**STATE OF TENNESSEE**
**DEPARTMENT OF TRANSPORTATION**
**DESIGN DIVISION**
**NASHVILLE, TENNESSEE 37243-0348**

# INSTRUCTIONAL BULLETIN NO. 10-14

## Regarding Revised Preface, Table of Contents, List of Figures, List of Tables, Section I – General, and Section VII – Index

**Effective for the February, 2011 letting (December 8, 2010 Turn-In Date)**, entire Section 1 (Revised: October 1, 2010), Preface, Table of Contents, List of Figures, List of Tables and Section VII – INDEX of the Design Guidelines are revised. They are attached to replace the existing sections in the Roadway Design Guidelines.

A new CHAPTER 3 - GUIDELINES FOR DESIGN OF ROUNDABOUTS is added to Section 1. New guidelines are to be used with the Standard Drawings RD-TS-9, RD-TS-10, and RP-R-2.

This bulletin **voids Instructional Bulletins 08-15, 09-10, 09-12, 09-15, and 10-04**.

Carolyn Stonecipher, Civil Engineering Director
Design Division

October 8, 2010
CS:ARH

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# SECTION I - GENERAL

## CHAPTER 1 - PROJECT RECORDS

### 1-100.00 PROJECT FOLDER (See 2-100.00)

Design Project records consist of a Transportation Planning Report (TPR), survey notes, traffic data, geological reports, correspondence, and daily verbal communications relating to the production of project plans, and all other pertinent information regarding design development.

Each designer will be required to maintain an up-to-date project folder for each project.

Project design folder records will be labeled on the tab as follows:

County:____________ Route No.:________________________________________

Project Description:____________________________________________________

PIN:______________________

A copy of all correspondence, in chronological order by dates will be kept in the folder.

### 1-103.00 LETTING TO CONTRACT - DESIGN RECORDS

Assemble the following design records for the finalized project, which are to be maintained by the designer or design firm.

1. Final grade computations
2. Final grading quantity computations
3. Final right-of-way computations
4. Final hydraulic computations
5. Final roadway quantity computations

The file containing the items mentioned above will be combined with any office correspondence file on the project, to become a complete "Design Records" file and a part of the legal documents substantiating the final Construction Plans.

## 1-105.00 ROADWAY DESIGN CHECKLIST (See 2-105.00, 3-100.00 and 4-105.00)

In order to reduce plan revisions, errors, and standardize the preparation, format and content of plans, the following Roadway Design Checklist shall be used by all Designers, Consultants, Managers, Supervisors and personnel checking plans. This form shall be used on all projects.

The procedure for use of the form is as follows:

1. Download the latest Roadway Design Checklist in Word format from TDOT website.

2. Fill in the heading information on each sheet.

3. The designer or project supervisor will check off each blank when sure that each item is completed on the plans. NA (not applicable) may be used if an item is not required in a project.

4. Before submitting plans for a field review, the checklist shall be completed down to that particular stage of plans development.

## 1-110.00 PROJECT ACTIVITY STATUS SHEET (See 2-110.00 and 4-110.00)

Designers on all projects shall use the Project Activity Status Sheet that follows. This list is intended to help reduce plan errors. An up-to-date copy of this status sheet shall be kept in the project folder at all times.

This sheet shall be handled as follows:

1. Download the latest Project Activity Status Sheet in Word format from TDOT website.

2. Fill in heading information.

3. Each item is listed in the order in which it shall be accomplished and completion dates filled in as the activities are completed.

4. The heavy printed items are those normally shown in the “A&E” schedules and those dates shall be filled in under the "original" column by the TDOT supervisor and/or manager.

5. The other items shall have dates filled in by the designer and his supervisor under the "original" column, which fit within the “A&E”, schedule dates.

6. If schedule problems develop so that the “A&E” dates cannot be met, the Program Development and Scheduling Office shall be notified and the new dates entered on this "Status Sheet" under the revisions column.

7. The TDOT managers and/or supervisors will be responsible for keeping this "Status Sheet" up to date and furnishing an updated copy of this form to each TDOT or Consultant Designer for their information.

## 1-120.00 FIELD REVIEW PROCEDURES (See 2-330.00, 3-140.00 and 4-145.00)

**All personnel who make arrangements and conduct field reviews shall follow these guidelines as follows:**

1. All field reviews shall be scheduled and prints distributed **a minimum of three weeks** prior to the scheduled date of the field review. The beginning of the three weeks will start on the date the plans are either mailed or distributed from the Design Division. Field reviews scheduled in the region design offices should allow an additional two or three days for the prints to reach the headquarters offices.

2. The plans, when distributed, shall be complete through the appropriate stage of development in accordance to the Roadway Design Checklist.

3. Specialty support Design Division personnel shall be included on all Preliminary, Right-of-Way, Construction and Value Engineering Field Reviews.

   A. On all notices of Preliminary, Right-of-Way and Construction Field Reviews, include the Pavement Design Section with one set of half-size prints of the plans.

   B. On all notices of Construction Field Review, include the Design Traffic Engineering Section with one set of half-size prints of the plans. On Preliminary and Right-of-Way Field Reviews include the Design Traffic Engineering Section only on projects that include traffic signals and/or roadway lighting. (See sections 2-315.00 and 2-315.05 of Design Guidelines.)

4. Plans for Construction Field Reviews that involve a bridge shall include preliminary bridge layout drawings.

5. A complete field review report shall be distributed **within two weeks** of the review.

6. The Right-of-Way Field Review report shall include:

   A. Comment to Structures if the horizontal and vertical geometry is adequate to continue bridge design.

   B. The number of sets of final right-of-way distribution prints requested by the Regional Right-of-Way Office.

   C. All changes requested shall be included in the plans when submitted for right-of-way or construction authorization.

7. Send the Federal Highway Administration (FHWA) a Field Review Notice for all new and reconstruction projects on the Interstate System and all Demonstration Projects. Reviews for all new and reconstruction projects on the Interstate System and all Demonstration Projects shall be scheduled in coordination with FHWA. Appropriate project plans will be forwarded to FHWA for review. FHWA is not requiring Field Review Notices for any other Federal-Aid projects.

8. Do not send the FHWA a Field Review Report for projects, which were not attended by a representative of the FHWA.

9. Do not send to the Headquarters' Right-of-Way or Utilities Office Construction Field Review prints.

## 1-130.00 INSTRUCTIONS REGARDING PUBLIC HEARING AND PUBLIC MEETING REQUIREMENTS

In order to meet all legal requirements for advertising public hearings or public meetings, the Community Relations Division requests that all information pertaining to public hearings be received 45 days prior to the hearing and all information pertaining to public meetings 20 to 25 days prior to the meeting.

The manager requesting the hearing will be required to submit a cover letter, hearing notice, and location map. The cover letter and notice shall include the date of the hearing or meeting, the place the hearing or meeting is to be held, the project number, the description of the project, and the county in which the project is located. The cover letter shall additionally include the telephone number and address of the contact person. No action can be taken by the Community Relations Office to advertise the hearing or meeting if any of this information is not included in the notice and on the cover letter. Examples of the cover letter, hearing notice, and location map are attached.

The Tennessee Press requires that all advertisements be sent to their office in electronic format. Therefore, the Community Relations Office will need an e-mail of the notice as well as the location map for each project.

The Community Relations Office has requested that the location map be submitted as a Microsoft Word document. TDOT designers and managers may obtain information for converting Microstation drawings into Microsoft Word at:

http://www.tdot.state.tn.us/Chief_Engineer/assistant_engineer_design/design/v8/locationmaps.pdf

**STATE OF TENNESSEE**
**DEPARTMENT OF TRANSPORTATION**
**NASHVILLE, TENNESSEE 37243-1402**

**MEMORANDUM**

**TO:** Ms. Judy B. Steele, Director, Community Relations Division

**FROM:** Michael Agnew, Assistant Director, Design Division

**DATE:** May 19, 2006

**SUBJECT:** REQUEST FOR ADVERTISEMENT OF A DESIGN MEETING
Project No. IM-81-1(102)7, 32001-1124-44, PIN 101203.00
I-81, Interchange @ State Route 32 (US 25E) Exit 8
Hamblen and Jefferson Counties

We are requesting you to advertise this project for a design meeting as described in the attached document.

I have arranged with Ms. Janice Brown, principal of North Middle School, at (865-986-9944, ext. 302) to have the school cafeteria available at 421 Hickory Creek Road, Morristown, TN 37771, from 4:30 p.m. to 8:00 p.m. for a 5:00 p.m. to 7:30 p.m. design meeting on Wednesday, December 15, 2004.

A copy of the project location map is attached for your use.

MA/AR/et
Attachment

cc: Jeff C. Jones
Amanda K. Tidwell
Derrick Tibbs
(Regional Design Manager)
(Regional ROW Manager)
File

**Figure 1-1**
**Example Cover Letter**

**NOTICE OF HIGHWAY DESIGN MEETING**

The Tennessee Department of Transportation (TDOT), an equal opportunity affirmative action employer, will conduct a Highway Design Meeting on the 28th day of February 2006 in the gymnasium of Witt Elementary School, 4650 S Davy Crockett Parkway, Morristown, TN 37814, to discuss project number IM-81-1(102)7, I-81 Interchange (Exit 8) at SR-32 (US-25E) in Hamblen County as shown on the general location map.

**The project proposes to modify the I-81/SR-32 interchange and reconstruct SR-32 (US 25E) with five 12' travel lanes and two 12' shoulders within project limits. Out of the five lanes on SR-32, one will be the north bound third lane. The existing west bound I-81 on ramp will be replaced by a new free flow ramp at the northwest quadrant of the interchange. Northbound to westbound traffic from SR-32 to I-81 will also be routed through this new ramp. The existing east bound on and off ramps of I-81 will be realigned. Existing dual bridges on SR-32 will be replaced by a single bridge. Additional right-of-way and easements will be required along SR-32 and I-81.**

This meeting will be held from 5:00 - 7:00 p.m. during which time there will be a presentation followed by a question and answer session. The public is invited to ask questions and make comments during the meeting. Representatives of TDOT will be present to answer questions on any aspect of the project.

Plans are available for public inspection at the offices of:

Mr. Paul Beebe
7345 Region Lane
Knoxville, TN 37914
Phone: (865) 594-2442

or

Mr. Ataur Rahman
1300 James K. Polk Bldg.
Nashville, TN 37243-0348
Phone: (615) 741-7958

Persons with a disability, who require aids or services to participate at the meeting, may contact Ms. Margaret Mahler at the following address:

Ms. Margaret Mahler
ADA / Safety Coordinator
Tennessee Department of Transportation
Suite 400, James K. Polk Building
505 Deaderick Street
Nashville, Tennessee 37243

or by e-mail:

Margaret.Z.Mahler@tn.gov
Phone (615) 741-4984
Fax (615) 253-1477
TTY Relay (877) 831-0298

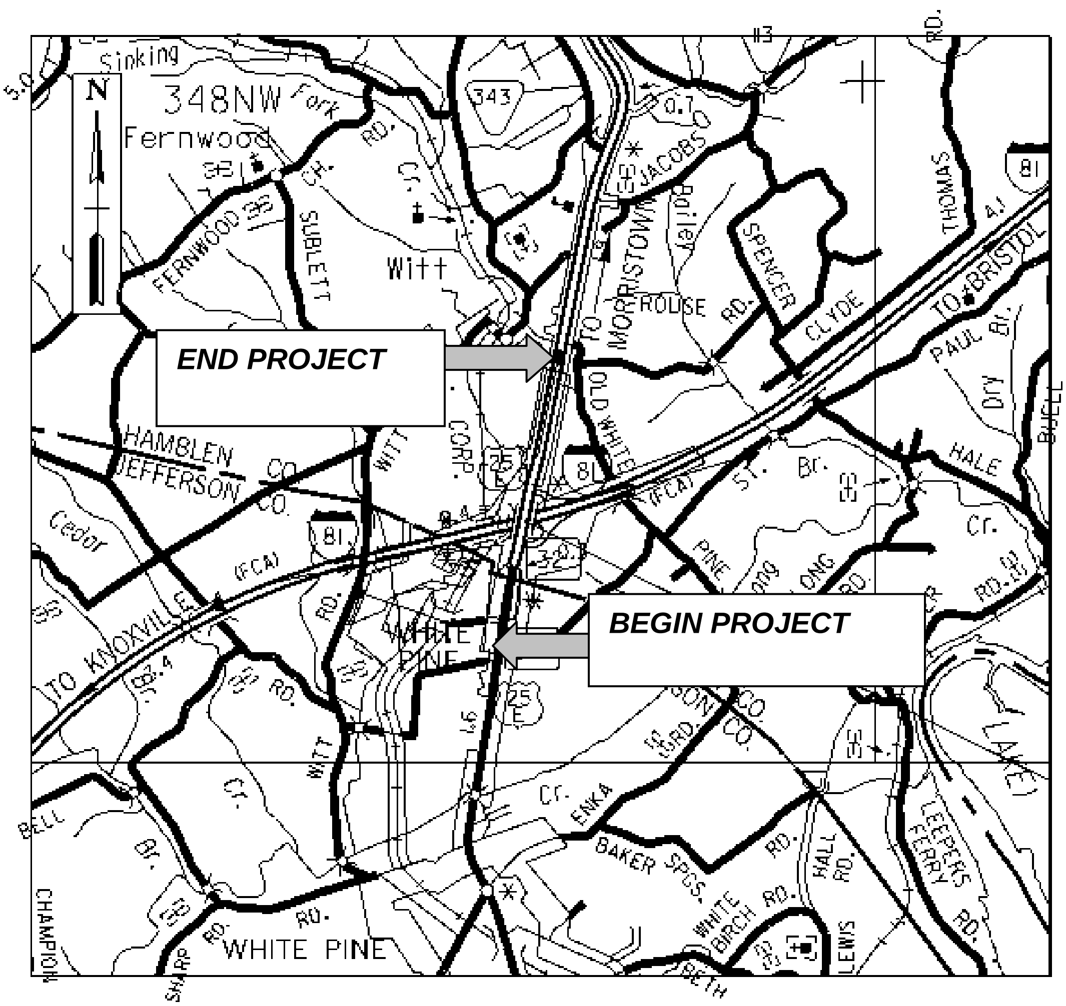
A court reporter will be available to receive oral statements to be included in the project transcript. In addition, comment sheets are available for those who prefer to make written statements. Written statements and other exhibits to be included in the project transcript may be submitted within ten (10) days after the meeting date to the following address:

Project Comments
Tennessee Department of Transportation
Suite 700, James K. Polk Building
505 Deaderick Street
Nashville, Tennessee 37243-0332

**Figure 1-2**
**Example Hearing Notice**

# HAMBLEN & JEFFERSON COUNTIES

## PROJECT NO. IM-81-1(102)7




## I-81, INTERCHANGE @ STATE ROUTE 32 (U.S. 25E) EXIT 8

## *GENERAL LOCATION MAP*

**Figure 1-3**
**Example Hearing Notice**

# CHAPTER 2 - DESIGN PROCEDURES

## 1-200.00 ROADWAY DESIGN STANDARDS AND GUIDELINES

A list of documents used to design roadways in Tennessee can be found as part of TDOT Department Policy. This policy indicates the current recognized design standards for new construction or reconstruction of existing highways and should be utilized while giving due regard to topography, natural conditions, availability of road material, and prevailing traffic conditions.

