Florida Greenbook Advisory Committee Meeting

January 21, 2016

Agenda

AGENDA

FLORIDA GREENBOOK ADVISORY COMMITTEE MEETING

Thursday, January 21, 2016, 8:30 AM – 5:00 PM

FDOT Turnpike Headquarters
Turkey Lake Service Plaza Florida's Turnpike Headquarters
Turnpike Mile Post 263
Auditorium A
Ocoee, Florida 34761

Thursday, January 21, 2016

8:30 – 9:00 Introductions and General Information

- Welcome and Introductions (Michael Shepard)
- March 2015 Meeting Minutes & Vote to Approve (Mary Anne Koos)
- Contact Information and Subcommittee Assignments (Mary Anne Koos)

9:00 – 9:30 Rulemaking and Sunshine Law

- Rulemaking Process (Jason Watts, General Counsel's Office)
- Sunshine Law (Jason Watts, General Counsel's Office)

9:30 – 10:15 Presentation of Proposed Revisions for 2016 Greenbook

- Introduction (Howard Webb)
- Chapter 3 – Geometric Design (Howard Webb)

10:15 – 10:30 ***Morning Break***

10:30 – 11:10 Presentation of Proposed Revisions for 2016 Greenbook (continued)

- Chapter 7 – Rail-Highway Crossings (Chris Tavella)

11:10 – 11:15 Orientation for Subcommittee Meetings (Michael Shepard, Mary Anne Koos)

- Auditorium A: Introduction and Geometric Design (Howard Webb)
- Room 2131: Rail-Highway Crossings (Chris Tavella)

11:15 – 12:45 ***Lunch***

12:45 – 2:30 Subcommittee Meetings for Final Drafting of Proposed 2016 Revisions

- Introduction and Geometric Design (Howard Webb)
- Rail-Highway Crossings (Chris Tavella)

2:30 – 2:45 ***Afternoon Break, Reconvene in Auditorium A***

2:45 – 3:45 Chapter Report and Vote on 2016 Chapter Revisions

- Introduction (Howard Webb)
- Chapter 3 – Geometric Design (Howard Webb)
- Chapter 7 – Rail-Highway Crossings (Chris Tavella)

3:45 – 4:30 Breakout Sessions for Future Greenbook Revisions (Auditorium A)

- Chapter 1 – Planning (Rick Hall)
- Chapter 2 – Land Development (Margaret Smith)
- Chapter 3 – Geometric Design (Howard Webb)
- Chapter 14 – Design Exceptions (Ramon Gavarrete)

4:30 - 5:00 Report on Goals for Future Chapter Revisions

5:00 ***Adjourn***

Minutes (Approved)

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Turnpike Mile Post 263
Auditorium A
Ocoee, Florida 34761

Thursday, January 21, 2016

Members in Attendance

Andy Garganta, Robert Behar, Gaspar Miranda, Kathy Thomas, Chris Tavella, Howard Webb, George Webb, Christopher Mora, Milton Martinez, Gail Woods, Margaret Smith, Gene Howerton, Richard Moss, Steve Neff, Richard Baier, Bernie Masing, Annette Brennan, Keith Bryant, John Fowler (for Jared Perdue), Charles Ramdatt

Associate Members in Attendance

Fred Schneider, David F. Kuhlman

FDOT Staff, Technical Advisors and Public in Attendance

Tim Lattner, Michael Shepard, Mary Anne Koos, Mary Jane Hayden, Paul Hiers, Alan El-Urfali, Frank Yokiel, Susan Ussach, Jeremy Crowe

General Information

- **Welcome and Introductions (Michael Shepard & Mary Anne Koos)**

  Florida Greenbook Committee and Associate Member Changes - Changes in membership for the Greenbook Committee were discussed and a new member, Milton Martinez, City of Tampa (urban local government for District 7)) was introduced. Mr. Martinez replaces Pete Brett. David Cerlanek (former urban local government for District 2) is now working for FDOT and a new member will need to be appointed.

- **Review Contact Information (Mary Anne Koos)**

  The Committee Membership list was circulated for everyone to update their contact information.

- **Update Subcommittee Assignments (Mary Anne Koos)**

The list of current chairs for the chapter subcommittees was reviewed, and chair assignments updated. Members also updated their subcommittee membership preferences.

