

ROUNDBOUTS: INTERIM REQUIREMENTS AND GUIDANCE

June 30, 2000



<u>Content</u>	<u>Page</u>
1.0 BACKGROUND	2
2.0 PROJECT SCOPING	3
2.1 Appropriate Applications	3
2.1.1 Improvement of Intersection Capacity	3
2.1.2 Reduction of Queue Storage Requirements	3
2.1.3 Accommodation of Unusual Intersection Geometries	3
2.1.4 Reduction of Accidents	4
2.1.5 Controlled Access (Raised Median) Locations	4
2.1.6 Traffic Calming	4
2.1.7 Aesthetics	4
2.2 Site Requirements	5
2.2.1 Terrain	5
2.2.2 Capacity Limitations	5
2.2.3 Adjacent Intersections and Highway Segments	5
2.2.4 Entry Volume Balance	6
2.2.5 Approach Alignment	6
2.2.6 Pedestrian & Bicyclists	6
2.2.7 Transit	7
2.2.8 Signs, Delineation, and Pavement Markings	7
2.2.9 Social, Environmental, and Economic Considerations	7
2.3 Coordination	7
3.0 GEOMETRIC DESIGN ELEMENTS	8
3.1 Design Criteria	8
3.1.1 Approach Highways and Right-Turn-Bypass Lane Design Criteria	8
3.1.2 Roundabout Design Criteria	8
3.2 Other Design Elements	11
3.3 Capacity Analysis	12
4.0 DESIGN STAGE	13
5.0 CONSTRUCTION STAGE	13
6.0 OPERATIONS AND MONITORING	13
7.0 REFERENCES	14

1.0 BACKGROUND

The modern roundabout is a type of circular intersection that has been successfully implemented in Europe and Australia over the past few decades. Despite the tens of thousands of roundabouts in operation around the world, there are only a few hundred in the United States. Until recently, roundabouts have been slow to gain support in this country. The lack of acceptance can generally be attributed to the negative experience with traffic circles or rotaries built in the earlier half of the twentieth century. Severe safety and operational problems caused these traffic circles to fall out of favor by the 1950's. However, substantial progress has been achieved in the subsequent design of circular intersections, and a modern roundabout should not be confused with the traffic circles of the past.

The modern roundabout is defined by three basic principles that distinguish it from a traffic circle.

1. Modern roundabouts follow the "yield-at-entry" rule in which approaching vehicles must wait for a gap in the circulating flow before entering the circle. Many traffic circles in the United States require circulating vehicles to grant the right of way to entering vehicles though few, if any, of these type circles exist in New York State. Some traffic circles also use stop signs or signals to control vehicle entry.
2. Modern roundabouts involve low speeds for entering and circulating traffic, as governed by small diameters and deflected entrances. In contrast, traffic circles emphasize high-speed merging and weaving, made possible by larger diameters and tangential entrances.

Adequate deflection of the vehicle entering a roundabout is the most important factor influencing their safe operation. Roundabouts should be designed so that the speed of all vehicles is restricted to 50 km/h or less within the roundabout. This is done by adjusting the geometry of the entrance alignment, splitter island, center island, and exit alignment to ensure that "through" vehicle paths are significantly deflected.

In giving priority to entering vehicles, a traffic circle tends to lock up at higher volumes. The operation of a traffic circle is further compromised by the high speed environment in which large gaps are required for proper merging. These deficiencies have been essentially eliminated with the modern roundabout designs.

The number of roundabouts constructed in the U.S. is relatively small. Those that are currently in operation have been reported to be performing favorably, when compared with conventional controlled intersection (i.e., stop signs or signals), in terms of shorter delays, increased capacity, improved safety, and improved aesthetics. Early results generally indicate that roundabouts have resulted in an overall reduction in the number and severity of accidents,

despite the initial concern that lack of familiarity with this type of intersection would lead to driver confusion.

The Federal Highway Administration (FHWA) has finalized "Roundabouts: An Informational Guide." Additionally, information on roundabouts will be introduced in the upcoming edition of AASHTO's "A Policy on Geometric Design of Highways and Streets."