## 1-200.05 LOW VOLUME (ADT ≤ 400) LOCAL ROAD

Standard drawing RD01-TS-1A should be used for the design of low-volume (current ADT ≤ 400) roadways classified as local roads. For additional guidance not covered on the standard drawing, designers should reference AASHTO "Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400)," 2001. For projects with design speeds greater than 40 mph, designers shall continue using standard drawing RD01-TS-1. Any exception to the use of standard drawing RD01-TS-1A on low volume local roads should be approved by the Design Division Director or the appropriate Assistant Director.

## 1-200.10 RESURFACING PROJECTS

## 1-200.12 HANDICAP RAMPS ON RESURFACING PROJECTS

In order to assist local governments with compliance with the Americans with Disabilities Act, it will now be the department's intent to repair or install handicap ramps which meet the Americans with Disabilities Act Accessibility Guidelines whenever possible when encountered on resurfacing projects.

Designers should refer to Section 3-310.05 and the RP-H-series standard drawings for additional guidance regarding design and placement of handicap ramps.

## 1-200.15 SAFETY IMPROVEMENTS ON RESURFACING PROJECTS

In order to enhance safety on state routes, low cost safety improvements should be included on all state route resurfacing projects. Eligible safety improvements include the following: installation of skid-resistant surfaces in intersections or curves, installation and upgrade of guardrails and end terminals, improvements for pedestrian or bicycle safety, improvements for safety of the disabled, addition of ADA compliant handicap ramps, installation of centerline rumble stripes, improvement to pavement markings, sign replacement or upgrades, installation of safety headwalls, removal of roadside objects to improve clear zone, correcting super elevation rates, improvements (such as vegetation removal) to improve stopping site distance and/or intersection sight distance without purchasing ROW or relocating utilities, and widening shoulders without purchasing ROW or relocating utilities. The applicable use of the above various safety improvements will be guided by the "Resurfacing Safety Checklist" (Figure 1-3a) and will be completed by the team responsible for each resurfacing project. This checklist will be used as documentation for decisions regarding low cost safety improvements on resurfacing projects.

Installation of shoulder rumble stripes, shoulder rumble strips, and raised pavement markers are also considered low cost safety improvements. Guidance for the application of these measures is found in Section 4 of the Design Guidelines.

For federally funded state route resurfacing projects for pavement designs 2” thick or less and the ADT is greater than 2,000, the project shall provide at a minimum for a minimum 2’ paved shoulder; compliance with current guidelines for placement of rumble stripes, rumble strips and raised pavement markers; and replacement of any end terminals not meeting NCHRP 350 requirements. For pavement designs 2” thick or less and an ADT less than 2,000, the project shall provide at a minimum for a minimum 2’ paved shoulder and the replacement of any end terminals not meeting NCHRP 350 requirements.

**Items for low cost safety improvements shall be funded separately from other resurfacing plan items in both federally funded and 100% state funded resurfacing projects if the total estimated costs of the safety upgrades are greater than $10,000.** . Therefore, designers should have an additional project number set up for payment of safety improvement items.

Designers will be responsible for obtaining the additional federal project number from the Programming Development and Scheduling Office and correctly identifying items by funding source in the resurfacing plans when safety improvements are identified to be included in a resurfacing project. Designers should advise the Programming Development and Scheduling Office the additional project number is needed for the inclusion of safety improvements in the resurfacing project.

**If the total estimated costs of the safety improvements are less than or equal to $10,000, a separate project number will not be required. Safety improvements shall be funded using the same project number and resurfacing funds used for other items in the project.**

## RESURFACING SAFETY REVIEW CHECKLIST

It is the intent of this checklist to identify “low cost safety improvements” that will provide improvements in the areas of lane departures/run-off-the-road crashes and pedestrian and bicycle safety on this route at a minimal cost. A review of the crash history data for this route will be necessary for completion of this checklist and should be attached to the final report. Special attention should be given to those areas identified in the crash history as “hot spots” where work should be accomplished to provide a significant improvement to safety.

| |
|---|
| County: |
| Route: |
| Description: |
| Log Miles: |
| ADT: |

1. Is shoulder width greater than or equal to 2’ and AADT greater than 2,000? If yes, follow guidance regarding the placement of either rumble stripes or rumble strips found in 4-411.03, 4-411.04 and 4-716.15 of the TDOT – Roadway Design Guidelines

   ________________________________________

   ________________________________________

2. If AADT is greater than 2,000 and shoulders are not present or less than 2’ wide, can minimum 2’ shoulders be added without utility relocations or the purchase of ROW? If so, provide a minimum 2’ shoulder.

   ________________________________________

   ________________________________________

3. Replace all guardrail and end terminals not meeting NCHRP 350 requirements.

   ________________________________________

   ________________________________________

4. Is signing adequate and visible, particularly in areas where curves exist? Does signing meet MUTCD requirements? Provide recommendations for upgrades and/or additional signing.

   ________________________________________

   ________________________________________

**Figure 1-3A**
**Resurfacing Safety Review Checklist**

5. Would the use of centerline rumble strips or rumble stripes or raised pavement markers help in the delineation of curves or areas with a known crash history?

______________________________________________

______________________________________________

6. Could the condition in curves be improved by correcting superelevation rates or widening shoulders without purchasing ROW or relocating utilities? Would the construction of a specialized skid resistant surface improve conditions in curves or intersections that cannot be addressed by other means? If so, please explain.

______________________________________________

______________________________________________

7. Are there roadside obstacles (trees, tree stumps more than 4" above the ground, utility poles, culverts, headwalls, mailboxes, etc.) that could be removed, relocated or delineated? Could the installation of safety headwalls improve the site condition? Are signs obscured by brush or trees that could be removed or tree stumps present that are more than 4" out of the ground?

______________________________________________

______________________________________________

8. Can improvements be made that would enhance pedestrian or bicycle safety (the addition of a bike lane, share the road signing, enhancement or upgrading crosswalks to TDOT standards)? Is the addition of approved handicap ramps needed to comply with ADA requirements?

______________________________________________

______________________________________________

9. Could improvements be made to ditches to assure proper drainage and/or to reshape ditches to mitigate substandard foreslope or backslope without the relocation of utilities or purchase of ROW?

______________________________________________

______________________________________________

10. Are there areas along the roadway where stopping sight distance is not adequate that can be improved by measures that would not require additional ROW acquisition or utility relocation? Are there intersections where intersection sight distance is not sufficient that can be improved by vegetation removal or other measures that do not require additional ROW or utility relocation?

______________________________________________

______________________________________________

**Figure 1-3A**
**Resurfacing Safety Review Checklist**

## 1-200.30 PROJECTS OF LIMITED SCOPE

Projects of limited scope will permit implementation of projects addressing safety and operational concerns in a timely manner without requiring design exceptions for those elements of the roadway that are beyond the scope of purpose and funding for the projects such as, traffic engineering, spot improvements, road safety audit review (RSAR) projects, and safety projects such as signing, marking, signalization, roadway lighting and traffic barriers which include very minor or no roadway work as permitted under 23 CFR 625.3 (e).

## 1-200.31 ROAD SAFETY AUDIT REVIEW (RSAR) PROJECTS

The primary purpose of Road Safety Audit Review program is to reduce the number of injuries and fatalities on public roads. A RSAR report is written for each RSAR project and should be used as guidance for the development of RSAR plans. Projects currently selected for the program are spot or section locations on interstates, state routes, and functionally classified local roads for the Highway Safety Improvement Program list. Projects may also be selected if qualified for the High Risk Rural Roads funds. Currently project funding comes from either Highway Safety Improvement Program funds ($1,000,000 limit per project) or High Risk Rural Roads funds (approximately $50,000 limit per project).

Scope of work for RSAR projects is developed by a RSAR Team and will consist of a Pre-Briefing Meeting, Onsite Visit, and Post Meeting or Conference Call of team members. A representative from either Headquarters Design or the Regional Design Office will be included on each team. The Assistant Director will coordinate with the Headquarters and Regional Design Managers to ensure Design is represented at each meeting. The representative will be responsible for ensuring design issues are addressed prior to finalizing and submitting the RSAR for approval.

Except as noted herein, guidance provided in the Design Guidelines do not apply to the development of RSAR projects. Proposed improvements should be designed in accordance with current design standards; however, it is not the intent of the RSAR program to bring all design elements up to current standards.

In order to provide consistency in the development of RSAR projects the following guidance should be used during the development of RSAR plans:

1) Plans should be developed in accordance with the approved RSAR report.

2) Scope of the project should be limited to items addressed in the RSAR report.

3) Any deviation from the RSAR report will require a revision to the report and estimate. Proposed changes should first be approved by the Design Division director prior to initiating a request to change the approved RSAR report.

4) Additional improvements should not be added to the project unless required to meet the objective outlined in the RSAR report.

5) Improvements to add additional capacity (except where identified in the RSAR report) should not to be added to RSAR projects.

6) Design Exceptions should only be requested when the proposed element to be improved cannot be brought up to current standard. Design Exceptions shall not be requested for other controlling elements of design that are not addressed in the RSAR report. Designers should document to the project file other controlling elements of design or design criteria identified that are not brought up to current standard.

7) Plans should be developed using the minimal amount of survey and plans detail necessary to provide sufficient detail to acquire right-of-way (if required) and construct the project. Example: Topography of adjacent properties is not needed when the improvement is going to be constructed inside existing right-of-way. However, erosion prevention and sediment control plan may need to be developed to the same detail as a typical roadway project.

8) The acquisition of additional right-of-way and easements and the relocation of utilities should be addressed in the RSAR report. Designs for RSAR projects not proposing additional right-of-way and/or easements or utility relocations acquisition should avoid additional right-of-way or utility relocations whenever possible. In the event that the need for additional right-of-way and/or utility relocation is identified during project development, the Design Manager shall immediately notify the Project Manager or RSAR Coordinator.

9) The Work Zone Significance Determination shall be completed and procedures in the Work Zone Safety and Mobility Manual shall be followed for all RSAR projects.

10) RSAR project development shall follow guidance regarding permits and submittals to the Environmental Division found in the Design Guidelines.

11) Signing and marking shall be in compliance with the current edition of the Manual on Uniform Traffic Control Devices.

12) The following note will be place on the Title Sheet directly above the Chief Engineer's signature. "**RSAR Project - Project of Limited Scope**"

### 1-200.35 LOCAL PROGRAM DEVELOPMENT PROJECTS

The Local program is intended to help Tennessee's Local Governments conduct environmental processes and clearances, design, construct, and maintain transportation facilities.
The TDOT Local Program Development Office is the single TDOT point of contact for project correspondence between the department and local governments. The detailed information about the program may be found at The Local Government Guidelines (LGG) manual.

Locally Managed Projects may be located on the National Highway System, State Routes, or Local Routes. In addition, the funding for each Locally Managed Project may come from Federal-aid and/or State Funds combined with Local Funds, or solely from Federal-aid, State Funds, or Local Funds. Projects to be designed under the local program are primarily on local roads. In general, they should not involve the state highway system, the national highway system or the interstate system.

All projects developed under the Local Program which involve a roadway shall be designed in accordance to TDOT Design Policies and Procedures, and Federal Regulations.

A TDOT Design Manager TDOT will manage all projects on the NHS System, as well as a manager may be assigned to provide Full Oversight of a project as determined. The TDOT Design Manager is responsible for ensuring all TDOT Design Policies and Procedures have followed. The TDOT Design Manager is not responsible for providing guidance or assistance in the actual design of the project. A “Design Certification Letter” will be required for all roadway projects. Any comments provided by the Department shall be incorporated into the design of the project.

Projects such as Bridge Replacement (BRZ) Projects, State Industrial Access (SIA), Local Interstate Connector (LCI), Intersection Improvements, Roadway Resurfacing, Roadway features or Auxiliary to Roadway Features, Roadway Signing and Striping Improvements, as well as Sidewalks-ADA Improvements, Bikeways, Shared-use Paths, Safe Routes to Schools, and Landscape Projects should be considered as a Roadway Project since the project scope would involve roadway design elements.

Projects such as Building Projects, Parking Improvements are non-roadway projects and they are covered under The Local Government Guidelines (LGG) manual-Chapter 10: Non-Traditional Projects .

Refer to *Local Program Guidelines*, Chapter 5, “Roadway Design Procedures, Including Structural Design” for more information.

### 1-205.00 SURVEY REQUIREMENTS

### 1-205.15 COORDINATE VALUES

Survey procedures require that all surveys shall be tied to the State Plane Coordinate System using the Tennessee Geodetic Reference Network (TGRN). All surveyed coordinate values will be based on the North American Datum 1983 (NAD/83) (1995 adjustment) coordinates and appropriate notes indicating such shall appear on the topography plot.

All design computations shall be based on these adjusted coordinate values. This will ensure that all computed points on the project would have coordinate values tied to the State Plane System. Assumed coordinates will not be used.

Coordinate values for all PI's shall be shown on present and proposed (if any are shown) layout sheets within each curve data table. Coordinate values shall also be listed for the beginning and ending points of the project. A **notation** near the title block in lower right hand corner for each sheet on which coordinates appear shall read, **"Coordinates are NAD/83 (1995), are datum adjusted by the factor of 1.000XXX" and tied to the TGRN. All elevations are referenced to the NAVD 1988.** The "1995" refers to the year of the most recent adjustment of coordinate values in Tennessee and 1.000XXX refers to the actual datum adjustment factor used for the project.

## 1-205.20 DIMENSIONS AND DIRECTIONS ON PLANS

In order to provide consistency and maintain accuracies, the following criteria are to be adopted for the roadway plans.

1. Distances shown on the plans shall be no more accurate than the nearest 0.01 foot (35 ft, 35.0 ft, and 35.00 ft, are acceptable: 35.001 ft is not acceptable).

2. Bearings shown on the plans shall be no more accurate than 1 second (for example N 35 00' 01" E is acceptable; N 35 00' 01.1" E is not acceptable). P. I. coordinates shall be computed to four decimal places, and then bearings recomputed to even seconds. Bearings and the beginning coordinate point are then held constant and P. I.'s and ending coordinates recomputed to four decimal places.

3. Coordinates of P. I.'s and G. P. S. control points shall be shown to an accuracy of 0.0001 foot. Any other coordinates shall be shown to an accuracy of 0.01 foot.

## 1-205.30 TRACT NUMBERS ON PLANS

On all design projects, tract, and/or parcel numbers assigned during the survey process **shall not** be deleted, changed, or renumbered. Tract numbers are assigned during the survey process and have the same parcel number in the GEOPAK “GPK” file. The parcel information contained in the GPK file is used in survey and plan preparation and right-of-way processes. There should not be any duplicate tract numbers on any one project.

All survey assigned tract numbers and property owner information will be retained on the plans through the preliminary field review, if one is conducted. After that time the tract information can be removed from the acquisition table, property map, and plan sheets but the previously assigned tract numbers shall not be changed nor deleted from the GPK file. Tract numbers shall not be renumbered on the plans.

No tract shall be deleted after the plans have been submitted for incidental or printed for a design public hearing. The information in the acquisition table, property map, and layout sheets shall be crossed out in all places using a single line to indicate that no acquisition is required. This will insure that all tract information is retained in the GPK file and not deleted nor written over. The tract information is then recoverable and can be used by other sections as the information is passed to the Right-of-Way and Construction Divisions or returned to the Survey Office for updating.