- **School Zone Signing and Marking (Alan El-Urfali)**

Alan El-Urfali advised the committee that FDOT has been asked to develop criteria for reduced speeds in school zones that would apply to all public roads. He asked whether FDOT should create a new manual to address school zone signing and marking on local roads. This would cover the establishment of the school zone and corresponding signing and marking. Charles Ramdatt suggested the Greenbook Committee review Chapter 7 of the MUTCD and see what changes can be made to the Greenbook before creating a new manual. Mary Anne Koos suggested the Chapter 18 - Signing and Marking subcommittee look into this issue. Gail Woods (subcommittee chair) and Alan El-Urfali (technical advisor to this subcommittee) agreed.

Review March 2015 Meeting Minutes & Vote to Approve (Mary Anne Koos)

- Steve Neff moved to approve the minutes as presented, seconded by Gail Woods, approved by the Committee with no objections.

Rulemaking and Sunshine Law

- **Sunshine Law (Jason Watts, General Counsel's Office)**

To comply with Florida's Sunshine law, Mr. Watts explained that members cannot discuss with each other the action they intend to take at a later meeting of the Greenbook Committee. An intermediary cannot be used either. Meetings of the Florida Greenbook and Subcommittees are posted on FDOT's public meetings web page. Mr. Watts stated that he is available to assist, if needed. If you email a committee member, that is considered a violation. Correspondence from a non-committee member to the committee (as a one-way communication to set up meetings) is acceptable.

- **Rulemaking Process (Susan Schwartz, General Counsel's Office)**

The Rule for the Florida Greenbook is 14-15.002, Florida Administrative Code (F.A.C.). Ms. Schwartz reviewed the "Rulemaking – 2015" presentation included in the meeting materials along with an overview of Florida's Government in the Sunshine Law.

"Rulemaking" is defined as the adoption, amendment or repeal of a rule and is the process used to adopt the Greenbook. In its simplest form, rulemaking consists of drafting the rule text, providing notice to the public, accepting public comment and filing the rule for adoption. Revisions to the Florida Greenbook begin with drafting proposed changes and review by the Committee. The proposed changes are then reviewed by FDOT's General Counsel Office and approved by FDOT's Secretary.

The Greenbook is published first in Rule Development, then in Rule Making. If there are no comments, or if all comments are addressed, it then goes to the Department of State (DOS) for Rule Adoption. Twenty days after it is posted by DOS, the manual becomes effective.

Presentation of Proposed Revisions for the 2015 Greenbook

- **Introduction (Howard Webb)**

Ms. Koos reviewed the color-coding of the text for the group. Green-highlighted text has already been approved by the Committee in previous meetings. Yellow are notes that will be deleted in the final format or are areas that need follow up discussion. Richard Baier questioned whether "design vehicle" and "complete streets" should be included as a new definition in this section. Ms. Koos stated that some definitions are included in specific chapters, rather than the introduction, because they were lengthy and better suited to the chapters.

George Webb questioned why Section 334.048, F.S. is included in the introduction, and suggested it be deleted. Mary Anne Koos will defer this question to FDOT General Counsel. (General Counsel's Office agreed we could remove the reference to this statute.)

The following comments were made on the definitions in the Introduction:

- Auxiliary Lane – George Webb suggested striking the last sentence. The group agreed.
- Boarding and Alighting – Charles Ramdatt suggested "…movement on or off a transit vehicle ~~bus~~"; Richard Baier questioned whether ADA should be mentioned in this definition. Ms. Koos explained that this definition is the US Access Board's definition, and that ADA requirements are covered within the chapters.
- Design Hour Volume – George Webb suggested "It includes total traffic…"
- High Speed – Bernie Masing suggested revising this to read "speeds greater than 45 mph" instead of "speeds of 50 mph or greater." (Was later revised to remain as written to be consistent with Chapter 3.)
- High Speed Rail – Charles Ramdatt wanted to make sure rail speeds between 70 mph and 110 mph are covered in the tables in the rail chapter.
- Horizontal Clearance – John Fowler suggested removing "motor vehicle" from the definition since horizontal clearance is also measured for shared use paths. The group agreed to discuss this during the breakout session later today. Decision was to revise definition when horizontal clearance is addressed in Chapter 3.
- Recovery Area – the group questioned the use of "clear zone" in this definition because a clear zone could be larger than a recovery area. This is the terminology that is directly from AASHTO. Michael Shepard agreed to take this question to AASHTO.
- Right of Way – George Webb asked to add "special district" to the list in this definition.

