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Memorandum

To: Andrew Vorce, AICP, Director
Michael Burns, Project Manager
Nantucket Planning & Economic
Development Commission
2 Fairgrounds Road
Nantucket, MA 02554

Date: June 23, 2008

Project No.: 10508.00

From: Joseph Magni, P.E. - Project Manager
Matthew Hayes, P.E. - Project Engineer
Erin Thompson, E.I.T. - Traffic Engineer

Re: Four Corners Intersection Evaluation
Nantucket, Massachusetts

INTRODUCTION

The Town of Nantucket, through its Board of Selectman, has retained Vanasse Hangen Brustlin, Inc (VHB) to evaluate the intersection of Prospect Street, Atlantic Avenue, Sparks Avenue and Surfside Road, known locally as Four Corners, to identify existing deficiencies, develop and analyze a variety of alternatives, and detail our recommendations. The Nantucket Planning & Economic Development Commission (NP&EDC) is programming state and federal funds through the Transportation Improvements Program for Fiscal Year 2009 to implement the preferred design alternative chosen from the concepts presented herein.

The intersection was most recently studied as part of the Mid-Island Traffic Study¹ performed by Greenman-Pedersen, Inc (GPI) in 2005 for the NP&EDC. For the purposes of this technical memorandum, data collection efforts performed as part of this the study has been utilized.

EXISTING CONDITIONS

Surfside Road from the south and Atlantic Avenue from the north intersect in the mid-island area. Prospect Street intersects this roadway from the west and Sparks Avenue forms the easterly leg of the intersection. Prospect Street and Sparks Avenue are offset by approximately 165 feet. All approaches consist of a single multi-purpose lane and are under STOP-control. The Nantucket High School is located on the southeast quadrant of the intersection. The telephone control cabinets (*Inset 1*) is also located on this corner and approximately 115' south of Sparks Avenue is a large Elm tree (*Inset 2*) that must be retained and protected from an historical perspective. The high school driveway is located just south of the Elm tree. There is currently signage identifying the area as a 20mph school zone.



Inset 1 - Telephone Control Cabinets

¹ *Traffic Study & Strategy for the Mid-Island Area*, Greenman-Pedersen, Inc, July 8, 2005



Inset 2 – Elm Tree, looking north on Surfside Road

The main entrance to the Nantucket Cottage Hospital is located approximately 300 feet west of the intersection along Prospect Street. The southwest and northeast quadrants of the intersection are under ownership of the hospital. A private residential home is located on the northwest quadrant of the intersection with driveway access on Atlantic Avenue. There are several utility poles close to the edge of road, narrowing sidewalks at various locations (*Inset 3*).

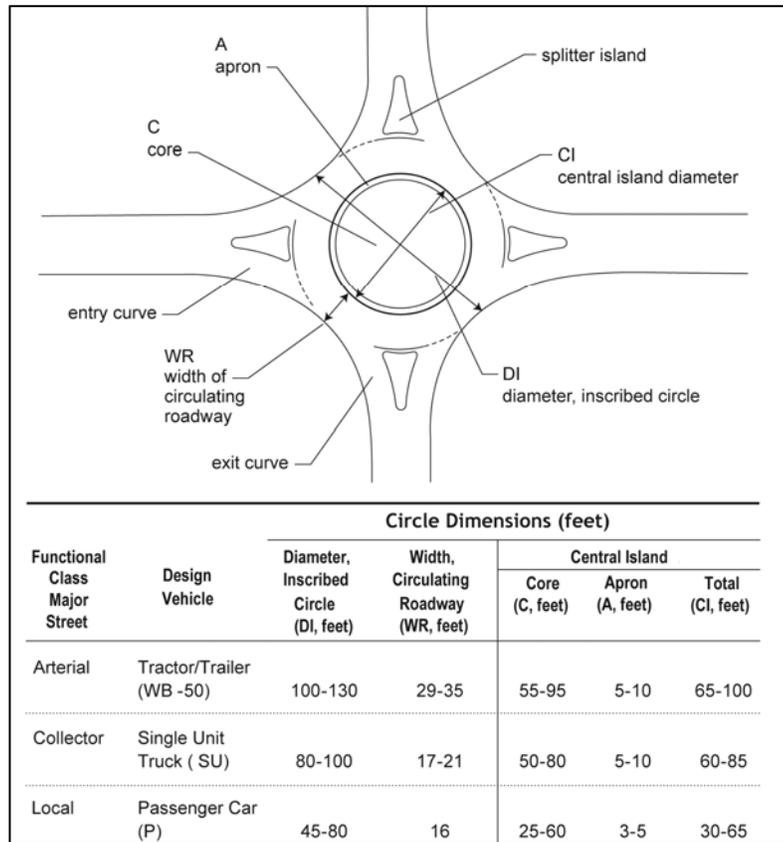
As previously reported, the intersection experienced 13 crashes from 2000 through 2003. These crashes included a pedestrian and bicyclist injury but generally consisted of rear-end and angle type collisions. More recent data is now available from the Massachusetts Highway Department (MassHighway) and has been reviewed. There were 3 reported crashes during the 2004-2006 time period. Two of these crashes were rear-end type and the other was an angle crash. It is worth noting that there have been no known fatalities reported at this location. Rear-end and angular collisions can be expected at this intersection due to the offset nature of Prospect Street to Sparks Avenue, sight distance constraints, and minimal roadway widths.



