REF: MAX-2010041.00

DRAFT

DATE: November 10, 2010

TO: Mr. Mike Burns
Nantucket Planning & Economic Development Commission
16 Broad Street
Nantucket, Massachusetts 02554

FROM: Mr. John W. Diaz, P.E., P.T.O.E., Project Manager
Mr. Colin White, E.I.T., Assistant Engineer

RE: Technical Memorandum
Alternative Traffic Control Analysis
Surfside Road at Bartlett Road
Nantucket, Massachusetts

Greenman-Pedersen, Inc. (GPI) has conducted this study to evaluate alternative traffic control operations at Surfside Road at Bartlett Road in Nantucket, Massachusetts.

Surfside Road at Bartlett Road is a T-type intersection with Bartlett Road being the minor street approach under stop control. This study will evaluate four proposed operations utilizing:

- all way stop control
- stop control on Bartlett Rd only w/ a raised intersection
- stop control on Bartlett Rd only w/ two lanes on Bartlett Rd
- roundabout control

This study builds on data and recommendations presented in the *Traffic Study & Strategy for the Mid-Island Area* in order to evaluate existing and proposed operations.

EXISTING CONDITIONS

Surfside Road at Bartlett Road is a T-type intersection with Bartlett Road being the minor street approach currently under stop control. Single approach lanes are present on all three legs of this intersection. The Surfside Road Bicycle Path is located on the westerly side of Surfside Road. A crosswalk is present across the Bartlett Road approach; however, the existing crosswalk is set back away from the intersection and cars often block the crosswalk forcing bike and pedestrians to negotiate through stopped vehicles. The Bartlett Road Bicycle Path is located on the south side of Bartlett Road connecting with the Surfside Road Bicycle Path. The Nantucket Elementary School is located to the north of this intersection, on the east side of Surfside Road. Sight distance is limited at this intersection looking to the north from Bartlett Road due to the horizontal alignment of Surfside Road and vegetation.

Surfside Road consists of two ten foot lanes with one foot shoulders and Bartlett Road consists of two 9.5 to 10 foot lanes. The pavement on Surfside Road is in good condition as it appears to have been recently paved. The pavement on Bartlett Road is in good condition with little to no cracking. Bartlett Road consists of a double yellow center line, a stop line and ten foot crosswalk lines. Surfside road consists of a double yellow center line and two solid white edge lines. Stop signs are located along the Bartlett Road approach and along the two bike path approaches to the crosswalk. There is a street light on the utility pole in the northwest corner and there are additional street lights along Surfside Road and Bartlett Road. An aerial picture of the intersection is shown below.

The Nantucket Regional Transit Authority has two routes through the intersection. The Miacomet Loop runs northbound on Surfside Road and turns left onto Bartlett Road. The Mid Island Loop runs southbound on Surfside Road and continues straight through the intersection.

Traffic Volumes

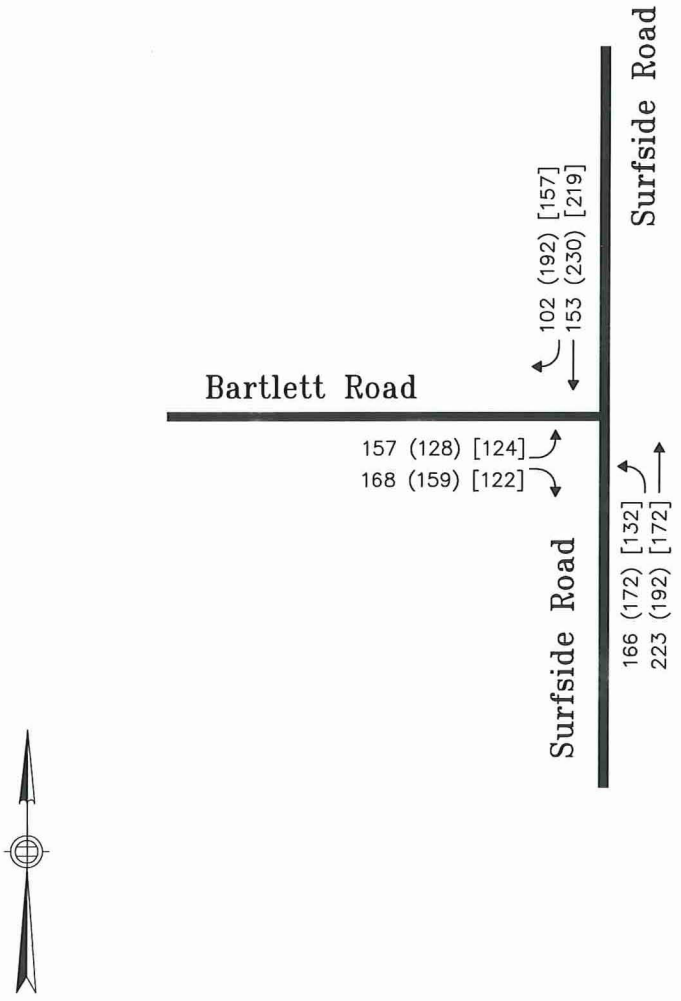
GPI conducted new traffic counts at the study location in September 2009. Manual Turning Movement Counts (TMCs) were completed on September 11th and September 21st 2010 and Automatic Traffic Recorder (ATR) Counts were collected from September 11th to September 21st along each leg of the intersection. Figure 1 depicts the 2010 TMC volumes and Table 1 depicts the ATR volumes. The traffic count data is provided in the Appendix.

