ROUNDABOUT IMPLEMENTATION REPORT

Final Draft

MILESTONE ROTARY

ORANGE STREET/ SPARKS AVENUE/ OLD SOUTH ROAD/
MILESTONE ROAD

NANTUCKET, MASSACHUSETTS

PREPARED FOR:

NANTUCKET PLANNING AND ECONOMIC DEVELOPMENT
COMMISSION

September 2006
06914.800

Ourston Roundabout Engineering

Ourston Roundabout Engineering

September 11, 2006

Nantucket Planning and Economic Development Commission
16 Broad Street
Nantucket, MA 02554

Attention: Mr. T. Michael Burns, AICP
Transportation Planner

Dear Michael:

Re: Roundabout Implementation Report -- Final Draft
Milestone Rotary
Milestone Road/ Orange Street/ Old South Road/ Sparks Avenue
Our Project No. 06914.800

Ourston Roundabout Engineering, Inc. has been retained by the Nantucket Planning and Economic Development Commission to prepare a preliminary design for a roundabout to replace the Milestone Rotary at the intersection of Orange Street, Sparks Avenue, Old South Road, and Milestone Road.

The preliminary design is shown as Figure 3 at the end of the report. It is based on an ellipse, with an inscribed circle diameter (ICD) varying between 140 and 148 feet. The roundabout is located such that a pedestrian area can be accommodated between Sparks Avenue and Old South Road. Sidewalks are located around the rest of the roundabout as well, and bicycle lanes are shown on Orange Street that terminate at the roundabout. The size and location of the roundabout would impact the lands between Old South Road and Milestone Road and along the east side of Orange Street.

All entries of the roundabout flare from one to two lanes. The Orange Street entry is configured as a left plus a through/right turn lane as per the existing rotary. This is duplicated at Old South Road, which has been widened from a single-lane entry. The Milestone Road entry is configured as a left/through plus a right turn lane as per the existing rotary. This is duplicated at Sparks Avenue, which also has been widened from a single-lane entry. This configuration enables the exits to be single-lane, like the existing rotary, and keeps the ICD small. To educate about correct lane use, the truck apron is shaped so that motorists entering from Milestone Road or Sparks Avenue and making a left turn will be "spiralled out" to the outer lane of the circulatory road so they are not trapped in their lane and forced into making an unsafe lane change inside the roundabout.

The preliminary design addresses the geometric deficiencies with the existing rotary as follows:

- *There is currently no lateral deflection for motorists entering the rotary from Orange Street, and little lateral deflection for those entering from Sparks Avenue and Milestone Road*. The Orange Street and Milestone Road entries have been realigned, and a larger central island introduced to increase deflection for all motorists. The design of the roundabout will all but eliminate the possibility of a high-speed injury collision. The fastest possible speed through, in the absence of other traffic and ignoring all signs and pavement markings, will be under 30 mph.

110 Scotia Court, Unit 41
Whitby, ON L1N 8Y7 Canada
Phone: (905) 686-6402
Fax: (905) 432-7877
www.ourston.com
mail@ourston.com

- *The lack of deflection on the Orange Street and Milestone Road entries means that these motorists tend to enter the rotary at higher speeds, and sometimes in platoons*. The introduction of YIELD control on all entries, and the increased deflection, will slow traffic down and give all motorists a more equal opportunity to enter the roundabout.

- *Congestion is being experienced on the single-lane Sparks Avenue and Old South Road entries to the rotary during peak times in the summer*. The roundabout will significantly lessen delays and queues in the short term compared to the rotary. In the longer term, it will generally maintain low delays and queues except for a few critical time periods. The worst-case conditions for motorists in the future are expected to be during the 2014 PM peak hour on the Sparks Avenue left/through lane, with an average delay of 75 seconds per vehicle and a 95th percentile queue of about 20 vehicles. These values are relatively high for a roundabout, and are about the same as conditions currently being experienced by motorists entering the existing rotary from Old South Road during peak times. This is a function of the design trade-offs associated with the size and location of the roundabout to minimize property impacts. All other delays and queues will be lower than these values. Future delays and queues will be much higher along Sparks Avenue and Old South Road if the existing rotary is to remain.

- *Pedestrian and bicycle travel through the rotary is difficult*. The roundabout includes sidewalks and pedestrian crossings on all four legs, rather than just Sparks Avenue and Old South Road, and bicycle lanes and terminations on Orange Street.

- *There are numerous access and parking conflicts on the southwest corner, between Sparks Avenue and Old South Road, including some motorists cutting through the front of the parking lot*. The outer curb of the roundabout provides an opportunity to consolidate access to the parking lot to two locations and make cutting through less likely. Cut outs for driveway access have also been provided in the Orange Street and Old South Road splitter islands.

From the conceptual design work and the development of the preliminary design, a safe and efficient roundabout is possible at this location. The roundabout will be able to accommodate current traffic volumes and some measure of future growth, have a reduced potential for collisions, and better serve pedestrians and bicyclists than the existing rotary. We therefore recommend replacing the Milestone Rotary with a roundabout.

Yours truly,

OURSTON ROUNDABOUT ENGINEERING, INC.

Philip Weber, P.Eng.
Senior Project Manager

/pw

110 Scotia Court, Unit 41
Whitby, ON L1N 8Y7 Canada
Phone: (905) 686-6402
Fax: (905) 432-7877
www.ourston.com
mail@ourston.com

TABLE OF CONTENTS

FIGURES

APPENDICES

This report was prepared with funding from the Massachusetts Highway Department
and the Federal Highway Administration.

1.0 INTRODUCTION

1.1 BACKGROUND AND PROBLEM DEFINITION

Ourston Roundabout Engineering, Inc. has been retained by the Nantucket Planning and Economic Development Commission to prepare a preliminary design for a roundabout to replace the Milestone Rotary at the intersection of Orange Street, Sparks Avenue, Old South Road, and Milestone Road.

The rotary serves motorists traveling between the downtown area, Nantucket Memorial Airport, Mid-Island, Siaconset, and Madaket. It operates as a typical rotary with tangential entries under YIELD control, with the exception of the Sparks Avenue approach which intersects at 90 degrees under STOP control. The Orange Street and Milestone Road legs have entries that flare from one to two lanes. The other two legs have single-lane entries. All exits are single-lane. The inscribed circle diameter (ICD) of the rotary is about 120 feet. Refer to Figure 1.

FIGURE 1
The Milestone Rotary, Looking West

Photo: Pictometry International

The idea of replacing the rotary with a roundabout had its origins in the *Traffic Study & Strategy for the Mid-Island Area* dated July 8, 2005. The study identified several geometric deficiencies at the rotary and recommended that consideration be given to replacing it with a roundabout. Some of the problems with the rotary include:

- *There is currently no lateral deflection for motorists entering the rotary from Orange Street, and little lateral deflection for those entering from Sparks Avenue and Milestone Road*. This allows the possibility of high-speed collisions with circulating traffic. In particular, Orange Street is aligned straight through the intersection, creating a condition where an entering motorist could crash into a circulating motorist at high speed at nearly a 90 degree angle. This collision type almost always results in injuries.

- *The lack of deflection on the Orange Street and Milestone Road entries means that these motorists tend to enter the rotary at higher speeds, and sometimes in platoons*. Under conditions of high demand they can dominate the rotary, making it difficult for other motorists to enter. This condition would exist at the Sparks Avenue entry were it not for the STOP control and high circulating flow from the previous entries.

- *Congestion is being experienced on the single-lane Sparks Avenue and Old South Road entries to the rotary during peak times in the summer*. The resulting delays and queues are expected to increase with further development and traffic growth. The 2014 traffic forecasts from the *Traffic Study & Strategy for the Mid-Island Area* are for a 3 percent increase in traffic per year over 10 years, or 34 percent in total.

- *Pedestrian and bicycle travel through the rotary is difficult. Most of the demand is between Orange Street and the newly-completed bike path along the east side of Old South Road*. Because there is no pedestrian crossing of Milestone Road most pedestrians and bicyclists cross Sparks Avenue and Old South Road, through the parking lot on the southwest corner. If these users are traveling from the bike path to the downtown area they must cross Orange Street (where there is no pedestrian crossing) or ride against traffic on the sidewalk on the west side.

- *There are numerous access and parking conflicts on the southwest corner, between Sparks Avenue and Old South Road, including some motorists cutting through the front of the parking lot*. Some consolidation of access would be useful in conjunction with a roundabout.

The average daily traffic (ADT) through the rotary is estimated from the 2004 traffic counts in the *Traffic Study & Strategy for the Mid-Island Area* at about 25,000 vehicles per day. This is for the month of July, which is considered to be the busiest month. The highest hourly volumes are during the PM peak hour at about 2,700 vehicles per hour.

The Milestone Rotary is experiencing on average 6 collisions per year. Approximately 5 percent involve injury and 5 percent involve bicyclists. Apparently the collision rate of 0.57 per million vehicles entering is below district and state averages for the same range of intersection volumes.

1.2 ROTARIES AND ROUNDABOUTS

Rotaries are a common means of traffic control in the northeast, having been installed in Massachusetts, New York, New Jersey, and several other states starting in the 1940's. They generally fell out of favor by the 1960's because of operational problems, and many were replaced with traffic signals or grade separated interchanges.

The operational problems with rotaries include:

- One or more entries that are tangential to the central island. This means that entering motorists experience little or no lateral deflection, and thus in the absence of traffic control (or if they ignore the traffic control), they can enter the rotary at speed. This is evident on three of the four entries to the Milestone Rotary. Fortunately this highly probable collision type does not seem to be manifesting itself as a recorded collision problem, but the potential is there.

- Inconsistent traffic control. Some rotaries operated with YIELD or STOP control for circulating motorists, rather than entering motorists. This meant that under high traffic flows circulating traffic could back up and block traffic from entering, eventually locking the entire rotary. This is not the case with the Milestone Rotary, as all entries are under YIELD (or STOP) control.