Inset 3 – Utility pole on southwest corner

DESIGN ALTERNATIVES

As early as 1982, Bruce Campbell Associates proposed the realignment of Prospect Street to eliminate the off-set intersection configuration. At the time abutters and the community rejected the notion of relocating residents for transportation improvements. With much of the abutting land now under the ownership of the local hospital and school district, the Board of Selectman is anticipating that modifications to the intersection will be embraced. Three design alternatives were considered and are described below. Reference is made to concept plans enclosed with this memo. The first two alternatives are roundabouts. A description of the various components and design features of a roundabout can be found on the following page.



From Massachusetts Highway Design Guide, Exhibit 6-27

- Alternative 1 (120' diameter roundabout)** – The circle is large enough to accommodate a WB-50 design vehicle while maintaining a large center island for landscaping with a 7' truck apron. (See Figure 1) All approaches have splitter islands capable of providing sufficient pedestrian refuge however crosswalks have only been proposed on two approaches: Sparks Avenue and Surfside Road. In order to have crosswalks on all approaches, a sidewalk easement would be necessary on the northwest corner or the splitter island on Atlantic Avenue would need to become mountable for larger vehicles. This alternative shifts traffic further from the Elm tree and maintains the current telephone boxes. Three houses owned by the hospital, including 1 Surfside Road (*Inset 4*), would need to be relocated, with two more being within the 10' setback zoning requirements. Several utility poles would have to be relocated.



Inset 4 – 1 Surfside Avenue, from Prospect Street

- **Alternative 2 (100' diameter roundabout)** – This alternative is similar to the Alternative 1 except the circle diameter has been reduced. (See Figure 2) The vehicular levels of service are not significantly impacted by the reduction of the diameter, but the queue on Surfside Road will increase due to the elimination of the slip lane. Because the overall circle diameter is smaller, truck maneuvers become more difficult. The center island is much smaller with a 14' truck apron. The splitter islands would have to be all or partially mountable to accommodate larger vehicles. This reduces the amount of protection for pedestrians as they cross the roads. Two houses owned by the hospital would be required to be relocated and the porch of 61 Prospect Street (*Inset 5*) would need to be removed. It is likely that house will be within the 10' zoning setback requirement. This option also shifts traffic away from the Elm tree and maintains the telephone boxes. Two utility poles would have to be relocated.