- Traffic Lane – Gail Woods suggested removing "Traffic lanes" from definition since it is redundant.
- Vertical Clearance - Milton Martinez questioned if we should define "Vertical Clearance" since Horizontal Clearance is defined. The subcommittee will review this in the breakout session.
- Wide Outside Lane – Christopher Mora questioned if we could make this 13' instead of 14'. Howard Webb clarified that 14' provides the minimum width for a vehicle and a bike to be in the same lane. The definition remained as was written in the draft.

- **Chapter 3 – Geometric Design (Howard Webb)**

Mr. Webb presented the proposed changes for the chapter, as shown in the draft dated January 14, 2016.

- Section C.1 Design Speed was rewritten and the corresponding Table 3-1 Recommended Design Speed modified to provide a range of speed, differentiate between rural and urban streets and highways, and include values for lower volume roads. The group decided to have the subcommittee look at the updated language related to selecting design speed (2nd paragraph) in the breakout session.
- Table 3-2 Design Vehicles, Table 3-3 Stopping Sight Distances, Table 3-4 Passing Sight Distances, Table 3-9 Rounded K-Values, and Table 3-10 Minimum Lane Widths were updated with 2011 AASHTO values. The object height for stopping sight distance was revised from 6 inches to 2 feet.
- Keith Bryant requested Table 3-10 be changed from 12' travel lanes for local rural roads with an ADT> 1500 to 11'.

- **Chapter 7 – Rail-Highway Grade Crossings (Chris Tavella)**

Mr. Tavella presented the proposed changes for the chapter, as shown in the draft dated January 12, 2016.

The Objective was updated to be more in-line with the intent of this chapter.

- Table 7-1 Sight Distance at Rail- Highway Grade Crossings was revised to use a WB-67 design vehicle, since it is the largest anticipated vehicle (73.5 feet).
- Section C.3.c Medians was revised to state that a raised median is the ideal way to deter vehicles from crossing through the closed gates.
- Section C.3.d Sidewalks and Shared Use Paths is a new section.
- Figures 7-2 Pedestrian Crossings and 7-3 Flangeways and Flangeway Gaps were added to clarify where detectable warnings should be placed and to illustrate the location of the flangeway in the rail crossing.

- Sections C.5 Vertical Clearance and C.6 Horizontal Clearance language was added.
- Figure 7-4 Track Section was added to show where the dimensions are taken from in measuring horizontal and vertical clearance.
- Section C.9 Traffic Control Devices includes minor clarifications and added Figure 7-5 Median Signal Gates for Multilane Curbed Section to illustrate different gate mounting options and gap dimensions.
- The Figures in Section C.12 Crossing Configuration were updated to be consistent with the current MUTCD. Figures 7-6 and 7-7 for Passive and Active Rail-Highway Grade Crossing Configuration replaced the old Figure 7-2. Chris Tavella polled the committee to determine whether we should include the values for dimension "A" in the Greenbook or simply reference the MUTCD. Consensus was that referring to the MUTCD is the preferred approach. This way, if the MUTCD is updated, we do not have to change the Greenbook.
- Section E. Quiet Zones was added, including a new Figure 7-8 Gate Configurations for Quiet Zones.
- Section D High Speed Rail was added.

**** Lunch Break 11:45 AM – 12:45 PM ****

Subcommittee Breakout Meetings for Final Drafting of Proposed 2015 Revisions

The Committee broke out into chapter subcommittee groups to discuss in more detail the revisions proposed in the meeting package and to follow up on the comments from the morning's presentations. The following subcommittees met:

- Introduction and Chapter 3 – Geometric Design
- Chapter 7 – Rail-Highway Crossings

Chapter Reports and Approval of Updates for 2016 Greenbook

- **Introduction (Howard Webb)**
- Mr. Webb presented an overview of the proposed revisions to the draft following the Introduction and Geometric Design subcommittee breakout meeting. The draft was approved, with the following revisions:
- Design Vehicle - added the definition "A vehicle, with representative weight, dimensions, and operating characteristics, used to establish highway design controls for accommodating vehicles of designated classes" consistent with AASHTO.
- High Speed – retain "Speeds of 50 mph or greater." to be consistent with Chapter 3.
- High Speed Rail – leave definition as-is.