## 1-210.00 RAILROAD COORDINATION

## 1-210.02 GRADE SEPARATED RAILROAD CROSSINGS (See 1-210.05 and 2-325.00)

In order to facilitate and expedite the Railroad's review of all future highway plans, which include a highway-railroad grade separation, the following information must be included to the preliminary plans, which are to be sent to the railroad for comments and/or approval:

1. A minimum of five railroad cross-sections shall be provided at the following locations.

- The roadway grade at the proposed bridge
- Both faces of the proposed bridge
- ROW limits (minimum 100 ft.) from face of the proposed bridge (perpendicular to the railroad alignment)

a) The proposed bridge toe of abutment fill slopes, existing railroad drainage structures and ditches, and roadside ditches should be shown on applicable all cross-sections.

b) For any proposed structure (example: retaining wall, end wall); a cross section view showing the location of such structures in relation to the location of a railroad track shall be shown.

c) Cross sections need to show any changes proposed during grading operations to the railroad embankment, drainage ditches, or sub-track structures.

Note: If the distance between the subject cross sections exceeds 50 feet an additional cross sections are required to adequately depict conditions along the tracks. See Figure 1-3B.

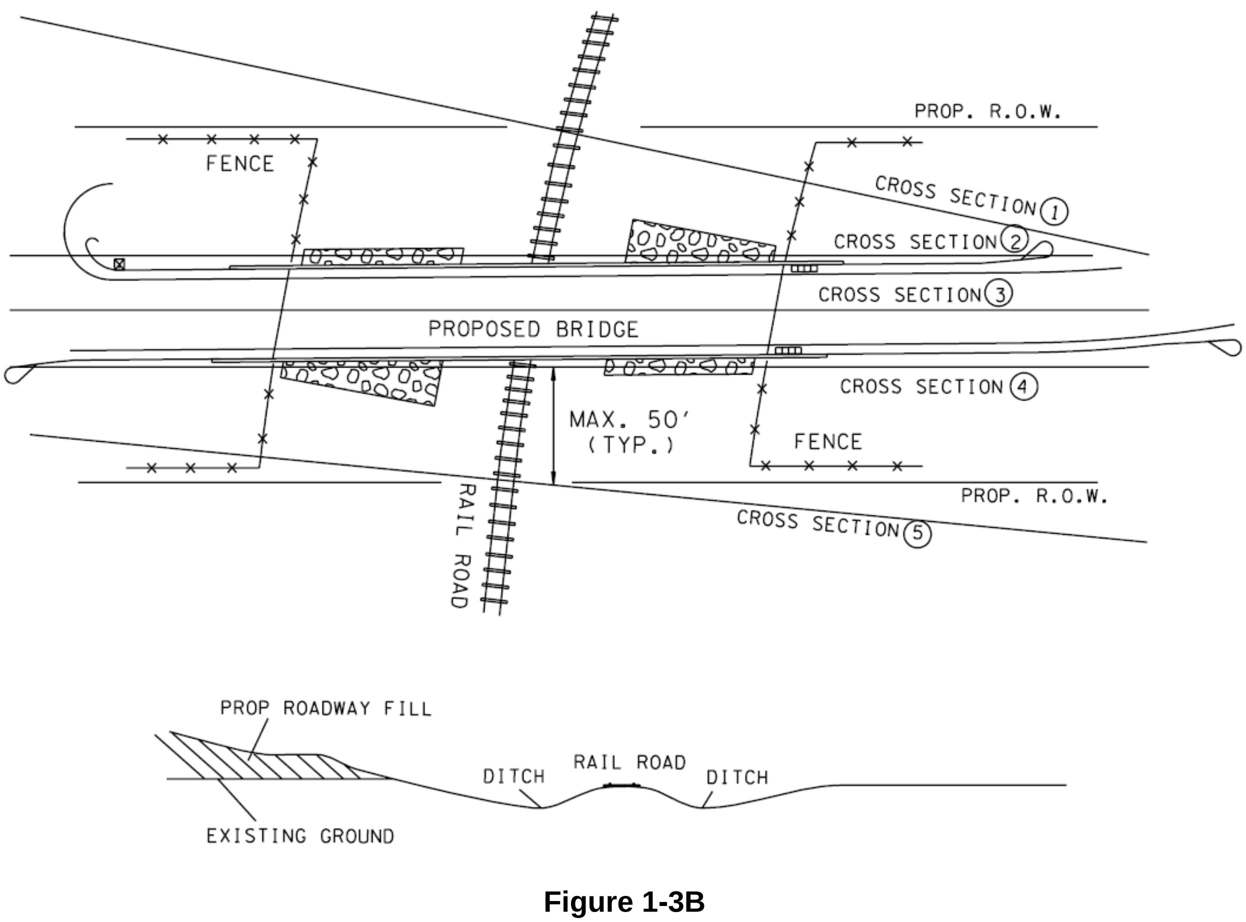



**Figure 1-3B**
**Example Cross Section Locations**

2. The following information must be on the preliminary plans,

   a. Proposed minimum vertical clearance and horizontal clearance on both sides of track

   b. At skewed crossings, drawing must include a structure elevation view normal to the track

   c. Proposed distance from centerline of track to toe of end slopes at their intersection with natural ground

   d. If end slopes are to be paved, indicate limits of paving

   e. Location of pole lines on railroad right-of-way

   f. Existing and proposed drainage structures

   g. Railroad station at highway-railroad intersection, or distance in feet from nearest railroad mile pole

In general, the information listed above is the minimum information needed by the railroad to enable them to make a logical investigation of the proposed project. To furnish less information would only serve to delay the railroad's approval of the plans. Include easement note as shown in 1-210.05.

Figure 1-4 indicates a method of showing the easement for a roadway bridge crossing over railroad.

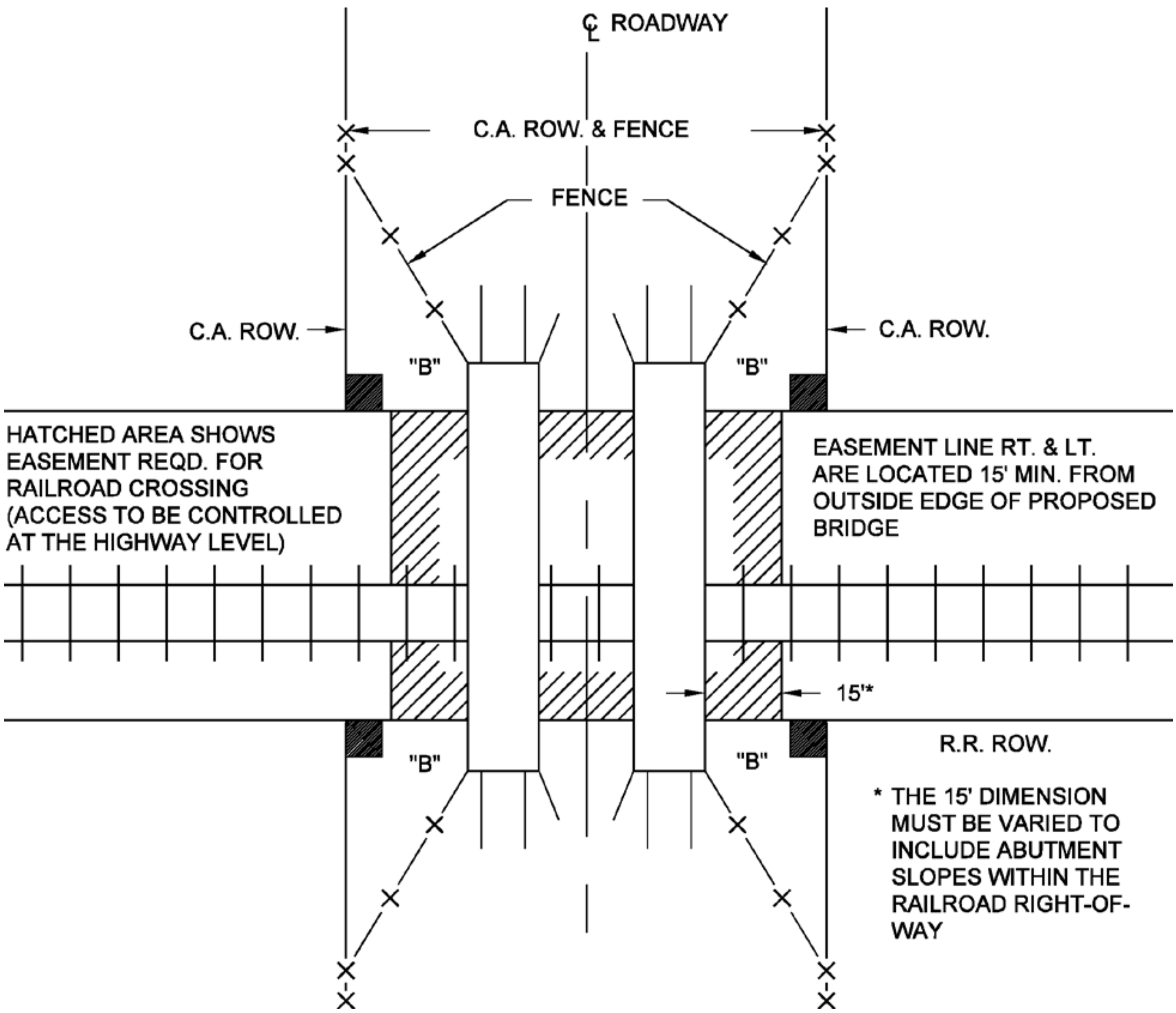



**Figure 1-4**
**Method of Showing "Easement" for Railroad Crossings**

## 1-210.05 AT-GRADE RAILROAD CROSSINGS (See 1-210.00 and 2-325.00)

All designers shall prepare plans for at-grade railroad crossings using the following design criteria where feasible:

Alignment: 90 degrees to the railroad desirable, 70 degrees minimum, with good sight distance in both directions.

Grade: Where crossings involve two or more tracks, the top of rails for all tracks shall be brought to the same plane where practicable. The surface of the highway shall be in the same plane as the top of rails for a distance of 2 feet outside of rails for either multiple or single-track crossings. The top of rail plane shall be connected with the grade line of the highway each way by vertical curves (if necessary) of such length as is required to provide riding conditions and sight distances normally applied to the highway under consideration. It is desirable that the surface of the roadway be not more than 3 inches higher or 6 inches lower than the top of the nearest rail at a point 30 feet from the rail measured at right angles, thereto, unless track superelevation dictates otherwise. Desirable grades on the tangent immediately adjacent to the grade across the rails of the track shall be 5% or less but no steeper than 7%.

Curbs: Proposed roadway curbs and/or curbs and gutter shall terminate no less than 13 feet from the centerline of the nearest tracks for at-grade railroad crossings.

The roadway right-of-way lines will terminate at the railroad right-of-way as shown on Figure 1-5. No easement will be shown on the plans for this crossing. The easement note as given below will be added to the present layout sheet near the crossing.

"Easement required for the railroad crossing is to be obtained by the Utilities Engineer by provisions contained in the crossing agreement negotiated with the railroad."

Bearings and distances will be provided along both the railroad right-of-way and the proposed roadway right-of-way lines. The distance to the nearest milepost will be shown at the intersection of the centerlines of the roadway and railroad.

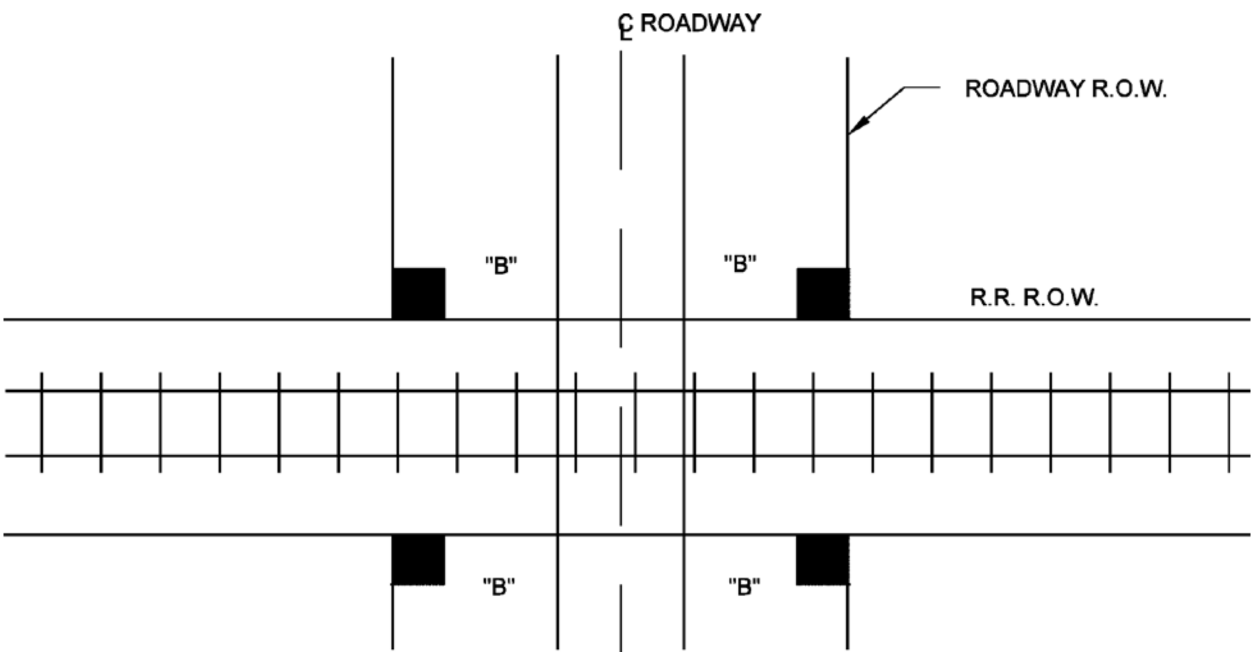



**Figure 1-5**
**Method for Showing Right-of-Way at an At-Grade Railroad Crossing**

## 1-210.10 RAILROAD RIGHT-OF-WAY ENCROACHMENT – PARALLEL CONSTRUCTION

When the proposed roadway is parallel to the railroad, as shown on Figure 1-6, the railroad shall be given a tract number and included in the right-of-way tabulation block as permanent easement to be acquired by the Right-of-Way Division.