- Inefficient use of space to achieve capacity. Rotaries generally achieve higher capacities by increasing size. This allows more traffic to circulate at the same time or be stored in the circle, or increases weaving distances to allow more time for motorists to change lanes to find their exit. Unfortunately, making the rotaries larger also led to higher speeds and more frequent and serious collisions. The Milestone Rotary is too small to exhibit these characteristics, but it could benefit from a re-design to increase traffic capacity.

Figure 2 shows a large rotary that has now been replaced with a roundabout in Kingston, New York. Note the tangential entries, similar to the Milestone Rotary. The smaller roundabout is proving to be safer and have higher capacity than the former rotary.

FIGURE 2
Rotary Being Replaced with Roundabout, Kingston, New York

Photo: New York Department of Transportation

Well-designed roundabouts do not experience the problems of rotaries because entries are always under YIELD control, because there is deflection on the approaches to slow motorists before they enter, and because it is safe to accommodate pedestrians and other users due to slow traffic speeds and consistent conditions for motorists.

2.0 THE ROUNDABOUT DESIGN

2.1 CONCEPT DEVELOPMENT

We initially developed two roundabout concepts to "explore the design space". This is where concepts are developed to explore capacity, safety, and cost trade-offs. Usually the costs involve grading or property impacts.

The first concept was a roundabout with an inscribed circle diameter (ICD) of 180 feet. This is considerably larger than the existing rotary in order to develop enough deflection for the Milestone Road to Orange Street movement using the existing alignment of Milestone Road. The main advantage of this concept was more vehicular capacity due to the larger size of the roundabout and wider entry possible on Sparks Avenue. The main disadvantage was that property would be required between Old South Road and Milestone Road, and at the parking lot between Sparks Avenue and Old South Road.

The second concept had a smaller ICD of 140 feet, somewhat larger than the existing rotary. In this case deflection was achieved for the Milestone Road to Orange Street movement by re-aligning part of Milestone Road from about 250 feet back from the edge of the roundabout. The main advantage of this concept was less property required overall. However, there would be very high peak hour queuing on the Sparks Avenue approach in the future because only a single-lane entry could be developed. There would also still be property impacts to the parking lot between Sparks Avenue and Old South Road.

Both concepts developed deflection for the Orange Street entry by re-aligning the approach, which meant minor property impacts on the east side of Orange Street.

Based on discussions with the Nantucket Planning and Economic Development Commission, it was determined that the second concept was favored, but with modifications that would eliminate impacts to the parking lot between Sparks Avenue and Old South Road.

2.2 DESCRIPTION OF PRELIMINARY DESIGN

The preliminary roundabout design is based on an ellipse rather than a circle, with an ICD varying between 140 and 148 feet. This has been done in order to attain better overall deflection (a topic discussed later). The roundabout has been moved to the east compared with the second concept so that a pedestrian area can be accommodated between Sparks Avenue and Old South Road. This has again resulted in property impacts between Old South Road and Milestone Road. Deflection for the Orange Street and Milestone Road approaches has been achieved similar to the second concept.

The preliminary design is shown as Figure 3 at the end of the report. The approximate limits of construction from the middle of the intersection are:

- 250 feet along Orange Street excluding the bike lanes.
- 120 feet along Sparks Avenue.
- 230 feet along Old South Road.
- 400 feet along Milestone Road.

The presence of an outer curb for the entire roundabout provides an opportunity to consolidate access to the parking lot between Sparks Avenue and Old South Road to two locations and make cutting through less likely. Cut outs for driveway access have been provided in the Orange Street and Old South Road splitter islands. These cut outs should be the same material as the splitter islands, but be mountable curb instead

of barrier curb. The preliminary design also includes the location of sidewalks and pedestrian crossings on all four legs, and bicycle lanes and terminations on Orange Street.

All entries of the roundabout flare from one to two lanes. The Orange Street entry is configured as a left plus a through/right turn lane as per the existing rotary. This is duplicated at Old South Road, which has been widened from a single-lane entry. The Milestone Road entry is configured as a left/through plus a right turn lane as per the existing rotary. This is duplicated at Sparks Avenue, which also has been widened from a single-lane entry. This configuration enables the exits to be single-lane, like the existing rotary, and keeps the ICD small. To educate about correct lane use, the truck apron is shaped so that motorists entering from Milestone Road or Sparks Avenue and making a left turn will be "spiralled out" to the outer lane of the circulatory road so they are not trapped in their lane and forced into making an unsafe lane change inside the roundabout.

Figure 4 shows recommended signing for the roundabout. The design of the map-type diagrammatic signs is based on sign design guidelines from the UK, and has been used on a number of roundabout projects in the US.

2.3 CAPACITY ANALYSIS

A capacity analysis of the roundabout was undertaken using the computer program RODEL.[1] The program is based on research from a comprehensive study undertaken in the United Kingdom in the late 1970s of the entry capacities of roundabouts at 86 public road sites. From the research very robust empirical formulas for capacity prediction were developed from direct measurement.[2] The formulas relate the capacity of a roundabout entry to the circulating flow past that entry, and the effect of 6 geometric design parameters: ICD, entry width, road half width, effective flare length, entry radius and entry angle. Following the initial research the methods were validated to confirm the suitability of the parameters, the most recent on 35 roundabouts in 1997 which concluded that no changes to the original formulas were necessary. Our early experience is proving the UK formulas to be valid for US roundabouts and conditions.

The capacity analysis was carried out using the 2004 traffic counts and 2014 traffic forecasts in the *Traffic Study & Strategy for the Mid-Island Area*. The entries were checked on an individual lane basis, since RODEL assumes equal lane utilization rather than the left plus through/right or left/through plus right turn configurations of the preliminary design. A table summarizing the analysis, and selected RODEL outputs, are included in Appendix A.

The following average delays and levels of service (LOS) can be expected by 2014 during the summer peak periods:

- On the Orange Street entry, about 45 seconds per vehicle during the PM and Saturday peak periods in the through/right turn lane, or LOS 'E'. All other average delays would be less than 15 seconds per vehicle, or LOS 'A' to 'B'.
- On the Sparks Avenue entry, about 75 seconds per vehicle during the PM peak period (LOS 'F'), and 45 seconds during the Saturday peak period (LOS 'E'), in the left/through lane. All other average delays would be less than 20 seconds per vehicle, or LOS 'A' to 'C'.

---

1 RODEL 1 – Interactive Roundabout Design, Rodel Software Ltd. and Staffordshire County Council, United Kingdom (Licensed to Ourston Roundabout Engineering, 2000).

2 R.M. Kimber, *The Traffic Capacity of Roundabouts*, LR942, TRL, 1980.

- On the Old South Road entry, up to 50 seconds per vehicle during the PM peak period in the through/right turn lane, or LOS 'E'. All other average delays would be less than 20 seconds per vehicle, or LOS 'A' to 'C'.
- On the Milestone Road entry, about 35 seconds per vehicle during the PM peak period in the left/through lane, or LOS 'D'. All other average delays would be less than 15 seconds per vehicle, or LOS 'A' to 'B' .

Thus the highest average delay is expected to be during the 2014 PM peak hour on the Sparks Avenue entry, at about 75 seconds per vehicle. This is relatively high for a roundabout, and is about the same as delays currently being experienced by motorists entering the existing rotary from Old South Road during peak times. This high peak hour delay is a function of the design trade-offs associated with the size and location of the roundabout to minimize property impacts. The first concept would have resulted in more vehicular capacity but at the cost of greater property impacts, particularly along the east side of Orange Street.

The highest 95th percentile queue is expected during the 2014 PM peak hour on the Sparks Avenue entry, at about 20 vehicles. Again this is fairly high, and may affect driveway access along Sparks Avenue during these occasional time periods. The second-highest 95th percentile queue is expected on the Orange Avenue entry during the 2014 PM peak hour, at about 15 vehicles.

These are future peak hour values. Average delays and queues will be lower until such time as the forecast 2014 traffic volumes are reached. In fact, little delay and queuing should be evident with a roundabout until about 2010.

The existing rotary was also modeled with RODEL. However, the results should be used with caution because the geometric parameters of the rotary are outside the normal operating range of the program. It is certain that future delays and queues will be much higher along Sparks Avenue and Old South Road if the existing rotary is to remain. As a worst-case, the analysis shows that during the 2014 PM peak period on the Sparks Avenue entry to the rotary, average delays will likely be over 8 minutes per vehicle, with 95th percentile queues of well over 100 vehicles. A table summarizing the analysis is in Appendix A.

It should be noted that during peak times pedestrians and bicyclists in the crosswalks of a roundabout (or even a rotary in some cases) will experience low delays because they can cross between vehicles queued at the yield line.

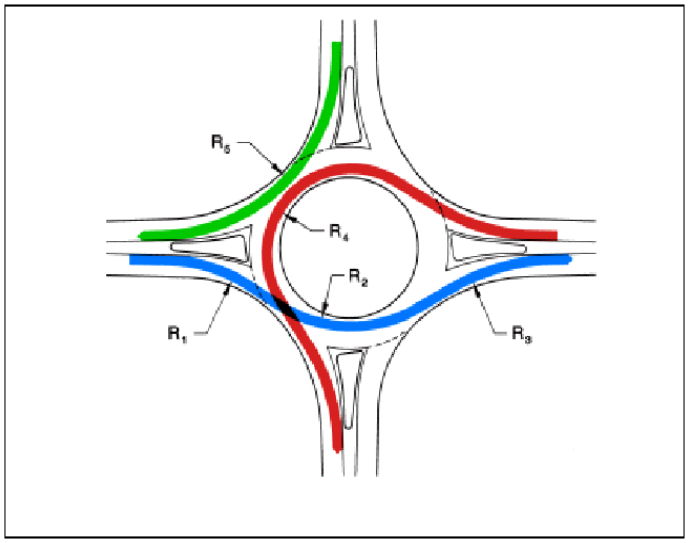
2.4 DEFLECTION

Several checks were conducted through the conceptual design process, and finalized during the preliminary design. The most important is entry deflection, which is considered a "proxy" for safety. The more deflection an entry has, generally the more safe it should be. This is because deflection will slow motorists, making them more likely to yield on entry and less likely to cause entry-circulating collisions. However, there are limits. An entry that is over-deflected can cause rear-end or loss of control collisions.