Inset 5 – 61 Prospect Street

- **Alternative 3 (4-Way Stop)** - This alternative, as shown in Figure 3, is similar to the concept presented in the Mid-Island Study. Prospect Street and Sparks Avenue are realigned to form a more traditional all-way stop-controlled intersection. The original concept (Figure 4) was deficient in that it did not accommodate larger vehicles and the slip lane on Surfside Road was not long enough to be beneficial. In order for northbound right turns to have sufficient access to the slip lane by not being block by the queue of the left and through traffic on Surfside Road, the lane would need to be extended to Vesper Lane. To avoid the Elm tree, the slip lane has been located on the school property. The parking lot entrance on Surfside could be relocated to Sparks Avenue with no loss of parking spaces. It is unclear as to where the current school crosswalk (*Figure 6*) on Surfside Road at Vesper Lane should be relocated. Prospect Street and Sparks Avenue have been realigned more severely than shown in the original concept to facilitate turning movements by larger vehicles. This alignment requires the need to relocate two houses owned by the hospital on Prospect Street and the potential construction of a retaining wall for the home at 77 Sparks Avenue. Crosswalks on all four approaches can be provided. Approximately four utility poles would require relocation but the Elm tree and telephone boxes would be untouched. Using the traffic volumes projected in the Mid-Island Study, this alternative is expected to operate poorly with significant driver delay.



Figure 6 – Looking south on Surfside Drive

Other alternatives were dismissed:

- Sparks Avenue realignment – Sparks Avenue approaches Surfside Road/ Atlantic Avenue at an acute angle that makes vehicle turning movements difficult. By realigning the roadway to form a traditional 'T' intersection with Surfside Road/ Atlantic Avenue vehicle movements would be easier. However, there would be minimal separation to the intersection with Prospect Street. Vehicle movement turning counts identify a large proportion of traffic from Prospect Street heading to Sparks Avenue. A vehicle would have to make a right off Prospect Street and then wait for a gap in traffic before turning left onto Sparks Avenue. With narrow lanes and the short distance between locations, the intersection would quickly grid-lock during peak travel periods.
- Roundabout with 3 approaches - The school property has a generous lawn on the southeast corner that was considered for the placement of a roundabout. Atlantic Avenue would be realigned to form a 'T' intersection with Prospect Street. Through and left-turning traffic from Atlantic Avenue traffic would enter the traffic stream on Prospect Street and together they would enter the roundabout as a single approach. This alternative was discarded for several reasons. The circle has to accommodate the WB-50 design vehicle and the right turn from Surfside Road northbound to Sparks Avenue is complicated by the location of the Elm tree. The circle would end up close to the realigned intersection of Prospect Street and Atlantic Avenue, leaving insufficient room for Atlantic Avenue traffic to combine with Prospect Street prior to entering the circle.
- Signalization – The intersection does meet several vehicular volume warrants and has potential to reach the school crossing criteria. However a traffic signal is undesirable on the Island. Vehicle turning movements would remain difficult without significant roadway widening and/or realignment. To obtain acceptable levels of service, exclusive turn lanes on several approaches would be required.

TRAFFIC OPERATIONS ANALYSIS

This memorandum utilizes the projected 2014 volumes from the Mid-Island Study based on 2004 traffic counts for the analysis. MassHighway does not typically accept traffic counts more than three years old. However a review of the count data provided by MassHighway shows little growth on various parts of the island since 2003. The 2014 project volumes assumed a 3% per year growth rate and therefore are considered to be conservative and have not been adjusted.

The capacity analyses for the roundabout alternatives were performed using *aaSIDRA*². Stop-controlled alternatives were analyzed utilizing *HCS2000*³. Both software programs are recognized and accepted by MassHighway for performing unsignalized intersection capacity analysis.

Level-of-Service Criteria

Level-of-service (LOS) is the term used to denote the different operating conditions which occur on a given roadway segment under various traffic volumes loading. It is a qualitative measurement of the effect of a number of factors including roadway geometry, speed, travel delay and freedom to maneuver. LOS provides an index to the operational qualities of a roadway segment or an intersection with letter designations ranging from A to F. LOS A represents the best operating condition, and LOS F represents the worst operating condition.

The level-of-service designation is reported slightly differently for signalized and unsignalized intersections. For signalized intersections, the analysis considers the operations of all traffic entering the intersection and the LOS designation is for the overall operations at the intersection. For unsignalized intersections, the analysis assumes that the traffic on the mainline is not affected by traffic on the side streets. Therefore, LOS designations are determined for the critical movements at the intersection, which are typically the turning movements. The evaluation criteria used to analyze the study intersection are based on the Highway Capacity Manual⁴. It has been common practice and recommended by the Transportation Research Board to utilize the signalize intersection criteria for roundabouts. Criteria are shown in the following table.