The Department has formed a Modern Roundabout Committee to identify issues associated with Roundabouts and develop and progress action plans to address these issues. Also, the committee will develop a Department policy and guidance document on Roundabouts. This committee is comprised of representatives from FHWA, and Regional and Main Office functional areas.

2.0 PROJECT SCOPING

2.1 Appropriate Applications

Roundabouts should be constructed for the primary purpose of improving operations and/or safety at intersections. They may also be considered for traffic calming or aesthetic reasons. Prime candidates for implementing modern roundabouts are areas of existing traffic circles. Examples of appropriate uses for roundabouts are in the following subsection.

2.1.1 Improvement of Intersection Capacity

When considering methods to increase the capacity of an intersection, the use of a roundabout may be a preferable alternative to stop signs or traffic signals. With conventional types of traffic controls, only alternating streams of vehicles are permitted to proceed through the intersection at one time, causing a loss of capacity to occur when the intersection clears between phases. In contrast, the only restriction on entering a roundabout is the availability of gaps in the circulating flow. The slow speeds within the circulating roadway allow road users to safely select a gap that is relatively small. Pedestrians are safely accommodated since the vehicular speeds are slower and crossing tasks are simpler (as a result of the refuge area in the splitter islands). By allowing vehicles to enter simultaneously from multiple approaches using short headway, and eliminating the need for a separate pedestrian signal phase, a possible advantage in capacity can be achieved with a roundabout. This advantage becomes more prominent when the volumes of left or right turning movements are relatively high.

2.1.2 Reduction of Queue Storage Requirements

Roundabouts can produce operational improvements in locations where the space available for queuing is limited. Roads are often widened to create storage for vehicles waiting at traffic signals, but the reduced delays and continuous flows at roundabouts allow the use of fewer lanes between intersections. Possible applications may be found at existing diamond interchanges, where high left turn volumes can cause the signalized intersection to fail. By constructing a pair of roundabouts at the ramp intersections, capacity improvements to the interchange can be accomplished without the costly requirement of widening the structure to carry additional lanes over or under the freeway.

2.1.3 Accommodation of Unusual Intersection Geometries

Conventional forms of traffic control are often less efficient at intersections with a difficult skew angle, a significant offset, an odd number of approaches, or close spacing. Roundabouts may be better suited for such intersections because they do not require complicated signing (though still critical to the design) or signal phasing. Their ability to accommodate high turning volumes make them especially effective at "Y" or "T" junctions. Roundabouts may also be useful in eliminating a pair of closely spaced intersections by combining them to form a multilegged roundabout.

2.1.4 Reduction of Accidents

At some locations, a roundabout can provide a possible solution for high accident rates by reducing the number of conflict points at which the paths of opposing vehicles intersect. For example, many accidents at conventional intersections occur when a driver either (1) misjudges the distance or speed of approaching vehicles while making a left turn, or (2) causes a right angle collision after violating a red light or stop sign. Such accidents would be eliminated with a roundabout where left turns and crossing movements are prohibited. Furthermore, collisions at roundabouts would involve low speeds and low angles of impact, and therefore, are less likely to result in serious injury for the road users involved. Refer to Section 5.3 of FHWA's "Roundabouts: An Informational Guide" for information on crash statistics.

2.1.5 Controlled Access (Raised Median) Locations

Depending on the specific site conditions, the introduction of roundabouts may be possible in situations where access needs to be controlled via raised medians. Roundabouts would facilitate left turns and U-turns to access properties on the opposite side of the highway. Improved access via roundabouts might reduce opposition to left turn restrictions.

2.1.6 Traffic Calming

At some locations, a roundabout may present a solution to a demonstrated need for traffic calming along the intersecting roadways. Roundabouts encourage vehicular traffic speed reduction/consistency, resulting in a traffic calming effect that results in a more balanced operating environment for all road users. Highway Design Manual (HDM) Chapter 25 should be referenced for additional traffic calming measures.

Roundabouts for traffic calming purposes should generally be located on local roads, in residential areas. However, collector roads can also benefit from the localized speed reduction created by a roundabout. As shown in HDM Chapter 25, Table 25-1, roundabouts for traffic calming on arterial highways are generally not recommended, but may be acceptable on a case by case basis.