Deflection is calculated by determining worst-case or fastest-path speeds for each entry. A fastest-path speed is the fastest possible speed through a roundabout. It is only possible in the absence of other traffic and ignoring all signs and pavement markings, and studies have shown less that 30 percent of the driving population is capable of driving a fastest-path. Thus it is a conservative measure.

Figure 4 illustrates the radii corresponding to various fastest-path checks from the FHWA publication *Roundabouts: An Informational Guide*.

FIGURE 4
Vehicle Path Radii (from the FHWA Guide)



- R_1 = Entry path radius
- R_2 = Circulating radius
- R_3 = Exit path radius

- R_4 = Left turn radius
- R_5 = Right turn radius

Source: Roundabouts: An Informational Guide

A fastest-path check is carried out by drawing a curve that represents the straightest possible path through a roundabout. The path should be offset 5 feet from the face of curb or 3 feet from a painted centerline, and is best represented by a smooth spline from entry to exit. For example the R_1, R_2, R_3 spline comes within 5 feet of the curb at the entry, 5 feet of the central island, and 5 feet of the curb at the exit. The minimum radii of the arcs along this spline correspond to the R_1, R_2, and R_3 radii. Of these, the R_1 entry path radius is usually the most critical. On skewed intersections sometimes it is the R_5 or right turn radius.

A balanced design minimizes the differences between the various R_1 values. The R_3 exit path radius is not a critical check unless the value is overly small, as a motorist's ability to accelerate from the R_2 position to the exit area rarely exceeds the calculated exit speed owing to the R_3 path. R_4 is governed by the size of the central island and generally operates at the lowest speed.

Contrary to expectation, a tight entry radius and straight alignment of the entry into the central island does not always equate to a low entry path radius, as evident in Figure 5. Entry radius comes from the geometric design, while entry *path* radius comes out of the composition of the design (arrangement of entry alignment and circle) and is a result of the fastest-path through a roundabout.

For the preliminary design, we measured the following R_1 values, plus critical R_5 or right turn radius from Milestone Road to Orange Street:

- Orange Street R_1 value of 214 feet, or 27 mph.
- Sparks Avenue R_1 value of 158 feet, or 24 mph.
- Old South Road R_1 value of 210 feet, or 27 mph.
- Milestone Road R_5 (right turn) value of 239 feet or 28 mph.

Thus the fastest possible speed through the roundabout, in the absence of other traffic and ignoring all signs and pavement markings, is under 30 mph. Figure 6 at the end of the report shows the deflection checks for these movements.

FIGURE 5
Example of Too Little Entry Path Deflection

Photo: Ourston Roundabout Engineering

2.5 OTHER DESIGN CHECKS

The roundabout can accommodate a WB-50 design vehicle. Judging by the size of the current rotary this is the largest truck able to use the intersection. A truck apron is provided for vehicle over-tracking. It should be noted that trucks will need to use both lanes of the entry when:

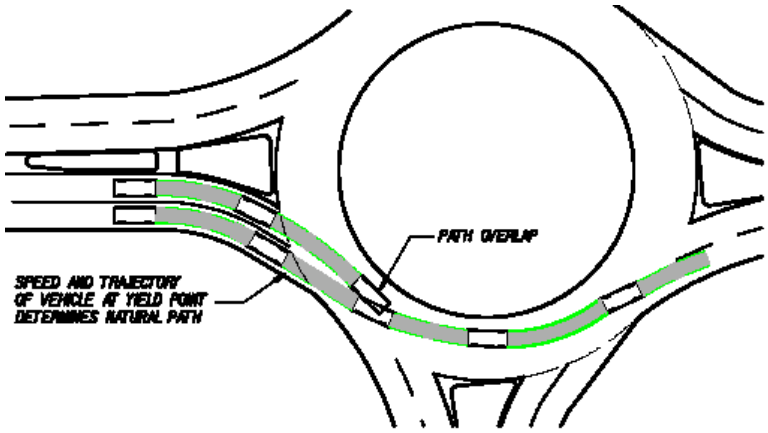
- Entering the roundabout from Sparks Avenue.
- Turning right from Old South Road to Milestone Road.

This is similar to a truck swinging wide to make a right turn at a conventional intersection, and is common at many roundabouts. Figures 7 and 8 at the end of the report show right turns and left turns for the WB-50 design vehicle through the preliminary design.

Another important design check, applicable to multi-lane roundabouts, is that of avoiding path overlap on the entries or exits. The natural path of vehicles can be determined by assuming motorists stay within their lane up to the yield line. At the yield line, they will maintain their natural trajectory into the circulatory road and through to the exit. If the roundabout geometry tends to lead vehicles into the wrong lane, this can result in path overlap. Figure 9 shows an example of entry path overlap. Path overlap can occur at roundabout exits as well.

The preliminary design was checked to ensure a low probability of entry path overlap, particularly on the Orange Street and Old South Road entries where two vehicles can enter the roundabout and circulate side by side.

FIGURE 9
Example of Entry Path Overlap



Source: Wisconsin Department of Transportation Facilities Development Manual

A final design check was to ensure that any pedestrian refuge areas on the splitter islands are at least 8 feet wide, to accommodate a bicyclist or person pushing a stroller. The splitter island on the Sparks Avenue leg is too small to accommodate pedestrians, and so pedestrians must cross to the outside of the splitter island as they do with the existing rotary.

3.0 CONSTRUCTION ISSUES

3.1 ILLUMINATION

With reconstruction of the rotary the opportunity should be taken to improve the illumination of the intersection. There are currently two luminaires on the central island of the rotary. Generally the preferred practice at roundabouts is to illuminate them from the perimeter in, rather than from the central island out, and place luminaires to light conflict areas, pedestrian crosswalks and important signs from the front. The luminaires should depart from a straight line along the edge of the road at the roundabout to identify it to motorists from a distance at night.

3.2 SIGHTLINES AND LANDSCAPING

Minimum stopping sight distance of the yield line of a roundabout is required for approaching motorists. As with other intersections, minimum sightlines should also be preserved between entering motorists and pedestrians about to step into the crosswalks on the upstream or downstream legs of the roundabout. Landscaping within these sightlines should be limited in height to under 3 feet.

Landscaping should be limited in height in the central island to preserve sightlines for circulating motorists. However, it is good practice to have an area of the central island higher than 3 feet to block through sightlines and provide a terminal vista to approaching motorists. The size of this area is dependent on sightline requirements for circulating motorists. Figure 10 at the end of this report shows the area in the central island of the preliminary design in which landscaping of any height may be implemented.

3.3 CONSTRUCTION STAGING

Ideally when a roundabout is constructed at an existing location the entire intersection is closed to traffic. It will likely not be possible in this case to close the entire rotary for the reconstruction process. Therefore the best course of action may be to close the Sparks Avenue leg of the intersection for the duration of the work, as traffic could be redirected to Orange Street, and build the roundabout in two stages. A suggestion is to build the east side of the roundabout first, using the two lanes southbound on Orange Street and the parking lot on the corner between Sparks Avenue and Old South Road as a temporary widening to detour traffic. Once the east side is completed, traffic could be switched over in order to build the west side of the roundabout.

3.4 PRELIMINARY COST ESTIMATE

The reconstruction of the Milestone Rotary to a roundabout is expected to cost approximately $475,000. This includes road base, asphalt, curb work, and re-alignment of the Orange Street and Milestone Road approaches within the limits of construction, signs and markings, utility pole relocations, illumination, drainage, landscaping of the central island, traffic control, engineering and contingencies. The estimate does not include the acquisition of property.

Frontages along which property impacts can be anticipated are also shown in Figure 10 at the end of this report. There will be impacts between Old South Road and Milestone Road, and on the east side of Orange Street. However, there may be the opportunity to sell some excess land on the west side of Orange Street adjacent to the roundabout entry.

4.0 CONCLUSIONS

4.1 PROBLEM EVALUATION AND CONCLUSIONS

The preliminary roundabout design should address the geometric deficiencies with the existing rotary as identified in the *Traffic Study & Strategy for the Mid-Island Area*. The details are as follows:

- *There is currently no lateral deflection for motorists entering the rotary from Orange Street, and little lateral deflection for those entering from Sparks Avenue and Milestone Road*. The Orange Street and Milestone Road entries have been realigned, and a larger central island introduced to increase deflection for all motorists. The design of the roundabout will all but eliminate the possibility of a high-speed injury collision. The fastest possible speed through, in the absence of other traffic and ignoring all signs and pavement markings, will be under 30 mph.

- *The lack of deflection on the Orange Street and Milestone Road entries means that these motorists tend to enter the rotary at higher speeds, and sometimes in platoons*. The introduction of YIELD control on all entries, and the increased deflection, will slow traffic down and give all motorists a more equal opportunity to enter the roundabout.