<u>Level of Service</u>	<u>Unsignalized Intersection Delay Range (sec/veh)</u>	<u>Roundabout Control Delay (sec/veh)</u>
A	0-10	< 10
B	> 10-15	> 10 - 20
C	> 15-25	> 20 - 35
D	> 25-35	> 35 - 55
E	> 35-50	> 55 - 80
F	> 50	>80

Source: Highway Capacity Manual 2000, Transportation Research Board, Washington, DC, 2000.

Capacity Analyses Discussion

Three different peak periods were reviewed for all selected alternatives: weekday morning, weekday evening and Saturday mid-day. The results are summarized in the table on the next page.

Both roundabout alternatives, under 2014 design year, are expected to operate at excellent levels of service. Prospect Street may experience queue lengths over 200 feet during peak travel times and under Alternative 2, Surfside Road could have queues reaching 300 feet. Alternative 3 reports much higher queues and significantly higher vehicle delay.

² *Signalized & Unsignalized Intersection Design & Research Aid, aaSIDRA 3.2.0 1455 Version*; Akcelik & Associates Pty Ltd. Greyhorn, Victoria, Australia; 2007.

³ *Highway Capacity Software, HCS2000 Version 4.1f*; McTrans, University of Florida; 2003.

⁴ *Highway Capacity Manual 2000*; Transportation Research Board, Washington, D.C.; 2000.

Capacity Analysis Summary – 2014 Volumes

	Alternative 1				Alternative 2				Alternative 3			
	V/C*	Delay**	LOS***	95 th Queue ⁽¹⁾	V/C	Delay	LOS	95 th Queue	V/C	Delay	LOS	95 th Queue ⁽²⁾
Weekday Morning												
Prospect Street - LTR	0.58	6.1	A	161	0.61	7.2	A	178	0.84	32.88	D	245
Sparks Avenue - LTR	0.56	6.3	A	129	0.54	6.7	A	143	0.86	36.24	E	263
Surfside Road - LT	0.42	3.5	A	66	0.74	9.5	A	282	0.64	20.45	C	122
Atlantic Avenue - LTR	0.26	4.5	A	51	0.28	4.9	A	55	0.45	15.95	C	75
Overall	0.58	5.1	A		0.74	7.6	A			29.16	D	
Weekday Evening												
Prospect Street – LTR	0.74	13.9	B	271	0.78	16.5	B	303	1.00	77.57	F	506
Sparks Avenue – LTR	0.57	6.9	A	135	0.55	7.3	A	147	1.00	77.56	F	490
Surfside Road – LT	0.39	3.5	A	64	0.70	8.7	A	250	0.66	27.60	D	145
Atlantic Avenue – LTR	0.47	5.8	A	101	0.47	6.6	A	112	0.73	31.79	D	177
Overall	0.75	7.5	A		0.79	10.1	B			59.57	F	
Saturday Midday												
Prospect Street – LTR	0.65	8.7	A	203	0.69	10.3	B	226	0.89	39.65	E	292
Sparks Avenue – LTR	0.55	6.2	A	123	0.53	6.5	A	136	0.90	43.33	E	308
Surfside Road – LT	0.52	3.6	A	83	0.76	9.4	A	312	0.60	20.21	C	112
Atlantic Avenue – LTR	0.32	4.6	A	64	0.34	5.0	A	69	0.52	18.08	C	92
Overall	0.67	5.7	A		0.76	8.4	A			33.99	D	

* V/C -- Volume-to-capacity ratio.