Traffic on a given roadway typically fluctuates throughout the year depending on the area and the type of roadway. To determine if the data required adjustment to account for this fluctuation, Massachusetts Department of Transportation (MassDOT) seasonal adjustment factors were reviewed. Based on statewide 2007 weekday traffic data for recreational routes, September volumes are expected to be approximately 7% higher than average-month conditions. Therefore, the September 2010 volumes were not factored in order to reflect conservative average-month conditions. The seasonal adjustment worksheet is provided in the Appendix.

Table 1
EXISTING AVERAGE MONTH TRAFFIC VOLUME SUMMARY[a]

Location/Time Period	Daily Volume[a] (vpd)[b]	Peak Hour Volume (vph)[c]	K Factor (%)[d]	Directional Distribution[e]
Surfside Road				
South of Bartlett Road:				
Weekday	9,117			
AM Peak Hour		604	6.6	54% NB
PM Peak Hour		841	9.2	52% SB
Weekend				
Midday Peak Hour	8,254	695	8.4	52% NB
Bartlett Road				
West of Surfside Road:				
Weekday	7,044			
AM Peak Hour		500	7.1	56% EB
PM Peak Hour		608	8.6	58% WB
Weekend	6,992			
Midday Peak Hour		591	8.5	51% EB

[a]September 2010 traffic volumes.
[b]In vehicles per day.
[c]In vehicles per hour.
[d]Percentage of daily traffic occurring during the peak hour.
[e]NB = northbound; SB = southbound; EB=eastbound; WB=westbound



2010 Wkdy AM (PM) [Sat] PHV

Figure 1

2010 Peak Hour Volumes
Not To Scale

Accidents

Accident data for the intersection was gathered from the Nantucket Police Department for the period between 2007 and 2009. During that period, a total of ten accidents (or 3.3 per year) were reported. While the number of accidents is important, the accident rate is a more effective measure of safety. The accident rate accounts for the volume of traffic when examining crash statistics. The intersection of Surfside Road at Bartlett Road experienced a crash rate of 0.77 accidents per million entering vehicles (acc/mev). This is higher than the district wide (0.59 acc/mev) and statewide (0.66 acc/mev) averages for unsigalized intersections, and therefore may be indicative of a safety problem. A contributing factor may be the sight-distance restrictions looking north from Bartlett Road. Thirty percent were cross movement accidents and forty percent were rear end accidents. Thirty percent of the accidents occurred during peak hours and thirty percent occurred during wet or rainy conditions. Two of the accidents involved personal injury. One of the injuries was fatal. The fatal injury involved a moped with a broken head light turning on to Bartlett Street in front of an oncoming vehicle. Table 2 summarizes the accidents. The crash reports and crash rate worksheet are provided in the Appendix.

Table 2
ACCIDENT SUMMARY

	Number of Accidents		Severity [a]			Accident Type [b]						Percent During	
Location (crash rate)	Total	Average per Year	PD	PI	F	CM	RE	HO	FO	SS	NR	Peak Hours	Wet/Icy Conditions
Surfside Road at Bartlett Road **(0.77 acc/mev)***	10	3.33	8	1	1	3	4	1	0	2	0	33%	33%

Source: Nantucket Police Department.
* acc/mev = accidents per million entering vehicles.
[a]PD = property damage only; PI = personal injury; F = fatality.
[b]CM = cross movement/angle; RE = rear end; HO = head on;
FO = fixed object; SS = sideswipe; NR=not reported.

DESIGN YEAR CONDITIONS

The design for improvements to the study location is based on volume conditions projected to a future design year. A ten-year projection is utilized for this project, which is suggested by MassDOT.

Based on the Mid-Island Traffic Study and Strategy prepared by GPI (2005) and current traffic volumes, a growth rate of 3.0% has been assumed for this area. This growth rate was compounded for the ten-year design year horizon and applied to the existing 2010 traffic volumes. The 2020 design volumes are shown on Figure 7 for the weekday AM, weekday PM and weekend Midday peak average month hours.

PROPOSED ALTERNATIVES

All Way Stop Condition – For an all way stop controlled intersection to be considered, certain criteria must be met. Based on the 2009 MUTCD, certain warrants for All Way Stop Control should be satisfied. These include at least eight hours of 300 vehicles or more on the major street and 200 vehicles or more on the minor street. Based on both 2010 and 2020 volumes, this intersection meets those requirements.

For this alternative, stop lines and signs would be added to both Surfside Road approaches making this a 3-way stop controlled intersection. Since all vehicles are required to stop, it is anticipated that safety would be improved and fewer accidents would likely occur resulting from poor sight distances. A conceptual rendering is shown in Figure 2. Since the current stop line for Bartlett Road is set back from the intersection along with the crosswalk, sight distances to the north are limited and some blocking of the crosswalk occurs. The crosswalk and stop line for Bartlett Road would be moved closer to the intersection and the bike path would be realigned to meet the crosswalk. This would make the intersection safer for path users by making them more visible. The utility pole in the northwest corner of the intersection would need to be relocated due to the bike path realignment. This alternative would require little or no property taking or permanent easements.

The operations for the 2010 volumes appear to be well balanced between all approaches, thus an all way stop control works well with an overall LOS of C for the intersection. However, when the volumes are grown ten years at three percent, the morning and evening peak hours experience failing LOS's. The cost for these improvements is estimated between $20,000 and $30,000 with most of the cost being attributed to the realignment of the bike path.