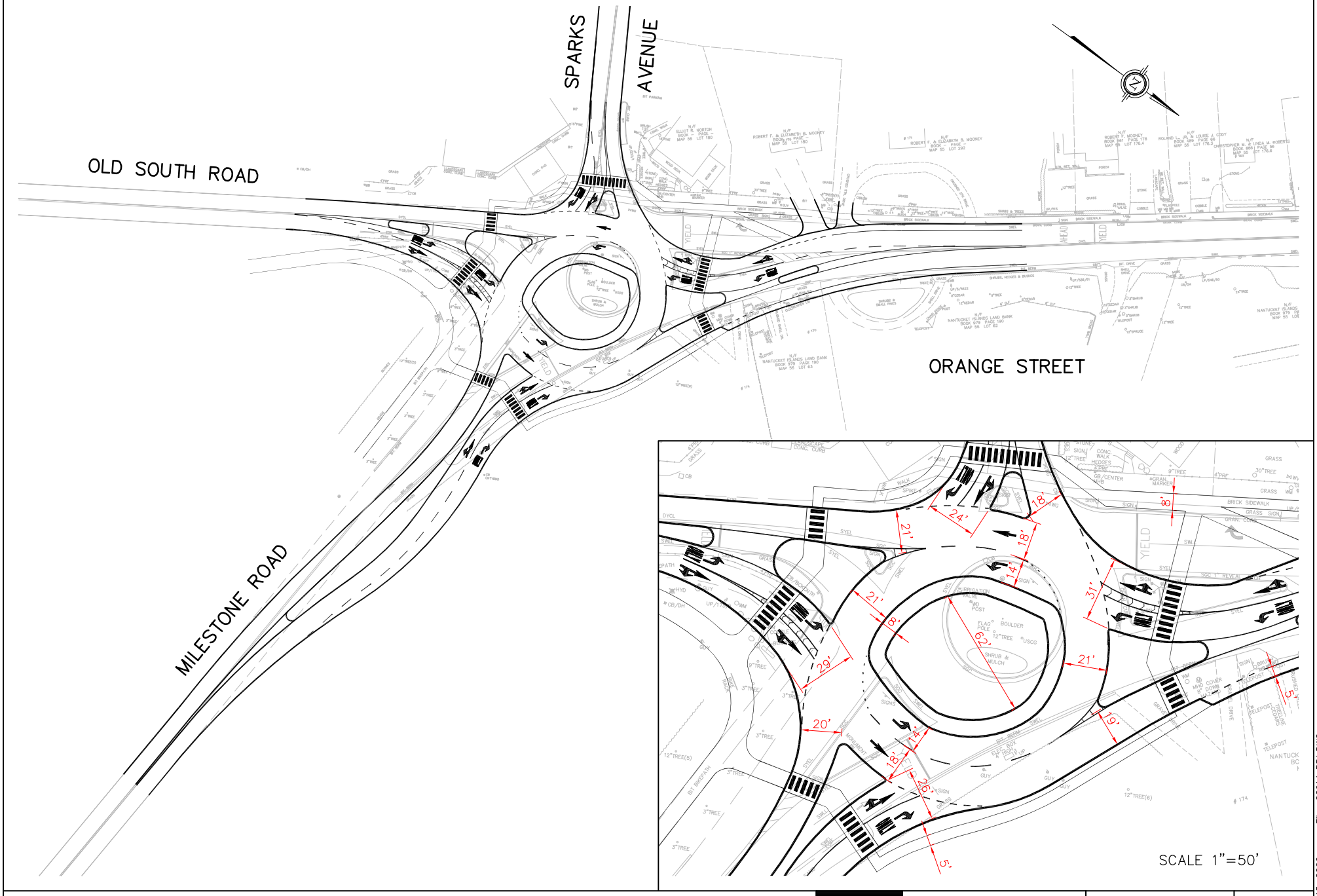
- *Congestion is being experienced on the single-lane Sparks Avenue and Old South Road entries to the rotary during peak times in the summer*. The roundabout will significantly lessen delays and queues in the short term compared to the rotary. In the longer term, it will generally maintain low delays and queues except for a few critical time periods. The worst-case conditions for motorists in the future are expected to be during the 2014 PM peak hour on the Sparks Avenue left/through lane, with an average delay of 75 seconds per vehicle and a 95th percentile queue of about 20 vehicles. These values are relatively high for a roundabout, and are about the same as conditions currently being experienced by motorists entering the existing rotary from Old South Road during peak times. This is a function of the design trade-offs associated with the size and location of the roundabout to minimize property impacts. All other delays and queues will be lower than these values. Future delays and queues will be much higher along Sparks Avenue and Old South Road if the existing rotary is to remain.

- *Pedestrian and bicycle travel through the rotary is difficult*. The roundabout includes sidewalks and pedestrian crossings on all four legs, rather than just Sparks Avenue and Old South Road, and bicycle lanes and terminations on Orange Street.

- *There are numerous access and parking conflicts on the southwest corner, between Sparks Avenue and Old South Road, including some motorists cutting through the front of the parking lot*. The outer curb of the roundabout provides an opportunity to consolidate access to the parking lot to two locations and make cutting through less likely. Cut outs for driveway access have also been provided in the Orange Street and Old South Road splitter islands.

4.2 RECOMMENDATION

From the conceptual design work and the development of the preliminary design, a safe and efficient roundabout is possible at this location. The roundabout will be able to accommodate current traffic volumes and some measure of future growth, have a reduced potential for collisions, and better serve pedestrians and bicyclists than the existing rotary. We therefore recommend replacing the Milestone Rotary with a roundabout.