** Average Intersection delay, expressed in seconds per vehicle.

*** LOS -- Level-of-Service.

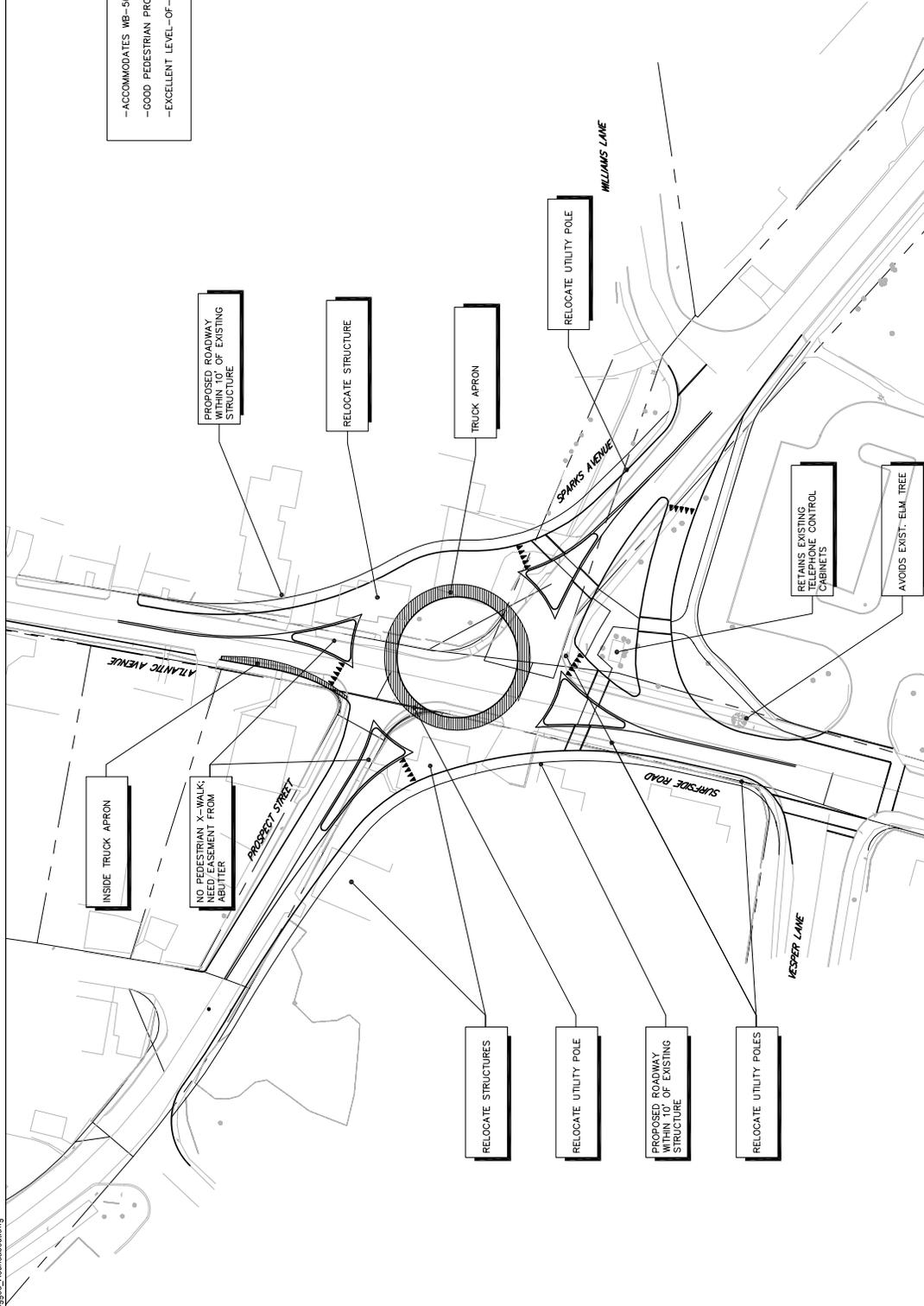
(1) 95th queue expressed in feet

(2) Calculated using methodology outlined in Tian and Kyle, *Transportation Research Record: Journal of the Transportation Research Board*, No. 1988, Transportation Research Board of National Academics, Washington D.C. 2006

CONCLUSION AND RECOMMENDATION

The existing configuration of the intersection and the components of the three design alternatives are compared in Exhibit 1. Based on our review of the data (i.e., existing geometry, traffic volumes, vehicle crashes, pedestrian activity, crash data, and utility constraints) we recommend Alternative 1 as the preferred alternative. Although it requires the relocation of 3 residential structures and potential zoning waivers of two additional structures, it is our opinion that the 120' diameter roundabout will ensure a design that will accommodate vehicle and pedestrian traffic for many years to come and at the same time fit into the character of Nantucket.

