplied by the MassDEP. A copy of the regulations, instructions and reporting forms supplied by the MassDEP are available from MassDEP SERO. Additional provisions relating to the monitoring requirements, compliance schedules, planned changes, and 24-hour reporting are contained in MassDEP regulations at 314 CMR 5.19 and 5.20. A copy of these regulations is available from MassDEP SERO.

The MassDEP suggests that inspections of the treatment plant be completed by a Massachusetts Registered Professional Engineer knowledgeable in wastewater treatment processes. These inspections are required at least once a month to inspect the operation of the collection, treatment, and disposal facilities and to consult with the plant operator. During these visits, the Engineer will review the facility's operation and maintenance records, check the monitoring reports, and inspect the treatment, sampling, and flow measurement equipment.

Refer to **Appendix H – Glossary of Terms** and **Appendix I – Formulas and Conversion Factors**.

## 20.8 LIST OF FORMS

Over the years, the operating staff has developed the following various forms for which have been utilized during the operation and maintenance of the Surfside WWTF. The operating staff should review the information on at least a yearly basis and replace outdated information.

- Operation Report of WWTF for Misc. Data;
- Operation Report of Primary Treatment Data;
- Typical Log Sheet for Rotary Press Operations;
- Septage Log;
- Pumping Station Log;
- Laboratory Report – Daily & Weekly Tests;
- Total Suspended Solids – Sampling Report;
- Suspended Solids Analysis – Total, Volatile, & Fixed – Sampling Report;
- Data Sheet for Solids in Sludge – Test Report;
- Data Sheet for BOD – Test Report;
- COD Determination – Test Report;
- Oil & Grease Analysis – Sample Report;
- Data Sheet for (process location) Alkalinity Determination – Sample report;
- Data Sheet for Ammonia Nitrogen Determination – Sample Report;
- Data Sheet for TKN Determination – Test Report;
- Groundwater Permit Monthly Report Summary Sheet;
- Monthly Operation & Maintenance Report (4 – pages);
- Mass. Groundwater Discharge Permit Program-Compliance Monitoring Report; and
- Annual Report – Operating Data.

# APPENDIX A – BASIC DESIGN DATA

| Description | Remark / Value |
|---|---|
| **Flows and Loadings** | |
| Design Average Daily Flow (mgd) | 3.50 |
| $BOD_5$ Concentration (mg/l) | 341 |
| TSS Concentration (mg/l) | 466 |
| TKN Concentration (mg/l) | 40 |
| $NH_4$-N Concentration (mg/l) | 25 |
| Total P Concentration (mg/l) | 9 |
| WWTFDesign Flow Average Day, Peak Month (mgd) | 3.50 |
| WWTF Max. Day, Peak Month (mgd) | 5.25 |
| Design Flow Peaking Factor | 2.4 |
| WWTF Design Instantaneous Max. Flow (mgd) | 7.71 |
| Design $BOD_5$ Load Average Day, Peak Month (lbs/day) | 9,946 |
| Design TSS Load Average Day, Peak Month (lbs/day) | 13,589 |
| Design TKN Load Average Day, Peak Month (lbs/day) | 1,155 |
| Design $NH_4$-N Load Average Day, Peak Month (lbs/day) | 730 |
| Design Total P Load Average Day, Peak Month (lbs/day) | 270 |
| Headworks | |
| Type of Unit | In-Channel Grinder |
| Number of Units | 1 |
| Capacity, each (mgd) | 7.70 |
| Motor Horsepower (hp) | 5 |
| Type of Unit | Bar Rack |
| No. of Units | 1 |
| Bar Opening (in.) | 2¼ |
| Type of Unit | Parshall Flume |
| No. of Units | 1 |
| Flume Size (in.) | 12 |
| Max. Capacity (mgd) | 5.80 |
| Type of Unit | Aerated Grit Chamber |
| No. of Units | 1 |
| Chamber Length (ft. & in.) | 15’-0” |
| Chamber Width (ft. & in.) | 17’-0” |
| Sidewater Depth (ft. & in.) | 14’-10” |
| Detention Time @ Max. Cap.(min.) | 3.9 |
| Grit Screw Drive Protection | Shear Pin |
| Screw Drive Motor Horsepower (hp) | 1.0 |
| Screw Conveyor Dia. (in.) | 6 |
| Air Diffuser System | Single Pipe Header |
| Type of Unit | Air Blowers |
| No. of Air Blowers | 2 |
| Air Blower Cap. (icfm) | 120 |
| Blower Discharge Pressure (psig) | 5 |
| Intake/Discharge Size (in) | 2/2 |

| Description | Remark / Value |
|---|---|
| Type of Unit | Grit Pump |
| Grit Pump Type | Recessed Impeller |
| Grit Pump Cap. (gpm) | 220 |
| Grit Pump Motor Horsepower (hp) | 7.5 |
| Drive Type | Constant Speed V-Belt |
| | |
| Primary Treatment | |
| No. of Units | 3 |
| Type | Rectangular |
| Length Each (ft.) | 81.5 |
| Width Each (ft.) | 18 |
| Sidewater Depth (ft.) | 7 |
| Design Flow, Avarage Peak Month (mgd) | 3.50 |
| Design Flow Max. Day (mgd) | 5.25 |
| WWTF Design Instantaneous Max. Flow (mgd) | 7.71 |
| Design $BOD_5$ Load Average Day, Peak Month (lbs/day) | 10,252 |
| Design TSS Load Average Day, Peak Month (lbs/day) | 14,501 |
| $BOD_5$ Removal (%) | 30 |
| TSS Removal (%) | 60 |
| Primary Influent Phosphorous Concentration (mg/l) | 9 |
| Primary Effluent Phosphorous Concentration (mg/l) | 7 |
| Estimated $BOD_5$ Removal (lbs/day) | 3,076 |
| Primary Sludge Solids Quantity (lbs/day) | 8,700 |
| Primary Sludge Concentration (Estimated)(mg/l) | 40,000 |
| Primary Sludge Volume (gpd) | 26,080 |
| Overflow Rate at Design Flow (gpd/$ft^2$) | 795 |
| Overflow Rate at Max. Day Flow (gpd/$ft^2$) | 1,193 |
| Overflow Rate at Instantaneous Peak Flow (gpd/$ft^2$) | 1,752 |
| Detention Time at Design Flow (hrs.) | 1.6 |
| Detention Time at Max. Day Flow (hrs.) | 1.1 |
| Detention Time at Instantaneous Peak Flow (hrs.) | 0.7 |
| | |
| Type of Sludge Pump | Double Disc |
| No. of Sludge Pumps (each) | 3 |
| Suction Size (inches) | 6 |
| Discharge Size (inches) | 6 |
| Flow (gpm) | 80 |
| TDH (ft.) | 15 |
| Horsepower (each) | 5 |
| Pump Speed (rpm) | 300 |
| No. of Grinders | 3 |
| Grinder Size (inches) | 6 |
| Grinder Horsepower | 5 |
| | |
| **Sludge and Septage Systems (Primary)** | |
| Sludge & Septage Holding Tanks (size data approx.) | |
| No. of Tanks (2-sizes) | 4 |
| Tank Length (3-smaller) | 18’-0” |
| Tank Width (3-smaller) | 16’-3” |
| Tank Length (1-larger) | 25’-0” |
| Tank Width (1-larger) | 13’-0” |
| Sidewater Depth (all) | 9’-0” |
| Unit Volume (Orig. Septage)(gal.) | 19,691 |

| Description | Remark / Value |
|---|---|
| Unit Volume (Orig. Larger Sludge)((gal.) | 39,382 |
| Total Volume (Orig. Two Smaller Sludge)(gal.) | 21,879 |
| Total Volume (All Tanks)(gal.) | 80,952 |
| | |
| No. of Blowers | 4 |
| Type of Blower | 2-lobe involute |
| Blower Capacity (icfm) | 120 |
| Blower Discharge Pressure (psig) | 5 |
| Blower Intake/Discharge Size (in.) | 2/2 |
| Drive Type | VFD |
| | |
| No. of Septage/Sludge Grinders | 2 |
| Type of Grinder | 2-Shaft Design |
| Grinder Capacity (gpm) | 400 |
| Grinder Motor Horsepower (hp) | 2 |
| | |
| No. of Septage/Sludge Pumps | 2 |
| Type of Pump | Double Disc (PD) |
| Pump Capacity (gpm) | 80 |
| Pump Motor Horsepower (hp) | 5 |
| Pump Size (in.) | 4 |
| Drive Type | VFD |
| | |
| No. of Septage Receiving Stations | 1 |
| Type of Station | Self-Contained |
| Station Capacity (gpm) | 400 |
| Holding Tank Capacity (gal.) | 504 |
| Drive Screw Motor Horsepower (hp) | 2 |
| Solids Separation Method | Screening/Wash Water |
| | |
| Advanced Treatment System | |
| *Distribution Box* | |
| Type of Unit | Two Way Flow Split |
| No. Of Weir Gates | 2 |
| Gate Size (WxH)(ft.) | 5 x 2 |
| | |
| *Pre-Anoxic Tanks* | |
| No. of Tanks | 2 |
| Length (ft.& in.)(each) | 35’-6” |
| Width (ft. & in.)(each) | 29”-4” |
| Sidewater Depth (ft. & in.)(each) | 13’-6” |
| Unit Volume (gal.) | 90,000 |
| Total Volume (gal.) | 180,000 |
| Detention Time @ ADF (hrs) | 5.58 |
| | |
| No. of Submersible Pumps | 4 |
| Submersible Pump Type | Tube/Propeller |
| Pump Propeller Diameter (in.) | 20 |
| Pump Propeller Speed (rpm) | 565 |
| Pump Motor Horsepower (hp) | 7.64 |
| Pump Capacity (gpm) | 4165 |
| Pump Head (ft.) | 3.86 |
| Pump Drive | Direct |

| Description | Remark / Value |
|---|---|
| No. of Mechanical Mixers | 4 |
| Submersible Mixer Type | Propeller |
| Mixer Propeller Diameter (in.) | 11.8 |
| Mixer Propeller Speed | 1111 |
| Mixer Motor Horsepower (hp) | 2.3 |
| Mixer Flow Rate (gpm) | 2600 |
| Mixer Drive | Direct |
| *Aeration Basins (Including Post-Anoxic Tank)* | |
| No. of Basins | 3 |
| Length (ft. & in.) | 80'-1" |
| Width (ft. & in.) | 16'-3" |
| Sidewater Depth (ft. & in.) | 17'-7" |
| Basin Volume (gal.)(each) | 170,000 |
| Total Volume (gal.) | 340,000 |
| Detention Time (hrs) | 2.33 |
| *Aeration Diffuser System (Aeration Tank Only)* | |
| Aeration Tank Nos. | 1 – 3 |
| Zone Nos. | 1 – 2 |
| Grids per Tank | 2 |
| Distributor Legs per Grid | 10 |
| Diffuser Elements per Distributor | 26 |
| Diffuser Elements per Grid | 260 |
| Diffuser Type & Size | 9" EPDM Membrane |
| *Air Blower System (Aeration Tank Only)* | |
| No. of Blowers | 3 |
| Speed @ Max. Capacity (rpm) | 2967 |
| Max. Inlet Cap. (icfm) | 1040 |
| Max. Operating Pressure (psig) | 9 |
| Max. Horsepower (hp) | 60 |
| Blower Intake/Discharge Size (in.) | 6/6 |
| Drive Type | Variable Speed |
| Noise Attenuation | Yes |
| **Post-Anoxic Basins (Future)** | |
| No. of Basins | 3 |
| Length (ft. & in.) | 13'-2" |
| Width (ft. & in.) | 19'-1" |
| Sidewater Depth (ft. & in.) | 17'-7" |
| Unit Volume (gal.) | 30,000 |
| Total Volume (gal.) | 90,000 |
| Detention Time (hrs) | 0.62 |
| *Air Diffuser System* | |
| Post-Anoxic Tank Nos. | 1 – 3 |
| Zone No. | 3 |
| Grids per Tank | 1 |
| Distributor Legs per Grid | 7 |
| Diffuser Elements per Distributor | 9 |
| Diffuser Elements per Grid | 63 |
| Diffuser Type & Size | 9" EPDM Membrane |

| Description | Remark / Value |
|---|---|
| *Air Blower System (shared Aeration Blowers)* | |
| No. of Blowers | 3 |
| Speed @ Max. Cap. (rpm) | 2967 |
| Max. Inlet Cap. (icfm) | 1040 |
| Max. Operating Pressure (psig) | 9 |
| Max. Horsepower (hp) | 60 |
| Blower Intake/Discharge Size (in.) | 6/6 |
| Drive Type | Variable Speed |
| Noise Attenuation | Yes |
| **Membrane Bioreactors (MBRs)** | |
| No. of Basins | 4 |
| Length (ft. & in.) | 45’-0” |
| Width (ft. & in.) | 14’-0” |
| Sidewater Depth (ft. & in.) | 16’-6” |
| Unit Volume (gal) | 78,000 |
| Total Volume (gal) | 156,000 |
| No. of Cassettes per Basin | 5 |
| Total No. of Cassettes | 20 |
| *MBR Blowers* | |
| No. of Blowers | 5 |
| Type | Rotary Lobe (PD) |
| Inlet Capacity (scfm) | 1728 |
| Discharge Pressure (psig) | 8.00 |
| Buildout Inlet Capacity (scfm) | 1728 |
| Buidout Discharge Pressure psig) | 8.00 |
| Blower Horsepower (hp) | 100 |
| Blower Speed (rpm) | 2778 |
| No. of MBR Cassettes (per Basin) | 5 |
| Total No. of Cassettes | 20 |
| *MBR Permeate/Backpulse Pumps* | |
| Number of Pumps | 4 |
| Type of Pump | Positive Displacement |
| Flow Range (gpm) | 375-1605 |
| Discharge Pressure (psig) | 16-25 |
| Motor Horsepower (hp) | 50 |
| Motor Speed (rpm) | 540 |
| Drive Type | Variable Speed |
| *MBR Chemical Cleaning System* | |
| No. of Pumps | 4 |
| Type of Pumps | Permeate/Backpulse |
| Backpulse Flow Rate (gpm) | 683-1365 |
| Backpulse Discharge TDH (ft.) | 16-25 |
| Chemical #1 Injected | Citric Acid |
| Chemical #2 Injected | Sodium Hypochlorite |
| *Waste Activated Sludge Pumps* | |
| No. of Pumps | 2 |
| Type of Pump | Double Disc |
| Port Size (in.) | 4 |

| Description | Remark / Value |
|---|---|
| Speed (rpm) | 232 |
| Flow Rate (gpm) | 80 |
| Discharge TDH (ft.) | 25 |
| Motor Horsepower (hp) | 5 |
| Drive Type | Variable Speed |
| *Tank Drain Pumps* | |
| No. of Pumps | 2 |
| Type of Pump | Double Disc |
| Pump Capacity (gpm) | 80 |
| Pump Motor Horsepower (hp) | 5 |
| Pump Size (in.) | 4 |
| Drive Type | VFD |
| *DO Analyzer/Transmitter* | |
| No. of Units | 6 |
| Manufacturer | HACH-Danfoss-Evita |
| Sensor Model No. | PT#OXY1100 |
| Transmitter Model No. | PT#OXY4100 |
| Converter Model No. | PT#OXY7000 |
| Range | 0-10 mg/l |
| Sensor Mounting | Floating Ball |
| **Ultra Violet Disinfection** | |
| Type of Unit | Medium Pressure |
| Type of Structure | Open Channel |
| Design Flow (mgd) | 3.50 |
| Design Max. Day Flow (mgd) | 5.25 |
| Number of Units | 1 + 1 standby |
| Number of Modules Per Unit (each) | 2 |
| Number of Lamps per Module (each) | 12 |
| Total Number of Lamps Per Unit | 24 |
| U.V. Dosage, each unit (Microwatts-sec/cm2) | 51,640 |
| U.V. Transmission (percent) | 65 |
| Channel Water Depth (inches) | 42 |
| Effluent Fecal Coliform Concentration (#/100ml) | 200 |
| **Effluent Flow Measurement** | |
| No. of Units | 1 |
| Type of Unit | Parshall Flume |
| Throat Size (in.) | 24 |
| Measured Flow Range (mgd) | 0 - 8 |
| **Sludge Systems** | |
| **Sludge Holding Tanks & Pumps** | |
| No. of Sludge Tanks (new) | 2 |
| Sludge Volume (gal.)(each) | 200,000 |
| Estimated Daily Sludge Quantity (lbs/day) | 15,314 |
| Estimated Sludge Concentration (mg/l) | 17,984 |
| Estimated Daily Raw Sludge Flow (Surfside)(gpd) | 101,304 |
| Estimated Daily Raw Sludge Flow (Siasconset)(gpd) | 800 |
| Estimated Daily Raw Sludge Flow (gpd) | 102,104 |
| Estimated Sludge Holding Time (days) | 4.0 |

| Description | Remark / Value |
|---|---|
| Type of Mixing | Air |
| Mixing Rate (scfm/1000ft$^3$) | 650 |
| No. of Blowers (each) | 1,700 |
| Blower Capacity at Low Speed (icfm) | Two Speed |
| Blower Motor (HP) | 12 |
| Diffuser Submergence (ft.) | Double Disc |
| No. of Sludge Pumps (each) | 6 |
| Flow (gpm)(each) | 350 |
| **Sludge Dewatering (used centrifuge values)** | |
| Type of System | 102,104 |
| Run Time (hrs/week) | 36 |
| Power Required (HP) | 20 |
| Polymer Required (lbs/dry-ton) | 18 |
| Estimated Dewatered Sludge Concentration (mg/l) | 250,000 |
| Dewatered Sludge Volume (gpd) | 6,978 |
| Dewatered Sludge $BOD_5$ (mg/l) | 250,000 |
| Dewatered Sludge $NH_3$-N (mg.l) | 6,805 |
| Dewatered Sludge Organic-N (mg/l) | 6,837 |
| Dewatered Sludge TP (mg/l) | 95,127 |
| Centrate $BOD_5$ (mg/l) | 965 |
| Centrate $NH_3$-N (mg/l) | 25 |
| Centrate $NO_3$-N (mg/l) | 0 |
| Cebtrate TN (mg/l) | 100 |
| Centrate TP (mg/l) | 20 |
| **Sludge Dewatering Feed System** | |
| Rotary Press Feed Pumps | |
| No. of Feed Pumps | 3 |
| Type of Feed Pump | Double Disc |
| Feed Pump Capacity (gpm) | 175 |
| Feed Pump Motor Horsepower (hp) | 10 |
| Feed Pump Size (in.) | 6 |
| Drive Type | VFD |
| Rotary Press Feed Grinders | |
| No. of Grinders | 3 |
| Type of Grinder | 2-Shaft Design |
| Grinder Flow (gpm) | 600 |
| Grinder Size (in.) | 6 |
| Grinder Motor Horsepower (hp) | 3 |
| Drive Type | Direct |
| **Odor Control System** | |
| Type of System | Single Stage |
| Method of Treatment | Packed Tower |
| Inlet $H_2S$ (ppm) | 20 |
| Estimated Air Flow – Headworks (cfm) | 300 |
| Estimates Air Flow – Primary Clarifiers (cfm) | 2,400 |
| Estimated Air Flow – Yard Pumping Station | 800 |
| Estimated Air Flow – Anoxic and Aeration Tanks (cfm) | 4,700 |
| Estimated Air Flow – MBR Tanks (cfm) | 10,000 |
| Estimated Air Flow – UV System (cfm) | 1,000 |

| Description | Remark / Value |
|---|---|
| Estimated Air Flow – Septage Receiving Area (cfm) | 7,700 |
| Estimated Air Flow – Sludge Processing Area (cfm) | 800 |
| Estimated Air Flow – Existing Sludge Holding Tanks (cfm) | 2,000 |
| Estimated Air Flow – New Sludge Holding Tanks (cfm) | 5,600 |
| Estimated Total Air Flow (cfm) | 35,300 |
| Equivalent$H_2S$ Concentration (ppm) | 20 |
| Fan Headloss (inches) | 2 |
| Fan Speed (rpm) | 590 - 880 |
| Fan Motor Size (HP) | 60 - 27 |
| **Plant Water System** | |
| Total Number of Pumps | 3 |
| No. of Main Pumps | 2 |
| No. of Jockey Pumps | 1 |
| Total System Capacity (gpm) | 30 |
| Main Pump Capacity (gpm) | 150 |
| Jockey Pump Capacity (gpm) | 50 |
| Pump TDH (ft.) | 143 |
| Main Pump Horsepower (HP) | 10 |
| Jockey Pump Horsepower (HP) | 3 |
| **Rapid Infiltration Basins** | |
| Total Number of Existing Basins | 10 |
| Total Number of New Basins | 5 |
| Total Number of Basins | 15 |
| Length of Basins (ft.) | 209 |
| Width of Basins (ft.) | 209 |
| Maximum Operating Depth (inches) | 12 |

## APPENDIX B – MASSDEP GROUNDWATER DISCHARGE PERMIT

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
**DEPARTMENT OF ENVIRONMENTAL PROTECTION**
SOUTHEAST REGIONAL OFFICE
20 RIVERSIDE DRIVE, LAKEVILLE, MA 02347 • 508-946-2700

MITT ROMNEY
Governor

KERRY HEALEY
Lieutenant Governor

STEPHEN R. PRITCHARD
Secretary

ROBERT W. GOLLEDGE, Jr.
Commissioner

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JUN 19 2006
EARTHTECH
196 BAKER AVE CONCORD MA

COPY

June 15, 2006

Jeffrey Willett
Town of Nantucket
Department of Public Works
P.O. Box 239
Nantucket, Massachusetts 02554

RE: FINAL GROUNDWATER DISCHARGE PERMIT

AT: Surfside Wastewater Treatment Facility
South Shore Road, Nantucket

Transmittal No. W065519
Permit No. 200-2

Dear Mr. Willett:

In response to your application for a permit to discharge into the ground, a treated effluent from the proposed upgraded wastewater treatment facility located at South Shore Road in Nantucket, Massachusetts, and after due public notice, I hereby issue the attached final permit.

No comments objecting to the issuance or terms of the permit were received by the Department during the public comment period. Therefore, in accordance with 314 CMR 2.08, the permit becomes effective on the date of issuance.

Parties aggrieved by the issuance of this permit are hereby advised of their right to request an Adjudicatory Hearing under the provision of Chapter 30A of the Massachusetts General Laws and 314 CMR 1.00, Rules for the Conduct of Adjudicatory Proceedings. Unless the person requesting the adjudicatory hearing requests and is granted a stay of the terms and conditions of the permit, the permit shall remain fully effective.

This information is available in alternate format. Call Donald M. Gomes, ADA Coordinator at 617-556-1057. TDD Service - 1-800-298-2207.
MassDEP on the World Wide Web: http://www.mass.gov/dep
Printed on Recycled Paper

2

Please contact David Burns at 508-946-2738 or Ron White at 617-292-5790, should you have any questions.

Sincerely,

David R. Burns
Bureau of Resource Protection

DRB/cb

cc: w/enclosures
Nantucket Board of Selectmen
Nantucket Board of Health
Earthtech
DEP Municipal Assistance-Boston
Attn: Mr. Hamm
DEP Watershed Permitting Program-Boston
Attn: Mr. Ferris
DEP OGC Boston
Attn: Mr. Lehan
DEP/Boston
Attn: Marybeth Chubb

Surfside WWTF Groundwater
Discharge Permit 200-2

1

RECEIVED
JUN 19 2006
EARTHTECH
196 BAKER AVE CONCORD MA

**GROUNDWATER DISCHARGE PERMIT**

Name and Address of Applicant: Town of Nantucket, Broad Street, Nantucket, MA

Date of Application: June 28, 2005

Application/**Permit No. SE# 200-2**

Date of Issuance: June 15, 2006

Date of Expiration: June 15, 2011

Effective Date: June15, 2006

**AUTHORITY FOR ISSUANCE**

Pursuant to authority granted by Chapter 21, Sections 26-53 of the Massachusetts General Laws, as amended, the following permit hereby issued to: **the Town of Nantucket** (hereinafter called "the permittee") authorizing discharges from an upgraded wastewater treatment facility located at **Surfside** _to the ground, such authorization being expressly conditional on compliance by the permittee with all terms and conditions of the permit hereinafter set forth.

6/15/06
Date

David R. Burns, DEP BRP SERO

## I. SPECIAL CONDITIONS

### A. Effluent Limits

The permittee is authorized to discharge into the ground from the modified wastewater treatment facilities for which this permit is issued a treated effluent whose characteristics within one month of startup and continuing thereafter shall not exceed the following values:

| Effluent Characteristics | Discharge Limitations |
|---|---|
| Flow | 3.5 million gallons per day |
| Oil & Grease | 15 mg/l |
| Total Suspended Solids (TSS) | 30 mg/l |
| Biochemical Oxygen Demand 5-day @ 20c (BOD5) | 30 mg/l |
| Total Nitrogen (TKN+NO2+NO3) | 10 mg/l |
| Nitrate Nitrogen | 10 mg/l |
| Settleable Solids | 0.1 ml/l |
| Total Dissolved Solids | 1000 mg/l |
| Fecal Coliform Bacteria | 200 org/100 ml |

a) The pH of the effluent shall not be less than 6.5 nor greater than 8.5 at any time, or not more than 0.2 standard units outside the naturally occurring range.

b) The discharge of the effluent shall not result in any demonstrable adverse effect on the groundwater or violate any water quality standards that have been promulgated.

c) The monthly average concentration of BOD and TSS in the discharge shall not exceed 15 percent of the monthly average concentrations of BOD and TSS in the influent into the permittee's wastewater treatment facility.

d) When the effluent discharged for a period of 90 consecutive days exceeds 80 percent of the permitted flow limitations, the permittee shall submit to the permitting authorities projected loadings and a program for maintaining satisfactory treatment levels consistent with approved water quality management plans.

Surfside WWTF Groundwater
Discharge Permit 200-2

3

**B. Monitoring and Reporting**

1) The permittee shall monitor and record the quality of the **influent** and the quality and quantity of the **effluent** prior to discharge to the leaching facilities according to the following schedule and other provisions:

**INFLUENT:**

| Parameter | Minimum Frequency of Analysis | Sample Type |
|---|---|---|
| PH | Daily | Grab |
| TSS | Weekly | 24 hour composite |
| BOD5 | Weekly | 24 hour composite |
| Ammonia Nitrogen | Weekly | 24 hour composite |

**EFFLUENT:**

| Parameter | Minimum Frequency of Analysis | Sample Type |
|---|---|---|
| Flow | Daily Reading | Max-Min-Avg |
| PH | Daily | Grab |
| TSS | Weekly | 24 hour composite |
| BOD5 | Weekly | 24 hour composite |
| Oil & Grease | Monthly | 24 hour composite |
| Nitrate Nitrogen | Monthly | 24 hour composite |
| Total Nitrogen (NO2+NO3+TKN) | Monthly | 24 hour composite |
| Total Phosphorous | Quarterly | 24 hour composite |
| Orthophosphate | Quarterly | 24 hour composite |
| Fecal Coliform | Monthly | grab |
| Total Dissolved Solids | Monthly | grab |
| Volatile Organic Compounds* | Quarterly | grab |

* EPA Method 624

2) The permittee shall monitor a minimum of five (5) monitoring wells identified as N-1(UG), N-3R, N-8, N-9, N-10, and N-11 on the plan entitled "Surfside WWTF Upgrade Plans and Specifications dated July 2005" as follows:

| Parameter | Frequency of Analysis |
|---|---|
| Static Water Level | Quarterly |
| Specific Conductance | Quarterly |
| PH | Quarterly |
| Total Nitrogen (NO2+NO3+TKN) | Quarterly |
| Nitrate Nitrogen | Quarterly |
| Total Phosphorus | Quarterly |
| Orthophosphate | Quarterly |
| Volatile Organic Compounds | Annually* |

*EPA Method 624

3) Any grab sample or composite sample required to be taken less frequently than daily shall be taken during the period of Monday through Friday inclusive. All composite samples shall be taken over the operating day.

The permittee shall submit all monitoring reports within 30 days of the last day of the reporting month. Reports shall be on an acceptable form, properly filled and signed and shall be sent to: the **Regional Director, Department of Environmental Protection, Southeast Regional Office, 20 Riverside Drive, Lakeville, MA 02347**, and to the **Program Director, Watershed Permitting, Department of Environmental Protection, One Winter Street/6th Floor, Boston, MA 02108**, and to the **Board of Health, Nantucket, MA.**

**C. Supplemental Conditions**

* A staffing plan for the facility shall be submitted to the Department once every two years or whenever there are staffing changes.

* The permittee shall contract to have any and all solids and sludge generated by the treatment system for which this permit is issued removed off site by a properly licensed waste hauler for disposal at an EPA/DEP approved facility. The name and license number of the hauler along with the quality of wastes removed and the date(s) of removal shall be reported by the permittee in writing to the Department.

**Appeal Rights**

This Permit is an action of the Department. Any person aggrieved by this action, may request an Adjudicatory Hearing. A request for a hearing must be made in writing and postmarked within thirty (30) days of the Permit issuance date. Under 310 CMR 1.01(6)(b), the request must state clearly and concisely the facts, which are the grounds for the request, and the relief sought.

The Hearing request along with a valid check payable to the Commonwealth of Massachusetts in the amount of one hundred dollars ($100.00) must be mailed to:

Commonwealth of Massachusetts
Department of Environmental Protection
P.O. Box 4062
Boston, MA 02211-4062

The request will be dismissed if the filing fee is not paid, unless the appellant is exempt or granted a waiver as described below. The filing fee is not required if the appellant is a city or town (or municipal agency), county, or district of the Commonwealth of Massachusetts, or a municipal housing authority. The Department may waive the adjudicatory hearing filing fee for a person who shows that paying the fee will create an undue financial hardship. A person seeking a waiver must file, together with the hearing request as provided above, an affidavit setting forth the facts believed to support the claim of undue financial hardship.

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# APPENDIX C - STANDARD OPERATING PROCEDURES FOR GROUNDWATER SAMPLING

## 1.0 TABLE OF CONTENTS


| | | |
|---|---|---|
| 1.0 | Table of Contents | 1 |
| 1.1 | Introduction | 1 |
| 1.2 | Organization of Sampling Equipment and Sampling Forms | 2 |
| 1.3 | Monitor Well Purging Activities | 3 |
| 1.4 | Groundwater Sample Collection | 4 |
| 1.5 | Sample Handling Procedures | 6 |
| 1.5.1 | Sample Identification | 6 |
| 1.5.2 | Labels | 6 |
| 1.5.3 | Chain-of-Custody Procedures | 6 |
| 1.5.4 | Sample Shipment | 7 |
| 1.6 | Quality Assurance Procedures | 8 |
| 1.6.1 | Trip Blanks | 8 |
| 1.6.2 | Field Blanks | 8 |
| 1.6.3 | Equipment Blanks | 9 |
| 1.6.4 | Field Duplicated | 9 |
| 1.6.5 | MS/MSD Samples | 9 |
| 1.7 | Decontamination Procedures | 10 |


## 1.1 Introduction

This appendix describes the SOPs for all of the tasks associated with sampling the monitor wells. Slight modifications to these SOPs may be deemed necessary based on the results of the field reconnaissance. The sampling tasks described in this appendix include the following activities:

- Organization of Sampling Equipment and Sampling Forms;
- Monitor Well Purging and Stabilization of Water Quality;
- Groundwater Sample Collection;
- Sample Handling and Delivery to the Laboratory; and
- Chain-of-Custody Procedures.

## 1.2 Organization of Sampling Equipment and Sampling Forms

Prior to the start of sampling activities, the sampling personnel will gather the sampling equipment, containers and forms. Equivalent equipment may be used, where applicable. Prior to use, the equipment will be clean and operational and will consist of the following:

- A submersible Grundfos© Rediflow pump (or equivalent) of appropriate diameter for each monitor well.
- Sufficient tubing of appropriate material, diameter and length to be dedicated to each monitor well
- A Horiba U-10 meter fitted with a flow-through cell to measure pH, specific conductance, temperature, turbidity and dissolved oxygen (or equivalent).
- Calibrated containers and drums for directing and collecting water downstream of the flow-through cell, to measure pumping rate, total discharge and contain purge water for appropriate waste management activities.

The groundwater sampling form will be filled out and signed by the sampling personnel during sampling activities.

## 1.3 Monitor Well Purging Activities

The purpose of well purging is to bring water from the aquifer into the well casing prior to sampling because the water within the well casing may not be representative of the surrounding aquifer. Standing water in a monitor well may not be representative of nearby groundwater because a monitor well is generally vented into the atmosphere. Contact with the atmosphere allows the influx of atmospheric oxygen, changing the reduction/oxidation (redox) potential of groundwater, and hence, the solubility of certain dissolved species. Purging is performed to remove the standing water prior to sample collection. Purging induces stresses that can suspend small particles and draw them into the monitor well. In addition purging may possibly strip volatile organic compounds (VOCs) from the water. If the pump flow rate is reduced, these stresses are reduced. To address the concern over sample turbidity and stripping of VOCs, a low-flow sampling procedure will be used to minimize the stresses that might suspend fine particles.

Water purged from the groundwater wells will be monitored for changes in temperature, pH, specific conductance, turbidity, and dissolved oxygen with a Horiba U-10 meter (or equivalent). Temperature, pH, specific conductance, turbidity and dissolved oxygen are referred to as the water quality parameters in this document.

In preparation for purging the groundwater wells, the purging and monitoring equipment will be organized and confirmed operational. A submersible Grundfos© Redi-Flo pump (or equivalent) will be lowered into the well and suspended in the upper portion of the screen interval. A cable will be attached to the pump and will be used to lower the pump into the monitor wells. The cable will be measured and marked with a segment of tape to indicate the length of the cable that can be lowered into the well so that the intake of the pump is not lowered past the designated depth. The cable will be attached to the pump and to the well head, so that the location of the pump cannot shift during purging and sampling.

Appropriate diameter tubing will be used for the discharge tubing. The dedicated tubing will be connected to the pump at the pump outlet (barbed fitting) with a hose clamp. The discharge from the bladder pump will be secured to the flow-through cell fitted to the Horiba U-10 water quality parameter meter. The discharge from the flow through cell will be connected to a calibrated container to contain waste water. A two way stainless or Teflon valve will be located in the discharge tube immediately upstream (i.e., in front) of the flow-through cell for sampling purposes. At the beginning of purging, the flow rate will be adjusted using the variable speed of the pump to generate flow and drawdown as outlined below. If the drawdown exceeds the target drawdown, the flow rate will be reduced accordingly.

| Well Diameter | Target Flow Rate | Target Drawdown |
|---|---|---|
| 2-inch | 1 L/min | $\leq$ 1.0 foot |
| 4-inch | 1 L/min | $\leq$ 1.0 foot |
| 5-inch | 1 L/min | $\leq$ 1.0 foot |

The volume of purge water and duration of this first stage of purging will then be recorded. Purging will continue with measurements of water quality parameters every 5-10 minutes, until water quality parameters stabilize. Water quality parameters that will be measured are pH, specific conductance, temperature, dissolved oxygen, and turbidity. Water quality parameters will be measured in the field according to the procedures outlined below:

- During the purging process, groundwater will fill the flow-through cell. The cell should be adjusted until air bubbles are removed. The fittings will be adjusted to be essentially leak-free. The Horiba U-10 probe will be located in the flow-through-cell, and water quality parameters will be collected as water flows through the cell.

- The subsequent readings will be documented on the groundwater sampling field sheets. Measurements will be repeated every 5-10 minutes and at least five sets of measurements will be completed for every well. Visual observations of the clarity and color of the pump discharge water also will be recorded. In addition, water levels in the wells will be periodically measured during purging. These successive field parameter measurements will be used to determine when purging is sufficient and sample collection may proceed. In general, purging will continue until all field parameters and visual

observations show no significant fluctuations or trends (increasing or decreasing over time). The stabilization of water quality parameters will be defined as no consistent increasing or decreasing trend among the previous five readings and/or changes among the previous three readings of no more than:

- ±0.1 unit for pH,
- ±3% for specific conductance (%),
- ±0.2 °C for temperature,
- ±10% for turbidity (%), and
- ±5% for dissolved oxygen (%).

- The Horiba U-10 water parameter meter (or equivalent) will be used to monitor the development of the wells. The Horiba U-10 meter (or equivalent) will be calibrated at field temperature a minimum of twice a day: once prior to commencing field work and at the end of day after sampling has been completed. Instrument calibration will be conducted in accordance with manufacturer's instructions. The Horiba instrument will also will be recalibrated at anytime during sampling activities if inconsistent readings are suspected.

The purging goal will be to achieve turbidity below 5 NTU and stabilization of the water quality parameters. However, this may not be possible in all wells. The total volume purged will be at least 3 well volumes. The total volume purged and the time will be recorded at the end of each stage of purging. The volume of purge water removed from each well will be measured using a calibrated container. Immediately following purging, a sample of groundwater will be collected according to the procedures described in Section 4.4.2. Groundwater purge water will be stored in accordance with the Waste Management Plan presented in Section 4.4.5.

## 1.4 Groundwater Sample Collection

This section describes the procedures to be followed for the collection of groundwater samples. These procedures will be implemented immediately following the pre-sampling activities described. The activities for groundwater sample collection include: (1) sample withdrawal; (2) sample handling, and (3) post sampling confirmation of water quality parameter measurements.

The groundwater sample will be collected immediately following the purging activities described above. The samples will be collected using the submersible Grundfos© Redi-Flo pump (or equivalent) and the discharge tube used for purging. The sample will be collected from a sampling valve or port located immediately upstream of the flowthrough cell. The submersible Grundfos© Redi-Flo pump (or equivalent) will be operated at a discharge rate of approximately 100 ml/minute for VOC samples. The discharge tubing will be cleared at a low pumping rate before samples are collected. The volume of water to be cleared will be calculated with the following equation:

$$V = 0.041 \times d^2 \times H$$

Where:

- V = volume of water in the length of tube located between the pump and the sampling port, in gallons;
- d = inside diameter of the tube, in inches;
- H = length of tubing between the pump and sampling port, in feet.

Note: A conversion to liters is: V/0.264 = volume in liters.

In addition, samples will be collected in accordance with the other following guidelines:

- Gloves worn during purging will be discarded and replaced with clean gloves for sampling;
- Sample containers will not be opened until immediately prior to filling;
- The insides of sample containers will not be touched, including with clean gloves;
- Chain-of-custody forms will be maintained throughout the sample collection;
- Samples will be collected and containerized in accordance with the volatility of the target analytes;
- Sampling containers will be filled slowly and with minimal aeration with the pump (see above);
- Sampling containers will be filled completely, but not overfilled, as this will result in the loss of preservative;
- Sampling containers will be filled as expeditiously as possible to minimize the time between filling the first sample container and the last; and
- Filled sample containers will be labeled, prepared for transport, and stored in an ice chest or cooler.

Samples collected for dissolved metals will be filtered using a Nalgene© in-line 0.45-µm filter or equivalent. Filtering will be performed by collecting about 500 mL in a clean plastic bottle and using a hand pump to pump the sample from this container through the in-line filter into the 500-mL sample container. Approximately 1/10 of a liter of water will be pumped through the filter and disposed of before sample collection. Alternatively, an inline filter will be attached directly to the tubing and filtered directly into the sample container.

Following sampling, the well will be retested for groundwater quality parameters (pH, specific conductivity, temperature turbidity, and dissolved oxygen). The retesting will serve as a measure of purge efficiency and as a check on the stability of the water samples over time. The retest will be conducted by pumping water through the flow-through cell, and the readings will be documented.

## 1.5 Sample Handling Procedures

### *1.5.1 Sample Identification*

Samples will be identified using the well identification and the date. For example, the sample name PC-056-20060110 will represent the sample collected from well PC-056 on January 10, 2006. The well identification for trip, field and equipment blanks will be TB, FB, and EB respectively. Sample names for field duplicates will have a D immediately after the well identification.

### *1.5.2 Labels*

Sample labels are accountability documents and are attached to a sample. The following information, as appropriate, will be included on the sample labels using waterproof, non-erasable ink:

- Project number;
- Sample identification;
- Date and time, (day/month/year);
- The initials of the sampler(s);
- Whether the sample is preserved or unpreserved; and
- The general types of analyses to be performed.

### *1.5.3 Chain-of-Custody Procedures*

Chain-of-Custody procedures comprise the following elements: (1) maintaining custody of samples, and (2) documentation of the chain-of-custody. To document chain-of-custody, an accurate record must be maintained to trace the possession of each sample from the moment of collection through analysis and reporting.

The field Chain-of-Custody Record is used to record the custody of all samples collected and maintained by investigators. All sample sets will be accompanied by a Chain-of-Custody Record. This Chain-of-Custody Record documents transfer of custody of samples from the sample custodian to another person, to the laboratory, or other organizational entities. The Chain-of-Custody Record also serves as a sample logging mechanism for the laboratory sample custodian. A separate Chain-of-Custody Record will be used for each final destination or laboratory used during the investigation. The following rules apply to Chain-of-Custody Records:

- All information must be supplied in the indicated spaces to complete the field Chain-of-Custody Record.

- All samplers and sampling team leaders (if applicable) must sign in the designated signature block.
- One sample should be entered on each line and not be split among multiple lines.
- The total number of sample containers for each sample must be listed in the appropriate column. Required analyses should be circled or entered in the appropriate location as indicated on the Chain-of-Custody Record.
- The sample custodian and subsequent transferee(s) should document the transfer of the samples listed on the Chain-of-Custody Record. The person who originally relinquishes custody should be the sample custodian. Both the person relinquishing the samples and the person receiving them must sign the form. The date and time that this occurs should be documented in the proper space on the Chain-of-Custody Record.
- Usually, the last person receiving the samples should be the laboratory sample custodian or their designee(s).

The Chain-of-Custody Record is a serialized document. Once the Record is completed, it becomes an accountability document and will be maintained in the project file.

### *1.5.4 Sample Shipment*

Prior to sampling, the sample containers will be stored properly in a cooler to reduce the potential for breakage, spillage, or label deterioration. Proper sample storage consists of “bubble wrap” around glass bottles or vials, sealable Zip-Lock®-type bags around sample containers, and packing material to occupy remaining voids.

Immediately following sampling, the samples will be stored in coolers with wet ice. The samples will continue to be stored in this manner until the samples are analyzed in the laboratory. The presence of solid ice within and the internal temperature of the cooler will be checked periodically in the field and recorded on daily field sheets. In addition, the presence of ice and the temperature of the samples will be measured and recorded upon receipt by the laboratory. On hot days, the field samplers will periodically monitor the cooler to remove melted ice and add ice, as needed, to maintain the acceptable volume of ice.

The coolers containing the groundwater sample containers will be delivered to the laboratory on the same day the samples are collected. The laboratory for this project will be Del Mar Analytical, Inc. in Las Vegas, Nevada. Fresh wet ice will be added as required. Each set of samples will be accompanied by a chain-of-custody form, which outlines the contents of the cooler. Information to be included on the chain-of-custody form is described in Section 4.4.3.3. The chain-of-custody form will be completed and

signed by the sampler(s) before departing the monitoring point, but after the samples have been packed into the cooler containing ice. The completed chain-of-custody form then will be sealed in a Zip-Lock®-type bag and placed in the cooler. Whenever the cooler is exchanged from one person to the other (including couriers and laboratory personnel), the persons relinquishing and receiving the cooler will sign and date the chain-of-custody form. A custody seal will be placed on the front of the cooler and bear the signature of the collector and collection date. The laboratory receptionist will confirm the integrity of the signature upon receipt of the cooler

## 1.6 Quality Assurance Procedures

Field QC samples will be collected and analyzed to assess the consistency and performance of the groundwater sampling activities. QC samples for this project will include field duplicates, MS/MSD, equipment rinsates when necessary, and trip blanks.

### *1.6.1 Trip Blanks*

Trip blanks will be prepared by the laboratory in 40-milliliter (mL) vials with analyte-free water. The trip blanks will be carried into the field, stored, and shipped to the laboratory along with the water samples. One trip blank will be shipped with each cooler that contains samples to be analyzed for VOCs. Trip blanks are evaluated to determine whether VOC cross-contamination between samples has occurred during storage and transportation. Trip blanks apply only to volatile organics and must be free of headspace.

### *1.6.2 Field Blanks*

Collection and analysis of field blanks are provided as QC checks on the integrity of sample collection and handling procedures. Prepare field blank samples by using deionized water and sample bottles randomly selected from the bottles prepared for environmental samples. Assign field blank samples unique sample numbers so as to not be identified by the laboratory as blank samples.

Collect and analyze one field blank each day that the environmental samples are collected. Analyze each field blank by using the same methods and procedures as those to be used for volatile organic compounds for the environmental sample.

#### *1.6.3 Equipment Blanks*

Collection and analysis of field equipment blanks are provided as QC checks on the integrity of equipment decontamination procedures. Prepare equipment rinsate samples by using deionized water and sample bottles randomly selected from the bottles prepared for environmental samples. Assign equipment rinsate samples unique sample numbers so as to not be identified by the laboratory as rinsate samples.

Collect and analyze one equipment rinsate blank for every day of sampling when using non-dedicated equipment to sample groundwater. Analyze these blanks for the same sample compounds, elements, or parameters as those analyzed for the collected environmental samples.

#### *1.6.4 Field Duplicates*

Field duplicates are two samples (an original and a duplicate) of the same matrix, to the extent practicable, collected at the same time and location and using the same sampling techniques. Field duplicate samples are used to evaluate the precision of the overall sample collection and analysis process. Field duplicates will be collected at a frequency of 1 per 10 regular samples and will be analyzed for the full set of analyses used for the regular sample collected. Exact locations of duplicate samples and sample identifications will be recorded in the field logbook.

#### *1.6.5 MS/MSD Samples*

The laboratory will analyze an MS/MSD for every twenty samples analyzed or for every analytical batch prepared, whichever is more frequent. Field personnel will collect triple the amount or the volume of the sample matrix for the designated MS/MSD sample. The MS/MSD sample will be used to determine the precision of the sample preparation and analytical methods.

### 1.7 Decontamination Procedures

The purpose of decontamination is: (1) to eliminate the transfer of contaminants from one groundwater monitor well to another, and (2) to protect the health and safety of personnel who may come in contact with contaminated equipment. Decontamination procedures described in this section will be performed at the beginning of each day of field work, between each boring and monitor point, at the end of each day of field work, and whenever the equipment is suspected of having been contaminated.

A simple triple rinse system is utilized to decontaminate the pump and electrical lead between wells. The triple rinse system involves running the pump in cleaning tubes that contain three progressively cleaner grades of water. The following steps will be followed:

- Remove the pump, electrical lead and dedicated tubing from the well.
- Disconnect the dedicated PE tubing from the pump.
- Place the pump and electrical lead into the Integrated Decon Sink and perform an initial rinse using a high-pressure washer.
- Place the pump into the first cleaning tube or bucket containing approximately 5 gallons of a Liquinox / clean water solution. Run the pump within the solution for 2 minutes.
- Place the pump into the second cleaning tube or bucket containing approximately 5 gallons of clean water. Run the pump within the water for 2 minutes.
- Place the pump into the third cleaning tube or bucket containing approximately 5 gallons of clean water. Run the pump within the water for 2 minutes.
- Finally, place the pump and electrical lead into the Integrated Decon Sink and perform a final rinse using a high-pressure washer.
- Replace water and water solutions daily.

# APPENDIX D – CONFINED SPACE REGULATIONS

## 1.0 TABLE OF CONTENTS


| | | |
|---|---|---|
| 1.0 | Table of Contents | 1 |
| 1.1 | Confines Space Entry | 1 |
| 1.1.1 | Introduction | 1 |
| 1.1.2 | Potential Hazards of Confined Spaces | 1 |
| 1.1.3 | Classified Hazards of Confined Spaces | 2 |
| 1.1.4 | Confined Space Entry Permit System | 2 |
| 1.1.5 | Training for Confined Space Work | 3 |
| 1.1.6 | Necessary Equipment for Confined Space | 4 |
| 1.1.7 | Necessary Personnel | 6 |
| 1.1.8 | Atmospheric Testing of Confined Spaces | 6 |
| 1.1.9 | Oxygen Deficient Atmospheres | 7 |
| 2.0 | Electrical | 7 |


## 1.1 CONFINED SPACE ENTRY

### *1.1.1 Introduction*

A “confined space” is defined as any enclosed or semi-enclosed space that has limited openings for entry and exit, that is not intended for continuous employee occupancy, and that does not have sufficient natural or mechanical ventilation to prevent buildup of a hazardous atmosphere. Virtually all the manholes and tanks at the Surfside WWTF are closed and therefore must be considered confined spaces. Additionally, areas listed on the following pages are considered confined space areas.

### *1.1.2 Potential Hazards of Confined Spaces*

There are many hazards associated with confined spaces. Some of these include:

- Explosive gases;
- Toxic gases;
- Oxygen deficiency (asphyxiation);
- Falling;
- Bumping into obstructions;
- Suffocation;
- Electrical hazards; and

- Mechanical hazards.