2.1.7 Aesthetics

Although aesthetics are not a primary consideration when assessing the viability of roundabouts at particular intersections, it may impact public acceptance of such a facility and the overall ambience of the local environment.

2.2 Site Requirements

The following requirements should be considered when determining whether a proposed site is suitable for a roundabout:

2.2.1 Terrain

Roundabouts should be considered only in areas that can accommodate an acceptable outside diameter and other appropriate geometric design elements (see Section 3.1 of this document). To limit the earthwork needed to provide adequate drainage, cross slopes, and sight distance, roundabouts should preferably be located on relatively level terrain.

2.2.2 Capacity Limitations

For proposed roundabout sites, an analysis of traffic volumes and turning movements should be conducted to determine whether the roundabout would reduce delay more than another form of traffic control or operational improvement (see Section 3.3 of this document). Although modern roundabouts have only recently begun to appear in the U.S., the British and other European countries have reportedly experienced resounding success with the implementation of modern roundabouts. Unfortunately, there is a lack of U.S. empirical data confirming the

European experience. Until further data is available, roundabouts should be considered only at intersections where projected circulating volumes generally do not exceed 6,000 vehicles per hour.

The design of a roundabout should be based on estimated traffic 20 years after the estimated time of completion (ETC) of construction. ETC+10 traffic projections may be used for comparison with alternative signalized intersection projects and for initial layout. However, ETC+20 should be the basis for the full build alternative regardless of whether the proposal involves a new facility or an operational improvement. ETC+30 should be considered if the roundabout is near a bridge that is included in the project or programmed for future work. When costs are used to compare alternatives, the life cycle costs are to be used.

2.2.3 Adjacent Intersections and Highway Segments

Consideration should be given to the interactive effects between a proposed roundabout and the adjacent intersections. Roundabouts are not suitable in areas with a coordinated traffic signal system, because such systems break down when the progression of platoons is disrupted by the unregulated movement through a roundabout. Similarly, a roundabout should not be constructed at a location where the flow of vehicles leaving the intersection would be obstructed by queues from downstream traffic controls.

Conventional traffic controlled intersections provide alternating traffic streams and gaps which facilitate driveway access (mid-block left turns). The potential loss of this benefit by installing a roundabout should be carefully analyzed.

2.2.4 Entry Volume Balance

Careful capacity analysis should be performed at intersection locations where entry flows are unbalanced. When the volume on the major road is much heavier than that on the minor road, the equal treatment of approaches may increase delay to the major road. Also, if the major road carries a heavy stream of through traffic, the lack of adequate gaps in the dominant flow may deter the minor flow from entering the roundabout. See section 3.3 Capacity Analysis for information regarding gaps and how they are considered in design.

2.2.5 Approach Alignment

The alignment of the approach roadway must enable the development of an acceptable entry deflection without the creation of severe horizontal curvature or poor stopping sight distance. To determine if an acceptable approach geometry can be established, the centerline of the approach roadway should be projected across the roundabout. The projected centerline should intersect, or be to the left of, the center of the proposed roundabout. For additional

information on approach alignment and a graphic of this criteria, refer to Section 6.2.4 of the FHWA "Roundabouts: An Informational Guide."

Rumble strips and/or warning signals may be considered on high speed approaches (i.e., speed of 80 km/h or greater) to help slow motorists. Additionally, a series of reverse curves may be used as nonstandard features to help transition speeds below 80 km/h before the roundabout entry deflection. In such cases, the safe operating speed of each successive curve should not be reduced by more than 20 km/h from the safe operating speed of the previous curve or the 85th percentile speed of the approach highway section. The use of such nonstandard features may not diminish, but actually enhance the function and safety of the roundabout.

2.2.6 Pedestrian & Bicyclists

Roundabout design on unlimited access highways should anticipate the needs of pedestrians and bicyclists. Therefore, pedestrian and bicyclist activity must be considered when scoping and designing a roundabout. Several studies have indicated that roundabouts result in fewer pedestrian accidents when compared to signalized and unsignalized intersections. In most circumstances, roundabouts provide satisfactory operations for bicyclists, however, a separate bicycle path or multiuse path should be considered at multilane roundabouts, especially in areas with high bicycle volumes. Roundabouts present special challenges for the elderly and persons with disabilities (especially the blind). Blind pedestrians have difficulty locating crossings and determining crossing gaps. Refer to FHWA's "Roundabouts: An Informational Guide" for a detailed discussion of the pedestrian and bicyclist considerations.

