

# **Lilac Hills Ranch**

## **Traffic Impact Study**

**Prepared for**

ACCRETIVE INVESTMENT, INC.  
12275 El Camino Real, Ste. 110  
San Diego, CA 92130

### **FEIR APPENDICES**

## **Mountain Ridge Fire Station Alternative**

### **July 1, 2015**

**Prepared by**

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**Appendix A**

**Roundabout Peer Review by Reid Middleton**

## Pedestrians at Lilac Hills Ranch Roundabouts

February 20, 2014

The proposed Lilac Hills Ranch roundabout intersections are located at the northwest and northeast corners of the development and are referred to as Intersection 1 and 2 respectively in the Reid Middleton *Lilac Hills Intersection Analysis* (dated October 22, 2013). Both intersections are surrounded by single-family detached units. See Figures 1 and 2.



Figure 1. Roundabout Intersection 1

The new community is a mixed use pedestrian oriented sustainable community within an unincorporated area of San Diego County. The development design will result in a high internal capture rate generating little pedestrian traffic entering and exiting the community via roundabout intersections 1 and 2. However, both roundabout intersections are located adjacent to multi-use and feeder trails and these trails will generate recreational pedestrian traffic.

Intersection capacity analysis is conducted for the AM and PM peak hours when motor vehicle traffic is the greatest. The PM peak hour is typically the higher of the two. The majority of the recreational pedestrian traffic will occur following the PM peak hour; after the users have commuted home and then participate in their evening run, walk, etc.



**Figure 2. Roundabout Intersection 2**

It is a challenge to forecast recreational pedestrian traffic due to the lack of documentation on trail usage and demand. What little data that is available is related to pedestrian trips between home and work, shopping, or school but not recreational. For this analysis 50 pedestrians are added at each pedestrian crossing during the PM peak hour. This value is much higher than expected.

The Reid Middleton *Lilac Hills Intersection Analysis* (dated October 22, 2013) showed the greatest delay for roundabout Intersections 1 and 2 occurred during the PM peak hour with Road 3. The overall intersection average delays were 5.5 and 6.8 seconds/vehicle (sec/veh) respectively. The very low delays indicated many gaps in the traffic and a large reserve capacity.

The analysis software dictates that approaching and exiting motor vehicle traffic will yield to all pedestrian traffic. Because both roundabouts are operating well below capacity and many gaps exist in the approaching traffic, the added pedestrians have no measurable impact on roundabout performance. The overall intersection average delays remain at 5.5 and 6.8 sec/veh. Movement summaries are attached.

# MOVEMENT SUMMARY

Site: 2030 PM PH 4-Leg w Road 3  
RMG w Peds

Intersection #1, 4-Leg, Reid Middleton Geometry (RMG)  
2030 PM Peak Hour  
With Road 3 - Base + Project - With Pedestrians

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
<b>South: NB Approach</b>											
3	L	26	2.0	0.041	15.5	LOS B	0.2	5.1	0.66	0.77	23.7
8	T	1	2.0	0.041	7.3	LOSA	0.2	5.1	0.66	0.59	24.7
18	R	1	2.0	0.041	8.7	LOSA	0.2	5.1	0.66	0.64	24.4
<b>Approach</b>		28	2.0	0.041	14.9	LOS B	0.2	5.1	0.66	0.76	23.8
<b>East: WB Approach</b>											
1L	L	1	2.0	0.406	9.5	LOSA	2.1	52.8	0.40	0.91	25.3
6T	T	464	2.0	0.406	4.5	LOSA	2.1	52.8	0.40	0.46	27.5
6R	R	1	2.0	0.406	4.6	LOSA	2.1	52.8	0.40	0.52	26.7
<b>Approach</b>		466	2.0	0.406	4.5	LOSA	2.1	52.8	0.40	0.46	27.5
<b>North: SB Approach</b>											
7	L	1	2.0	0.103	9.9	LOSA	0.4	10.3	0.44	0.79	24.9
4	T	1	2.0	0.103	3.6	LOSA	0.4	10.3	0.44	0.43	26.5
14	R	98	2.0	0.103	6.3	LOSA	0.4	10.3	0.44	0.59	26.8
<b>Approach</b>		100	2.0	0.103	6.3	LOSA	0.4	10.3	0.44	0.59	26.8
<b>West: EB Approach</b>											
5	L	196	2.0	0.749	10.4	LOS B	7.0	177.1	0.07	0.89	29.6
2	T	722	2.0	0.749	4.3	LOSA	7.0	177.1	0.07	0.36	34.1
12	R	45	2.0	0.749	5.7	LOSA	7.0	177.1	0.07	0.51	33.0
<b>Approach</b>		962	2.0	0.749	5.6	LOSA	7.0	177.1	0.07	0.47	32.9
<b>All Vehicles</b>		1557	2.0	0.749	5.5	LOSA	7.0	177.1	0.20	0.48	30.4

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# MOVEMENT SUMMARY

Site: 2030 PM PH w Road 3 RMG w Peds

Intersection #2, Reid Middleton Geometry (RMG)  
2030 PM Peak Hour  
With Road 3 - With Pedestrians

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
<b>South: NB Approach</b>											
3	L	37	2.0	0.048	10.4	LOS B	0.2	5.2	0.48	0.70	24.4
8	T	1	2.0	0.048	7.4	LOS A	0.2	5.2	0.48	0.55	31.3
18	R	5	2.0	0.048	6.7	LOS A	0.2	5.2	0.48	0.56	26.4
Approach		43	2.0	0.048	9.9	LOS A	0.2	5.2	0.48	0.68	24.8
<b>East: WB Approach</b>											
1L	L	8	2.0	0.251	10.5	LOS B	1.4	34.6	0.16	0.88	29.6
6T	T	247	2.0	0.251	4.4	LOS A	1.4	34.6	0.16	0.37	33.5
6R	R	98	2.0	0.251	6.8	LOS A	1.4	34.6	0.16	0.53	32.9
Approach		352	2.0	0.251	5.2	LOS A	1.4	34.6	0.16	0.43	33.2
<b>North: SB Approach</b>											
7	L	196	2.0	0.209	13.5	LOS B	0.8	21.2	0.38	0.73	29.0
4	T	1	2.0	0.209	6.7	LOS A	0.8	21.2	0.38	0.52	31.9
14	R	1	2.0	0.209	7.9	LOS A	0.8	21.2	0.38	0.59	31.5
Approach		198	2.0	0.209	13.4	LOS B	0.8	21.2	0.38	0.73	29.0
<b>West: EB Approach</b>											
5	L	1	2.0	0.341	13.0	LOS B	1.7	42.7	0.38	0.87	29.9
2	T	328	2.0	0.341	4.3	LOS A	1.7	42.7	0.38	0.44	27.6
12	R	51	2.0	0.341	4.5	LOS A	1.7	42.7	0.38	0.50	26.7
Approach		380	2.0	0.341	4.4	LOS A	1.7	42.7	0.38	0.45	27.5
All Vehicles		974	2.0	0.341	6.8	LOS A	1.7	42.7	0.30	0.51	29.4

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

**W Lilac Rd Roundabouts  
San Diego County  
Accretive Investments, Inc.**

**Roundabout Peer Review  
Exhibit of Findings  
October 2013**

# Roundabout Exhibit of Findings

## W Lilac Rd Roundabouts San Diego County

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The engineering material and data contained in this report were prepared under the supervision and direction of the undersigned, whose seal as a registered professional engineer is affixed below.



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# Review Comments/Design Notes

Project Title:	W Lilac Rd Roundabouts	Design Phase (%):	Conceptual
Owner:	Accretive Investments, Inc.	Date:	October 25, 2013

Topic/ Reference	Comment
Introduction/ Initial Design Assumptions	<p>Reid Middleton (RM) was contracted by Accretive Investments, Inc. to provide a peer review of two single lane roundabouts on W Lilac Rd. The conceptual roundabouts had been prepared by Landmark Consulting. RM was given the following assumptions for the design:</p> <ul style="list-style-type: none"> <li>- The design vehicle for these roundabouts is a WB-50.</li> <li>- Roundabout 1 (RB 1): The approach speeds from the existing west leg (W Lilac Rd) and from the proposed east leg (IOD) are 40mph. The speeds from the existing north leg (W Lilac Rd), proposed south leg (Residential Rd), and proposed southeast leg (Main St) are 30mph.</li> <li>- Roundabout 2 (RB 2): The approach speeds from the existing north leg (W Lilac Rd) and existing east leg (W Lilac Rd) are 40mph. The speeds from the proposed west leg (Main St) and proposed south leg (Residential Rd) are 30 mph.</li> </ul> <p>RM reviewed the roundabout traffic analysis, horizontal geometrics, and preliminary grading of the proposed roundabouts. To achieve a safe and efficient design, a roundabout needs proper deflection, good speed control and natural drive paths. In reviewing the layout of these roundabout designs, it was determined that the horizontal geometrics would not adequately achieve these goals (Figures 1-2). RM provided several alternative new layouts that address the concerns of the initial layouts and will provide the desired user behavior at these intersections (Figures 3-6). A comparison of the initial and RM proposed layouts can be seen in Figure 7-8. In addition, Appendix B contains all the corresponding back-up calculations for the horizontal geometrics of the RM conceptual roundabouts.</p> <p>To calculate the fastest paths in the initial and RM designed roundabouts, the method developed by the Ada County Highway District was used. The method was created to be objective, repeatable, conform to the current FHWA Roundabout Guide and to reflect anticipated driver behavior and vehicle performance. A copy of this method can be seen in Appendix D. The design vehicle (WB-50) movements were calculated with a tire clearance of 18in to the outside curb, 6in to mountable curbs, and 0in to truck aprons. Due to the conservative nature of Autoturn™, this distance will ensure trucks can negotiate the roundabout comfortably.</p> <p>RM will be available to answer any questions that might arise from the specifics of these layouts.</p>



Topic/ Reference	Comment
Intersection 1 Traffic Analysis (Appendix A)	The all-way-stop-control does not accommodate the volumes at this intersection. The traffic signal and roundabout both provide good intersection performance; however, the roundabout provides greater reserve capacity for future growth (lower v/c ratios). The roundabout also provides a safer intersection where a diverse mix of users can successfully share the public right-of-way in a calm and aesthetic environment. The roundabout allows greater flexibility to accommodate a revised road configuration such as the addition of the IOD (or replacing W Lilac Rd with the IOD. Traffic analysis for a five leg roundabout (that incorporates both W Lilac Rd and IOD) show this configuration would work well with the traffic volumes. For full intersection analysis see Appendix A.
Intersection 2 Traffic Analysis (Appendix A)	The all-way-stop-control, the traffic signal and the roundabout all accommodate the traffic volumes at Intersection 2. Like Intersection 1, the roundabout provides greater reserve capacity for future growth (lower v/c ratios), and provides the other benefits listed above. For full intersection analysis see Appendix A.
Intersection Safety	<p>Roundabouts offers safety features that traffic signals do not. The strength of a roundabout is entry speed reduction and speed consistency through the intersection. A well-designed roundabout minimizes differential speeds to reduce collision rates and severity of collisions between conflicting vehicles. According to NCHRP Report 572, a roundabout has a 76% reduction in severe injury collisions compared to traffic signals.</p> <p>The roundabout geometry removes the most severe collisions. Head on, right angle, and T-bone collisions do not occur at a roundabout; the geometry does not facilitate these types of collisions. The slow motor vehicle speeds through the intersection establishes a safer condition for pedestrians and bicycles users as well.</p> <p>At Intersection 1, a roundabout alternative will provide additional safety benefits due to the roadway configuration. The existing curvature of W Lilac Rd does not lend itself to the construction of a safe traffic signal. However, a roundabout uses this existing curvature to its advantage by slowing and directing vehicles to properly enter the intersection.</p> <p>Traffic signals do not always operate safely and efficiently under skewed roadway conditions. The intersect angle of proposed and existing alignments at Intersection 1 create this skewed condition, especially if the IOD alignment is constructed. Roundabouts on the other hand, can create order from alignments that intersect at skewed angles which results in added safety benefits.</p> <p>The roundabout will also offer added safety benefits at Intersection 2 where the roadway alignments also intersect at skewed angles. At this intersection, the higher approach speeds of W Lilac Rd (40mph) and roadway alignments make the roundabout a much safer alternative over the all-way-stop-control and traffic signal control.</p>
Peer Review RB 1	A four-leg conceptual roundabout with the existing W Lilac Rd configuration was reviewed. The following item nos. 1-13 correspond to the triangular callouts on Figure 1.



Topic/ Reference	Comment
Item 1 (Figure 1)	The geometry for the approach from Main St does not slow vehicles as they enter the roundabout. Vehicles can enter the roundabout at a speed greater than 40mph while the conflicting traffic would be traveling approximately 15mph. Speeds this fast negate the innate safety benefits associated with single lane roundabouts. There will be an increase in failure to yield, increasing the potential for collisions. In addition, these potential collisions will result in severe damage due to the high speed differentials. A speed differential 6-7mph in conflicting paths is recommended at this location. In addition, entering speeds should be approximately 20-22mph.
Item 2 (Figure 1)	The geometry for the approach from Main St does nothing to slow vehicles down prior to the crosswalk location. The safety of pedestrian, bicycles, and equestrian users are dependent on slow vehicle speeds, controlled by the geometry of the roundabout. In addition, the commuter bicyclists will want to merge with vehicle traffic to negotiate the roundabout which is easier and safer when speeds are kept around 20-22mph.
Item 3 (Figure 1)	The geometry for the approaches from W Lilac Rd (both the west and north leg) do not slow vehicles sufficiently. Vehicles can enter the roundabout at 25mph while an entering speed of 20-22mph is more appropriate for a roundabout. See Item 2.
Item 4 (Figure 1)	The exit onto Main St, Residential St and W Lilac Rd (west leg) is not a natural path. Vehicles will need to brake to negotiate the exit safely, contrary to driver expectation. In addition, the splitter island does not guide circulating vehicles out of the roundabout in a path that is natural (see cyan line). The radius of this splitter island stripe should be tangent with the central truck apron curb. The potential for curb strikes on these exits is high and the capacity will be decreased with this type of design.
Item 5 (Figure 1)	Pavement marking arrows in circulating lane for a single lane roundabout are not recommended.
Item 6 (Figure 1)	The splitter island is too short on the Residential St. A minimum splitter island length of 50ft is recommended for this location. In addition, the pedestrian refuge is compromised on this leg. The pedestrian refuge island is an important safety feature at this location due to the trail connection and pedestrian connectivity.
Item 7 (Figure 1)	The bicycle crossing on W Lilac Rd (west leg) is located too far from the roundabout to get any safety benefits associated with vehicles slowing to negotiate the intersection. Ideally these crossings should be located one car length from the circulating roadway of the roundabout.
Item 8 (Figure 1)	The design vehicle (WB-50) does not seem to be accommodated on the exit to the Residential St and to Main St (see green lines depicting the tire tracks). A design vehicle should be able to negotiate the roundabout without having to put the tractor tires onto the truck apron (which is reserved for the trailer part of the truck). It is recommended that a WB-50 be able to negotiate this roundabout to ensure construction vehicles for the development will have adequate access.



Topic/ Reference	Comment
Item 9 (Figure 1)	It is not clear how this roundabout would accommodate the proposed IOD without major shifts in central island location or other approach alignments.
Item 10 (Figure 1)	The minimum recommended multiuse trail is 8ft. On Main St from the bike ramp to the pedestrian crosswalk, a minimum width of 8ft should be maintained.
Item 11 (Figure 1)	The bike ramp to the multiuse trail from W Lilac Rd and Main St is too wide. This may be mistaken as a driveway and entice vehicle traffic. In addition, RM does not recommend bicycle ramps oriented this way as less experienced bicyclists will swerve into travel lane to line themselves up with the ramp. See Appendix E for more explanation on Bicycle Treatment Facilities.
Item 12 (Figure 1)	The bicycle ramp exiting onto Main St is angled in a way that inexperienced bicyclists will be guided into the vehicle traffic. See Appendix E for more explanation on Bicycle Facilities.
Item 13 (Figure 1)	This location is not recommended as a bicycle crossing (see Item 7).
Peer Review RB 2	The conceptual layout of RB 2 was in the development stages of design. Therefore, the roundabout details were not reviewed, including the design of bicycle and pedestrian facilities. The following item nos. 14-21 correspond to the triangular callouts on Figure 2.
Item 14 (Figure 2)	The taper rate for the splitter island on the Residential St is abrupt for an approach speed of 30mph.
Item 15 (Figure 2)	The geometry for the approach from W Lilac Rd (north leg) does not slow vehicles sufficiently as they enter the roundabout. Vehicles can enter the roundabout at 25mph while an entering speed of 20-22mph is more appropriate for a roundabout. This will ensure the safety benefits and capacity predicted for this single lane roundabout are achieved.
Item 16 (Figure 2)	The geometry for the approach from Main St and the Residential St does nothing to slow vehicles down prior to the crosswalk location, which causes safety concerns.



Topic/ Reference	Comment
Item 17 (Figure 2)	The pedestrian refuge island on the Residential St may not meet current standards for a minimum distance of 6.0ft. This refuge does not provide adequate protection.
Item 18 (Figure 2)	The splitter islands are too short on W Lilac Rd (both the north and east legs). A minimum splitter island length is 50ft, however due to the higher speeds on this approach a longer splitter island is desirable (100-150ft).
Item 19 (Figure 2)	The right turn from westbound W Lilac Rd is an unnatural path. Drivers will straighten this path out (see difference between outside curb lines and the blue line). The straightened path creates a faster right turn that is appropriate at this location. In addition, the unused space is inefficient and will collect debris.
Item 20 (Figure 2)	All of the exits from this roundabout are designed with an unnatural path, however, it is more pronounced on the W Lilac Rd (north and east legs). Vehicles will need to brake to negotiate these exits safely, contrary to driver expectation. In addition, the splitter island does not guide circulating vehicles out of the roundabout in a path that is natural (see cyan line). The radius of this splitter island stripe should be tangent with the central truck apron curb. The potential for curb strikes on these exits is high and the capacity will be decreased with this type of design.
Item 21 (Figure 2)	The design vehicle (WB-50) does not seem to be accommodated on the exit to the Residential St and to Main St (see green lines depicting the tire tracks). A design vehicle should be able to negotiate the roundabout without having to put the tractor tires onto the truck apron (which is reserved for the trailer part of the truck). It is recommended that a WB-50 be able to negotiate this roundabout to ensure construction vehicles for the development will have adequate access.
RM Design RB 1 RB 1 (Alt A) RB 1 (Alt B)	RM designed a conceptual roundabout that addresses the above concerns of the first intersection. This layout, RB 1, is designed to accommodate the existing W Lilac Rd (north leg). The following item nos. 22-25 correspond to the circular callouts on Figure 3. The roundabout is versatile so that with minor modifications, it will accommodate the proposed IOD alignment rather than the existing W Lilac Rd (north leg). The location of the central island and three legs are the same in this roundabout, RB 1 (Alt A) as in RB 1. An accurate representation of the roundabout impacts, regardless of which alignment is built for that fourth leg, can be determined and quantified for the majority of the intersection. Item no. 26 corresponds to the circular callouts on Figure 4. Finally, in an effort to provide for both the W Lilac Rd (north leg) and proposed IOD alignment, a five-leg roundabout, RB 1 (Alt B) was designed. The following item nos. 27-29 correspond to the circular callouts on Figure 5. Appendix B contains all the corresponding back-up calculations for the horizontal geometrics of these RM conceptual roundabouts such as fastest paths, truck turning movements and sight distance requirements.



Topic/ Reference	Comment
Item 22 (Figure 3)	Bike ramps are detailed based on RM recommended design. The reasoning behind this type of design can be found in Appendix E.
Item 23 (Figure 3)	Pedestrian refuge islands were designed with equestrian users in mind – the width is a minimum of 10ft.
Item 24 (Figure 3)	Multiuse trail and landscaping buffer widths can be adjusted. (Multiuse trail minimum width is 8ft with 10ft being desirable).
Item 25 (Figure 3)	This type of ramp was used to indicate that all multiuse path users except bicyclists should use this pedestrian crossing and subsequent multiuse paths. The bike path continues around the north side of the roundabout and “bike only” pavement markings could be used. For bicycle users, the path around the north of the roundabout was designed to limit crosswalk exposure for those traveling from Main St to westbound W Lilac Rd (only one crossing versus three if they traverse using the southern multiuse path).
Item 26 (Figure 4)	Entry curvature on Main St and exit curvature on W Lilac Rd changed slightly to accommodate the proposed IOD alignment. All other curb locations remain the same as RB 1.
Item 27 (Figure 5)	The splitter island length is influenced by the approach speed. When the approach speed is 30mph a minimum splitter island length of 50ft is acceptable. At higher speeds, the splitter island length increases.
Item 28 (Figure 5)	This type of ramp was used to indicate that all multiuse path users should use this pedestrian crossing and subsequent multiuse paths. Bicyclists are encouraged to use the southern multiuse path system as this route does not substantially increase their crosswalk exposure.

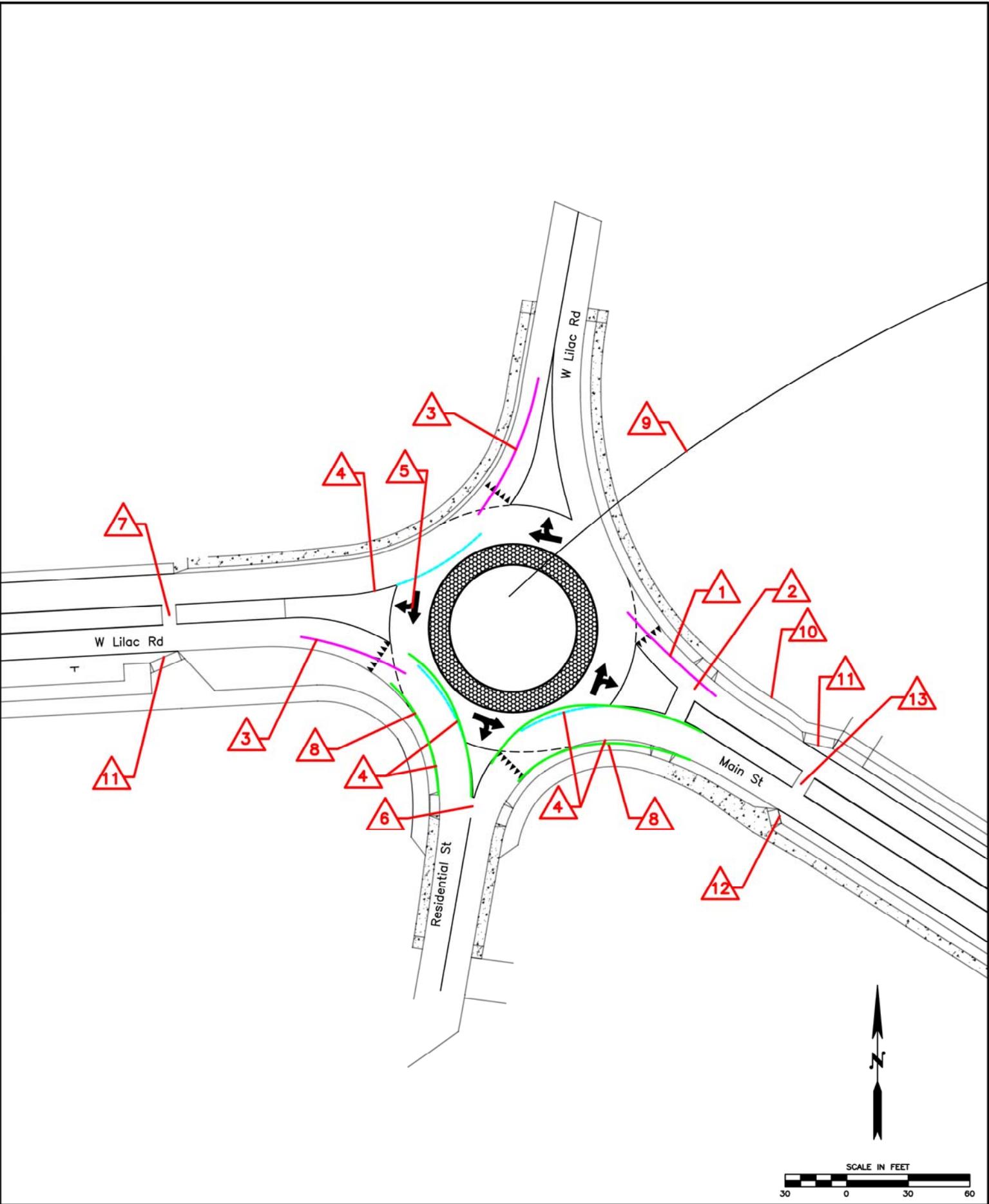


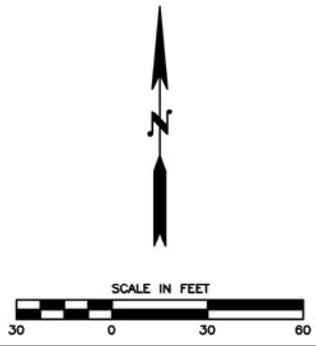
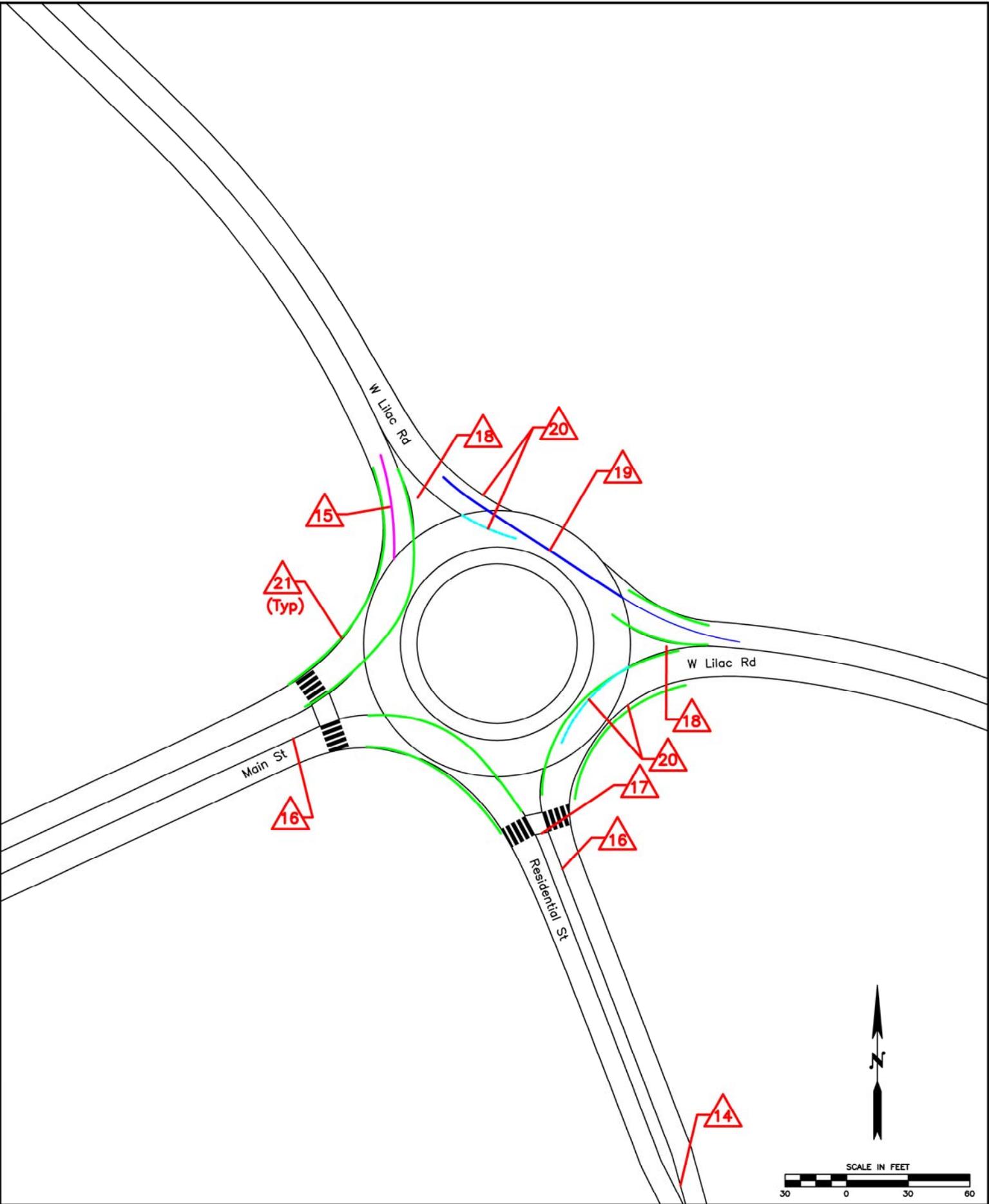
Topic/ Reference	Comment
Item 29 (Figure 5)	This roundabout provides an excellent way of designing for the existing W Lilac Rd, but leaving options open for future IOD alignment development. Residents that live along W Lilac Rd will not have to be inconvenienced with a road closure, and they will not have a negative impact on the roundabout safety or operations. The IOD leg can be built at a later time with no impact to existing roundabout operations.
RM Design RB 2	RM designed a conceptual roundabout, RB 2 that addresses the above concerns of the second intersection. The following item nos. 30-31 correspond to the circular callouts on Figure 6. Appendix B contains all the corresponding back-up calculations for the horizontal geometrics of these RM conceptual roundabouts such as fastest paths, truck turning movements and sight distance requirements.
Item 30 (Figure 6)	Pedestrian facilities and corresponding crosswalk locations can be adjusted as needed based on proposed routes.
Item 31 (Figure 6)	Taking out the reverse curves on the W Lilac Rd exit (north leg) allows for a more natural vehicle path as cars exit the roundabout.