All the above hazards can be eliminated, by taking a common sense approach to work in-confined spaces and by strictly adhering to all safety rules associated with confined spaces.

### *1.1.3 Classified Hazards of Confined Spaces*

Confined spaces are classified based on existing or potential hazards relative to the confined space. The classification is based on the characteristics of the confined space, oxygen level, flammability, and toxicity. **Table D.1** shows the classification of confined spaces. The Chief WWTF Operator with consultation from the assigned Health Safety Officer is the appropriate person to make decisions regarding the classification of confined spaces.

**TABLE D.1 - NIOSH CRITERIA FOR CONFINED SPACE CLASSIFICATION**

| Parameters | Class A | Class B | Class C |
|---|---|---|---|
| Characteristics | Immediately dangerous to life-rescue procedures require the entry of more than one person fully equipped with life support equipment maintenance of communication requires an additional standby person stationed within the confined space. | Dangerous, but not immediately life threatening-rescue procedures require the entry of no more than one person fully equipped with life support equipment-indirect visual or auditory communication with workers. | Potential hazard-requires no modification of work procedures-standard rescue procedures-direct communication with workers, from outside the confined space. |
| Oxygen | 16 % or less *(122 mm Hg) or greater than 25 % *(190 mm Hg) | 16.1 % to 19.4 % *(122-147 mm Hg) or 21.5 % to 25 % (163 – 190 mm Hg) | 19.5 % - 21.45 % *(148-163 mm Hg) |
| Flammability Characteristics | 20 % or greater of LFL | 10 % - 19 % LFL | 10 % LFL or less |
| Toxicity | **IDLH | Greater than contamination level, referenced in 29 CFR Part 1910 Sub Part Z – Less than ** IDLH | Less than contamination level referenced in 29 CFR Part 1910 Sub Part Z |

* Based upon a total atmospheric pressure of 760 mm Hg (see level)

** Immediately Dangerous to Life to Health – as referenced in NIOSH Registry of Toxic and Chemical Substances, manufacturing chemists data sheets, industrial hygiene guides or other recognized authorities.

### *1.1.4 Confined Space Entry Permit System*

The National Institute for Occupational Safety and Health (NIOSH) recommends that entry into or working in any area where potentially hazardous conditions may exist should be by confined space entry permit only. A permit is a authorization and approval in writing that specifies the location and type of work to be done. It certifies that all existing hazards have been evaluated by a qualified person and that necessary protective measures have been taken to insure the safety of each employee. The Chief WWTF Operator or qualified person should be responsible for securing the permit and both should sign off when the work and hazards have been located and described. A work safety permit/confined space entry permit will include the following:

- Hazards that may be encountered.
- Complete isolation checklist, including blanking and/or disconnecting: electrical lockout, and mechanical lockout.
- Special clothing and equipment, including personal protective equipment and clothing; safety harness and/or lines; tools approved for use in accordance with the hazardous Location Classification (NEC-1981); and approved electrical equipment.
- Atmospheric testing readings, including oxygen level, flammability and/or explosive levels, and toxic substance levels.
- Atmospheric monitoring while work is being performed (Class A on a continuous basis and Class B as determined by the qualified person).
- Personnel training and complete understanding of the hazards.
- Standby person(s) as named on the permit.
- Emergency procedures and location of the first aid equipment.

Confined space classification A, B, and C. The permit should be updated for each shift or crew change with the same requirements. The permit for a Class A or B confined space should be posted in a conspicuous place, close to the confined space work area, and a copy filed in the facility office. An example of the confined space entry permit to be used at the Surfside WWTF is shown on **Table D.2**. The confined space entry permit is a guide and is not limited to the areas listed. The training requirements of personnel entering and/or working in confined space will be suitable for the nature of the hazard and the work to be performed, and will therefore vary with the confined safe classification.

**TABLE D.2 - WASTEWATER TREATMENT FACILITY CONFINED SPACE PERMIT**

Location _____ Permit No. _____

Description of Work _____

_____

_____

Requested by _____ Issued by _____
(Supervisor)

Nearest Telephone _____ Issued by _____

Lockout Procedure Followed _____

_____

_____

Rescue Equipment Provided _____

_____

_____

**Atmospheric Tests**

| Time | % $O_2$ | % LEL | Tested By | Equipment Used |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Respiration Protection Required _____

Ventilation Equipment Used _____

**THIS CONFINED SPACE HAS BEEN INSPECTED AND ENTRY AUTHORIZED ONLY FOR THE (1st, 2nd, 3rd) SHIFT OF _____ (Date) SUBJECT TO "CONFINED SPACE ENTRY PROCEDURE".**

_____ _____ _____

Issued By Date Time

### *1.1.5 Training for Confined Space Work*

Personnel who work in the vicinity of confined spaces shall be made aware of the hazards associated with confined spaces at the time of their employment. Personnel who are required to work in a confined space, or in support of those working in a confined space, will have additional training in the following areas:

- Emergency entry and exit procedures;
- Use of applicable respirators;
- First aid;
- Lockout procedures;
- Safety equipment use;
- Permit system; and
- Work practices.

Rescue and training drills designed to maintain proficiency will be conducted with all new employees, and thereafter, at least annually or at lesser intervals, with all employees. Training in all aspects of confined space safety will be an ongoing process.

### *1.1.6 Necessary Equipment for Confined Space*

The following is a list of equipment which must be on hand for entering and working in confined spaces. All personnel must have a clear understanding of the use of the equipment and user ability to operate it efficiently.

- Fresh air blower and large diameter flexible hose for ventilation.
- Atmosphere-testing equipment to guard against oxygen deficiency and combustible gas and toxic hydrogen sulfide gas.
- Harness and individual life lines for each person going into the confined space and for the standby outside the confined space.
- Self-contained air breathing apparatus for each person going into the confined space and for the standby rescue crew.
- Inhalator and resuscitator.
- Protective clothing, including rubber boots, gloves, rain gear, hard hats with chin straps, and face shields or goggles.
- Explosion proof lights.
- Communication equipment, if the scope of work makes it necessary.
- First aid kit (including amyl-nitrite capsules for $H_2S$ exposure).

- Miscellaneous tools, as required.
- Appropriate lifting equipment with parachute-type harness ready for use during entry-egress.

### *1.1.7 Necessary Personnel*

It is necessary that sufficient personnel are available outside the confined space as backup or for assistance as well as employing the “Buddy System” for work within the confined space. No entry permit will be approved unless sufficient staff are available to meet the minimum requirements of the program.

### *1.1.8 Atmospheric Testing of Confined Spaces*

All confined spaces must be considered dangerous before entry, until proven safe. A test of the atmosphere must be performed before any employee enters a confined space and continuously after entry.

The principal atmospheric tests will be for oxygen deficiency, explosion and toxic gases. The atmosphere should also be tested for the presence of hydrogen sulfide, carbon monoxide, methane, carbon dioxide, or any other gas suspected of being present in the particular space.

It is important to understand that some gases or vapors are heavier than air and will settle to the bottom of a confined space. Also, some gases are lighter than air and will be found around the top of the confined space area.

Therefore, it is necessary to test all areas (top, middle, bottom) of a confined space to determine what gases are present.

If the atmosphere is found to contain toxic or explosive gases or has an oxygen concentration less than 19.5 percent or greater than 25 percent the area must be ventilated. An air supply blower for positive displacement of the atmosphere should also be used. If a hazardous atmosphere persists in spite of ventilation, it will be necessary for the employee to utilize respiratory protection equipment while in the confined space. Entrance into a atmosphere containing any type of hazardous gas will require the use of self-contained breathing apparatus (SCBA).

Entry into an environment containing combustible or flammable materials should only be attempted under emergency conditions such as employee rescue. SCBAs must be used, as well as non-sparking equipment.

Personnel working in a confined space must be equipped with a continuous atmospheric monitoring device. This is true even if the atmosphere was found to be safe before entry to the confined space. This continuous monitor is extremely as the confined atmosphere can change quickly into a hazardous environment, even with continuous ventilation.

### *1.1.9 Oxygen Deficient Atmospheres*

An oxygen-deficient atmosphere will have less than 19.5 percent available oxygen. Nineteen and one-half (19.5) percent must be considered the minimum level for safe entry into a confined space without a breathing apparatus. Refer to **Table D-1** and **Table D.3**.

## 2.0 ELECTRICAL

Only trained electricians will perform electrical repairs. Always open, lockout and tag the main power source of the section or equipment to be worked on. Check components for power with the volt-ohm-milliamp meter (VOM).

Electric shock occurs when the body becomes part of an energized electrical path and energy is transferred between parts of the body, or through the body, to the ground or the earth.

Current flowing through the central nervous system, under certain conditions, can cause serious injury or death.

Conditions which cover the severity of a shock are as follows:

- The type of current (AC or DC) is important. Low voltage (up to 24 volts) and **direct current (DC)** circuits do not normally present a hazard to human life; however, under some circumstances, sever burns can result. Even at low voltage (just over 24 volts), **alternating current (AC)** circuits can be dangerous and present a lethal threat.

- The resistance of the body and the degree to which the skin is insulated from the ground govern the amount of current flowing through the body. The skin offers the principle resistance which the human body presents to the flow of current. Time becomes critical when electricity flowing through the body causes loss of muscular control, contraction of the chest (which affects breathing) and ventricular fibrillation of the heart. When fibrillation of the heart occurs, the heart's pumping rhythm becomes irregular and it functions improperly.

**TABLE D.3 - CHECK LIST OF CONFINED SPACE CONSIDERATIONS**

| Item | Class A | Class B | Class C |
|---|---|---|---|
| 1. Permit | X | X | X |
| 2. Atmospheric Testing | X | X | X |
| 3. Monitoring | X | O | X |
| 4. Medical Surveillance | X | X | O |
| 5. Training of Personnel | X | X | X |
| 6. Labeling & Posting | X | X | X |
| 7. Preparation | | | |
| Isolate/Lockout/Tag | X | X | O |
| Purge and Ventilate | X | X | O |
| Cleaning Processes | O | O | O |
| Requirements for Special Equipment & Tools | X | X | O |
| 8. Procedures | | | |
| Initial Plan | X | X | X |
| Standby | X | X | O |
| Comm,/Observation | X | X | X |
| Rescue | X | X | X |
| Work | X | X | X |
| 9. Safety Equipment and Clothing | | | |
| Head Protection | O | O | O |
| Hearing Protection | O | O | O |
| Hand Protection | O | O | O |
| Foot Protection | O | O | O |
| Body Protection | O | O | O |
| Respiratory Protection | O | O | O |
| Safety Belts | X | X | X |
| Lift Lines Harness | X | O | O |
| 10. Rescue Equipment | X | X | X |
| 11. Record Keeping Exposure | X | X | O |

X – Indicates Requirements
O – Indicates Determination by the Qualified Person

# APPENDIX E – MATERIAL SAFETY DATA SHEETS

Since Material Safety Data Sheets (MSDS) are updated frequently, the operating staff should obtain and include the information in this appendix. The operating staff should review the information on at least a yearly basis and replace outdated information.

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# APPENDIX F – RIGHT TO KNOW REGULATIONS

OSHA's Regulation 79 standard is based on a simple concept - that employees have both a need and a right to know the hazards and the identities of the chemicals they are exposed to when working. More than 30 million workers are potentially exposed to one or more chemical hazards. There are an estimated 650,000 existing hazardous chemical products, and hundreds of new ones are being introduced annually. This poses a serious problem for exposed workers and their employers. Information in this Appendix was obtained directly from OSHA's web site. Employees should reference this website for information and updated regulations.

The federal "Hazard Communications Standard" or "OSHA Right-To-Know Law" as it is more commonly named. The objective of this law is to transmit information concerning the nature of chemical hazards that employees may be exposed to in their work environment and what measures they can take to protect themselves.

According to the OSHA right-to-know standard, employees must have access to the Material Safety Data Sheets (MSDSs) for the hazardous chemicals present in their workplace. These MSDSs must be readily available to the workers and accessible during each work shift.

## SUMMARY

Protection under OSHA's Hazard Communication Standard (HCS) includes all workers exposed to hazardous chemicals in all industrial sectors. This standard is based on a simple concept - that employees have both a need and a right to know the hazards and the identities of the chemicals they are exposed to when working. They also need to know what protective measures are available to prevent adverse effects from occurring.

## SCOPE OF COVERAGE

More than 30 million workers are potentially exposed to one or more chemical hazards. There are an estimated 650,000 existing hazardous chemical products, and hundreds of new ones are being introduced annually. This poses a serious problem for exposed workers and their employers.

## BENEFITS

The HCS covers both physical hazards (such as flammability or the potential for explosions), and health hazards (including both acute and chronic effects). By making information available to employers and employees about these hazards, and recommended precautions for safe use, proper implementation of

the HCS will result in a reduction of illnesses and injuries caused by chemicals. Employers will have the information they need to design an appropriate protective program. Employees will be better able to participate in these programs effectively when they understand the hazards involved, and to take steps to protect themselves. Together, these employer and employee actions will prevent the occurrence of adverse effects caused by the use of chemicals in the workplace.

**REQUIREMENTS**

The HCS established uniform requirements to make sure that the hazards of all chemicals imported into, produced, or used in U.S. workplaces are evaluated and that this hazard information is transmitted to affected employers and exposed employees.

Chemical manufacturers and importers must convey the hazard information they learn from their evaluations to downstream employers by means of labels on containers and material safety data sheets (MSDS's). In addition, all covered employers must have a hazard communication program to get this information to their employees through labels on containers, MSDS's, and training.

This program ensures that all employers receive the information they need to inform and train their employees properly and to design and put in place employee protection programs. It also provides necessary hazard information to employees so they can participate in, and support, the protective measures in place at their workplaces.

All employers in addition to those in manufacturing and importing are responsible for informing and training workers about the hazards in their workplaces, retaining warning labels, and making available MSDS's with hazardous chemicals.

Some employees deal with chemicals in sealed containers under normal conditions of use (such as in the retail trades, warehousing and truck and marine cargo handling). Employers of these employees must assure that labels affixed to incoming containers of hazardous chemicals are kept in place. They must maintain and provide access to MSDS's received, or obtain MSDS's if requested by an employee. And they must train workers on what to do in the event of a spill or leak. However, written hazard communication programs will not be required for this type of operation.

All workplaces where employees are exposed to hazardous chemicals must have a written plan which describes how the standard will be implemented in that facility. The only work operations which do not have to comply with the written plan requirements are laboratories and work operations where employees only handle chemicals in sealed containers.

The written program must reflect what employees are doing in a particular workplace. For example, the written plan must list the chemicals present at the site, indicate who is responsible for the various aspects of the program in that facility and where written materials will be made available to employees.

The written program must describe how the requirements for labels and other forms of warning, material safety data sheets, and employee information and training are going to be met in the facility.

**EFFECT ON STATE RIGHT-TO-KNOW LAWS**

The HCS pre-empts all state (in states without OSHA-approved job safety and health programs) or local laws which relate to an issue covered by HCS without regard to whether the state law would conflict with, complement, or supplement the federal standard, and without regard to whether the state law appears to be "at least as effective as" the federal standard.

The only state worker right-to-know laws authorized would be those established in states and jurisdictions that have OSHA-approved state programs.

These states and jurisdictions include: Alaska, Arizona, California, Connecticut (state and municipal employees only), Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Mexico, New York (state and municipal employees only), North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, Virgin Islands, Virginia, Washington, and Wyoming.

**FEDERAL WORKERS**

Under the hazard communication standard federal workers are covered by executive order.

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## APPENDIX G – DOT REGULATIONS FOR LOADING AND UNLOADING CHEMICALS



(e) *Shipping paper accessibility—accident or inspection.* A driver of a motor vehicle containing hazardous material, and each carrier using such a vehicle, shall ensure that the shipping paper required by this section is readily available to, and recognizable by, authorities in the event of accident or inspection. Specifically, the driver and the carrier shall:

(1) Clearly distinguish the shipping paper, if it is carried with other shipping papers or other papers of any kind, by either distinctively tabbing it or by having it appear first; and

(2) Store the shipping paper as follows:

(i) When the driver is at the vehicle's controls, the shipping paper shall be: (A) Within his immediate reach while he is restrained by the lap belt; and (B) either readily visible to a person entering the driver's compartment or in a holder which is mounted to the inside of the door on the driver's side of the vehicle.

(ii) When the driver is not at the vehicle's controls, the shipping paper shall be: (A) In a holder which is mounted to the inside of the door on the driver's side of the vehicle; or (B) on the driver's seat in the vehicle.

[Amdt. 177-35, 41 FR 16130, Apr. 15, 1976, as amended by Amdt. 177-35A, 41 FR 40691, Sept. 20, 1976; Amdt. 177-48, 45 FR 47670, Nov. 10, 1980; Amdt. 177-65, 50 FR 11055, Mar. 19, 1985; Amdt. 177-72, 53 FR 17160, May 13, 1988]

### § 177.823 Movement of motor vehicles in emergency situations.

(a) A carrier may not move a transport vehicle containing a hazardous material unless the vehicle is marked and placarded in accordance with part 172 or as authorized in § 171.12a of this subchapter, or unless, in an emergency:

(1) The vehicle is escorted by a representative of a state or local government;

(2) The carrier has permission from the Department; or

(3) Movement of the transport vehicle is necessary to protect life or property.

(b) *Disposition of contents of cargo tank when unsafe to continue.* In the event of a leak in a cargo tank of such a character as to make further transportation unsafe, the leaking vehicle should be removed from the traveled portion of the highway and every available means employed for the safe disposal of the leaking material by preventing, so far as practicable, its spread over a wide area, such as by digging trenches to drain to a hole or depression in the ground, diverting the liquid away from streams or sewers if possible, or catching the liquid in containers if practicable. Smoking, and any other source of ignition, in the vicinity of a leaking cargo tank is not permitted.

(c) *Movement of leaking cargo tanks.* A leaking cargo tank may be transported only the minimum distance necessary to reach a place where the contents of the tank or compartment may be disposed of safely. Every available means must be utilized to prevent the leakage or spillage of the liquid upon the highway.

[Amdt. 177-35, 41 FR 16130, Apr. 15, 1976, as amended by Amdt. 177-67, 50 FR 41521, Oct. 11, 1985; Amdt. 177-86, 61 FR 18933, Apr. 29, 1996]

## Subpart B—Loading and Unloading

NOTE: For prohibited loading and storage of hazardous materials, see § 177.848.

### § 177.834 General requirements.

(a) *Packages secured in a vehicle.* Any tank, barrel, drum, cylinder, or other packaging, not permanently attached to a motor vehicle, which contains any Class 3 (flammable liquid), Class 2 (gases), Class 8 (corrosive), Division 6.1 (poisonous), or Class 7 (radioactive) material must be secured against movement within the vehicle on which it is being transported, under conditions normally incident to transportation.

(b) [Reserved]

(c) *No smoking while loading or unloading.* Smoking on or about any motor vehicle while loading or unloading any Class 1 (explosive), Class 3 (flammable liquid), Class 4 (flammable solid), Class 5 (oxidizing), or Division 2.1 (flammable gas) materials is forbidden.

(d) *Keep fire away, loading and unloading.* Extreme care shall be taken in the loading or unloading of any Class 1 (explosive), Class 3 (flammable liquid),

Class 4 (flammable solid), Class 5 (oxidizing), or Division 2.1 (flammable gas) materials into or from any motor vehicle to keep fire away and to prevent persons in the vicinity from smoking, lighting matches, or carrying any flame or lighted cigar, pipe, or cigarette.

(e) *Handbrake set while loading and unloading.* No hazardous material shall be loaded into or on, or unloaded from, any motor vehicle unless the handbrake be securely set and all other reasonable precautions be taken to prevent motion of the motor vehicle during such loading or unloading process.

(f) *Use of tools, loading and unloading.* No tools which are likely to damage the effectiveness of the closure of any package or other container, or likely adversely to affect such package or container, shall be used for the loading or unloading of any Class 1 (explosive) material or other dangerous article.

(g) *Prevent relative motion between containers.* Containers of Class 1 (explosive), Class 3 (flammable liquid), Class 4 (flammable solid), Class 5 (oxidizing), Class 8 (corrosive), Class 2 (gases) and Division 6.1 (poisonous) materials, must be so braced as to prevent motion thereof relative to the vehicle while in transit. Containers having valves or other fittings must be so loaded that there will be the minimum likelihood of damage thereto during transportation.

(h) *Precautions concerning containers in transit; fueling road units.* Reasonable care should be taken to prevent undue rise in temperature of containers and their contents during transit. There must be no tampering with such container or the contents thereof nor any discharge of the contents of any container between point of origin and point of billed destination. Discharge of contents of any container, other than a cargo tank or IM portable tank, must not be made prior to removal from the motor vehicle. Nothing contained in this paragraph shall be so construed as to prohibit the fueling of machinery or vehicles used in road construction or maintenance.

(i) *Attendance requirements.* (1) *Loading.* A cargo tank must be attended by a qualified person at all times when it is being loaded. The person who is responsible for loading the cargo tank is also responsible for ensuring that it is so attended.

(2) *Unloading.* A motor carrier who transports hazardous materials by a cargo tank must ensure that the cargo tank is attended by a qualified person at all times during unloading. However, the carrier's obligation to ensure attendance during unloading ceases when:

(i) The carrier's obligation for transporting the materials is fulfilled;

(ii) The cargo tank has been placed upon the consignee's premises; and

(iii) The motive power has been removed from the cargo tank and removed from the premises.

(3) Except for unloading operations subject to §§177.840 (p) or (q), a qualified person "attends" the loading or unloading of a cargo tank if, throughout the process, he is alert and is within 7.62 meters (25 feet) of the cargo tank. The qualified person attending the unloading of a cargo tank must have an unobstructed view of the cargo tank and delivery hose to the maximum extent practicable during the unloading operation.

(4) A person is "qualified" if he has been made aware of the nature of the hazardous material which is to be loaded or unloaded, he has been instructed on the procedures to be followed in emergencies, he is authorized to move the cargo tank, and he has the means to do so.

(j) *Manholes and valves closed.* A person may not drive a cargo tank and a motor carrier may not permit a person to drive a cargo tank motor vehicle containing a hazardous material regardless of quantity unless:

(1) All manhole closures are closed and secured; and

(2) All valves and other closures in liquid discharge systems are closed and free of leaks.

(k) [Reserved]

(l) *Use of cargo heaters when transporting certain hazardous material.* Transportation includes loading, carrying, and unloading.

(1) *When transporting Class 1 (explosive) materials.* A motor vehicle equipped with a cargo heater of any type may transport Class 1 (explosive) materials only if the cargo heater is

rendered inoperable by: (i) Draining or removing the cargo heater fuel tank; and (ii) disconnecting the heater's power source.

(2) *When transporting certain flammable material*—(i) *Use of combustion cargo heaters.* A motor vehicle equipped with a combustion cargo heater may be used to transport Class 3 (flammable liquid) or Division 2.1 (flammable gas) materials only if each of the following requirements are met:

(A) It is a catalytic heater.

(B) The heater's surface temperature cannot exceed 54 °C (130 °F)—either on a thermostatically controlled heater or on a heater without thermostatic control when the outside or ambient temperature is 16 °C (61 °F) or less.

(C) The heater is not ignited in a loaded vehicle.

(D) There is no flame, either on the catalyst or anywhere in the heater.

(E) The manufacturer has certified that the heater meets the requirements under paragraph (l)(2)(i) of this section by permanently marking the heater *"MEETS DOT REQUIREMENTS FOR CATALYTIC HEATERS USED WITH FLAMMABLE LIQUID AND GAS."*

(F) The heater is also marked *"DO NOT LOAD INTO OR USE IN CARGO COMPARTMENTS CONTAINING FLAMMABLE LIQUID OR GAS IF FLAME IS VISIBLE ON CATALYST OR IN HEATER."*

(G) Heater requirements under § 393.77 of this title are complied with.

(ii) *Effective date for combustion heater requirements.* The requirements under paragraph (l)(2)(i) of this section govern as follows:

(A) Use of a heater manufactured after November 14, 1975, is governed by every requirement under (l)(2)(i) of this section;

(B) Use of a heater manufactured before November 15, 1975, is governed only by the requirements under (l)(2)(i)(A), (C), (D), (F) and (G) of this section until October 1, 1976; and

(C) Use of any heater after September 30, 1976, is governed by every requirement under paragraph (l)(2)(i) of this section.

(iii) *Restrictions on automatic cargo-space-heating temperature control devices.* Restrictions on these devices have two dimensions: Restrictions upon use and restrictions which apply when the device must not be used.

(A) *Use restrictions.* An automatic cargo-space-heating temperature control device may be used when transporting Class 3 (flammable liquid) or Division 2.1 (flammable gas) materials only if each of the following requirements is met:

(*1*) Electrical apparatus in the cargo compartment is nonsparking or explosion proof.

(*2*) There is no combustion apparatus in the cargo compartment.

(*3*) There is no connection for return of air from the cargo compartment to the combustion apparatus.

(*4*) The heating system will not heat any part of the cargo to more than 54 °C (129 °F).

(*5*) Heater requirements under § 393.77 of this title are complied with.

(B) *Protection against use.* Class 3 (flammable liquid) or Division 2.1 (flammable gas) materials may be transported by a vehicle, which is equipped with an automatic cargo-space-heating temperature control device that does not meet each requirement of paragraph (l)(2)(iii)(A) of this section, only if the device is first rendered inoperable, as follows:

(*1*) Each cargo heater fuel tank, if other than LPG, must be emptied or removed.

(*2*) Each LPG fuel tank for automatic temperature control equipment must have its discharge valve closed and its fuel feed line disconnected.

(m) Tanks constructed and maintained in compliance with Spec. 106A or 110A (§§ 179.300, 179.301 of this subchapter) that are authorized for the shipment of hazardous materials by highway in part 173 of this subchapter must be carried in accordance with the following requirements:

(1) Tanks must be securely chocked or clamped on vehicles to prevent any shifting.

(2) Equipment suitable for handling a tank must be provided at any point where a tank is to be loaded upon or removed from a vehicle.

(3) No more than two cargo carrying vehicles may be in the same combination of vehicles.

(4) Compliance with §§174.200 and 174.204 of this subchapter for combination rail freight, highway shipments and for trailer-on-flat-car service is required.

(n) Specification 56, 57, IM 101, and IM 102 portable tanks, when loaded, may not be stacked on each other nor placed under other freight during transportation by motor vehicle.

(o) *Unloading of IM portable tanks.* An IM portable tank may be unloaded while remaining on a transport vehicle with the power unit attached if the tank meets the outlet requirements in §178.345–11 of this subchapter and the tank is attended by a qualified person during the unloading in accordance with the requirements in paragraph (l) of this section.

[29 FR 18795, Dec. 29, 1964. Redesignated at 32 FR 5606, Apr. 5, 1967]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting §177.834, see the List of CFR Sections Affected appearing in the Finding Aids section of this volume.

**§ 177.835 Class 1 (explosive) materials.**

(See also §177.834 (a) to (j).)

(a) *Engine stopped.* No Class 1 (explosive) materials shall be loaded into or on or be unloaded from any motor vehicle with the engine running.

(b) *Care in loading, unloading, or other handling of Class 1 (explosive) materials.* No bale hooks or other metal tools shall be used for the loading, unloading, or other handling of Class 1 (explosive) materials, nor shall any package or other container of Class 1 (explosive) materials, except barrels or kegs, be rolled. No packages of Class 1 (explosive) materials shall be thrown or dropped during process of loading or unloading or handling of Class 1 (explosive) materials. Special care shall be exercised to the end that packages or other containers containing Class 1 (explosive) materials shall not catch fire from sparks or hot gases from the exhaust tailpipe.

(l) Whenever tarpaulins are used for covering Class 1 (explosive) materials, they shall be secured by means of rope, wire, or other equally efficient tie downs. Class 1 (explosive) materials placards or markings required by §177.823 shall be secured, in the appropriate locations, directly to the equipment transporting the Class 1 (explosive) materials. If the vehicle is provided with placard boards, the placards must be applied to these boards.

(2) [Reserved]

(c) *Class 1 (explosive) materials on vehicles in combination.* Division 1.1 or 1.2 (Class A explosive) materials may not be loaded into or carried on any vehicle or a combination of vehicles if:

(1) More than two cargo carrying vehicles are in the combination;

(2) Any full trailer in the combination has a wheel base of less than 184 inches;

(3) Any vehicle in the combination is a cargo tank which is required to be marked or placarded under §177.823; or

(4) The other vehicle in the combination contains any:

(i) Substances, explosive, n.o.s., Division 1.1A (explosive) material (Initiating explosive),

(ii) Packages of Class 7 (radioactive) materials bearing "Yellow III" labels,

(iii) Division 2.3 (poisonous gas) or Division 6.1 (poisonous) materials, or

(iv) Hazardous materials in a portable tank or a DOT specification 106A or 110A tank.

(d) [Reserved]

(e) *No sharp projections inside body of vehicles.* No motor vehicle transporting any kind of Class 1 (explosive) material shall have on the interior of the body in which the Class 1 (explosive) materials are contained, any inwardly projecting bolts, screws, nails, or other inwardly projecting parts likely to produce damage to any package or container of Class 1 (explosive) materials during the loading or unloading process or in transit.

(f) *Class 1 (explosive) materials vehicles, floors tight and lined.* Motor vehicles transporting Division 1.1, 1.2, or 1.3 (Class A or Class B explosive) materials shall have tight floors; shall have that portion of the interior in contact with the load lined with either non-metallic material or non-ferrous metals, except that the lining is not required for truck load shipments loaded by the Departments of the Army, Navy or Air Force of the United States Government provided the Class 1 (explosive) materials are of such nature that they are not liable to leakage of dust, powder, or vapor which might become the cause

# CHEMICAL DELIVERY

Loading and unloading of chemicals as directed by the United States Department of Transportation.

Excerpts from Title 49, Transportation Suppart B, Paragraphs E and I, Pages 545 & 546.

(3) Handbrake set while loading and unloading.

"No hazardous material shall be loaded into or on, or unloaded from, any motor vehicle unless the handbrake be securely set and all other reasonable precautions be taken to prevent motion of the motor vehicle during such loading or unloading process."

(I) Attendance Requirements

"(1) Loading. A cargo tank must be attended by a qualified person at all times when it is being loaded. The person who is responsible for loading the cargo tank is also responsible for ensuring that it is so attended."

"(2) Unloading. A motor carrier who transports hazardous materials by a cargo tank must ensure that the cargo tank is attended by a qualified person at all times during unloading. However, the carrier's obligation to ensure attendance during unloading ceases when -

(i) The carriers obligation for transporting the materials is fulfilled;

(ii) The cargo tank has been placed upon the consignee's premises; and

(iii)The motive power has been removed from the cargo tank and removed from the premises."

(3) "A person 'attends' the loading or unloading of a cargo tank if, throughout the process, he is awake, has an unobstructed view of the cargo tank, and is within 7.62 meters (25 feet) of the cargo tank."

(4) "A person is 'qualified' if he has been made aware of the nature of the hazardous material which is to be loaded or unloaded, he has been instructed on the procedures to be followed in emergencies, he is authorized to move the cargo tank, and he has the means to do so."

(5) "A delivery hose, when attached to the cargo tank, is considered a part of the vehicle."

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# APPENDIX H – GLOSSARY OF WASTEWATER TERMS

## A

**Absorb -** To take in.

**Accretion -** A gradual increase in land area adjacent to a river.

**Acid Rain** - The acidic rainfall which results when rain combines with sulfur oxides emissions from combustion of fossil fuels.

**Acre-Foot -** The amount of water required to cover one acre to a depth of one foot. An acre-foot equals 325,851 gallons, or 43,560 cubic feet. A flow of 1 cubic feet per second produce 1.98 acre-feet per day.

**Activated Carbon Adsorption -** The process of pollutants moving out of water and attaching on to activated carbon.

**Activated Sludge -** Term given to a method of wastewater treatment that uses aerobic and facultative bacteria in suspension to remove wastes. Activated sludge is a popular method of treatment, and dozens of variations on the basic process exist.

**Adhesion** - The molecular attraction asserted between the surfaces of bodies in contact. Compare cohesion.

**Adsorption** - The adhesion of a substance to the surface of a solid or liquid. Adsorption is often used to extract pollutants by causing them to be attached to such adsorbents as activated carbon or silica gel. Hydrophobic, or water-repulsing adsorbents, are used to extract oil from waterways in oil spills.

**Aeration** - The mixing or turbulent exposure of water to air and oxygen to dissipate volatile contaminants and other pollutants into the air

**Aeration Basins -**Provide the conditions necessary (food, air and water) for the decomposition of organic waste. This process is often referred to as activated sludge to indicate the "activation" of microorganisms for organic decomposition and removal.

**Aerobic -**Wastewater treatment depending on oxygen for bacterial breakdown of waste.

**Aerobic Bacteria –** Bacteria that require the presence of free or dissolved oxygen in their environment for survival and reproduction.

**Alkalinity** - The measurement of constituents in a water supply which determine alkaline conditions. The alkalinity of water is a measure of its capacity to neutralize acids.

**Algal Bloom** - A phenomenon whereby excessive nutrients within a river, stream or lake cause an explosion of plant life which results in the depletion of the oxygen in the water needed by fish and other aquatic life. Algae bloom is usually the result of urban runoff (of lawn fertilizers, etc.). The potential tragedy is that of a "fish kill," where the stream life dies in one mass extinction.

**Anaerobic -** Wastewater treatment in which bacteria breakdown waste without using oxygen.

**Anaerobic Bacteria -** Bacteria that live and reproduce in an environment that contains no free or dissolved oxygen. They get their required oxygen by breaking down chemical compounds that contain oxygen such as sulfate ($SO_4$) or nitrate ($NO_3$).

**Aquatic** - Growing in, living in, or frequenting water.
**Aquifer** - A geologic formation that will yield water to a well in sufficient quantities to make the production of water from this formation feasible for beneficial use; permeable layers of underground rock or sand that hold or transmit groundwater below the water table.

**Artesian Aquifer** - A geologic formation in which water is under sufficient hydrostatic pressure to be discharged to the surface without pumping.

**Artesian Well** - A water well drilled into a confined aquifer where enough hydraulic pressure exists for the water to flow to the surface without pumping.

## B

**Backsiphonage** - Reverse seepage of water in a distribution system.

**Backwashing** - Reversing the flow of water through a home treatment device filter or membrane to clean and remove deposits.

**Bar Screen -**Preliminary treatment apparatus used to remove large pieces of trash -- sticks, rags, and the like -- from raw wastewater.

**Barrage** - Any artificial obstruction placed in water to increase water level or divert it. Usually the idea is to control peak flow for later release.

**Beneficial Use** - the amount of water necessary when reasonable intelligence and diligence are used for a stated purpose; Texas law recognizes the following uses as beneficial: (1) domestic and municipal uses, (2) industrial uses, (3) irrigation, (4) mining, (5) hydroelectric power, (6) navigation, (7) recreation, (8) stock raising, (9) public parks, and (10) game preserves.

**Bioaccumulation** - Uptake and retention of substances by an organism from its surrounding medium (usually water) and from food.

**Biomonitoring** - A test used to evaluate the relative potency of a chemical by comparing its effect on a living organism with the effect of a standard population on the same type of organism.

**Bioremediation** -A process that uses living organisms to remove pollutants.

**Biosolids** - A nutrient-rich organic material resulting from the treatment of wastewater. Biosolids contain nitrogen and phosphorus along with other supplementary nutrients in smaller doses, such as potassium, sulfur, magnesium, calcium, copper and zinc. Soil that is lacking in these substances can be reclaimed with biosolids use. The application of biosolids to land improves soil properties and plant productivity, and reduces dependence on inorganic fertilizers.

**Blackwater** - Wastewater from toilet, latrine, and agua privy flushing and sinks used for food preparation or disposal of chemical or chemical-biological ingredients.

**Blinds** - Water samples containing a chemical of known concentration given a fictitious company name and slipped into the sample flow of the lab to test the impartiality of the lab staff.

**Blowdown** - The water drawn from boiler systems and cold water basins of cooling towers to prevent the buildup of solids.

**Boiling Point** - The temperature at which a liquid boils. It is the temperature at which the vapor pressure of a liquid equals the pressure on its surface. If the pressure of the liquid varies, the actual boiling point varies. For water it is 212 degrees Fahrenheit or 100 degrees Celsius.
**BOD (Biochemical Oxygen Demand) -** A measure of the amount of oxygen required to neutralize organic wastes

**Brine** - Highly salty and heavily mineralized water containing heavy metal and organic contaminants.

**Buoyancy**
The tendency of a body to float or rise when immersed in a fluid; the power of a fluid to exert an upward force on a body placed in it.

## C

**Calcium Carbonate** - CACO3 - a white precipitate that forms in water lines, water heaters and boilers in hard water areas; also known as scale.

**Calorie** - Amount of energy required to raise the temperature of 1 gram of water 1 degree Celsius.

**Carbonates** - The collective term for the natural inorganic chemical compounds related to carbon dioxide that exist in natural waterways.

**CERCLA** - Comprehensive Environment Response, Compensation and Liability Act. Also known as SUPERFUND. The Act gave EPA the authority to clean up abandoned, leaky hazardous waste sites.

**CFU** - Colony forming units.

**Chlorination** - The adding of chlorine to water or sewage for the purpose of disinfection or other biological or chemical results.

**Chlorine Demand** - The difference between the amount of chlorine added to water, sewage, or industrial wastes and the amount of residual chlorine remaining at the end of a specific contact period.

**Chute Spillway** - The overall structure which allows water to drop rapidly through an open channel without causing erosion. Usually constructed near the edge of dams.

**Circulate** - To move in a circle, circuit or orbit; to flow without obstruction; to follow a course that returns to the starting point.

**Cistern** -A tank used to collect rainwater runoff from the roof of a house or building.

**Coagulation** - In water treatment, the use of chemicals to make suspended solids gather or group together into small flocs.

**COD (Chemical Oxygen) -** The COD test measures the chemical oxidant required to break down organics. COD is an indicator of the concentration of organics in water. The COD test can be completed in a few hours and is frequently substituted for BOD. COD levels are usually greater than BOD for a give wastewater.

**Cohesion** - A molecular attraction by which the particles of a body are united throughout the mass whether like or unlike.

**Cold Vapor** - Method to test water for the presence of mercury.

**Coliform Bacteria** - Non-Pathogenic microorganisms used in testing water to indicate the presence of pathogenic bacteria.

**Colloids** - Finely divided solids which will not settle but which may be removed by coagulation or biochemical action.

**Combined Sewer** - A sewer system that carries both sanitary sewage and stormwater runoff. When sewers are constructed this way, wastewater treatment plants have to be sized to deal with stormwater flows and oftentimes some of the water receives little or no treatment.

**Composite Sample, Weighted** - A sample composed of two or more portions collected at specific times and added together in volumes related to the flow at time of collection..

**Concentration** - Amount of a chemical or pollutant in a particular volume or weight of air, water, soil, or other medium.

**Condensation** - The change of state from a gas to a liquid.

**Confluent Growth** - In coliform testing, abundant or overflowing bacterial growth which makes accurate measurement difficult or impossible.

**Conservation** - To protect from loss and waste. Conservation of water may mean to save or store water for later use.

**Contamination** - The introduction into water of sewage or other foreign matter that will render the water unfit for its intended use.

**Critical Low Flow** - Low flow conditions below which some standards do not apply. The impacts of permitted discharges are analyzed at critical low-flow.

**Cubic Foot Per Second (CFS)** - The rate of discharge representing a volume of one cubic foot passing a given point during 1 second. This rate is equivalent to approximately 7.48 gallons per second, or 1.98 acre-feet per day.

## D

**Deionized Water** - Water free of inorganic chemicals.

**Demand** - The number of units of something that will be purchased at various prices at a point in time.

**Deposit** - Something dropped or left behind by moving water, as sand or mud.

**Desalination** - The process of salt removal from sea or brackish water.

**Detention Time -** Time a theoretical particle/water drop will remain in a tank or basin. The product of capacity divided by flow.

**Detection limit** - The lowest level that can be determined by a specific analytical procedure or test method.

**Diatomaceous** - Consisting of or abounding in diatoms, a class of unicellular or colonial algae having a silicified cell wall that persists as a skeleton after death.

**Diluting Water** Distilled water that has been stabilized, buffered, and aerated. Used in the BOD test.

**Discharge** - The volume of water that passes a given point within a given period of time. It is an all-inclusive outflow term, describing a variety of flows such as from a pipe to a stream, or from a stream to a lake or ocean.

**Discharge Permit** - A permit issued by a state or the federal government to discharge effluent into waters of the state or the United States. In many states both State and federal permits are required.

**Disinfection** - The killing of the larger portion of the harmful and objectionable bacteria in the sewage. Usually accomplished by introduction of chlorine, but more and more facilities are using exposure to ultraviolet radiation, which renders the bacteria sterile.

**disinFection Byproducts** - Halogenated organic chemicals formed when water is disinfected.

**Dissolve** - The process by which solid particles mix molecule by molecule with a liquid and appear to become part of the liquid.

**Dissolved Oxygen (DO) -** The amount of free oxygen available in water or other liquid solution for use by bacteria. Measured in ppm (parts per million) or mg/l (milligrams per liter).

**Dissolved Solids** - Inorganic material contained in water or wastes. Excessive dissolved solids make water unsuitable for drinking or industrial uses.

**Distillation** - Water treatment method where water is boiled to steam and condensed in a separate reservoir. Contaminants with higher boiling points than water do not vaporize and remain in the boiling flask.

**Distilled Water** - Water that has been treated by boiling and condensation to remove solids, inorganics, and some organic chemicals.

**Diversion** - To remove water from a water body. Diversions may be used to protect bottomland from hillside runoff, divert water away from active gullies, or protect buildings from runoff.

**Drainage Area** - The area, measured in a horizontal plane, enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into the stream above the specified location.

**Duplicates** - Two separate samples with separate containers taken at the same time at the same place.

## E

**Effluent** - Any substance, particularly a liquid, that enters the environment from a point source. Generally refers to wastewater from a sewage treatment or industrial plant.

**Enteric Viruses** - A category of viruses related to human excreta found in waterways.

**Environment** - Aggregate of external conditions that influence the life of an individual organism or population.

**EPA** - Environmental Protection Agency

**Erosion** - The wearing away of the land surface by wind, water, ice or other geologic agents. Erosion occurs naturally from weather or runoff but is often intensified by human land use practices.

## F

**Facultative Bacteria -**bacteria that function equally well whether free or dissolved oxygen is available in their environment or not.

**Fecal Coliform** - The portion of the coliform bacteria group which is present in the intestinal tracts and feces of warm-blooded animals. A common pollutant in water.

**Fermentation, Anaerobic** - Process in which carbohydrates are converted in the absence of oxygen to hydrocarbons (such as methane).

**Filter** - A device used to remove solids from a mixture or to separate materials. Materials are frequently separated from water using filters.

**Filtration** - The mechanical process which removes particulate matter by separating water from solid material, usually by passing it through sand.

**Flocculation** - Large scale treatment process involving gentle stirring whereby small particles in flocs are collected into larger particles so their weight causes them to settle to the bottom of the treatment tank.

**Flora** - Plant population of a region.

**Flow** - The rate of water discharged from a source expressed in volume with respect to time.

**Flow augmentation** - The addition of water to meet flow needs.

**Force Main -** Sewer line fed by a lift station; carries pumped wastewater to a point where other pumps or gravity can take over.

**Freezing** - The change of a liquid into a solid as temperature decreases. For water, the freezing point is 32 F or 0 C.

**Fresh Water** - Water containing less than 1,000 parts per million (ppm) of dissolved solids of any type.

**Fresh Salt Water Interface** - The region where fresh water and salt water meet. In the Edwards region, it is commonly referred to as the "bad water line", although it is zone and not a line.

**Frost** - A covering of minute ice crystals on a cold surface.

## G

**Gallon** - A unit of volume. A U.S. gallon contains 231 cubic inches, 0.133 cubic feet, or 3.785 liters. One U.S. gallon of water weighs 8.3 lbs.

**Geohydrology** - A term which denotes the branch of hydrology relating to subsurface or subterranean waters; that is, to all waters below the surface.

**Grab Sample** - A sample taken at a given place and time.

**Granular Activated Carbon** - Pure carbon heated to promote "active" sites which can adsorb pollutants. Used in some home water treatment systems to remove certain organic chemicals and radon.

**Gravity Sewer -** Sewer line that uses a declining grade to induce the flow of wastewater. This is the most common type of sewer line in existence.
**Greywater** - Wastewater from clothes washing machines, showers, bathtubs, handwashing, lavatories and sinks that are not used for disposal of chemical or chemical-biological ingredients.

**Groundwater** - Water within the earth that supplies wells and springs; water in the zone of saturation where all openings in rocks and soil are filled, the upper surface of which forms the water table.

**Groundwater recharge** - The inflow to a ground water reservoir.

**Groundwater runoff** - The portion of runoff which has passed into the ground, has become ground water, and has been discharged into a stream channel as spring or seepage water.

## H

**Hard Water** - Water containing a high level of calcium, magnesium, and other minerals. Hard water reduces the cleansing power of soap and produces scale in hot water lines and appliances.

**Hardness (Water)** - Condition caused by dissolved salts of calcium, magnesium, and iron, such as bicarbonates, carbonates, sulfates, chlorides, and nitrates.

**Head** - The pressure of a fluid owing to its elevation, usually expressed in feet of head or in pounds per square inch, since a measure of fluid pressure is the height of a fluid column above a given or known point.

**Heavy Water** - Water in which all the hydrogen atoms have been replaced by deuterium.

**Hydrograph** - A chart that measures the amount of water flowing past a point as a function of time.

**Hydrologic Cycle** - Natural pathway water follows as it changes between liquid, solid, and gaseous states; biogeochemical cycle that moves and recycles water in various forms through the ecosphere. Also called the water cycle.

**Hydrologic Unit** - Is a geographic area representing part or all of a surface drainage basin or distinct hydrologic feature.

**Hydrometer** - An instrument used to measure the density of a liquid.

**Hydrostatic Head** - A measure of pressure at a given point in a liquid in terms of the vertical height of a column of the same liquid which would produce the same pressure.

**Hydrostatic Pressure** - Pressure exerted by or existing within a liquid at rest with respect to adjacent bodies.

## I

**Ice** - A solid form of water.

**Impermeable** - Material that does not permit fluids to pass through.

**Impervious** - The quality or state of being impermeable; resisting penetration by water or plant roots. Impervious ground cover like concrete and asphalt affects quantity and quality of runoff.

**Indicator Organisms** - Microorganisms, such as coliforms, whose presence is indicative of pollution or of more harmful microorganism.

**Indicator Tests** - Tests for a specific contaminant, group of contaminants, or constituent which signals the presence of something else (ex., coliforms indicate the presence of pathogenic bacteria).

**Influent -**
The commercial and residential waste materials carried in water via underground pipes to the water pollution control facility; (also referred to as wastewater or sewage).

**Interbasin Transfer** -
The physical transfer of water from one watershed to another; regulated by the Texas Water Code.

## J

## K

## L

**Laboratory Water** - Purified water used in the laboratory as a basis for making up solutions or making dilutions. Water devoid of interfering substances.

**Lag Time** - The time from the center of a unit storm to the peak discharge or center of volume of the corresponding unit hydrograph.

**Lagoon** - A shallow pond where sunlight, bacterial action, and oxygen work to purify wastewater. Lagoons are typically used for the storage of wastewaters, sludges, liquid wastes, or spent nuclear fuel.

**Lake** - An inland body of water, usually fresh water, formed by glaciers, river drainage etc. Usually larger than a pool or pond.

**Leachate** - Water containing contaminants which leaks from a disposal site such as a landfill or dump.

**Leaching** - Extraction or flushing out of dissolved or suspended materials from the soil, solid waste, or another medium by water or other liquids as they percolate down through the medium to groundwater.

**Lift Station -** An assembly of a wet well, a level control, and one or more pumps designed to take the flow from a gravity sewer system and boost it over a hill or up some other grade where the installation of gravity sewer lines is impossible or impractical.

**Limiting Factor** - Factor such as temperature, light, water, or a chemical that limits the existence, growth, abundance, or distribution of an organism.

**Liquid** - A state of matter, neither gas nor solid, that flows and takes the shape of its container.

## M

**Marsh** - An area periodically inundated and treeless and often characterized by grasses, cattails, and other monocotyledons

**MCL - Maximum Contaminant Level** - The maximum level of a contaminant allowed in water by federal law. Based on health effects and currently available treatment methods.

**Median Streamflow** - The rate of discharge of a stream for which there are equal numbers of greater and lesser flow occurrences during a specified period.

**Melting** - The changing of a solid into a liquid.

**Meltwater** - Water that comes from the melting ice of a glacier or a snowbank.

**Method Blank** - Laboratory grade water taken through the entire analytical procedure to determine if samples are being accidentally contaminated by chemicals in the lab

**Micrograms per Liter - Ug/L** - Micrograms per liter of water. One thousands micrograms per liter is equivalent to 1 milligram per liter. This measure is equivalent to parts per billion (ppb)

**Migration** - The movement of oil, gas, contaminants, water, or other liquids through porous and permeable rock.

**Milligrams per Liter - Mg/L** - milligrams per liter of water. This measure is equivalent to parts per million (ppm).

**MGD (Million Gallons Per Day) -** Common unit of flow measurement in a wastewater treatment plant. 1,000,000 gallons.

**Minimum Streamflow** - The specific amount of water reserved to support aquatic life, to minimize pollution, or for recreation. It is subject to the priority system and does not affect water rights established prior to its institution.