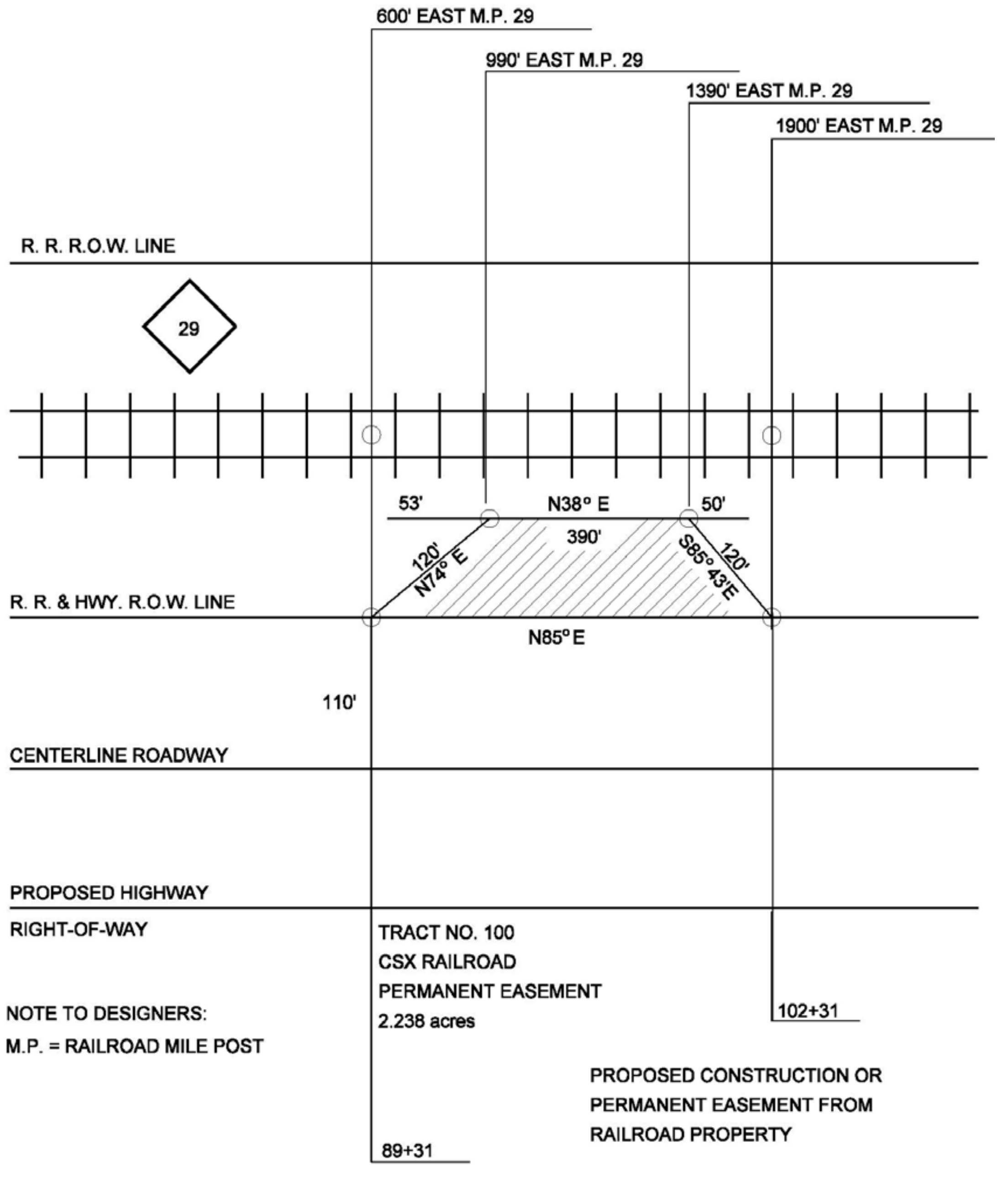



**Figure 1-6**
**Example for Preparation of Right-of-Way Details when Encroachment is Parallel to the Railroad**

When constructing a roadway parallel to a track roadbed, if work is required inside the railroad right-of-way, the preferred construction limit (toe of slope) shall be no closer than 50 feet from the centerline of the nearest track.

If it is necessary to encroach nearer than the 50 feet described above, a set of preliminary plans, including cross-sections, showing how the proposed work ties to the existing railroad roadbed, are to be sent to the utility section of the Right-of-Way Office for review, comment and submittal to the railroad. Example is shown in Figure 1-7 below.

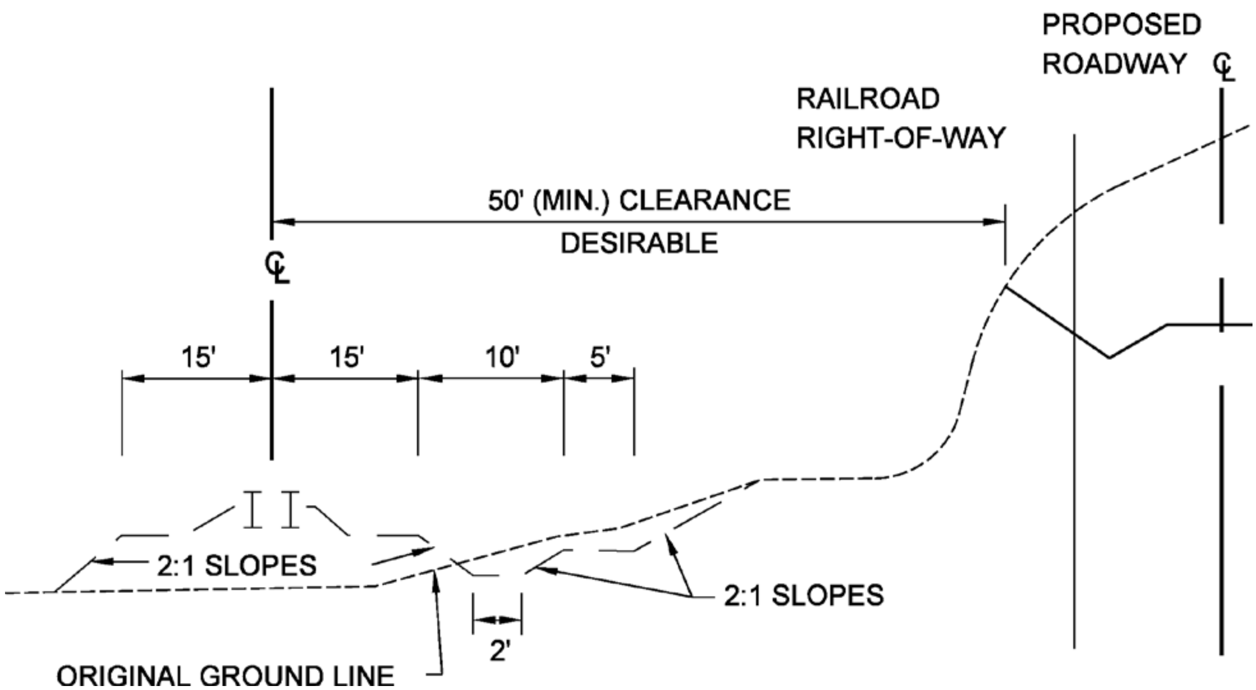



**Figure 1-7**
**Sketch Showing the Minimum Requirement for Railroad Typical Roadbed Section. To Be Used as a Reference for Designers Working Inside Railroad Right-of-Way.**

## 1-215.00 KNOWN ENVIRONMENTAL CONSTRAINTS

Any known environmental constraints identified in the environmental document or other expert sources should be indicated on the plans and brought to the Project Managers attention as soon as the constraints are recognized. Constraints may include, but not limited to the following: blue line steams, wetlands, a tree with political ties, registered historical sites, etc. Ecology, permit assessment, and SWPPP review items encountered are to be addressed prior to the right-of-way plan submittal.

## 1-220.00 PLANS REVISION DISTRIBUTION SCHEDULE

The current plans revision distribution schedule is listed below. This schedule is to be used for distribution of all plans revisions. Distribution schedules are attached for letting, right-of-way, and construction plans revision. Please note that revisions are filed and referred to by project number and revision dates, therefore, only one revision per day should be made on any project.

### Distribution of Right-of-Way Plans Revisions

The following distribution will occur for all of right-of-way revisions regardless of whether they have been let to contract or not. Send original to the Director of the State Right-of-Way Division and copies to the appropriate Regional Right-of-Way Manager.

For Regions 1 and 4

- Director, State Right-of-Way Division – W/1 set (full size) & 1 set (half size) prints
- Regional Right-of-Way Manager, Region 1 – W/(See distribution of plans revisions on Right-of-Way Plans Revisions Request Form)
- Regional Right-of-Way Manager, Region 4 – W/(See distribution of plans revisions on Right-of-Way Plans Revisions Request Form)

For Region 2 and 3

- Director, State Right-of-Way Division – W/1 set (full size) & 2 sets (half size) prints
- Regional Right-of-Way Manager, Region 2 – W/(See distribution of plans revisions on Right-of-Way Plans Revisions Request Form)
- Regional Right-of -Way Manager, Region 3 – W/(See distribution of plans revisions on right-of-way Plans Revisions Request Form)

If the right-of-way revision is initiated by the Regional Right-of-Way Office, the initial right-of-way plans revisions will carry the same distribution as shown on the “Right-of-Way Print Plans Request Form”. The “Right-of-Way Plans Revision Form” should reflect that distribution. As the right-of-way process proceeds forward towards its end the distribution of right-of-way revisions will be reduced dramatically. The reduced number of sets of revised right-of-way plans should therefore be shown on the “Right-of-Way Plans Revision Form”. This situation should occur during the later stages of right-of-way acquisition and most of the time after the project has been let to contract.

If the right-of-way plans revision is initiated by the Design Division, the designer must check with the Regional Right-of-Way Office to find out the required distribution of right-of-way plans at that particular phase of the project.

**Distribution of Letting Plans Revisions**

Note: Designers should check with the State Construction Office to determine if plans revision notes and letters are required. If so, please furnish the items listed under the appropriate letting date, and contact the Assistant State Construction Engineer responsible for the project to see if a revision can be processed before the letting.

For Regions 1, 2, 3, and 4

Letting Revision Distribution for projects with the following prefixes:

I, IM, ID, NH-1, STP-1, CM-1, MA-1, IXA-1, BR-1 and DPI

Send original to the Projects Management Engineer of the FHWA Division.

- FHWA Division, Project Management Engineer W/1 set prints (half size) & 4 copies of the letter
- Construction Division Director W/2 rev. sets prints (half size), 2 copies of the letter & 1 copy of the estimate revision request form
- Design Division, C.E. Manager 2 /w/1 rev set prints (half size) & 1 copy of the letter
- Design Division, Quality Assurance Office, C.E. Manager 1 W/1 set prints (half size) & 1 copy of the letter
- Printing Services Superintendent W/4 copies of the letter
- Program Operations Office, Estimates Section W/1 set rev. prints (half size), 1 copy of the letter and 1 copy of the estimate revision request form

Letting Revision Distribution for all other project prefixes including 100 percent state and IME.

Send original to the Director of the Construction Division.

- Construction Division Director W/2 rev. sets prints (half size), 2 copies of the letter & 1 copy of the estimate revision request form
- Design Division, C.E. Manager 2 W/1 rev. set prints (half size) & 1 copy of the letter
- Design Division, Quality Assurance Office, C.E. Manager 1 W/1 set prints (half size) & 1 copy of the letter
- Printing Services Superintendent W/4 copies of the letter
- Program Operations Office, Estimates Section W/1 set rev. prints (half size), 1 copy of the letter and 1 copy of the estimate revision request form

**Distribution of Construction Plans Revisions**

For Regions 1, 2, 3, and 4

Construction Revision Distribution for projects with the following prefixes:

I, IM, ID, NH-1, STP-1, CM-1, MA-1, IXA-1, BR-1 and DPI

Send original to the Projects Management Engineer of the FHWA Division and copies to the appropriate Regional Construction Manager.

- FHWA Division, Projects Management Engineer W/1 set prints (half size) & 4 copies of the letter
- Regional Construction Manager, Region 1 – W/9 sets prints (full size), 6 sets (half size) prints & 1 copy of letter
- Regional Construction Manager, Region 2 – W/9 sets prints (full size), 7 sets (half size) prints & 1 copy of letter
- Regional Construction Manager, Region 3 – W/8 sets prints (full size), 7 sets (half size) prints & 1 copy of letter
- Regional Construction Manager, Region 4 – W/9 sets prints (full size), 6 sets (half size) prints & 1 copy of letter
- C.E. Manager 2, Design Division – W/1 set (half size) prints & 1 copy of the letter
- C. E Manager 1, Design Division, Quality Assurance Office – 1 set (half size) prints & 1 copy of the letter

Construction Revision Distribution for all other project prefixes including 100 percent state and IME.

Send original to the appropriate Regional Construction Manager.

- Regional Construction Manager, Region 1 – W/9 sets prints (full size), 6 sets (half size) prints & 1 copy of letter
- Regional Construction Manager, Region 2 – W/8 sets prints (full size), 7 sets (half size) prints & 1 copy of letter
- Regional Construction Manager, Region 3 – W/8 sets prints (full size), 7 sets (half size) prints & 1 copy of letter
- Regional Construction Manager, Region 4 – W/9 sets prints (full size), 6 sets (half size) prints & 1 copy of letter
- C.E. Manager 2, Design Division – W/1 set (half size) prints & 1 copy of the letter
- C.E. Manager 1, Design Division, Quality Assurance Office – 1 set (half size) prints & 1 copy of the letter

# CHAPTER 3 - GUIDELINES FOR DESIGN OF ROUNDABOUTS

## 1-300.00 GENERAL ROUNDABOUT DESIGN PRINCIPLES

TDOT roundabout designs should consist of either a single lane or multi-lane facility for both urban and rural settings. The design of a roundabout requires balancing the needs of the existing and proposed traffic in a given location with providing intersection control that is efficient and user friendly for the traveling public. The design should provide for reduced and consistent speeds throughout the intersection. This will enhance both safety and operational performance at the intersection.

At a minimum, all TDOT roundabouts should follow these basic design principles:

- Provide a yield at all entry points
- Yield right-of-way to circulating vehicles
- Counterclockwise vehicular traffic passes to the right of the center island
- Splitter islands at all approaches providing channelized approaches
- Entry deflection required to control speed
- Maintain consistent speeds throughout
- Limit pedestrian traffic to designated locations at the approach legs
- Parking and private driveways prohibited within the circulatory roadway
- Provide proper sight distance, marking, signing, and visibility

Roundabout designs are site specific to each individual intersection and should not be considered as a template to be used at other locations. The designer should be aware that there is not an absolute design for any given site. Each proposed location will require new information and analysis and may contain site specific design issues to overcome during the project development process.

The basis for these roundabout Design Guidelines is the Federal Highway Administration's (FHWA) Report No. FHWA-RD-00-067, *Roundabouts: An Informational Guide*, dated June 2000. Available on-line, this document is widely considered the most comprehensive guide for planning and designing roundabouts; however, the designer should not consider this document as the rule book for proper design. Other supplemental information and standards of practice have been adopted for these Design Guidelines.

## 1-305.00 GENERAL ROUNDABOUT DESIGN CONSIDERATIONS

### 1-305.05 DESIGN SPEED AND DESIGN VEHICLE SELECTION FOR ROUNDABOUTS

A roundabout operates most effectively when the final design results in a desired speed reduction and a consistent speed is maintained throughout the intersection. Design speed is fundamental to attaining desired operational performance at the intersection. The design speed of a roundabout is determined from the fastest vehicle path allowed by the geometry. Geometric and other design features should be properly selected and checked to ensure speeds are appropriately reduced at the approach, entry, circulating lanes, and exit of the intersection. A combination of all design elements working together is ultimately how the final design speed will be dictated. Table 1-1 provides the recommended design speed based on the type of roundabout.

| Roundabout Type | Recommended Entry Design Speed R1 (mph) |
|---|---|
| Urban Single Lane | 20 |
| Urban Multi-Lane | 25 |
| Rural Single Lane | 25 |
| Rural Multi-Lane | 30 |

**Table 1-1**
**Recommended Entry Design Speed (R1) for Roundabouts**
Reference: FHWA, *Roundabouts: An Informational Guide, 2000*

The choice of design vehicle should be based on the type of roadway, volume and type of vehicles expected, and the intersection location. For the purpose of most TDOT designs, the AASHTO WB-62 vehicle should be used for designing roundabouts, especially those located on the state highway system, freeway or other controlled access facility ramp terminals, or industrial areas where a high percentage of truck traffic is expected. The circulatory roadway width should readily accommodate a WB-50 design vehicle without the need to track onto the truck apron; however, larger vehicles (WB-62, etc…) are expected to track onto the truck apron.