- Vertical Clearance – added the definition "Minimum unobstructed vertical passage space".

Moved by Howard Webb to approve the changes, seconded by Richard Moss. The changes were approved unanimously.

- **Chapter 3 – Geometric Design (Howard Webb)**

Mr. Webb presented an overview of the proposed revisions to the draft following the Geometric Design subcommittee breakout meeting. The draft was approved, with the following revisions:

- Section C.1 Design Speed – the second paragraph was revised to read "For this reason, the selected design speed should be consistent with the speeds that drivers are likely to expect on a given street or highway facility. The design speed shall not be less than the expected posted or legal speed limit.
- Table 3-1 Recommended Design Speed – the committee discussed lower design speeds for the following types of facilities: rural arterial, 45 mph; rural collectors, all volumes, 35 mph; rural local, all volumes, 25 mph. Delete the provisions of 50 mph minimum for rural collectors and 30 mph for rolling terrain for local facilities and the fourth footnote. Revise footnote 1 to expand the areas in which urban design speeds can be appropriate to short, local rural roads. The committee directed that the proposed revisions be verified for consistency with AASHTO. (Following review of the AASHTO criteria, the values proposed during the Greenbook meeting for rural arterials, rural collectors, and rural local roads are below the AASHTO recommended values. Revisions are on hold until a revised table reflecting the AASHTO recommended values can be presented to the full Greenbook Committee for approval.)
- Section C.2 Design Vehicles – revised the definition for design vehicle to be consistent with the AASHTO Glossary (2009).
- Table 3-2 Design Vehicle – retained the WB-67 values since this was the design vehicle used in Chapter 7 to determine dimensions for sight distance triangles at grade crossings.
- Table 3-10 Minimum Lane Widths – revised the table values for arterial urban facilities with design speeds 45 mph or less to 11 feet. Footnote 3 was extended to apply to all urban arterials with speeds 45 mph or less, rural collectors with ADT of 400 to 1500 vpd, all urban collectors, all rural local roads with an ADT of 400 to 1500 vpd, and rural local roads with ADT less than 400 vpd with design speeds greater than 45 mph. The committee added an additional footnote 8 to allow 11 foot lanes for design speeds less than 50 mph. Footnote 8 applies to all rural arterials, and rural collectors and local roads with ADT greater than 1500 vpd.
- Section C.7.c Shoulders - revised to read "Paved outside shoulders are required for rural high speed multilane highways and freeways. They provide added safety…"

- Table 3-14 Median Width for Rural Highways and Urban Streets - remains unchanged, but will be discussed in future meetings. The committee will discuss a provision for traffic separators which can support pedestrian crossings.
- C.8.b.4 Auxiliary Lanes – delete the third paragraph about acceleration lanes, as it was not found to be necessary.

Moved by Howard Webb to approve the changes, seconded by Steve Neff. The changes were approved unanimously.

- **Chapter 7 – Rail-Highway Crossings (Chris Tavella)**

Mr. Tavella presented an overview of the subsequent revisions to the draft following the Rail-Highway Crossings subcommittee breakout meeting. These include:

- Section C.3.c Medians – revised the second paragraph for clarity and added a photo of flush median channelization to create Figure 7-2 Flush Median Channelization Devices.
- Section C.12 Crossing Configuration – added descriptions of active and passive rail-highway grade crossings and revised the names of Figures 7-6 and 7-7 to Passive and Active Rail-Highway Grade Crossing Configuration.
- Sections and Figures should be renumbered to adjust for the addition of the new Figure on median channelization and edit to have Section B.3 Rail-Highway Grade Crossing Near or Within Project Limits become its own Section C.

Moved by Chris Tavella to approve the changes, seconded by Charles Ramdatt. The changes were approved unanimously.

Review of the Purpose of Today's Meeting, and Next Steps (Mary Anne Koos)

- Today's meeting was to approve revisions for the Introduction, Chapter 3 and Chapter 7 of the Florida Greenbook. These revisions will now be moved forward with earlier approved revisions that have not been included in rulemaking. The new edition will be the 2016 Florida Greenbook.
- April's meeting will be to begin revisions for the 2018 (?) edition of the Greenbook Chapters to be updated for the next edition will be 1, 2, 3, 14, & 18.