**Mixed Liquor -** Term used to describe the mixture of wastewater with activated sludge in a treatment plant.

**Municipal Sewage** - Sewage from a community which may be composed of domestic sewage, industrial wastes or both.

## N

**NPDES -** "National Pollutant Discharge Elimination System. Permitting system set up by Federal law in 1972 with the intended purpose of protecting the waters of the United States,

**Natural flow** - The rate of water movement past a specified point on a natural stream. The flow comes from a drainage area in which there has been no stream diversion caused by storage, import, export, return flow, or change in consumptive use caused by man-controlled modifications to land use. Natural flow rarely occurs in a developed country.

**Natural Resource** - Any form of matter or energy obtained from the environment that meets human needs.

**NIPDWR** - National Interim Primary Drinking Water Regulations.

**Nitrogen** - A plant nutrient that can cause an overabundance of bacteria and algae when high amounts are present, leading to a depletion of oxygen and fish kills. Several forms occur in water, including ammonia, nitrate, nitrite or elemental nitrogen. High levels of nitrogen in water are usually caused by agricultural runoff or improperly operating wastewater treatment plants.

**Nonconsumptive Use** - Using water in a way that does not reduce the supply. Examples include hunting, fishing, boating, water-skiing, swimming, and some power production.

**Noncontact Recreation** - Recreational pursuits not involving a significant risk of water ingestion, including fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity.

**Nonporous** - Something which does not allow water to pass through it..

**Nonpoint Source** - Source of pollution in which wastes are not released at one specific, identifiable point but from a number of points that are spread out and difficult to identify and control.

**Nonpotable** - Not suitable for drinking.

**Nonthreshold pollutant** - Substance or condition harmful to a particular organism at any level or concentration.

**NPDES Permit** - Permit issued under the National Pollutant Discharge Elimination System for companies discharging pollutants directly into the waters of the United States.

**NTU** - Nephlometric turbidity units.

**Nutrient** - As a pollutant, any element or compound, such as phosphorous or nitrogen, that fuels abnormally high organic growth in aquatic ecosystems.

## O

**Organic Chemicals** - Chemicals containing carbon.

**Outfall** - The place where a wastewater treatment plant discharges treated water into the environment.

**Oxygen Demanding Waste** - Organic water pollutants that are usually degraded by bacteria if there is sufficient dissolved oxygen (DO) in the water.

## P

**PPM (Parts per Million) -** A measurement of concentration in a solution; i.e. how many "parts" of what is being measured for every one million equivalent "parts" of the solution. Example -- one red sand grain mixed in among 999,999 other white sand grains yields a red sand grain measurement of 1 ppm. Functionally equivalent to mg/l.

**Pathogens -** Bacteria or other things (virii, et. al) that cause disease in a host.

**Peak Flow** - In a wastewater treatment plant, the highest flow expected to be encountered under any operational conditions, including periods of high rainfall and prolonged periods of wet weather.

**Percolation** - The movement of water through the subsurface soil layers, usually continuing downward to the groundwater or water table reservoirs.

**Permeability** - The ability of a water bearing material to transmit water. It is measured by the quantity of water passing through a unit cross section, in a unit time, under 100 percent hydraulic gradient.

**pH** - Numeric value that describes the intensity of the acid or basic (alkaline) conditions of a solution. The pH scale is from 0 to 14, with the neutral point at 7.0. Values lower than 7 indicate the presence of acids and greater than 7.0 the presence of alkalis (bases). Technically speaking, pH is the logarithm of the reciprocal (negative log) of the hydrogen ion concentration (hydrogen ion activity) in moles per liter.

**Phosphorous** - A plant nutrient that can cause an overabundance of bacteria and algae when high amounts are present, leading to a depletion of oxygen and fish kills. High levels of phosphorous in water are usually caused by agricultural runoff or improperly operating wastewater treatment plants.

**Plug** - Cement, grout, or other material used to fill and seal a hole drilled for a water well.

**Point Source** - Source of pollution that involves discharge of wastes from an identifiable point, such as a smokestack or sewage treatment plant.

**Pollution** - Undesirable change in the physical, chemical, or biological characteristics of the air, water, or land that can harmfully affect the health, survival, or activities of human or other living organisms.

**Pond** - A body of water usually smaller than a lake and larger than a pool either naturally or artificially confined.

**Porous** - Something which allows water to pass through it.

**Potable** - Suitable, safe, or prepared for drinking.

**PPB - Parts per bIllion** - Number of parts of a chemical found in one billion parts of a solid, liquid, or gaseous mixture. Equivalent to micrograms per liter (Ug/L).

**PPM - Parts per Million** - Number of parts of a chemical found in one million parts of a solid, liquid, or gaseous mixture. Equivalent to milligrams per liter (mg/L).

**Precipitate** - A solid which has come out of an aqueous solution. (ex., iron from groundwater precipitates to a rust colored solid when exposed to air).

**Preservative** - A chemical added to a water sample to keep it stable and prevent compounds in it from changing to other forms or to prevent microorganism densities from changing prior to analysis.

**Primary Treatment** - Mechanical treatment in which large solids are screened out and suspended solids in the sewage settle out as sludge.

**Pump** - A device which moves, compresses, or alters the pressure of a fluid, such as water or air, being conveyed through a natural or artificial channel.

**Pumped Hydroelectric Storage** - Storing water for future use in generating electricity. Excess electrical energy produced during a period of low demand is used to pump water up to a reservoir. When demand is high, the water is released to operate a hydroelectric generator.

**Purge** - To force a gas through a water sample to liberate volatile chemicals or other gases from the water so their level can be measured.

**Purgeable Organics** - volatile organic chemicals which can be forced out of the water sample with relative ease through purging.

## Q

## R

**Rain** - Water drops which fall to the earth from the air.

**Rain Gage** - Any instrument used for recording and measuring time, distribution, and the amount of rainfall.

**"Raw" Wastewater** -- Wastewater that has not been treated by any means at all.

**RCRA** - Resource Conservation and Recovery Act - federal legislation requiring that hazardous waste be tracked from "cradle" (generation) to "grave" (disposal).

**Receiving Waters** - A river, ocean, stream, or other watercourse into which wastewater or treated effluent is discharged.

**Recharge** - Refers to water entering an underground aquifer through faults, fractures, or direct absorption.

**Recharge Zone** - The area where a formation allows available water to enter the aquifer. Generally, that area where the Edwards Aquifer and associated limestones crop out in Kinney, Uvalde, Medina, Bexar, Comal, Hays, Travis, and Williamson counties and the outcrops of other formations in proximity to the Edwards limestone, where faulting and fracturing may allow recharge of the surface waters to the Edwards Aquifer.

**Reclaimed Water** - Domestic wastewater that is under the direct control of a treatment plant owner/operator which has been treated to a quality suitable for a beneficial use.

**Reservoir** - A pond, lake, tank, or basin (natural or human made) where water is collected and used for storage. Large bodies of groundwater are called groundwater reservoirs; water behind a dam is also called a reservoir of water.

**Residual Chlorine** - The available chlorine which remains in solution after the demand has been satisfied.

**Reverse Osmosis** - A water treatment method whereby water is forced through a semipermeable membrane which filters out impurities.

**River** - A natural stream of water of considerable volume.

**River Basin** - The area drained by a river and its tributaries.

**Runoff** - Surface water entering rivers, freshwater lakes, or reservoirs.

## S

**Saline Water** - Water containing more than 1,000 parts per million (ppm) of dissolved solids of any type.

**Salinity** - Amount of dissolved salts in a given volume of water.

**Sanitary Landfill** - Landfill that is lined with plastic or concrete or located in clay-rich soils to prevent hazardous substances from leaking into the environment.

**Saturation** - The condition of a liquid when it has taken into solution the maximum possible quantity of a given substance at a given temperature and pressure.

**Seal** - The impermeable material, such as cement grout bentonite, or puddling clay placed in the annular space between the borehole wall and the casing of a water well to prevent the downhole movement of surface water or the vertical mixing of artesian waters.

**Secondary Treatment** - Second step in most waste treatment systems, in which bacteria break down the organic parts of sewage wastes; usually accomplished by bringing the sewage and bacteria together in trickling filters or in the activated sludge process. Compare primary treatment, tertiary treatment.

**Sedimentation** - A large scale water treatment process where heavy solids settle out to the bottom of the treatment tank after flocculation.

**Separate Sewer** - A sewer system that carries only sanitary sewage, not stormwater runoff. When a sewer is constructed this way, wastewater treatment plants can be sized to treat sanitary wastes only and all of the water entering the plant receives complete treatment at all times.

**Septage-** The materials derived from subsurface wastewater disposal systems in areas not serviced by public sewer.

**Septic -** A condition produced by the presence of anaerobic bacteria. Severe septic conditions are revealed by black, odorous water with little or no dissolved oxygen present.

**Septic Tank** - Underground receptacle for wastewater from a home. The bacteria in the sewage decompose the organic wastes, and the sludge settles to the bottom of the tank. The effluent flows out of the tank into the ground through drains.

**Settleable Solids** - In sewage, suspended solids that will settle when the sewage is brought to a quiet state for a reasonable length of time, usually two hours.

**Siltation** - The deposition of finely divided soil and rock particles upon the bottom of stream and river beds and reservoirs.

**Sludge** - Solid matter that settles to the bottom of sedimentation tanks in a sewage treatment plant and must be disposed of by digestion or other methods or recycled to the land.

**Snow** - Precipitation in the form of branched hexagonal crystals, often mixed with simple ice crystals, which fall more or less continuously from a solid cloud sheet. These crystals may fall either separately or in cohesive clusters forming snowflakes.

**Solute** - Any substance derived from the atmosphere, vegetation, soil, or rock that is dissolved in water.

**Soil Erosion** - The processes by which soil is removed from one place by forces such as wind, water, waves, glaciers, and construction activity and eventually deposited at some new place.

**Specific Heat** - The amount of heat required to raise the temperature of a kilogram of a substance (water) by 1 degree Celsius.

**Spillway** - The channel or passageway around or over a dam through which excess water is diverted.

**Standard Solution** - Any solution in which the concentration is known.

**Stormwater Discharge** - Precipitation that does not infiltrate into the ground or evaporate due to impervious land surfaces but instead flows onto adjacent land or water areas and is routed into drain/sewer systems.

**Stream** - A general term for a body of flowing water.

**Surface Water** - Water that flows in streams and rivers and in natural lakes, in wetlands, and in reservoirs constructed by humans.

## T

**Tertiary Treatment** Removal from wastewater of traces or organic chemicals and dissolved solids that remain after primary treatment and secondary treatment.

**TDS - Total Dissolved Solids** - The sum or all inorganic and organic particulate material. TDS is an indicator test used for wastewater analysis and is also a measure of the mineral content of bottled water and groundwater. There is a relationship between TDS and conductivity. In general, for the San Antonio River basin, TDS/.6 approximates conductivity. Or, conductivity * .6 approximates TDS. People monitoring water quality can measure electrical conductivity quickly in the field and estimate TDS without doing any lab tests at all.

**Toxicity Reduction Evaluation (TRE)** - A study conducted to determine the source(s) of toxicity in a discharge effluent so that these sources can be controlled sufficiently to allow a discharger to comply with their permit limits.

**Toxicity Test** - The means to determine the toxicity of a chemical or an effluent using living organisms. A toxicity test measures the degree of response of an exposed test organism to a specified chemical or effluent.

**TSS (Total Suspended Solids) -** Components in influent or septage that result in particle deposition in receiving waters.

## U

**Ultraviolet Disinfection (UV) -** A disinfection method in which final wastewater effluent is exposed to ultraviolet light to kill pathogens and microorganisms.

**USGS** -United States Geological Survey

**Underdrain** - A concealed drain with openings through which the water enters when the water table reaches the level of the drain.

**Underflow** - Movement of water through subsurface material.

**Upflow** - An upward flow.

## V

## W

**Wastewater** - Water containing waste including greywater, blackwater or water contaminated by waste contact, including process-generated and contaminated rainfall runoff.

**Water** - The liquid that descends from the clouds as rain; forms streams, lakes, and seas, and is a major constituent of all living matter. It is an odorless, tasteless, colorless, very slightly compressible liquid.

**Water Cycle** - Natural pathway water follows as it changes between liquid, solid, and gaseous states; biogeochemical cycle that moves and recycles water in various forms through the ecosphere. Also called the hydrologic cycle.

**Water Pollution** - Degradation of a body of water by a substance or condition to such a degree that the water fails to meet specified standards or cannot be used for a specific purpose.

**Water Table** - Level below the earth's surface at which the ground becomes saturated with water. The surface of an unconfined aquifer which fluctuates due to seasonal precipitation.

**Water Table Aquifer** - An aquifer confined only by atmospheric pressure (water levels will not rise in the well above the confining bed).

**Watershed** - Land area from which water drains toward a common watercourse in a natural basin.

**Wetland** - Area that is regularly wet or flooded and has a water table that stands at or above the land surface for at least part of the year, such as a bog, pond, fen, estuary, or marsh.

**Whole-Effluent Toxicity** - The aggregate toxic effect of an effluent measured directly by a toxicity test.

## X

## Y

**Yield** - the quantity of water expressed either as a continuous rate of flow (cubic feet per second, etc.) or as a volume per unit of time. It can be collected for a given use, or uses, from surface or groundwater sources on a watershed.

## Z

**Zone of Aeration** - A region in the Earth above the water table. Water in the zone of aeration is under atmospheric pressure and will not flow into a well.

**Zone of Saturation** - The space below the water table in which all the interstices (pore spaces) are filled with water. Water in the zone of saturation is called groundwater.

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## APPENDIX I – FORMULAS AND CONVERSION FACTORS

| | |
|---|---|
| Acid Feed Rate = | $\frac{\text{(Waste Flow)(Waste Normality)}}{\text{Acid Normality}}$ |
| Alkalinity = | $\frac{\text{(mL of Titrant)(Acid Normality)(50,000)}}{\text{mL of Sample}}$ |
| Area of Circle = | (.785) (Diameter$^2$) or (□)(Radius$^2$) |
| Area of Cylinder = | [ (.785)(Diameter$^2$)] + [(□)(Diameter)(Height)] |
| Area of Rectangle = | (Length)(Width) |
| Area of Triangle = | $\frac{\text{(Base)(Height)}}{2}$ |
| Chemical Feed Pump Setting, % Stroke = | $\frac{\text{(Desired Flow)(100\%)}}{\text{Maximum Flow}}$ |
| Chemical Feed Pump Setting, mL/min = | $\frac{\text{(Flow, MGD)(Dose, mg/L)(3.785 L/gal)(1,000,000 gal/MG)}}{\text{(Liquid, mg/mL)(24 hr/day)(60 min/hr)}}$ |
| Circumference of Circle = | (3.14)(Diameter) |
| Composite Sample Single Portion = | $\frac{\text{(Instantaneous Flow)(Total Sample Volume)}}{\text{(Number of Portions)(Average Flow)}}$ |
| Detention Time = | $\frac{\text{Volume}}{\text{Flow}}$ |
| Digested Sludge Remaining, % = | $\frac{\text{(Raw Dry Solids)(Ash Solids)(100\%)}}{\text{(Digested Dry Solids)(Digested Ash Solids)}}$ |
| Discharge = | $\frac{\text{Volume}}{\text{Time}}$ |
| Dosage, lbs/day = | (mg/L)(8.34)(MGD) |

Efficiency, % = $\frac{(\text{In} - \text{Out})(100\%)}{\text{In}}$

Feed rate, lbs/day = $\frac{(\text{Dosage, mg/L})(\text{Capacity, MGD})(8.34\ \text{lbs/gal})}{(\text{Available fluoride ion})(\text{Purity})}$

Feed rate, gal/min (Saturator) = $\frac{(\text{Plant capacity, gal/min})(\text{Dosage, mg/L})}{(18{,}000\ \text{mg/L})}$

Filter Backwash Rate = $\frac{\text{Flow}}{\text{Filter Area}}$

Filter Yield, lbs/hr/sq ft = $\frac{(\text{Solids Loading, lbs/day})(\text{Recovery, \%/100\%})}{(\text{Filter operation, hr/day})(\text{Area, ft}^2)}$

Food/Microorganism Ratio = $\frac{\text{BOD, lbs/day}}{\text{MLVSS, lbs}}$

Gallons/Capita/Day = $\frac{\text{Gallons/Day}}{\text{Population}}$

Hardness = $\frac{(\text{mL of Titrant})(1{,}000)}{\text{mL of Sample}}$

Horsepower = $\frac{(\text{Flow, gpm})(\text{Head, ft})}{(3{,}960)(\text{Efficiency})}$

Hydraulic Loading Rate = $\frac{\text{Flow}}{\text{Area}}$

Mean Cell Residence Time (MCRT) = $\frac{\text{Suspended Solids in Aeration System, lbs}}{\text{SS Wasted, lbs/day + SS Lost, lbs/day}}$

Organic Loading Rate = $\frac{\text{Organic Load, lbs BOD/day}}{\text{Volume}}$

Oxygen Uptake = $\frac{\text{Oxygen Usage}}{\text{Time}}$

Population Equivalent = $\frac{(\text{Flow MGD})(\text{BOD, mg/L})(8.34\ \text{lbs/gal})}{\text{lbs BOD/day/person}}$

Reduction in Flow, % = $\frac{\text{(Original Flow- Reduced Flow)(100\%)}}{\text{Original Flow}}$

Slope = $\frac{\text{Drop or Rise}}{\text{Distance}}$

Sludge Age = $\frac{\text{Mixed Liquor Solids, lbs}}{\text{Primary Effluent Solids, lbs/day}}$

Sludge Index = $\frac{\text{\%Settleable Solids}}{\text{\%Suspended Solids}}$

Sludge Volume Index = $\frac{\text{(Settleable Solids, \%)(10,000)}}{\text{MLSS, mg/L}}$

Solids Applied, lbs/day = (Flow, MGD)(Concentration)(8.34 lbs/gal)

Solids Concentration = $\frac{\text{Weight}}{\text{Volume}}$

Solids Loading, lbs/day/sq ft = $\frac{\text{Solids Applied, lbs/day}}{\text{Surface Area, sq ft}}$

Solids, mg/L = $\frac{\text{(Dry Solids, grams)(1,000,000)}}{\text{mL of sample}}$

Surface Loading Rate = $\frac{\text{Flow}}{\text{Area}}$

Velocity = $\frac{\text{Flow}}{\text{Area}}$ or $\frac{\text{Distance}}{\text{Time}}$

Volatile Solids, % = $\frac{\text{(Dry Solids}^{\sim}\text{ Ash Solids)(100\%)}}{\text{Dry Solids}}$

Volume of Rectangle = (Length)(Width)(Height)

Volume of Cone = (1/3)(.785)(Diameter$^2$)(Height)

Volume of Cylinder = (.785)(Diameter$^2$)(Height)

Waste Milliequivalent = (mL)(Normality)

Waste Normality = $\frac{\text{(Titrant Volume)(Titrant Normality)}}{\text{Sample Volume}}$

Weir Overflow Rate = $\frac{\text{Flow}}{\text{Weir Length}}$

Conversion Factors

1 acre = 43,560 square feet
1 cubic foot = 7.5 gallons
1 foot = 0.305 meters
1 gallon = 3.79 liters
1 gallon = 8.34 pounds
1 grain per gallon = 17.1 mg/L
1 horsepower = 0.746 kilowatts
1 million gallons per day = 694 gallons per minute
1 pound = 0.454 kilograms
1 pound per square inch = 2.31 feet of water
Degrees Celsius = (Degrees Fahrenheit - 32) (5/9)
Degrees Fahrenheit = (Degrees Celsius) (9/5) + 32
1% = 10,000 mg/L

Abbreviations

| | |
|---|---|
| BOD | biochemical oxygen demand |
| ft | feet |
| gpd | gallons per day |
| gpg | grains per gallon |
| gpm | gallons per minute |
| lbs | pounds |
| mg/L | milligrams per liter |
| MGD | million gallons per day |
| mL | milliliter |
| MLSS | mixed liquor suspended solids |
| MLVSS | mixed liquor volatile suspended solids |

WOODARD
&CURRAN

woodardcurran.com
COMMITMENT & INTEGRITY DRIVE RESULTS

**COMMITMENT & INTEGRITY**
**DRIVE RESULTS**

980 Washington Street, Suite 325N
Dedham, Massachusetts 02026
www.woodardcurran.com

T 800.446.5518
T 781.251.0200
F 781.251.0847

WOODARD &CURRAN

January 23, 2014

Mr. Alan Slater
MassDEP Boston Office
One Winter Street
Boston, Massachusetts 02108

Mr. Steven Hallem
MassDEP Boston Office
One Winter Street
Boston, MA 02108

Mr. Ronald White
MassDEP Boston Office
One Winter Street
Boston, MA 02108

Mr. Brian Dudley
MassDEP Barnstable Office
3195 Main Street
Barnstable, MA 02630

Re: BRP WP 83 Application – Hydrogeologic Evaluation to Support Request to Modify Town of Nantucket Surfside WWTF Groundwater Discharge Permit

Dear Gentlemen:

As discussed, please find enclosed the full BRP WP 83 Application for a Hydrogeological Evaluation for the Surfside WWTF. This Application is being filed in tandem with a BRP WP 11 Modification for a Groundwater Discharge Permit for the same site.

We look forward to your positive review of the two applications. If you need any additional information, please contact me direct

Sincerely,

WOODARD & CURRAN INC.

Rosemary Blacquier

Rosemary Blacquier
Project Manager

RTB/rtb
223970

Enclosure(s)

cc: Kara Buzanoski, Nantucket DPW Director
Tom Hazlett, Woodard & Curran
Cary Parsons, Woodard & Curran

WOODARD
&CURRAN

# MassDEP BRP WP 83 Application

## Hydrogeological Evaluation

MassDEP
Transmittal X259157

Surfside
Wastewater
Treatment Facility

Project No. 223970

**Town of Nantucket, Massachusetts**

**Department of Public Works**

January 2014

**980 Washington Street, Suite 325**
**Dedham, MA 02026**
**(781) 251 - 0200**

woodardcurran.com
COMMITMENT & INTEGRITY DRIVE RESULTS

SUPPLEMENTAL RESPONSES TO BRP WP 83
PROPOSED MODIFICATION OF GROUNDWATER DISCHARGE PERMIT NO. SE#1-200
SURFSIDE WASTEWATER TREATMENT FACILITY
NANTUCKET, MASSACHUSETTS 02554
TRANSMITTAL NO.X259157

# TABLE OF CONTENTS

**SECTION**

**Transmittal Letter and Form**

**BRP WP 83 Form**

**SUPPLEMENTAL INFORMATION**

# LIST OF FIGURES

**FIGURE**

Figure 1: MassDEP Coordinate Map

Figure 2: MassGIS Site Data Map with Private and Public Supplies

Figure 3: Map of Discharge Beds and Monitoring Well Locations

# APPENDICES

**Appendix**

Appendix A: Copy of Public Notice Published in the Environmental Monitor January 22, 2014

Appendix B: Copy of Approved Scope of Work

Appendix C: Hydrogeological Technical Memorandum Report

**Enter your transmittal number** → X259157
Transmittal Number

Your unique Transmittal Number can be accessed online: http://mass.gov/dep/service/online/trasmfrm.shtml

**Massachusetts Department of Environmental Protection**

# Transmittal Form for Permit Application and Payment

**1.** Please type or print. A separate Transmittal Form must be completed for each permit application.

**2.** Make your check payable to the Commonwealth of Massachusetts and mail it with a copy of this form to: DEP, P.O. Box 4062, Boston, MA 02211.

**3.** Three copies of this form will be needed.

**Copy 1 - the original** must accompany your permit application. **Copy 2** must accompany your fee payment. **Copy 3** should be retained for your records

**4.** Both fee-paying and exempt applicants must mail a copy of this transmittal form to:

**MassDEP**
**P.O. Box 4062**
**Boston, MA**
**02211**

*** Note:**
For BWSC Permits, enter the LSP.

## A. Permit Information

BRP WP 83
1. Permit Code: 7 or 8 character code from permit instructions

Hydrogeological Evaluation
2. Name of Permit Category

Modification for Existing Groundwater Discharge Permit
3. Type of Project or Activity

## B. Applicant Information – Firm or Individual

Town of Nantucket Department of Public Works
1. Name of Firm - Or, if party needing this approval is an individual enter name below:

Buzanoski
2. **Last Name** of Individual

Kara
3. **First Name** of Individual

4. MI

188 Madaket Road
5. Street Address

Nantucket
6. City/Town

MA
7. State

02554
8. Zip Code

508.228.7244
9. Telephone #

10. Ext. #

Kara Buzanoski
11. Contact Person

kbuzanoski@nantucket-ma.gov
12. e-mail address (optional)

## C. Facility, Site or Individual Requiring Approval

Surfside Wastewater Treatment Facility
1. Name of Facility, Site Or Individual

South Shore Road
2. Street Address

Nantucket
3. City/Town

MA
4. State

02554
5. Zip Code

508.228.7244
6. Telephone #

7. Ext. #

Unknown
8. DEP Facility Number (if Known)

Unknown
9. Federal I.D. Number (if Known)

N/A
10. BWSC Tracking # (if Known)

## D. Application Prepared by (if different from Section B)*

Rosemary Blacquier Woodard & Curran, Inc.
1. Name of Firm Or Individual

980 Washington Street
2. Address

Dedham
3. City/Town

MA
4. State

02026
5. Zip Code

781.251.0200
6. Telephone #

2510
7. Ext. #

Rosemary Blacquier
8. Contact Person

9. LSP Number (BWSC Permits only)

## E. Permit - Project Coordination

1. Is this project subject to MEPA review? ☐ yes ☒ no
   If yes, enter the project's EOEA file number - assigned when an Environmental Notification Form is submitted to the MEPA unit:

EOEA File Number

## F. Amount Due

*DEP Use Only*

*Permit No:*

*Rec'd Date:*

*Reviewer:*

### Special Provisions:

1. ☒ **Fee** Exempt (city, town or municipal housing authority)(state agency if fee is $100 or less).
   *There are no fee exemptions for BWSC permits, regardless of applicant status.*
2. ☐ Hardship Request - payment extensions according to 310 CMR 4.04(3)(c).
3. ☐ Alternative Schedule Project (according to 310 CMR 4.05 and 4.10).
4. ☐ Homeowner (according to 310 CMR 4.02).

Check Number | Dollar Amount | Date

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection–Groundwater Discharge Permit Program

# BRP WP 83 Application to Prepare a Hydrogeological Evaluation

X259157
Transmittal Number #

SE#1-200
Facility ID/Permit # (if known)

## A. General Information

**Important:** When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

1. Applicant Information:

Town of Nantucket Department of Public Works
Name — Company Name (If applicable)

188 Madaket Road
Address

Nantucket — MA
City/Town — State

508.228.7244 — 02554
Telephone — Zip Code

kbuzanoski@nantucket-ma.gov
Email address

2. Applicant Contact Information (if different from above):

Kara Buzanoski
Contact Name — Company Name (If applicable)

Director
Title

Address

City/Town — State

Telephone — Zip Code

email address

## B. Project Information

1. Has a pre-scoping meeting been held with MassDEP personnel?

☒ Yes ☐ No If yes, date of pre-scoping meeting: 6/18/13 and 12/6/13

2. Has a public notice been placed in the Environmental Monitor that the scope of work has been prepared and will be submitted to MassDEP in accordance with 314 CMR 5.09(1)(b)?

☒ Yes ☐ No If yes, date of Environmental Monitor: 1/22/14

3. Is there a discharge presently located on the site?

☒ Yes ☐ No If yes, answer the following:

When did the discharge begin? Date of startup: 2008*

Description of discharge:

*This is based on the upgraded MBR WWTF that went on-line in 2008 (Discharge of some consistency has been active on the site since the early 1900s). Discharge is sanitary sewage treated at the MBR Facility with ultraviolet disinfection prior to discharge to 15 open sand beds.

## B. Project Information (cont.)

4. Improvements - Are you required by any Federal, State or local authority to meet any implementation schedule for the construction, upgrading or operation of wastewater treatment equipment or practices or any other environmental programs which may affect the discharges described in this application? This includes, but is not limited to; permit conditions, administrative or enforcement orders, enforcement compliance schedule letters, stipulations, court orders, and grant or loan conditions.

☐ Yes ☒ No

If yes, answer the following:

Description of order or agreement (include enforcement document number, if applicable):

N/A

Identification No. of Affected Treatment Facility N/A

Description of Project

N/A

N/A
Final Compliance Date

## C. Site Information

1. GPS Coordinates:

   a) Enter Latitude and Longitude to the nearest whole second for the proposed site.

   Latitude: 41.2438 Longitude: -70.1064

   b) Provide a narrative description of the site and the feature to be permitted. As an example: "The site is on the west side of Main Street, the third building north of High Street. The disposal field lies 100 feet off the southwest corner of the building."

   c) Attach a site map based on the MassGIS Coordinate Information Tool that clearly indicates the site. The Coordinate Information Tool is available at http://maps.massgis.state.ma.us/images/dep/xyinfo/get_xy.html.

# BRP WP 83 Application to Prepare a Hydrogeological Evaluation

X259157
Transmittal Number #
SE#1-200
Facility ID/Permit # (if known)

## C. Site Information (cont.)

2. Provide a topographic map or maps of the area extending at least to one mile beyond the property boundaries of the site which clearly show the following:

   1) The legal boundaries of the site;
   2) All hazardous waste management facilities;
   3) All springs and surface water bodies in the area, plus all drinking water wells within one mile of the facility which are identified in the public record or otherwise known to you.
   4) All Zone II's or IWPA's.

3. Please list any public or private drinking water supply wells within 2,500 feet of the proposed site:

| Well Location | Type of Well (Public/Private) | Status (Active/Inactive) | Safe Yield |
|---|---|---|---|
| Star of the Sea Hostel | Public - TNC | Seasonal | N/A |
| Surfside Beach | Public | Seasonal | N/A |

## D. Certification

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I will be responsible for publication of public notice of the applicable permit proceedings identified under 314 CMR 2.06(1)(a) through (d)."

Signature of Applicant

Kara Buzanoski
Printed Name of Applicant

1/17/14
Date Signed

Rosemary Blacquier
Name of Preparer

781.251.0200
Telephone

Project Manager
Title of Preparer

rblacquier@woodardcurran.com
email

Supplemental Responses to BRP WP 83
Proposed Modification of Groundwater Discharge Permit No. SE#1-200
Surfside Wastewater Treatment Facility
Nantucket, Massachusetts 02554
Transmittal No. X259157

## C. Site Information

**1 (b) *Provide a narrative description of the site and the feature to be permitted.***

The Surfside WWTF Facility and Discharge Beds site is located on the southern shore directly abutting the Atlantic Ocean. Both Figures 1 and 2 detail the locus plan. The complex is situated at the end of south Shore Road and east of Miacomet Pond. The WWTF is immediately north of fifteen open sand beds that abut the shoreline adjacent to the Atlantic Ocean. The open sand beds range in size from 35,717 square feet (bed #4) to 47,306 square feet (bed #8) encompassing a total of almost 15 acres. The WWTF utility is located wholly on Town-owned parcels that encumber approximately 80 acres, with multiple smaller Town-owned properties immediately abutting the WWTF to the west.

This modification to the existing Groundwater Discharge Permit No. 200-2 is requesting that additional flow be allowed to be discharged to the existing 15-bed configuration-from existing 3.4 MGD to 4.0 MGD. The Particle Trace Analyses completed as part of the Hydrogeological Study detailed in the December 16, 2013 Technical Memorandum included herein to support the modification to the current Groundwater Discharge Permit, details all flow from the WWTF and subsequent open sand beds are contained within Town property limits and/or to the ocean. The detail also confirms maintaining a four-foot separation during high flow periods for 30-days in August. Historically, the Town sees high flows for two weeks in August, so the August Particle Trace is a conservative analysis.

**1 (c) Attach a site map based on the MassGIS Coordinate Information Tool that clearly indicates the site.**

Refer to Figure 1 included herein.

**2 Provide topographic map or maps of the area extending at least to one mile beyond the property boundaries of the site which clearly show the following:**

1. **Legal boundaries of the site**
2. **All hazardous waste management facilities**
3. **All springs and surface water bodies in the area, plus all drinking water wells within one mile of the facility which are identified in the public record or otherwise know to you**
4. **All Zone II's or IPWA's**

Refer to Figure 2 from MassGIS and Town Assessor and GIS records that details the following:

1. Legal boundaries of site, as well as surrounding sites
2. No hazardous waste management facilities within one mile of the site
3. All water bodies and wetlands from MassGIS shown. Approximately 334 parcels within the one mile radius with private wells. All private wells are upgradient to the WWTF discharge and not in an area of impact to the existing or proposed discharge. The Particle Trace Analyses completed and in the Hydrogeological Technical Memorandum detail all flow going south to the Atlantic Ocean.

**3 Please list any public or private drinking water supply wells within 2,500 feet of the proposed site**

Figure 2 from MassGIS shows two public water supply wells within 2,500 feet from the WWTF site:

| | | | |
|---|---|---|---|
| Source ID 4197010-01G | Star of the sea Youth Hostel | Public Water Supply –TNC | Yield-Unknown |
| Source ID 4197008-01G | Surfside Beach | Public Water Supply | Yield-Unknown |

Refer to Figure 3 included herein for a map of the site's monitoring wells.

MassDEP
Massachusetts Department of Environmental Protection

## Coordinate Information Tool

Click on the map and get coordinate information in NAD83UTM and WGS84 (Lat/Lon).

Enter Address: South shore Road Nantucket MA [Search]

1. Enter a complete street address then click the Search button.
2. To refine the map display use the Map Tools then click on location with the XY tool.

**Helpful Links**

Priority Resource Map View

MCP NRS Map

Commonwealth of Massachusetts Office of Geographic Information (MassGIS)

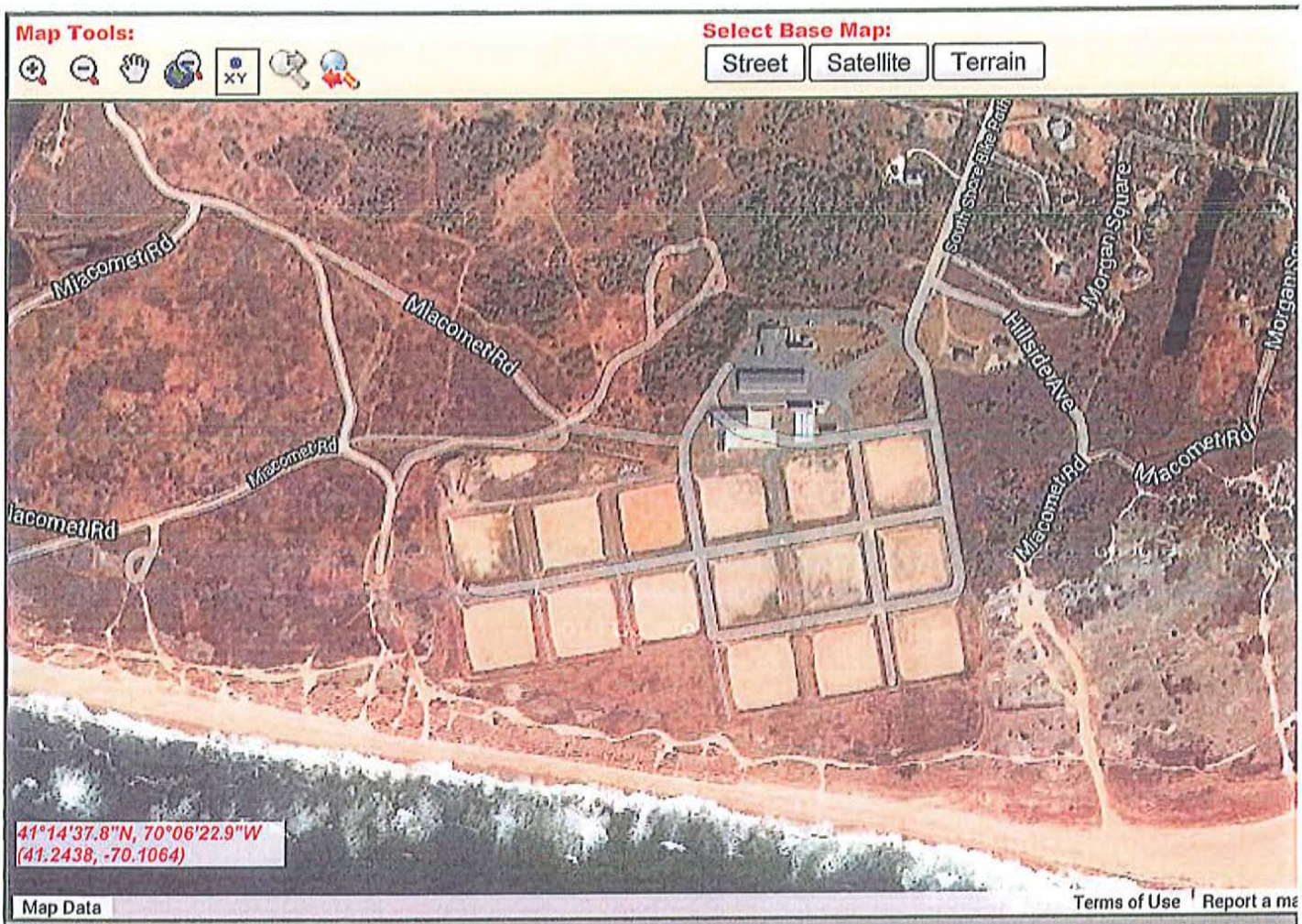
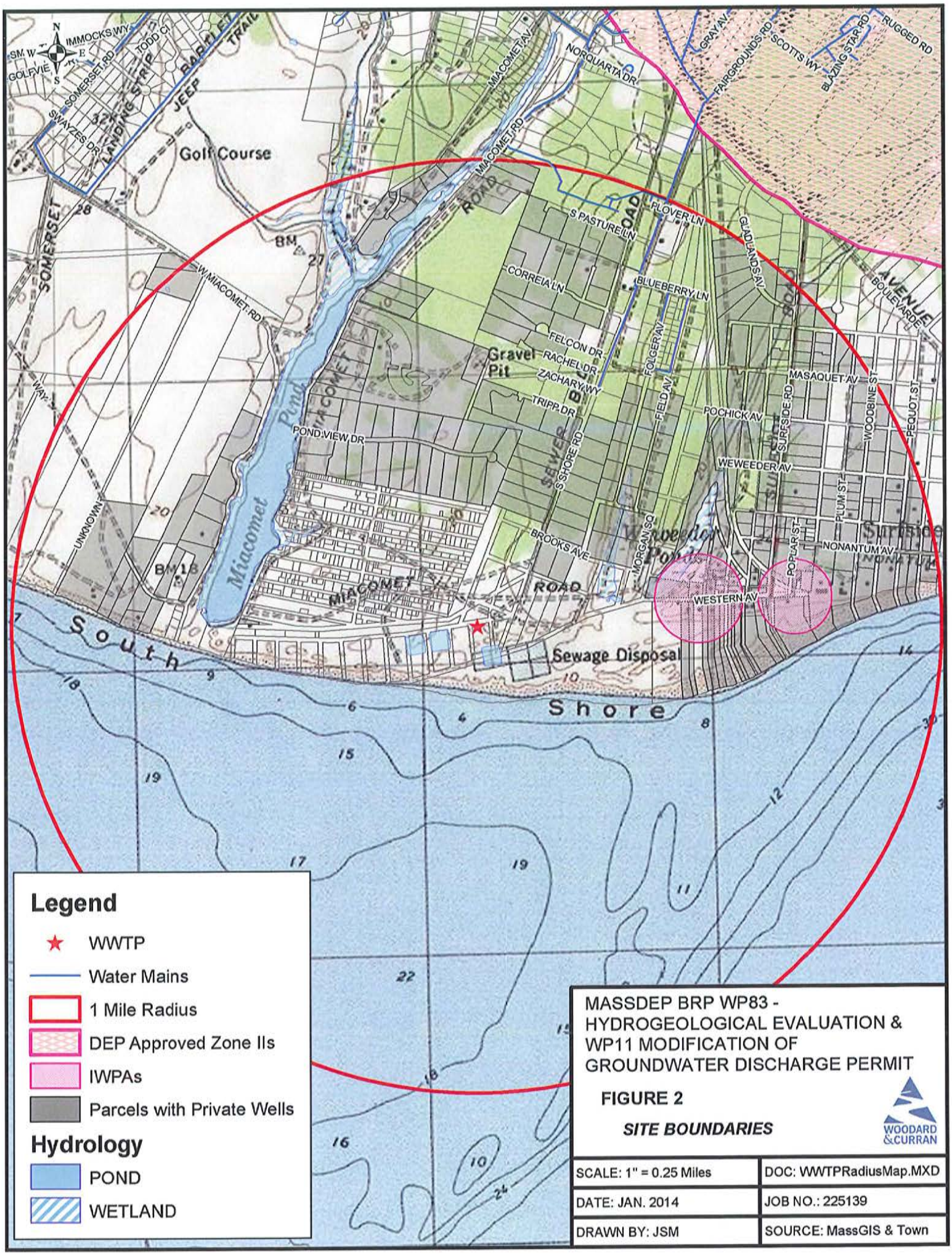



Figure 1




MASSDEP BRP WP83 - HYDROGEOLOGICAL EVALUATION & WP11 MODIFICATION OF GROUNDWATER DISCHARGE PERMIT

**FIGURE 2**

***SITE BOUNDARIES***

WOODARD & CURRAN

| | |
|---|---|
| SCALE: 1" = 0.25 Miles | DOC: WWTPRadiusMap.MXD |
| DATE: JAN. 2014 | JOB NO.: 225139 |
| DRAWN BY: JSM | SOURCE: MassGIS & Town |

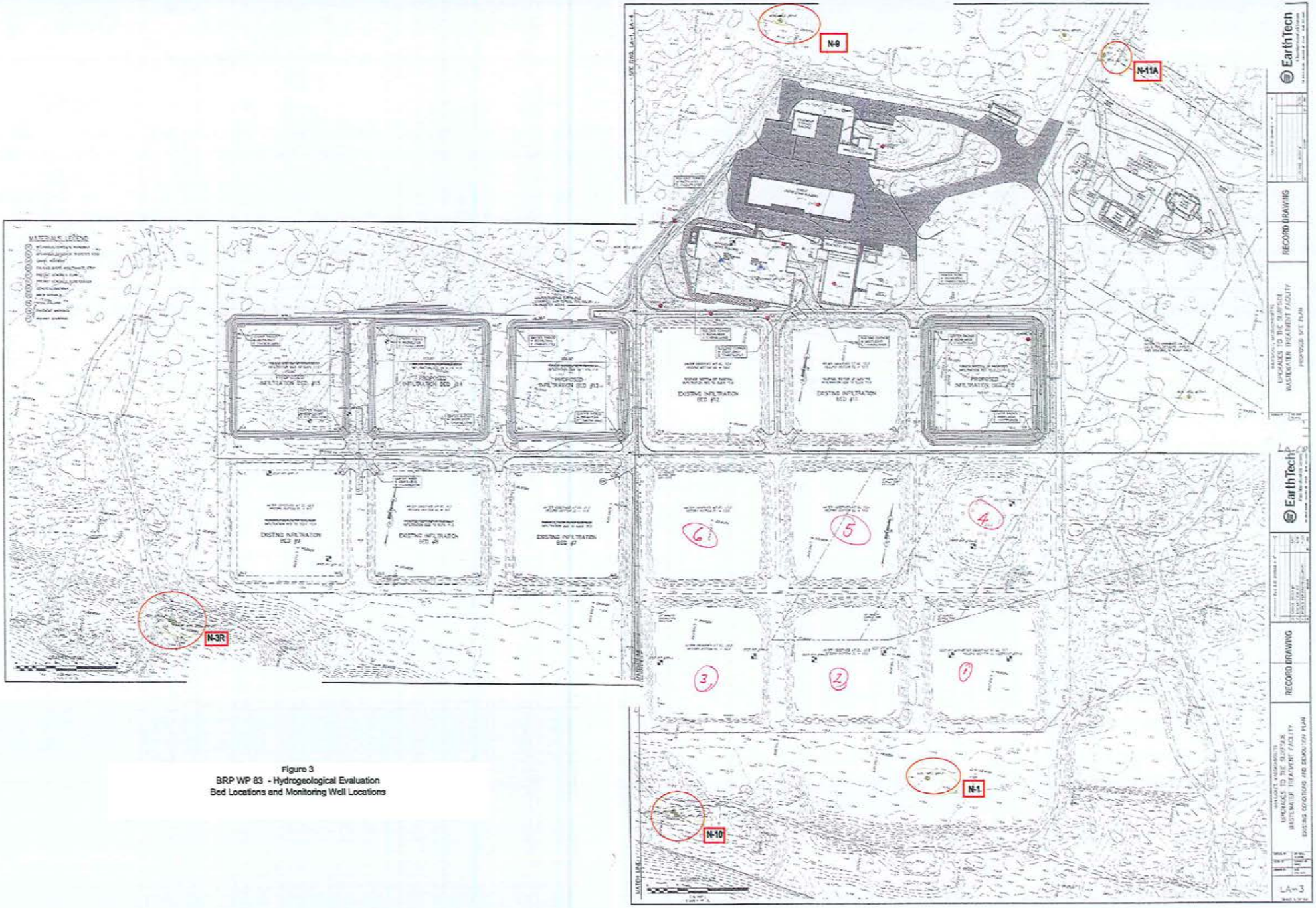



Figure 3
BRP WP 83 - Hydrogeological Evaluation
Bed Locations and Monitoring Well Locations

# APPENDIX A: PUBLIC NOTICE FROM ENVIRONMENTAL MONITOR

Welcome to the *Environmental Monitor* page. In order to access previous issues of the *Environmental Monitor* published si the launch of the new MEPA website on September 23, 2009, please select the year and publication date from the followir drop-down lists.

In order to access issues of the *Environmental Monitor* published from 2002 through September 9, 2009, please click on t Environmental Monitor Archives link.

Select Year:

Select Publication Date:

Back Environmental Monitor Archive:

## MEPA Environmental Monitor - Current Issue

Jan 22, 2014
Volume 81, Issue 6

The Environmental Monitor
a publication of the
Massachusetts Executive Office of Energy and Environmental Affairs
Deval L. Patrick, Governor
Richard K. Sullivan, Jr., Secretary

**The Environmental Monitor** provides information on projects under review by the Massachusetts Environmental Policy Act (MEPA) office, recent MEPA decisions of the Secretary of Energy & Environmental Affairs, and public notices from environmental agencies. Please note that the links on this page require the use of Adobe Acrobat Reader®, which is available free of charge at http://www.adobe.com/products/acrobat/readstep.html.

**Projects Submitted January 1-15, 2014**

- Environmental Notification Forms
- Environmental Impact Reports
- Notices of Project Change

**Other Projects Under Review**

- Environmental Notification Forms
- Environmental Impact Reports
- Notices of Project Change

**Secretary's Certificates January 1-15, 2014**

- Environmental Notification Forms
- Environmental Impact Reports
- Notices of Project Change
- Records of Decision

**Requests for Advisory Opinion**

**Public Notices**

- Submitting Public Notices

**Site Visits**

## Projects Submitted January 1-15, 2014

### Environmental Notification Forms

| EEA No. | Project Name | Location | Comments Due | For Copies | MEPA Analy |
|---|---|---|---|---|---|
| 15141 | Lower Millyard Redevelopment Project | Amesbury | 2/11/2014 | | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Gene Crouch (617) 924-1770 | Purvi Patel (61 626-1029 |
| 15142 | Sullivan Courthouse Renovation | Cambridge | 2/21/2014 | Corinne Snowden (978) 897-7100 | Nicholas Zavol (617) 626-103 |
| 15143 | McLean's Way | Duxbury | 2/11/2014 | Brian Madden (508) 746-9491 | Alex Strysky ( 626-1025 |
| 15144 | Logan Express Parking Garage | Framingham | 2/21/2014 | Stewart Dalzell (617) 568-3524 | Alex Strysky ( 626-1025 |
| 15145 | Nashua River Canoe Access | Lancaster | 2/11/2014 | Douglas Cameron (617) 727-1843 | Nicholas Zavol (617) 626-103 |
| 15146 | Medford Mews | Medford | 2/11/2014 | Robert Ricchi (617) 357-7044 x209 | Purvi Patel (61 626-1029 |
| 15147 | Interstate 195 Stormwater Retrofit Project | New Bedford | 2/11/2014 | Sean Ross (857) 368-8814 | Holly Johnson (617) 626-102 |
| 15148 | Tidmarsh Farms and Beaver Dam Brook Restoration Project | Plymouth (Manomet) | 2/21/2014 | Neal Price (508) 833-6600 | Alex Strysky ( 626-1025 |
| 15149 | Worcester Regional Airport Instrument Landing Systems and Taxiway Improvements | Worcester and Leicester | 2/21/2014 | Stewart Dalzell (617) 568-3524 | Anne Canaday (617) 626-103 |

### Environmental Notification Forms - Site Visits

No Data Found.