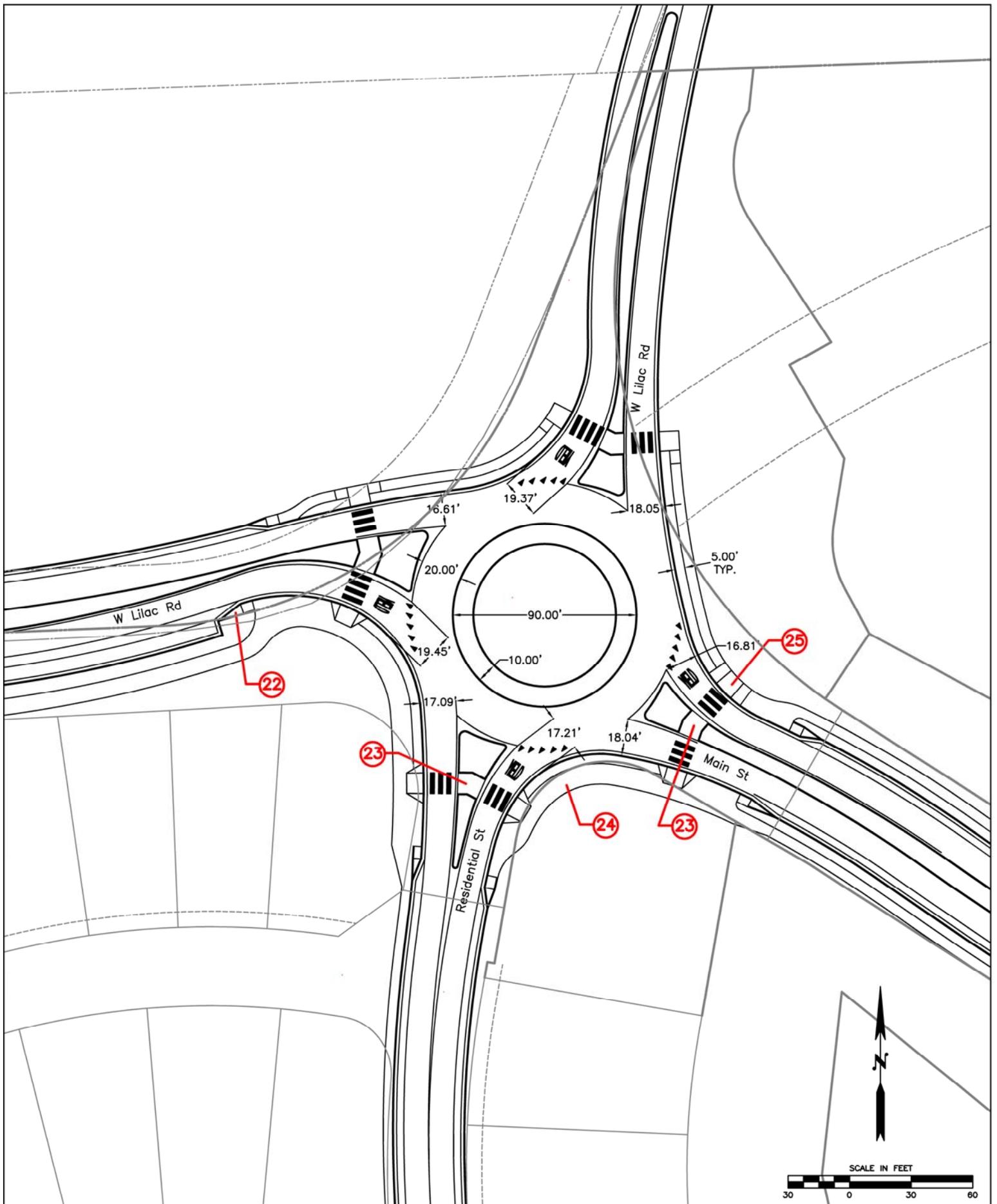


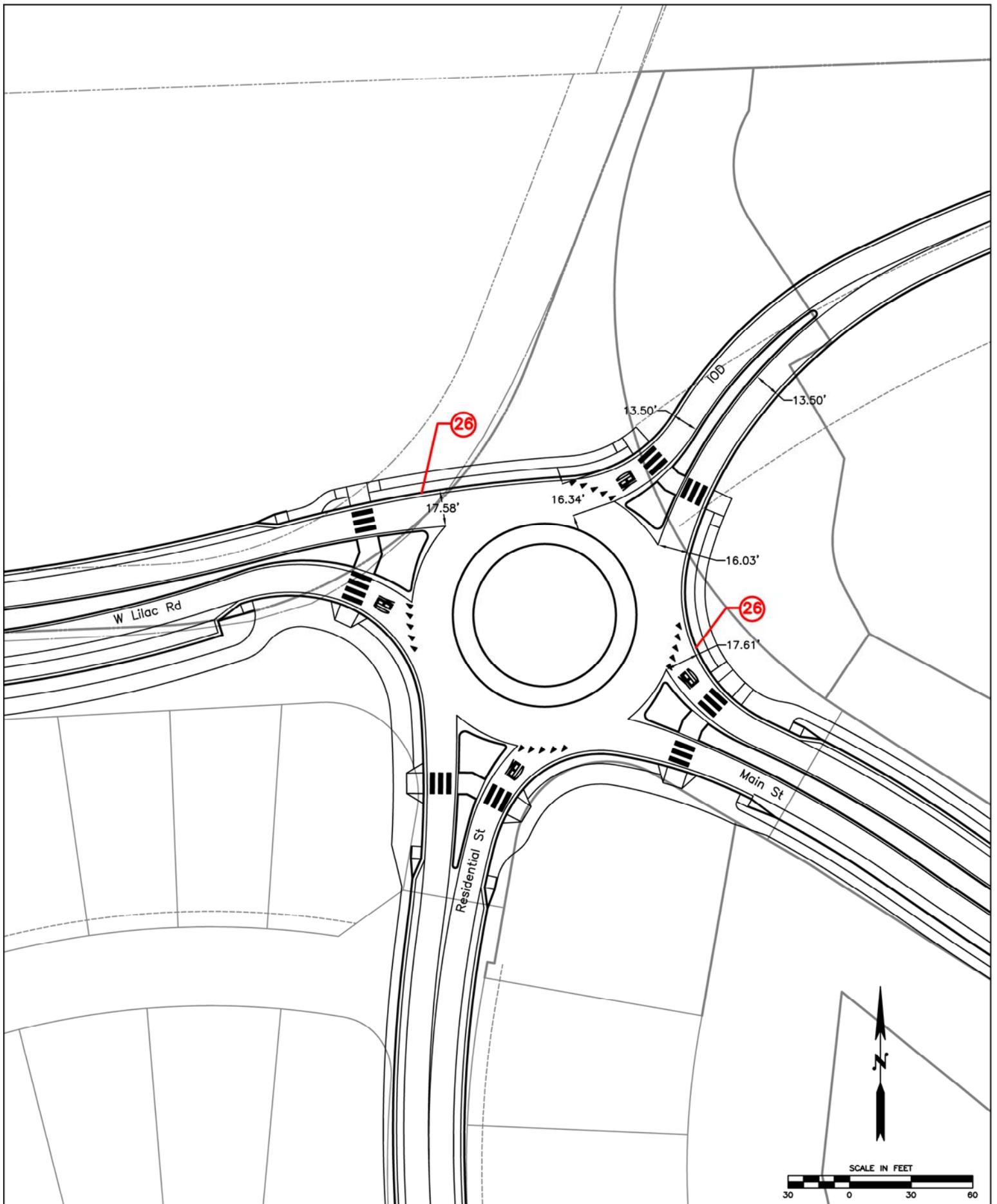
Topic/ Reference	Comment
Grading (Appendix C)	<p>Because design speeds (and fastest paths speeds) are controlled at roundabouts, there is flexibility in constructing roundabouts at topographically challenging sites. It appears the following grading guidelines are achievable in both RB 1 and RB 2 (See Appendix C):</p> <ul style="list-style-type: none"> <li>• Design the central island profile with vertical curve values equal to circulating speeds (15mph)</li> <li>• Design the central island profile with a maximum grade of 4%</li> <li>• Use an approximate 2% cross slope (1.5% to 2.5%) for circulating lane, approach lanes and exit lanes</li> <li>• Design outside curb profiles based on elevations of central island profile with appropriate cross slopes. Vertical curve values will be based on the design speed of the roundabout (20mph)</li> <li>• Tie into existing/proposed curb alignments at the leading edge of the splitter islands using vertical curve values consistent with approach speeds</li> <li>• Detail spot elevations based on vertical curve grading and check that all of the above guidelines are incorporated (<i>not included in Appendix C – detailed in final design</i>)</li> <li>• Check that positive drainage is achieved (<i>not included in Appendix C – detailed in final design</i>)</li> <li>• Check that all ADA grading requirements are met at pedestrian refuge islands (<i>not included in Appendix C – detailed in final design</i>)</li> </ul> <p>The initial finished grade at the location of RB 1 will need to be modified to incorporate roundabout grading principles. The initial finished grade at the location of RB 2 will only need slight adjustments to accommodate roundabout grading principles. These profiles can be finessed as final design continues to optimize grading. Based on preliminary roundabout grading, it appears that roundabouts can be constructed at these two locations without compromising the operations or safety of the intersections.</p>
Conclusion	<p>Through the use of curbs, truck aprons, sidewalks, and landscaping, the roundabout is a great way to balance the varying needs of heavy vehicles, commuter vehicles, local traffic, bicyclists, pedestrians and equestrian users. These roundabouts will create an environment where this diverse mix of users can successfully share the public right-of-way.</p> <p>The roundabouts will accommodate the predicted traffic with slightly less overall intersection delay than the traffic signal and with added safety benefits. The geometric flexibility of roundabouts can incorporate either the existing W Lilac Rd, the proposed IOD alignment, or both with improved safety and capacity over a traffic signal. Well-designed, single-lane roundabouts will operate more safely and efficiently at the two intersection locations on W Lilac Rd than the other options and are the recommended alternative.</p>

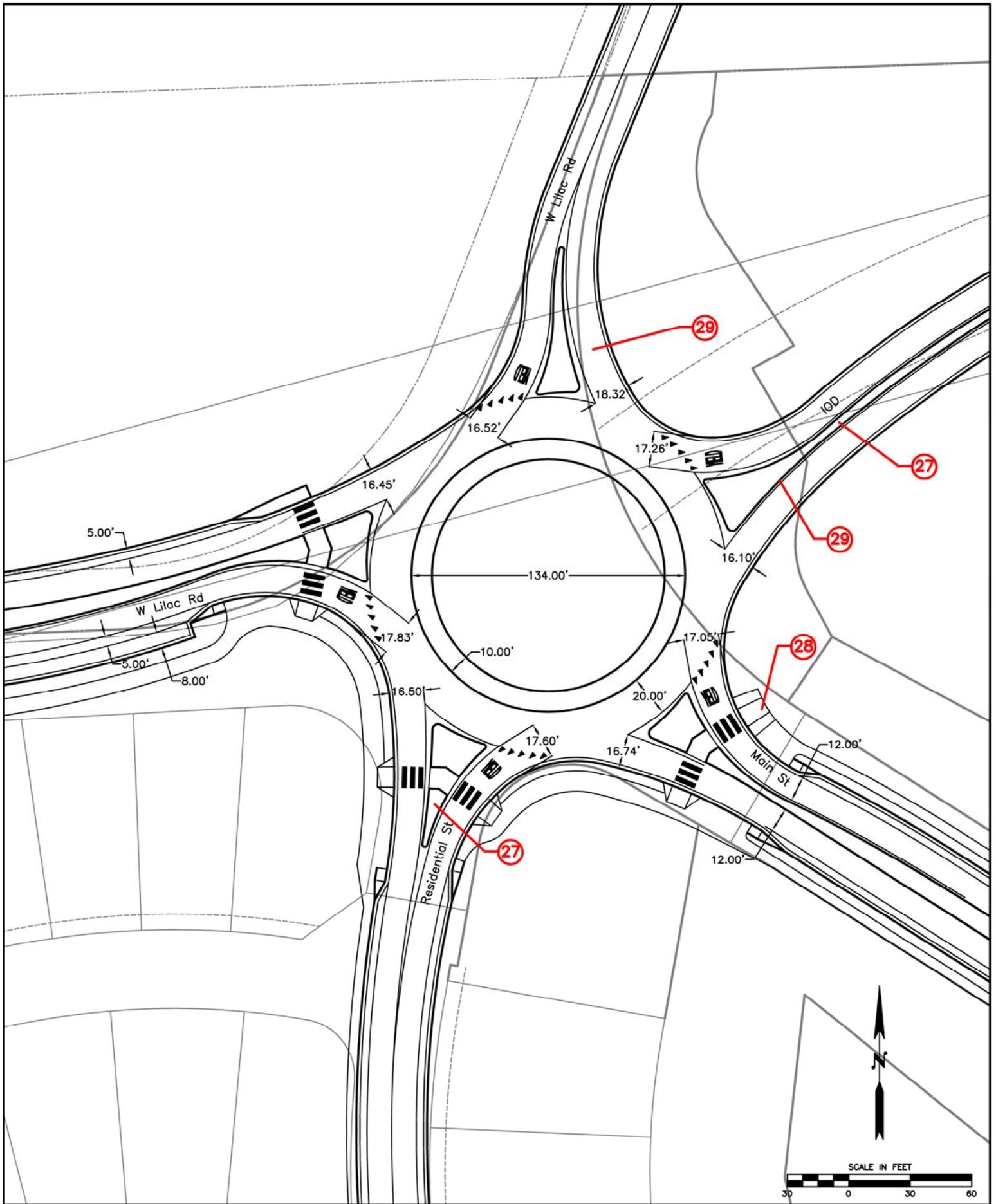


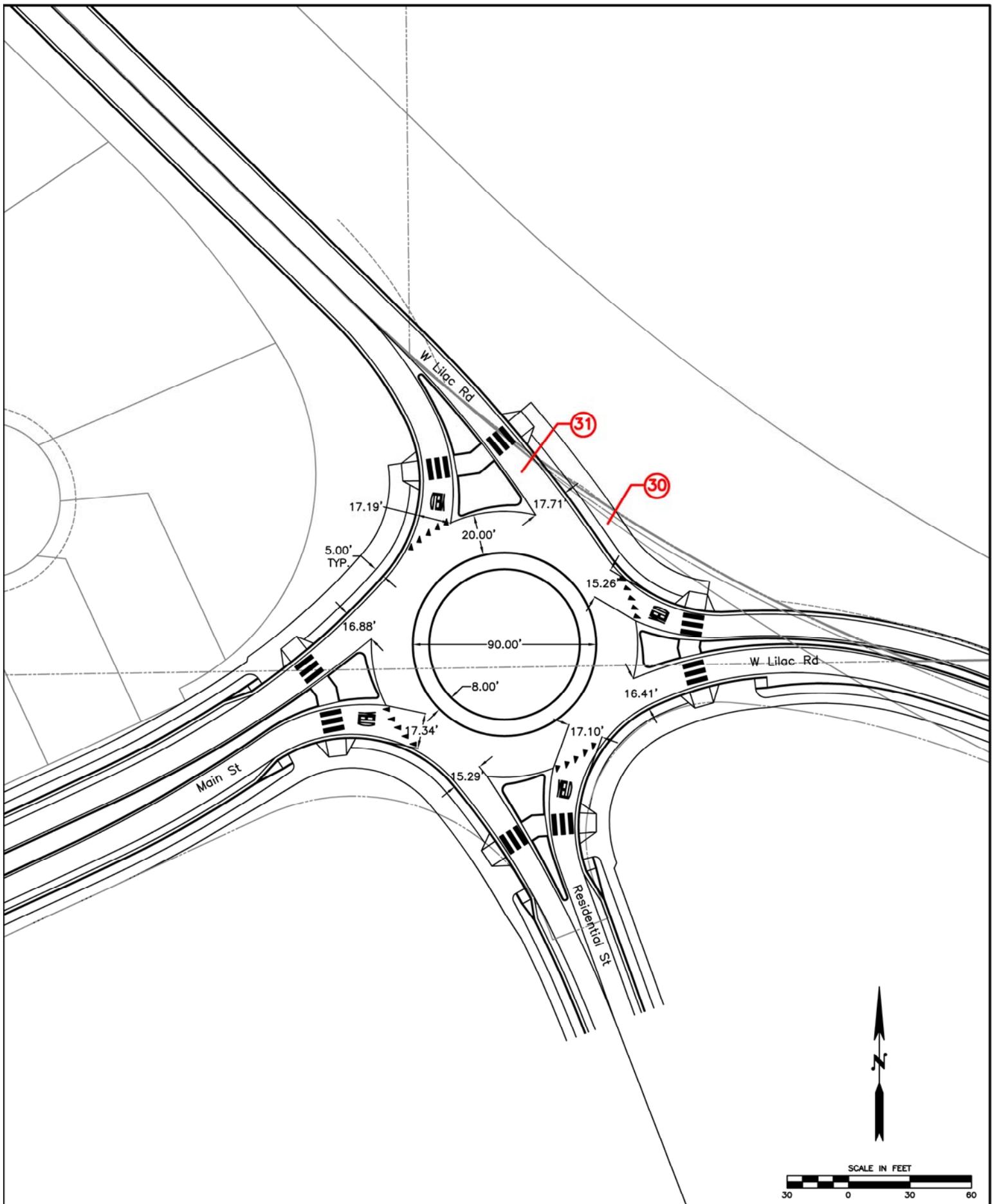


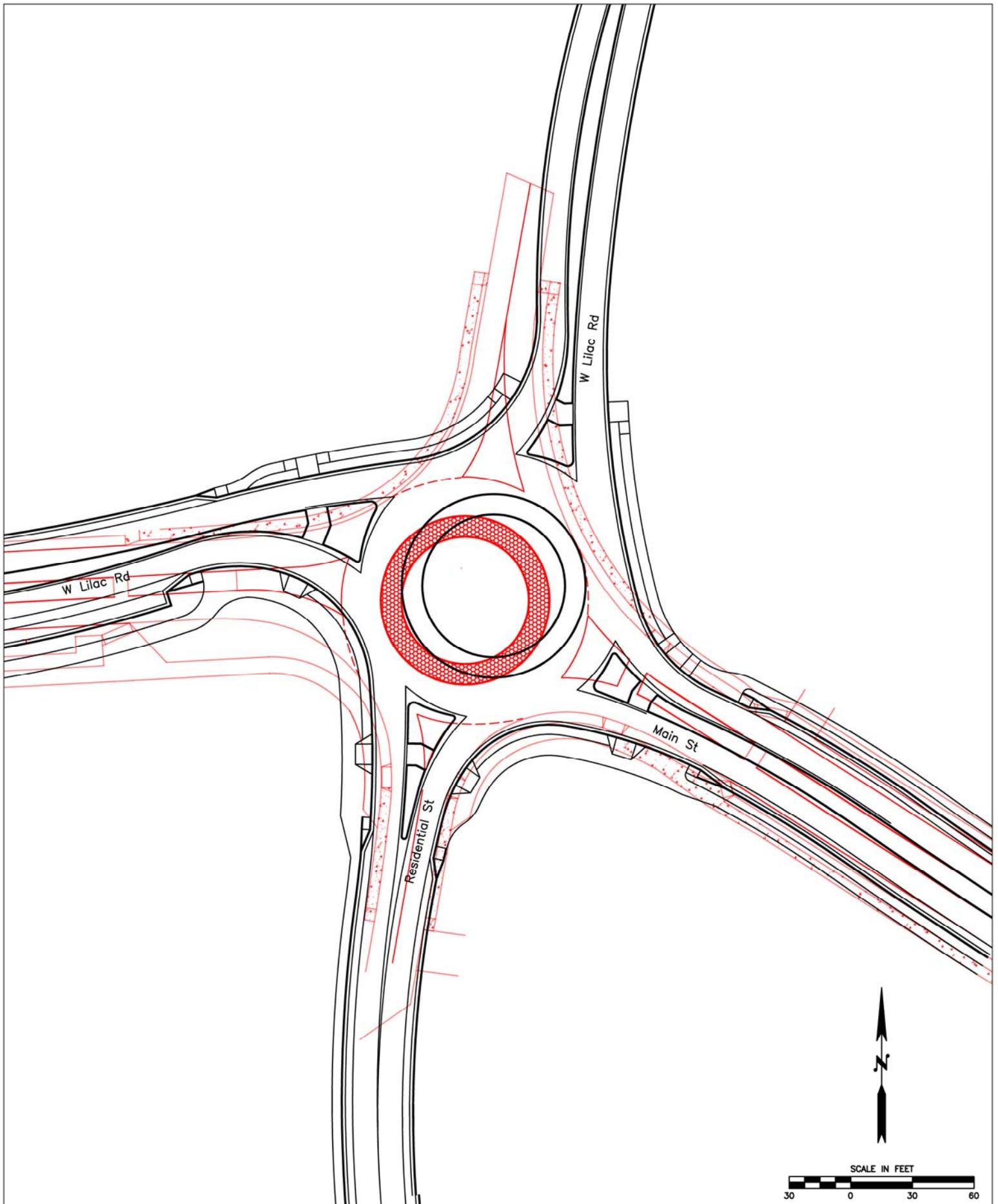


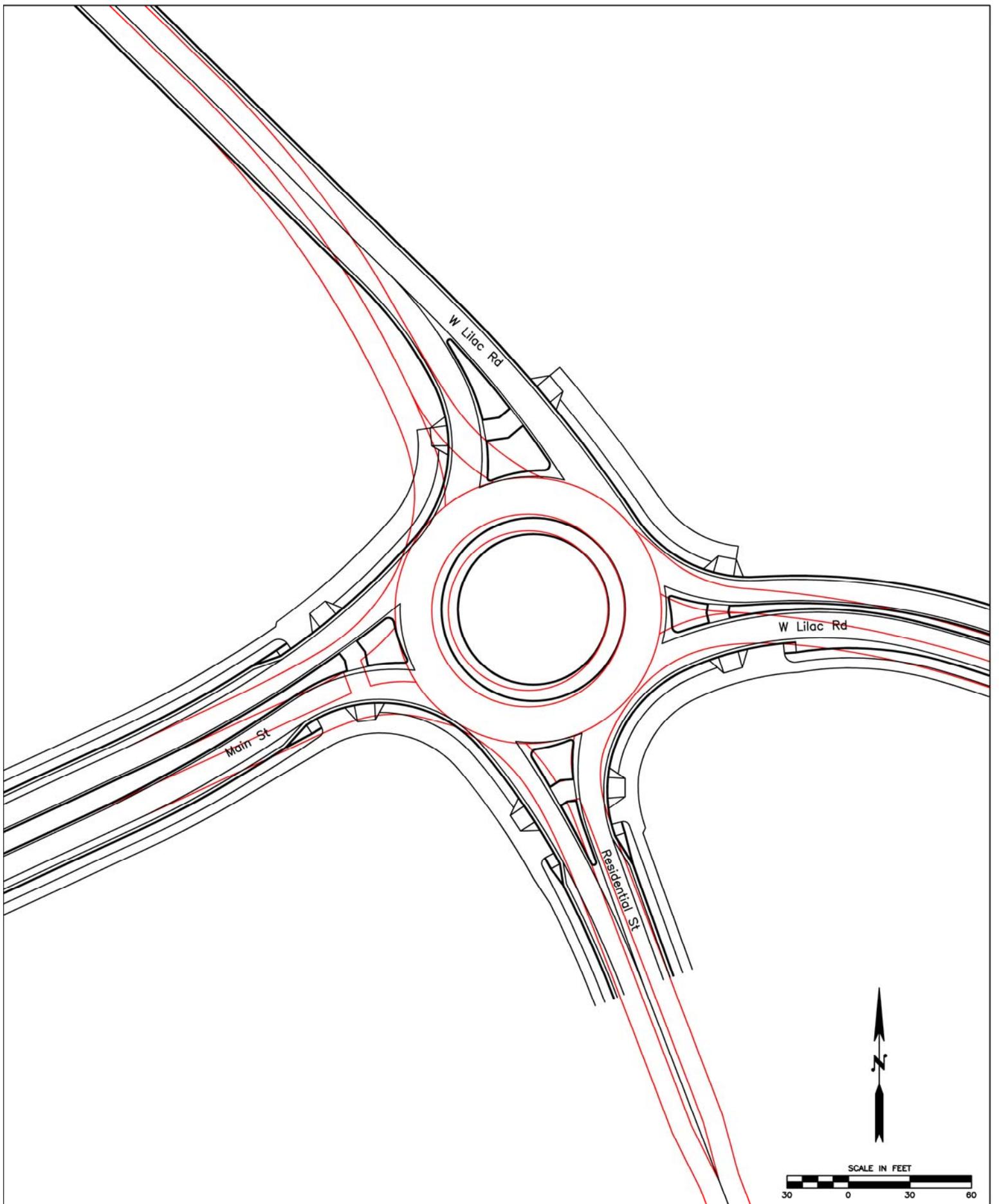












# APPENDIX A (TRAFFIC ANALYSIS)



## Lilac Hills Intersection Analysis October 22, 2013

This report summarizes the operational analysis of two intersections located at the west (Intersection 1) and east end (Intersection 2) of the Lilac Hills Ranch. Each intersection is analyzed for three types of intersection control.

1. All-Way Stop-Control (AWSC)
2. Traffic Signal
3. Roundabout

Analysis is conducted for the AM and PM peak hours at each intersection for two conditions: with and without Road 3. AWSC and traffic signal analysis is conducted with Synchro, Version 8.0; roundabout analysis is conducted using SIDRA, Version 5.1 with an Environmental Factor of 1.1. Roundabout analysis is conducted with Reid Middleton conceptual layout geometry. Tables 1 and 2 summarize 2030 AM and PM peak hour volumes provided by Landmark Consulting.

**Table 1. Intersection 1 - 2030 Peak Hour Traffic Volumes**

Time & Approach	Left	Through	Right
<b>AM Peak Hour Without Road 3</b>			
NB Approach	52	0	2
SB Approach	0	0	70
EB Approach	60	296	18
WB Approach	1	506	0
Intersection Total	1,005		
<b>PM Peak Hour Without Road 3</b>			
NB Approach	24	0	1
SB Approach	0	0	70
EB Approach	80	529	41
WB Approach	1	342	0
Intersection Total	1,088		
<b>AM Peak Hour With Road 3</b>			
NB Approach	52	0	2
SB Approach	0	0	140
EB Approach	90	341	18
WB Approach	1	626	0
Intersection Total	1,270		
<b>PM Peak Hour With Road 3</b>			
NB Approach	24	0	1
SB Approach	0	0	90
EB Approach	180	664	41
WB Approach	1	427	0
Intersection Total	1,428		

Table 2. Intersection 2 - 2030 Peak Hour Traffic Volumes

Time & Approach	Left	Through	Right
<b>AM Peak Hour Without Road 3</b>			
NB Approach	59	0	9
SB Approach	60	0	0
EB Approach	0	140	32
WB Approach	5	121	70
Intersection Total	496		
<b>PM Peak Hour Without Road 3</b>			
NB Approach	34	0	5
SB Approach	80	0	0
EB Approach	0	167	47
WB Approach	7	142	70
Intersection Total	552		
<b>AM Peak Hour With Road 3</b>			
NB Approach	59	0	9
SB Approach	90	0	0
EB Approach	0	185	0
WB Approach	5	241	140
Intersection Total	761		
<b>PM Peak Hour With Road 3</b>			
NB Approach	34	0	5
SB Approach	180	0	0
EB Approach	0	302	47
WB Approach	7	227	90
Intersection Total	892		

Table 3 summarize the Level of Service thresholds for AWSC, roundabout, and traffic signal control.

Table 3. AWSC and Roundabout LOS Criteria

Level of Service	AWSC & Roundabout Intersection Average Delay Per Vehicle (sec/veh)	Traffic Signal Intersection Average Delay Per Vehicle (sec/veh)
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

### Intersection 1

Analysis showed the need for left-turn lanes on the eastbound and westbound approaches to Intersection 1 for the traffic signal control. Traffic signal analysis is conducted with a 60 second cycle and permitted left turns.

Intersection 1 AWSC fails with Road 3. The traffic signal and roundabout provide good intersection performance but the roundabout provides greater reserve capacity for future growth (lower v/c ratios), traffic calming, and a safer intersection.

Table 4. Intersection 1, 2030 AM Peak Hour Operational Analysis, Without Road 3

Performance Measure	Northbound Approach	Southbound Approach	Eastbound Approach		Westbound Approach		Int Delay
	Left/Thru/Right	Left/Thru/Right	Left	Thru/Rt	Left	Thru/Rt	
<b>All-Way Stop-Control</b>	Left/Thru/Right	Left/Thru/Right	Left	Thru/Rt	Left	Thru/Rt	20.1 – C
v/c Ratio	0.11	0.13	0.11	0.52	0.00	0.83	
Mvmt Delay, sec/veh	--	--	8.6 – A	13.2 – B	7.7 – A	28.2 – D	
App Delay, sec/veh	10.4 – B	9.7 – A	12.4 – B		28.2 – D		
95% Queue, feet <sup>1</sup>	--	--	--	--	--	--	
<b>Traffic Signal</b>	Left/Thru/Right	Left/Thru/Right	Left	Thru/Rt	Left	Thru/Rt	7.8 – A
v/c Ratio	0.20	0.18	0.19	0.38	0.00	0.61	
Mvmt Delay, sec/veh	--	--	5.8 – A	6.0 – A	4.0 – A	8.9 – A	
App Delay, sec/veh	12.7 – B	5.4 – A	6.0 – A		8.9 – A		
95% Queue, feet	32	22	18	64	1	119	
<b>Roundabout</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right		Left/Thru/Right		5.1 – A
v/c Ratio	0.06	0.09	0.31		0.43		
Mvmt Delay, sec/veh	--	--	--		--		
App Delay, sec/veh	11.4 – B	6.8 – A	5.3 – A		4.0 – A		
95% Queue, feet	6	9	31		60		

Int = Intersection; Mvmt = Movement; App = Approach

<sup>1</sup>HCM does not provide 95% queue lengths for AWSC Intersections

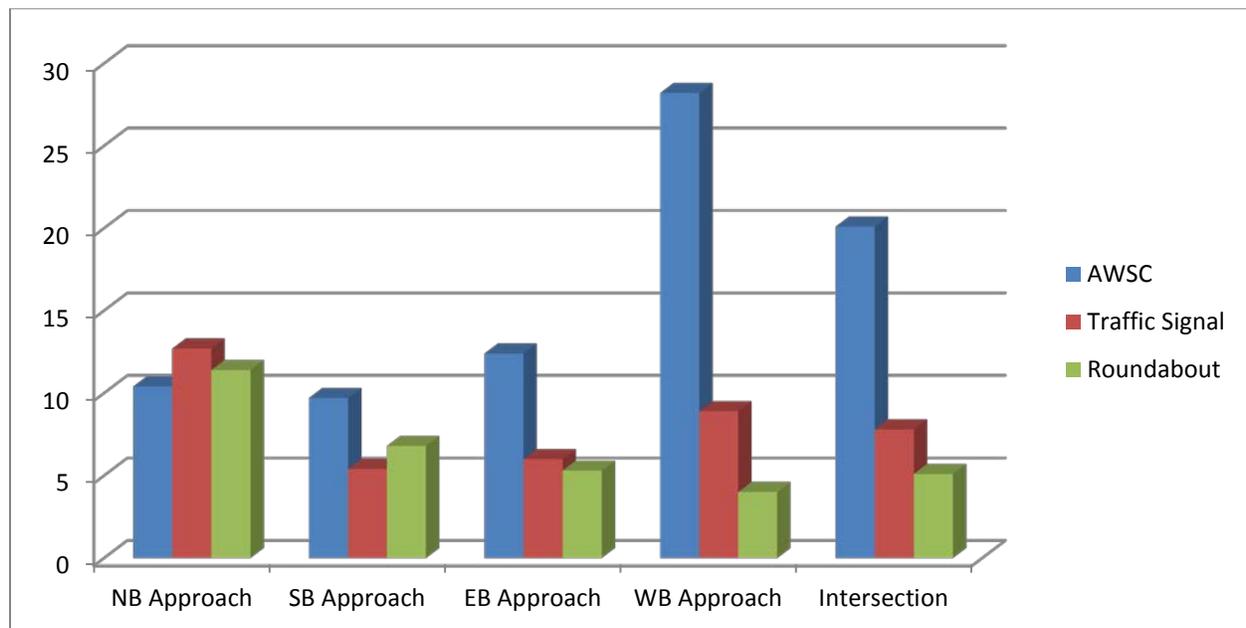


Figure 1. Intersection 1, 2030 AM Peak Hour Average Delay (sec/veh), Without Road 3

Table 5. Intersection 1, 2030 PM Peak Hour Operational Analysis, Without Road 3

Performance Measure	Northbound Approach	Southbound Approach	Eastbound Approach		Westbound Approach		Int Delay
			Left	Thru/Rt	Left	Thru/Rt	
<b>All-Way Stop-Control</b>	Left/Thru/Right	Left/Thru/Right	Left	Thru/Rt	Left	Thru/Rt	24.3 – C
v/c Ratio	0.05	0.13	0.14	0.89	0.00	0.58	
Mvmt Delay, sec/veh	--	--	8.5 – A	34.8 - D	7.9 – A	14.7 – B	
App Delay, sec/veh	10.1 – B	9.7 – A	31.6 – D		14.7 – B		
95% Queue, feet <sup>1</sup>	--	--	--	--	--	--	
<b>Traffic Signal</b>	Left/Thru/Right	Left/Thru/Right	Left	Thru/Rt	Left	Thru/Rt	7.0 – A
v/c Ratio	0.10	0.20	0.16	0.63	0.00	0.38	
Mvmt Delay, sec/veh	--	--	3.4 – A	8.2 – A	3.0 - A	5.3 - A	
App Delay, sec/veh	13.9 – B	6.4 – A	7.7 – A		5.3 - A		
95% Queue, feet	21	25	18	120	1	62	
<b>Roundabout</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right		Left/Thru/Right		5.0 - A
v/c Ratio	0.03	0.07	0.55		0.29		
Mvmt Delay, sec/veh	--	--	--		--		
App Delay, sec/veh	12.6 – B	5.9 - A	5.1 – A		3.9 - A		
95% Queue, feet	4	7	76		34		

Int = Intersection; Mvmt = Movement; App = Approach

<sup>1</sup>HCM does not provide 95% queue lengths for AWSC Intersections

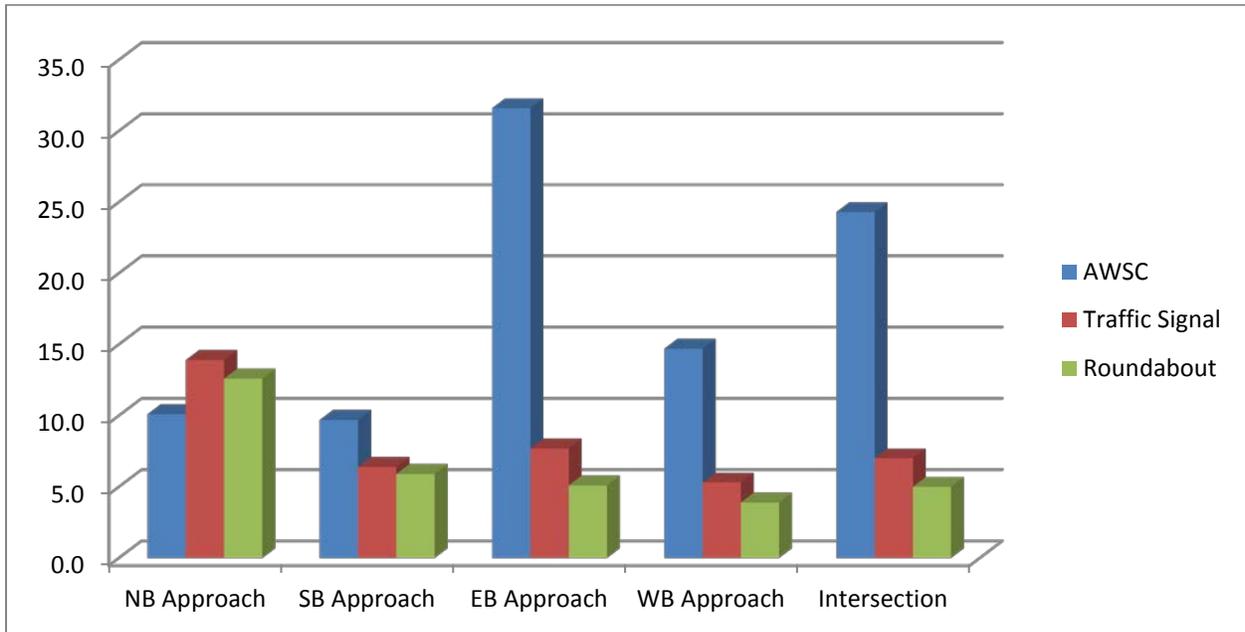


Figure 2. Intersection 1, 2030 PM Peak Hour Average Delay (sec/veh), Without Road 3