In cases where a roundabout is being located in an area with minimal truck traffic, or where the roundabout is being located on an urban collector, local road, or where community sensitive design parameters are being used for design, the WB-50 design vehicle may be used for the entire design, including the turning movements check at the truck apron. Where over-sized trucks are expected, the designer may want to consider designing the roundabout for a legal vehicle larger than the WB-62.

The design vehicle should be accommodated while maintaining a minimum 2-foot separation between the truck and the curb face. Additionally, the designer should be aware that for multi-lane roundabouts, large trucks rarely track within the circulatory lanes marked on the pavement and may utilize both lanes, or possibly both lanes *and* the truck apron, while attempting to navigate through the intersection.

### 1-305.10 HORIZONTAL ALIGNMENT CONSIDERATIONS FOR ROUNDABOUTS

All approaching roadway centerlines should pass near the center of the proposed circle, as close to a 90 degree angle as possible when projected across the intersection. This configuration should allow for necessary entry deflection without creating severe horizontal curvature or reduced stopping sight distance. The designer should attempt to achieve this configuration on most projects. Where this is not possible at an approach, the designer may offset an approach centerline to the left of the circle's center. It is not recommended that any approach leg to a roundabout be offset to the right of the circle's center. A right-of-center layout will result in the alignment entering at a greater tangential angle and may lead to higher entry speeds, greater potential for vehicle roll-over, and increased pedestrian conflicts.

Where feasible, the designer should attempt to equally space entries into the circulatory roadway. For new facilities, adjustments to the approaches in advance of the roundabout may be required. For urban roundabouts, the ability to provide equally spaced entries may not always be possible, especially when existing intersecting roadways are skewed from the mainline. When considering adjustment to approaches the proposed right-of-way cost should be factored into the final design decision. Where estimated right-of-way and construction costs are excessive, the roundabout design may be eliminated.

## 1-305.15 LONGITUDINAL GRADE CONSIDERATIONS FOR ROUNDABOUTS

An important factor when determining the optimum location of a roundabout is the longitudinal (profile) grade passing through the intersection. A relatively flat area with minor grade changes for drainage is preferred. The longitudinal grade through a roundabout should be limited to a maximum of 4 percent. Flatter longitudinal grades are preferred. Longitudinal grades in excess of 4 percent are not recommended due to the increased potential for load shifting within semi-trailers traversing the intersection, especially on the down-slope side of the central island, which can result in overturning of the vehicle.

Where a longitudinal grade cannot be designed less than 4 percent, the designer should consider benching the roundabout into a localized flat area and steepening the roadway approaches to the intersection. The design should accommodate for the steeper approach grades by providing adequate braking distance.

Large differences in grades through and around a roundabout can create sight distance problems; refer to the sight distance design criteria in Section 1-225.20 for more information. Roundabout sight triangles should be approximated during the preliminary design stage since they are different than for a normal intersection. Having proper sight triangles is essential to roundabout operation and performance.

## 1-305.20 RIGHT-OF-WAY REQUIREMENTS FOR ROUNDABOUTS

The purchase of right-of-way may be a determining factor when locating a roundabout. As compared to a traffic signal or a stop-controlled intersection, roundabouts usually require more right-of-way closer to the intersection and less right-of-way further away. Roundabouts designed in tight urban areas where building corners and/or right-of-way corners are close to the intersection may require additional right-of-way so that required sight distances are achieved. Additional right-of-way may also be required to alleviate skewed entries, accommodate multi-lane roundabouts, provide for right-turn bypass lanes, or maintain required intersection sight distances.

If there is a possibility for future expansion of a roundabout from a single lane to a multi-lane facility, the designer should consider designing the roundabout to a multi-lane standard with provisions for expanding the initial roundabout included in the design. The intersection may be opened as a single lane roundabout and then enlarged toward the central island and splitter islands at a later date. Expansion should normally be inward, so the designer should provide an adequately sized inscribed circle diameter and splitter islands if future expansion is expected.

## 1-305.25 CONSIDERATIONS FOR HIGH SPEED APPROACHES AND RURAL LOCATIONS FOR ROUNDABOUTS

High speed approaches and rural roundabout locations require additional attention because of the need for speed reduction of the approaching vehicles. Any approach to a roundabout with a posted speed of 45 mph or greater should be considered a high speed approach, even if the project site is located in an urban or urbanizing area. At these locations, drivers may not be anticipating a roundabout or any other type of speed interruption. Drivers should be able to discern the impending intersection configuration and react to changing operational needs. Providing sufficient entry deflection is one of the most important design parameters for roundabouts with high speed approaches.

At high speed approaches or rural locations the designer may consider additional speed reducing design elements including:

- Providing visibility of the roundabout from a greater distance.
- Adding reverse curvature at the high speed approach leg. The reverse curves should have a broad radius at the first curve, moderate at the second, and a sharp radius at the last curve before the yield line. See Section 6.5 in FHWA *Roundabouts: An Informational Guide*, for a graphical representation.
- Alignment and cross-sectional cues to alert drivers of the pending change in geometry such as longer splitter islands for additional deceleration length (see AASHTO recommendations for required braking distance), adding curb or curb and gutter to both sides of the approach, and a transition section where the shoulders narrow for the curbed section.
- Additional signs and pavement markings to supplement geometric features, landscaping features to produce a “tunneling” effect, and roadway lighting.

Standard AASHTO guidelines for island design should be followed for the splitter island designs. This includes using larger nose radii at approach corners to maximize island visibility and offsetting curb lines at the approach ends to create a funneling effect. The funneling treatment also aids in reducing speeds as vehicles approach the roundabout.

For rural locations where a roadway shoulder is being used for a bike route or for urban areas designated as a bike lane, the shoulder should not continue through the roundabout. The roadway shoulder should end approximately 100 feet prior to the yield line and a bicycle ramp should be provided to allow cyclists the option of exiting the roadway to a multi-use path around the roundabout or remaining on the roadway. Riders choosing to continue through the roundabout will be required to merge with the vehicular traffic in both position and speed. The additional lane width of the circulatory roadway should be adequate to accommodate cyclists choosing to pass through the circle. The designer should not specifically mark a shoulder or bike lane within the circulatory roadway.

## 1-305.30 GRADING AND DRAINAGE CONSIDERATIONS FOR ROUNDABOUTS

The optimum grading scheme for a roundabout is to slope the circulatory roadway away from the central island (i.e. the center of the central island is the highest point in the intersection). This will aid in achieving the desired visibility of the central island to the approaching motorist. The designer should accept the adverse superelevation for left turning and through vehicles in the travel lanes of the circulatory roadway.

While each location will be unique, grading a roundabout to slope away from the central island should follow these general guidelines:

- The ground slope of the central island should not exceed 6H:1V (per AASHTO *Roadside Design Guide*).
- The central island earthen area should always be raised, not depressed.
- The slope of the truck apron should not exceed 4 percent and should normally be between 2 and 3 percent, away from the central island. When the entire intersection is placed on a constant longitudinal grade, special attention should be given to ensure that the slope of the truck apron on the down-grade side of the center circle does not exceed 4 percent. Apron cross-slopes above 4 percent may lead to roll-over or load shifting within trucks.
- Roadway cross slope of the circulatory roadway should be a maximum of 2 percent sloping away from the center circle. Superelevation sloping toward the central island will normally result in increased vehicle speeds and will additionally result in the need to place stormwater inlets along the truck apron.
- The maximum grade in any direction of travel along the circulatory roadway should be 4 percent.

The designer should note that by sloping the entire intersection away from the central island, visibility is improved since the center of the circle becomes the highest point in the intersection. Sloping the roadway inward is not preferred, unless the design is for a multi-lane roundabout in which one-third of the lane width can slope inwards and two thirds can slope outwards from the central island.

Stormwater runoff should be controlled to minimize sheet flow across the roundabout. The designer should consider the vehicle wheel path traveling through the roundabout when considering placement of catch basins and inlets. The most desirable location of stormwater inlets is between the entrance and exits of the roundabout. Additional inlets in the roundabout may be required and installed above the splitter islands. Concentrated storm drainage that is directed towards a roundabout should be intercepted where practical prior to entering the circulatory roadway. The designer should not place inlets or low points within crosswalks.

Drainage for the circulatory roadway should typically be toward the exterior of the intersection; away from the central island. Inlets should be placed in the outer curb line of the roundabout, away from, and up-slope, of crosswalks. When the roundabout is placed on a roadway with a constant grade that passes completely through the intersection, the designer may be required to place an inlet adjacent to the central island. In rare cases where the central island is large enough and/or contains complex landscaping plans, the designer may consider placing an area drain within the central island to minimize runoff to the roadway.

## 1-310.00 GEOMETRIC DESIGN ELEMENTS FOR ROUNDABOUTS

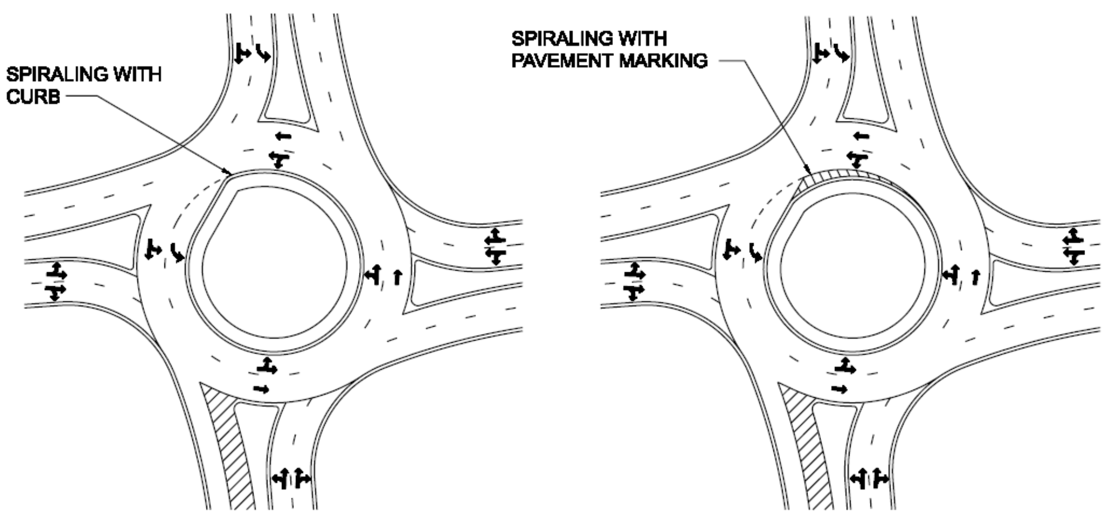
A roundabout intersection incorporates a different group of geometric elements than a traditional signal or stop controlled intersection. Roundabout design ranges should not be considered absolute. Some locations may require the designer to deviate slightly from the given design ranges on an as-needed basis. The following list of geometric features is generally considered the most basic of design elements for a simple roundabout intersection.

1. **Inscribed Circle Diameter (ICD)** is the basic diameter of the roundabout circle. The ICD is measured from curb face to curb face across the largest part of the circle. The ICD size can vary at different parts of the circle due to spirals on the inside lanes (see Figure 1-8). Larger ICDs may help to reduce circulating speeds but may also result in the need for additional right-of-way. Determining the optimal ICD size is typically an iterative process. The designer may consider making minor changes in the size of the ICD, but should also be cautioned from deviating too much from the original requirements of the roundabout traffic model. See the RD-series Standard Drawings for ICD size.

   The use of a smaller ICD may not adequately allow for the WB-62 to make a left or u-turn. Ultimately, the design vehicle selected will have a direct influence on the ICD, especially for single lane roundabouts where the ICD is most influenced by the vehicle selected. While a truck apron is required at all roundabouts, the width of the truck apron may be larger when the ICD is small.

2. **Circulatory Roadway Width** is the travelled way width of the roadway for vehicles circulating around the central island. This width is typically measured from the curb face at the central island to the edge of the gutter of the ICD. The width of the circulatory roadway is directly dependent on the entry width into the roundabout, and is typically designed to be 1.0 to 1.2 times as wide as the width of the largest entry. The circulatory roadway width does not include the mountable truck apron.

   **Spirals** are used to lead vehicles into their proper lane within the circulating roadway and are effective in keeping vehicles in the proper lane as they traverse the roundabout. A spiral is either a hard raised surface or painted line that develops at the central island and continues "spiraling out" until it ties into a circulating lane. Spirals should be considered for use when multiple left-turning lanes are present so that turning movements and through movements do not overlap. Figure 1-8 depicts two options for providing spirals when used in a design at a multi-lane roundabout.




Spiral with Extended Central Island (Preferred) Spiral with Pavement Marking (Acceptable)

**Figure 1-8**
**Spirals for Multilane Roundabouts**

3. **Entry Deflection** is the curvature (deflection) of the roadway as the roadway enters the roundabout. Deflection is used as a passive speed control measure for entering vehicles and should be applied prior to the yield line. Proper and adequate entry deflection promotes reduced entry speed and speed consistency. Deflection also positions the entering vehicle so that the driver can see the circulating vehicles already in the roundabout. Entry deflection has a direct correlation with fastest path speeds, phi angle, truck turning movements, and path overlap, and will ultimately affect all aspects of a roundabout. Deflection is also critical for preventing wrong way movements at the entries.

   If the computed speed at the entry (the speed corresponding to the R1 critical path radius – see Figure 1-11) is high, the designer should consider increasing the entry deflection. To gain additional area for entry deflection, the designer can offset the roadway alignment of the approach leg to the left of the circle center. When used, a left-of-center offset is particularly beneficial to achieving desired deflection at roundabouts with small ICD's.

   **Entry Width** is the width of the entering travelled way as it approaches the roundabout after the flare length has ended (flare length is the distance from approach width to entry width). Entry width is the largest determinant of a roundabout's capacity and has a direct correlation to the fastest path measurement and truck turning movements. The most accurate location for measuring entry width is typically at the end of the splitter island, beginning at the intersection of the yield line and the left edge of the travel way, measured to the right edge of travel way. This measurement should be taken perpendicular to the right (exterior) gutter. Design ranges for entry width are provided on the Standard Drawings.

4. **Entry Radius** is the radius of the curve that leads vehicles into the roundabout. The entry radius is measured at the face of the outer curb line. The designer should use a radius that is small enough to reduce vehicle speeds, but not so small that vehicle turning movements are compromised. Acceptable ranges for entry radius can be found on the Standard Drawings.

5. **Exit Width** is the width at the exit roadway from a roundabout measured from curb face to curb face. The exit width should correlate with the upstream entries and circulating roadway width to ensure that it is wide enough. The designer should ensure that the exit width provided is not too narrow for vehicles as they attempt to leave the roundabout, resulting in possible delays. In general, the exit width should be no less than the entry width and it should transition to the full width cross-section of the receiving roadway.

6. **Exit Radius** is the radius of the curve that leads a vehicle out of the roundabout. The radius is measured along the face of the outer curb line. Exit radii are generally larger than entry radii to allow for smoother exits and minimize the potential for delays; however, to ensure low speeds at the downstream crosswalk, the exit path radius should not be significantly greater than the circulatory path radius either. Ideally, the exit curve should be tangential to the circulatory roadway. Design ranges for exit radius can be found on the Standard Drawings.

7. **Approach Width:** The approach width is the width of the approach leg prior to the flare length. The approach width, or half width, is measured from edge of travel way to edge of travel way.

