KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING / PLANNING
1850 Centennial Park Drive, Suite 130, Reston, Virginia 20191 P 703-885-8970 F 703-885-8971

TECHNICAL MEMORANDUM

VDOT Central Region On-Call – Task Order 12-039

Roundabout Screening Guidelines

Date:	July 11, 2013	Project #: 11764.8
To:	Mike Clements	
From:	Pete Jenior, Chris Tiesler, and Ed Myers	
cc:	Andy Boenau, Timmons Group	

At a project team meeting at Timmons Group offices in Richmond, VA, on March 14, 2013, attendees agreed that Kittelson & Associates, Inc. (KAI) will develop the following under this task order:

- Screening guidance identifying when roundabouts are or are not feasible
- A planning-level tool such a spreadsheet that compares roundabouts to other forms of intersection control on a case-by-case (i.e. site-specific) basis
- Design guidance for roundabouts

This memorandum presents screening guidance – the first of the three deliverables noted above – in draft form.

INTRODUCTION

Modern roundabouts, which first appeared in the United States in the early 1990s, are becoming an increasingly popular form of intersection control. Roundabouts offer a number of benefits compared to signalized and stop-controlled intersections. Studies have identified a 65% reduction in injury crashes compared to a traffic signal and an 80% reduction in injury crashes compared to two-way stop-control[1,2]. Reductions in pedestrian and bicycle crashes have been observed as well[3]. Roundabouts often operate with less delay and lower volume to capacity ratios than similarly-sized signalized intersections, as drivers may proceed whenever no conflicting vehicles are present. Roundabouts also eliminate the need for traffic signal maintenance and electrical supply when they are used in lieu of a signal. Finally, roundabouts may eliminate the need for lanes, such as left-turn lanes, at an intersection.

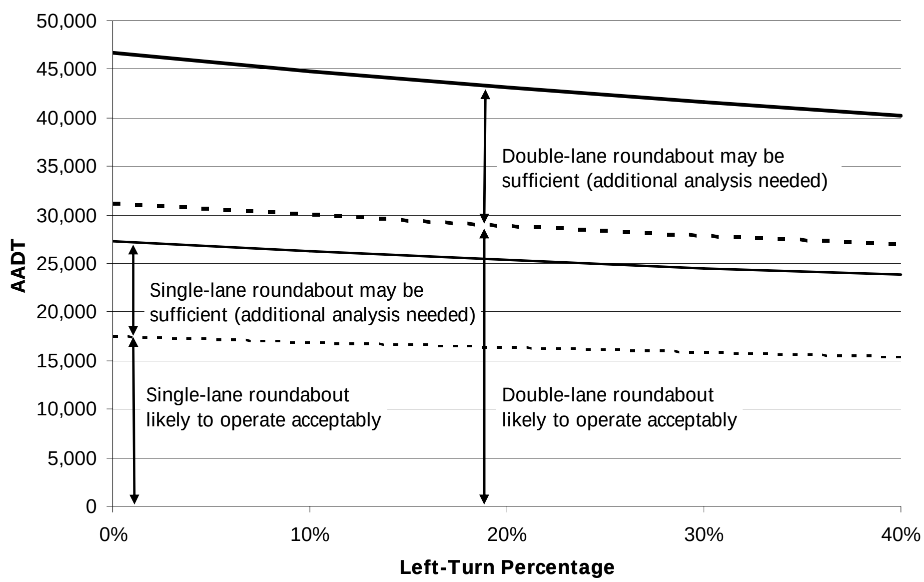
The screening criteria below are intended for use in at an early stage of the planning process for projects involving intersection improvements. The purpose of the criteria is to identify if a roundabout is feasible or not at a given intersection.

SCREENING CRITERIA

Step 1 – Determine Lane Needs

Use Figure 1 below to assess if a single-lane or double-lane roundabout is needed based on AADT and the left-turn percentage of all legs. The vertical axis represents the total AADT of both roads at the intersection. For three leg sites, lane needs may be approximated by using 75% of the service volumes in Figure 1.

Figure 1 – Planning Level Daily Intersection Volumes (NCHRP Report 672 Exhibit 3-12)



Thresholds in Figure 1 include the following assumptions of traffic characteristics:

- Ratio of peak-hour to daily traffic (K) of 0.09 to 0.10
- Direction distribution of traffic (D) of 0.52 to 0.58
- Ratio of minor street to total entering traffic of 0.33 to 0.50
- Acceptable volume-to-capacity ratio of 0.85 to 1.00

If conditions at a study intersection are believed to significantly differ from these assumptions, it is recommended that peak hour turning movement counts be obtained and the intersection be analyzed using the procedure in Chapter 21 of the Highway Capacity Manual (HCM) 2010 using Highway Capacity Software (HCS) or Sidra, both of which faithfully implement the HCM 2010 procedure.

Figure 1 is intentionally limited to one- and two-lane roundabouts. A handful of the 2,500+ roundabouts in the United States have three lanes, although there are none in Virginia. Some three-lane roundabouts are retrofits of three-lane traffic circles, expansions of older two-lane roundabouts, or only have three lanes on one entry. While three-lane roundabouts may be appropriate in some cases, there is minimal planning-level guidance available for them. Traffic analysis of three-lane roundabouts exceeds limits of current methodologies, and usually requires a more rigorous and detailed evaluation through microsimulation.