Table 6. Intersection 1, 2030 AM Peak Hour Operational Analysis, With Road 3

Performance Measure	Northbound Approach	Southbound Approach	Eastbound Approach		Westbound Approach		Int Delay
<b>All-Way Stop-Control</b>	Left/Thru/Right	Left/Thru/Right	Left	Thru/Rt	Left	Thru/Rt	55.6 – F
v/c Ratio	0.12	0.27	0.18	0.65	0.0	1.12	
Mvmt Delay, sec/veh	--	--	9.7 – A	18.1 – C	8.3 - A	97.5 – F	
App Delay, sec/veh	11.3 – B	11.6 – B	16.4 – C		97.4 – F		
95% Queue, feet <sup>1</sup>	--	--	--	--	--	--	
<b>Traffic Signal</b>	Left/Thru/Right	Left/Thru/Right	Left	Thru/Rt	Left	Thru/Rt	8.3 – A
v/c Ratio	0.18	0.33	0.35	0.39	0.00	0.68	
Mvmt Delay, sec/veh	--	--	8.3 – A	5.7 – A	4.0 – A	9.8 – A	
App Delay, sec/veh	14.8 – B	6.0 – A	6.2 – A		9.8 – A		
95% Queue, feet	38	36	31	77	1	168	
<b>Roundabout</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right		Left/Thru/Right		5.5 – A
v/c Ratio	0.06	0.19	0.37		0.54		
Mvmt Delay, sec/veh	--	--	--		--		
App Delay, sec/veh	11.8 - B	7.9 – A	5.5 – A		4.3 – A		
95% Queue, feet	6	24	43		88		

Int = Intersection; Mvmt = Movement; App = Approach

<sup>1</sup> HCM does not provide 95% queue lengths for AWSC Intersections

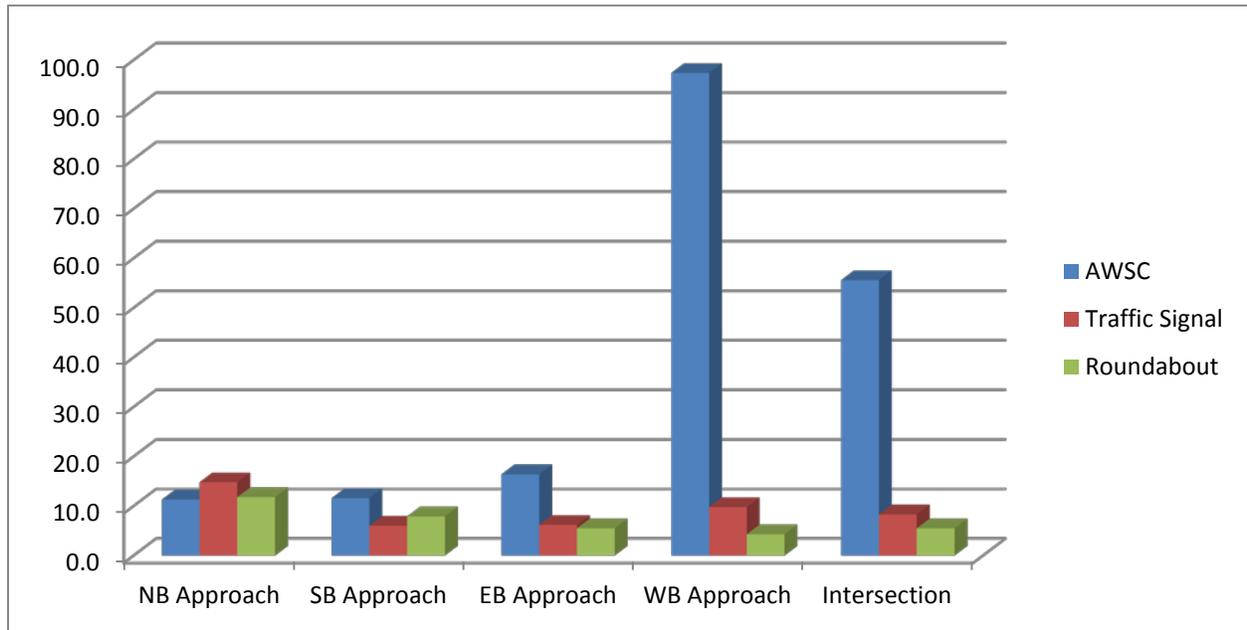


Figure 3. Intersection 1, 2030 AM Peak Hour Average Delay (sec/veh), With Road 3

Table 7. Intersection 1, 2030 PM Peak Hour Operational Analysis, With Road 3

Performance Measure	Northbound Approach		Southbound Approach		Eastbound Approach		Westbound Approach		Int Delay
	Left/Thru/Right	Left/Thru/Right	Left	Thru/Rt	Left	Thru/Rt	Left	Thru/Rt	
<b>All-Way Stop-Control</b>	Left/Thru/Right		Left/Thru/Right		Left	Thru/Rt	Left	Thru/Rt	62.2 – F
v/c Ratio	0.05		0.17		0.33	1.16	0.00	0.76	
Mvmt Delay, sec/veh	--		--		10.7 - B	107.1 – F	8.2 – A	24.2 – C	
App Delay, sec/veh	10.6 – B		10.5 – B		87.5 – F		24.2 – C		
95% Queue, feet <sup>1</sup>	--		--		--	--	--	--	
<b>Traffic Signal</b>	Left/Thru/Right		Left/Thru/Right		Left	Thru/Rt	Left	Thru/Rt	7.4 – A
v/c Ratio	0.12		0.27		0.38	0.70	0.00	0.42	
Mvmt Delay, sec/veh	--		--		6.0 – A	8.8 – A	3.0 – A	5.1 – A	
App Delay, sec/veh	17.6 – B		7.6 – A		8.2 – A		5.1 – A		
95% Queue, feet	24		32		43	172	1	81	
<b>Roundabout</b>	Left/Thru/Right		Left/Thru/Right		Left/Thru/Right		Left/Thru/Right		5.5 – A
v/c Ratio	0.04		0.10		0.74		0.40		
Mvmt Delay, sec/veh	--		--		--		--		
App Delay, sec/veh	14.9 – C		6.3 – A		5.6 – A		4.5 – A		
95% Queue, feet	5		10		177		53		

Int = Intersection; Mvmt = Movement; App = Approach

<sup>1</sup> HCM does not provide 95% queue lengths for AWSC Intersections

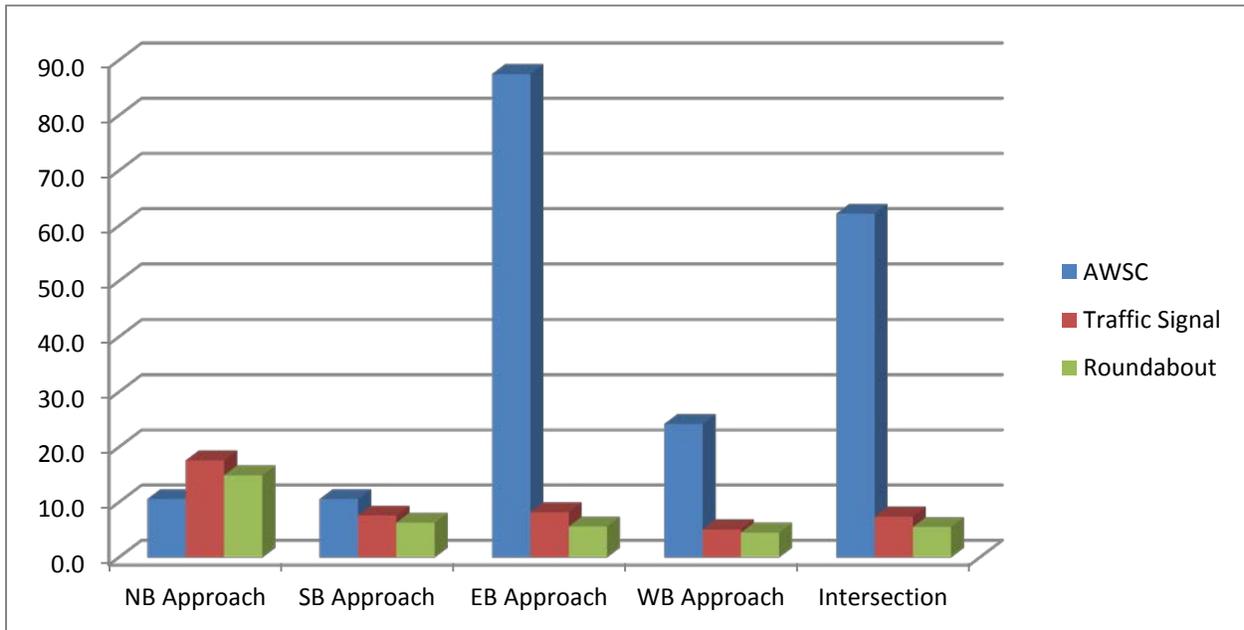


Figure 4. Intersection 1, 2030 PM Peak Hour Average Delay (sec/veh), With Road 3

## Intersection 2

Analysis for Intersection 2 is conducted with single-lane approaches on all legs. Traffic signal analysis is conducted with a 60 second cycle and permitted left turns.

Intersections 2 accommodates AM and PM peak hour traffic for all the intersection controls with and without Road 3. The roundabout provides greater reserve capacity for future growth (lower v/c ratios), traffic calming, and a safer intersection.

Table 8. Intersection 2, 2030 AM Peak Hour Operational Analysis, Without Road 3

Performance Measure	Northbound Approach	Southbound Approach	Eastbound Approach	Westbound Approach	Int Delay
<b>All-Way Stop-Control</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	8.7 – A
v/c Ratio	0.10	0.10	0.23	0.26	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	8.6 – A	8.7 – A	8.8 – A	8.8 – A	
95% Queue, feet <sup>1</sup>	--	--	--	--	
<b>Traffic Signal</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	6.1 – A
v/c Ratio	0.12	0.11	0.31	0.35	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	6.1 - A	6.6 - A	6.2 – A	5.7 - A	
95% Queue, feet	17	16	29	29	
<b>Roundabout</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	6.1 – A
v/c Ratio	0.07	0.06	0.15	0.11	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	8.6 – A	12.6 – B	3.7 – A	4.8 – A	
95% Queue, feet	6	5	15	12	

Int = Intersection; Mvmt = Movement; App = Approach

<sup>1</sup>HCM does not provide 95% queue lengths for AWSC Intersections

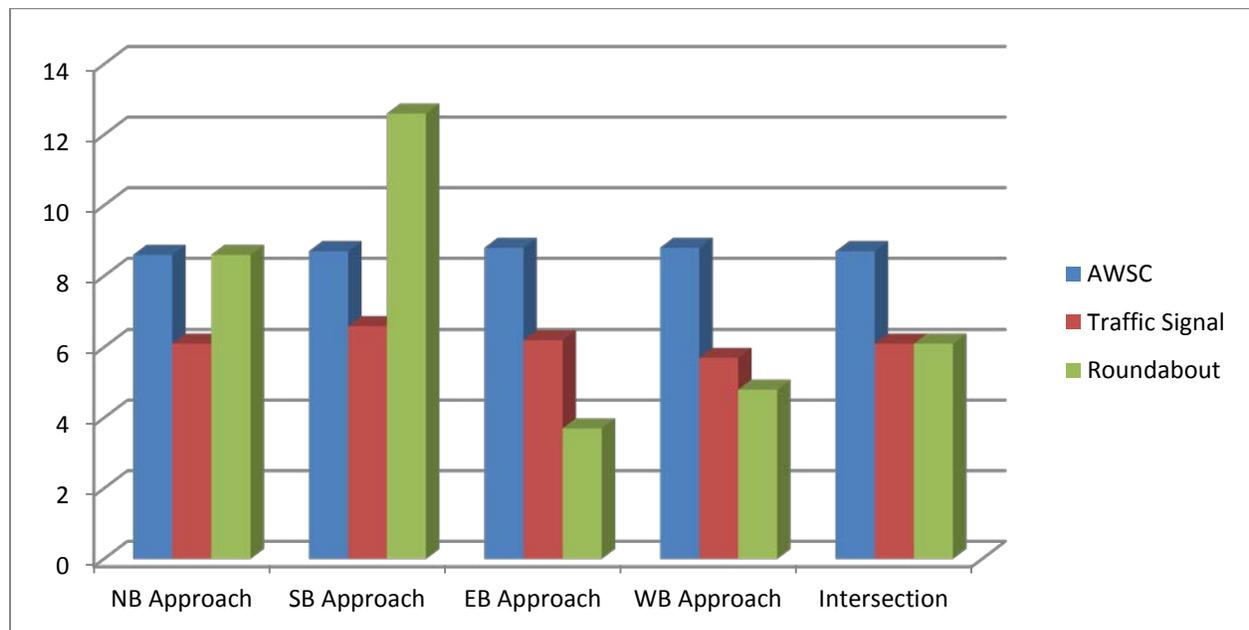


Figure 5. Intersection 2, 2030 AM Peak Hour Average Delay (sec/veh), Without Road 3

Table 9. Intersection 2, 2030 PM Peak Hour Operational Analysis, Without Road 3

Performance Measure	Northbound Approach	Southbound Approach	Eastbound Approach	Westbound Approach	Int Delay
<b>All-Way Stop-Control</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	9.1 – A
v/c Ratio	0.06	0.13	0.29	0.29	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	8.6 – A	9.0 – A	9.2 – A	9.1 – A	
95% Queue, feet <sup>1</sup>	--	--	--	--	
<b>Traffic Signal</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	6.5 – A
v/c Ratio	0.07	0.15	0.36	0.37	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	6.1 – A	7.2 – A	6.7 – A	6.3 – A	
95% Queue, feet	12	22	39	37	
<b>Roundabout</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	6.1 – A
v/c Ratio	0.04	0.09	0.19	0.17	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	8.8 – A	12.8 – B	3.8 – A	5.4 – A	
95% Queue, feet	4	8	20	21	

Int = Intersection; Mvmt = Movement; App = Approach

<sup>1</sup>HCM does not provide 95% queue lengths for AWSC Intersections

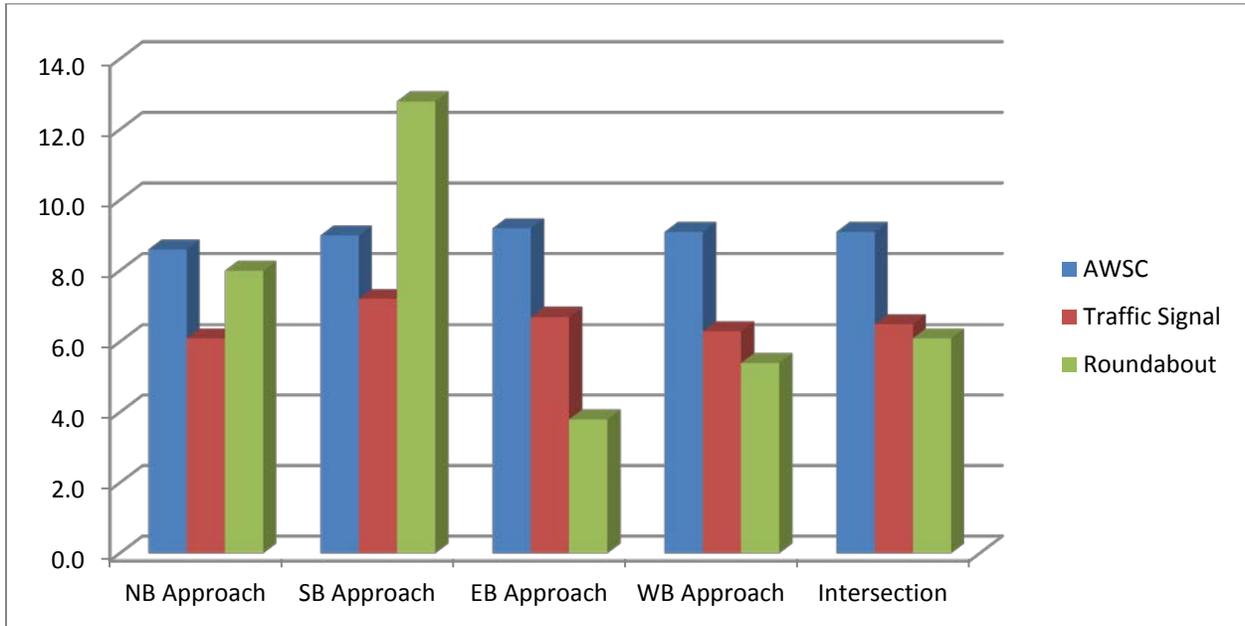


Figure 6. Intersection 2, 2030 PM Peak Hour Average Delay (sec/veh), Without Road 3

Table 10. Intersection 2, 2030 AM Peak Hour Operational Analysis, With Road 3

Performance Measure	Northbound Approach	Southbound Approach	Eastbound Approach	Westbound Approach	Int Delay
<b>All-Way Stop-Control</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	11.3 – B
v/c Ratio	0.12	0.16	0.32	0.53	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	9.6 – A	9.9 – A	10.2 – B	12.6 – B	
95% Queue, feet <sup>1</sup>	--	--	--	--	
<b>Traffic Signal</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	8.1 – A
v/c Ratio	0.20	0.28	0.31	0.55	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	9.1 – A	10.9 – B	6.3 – A	8.3 – A	
95% Queue, feet	28	38	48	84	
<b>Roundabout</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	6.4 – A
v/c Ratio	0.07	0.10	0.17	0.31	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	8.9 – A	13.2 – B	3.8 – A	5.5 – A	
95% Queue, feet	7	10	18	44	

Int = Intersection; Mvmt = Movement; App = Approach

<sup>1</sup> HCM does not provide 95% queue lengths for AWSC Intersections

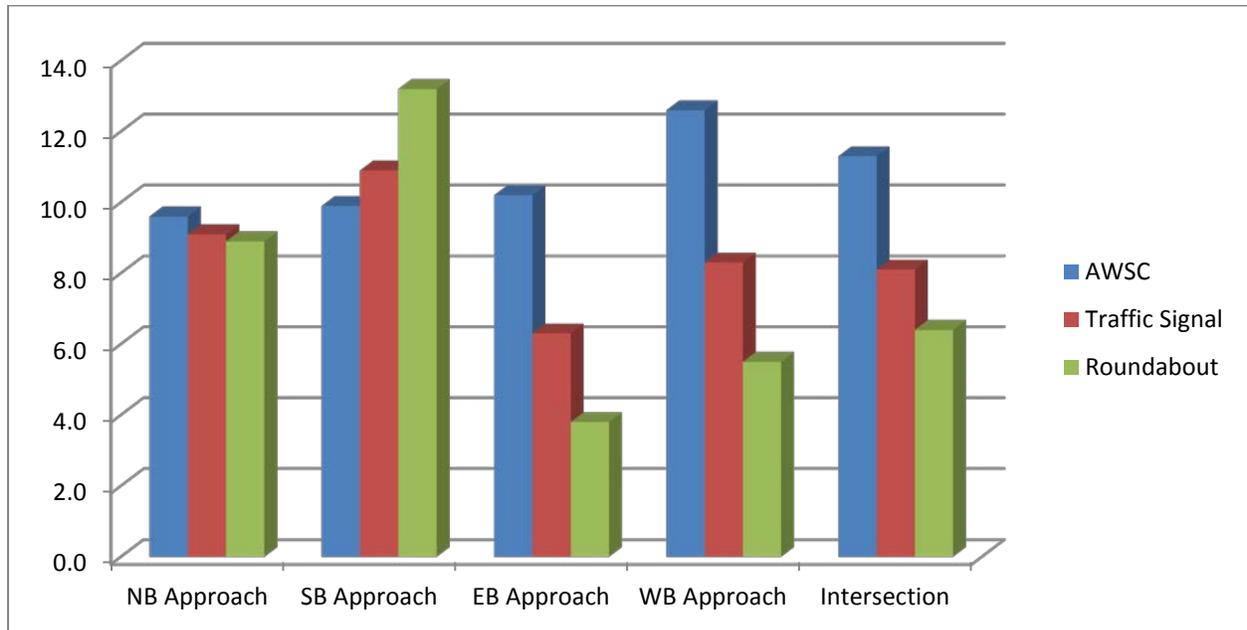


Figure 7. Intersection 2, 2030 AM Peak Hour Average Delay (sec/veh), With Road 3

Table 11. Intersection 2, 2030 PM Peak Hour Operational Analysis, With Road 3

Performance Measure	Northbound Approach	Southbound Approach	Eastbound Approach	Westbound Approach	Int Delay
<b>All-Way Stop-Control</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	13.1 - B
v/c Ratio	0.08	0.33	0.54	0.50	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	9.9 – A	12.1 – B	14.1 – B	13.1 - B	
95% Queue, feet <sup>1</sup>	--	--	--	--	
<b>Traffic Signal</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	10.3 – B
v/c Ratio	0.09	0.45	0.53	0.49	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	8.0 – A	12.7 – B	10.4 – B	9.3 – A	
95% Queue, feet	20	76	113	98	
<b>Roundabout</b>	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	Left/Thru/Right	6.8 – A
v/c Ratio	0.05	0.21	0.34	0.25	
Mvmt Delay, sec/veh	--	--	--	--	
App Delay, sec/veh	9.9 – A	13.4 – B	4.4 - A	5.2 – A	
95% Queue, feet	5	21	43	35	

Int = Intersection; Mvmt = Movement; App = Approach

<sup>1</sup> HCM does not provide 95% queue lengths for AWSC Intersections

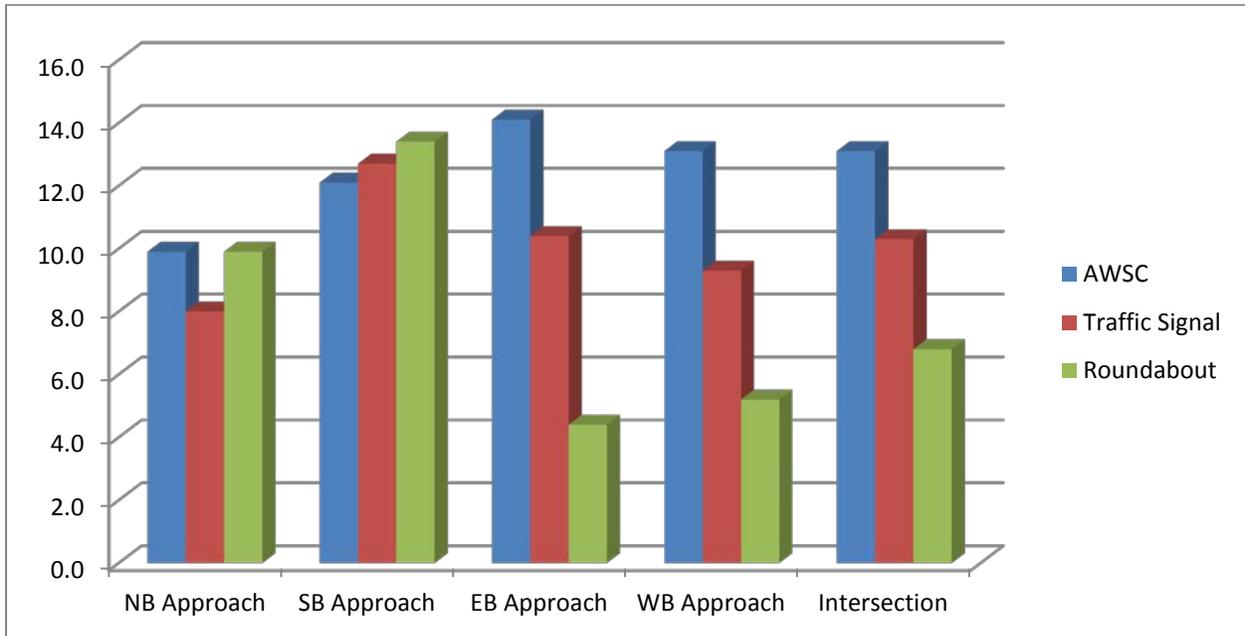


Figure 8. Intersection 2, 2030 PM Peak Hour Average Delay (sec/veh), With Road 3

### Intersection 1 a with Five Leg Roundabout

Intersection 1 was also analyzed with a five-leg roundabout that would provide access to approximately 12 single-unit homes on the north leg. The five-leg roundabout accommodates the 2030 peak hour volumes with low delays, short 95<sup>th</sup> percentile queues, and reserve capacity for future growth. The five-leg roundabout provides access to the single-unit homes on the north leg, traffic calming, and a safer intersection. See Table 12 and Figure 9.

Table 12. Intersection 1, 2030 with a Five Leg Roundabout

Performance Measure	NB Approach	SB Approach	EB Approach	NWB Approach	SWB Approach	Int Delay
<b>AM PH without Road 3</b>	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	8.8 – A
v/c Ratio	0.06	0.01	0.30	0.44	0.09	
Mvmt Delay, sec/veh	--	--	--	--	--	
App Delay, sec/veh	11.2 – B	8.3 – A	5.2 – A	11.6 – B	6.6 – A	
95% Queue, feet <sup>1</sup>	5	1	34	61	10	
<b>PM PH without Road 3</b>	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	7.2 – A
v/c Ratio	0.03	0.01	0.52	0.30	0.08	
Mvmt Delay, sec/veh	--	--	--	--	--	
App Delay, sec/veh	12.2 – B	7.2 – A	4.9 – A	11.5 – B	5.6 – A	
95% Queue, feet	4	1	80	34	8	
<b>AM PH with Road 3</b>	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	9.2 – A
v/c Ratio	0.06	0.02	0.36	0.56	0.20	
Mvmt Delay, sec/veh	--	--	--	--	--	
App Delay, sec/veh	11.6 – B	9.5 – A	5.4 – A	11.9 – B	7.6 – A	
95% Queue, feet	6	2	45	89	27	
<b>PM PH with Road 3</b>	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	Lt/Thru/Rt	7.7 – A
v/c Ratio	0.04	0.01	0.70	0.40	0.10	
Mvmt Delay, sec/veh	--	--	--	--	--	
App Delay, sec/veh	14.4 – B	7.6 – A	5.5 – A	12.1 – B	6.0 – A	
95% Queue, feet	5	1	189	51	12	

NB = Northbound; SB = Southbound; EB = Eastbound; NWB = Northwest bound; SWB = Southwest bound  
 PH = Peak Hour; Int = Intersection; Mvmt = Movement; App = Approach

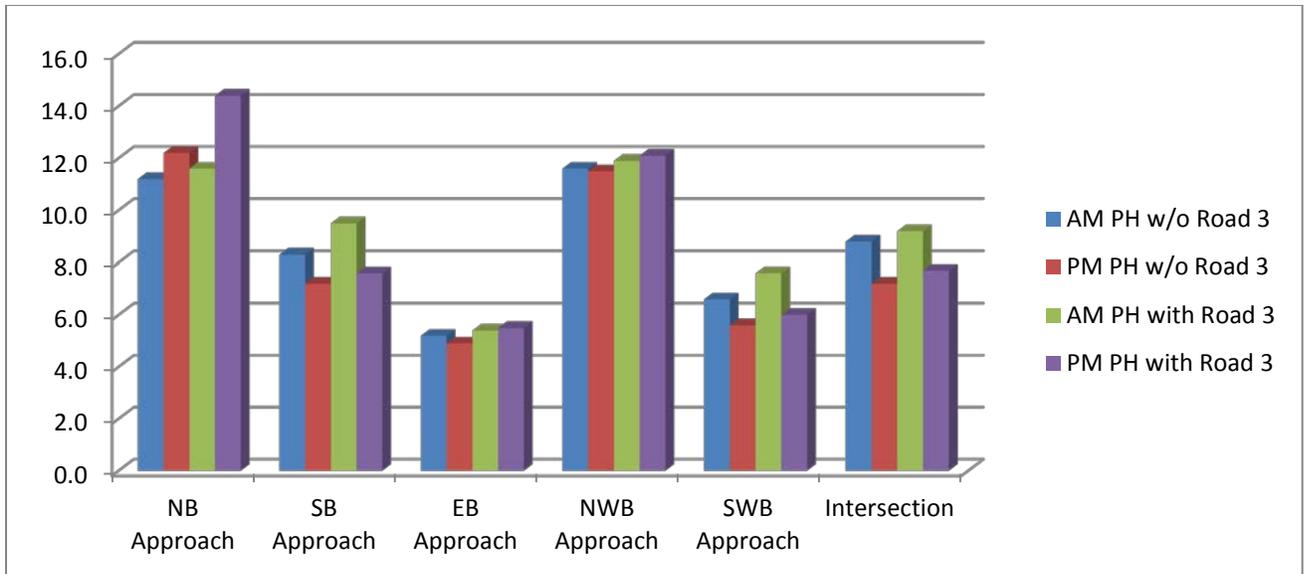


Figure 9. Intersection 1, 2030 with a Five-Leg Roundabout

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# Intersection 1

## All-Way Stop Control Analysis

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop				Stop
Volume (vph)	60	296	18	1	506	1	52	1	2	1	1	70
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	65	322	20	1	550	1	57	1	2	1	1	76
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1						
Volume Total (vph)	65	341	1	551	60	78						
Volume Left (vph)	65	0	1	0	57	1						
Volume Right (vph)	0	20	0	1	2	76						
Hadj (s)	0.53	-0.01	0.53	0.03	0.20	-0.55						
Departure Headway (s)	6.1	5.5	5.9	5.4	6.6	5.8						
Degree Utilization, x	0.11	0.52	0.00	0.83	0.11	0.13						
Capacity (veh/h)	566	637	585	651	493	550						
Control Delay (s)	8.6	13.2	7.7	28.2	10.4	9.7						
Approach Delay (s)	12.4		28.2		10.4	9.7						
Approach LOS	B		D		B	A						
Intersection Summary												
Delay			20.1									
HCM Level of Service			C									
Intersection Capacity Utilization			49.7%		ICU Level of Service		A					
Analysis Period (min)			15									



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↗		↖	↗			↕			↕	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	80	529	41	1	342	1	24	1	1	1	1	70
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	87	575	45	1	372	1	26	1	1	1	1	76

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total (vph)	87	620	1	373	28	78
Volume Left (vph)	87	0	1	0	26	1
Volume Right (vph)	0	45	0	1	1	76
Hadj (s)	0.53	-0.02	0.53	0.03	0.20	-0.55
Departure Headway (s)	5.8	5.2	6.1	5.6	6.8	5.9
Degree Utilization, x	0.14	0.89	0.00	0.58	0.05	0.13
Capacity (veh/h)	614	685	574	631	489	562
Control Delay (s)	8.5	34.8	7.9	14.7	10.1	9.7
Approach Delay (s)	31.6		14.7		10.1	9.7
Approach LOS	D		B		B	A

Intersection Summary	
Delay	24.3
HCM Level of Service	C
Intersection Capacity Utilization	51.8%
ICU Level of Service	A
Analysis Period (min)	15



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↗		↖	↗			↕			↕	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	90	341	18	1	626	1	52	1	2	1	1	140
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	371	20	1	680	1	57	1	2	1	1	152

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total (vph)	98	390	1	682	60	154
Volume Left (vph)	98	0	1	0	57	1
Volume Right (vph)	0	20	0	1	2	152
Hadj (s)	0.53	0.00	0.53	0.03	0.20	-0.56
Departure Headway (s)	6.5	6.0	6.4	5.9	7.3	6.3
Degree Utilization, x	0.18	0.65	0.00	1.12	0.12	0.27
Capacity (veh/h)	536	585	541	617	453	539
Control Delay (s)	9.7	18.1	8.3	97.5	11.3	11.6
Approach Delay (s)	16.4		97.4		11.3	11.6
Approach LOS	C		F		B	B

**Intersection Summary**

Delay	55.6
HCM Level of Service	F
Intersection Capacity Utilization	63.4%
ICU Level of Service	B
Analysis Period (min)	15



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↗		↖	↗			↕			↕	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	180	664	41	1	427	1	24	0	1	1	1	90
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	196	722	45	1	464	1	26	0	1	1	1	98