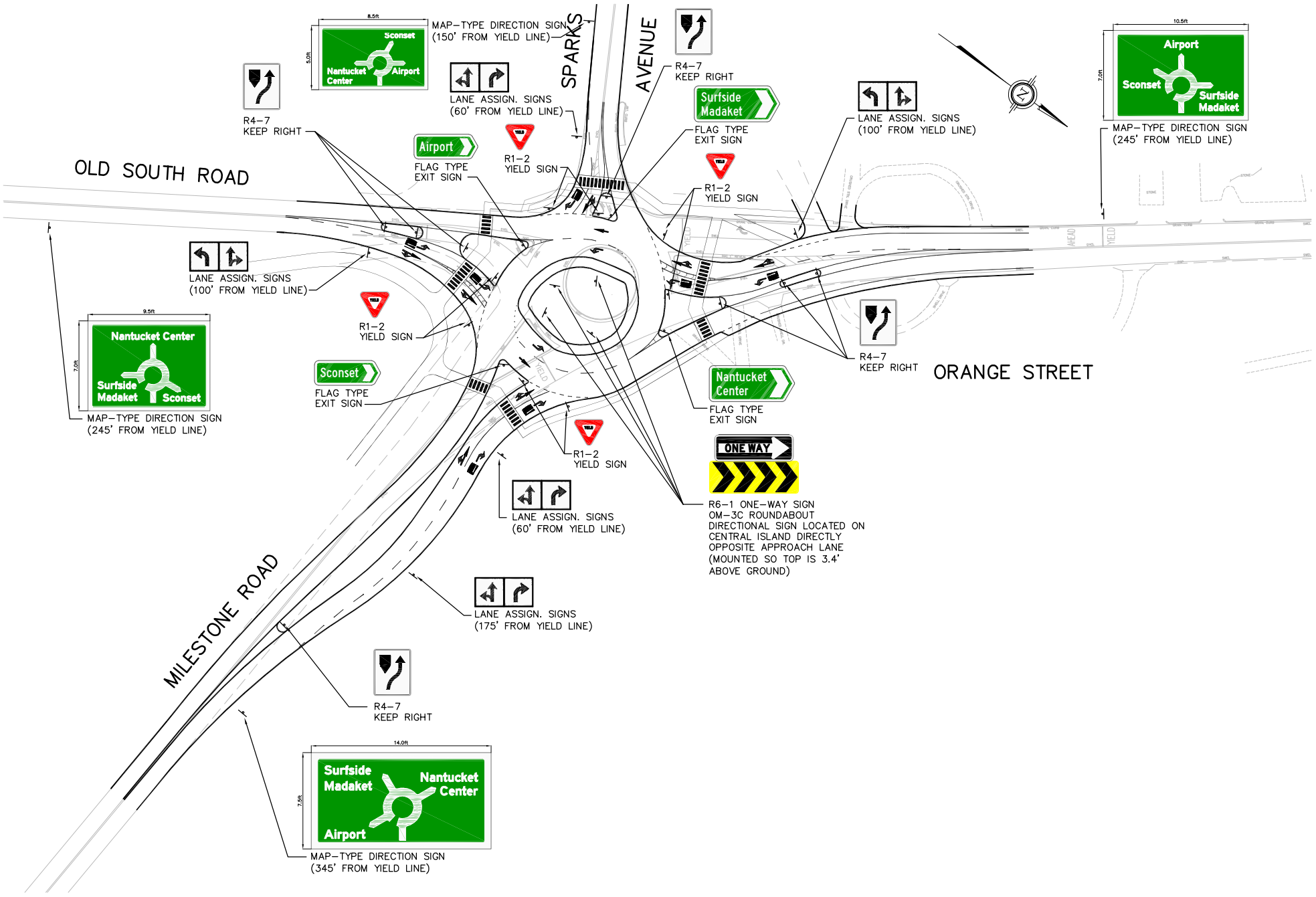


MILESTONE ROUNDABOUT–PRELIMINARY DESIGN
PLAN – DIMENSIONED
NANTUCKET, MASSACHUSETTS

OURSTON ROUNDABOUT ENGINEERING
www.OURSTON.com

DATE	PROJECT No.
SEPTEMBER, 2006	06914
SCALE	FIGURE No.
1"=100'	3

File: 06914 PRLNWG
R/P Date – SEPT 13, 2006

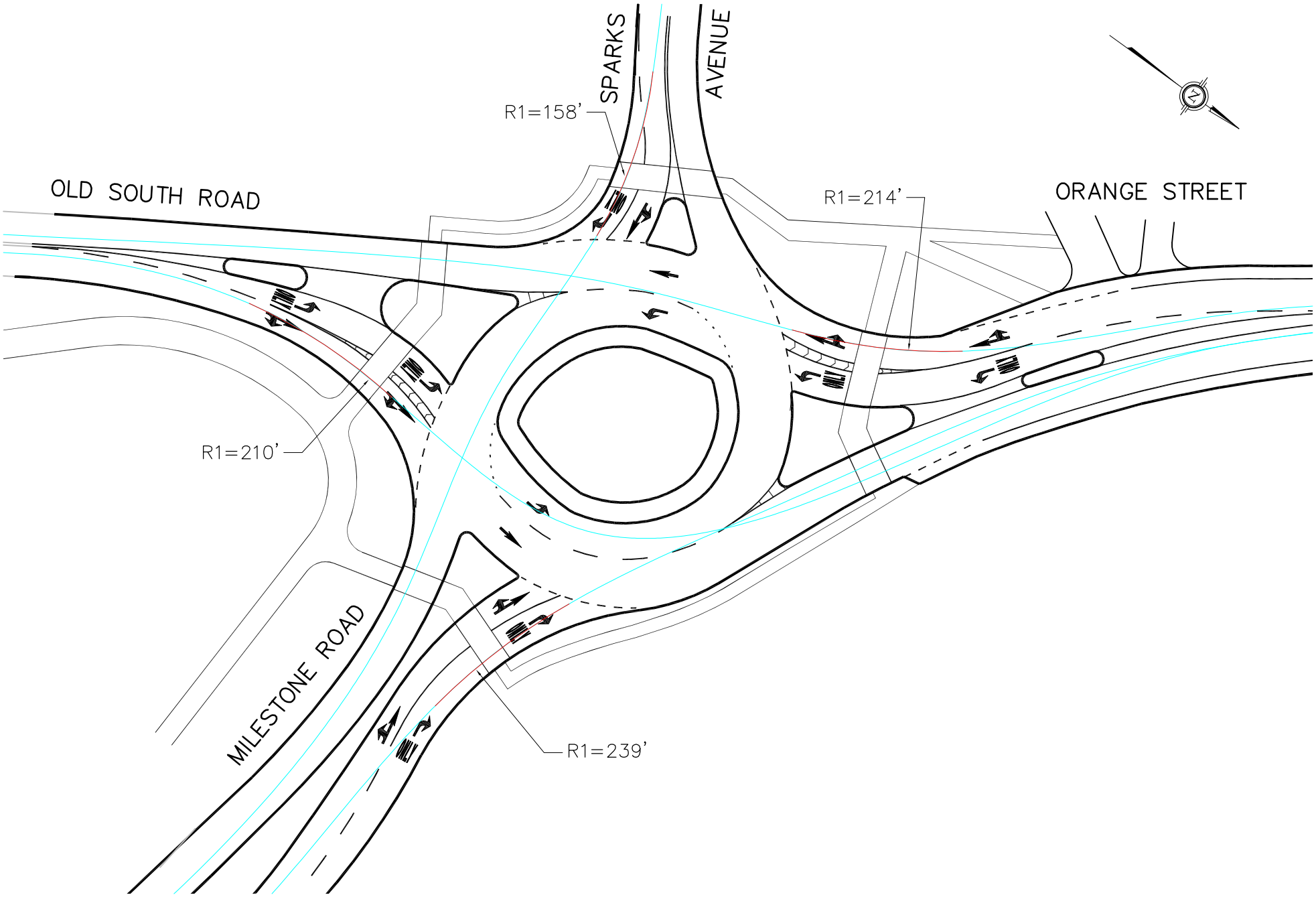


MILESTONE ROUNDABOUT–PRELIMINARY DESIGN SIGNING NANTUCKET, MASSACHUSETTS

OURSTON ROUNDABOUT ENGINEERING
www.OURSTON.com

DATE	PROJECT No.
SEPTEMBER, 2006	06914
SCALE	FIGURE No.
1"=100'	4

File: 06914 PRI.DWG
R/P Date - SEPT 13, 2006

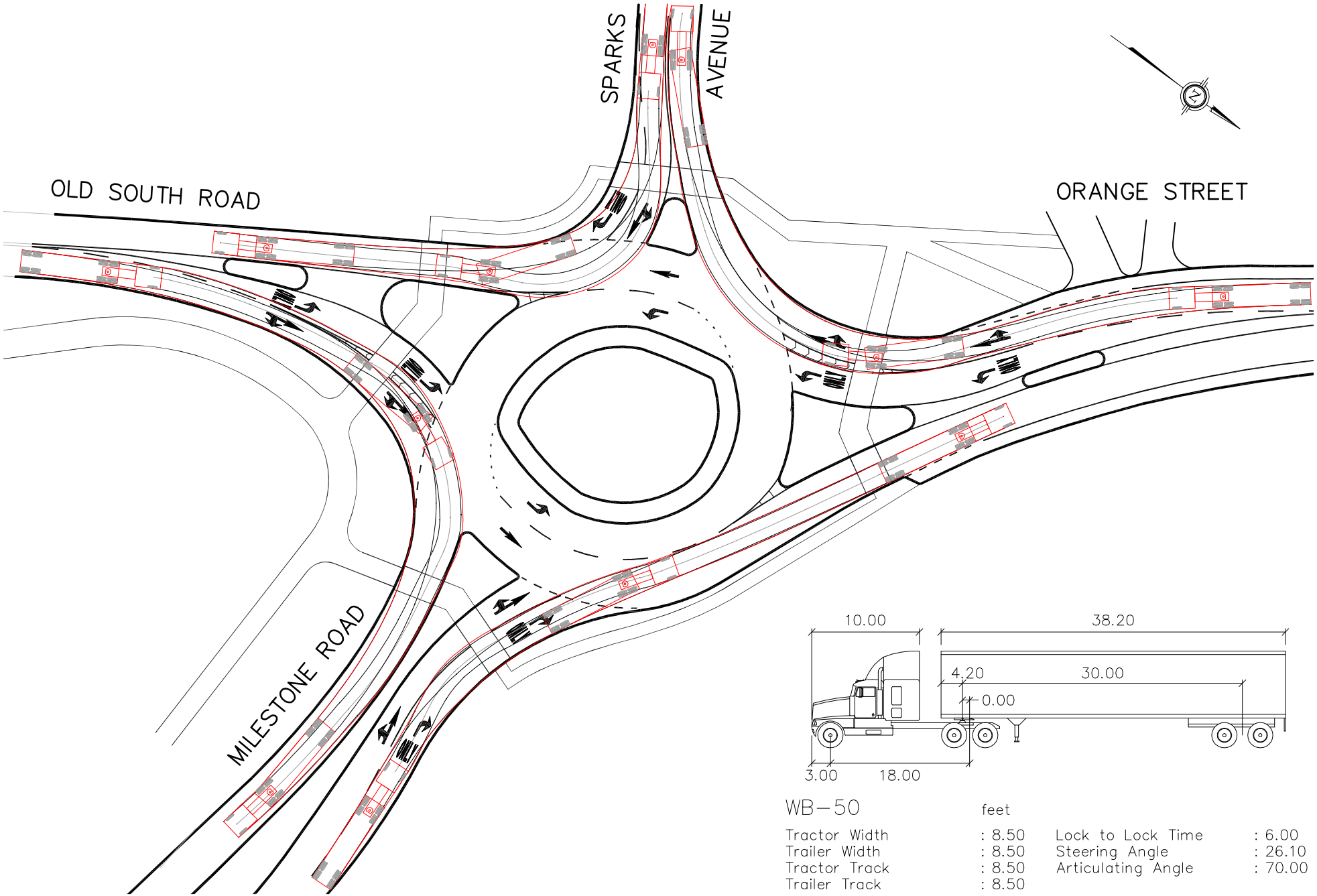


MILESTONE ROUNDABOUT–PRELIMINARY DESIGN
CRITICAL DEFLECTION PATHS
NANTUCKET, MASSACHUSETTS

OURSTON ROUNDABOUT ENGINEERING
www.OURSTON.com

DATE	PROJECT No.
SEPTEMBER, 2006	06914
SCALE	FIGURE No.
1"=50'	6

R/P Date – SEPT 10, 2006 File: 06914 PR1.DWG



WB–50 feet

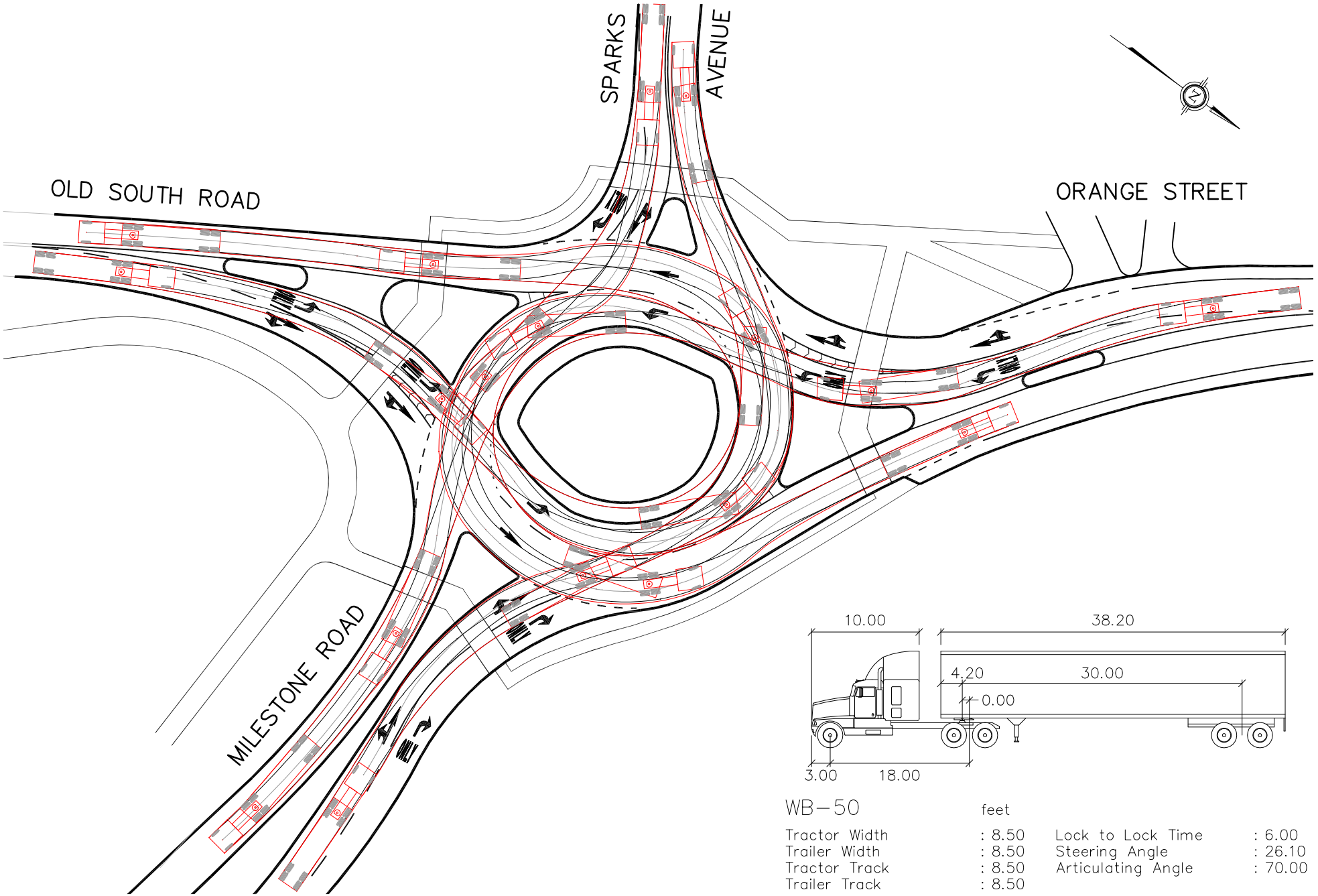
Tractor Width	: 8.50	Lock to Lock Time	: 6.00
Trailer Width	: 8.50	Steering Angle	: 26.10
Tractor Track	: 8.50	Articulating Angle	: 70.00
Trailer Track	: 8.50		