2.2.7 Transit

Transit considerations at a roundabout are similar to those at a conventional intersection. If the roundabout is proposed along a bus route, the roundabout should be designed to accommodate a bus design vehicle without the need to use a truck apron. Bus stops should be located carefully to minimize the probability of vehicle queues spilling back into the circulatory roadway. This typically means that bus stops located on the far side of the intersection need to have pullouts or be further downstream from the splitter island. Pedestrian access routes to transit should be designed for safety, comfort, and convenience. Pedestrian crossing capacity should be accounted for if demand is significant, such as near a station or terminus.

2.2.8 Signs, Delineation, and Pavement Markings

Chapter 7 of the FHWA's "Roundabouts: An Informational Guide" contains typical signing and pavement marking layouts. In general, the yield line and any crosswalks are to be delineated. Concentric striping within the circulating roadway is not permitted (with the exception of intermittent concentric striping near splitter islands). Additionally, traffic signals are not to be

installed on the roundabout legs. When traffic signals are necessary, a signalized intersection should be used instead of a roundabout.

Until sign and pavement marking guidelines for roundabouts are developed by the Department, designers should contact the Main Office Traffic Operations Bureau for design assistance.

2.2.9 Social, Environmental, and Economic Considerations

Consideration should be given to the social, environmental and economic impacts when planning to implement a modern roundabout. Refer to DPM Appendix A for a summary of social, economic, and environmental considerations.

2.3 Coordination

Early coordination with the Design Quality Assurance Bureau's (DQAB's) Region Liason Engineer during the Project Scoping Stage is suggested to determine whether a roundabout should be included as a considered alternate. This should be done prior to any planning level coordination with outside agencies and elected officials.

To minimize public opposition, special emphasis should be placed on educating the public about the differences between roundabouts and traffic circles. Brochures, videotapes, and mass media can be used during the scoping, design, and construction stages to improve public perception and educate drivers.

3.0 GEOMETRIC DESIGN ELEMENTS

3.1 Design Criteria

Design criteria must be established for the approach highways, roundabout, and any right-turn-bypass lanes. When the proposed design will not meet any of the critical design elements, a nonstandard feature justification shall be prepared in accordance with HDM Section 2.8 and approved in accordance with the TEA-21 matrix in the Design Procedure Manual (DPM).

Figure 1, on page 15, graphically shows many of the following critical design elements. Refer to FHWA's "Roundabouts: An Informational Guide" for a detailed description and other figures.

3.1.1 Approach Highways and Right-Turn-Bypass Lane Design Criteria

The Design Approval Document must contain a list of critical design elements must be provided in a table for the approach highways and right-turn-bypass lanes. The critical design elements are to be established using NYSDOT HDM Chapter 2.

The design criteria table shall include the existing value, criteria value (or range of values), and the proposed value for each critical design element. At least two sets of criteria will generally be needed for the approach highways. For example, a typical roundabout project will require design criteria for the north/south highway and for the east/west highway.

3.1.2 Roundabout Design Criteria

The following critical design elements must be included in a design criteria table for a proposed roundabout. The table shall include the criteria value (or range of values), existing values if a traffic circle currently exists, and the proposed value for each critical design element.

- a. Maximum Entry Speed - The maximum entry speed is 50 km/h. The basic principle of roundabout design is to restrict the operating speed within the intersection by deflecting the paths of entering and circulating vehicles. The vehicle path should be determined by finding the fastest path (i.e., a racing line) through the roundabout while maintaining a 1 m offset to curb, edge of pavement, and centerline. Safety and capacity benefits can be fully achieved only if vehicles are physically unable to traverse the roundabout at speeds higher than 50 km/h.
- b. Maximum Entry Superelevation - The maximum entry superelevation is 5.0%.
- c. Effective Flare Length - A flare may be used to increase the entry width and capacity of a roundabout by providing additional lanes at the entry. The effective flare length is equal to the distance from the entry width to a point where the approach width is equal to half the sum of the entry width and the approach traveled way width prior to influence from the roundabout. Where flaring is used, an effective flare length of 12.5 m to 100 m should be used in urban areas and 20 m to 100 m should be used in rural areas. 30 m is preferred in both urban and rural areas.
- d. Minimum Entry Lane Width - The minimum entry lane width is 3.0 m, measured between lane markings and/or the curb(s) along the entry width, as defined below.
- e. Maximum Entry Width - The entry width is the perpendicular distance from the right curb line of the entry to the point where the left edge line or curb intersects the yield line (inscribed circle). A flare may be used to increase the entry width and capacity of a roundabout by providing additional lanes at the entry. Because flared entries tend to increase the potential for accidents, they should be used only when required by traffic