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total (vph)	196	766	1	465	27	100
Volume Left (vph)	196	0	1	0	26	1
Volume Right (vph)	0	45	0	1	1	98
Hadj (s)	0.53	-0.01	0.53	0.03	0.20	-0.55
Departure Headway (s)	6.0	5.4	6.4	5.9	7.2	6.2
Degree Utilization, x	0.33	1.16	0.00	0.76	0.05	0.17
Capacity (veh/h)	582	666	548	597	459	541
Control Delay (s)	10.7	107.1	8.2	24.2	10.6	10.5
Approach Delay (s)	87.5		24.2		10.6	10.5
Approach LOS	F		C		B	B

Intersection Summary						
Delay			62.2			
HCM Level of Service			F			
Intersection Capacity Utilization		58.8%		ICU Level of Service		B
Analysis Period (min)			15			

# Intersection 1

## Traffic Signal Analysis

Traffic Signal

Int 1 - 2030 AM PH Traffic Signal without Road 3.syn

1: NB Approach/SB Approach & EB Approach/WB Approach

10/8/2013



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	296	18	1	506	1	52	1	2	1	1	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	100		0	100		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	1846	0	1770	1863	0	0	1770	0	0	1615	0
Flt Permitted	0.374			0.555				0.688			0.996	
Satd. Flow (perm)	697	1846	0	1034	1863	0	0	1275	0	0	1610	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		9						2			76	
Link Speed (mph)		25			30			30			30	
Link Distance (ft)		378			388			430			422	
Travel Time (s)		10.3			8.8			9.8			9.6	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)												
Lane Group Flow (vph)	65	342	0	1	551	0	0	60	0	0	78	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Total Split (s)	38.0	38.0		38.0	38.0		22.0	22.0		22.0	22.0	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Act Effct Green (s)	14.5	14.5		14.5	14.5			7.2			7.2	
Actuated g/C Ratio	0.48	0.48		0.48	0.48			0.24			0.24	
v/c Ratio	0.19	0.38		0.00	0.61			0.20			0.18	
Control Delay	5.8	6.0		4.0	8.9			12.7			5.4	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	5.8	6.0		4.0	8.9			12.7			5.4	
LOS	A	A		A	A			B			A	
Approach Delay		6.0			8.9			12.7			5.4	
Approach LOS		A			A			B			A	
Queue Length 50th (ft)	4	25		0	47			7			0	
Queue Length 95th (ft)	18	64		1	119			32			22	
Internal Link Dist (ft)		298			308			350			342	
Turn Bay Length (ft)	100			100								
Base Capacity (vph)	672	1781		997	1797			801			1039	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.10	0.19		0.00	0.31			0.07			0.08	

Intersection Summary

Area Type: Other  
 Cycle Length: 60  
 Actuated Cycle Length: 30.1  
 Control Type: Actuated-Uncoordinated  
 Maximum v/c Ratio: 0.61  
 Intersection Signal Delay: 7.8  
 Intersection Capacity Utilization 49.7%

Intersection LOS: A  
 ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 1: NB Approach/SB Approach & EB Approach/WB Approach

 ø2	 ø4
22 s	38 s
 ø6	 ø8
22 s	38 s

Traffic Signal

Int 1 - 2030 PM PH Traffic Signal without Road 3.syn

1: NB Approach/SB Approach & EB Approach/WB Approach

10/8/2013



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	529	41	1	342	1	24	1	1	1	1	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	100		0	100		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	1842	0	1770	1863	0	0	1772	0	0	1615	0
Flt Permitted	0.540			0.337				0.716			0.997	
Satd. Flow (perm)	1006	1842	0	628	1863	0	0	1327	0	0	1612	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		11						1			76	
Link Speed (mph)		25			30			30			30	
Link Distance (ft)		378			388			430			422	
Travel Time (s)		10.3			8.8			9.8			9.6	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)												
Lane Group Flow (vph)	87	620	0	1	373	0	0	28	0	0	78	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Total Split (s)	38.0	38.0		38.0	38.0		22.0	22.0		22.0	22.0	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Act Effct Green (s)	16.7	16.7		16.7	16.7			6.5			6.5	
Actuated g/C Ratio	0.53	0.53		0.53	0.53			0.21			0.21	
v/c Ratio	0.16	0.63		0.00	0.38			0.10			0.20	
Control Delay	4.3	8.2		3.0	5.3			13.9			6.4	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	4.3	8.2		3.0	5.3			13.9			6.4	
LOS	A	A		A	A			B			A	
Approach Delay		7.7			5.3			13.9			6.4	
Approach LOS		A			A			B			A	
Queue Length 50th (ft)	5	51		0	26			3			0	
Queue Length 95th (ft)	18	120		1	62			21			25	
Internal Link Dist (ft)		298			308			350			342	
Turn Bay Length (ft)	100			100								
Base Capacity (vph)	953	1746		595	1765			796			997	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.09	0.36		0.00	0.21			0.04			0.08	

Intersection Summary

Area Type: Other  
 Cycle Length: 60  
 Actuated Cycle Length: 31.6  
 Control Type: Actuated-Uncoordinated  
 Maximum v/c Ratio: 0.63  
 Intersection Signal Delay: 7.0  
 Intersection Capacity Utilization 51.8%

Intersection LOS: A  
 ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 1: NB Approach/SB Approach & EB Approach/WB Approach

 ø2	 ø4
22 s	38 s
 ø6	 ø8
22 s	38 s

Traffic Signal

Int 1 - 2030 AM PH Traffic Signal with Road 3.syn

1: NB Approach/SB Approach & EB Approach/WB Approach

10/8/2013



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	90	341	18	1	626	1	52	1	2	1	1	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	100		0	100		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	1848	0	1770	1863	0	0	1770	0	0	1615	0
Flt Permitted	0.285			0.521				0.819			0.998	
Satd. Flow (perm)	531	1848	0	970	1863	0	0	1518	0	0	1612	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		8						2			152	
Link Speed (mph)		25			30			30			30	
Link Distance (ft)		378			388			430			422	
Travel Time (s)		10.3			8.8			9.8			9.6	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)												
Lane Group Flow (vph)	98	391	0	1	681	0	0	60	0	0	154	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Total Split (s)	39.0	39.0		39.0	39.0		21.0	21.0		21.0	21.0	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Act Effct Green (s)	18.5	18.5		18.5	18.5			7.6			7.6	
Actuated g/C Ratio	0.53	0.53		0.53	0.53			0.22			0.22	
v/c Ratio	0.35	0.39		0.00	0.68			0.18			0.33	
Control Delay	8.3	5.7		4.0	9.8			14.8			6.0	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	8.3	5.7		4.0	9.8			14.8			6.0	
LOS	A	A		A	A			B			A	
Approach Delay		6.2			9.8			14.8			6.0	
Approach LOS		A			A			B			A	
Queue Length 50th (ft)	8	30		0	67			8			0	
Queue Length 95th (ft)	31	77		1	168			38			36	
Internal Link Dist (ft)		298			308			350			342	
Turn Bay Length (ft)	100			100								
Base Capacity (vph)	489	1702		893	1715			797			917	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.20	0.23		0.00	0.40			0.08			0.17	

Intersection Summary

Area Type: Other  
 Cycle Length: 60  
 Actuated Cycle Length: 34.6  
 Control Type: Actuated-Uncoordinated  
 Maximum v/c Ratio: 0.68  
 Intersection Signal Delay: 8.3  
 Intersection Capacity Utilization 63.4%

Intersection LOS: A  
 ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 1: NB Approach/SB Approach & EB Approach/WB Approach

↑ ø2	→ ø4
21 s	39 s
↓ ø6	← ø8
21 s	39 s

Traffic Signal  
1: NB Approach/SB Approach & EB Approach/WB Approach

Int 1 - 2030 PM PH Traffic Signal with Road 3.syn

10/8/2013



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	180	664	41	1	427	1	24	0	1	1	1	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	100		0	100		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	1846	0	1770	1863	0	0	1768	0	0	1617	0
Flt Permitted	0.471			0.259				0.693			0.997	
Satd. Flow (perm)	877	1846	0	482	1863	0	0	1284	0	0	1612	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		9						1			98	
Link Speed (mph)		25			30			30			30	
Link Distance (ft)		378			388			430			422	
Travel Time (s)		10.3			8.8			9.8			9.6	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)												
Lane Group Flow (vph)	196	767	0	1	465	0	0	27	0	0	100	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Total Split (s)	39.0	39.0		39.0	39.0		21.0	21.0		21.0	21.0	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Act Effct Green (s)	22.4	22.4		22.4	22.4			6.7			6.7	
Actuated g/C Ratio	0.60	0.60		0.60	0.60			0.18			0.18	
v/c Ratio	0.38	0.70		0.00	0.42			0.12			0.27	
Control Delay	6.0	8.8		3.0	5.1			17.6			7.6	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	6.0	8.8		3.0	5.1			17.6			7.6	
LOS	A	A		A	A			B			A	
Approach Delay		8.2			5.1			17.6			7.6	
Approach LOS		A			A			B			A	
Queue Length 50th (ft)	14	73		0	35			5			0	
Queue Length 95th (ft)	43	172		1	81			24			32	
Internal Link Dist (ft)		298			308			350			342	
Turn Bay Length (ft)	100			100								
Base Capacity (vph)	780	1643		429	1656			617			825	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.25	0.47		0.00	0.28			0.04			0.12	

Intersection Summary

Area Type: Other  
 Cycle Length: 60  
 Actuated Cycle Length: 37.6  
 Control Type: Actuated-Uncoordinated  
 Maximum v/c Ratio: 0.70  
 Intersection Signal Delay: 7.4  
 Intersection Capacity Utilization 58.8%

Intersection LOS: A  
 ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 1: NB Approach/SB Approach & EB Approach/WB Approach

 ø2	 ø4
21 s	39 s
 ø6	 ø8
21 s	39 s

Intersection 1

Roundabout Analysis

# MOVEMENT SUMMARY

Site: 2030 AM PH 4-Leg w/o Road 3  
RMG

Intersection #1, 4-Leg, Reid Middleton Geometry (RMG)  
2030 AM Peak Hour  
Without Road 3 - Base + Project

Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph	
<b>South: NB Approach</b>												
3	L	57	2.0	0.060	11.8	LOS B	0.2	5.7	0.39	0.70	25.1	
8	T	1	2.0	0.060	3.6	LOS A	0.2	5.7	0.39	0.38	26.4	
18	R	2	2.0	0.060	4.9	LOS A	0.2	5.7	0.39	0.47	26.1	
Approach		60	2.0	0.060	11.4	LOS B	0.2	5.7	0.39	0.68	25.1	
<b>East: WB Approach</b>												
1L	L	1	2.0	0.429	9.0	LOS A	2.4	60.1	0.31	0.91	25.4	
6T	T	550	2.0	0.429	4.0	LOS A	2.4	60.1	0.31	0.40	27.8	
6R	R	1	2.0	0.429	4.1	LOS A	2.4	60.1	0.31	0.47	26.9	
Approach		552	2.0	0.429	4.0	LOS A	2.4	60.1	0.31	0.40	27.8	
<b>North: SB Approach</b>												
7	L	1	2.0	0.085	10.4	LOS B	0.3	8.9	0.49	0.80	24.6	
4	T	1	2.0	0.085	4.2	LOS A	0.3	8.9	0.49	0.48	26.3	
14	R	76	2.0	0.085	6.8	LOS A	0.3	8.9	0.49	0.62	26.7	
Approach		78	2.0	0.085	6.8	LOS A	0.3	8.9	0.49	0.62	26.6	
<b>West: EB Approach</b>												
5	L	65	2.0	0.314	10.3	LOS B	1.2	31.4	0.03	0.94	29.6	
2	T	322	2.0	0.314	4.3	LOS A	1.2	31.4	0.03	0.37	34.3	
12	R	20	2.0	0.314	5.6	LOS A	1.2	31.4	0.03	0.53	33.2	
Approach		407	2.0	0.314	5.3	LOS A	1.2	31.4	0.03	0.47	33.4	
All Vehicles		1097	2.0	0.429	5.1	LOS A	2.4	60.1	0.22	0.46	29.3	

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# MOVEMENT SUMMARY

Site: 2030 PM PH 4-Leg w/o Road 3  
RMG

Intersection #1, 4-Leg, Reid Middleton Geometry (RMG)  
2030 PM Peak Hour  
Without Road 3 - Base + Project

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
South: NB Approach											
3	L	26	2.0	0.033	13.2	LOS B	0.1	3.6	0.52	0.72	24.7
8	T	1	2.0	0.033	5.0	LOS A	0.1	3.6	0.52	0.48	25.8
18	R	1	2.0	0.033	6.3	LOS A	0.1	3.6	0.52	0.55	25.6
Approach		28	2.0	0.033	12.6	LOS B	0.1	3.6	0.52	0.71	24.7
East: WB Approach											
1L	L	1	2.0	0.294	8.9	LOS A	1.4	34.4	0.25	0.93	25.3
6T	T	372	2.0	0.294	3.9	LOS A	1.4	34.4	0.25	0.39	28.1
6R	R	1	2.0	0.294	4.0	LOS A	1.4	34.4	0.25	0.46	27.0
Approach		374	2.0	0.294	3.9	LOS A	1.4	34.4	0.25	0.39	28.0
North: SB Approach											
7	L	1	2.0	0.074	9.5	LOS A	0.3	6.6	0.36	0.78	25.0
4	T	1	2.0	0.074	3.3	LOS A	0.3	6.6	0.36	0.37	26.8
14	R	76	2.0	0.074	5.9	LOS A	0.3	6.6	0.36	0.55	27.0
Approach		78	2.0	0.074	5.9	LOS A	0.3	6.6	0.36	0.55	27.0
West: EB Approach											
5	L	87	2.0	0.546	10.3	LOS B	3.0	75.9	0.04	0.94	29.6
2	T	575	2.0	0.546	4.3	LOS A	3.0	75.9	0.04	0.37	34.2
12	R	45	2.0	0.546	5.6	LOS A	3.0	75.9	0.04	0.53	33.1
Approach		707	2.0	0.546	5.1	LOS A	3.0	75.9	0.04	0.45	33.5
All Vehicles		1187	2.0	0.546	5.0	LOS A	3.0	75.9	0.14	0.44	30.7

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# MOVEMENT SUMMARY

Site: 2030 AM PH 4-Leg w Road 3  
RMG

Intersection #1, 4-Leg, Reid Middleton Geometry (RMG)  
2030 AM Peak Hour  
With Road 3 - Base + Project

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
<b>South: NB Approach</b>											
3	L	57	2.0	0.063	12.2	LOS B	0.2	6.2	0.43	0.71	25.0
8	T	1	2.0	0.063	3.9	LOS A	0.2	6.2	0.43	0.42	26.2
18	R	2	2.0	0.063	5.3	LOS A	0.2	6.2	0.43	0.50	26.0
Approach		60	2.0	0.063	11.8	LOS B	0.2	6.2	0.43	0.70	25.1
<b>East: WB Approach</b>											
1L	L	1	2.0	0.542	9.3	LOS A	3.5	87.9	0.40	0.89	25.4
6T	T	680	2.0	0.542	4.3	LOS A	3.5	87.9	0.40	0.44	27.5
6R	R	1	2.0	0.542	4.4	LOS A	3.5	87.9	0.40	0.49	26.6
Approach		683	2.0	0.542	4.3	LOS A	3.5	87.9	0.40	0.44	27.5
<b>North: SB Approach</b>											
7	L	1	2.0	0.191	11.5	LOS B	0.9	23.9	0.62	0.86	24.2
4	T	1	2.0	0.191	5.3	LOS A	0.9	23.9	0.62	0.61	25.7
14	R	152	2.0	0.191	7.9	LOS A	0.9	23.9	0.62	0.73	26.3
Approach		154	2.0	0.191	7.9	LOS A	0.9	23.9	0.62	0.73	26.3
<b>West: EB Approach</b>											
5	L	98	2.0	0.377	10.3	LOS B	1.7	42.6	0.03	0.92	29.6
2	T	371	2.0	0.377	4.3	LOS A	1.7	42.6	0.03	0.36	34.3
12	R	20	2.0	0.377	5.6	LOS A	1.7	42.6	0.03	0.52	33.1
Approach		488	2.0	0.377	5.5	LOS A	1.7	42.6	0.03	0.48	33.1
All Vehicles		1385	2.0	0.542	5.5	LOS A	3.5	87.9	0.30	0.50	28.9

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# MOVEMENT SUMMARY

Site: 2030 PM PH 4-Leg w Road 3  
RMG

Intersection #1, 4-Leg, Reid Middleton Geometry (RMG)  
2030 PM Peak Hour  
With Road 3 - Base + Project

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
<b>South: NB Approach</b>											
3	L	26	2.0	0.041	15.5	LOS B	0.2	5.1	0.66	0.77	23.7
8	T	1	2.0	0.041	7.3	LOS A	0.2	5.1	0.66	0.59	24.7
18	R	1	2.0	0.041	8.7	LOS A	0.2	5.1	0.66	0.64	24.4
Approach		28	2.0	0.041	14.9	LOS B	0.2	5.1	0.66	0.76	23.8
<b>East: WB Approach</b>											
1L	L	1	2.0	0.403	9.5	LOS A	2.1	52.8	0.40	0.91	25.3
6T	T	464	2.0	0.403	4.5	LOS A	2.1	52.8	0.40	0.46	27.5
6R	R	1	2.0	0.403	4.6	LOS A	2.1	52.8	0.40	0.52	26.7
Approach		466	2.0	0.403	4.5	LOS A	2.1	52.8	0.40	0.46	27.5
<b>North: SB Approach</b>											
7	L	1	2.0	0.102	9.9	LOS A	0.4	10.3	0.44	0.79	24.9
4	T	1	2.0	0.102	3.6	LOS A	0.4	10.3	0.44	0.43	26.5
14	R	98	2.0	0.102	6.3	LOS A	0.4	10.3	0.44	0.59	26.8
Approach		100	2.0	0.102	6.3	LOS A	0.4	10.3	0.44	0.59	26.8
<b>West: EB Approach</b>											
5	L	196	2.0	0.744	10.4	LOS B	7.0	177.1	0.07	0.89	29.6
2	T	722	2.0	0.744	4.3	LOS A	7.0	177.1	0.07	0.36	34.1
12	R	45	2.0	0.744	5.7	LOS A	7.0	177.1	0.07	0.51	33.0
Approach		962	2.0	0.744	5.6	LOS A	7.0	177.1	0.07	0.47	32.9
All Vehicles		1557	2.0	0.744	5.5	LOS A	7.0	177.1	0.20	0.48	30.4

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

## Intersection 2

### All-Way Stop Control Analysis



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	1	140	32	5	121	70	59	1	9	60	1	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	152	35	5	132	76	64	1	10	65	1	1

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	188	213	75	67
Volume Left (vph)	1	5	64	65
Volume Right (vph)	35	76	10	1
Hadj (s)	-0.08	-0.18	0.13	0.22
Departure Headway (s)	4.4	4.3	5.0	5.1
Degree Utilization, x	0.23	0.26	0.10	0.10
Capacity (veh/h)	778	794	655	638
Control Delay (s)	8.8	8.8	8.6	8.7
Approach Delay (s)	8.8	8.8	8.6	8.7
Approach LOS	A	A	A	A

Intersection Summary			
Delay		8.7	
HCM Level of Service		A	
Intersection Capacity Utilization	24.6%		ICU Level of Service A
Analysis Period (min)		15	



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	1	167	47	7	142	70	34	1	5	80	1	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	182	51	8	154	76	37	1	5	87	1	1

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	234	238	43	89
Volume Left (vph)	1	8	37	87
Volume Right (vph)	51	76	5	1
Hadj (s)	-0.10	-0.15	0.13	0.22
Departure Headway (s)	4.4	4.4	5.2	5.3
Degree Utilization, x	0.29	0.29	0.06	0.13
Capacity (veh/h)	782	785	618	621
Control Delay (s)	9.2	9.1	8.6	9.0
Approach Delay (s)	9.2	9.1	8.6	9.0
Approach LOS	A	A	A	A

Intersection Summary			
Delay		9.1	
HCM Level of Service		A	
Intersection Capacity Utilization	28.5%		ICU Level of Service A
Analysis Period (min)		15	

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	1	185	32	5	241	140	59	1	9	90	1	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	201	35	5	262	152	64	1	10	98	1	1
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total (vph)	237	420	75	100								
Volume Left (vph)	1	5	64	98								
Volume Right (vph)	35	152	10	1								
Hadj (s)	-0.05	-0.18	0.13	0.22								
Departure Headway (s)	4.9	4.6	5.8	5.8								
Degree Utilization, x	0.32	0.53	0.12	0.16								
Capacity (veh/h)	693	762	538	546								
Control Delay (s)	10.2	12.6	9.6	9.9								
Approach Delay (s)	10.2	12.6	9.6	9.9								
Approach LOS	B	B	A	A								
Intersection Summary												
Delay			11.3									
HCM Level of Service			B									
Intersection Capacity Utilization			37.1%	ICU Level of Service	A							
Analysis Period (min)			15									



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	1	302	47	7	227	90	34	1	5	180	1	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	328	51	8	247	98	37	1	5	196	1	1

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	380	352	43	198
Volume Left (vph)	1	8	37	196
Volume Right (vph)	51	98	5	1
Hadj (s)	-0.05	-0.13	0.13	0.23
Departure Headway (s)	5.1	5.1	6.4	6.1
Degree Utilization, x	0.54	0.50	0.08	0.33
Capacity (veh/h)	668	672	463	534
Control Delay (s)	14.1	13.1	9.9	12.1
Approach Delay (s)	14.1	13.1	9.9	12.1
Approach LOS	B	B	A	B

Intersection Summary			
Delay		13.1	
HCM Level of Service		B	
Intersection Capacity Utilization	40.5%		ICU Level of Service A
Analysis Period (min)		15	

Intersection 2

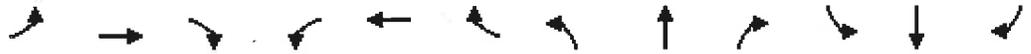
Traffic Signal Analysis

Traffic Signal

Int 2 - 2030 AM PH Traffic Signal without Road 3.syn

1: NB Approach/SB Approach & EB Approach/WB Approach

10/4/2013



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Volume (vph)	1	140	32	5	121	70	59	1	9	60	1	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	0	1816	0	0	1772	0	0	1754	0	0	1774	0
Flt Permitted		0.997			0.989			0.762			0.734	
Satd. Flow (perm)	0	1811	0	0	1754	0	0	1394	0	0	1365	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		27			64			10			1	
Link Speed (mph)		25			30			30			30	
Link Distance (ft)		378			388			430			422	
Travel Time (s)		10.3			8.8			9.8			9.6	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	188	0	0	213	0	0	75	0	0	67	0
Turn Type	Perm	NA										
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Total Split (s)	33.0	33.0		33.0	33.0		27.0	27.0		27.0	27.0	
Total Lost Time (s)		4.0			4.0			4.0			4.0	
Act Effct Green (s)		7.5			7.4			10.1			10.1	
Actuated g/C Ratio		0.33			0.32			0.44			0.44	
v/c Ratio		0.31			0.35			0.12			0.11	
Control Delay		6.2			5.7			6.1			6.6	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		6.2			5.7			6.1			6.6	
LOS		A			A			A			A	
Approach Delay		6.2			5.7			6.1			6.6	
Approach LOS		A			A			A			A	
Queue Length 50th (ft)		10			10			4			4	
Queue Length 95th (ft)		29			29			17			16	
Internal Link Dist (ft)		298			308			350			342	
Turn Bay Length (ft)												
Base Capacity (vph)		1811			1754			1353			1324	
Starvation Cap Reductn		0			0			0			0	
Spillback Cap Reductn		0			0			0			0	
Storage Cap Reductn		0			0			0			0	
Reduced v/c Ratio		0.10			0.12			0.06			0.05	

Intersection Summary

Area Type: Other  
 Cycle Length: 60  
 Actuated Cycle Length: 23  
 Control Type: Actuated-Uncoordinated  
 Maximum v/c Ratio: 0.35  
 Intersection Signal Delay: 6.1  
 Intersection Capacity Utilization 24.6%  
 Analysis Period (min) 15  
 Intersection LOS: A  
 ICU Level of Service A

Splits and Phases: 1: NB Approach/SB Approach & EB Approach/WB Approach

 02	 04
27 s	33 s
 06	 08
27 s	33 s

Traffic Signal

Int 2 - 2030 PM PH Traffic Signal without Road 3.syn

1: NB Approach/SB Approach & EB Approach/WB Approach

10/4/2013



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Volume (vph)	1	167	47	7	142	70	34	1	5	80	1	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	0	1809	0	0	1779	0	0	1758	0	0	1772	0
Flt Permitted		0.998			0.982			0.775			0.731	
Satd. Flow (perm)	0	1805	0	0	1751	0	0	1421	0	0	1359	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		32			54			5			1	
Link Speed (mph)		25			30			30			30	
Link Distance (ft)		378			388			430			422	
Travel Time (s)		10.3			8.8			9.8			9.6	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	234	0	0	238	0	0	43	0	0	89	0
Turn Type	Perm	NA										
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Total Split (s)	33.0	33.0		33.0	33.0		27.0	27.0		27.0	27.0	
Total Lost Time (s)		4.0			4.0			4.0			4.0	
Act Effct Green (s)		8.0			8.0			10.2			10.2	
Actuated g/C Ratio		0.35			0.35			0.45			0.45	
v/c Ratio		0.36			0.37			0.07			0.15	
Control Delay		6.7			6.3			6.1			7.2	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		6.7			6.3			6.1			7.2	
LOS		A			A			A			A	
Approach Delay		6.7			6.3			6.1			7.2	
Approach LOS		A			A			A			A	
Queue Length 50th (ft)		14			13			3			6	
Queue Length 95th (ft)		39			37			12			22	
Internal Link Dist (ft)		298			308			350			342	
Turn Bay Length (ft)												
Base Capacity (vph)		1805			1751			1353			1294	
Starvation Cap Reductn		0			0			0			0	
Spillback Cap Reductn		0			0			0			0	
Storage Cap Reductn		0			0			0			0	
Reduced v/c Ratio		0.13			0.14			0.03			0.07	

Intersection Summary

Area Type: Other  
 Cycle Length: 60  
 Actuated Cycle Length: 22.8  
 Control Type: Actuated-Uncoordinated  
 Maximum v/c Ratio: 0.37  
 Intersection Signal Delay: 6.5  
 Intersection Capacity Utilization 28.5%  
 Analysis Period (min) 15  
 Intersection LOS: A  
 ICU Level of Service A

Splits and Phases: 1: NB Approach/SB Approach & EB Approach/WB Approach

 02	 04
27 s	33 s
 06	 08
27 s	33 s

Traffic Signal

Int 2 - 2030 AM PH Traffic Signal with Road 3.syn

1: NB Approach/SB Approach & EB Approach/WB Approach

10/4/2013



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Volume (vph)	1	185	32	5	241	140	59	1	9	90	1	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	0	1825	0	0	1770	0	0	1754	0	0	1773	0
Flt Permitted		0.998			0.996			0.710			0.676	
Satd. Flow (perm)	0	1822	0	0	1764	0	0	1299	0	0	1258	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		20			66			10			1	
Link Speed (mph)		25			30			30			30	
Link Distance (ft)		378			388			430			422	
Travel Time (s)		10.3			8.8			9.8			9.6	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	237	0	0	419	0	0	75	0	0	100	0
Turn Type	Perm	NA										
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Total Split (s)	33.0	33.0		33.0	33.0		27.0	27.0		27.0	27.0	
Total Lost Time (s)		4.0			4.0			4.0			4.0	
Act Effct Green (s)		11.2			11.2			7.8			7.8	
Actuated g/C Ratio		0.41			0.41			0.28			0.28	
v/c Ratio		0.31			0.55			0.20			0.28	
Control Delay		6.3			8.3			9.1			10.9	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		6.3			8.3			9.1			10.9	
LOS		A			A			A			B	
Approach Delay		6.3			8.3			9.1			10.9	
Approach LOS		A			A			A			B	
Queue Length 50th (ft)		16			29			6			9	
Queue Length 95th (ft)		48			84			28			38	
Internal Link Dist (ft)		298			308			350			342	
Turn Bay Length (ft)												
Base Capacity (vph)		1730			1677			1108			1072	
Starvation Cap Reductn		0			0			0			0	
Spillback Cap Reductn		0			0			0			0	
Storage Cap Reductn		0			0			0			0	
Reduced v/c Ratio		0.14			0.25			0.07			0.09	

Intersection Summary

Area Type: Other  
 Cycle Length: 60  
 Actuated Cycle Length: 27.4  
 Control Type: Actuated-Uncoordinated  
 Maximum v/c Ratio: 0.55  
 Intersection Signal Delay: 8.1  
 Intersection Capacity Utilization 37.1%  
 Analysis Period (min) 15  
 Intersection LOS: A  
 ICU Level of Service A

Splits and Phases: 1: NB Approach/SB Approach & EB Approach/WB Approach

 ø2	 ø4
27 s	33 s
 ø6	 ø8
27 s	33 s

Traffic Signal

Int 2 - 2030 PM PH Traffic Signal with Road 3.syn

1: NB Approach/SB Approach & EB Approach/WB Approach

10/4/2013

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1	302	47	7	227	90	34	1	5	180	1	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	0	1829	0	0	1792	0	0	1758	0	0	1773	0
Flt Permitted		0.999			0.989			0.730			0.697	
Satd. Flow (perm)	0	1827	0	0	1774	0	0	1338	0	0	1297	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		17			43			5			1	
Link Speed (mph)		25			30			30			30	
Link Distance (ft)		378			388			430			422	
Travel Time (s)		10.3			8.8			9.8			9.6	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	380	0	0	353	0	0	43	0	0	198	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Total Split (s)	32.0	32.0		32.0	32.0		28.0	28.0		28.0	28.0	
Total Lost Time (s)		4.0			4.0			4.0			4.0	
Act Effct Green (s)		12.1			12.1			10.5			10.5	
Actuated g/C Ratio		0.39			0.39			0.34			0.34	
v/c Ratio		0.53			0.49			0.09			0.45	
Control Delay		10.4			9.3			8.0			12.7	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		10.4			9.3			8.0			12.7	
LOS		B			A			A			B	
Approach Delay		10.4			9.3			8.0			12.7	
Approach LOS		B			A			A			B	
Queue Length 50th (ft)		37			31			4			21	
Queue Length 95th (ft)		113			98			20			76	
Internal Link Dist (ft)		298			308			350			342	
Turn Bay Length (ft)												
Base Capacity (vph)		1608			1565			1070			1036	
Starvation Cap Reductn		0			0			0			0	
Spillback Cap Reductn		0			0			0			0	
Storage Cap Reductn		0			0			0			0	
Reduced v/c Ratio		0.24			0.23			0.04			0.19	

Intersection Summary

Area Type: Other  
 Cycle Length: 60  
 Actuated Cycle Length: 31.1  
 Control Type: Actuated-Uncoordinated  
 Maximum v/c Ratio: 0.53  
 Intersection Signal Delay: 10.3  
 Intersection Capacity Utilization 40.5%  
 Analysis Period (min) 15  
 Intersection LOS: B  
 ICU Level of Service A

Splits and Phases: 1: NB Approach/SB Approach & EB Approach/WB Approach

 ø2	 ø4
28 s	32 s
 ø6	 ø8
28 s	32 s

Intersection 2

Roundabout Analysis

# MOVEMENT SUMMARY

Site: 2030 AM PH w/o Road 3 RMG

Intersection #2, Reid Middleton Geometry (RMG)  
2030 AM Peak Hour  
Without Road 3

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
<b>South: NB Approach</b>											
3	L	64	2.0	0.067	9.1	LOS A	0.2	6.3	0.29	0.64	24.7
8	T	1	3.0	0.067	6.1	LOS A	0.2	6.3	0.29	0.44	32.5
18	R	10	2.0	0.067	5.5	LOS A	0.2	6.3	0.29	0.46	27.1
Approach		75	2.0	0.067	8.6	LOS A	0.2	6.3	0.29	0.62	25.1
<b>East: WB Approach</b>											
1L	L	5	2.0	0.109	10.6	LOS B	0.5	12.3	0.18	0.90	29.6
6T	T	132	2.0	0.109	4.6	LOS A	0.5	12.3	0.18	0.39	33.4
6R	R	1	3.0	0.109	6.8	LOS A	0.5	12.3	0.18	0.55	32.8
Approach		138	2.0	0.109	4.8	LOS A	0.5	12.3	0.18	0.42	33.2
<b>North: SB Approach</b>											
7	L	65	3.0	0.059	12.8	LOS B	0.2	5.3	0.27	0.68	29.3
4	T	1	3.0	0.059	6.0	LOS A	0.2	5.3	0.27	0.43	32.7
14	R	1	3.0	0.059	7.1	LOS A	0.2	5.3	0.27	0.50	32.2
Approach		67	3.0	0.059	12.6	LOS B	0.2	5.3	0.27	0.68	29.4
<b>West: EB Approach</b>											
5	L	1	3.0	0.153	12.4	LOS B	0.6	15.2	0.17	0.88	30.0
2	T	152	2.0	0.153	3.7	LOS A	0.6	15.2	0.17	0.35	28.3
12	R	35	2.0	0.153	3.8	LOS A	0.6	15.2	0.17	0.43	27.2
Approach		188	2.0	0.153	3.7	LOS A	0.6	15.2	0.17	0.37	28.1
All Vehicles		468	2.2	0.153	6.1	LOS A	0.6	15.2	0.21	0.47	29.0