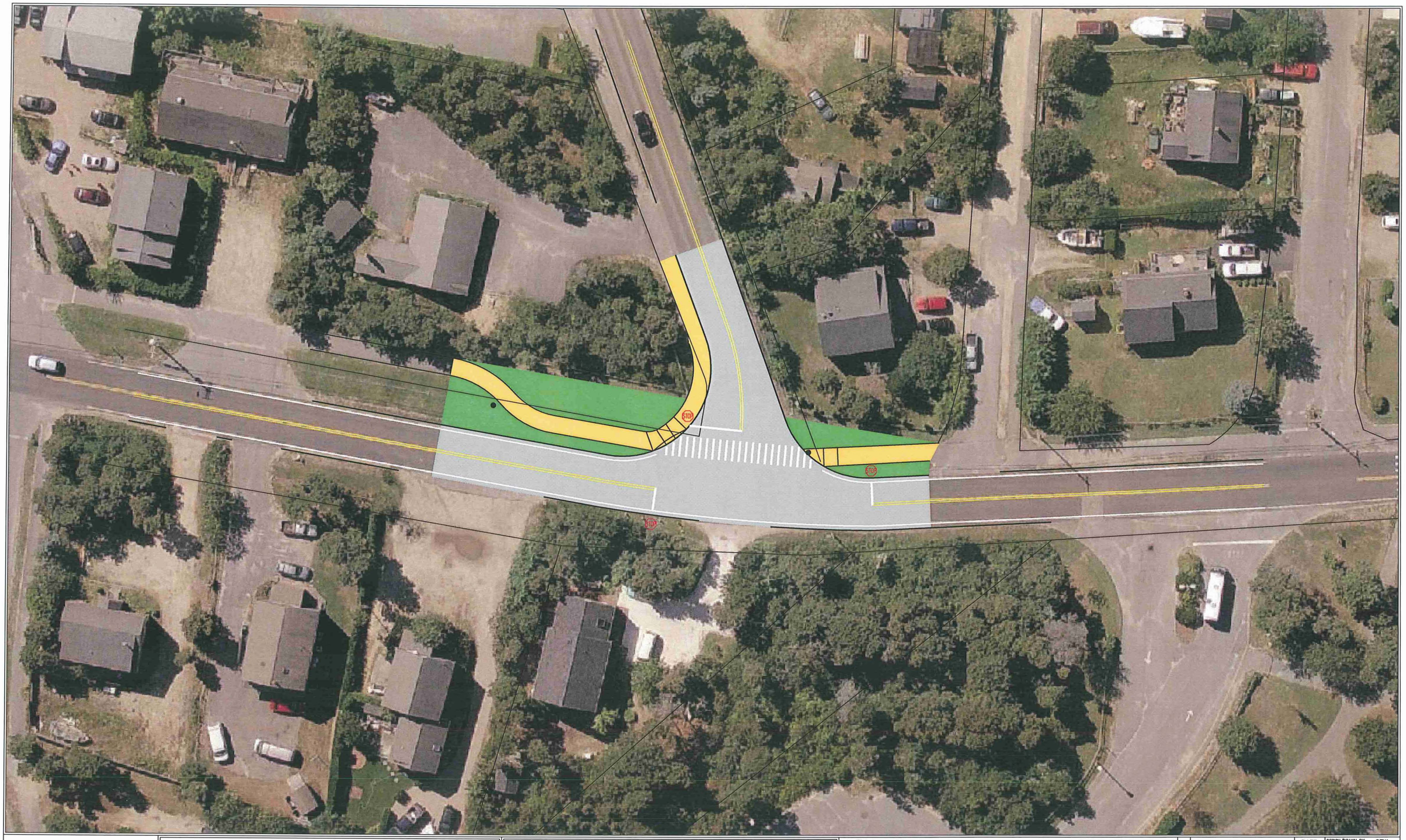
Roundabout Condition – A full roundabout would require significant construction (full depth construction) and property taking. The roundabout would encroach on three private properties. Multiple trees would need to be removed and the utility pole in the northwest corner of the intersection would need to be relocated. The bike path would also need to be relocated to cross Bartlett Road further to the west. A conceptual rendering is shown in Figure 3.

The operations for the roundabout are very good for the present 2010 year with all approaches having a LOS A. For the future year, all approaches have a LOS B or better. A roundabout increases driver and pedestrian safety mainly because of the low travel speed for vehicles in the roundabout. The cost for these improvements is estimated between $500,000 and $600,000 not including right of way costs.

Mini-Roundabout Condition – The construction of a mini-roundabout was explored because this intersection met the requirements of a mini-roundabout. The requirements from the FHWAs technical summary on mini-roundabouts include approach speeds of 30MPH or less, Average Daily Traffic of 15,000 or less and an inscribed circle diameter of not more than 90 feet.

A mini-roundabout would require minimal full depth construction and no property taking. Non-mountable splitter islands and a mountable center island would also be required. The bike path would need minimal realignment and would cross Bartlett Road at the splitter island. A conceptual rendering is shown in Figure 4.

The operations for the mini-roundabout are expected to be similar to that of a full roundabout. A roundabout increases driver and pedestrian safety mainly because of the low travel speed for vehicles in the roundabout. The cost for building a mini-roundabout is estimated between $60,000 and $80,000, which is considerably less than the full roundabout.