### Environmental Impact Reports

No Data Found.

### Notices of Project Change

No Data Found.

## Other Projects Under Review

### Environmental Notification Forms

| EEA No. | Project Name | Location | Comments Due | For Copies | MEPA Analy |
|---|---|---|---|---|---|
| 15139 | Existing Rock Revetment | Dennis | 1/28/2014 | Peter Markunas (508) 237-1456 | Holly Johnson (617) 626-102 |
| 15140 | Ceco Realty Expansion | West Boylston | 1/28/2014 | Andrysick Land Surveying (978) 464-5890 | Purvi Patel (61 626-1029 |

### Environmental Impact Reports

| EEA No. | Project Name | Location | Document Type | Comments Due | For Copies | MEPA Analy |
|---|---|---|---|---|---|---|
| 14069 | Harvard University's Campus in Allston | Boston (Allston) | DEIR | 2/07/2014 | Will Donham (617) 495-1315 | Holly Johnson (617) 626-102 |
| 15033 | MGM Springfield | Springfield | DEIR | 1/31/2014 | Corinne Snowden (978) 897-7100 | Nicholas Zavol (617) 626-103 |
| 15041 | 101 Madison Street Redevelopment | Plainville | Single EIR | 2/07/2014 | Kevin Dandrade or Richard Friberg (978) 794-1792 | Nicholas Zavol (617) 626-103 |
| 15060 | Wynn Everett | Everett | DEIR | 2/11/2014 | Judith Kohn (617) 357-7044 | Anne Canaday (617) 626-103 |
| 15098 | Raynham Park Casino | Raynham | DEIR | 2/07/2014 | Sandra Brock (617) 338-0063 | Anne Canaday (617) 626-103 |
| 5484/8696 | L.G. Hanscom Field | Bedford | 2012 ESPR | 3/11/2014 | Thomas Ennis (617) 568-3546 | Alex Strysky ( 626-1025 |

### Notices of Project Change

| EEA No. | Project Name | Location | | For Copies | MEPA Analy |
|---|---|---|---|---|---|

| | | | Comments Due | | |
|---|---|---|---|---|---|
| 14495 | Taunton Municipal Airport Improvements | Taunton | 1/28/2014 | Corinne Snowdon (978) 897-7100 | Purvi Patel (61 626-1029 |

# Secretary's Certificates January 1-15, 2014

## Environmental Notification Forms

| EEA No. | Project Name | Location | Action | Actio Date |
|---|---|---|---|---|
| 15123 | Mass Central Rail Trail | Berlin, Bolton, Hudson, Stow, Sudbury, Wayland, Weston and Waltham | Does not require an Environmental Impact Report | 01/10/2 |
| 15131 | J. Henry Higgins Middle School | Peabody | Does not require an Environmental Impact Report | 01/03/2 |
| 15132 | MassDOT Sandwich Maintenance Facility Solid Waste Landfill Closure | Sandwich | Does not require an Environmental Impact Report | 01/03/2 |

## Environmental Impact Reports

| EEA No. | Project Name | Location | Document Type | Action | Actio Date |
|---|---|---|---|---|---|
| 14154 | Comprehensive Wastewater Management Plan and Targeted Watershed Management Plan | Falmouth | FEIR | Adequately and properly complies with MEPA | 01/10/2 |

## Notices of Project Change

| EEA No. | Project Name | Location | Action | Actio Date |
|---|---|---|---|---|
| 14601 | Genzyme Framingham Master Plan | Framingham | Does not require an Environmental Impact Report | 01/10/2 |

## Records of Decision

| EEA No. | Project Name | Location | Comments Due | Action | Actio Date |
|---|---|---|---|---|---|
| 14601 | Genzyme Framingham Master Plan | Framingham | 02/05/2014 | Secretary proposes to grant a Phase 1 Waiver | 01/10/2 |
| 15123 | Mass Central Rail Trail | Berlin, Bolton, Hudson, Stow, Sudbury, Wayland, Weston and Waltham | 02/05/2014 | Secretary proposes to grant a Full EIR Waiver | 01/10/2 |

## Special Review Procedures

No Data Found.

## Public Benefits Determinations

No Data Found.

## Advisory Opinions

No Data Found.

# Requests for Advisory Opinion

No Data Found.

## Public Notices

| Agency | Notice Type | Location |
|---|---|---|
| DEP | Notice of Application for a 401 Water Quality Certification | Dunstable |
| DEP | Notice of Public Meeting, re: Fan Pier Chapter 91 Licensing | Boston (South Boston) |
| DEP | Notice of Scope of Work for a Hydrogeologic Evaluation | Nantucket |
| DEP | Notice of Public Hearings, re: 2014 Draft Intended Use Plans | Statewide |

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PUBLIC NOTICE OF HYDROGEOLOGIC EVALUATION SCOPE OF WORK
PURSUANT TO 314 CMR 5.09(1)(b)

Pursuant to 314 CMR 5.09(1)(b), public notice is hereby given that a Scope of Work for a Hydrogeologic Evaluation has been prepared and submitted to the Massachusetts Department of Environmental Protection at its Boston and Hyannis offices at One Winter Street, Boston, Massachusetts and 3195 Main Street, West Barnstable, Massachusetts, respectively. The Scope of Work was prepared on behalf of the Town of Nantucket to support proposed modifications to the existing Surfside WWTF Groundwater Discharge Permit. Additional information regarding this Scope of Work may be obtained by contacting Rosemary T. Blacquier, Project Manager at Woodard & Curran, Inc., 980 Washington Street, Dedham, MA 02026 or 781-251-0200.

# APPENDIX B: SCOPE OF WORK

**COMMITMENT & INTEGRITY**
**DRIVE RESULTS**

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WOODARD &CURRAN

August 16, 2013

Mr. Alan Slater
MassDEP Boston Office
One Winter Street
Boston, Massachusetts 02108

Mr. Steven Hallem
MassDEP Boston Office
One Winter Street
Boston, MA 02108

Mr. Brian Dudley
MassDEP Barnstable Office
3195 Main Street
Barnstable, MA 02630

**RE: PROPOSAL TO MassDEP - SCOPE OF WORK REGARDING ADDITIONAL LOADING OF TREATED WASTEWATER TO SURFSIDE WWTF DISPOSAL BEDS, NANTUCKET, MA**

Dear Gentlemen:

Please accept this letter as the Town's proposed Scope of Work to determine additional loading of treated wastewater to the Surfside WWTF discharge beds on Nantucket as requested at our meeting held on June 18, 2013 at MassDEP Boston. The meeting on June 18, 2013 at Mass DEP Boston office was attended by the three of you and me, Rosemary Blacquier, and Cary Parsons of Woodard & Curran. We discussed the proposal for Nantucket to increase its wastewater discharge to the Surfside WWTF disposal facility by approximately 400,000 gpd or loading at 6 gallons per day per square foot versus the current practice of loading at 5 gallons per day per square foot. The existing Groundwater Discharge Permit, No. 200-2, limits the facility to disposing of 3.5 mgd (Max Day) at the Surfside WWTF beds. Based on the results of the on-going Comprehensive Wastewater Management Plan (CWMP) Update, updated flows to the sewer service collection areas will require the treatment and disposal of 3.9 mgd. Despite the limitations on disposal of 3.5 mgd to the existing Surfside WWTF beds, the Surfside WWTF beds had previously been permitted by MassDEP (March 4, 1992) for disposal of 5.8 mgd. In 1992, the WWTF was primary treatment and included 10 discharge beds. At this time, the Town has upgraded its WWTF to MBR Technology and added five additional beds for discharge, with a WWTF design of 5.8mgd and a 3.5 mgd (Max Day) Groundwater Discharge Permit.

During our meeting in Boston, the various sources of this new wastewater demand were considered and geographical and financial advantages of using the Surfside WWTF for treating the additional flows and loads were discussed. The financial advantage is self-evident, in not having to permit, design and construct an additional WWTF at a new site. There are however, multiple reasons to utilize the existing infrastructure at Surfside at its highest and best use versus designing, permitting and constructing an additional WWTF on Island. Politically, the public has spoken loud and clear against a WWTF on the former FAA site as proposed in the 2004 CWMP. Environmentally, there are also strong issues that will make the Madaket site difficult and expensive to permit that evolved during intensive surveys through the Natural Heritage and Endangered Species Program (NHESP) and the Massachusetts Historical

Commission (MHC) Intensive Survey. The Town, in its effort to be proactive and address the issues detailed in the Massachusetts Estuaries Program (MEP) and subsequent Total Maximum Daily Loads (TMDLs) issued in the Madaket area, understands that an approach to a facility in Madaket will not be received positively by the residents and taxpayers, thus foiling a long and arduous journey with a federally-owned property.

Technically and financially, the feasibility of piping the wastewater from the Madaket area of the Island was discussed and all agreed that a re-evaluation of the permit limit for the Surfside WWTF groundwater disposal beds was in the Town's best interest at this point in time. The potential for resident and taxpayer approval of the Surfside option is far greater than a separate facility in Madaket as it already exists and functions well within the Community. Prior to our meeting, W&C had gathered some technical documents, which suggest that the Surfside disposal beds may be hydrogeologically able to accept more than the presently permitted 3.5 mgd (Max Day).

In addition to the possible hydrogeological ability of the Surfside beds to accept additional highly treated effluent (MBR Facility), Woodard &Curran brought up several policy aspects of adding more water to the disposal beds. The first aspect is the likelihood that given the area of the existing beds, the proposed additional loading would probably push the loading rate of the beds over the current limit of 5 gallons per square foot per day. During the meeting it was discussed that current operations at the beds could serve as a demonstration of the capability of the Surfside beds to infiltrate the additional loading and facilitate permitting a higher loading rate than the traditional limit. It was discussed that the methods currently used by staff at the facility to load the beds include loading one or two beds at a time, which accounts for a loading rate of approximately 30 to 40 gallons per day per square foot. The Town is prepared to show that this manner of operation is sound, technically feasible and meets the existing permit intent.

A second policy aspect of additional loading involves the traditional requirement that any permit should be based on the concept of estimating groundwater mounding from wastewater loading at the time of seasonal high groundwater. That mounding should maintain an unsaturated separation of 4 feet between the top of the mound and bottom of the disposal facility. The information available at the time of the meeting was not sufficient to know the actual elevation of groundwater below the beds at the seasonal high period, which typically occurs in the spring. However, there is some groundwater mounding analysis done with a computer groundwater model from earlier permitting rounds (1990s) that suggests that a loading of 3.4 mgd will maintain the traditional 4 foot separation in the seasonal high groundwater condition. Woodard & Curran will translate this to current conditions utilizing existing record information.

Woodard & Curran discussed one distinctive condition at the Surfside site with respect to seasonal high groundwater policy; namely that the spring seasonal high groundwater condition never coincides with the seasonal high wastewater flows. The highest wastewater flows and highest mounding condition occurs in August of each year due to the seasonality of the community and August being the most populous month. MassDEP personnel acknowledged this offset of the two traditionally limiting conditions. It was also discussed that based on historical water level records at the site, the existing data can potentially determine if future reloading of the beds at the previously-mentioned rate would require a permit with different limits based on time of year.

Woodard & Curran is prepared to review and summarize the Town's historical records in order to make a determination here. As mentioned above, at the time of the MassDEP meeting, we had limited information on the hydrogeological conditions at the Surfside beds location. However, it was known from various reference lists that several significant reports and sets of site data existed at one time, as well as recent water groundwater level readings since the most recent permitting in 2006. Woodard & Curran was able to obtain and review much of this historical data as referenced below. Based on

review of such, it is our preliminary conclusion that the potential to load the Surfside beds at an additional square foot per day (from 5 to 6) is plausible based on the current loading methodology.

This, in addition to, previous permits on this site dating back to the early 1990s, supports the additional load. With the MassDEP response to the policy issues as discussed, it seems plausible for Woodard & Curran to pursue the analysis of conditions at the Surfside beds location if the suggested discharge to the existing beds were increased. Our goal is to receive approval from MassDEP to allow the additional wastewater flows permitted at a minimal cost and time to our client based on historical data and current conditions. To that end, Woodard & Curran has been able to acquire additional existing, historical information. The references available to date for review include:

- Groundwater Discharge Permit Application BRP WP 11
  Town of Nantucket, Department of Public Works - 188 Madaket Road - Nantucket, MA
  Prepared by Earth Tech 196 Baker Ave Concord, MA June 28, 2005
- Goldberg, Zoino, Dunnicliff & Associates, Inc. Nantucket EIS Geohydrologic Report. Newton Upper Falls, MA. May9, 1980
- Pleistocene Hydrology of Nantucket Island, Massachusetts
  Person, Mark, et al. Presented April 2001 First International Conference on Saltwater Intrusion and Coastal Aquifers – Essaouira, Morocco
- Approval of Groundwater Discharge Permit No. I-200 Surfside, Nantucket, MA Feb 25, 1992
  To Department of Public Works, Nantucket, MA
  Signed – Brian Donahoe, Division of Water Pollution Control
- Woods Hole Group - July 2002 – Historical Change Analysis for the Surfside, Nantucket Coastline
- Final Permit – Groundwater Discharge Permit No. 200-2 June 15, 2006 – approval signed by David R. Burns, Bureau of Resource Protection
- Final Environmental Impact Statement – Wastewater Treatment Facilities Nantucket, Nantucket County Mass. August 1981
- Additional records of groundwater levels from at least the last three years are being collected at this time and will be available for analysis when W&C does the groundwater mounding analysis. It is likely that more groundwater level data in addition to the last three years will also become available.

**Proposed Scope of Work – Analysis for Additional Bed Loading**

Given the conditions and regulatory discussions mentioned above, Woodard & Curran proposes the following tasks to confirm that the Surfside WWTF disposal beds can properly accept the proposed additional loading of one gallon per day per square foot, from 5 gallons per day per square foot to 6 gallons per day per square foot. To support this, Woodard & Curran proposes to complete the following tasks:

**Task 1:** Using available recorded water level data (or estimates based on the Frimpter Method); develop a suitable typical water table elevation map for the month with highest recorded wastewater flows historically (August).

**Task 2:** With reference to the Earth Tech record drawings for bed sizes, and field observations, Woodard &Curran will calculate the actual loading of the beds (gallons per square foot per day) in present day operation during the rotation sequence when only one or two beds are used per day to accept all of the flow as is currently done.

**Task 3:** Collect any additional water level readings or anecdotal information to document that the existing beds are able to accept greater than 5 gpd/ ft sq. This Task may also include a mounding analysis to estimate mound and clearance of four feet to groundwater in August (Nantucket high flow time period) conditions.

**Task 4:** .Utilizing existing Massachusetts Shoreline Data, show that the coastal area of the beds is stable and actually experiencing accretion in order to defray any existing erosion concerns.

**Task 5:** Utilizing existing information, prepare calculations to demonstrate that an increased loading to the existing beds does not impact the stability of the beach or present any velocity or gradient issues.

Once MassDEP approves of the above-detailed scope, Woodard & Curran will prepare a Letter Report, with all appropriate back-up data, to support the additional loading of the Surfside beds from five (5) gallons per day per square foot to six (6) gallons per day per square foot. The current Surfside Groundwater Discharge permit renewal was extended by Chapter 238 of the Acts of 2012 to 6/15/2015. The timing of the renewal is optimal as the CWMP Update is due to be finalized in December 2013 with a Final Recommended Plan that includes an increase of wastewater collection, treatment and discharge over a 20-year planning period, of 400,000 GPD. This timing will give the Town the necessary back-up for the Groundwater Discharge Permit Renewal application.

We look forward to your positive response to our proposed scope of work. Once approved, Woodard & Curran will initiate the required work in order to complete this task by mid-September 2013.

Sincerely,

WOODARD & CURRAN INC.

Thomas F. Hazlett, P.E.
Project Manager

TFH/rtb
Project #223970
cc: C. Elizabeth Gibson, Nantucket Town Manager
Kara Buzanoski, Nantucket DPW Director
Kevin Manning, Nantucket DPW
Helen T. Gordon, Woodard & Curran
Cary Parsons, Woodard & Curran
Jon Himlan, Woodard & Curran
Rosemary Blacquier, Woodard & Curran

# APPENDIX C: HYDROGEOLOGICAL EVALUATION REPORT

COMMITMENT & INTEGRITY
DRIVE RESULTS

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**TECHNICAL MEMORANDUM**

**TO:** Massachusetts Department of Environmental Protection (MassDEP)
**FROM:** Cary Parsons, Tom Hazlett and Rosemary Blacquier
**DATE:** December 16, 2013
**RE:** Final Hydrogeological Report – Analysis For Additional Loading of Groundwater Disposal Beds at Surfside WWTF, Nantucket, MA

## BACKGROUND

The Town of Nantucket is in the process of completing a Comprehensive Wastewater Management Plan (CWMP) Update based on the Final Recommended Plan detailed in the 2004 CWMP Report. The major driver to the Update is the completion of Massachusetts Estuaries Program (MEP) Reports at various embayment/estuary locations on Island that are documented as degraded due to nutrient loading with the major contributor being on-site wastewater disposal systems. A review was completed and based on the MEP recommendations additional areas are now being recommended to be connected to the municipal wastewater system at Surfside WWTF. Revised wastewater flows were calculated that identified a need for additional capacity at the Town's main WWTF at Surfside. A capacity analysis determined the WWTF could handle the additional flows under its current permit with the limiting factor being the groundwater discharge beds that are permitted to handle 3.4 MGD. A total of 4.0 MGD is needed to handle the additional flows.

An initial meeting with MassDEP at their Boston offices on June 18, 2013 opened the discussion of increasing the loading to the beds based on existing conditions and current operations. Subsequent to the June meeting, a Scope of Work was developed and sent to MassDEP on August 16, 2013 and ultimately approved by MassDEP to complete a hydrogeological evaluation to determine if loading the existing beds at a higher rate was feasible. This evaluation agreed to look at three main items: 1) Capacity of existing beds to handle additional discharge through hydrogeological analysis; 2) Analysis of existing shoreline down gradient from WWTF relating to stability of shoreline; and 3) Determination of additional loading to identify any potential threat of breakout conditions to the down gradient beach/shoreline area as a result of additional loading. At the meeting on December 6, 2013 it was agreed that the model would be re-run utilizing both summer maximum and average daily build out flows, with the summer max run for the month of August (4.0 MGD for August) and the remainder of the year run at summer average daily flows at build out flows of 2.92 MGD. This schedule would also be considered conservative as the Town stated the Surfside WWTF only receives the maximum summer flows for two weeks in August.

This Technical Memorandum represents the final deliverable for the above referenced tasks. This Technical Memorandum summarizes current site conditions, the data utilized in the hydrogeological evaluation, including the model and method for determining high groundwater, the actual analysis and results, the shoreline stability analysis, potential for breakout determination and conclusions. This analysis will serve as the basis for the CWMP Update recommendation for Surfside WWTF and for renewal of the Town's Groundwater Discharge Permit No.SE#1-200, which was extended by Chapter 238 of the Acts of 2012 and is now due on 6/15/2015. At the December 6, 2013 meeting MassDEP agreed that once the hydrogeological analysis was in order to support the additional flow, they will re-issue the new permit now and not wait until it expires in June 2015.

Additional information requested at the December 6, 2013 meeting was a copy of the revised FEMA maps for the site. Refer to Figure 18 for a copy of the map of the site. The Emergency Management Director for Nantucket, Dave Fronzuto, was contacted to discuss the site and any changes to the area that would be of concern. He also contacted Coastal Zone Management (CZM) to assess their

conclusions of this area and it was stated that there were very few changes, if any, to this area and that the site was considered stable.

The Woodard & Curran approach to this Technical Memorandum, as described in our August 16th Scope of Work was to replicate the modeling exercise that was completed in 2002 by EarthTech and reported on in their 2005 Groundwater Discharge Permit Application to support additional loading of existing beds without environmental or public health impact.

The Town is in the process of having the wells on site surveyed, as discussed and agreed to on December 6, 2013, and will utilize the new data resulting from the survey for future well readings. Once this is complete, the Department will be notified that all survey work is complete.

## 1.0 CURRENT SITE CONDITIONS

The Surfside WWTF is located on the south side of Nantucket Island directly abutting the Atlantic Ocean. There are presently 15 open sand beds currently in use for wastewater disposal after treatment at the Surfside MBR Facility. Each of the beds contains approximately one acre in bottom area. On Sept 11, 2013, W&C's geologist and Kevin Manning (treatment plant operator from Nantucket) measured the bottom dimensions of each bed not described in the As Built drawings developed by EarthTech, totaling 10 in all. The beds are of slightly different sizes, ranging from the smallest at 35,700 square feet to the largest which is about 44,900 square feet. The median size is 42400 square feet. The bed dimensions are shown in Table 1 below.

**Table 1**
**Nantucket Surfside Bed Areas**

| | | North South (ft) | East West (ft) | | Bed Area (sqft) | | |
|---|---|---|---|---|---|---|---|
| **1** | * | 216 | 208 | | 44928 | | |
| **2** | * | 211 | 210 | | 44310 | | |
| **3** | * | 212 | 211 | | 44732 | | |
| **4** | * | 191 | 187 | | 35717 | | |
| **5** | * | 201 | 204 | | 41004 | | |
| **6** | * | 199 | 204 | | 40596 | | |
| **7** | * | 206 | 204 | | 42024 | | |
| **8** | * | 217 | 218 | | 47306 | | |
| **9** | * | 211 | 215 | | 45365 | | |
| **10** | x | 200 | 193 | | 38600 | | |
| **11** | * | 198 | 201 | | 39798 | | |
| **12** | * | 189 | 204 | | 38556 | | |
| **13** | x | 206 | 206 | | 42436 | | |
| **14** | x | 212 | 212 | | 44944 | | |
| **15** | x | 212 | 212 | | 44944 | | |
| **TOTAL** | | | | | **635,260** | | |

* measured by Cary and Kevin 9-11-13
x taken from record drawings

Using the above Table 1, with a 2,000,000 GPD Daily Flow and a total bed area of 635,260 that relates to a current loading factor of 3.15 GPD/sqft.

The entire Surfside WWTF site is located in an area similar to Cape Cod and is composed of glacial outwash sands and gravels. The aquifer is a simple water table aquifer with no complexities such as confining beds or semi-confined layers. The full depth of the working aquifer is not known from borings

Woodard& Curran has access to; however, the EarthTech report utilized and noted in the next section suggests that the aquifer materials may extend to depths greater than 200 feet. The EarthTech report details that the fresh water aquifer may only extend to 100 or 200 feet based on the Ghyben-Herzberg principal. Ghyben-Herzberg states that for every 1 foot of fresh water that is standing above sea level, the fresh water / salt water interface should be 40 feet below sea level.

The following map downloaded from Google Earth, Figure 1, shows an aerial view of the entire Surfside site, including the WWTF, discharge beds and lower beach/shoreline area.

Google earth

feet 3000
km 1

Figure 1

FIG X

## 1.1 DATA UTILIZED IN HYDROGEOLOGICAL EVALUATION

The greatest effort in this task was to establish the appropriate water table map for a typical August from data that is available at this time. Fortunately, the earlier reports completed by EarthTech and GZA, provided the appropriate fall high water table using the Frimpter method. Data obtained from various reports in the paper trail for the Surfside location, (noted when used); have given Woodard & Curran some basic information to manipulate in trying to create a typical August water table map. The process of creating the August water table map is described in a section below.

Groundwater levels for the 2002 EarthTech report, drew on earlier work compiled in the 1980's and 1990's and used the Frimpter Method to establish the necessary water table maps. The EarthTech report and the GZA report of 1980 both referenced a Sept 1979 GWL map presented in the GZA report of 1980. Woodard & Curran accepted the Sept 20, 1979 GWL map as representative of typical conditions in the August and Sept period of high flow for the treatment plant and utilized this same data for this exercise.

Based on the description from EarthTech in their June 2005 report, Woodard & Curran built a nearly duplicate groundwater model to the model presented in the EarthTech report. Woodard & Curran located the existing 15 disposal beds as they are now found in the field. Each disposal bed was given a different color in the model to signify its disposal load. Refer to Figure 1 for the map downloaded from Google Earth as a site plan of the facility. The Woodard & Curran model has three model layers as does the EarthTech model. These layers represent the thickness of the fresh water aquifer and the aquifer thickness increases as one moves from the shore line back into the interior of the island.

An additional large scale site plan of the facility is included in Attachment A. Previous reports and data utilized in this evaluation are listed in the August 16, 2013 Scope of Work included in Attachment B.

The GW model chosen for this modeling exercise is the same as used by EarthTech. This is the MODFLOW model from the USGS, perhaps the most widely used model in groundwater level prediction. The Woodard & Curran model was constructed to mimic the EarthTech model as closely as possible. The model was calibrated against the only recently published groundwater table map for the area, the Sept 20, 1979 map published by GZA in their 1980 report and reused by EarthTech in the GDP application of 2005.

Exact model data files were not published by EarthTech in their 2005 report, however, from the data given, Woodard & Curran has closely reproduced the model. The calibration statistics for the Woodard & Curran model are given in the Table 2 below.

**Table 2**
**Woodard & Curran Calibration Statistics**

| Name | Observed | Computed | Residual |
|---|---|---|---|
| N-1 | 2.7 | 2.9 | -0.19149 |
| N-8 | 2 | 2.9 | -0.88175 |
| SU-M | 3.7 | 3.3 | 0.354274 |
| N-13 | 3.8 | 3.7 | 0.108642 |
| N-5 | 4.3 | 4.2 | 0.130373 |
| N-3 | 4.1 | 4.1 | 0.044081 |
| N-4 | 4.5 | 3.8 | 0.685391 |
| N-6 | 4.3 | 4.5 | -0.22127 |
| N-9 | 4.6 | 5.2 | -0.59368 |
| | | | |
| Residual Mean | | -0.06283 | |
| Absolute Residual Mean | | | 0.356774 |
| Residual Std. Deviation | | 0.447967 | |
| Sum of Squares | | 1.841593 | |
| RMS Error | 0.452351 | | |
| Min. Residual | | -0.88175 | |
| Max. Residual | | 0.685391 | |
| Number of Observations | | | 9 |
| Range in Observations | | 2.6 | |
| Scaled Residual Std. Deviation | | | 0.172295 |
| Scaled Absolute Residual Mean | | | 0.137221 |
| Scaled RMS Error | | 0.173981 | |
| Scaled Residual Mean | | -0.02416 | |

The calibration statistical values presented in Table 2 above are representative to those presented in the EarthTech Report and suggests a reasonably solid calibration for the W&C model.

**Calculations of Typical Fall Water Table**

As mentioned above, the earlier reports from GZA and EarthTech have reported that due to conditions of the beds being in continual service, the Frimpter Method is the only method for determining reasonable groundwater levels at the site.(see page 5-EarthTech GWD permit application-6-28-05). Woodard & Curran has not attempted to rerun the Frimpter method for estimating groundwater levels in the fall. We have accepted the water levels as presented via the Frimpter method in the EarthTech report for Sept 20, 1979.

Below, we present our discussion for working with the Frimpter groundwater levels.

**Water Table**

Woodard & Curran prepared a water-table contour map for Surfside using September 1979 data, the period for which a pre-existing groundwater-flow model was constructed (EarthTech, 2002). Groundwater-elevation data are from gauging events conducted by GZA personnel (GZA, 1980) prior to construction of the Surfside treatment facility. The contours presented in Figure 2 from the Earth Tech Report, below, indicate a southerly flow of groundwater toward the coastline. It should be noted that GZA adjusted the manually gauged water levels via the Frimpter Method to obtain an annually average

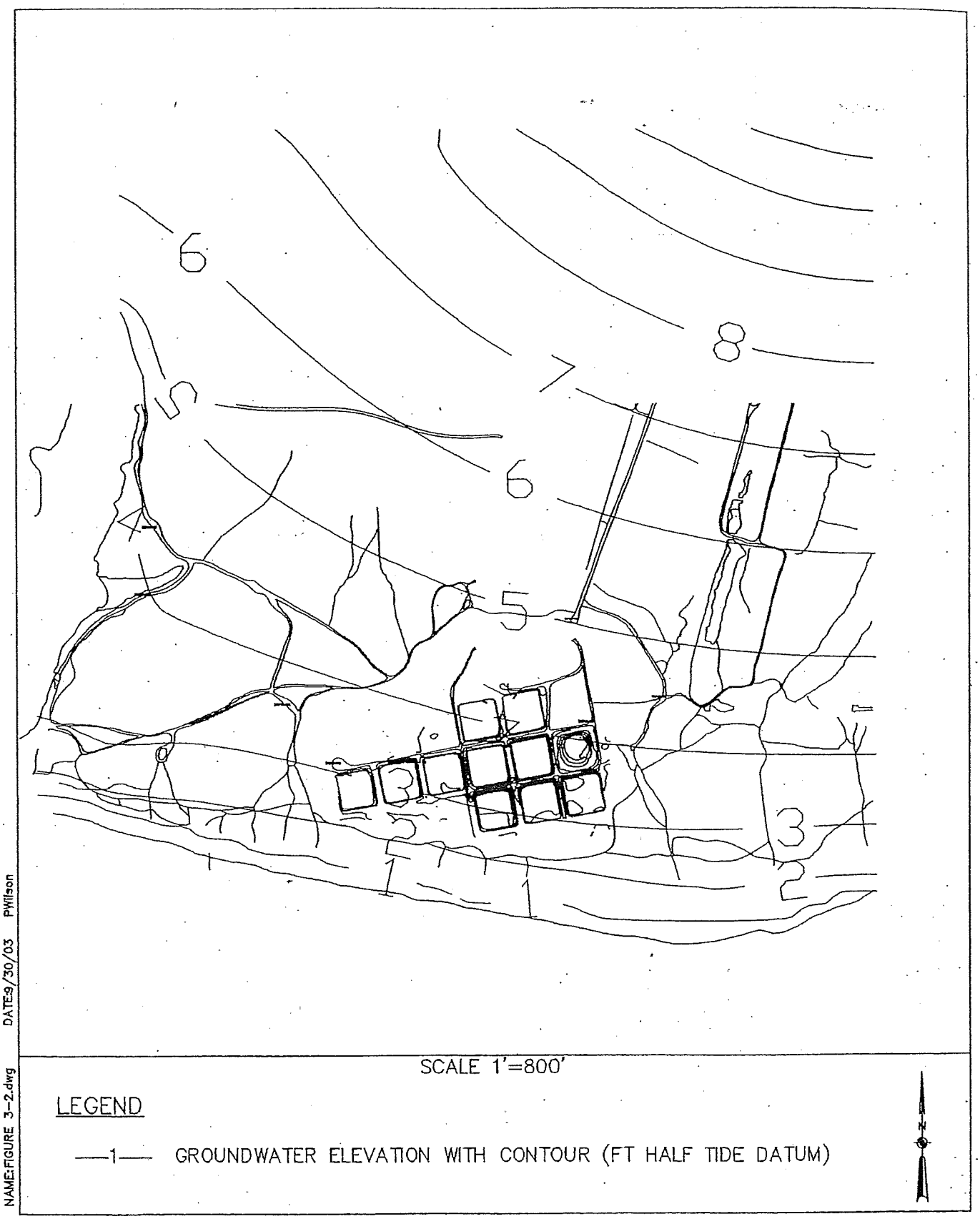



FIGURE 3–2
STEADY STATE WATER TABLE CONTOURS
SURFSIDE WWTF SITE
NANTUCKET, MASSACHUSETTS

EARTH TECH

Figure 2

data set, which was used for calibration of the flow model. The original data represented a seasonally dry period, and were increased by approximately 0.2 feet. Woodard & Curran incorporated the historic 1979 data, with the 2002 Frimpter adjustment, to generate potentiometric contours and flow directions, and to calibrate a steady state flow model. The model then is used to simulate groundwater mounding at Surfside in response to increases in discharge of treated effluent.

Current data are available at Surfside, which include five groundwater wells which are gauged by Surfside personnel on a quarterly basis. However, the newly installed wells do not have surveyed measuring points, and topographic maps exhibit a discrepancy of elevation compared with historical well surveys. In addition, the methodology for recent gauging events includes measuring the height of water column from the bottom of the well. Over time, wells may accumulate silt from the surrounding formation, or may be clogged with foreign material deposited in the well. Thus, the height of water column may change over time irrespective of a constant depth to groundwater. Furthermore, the recent data represents a system currently subjected to discharged effluent, whereas the historical data set is more representative of a steady state, long-term, ambient environment. For these reasons, the historical data set is used for constructing a base model upon which to observe the response to discharged of treated effluent. As was discussed at the December 6th meeting, the Town will have the wells surveyed for future readings.

In an additional effort to compare the Woodard& Curran model to the EarthTech model, we duplicated the EarthTech example of loading the beds with 3.4 MGD to try for similar groundwater contours. The match of groundwater levels was very close, confirming that the Woodard & Curran model is a close replica of the models previously approved.

One can reference the following Figure 3 as an example of the groundwater level that was used as the calibrated groundwater map to which the proposed increased effluent flow to a maximum load of 4 MGD in the August timeframe was applied. The groundwater levels shown on Figure 3 are very similar to the levels shown on Figure 2 in the 2005 EarthTech GDA submittal.

With the Woodard & Curran Groundwater model properly calibrated, we moved on with the effort to simulate the aquifer response to applying the treated effluent as discussed at the December 6th meeting; summer flow at full build out at 4.0 MGD for the entire month of August only and the remainder of the year at the summer average daily flow at full buildout of 2.92 MGD to the beds at Surfside. The results of this transient modeling effort are shown on Figures 4 through 15, with Figure 11 - August, showing the most dramatic mound. The simulation shows 4.0 MGD for the entire month of August, which is conservative given the Town receives maximum flows for a two week period in August.

The groundwater elevation under the beds in the no-load static condition, Figure 4, is 2.73 feet msl with the month of August loading rate at 9.26 feet msl, which shows a 6.53 foot groundwater mound. Referring to the Earth Tech record drawing in Attachment A, this shows the bottom of bed #12 at elevation 13 feet. In Figure 13, the modeling shows contours on bed #12 (highest groundwater elevation is in bed #12) at approximately 9 feet at end of month. This shows an approximate vertical separation of 4 feet as the worst case scenario in all models. All other loading scenarios exceed the four foot separation with the mound considerably less than in August.

## 1.2 SUMMARY OF HYDROGEOLOGIAL ANALYSIS

The aquifer response to application of 3.4 MGD as modeled by EarthTech was to mound to levels of 8 feet (+) in the center of the discharge beds. When the discharge was increased to the transient model in the Woodard & Curran models, as expected the August scenario showed the most dramatic mound. All other scenarios showed considerably less mounds with vertical separations exceeding four feet in all beds.

The new models also show that all flow is directed towards the ocean. With the maximum load period of August at full build out flow of 4.0 MGD, Figure 19 details a Particle Trace that shows all flows going to the ocean. There is no impact of flow shown towards Miacomet Pond.

The revised transient models clearly show that a vertical separation of four feet is maintained at all beds during the year. Refer to Figures 4 through 15 for each month scenario modeled.

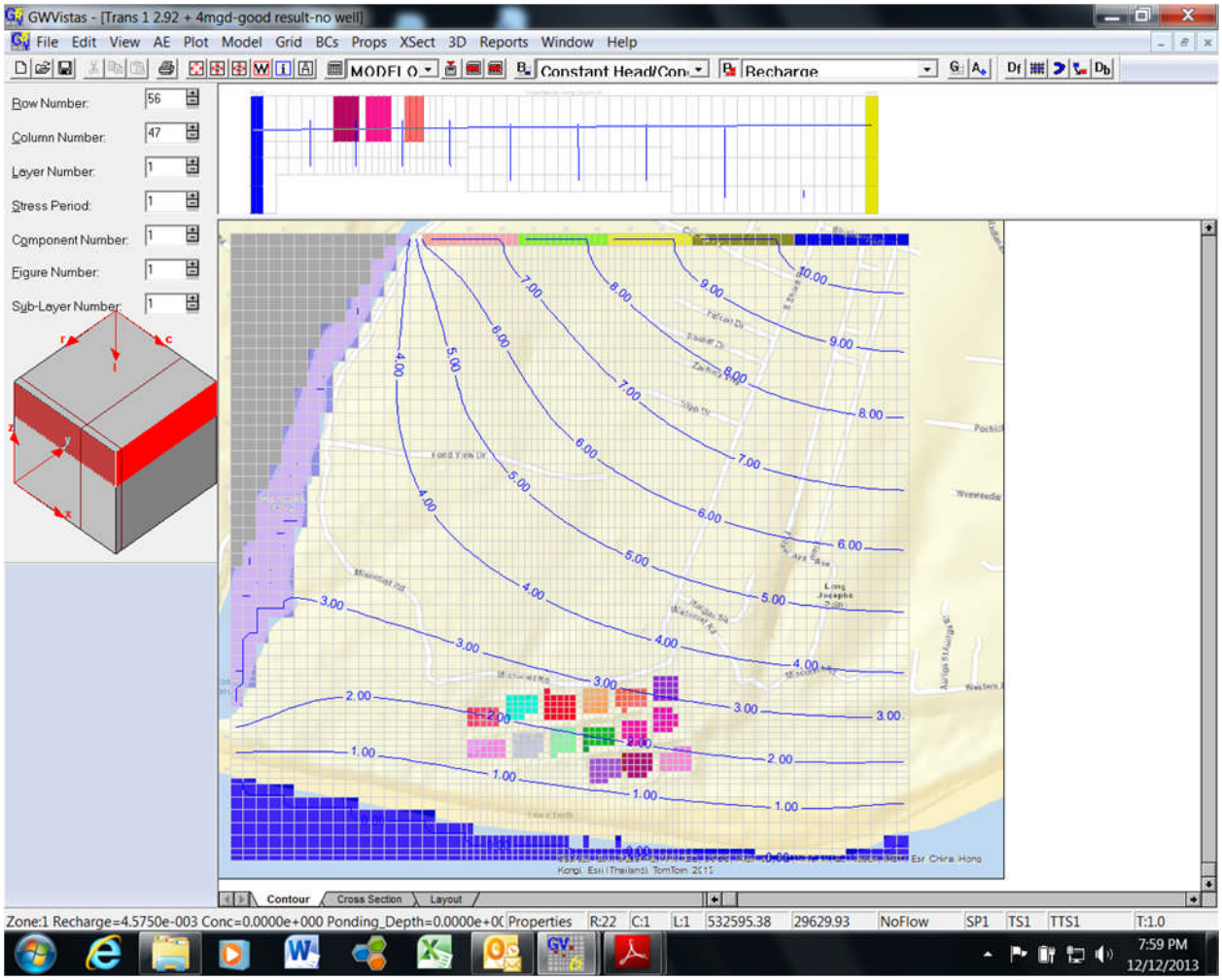



Figure 3

STATIC GROUNDWATER

CONTOURS

(NO LOADING)