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# MOVEMENT SUMMARY

Site: 2030 PM PH w/o Road 3 RMG

Intersection #2, Reid Middleton Geometry (RMG)  
 2030 PM Peak Hour  
 Without Road 3

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
<b>South: NB Approach</b>											
3	L	37	2.0	0.040	9.3	LOS A	0.1	3.8	0.32	0.65	24.7
8	T	1	2.0	0.040	6.2	LOS A	0.1	3.8	0.32	0.45	32.3
18	R	5	2.0	0.040	5.6	LOS A	0.1	3.8	0.32	0.47	27.0
Approach		43	2.0	0.040	8.8	LOS A	0.1	3.8	0.32	0.62	25.1
<b>East: WB Approach</b>											
1L	L	8	2.0	0.172	10.5	LOS B	0.8	21.0	0.14	0.88	29.6
6T	T	154	2.0	0.172	4.4	LOS A	0.8	21.0	0.14	0.37	33.6
6R	R	76	2.0	0.172	6.8	LOS A	0.8	21.0	0.14	0.53	33.0
Approach		238	2.0	0.172	5.4	LOS A	0.8	21.0	0.14	0.44	33.2
<b>North: SB Approach</b>											
7	L	87	2.0	0.088	13.0	LOS B	0.3	7.9	0.28	0.69	29.2
4	T	1	2.0	0.088	6.1	LOS A	0.3	7.9	0.28	0.44	32.6
14	R	1	2.0	0.088	7.4	LOS A	0.3	7.9	0.28	0.52	32.0
Approach		89	2.0	0.088	12.8	LOS B	0.3	7.9	0.28	0.69	29.3
<b>West: EB Approach</b>											
5	L	1	2.0	0.193	12.5	LOS B	0.8	20.1	0.21	0.87	30.0
2	T	182	2.0	0.193	3.8	LOS A	0.8	20.1	0.21	0.37	28.2
12	R	51	2.0	0.193	3.9	LOS A	0.8	20.1	0.21	0.44	27.1
Approach		234	2.0	0.193	3.8	LOS A	0.8	20.1	0.21	0.39	28.0
<b>All Vehicles</b>		<b>604</b>	<b>2.0</b>	<b>0.193</b>	<b>6.1</b>	<b>LOS A</b>	<b>0.8</b>	<b>21.0</b>	<b>0.20</b>	<b>0.47</b>	<b>29.7</b>

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# MOVEMENT SUMMARY

Site: 2030 AM PH w Road 3 RMG

Intersection #2, Reid Middleton Geometry (RMG)  
 2030 AM Peak Hour  
 With Road 3

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
<b>South: NB Approach</b>											
3	L	64	2.0	0.070	9.5	LOS A	0.3	6.9	0.35	0.66	24.6
8	T	1	2.0	0.070	6.4	LOS A	0.3	6.9	0.35	0.48	32.2
18	R	10	2.0	0.070	5.8	LOS A	0.3	6.9	0.35	0.50	26.9
Approach		75	2.0	0.070	8.9	LOS A	0.3	6.9	0.35	0.64	25.0
<b>East: WB Approach</b>											
1L	L	5	2.0	0.310	10.6	LOS B	1.7	44.1	0.22	0.85	29.5
6T	T	262	2.0	0.310	4.6	LOS A	1.7	44.1	0.22	0.39	33.1
6R	R	152	2.0	0.310	6.9	LOS A	1.7	44.1	0.22	0.54	32.7
Approach		420	2.0	0.310	5.5	LOS A	1.7	44.1	0.22	0.45	32.9
<b>North: SB Approach</b>											
7	L	98	2.0	0.097	13.4	LOS B	0.4	9.5	0.37	0.71	29.0
4	T	1	2.0	0.097	6.5	LOS A	0.4	9.5	0.37	0.49	32.0
14	R	1	2.0	0.097	7.8	LOS A	0.4	9.5	0.37	0.57	31.6
Approach		100	2.0	0.097	13.2	LOS B	0.4	9.5	0.37	0.71	29.1
<b>West: EB Approach</b>											
5	L	1	2.0	0.169	12.5	LOS B	0.7	17.7	0.22	0.89	30.0
2	T	201	2.0	0.169	3.8	LOS A	0.7	17.7	0.22	0.38	28.2
12	R	1	2.0	0.169	3.9	LOS A	0.7	17.7	0.22	0.46	27.1
Approach		203	2.0	0.169	3.8	LOS A	0.7	17.7	0.22	0.38	28.2
All Vehicles		798	2.0	0.310	6.4	LOS A	1.7	44.1	0.25	0.48	30.1

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# MOVEMENT SUMMARY

Site: 2030 PM PH w Road 3 RMG

Intersection #2, Reid Middleton Geometry (RMG)  
2030 PM Peak Hour  
With Road 3

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
<b>South: NB Approach</b>											
3	L	37	2.0	0.047	10.4	LOS B	0.2	5.2	0.48	0.70	24.4
8	T	1	2.0	0.047	7.4	LOS A	0.2	5.2	0.48	0.55	31.3
18	R	5	2.0	0.047	6.7	LOS A	0.2	5.2	0.48	0.56	26.4
Approach		43	2.0	0.047	9.9	LOS A	0.2	5.2	0.48	0.68	24.8
<b>East: WB Approach</b>											
1L	L	8	2.0	0.249	10.5	LOS B	1.4	34.6	0.16	0.88	29.6
6T	T	247	2.0	0.249	4.4	LOS A	1.4	34.6	0.16	0.37	33.5
6R	R	98	2.0	0.249	6.8	LOS A	1.4	34.6	0.16	0.53	32.9
Approach		352	2.0	0.249	5.2	LOS A	1.4	34.6	0.16	0.43	33.2
<b>North: SB Approach</b>											
7	L	196	2.0	0.208	13.5	LOS B	0.8	21.2	0.38	0.73	29.0
4	T	1	2.0	0.208	6.7	LOS A	0.8	21.2	0.38	0.52	31.9
14	R	1	2.0	0.208	7.9	LOS A	0.8	21.2	0.38	0.59	31.5
Approach		198	2.0	0.208	13.4	LOS B	0.8	21.2	0.38	0.73	29.0
<b>West: EB Approach</b>											
5	L	1	2.0	0.339	13.0	LOS B	1.7	42.7	0.38	0.87	29.9
2	T	328	2.0	0.339	4.3	LOS A	1.7	42.7	0.38	0.44	27.6
12	R	51	2.0	0.339	4.5	LOS A	1.7	42.7	0.38	0.50	26.7
Approach		380	2.0	0.339	4.4	LOS A	1.7	42.7	0.38	0.45	27.5
All Vehicles		974	2.0	0.339	6.8	LOS A	1.7	42.7	0.30	0.51	29.4

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# Intersection 1

## Five-Leg Roundabout Analysis

# MOVEMENT SUMMARY

Site: 2030 AM PH 5-Leg w/o Road 3  
RMG

Intersection #1, 5-Leg, Reid Middleton Geometry (RMG)  
2030 AM Peak Hour  
Without Road 3 - Base + Project

Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph	
<b>South: NB Approach</b>												
3	L	57	2.0	0.055	11.7	LOS B	0.2	5.3	0.37	0.68	25.4	
8	T	1	2.0	0.055	1.9	LOS A	0.2	5.3	0.37	0.28	27.0	
18	R	3	2.0	0.055	6.9	LOS A	0.2	5.3	0.37	0.51	32.0	
Approach		61	2.0	0.055	11.2	LOS B	0.2	5.3	0.37	0.66	25.6	
<b>South East: NWB Approach</b>												
3X	L	551	2.0	0.441	11.6	LOS B	2.4	61.0	0.31	0.65	29.8	
18X	R	2	2.0	0.441	5.4	LOS A	2.4	61.0	0.31	0.42	32.7	
Approach		553	2.0	0.441	11.6	LOS B	2.4	61.0	0.31	0.65	29.8	
<b>North East: SWB Approach</b>												
1X	L	2	2.0	0.086	14.0	LOS B	0.4	10.3	0.54	0.91	30.0	
16X	R	77	2.0	0.086	6.4	LOS A	0.4	10.3	0.54	0.57	32.5	
Approach		79	2.0	0.086	6.6	LOS A	0.4	10.3	0.54	0.58	32.4	
<b>North: SB Approach</b>												
7	L	2	2.0	0.009	14.9	LOS B	0.0	1.1	0.58	0.73	29.1	
4	T	1	2.0	0.009	3.3	LOS A	0.0	1.1	0.58	0.39	26.2	
14	R	4	2.0	0.009	6.3	LOS A	0.0	1.1	0.58	0.51	26.7	
Approach		8	2.0	0.009	8.3	LOS A	0.0	1.1	0.58	0.55	27.3	
<b>West: EB Approach</b>												
5	L	67	2.0	0.296	11.0	LOS B	1.3	33.7	0.05	0.92	30.8	
12	R	341	2.0	0.296	4.0	LOS A	1.3	33.7	0.05	0.33	35.4	
Approach		409	2.0	0.296	5.2	LOS A	1.3	33.7	0.05	0.43	34.5	
All Vehicles		1110	2.0	0.441	8.8	LOS A	2.4	61.0	0.24	0.56	31.2	

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# MOVEMENT SUMMARY

Site: 2030 PM PH 5-Leg w/o Road 3  
RMG

Intersection #1, 5-Leg, Reid Middleton Geometry (RMG)  
2030 PM Peak Hour  
Without Road 3 - Base + Project

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
<b>South: NB Approach</b>											
3	L	26	2.0	0.032	13.0	LOS B	0.1	3.5	0.52	0.71	25.1
8	T	1	2.0	0.032	3.2	LOS A	0.1	3.5	0.52	0.40	26.1
18	R	2	2.0	0.032	7.8	LOS A	0.1	3.5	0.52	0.56	31.3
Approach		29	2.0	0.032	12.2	LOS B	0.1	3.5	0.52	0.69	25.5
<b>South East: NWB Approach</b>											
3X	L	373	2.0	0.298	11.5	LOS B	1.3	34.1	0.26	0.65	30.0
18X	R	2	2.0	0.298	5.3	LOS A	1.3	34.1	0.26	0.40	33.1
Approach		375	2.0	0.298	11.5	LOS B	1.3	34.1	0.26	0.65	30.0
<b>North East: SWB Approach</b>											
1X	L	2	2.0	0.075	13.0	LOS B	0.3	7.9	0.42	0.91	30.4
16X	R	77	2.0	0.075	5.4	LOS A	0.3	7.9	0.42	0.48	33.2
Approach		79	2.0	0.075	5.6	LOS A	0.3	7.9	0.42	0.49	33.1
<b>North: SB Approach</b>											
7	L	2	2.0	0.007	13.8	LOS B	0.0	0.8	0.45	0.73	29.6
4	T	1	2.0	0.007	2.2	LOS A	0.0	0.8	0.45	0.29	26.8
14	R	4	2.0	0.007	5.2	LOS A	0.0	0.8	0.45	0.45	27.2
Approach		8	2.0	0.007	7.2	LOS A	0.0	0.8	0.45	0.51	27.8
<b>West: EB Approach</b>											
5	L	96	2.0	0.518	10.9	LOS B	3.2	80.0	0.06	0.92	30.7
12	R	620	2.0	0.518	4.0	LOS A	3.2	80.0	0.06	0.33	35.3
Approach		715	2.0	0.518	4.9	LOS A	3.2	80.0	0.06	0.41	34.6
All Vehicles		1207	2.0	0.518	7.2	LOS A	3.2	80.0	0.16	0.50	32.5

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# MOVEMENT SUMMARY

Site: 2030 AM PH 5-Leg w Road 3  
RMG

Intersection #1, 5-Leg, Reid Middleton Geometry (RMG)  
2030 AM Peak Hour  
With Road 3 - Base + Project

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop Queued	Effective Stop Rate per veh	Average Speed mph
<b>South: NB Approach</b>											
3	L	57	2.0	0.058	12.0	LOS B	0.2	5.8	0.42	0.69	25.3
8	T	1	2.0	0.058	2.2	LOS A	0.2	5.8	0.42	0.32	26.7
18	R	3	2.0	0.058	7.2	LOS A	0.2	5.8	0.42	0.54	31.8
Approach		61	2.0	0.058	11.6	LOS B	0.2	5.8	0.42	0.68	25.5
<b>South East: NWB Approach</b>											
3X	L	682	2.0	0.556	12.0	LOS B	3.5	89.4	0.41	0.67	29.5
18X	R	2	2.0	0.556	5.7	LOS A	3.5	89.4	0.41	0.47	32.1
Approach		684	2.0	0.556	11.9	LOS B	3.5	89.4	0.41	0.66	29.5
<b>North East: SWB Approach</b>											
1X	L	2	2.0	0.193	15.1	LOS B	1.1	26.9	0.67	0.94	29.6
16X	R	153	2.0	0.193	7.5	LOS A	1.1	26.9	0.67	0.67	31.8
Approach		155	2.0	0.193	7.6	LOS A	1.1	26.9	0.67	0.67	31.8
<b>North: SB Approach</b>											
7	L	2	2.0	0.015	16.7	LOS B	0.1	2.2	0.71	0.75	28.2
4	T	1	2.0	0.015	5.1	LOS A	0.1	2.2	0.71	0.51	25.5
14	R	8	2.0	0.015	8.1	LOS A	0.1	2.2	0.71	0.60	26.3
Approach		11	2.0	0.015	9.5	LOS A	0.1	2.2	0.71	0.62	26.6
<b>West: EB Approach</b>											
5	L	100	2.0	0.355	11.0	LOS B	1.8	44.7	0.05	0.90	30.8
12	R	390	2.0	0.355	4.0	LOS A	1.8	44.7	0.05	0.33	35.4
Approach		490	2.0	0.355	5.4	LOS A	1.8	44.7	0.05	0.44	34.3
All Vehicles		1401	2.0	0.556	9.2	LOS A	3.5	89.4	0.32	0.59	31.0

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# MOVEMENT SUMMARY

Site: 2030 PM PH 5-Leg w Road 3  
RMG

Intersection #1, 5-Leg, Reid Middleton Geometry (RMG)  
2030 PM Peak Hour  
With Road 3 - Base + Project

Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
<b>South: NB Approach</b>											
3	L	26	2.0	0.039	15.2	LOS B	0.2	5.1	0.67	0.75	24.2
8	T	1	2.0	0.039	5.4	LOS A	0.2	5.1	0.67	0.53	25.3
18	R	2	2.0	0.039	10.0	LOS A	0.2	5.1	0.67	0.65	30.2
Approach		29	2.0	0.039	14.4	LOS B	0.2	5.1	0.67	0.74	24.6
<b>South East: NWB Approach</b>											
3X	L	465	2.0	0.395	12.1	LOS B	2.0	50.7	0.39	0.69	29.6
18X	R	2	2.0	0.395	5.9	LOS A	2.0	50.7	0.39	0.49	32.2
Approach		467	2.0	0.395	12.1	LOS B	2.0	50.7	0.39	0.69	29.6
<b>North East: SWB Approach</b>											
1X	L	2	2.0	0.103	13.4	LOS B	0.5	12.0	0.50	0.91	30.3
16X	R	99	2.0	0.103	5.8	LOS A	0.5	12.0	0.50	0.52	32.8
Approach		101	2.0	0.103	6.0	LOS A	0.5	12.0	0.50	0.53	32.7
<b>North: SB Approach</b>											
7	L	2	2.0	0.008	14.2	LOS B	0.0	0.9	0.51	0.73	29.4
4	T	1	2.0	0.008	2.6	LOS A	0.0	0.9	0.51	0.34	26.5
14	R	4	2.0	0.008	5.6	LOS A	0.0	0.9	0.51	0.48	26.9
Approach		8	2.0	0.008	7.6	LOS A	0.0	0.9	0.51	0.53	27.6
<b>West: EB Approach</b>											
5	L	204	2.0	0.704	11.0	LOS B	7.4	189.0	0.11	0.86	30.7
12	R	766	2.0	0.704	4.1	LOS A	7.4	189.0	0.11	0.32	35.0
Approach		971	2.0	0.704	5.5	LOS A	7.4	189.0	0.11	0.43	33.9
All Vehicles		1576	2.0	0.704	7.7	LOS A	7.4	189.0	0.23	0.52	32.1

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model used.

# APPENDIX B

## (ROUNABOUT CALCULATIONS)



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Figure B-11	Sight Distance Calculations

### Roundabout 1 (Alt A)

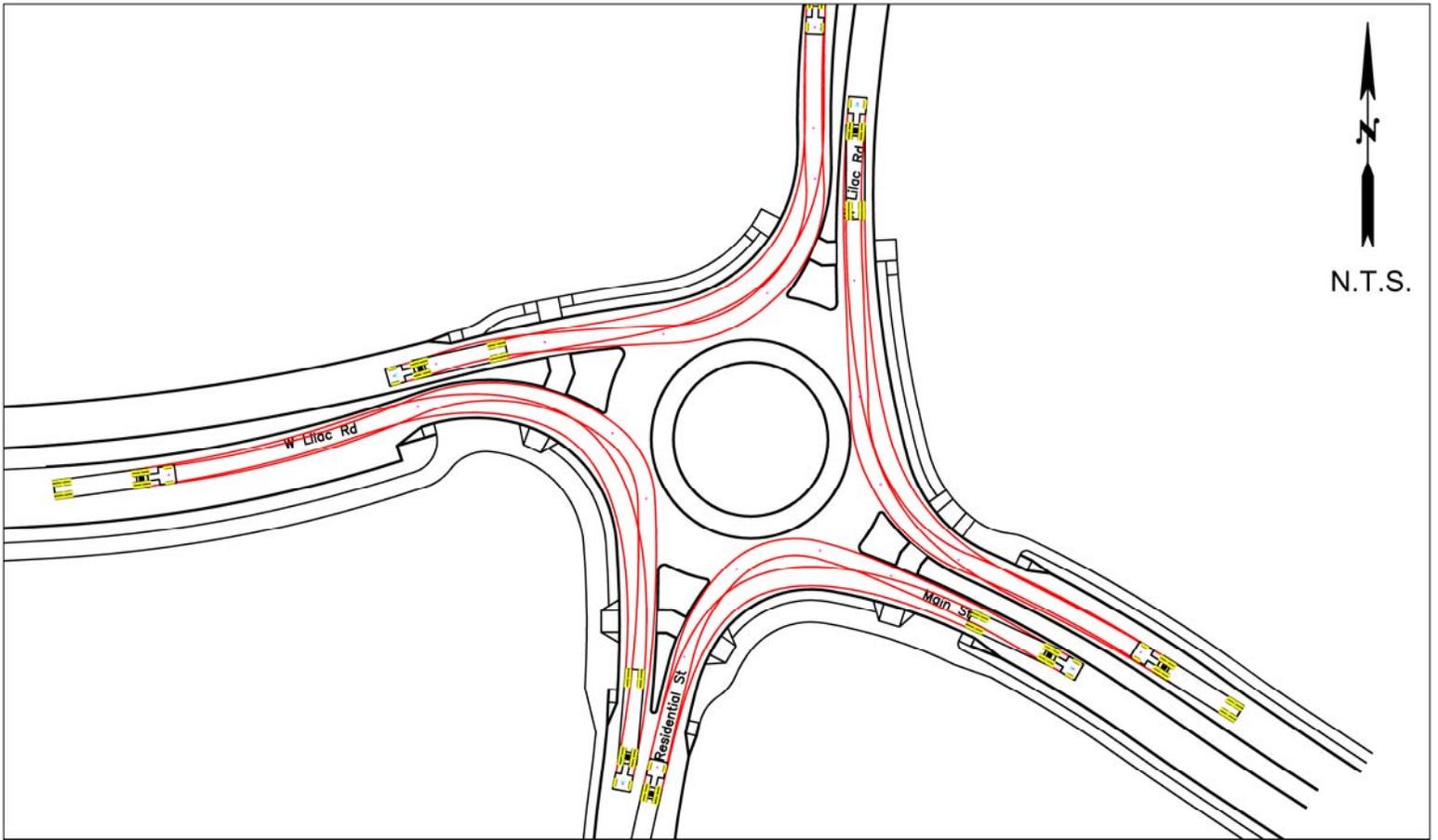
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### Roundabout 1 (Alt B)

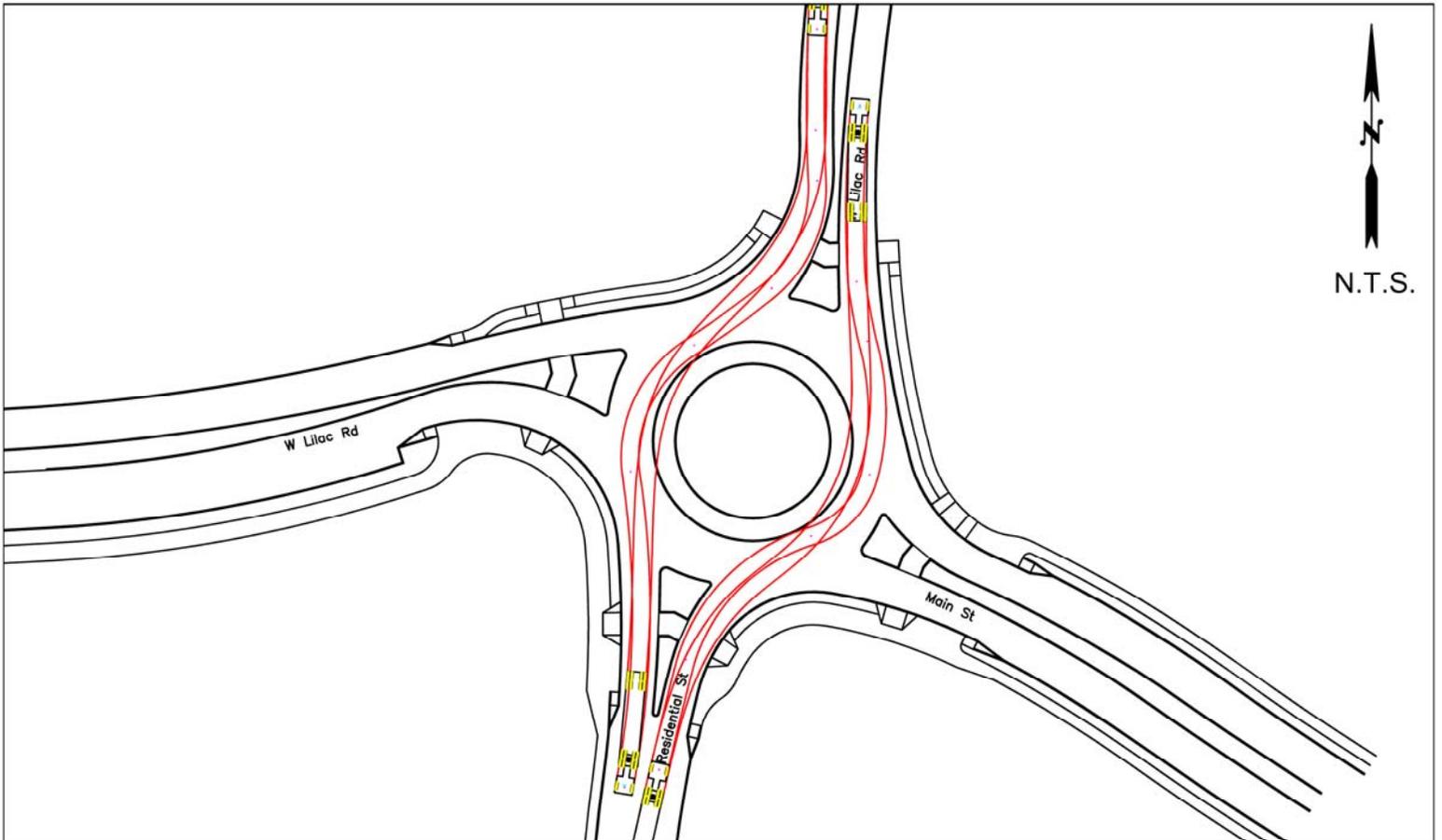
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### Roundabout 2

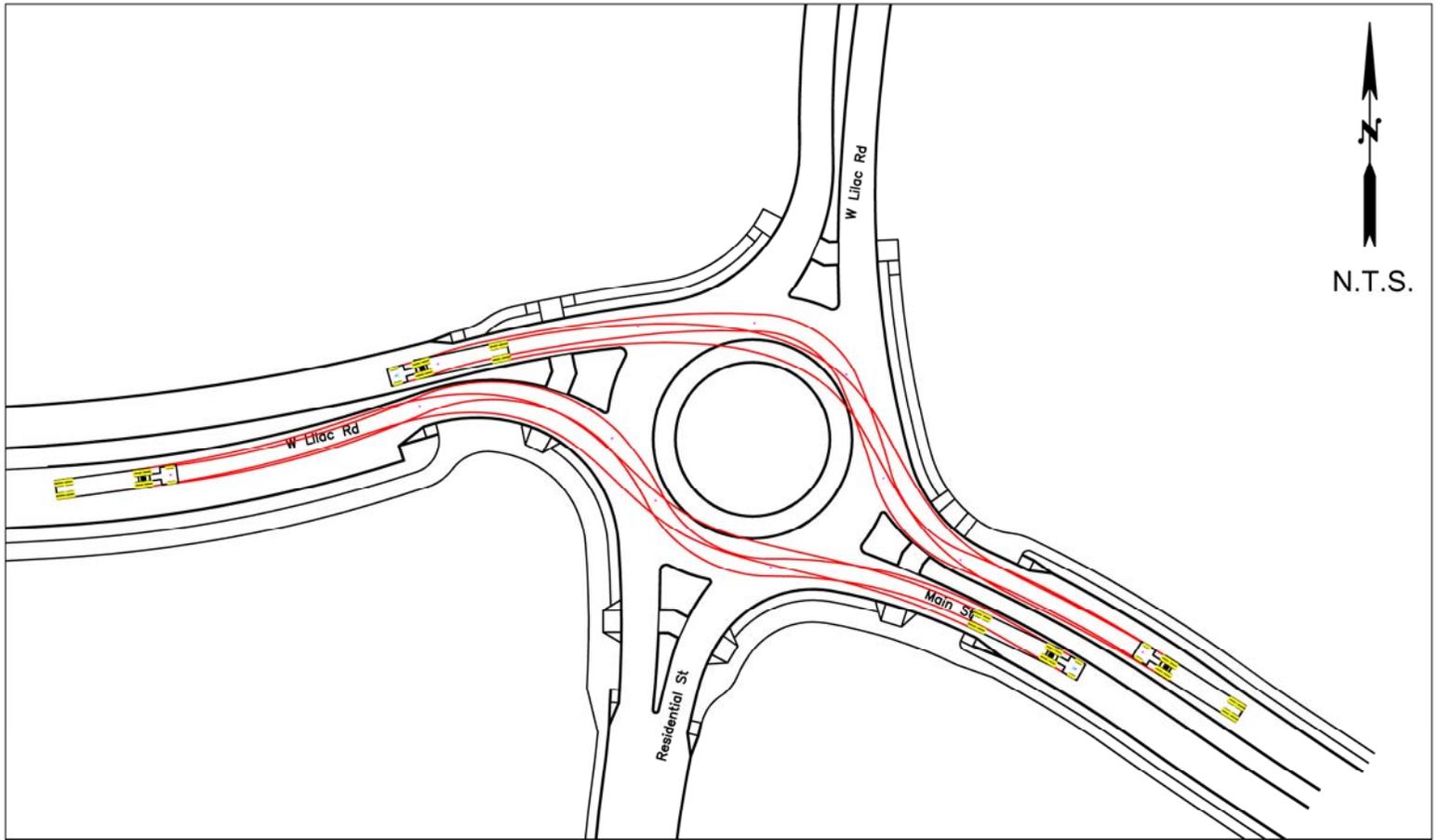
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Figure B-41	Pedestrian Stopping Sight Distance
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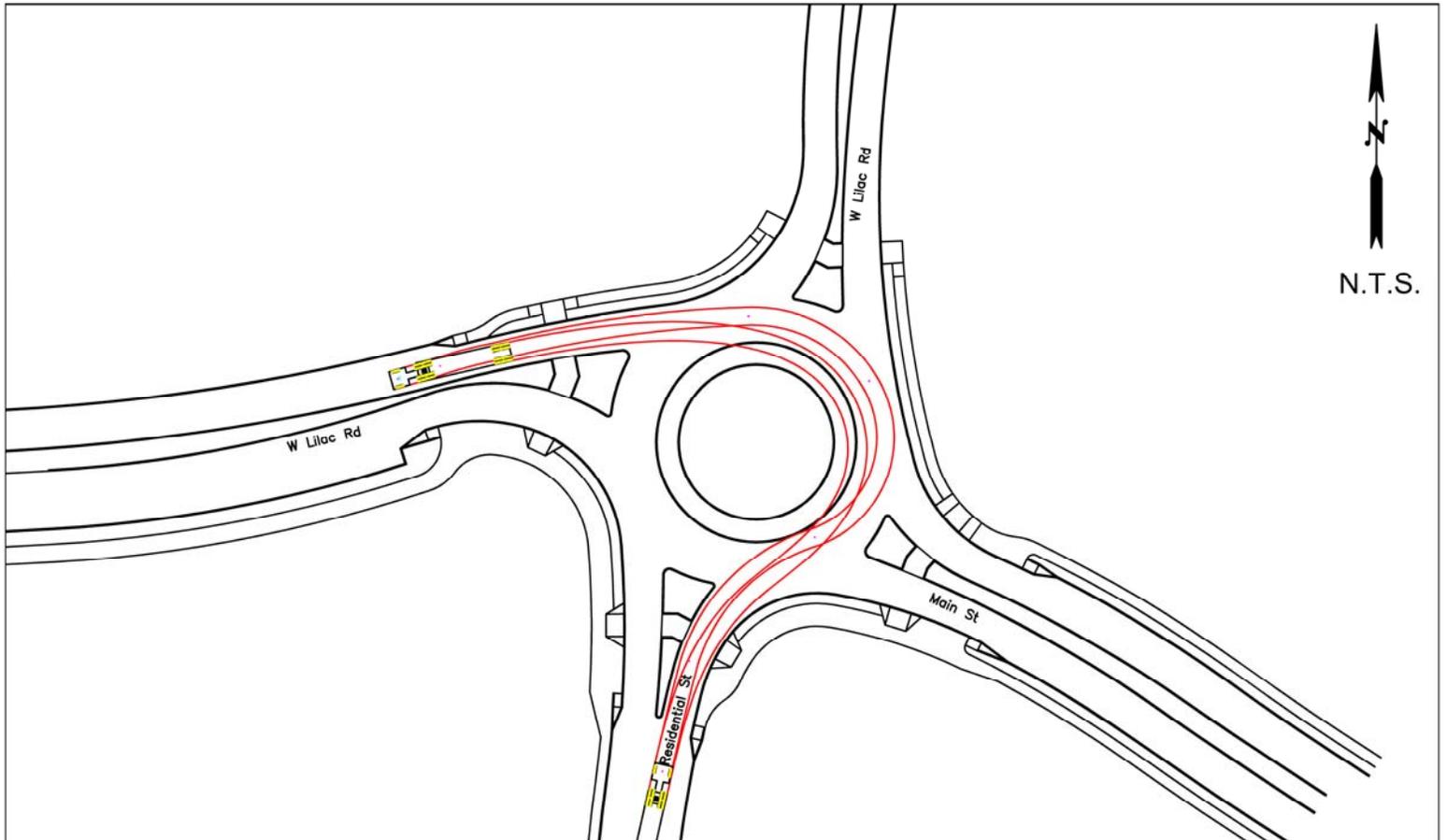
WB-50 Turning Movements