MILESTONE ROUNDABOUT–PRELIMINARY DESIGN
DESIGN VEHICLE RIGHT TURNS
NANTUCKET, MASSACHUSETTS

OURSTON ROUNDABOUT ENGINEERING
www.OURSTON.com

DATE	PROJECT No.
SEPTEMBER, 2006	06914
SCALE	FIGURE No.
1"=50'	7

R/P Date – SEPT 10, 2006 File: 06914 PR1.DWG



WB–50 feet

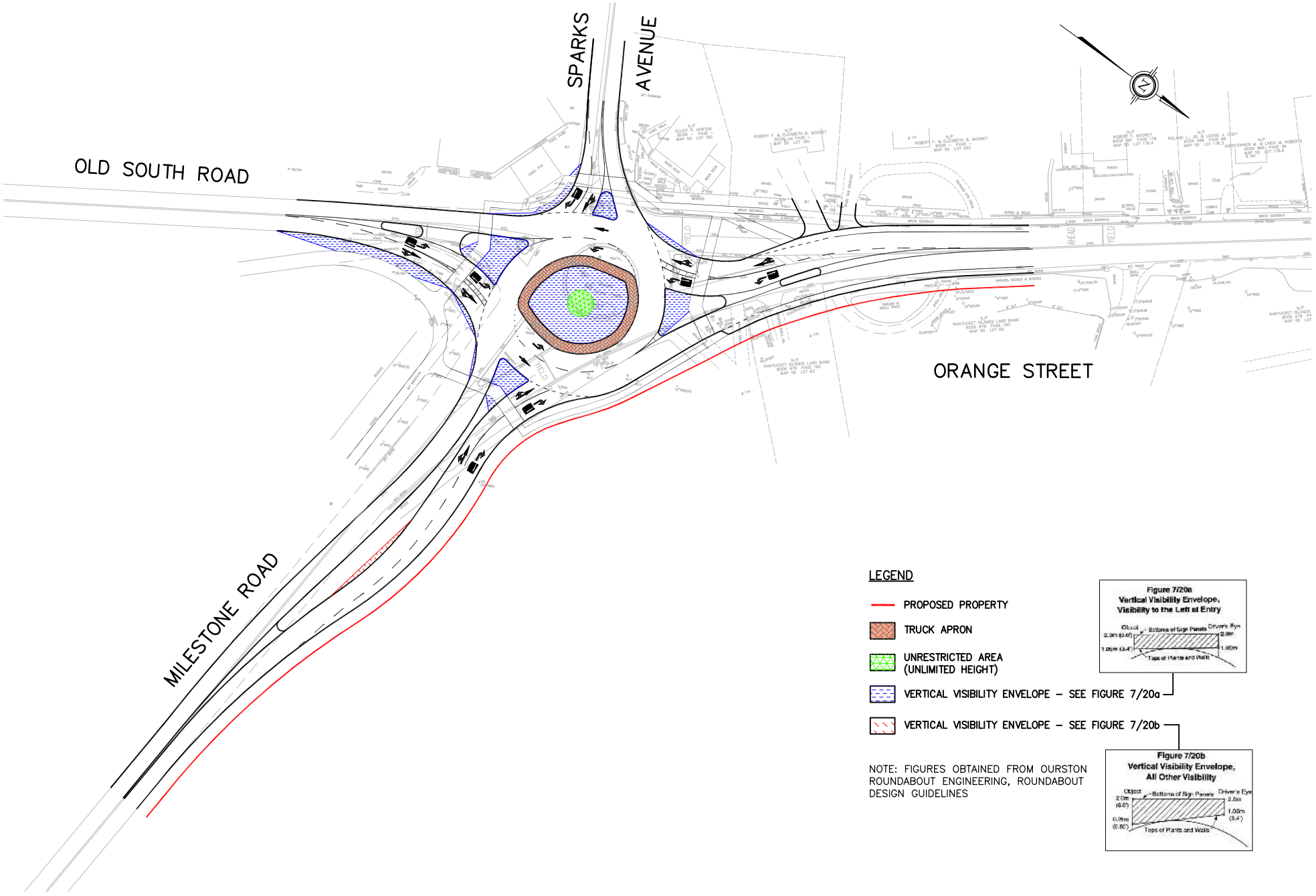
Tractor Width	: 8.50	Lock to Lock Time	: 6.00
Trailer Width	: 8.50	Steering Angle	: 26.10
Tractor Track	: 8.50	Articulating Angle	: 70.00
Trailer Track	: 8.50		

MILESTONE ROUNDABOUT–PRELIMINARY DESIGN
DESIGN VEHICLE LEFT TURNS
NANTUCKET, MASSACHUSETTS

OURSTON ROUNDABOUT ENGINEERING
www.OURSTON.com

DATE	PROJECT No.
SEPTEMBER, 2006	06914
SCALE	FIGURE No.
1"=50'	8

File: 06914 PR1.DWG
R/P Date – SEPT 10, 2006



MILESTONE ROUNDABOUT–PRELIMINARY DESIGN
PROPERTY IMPACTS & CLEARVIEW AREAS
NANTUCKET, MASSACHUSETTS

OURSTON ROUNDABOUT ENGINEERING
www.OURSTON.com

DATE	PROJECT No.
SEPTEMBER, 2006	06914
SCALE	FIGURE No.
1"=100'	10

File: 06914 PRI.DWG
R/P Date – SEPT 10, 2006

APPENDIX A
CAPACITY ANALYSIS OUTPUT

Ourston Roundabout Engineering

TABLE A
Summary of Existing Rotary Operational Performance

Entry Lane	2004 Traffic Counts			2014 Traffic Forecasts		
	Avg. Delay (s/vehicle)	LOS	Max. Queue (vehicles)	Avg. Delay (s/vehicle)	LOS	Max. Queue (vehicles)
AM Peak Hour						
Orange St Right/Thru	11	B	1	23	C	4
Orange St Left	8	A	1	12	B	1
Sparks Ave	19	C	4	214	F+	73
Old South Rd	20	C	4	205	F+	74
Milestone Right	11	B	1	22	C	4
Milestone Rd Thru/Left	11	B	1	23	C	4
PM Peak Hour						
Orange St Right/Thru	31	D	7	323	F+	111
Orange St Left	13	B	2	40	E	8
Sparks Ave	55	F	14	514	F+	178
Old South Rd	38	E	10	316	F+	123
Milestone Right	13	B	2	28	D	6
Milestone Rd Thru/Left	19	C	4	111	F+	38
Saturday Peak Hour						
Orange St Right/Thru	35	D	5	556	F+	172
Orange St Left	11	B	1	20	C	2
Sparks Ave	35	D	5	699	F+	201
Old South Rd	27	D	4	381	F+	119
Milestone Right	13	B	1	24	C	3
Milestone Rd Thru/Left	13	B	1	26	D	3

Notes: The geometric parameters of the existing rotary are outside the normal operating range of RODEL. Results should be used with caution. The rotary was modeled using a capacity factor of 0.80 on Sparks Avenue and Old South Road.
LOS is based on All-Way STOP criteria as per the Highway Capacity Manual.