GRAPHIC SCALE
0 20 40 60 FEET

FIGURE 2
SURFSIDE RD AT BARTLETT RD
CONCEPTUAL PLAN
NANTUCKET, MA

PROJECT: **DESIGN SERVICES FOR THE TRANSPORTATION IMPROVEMENT PROJECT**

NANTUCKET, MASSACHUSETTS

PREPARED FOR: Town of Nantucket

GPI Greenman-Pedersen, Inc.
Engineers, Architects, Planners, Construction Engineers & Inspectors
105 Central Street, Suite 4100, Stoneham MA 02180, Tel. (781) 279-5500
61 Spit Brook Road, Suite 110, Nashua NH 03060, Tel. (603) 891-2213
800 South Main Street, Mansfield MA 02048, Tel. (508) 339-9350
Other Offices In: FL, MD, MI, NJ, NY, OH, PA, VA, VT, WA http://www.gpinet.com

NO.	REVISION	DATE

DESIGN/DRAWN BY:	CTW
CHECK BY:	NFC
DATE:	10/15/2010
SCALE:	1"=40'
JOB NO.:	MAX-2010041.00
FILE NAME:	
DRAWING NO.:	1 OF 5

GRAPHIC SCALE
0 20 40 60 FEET

FIGURE 3
SURFSIDE RD AT BARTLETT RD
CONCEPTUAL PLAN
NANTUCKET, MA

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FILE NAME:	
DRAWING NO.:	2 OF 5

GRAPHIC SCALE

0 20 40 60 FEET

FIGURE 4
SURFSIDE RD AT BARTLETT RD
CONCEPTUAL PLAN
NANTUCKET, MA

PROJECT: **DESIGN SERVICES FOR THE TRANSPORTATION IMPROVEMENT PROJECT**

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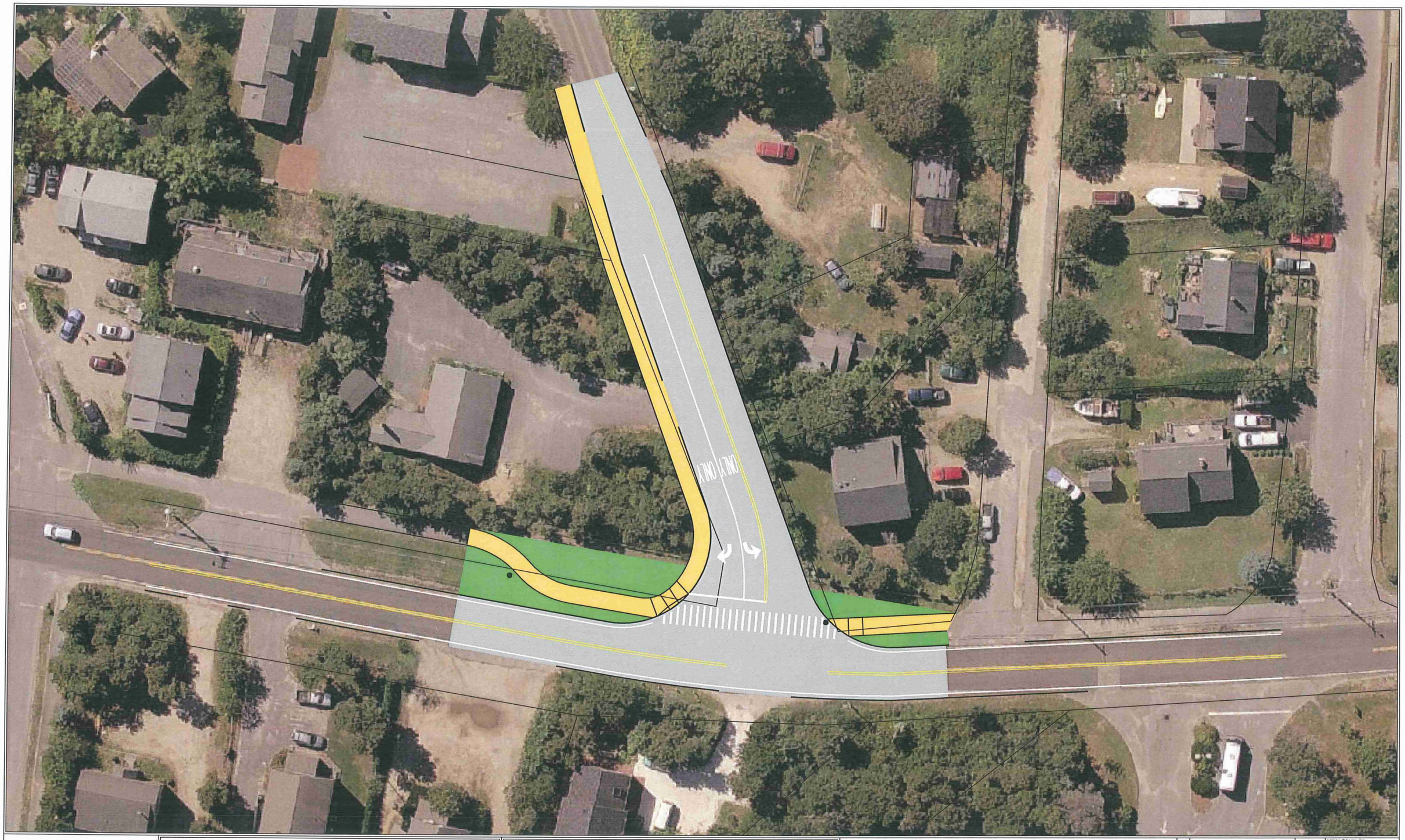