Update of AASHTO's 13 Controlling Elements (Michael Shepard)

Mr. Shepard provided a brief update of AASHTO's proposed revisions to the 13 controlling elements.

- High Speed: 13 elements changing to 10 (bridge width, vert. align, & horizontal clearance are going away)
- Low Speed: 13 elements changing to 2 (design speed & structural capacity (newly-named design loading structural capacity) will remain).

Breakout Sessions and Chapter Chair Reports for Future Greenbook Revisions and Discussion

Subcommittees met in separate groups to strategize future revisions to the following chapters:

- Chapter 1 and 2– Planning (Rick Hall) and Land Development (Margaret Smith)

The subcommittees agreed to meet jointly to develop their revisions. Chapter 2 will take the lead.

- Chapter 3 – Geometric Design (Howard Webb)

The subcommittee agreed to review the criteria pertaining to horizontal clearance and lateral offset. In response to Mr. Ramdatt's request, they agreed to review median widths in general and to add criteria for traffic separators and pedestrian median refuges. Review refuge islands in Chapter 8 - Pedestrians and Chapter 15 – Traffic Calming for options to support pedestrian crossings.

- Chapter 14 - Design Exceptions (Ramon Gavarrete)

The subcommittee agreed to meet at a later date by teleconference.

- Chapter 18 – Signing and Marking (Gail Woods)

The subcommittee agreed to work with FDOT's Traffic Operations Office to determine if we need to add criteria to the Florida Greenbook to satisfy ***F.S. 316.1895 Establishment of school speed zones, enforcement; designation***. Alan El-Urfali (FDOT, Traffic Operations) will look into placing guidance in Traffic Engineering Manual (TEM), and the Greenbook will refer to TEM. (A subsequent discussion with Susan Schwartz, of FDOT's General Counsel Office, clarified the guidance will need to be in the Greenbook if it will be a requirement for local governments, since the TEM does not go through rulemaking.)

Other Topics

- Andy Garganta recommended that the FGB Committee always meet at the Turnpike HQ. There was no opposition to this suggestion.
- It may be too late to relocate the April 2016 FGB meeting, but we will attempt to do so. Future meetings can be located at the Florida Turnpike Headquarters.
- George Webb asked how Complete Streets has impacted FDOT's business. Michael provided a general overview and stated that they are already (and have been) implementing the Complete Streets philosophy.

The Meeting adjourned at 4:15 PM.

Introductions, Minutes and General Information

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Minutes (Draft)

FLORIDA GREENBOOK ADVISORY COMMITTEE MEETING

Thursday, March 26, 2015, 8:00 AM – 5:00 PM

Friday, March 27, 2015, 8:00 AM – 12:00 PM

FL Highway Patrol-Troop C Headquarters Auditorium
11305 N. McKinley Drive, Tampa, FL 33612

Thursday, March 26, 2015

Members in Attendance

Bernie Masing, Ramon D. Gavarrete, Andy Tilton, Steven M. Neff, Nelson Bedenbaugh (for Kathy Thomas), Kenneth Dudley, Gene Howerton, David Cerlanek, John Fowler (for District 3 DDE), Rick Hall, Keith Bryant, Howard Webb, Robert Behar, Christopher R. Mora, George T. Webb, Annette Brennan, Gail Woods, Charles Ramdatt, Richard Baier, Chris Tavella, Andres Garganta, Gaspar Miranda, Richard Moss, Richard Diaz, Peter R. Brett, Margaret Smith

Associate Members in Attendance

Joy Puerta, Mark V. Massaro, David F. Kuhlman, Frederick J. Schneider

FDOT Staff, Technical Advisors and Public in Attendance

Duane Brautigam, Michael Shepard, Mary Anne Koos, Paul Hiers, Billy Hattaway, Chester Henson, Fred Heery, DeWayne Carver, George Borchik, Christine Lofye, Kevin Miller.

General Information

- **Welcome and Introductions (Michael Shepard)**

  Florida Greenbook Committee and Associate Member Changes - Changes in membership for the Greenbook Committee were discussed and new members, Richard Baier (Sumter County), Margaret Smith (Pasco County), and Richard Moss (District 7, FDOT) introduced. John Fowler (for Scott Golden, FDOT District 3) and Nelson Bedenbaugh (for Kathy Thomas, FDOT District 2) were also introduced.