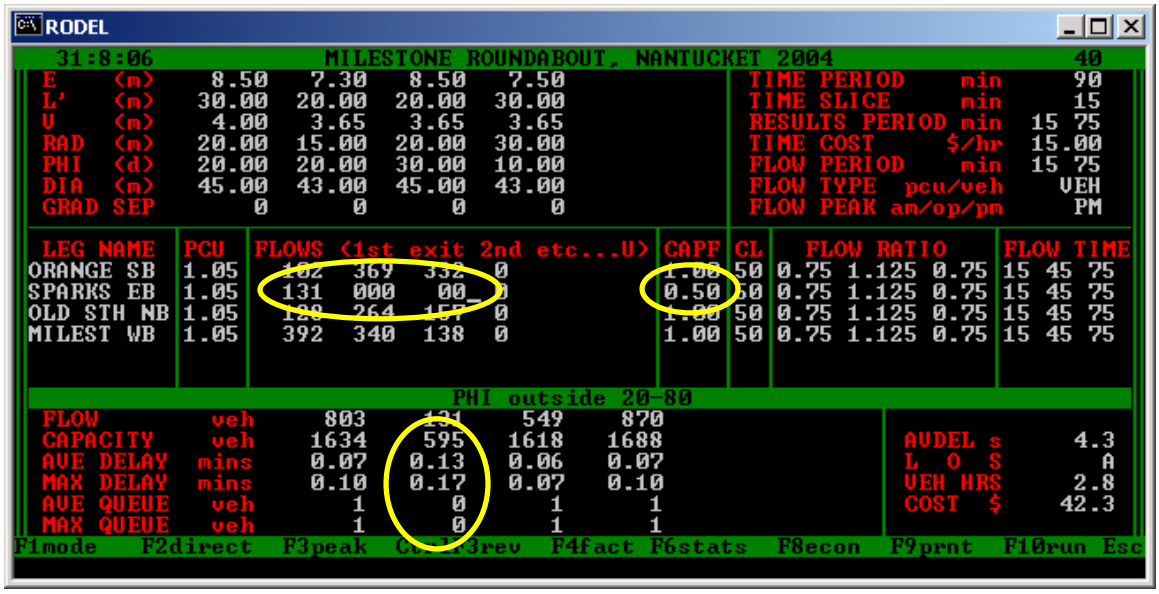
Ourston Roundabout Engineering

TABLE B
Summary of Proposed Roundabout Operational Performance

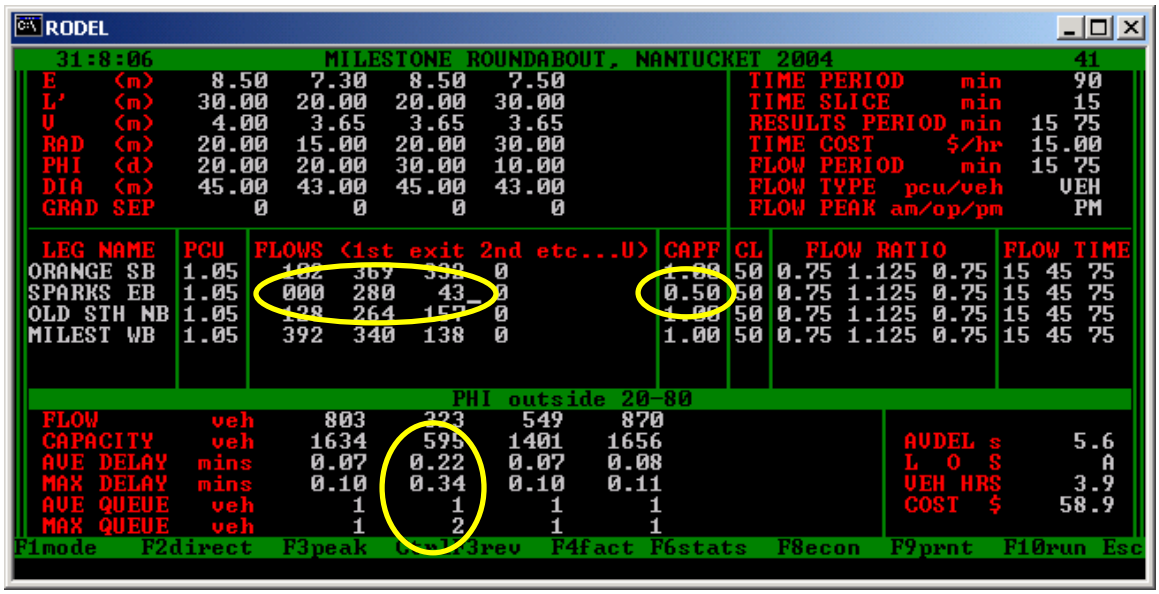
Entry Lane	2004 Traffic Counts			2014 Traffic Forecasts		
	Avg. Delay (s/vehicle)	LOS	Max. Queue (vehicles)	Avg. Delay (s/vehicle)	LOS	Max. Queue (vehicles)
AM Peak Hour						
Orange St Right/Thru	7	A	1	10	A	1
Orange St Left	5	A	0	7	A	1
Sparks Ave Right	7	A	0	8	A	1
Sparks Ave Thru Left	9	A	1	17	C	3
Old South Rd Right/Thru	9	A	1	16	C	3
Old South Left	7	A	0	8	A	1
Milestone Right	8	A	1	13	B	2
Milestone Rd Thru/Left	8	A	1	13	B	2
PM Peak Hour						
Orange St Right/Thru	11	B	2	47	E	16
Orange St Left	7	A	1	13	B	2
Sparks Ave Right	8	A	0	11	B	1
Sparks Ave Thru Left	13	B	2	76	F	19
Old South Rd Right/Thru	12	B	2	8	A	1
Old South Left	7	A	0	48	E	13
Milestone Right	8	A	1	16	C	3
Milestone Rd Thru/Left	10	A	2	35	D	11
Saturday Peak Hour						
Orange St Right/Thru	12	B	2	45	E	9
Orange St Left	7	A	1	10	A	1
Sparks Ave Right	8	A	0	10	A	1
Sparks Ave Thru Left	13	B	1	43	E	6
Old South Rd Right/Thru	10	A	1	22	C	3
Old South Left	7	A	0	10	A	1
Milestone Right	8	A	1	14	B	2
Milestone Rd Thru/Left	8	A	1	14	B	2

Notes: RODEL output is provided for the shaded conditions only.
LOS is based on All-Way STOP criteria as per the Highway Capacity Manual.

Orange St/Sparks Ave/Old South Rd/Milestone Rd
RODEL 1 Output, 50th Percentile Confidence Level
2004 Traffic Count, PM Peak Hour

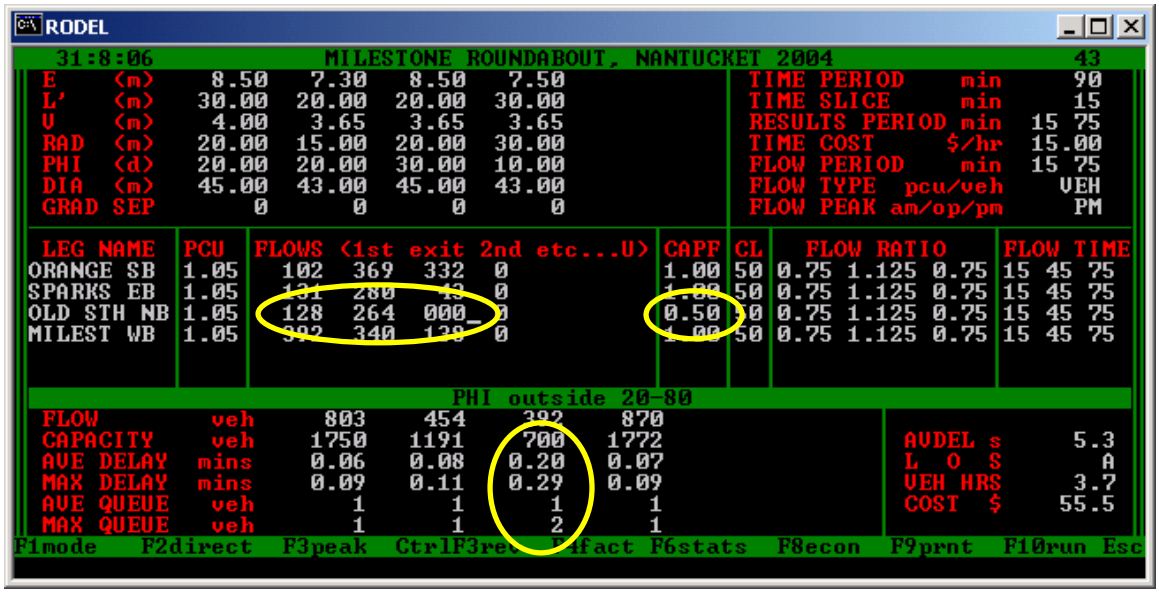


Sparks Avenue, Right Lane

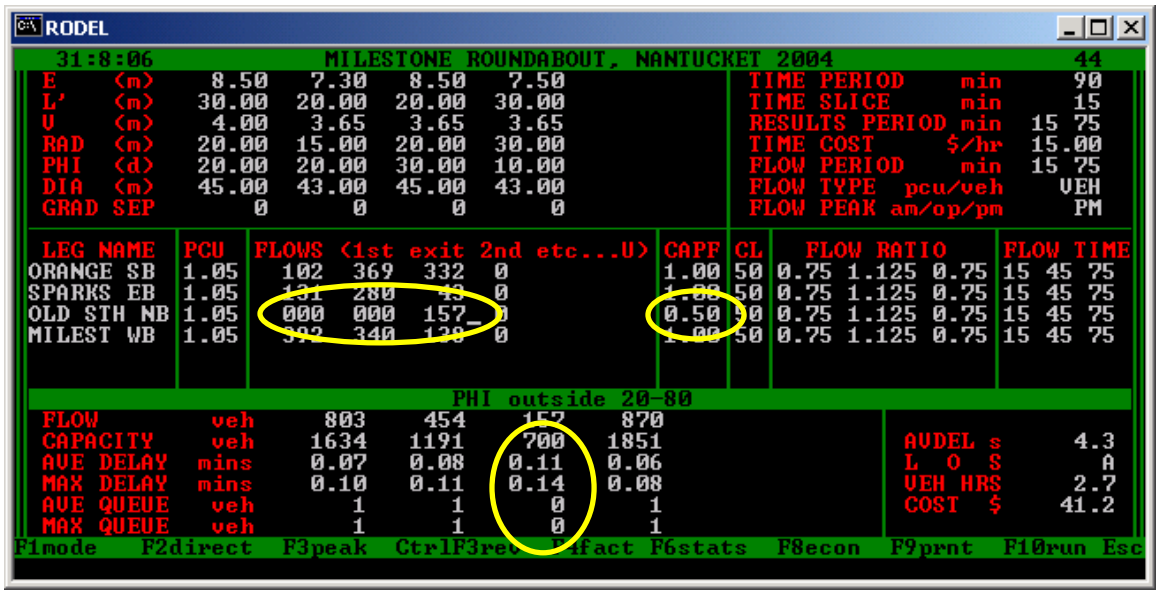


Sparks Avenue, Through/Left Lane

Orange St/Sparks Ave/Old South Rd/Milestone Rd
RODEL 1 Output, 50th Percentile Confidence Level
2004 Traffic Count, PM Peak Hour