GRAPHIC SCALE
0 20 40 60 FEET

FIGURE 5
SURFSIDE RD AT BARTLETT RD
CONCEPTUAL PLAN
NANTUCKET, MA

PROJECT: **DESIGN SERVICES FOR THE TRANSPORTATION IMPROVEMENT PROJECT**

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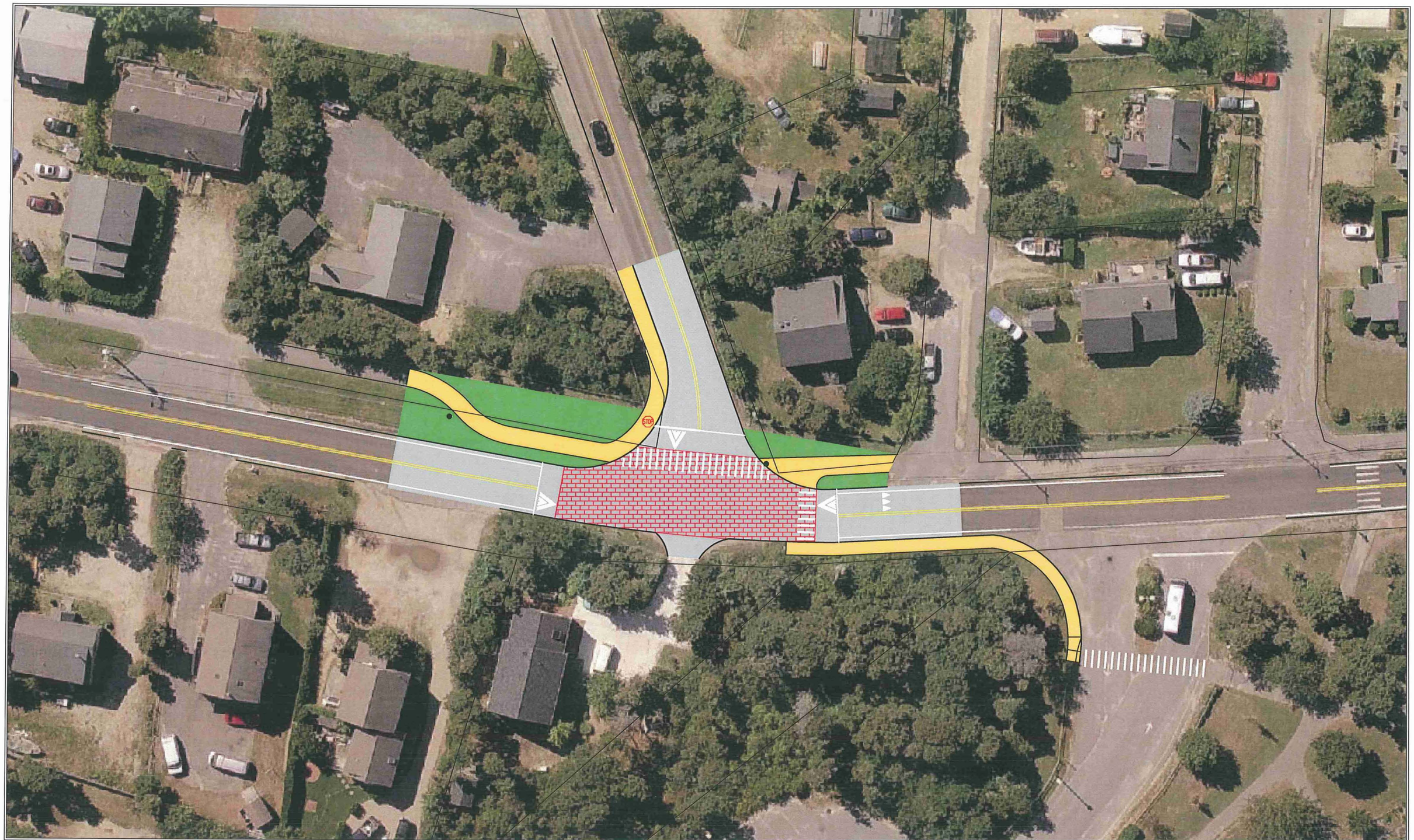

GRAPHIC SCALE

0 20 40 60 FEET

FIGURE 6
SURFSIDE RD AT BARTLETT RD
CONCEPTUAL PLAN
NANTUCKET, MA

PROJECT: **DESIGN SERVICES FOR THE TRANSPORTATION IMPROVEMENT PROJECT**

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DRAWING NO.:	5 OF 5

Turning Lanes on Bartlett Road – For this alternative, a right turn lane would be added to Bartlett Road and the existing lane would become a left turn only lane. This would require widening Bartlett Road with minor full depth construction and would require property taking to accommodate the additional lane. The crosswalk and stop line for Bartlett Road would be moved closer to the intersection and the bike path would be realigned to meet the crosswalk. The utility pole in the northwest corner of the intersection would need to be relocated due to the bike path realignment. A conceptual rendering is shown in Figure 5.

The operations for this alternative are better than existing operations; however the Bartlett Road approach continues to fail (LOS F) under the 2020 design year. The Bartlett Road approach has a LOS E or D in the present year which is acceptable but not desirable. This alternative increases safety only because the crosswalk on Bartlett Road would be moved closer to the intersection. The cost for building these improvements is estimated between $80,000 and $100,000, not including right of way costs.

Raised Intersection – For this alternative, the lane geometry would not change but the intersection would be raised six inches. Ten foot long ramps would be constructed on each approach at the raised pavement. The crosswalk over Bartlett Road would be on the raised portion of the intersection and the bike path would be realigned to meet the crosswalk. The utility pole in the northwest corner of the intersection would need to be relocated due to the bike path realignment. This alternative includes an additional crosswalk on Surfside Road on the northern portion of the raised intersection, although this crosswalk could be added to some of the other alternatives if desired. A sidewalk would be built on the east side of Surfside Road from the crosswalk to the school entrance and a crosswalk would connect the proposed sidewalk with the existing on the other side of the school driveway. A conceptual rendering is shown in Figure 6.

The operations and safety for this alternative are expected to be slightly better than existing operations because the raised intersection will slow down traffic along Surfside Road. However, LOS F is still expected along Bartlett Road for the 2010 and 2020 peak hours. The cost for building these improvements is estimated to be $150,000 to $175,000 with approximately $8,000 of that cost for the additional crosswalks and sidewalks.