8. **Right-Turn Bypass Lanes (Slip Lanes):** An exclusive lane used to accommodate a high right-turn volume; whereby, allowing right-turning traffic to bypass the roundabout. See Figure 1-9 for a schematic of a typical right turn bypass lane. In areas that have a high volume of pedestrian traffic, additional attention should be given to the design of the right turn bypass lane to allow for pedestrians to have the right-of-way. The designer should consider other options for accommodating anticipated right-turn volumes prior to using a bypass lane in an urban environment due to the potential for high pedestrian volumes. However, in some cases, the need for a multilane roundabout may be eliminated by providing a right-turn bypass lane.

   For rural roundabouts, right-turn bypass lanes may be considered when their need is warranted. When used, the designer should accommodate for greater vehicle speeds in the bypass lane and an increased risk to pedestrians crossing the quadrant of the intersection where the bypass lane is to be located. The project designer should examine the present and projected pedestrian and bicycle demand at the rural location under consideration, and properly design pedestrian crossings, signalization, and signing at the bypass lane.

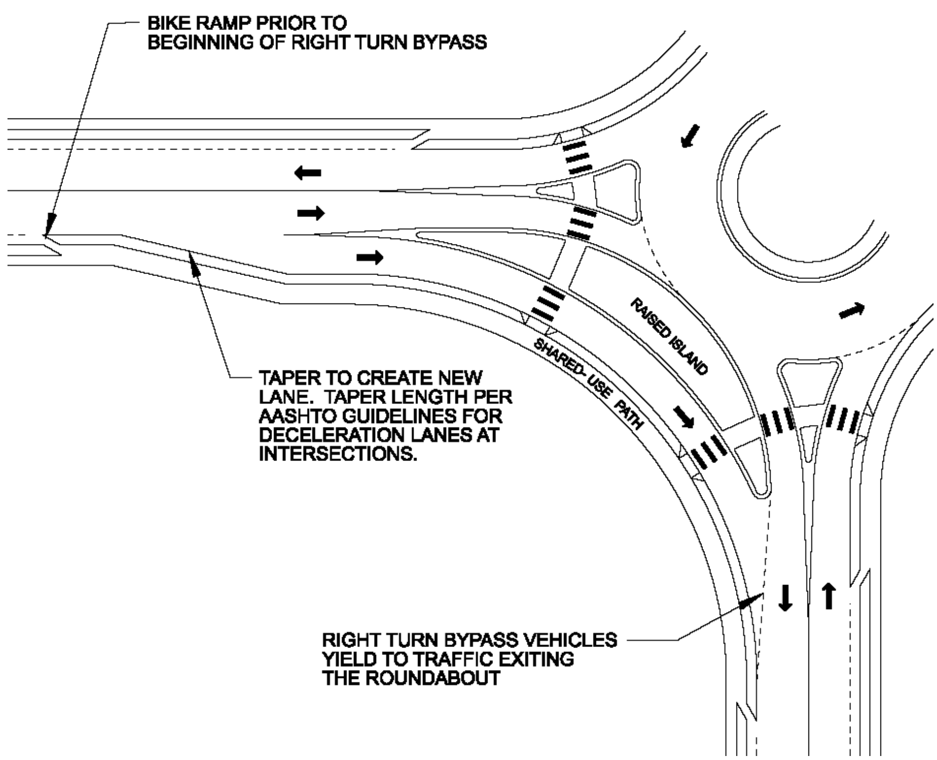



**Figure 1-9**
**Typical Right-Turn Bypass Lane**

Where a bypass lane is used, the following design criteria should be considered:

- Run a fastest path check through the bypass lane so that the bypass lane does not produce excessive speeds. Vehicle speeds in the bypass lane should be similar to those in the roundabout.
- Once a vehicle is committed to using the bypass lane, the design should not allow for access back into the circulating roadway.
- Minimizing the radius of the bypass lane may provide greater safety for crossing pedestrians; however, the design vehicle should be checked on all aspects of the bypass lane geometry.
- Traffic exiting the roundabout should be given the right-of-way over traffic exiting any bypass lanes. Providing a yield-controlled entrance onto the adjacent exit roadway from the bypass lane is required.
- In rural locations where right-of-way is available, an acceleration lane with appropriate taper rates based on AASHTO guidelines is the preferred merging method at the end of the bypass lane.
- Pedestrian crossing points should be designed per ADA guidelines in addition to the other requirements found in these roundabout guidelines.
- Proper lighting should be provided, where applicable.

Bypass lanes can potentially add a significant amount of required right-of-way area to the intersection design. The final decision to use a bypass lane should take into account pedestrian and right-of-way constraints. Proper analysis should ensure all right-turn bypass lanes have been justified prior to proceeding with a detailed design.

9. **Truck Apron:** A mountable circular concrete pad along the outer edge of the central island used to accommodate turning movements of larger vehicles. The truck apron is designed to allow the rear tires of large vehicles to traverse the apron as they are making through and left turn movements. The width of the truck apron should be in the range of 6 to 10 feet. Final truck apron design (width) should be based on truck turning analysis (design vehicle tracking) plus a recommended buffer of 2-feet in width for driver irregularity. Truck aprons should not be less than 6 feet wide.

   The truck apron shall not be flush with the traffic lanes nor merely painted on the roadway surface. Truck aprons are not intended for passenger vehicles or small trucks; therefore, a mountable curb that provides enough vertical grade difference should be used so as to appear unappealing to the driver of a smaller vehicle.

   It is preferable that the design of the truck apron provide a color or surface texture contrast from the circulatory roadway. This should normally be accomplished with an asphalt roadway and a concrete truck apron. Where the roadway surface is to be concrete, the designer may consider the use of stamped or colored concrete or brick pavers to achieve this contrast. The use of asphalt on the truck apron should be avoided.

## 1-320.00 ROUNDABOUT DESIGN CHECKS AND MEASUREMENTS

Roundabouts are generally considered a passive form of intersection control. Roundabouts create a situation in which drivers are expected to slow down as they enter the intersection through the use of visual cues and roadway geometry. Since a roundabout does not require a vehicle to completely stop, the design should ensure that vehicle speeds are reduced as the vehicle enters the roundabout. Vehicles entering at a slow, consistent, and controlled pace are essential to roundabout design, safety, and operation.

Design checks are measurements that are taken on various geometric elements of a roundabout to verify that the design will have sufficient entry angles, proper deflection and speed reduction, adequate area for turning movements, and adequate sight distance. Design checks are also necessary to show that the desired capacity and speed will be maintained for the types of vehicles that are expected to use the intersection. The design check process is essential to a roundabout design. Verifying the design through the use of design checks can be a tedious process, but is necessary for proper roundabout design.

The following design checks should be performed for proper roundabout design:

1. Fastest Path – The measure of a single vehicle's shortest (smoothest) path through a roundabout given the absence of any other traffic and given that the driver ignores all lane markings, traverses the entry, and travels around the central island and through the exit. In order for the designer to determine the maximum expected vehicle speeds at, and through the roundabout, fastest path measurements should be calculated. The fastest path should be measured at all approaches to a roundabout and should include path analysis for all left-turn, right-turn, and through movements at the intersection (i.e. a total of 12 measurements for a 4-leg intersection). Under certain circumstances, the critical path may be the right-turn movement; however, in most cases it will likely be the through movement. The longest of the fastest paths is typically the left-turn movement at the intersection.

   Fastest path measurements are typically taken by constructing a b-spline (polyline) curve in a CADD program. The b-spline curve (See Figure 1-10) should represent the centerline of the vehicle that is attempting to traverse the roundabout at the highest rate of speed possible while ignoring other vehicles, pedestrians, pavement markings, and signing. Three b-spline curves should be constructed for each approach into a roundabout.

   When laying out a b-spline curve, the designer should use an assumed width for a vehicle of 6 feet and to maintain a minimum of 2-feet of clearance from the roadway centerline or any curb face. When constructing b-spline curves for the centerline of the vehicle path, maintain the following minimum offset distances:

   - 5 ft. from face of a concrete curb (2' clearance + 3 ft to center of vehicle),
   - 5 ft. from a roadway centerline, and
   - 3 ft. from a painted edge line (if no curb is present).

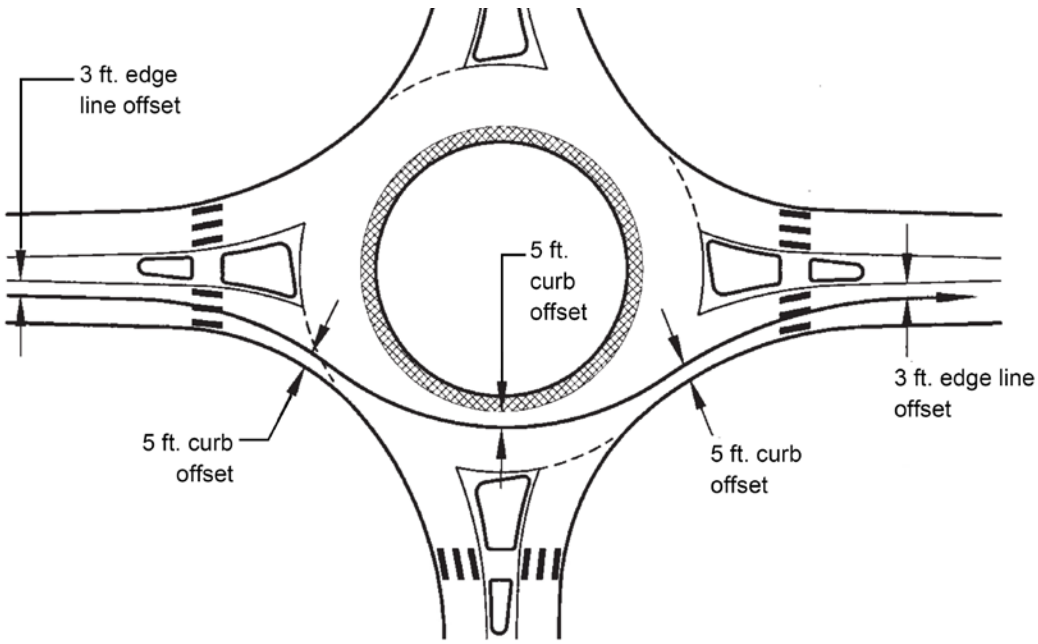



**Figure 1-10**
**Fastest Path for Through Movement at Single Lane Roundabout**
Adapted From: FHWA, *Roundabouts: An Informational Guide*

The through movement b-spline curve (as shown above in Figure 1-10) will be constructed to represent a vehicle entering a roundabout, passing to the right of the central island, and exiting the roundabout on the opposite side of the circle. The left-turn movement b-spline curve will be constructed to represent a vehicle entering a roundabout and making a left turn-around the central island. The right-turn movement b-spline curve will be constructed to represent a vehicle entering a roundabout and then making an immediate right-turn out of the roundabout. These movements are depicted in Figure 1-11.

Once the designer has constructed b-spline curves for the through, left-turn, and right-turn movements for each approach to the roundabout, corresponding speeds can be computed from each critical (minimum) path radius measured along the b-spline curve. The five critical path radii in a roundabout are:

- R1 - The minimum radius on the through movement b-spline curve, typically measured prior to the yield line, but not more than 165’ prior to yield line.
- R2 - The minimum radius on the through movement b-spline curve measured in the circulatory lanes around the central island.
- R3 - The minimum radius on the through movement b-spline curve measured at the exit to the roundabout.
- R4 - The minimum radius on the left-turn b-spline curve measured in the circulatory roadway around the central island.
- R5 - The minimum radius on the right-turn b-spline curve. Measured at the tightest point.

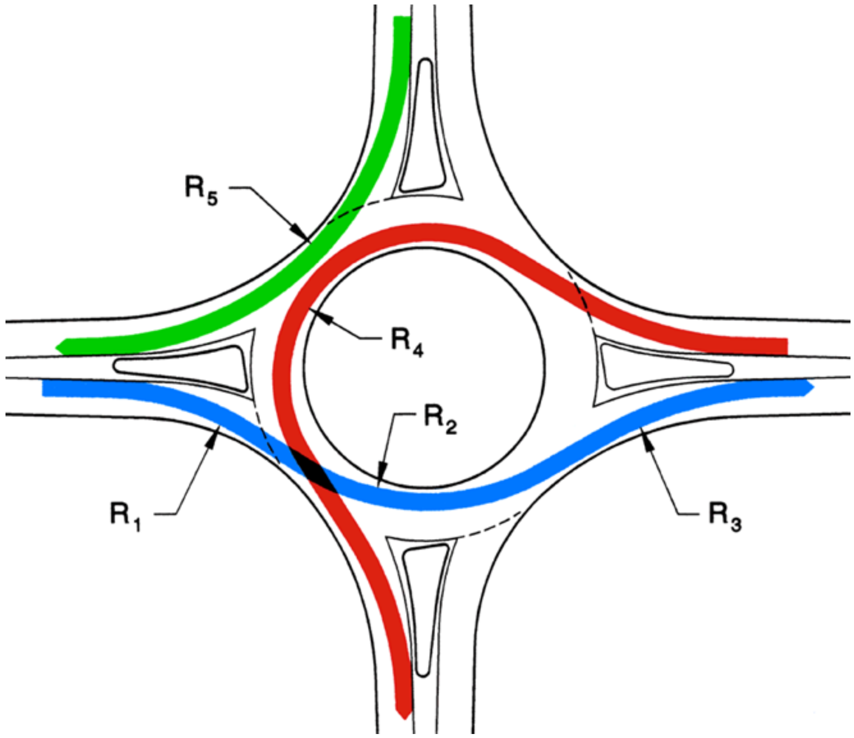



**Figure 1-11**
**Critical Path Radii at a Roundabout**
Reference: FHWA, *Roundabouts: An Informational Guide*

It should be noted that critical path radius does NOT equal curb radius. Each critical path radius should be measured in a CADD program; generally the designer can draw a new curve on top of the b-spline curve in order to measure the critical radii. Speeds should be recorded for all critical radii. Once the critical path radii are measured the designer can determine the corresponding speed associated with each critical path radius using methodology in AASHTO's *A Policy on Geometric Design of Highways and Streets*. Figure 1-12 correlates the measured radius to a computed speed using the AASHTO methodology.

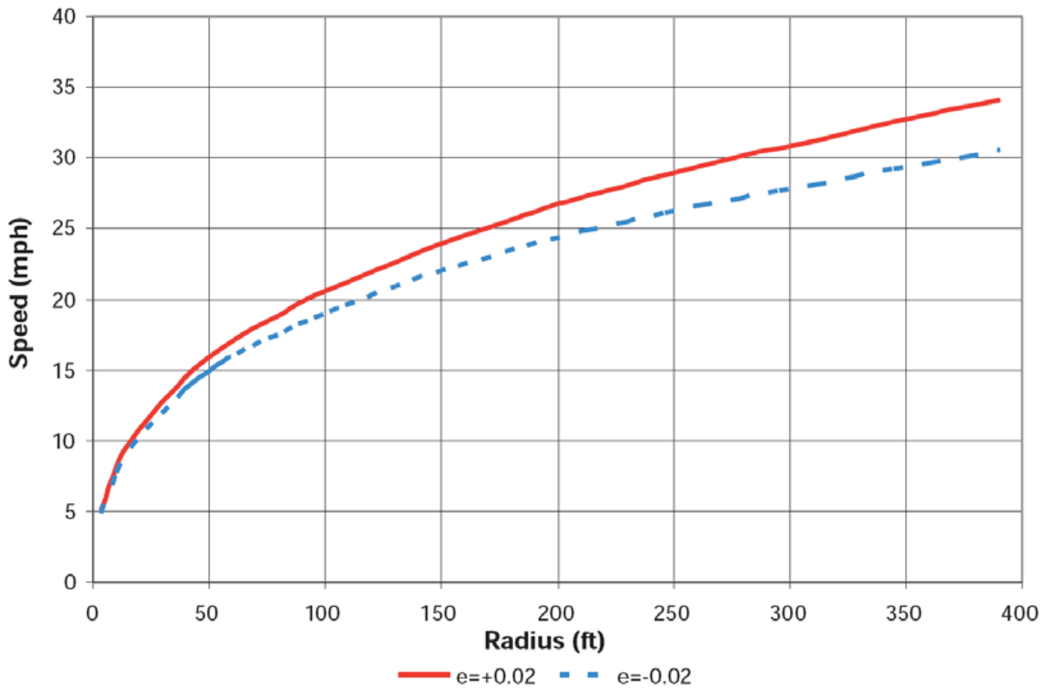



**Figure 1-12**
**Speed-Radius Relationship**
Reference: FHWA, *Roundabouts: An Informational Guide*

Figure 1-12 gives the designer an estimate of the maximum speeds through the roundabout at various locations: entrance, circulatory roadway, and exit. Use the +0.02 curve for measurements at the entry and exit (R1, R3, and R5) and use the -0.02 curve for those around the central island (R2 and R4).