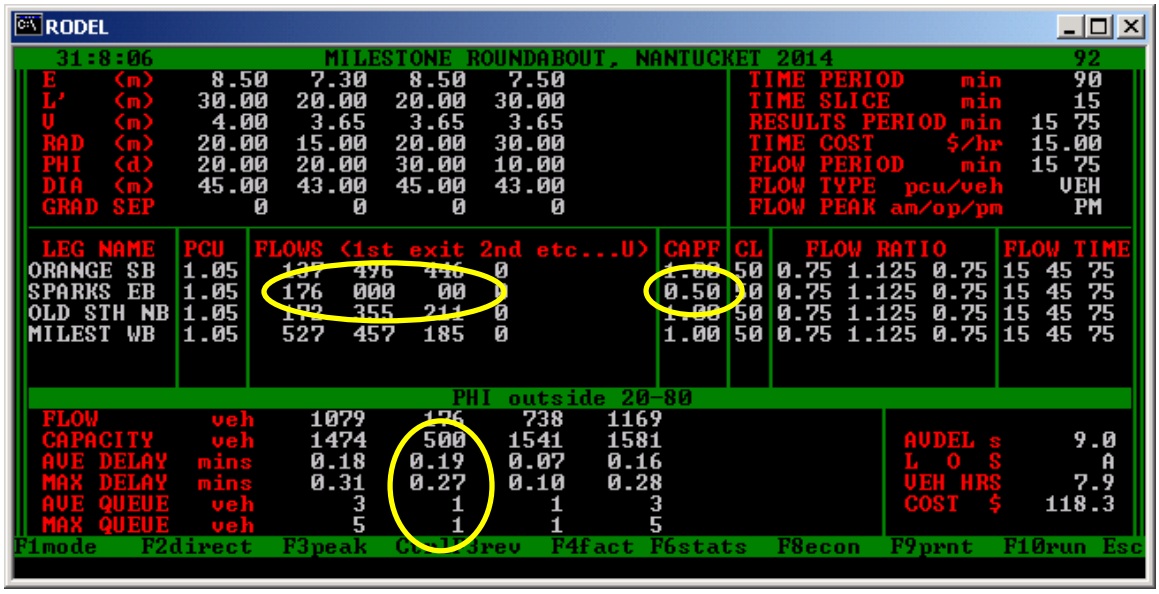


Old South Road, Right/Through Lane

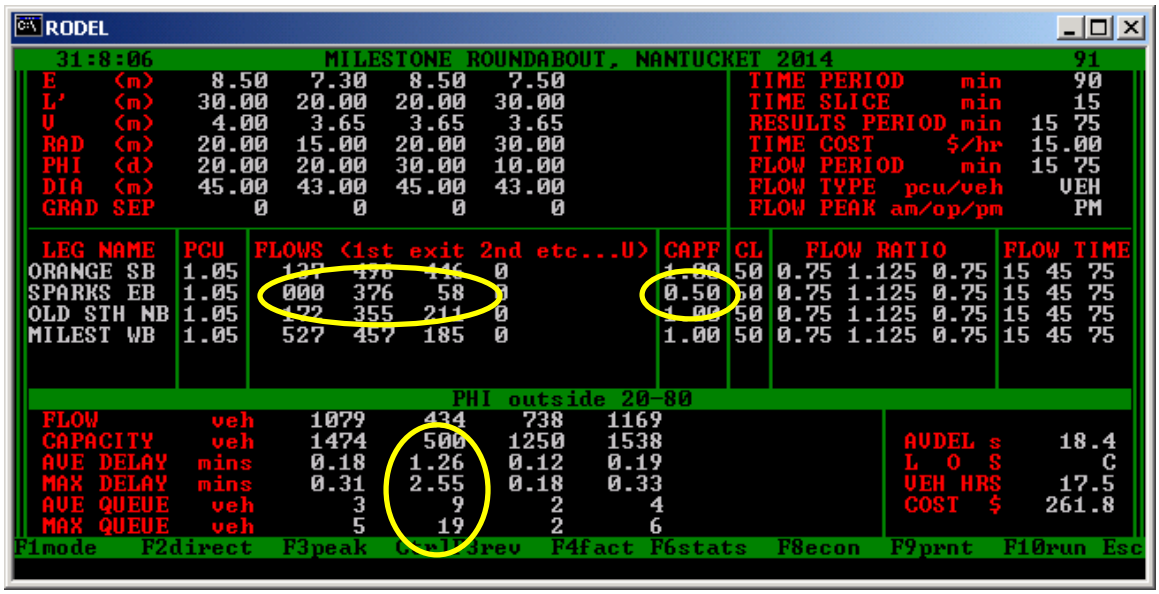


Old South Road, Left Lane

Orange St/Sparks Ave/Old South Rd/Milestone Rd
RODEL 1 Output, 50th Percentile Confidence Level
2014 Traffic Forecasts, PM Peak Hour

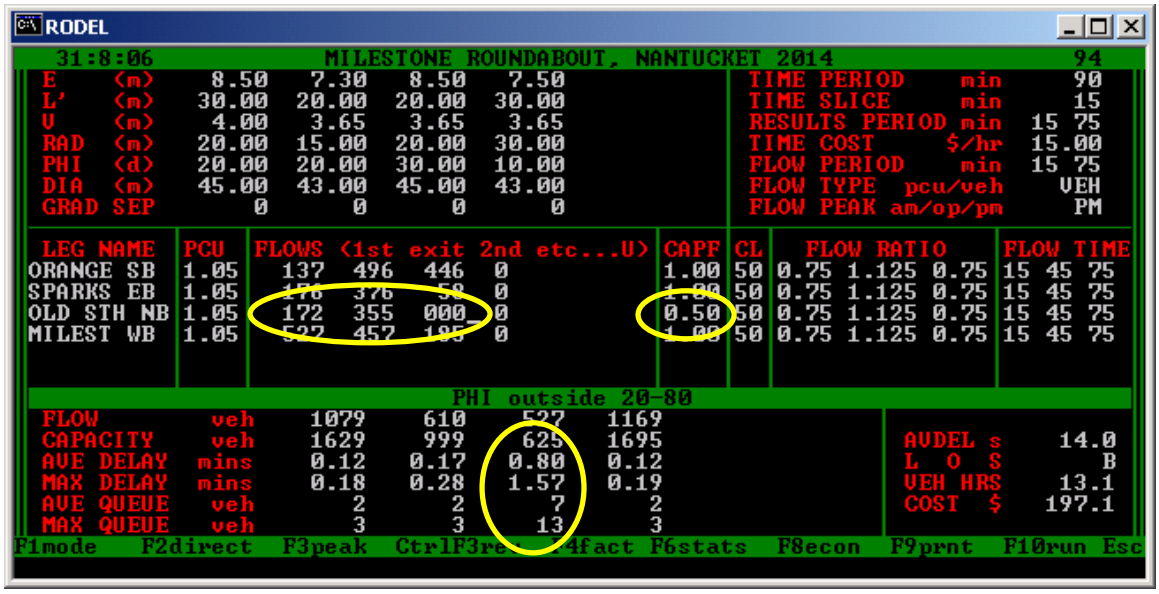


Sparks Avenue, Right Lane

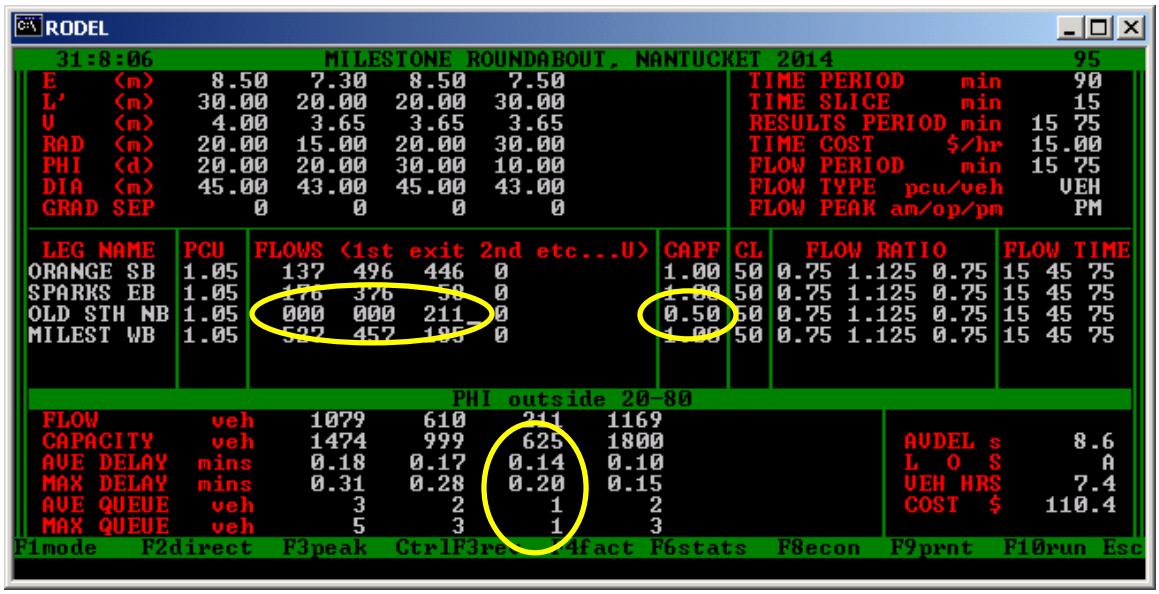


Sparks Avenue, Through/Left Lane

Orange St/Sparks Ave/Old South Rd/Milestone Rd
RODEL 1 Output, 50th Percentile Confidence Level
2014 Traffic Forecasts, PM Peak Hour



Old South Road, Right/Through Lane



Old South Road, Left Lane