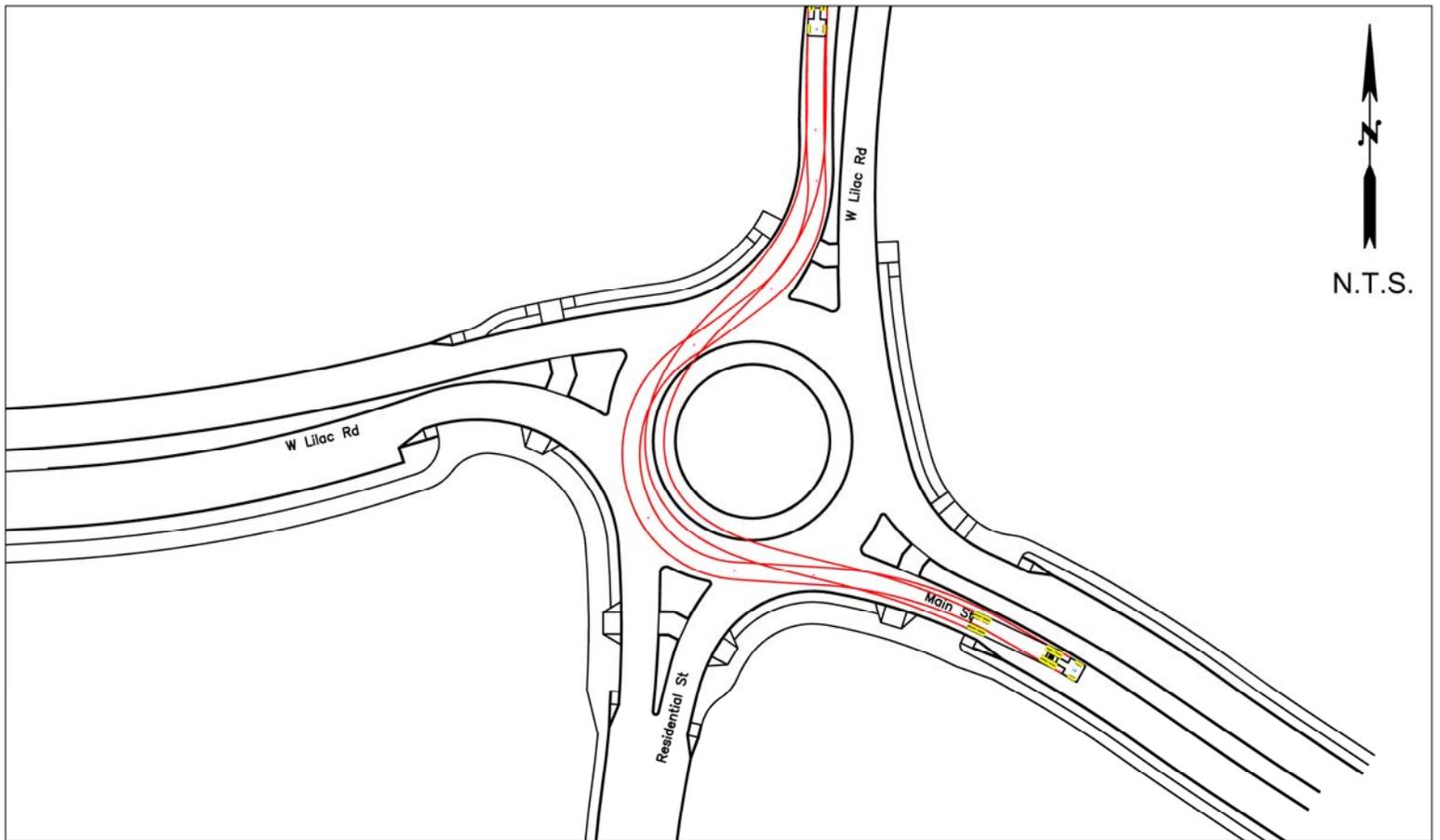
WB-50 Turning Movements



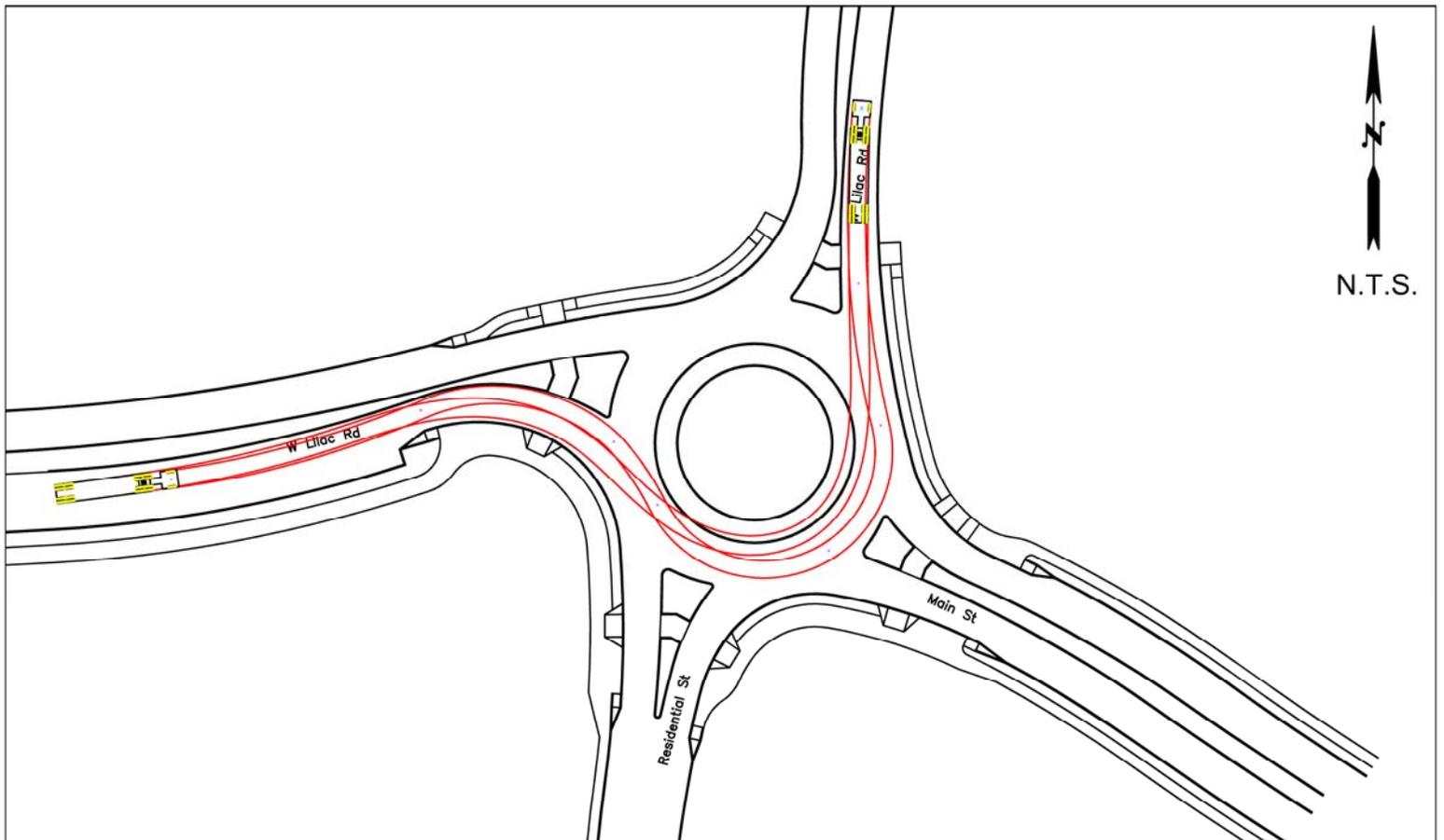
WB-50 Turning Movements



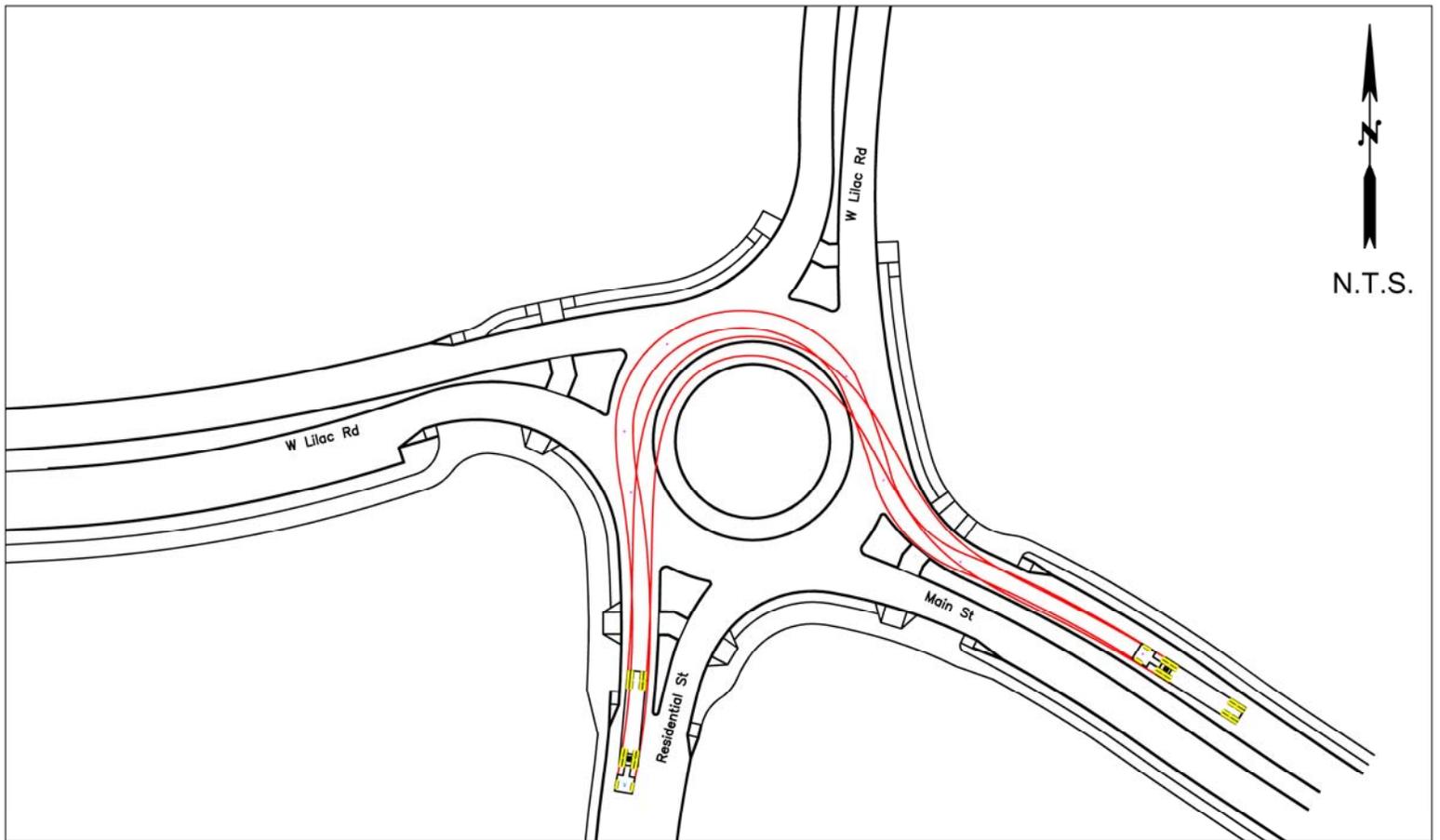
WB-50 Turning Movements



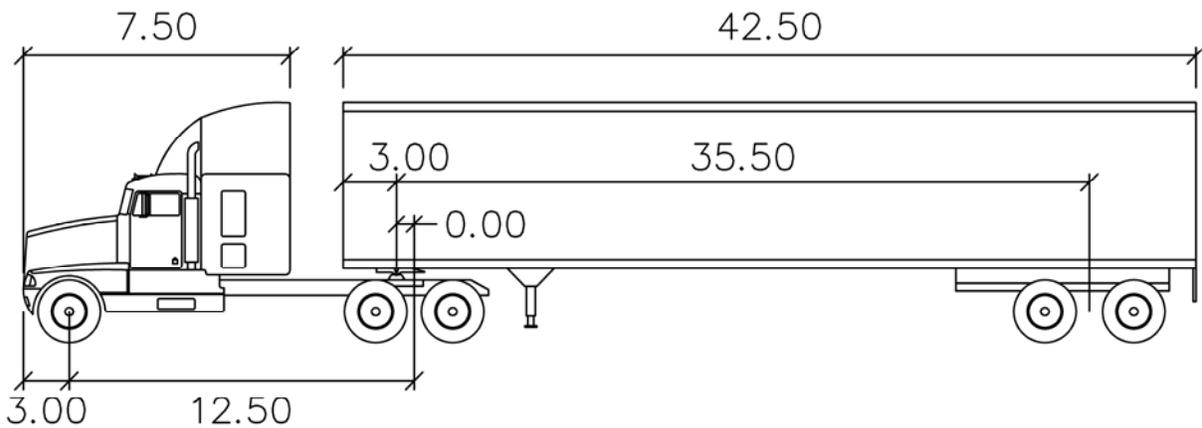
WB-50 Turning Movements



WB-50 Turning Movements



WB-50 Turning Movements

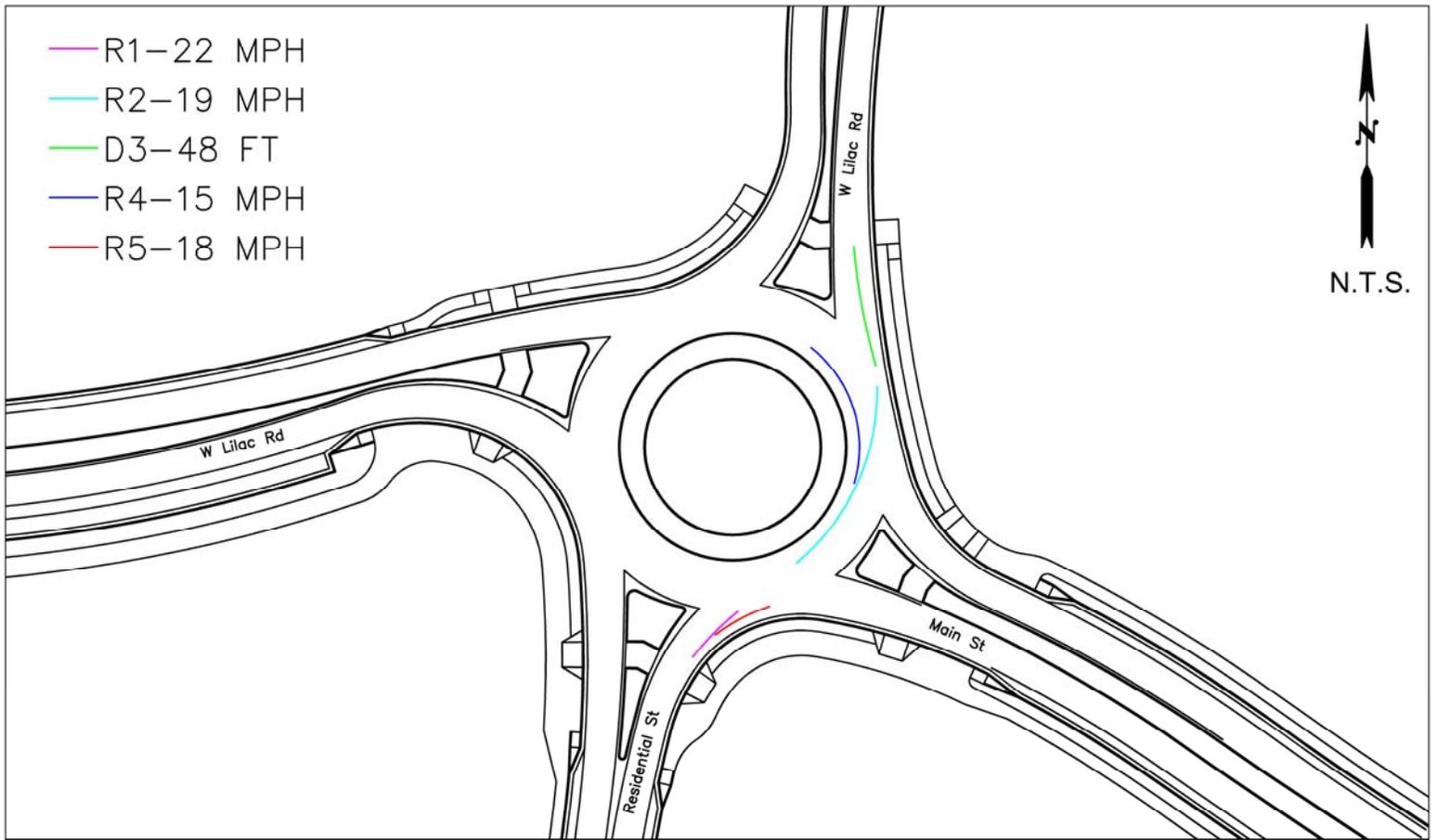


WB-50

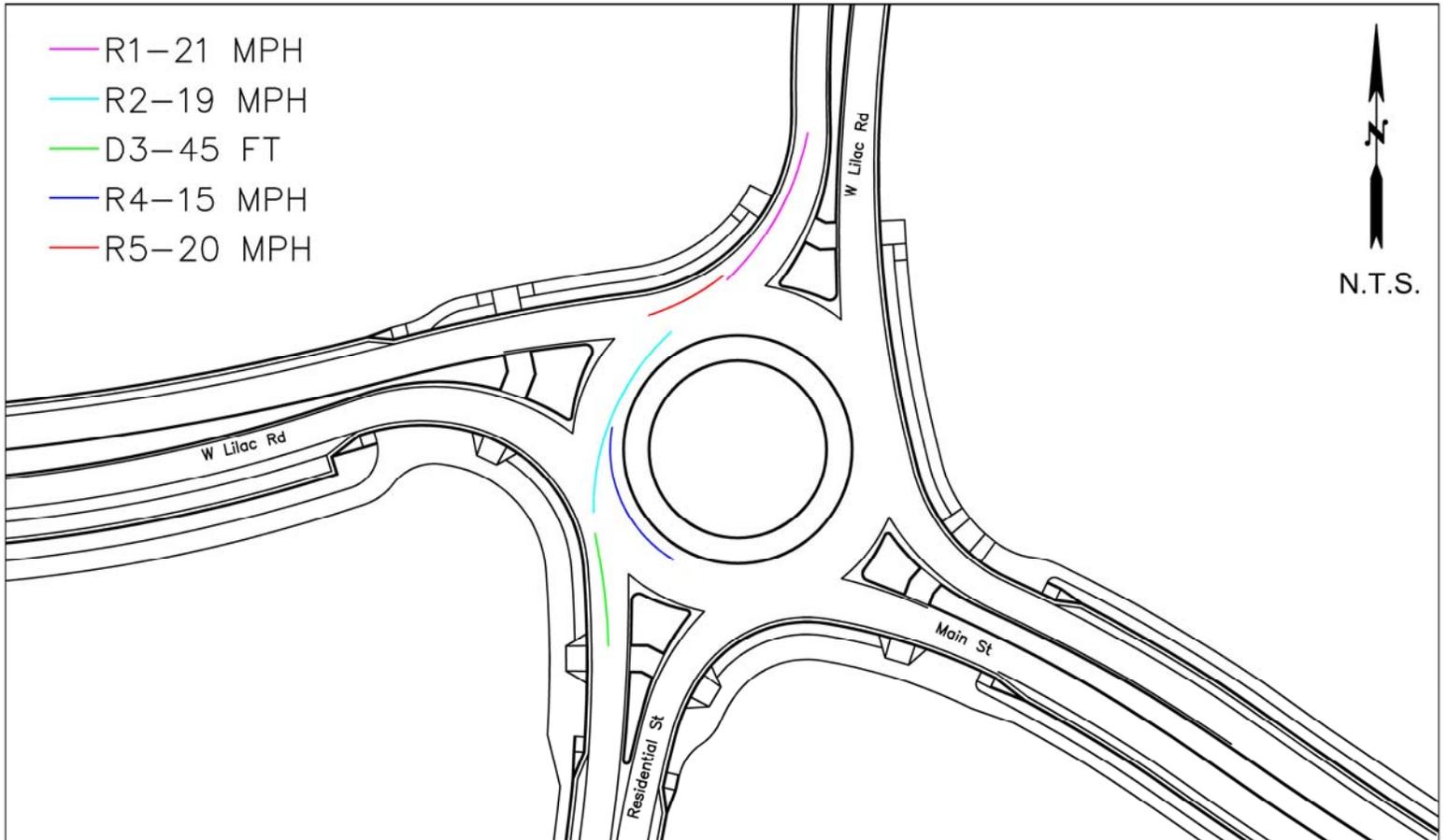
feet

Tractor Width	: 8.00	Lock to Lock Time	: 6.0
Trailer Width	: 8.50	Steering Angle	: 17.7
Tractor Track	: 8.00	Articulating Angle	: 70.0
Trailer Track	: 8.50		

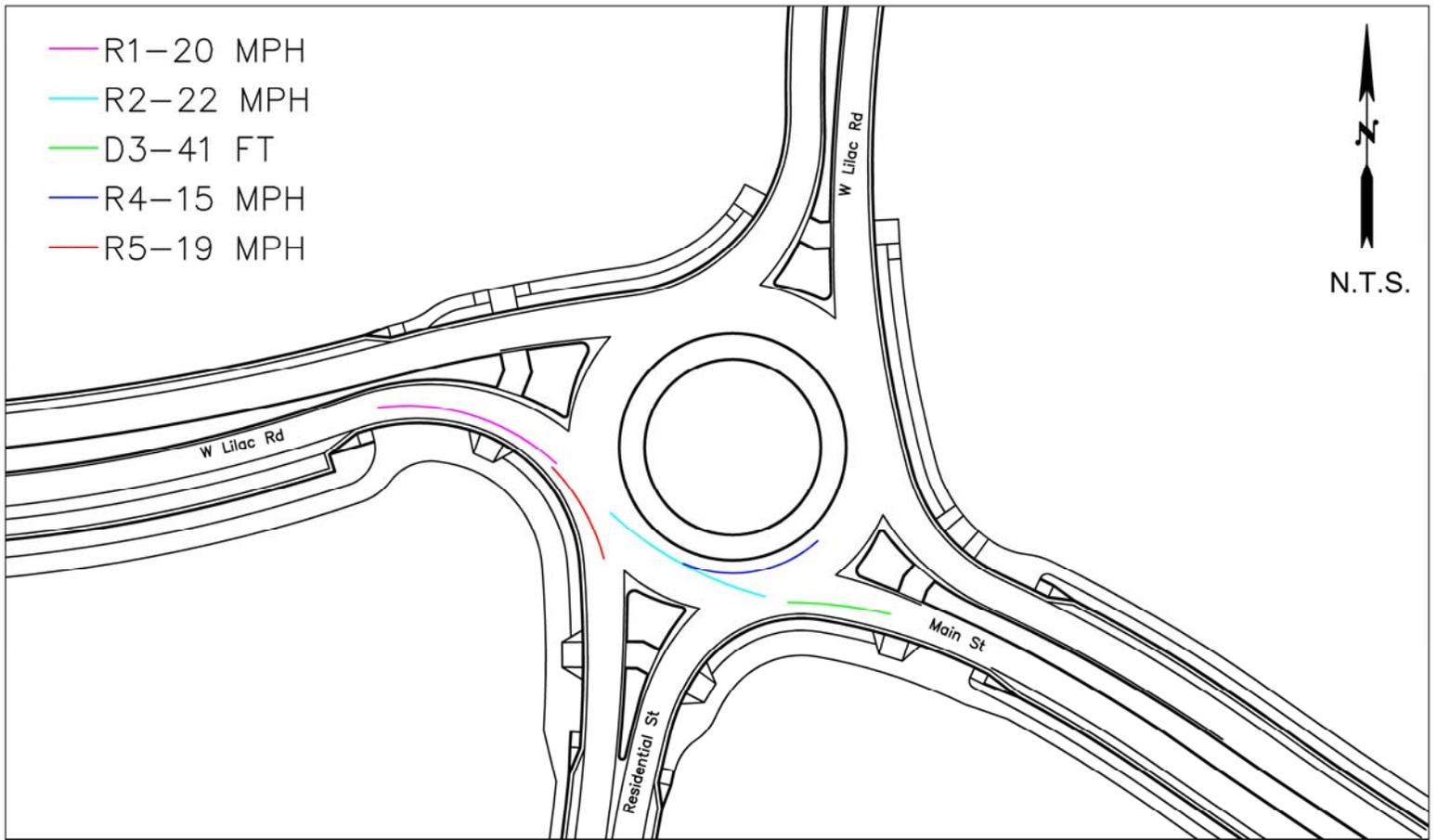
WB-50 Truck Profile



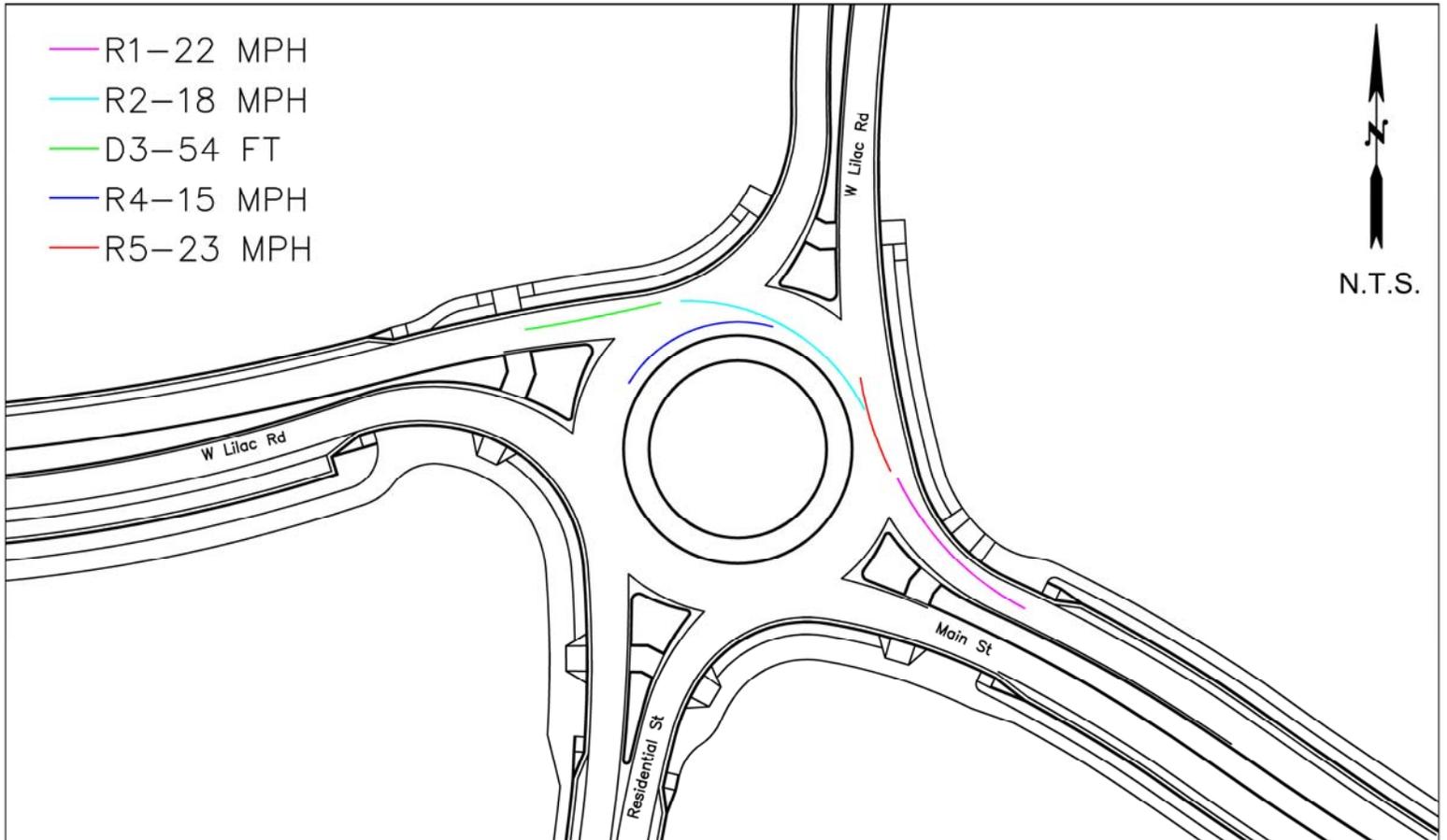
Northbound



Southbound



Eastbound



Westbound

# Reid Middleton RB 1 - Speed Calculations

W Lilac Rd Roundabouts  
October 2013

	Northbound		Southbound		Eastbound		Westbound	
	Radius (ft)	Speed (mph)						
R1	112	22	106	21	87	20	114	22
R2	88	18	94	19	140	22	78	18
R3*	-	27	-	27	-	28	-	28
R4	50	15	50	15	50	15	50	15
R5	74	18	92	20	81	19	125	23

\* R3 speed = lesser of [speed-radius table value] or  $[R2 + \text{Acceleration} * \text{Distance to Crosswalk}]$   
 +2% superelevation assumed for R1, R3, and R5 movements  
 -2% superelevation assumed for R2 and R4 movements

Calculated R3 Speed from Acceleration and Distance to Crosswalk

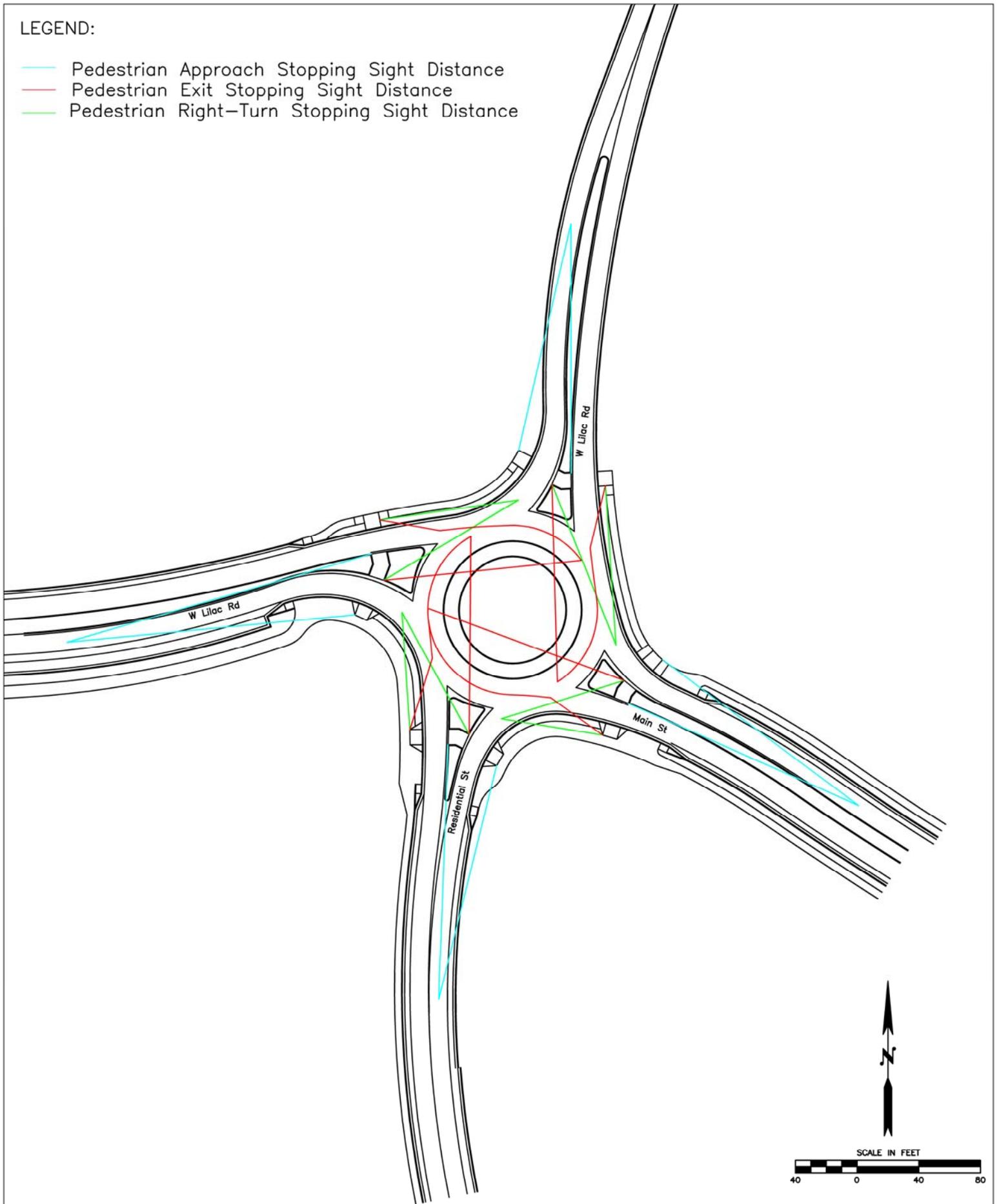
FHWA Acceleration  $6.9 \text{ ft/sec}^2$

NCHRP Report 572

	Beginning Speed R2 (MPH)	R2 Speed in FT/SEC	Distance from R2 to Crosswalk (ft)	Approx. Travel Time (sec)	Speed Increase (mph)	Exiting Speed (mph)
Northbound	18	26	48	1.8	9	27
Southbound	19	28	45	1.6	8	27
Eastbound	22	32	41	1.3	6	28
Westbound	18	26	54	2.1	10	28