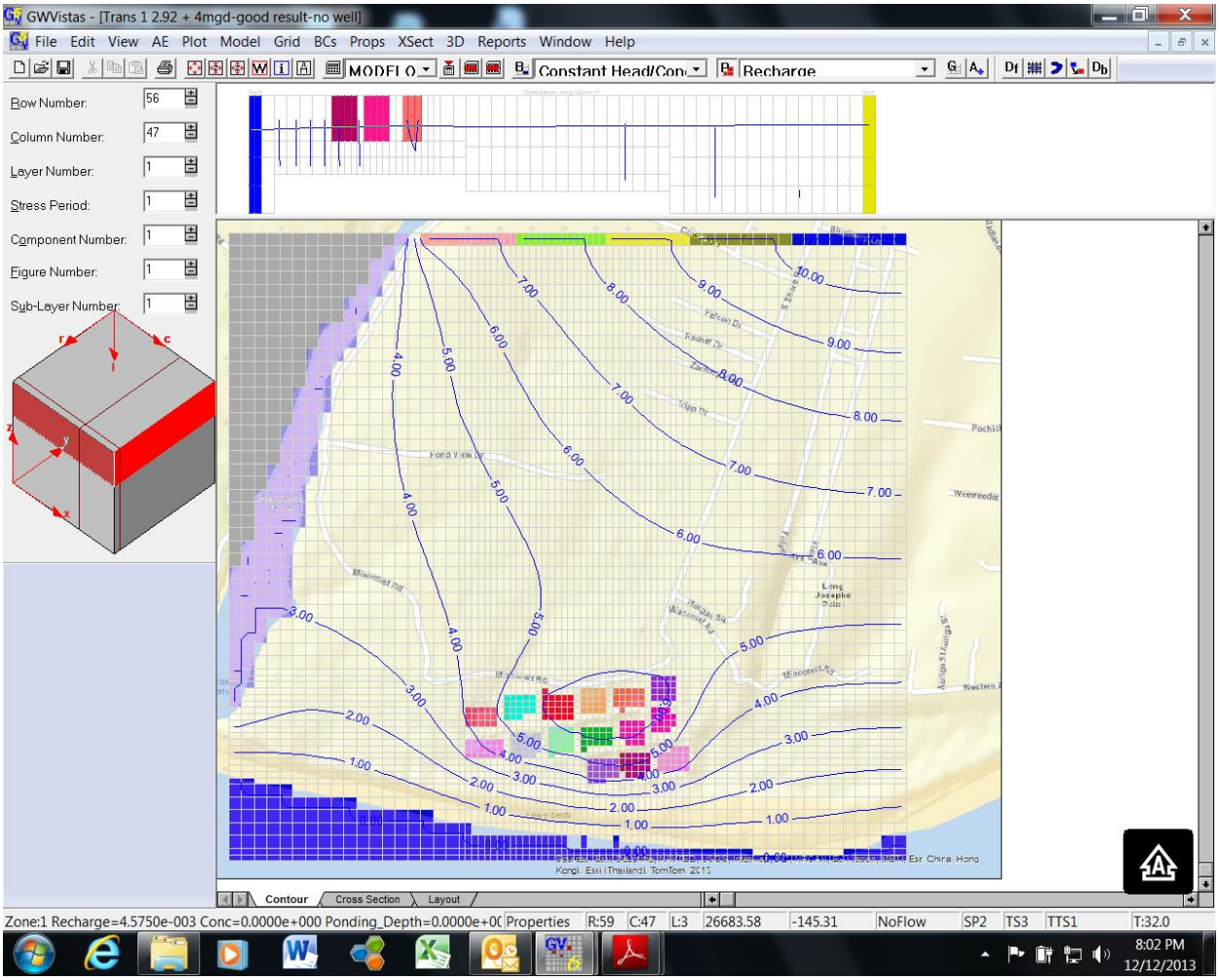



Figure 4

JANUARY AT

2.92 MGD

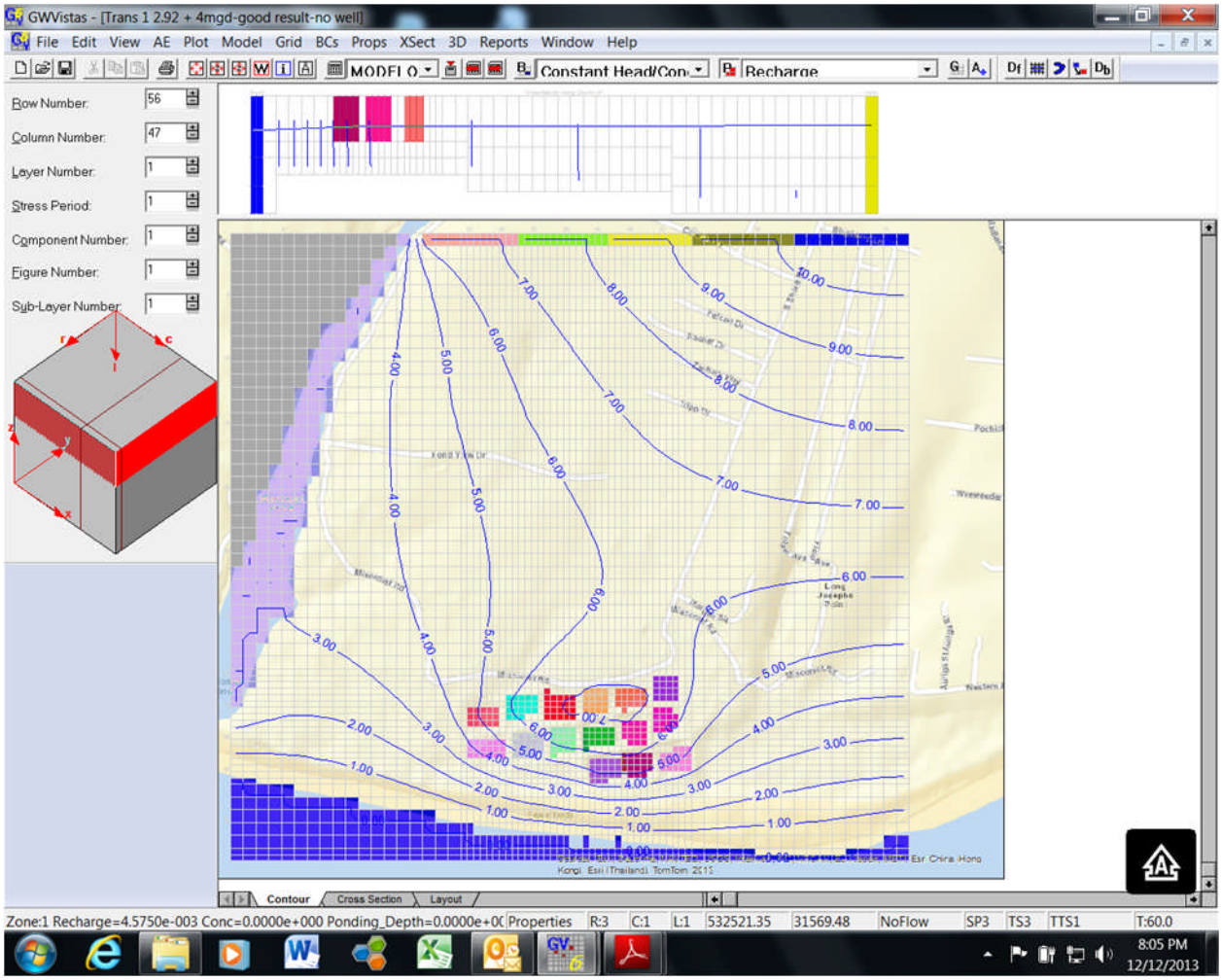



Figure 5

FEB AT

2.92 MGD

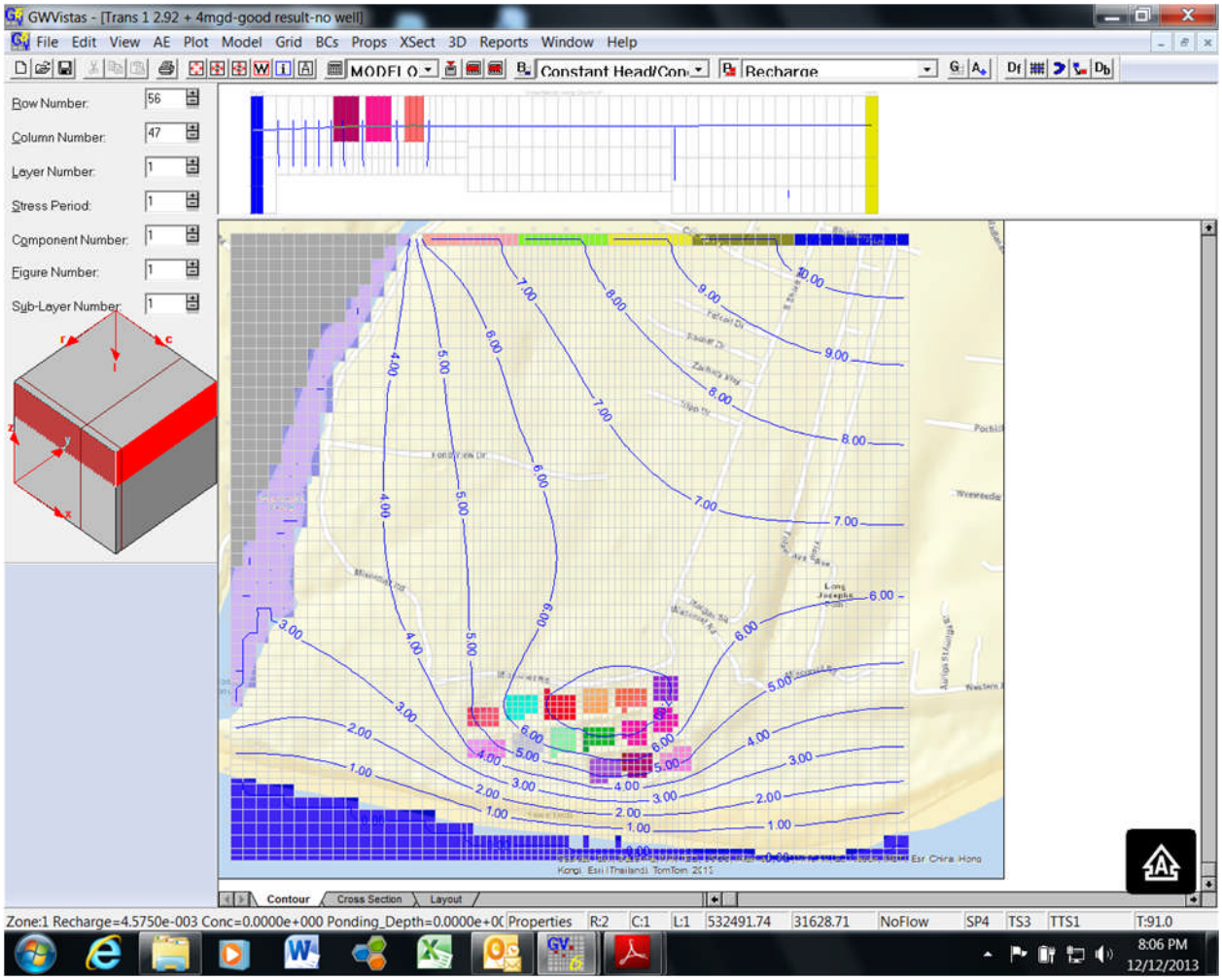



Figure 6

MAR AT

2.92 MGD

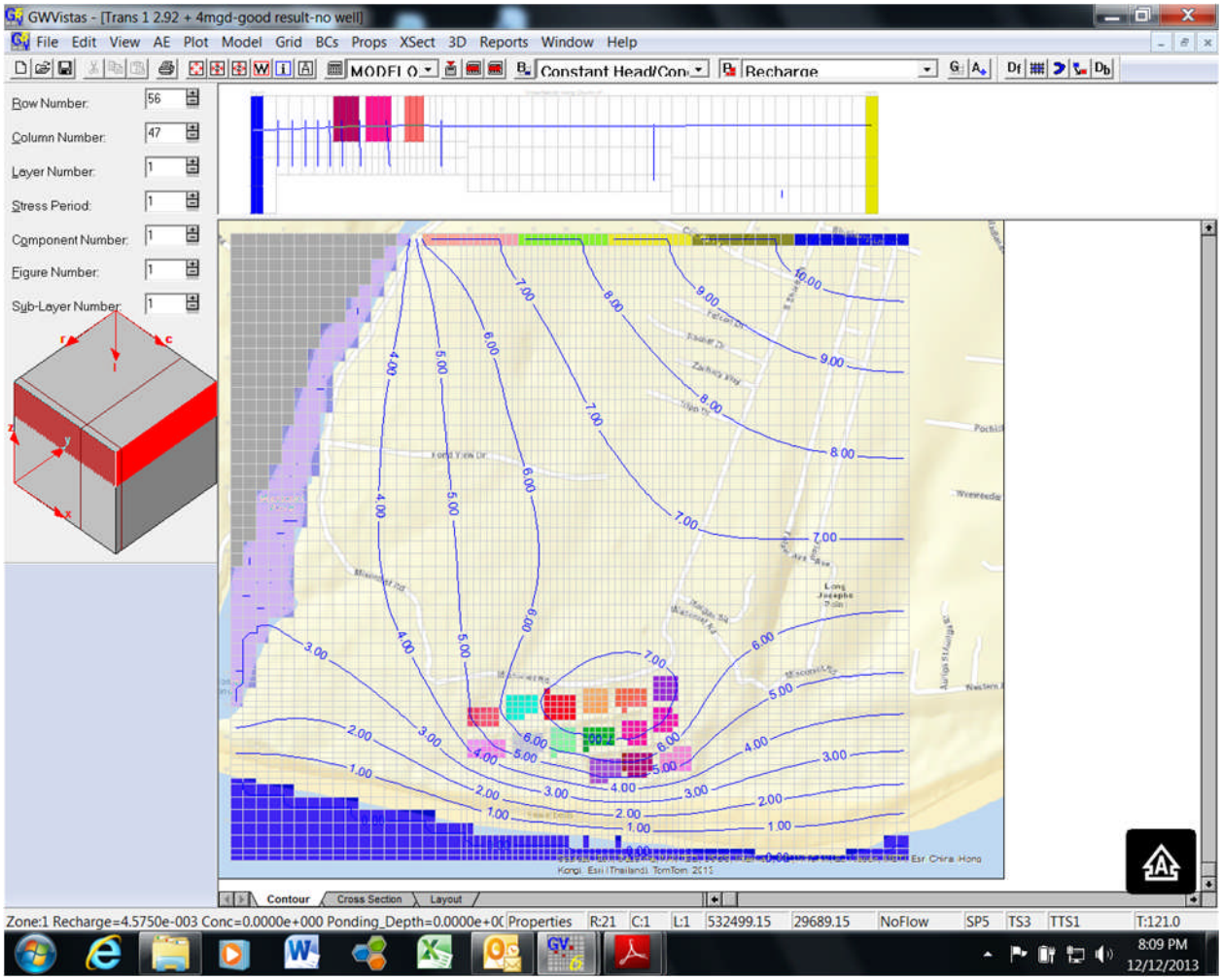



Figure 7

APR AT

2.92 MGD

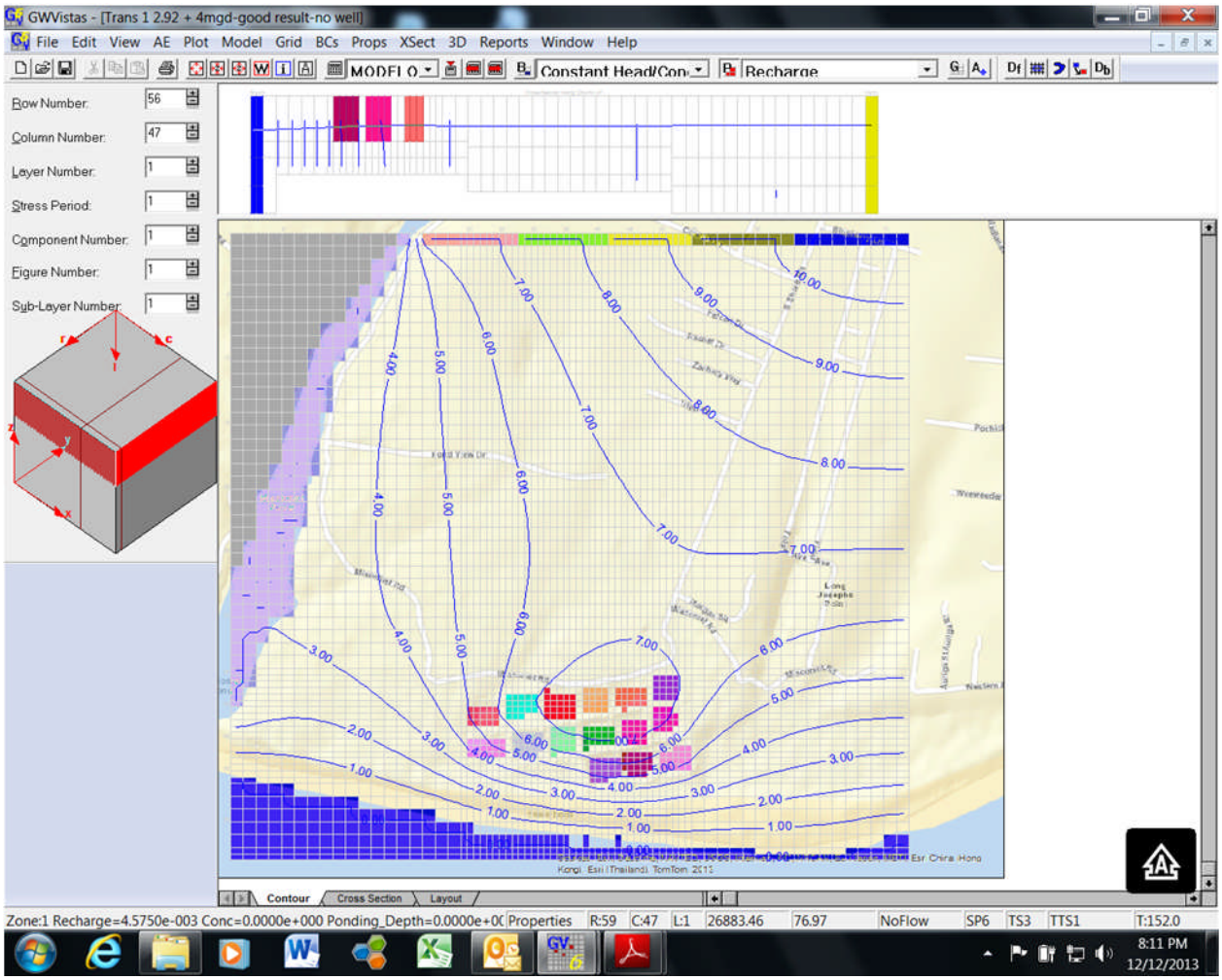



Figure 8

MAY AT

2.92 MGD

Figure 9

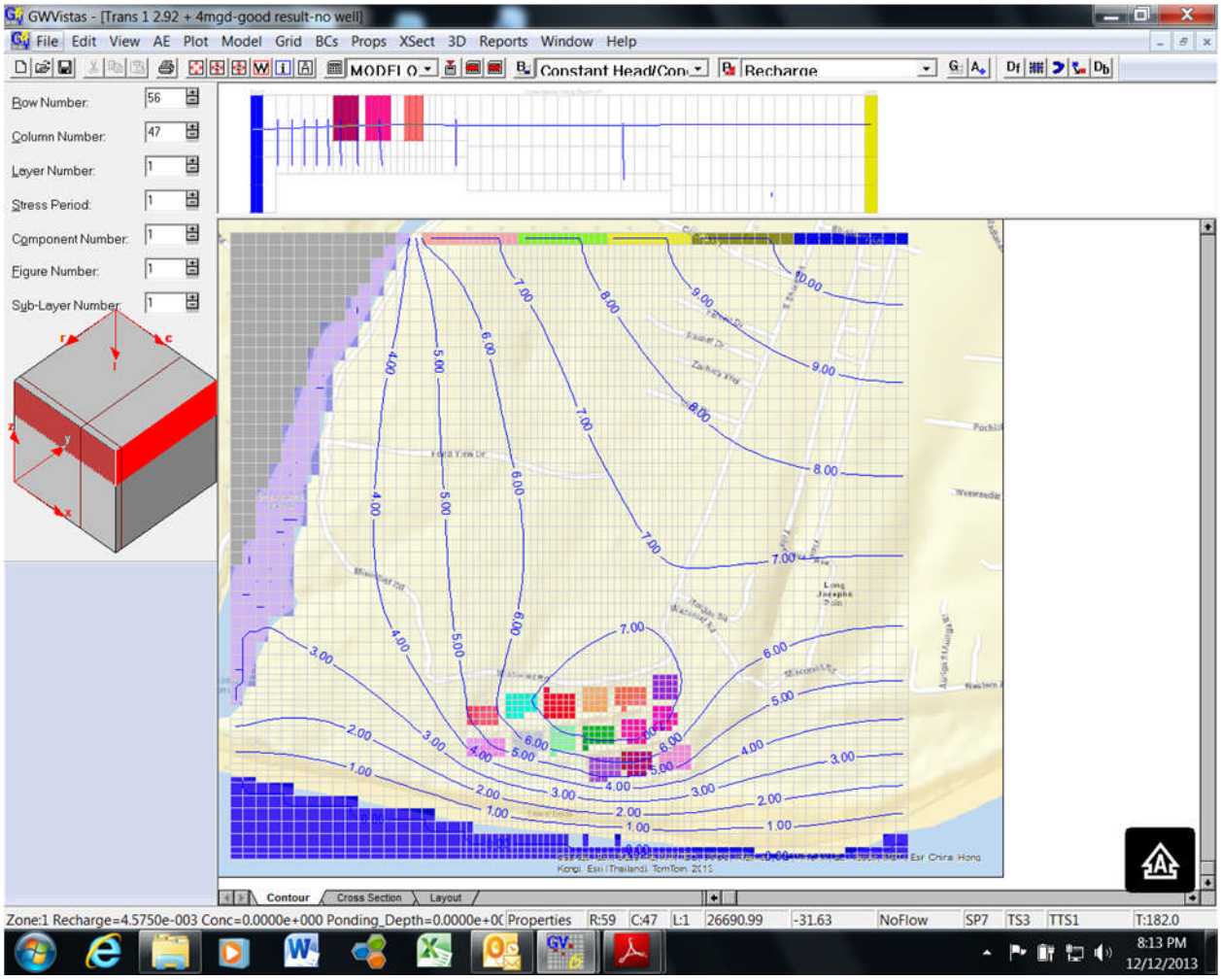



Figure 9

JUNE AT

2.92 MGD

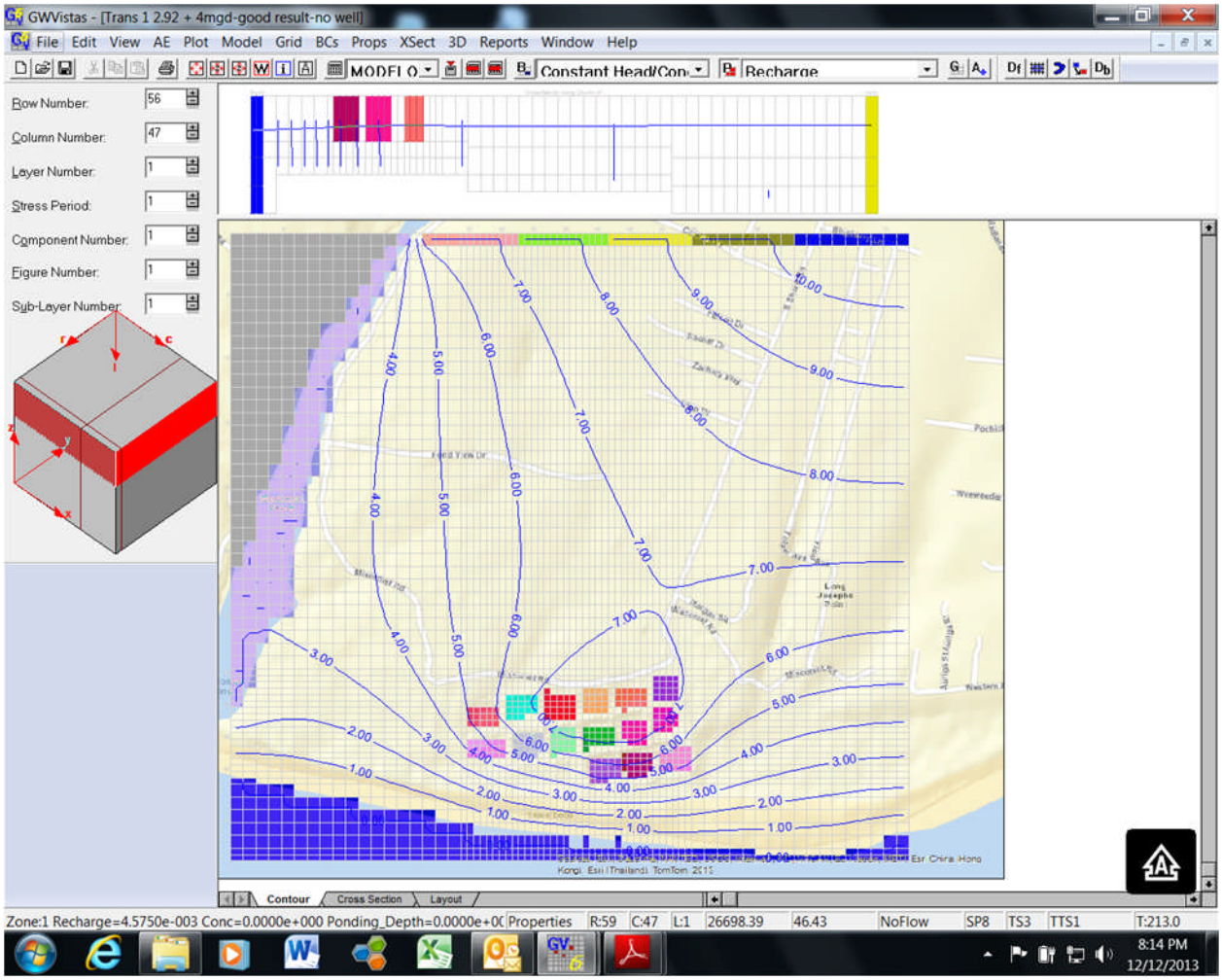



Figure 10

JULY AT

2.92 MGD

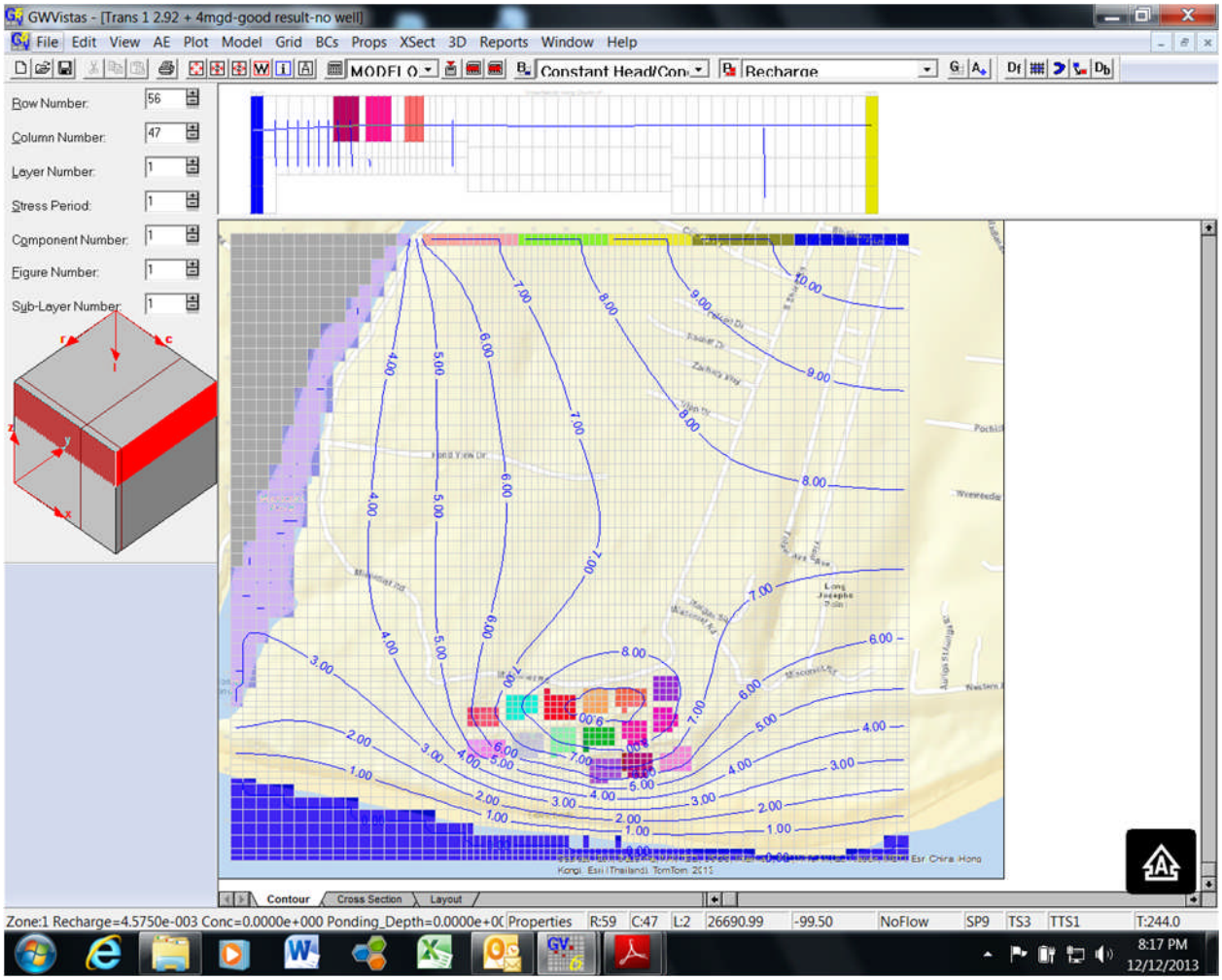



Figure 11

AUG AT

4.0 MGD

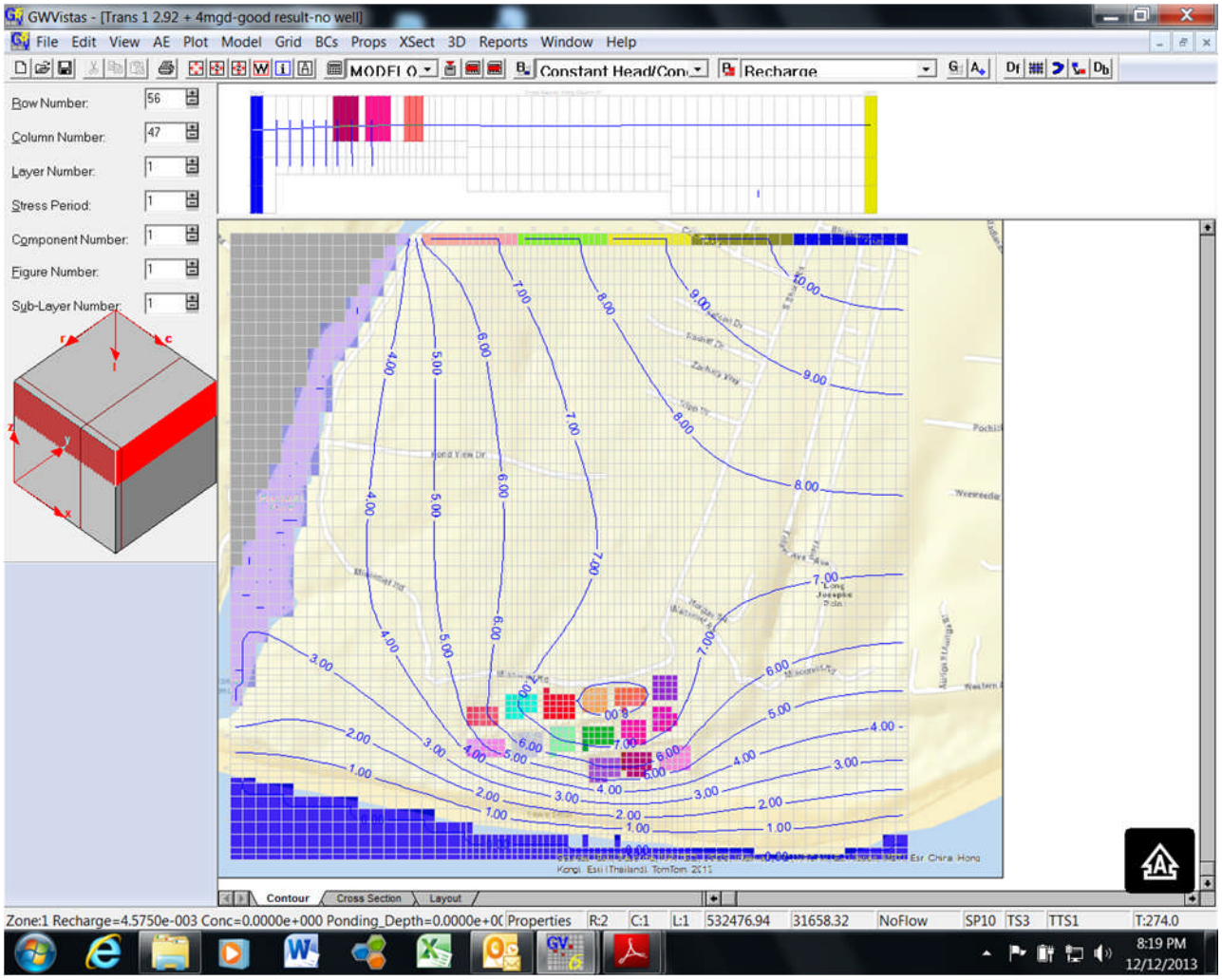



Figure 12

SEPT AT

2.92 MGD

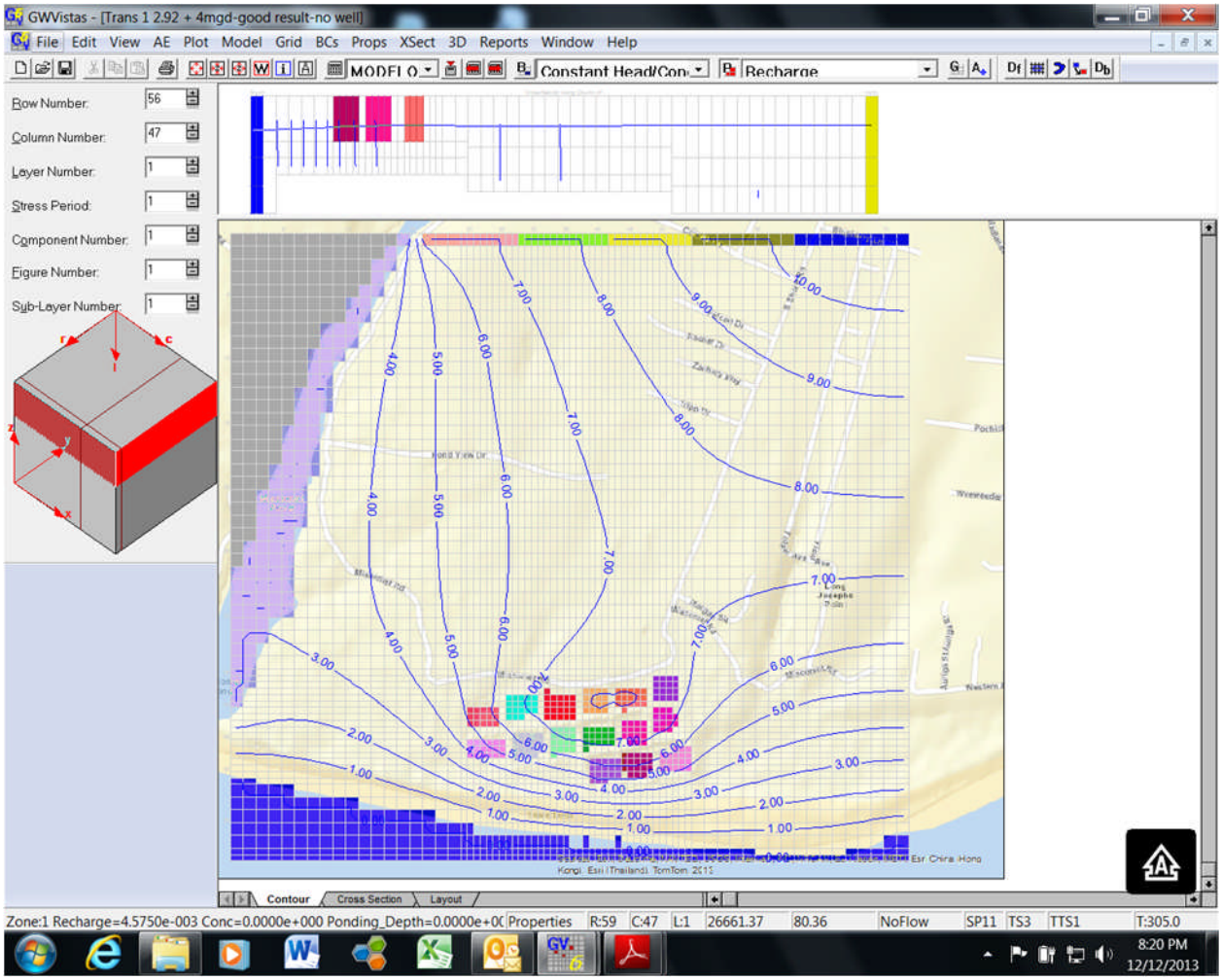



Figure 13

OCT AT

2.92 MGD

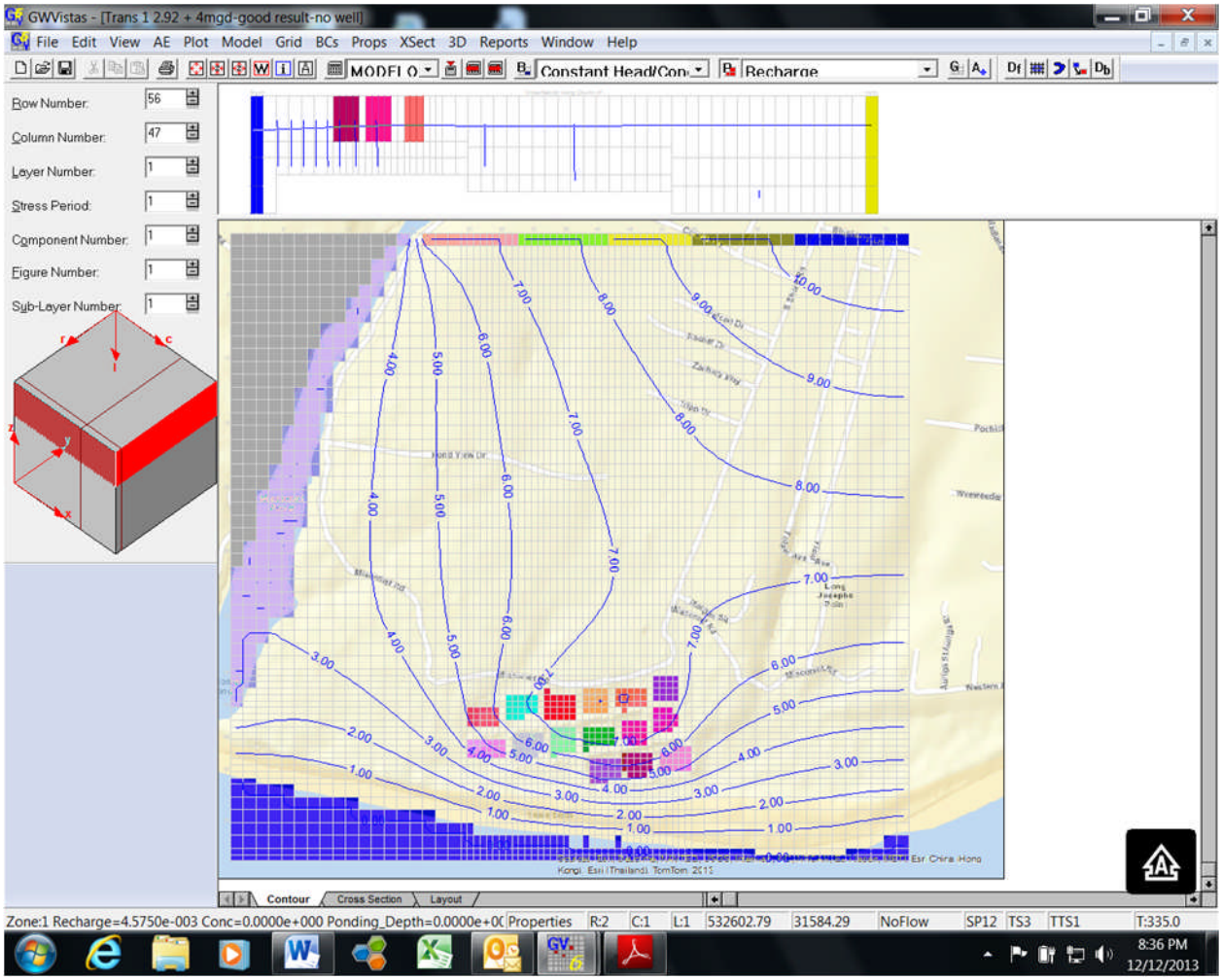



Figure 14

NOV AT

2.92 MGD

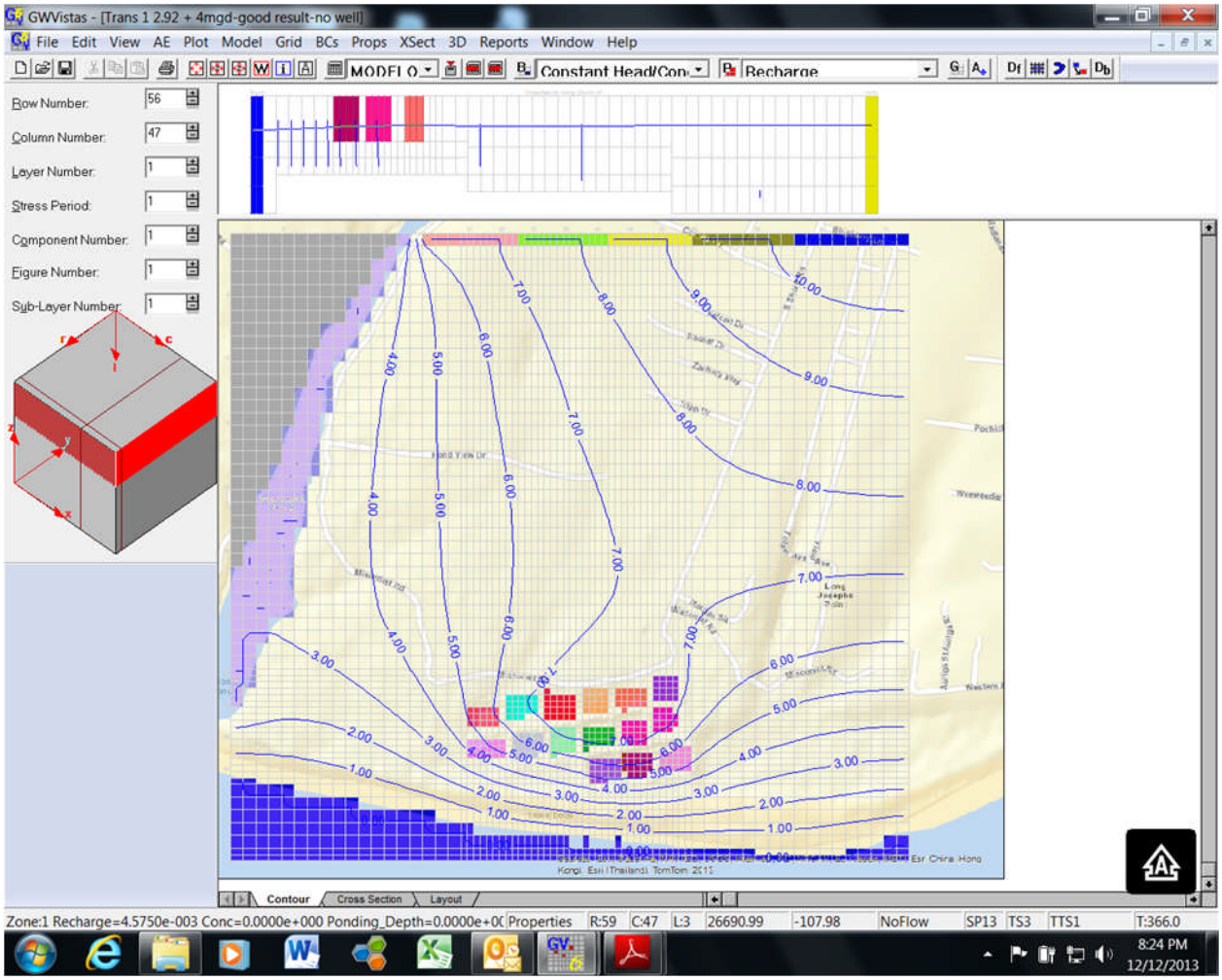



Figure 15

DEC AT

2.92 MGD

## 2.0 SHORELINE STABILITY ANALYSIS AND BREAKOUT DETERMINATION

The second task to address is the potential impact that additional flow at the Surfside Beds could have to the shoreline immediately down gradient by some 250 to 300 feet. We evaluated impacts of both shoreline stability and any potential for additional flow to breakout in the down gradient areas. To address this concern, Woodard & Curran resorted to existing published document from the Woods Hole Group, as well as recent datasets produced by the United States Army Corps of Engineers (ACOE). These documents address the stability of the shore line near the Surfside Beds with a review of several existing studies of the shoreline position in the area.

**Shoreline**

A review of the shoreline analysis by the Woods Hole Group (WHG, 2002) suggests that the shoreline near the Surfside WWTF has experienced consistent patterns of accretion or erosion from 1955 to 2002. Shoreline change during older datasets in the 1800s show greater fluctuation, which is not mimicked in recent data, either due to unique climatic factors or to greater discrepancies in data translation. Data from the WHG report indicate overall slight erosional trends in the shoreline immediately west of Surfside, stable trends south of Surfside, and accretion southeast and east of Surfside. WHG determined the average accretion or erosion rate for the period from 1955 to 2002 along transects running perpendicular to the shoreline. In general, the erosion rates southwest and west of Surfside range from zero to 0.4 ft/year, the rates immediately south of Surfside show little variance around zero, and the rate of change southeast and east of Surfside range from less than 1 ft/yr to 5 ft/yr.

An investigation by Woodard & Curran, using data from the Massachusetts Ocean Resource Information System (MORIS) database, yielded similar trends as shown on Figure 16 below. Erosion and accretion rates from 1955 to 2009 were calculated along MORIS shoreline transects in the vicinity of Surfside. In general, the western half of Surfside experienced weak erosion during the study period (less than 1 ft/yr), and the shoreline in the eastern half of Surfside experienced strong accretion (0.7 to 3.6 ft/yr).

Figure 16 represents the general shore line progression near the Surfside Beds from 1955 until 2009. In general, the shore line appears to be accreting along the area of the Beds. The shore line in place now includes the passage of Hurricane Sandy. Thus it seems that the natural shoreline processes are not eroding the area around the Surfside Beds.

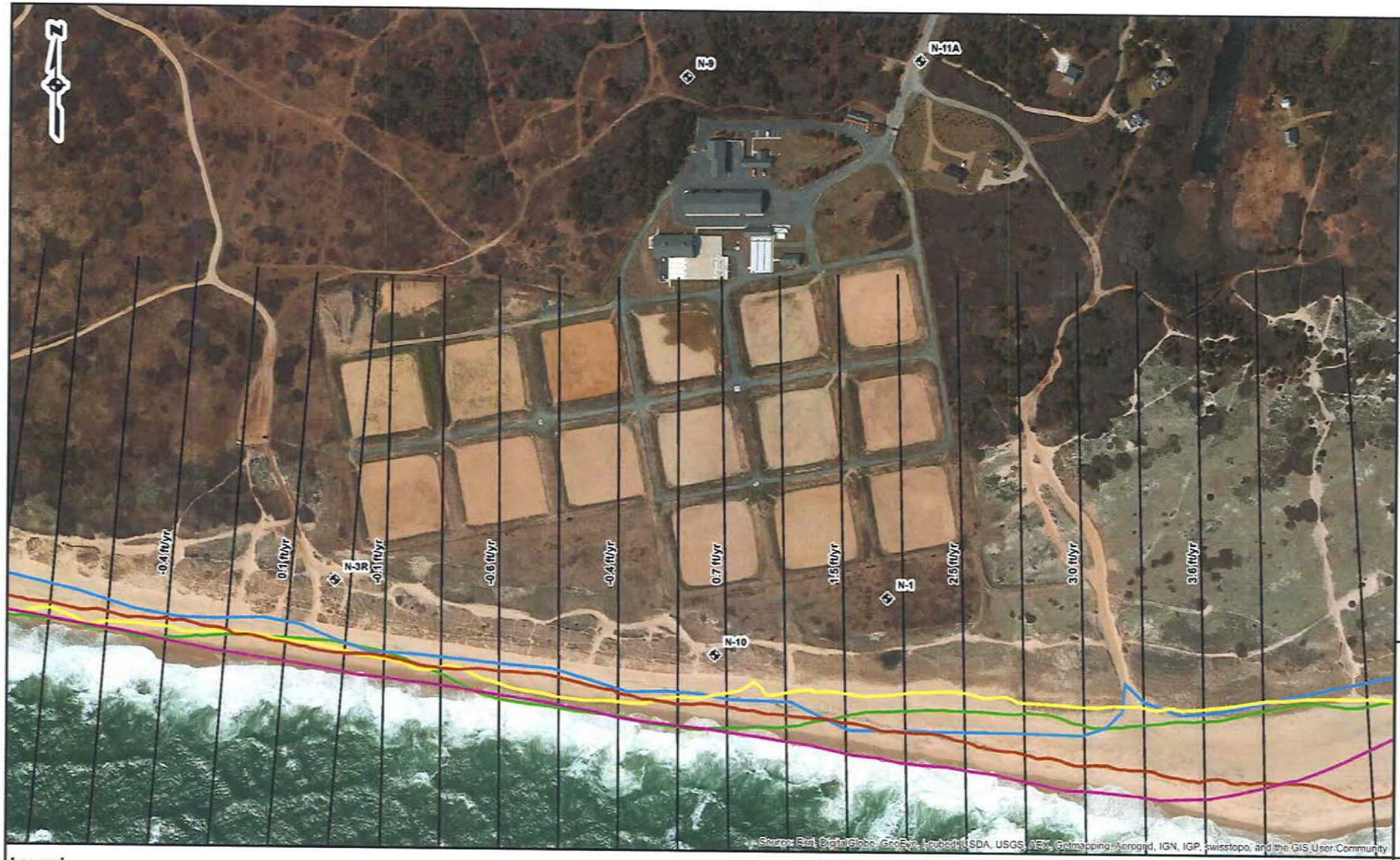
A second part of the question about shoreline stability dealt with the likelihood that the additional groundwater movement of groundwater from the Surfside Beds toward the ocean will make the dune banking in the area more susceptible to erosion under natural processes. To address this question Woodard& Curran compared the groundwater gradient in the area under the proposed increased discharge of wastewater to the typical required gradient in wastewater plumbing for domestic use. Domestic plumbing codes typically require a 1 inch drop in 8 feet of piping to move solids along an open pipe. This is a gradient of 0.125 inches per foot. The groundwater gradient after the proposed additional disposal at Surfside will be 0.016667 inches /inch, about 1/10 the gradient in domestic wastewater piping. Based on this comparison, the new groundwater gradient will not be steep enough to destabilize the slope at the ocean.

Additional datasets produced by the ACOE after Hurricane Sandy also support the shoreline stability in the Surfside WWTF area. Refer to Figure 17.

Additionally, the revised FEMA maps were reviewed to determine any changes as a result of the mapping updates and what, if any, issues this presents at this site. As discussed in previous sections of this TM, the Town's Emergency Management Director who is in charge of the flood zones stated that there were no changes to the site and that there are no potential impacts to the Surfside Site. CZM

also conferred with him and referred to the site as stable. Refer to Figure 18 for a copy of the FEMA map.

Results of the WHG, ACOE, FEMA and Woodard & Curran investigations suggest that the shoreline of Surfside is experiencing overall accretion from the mid-20th century to present. Weak erosion along the western region of the study area may continue, with an associated accretion of shoreline to the east with no impact to the WWTF.




**Legend**

**MORIS SHORELINE**

- 1955
- 1978
- 1994
- 2000
- 2009

MORIS SHORELINE TRANSECT AND 1955-2009 RATE OF CHANGE

SURFSIDE MONITORING WELL

MORIS = Massachusetts Ocean Resource Information System

0 125 250 500 Feet

WOODARD & CURRAN
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800.446.5518 | www.woodardcurran.com

# HISTORICAL SHORELINE 1955 - 2009

SURFSIDE TREATMENT PLANT
NANTUCKET, MASSACHUSETTS

PN: 223970

BY: BVA

DATE: OCTOBER 2013

Figure 16

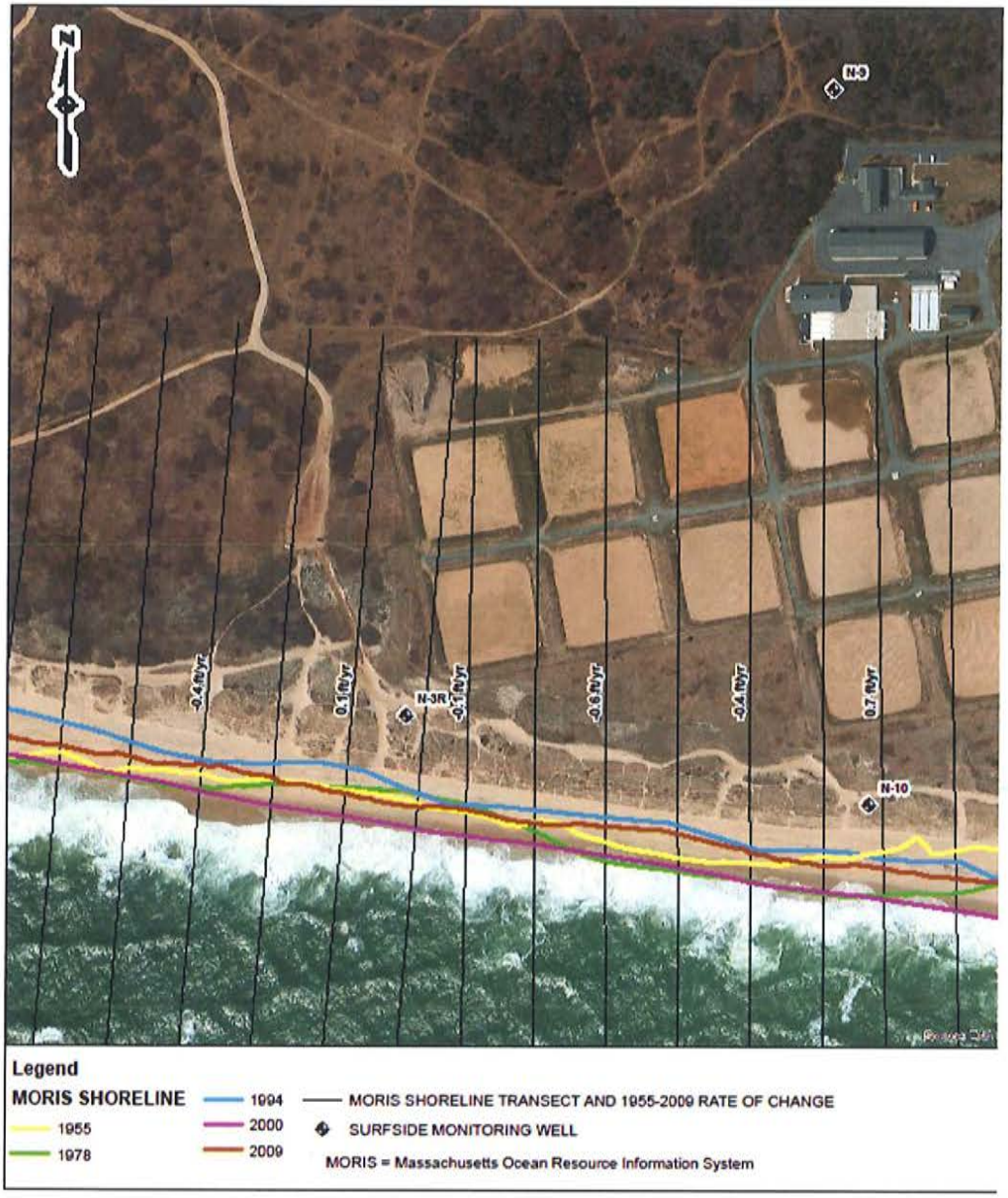
N-9
-0.4 ft/yr
0.1 ft/yr
N-3R
-0.1 ft/yr
-0.8 ft/yr
-0.4 ft/yr
0.7 ft/yr
N-10
Legend
MORIS SHORELINE
1955
1978
1994
2000
2009
MORIS SHORELINE TRANSECT AND 1955-2009 RATE OF CHANGE
SURFSIDE MONITORING WELL
MORIS = Massachusetts Ocean Resource Information System

Figure 17

26K
26L
26M
26N
27K
27L
27M
27N
28K
28L
28M
28N
29L
29M
MIACOMET RD
W MIACOMET RD
MIACOMET RD
POND VIEW DR
RACHEL DR
ZACHARY WY
TRIPP DR
S SHORE
CHERRY ST
FOLGER
FIELD A
S SHORE RD
FOLGER AV
FIELD AV
POCHICK AV
WEWEEDER AV
SURESIDE RD
NOBADEER AV
NONANTUM AV
MORGAN SQ
MORGAN SQ
MORGAN SQ
HILL SIDE AV
POLLOCK AV
STATION ST
AURIGA ST
CANONICUS ST
SURFSIDE RD
POPLAR ST
WESTERN AV
Legend
Flood Hazard (old)
Flood Zones (New)
FLD_ZONE
0.2 % Annual Flood Hazard
A
AE
VE
X

Figure 18

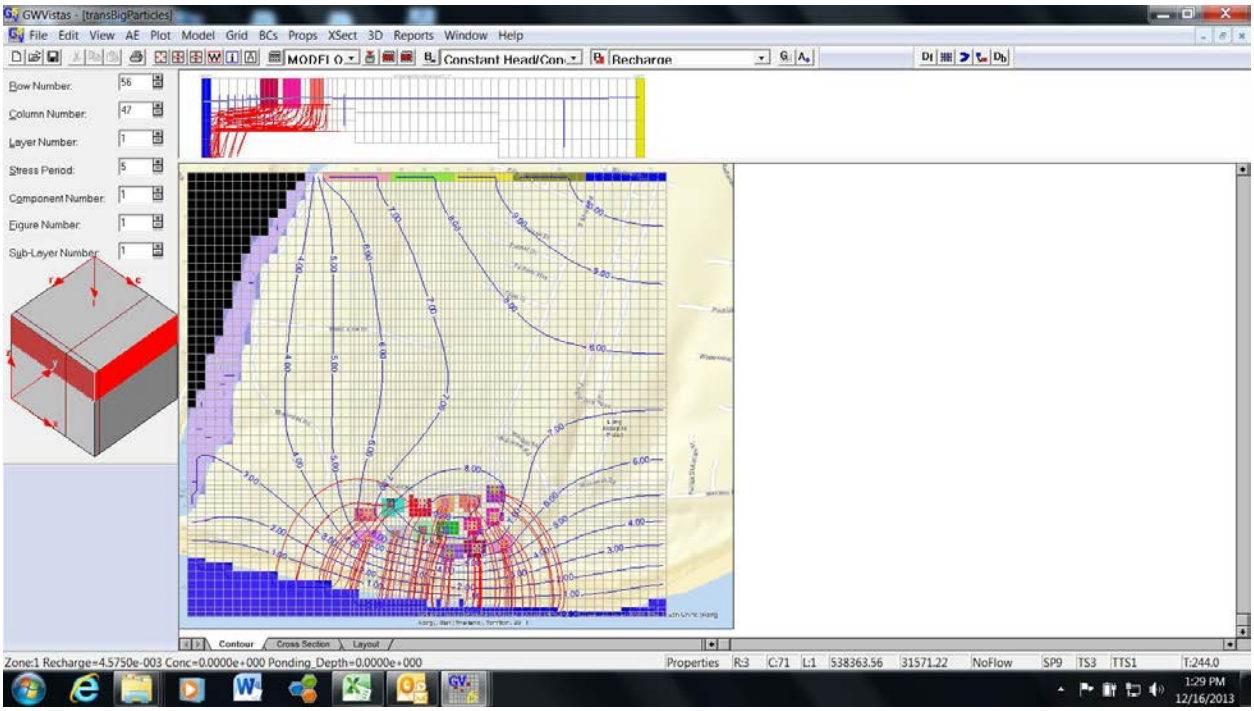


Figure 19

Aug Flow @ 4MGD

Particles added

( Note –all flow direct to Ocean)

## 3.0 CONCLUSIONS OF EVALUATION

The conclusions of the above tasks are as follows:

**Additional Bed Loading**

Additional loading to the existing beds at the Surfside WWTF, from 3.4 MGD to 4.0 MGD, based on summer loading at 4.0 MGD for the entire month of August only and at 2.92 MGD (summer average daily flow) for the remainder of the year is feasible under current conditions. The transient models detail the most dramatic mound during the month of August, which is expected given the maximum loading rate of 4.0 MGD for the entire month. While the modeling shows that additional loading raises the mounds in the upper beds, the overall system is able to handle the additional flow with vertical separation in the four foot range in bed #12, which previous records detail with the highest groundwater elevation. The remainder of the year under the transient models clearly shows considerably less mounding with vertical separations exceeding four feet. Additionally, the upgrades at the WWTF, most notably the upgrade to MBR technology, afford a highly treated effluent discharge that travels to the open Atlantic Ocean with no environmental impacts.