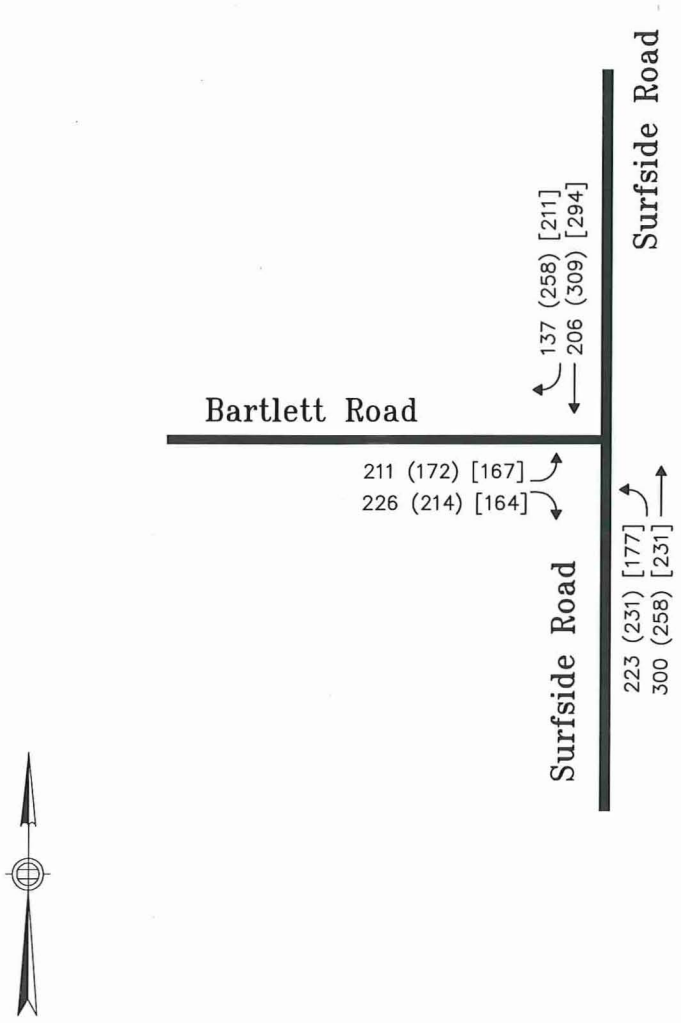
CAPACITY ANALYSIS METHODOLOGY

A primary result of capacity analysis is the assignment of levels of service to traffic facilities under various traffic flow conditions. The capacity analysis methodology is based on the concepts and procedures in the Highway Capacity Manual (HCM).[1] The concept of level of service (LOS) is defined as a qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers. A level-of-service definition provides an index to quality of traffic flow in terms of such factors as speed, travel time, freedom to maneuver, traffic interruptions, comfort, convenience, and safety.

Six levels of service are defined for each type of facility. They are given letter designations from A to F, with LOS A representing the best operating conditions and LOS F the worst. Since the level of service of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of levels of service, depending on the time of day, day of week, or period of year. A description of the operating condition under each level of service is provided below:

- *LOS A* describes conditions with little to no delay to motorists.
- *LOS B* represents a desirable level with relatively low delay to motorists.
- *LOS C* describes conditions with average delays to motorists.
- *LOS D* describes operations where the influence of congestion becomes more noticeable. Delays are still within an acceptable range.
- *LOS E* represents operating conditions with high delay values. This level is considered by many agencies to be the limit of acceptable delay.
- *LOS F* is considered to be unacceptable to most drivers with high delay values that often occur, when arrival flow rates exceed the capacity of the intersection.

[1] *Highway Capacity Manual 2000*, Transportation Research Board; Washington, D.C.; 2000.



2020 Wkdy AM (PM) [Sat] PHV

Figure 7
2020 Peak Hour Volumes
Not To Scale

Unsignalized Intersections

Levels of service for unsignalized intersections are calculated using the operational analysis methodology of the HCM. The procedure accounts for lane configuration on both the minor and major street approaches, conflicting traffic stream volumes, and the type of intersection control (STOP, YIELD, or all-way STOP control). The definition of level of service for unsignalized intersections is a function of average control delay. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. The level-of-service criteria for unsignalized intersections are shown in Table 3.

Roundabout Configurations

Levels of service criteria for roundabouts are not provided in the HCM. However, aaSIDRA (software package utilized in this study to analyze roundabouts) applies signalized intersection LOS criteria to roundabouts. aaSIDRA uses its own procedure for estimating delay based on its own methods and procedures. Table 3 summarizes the relationship between level of service and average control delay.

Table 3
LEVEL-OF-SERVICE CRITERIA FOR INTERSECTIONS

Level of Service	Unsignalized Intersection Criteria Average Control Delay (Seconds per Vehicle)	Roundabout Criteria Average Control Delay (Seconds per Vehicle)
A	≤10	≤10
B	>10 and ≤15	>10 and ≤20
C	>15 and ≤25	>20 and ≤35
D	>25 and ≤35	>35 and ≤55
E	>35 and ≤50	>55 and ≤80
F	>50	>80

Source: *Highway Capacity Manual 2000*, Transportation Research Board; Washington, D.C.; 2000. Page 17-2.

For roundabouts, this delay criterion may be applied in assigning level-of-service designations to individual lane groups, to individual intersection approaches, or to the entire intersection. For unsignalized intersections, this delay criterion may be applied in assigning level-of-service designations to individual lane groups or to individual intersection approaches.