volumes. The maximum width for single lane approaches is 10.5 m. The maximum width for two lane approaches is 15.0 m.

- f. **Entry Radius** - The entry radius is the minimum radius of curvature for the compound curve measured along the right curb at entry beginning before the yield line. The entry radius shall be from 10 m (6 m no trucks) to 100 m. The practical entry radius is approximately 20 m. Smaller radii may decrease capacity, while larger radii may cause inadequate entry deflection. Refer to section 3.2(c) of this document for further layout guidance.
- g. **Entry Angle** - To provide the optimum deflection for entering vehicles, the angle of entry shall be from 20E to 60E and desirably from 30E to 40E degrees. Smaller angles reduce visibility to the driver's left, while larger angles cause excessive braking on entry and a resulting decrease in capacity.
- h. **Approach Stopping Sight Distance** - The approach stopping sight distance is the minimum stopping sight distance to the back of queue or yield line at the roundabout entry. Determine this distance by using Section 6.3.9 of the FHWA "Roundabouts: An Informational Guide".
- i. **Intersection Sight Distance** - The intersection sight distance is the minimum sight distance to the left required to detect conflicts in the circulating roadway or on another approach to the roundabout. Determine this distance by using Section 6.3.10 of the FHWA "Roundabouts: An Informational Guide".
- j. **Sight Distance to Crosswalk** - The sight distance to crosswalk is the minimum intersection sight distance to the right required to determine if pedestrians or cyclists are entering the crosswalk. Determine this distance by using Section 6.3.9 of the FHWA "Roundabouts: An Informational Guide".
- k. **Inscribed Circle Diameter** - The inscribed circle diameter is determined from the largest diameter circle that can be inscribed in the circulating roadway. The diameter of the inscribed circle may range between 15 m and 100 m. The minimum diameter shall accommodate the design vehicle with a 1 m horizontal clearance. However, the safety advantages of a roundabout may begin to diminish when the diameter of the inscribed circle exceeds 75 m. Diameters over 100 m should not be used.
- l. **Circulating Roadway Cross Slope** - The pavement may be either crowned or sloped to one side, depending on the need to facilitate drainage or minimize adverse rollover rates for vehicle paths. Desirably, roundabouts should be sloped away from the center island. The allowable range is 0.5% to 2.5%.

- m. Circulating Roadway Width - The width of the circulatory roadway depends mainly on the number of entry lanes and the radius of vehicle paths. The roadway must be at least as wide as the maximum entry width and generally should not exceed 1.2 times the maximum entry width. The circulating roadway width and truck apron, if present, should accommodate the design vehicle with a 1 m horizontal clearance.
- n. Control of Access & Parking - Driveways and parking are not permitted along the circulating roadway except that commercial driveways are allowed if designed as an intersecting leg of a roundabout. Driveways and parking are also prohibited between the crosswalk and yield line. Where no crosswalk is provided, driveways and parking are not permitted within 25 m of the yield line.
- o. Minimum Circulating Sight Distance - Circulating Sight Distance is the stopping sight distance for the circulating vehicle. Determine this distance by using Section 6.3.9 of the FHWA "Roundabouts: An Informational Guide".
- p. Minimum Exit Radius - The exit radius is the minimum radius of curvature measured along the right curb at exit. The exit radius is to be 20 m to 100 m. The desirable exit radius is 20 m for single lane roundabouts and 40 m for multilane roundabouts.
- q. Pedestrian Accommodations - Pedestrian accommodations which comply with Americans with Disabilities Act & American with Disability Act Accessibility Guidelines, must be provided.
- r. Design Vehicle - The design vehicle has a substantial impact on the roundabout geometry. For maintenance operations, all state highways shall accommodate a single unit truck (SU). Larger design vehicles need to be used where bus or truck traffic is present. Consideration should be given to all vehicles legally permitted on the facility by the New York State Vehicle & Traffic Law. Refer to HDM section 5.8.1 for additional guidance.
- s. Rollover Rate - The rate equal to the algebraic difference in cross slope, with 4.0% being the maximum between travel lanes.