The full flow to 4.0 MGD will not be seen immediately, but, rather over a 20-year planning period. It is also in the Town's CWMP Update as an alternative, to maintain communication with MassDEP and various Cape and southeastern Massachusetts towns in the use of an ocean outfall. In a best case scenario at some point in the future, the treated effluent from Surfside could be discharged through an outfall to the Atlantic Ocean.

**Shoreline Stability**

This evaluation determined that the shoreline is stable and not subject to severe, impacts of erosion.

**Breakout Potential**

The evaluation determined that no breakout will occur as a result of additional loading to the existing beds.

**Particle Trace Analysis**

The model was re-run utilizing the August load period of 4.0 MGD in order to determine the direction of the flow. Figure 19 clearly details all flow towards the ocean. No flow is directed towards Miacomet Pond.

The Town of Nantucket looks forward to a positive review of this Technical Memorandum by MassDEP and an extension to its current Groundwater Discharge Permit No.SE#1-200 from 3.4 MGD to 4.0 MGD based on the conclusions stated above.

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Attachment A: Large Scale record Drawing of Site from Earth Tech Report
Attachment B: August 16, 2013 Scope of Work

# ATTACHMENT A
# Large Scale Record Drawing of Surfside Site – Earth Tech Report

N-9
N-11A
N-3R
N-1
N-10
MATERIALS LEGEND
BITUMINOUS CONCRETE PAVEMENT
BITUMINOUS CONCRETE THICKENED EDGE
GRAVEL ROADWAY
CRUSHED STONE MAINTENANCE STRIP
PRECAST CONCRETE CURB
PRECAST CONCRETE CURB CORNER
CONCRETE SIDEWALK
BRICK SIDEWALK
STEEL BOLLARD
PAVEMENT MARKINGS
HIGHWAY GUARDRAIL
SLUDGE PROCESSING BUILDING
EQUIPMENT STORAGE BUILDING
SOIL ANALYSIS BUILDING
ADVANCED TREATMENT BUILDING
PRIMARY TREATMENT BUILDING
PRIMARY CLARIFIER
PROPOSED INFILTRATION BED #15
PROPOSED INFILTRATION BED #14
PROPOSED INFILTRATION BED #13
PROPOSED INFILTRATION BED #10
EXISTING INFILTRATION BED #12
EXISTING INFILTRATION BED #11
EXISTING INFILTRATION BED #9
EXISTING INFILTRATION BED #8
EXISTING INFILTRATION BED #7
MATCH LINE
GRAPHIC SCALE
EarthTech
RECORD DRAWING
NANTUCKET, MASSACHUSETTS
UPGRADES TO THE SURFSIDE WASTEWATER TREATMENT FACILITY
PROPOSED SITE PLAN
EXISTING CONDITIONS AND DEMOLITION PLAN
LA-3
SHEET 6 OF 162

# ATTACHMENT B
## Scope of Work

**COMMITMENT & INTEGRITY**
**DRIVE RESULTS**

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August 16, 2013

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MassDEP Boston Office
One Winter Street
Boston, Massachusetts 02108

Mr. Steven Hallem
MassDEP Boston Office
One Winter Street
Boston, MA 02108

Mr. Brian Dudley
MassDEP Barnstable Office
3195 Main Street
Barnstable, MA 02630

**RE: PROPOSAL TO MassDEP - SCOPE OF WORK REGARDING ADDITIONAL LOADING OF TREATED WASTEWATER TO SURFSIDE WWTF DISPOSAL BEDS, NANTUCKET, MA**

Dear Gentlemen:

Please accept this letter as the Town's proposed Scope of Work to determine additional loading of treated wastewater to the Surfside WWTF discharge beds on Nantucket as requested at our meeting held on June 18, 2013 at MassDEP Boston. The meeting on June 18, 2013 at Mass DEP Boston office was attended by the three of you and me, Rosemary Blacquier, and Cary Parsons of Woodard & Curran. We discussed the proposal for Nantucket to increase its wastewater discharge to the Surfside WWTF disposal facility by approximately 400,000 gpd or loading at 6 gallons per day per square foot versus the current practice of loading at 5 gallons per day per square foot. The existing Groundwater Discharge Permit, No. 200-2, limits the facility to disposing of 3.5 mgd (Max Day) at the Surfside WWTF beds. Based on the results of the on-going Comprehensive Wastewater Management Plan (CWMP) Update, updated flows to the sewer service collection areas will require the treatment and disposal of 3.9 mgd. Despite the limitations on disposal of 3.5 mgd to the existing Surfside WWTF beds, the Surfside WWTF beds had previously been permitted by MassDEP (March 4, 1992) for disposal of 5.8 mgd. In 1992, the WWTF was primary treatment and included 10 discharge beds. At this time, the Town has upgraded its WWTF to MBR Technology and added five additional beds for discharge, with a WWTF design of 5.8mgd and a 3.5 mgd (Max Day) Groundwater Discharge Permit.

During our meeting in Boston, the various sources of this new wastewater demand were considered and geographical and financial advantages of using the Surfside WWTF for treating the additional flows and loads were discussed. The financial advantage is self-evident, in not having to permit, design and construct an additional WWTF at a new site. There are however, multiple reasons to utilize the existing infrastructure at Surfside at its highest and best use versus designing, permitting and constructing an additional WWTF on Island. Politically, the public has spoken loud and clear against a WWTF on the former FAA site as proposed in the 2004 CWMP. Environmentally, there are also strong issues that will make the Madaket site difficult and expensive to permit that evolved during intensive surveys through the Natural Heritage and Endangered Species Program (NHESP) and the Massachusetts Historical

Commission (MHC) Intensive Survey. The Town, in its effort to be proactive and address the issues detailed in the Massachusetts Estuaries Program (MEP) and subsequent Total Maximum Daily Loads (TMDLs) issued in the Madaket area, understands that an approach to a facility in Madaket will not be received positively by the residents and taxpayers, thus foiling a long and arduous journey with a federally-owned property.

Technically and financially, the feasibility of piping the wastewater from the Madaket area of the Island was discussed and all agreed that a re-evaluation of the permit limit for the Surfside WWTF groundwater disposal beds was in the Town's best interest at this point in time. The potential for resident and taxpayer approval of the Surfside option is far greater than a separate facility in Madaket as it already exists and functions well within the Community. Prior to our meeting, W&C had gathered some technical documents, which suggest that the Surfside disposal beds may be hydrogeologically able to accept more than the presently permitted 3.5 mgd (Max Day).

In addition to the possible hydrogeological ability of the Surfside beds to accept additional highly treated effluent (MBR Facility), Woodard &Curran brought up several policy aspects of adding more water to the disposal beds. The first aspect is the likelihood that given the area of the existing beds, the proposed additional loading would probably push the loading rate of the beds over the current limit of 5 gallons per square foot per day. During the meeting it was discussed that current operations at the beds could serve as a demonstration of the capability of the Surfside beds to infiltrate the additional loading and facilitate permitting a higher loading rate than the traditional limit. It was discussed that the methods currently used by staff at the facility to load the beds include loading one or two beds at a time, which accounts for a loading rate of approximately 30 to 40 gallons per day per square foot. The Town is prepared to show that this manner of operation is sound, technically feasible and meets the existing permit intent.

A second policy aspect of additional loading involves the traditional requirement that any permit should be based on the concept of estimating groundwater mounding from wastewater loading at the time of seasonal high groundwater. That mounding should maintain an unsaturated separation of 4 feet between the top of the mound and bottom of the disposal facility. The information available at the time of the meeting was not sufficient to know the actual elevation of groundwater below the beds at the seasonal high period, which typically occurs in the spring. However, there is some groundwater mounding analysis done with a computer groundwater model from earlier permitting rounds (1990s) that suggests that a loading of 3.4 mgd will maintain the traditional 4 foot separation in the seasonal high groundwater condition. Woodard & Curran will translate this to current conditions utilizing existing record information.

Woodard & Curran discussed one distinctive condition at the Surfside site with respect to seasonal high groundwater policy; namely that the spring seasonal high groundwater condition never coincides with the seasonal high wastewater flows. The highest wastewater flows and highest mounding condition occurs in August of each year due to the seasonality of the community and August being the most populous month. MassDEP personnel acknowledged this offset of the two traditionally limiting conditions. It was also discussed that based on historical water level records at the site, the existing data can potentially determine if future reloading of the beds at the previously-mentioned rate would require a permit with different limits based on time of year.

Woodard & Curran is prepared to review and summarize the Town's historical records in order to make a determination here. As mentioned above, at the time of the MassDEP meeting, we had limited information on the hydrogeological conditions at the Surfside beds location. However, it was known from various reference lists that several significant reports and sets of site data existed at one time, as well as recent water groundwater level readings since the most recent permitting in 2006. Woodard & Curran was able to obtain and review much of this historical data as referenced below. Based on

review of such, it is our preliminary conclusion that the potential to load the Surfside beds at an additional square foot per day (from 5 to 6) is plausible based on the current loading methodology.

This, in addition to, previous permits on this site dating back to the early 1990s, supports the additional load. With the MassDEP response to the policy issues as discussed, it seems plausible for Woodard & Curran to pursue the analysis of conditions at the Surfside beds location if the suggested discharge to the existing beds were increased. Our goal is to receive approval from MassDEP to allow the additional wastewater flows permitted at a minimal cost and time to our client based on historical data and current conditions. To that end, Woodard & Curran has been able to acquire additional existing, historical information. The references available to date for review include:

- Groundwater Discharge Permit Application BRP WP 11
  Town of Nantucket, Department of Public Works - 188 Madaket Road - Nantucket, MA
  Prepared by Earth Tech 196 Baker Ave Concord, MA June 28, 2005
- Goldberg, Zoino, Dunnicliff & Associates, Inc. Nantucket EIS Geohydrologic Report. Newton Upper Falls, MA. May9, 1980
- Pleistocene Hydrology of Nantucket Island, Massachusetts
  Person, Mark, et al. Presented April 2001 First International Conference on Saltwater Intrusion and Coastal Aquifers – Essaouira, Morocco
- Approval of Groundwater Discharge Permit No. I-200 Surfside, Nantucket, MA Feb 25, 1992
  To Department of Public Works, Nantucket, MA
  Signed – Brian Donahoe, Division of Water Pollution Control
- Woods Hole Group - July 2002 – Historical Change Analysis for the Surfside, Nantucket Coastline
- Final Permit – Groundwater Discharge Permit No. 200-2 June 15, 2006 – approval signed by David R. Burns, Bureau of Resource Protection
- Final Environmental Impact Statement – Wastewater Treatment Facilities Nantucket, Nantucket County Mass. August 1981
- Additional records of groundwater levels from at least the last three years are being collected at this time and will be available for analysis when W&C does the groundwater mounding analysis. It is likely that more groundwater level data in addition to the last three years will also become available.

**Proposed Scope of Work – Analysis for Additional Bed Loading**

Given the conditions and regulatory discussions mentioned above, Woodard & Curran proposes the following tasks to confirm that the Surfside WWTF disposal beds can properly accept the proposed additional loading of one gallon per day per square foot, from 5 gallons per day per square foot to 6 gallons per day per square foot. To support this, Woodard & Curran proposes to complete the following tasks:

**Task 1:** Using available recorded water level data (or estimates based on the Frimpter Method); develop a suitable typical water table elevation map for the month with highest recorded wastewater flows historically (August).

**Task 2:** With reference to the Earth Tech record drawings for bed sizes, and field observations, Woodard &Curran will calculate the actual loading of the beds (gallons per square foot per day) in present day operation during the rotation sequence when only one or two beds are used per day to accept all of the flow as is currently done.

**Task 3:** Collect any additional water level readings or anecdotal information to document that the existing beds are able to accept greater than 5 gpd/ ft sq. This Task may also include a mounding analysis to estimate mound and clearance of four feet to groundwater in August (Nantucket high flow time period) conditions.

**Task 4:** .Utilizing existing Massachusetts Shoreline Data, show that the coastal area of the beds is stable and actually experiencing accretion in order to defray any existing erosion concerns.

**Task 5:** Utilizing existing information, prepare calculations to demonstrate that an increased loading to the existing beds does not impact the stability of the beach or present any velocity or gradient issues.

Once MassDEP approves of the above-detailed scope, Woodard & Curran will prepare a Letter Report, with all appropriate back-up data, to support the additional loading of the Surfside beds from five (5) gallons per day per square foot to six (6) gallons per day per square foot. The current Surfside Groundwater Discharge permit renewal was extended by Chapter 238 of the Acts of 2012 to 6/15/2015. The timing of the renewal is optimal as the CWMP Update is due to be finalized in December 2013 with a Final Recommended Plan that includes an increase of wastewater collection, treatment and discharge over a 20-year planning period, of 400,000 GPD. This timing will give the Town the necessary back-up for the Groundwater Discharge Permit Renewal application.

We look forward to your positive response to our proposed scope of work. Once approved, Woodard & Curran will initiate the required work in order to complete this task by mid-September 2013.

Sincerely,

WOODARD & CURRAN INC.

Thomas F. Hazlett, P.E.
Project Manager

TFH/rtb
Project #223970
cc: C. Elizabeth Gibson, Nantucket Town Manager
Kara Buzanoski, Nantucket DPW Director
Kevin Manning, Nantucket DPW
Helen T. Gordon, Woodard & Curran
Cary Parsons, Woodard & Curran
Jon Himlan, Woodard & Curran
Rosemary Blacquier, Woodard & Curran

WOODARD
&CURRAN

woodardcurran.com
COMMITMENT & INTEGRITY DRIVE RESULTS

# APPENDIX I: CAPITAL IMPROVEMENTS PLAN

# FINANCING AND COST SCENARIOS

**TOWN OF NANTUCKET**
**DEPARTMENT OF PUBLIC WORKS**
**CAPITAL IMPROVEMENT PROGRAM FY 2016-2036**
**FOR CWMP AND EVALUATION AND MAPPING RECOMMENDATIONS**

| | | | | Estimated Project Cost | SRF 0% Loan Duration 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Comprehensive Wastewater Management Plan | Board of Health On-Site Solution | Septage Management Plan Includes System Pumping | Surfside<br>Tom Nevers High Density<br>Tom Nevers Low Density<br>Town-WPZ<br>Pocomo<br>Polpis<br>Quidnet<br>Wauwinet<br>Remainder of Island | $ 3,578,000 | $ 125,000 | $ 129,000 | $ 133,000 | $ 137,000 | $ 141,000 | $ 145,000 | $ 149,000 | $ 153,000 | $ 158,000 | $ 163,000 | $ 168,000 | $ 173,000 | $ 178,000 | $ 183,000 | $ 188,000 | $ 194,000 | $ 200,000 | $ 206,000 | $ 212,000 | $ 218,000 | $ 225,000 |
| | Natural Resources Department Annual Water Quality Program | Townwide Sampling Program | | $ 807,600 | $ 35,000 | $ 35,000 | $ 35,000 | $ 36,100 | $ 36,100 | $ 36,100 | $ 37,200 | $ 37,200 | $ 37,200 | $ 38,400 | $ 38,400 | $ 38,400 | $ 39,600 | $ 39,600 | $ 39,600 | $ 40,800 | $ 40,800 | $ 40,800 | $ 42,100 | $ 42,100 | $ 42,100 |
| | Department of Public Works Off-Site Solution | Infrastructure Expansion | Somerset | $ 14,760,000 | $ 1,476,000 | $ 13,284,000 | | | | | | | | | | | | | | | | | | | |
| | | | Design | $ 1,476,000 | | | | | | | | | | | | | | | | | | | | | |
| | | | Construction | $ 13,284,000 | | | | | | | | | | | | | | | | | | | | | |
| | | | Madaket/Warrens Landing | $ 47,186,000 | | $ 4,718,600 | $ 42,467,400 | | | | | | | | | | | | | | | | | | |
| | | | Design | $ 4,718,600 | | | | | | | | | | | | | | | | | | | | | |
| | | | Construction | $ 42,467,400 | | | | | | | | | | | | | | | | | | | | | |
| | | | Monomoy/Unconnected TSD Parcels* | $ 23,426,000 | | | $ 2,342,600 | $ 21,083,400 | | | | | | | | | | | | | | | | | |
| | | | Design* | $ 2,342,600 | | | | | | | | | | | | | | | | | | | | | |
| | | | Construction* | $ 21,083,400 | | | | | | | | | | | | | | | | | | | | | |
| | | | Hummock Pond North | $ 34,226,000 | | | | | | | | | | $ 3,422,600 | $ 30,803,400 | | | | | | | | | | |
| | | | Design | $ 3,422,600 | | | | | | | | | | | | | | | | | | | | | |
| | | | Construction | $ 30,803,400 | | | | | | | | | | | | | | | | | | | | | |
| | | | Hummock Pond South | $ 24,866,000 | | | | | | | $ 2,486,600 | $ 22,379,400 | | | | | | | | | | | | | |
| | | | Design | $ 2,486,600 | | | | | | | | | | | | | | | | | | | | | |
| | | | Construction | $ 22,379,400 | | | | | | | | | | | | | | | | | | | | | |
| | | | Shimmo | $ 23,472,000 | | | | | $ 2,347,200 | $ 21,124,800 | | | | | | | | | | | | | | | |
| | | | Design | $ 2,347,200 | | | | | | | | | | | | | | | | | | | | | |
| | | | Construction | $ 21,124,800 | | | | | | | | | | | | | | | | | | | | | |
| | | | Macomet | $ 20,762,000 | | | | | | | | | | | | | $ 2,076,200 | $ 18,685,800 | | | | | | | |
| | | | Design | $ 2,076,200 | | | | | | | | | | | | | | | | | | | | | |
| | | | Construction | $ 18,685,800 | | | | | | | | | | | | | | | | | | | | | |
| | | | Nantucket PLUS Parcels | $ 10,116,000 | | | | | | | | | | | | | | | | | | | | | |
| | | | Pump Station Assessment, Improvements, End of Life Replacement | $ 11,412,500 | $ 62,500 | | | $ 2,100,000 | | | | $ 2,500,000 | $ 1,250,000 | | | | | | $ 1,250,000 | $ 1,250,000 | | $ 1,250,000 | $ 1,750,000 | | |
| | | | Infrastructure Improvements - Downstream Improvements | $ 16,990,000.00 | | $ 8,076,000 | $ 3,514,000 | $ 5,400,000 | | | | | | | | | | | | | | | | | |
| | | | Surfside WWTF Improvements-Future Capacity | $ 1,204,000.00 | $ 1,204,000 | | | | | | | | | | | | | | | | | | | | |
| | | | Surfside WWTF Improvements - Energy Efficiency | $ 154,000.00 | $ 154,000 | | | | | | | | | | | | | | | | | | | | |
| | Department of Public Works CWMP Implementation | Adaptive Management Plan - TMDL's, Oversight and Management | | $ 525,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 | $ 25,000 |
| | | | | $ 229,099,500 | $ 3,081,500 | $ 26,267,600 | $ 48,517,000 | $ 28,781,500 | $ 2,549,300 | $ 21,330,900 | $ 2,697,800 | $ 25,094,600 | $ 1,470,200 | $ 3,649,000 | $ 31,034,800 | $ 236,400 | $ 2,318,800 | $ 18,933,400 | $ 1,502,600 | $ 1,509,800 | $ 265,800 | $ 1,521,800 | $ 2,029,100 | $ 285,100 | $ 292,100 |

| Total 20-Year Capital Improvements Plan By Department | Total |
|---|---|
| Department of Public Works | $ 229,099,500 |
| Board Of Health | $ 3,578,000 |
| Natural Resources Department | $ 807,600 |
| | $ 233,485,100 |

# Draft Schedule C

Prepared by MCWT Sep, 4 2014 - 11:06 AM

**Massachusetts Clean Water Trust**
**Hypothetical Preliminary Structuring Analysis**
**Town of Nantucket**
**Loan: CW-14-X4**

| | | | |
|---|---|---|---|
| Initial Loan Amount | 8,827,000.00 | Loan Origination Fee ($5.5/1000) | 48,548.50 |
| Principal Forgiveness | | Loan Term (in years) | 20 |
| Net Loan Obligation | 8,827,000.00 | Loan Rate | 0.00% |
| | | Closing Date | 9/1/2015 |
| | | First Interest | 1/15/2016 |
| | | First Principal | 7/15/2016 |

| Date | Principal | Interest | Total Debt Service | Admin Fee (0.15%) | Loan Origination Fee | Commonwealth Assistance Principal Forgiveness | Total Debt Service | Annual Debt Service |
|---|---|---|---|---|---|---|---|---|
| 9/1/2015 | | | | | | | | |
| 1/15/2016 | | | | 6,620.25 | 48,548.50 | | 55,168.75 | 55,168.75 |
| 7/15/2016 | 435,089.00 | | 435,089.00 | 6,620.25 | | | 441,709.25 | |
| 1/15/2017 | | | | 6,293.93 | | | 6,293.93 | 448,003.18 |
| 7/15/2017 | 435,742.00 | | 435,742.00 | 6,293.93 | | | 442,035.93 | |
| 1/15/2018 | | | | 5,967.13 | | | 5,967.13 | 448,003.06 |
| 7/15/2018 | 436,396.00 | | 436,396.00 | 5,967.13 | | | 442,363.13 | |
| 1/15/2019 | | | | 5,639.83 | | | 5,639.83 | 448,002.96 |
| 7/15/2019 | 437,051.00 | | 437,051.00 | 5,639.83 | | | 442,690.83 | |
| 1/15/2020 | | | | 5,312.04 | | | 5,312.04 | 448,002.87 |
| 7/15/2020 | 437,707.00 | | 437,707.00 | 5,312.04 | | | 443,019.04 | |
| 1/15/2021 | | | | 4,983.76 | | | 4,983.76 | 448,002.80 |
| 7/15/2021 | 438,364.00 | | 438,364.00 | 4,983.76 | | | 443,347.76 | |
| 1/15/2022 | | | | 4,654.99 | | | 4,654.99 | 448,002.75 |
| 7/15/2022 | 439,023.00 | | 439,023.00 | 4,654.99 | | | 443,677.99 | |
| 1/15/2023 | | | | 4,325.72 | | | 4,325.72 | 448,003.71 |
| 7/15/2023 | 439,682.00 | | 439,682.00 | 4,325.72 | | | 444,007.72 | |
| 1/15/2024 | | | | 3,995.96 | | | 3,995.96 | 448,003.68 |
| 7/15/2024 | 440,342.00 | | 440,342.00 | 3,995.96 | | | 444,337.96 | |
| 1/15/2025 | | | | 3,665.70 | | | 3,665.70 | 448,003.66 |
| 7/15/2025 | 441,003.00 | | 441,003.00 | 3,665.70 | | | 444,668.70 | |
| 1/15/2026 | | | | 3,334.95 | | | 3,334.95 | 448,003.65 |
| 7/15/2026 | 441,665.00 | | 441,665.00 | 3,334.95 | | | 444,999.95 | |
| 1/15/2027 | | | | 3,003.70 | | | 3,003.70 | 448,003.65 |
| 7/15/2027 | 442,328.00 | | 442,328.00 | 3,003.70 | | | 445,331.70 | |
| 1/15/2028 | | | | 2,671.96 | | | 2,671.96 | 448,003.66 |
| 7/15/2028 | 442,992.00 | | 442,992.00 | 2,671.96 | | | 445,663.96 | |
| 1/15/2029 | | | | 2,339.71 | | | 2,339.71 | 448,003.67 |
| 7/15/2029 | 443,657.00 | | 443,657.00 | 2,339.71 | | | 445,996.71 | |
| 1/15/2030 | | | | 2,006.97 | | | 2,006.97 | 448,003.68 |
| 7/15/2030 | 444,323.00 | | 444,323.00 | 2,006.97 | | | 446,329.97 | |
| 1/15/2031 | | | | 1,673.73 | | | 1,673.73 | 448,003.70 |
| 7/15/2031 | 444,990.00 | | 444,990.00 | 1,673.73 | | | 446,663.73 | |
| 1/15/2032 | | | | 1,339.98 | | | 1,339.98 | 448,003.71 |
| 7/15/2032 | 445,657.00 | | 445,657.00 | 1,339.98 | | | 446,996.98 | |
| 1/15/2033 | | | | 1,005.74 | | | 1,005.74 | 448,002.73 |
| 7/15/2033 | 446,326.00 | | 446,326.00 | 1,005.74 | | | 447,331.74 | |
| 1/15/2034 | | | | 671.00 | | | 671.00 | 448,002.74 |
| 7/15/2034 | 446,996.00 | | 446,996.00 | 671.00 | | | 447,667.00 | |
| 1/15/2035 | | | | 335.75 | | | 335.75 | 448,002.75 |
| 7/15/2035 | 447,667.00 | | 447,667.00 | 335.75 | | | 448,002.75 | |
| 1/15/2036 | | | | | | | | 448,002.75 |
| | 8,827,000.00 | | 8,827,000.00 | 139,685.61 | 48,548.50 | | 9,015,234.11 | 9,015,234.11 |

Notes:

*This project may qualify for principal forgiveness in accordance with Schedule B to the Financing Agreement. Principal forgiveness shown on this schedule is an estimate, and is not a guarantee.

# Draft Schedule C

Prepared by MCWT | Sep, 4 2014 - 11:05 AM

**Massachusetts Clean Water Trust**
**Hypothetical Preliminary Structuring Analysis**
**Town of Nantucket**
**Loan: CW-14-X3**

| | | | |
|---|---|---|---|
| Initial Loan Amount | 8,827,000.00 | Loan Origination Fee ($5.5/1000) | 48,548.50 |
| Principal Forgiveness | | Loan Term (in years) | 20 |
| Net Loan Obligation | 8,827,000.00 | Loan Rate | 2.00% |
| | | Closing Date | 9/1/2015 |
| | | First Interest | 1/15/2016 |
| | | First Principal | 7/15/2016 |

| Date | Principal | Interest | Total Debt Service | Admin Fee (0.15%) | Loan Origination Fee | Commonwealth Assistance Principal Forgiveness | Total Debt Service | Annual Debt Service |
|---|---|---|---|---|---|---|---|---|
| 9/1/2015 | | | | | | | | |
| 1/15/2016 | | 65,712.11 | 65,712.11 | 6,620.25 | 48,548.50 | | 120,880.86 | 120,880.86 |
| 7/15/2016 | 357,061.00 | 88,270.00 | 445,331.00 | 6,620.25 | | | 451,951.25 | |
| 1/15/2017 | | 84,699.39 | 84,699.39 | 6,352.45 | | | 91,051.84 | 543,003.09 |
| 7/15/2017 | 364,821.00 | 84,699.39 | 449,520.39 | 6,352.45 | | | 455,872.84 | |
| 1/15/2018 | | 81,051.18 | 81,051.18 | 6,078.84 | | | 87,130.02 | 543,002.86 |
| 7/15/2018 | 372,750.00 | 81,051.18 | 453,801.18 | 6,078.84 | | | 459,880.02 | |
| 1/15/2019 | | 77,323.68 | 77,323.68 | 5,799.28 | | | 83,122.96 | 543,002.97 |
| 7/15/2019 | 380,851.00 | 77,323.68 | 458,174.68 | 5,799.28 | | | 463,973.96 | |
| 1/15/2020 | | 73,515.17 | 73,515.17 | 5,513.64 | | | 79,028.81 | 543,002.76 |
| 7/15/2020 | 389,129.00 | 73,515.17 | 462,644.17 | 5,513.64 | | | 468,157.81 | |
| 1/15/2021 | | 69,623.88 | 69,623.88 | 5,221.79 | | | 74,845.67 | 543,003.48 |
| 7/15/2021 | 397,586.00 | 69,623.88 | 467,209.88 | 5,221.79 | | | 472,431.67 | |
| 1/15/2022 | | 65,648.02 | 65,648.02 | 4,923.60 | | | 70,571.62 | 543,003.29 |
| 7/15/2022 | 406,227.00 | 65,648.02 | 471,875.02 | 4,923.60 | | | 476,798.62 | |
| 1/15/2023 | | 61,585.75 | 61,585.75 | 4,618.93 | | | 66,204.68 | 543,003.30 |
| 7/15/2023 | 415,056.00 | 61,585.75 | 476,641.75 | 4,618.93 | | | 481,260.68 | |
| 1/15/2024 | | 57,435.19 | 57,435.19 | 4,307.64 | | | 61,742.83 | 543,003.51 |
| 7/15/2024 | 424,076.00 | 57,435.19 | 481,511.19 | 4,307.64 | | | 485,818.83 | |
| 1/15/2025 | | 53,194.43 | 53,194.43 | 3,989.58 | | | 57,184.01 | 543,002.84 |
| 7/15/2025 | 433,293.00 | 53,194.43 | 486,487.43 | 3,989.58 | | | 490,477.01 | |
| 1/15/2026 | | 48,861.50 | 48,861.50 | 3,664.61 | | | 52,526.11 | 543,003.12 |
| 7/15/2026 | 442,710.00 | 48,861.50 | 491,571.50 | 3,664.61 | | | 495,236.11 | |
| 1/15/2027 | | 44,434.40 | 44,434.40 | 3,332.58 | | | 47,766.98 | 543,003.09 |
| 7/15/2027 | 452,332.00 | 44,434.40 | 496,766.40 | 3,332.58 | | | 500,098.98 | |
| 1/15/2028 | | 39,911.08 | 39,911.08 | 2,993.33 | | | 42,904.41 | 543,003.39 |
| 7/15/2028 | 462,162.00 | 39,911.08 | 502,073.08 | 2,993.33 | | | 505,066.41 | |
| 1/15/2029 | | 35,289.46 | 35,289.46 | 2,646.71 | | | 37,936.17 | 543,002.58 |
| 7/15/2029 | 472,207.00 | 35,289.46 | 507,496.46 | 2,646.71 | | | 510,143.17 | |
| 1/15/2030 | | 30,567.39 | 30,567.39 | 2,292.55 | | | 32,859.94 | 543,003.11 |
| 7/15/2030 | 482,470.00 | 30,567.39 | 513,037.39 | 2,292.55 | | | 515,329.94 | |
| 1/15/2031 | | 25,742.69 | 25,742.69 | 1,930.70 | | | 27,673.39 | 543,003.34 |
| 7/15/2031 | 492,956.00 | 25,742.69 | 518,698.69 | 1,930.70 | | | 520,629.39 | |
| 1/15/2032 | | 20,813.13 | 20,813.13 | 1,560.98 | | | 22,374.11 | 543,003.51 |
| 7/15/2032 | 503,669.00 | 20,813.13 | 524,482.13 | 1,560.98 | | | 526,043.11 | |
| 1/15/2033 | | 15,776.44 | 15,776.44 | 1,183.23 | | | 16,959.67 | 543,002.79 |
| 7/15/2033 | 514,616.00 | 15,776.44 | 530,392.44 | 1,183.23 | | | 531,575.67 | |
| 1/15/2034 | | 10,630.28 | 10,630.28 | 797.27 | | | 11,427.55 | 543,003.22 |
| 7/15/2034 | 525,800.00 | 10,630.28 | 536,430.28 | 797.27 | | | 537,227.55 | |
| 1/15/2035 | | 5,372.28 | 5,372.28 | 402.92 | | | 5,775.20 | 543,002.75 |
| 7/15/2035 | 537,228.00 | 5,372.28 | 542,600.28 | 402.92 | | | 543,003.20 | |
| 1/15/2036 | | | | | | | | 543,003.20 |
| | 8,827,000.00 | 1,956,932.79 | 10,783,932.79 | 148,461.80 | 48,548.50 | | 10,980,943.09 | 10,980,943.09 |

Notes:

*This project may qualify for principal forgiveness in accordance with Schedule B to the Financing Agreement. Principal forgiveness shown on this schedule is an estimate, and is not a guarantee.

# Draft Schedule C

Prepared by MCWT | Oct, 24 2014 - 2:29 PM

**Massachusetts Clean Water Trust**
**Hypothetical Preliminary Structuring Analysis**
**Town of Nantucket**
**Loan: CW-15-X2**

| | | | |
|---|---|---|---|
| Initial Loan Amount | 42,467,400.00 | Loan Origination Fee ($5.5/1000) | 233,570.70 |
| Principal Forgiveness | | Loan Term (in years) | 20 |
| Net Loan Obligation | 42,467,400.00 | Loan Rate | 0.00% |
| | | Closing Date | 12/1/2016 |
| | | First Interest | 7/15/2017 |
| | | First Principal | 1/15/2018 |

| Date | Principal | Interest | Total Debt Service | Admin Fee (0.15%) | Loan Origination Fee | Commonwealth Assistance Principal Forgiveness | Total Debt Service | Annual Debt Service |
|---|---|---|---|---|---|---|---|---|
| 12/1/2016 | | | | | | | | |
| 7/15/2017 | | | | 31,850.55 | 233,570.70 | | 265,421.25 | |
| 1/15/2018 | 2,093,248.00 | | 2,093,248.00 | 31,850.55 | | | 2,125,098.55 | 2,390,519.80 |
| 7/15/2018 | | | | 30,280.61 | | | 30,280.61 | |
| 1/15/2019 | 2,096,390.00 | | 2,096,390.00 | 30,280.61 | | | 2,126,670.61 | 2,156,951.23 |
| 7/15/2019 | | | | 28,708.32 | | | 28,708.32 | |
| 1/15/2020 | 2,099,537.00 | | 2,099,537.00 | 28,708.32 | | | 2,128,245.32 | 2,156,953.64 |
| 7/15/2020 | | | | 27,133.67 | | | 27,133.67 | |
| 1/15/2021 | 2,102,689.00 | | 2,102,689.00 | 27,133.67 | | | 2,129,822.67 | 2,156,956.34 |
| 7/15/2021 | | | | 25,556.65 | | | 25,556.65 | |
| 1/15/2022 | 2,105,846.00 | | 2,105,846.00 | 25,556.65 | | | 2,131,402.65 | 2,156,959.30 |
| 7/15/2022 | | | | 23,977.27 | | | 23,977.27 | |
| 1/15/2023 | 2,109,007.00 | | 2,109,007.00 | 23,977.27 | | | 2,132,984.27 | 2,156,961.54 |
| 7/15/2023 | | | | 22,395.51 | | | 22,395.51 | |
| 1/15/2024 | 2,112,173.00 | | 2,112,173.00 | 22,395.51 | | | 2,134,568.51 | 2,156,964.02 |
| 7/15/2024 | | | | 20,811.38 | | | 20,811.38 | |
| 1/15/2025 | 2,115,343.00 | | 2,115,343.00 | 20,811.38 | | | 2,136,154.38 | 2,156,965.77 |
| 7/15/2025 | | | | 19,224.88 | | | 19,224.88 | |
| 1/15/2026 | 2,118,519.00 | | 2,118,519.00 | 19,224.88 | | | 2,137,743.88 | 2,156,968.75 |
| 7/15/2026 | | | | 17,635.99 | | | 17,635.99 | |
| 1/15/2027 | 2,121,699.00 | | 2,121,699.00 | 17,635.99 | | | 2,139,334.99 | 2,156,970.97 |
| 7/15/2027 | | | | 16,044.71 | | | 16,044.71 | |
| 1/15/2028 | 2,124,884.00 | | 2,124,884.00 | 16,044.71 | | | 2,140,928.71 | 2,156,973.42 |
| 7/15/2028 | | | | 14,451.05 | | | 14,451.05 | |
| 1/15/2029 | 2,128,073.00 | | 2,128,073.00 | 14,451.05 | | | 2,142,524.05 | 2,156,975.10 |
| 7/15/2029 | | | | 12,854.99 | | | 12,854.99 | |
| 1/15/2030 | 2,131,268.00 | | 2,131,268.00 | 12,854.99 | | | 2,144,122.99 | 2,156,977.99 |
| 7/15/2030 | | | | 11,256.54 | | | 11,256.54 | |
| 1/15/2031 | 2,134,467.00 | | 2,134,467.00 | 11,256.54 | | | 2,145,723.54 | 2,156,980.09 |
| 7/15/2031 | | | | 9,655.69 | | | 9,655.69 | |
| 1/15/2032 | 2,137,671.00 | | 2,137,671.00 | 9,655.69 | | | 2,147,326.69 | 2,156,982.39 |
| 7/15/2032 | | | | 8,052.44 | | | 8,052.44 | |
| 1/15/2033 | 2,140,880.00 | | 2,140,880.00 | 8,052.44 | | | 2,148,932.44 | 2,156,984.88 |
| 7/15/2033 | | | | 6,446.78 | | | 6,446.78 | |
| 1/15/2034 | 2,144,094.00 | | 2,144,094.00 | 6,446.78 | | | 2,150,540.78 | 2,156,987.56 |
| 7/15/2034 | | | | 4,838.71 | | | 4,838.71 | |
| 1/15/2035 | 2,147,312.00 | | 2,147,312.00 | 4,838.71 | | | 2,152,150.71 | 2,156,989.42 |
| 7/15/2035 | | | | 3,228.23 | | | 3,228.23 | |
| 1/15/2036 | 2,150,536.00 | | 2,150,536.00 | 3,228.23 | | | 2,153,764.23 | 2,156,992.45 |
| 7/15/2036 | | | | 1,615.32 | | | 1,615.32 | |
| 1/15/2037 | 2,153,764.00 | | 2,153,764.00 | 1,615.32 | | | 2,155,379.32 | 2,156,994.65 |
| 7/15/2037 | | | | | | | | |
| | 42,467,400.00 | | 42,467,400.00 | 672,038.59 | 233,570.70 | | 43,373,009.29 | 43,373,009.29 |

Notes:

*This project may qualify for principal forgiveness in accordance with Schedule B to the Financing Agreement. Principal forgiveness shown on this schedule is an estimate, and is not a guarantee.

# Draft Schedule C

Prepared by MCWT | Oct, 24 2014 - 2:26 PM

**Massachusetts Clean Water Trust**
**Hypothetical Preliminary Structuring Analysis**
**Town of Nantucket**
**Loan: CW-15-X1**

| | | | |
|---|---|---|---|
| Initial Loan Amount | 42,467,400.00 | Loan Origination Fee ($5.5/1000) | 233,570.70 |
| Principal Forgiveness | | Loan Term (in years) | 20 |
| Net Loan Obligation | 42,467,400.00 | Loan Rate | 2.00% |
| | | Closing Date | 12/1/2016 |
| | | First Interest | 7/15/2017 |
| | | First Principal | 1/15/2018 |

| Date | Principal | Interest | Total Debt Service | Admin Fee (0.15%) | Loan Origination Fee | Commonwealth Assistance Principal Forgiveness | Total Debt Service | Annual Debt Service |
|---|---|---|---|---|---|---|---|---|
| 12/1/2016 | | | | | | | | |
| 7/15/2017 | | 528,483.20 | 528,483.20 | 31,850.55 | 233,570.70 | | 793,904.45 | |
| 1/15/2018 | 1,717,849.00 | 424,674.00 | 2,142,523.00 | 31,850.55 | | | 2,174,373.55 | 2,968,278.00 |
| 7/15/2018 | | 407,495.51 | 407,495.51 | 30,562.16 | | | 438,057.67 | |
| 1/15/2019 | 1,755,184.00 | 407,495.51 | 2,162,679.51 | 30,562.16 | | | 2,193,241.67 | 2,631,299.35 |
| 7/15/2019 | | 389,943.67 | 389,943.67 | 29,245.78 | | | 419,189.45 | |
| 1/15/2020 | 1,793,331.00 | 389,943.67 | 2,183,274.67 | 29,245.78 | | | 2,212,520.45 | 2,631,709.89 |
| 7/15/2020 | | 372,010.36 | 372,010.36 | 27,900.78 | | | 399,911.14 | |
| 1/15/2021 | 1,832,306.00 | 372,010.36 | 2,204,316.36 | 27,900.78 | | | 2,232,217.14 | 2,632,128.27 |
| 7/15/2021 | | 353,687.30 | 353,687.30 | 26,526.55 | | | 380,213.85 | |
| 1/15/2022 | 1,872,129.00 | 353,687.30 | 2,225,816.30 | 26,526.55 | | | 2,252,342.85 | 2,632,556.70 |
| 7/15/2022 | | 334,966.01 | 334,966.01 | 25,122.45 | | | 360,088.46 | |
| 1/15/2023 | 1,912,817.00 | 334,966.01 | 2,247,783.01 | 25,122.45 | | | 2,272,905.46 | 2,632,993.92 |
| 7/15/2023 | | 315,837.84 | 315,837.84 | 23,687.84 | | | 339,525.68 | |
| 1/15/2024 | 1,954,390.00 | 315,837.84 | 2,270,227.84 | 23,687.84 | | | 2,293,915.68 | 2,633,441.36 |
| 7/15/2024 | | 296,293.94 | 296,293.94 | 22,222.05 | | | 318,515.99 | |
| 1/15/2025 | 1,996,866.00 | 296,293.94 | 2,293,159.94 | 22,222.05 | | | 2,315,381.99 | 2,633,897.97 |
| 7/15/2025 | | 276,325.28 | 276,325.28 | 20,724.40 | | | 297,049.68 | |
| 1/15/2026 | 2,040,265.00 | 276,325.28 | 2,316,590.28 | 20,724.40 | | | 2,337,314.68 | 2,634,364.35 |
| 7/15/2026 | | 255,922.63 | 255,922.63 | 19,194.20 | | | 275,116.83 | |
| 1/15/2027 | 2,084,607.00 | 255,922.63 | 2,340,529.63 | 19,194.20 | | | 2,359,723.83 | 2,634,840.65 |
| 7/15/2027 | | 235,076.56 | 235,076.56 | 17,630.74 | | | 252,707.30 | |
| 1/15/2028 | 2,129,913.00 | 235,076.56 | 2,364,989.56 | 17,630.74 | | | 2,382,620.30 | 2,635,327.60 |
| 7/15/2028 | | 213,777.43 | 213,777.43 | 16,033.31 | | | 229,810.74 | |
| 1/15/2029 | 2,176,204.00 | 213,777.43 | 2,389,981.43 | 16,033.31 | | | 2,406,014.74 | 2,635,825.47 |
| 7/15/2029 | | 192,015.39 | 192,015.39 | 14,401.15 | | | 206,416.54 | |
| 1/15/2030 | 2,223,501.00 | 192,015.39 | 2,415,516.39 | 14,401.15 | | | 2,429,917.54 | 2,636,334.09 |
| 7/15/2030 | | 169,780.38 | 169,780.38 | 12,733.53 | | | 182,513.91 | |
| 1/15/2031 | 2,271,825.00 | 169,780.38 | 2,441,605.38 | 12,733.53 | | | 2,454,338.91 | 2,636,852.82 |
| 7/15/2031 | | 147,062.13 | 147,062.13 | 11,029.66 | | | 158,091.79 | |
| 1/15/2032 | 2,321,200.00 | 147,062.13 | 2,468,262.13 | 11,029.66 | | | 2,479,291.79 | 2,637,383.58 |
| 7/15/2032 | | 123,850.13 | 123,850.13 | 9,288.76 | | | 133,138.89 | |
| 1/15/2033 | 2,371,649.00 | 123,850.13 | 2,495,499.13 | 9,288.76 | | | 2,504,787.89 | 2,637,926.78 |
| 7/15/2033 | | 100,133.64 | 100,133.64 | 7,510.02 | | | 107,643.66 | |
| 1/15/2034 | 2,423,193.00 | 100,133.64 | 2,523,326.64 | 7,510.02 | | | 2,530,836.66 | 2,638,480.33 |
| 7/15/2034 | | 75,901.71 | 75,901.71 | 5,692.63 | | | 81,594.34 | |
| 1/15/2035 | 2,475,858.00 | 75,901.71 | 2,551,759.71 | 5,692.63 | | | 2,557,452.34 | 2,639,046.68 |
| 7/15/2035 | | 51,143.13 | 51,143.13 | 3,835.73 | | | 54,978.86 | |
| 1/15/2036 | 2,529,667.00 | 51,143.13 | 2,580,810.13 | 3,835.73 | | | 2,584,645.86 | 2,639,624.73 |
| 7/15/2036 | | 25,846.46 | 25,846.46 | 1,938.48 | | | 27,784.94 | |
| 1/15/2037 | 2,584,646.00 | 25,846.46 | 2,610,492.46 | 1,938.48 | | | 2,612,430.94 | 2,640,215.89 |
| 7/15/2037 | | | | | | | | |
| | 42,467,400.00 | 9,627,296.20 | 52,094,696.20 | 714,261.53 | 233,570.70 | | 53,042,528.43 | 53,042,528.43 |

Notes:

*This project may qualify for principal forgiveness in accordance with Schedule B to the Financing Agreement. Principal forgiveness shown on this schedule is an estimate, and is not a guarantee.