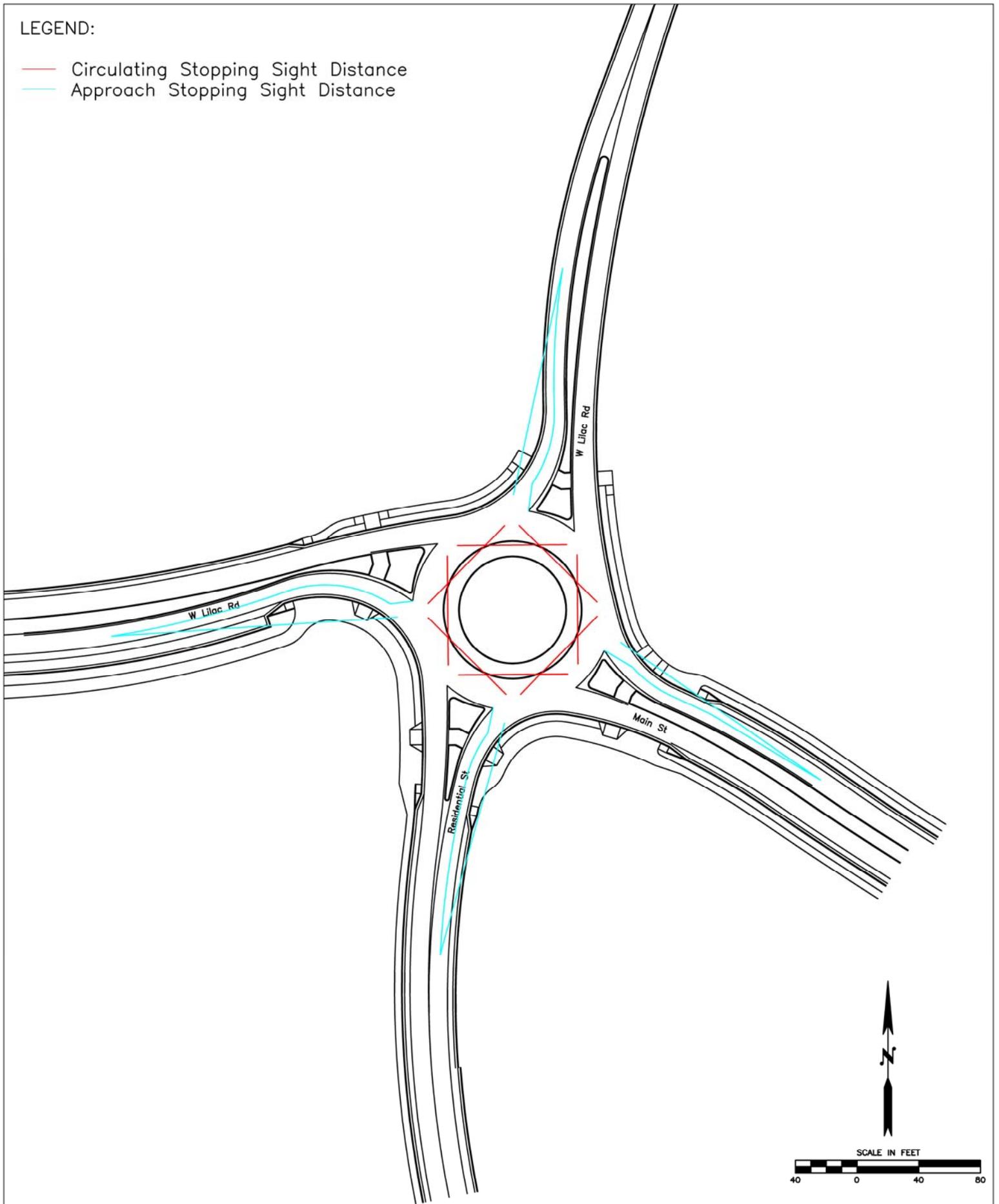
LEGEND:

- Pedestrian Approach Stopping Sight Distance
- Pedestrian Exit Stopping Sight Distance
- Pedestrian Right-Turn Stopping Sight Distance



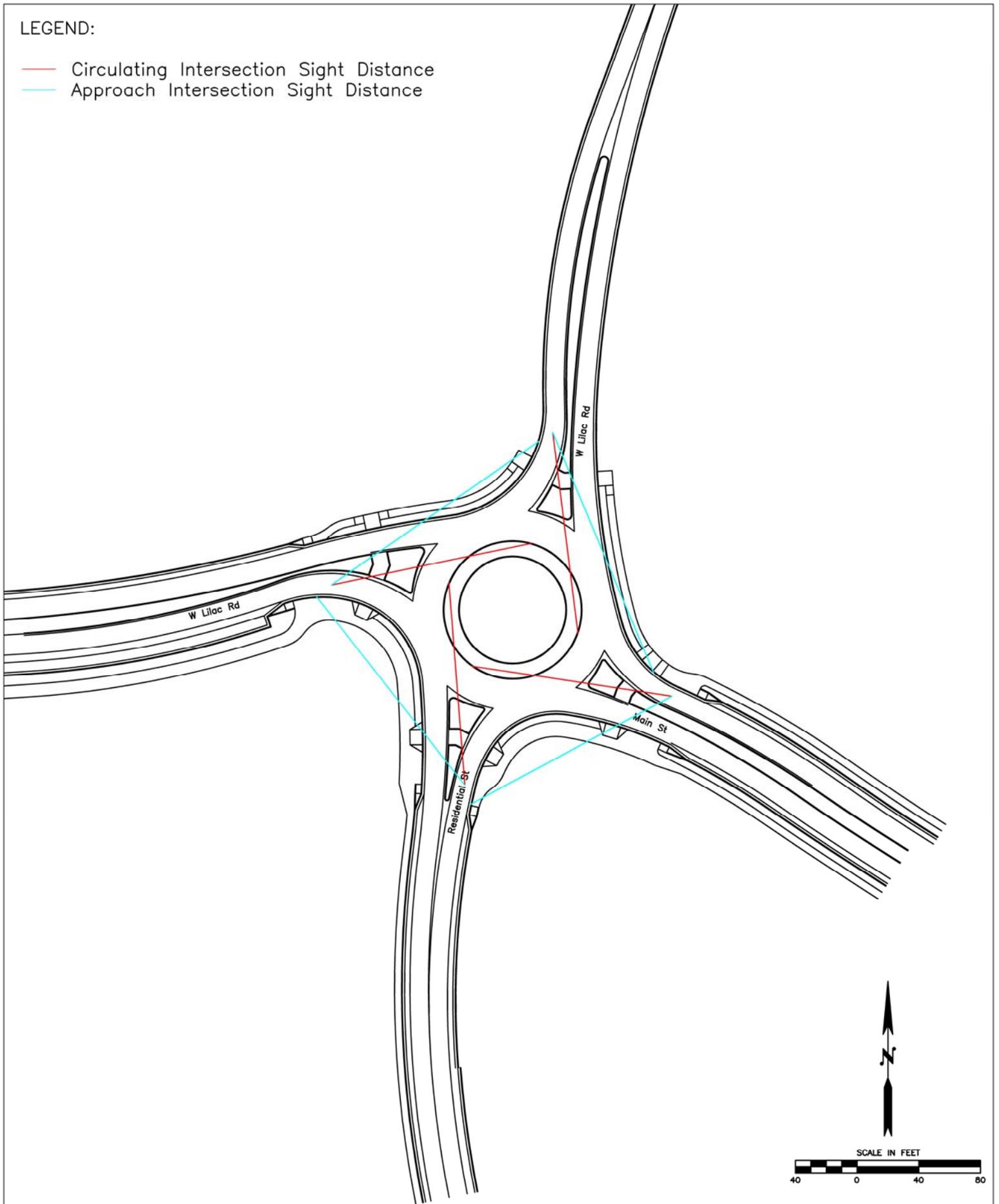
LEGEND:

- Circulating Stopping Sight Distance
- Approach Stopping Sight Distance



LEGEND:

- Circulating Intersection Sight Distance
- Approach Intersection Sight Distance



## Reid Middleton RB 1 - Sight Distance Calculations

W Lilac Rd Roundabouts  
October 2013

### Stopping Sight Distance

$$d = 1.468 \cdot 2.5 \cdot V + 1.087 \cdot V^2 / 11.2$$

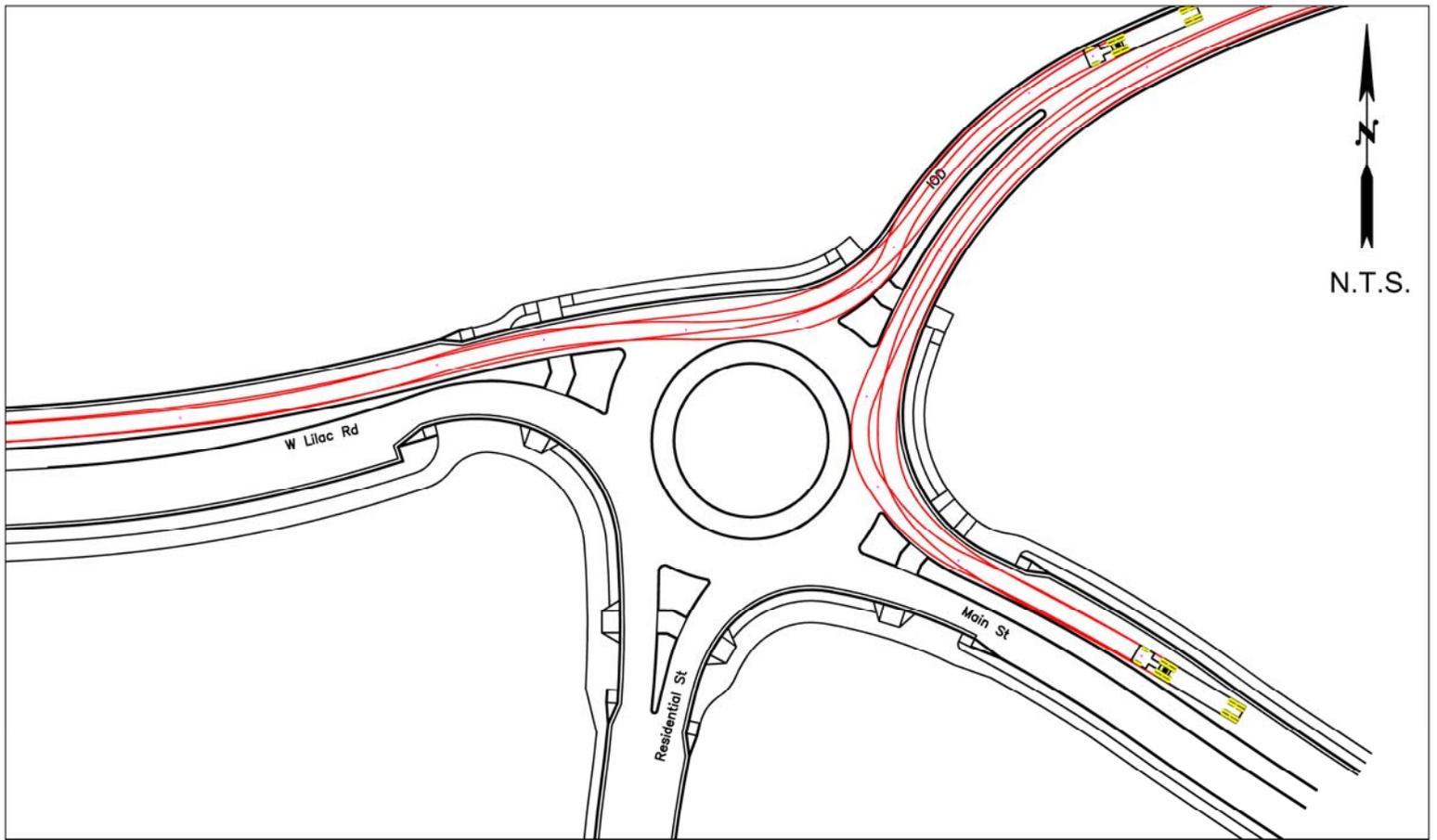
	Posted Speed Limit (mph)	R1 Speed (mph)	Average Approach Speed (mph)	Approach Stopping Sight Distance (ft)	R2 Speed (mph)	R3 Speed (mph)	Average Exit Speed (mph)	Exit Stopping Sight Distance (ft)
Northbound	30	22	26	161	19	27	23	136
Southbound	30	21	26	157	19	27	23	136
Eastbound	40	20	30	197	22	28	25	152
Westbound	30	22	26	161	18	28	23	136

	Circulating Speed (mph)	Circulating Stopping Sight Distance (ft)
Circulating	15	77

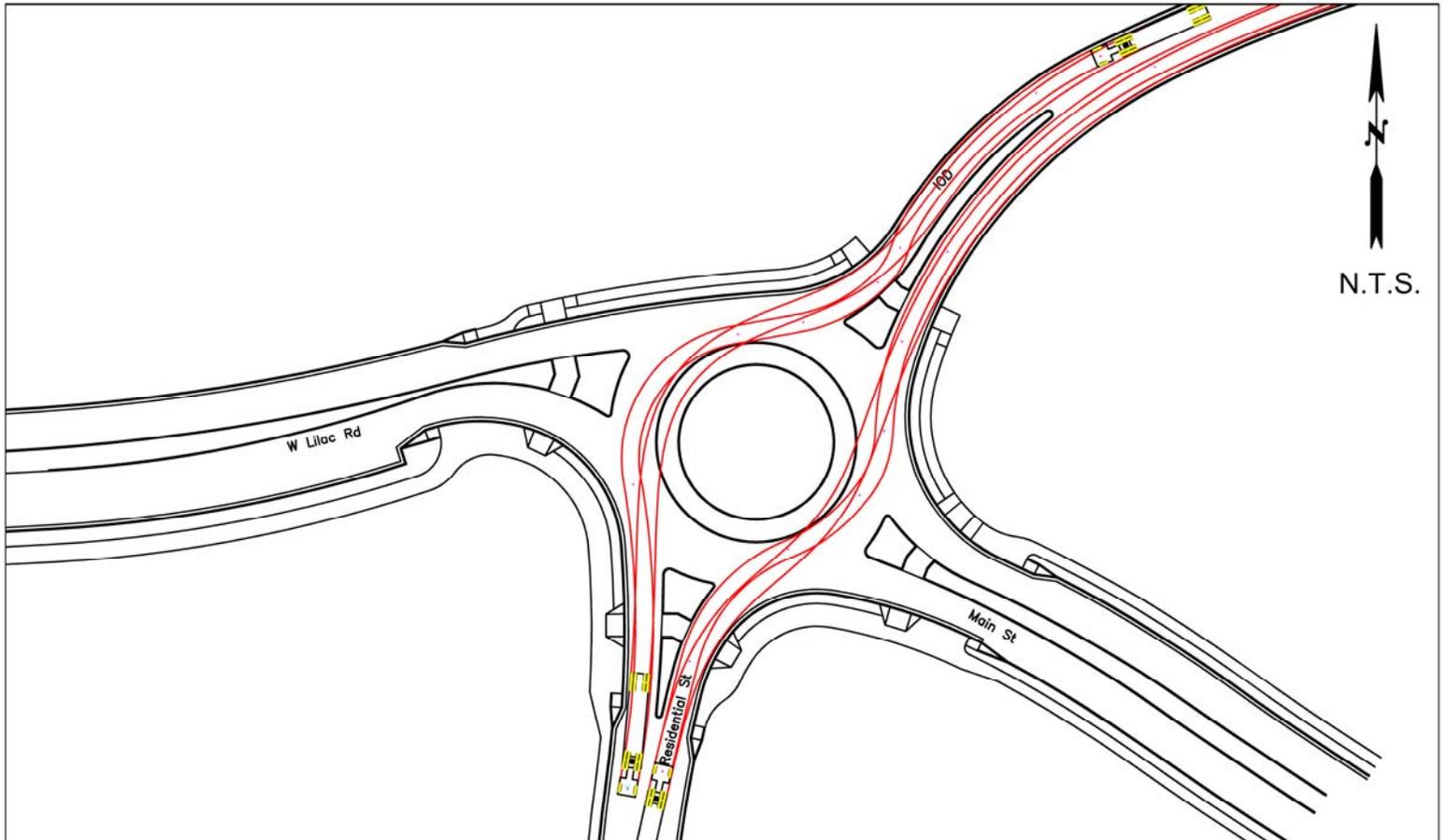
### Intersection Sight Distance

$$S = 1.468 \cdot V \cdot 5.0$$

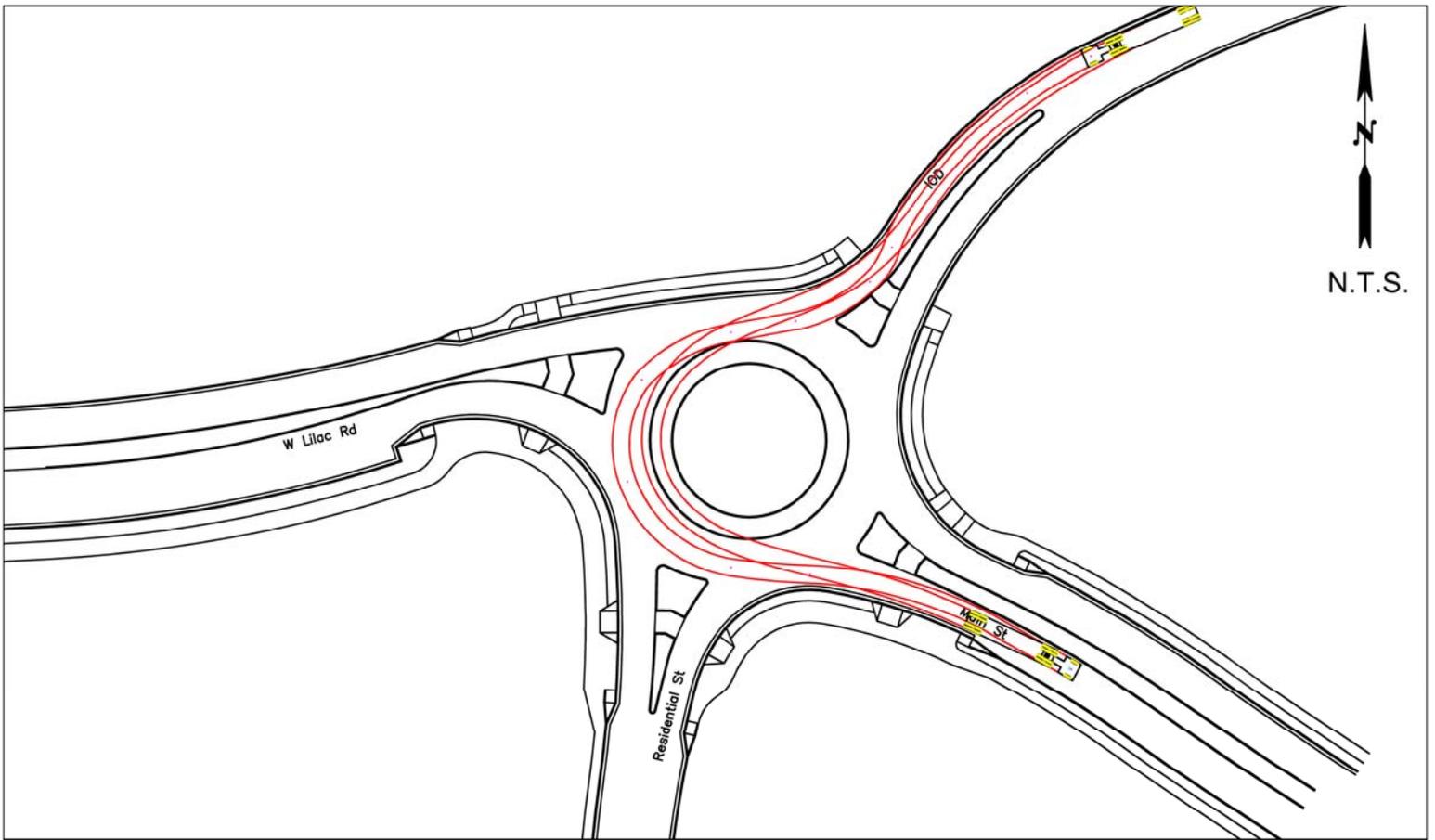
	Adjacent R1 Speed (mph)	Adjacent R2 Speed (mph)	Average Adjacent Entering Speed (mph)	Circulating Stream Speed (mph)	S1 - Entering Intersection Sight Distance (ft)	S2 - Circulating Intersection Sight Distance (ft)
Northbound	20	22	21	15	154	110
Southbound	22	18	20	15	147	110
Eastbound	21	19	20	15	147	110
Westbound	22	19	21	15	150	110



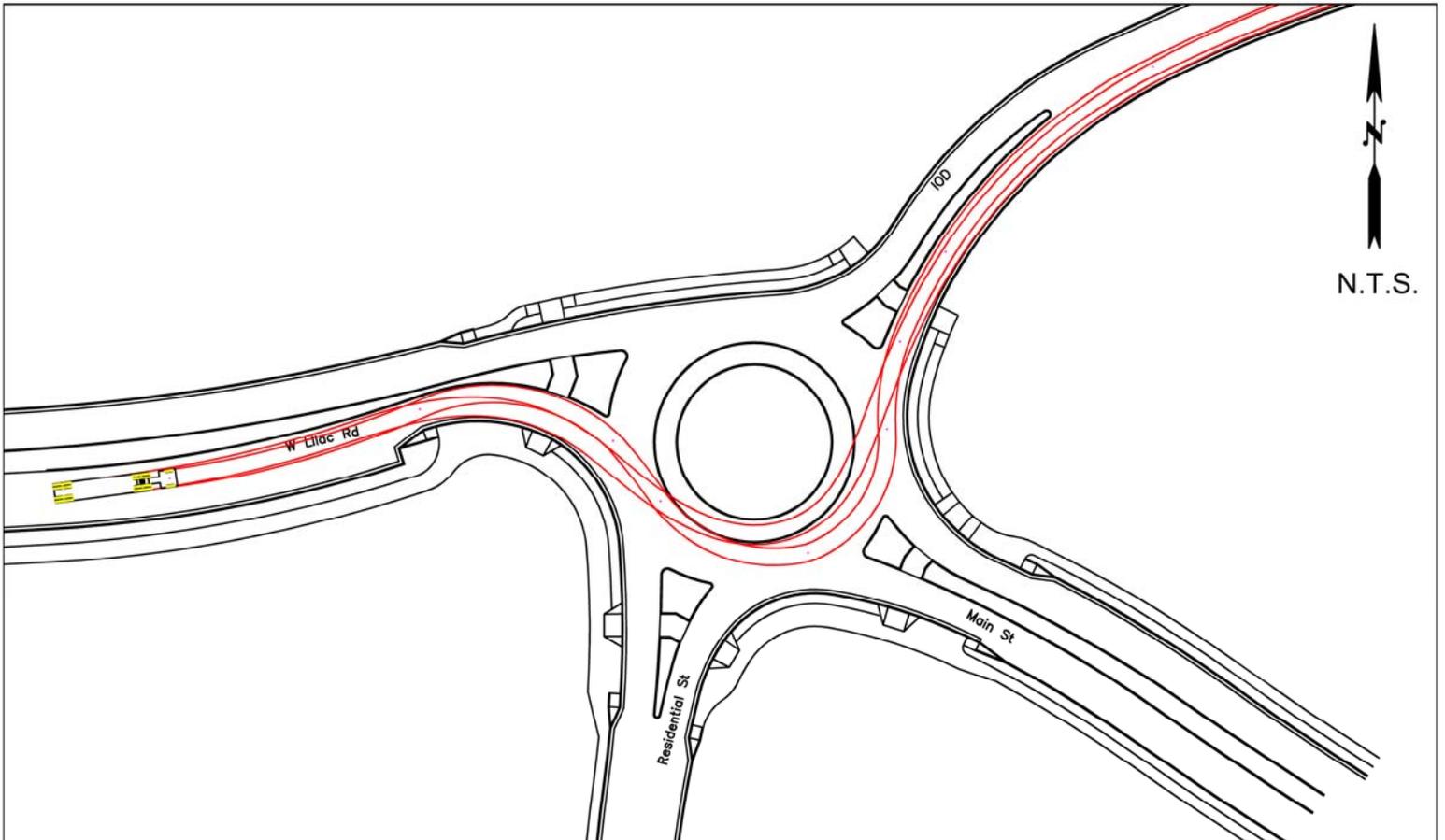
WB-50 Turning Movements



WB-50 Turning Movements



WB-50 Turning Movements



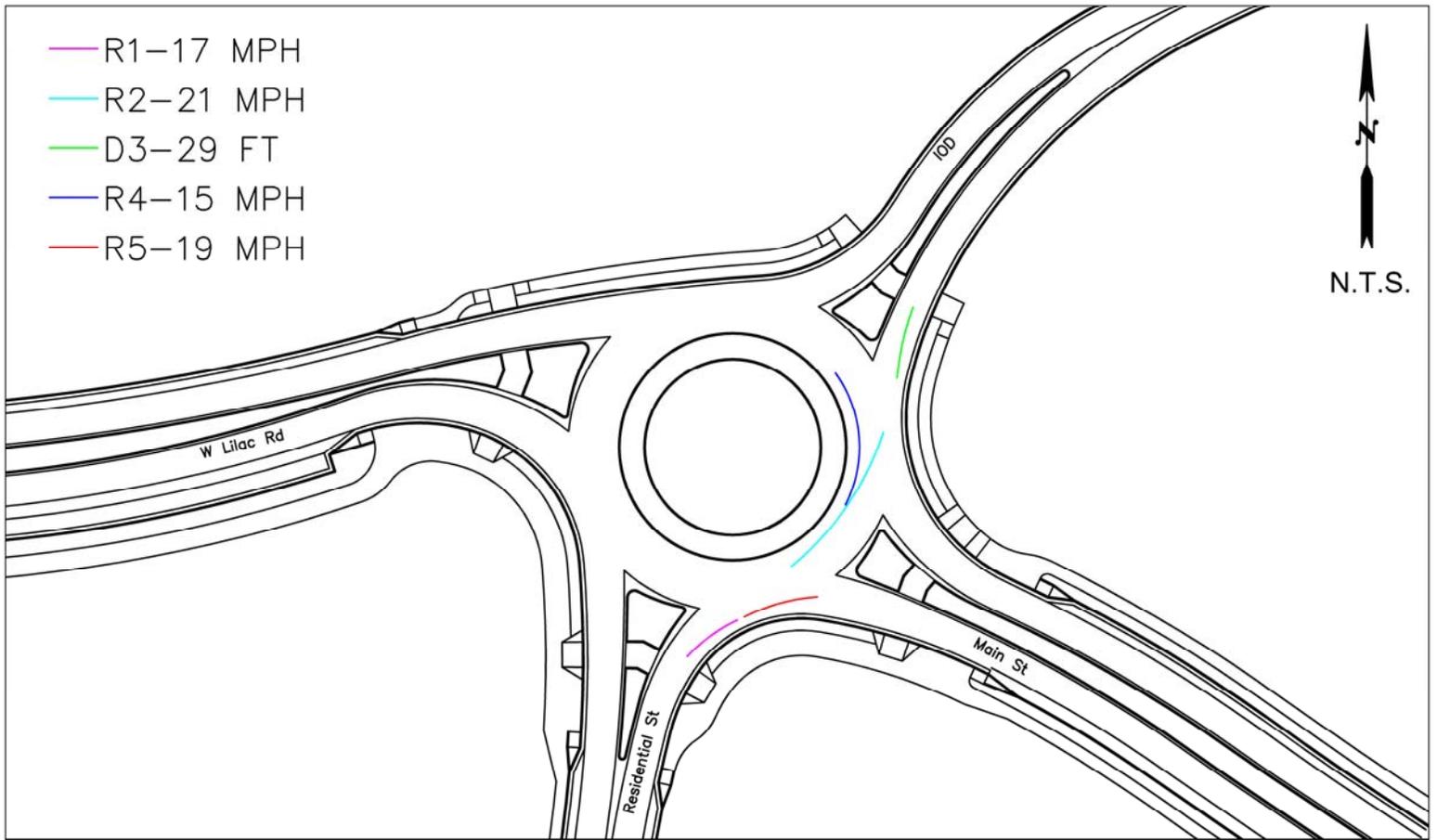
WB-50 Turning Movements

Reid Middleton RB 1 (Alt A) - TRUCK TURNING

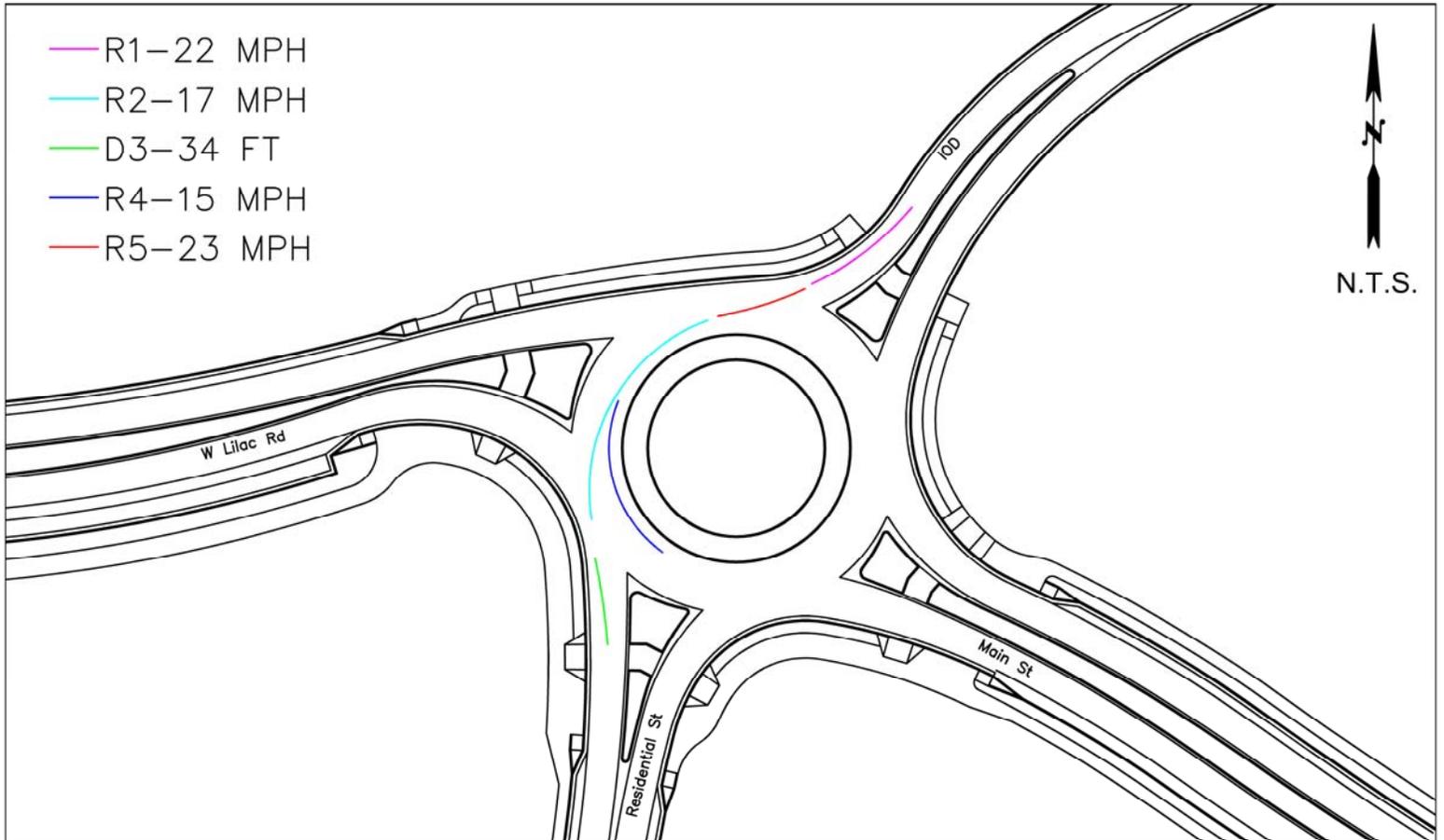
Figure B-13

W Lilac Rd Roundabouts

October 2013



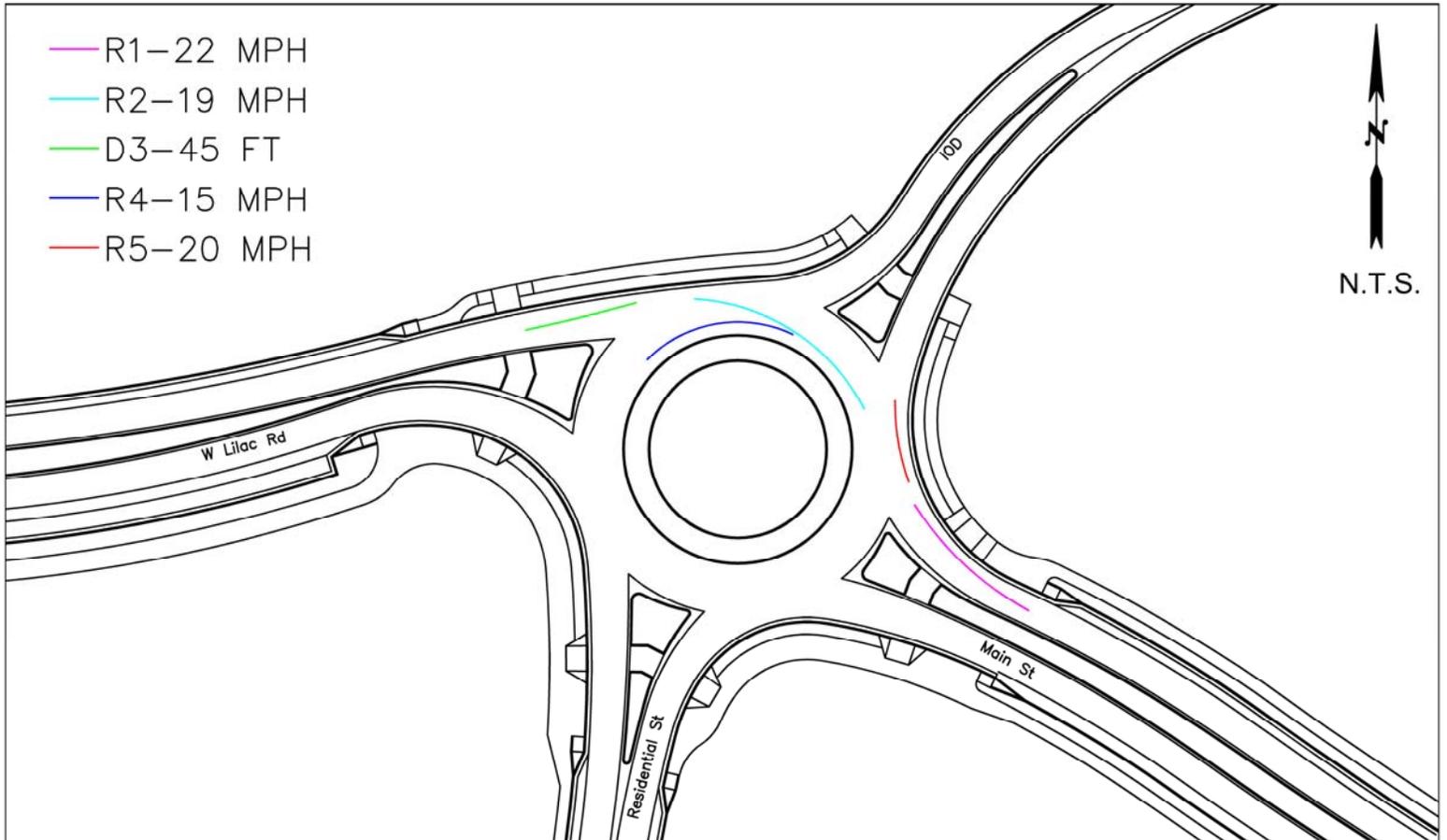
Northbound



Southbound

See Figure B-6 for Eastbound Speed Curves

Eastbound



Westbound

**Reid Middleton RB 1 (Alt A) - Speed Calculations**  
W Lilac Rd Roundabouts  
October 2013

Copied from Roundabout 1

	Northbound		Southbound		Eastbound		Westbound	
	Radius (ft)	Speed (mph)						
R1	64	17	115	22	88	20	123	22
R2	116	21	71	17	140	22	80	19
R3*	-	25	-	23	-	28	-	28
R4	50	15	50	15	50	15	50	15
R5	75	19	127	23	81	19	90	20