3.2 Other Design Elements

The following is a list of other design elements used in roundabout design. Refer to FHWA's "Roundabouts: An Informational Guide" for a more detailed discussion.

- a. Central Island - The central island is usually delineated by a raised, nonmountable curb, and its size is determined by the width of the circulatory roadway and the diameter of the inscribed circle. Fixed objects should not be placed within the central island on roundabouts with high speed approaches (85th percentile speed of 80 km/h or greater).

- b. **Truck Apron** - A truck apron is a traversable portion of the raised center island to accommodate the wheel path of oversized vehicles. A truck apron may be used for single lane roundabouts and generally should not be used on multilane roundabouts. When the truck apron is sloped away from the center island, the apron should be sloped at a maximum of 2.0% to facilitate drainage while minimizing rollovers and loss of load accidents, which can be induced when the left side wheels mount the apron. Additionally, the outside edge of the apron shall be traversable (1:3 maximum slope) with no vertical reveal and a maximum height of 75 mm.

- c. **Splitter Island** - The splitter island is placed within the leg of a roundabout to separate entering and exiting traffic and provide vehicle deflection prior to entering the roundabout. The splitter island and entry curvature should be designed so that the deflection occurs using a sharp radius (e.g., 20 m) curve terminating 10 m to 15 m before the yield line. A large radius or tangent is then used to guide vehicles into the roundabout.

The splitter island is usually designed with raised mountable curb in rural areas and non-mountable curb in urban areas to help inform motorists of the entry deflection and to provide a refuge for pedestrian crossings. Splitter islands are to be designed in accordance with AASHTO guidelines for island design as shown in Section 6.3.8 of the FHWA "Roundabouts: An Informational Guide." Fixed objects should not be placed within the splitter island for medium or high speed approaches (85th percentile speed greater than 60 km/h).

- d. **Bypass Lane** - A bypass lane may be warranted for heavy right turn volumes as it allows traffic to bypass the roundabout. Bypass lanes shall be designed as turning roadways in accordance with HDM Chapter 2.
- e. **Approach Width** - The approach width refers to the width of the entering travel lanes before flaring or any other influence from the roundabout. Design the approach width in accordance with HDM Chapter 2.
- f. **Exit Width** - The exit width is the perpendicular distance from the right curb line of the exit to the intersection of the left edge line and the inscribed circle. The exit width should be designed to accommodate the design vehicle.
- g. **Departure Width** - The departure width refers to the width of the lanes departing from the roundabout at a point where the width is no longer influenced by the roundabout. Design the departure width in accordance with HDM Chapter 2.

- h. Pedestrian facilities - Where pedestrian accommodations are to be provided:
 - Pedestrians should not cross the circulating roadway and/or enter the center island. Therefore, benches, sidewalks, etc., are not to be located in the center island.
 - Crosswalks should be installed 7.5 m upstream of the yield line at single lane roundabouts and between 7.5 m and 22.5 m back from the yield line at multilane roundabouts. Bringing crossings closer to the circle would reduce roundabout capacity, while placing them further away would expose pedestrians to higher vehicle speeds.
 - The splitter island should be a minimum of 1.8 m wide at the pedestrian crossing.
 - The pedestrian crossing through the splitter island shall be flush with the approach roadway to avoid the need for ramps in the splitter island.
 - Speed tables and other vertical shifts, as defined in HDM Chapter 25, are not to be used on state highways.
 - For additional information see FHWA "Roundabouts: An Informational Guide" and HDM Chapter 18.
- i. Bicyclist facilities - A bike lane is not to be carried into a roundabout. A shoulder or bike lane is to be terminated to permit a merge during the last 22 m to 30 m of the approach before the entrance to a roundabout. Where bicycle traffic is heavy, a separate bicycle path should be considered for multilane roundabouts.