# Draft Schedule C

Prepared by MCWT | Oct, 24 2014 - 2:30 PM

**Massachusetts Clean Water Trust**
**Hypothetical Preliminary Structuring Analysis**
**Town of Nantucket**
**Loan: CW-15-X3**

| | | | |
|---|---|---|---|
| Initial Loan Amount | 13,284,000.00 | Loan Origination Fee ($5.5/1000) | 73,062.00 |
| Principal Forgiveness | | Loan Term (in years) | 20 |
| Net Loan Obligation | 13,284,000.00 | Loan Rate | 0.00% |
| | | Closing Date | 12/1/2016 |
| | | First Interest | 7/15/2017 |
| | | First Principal | 1/15/2018 |

| Date | Principal | Interest | Total Debt Service | Admin Fee (0.15%) | Loan Origination Fee | Commonwealth Assistance Principal Forgiveness | Total Debt Service | Annual Debt Service |
|---|---|---|---|---|---|---|---|---|
| 12/1/2016 | | | | | | | | |
| 7/15/2017 | | | | 9,963.00 | 73,062.00 | | 83,025.00 | |
| 1/15/2018 | 654,778.00 | | 654,778.00 | 9,963.00 | | | 664,741.00 | 747,766.00 |
| 7/15/2018 | | | | 9,471.92 | | | 9,471.92 | |
| 1/15/2019 | 655,761.00 | | 655,761.00 | 9,471.92 | | | 665,232.92 | 674,704.83 |
| 7/15/2019 | | | | 8,980.10 | | | 8,980.10 | |
| 1/15/2020 | 656,745.00 | | 656,745.00 | 8,980.10 | | | 665,725.10 | 674,705.19 |
| 7/15/2020 | | | | 8,487.54 | | | 8,487.54 | |
| 1/15/2021 | 657,731.00 | | 657,731.00 | 8,487.54 | | | 666,218.54 | 674,706.07 |
| 7/15/2021 | | | | 7,994.24 | | | 7,994.24 | |
| 1/15/2022 | 658,718.00 | | 658,718.00 | 7,994.24 | | | 666,712.24 | 674,706.48 |
| 7/15/2022 | | | | 7,500.20 | | | 7,500.20 | |
| 1/15/2023 | 659,707.00 | | 659,707.00 | 7,500.20 | | | 667,207.20 | 674,707.40 |
| 7/15/2023 | | | | 7,005.42 | | | 7,005.42 | |
| 1/15/2024 | 660,697.00 | | 660,697.00 | 7,005.42 | | | 667,702.42 | 674,707.84 |
| 7/15/2024 | | | | 6,509.90 | | | 6,509.90 | |
| 1/15/2025 | 661,689.00 | | 661,689.00 | 6,509.90 | | | 668,198.90 | 674,708.79 |
| 7/15/2025 | | | | 6,013.63 | | | 6,013.63 | |
| 1/15/2026 | 662,682.00 | | 662,682.00 | 6,013.63 | | | 668,695.63 | 674,709.26 |
| 7/15/2026 | | | | 5,516.62 | | | 5,516.62 | |
| 1/15/2027 | 663,677.00 | | 663,677.00 | 5,516.62 | | | 669,193.62 | 674,710.24 |
| 7/15/2027 | | | | 5,018.86 | | | 5,018.86 | |
| 1/15/2028 | 664,674.00 | | 664,674.00 | 5,018.86 | | | 669,692.86 | 674,711.72 |
| 7/15/2028 | | | | 4,520.36 | | | 4,520.36 | |
| 1/15/2029 | 665,671.00 | | 665,671.00 | 4,520.36 | | | 670,191.36 | 674,711.71 |
| 7/15/2029 | | | | 4,021.10 | | | 4,021.10 | |
| 1/15/2030 | 666,671.00 | | 666,671.00 | 4,021.10 | | | 670,692.10 | 674,713.21 |
| 7/15/2030 | | | | 3,521.10 | | | 3,521.10 | |
| 1/15/2031 | 667,671.00 | | 667,671.00 | 3,521.10 | | | 671,192.10 | 674,713.20 |
| 7/15/2031 | | | | 3,020.35 | | | 3,020.35 | |
| 1/15/2032 | 668,674.00 | | 668,674.00 | 3,020.35 | | | 671,694.35 | 674,714.69 |
| 7/15/2032 | | | | 2,518.84 | | | 2,518.84 | |
| 1/15/2033 | 669,677.00 | | 669,677.00 | 2,518.84 | | | 672,195.84 | 674,714.68 |
| 7/15/2033 | | | | 2,016.58 | | | 2,016.58 | |
| 1/15/2034 | 670,683.00 | | 670,683.00 | 2,016.58 | | | 672,699.58 | 674,716.17 |
| 7/15/2034 | | | | 1,513.57 | | | 1,513.57 | |
| 1/15/2035 | 671,689.00 | | 671,689.00 | 1,513.57 | | | 673,202.57 | 674,716.14 |
| 7/15/2035 | | | | 1,009.80 | | | 1,009.80 | |
| 1/15/2036 | 672,698.00 | | 672,698.00 | 1,009.80 | | | 673,707.80 | 674,717.61 |
| 7/15/2036 | | | | 505.28 | | | 505.28 | |
| 1/15/2037 | 673,707.00 | | 673,707.00 | 505.28 | | | 674,212.28 | 674,717.56 |
| 7/15/2037 | | | | | | | | |
| | 13,284,000.00 | | 13,284,000.00 | 210,216.80 | 73,062.00 | | 13,567,278.80 | 13,567,278.80 |

Notes:

*This project may qualify for principal forgiveness in accordance with Schedule B to the Financing Agreement. Principal forgiveness shown on this schedule is an estimate, and is not a guarantee.

# Draft Schedule C

Prepared by MCWT | Oct, 24 2014 - 2:33 PM

**Massachusetts Clean Water Trust**
**Hypothetical Preliminary Structuring Analysis**
**Town of Nantucket**
**Loan: CW-15-X4**

| | | | |
|---|---|---|---|
| Initial Loan Amount | 13,284,000.00 | Loan Origination Fee ($5.5/1000) | 73,062.00 |
| Principal Forgiveness | | Loan Term (in years) | 20 |
| Net Loan Obligation | 13,284,000.00 | Loan Rate | 2.00% |
| | | Closing Date | 12/1/2016 |
| | | First Interest | 7/15/2017 |
| | | First Principal | 1/15/2018 |

| Date | Principal | Interest | Total Debt Service | Admin Fee (0.15%) | Loan Origination Fee | Commonwealth Assistance Principal Forgiveness | Total Debt Service | Annual Debt Service |
|---|---|---|---|---|---|---|---|---|
| 12/1/2016 | | | | | | | | |
| 7/15/2017 | | 165,312.00 | 165,312.00 | 9,963.00 | 73,062.00 | | 248,337.00 | |
| 1/15/2018 | 537,351.00 | 132,840.00 | 670,191.00 | 9,963.00 | | | 680,154.00 | 928,491.00 |
| 7/15/2018 | | 127,466.49 | 127,466.49 | 9,559.99 | | | 137,026.48 | |
| 1/15/2019 | 549,030.00 | 127,466.49 | 676,496.49 | 9,559.99 | | | 686,056.48 | 823,082.95 |
| 7/15/2019 | | 121,976.19 | 121,976.19 | 9,148.21 | | | 131,124.40 | |
| 1/15/2020 | 560,962.00 | 121,976.19 | 682,938.19 | 9,148.21 | | | 692,086.40 | 823,210.81 |
| 7/15/2020 | | 116,366.57 | 116,366.57 | 8,727.49 | | | 125,094.06 | |
| 1/15/2021 | 573,154.00 | 116,366.57 | 689,520.57 | 8,727.49 | | | 698,248.06 | 823,342.13 |
| 7/15/2021 | | 110,635.03 | 110,635.03 | 8,297.63 | | | 118,932.66 | |
| 1/15/2022 | 585,611.00 | 110,635.03 | 696,246.03 | 8,297.63 | | | 704,543.66 | 823,476.31 |
| 7/15/2022 | | 104,778.92 | 104,778.92 | 7,858.42 | | | 112,637.34 | |
| 1/15/2023 | 598,338.00 | 104,778.92 | 703,116.92 | 7,858.42 | | | 710,975.34 | 823,612.68 |
| 7/15/2023 | | 98,795.54 | 98,795.54 | 7,409.67 | | | 106,205.21 | |
| 1/15/2024 | 611,342.00 | 98,795.54 | 710,137.54 | 7,409.67 | | | 717,547.21 | 823,752.41 |
| 7/15/2024 | | 92,682.12 | 92,682.12 | 6,951.16 | | | 99,633.28 | |
| 1/15/2025 | 624,629.00 | 92,682.12 | 717,311.12 | 6,951.16 | | | 724,262.28 | 823,895.56 |
| 7/15/2025 | | 86,435.83 | 86,435.83 | 6,482.69 | | | 92,918.52 | |
| 1/15/2026 | 638,204.00 | 86,435.83 | 724,639.83 | 6,482.69 | | | 731,122.52 | 824,041.03 |
| 7/15/2026 | | 80,053.79 | 80,053.79 | 6,004.03 | | | 86,057.82 | |
| 1/15/2027 | 652,075.00 | 80,053.79 | 732,128.79 | 6,004.03 | | | 738,132.82 | 824,190.65 |
| 7/15/2027 | | 73,533.04 | 73,533.04 | 5,514.98 | | | 79,048.02 | |
| 1/15/2028 | 666,247.00 | 73,533.04 | 739,780.04 | 5,514.98 | | | 745,295.02 | 824,343.04 |
| 7/15/2028 | | 66,870.57 | 66,870.57 | 5,015.29 | | | 71,885.86 | |
| 1/15/2029 | 680,727.00 | 66,870.57 | 747,597.57 | 5,015.29 | | | 752,612.86 | 824,498.73 |
| 7/15/2029 | | 60,063.30 | 60,063.30 | 4,504.75 | | | 64,568.05 | |
| 1/15/2030 | 695,521.00 | 60,063.30 | 755,584.30 | 4,504.75 | | | 760,089.05 | 824,657.10 |
| 7/15/2030 | | 53,108.09 | 53,108.09 | 3,983.11 | | | 57,091.20 | |
| 1/15/2031 | 710,637.00 | 53,108.09 | 763,745.09 | 3,983.11 | | | 767,728.20 | 824,819.39 |
| 7/15/2031 | | 46,001.72 | 46,001.72 | 3,450.13 | | | 49,451.85 | |
| 1/15/2032 | 726,082.00 | 46,001.72 | 772,083.72 | 3,450.13 | | | 775,533.85 | 824,985.70 |
| 7/15/2032 | | 38,740.90 | 38,740.90 | 2,905.57 | | | 41,646.47 | |
| 1/15/2033 | 741,863.00 | 38,740.90 | 780,603.90 | 2,905.57 | | | 783,509.47 | 825,155.94 |
| 7/15/2033 | | 31,322.27 | 31,322.27 | 2,349.17 | | | 33,671.44 | |
| 1/15/2034 | 757,986.00 | 31,322.27 | 789,308.27 | 2,349.17 | | | 791,657.44 | 825,328.88 |
| 7/15/2034 | | 23,742.41 | 23,742.41 | 1,780.68 | | | 25,523.09 | |
| 1/15/2035 | 774,460.00 | 23,742.41 | 798,202.41 | 1,780.68 | | | 799,983.09 | 825,506.18 |
| 7/15/2035 | | 15,997.81 | 15,997.81 | 1,199.84 | | | 17,197.65 | |
| 1/15/2036 | 791,292.00 | 15,997.81 | 807,289.81 | 1,199.84 | | | 808,489.65 | 825,687.29 |
| 7/15/2036 | | 8,084.89 | 8,084.89 | 606.37 | | | 8,691.26 | |
| 1/15/2037 | 808,489.00 | 8,084.89 | 816,573.89 | 606.37 | | | 817,180.26 | 825,871.51 |
| 7/15/2037 | | | | | | | | |
| | 13,284,000.00 | 3,011,462.96 | 16,295,462.96 | 223,424.32 | 73,062.00 | | 16,591,949.28 | 16,591,949.28 |

Notes:

*This project may qualify for principal forgiveness in accordance with Schedule B to the Financing Agreement. Principal forgiveness shown on this schedule is an estimate, and is not a guarantee.

# APPENDIX J: OCEAN OUTFALL INFORMATION

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# OCEAN OUTFALL SYMPOSIUM

May 24, 2011

## A GUIDE TO VARIANCES UNDER THE MASSACHUSETTS OCEAN SANCTUARIES ACT

### I. Introduction to the Massachusetts Ocean Sanctuaries Act

The Massachusetts Ocean Sanctuaries Act, G.L. c. 132A, §§12A-16E & 18, as amended by the Oceans Act of 2008 (Chapter 114 of the Acts of 2008), ("the Act"), establishes protected ocean sanctuaries along most of the coastline of Massachusetts. Section 13 of the Act creates five ocean sanctuaries: the Cape Cod Ocean Sanctuary, the Cape Cod Bay Ocean Sanctuary, the Cape and Islands Ocean Sanctuary, the North Shore Ocean Sanctuary, and the South Essex Ocean Sanctuary. Id. at §13. The only part of the Massachusetts coastline that is not within an ocean sanctuary is the area east of metropolitan Boston. The Act prohibits or severely restricts the discharge of municipal wastewater into ocean sanctuaries.

The Massachusetts Office of Coastal Zone Management ("MCZM"), a division of the Massachusetts Executive Office of Energy and Environmental Affairs, is the designated state agency in charge of implementing the Act. Under the Act, MCZM is assigned to oversee, care for, and control ocean sanctuaries to ensure that they are protected "from any exploitive development or activity MCZM has enacted regulations to implement the Act. See 302 C.M.R. §5.00.

### II. Prohibited Activities Under the Act

The Act prohibits a number of activities in ocean sanctuaries and deals extensively with ocean outfalls. Section 15 of the Act prohibits the "dumping or discharge of commercial, municipal, domestic or industrial wastes" into ocean sanctuaries. G.L. c. 132A, §15(4). Additionally, municipal wastewater discharges are expressly not allowed in the Cape and Islands, Cape Cod, and Cape Cod Bay Ocean Sanctuaries. Id. at §16.

Notwithstanding the prohibitions against the discharge of municipal waste and wastewater into certain ocean sanctuaries, the Act permits an increase in volume or a change in the location of the end point of an existing discharge[1] from a publicly owned treatment works (a municipally owned wastewater treatment plant) through a variance procedure. Id.

[1] Existing discharge" is defined in the Act as follows: a municipal, commercial or industrial discharge at the volume and locations authorized by the appropriate federal and state agencies on July fifteenth, nineteen hundred and seventy, in the case of the Cape Cod Ocean Sanctuary; on December eighth, nineteen hundred and seventy-one, in the case of the Cape Cod Bay and Cape and Islands Ocean Sanctuary; on June twenty-seventh, nineteen hundred and seventy-two in the case of the North Shore Ocean Sanctuary; and on December thirtieth, nineteen hundred and seventy-six, in the case of the South Essex Ocean Sanctuary.

at §16A. A variance can only be issued by the Massachusetts Department of Environmental Protection ("DEP") if the discharge into an ocean sanctuary is the only feasible alternative to existing water pollution problems. Id. Any municipal wastewater discharge must also be approved and licensed by the appropriate state and federal agencies and be consistent with the objectives of the Act. G.L. c. 132A, §16. This includes a National Pollution Discharge Elimination System ("NPDES") permit issued by the U. S. Environmental Protection Agency and a Surface Water Discharge permit issued by DEP.

## III. Obtaining a Variance

A municipality may increase the volume or the location of an existing discharge from a publicly owned treatment works located within the Cape Cod, Cape Cod Bay, or Cape and Islands Ocean Sanctuaries by obtaining a variance issued by the DEP despite the limits discussed above if "a suitable quality of effluent is achieved to protect the appearance, ecology, and marine resources of the sanctuary." G.L. c. 132A, §16.

There are, however, significant restrictions limiting the authorization of variances in estuaries, coastal embayments, and lands subject to tidal actions. Id. at §16C.[2] DEP may not authorize a variance that would allow the change in location or increase in flow of an existing municipal wastewater discharge into a coastal embayment or estuary. Id. Discharges that would have a significant, adverse effect upon lands subject to tidal actions, embayments, and estuaries are also forbidden. Id. The Act provides a limited exception to the ban on variances for discharges into embayments and estuaries: a municipal wastewater discharge into an embayment or estuary is permitted only as an alternative to a more harmful discharge. Id.

### A. Application Requirements

DEP cannot issue a variance under the Act unless the following twelve prerequisites are met:

1. The proposed discharge[3] is the only feasible alternative, based upon technical, economic, environmental and public health factors.

2. The proposed discharge shall be consistent with the intent and purpose of the Act. A discharge must be able to meet the standards set forth in the Act to protect the appearance, ecology and marine resources of the waters of the ocean sanctuary.

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[2] Regulations define a "coastal embayment" as "coastal or marine waters that have a restricted opening to the ocean due at least in part to the formation of a barrier beach." 302 C.M.R. §5.10(2). An "estuary" is defined as a "semi-enclosed body of water which has a free connection with the open sea, within which sea water is measurably diluted with fresh water derived from outflowing fresh water rivers." Id. Information identifying specific embayments and estuaries can be found at http://www.mass.gov/czm/mapping/index.htm.

[3] "Proposed Discharge" is defined in the Act as an increase in volume or change in location of an existing discharge from a publicly owned treatment plant or combined sewer system. The Act does not, however, define the term "discharge." It is, therefore, unclear whether an existing discharge could include a groundwater as well as a surface water discharge.

3. The applicant shall have adopted and implemented a DEP approved plan for the pretreatment of all waste discharged into the municipal wastewater treatment system.

4. Following the Massachusetts Water Resources Commission's guidelines, the applicant shall have adopted and implemented a program for water conservation.

5. The applicant shall have adopted and implemented a DEP approved plan to regulate inflow and infiltration.

6. The applicant shall have adopted and implemented a DEP approved plan to control any combined sewer overflows.

7. The applicant shall have adopted and implemented a plan to review and control growth and connections to the municipal wastewater treatment system and treatment works. The objective of this plan is to ensure that the capacity of the treatment system and works will not be exceeded. The plan shall include notification requirements. DEP will be contacted whenever average flows within the system for any quarter equal or exceed eighty percent of the design capacity of the treatment plant. When this eighty percent threshold is met or exceeded, the applicant must begin the process to design and construct additional treatment capacity, or other effective responses. DEP must act to ensure that the design capacity of the treatment plant is not exceeded.

8. The proposed discharge will not significantly affect the quality or quantity of existing or proposed water supplies by reducing ground or surface water replenishment.

9. The proposed discharge must undergo a second level of treatment, as well as any other treatment needed to remove nutrients or other pollutants to avoid degradation of the ecology, appearance and marine resources of the designated sanctuary. Treatment must also be sufficient so that the discharge will meet water quality standards.

10. The proposed discharge is consistent with the policies of the Massachusetts Coastal Zone Management Program.

11. The proposed discharge and treatment plant are consistent with all applicable federal, state, and local laws, ordinances, by-laws, rules and regulations protecting the environment, including but not limited to G.L. c. 21, 91, 130 & 131.

12. The proposed discharge and outfall structure will not adversely impact marine fisheries or interfere with fishing grounds and the normal operation of fishing vessels.

The first, and most important, prerequisite is the "only feasible alternative" standard, Id., at §16B(1), which means that, other than the proposed discharge, there is no method of solving the particular water pollution problem, including land application, that:

a. will be approved by federal and state agencies;
b. is consistent with the objectives of the Act; and
c. is of greater or equal effectiveness in avoiding degradation of the water quality of the affected ocean sanctuary.

302 C.M.R. §5.04. There are no reported Massachusetts court cases that further interpret and apply the "only feasible alternative" standard to review a DEP decision to grant or deny a discharge variance under the Act. There are, however, federal cases that discuss the duty to consider "feasible alternatives" under certain federal laws. These federal cases provide helpful guidance to assist an applicant to identify and evaluate whether a proposed discharge is the "only feasible alternative" in the context of the Act.

Similar to the Act, the federal Clean Water Act, 33 U.S.C. §1344, allows the United States Army Corps of Engineers to issue a permit to alter wetlands only if there are no "feasible alternatives." 40 C.F.R. §230.10(a). To demonstrate that there are no feasible alternatives, an applicant for a permit to alter wetlands must undertake a thorough examination of alternatives. See Hough v. Marsh, 557 F. Supp. 74, 83-84 (D. Mass.1982). An alternative is feasible under the Clean Water Act if the alternative "is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." 40 C.F.R. § 230.10(a)(2). An alternative is also feasible if it has a less harmful impact on the ecosystem and results in fewer adverse environmental outcomes than the proposed alteration. Id. at § 230.10(a).

The factors set forth in the Clean Water Act provide an applicant with general guidance concerning the factors that should be assessed to determine whether a proposed discharge is the "only feasible alternative" for purposes of the Act. Typically, the only alternative to an ocean outfall variance is a groundwater discharge permit. Applying the factors from the Clean Water Act to the variance standard under the Act, therefore, an applicant needs to evaluate the availability of suitable land required for a groundwater discharge, groundwater modeling, the natural limits associated with groundwater flow, costs, and the practicability of existing technologies. An assessment of these factors is necessary for the applicant to demonstrate that an ocean outfall is the "only feasible alternative" under the Act.

Additionally, the National Environmental Policy Act of 1969, 42 U.S.C. §4321, requires that an environmental impact statement include "alternatives . . . bounded by some notion of feasibility." Yankee Power Corp. v. Natural Resources Defense Council, Inc., 435 U.S. 519, 551 (1978). In the context of the National Environmental Policy Act, a feasible alternative is not a remote and speculative possibility but an option that has readily determined effects. Id.

Under the Department of Transportation Act, the Secretary of Transportation may approve a federally funded transportation project requiring the use of park land or land of historical significance, only if "there is no prudent and feasible alternative to using that land." 49 U.S.C. §303(c). An alternative that does not further the objective of the proposed

project is not a feasible alternative and, therefore, does not need to be evaluated. Neighborhood Association of The Back Bay, Inc. v. Federal Transit Administration, 407 F. Supp. 2d 323, 340 (D. Mass. 2005).

Although these interpretations of "feasible alternatives" relate to federal laws, the above information may assist an applicant to decide what alternatives to analyze to support a conclusion that a proposed discharge is the "only feasible alternative" and entitled to a variance under the Act.

In addition to analyzing alternatives, an applicant also must eliminate any existing discharges into coastal embayments and estuaries from publicly owned facilities under its control as a condition to obtaining a variance. G.L. c. 132A, §16C.

Finally, a variance application must satisfy four additional requirements. First, the application must contain a final environmental impact report and a final facilities plan approved by the Division of Water Pollution Control. G.L. c. 132A, §16D(1). Second, the application must evaluate alternative means for waste disposal, including land disposal. Id. at §16D(2). Third, the application must prove that land disposal is not an appropriate alternative for all or some of the discharge. Id. at §16D(3). Fourth, the application must demonstrate that the proposed variance satisfies all twelve of the prerequisites set forth in §16B, which are discussed above. Id. at §16D (4).

B. The Application Process

An applicant for a variance must complete several steps at each level of the application process. An applicant is required to attend a pre-application conference with DEP and then submit its application to the Ocean Sanctuaries Coordinator and DEP. 302 C.M.R. §5.10(3). Regulations provide detailed descriptions of the materials that an applicant must submit to DEP and the Ocean Sanctuaries Coordinator. See Id. For example, an applicant must submit a five-part variance application, including an in-depth discussion of the twelve prerequisites established under G.L. c. 132A, §16B. Id. at §5.10(3)(b). For variance application requirements, please see 302 C.M.R. §5.10(3)(a)-(f).

Once an application is submitted, DEP must then evaluate the variance request. Id. at §5.10(4) & (5); G.L. c. 132A, §16E. DEP reviews a variance application to determine if the "proposed discharge into an ocean sanctuary will not seriously alter or otherwise endanger the appearance, ecology or maritime resources of the ocean, the seabed, or subsoil thereof, or the Cape Cod National Seashore." 302 C.M.R. §5.10(4). The term "seriously alter" is defined in the Regulations as including, for example, discharging any material that could significantly degrade water quality."

C. Public Hearing and Notice Requirements

The Act's public notice and hearing requirements ensure that members of the public may express their views concerning the proposed variance and that DEP's review of a variance application is informed by this input. DEP is required to publish a hearing notice and comment schedule in the *Environmental Monitor* and the applicant must publish notice in newspapers that serve municipalities bordering the ocean sanctuary. Id. at §5.10(5).

Documents concerning the proposed variance, such as the application, must be made available for public review. Id. at §5.10(5)(c). Any person may submit comments concerning the variance application to DEP within thirty days of the published notice. Id.

Within twenty days of the published notice, DEP must also hold a public hearing to gather public testimony related to the proposed variance. Id. at §5.10(5)(d). DEP then has sixty days after the close of the comment period to reach a decision to grant or deny a variance application. Id. at §5.10(5)(e).

Once the DEP Commissioner reaches a final decision whether or not to issue the variance, DEP must publish its decision in the *Environmental Monitor*. Additionally, DEP must provide direct notice of its decision to chief elected officials of affected municipalities, all parties who submitted written comments, and any other appropriate individuals. G.L. c. 132A, §16E.

Absent an appeal, a final decision to grant or deny a variance is effective thirty days after the decision is published. If DEP approves a variance, any conditions that DEP includes in the variance become conditions of a discharge permit issued by DEP under G.L. c. 21. Id. at §16F; 302 C.M.R. §5.10(8).

## IV. The Appeals Process

An aggrieved party may request an adjudicatory hearing on the decision to grant or deny a variance request by sending written notice by certified mail to the DEP Commissioner within thirty days after the decision is issued. G.L. c. 132A, §16E. The request for an adjudicatory hearing must state the party's objection(s) to the decision and include specific facts and issues in support of the objection(s) and must include all issues and facts the party wishes to raise. 302 C.M.R. §5.10(5)(g)(1).

Once it receives such a request, DEP must schedule an adjudicatory hearing within thirty days and public notice of the hearing must be published in the *Environmental Monitor* at least ten days prior to the adjudicatory hearing. Id. at §5.10(5)(g)(2). At the hearing, the variance applicant has the burden of proof with respect to all claims or issues of fact and law raised in the request for a hearing, and the variance applicant must demonstrate how the proposed discharge meets the criteria and requirements for a variance. 302 C.M.R. §5.10(5)(g)(2)(a) & (b). It is essential that a party establish a complete factual record at the adjudicatory hearing, including expert testimony, because if a party later decides to bring a further appeal in court, the court may review only the factual record created at the adjudicatory hearing. G.L. c. 30A, §14(5).

Following the adjudicatory hearing, the hearing officer makes a written recommendation to the DEP Commissioner to affirm, modify, or revoke the decision to grant or withhold a variance. Id. at § 5.10(5)(g)(5). The DEP Commissioner then has thirty days to issue a decision. Id. After the DEP Commissioner issues a decision, it is effective immediately, unless a party files a further appeal of the decision. G.L. c. 132A, §16E; Id. at §5.10(5)(h).

A party to the adjudicatory hearing has thirty days to appeal the decision to Superior Court. G.L. c. 132A, §16E. An appeal is brought in court under the Massachusetts Administrative Procedure Act, G.L. c. 30A §§1-18. Id. After a record review of the decision, a reviewing court may affirm, modify, or revoke the DEP decision, or remand the decision back to DEP. G.L. c. 132A, §14(7). A court's review of the decision is limited to determining whether DEP's decision was arbitrary, capricious, unsupported by substantial evidence, or based on error. Id. A court will also presume that DEP's decision is rational given DEP's expertise, experience, and knowledge concerning discharge variances. Thus, if DEP's grant or denial of a variance is reasonable and supported by the record compiled during the adjudicatory hearing, on appeal a court will uphold DEP's decision. See Id.

There is no reported state case law reviewing a variance decision under the Ocean Sanctuaries Act. There are, however, federal cases where courts have reviewed agency decisions concerning the "feasible alternatives' standard under the same standard provided by the Massachusetts Administrative Procedure Act. These cases may provide useful guidance for variance applicants under the Act because successful applicants must demonstrate that the proposed discharge is the "only feasible alternative."

Similar to Massachusetts courts, under the federal Administrative Procedure Act, 5 U.S.C. §706, federal courts are also limited when reviewing agencies' decisions. A federal court may overturn a federal agency's decision if the decision is arbitrary, capricious, not supported by evidence, or if the decision does not meet statutory requirements. Citizens to Preserve Overton Park, Inc. v. Volpe, 401 U.S. 402, 413-14 (1971). For a court to uphold an agency's determination that there are no feasible alternatives, the agency's decision must be reasonably supported in the record created at the earlier administrative hearing. Town of Norfolk v. U.S. Army Corps of Engineers, 968 F.2d 1438, 1448 (1st Cir. 1992). The record must contain evidence that the agency, when reaching its decision, considered all comments and alternatives available to mitigate harm and its final decision reflects an analysis of these considerations. Neighborhood Association of The Back Bay, Inc., 407 F. Supp. 2d at 340. Additionally, a federal court will uphold an agency's decision that there are no feasible alternatives if the court finds that the agency could have reasonably believed that alternatives involve unique problems. Citizens to Preserve Overton Park, Inc., 401 U.S. at 416.

## V. Conclusion

The Massachusetts Ocean Sanctuaries Act does not permit the siting of new wastewater discharges from publicly owned treatment works in the Cape Cod, Cape Cod Bay, or the Cape and Islands Ocean Sanctuaries. A variance may be possible for an existing discharge, but only for the relocation of an existing outfall pipe and/or an increase in the volume of wastewater discharged from an existing outfall. An application for an ocean outfall variance under the Act is a challenging undertaking, but, it is not impossible for an applicant to obtain a variance. The rigorous standards and procedures for obtaining a variance, however, present significant hurdles in terms of engineering studies, public acceptance, and costs.

*John W. Giorgio, Esq., is a principal in the firm of Kopelman and Paige, P. C., which is the state's largest municipal law firm, representing 120 cities and towns as city solicitor or town counsel. The firm also serves as special counsel to numerous other Massachusetts municipalities. Attorney Giorgio heads the firm's municipal environmental practice. He currently represents several communities undergoing wastewater treatment facilities planning and he specializes in wastewater permitting, construction, and regulatory compliance and enforcement. The firm's wastewater clients include the Towns of Provincetown, Wellfleet, Eastham, Harwich, Sandwich, Nantucket, Plymouth, Essex and Rockport. John is a graduate of Georgetown University and Boston College Law School where he served as an Associate Editor of the Environmental Affairs Law Review. He currently serves as a member of the Massachusetts Municipal Association's Environment Committee.*

426179/80000/0014

# APPENDIX K: PUBLIC OUTREACH INFORMATION

**Town of Nantucket**

# MEMO

TO: See attached list

FROM: C. Elizabeth Gibson, Town Manager

DATE: May 20, 2011

CC: Board of Selectmen
Board of Health

RE: Wastewater Action Plan

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As you may know, the Board of Selectmen is in the process of establishing its goals for 2011-12 (draft attached). One of the goals pertains to the development of the above plan. We are currently working on a schedule for a series of workshop meetings to take place throughout this summer and into the fall, which are meant to assist with the process of developing the Action Plan. As someone who has expressed concern or interest in the recent past about where the Town is going with its wastewater planning, we would like to invite you to a meeting on Monday, June 13th at 4:00 pm in the Training Room (2nd floor) of the Public Safety Facility to review your concerns, comments and suggestions with us. Your input is important as we begin the development of an Action Plan and our intent is to obtain it in advance, if at all possible, and not at the end. We would appreciate confirmation as to whether or not you will plan to attend the meeting. Meanwhile, we welcome you to provide any thoughts you would like to provide in writing or email prior to the meeting.

Please also feel free to contact me, Rick Atherton (rickatherton@comcast.net; 508-228-2366), Whitey Willauer (whitey@willauer.com; 508-228-1277) or Gregg Tivnan (gtivnan@nantucket-ma.gov; 508-228-7254) with any questions about the meeting.

Thank you. We hope to see you on June 13th.

*from the desk of.....*

C. Elizabeth Gibson
Town Manager
16 Broad Street
Nantucket, MA 02554
508-228-7255
lgibson@nantucket-ma.gov

DRAFT as of 5/18/11

# Board of Selectmen
# FY 12 Goals and Objectives

| OBJECTIVE | GOALS |
|---|---|
| **1. Improved Financial Management.** Restore confidence with the Town's financial management, including the timely submittal of audits, unqualified audit opinions, reduction and/or elimination of material weaknesses, completion of implementation of the Abrahams recommendations, timely and accurate cash reconciliations on a regular, consistent basis and confirmed by a 3rd party, such as the auditor or interim financial management services. | 1. Ensure each finding of the FY10 Management Letter is specifically scheduled to be addressed by 6/30/11 and submitted for review from the auditors with the request for a response by 8/1/11<br>2. A plan to address each recommendation of Abrahams Report implemented by 8/1/11 with implementation by 6/30/12.<br>3. Ensure compliance with the Department of Revenue Municipal Calendar to ensure timely report submittals.<br>4. Meet the milestones related to the Annual Audit Checklist developed by the Town's auditing firm to ensure the 2011 Audit Report is finalized by 12/31/2011.<br>5. Achieve an Unqualified Audit for FY11 |
| **2. Long-Term Wastewater/Water Quality Plan.** Adopt a Wastewater Action Plan, including the identification of projects proposed to be put to the voters for the next 5 years with criteria for prioritizing these projects, a funding and financing plan with various options, as well as pros, cons and some examination of alternatives, plus an agreed upon public process. | 1. Develop and approve a five-year multi-phase wastewater implementation plan by 12/31/11<br>2. Conduct multiple wastewater workshops held by BOS on specific topics throughout the summer and fall of 2011.<br>3. Seek funding at 2012 ATM for first phase of implementation plan<br>4. Continued implementation of the Stormwater Management Plan |
| **3. Long-Term Municipal Facilities Management.** Acquisition of additional resources for Property and Facilities Management for ALL public property, specifically real estate (including easements, public access) and buildings so that a maintenance plan(s) can be developed and all town property physically identified, marked and managed (if need be) | 1. Develop a multi-phase, multi-year municipal space and infrastructure improvement strategy involving the Town Building, Mooney Building, 20 South Water, 37 Washington and 2 FG by 12/1/11<br>2. Seek capital funding for first phase of municipal building strategy at 2012 ATM<br>3. Design a facilities/fleet maintenance division of DPW to be phased in over 5 years, seeking initial funding by 2013 ATM. |

***Monday, June 13, 2011/4pm – Wastwater Action Plan Meeting at 4 Fairgrounds Rd, Training Room***

***Interested/Concerned Parties***
Steve Anderson/Monomoy
Mark Barber/Shimmo
John Bartlett/Hummock Pond
Cormac Collier/Nantucket Land Council
Matt Fee/Town
Bee Gonnella/Monomoy-Shimmo
Bill Grieder/Madaket
Patricia and Peter Halstead/Monomoy
Peter Hoey/Capital Program Committee
Jim Kelly/Finance Committee
Terry Kelly/Hummock Pond
Jim Lentowski/Nantucket Conservation Foundation
Marty McGowan/Hummock Pond
Dual McIntyre/Tom Nevers
Deborah Nicholson/Monomoy
Susan O'Brien/Hummock Pond
Tim Soverino/Mid-Island
✓Charles Stott/Madaket – confirmed
John Tiffany/Capital Program Committee & Finance Committee
Nancy Wheatley/Tom Nevers

SVisco – attending

***Staff/Selectmen/Other***
Rick Atherton/Chairman-BOS
Whitey Willauer/Vice-chairman-BOS
Libby Gibson/Town Manager
Gregg Tivnan/Asst. Town Manager
Mohamed Nabulsi/Acting DPW Director
Bob Gardner/Wannacomet Water Manager
Richard Ray/Acting Director of Code Enforcement-Health Officer
Patty Roggeveen/Chairman-BOH
Andrew Vorce/Director of Planning
Dave Fronzuto/Marine Superintendent
John Daniels/Woodard & Curran
Jason Graziadei/Inquirer & Mirror

**STAKEHOLDERS MEETING REGARDING DEVELOPMENT**
**OF THE**
***WASTEWATER ACTION PLAN***

**MONDAY, JUNE 13, 2011 – 4-6 PM**
**PUBLIC SAFETY FACILITY TRAINING ROOM (2ND FLOOR)**

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| | | |
|---|---|---|
| **(5 Minutes)** | **TOPIC I.** | **Review of Question One – June 14 Special Election Ballot** |
| **(10 Minutes)** | **TOPIC II.** | **Overview of Development of *Wastewater Action Plan*** |
| | **TOPIC III.** | **Open Forum - Public Comment/Suggestions/Questions and Answers** |
| **(10 Minutes)** | **TOPIC IV.** | **Review of Working Schedule, Neighborhood Association and Other Civic Group Meetings** |

**Board of Selectmen Workshops Scheduled Workshop Subject Matter – Nantucket PSF Community Room from 4-6 PM**

- **July 13th – Madaket Preliminary Design Report and Start of MEP/TMDL Discussion**
- **August 10th –Overall CWMP Report, MEP/TMDL, Board of Health and Marine Fisheries Presentation**
- **September 14th – Wastewater Priorities and Funding Presentation**

**Attachments: Board of Selectmen 2011-2012 Goals**

WOODARD & CURRAN
980 WASHINGTON STREET
SUITE 325
DEDHAM, MASSACHUSETTS 02026
TEL. (781) 251-0200 • 1-800-446-5518
FAX (781) 251-0847

CLIENT
PROJECT
DESIGNED BY DATE
CHECKED BY DATE
PROJECT NO. SHEET NO. OF

# Sign in Sheet

| Name | Affiliation | CONTACT INFO |
|---|---|---|
| John Daniels | Woodard & Curran | 781-251-0200 jdaniels@woodardcurran.com |
| Rosemary Blacquier | Woodard & Curran | rblacquier@woodardcurran.com |
| Tom Hazlett | Woodard & Curran | thazlett@woodardcurran.com |
| Charles Stott | Madaket Homeowners Assoc. | 508/228-3675 stott.charlesg@gmail.com |
| Dual MacIntyre | Tom Nevers Civic Assn | dualmacintyre@comcast.net |
| Cosme Collier | Nantucket Land Council | Cosme@nantucketlandcouncil.org |
| DUNCAN G. FOG | SHIMMO ASSOC/NGBEHD | dlfog@nantucket.net |
| Peter HALSTED | Resident Bruseir Rd. | 508-228-5420 |
| PATRICIA HALSTED | " " | 508-228-0444 |
| PETER HOEY | CAP COM | 508-257-8367 phoey63@comcast.net |
| Emily Askin | Hummock Pond Assoc. | emilydrussell@hotmail.com |
| Clifford Williams | Fin Com | cliffack@yahoo.com |
| NANCY WHEATLEY | PAST CHAIR SEWER ADV. COMM | wheatley@cdm.com |
| Timothy M Soverino | Mid-Island Res | 508-228-2606 |
| DAVID GRAY SR | Grade 6c, Grade 3 Wastewater Op | ACKSOV@Hotmail.com ackgray@gmail.com |
| MARTY McGowan | Resident | MMC@pumpkinpondfarm.com |
| MOHAMED NABULSI | DPW | mnabulsi@nantucket-ma.gov |
| Stephen VISCO | Visco pumping (Septic) | Viscopumping@aol.com |
| DONALD T. VISCO | PLANNING COMM. | 508-228-1795 |
| WHITING WILLAUER | BOS | WHITBY@WILLAUER.COM |
| ANDREW VORCE | Director of Planning | avorce@nantucket-ma.gov |
| Patty Roggeveen | BOS | pattyroggeveen@gmail.com |
| Rick Atherton | BOS | rickatherton@comcast.net |
| Libby Gibson | Town Admin | lgibson@nantucket-ma.gov |
| GREGG TIVNAN | " " | gtivnan@nantucket-ma.gov |
| Dean Long | Cisco Brewers | Aiki Dean@gmail.com |
| STEVE ANDERSON | SHIMMO ASSOCIATION | shimmoack@verizon.net |

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FAX (781) 251-0847

CLIENT
PROJECT
DESIGNED BY DATE
CHECKED BY DATE
PROJECT NO. SHEET NO. OF

| | | |
|---|---|---|
| Bea Gonnella | Shimmo Quoc | 508-221-1883 |
| Mark W. Barber | 1 South Valley Rd Shimmo | 508-228-3481 |
| Chris Ravenscroft | 15 S. Valley Rd. Shimmo | cravenscroft@koberleinenvironmental.com |
| R.F. Cooper | Box 873 Second Ave. | 508 228-5106 |
| Jim Cooper | 8 Lyons Lnx. Box 1344 | 508-280-7584 |
| Marylou Stokes | 20 Beaucastel Rd | 508 325-5926 |
| Alexander Spencer<br>sandyspencer46@gmail.com | 7 South Valley Road | 508-325-6490 |
| Jim Kelly | 8 Shimmopond Road<br>shimmopond@aol.com | 508-228-5041 |
| Bill Grieder | Madaket Conservation Assoc. | 508-838-6010<br>bill.grieder@gmail.com |

**BOARD OF SELECTMEN**
**SEWER ACTION PLAN WORKSHOP NO. 2**
**MADAKET PLANNING AND CWMP DEVELOPMENT**

**WEDNESDAY, JULY 13, 2011 – 4-6 PM**
**NANTUCKET PSF TRAINING ROOM**

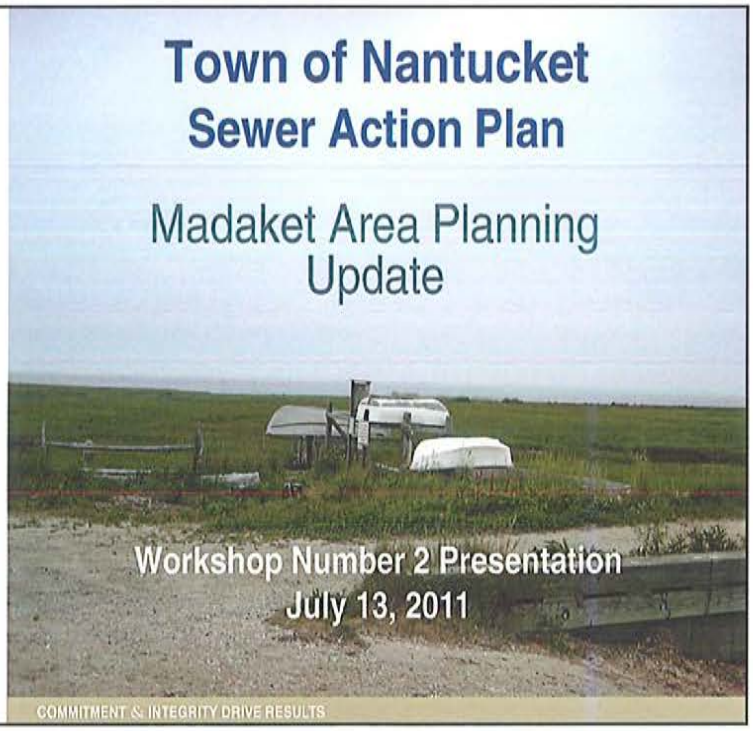
| | | |
|---|---|---|
| (5 Minutes) | TOPIC I. | Introduction by Board of Selectmen Chair |
| (15 Minutes) | TOPIC II. | Overview of Madaket Needs Area Planning and General Discussion of CWMP Recommendations |
| (15 Minutes) | TOPIC III. | What's Happened/Changed Since Completion of the CWMP |
| (70 Minutes) | TOPIC IV. | Open Forum - Public Comment/Suggestions/Questions and Answers |
| (10 Minutes) | TOPIC IV. | Review of Working Schedule, Neighborhood Association and Other Civic Group Meetings |

(5 Minutes) Board of Selectmen Workshops Nantucket PSF from 4-6 PM

- August 10th –Overall CWMP Report, Massachusetts Estuaries Program (MEP). Development of the Total Maximum Daily Load (TMDL) for Madaket Harbor Estuary System, Board of Health and Marine and Coastal Resources Department Presentation
- September 14th – Setting Wastewater Priorities and Initiating a Funding Discussion Presentation

# Town of Nantucket
# Sewer Action Plan

## Madaket Area Planning Update



Workshop Number 2 Presentation
July 13, 2011

COMMITMENT & INTEGRITY DRIVE RESULTS

## Madaket Planning Project Team

### Town of Nantucket

Board of Selectmen
Town Administration
Department of Public Works
Board of Health
Marine and Coastal Resources Department

### Woodard & Curran

John L. Daniels, Client Manager
Tom Hazlett, P.E, Project Manager
Rosemary Blacquier, Technical/Planning Specialist
Paul Dombrowski, WWTF Specialist

COMMITMENT & INTEGRITY DRIVE RESULTS

## Madaket Area Planning – Why?

- 2004 Comprehensive Wastewater Management Plan Recommendations
- Wastewater Need Criteria
  - Small Lots
  - Density of Systems
  - High Groundwater
  - Severe Soils
  - Systems Built Before 1978
  - Systems In 100 Year Flood Plain
  - Systems Within Madaket Harbor Watershed District

- 2011 Changes/Updates
- Supplement to 2004 CWMP Criteria
  - Massachusetts Estuaries Program (MEP)
    - Nitrogen Issues in Embayments
    - Madaket Harbor
    - Hither Creek
    - Long Pond
  - 2004 CWMP Recommendations
    - WWTF Design Based on MEP and TMDL
    - Treatment Alternatives
    - Update 2004 Recommendations

## Madaket Area Planning Limits From CWMP

# Madaket Harbor Estuary System

# Madaket Harbor Estuary System Nitrogen Load

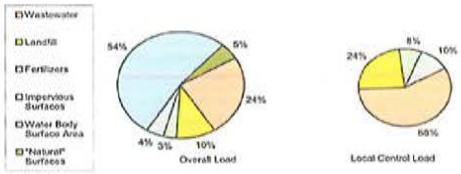



Figure IV-6. Land use-specific unattenuated nitrogen load (by percent) to the overall Madaket Harbor System watershed. "Overall Load" is the total nitrogen input within the watershed including atmospheric deposition to the estuary and nitrogen from natural surfaces (forests, grassland, etc), while the "Local Control Load" represents those nitrogen sources that could potentially be under local regulatory control.