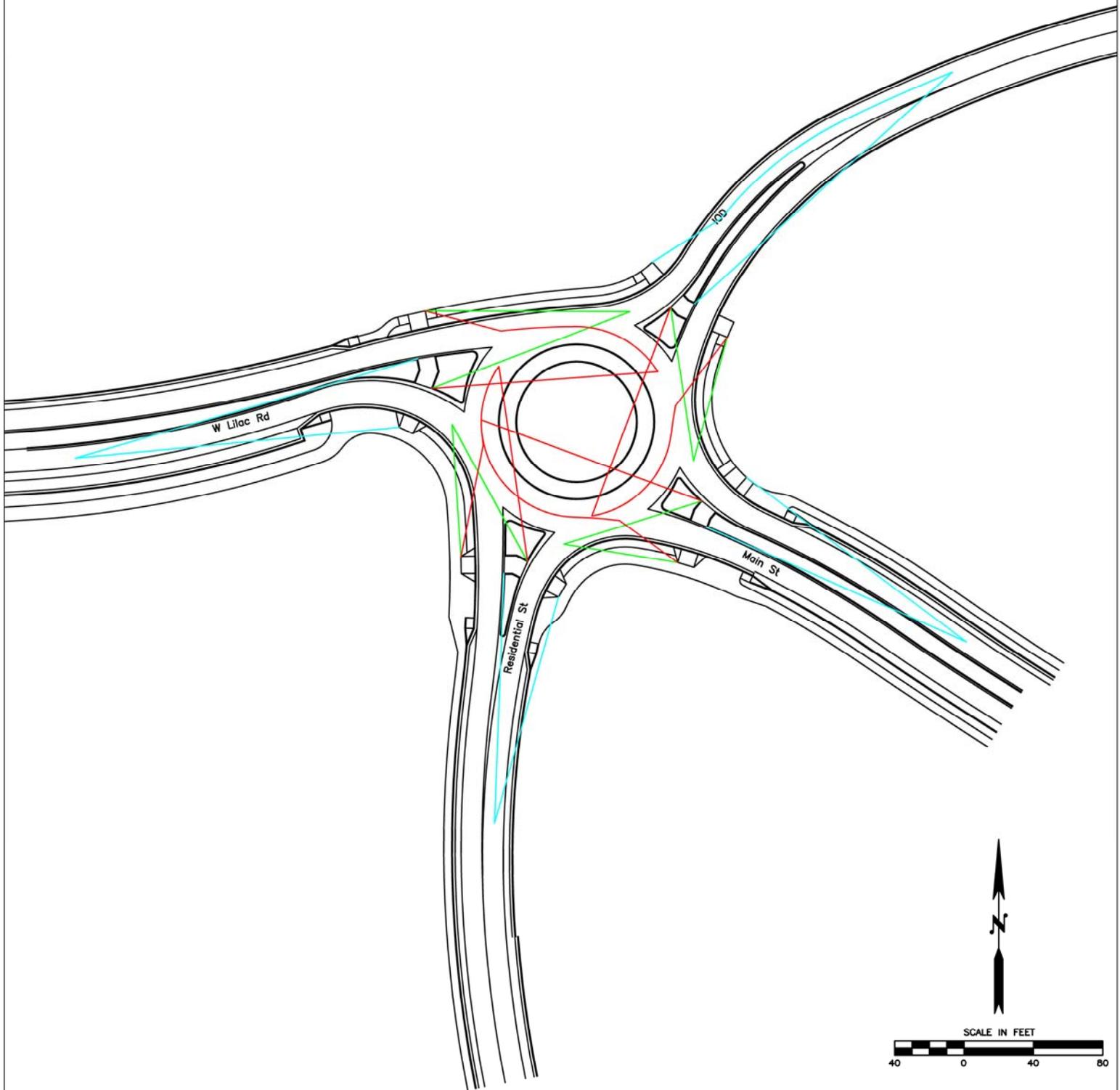
\* R3 speed = lesser of [speed-radius table value] or  $[R2 + \text{Acceleration} * \text{Distance to Crosswalk}]$   
+2% superelevation assumed for R1, R3, and R5 movements  
-2% superelevation assumed for R2 and R4 movements

Calculated R3 Speed from Acceleration and Distance to Crosswalk  
FHWA Acceleration 6.9 ft/sec<sup>2</sup> NCHRP Report 572

	Beginning Speed R2 (MPH)	R2 Speed in FT/SEC	Distance from R2 to Crosswalk (ft)	Approx. Travel Time (sec)	Speed Increase (mph)	Exiting Speed (mph)
Northbound	21	31	29	0.9	4	25
Southbound	17	25	34	1.4	6	23
Eastbound	22	32	41	1.3	6	28
Westbound	19	28	45	1.6	8	27

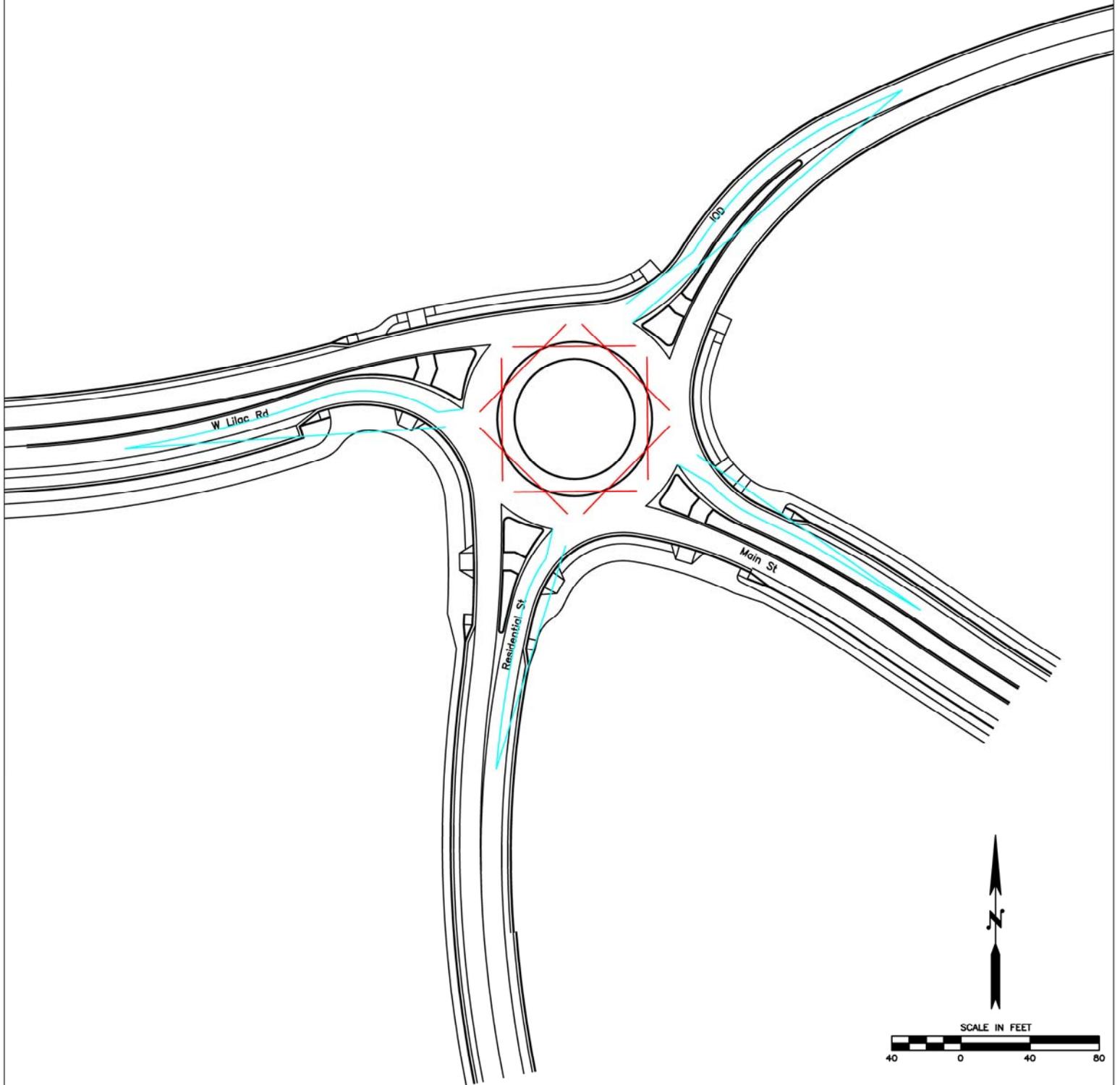
LEGEND:

- Pedestrian Approach Stopping Sight Distance
- Pedestrian Exit Stopping Sight Distance
- Pedestrian Right-Turn Stopping Sight Distance



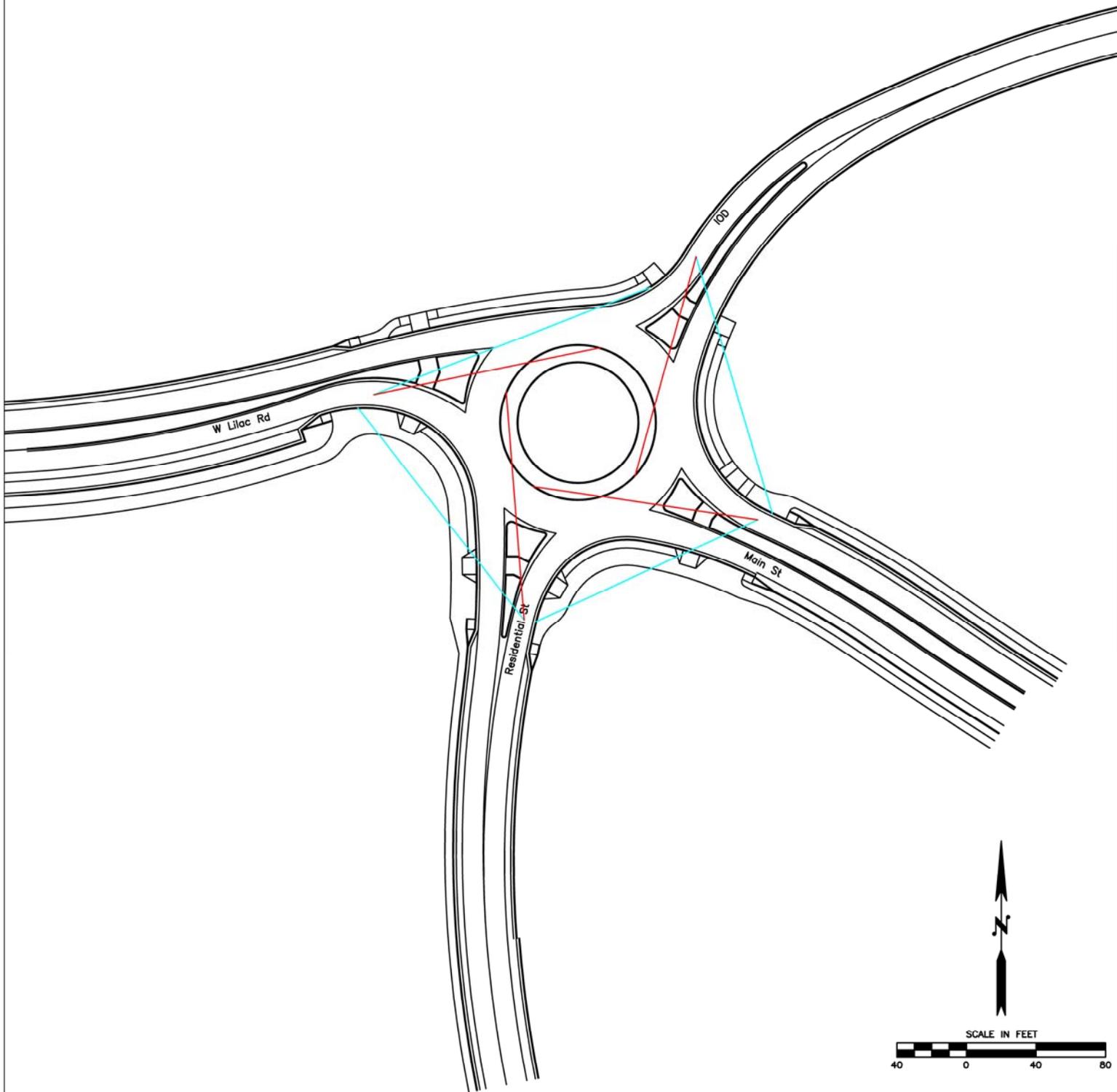
LEGEND:

- Circulating Stopping Sight Distance
- Approach Stopping Sight Distance



LEGEND:

- Circulating Intersection Sight Distance
- Approach Intersection Sight Distance



**Reid Middleton RB 1 (Alt A) - Sight Distance Calculations**  
W Lilac Rd Roundabouts  
October 2013

**Stopping Sight Distance**

$$d = 1.468 * 2.5 * V + 1.087 * V^2 / 11.2$$

**Copied from Roundabout 1**

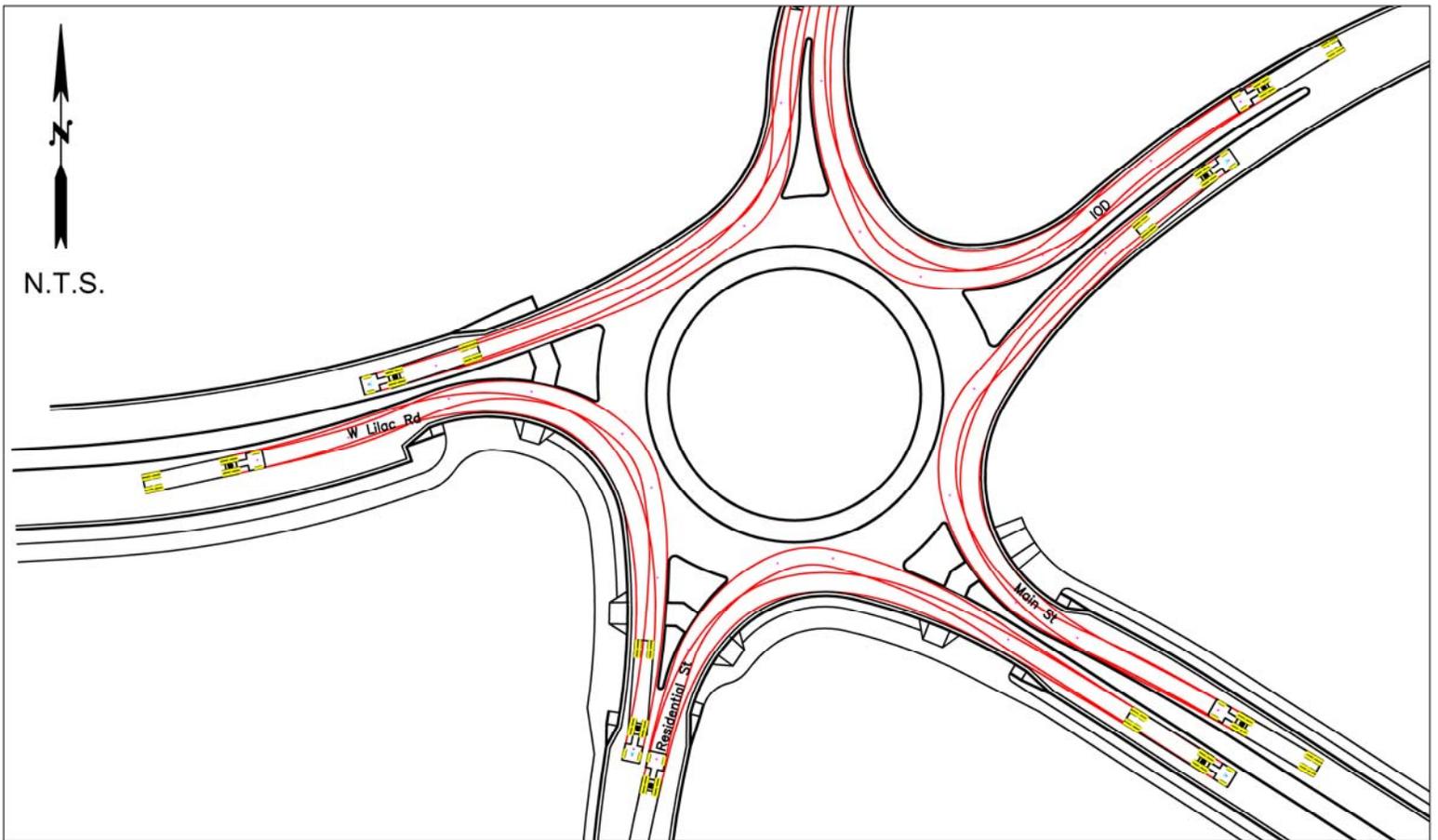
	Posted Speed Limit (mph)	R1 Speed (mph)	Average Approach Speed (mph)	Approach Stopping Sight Distance (ft)	R2 Speed (mph)	R3 Speed (mph)	Average Exit Speed (mph)	Exit Stopping Sight Distance (ft)
Northbound	30	17	24	<b>140</b>	21	25	23	<b>136</b>
Southbound	40	22	31	<b>207</b>	17	23	20	<b>112</b>
Eastbound	40	20	30	<b>197</b>	22	28	25	<b>152</b>
Westbound	30	22	26	<b>161</b>	19	28	24	<b>140</b>

	Circulating Speed (mph)	Circulating Stopping Sight Distance (ft)
Circulating	15	<b>77</b>

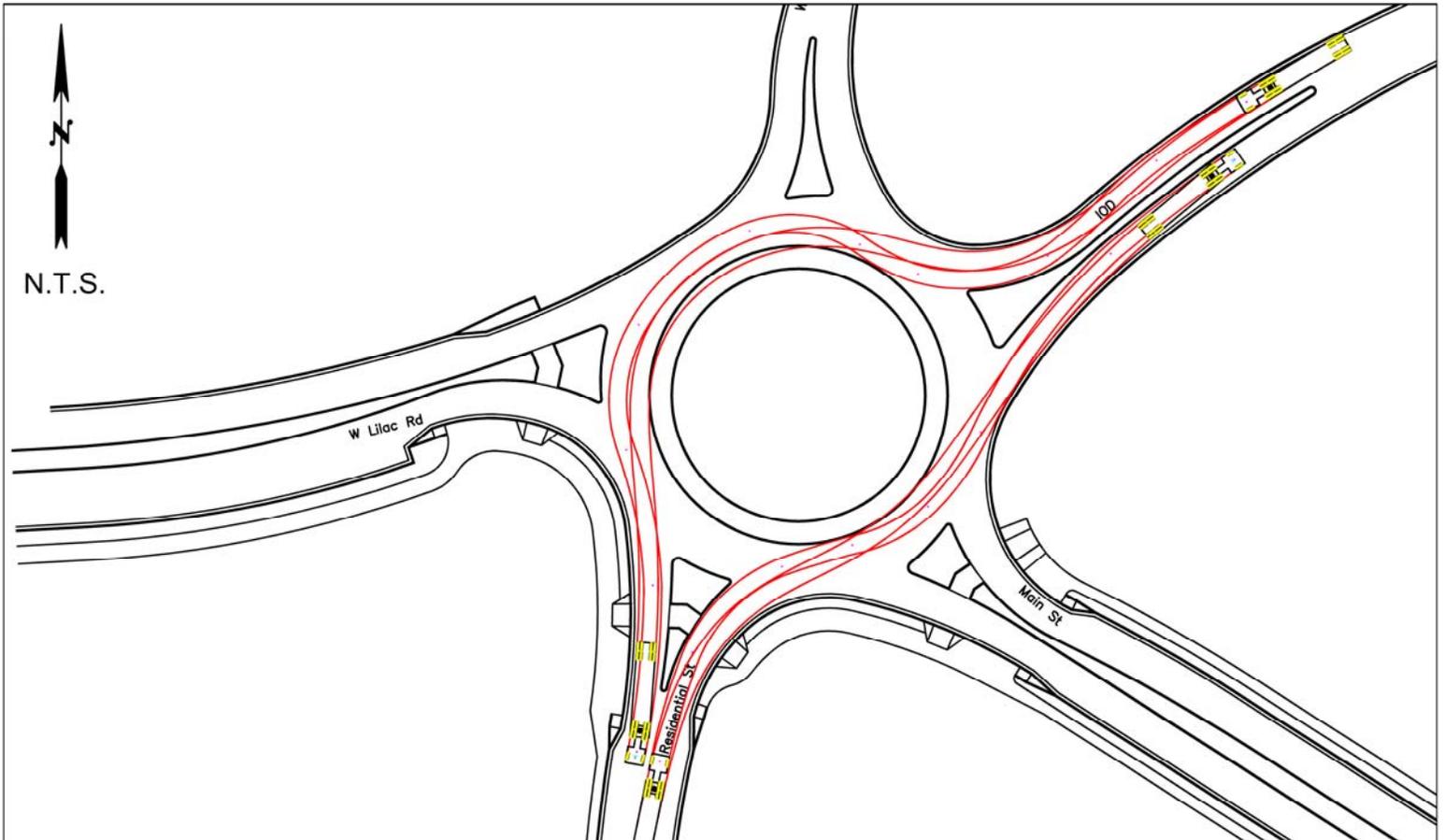
**Intersection Sight Distance**

$$S = 1.468 * V * 5.0$$

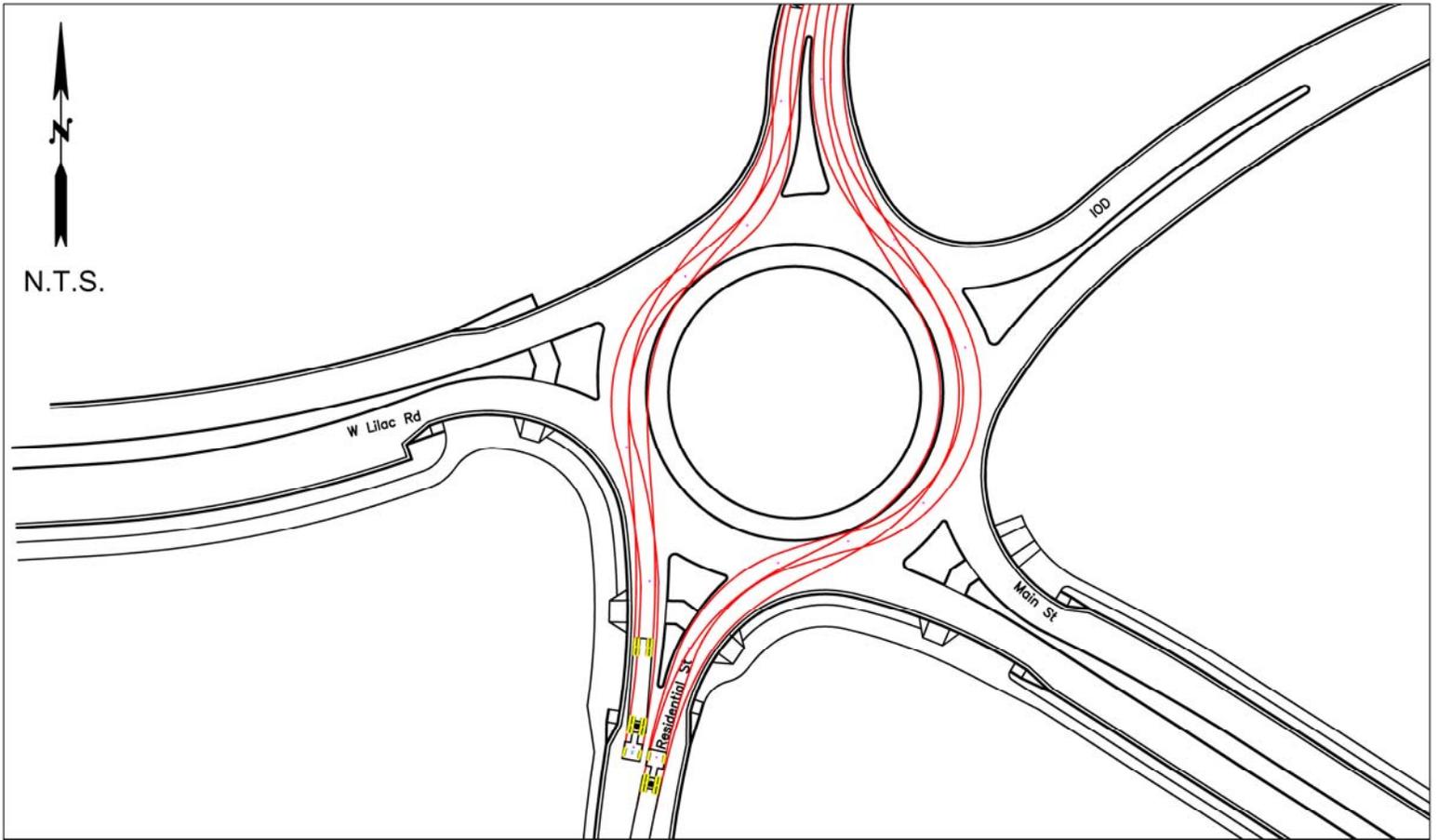
	Adjacent R1 Speed (mph)	Adjacent R2 Speed (mph)	Average Adjacent Entering Speed (mph)	Circulating Stream Speed (mph)	S1 - Entering Intersection Sight Distance (ft)	S2 - Circulating Intersection Sight Distance (ft)
Northbound	20	22	21	15	<b>154</b>	<b>110</b>
Southbound	22	19	21	15	<b>150</b>	<b>110</b>
Eastbound	22	17	20	15	<b>143</b>	<b>110</b>
Westbound	17	21	19	15	<b>139</b>	<b>110</b>



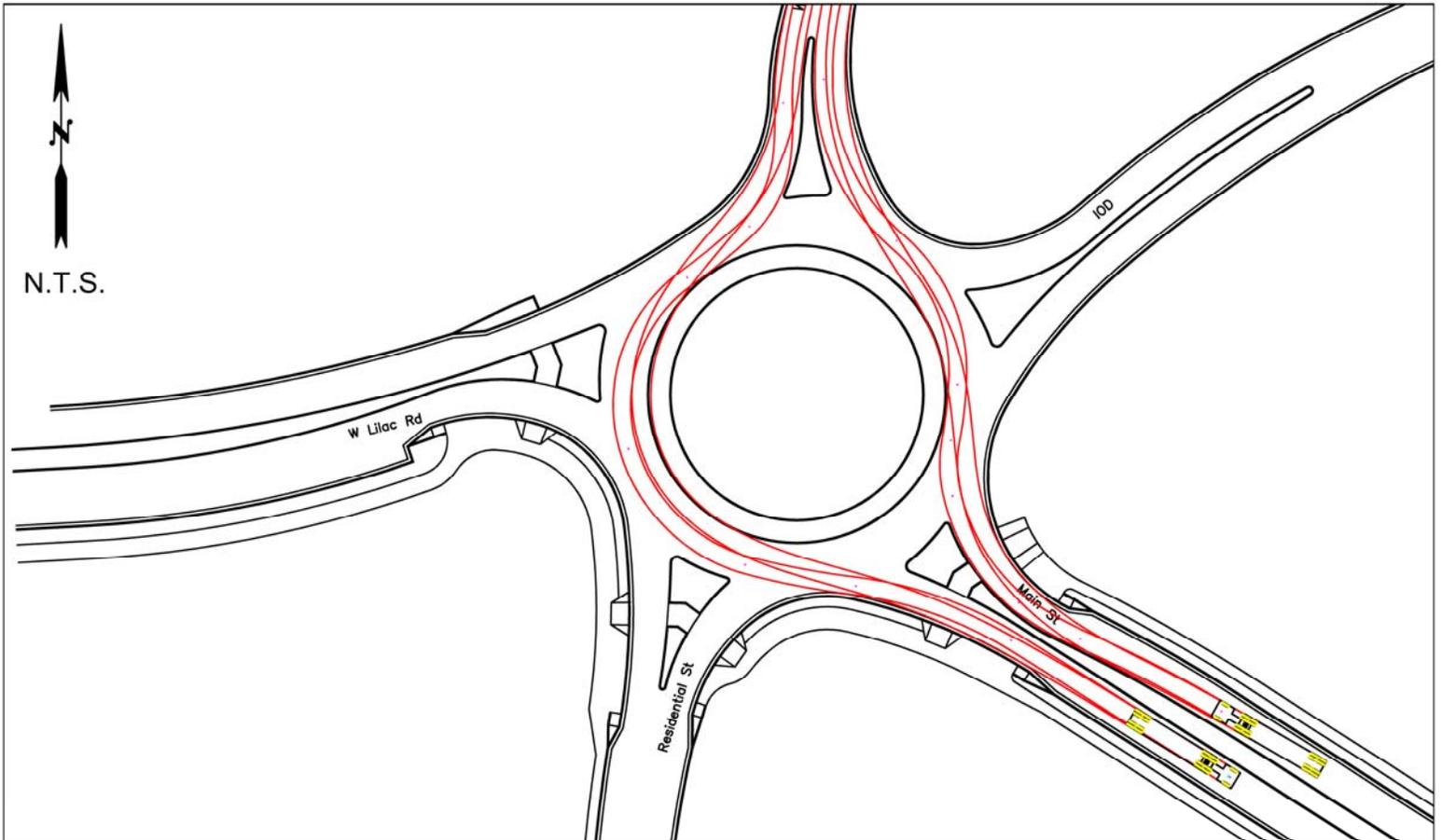
WB-50 Turning Movements



WB-50 Turning Movements



WB-50 Turning Movements



WB-50 Turning Movements