Speed consistency is critical and should be checked between all fastest path measurements. The designer should attempt to minimize variations in vehicular speeds. If one path has a speed differential significantly higher than the other paths, that movement will tend to control the roundabout and the lower speed movements will be affected with longer queues. A speed differential of no more than 6 mph is preferred between all paths. Since this may not always be possible, a speed differential of 12 mph shall be considered the maximum allowable. It is preferable for R3 to be greater than R2, and R2 to be greater than R1 (i.e. the entrance has the lowest speed).

When the initial design will not produce adequate speed consistency, the designer has several options for consideration to remedy the situation. The following is a list of options that the designer may consider to correct a speed control problem:

- Adjust the size of the inscribed circle diameter a few feet, either making it smaller or larger as needed.
- Adjust the entry radius by a few feet by either making it smaller or larger.

- Re-design the entry or exit so that the entry angle changes, thus creating more or less deflection as needed.
- Move the entire circle in one direction to increase or decrease the entry deflection.
- Re-evaluate the modeling to determine if a different lane configuration will be acceptable.

Designers should be aware that any change to a geometric element will affect the previously computed roundabout design checks and all checks will need to be re-evaluated after geometric changes are made.

2. Phi Angle – The angle measured between the entering and exiting roadways or in the case of a three legged roundabout, it is the angle measured between the entering and circulatory roadway. When the angle is measured between the entering and exiting roadways, the actual phi angle is half the angle measured. In the case of an angle being measured between entering and circulatory roadways the phi angle is the angle measured.

   Phi angle is typically measured as a design check to verify that the entering roadway, in relation to the nearest exiting roadway, allows a driver to see oncoming traffic within the circle, without the driver having to turn their head in an uncomfortable position. When a driver approaches the yield line, the roundabout geometry should allow for the driver to see oncoming vehicles within the circle without having to look over their left shoulder excessively; whereby producing driver discomfort. Acceptable values for the phi angle typically range from 16 to 40 degrees.

3. Path Overlap – A critical design issue for multi-lane roundabouts occurs when the natural paths of entering and exiting vehicles in adjacent lanes overlap or cross each other. This occurs when a vehicle enters a roundabout and is directed into an adjacent lane once inside the circulatory roadway as shown in Figure 1-13. The existence of path overlap should be checked at both the entrance and exits.

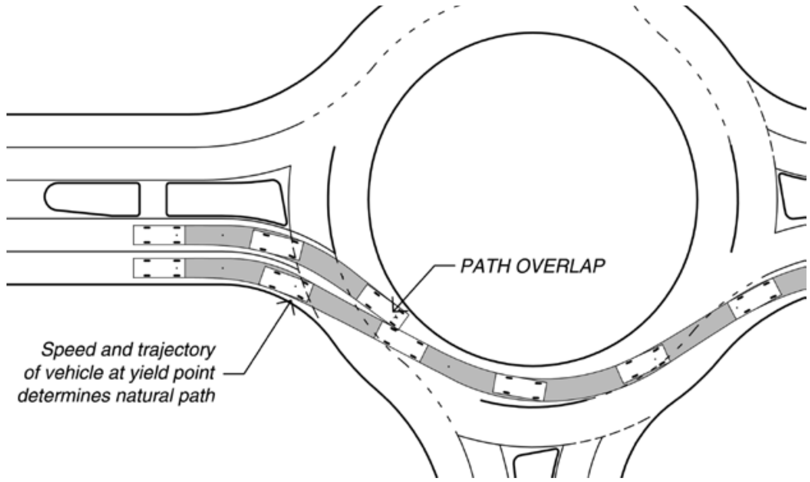



**Figure 1-13**
**Example of Vehicle Path Overlap**
Reference: KDOT, *Kansas Roundabout Guide*

Larger exit radii and/or tangential exits will aid in reducing the potential for exit path overlap. The designer can minimize the potential for entry path overlap by providing adequate entry deflection and ensuring multi-lane vehicle entry paths are properly aligned with the circulatory lanes ahead at the yield line. To accomplish this, the designer should locate the entry curve so that the projection of the inside entry lane at the yield line connects tangentially, or nearly tangentially, to the curb line ahead at the central island, as see in Figure 1-14.

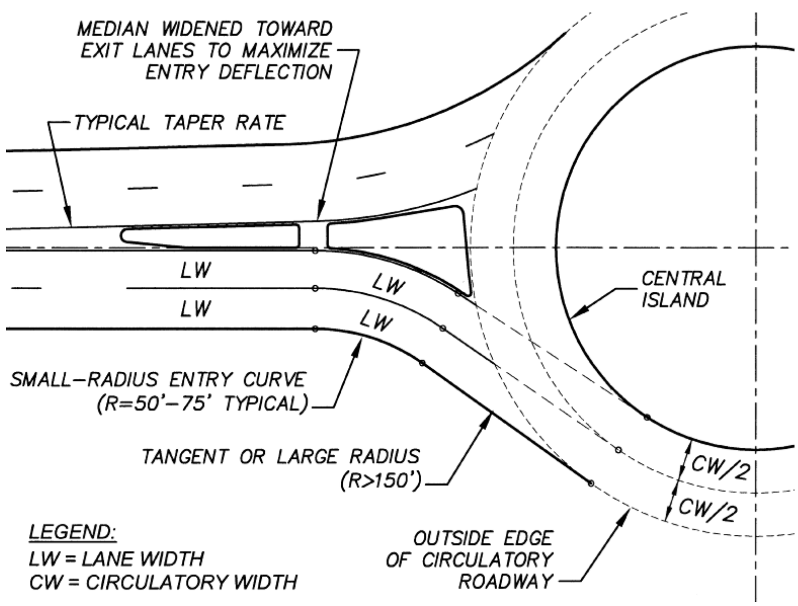



**Figure 1-14**
**Good Path Alignment into Multi-Lane Roundabout**
Reference: FHWA, *Roundabouts Technical Summary (FHWA-SA-10-006)*

Multi-lane roundabouts should be designed to minimize the potential for entry and exit path overlap which results in reduced operational performance due to unbalanced lane utilization on the approach. The designer should be particularly aware of path overlap, since it can lead to a higher rate of side-swipe collisions and may be adverse to the desired capacity of the roundabout. FHWA's *Roundabouts: An Informational Guide, 2000*; provides additional suggestions for eliminating path overlap at a multi-lane roundabout.

4. Truck Turning Movements – Truck movements should be reviewed for all roundabout designs to verify that the design vehicle can properly navigate all required turns. The right-turn movement tends to be the most challenging movement for a truck. The roundabout should be designed so that the truck tires do not track over the exterior concrete curbing or combined curb and gutter for the right-turn movement, nor over the splitter island curbing at the entry and exits. Trucks that are continuing through the roundabout or making a left turn can use the truck apron within the central island.

   TDOT roundabouts should be designed to accommodate a WB-50 vehicle within the traffic lanes, with the WB-62 design vehicle (or larger) expected to have to track over the truck apron. The truck apron at the central island will allow larger vehicles to track around the central island.

5. Stopping Sight Distance/Intersection Sight Distance – Key elements to safety and operating speed of a roundabout. There are three critical types of stopping sight distance that should be measured at roundabout intersections. Approach stopping sight distance, stopping sight distance on the circulatory roadway, and stopping sight distance to a crosswalk. These distances are normally measured to verify that there are no obstructions within the sight lines (triangles). Refer to FHWA's *Roundabouts: An Informational Guide* or the Standard Drawings for diagrams on the proper method for measuring stopping sight distance.

   When measuring intersection sight distance there are two conflicting approaches for a vehicle entering the roundabout. Intersection sight distance with the conflicting upstream entry and intersection sight distance within the circulatory roadway should be determined. Each should be checked independently and each should be measures along the expected vehicular path on the roadway, not as a straight line. While studies have shown that providing the minimum intersection sight distance may actually aid in speed reduction at some locations; for TDOT projects, speed should be controlled with geometric and other design elements, <u>not</u> by means of limiting sight distance. See Section 1-225.10 for additional speed reduction design elements.

   Stopping sight distance to crosswalks should be verified for both the entry and exit of the roundabout; especially at the exit crosswalk. NCHRP (Report 572, 2007) studies have shown that a higher percentage of drivers do not yield to pedestrians at the exit when compared to the entry. The proper design of the exit is essential to ensure adequate sight lines are provided between the driver and the pedestrian and that speeds are held to the desired amount. The designer should consider additional design features that will provide improved safety to pedestrians at crosswalks.

The roundabout design process should be considered an iterative process throughout the design. There may be several acceptable designs for a given location that will meet the desired performance objectives; however, this is rarely achieved on the first design iteration. Because of this, it is advisable that the designer prepare the preliminary layout drawings to a “sketch” level of detail. Design components are interrelated, and changing one affects others, so it is important that the designer evaluate the performance of the entire intersection design as changes are made to ensure that the individual components are compatible. If a change is made to one component of a roundabout design such as the ICD size, angle of approaches, or lane width, the designer should verify that other components of the roundabout will still meet the design criteria.

The flow chart in Figure 1-15 provides the general procedure and steps for designing a typical roundabout.

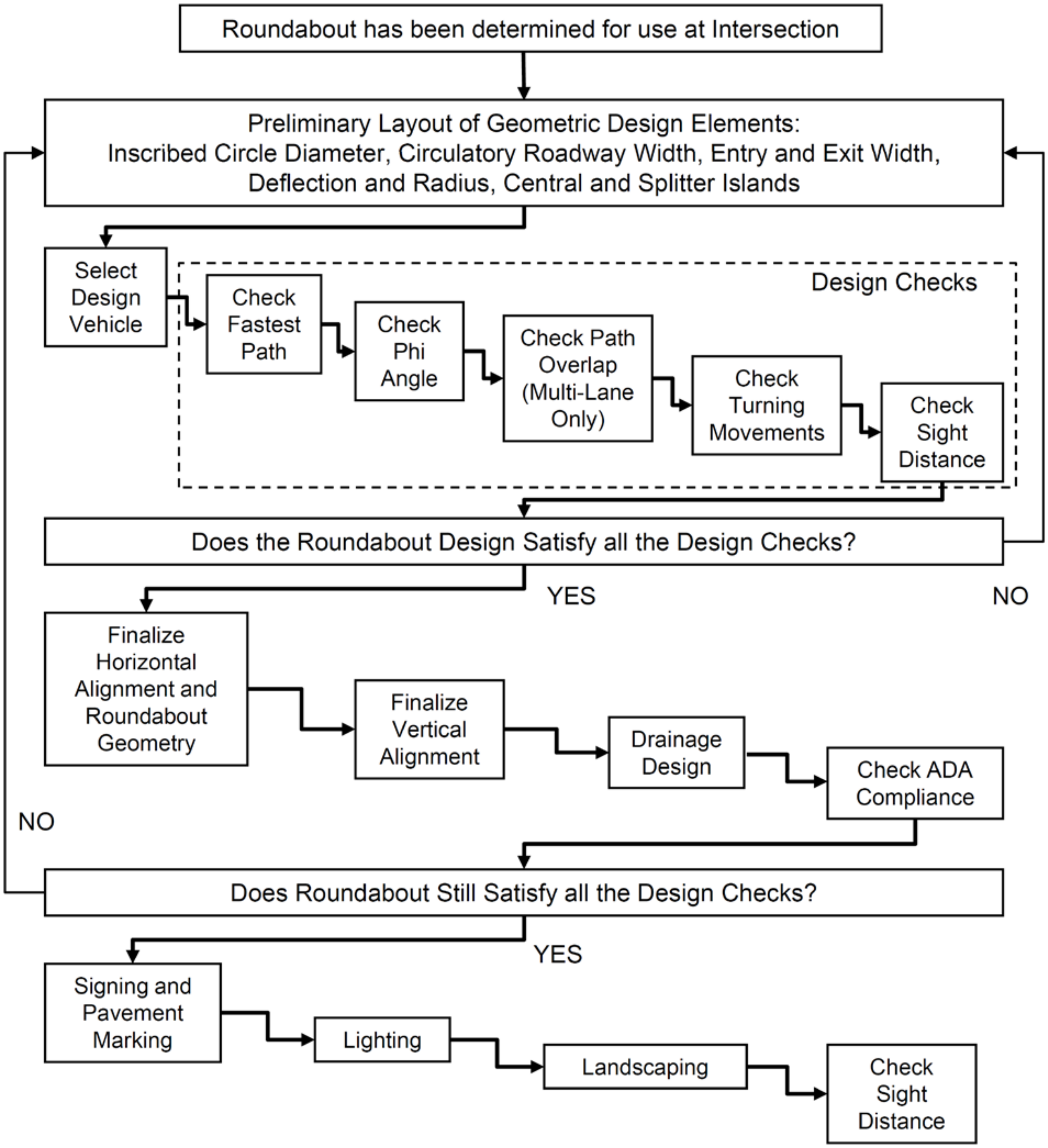



**Figure 1-15**
**Typical Roundabout Design Procedure**

## 1-330.00 ROADWAY DESIGN CONSIDERATIONS FOR ROUNDABOUTS

## 1-330.05 DETERMINING ROUNDABOUT LOCATION

For projects utilizing a roundabout for intersection control, optimum location, project goals, and system considerations should be reviewed before formal design begins. These additional design considerations should take into account existing and proposed grades, availability and cost of right-of-way, proximity to other intersections (especially signalized intersections), railroad crossings, intersecting roadway skew angles, and private driveway locations.

## 1-330.10 ROUNDABOUT PROXIMITY TO OTHER INTERSECTIONS

Roundabout proximity to other types of intersection control should be considered when determining a location for a roundabout. The typical spacing between intersections where one or more of the intersections is a roundabout, will generally be shorter than a series of signalized or stop controlled intersections. There is no absolute minimum distance between a roundabout and another intersection. In order to determine a satisfactory distance, a queue length evaluation should be completed prior to commencing with design. This queue length evaluation should include all queue lengths associated with the roundabout and any adjacent signalized or stop controlled intersections.

## 1-330.15 ACCESS MANAGEMENT AND PRIVATE DRIVEWAYS AT ROUNDABOUTS

Parking will not be allowed within the circulatory roadway of roundabouts designed by the Department. The designer should attempt to minimize or avoid locating on-street parking areas within the splitter island area or within the transition to the splitter island. For new designs, parking should be terminated a minimum of 75 feet from the yield point, which is at the entrance to the circulatory roadway.