## What's Changed Since 2004 CWMP?

- Madaket/Warren's Landing Needs Areas
  - 2004 CWMP Needs Area Changes
    - Town Water
    - Zoning
    - Public Health Regulations
    - MEP
      - TMDL

## What's NOT Changed Since 2004 CWMP?

- Madaket/Warren's Landing Needs Areas
  - 2004 CWMP Needs Area Criteria
    - Small Lots
    - Density of Systems
    - High Groundwater
    - Severe Soils
    - Systems Built Before 1978
    - Systems In 100 Year Flood Plain
    - Systems Within Madaket Harbor Watershed District

## 2004 CWMP Recommendations

- Long-Term Off-Site Wastewater Solution
- Evaluated
  - On-Site Wastewater Disposal Systems
  - Innovative/Alternative Systems
  - Neighborhood/Cluster Solutions
  - No Regional Opportunity
  - Local Solution

## Final 2004 CWMP Recommendations

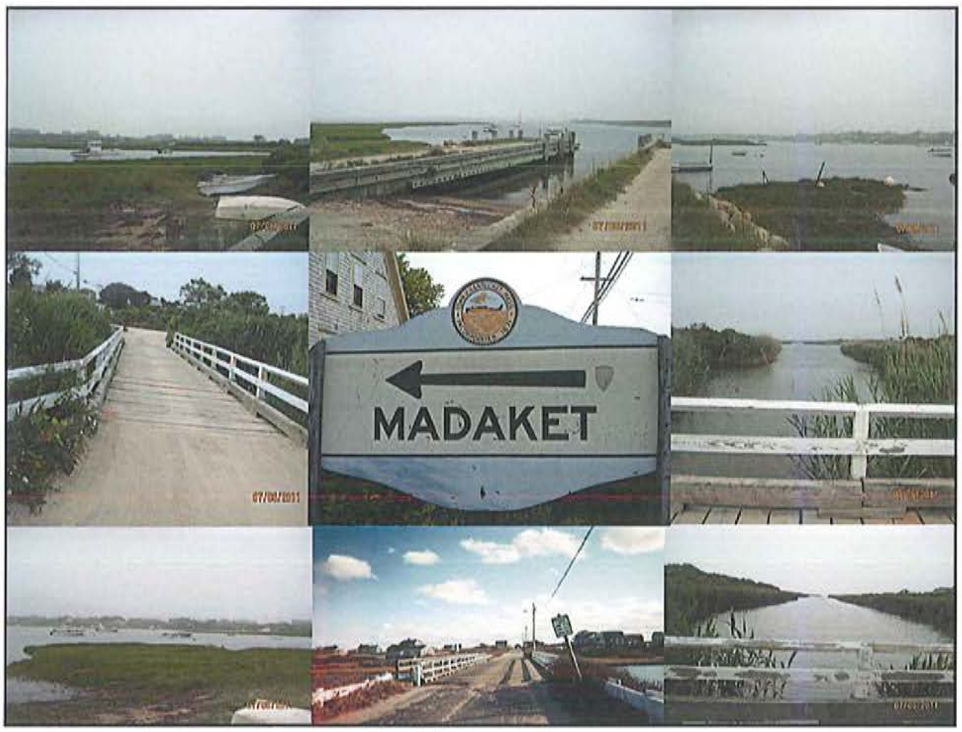
- Long-Term Off-Site Wastewater Solution
- Local Solution
  - Wastewater Collection System
    - Gravity, Low-Pressure and/or Combination
  - WWTF at Former FAA Site
    - Preliminary Evaluations Completed in 2004 CWMP
      - Hydrogeological Study – Groundwater Discharge
  - WWTF Design
    - To Be Based on Final MEP Outcome
    - Total Maximum Daily Limit (TMDL)

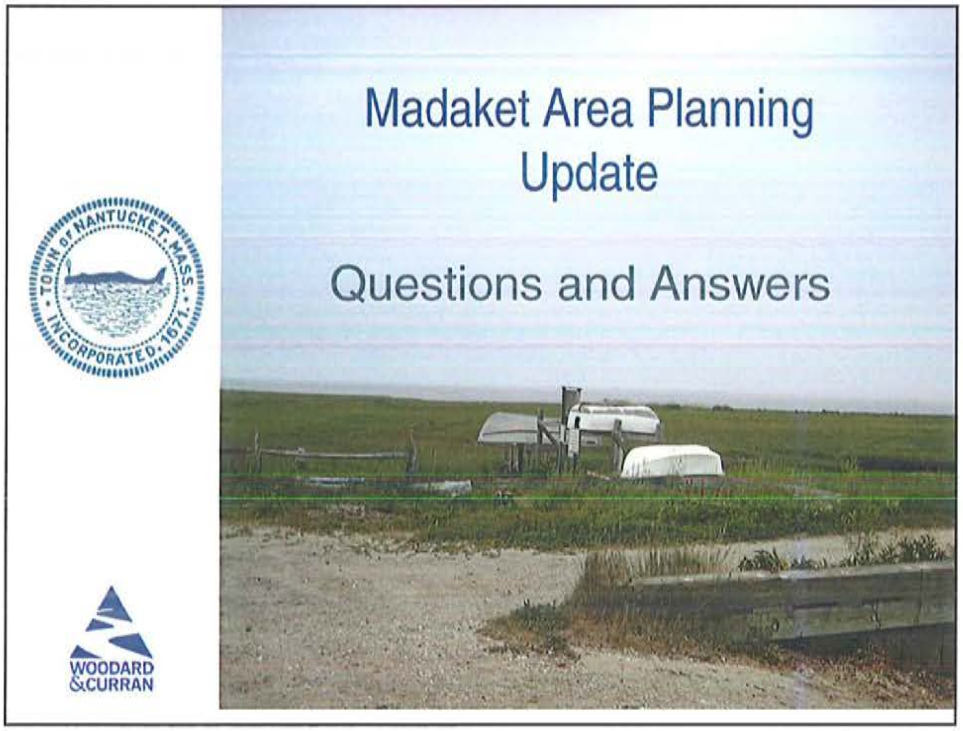
## Current Madaket Planning Stage

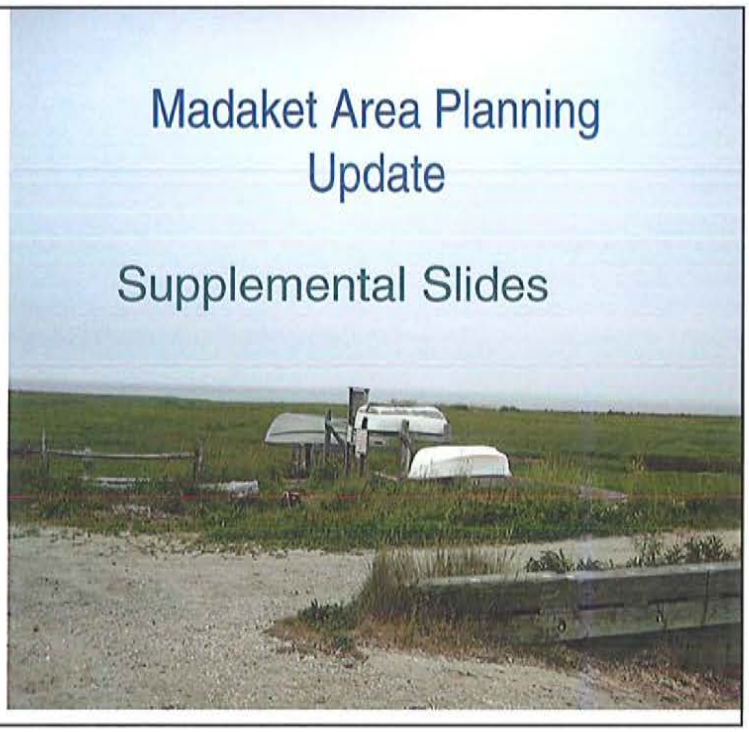
- General Services Administration Process
  - Securing of Former FAA Site
    - Department of Health and Human Services (HHS) Sponsor
- State Planning Process
  - Natural Heritage and Endangered Species Program (NHESP)
  - Massachusetts Historical Commission (MHC)
- Technical Piece
  - Engineering Review Process
- Funding Piece
  - State Revolving Fund (SRF)
  - United States Department of Agriculture Rural Development (USDA /RD)

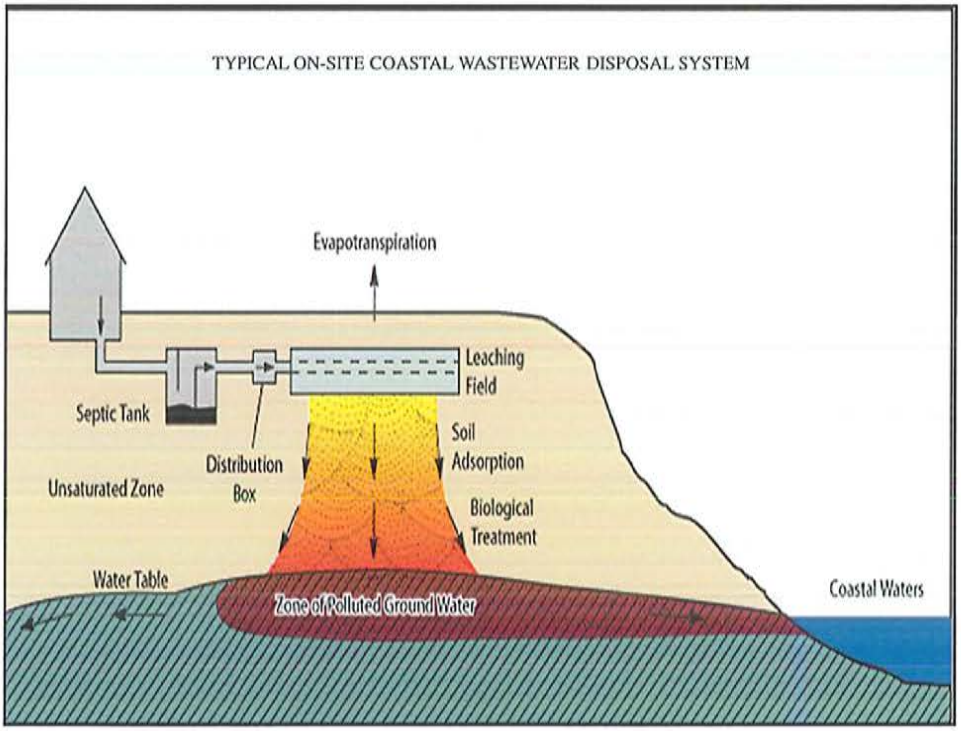
## What's Next?

- Incorporate the MEP Supplemental Data to CWMP
- Review Soon to be Released TMDL From MEP
- Review 2004 Final Plan With Above Updates
  - Are Revisions to Final 2004 CWMP Warranted?
  - Work With Town to Finalize Madaket/Warren's Landing Planning


MADAKET


Madaket Area Planning Update
Questions and Answers
TOWN of NANTUCKET, MASS.
INCORPORATED 1671
WOODARD &CURRAN


Madaket Area Planning
Update
Supplemental Slides


TYPICAL ON-SITE COASTAL WASTEWATER DISPOSAL SYSTEM
Evapotranspiration
Leaching Field
Septic Tank
Distribution Box
Soil Adsorption
Unsaturated Zone
Biological Treatment
Water Table
Zone of Polluted Ground Water
Coastal Waters

# Town of Nantucket
# Board of Selectmen Workshop
# Madaket Planning update
# July 13, 2011

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**Town of Nantucket**
**Board of Selectmen Workshop**
**Madaket Planning update**
**July 13, 2011**

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**Town of Nantucket**
**Board of Selectmen Workshop**
**Madaket Planning update**
**July 13, 2011**

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| ANN SCHRAFF KEATING | 5 NORTH POINT, FISHERS LANDING | ANNKEA@AOL.C |

**BOARD OF SELECTMEN WORKSHOP**
**MASSACHUSETTS ESTUARIES PROGRAM**
**NANTUCKET BOARD OF HEALTH**
**NANTUCKET DIVISION OF MARINE FISHERIES**

**WEDNESDAY, AUGUST 10, 2011 – 4-6 PM**
**NANTUCKET PSF TRAINING ROOM**

| | | |
|---|---|---|
| (5 Minutes) | TOPIC I. | Introduction by Board of Selectmen Chair |
| (40 Minutes) | TOPIC II. | Overview of Massachusetts Estuaries Program (MEP)<br>MassDEP – Brian Dudley<br>School for Marine Science and Technology (SMAST) – Dr. Brian Howes and Roland Samimy<br>o General MEP Discussion<br>o Madaket MEP<br>o Nantucket Harbor MEP<br>o Additional Model Runs-Monomoy / Shimmo |
| (20 Minutes) | TOPIC III. | Nantucket Board of Health – Richard Ray<br>o Mandatory Sewer Hook Up Regulations<br>o Potential Sewer Extensions |
| (20 Minutes) | TOPIC IV. | Nantucket Marine and Coastal Resources Department<br>o Update of Water Quality Testing Results<br>o ? |
| (30 Minutes) | TOPIC V. | Questions and Answers |
| (5 Minutes) | TOPIC VI. | Review of Working Schedule, Neighborhood Association and Other Civic Group Meetings |

**Board of Selectmen Workshops – Nantucket PSF Community Room from 4-6 PM**

- September 14th – Setting Wastewater Priorities and Initiating a Funding Discussion Presentation
- October 12th –
- November 15th -

# Town of Nantucket
## Sewer Action Plan

Massachusetts Estuaries Program Update

Workshop Number 3 Presentation
August 10, 2011

COMMITMENT & INTEGRITY DRIVE RESULTS

# Wastewater Action Planning Project Team

**Town of Nantucket**

**Board of Selectmen**
**Town Administration**
**Department of Public Works**
**Board of Health**
**Marine and Coastal Resources Department**

**Massachusetts Department of Environmental Protection**
**School of Marine Science and Technology**

**Woodard & Curran**

**John L. Daniels, Client Manager**
**Tom Hazlett, P.E, Project Manager**
**Rosemary Blacquier, Technical/Planning Specialist**
**Paul Dombrowski, WWTF Specialist**

COMMITMENT & INTEGRITY DRIVE RESULTS

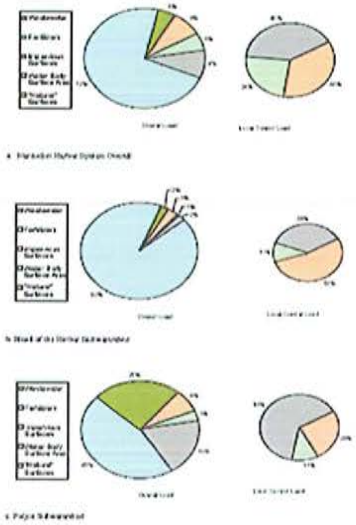
## Massachusetts Estuaries Reports (MEP)

- Nantucket Harbor – Completed
  - Total Maximum Daily Load (TMDL) Established
    - Based on MEP Thresholds
- Sesachacha Pond – Completed
  - TMDL Established
    - Based on MEP Thresholds
- Madaket Harbor / Long Pond – Completed
  - TMDL In Process – Thresholds Established
    - Draft Report Released
    - Public Hearing

## Nantucket Harbor MEP

## Nantucket Harbor Delineations

## Nantucket Harbor Estuary System Nitrogen Load



# Model of Nantucket Harbor – Brant Point Tide Rotation

MASSACHUSETTS ESTUARIES PROJECT

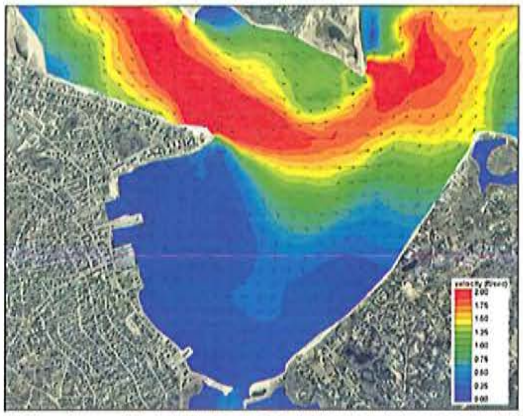


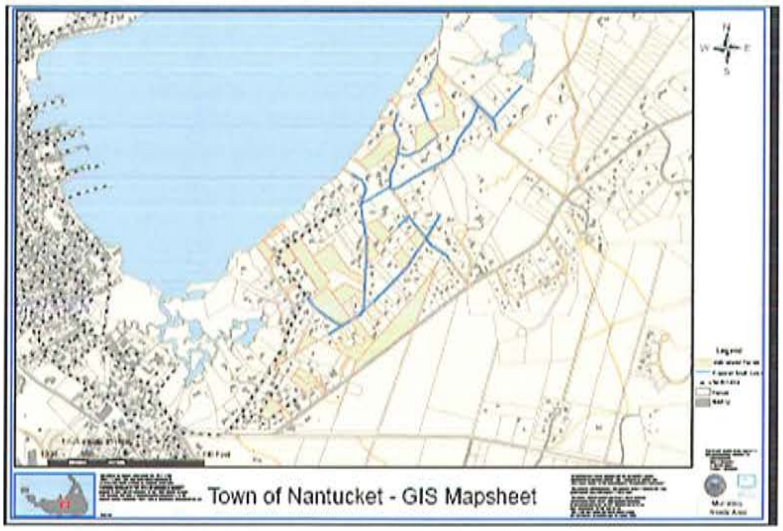
Figure V-26. Close-up of Nantucket Harbor, showing output from the hydrodynamic model at a single time step, where a recirculation eddy (or gyre) has set up on the south side of Brant Point.

# Nantucket Harbor Total Nitrogen Concentrations – MEP Report

MASSACHUSETTS ESTUARIES PROJECT

Figure VI-8. Contour plot of modeled total nitrogen concentrations (mg/L) in the Nantucket Harbor system, for projected build-out scenario 'A' loading conditions.

## Nantucket Harbor MEP




## Nantucket Harbor Nitrogen Load Rates, Thresholds and Targets

| Embayments | Present Watershed Load kg/day | Target Threshold Watershed Load kg/day | Difference |
|---|---|---|---|
| Head of Harbor | 1.86 | 0.79 | 1.07 |
| Quaise Basin | 2.12 | 1.14 | 0.98 |
| Town Basin | 12.22 | 10.71 | 1.51 |
| Polpis Harbor | 3.52 | 2.18 | 1.34 |
| Total | 19.72 kg/day | 14.89 kg/day | 4.9 kg/day |

# Nantucket Harbor Septic Thresholds

**MEP REPORT THRESHOLDS – SEPTIC LOADS**

Table VIII-2. Comparison of sub-embayment watershed ***septic loads*** (attenuated) used for modeling of present and threshold loading scenarios of the Nantucket Harbor system. These loads do not include direct atmospheric deposition (onto the sub-embayment surface), benthic flux, runoff, or fertilizer loading terms.

| sub-embayment | present septic load (kg/day) | threshold "A" septic load (kg/day) | Threshold "A" septic load % change | threshold "B" septic load (kg/day) | Threshold "B" septic load % change |
|---|---|---|---|---|---|
| Head of the Harbor | 0.705 | 0.141 | -80.0% | 0.000 | -100.0% |
| Polpis Harbor | 0.435 | 0.087 | -80.0% | 0.000 | -100.0% |
| Quaise Basin | 0.392 | 0.078 | -80.0% | 0.000 | -100.0% |
| Town Basin | 5.194 | 0.000 | -100.0% | 0.000 | -100.0% |
| System Total | 6.726 | 0.306 | -95.4% | 0.000 | -100.0% |

# Final MEP Recommendations

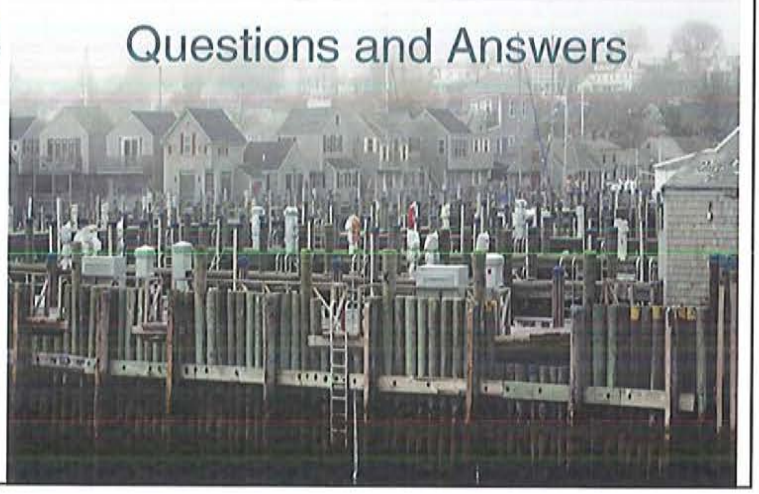
- 2004 CWMP Update to Incorporate
- Nantucket Harbor TMDL
  - Plan to Meet Thresholds
- Sesachacha Pond TMDL
  - Plan to Meet Thresholds
- Madaket Harbor / Long Pond TMDL
  - Once Completed, Plan to Meet Thresholds

## What's Next?

- Incorporate the MEP Supplemental Data to CWMP Update
- Review Soon to be Released Madaket Harbor and Long Pond TMDL From MEP
- Develop Plans to Meet Thresholds – Incorporate in CWMP update

## Massachusetts Estuaries Program Update

## Questions and Answers



# Massachusetts Estuaries Program Update

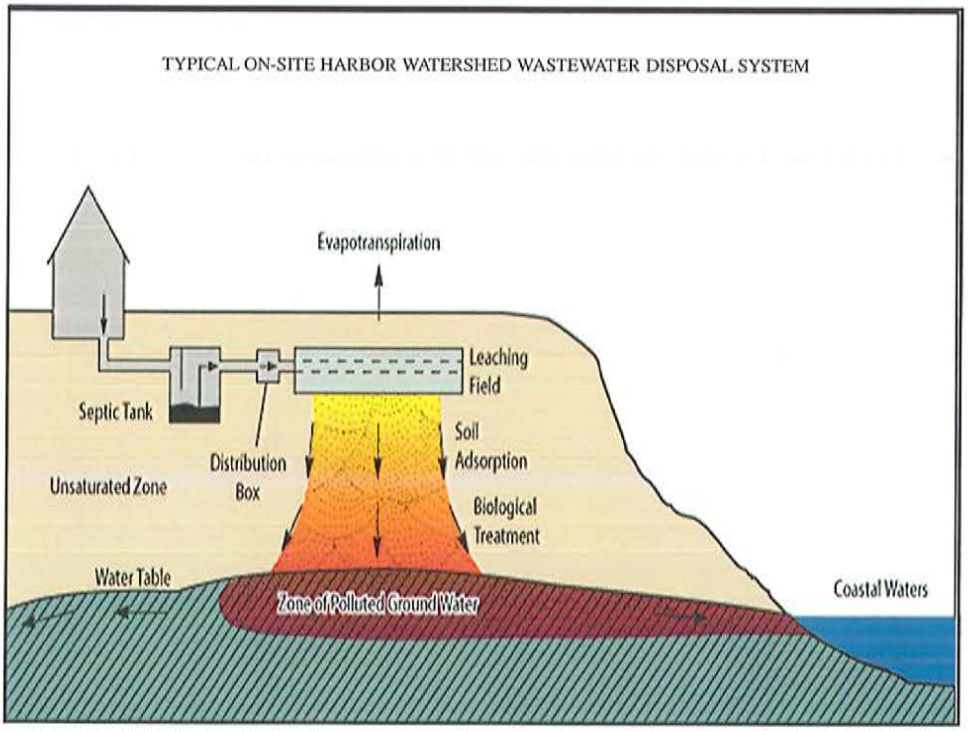
## Supplemental Slides

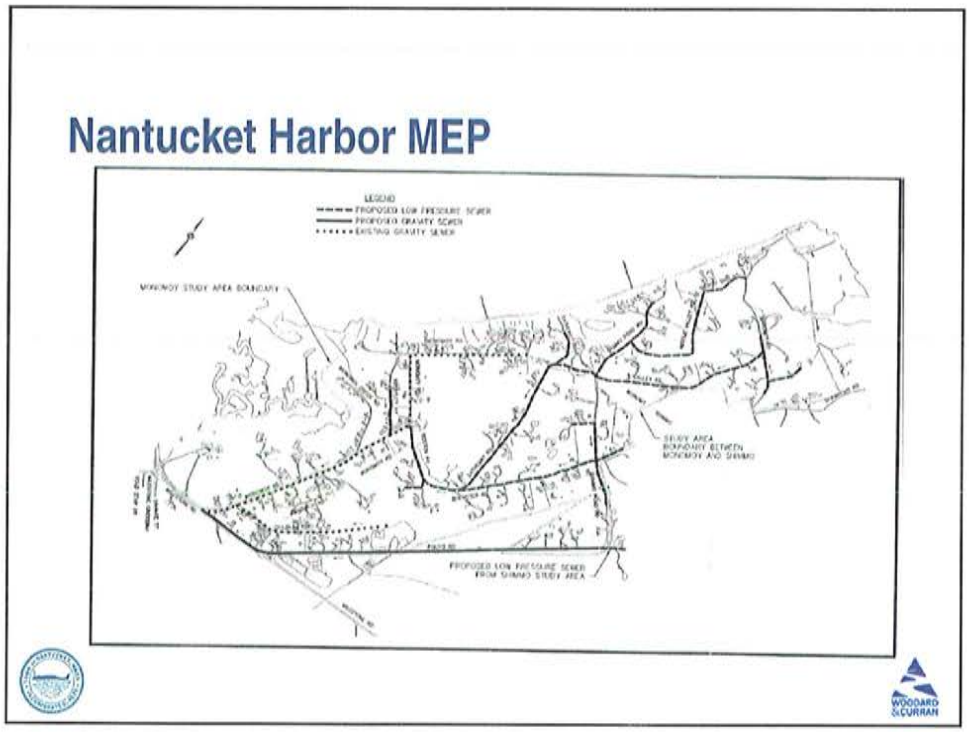
WOODARD &CURRAN

**2 Total Nitrogen TMDLs**

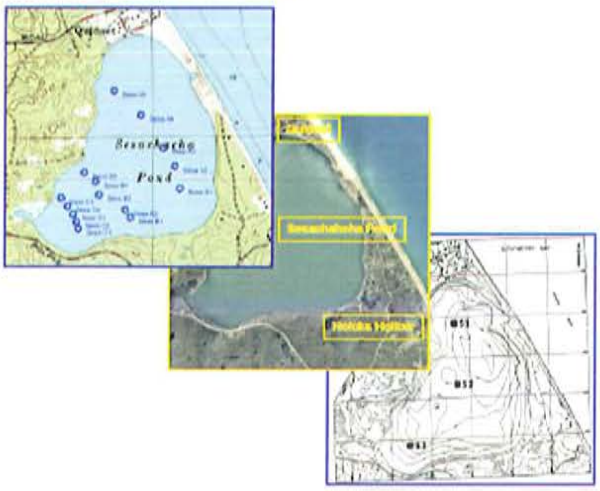
| Embayment | Description | Sub-Embayment | TMDL (kg/day) |
|---|---|---|---|
| Nantucket Harbor Water Body Segment # MA97-01_2004 | Determined to be impaired for nutrients, pathogens, and noxious aquatic plants by MassDEP. | Head of Harbor | 23 |
| | | Quaise Basin | 64 |
| | | Town Basin | 25 |
| Polpis Harbor Water Body Segment # MA97-26_2004 | Determined to be impaired for nutrients, other habitat alterations, and pathogens by MassDEP. | | 31 |

WOODARD &CURRAN

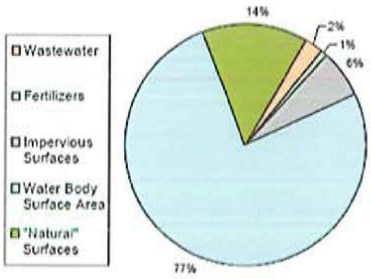

TYPICAL ON-SITE HARBOR WATERSHED WASTEWATER DISPOSAL SYSTEM
Evapotranspiration
Leaching Field
Septic Tank
Soil Adsorption
Distribution Box
Unsaturated Zone
Biological Treatment
Water Table
Zone of Polluted Ground Water
Coastal Waters


Nantucket Harbor MEP
WOODARD & CURRAN

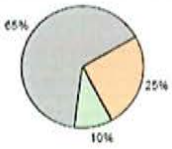
## Sesachacha Pond MEP




## Sesachacha Pond Estuary System Nitrogen Load




Overall Load




Local Control Load

# Sesachacha Pond TMDL

A similar improvement in the TN concentration in the following year was found, with the simulated spring level set to 0.82 mg/L. This starting concentration was derived using the difference in the TN concentrations computed at the end of the 2003 simulations with and without the mid-summer breach. This difference was determined to be 0.42 mg/L, and was assumed to carry through to the simulated 2004 spring. This 0.42mg/L difference was subtracted from the measured 2003 pre-breach concentration of 1.24 mg/L to arrive at the modified starting concentration of 0.82 mg/L.. Simulation results from the second consecutive year with a mid-summer breach show that the TN concentration never rises above 1.00 mg/L, and that the average TN concentration is 0.64, which is a 0.13 mg/L improvement over average conditions computed for the 2003 season without a mid-summer breach.

Model results indicate that water quality improvements that may provide more stable environment for flora and fauna is possible with the addition of a successful mid-summer breach. Data indicate that openings as short as six days are sufficient to provide sufficient tidal flushing and raise salinity levels near 30 ppt. Pond salinity is a useful indicator of breach success, as opposed to the duration of the opening. With the mid-summer breach, it should be possible to maintain salinities above 25 ppt and TN concentrations below 1.00 mg/L.

A significant improvement in the nitrogen related health of Sesachacha Pond infaunal animal habitat would result from the above modeled addition of a mid summer opening. It would be possible to use the monthly monitoring data to indicate when the mid-summer breach should occur. The primary indicator would be when the pond salinity drops below 25 ppt. The secondary indicator would be when the pond TN concentration rises above 0.95 mg/L. If this strategy is followed in the future, the result would be year-round salinities above 22 ppt and TN concentrations below 1.00 mg/L. It is important to note that the modeled maximum and average TN levels are likely conservative estimates as they do not include potential reductions in the rate of sediment nitrogen regeneration often associated with the lowering of nitrogen enrichment of embayment waters.

# Madaket Harbor MEP

# Madaket Harbor Estuary System Nitrogen Load

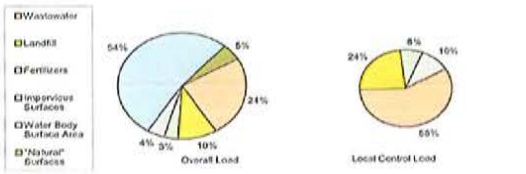



Figure IV-6. Land use-specific unattenuated nitrogen load (by percent) to the overall Madaket Harbor System watershed. "Overall Load" is the total nitrogen input within the watershed including atmospheric deposition to the estuary and nitrogen from natural surfaces (forests, grassland, etc), while the "Local Control Load" represents those nitrogen sources that could potentially be under local regulatory control

5

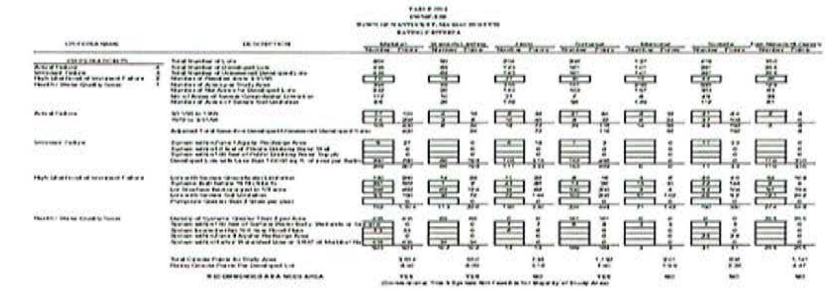
# Madaket Harbor and Long Pond Thresholds

Table VIII-2. Comparison of sub-embayment watershed septic loads (attenuated) used for modeling of present and threshold loading scenarios of the Madaket Harbor System. These loads do not include direct atmospheric deposition (onto the sub-embayment surface), benthic flux, runoff, or fertilizer loading terms.

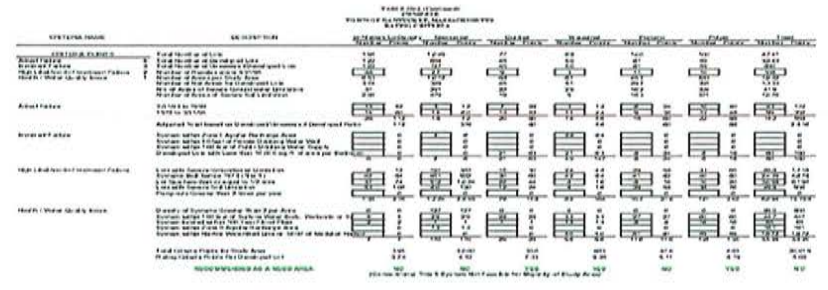
| sub-embayment | present septic load (kg/day) | threshold septic load (kg/day) | threshold septic load % change |
|---|---|---|---|
| Madaket Harbor | 0.384 | 0.384 | 0.0% |
| Hither Creek | 2.907 | 0.000 | -100.0% |
| Madaket Ditch | 1.510 | 1.510 | 0.0% |
| North Head Long Pond | 0.071 | 0.071 | 0.0% |
| Long Pond | 0.342 | 0.342 | 0.0% |
| System Total | 5.214 | 2.307 | -55.8% |

## Madaket Harbor and Long Pond TMDL - TBD

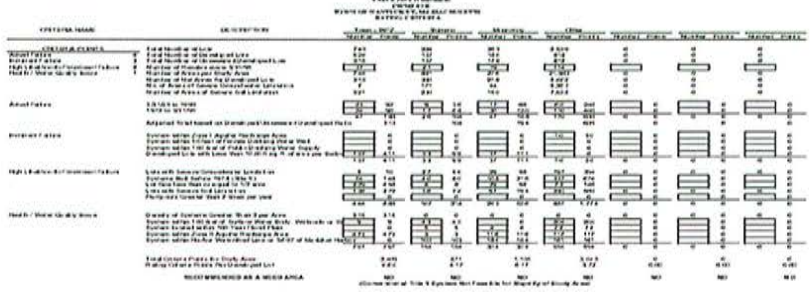
# CWMP Needs Areas Matrix



# CWMP Needs Areas Matrix



# CWMP Needs Areas Matrix



# Monomoy Build Out Analysis

**Monomoy Build Out Analysis**
**Prepared by Nantucket Planning Office Revised Feb 16, 2011**

| | 1 Unit | 2 Unit | 3 or more Units | Total Units |
|---|---|---|---|---|
| **Existing Dwelling** | 44 | 120 | 14 | 178 |
| **Flow** | @ 385 = 16,940 g/d | @ 605 = 72,600 g/d | @ 715 = 10,010 g/d | 99,550 g/d |
| **Future Dwelling** | 44 | 56 | 0 | 100 |
| **Flow** | * = 9,680 g/d | ** = 30,800 g/d | 0 g/d | 40,480 g/d |
| **Total** | 88<br>26,620 g/d | 176<br>103,400g/d | 14<br>10,010 g/d | **278**<br>**140,030 g/d** |

**Key:**

g/d= gallons per day

- * 44 second dwellings on existing lots @ 220/unit = 9,680 g/d
- ** 36 units 16 vacant lots;
  20 units on newly created lots; @ 550/unit = 30,800 g/d

- Flow based on 110 gallons per bedroom per day
- 1 unit assumed at 3.5 bedrooms
- 2 units assumed at 2 bedrooms

# Shimmo Build Out Analysis

**Shimmo Build Out Analysis**
**Prepared by Nantucket Planning Office Revised Feb 16, 2011**

| | 1 Unit | 2 Unit | 3 or more Units | Total Units |
|---|---|---|---|---|
| Existing Dwelling | 76 | 112 | 28 | 216 |
| Flow | @ 385 = 29,260 g/d | @ 605 = 67,760 g/d | @ 715 = 20,020 g/d | 117,040 g/d |
| Future Dwelling | 67 | 118 | 0 | 185 |
| Flow | * = 14,740 g/d | ** = 64,900 g/d | 0 g/d | 79,640 g/d |
| Total | 143 44,000 g/d | 230 132,660 g/d | 28 20,020 g/d | 401 196,680 g/d |

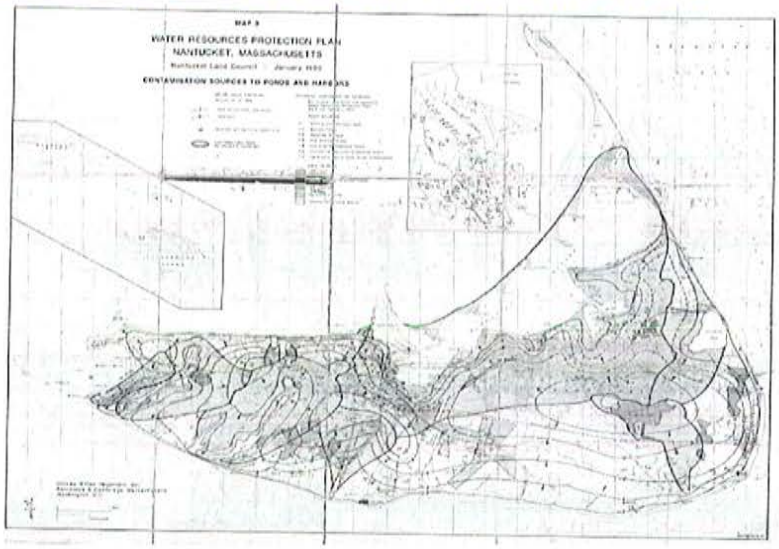
Key:

g/d = gallons per day

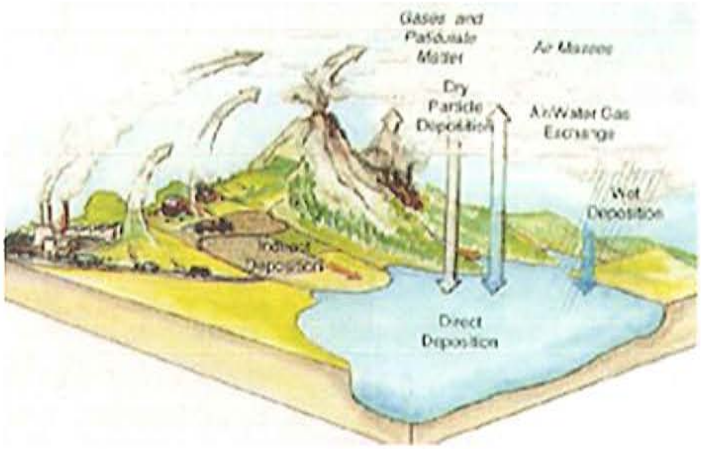
- * 67 second dwellings on accessory lots @ 220/unit = 14,740 g/d
- ** 34 units 17 vacant lots: @ 550/unit =18,700 g/d
  84 units on newly created lots: @ 550/unit = 46,200 g/d
  Total = 64,900 g/d

- Flow based on 110 gallons per bedroom per day
- 1 unit assumed at 3.5 bedrooms
- 2 units assumed at 2 bedrooms

# Nantucket Groundwater Flow Directions



# Atmospheric Deposition Sample (USGS)



# Town of Nantucket
# Board of Selectmen Workshop
# Massachusetts Estuaries Program
# August 10, 2011

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| Clifford Williams | FinCom | 18 Williams St | 5083605165 /cliffack@yahoo.com |
| Tara Riley | MCRD | 34 Washington St | 508 958-2152 |
| DAVE FRONZUTO | MCRD | " " | 508-958-7280 |
| PETER BOYCE | SHAB | 65 Meadowview Dr | 508-228-9662 PBOYCE@AAS.ORG |
| DAVID WORTH | | 19 Long Pond Dr | DAVID.D.WORTH@gmail.com |
| LESLIE FORBES | -Tristrams Landing Long Pond Homeowners Assn. | 19 LONG POND DR | LWForbes@gmail.com |

# Town of Nantucket
# Board of Selectmen Workshop
# Massachusetts Estuaries Program
# August 10, 2011

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| | | | 228-5746 shimmoock@verizon.net |
| SCOTT NEWQUIST | SIASCONSET RESIDENT | 29 MAIN ST., SIASCONSET | 257-9620 |
| TIM MADDEN | 19 WAUWINET | | Timothy.Madden@MAHouse.g |
| Mackey Noorgian | 46 Mermaid Pond Rd | | Antoinette.Noorgian@Gmail.com |
| MIKE ANGELMYER | 18 VESTAL CT | TOWN | |
| DEBORAH NICHOLSON | 86 BREWSTER RD | 228-1642 | beachmom02554@hotmail.co |
| PETER HALKED | 25 BREWSTER Rd | 228-5420 | |
| MARJORIE COLLEY - MADAKET CONSERVATION ASSN | | 52 Tennessee Ave | marjoriecolley@yahoo.co |
| Luke & Jenny Hunt - Shimmo resident | | 15 Shimmo Pond Rd | Mclunt@ad |
| ARTHUR GASPARRO | 20 MARY ANN DR. | | ARTHUR63@COMCAST.NET |

**WASTEWATER ACTION PLAN WORKING GROUP MEETING**
**TOWN & COUNTY BUILDING CONFERENCE ROOM**
**8:30AM**

**AGENDA**
**THURSDAY, SEPTEMBER 22, 2011 –**

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1. Recap Wastewater Action Plan and Timeline Voted on and Contracted For Spring 2011

2. Brief Summary of Events Taken Place:

   a. 4/28 - BOS Workshop #1 – Selectmen's concerns/requests

   b. 6/13 - Stakeholders Meeting – Solicited questions/concerns with wastewater planning

   c. 7/13 - BOS Workshop #2 – Madaket Area Planning

   d. 7/14 – Nantucket/SMAST Water Quality Presentation at the Coffin School – results of water quality testing Island-wide

   e. 8/10 – BOS Workshop #3 – Nantucket Harbor, Madaket Harbor, Long Pond TMDLS – MassDEP Brian Dudley, SMAST Brian Howes and Marine Department Dave Fronzuto presented

   f. 9/14 – BOS Workshop #4 – CANCELLED

   g. 10/5 – Regular BOS Meeting – Wastewater Action Plan Presentation

      i. Recap of Events – Public Comment
      ii. Events/Schedule Moving Forward

   h. Island Community Group Presentations/Meetings
   i. BOS reporting/Updates

3. BOS FY2012 Goals and Objectives (adopted 5/25/11)

   a. Long-term wastewater/water quality plan
   b. Conduct multiple workshops in 2011
   c. Continue implementation Stormwater Management Plan
   d. Develop 5-year Implementation Plan by 12/31/11
   e. 2012 Annual Town Meeting – seek first phase of funding

   (See original schedule attached)

4. <u>MUST</u> Items Left to be Accomplished in October 2011

   a. Madaket Draft TMDL issuance and public hearing on-Island

   b. Additional SMAST model runs (3) public presentation on-Island

5. Proposal Moving Forward to Accomplish BOS FY2012 Goals & Objectives
    a. Present Implementation Plan
    b. Fund Phase I at 2012 Annual Town Meeting
    c. Revisit 2004 CWMP
        i. per language in CWMP
        ii. per language in Final Environmental Impact Report MEPA Certificate
        iii. per Brian Dudley of MassDEP at 8/10 BOS Workshop to incorporate plan to address TMDLs
    d. Revisit 2004 Capital Improvements Plan
        i. To reflect revised planning & implementation process

Accomplishing this work will provide the Town with the following:

- The most comprehensive base and plan for action that is possible under the current "Needs", regulatory, and funding situation;
- A plan that can be implemented by the Town on the Town's terms and schedule;
- A continued, hands-off, supportive partnership with the MassDEP;
- A formal response and plan for meeting TMDLs for Nantucket Harbor and Madaket Harbor/Long Pond;
- The maximum potential for federal and/or state offsetting funding opportunities; and
- Study, evaluate, and reshape the 2004 CWMP into an Integrated Water Resources Management Plan.

# Town of Nantucket

## Board of Selectmen
## Town Administration

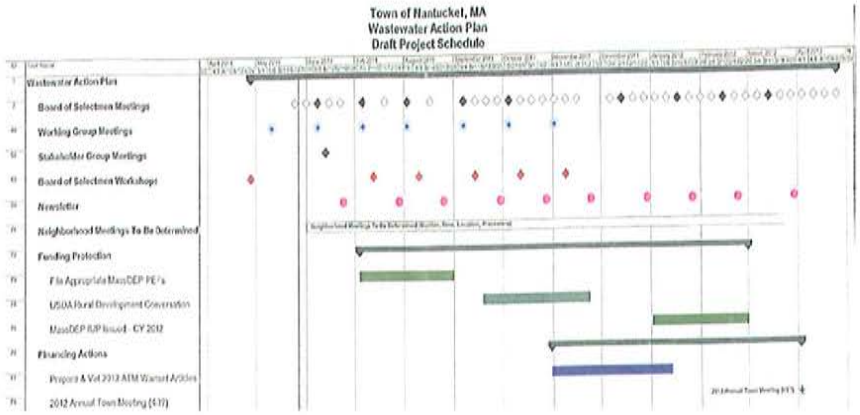
### Wastewater Action Plan Update

COMMITMENT & INTEGRITY DRIVE RESULTS

## Wastewater Action Plan Summary

- Wastewater Action Plan Scope – Voted and Contracted in Spring 2011
- FY2012 Goals and Objectives – Adopted May 25, 2011
  - Long-Term Wastewater/Water Quality Plan
    - Board of Selectmen Meetings
    - Board of Selectmen Workshops
    - Working Group Meetings
    - Stakeholder Group Meeting
    - Newsletters
    - Neighborhood / Civic / Environmental Group Briefing Sessions

## Wastewater Action Plan Schedule




## Working Group Meetings

- May 11, 2011
- June 8, 2011
- July 6, 2011
- August 3, 2011
- September 7 & 22, 2011

## Board of Selectmen Workshops

- April 28, 2011
  - Board of Selectmen / Town Administration
  - Recap of Comprehensive Wastewater Management Plan (CWMP) Approved in 2004
  - Review Goals and Objectives for FY2012
  - Goal No. 2 - Long-term Wastewater/Water Quality Plan
    - Selectmen Concerns and Requests
      - Develop Wastewater Action Plan Schedule and Timeline
      - Develop Wastewater Action Plan Topics for Discussion/Vetting

## Board of Selectmen Workshops

- July 13, 2011
- **Madaket Needs Area Planning Update**
  - 2004 CWMP – What's Changed? What's the Same?
  - Massachusetts Estuaries Plan (MEP)
    - TMDL - MassDEP
    - Current Planning
      - FAA Land / GSA
      - NHESP
      - MHC
      - Technical Update
  - CWMP Update
    - MEP / TMDL
    - Zoning
    - Town Water

## Board of Selectmen Workshops

- August 10, 2011
  - Massachusetts Estuaries Program (MEP) Update
    - Program Overview – Brian Dudley, MassDEP
    - MEP Summary – Dr. Brian Howes, SMAST
      - Nantucket Harbor
      - Sesachacha Pond
      - Madaket Harbor / Long Pond
      - Additional Model Runs
    - Marine and Coastal Resources – Dave Fronzuto
      - Water Quality Testing

## Board of Selectmen Meetings – WAP Updates

- June 1, 2011
- June 8, 2011
- July 6, 2011
- August 3, 2011
- September 7, 2011
- October 5, 2011

## Stakeholder Group Meeting

- June 13, 2011
  - Invited Island-wide Stakeholders to Open Forum
  - Agenda Items
    - Review of Question One – June 14th Special Election Ballot
    - Overview of Wastewater Action Plan
    - Open Forum
      - Solicit Input From Stakeholders
    - Review Working Schedule, Neighborhood Association and Other Civic Group Meetings

## Neighborhood & Other Civic Group Meetings

- July 11 – Nantucket Community Association
- July 16 – Non-Voting Taxpayers
- July 30 – Brant Point Association
- August 3 – Nantucket Garden Club
- August 6 – Tom Nevers Association
- August 16 – Nantucket Community Association Annual Forum
- August 17 – Rotary Club
- August 18 – Shimmo Association
- August 20 – Civic League President's Breakfast
- XX – Madaket
- XX – Hummock Pond
- XX – Quidnet/Squam

## *Wastewater Action Plan* Newsletter

- First Edition of Newsletter – July 2011
- Bulk-Mailed to All Island Properties
- Hand-Out at Workshops and Meetings
- Available at Town Hall
- Posted on Town's Website
- Schedule for Future Issues

## Proposal Moving Forward - Technical

- Madaket/Long Pond Draft TMDL – Public Presentation
- Additional SMAST Model Runs – Nantucket Harbor

## Proposal Moving Forward - Administrative

- Present Implementation Plan
- Scope CWRMP
- Fund CWRMP at 2012 Annual Town Meeting (ATM)
- Modify Madaket PDR Assignment
- Additional Newsletters
- Designing Dedicated WAP Location on Town Website
- Prepare BOS Position Document
- Integrate 2012 ATM Capital and Departmental Budget Requests
- Pre-Town Meeting Process
- March 31, 2012 – Annual Town Meeting

## Proposal Moving Forward – Integration Process

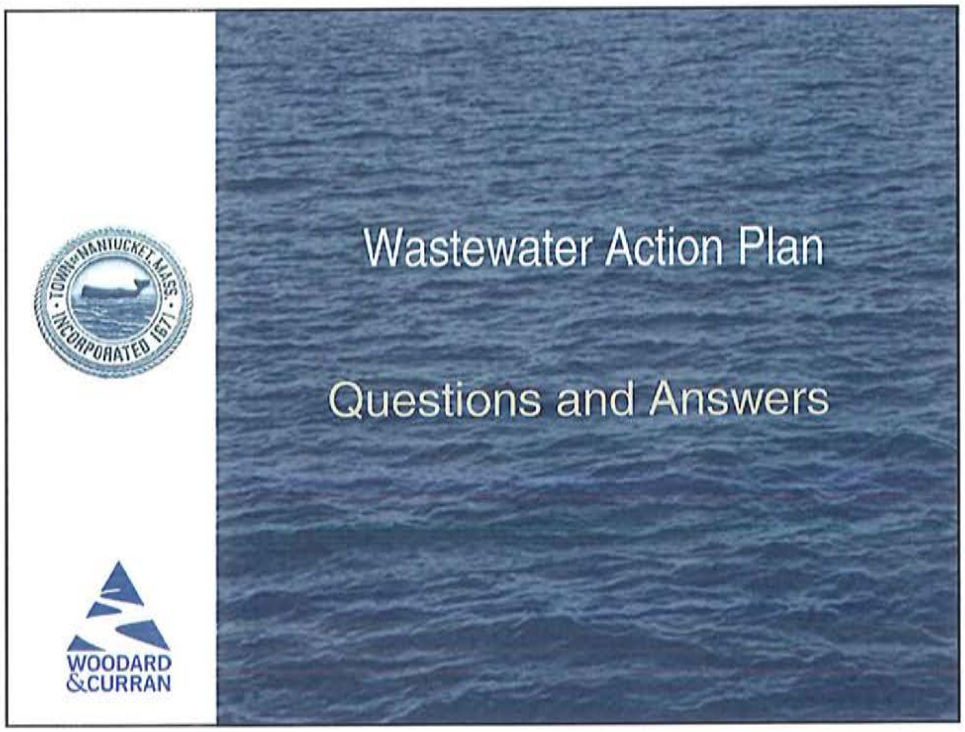
- Comprehensive Water Resources Management Plan

| 2004 CWMP | MEP / TMDLs | I/I Rehabilitation Program |
|---|---|---|
| Surfside WWTF Capacity Analysis | Nantucket Harbor Flushing | Septic Mgmt Plan<br>Tight Tank Policy<br>Sewer Connection Policy |
| Marine & Coastal Dept. Water Quality Testing | Fertilizer Mgmt Plan | Hummock Pond MEP / TMDL (Needs Area Status?) |
| I/A Technologies Update | Stormwater Mgmt Plan | Water System Expansion |
| Current Zoning Regulations | Madaket Sewerage | Landfill Mining Project |
| Roadway/Drainage Preventative Maintenance | Capital Improvements Plan | Funding / Financing |
| | Stakeholder / Citizen Advisory Participation | |

## Components Of Integrated Plan

## Funding/Financial Opportunities

- CY2012 State Revolving Fund Project Evaluation Form
- Sewer Enterprise versus General Fund
- Budget / Sustainability Analysis
- Local Cost Sharing options
- Offsetting Federal, State and Other Funding Programs


Wastewater Action Plan
Questions and Answers
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COMMITMENT & INTEGRITY DRIVE RESULTS