CAPACITY ANALYSIS RESULTS

Level-of-service analyses were conducted at the study area location for four alternatives under the Existing and Proposed configurations while utilizing 2010 and projected 2020 traffic volumes. The capacity analysis methodology is based on the concepts and procedures in the HCM or aaSIDRA software as previously described. Tables 4 through 7 show the level-of-service results while the analysis worksheets for all conditions are provided in the Appendix.

Existing Conditions – Under existing conditions, the intersection of Bartlett Road and Surfside Road has a failing LOS on Bartlett Road in both the AM and PM Peak Hours while the Saturday Midday Peak Hour has a LOS D. Both Surfside Road approaches have a LOS of A. In the year 2020, operations for Bartlett Road will worsen incrementally to have delays of around 500 sec/veh and v/c ratios of around 2.0 mev/hour while Surfside Road will stay at LOS A. Table 4 summarizes the analysis.

Two Lanes on Bartlett Road – In this option, Bartlett Road consists of separate left and right turn lanes. This improves the operations on Bartlett Road from a LOS F to a LOS E during the 2010 year, but under the 2020 design year operations worsen to a LOS F with delays of 160 seconds and v/c ratios of 1.60. Surfside Road has good operations with LOS A, delays of ten seconds or less and v/c ratio of 0.30 or less. Table 5 summarizes the analysis.

All Way Stop Control – Adding stop signs to both Surfside Road approaches improves overall operation in 2010 to at least a LOS C and delays of around twenty seconds. Although the Surfside Road operations decreased some, Bartlett Road operations increased dramatically. In the future year of 2020, operations worsen to LOS F for the eastbound and northbound approaches in the AM and the northbound and southbound in the PM. In the PM, delays reach 137 seconds with a degree of saturation of 1.22. Overall delay for this approach is 90 seconds. Table 6 summarizes the analysis.

Roundabout – With the implementation of a roundabout, a LOS A is expected for all approaches for the existing 2010 year. For the future year of 2020, a LOS B or better is expected.
While calibration methods and capacity methodology has not yet been finalized (the FHWA technical summary of mini-roundabouts (FHWA-SA-10-007) states that "operational performance models for mini-roundabouts have not been developed for U.S. conditions. The calibration to U.S. drivers of international models, such as those from the U.K., has not been determined."), it is expected that many of the operational characteristics (delays, v/c, LOS) of a mini-roundabout would be similar to a standard modern roundabout. Table 7 summarizes the analysis.

Table 4

UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE ANALYSIS SUMMARY 2010 EXISTING CONDITIONS

	2010 AM Peak Hour				2010 Midday Peak Hour				2010 PM Peak Hour			
Location/Movement	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Surfside Rd at Bartlett Rd												
Bartlett Rd EB left/right	0.99	74.0	F	299	0.70	32.4	D	132	0.90	59.8	F	221
Surfside Rd NB left/thru	0.15	8.5	A	14	0.14	8.7	A	12	0.18	9.2	A	17
Surfside Rd SB Thru/right	0.00	0.0	A	0	0.00	0.0	A	0	0.00	0.0	A	0
Overall Intersection	--	--	--	--	--	--	--	--	--	--	--	--

[a]Volume to capacity ratio.
[b]Average control delay in seconds per vehicle.
[c]Level of service.
[d]95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 4 Cont.

UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE ANALYSIS SUMMARY 2020 EXISTING CONDITIONS

	2020 AM Peak Hour				2020 Midday Peak Hour				2020 PM Peak Hour			
Location/Movement	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Surfside Rd at Bartlett Rd												
Bartlett Rd EB left/right	2.03	505.7	F	982	1.42	243.5	F	525	1.97	490.5	F	787
Surfside Rd NB left/thru	0.23	9.2	A	22	0.21	9.6	A	20	0.28	10.6	A	29
Surfside Rd SB Thru/right	0.00	0.0	A	0	0.00	0.0	A	0	0.00	0.0	A	0
Overall Intersection	--	--	--	--	--	--	--	--	--	--	--	--

[a]Volume to capacity ratio.
[b]Average control delay in seconds per vehicle.
[c]Level of service.
[d]95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 5

UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE ANALYSIS SUMMARY
2010 TURNING LANES CONDITIONS

	2010 AM Peak Hour				2010 Midday Peak Hour				2010 PM Peak Hour			
Location/Movement	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Surfside Rd at Bartlett Rd												
Bartlett Rd EB left	0.73	47.9	E	128	0.51	29.9	D	67	0.63	44.5	E	94
Bartlett Rd EB right	0.26	11.1	B	26	0.20	11.3	B	18	0.27	12.5	B	27
Surfside Rd NB left/thru	0.15	8.5	A	14	0.14	8.7	A	12	0.18	9.2	A	17
Surfside Rd SB Thru/right	0.00	0.0	A	0	0.00	0.0	A	0	0.00	0.0	A	0
Overall Intersection	--	--	--	--	--	--	--	--	--	--	--	--

[a]Volume to capacity ratio.
[b]Average control delay in seconds per vehicle.
[c]Level of service.
[d]95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 5 Cont.

UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE ANALYSIS SUMMARY
2020 TURNING LANES CONDITIONS

	2020 AM Peak Hour				2020 Midday Peak Hour				2020 PM Peak Hour			
Location/Movement	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Surfside Rd at Bartlett Rd												
Bartlett Rd EB left	1.64	363.1	F	451	1.11	154.2	F	245	1.54	342.4	F	341
Bartlett Rd EB right	0.39	13.2	B	46	0.31	13.4	B	33	0.43	16.3	C	54
Surfside Rd NB left/thru	0.23	9.2	A	22	0.21	9.6	A	20	0.28	10.6	A	29
Surfside Rd SB Thru/right	0.00	0.0	A	0	0.00	0.0	A	0	0.00	0.0	A	0
Overall Intersection	--	--	--	--	--	--	--	--	--	--	--	--

[a]Volume to capacity ratio.
[b]Average control delay in seconds per vehicle.
[c]Level of service.
[d]95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 6

UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE ANALYSIS SUMMARY
2010 ALL WAY STOP CONDITIONS

	2010 AM Peak Hour				2010 Midday Peak Hour				2010 PM Peak Hour			
Location/Movement	x[a]	Delay[b]	LOS[c]	Queue[d]	x	Delay	LOS	Queue	x	Delay	LOS	Queue
Surfside Rd at Bartlett Rd												
Bartlett Rd EB left/right	0.66	19.5	C	--	0.45	13.4	B	--	0.54	16.1	C	--
Surfside Rd NB left/thru	0.74	23.8	C	--	0.57	15.7	C	--	0.67	20.1	C	--
Surfside Rd SB Thru/right	0.50	14.5	B	--	0.59	15.5	C	--	0.76	23.9	C	--
Overall Intersection	**--**	**19.9**	**C**	--	**--**	**15.0**	**C**	--	**--**	**20.6**	**C**	--

[a]Degree of Utilization.
[b]Average control delay in seconds per vehicle.
[c]Level of service.
[d]95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 6 Cont.

UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE ANALYSIS SUMMARY
2020 ALL WAY STOP CONDITIONS

	2020 AM Peak Hour				2020 Midday Peak Hour				2020 PM Peak Hour			
Location/Movement	x[a]	Delay[b]	LOS[c]	Queue[d]	x	Delay	LOS	Queue	x	Delay	LOS	Queue
Surfside Rd at Bartlett Rd												
Bartlett Rd EB left/right	1.01	66.7	F	--	0.72	25.0	D	--	0.82	34.2	D	--
Surfside Rd NB left/thru	1.18	125.3	F	--	0.90	43.2	E	--	1.04	75.8	F	--
Surfside Rd SB Thru/right	0.80	32.5	D	--	0.95	49.8	E	--	1.22	136.6	F	--
Overall Intersection	**--**	**80.3**	**F**	--	**--**	**40.9**	**E**	--	**--**	**89.9**	**F**	--

[a]Degree of Utilization.
[b]Average control delay in seconds per vehicle.
[c]Level of service.
[d]95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 7

UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE ANALYSIS SUMMARY
2010 ROUNDABOUT CONDITIONS

	2010 AM Peak Hour				2010 Midday Peak Hour				2010 PM Peak Hour			
Location/Movement	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Surfside Rd at Bartlett Rd												
Bartlett Rd EB left/right	0.36	8.6	A	88	0.31	9.2	A	66	0.36	9.3	A	83
Surfside Rd NB left/thru	0.43	8.0	A	111	0.32	7.4	A	75	0.38	7.7	A	94
Surfside Rd SB Thru/right	0.30	8.4	A	67	0.39	8.0	A	96	0.47	8.7	A	121
Overall Intersection	--	**8.3**	**A**	--	--	**8.1**	**A**	--	--	**8.5**	**A**	--

[a]Volume to capacity ratio.
[b]Average control delay in seconds per vehicle.
[c]Level of service.
[d]95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 7 Cont.

UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE ANALYSIS SUMMARY
2020 ROUNDABOUT CONDITIONS

	2020 AM Peak Hour				2020 Midday Peak Hour				2020 PM Peak Hour			
Location/Movement	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Surfside Rd at Bartlett Rd												
Bartlett Rd EB left/right	0.52	9.6	A	144	0.46	10.5	B	109	0.55	11.6	B	83
Surfside Rd NB left/thru	0.63	9.9	A	207	0.46	8.1	A	121	0.54	8.5	A	94
Surfside Rd SB Thru/right	0.44	9.3	A	109	0.56	9.0	A	160	0.68	11.9	B	121
Overall Intersection	--	**9.6**	**A**	--	--	**9.1**	**A**	--	--	**10.7**	**B**	--

[a]Volume to capacity ratio.
[b]Average control delay in seconds per vehicle.
[c]Level of service.
[d]95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

CONCLUSIONS AND RECOMMENDATIONS

A summary of the proposed alternatives is shown in Table 8.

Table 8
PROPOSED ALTERNATIVES SUMMARY

Option	Description	2010 LOS	2020 LOS	Cost	Row Required
1	All-Way Stop	C	F	$60K	No
2	Roundabout	A	B	$550K	Yes
3	Mini-Roundabout	A	B	$70K	No
4	Turning Lanes	E	F	$90K	Yes
5	Raised Intersection	F	F	$160K	No

Under the existing two-way stop condition at the intersection of Surfside Road at Bartlett Road, the Bartlett Road approach experiences significant delay at all peak hours in both the present and future years. The Surfside Road approaches have little delay since they are not required to stop.

As an interim measure, an all way stop condition at this intersection would work well for the present 2010 year. All approaches would have a LOS C or better for all peak hours. Operations for the future year of 2020 would have LOS F for the eastbound and northbound approaches in the AM and the northbound and southbound in the PM, making this a less than desirable permanent alternative.

The preferred long term alternative is the mini-roundabout option. This option combines the operations of a roundabout without the required footprint and costs. Due to the fact that a mini-roundabout fits within the existing roadway, future alterations of this intersection would be possible. Operations for the year 2020 would be a LOS B or better. No land taking is necessary and minimal full depth work would be required. The cost for this alternative would be significantly less than a full roundabout at $60,000 to $80,000. It should be noted that it is critical that the mini-roundabout be designed and constructed properly to slow and deflect through traffic, but also be conducive to larger vehicle movements.