Where driveways are present, the designer should consider methods for locating private driveways outside of the roundabout, so that a vehicle cannot take direct access to the circulatory roadway from the private property. Additionally, the designer should avoid providing private driveways anywhere within the vicinity of the splitter island. Where this is unavoidable, the driveway connection should be designed with a small raised island restricting traffic to a right-in/right-out movement, and the designer should check for proper sight distance to the left of the driveway for vehicles entering or exiting the roundabout. For most TDOT projects, driveway access between the crosswalk and yield line at the entrance (or exit) to the roundabout will not be permitted except under extraordinary circumstances.

Bus stops should be located as far away as possible from the entries and exits and should not be placed within the circulatory roadway or within the area of the splitter islands. Pedestrian crossing areas at the splitter islands should not be used for bus stop locations.

## 1-330.20 RAILROAD CROSSINGS AT ROUNDABOUTS

Roundabouts should not be designed at a location where the existing railroad line will pass through the center circle (or any portion) of the roundabout. The exception to this will be where an existing intersection is being reconstructed, and an existing rail line currently passes through the intersection. Even in this case, the designer should explore all options for relocating the roundabout to a location that the rail line crosses only one leg in proximity to the roundabout. In all cases involving a project in close proximity to a railroad track, the designer should acquire a queue length evaluation to ensure that vehicles will not queue onto the active rail line. Other options to minimize the possibility of a vehicle being on the railroad track is to pre-empt the roundabout with gates or flashing beacons at all the entrances and the exit feeding to the railroad track.

### 1-330.25 SERIES OF ROUNDABOUTS

Roundabouts should be evaluated for installation along a corridor, because they have advantages and disadvantages over traditional signalized corridors and may provide for design flexibility in urban and developing areas. Traffic and planning studies should be evaluated before considering a corridor containing a series of roundabouts. Each roundabout in a corridor or ramp interchange should be designed as a completely new intersection, just as a designer would treat a series of signalized intersections.

Roundabouts typically tend to have a higher capacity and lower delays than a traditional signalized intersection. This leads to shorter travel times through roundabout corridors than through signalized corridors.

### 1-330.30 ROUNDABOUTS USED AT INTERCHANGES

Roundabouts may be considered as an acceptable design option for intersection control at interchange ramp locations. Unlike a typical stop or signal controlled interchange, roundabouts generally require less space between ramps. This may save on right-of-way costs when considering a new interchange, especially when right-of-way is constrained or when the interchange is located near a narrow structure such as an underpass or overpass. Additionally, when designing a roundabout in close proximity to an interstate or other controlled access route approved for large trucks, the WB-62 design vehicle should be used for analysis.

Sight distance should be a significant design parameter when designing tightly spaced roundabouts at interchanges. The designer should verify that bridge abutments, piers, and/or bridge railings do not interfere with sight distance requirements. A full traffic analysis should be performed before a roundabout is considered at an interchange since roundabouts will be closely spaced. Additionally, an analysis should be performed to verify that required and appropriate signing can be adequately provided and visible to motorists at both new and retrofitted interchange locations.

### 1-340.00 PEDESTRIAN, BICYCLE, AND ADA CONSIDERATIONS FOR ROUNDABOUTS

The number of pedestrian/vehicle conflict points is reduced when a roundabout is used for intersection control. Since a roundabout may not have pedestrian signal phases or pedestrian push-buttons, and does not require vehicles to make a complete stop, other measures should be designed to ensure drivers and pedestrians are clearly able to see each other. Proper design should produce conditions needed to allow vehicles to yield to the pedestrians and at a reduced speed.

Since a goal of any roundabout is to reduce speeds without actually stopping the vehicles, a properly designed roundabout will reduce the risk of pedestrian/vehicle collisions due to the slow speeds expected. There are design elements that may be beneficial to pedestrian safety when designing the crosswalks at a roundabout. The following general design criteria should be considered for crosswalks at roundabouts:

- Minimized crossing distance to reduce pedestrian exposure to traffic.
- Where possible, crosswalks should be designed to provide pedestrians a straight walking path across the traffic lanes (90 degrees to traffic flow preferred), including any right-turn bypass lanes. This may not apply to small single lane approaches where a straight crossing route can be provided regardless of splitter island or roadway deflection.
- To minimize out-of-direction travel for pedestrians, crosswalks should be located as close as possible to the intersection while still maintaining required queue space for vehicles. A mid-block pedestrian crossing near a roundabout is not recommended.
- At single lane roundabouts, crosswalks should typically be located one vehicle length (approximately 20 feet minimum) behind the yield line; this gives the driver at the yield line the ability to concentrate on entering the roundabout.
- For multi-lane roundabouts crosswalks may be located one vehicle length behind the yield line. A designer may need to “bend” crosswalk alignments at the splitter island, where necessary to provide 90 degree crossings at the entrance/exit lanes where possible.
- Splitter islands should be a minimum width of 6 feet at the narrow end of the island – 9.5 feet preferred. The refuge area (gap) within the splitter island should be 10’ long. Therefore the minimum dimensions for the refuge area should be 6’ x 10’. See the Standard Drawings.
- The finished grade of the pedestrian crossing (refuge) areas within the splitter islands should be at or slightly above the elevation of the adjacent pavement. The designer should avoid elevating the refuge area except the minimal amount needed for proper drainage.

Additional details for crosswalks can be found on the Standard Drawings. The Standard Drawings for handicap ramps provide details for ramps at the exterior curb cuts for crosswalks. The splitter island refuge area should be wide enough to accommodate multiple modes of pedestrian traffic including side-by-side wheelchairs, bicycles with trailers, pedestrians, and pedestrians with baby strollers.

Accommodating designs for visually impaired and disabled pedestrians should be a priority at roundabouts since those pedestrians tend to rely on audio signals more than other pedestrians. Roundabouts generally do not require audio devices for pedestrian crossings, but in special cases they may be needed at a roundabout. In addition, detectable warning surfaces should be provided at all paths, including the splitter island refuge area, leading to any traffic lane. The Design Division’s handicap ramp Standard Drawings and roundabout Standard Drawings provide detectable warning surface details. All pedestrian facilities should be designed to comply with the latest version of the Americans with Disabilities Act.

The TDOT bicycle and pedestrian policy requires consideration be given to providing provisions for bicycles to be integrated into new construction and reconstruction of roadway projects through design features appropriate for the context and function of the transportation facility.

Bicyclists should be given a choice when approaching a roundabout of either going through the roundabout and mixing with the vehicles in the circulatory stream, or exiting the roadway prior to entering the roundabout and continuing around the roundabout on a shared-use path (sidewalk) with pedestrians. To optimize safety and the most efficient operation of the roundabout, bicyclists should be provided with shared-use paths around the perimeter of the roundabout. For the purposes of most TDOT design projects, the designer should provide bike ramps for exiting the roadway to the shared use path, and then ramps for re-entering the roadway, bicycle lane, or roadway shoulder on the opposite side of the roundabout.

The bicycle exit ramp (the ramp the bicyclist uses to exit the roadway prior to the roundabout) should be provided prior to the pedestrian crossing or at least 100’ prior to the yield line, whichever of the two is greater. At the exits, a bicycle entrance ramp should be provided after a pedestrian crosswalk or 100’ from the exit, whichever is greater.

Bicycle ramps should be a minimum 6’ wide between the roadway and the shared-use path. This width will be large enough to accommodate a bicycle pulling a child cart, but small enough to prevent a vehicle from using it. The bicycle exit and entrance ramp should typically be placed at a 20 to 45 degree departure angle from the roadway. A perpendicular bicycle ramp is not recommended since it would require a bicyclist to stop their forward momentum as they exit (or enter) the roadway. See the Standard Drawings for details of bicycle entrance and exit ramps.

Where cyclists prefer to pass through the roundabout, the designer should treat them as a vehicle in the circulating stream. Any designated bike lanes on the approach to the roundabout should be terminated a minimum of 100 feet upstream of the yield line. This will allow the bicycle to mix with the traffic, both in lane position and speed. Specific pavement markings for bicycles should not be present within the circulatory roadway.

If the roundabout is being designed at a location where there is a designated shared-use path, the design should include those geometric features detailed on standard drawing RD-TS-8. To minimize confusion between bicycle ramps and pedestrian ramps, detectable warning surfaces should be placed at the top of the bicycle ramps rather than at the bottom as is the practice with pedestrian ramps. At rural and urban locations where current pedestrian and bicycle traffic is not significant, but expected to increase, the designer should include measures in the plans to accommodate future needs or demands. These may include:

- Rough grading the perimeter of the roundabout to accommodate future sidewalks, landscaping buffer strip, shared use paths, etc…
- Installing handicap ramps or lowered curb at logical “future” locations along perimeter curbing
- Providing cut-throughs (gaps) at the splitter islands for future crosswalks
- Obtaining adequate right-of-way to accommodate future measures including lighting

Additionally, the designer should refer to the AASHTO Guide for the Development of Bicycle Facilities, 1999.

## 1-350.00 SIGNING AND PAVEMENT MARKING FOR FOUNDABOUTS

The concept for signing and marking a roundabout is similar to standard intersection signing and marking. The signing and marking plan should stress proper regulatory, advanced warning, and directional guidance to provide positive guidance to the motorist. Each roundabout design will be unique, and the signing and marking plans can become complex. Signing and marking needs are different for urban and rural applications and for varying types of roundabouts.

All signing and marking plans should conform to the current edition of the *Manual on Uniform Traffic Control Devices* (MUTCD). The FHWA's *Roundabouts: An Informational Guide*, the Design Division's *Traffic Design Manual* and the Standard Drawings may be used for additional reference or guidance for signing roundabouts and the approaches to a roundabout.

The following additional sign criteria should be considered for roundabouts over that which may be present at a normal intersection:

- Roundabout ahead signs
- Advanced diagrammatic guide signs and markings
- Yield signs on more than one approach to an intersection
- Long chevron plate typically used in the center circle
- Exit guide signs

For urban roundabouts, the design will need to balance providing adequate signing for a more familiar user of the intersection with the tendency to use too many signs. Street name signs are typically considered a necessity for urban locations. For rural applications, where higher approach speeds are expected and normal signage and geometric features will not produce the desired reduction in speed, the designer should consider the following additional measures:

- Large advanced warning signs
- Word markings on the pavement
- Speed reduction warning signs

Additional requirements for pavement markings and signs for bicycles can be found on the T-M-series Standard Drawings.

### 1-360.00 ROADWAY LIGHTING FOR ROUNDABOUTS

Illumination may be requested at urban and suburban roundabouts and the design should be coordinated with local officials. The lighting of rural roundabouts is recommended, but may not be necessary in all circumstances. The decision to illuminate a rural intersection should be on a case-by-case basis and will depend on factors such as availability of a power source, volume of anticipated night-time vehicular or pedestrian traffic, and available sight distance. Regardless of lighting, a roundabout intersection should be signed and marked in accordance with the *Manual on Uniform Traffic Control Devices.* The design of roundabouts can vary greatly from project to project; therefore, specific illumination guidelines and design criteria is not appropriate. When lighted, the following features and guidance should be considered by the designer for lighting a roundabout intersection:

- Roundabouts should be illuminated from the outside in towards the center circle. For vehicles approaching the intersection, this will improve the visibility of the central island

and of the vehicles already in the circulating stream of the roundabout. Avoid placing light poles within the central island.

- Good illumination should be provided at the approach nose of splitter islands, all conflict areas where vehicles are entering the circulating stream, and at locations where traffic departs from the circulation to exit the roundabout.
- Pedestrian crossings and bicycle merging areas should be given special consideration. Light poles placed 10 to 30 feet in advance of a crosswalk is recommended to provide positive contrast on the pedestrians.
- Clear zone requirements from the AASHTO *Roadside Design Guide* should be considered when lighting is provided. Illumination poles or masts should not be placed within small splitter islands, on the right-hand perimeter just downstream of an exit point, or on the central island directly opposite of an entry roadway.
- In rare cases when it is desired to illuminate objects within the central island the designer should consider using ground-level lighting that shines upward and away from the nearest edge of pavement. In these cases a separate electrical disconnect should be provided for blackout protection.
- It is recommended that the approach and/or exit roadways serving the roundabout be illuminated up to 260 feet beyond the final trajectory changes at each exit, especially at rural sites where lighting is used.
- Short dark areas between a series of roundabouts or dark areas between an illuminated roundabout and an existing illuminated roadway section should be avoided.

On projects developed for the Department with proposed lighting, the designer (or consultant) should forward a set of preliminary plans to the Signal and Lighting Office to determine the need (if any) for lighting, level of illumination, and pole locations at the time of the preliminary plans submittal.

### 1-370.00 LANDSCAPING GUIDELINES FOR ROUNDABOUTS

Properly designed landscaping typically increases the efficiency of the roundabout and improves safety of the circulatory intersection. For urban areas, landscaping may be requested by the local entity to enhance the aesthetics of the intersection. Landscaping can improve intersection performance and safety for the following reasons:

- When used at the right and/or left of the approaches, vehicle speeds are typically reduced due to the tunneling effect perceived by motorists.
- Landscaping makes the central island more conspicuous (noticeable) to drivers; whereby indicating to the approaching driver that they cannot pass straight through the intersection.
- Properly placed landscaping obstructs the motorists view across the intersection; whereby forcing drivers to look in the standard left and right directions.
- In high pedestrian areas, landscaping will tend to channel pedestrians to designated cross-walk locations reducing unwanted pedestrian/vehicle conflict points. This is vital since roundabouts may not have pedestrian push buttons and signals.

The central island, large splitter islands, and the approaches to the intersection present opportunity for landscaping; however, the landscaping should be designed to optimize safety and operation. The designer should consider the following guidelines for developing a safe, effective, and low-maintenance landscaping plan for a roundabout:

- Maintain required stopping and intersection sight distance for the circulatory roadway around the central island. Keep the outside 6 feet of the central island (above the truck apron) free from significant landscaping features except very low-growth plants and grass (preferable) to maintain sight distance. In no case should this width be less than 6 feet; however the actual width may be greater and should be determined by computing the required circulatory roadway and intersection sight distances.
- Avoid landscaping in splitter islands except where the island is long and/or exceptionally wide. When used, the maximum height of landscaping features at maturity should not exceed 30 inches measured from the nearest pavement edge to the tallest point of the mature vegetation, including the curb height. See RD-SD-2.
- Consider low maintenance, drought resistant grasses and hearty plant material in the raised center island, larger splitter islands, and buffer strips. Minimize fixed objects (trees, large boulders, walls, etc…) in as much as possible. Avoid trees with large canopies. The central island should be considered similar to a median, with all objects being breakaway.
- Splitter islands can be hardscaped (concrete, textured concrete, brick pavers, etc…) to reduce maintenance and maintain required site distances. A hardscaping that is different from the sidewalk or shared-use path is recommended to ensure that pedestrians and bicyclist do not confuse the splitter island with a sidewalk.
- The designer should avoid placing benches, street furniture, or plaques and monuments with small text in the central island so as not to attract pedestrians to the center island.

When landscaping is requested by the local government, the designer should coordinate with the local agency for development of the landscaping plans and for specific landscaping features that may be requested at the intersection, especially for those located in urban or historic districts. Additional guidance regarding landscape design may be found in TDOT Landscape Design Manual.

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