Step 2 - Right-of-Way

Based on lane needs identified in Step 1, determine the approximate footprint of the roundabout. Table 1 lists typical ranges of inscribed circle diameter (ICD). The ICD is the distance across the circle inscribed by the outer curb (or edge) of the circulatory roadway; it includes the central island, truck apron, and circulatory roadway. Mini-roundabouts are a special subset of roundabouts that feature fully traversable central islands and in some cases fully traversable splitter islands. They are best suited for low speed, constrained environments.

Table 1 – Typical Ranges of Inscribed Circle Diameters (adapted from NCHRP Report 672 Exhibit 6-9)

Roundabout Configuration	Typical Design Vehicle	Common Inscribed Circle Diameter Range*
Mini-Roundabout	SU-30	45 to 90 ft
Single-Lane Roundabout	B-40	90 to 150 ft
	WB-50	105 to 150 ft
	WB-67	130 to 180 ft
Multilane Roundabout (2 lanes)	WB-50	150 to 220 ft
	WB-67	165 to 220 ft
Multilane Roundabout (3 lanes)	WB-50	200 to 250 ft
	WB-67	220 to 300 ft

* Assumes 90-degree angles between entries and no more than four legs. List of possible design vehicles not all-inclusive.

With the range of the ICD known, the approximate magnitude of the roundabout and associated impacts can be initially judged from an aerial photo or plan sheet, as illustrated below in Figure 2.

Figure 2 – Example of Approximate Impacts of a Single-Lane Roundabout with WB-67 Design Vehicle

The footprint and associated impacts should be assessed at a similar level for signalized and stop-controlled alternatives to allow for a comparison between the control types. The following items should be considered for all alternatives:

- Right-of-way
- Potential impacts to wetlands, historic properties, Section 4(f) properties, or other environmental resources
- Potential impacts to drainage structures, utilities, or other existing infrastructure
- Topography and grading needs

A roundabout may be infeasible if it has substantially greater impacts or costs compared to other alternatives for any of the items noted above.

Step 3 - Network Interactions

A planning-level assessment of network interactions is necessary when the study intersection is in close proximity to other intersections.

Roundabouts generally have shorter queue lengths than signalized intersections because they process vehicles whenever a gap in traffic is available rather than holding them for the duration of a red interval. Roundabouts operate most efficiently when vehicles within the circulatory roadway keep moving and do not stop, which would block entries. Likewise, signalized intersections operate most efficiently when drivers do not stop within the intersection and block of the flow of traffic on the cross street. Ideally, both roundabouts and signals should be located in places where they are not subject to queue spillback from adjacent intersections. However, this is sometimes not possible due to existing land uses and the road network that is in place.

If queue spillback between adjacent intersections (signalized or roundabout-controlled) is forecast to occur, the frequency and duration of spillback should be determined and compared to the forecast spillback of a traffic signal queue. A roundabout should not be deemed infeasible at this stage in the project planning process because occasional queue spillback may be offset by other considerations. For example, a roundabout may provide reduced delay and improved safety compared to a traffic signal over the entire lifespan of an intersection, and 95th percentile queue spillback may occur with either a traffic signal or roundabout during a peak hour in the latter years of an intersection's lifespan.

Roundabouts are feasible on corridors with coordinated signal systems. Roundabouts may be particularly desirable at intersections:

- On corridors with a low percentage of through trips and a high percentage of turning traffic
- Sufficiently far from signalized intersections such that platoons are dispersed and there is limited ability to progress traffic
- Where safety improvements are desired
- Where community enhancement is desired
- Where traffic calming and reduced speeds are desired
- Where there is a need for u-turns
- Where unusual geometry creates design and signal phasing challenges
- At the endpoint of a coordinated signal system

For a new facility or a substantially rebuilt facility, a corridor of roundabouts may be considered in addition to a coordinated signal system.

NEXT STEPS

If a roundabout is considered feasible, it should be advanced through the project planning process with other alternatives. Typically, the next steps would be peak hour traffic analysis and development of a sketch-level concept design to further investigate right-of-way needs, costs and potential impacts.

If a roundabout is not considered feasible, it should be dropped from further consideration.

REFERENCES

1. Gross, F., C. Lyon, B. Persaud, R. Srinivasan. "Safety Effectiveness of Converting Signalized Intersections to Roundabouts", Presented at the 91st Annual Meeting of the Transportation Research Board, Washington, D.C., January 22 - 26, 2012.
2. Rodegerdts, L., J. Bansen, C. Tiesler, J. Knudsen, E. Myers, M. Johnson, M. Moule, B. Persaud, C. Lyon, S. Hallmark, H. Isebrands, R. B. Crown, B. Guichet, and A. O'Brien. *NCHRP Report 672:*

Roundabouts: An Informational Guide, 2nd ed. Transportation Research Board of the National Academies, Washington, D.C., 2010.

3. Persaud, B., R. Retting, P. Garder, and D. Lord. "Crash Reductions Following Installations of Roundabouts in the United States." Insurance Institute for Highway Safety, Arlington, VA. March. 2000