DRAFT

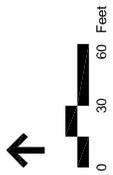


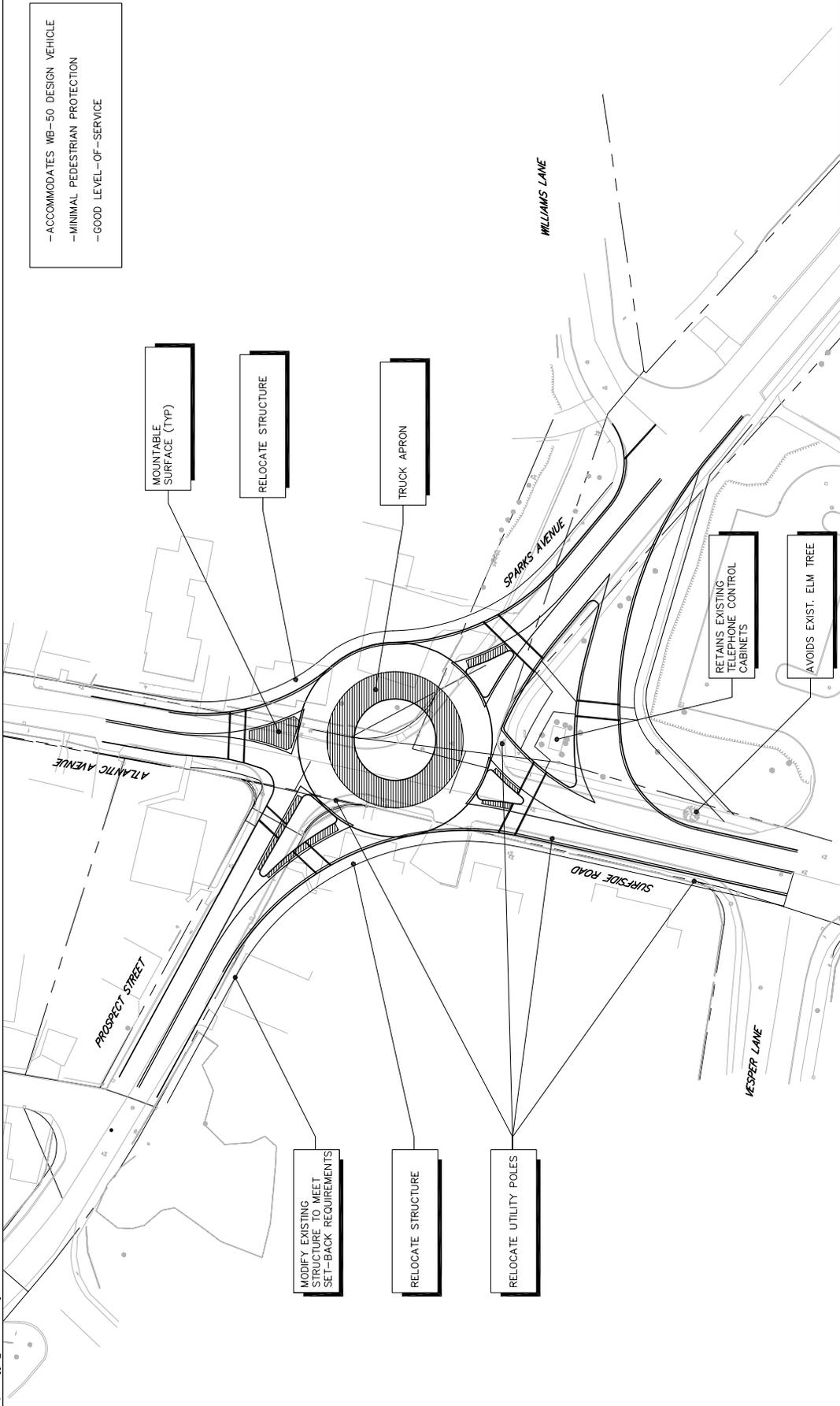
-ACCOMMODATES WB-50 DESIGN VEHICLE
 -GOOD PEDESTRIAN PROTECTION
 -EXCELLENT LEVEL-OF-SERVICE

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Figure 1

Alternative 1
 Four Corners Intersection
 Nantucket, MA





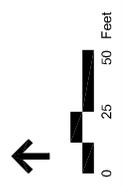
Vanasse Hangen Brustlin, Inc.