3.3 Capacity Analysis

There are two approaches to calculating the capacity of a roundabout. The first method involves an empirical formula based on field measurements at saturated roundabouts. The second method uses an analysis based on gap acceptance. The 1997 Highway Capacity Manual (HCM) and version 3.1c of the Highway Capacity Software include a procedure for determining the capacity of single lane roundabouts using the gap acceptance approach. For analyzing multilane roundabouts, the HCM suggests the use of software programs, but no specific program is mentioned. The Department recognizes that there are advantages to using empirical models to develop relationships between geometric design characteristics and roundabout performance. Therefore, all Department projects shall be analyzed using the empirical methodology. The Department has selected RODEL 1 as the standard software for analyzing roundabouts. Other programs are permitted, provided a RODEL 1 analysis is performed for comparison purposes since the fundamental differences between the empirical and analytical methods may sometimes produce inconsistent results. The RODEL 1 analysis is to be performed using a 0.85 confidence level. The use of the 0.85 confidence level will help avoid a gross underestimation of delays.

To ensure reasonable output, the input data must be carefully checked for accuracy. For example, since the RODEL software was developed in England and vehicles travel in opposite directions from that in the United States, designers must label the roundabout entrance legs consecutively in a counterclockwise direction to ensure proper vehicle movement. A United States version of the RODEL software manual is available on DQAB's IntraDOT site and on the Design Division's Server under Documents & Resources/Roundabout Design Info/RODEL.

4.0 DESIGN STAGE

The Design Approval Document shall be prepared for all roundabout projects using the format and content in Appendix B of the Design Procedure Manual. The Design Approval Document includes a comprehensive list of issues to ensure a full range of design issues, such as drainage, pedestrians, bicyclists, lighting, etc., are considered. As a modification to Design Procedure Manual Appendix B, the list of critical design elements in Section 3.1 of this document shall be used for roundabout projects.

Designers are to submit to DQAB for review all draft design approval documents and Advance Detail Plans for projects including roundabouts to be let by the Department. DQAB will review the roundabout designs for conformance with the general concepts contained in this document.

5.0 CONSTRUCTION STAGE

Small deviations in geometric layout, signing, or striping can have an adverse impact on traffic circulation. Therefore, designers must alert Engineer in Charge (EIC) via the Regional Construction Group that any changes to the roundabout geometric layout, signing, or striping must be made with field change sheets and reviewed by the designer during the order on contract review process.

6.0 OPERATIONS AND MONITORING

To further aid the effort to improve design standards, the Department will accumulate statistics on geometry, traffic volumes and accident histories for new roundabouts. To assist in this effort, the Region should notify their Regional Liaison Engineer in DQAB as soon as any issue is raised regarding the safety and operation of a roundabout.

7.0 REFERENCES

The following is a list of reference material used to prepare this document. Questions regarding these references should be directed to your member of the Roundabout Committee or Joe

Mondillo, the Roundabout Committee Chair and principle author for HDM Chapter 26 Roundabouts. Joe can be reached via e-mail or at (518) 457-2048.

1. "Roundabouts: An Informational Guide," Pub. No. FHWA-RD-00-062, FHWA, 2000.
2. "Highway Capacity Manual," Special Report 209. Transportation Research Board, Washington, D.C., 1997, pp. 10-81 thru 10-89.
3. "Roundabouts" California - Design Info. Bulletin 80, 1998.
4. "Modern Roundabouts for Oregon," Oregon Department of Transportation, Research Unit, 200 Hawthorne SE, Suite B-240, Salem, OR 97310, June, 1998.
5. "Roundabout Design Guidelines," Maryland Department of Transportation, State Highway Administration, PO Box 717, Baltimore, MD 21203-0717, 1997.
6. "Florida Roundabout Guide," Florida Department of Transportation, March, 1996.
7. "Geometric Design of Roundabouts," TD 16/93, Design Manual for Roads and Bridges, Volume 6 Road Geometry, Section 2 Junctions, Part 3, The Department of Transport, Great Britain, 1993.