Figure 2

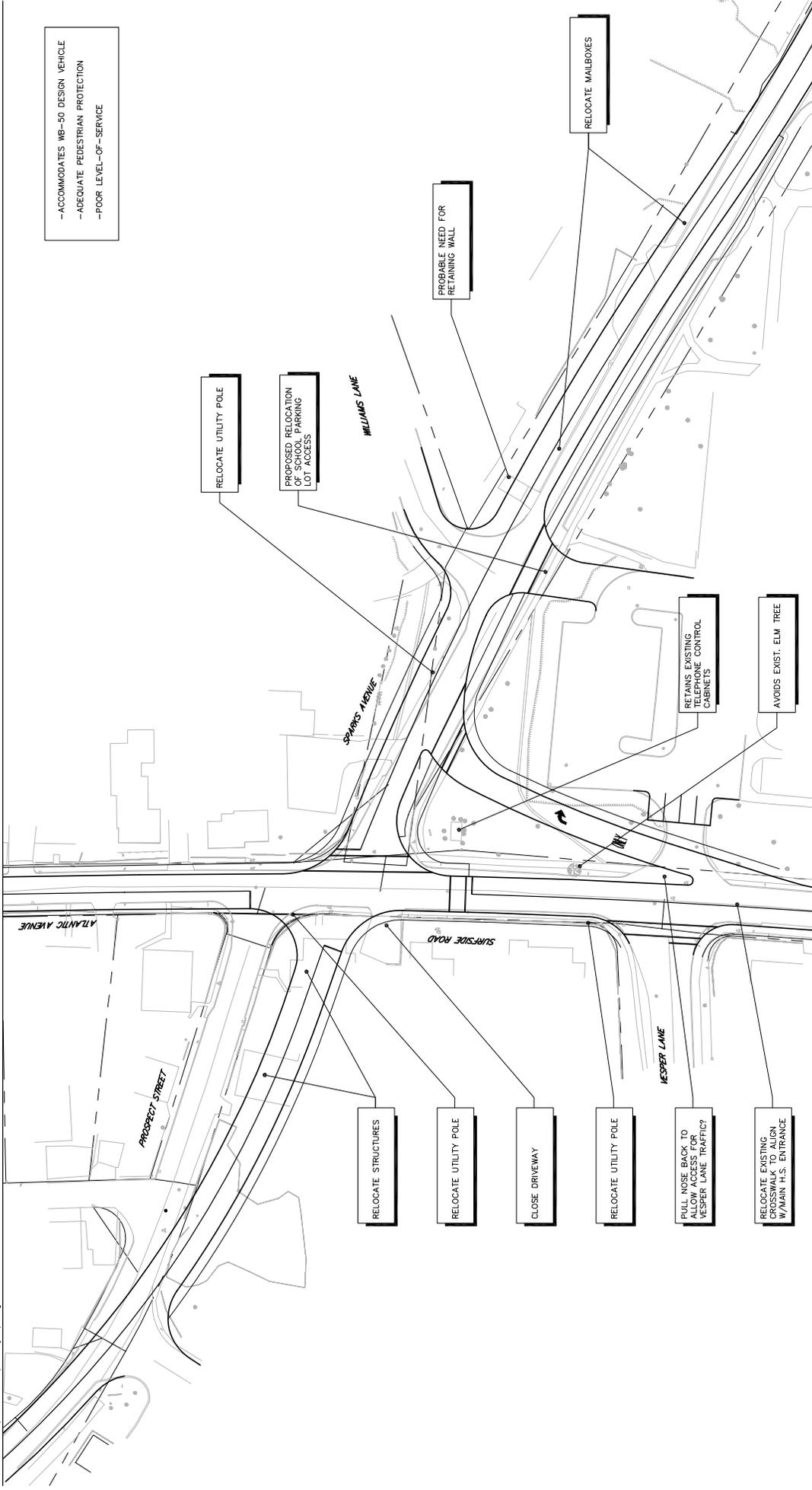
Alternative 2

Four Corners Intersection

Nantucket, MA



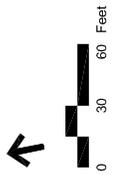
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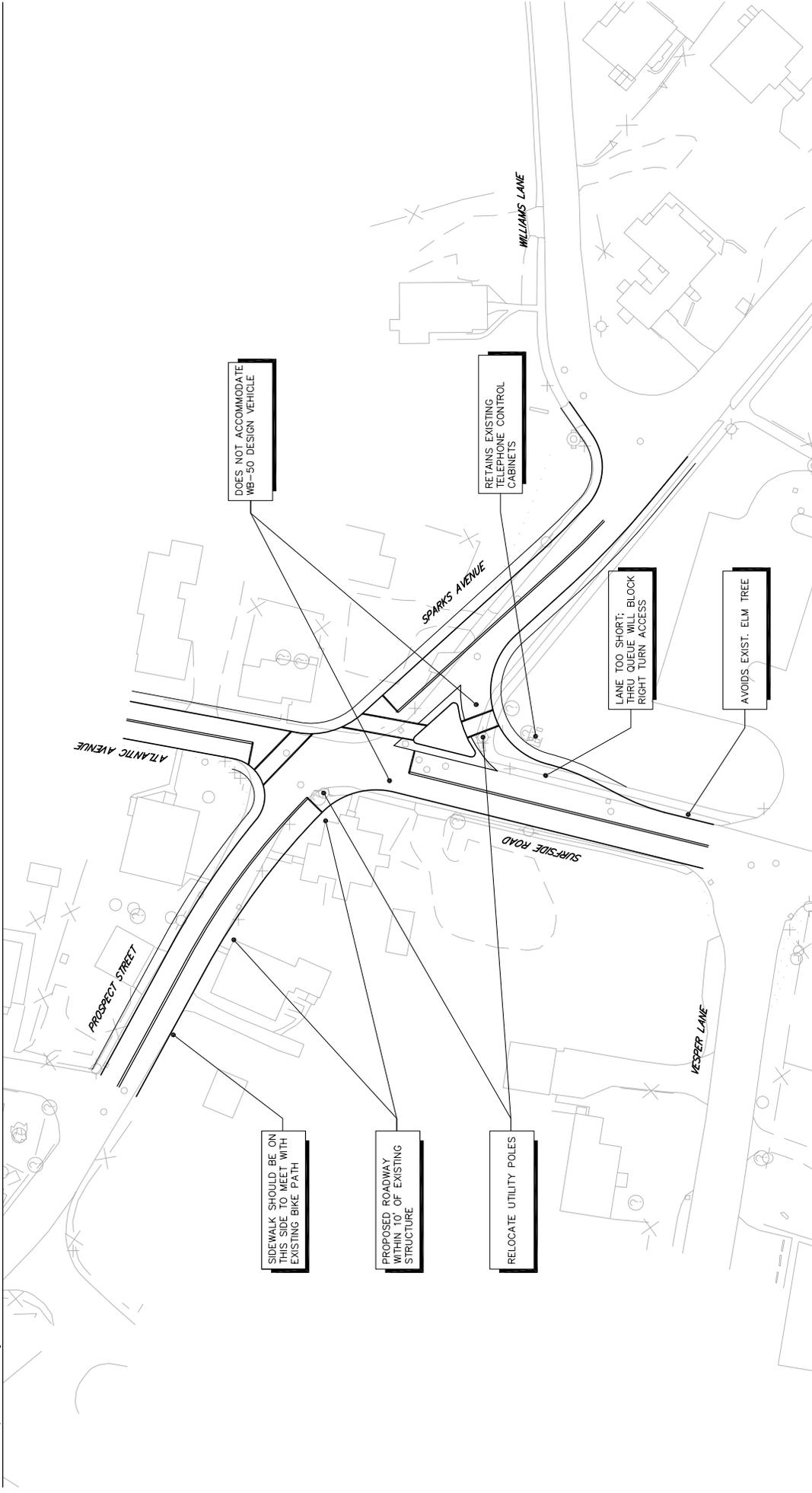


- ACCOMMODATES WB-50 DESIGN VEHICLE
- ADEQUATE PEDESTRIAN PROTECTION
- POOR LEVEL-OF-SERVICE

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Figure 3
Alternative 3
Four Corners Intersection
Nantucket, MA





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Figure 4

Original Concept
Four Corners Intersection
Nantucket, MA