- **Review March 2014 Meeting Minutes & Vote to Approve (Mary Anne Koos)**

  David Kuhlman requested the minutes be amended regarding the discussion summary from the Work Zone Safety Subcommittee. The minutes were revised to read: "The subcommittee began by discussing MOT schemes for utility operations that may be less stringent than those provided in the FDOT 600 Series Indexes. The proposal was to replicate criteria for low speed, low volume roads found in the MUTCD." Howard Webb moved to approve the minutes as revised, seconded by Andy Tilton, approved by the Committee with no further edits.

- **Review Contact Information (Mary Anne Koos)**

The Committee Membership list was circulated for everyone to update their contact information.

- **Update Subcommittee Assignments (Mary Anne Koos)**

The list of current chairs for the chapter subcommittees was reviewed, and chair assignments updated. Members also updated their committee membership preferences.

Rulemaking and Sunshine Law

- **Rulemaking Process (Susan Schwartz, General Counsel's Office)**

The Rule for the Florida Greenbook is 14-15.002, Florida Administrative Code (F.A.C.). Ms. Schwartz reviewed the "Rulemaking – 2015" presentation included in the meeting materials along with an overview of Florida's Government in the Sunshine Law.

"Rulemaking" is defined as the adoption, amendment or repeal of a rule and is the process used to adopt the Greenbook. In its simplest form, rulemaking consists of drafting the rule text, providing notice to the public, accepting public comment and filing the rule for adoption. Revisions to the Florida Greenbook begin with drafting proposed changes and review by the Committee. The proposed changes are then reviewed by FDOT's General Counsel Office and approved by FDOT's Secretary.

The Greenbook is published first in Rule Development, then in Rule Making. If there are no comments, or if all comments are addressed, it then goes to the Department of State (DOS) for Rule Adoption. Twenty days after it is posted by DOS, the manual becomes effective.

The 2013 Florida Greenbook (Draft) is still in the rulemaking process. FDOT staff are working to resolve concerns expressed by the Legislature's Joint Administrative Procedures Committee (JAPC).

- **Sunshine Law (Susan Schwartz, General Counsel's Office)**

To comply with Florida's Sunshine law, Ms. Schwartz explained that members cannot discuss with each other the action they intend to take at a later meeting of the Greenbook Committee. Subcommittee meetings don't need to be noticed if the meeting is just for fact finding and the final recommendations come before the full committee for approval. Meetings of the Florida Greenbook and Subcommittees are posted on FDOT's public meetings web page.

Presentation of Proposed Revisions for the 2015 Greenbook

- **Chapter 6 – Roadway Lighting (Bernie Masing)**

Mr. Masing presented the proposed changes for the chapter, as shown in the draft dated March 23, 2015. These updates include a discussion of lighting bicycle and pedestrian facilities adjacent to roadways, adding a new section "Types of Illumination", removing the values for freeways from Table 7-1 Level of Illumination for Streets and Highways since freeways will be guided by the Plans Preparation Manual (PPM) criteria, and adding a description of luminance and Table 7-2 Road Surface Conditions. A section on Adaptive Lighting to provide guidance in coastal areas or where lower levels of lighting might be required was added. A new Reference section was added.

- **Chapter 11 – Work Zone Safety (Chris Tavella)**

Mr. Tavella presented the proposed changes for the chapter, as shown in the draft dated March 23, 2015. These updates include expanding the intent to include pedestrians, bicyclists, and motorists and factors which need to be considered when developing a work zone safety plan. The section on Work Zone Management was revised to require that all roadwork operations shall follow a coordinated temporary traffic control plan.

- **Chapter 8 – Pedestrian Facilities (Annette Brennan)**

Ms. Brennan presented the proposed changes for the chapter, as shown in the draft dated March 24, 2015. The types of pedestrian facilities was expanded, minimum sidewalk and utility strip widths revised, preferred location for sidewalks updated, and a requirement to evaluate sidewalk termini added. Criteria for acceptable running and cross slopes for projects in the right of way or in an alteration were added.

Figures were added for the shoulder point, location of sidewalk relative to a guardrail, typical dimensions of a standalone pedestrian bridge. A reference to the FDOT Structures Manual was added for design of engineered steel and concrete pedestrian bridges. Drop-off hazards were defined and a figure illustrating the thresholds for when drop offs require shielding was added.

Criteria for when crosswalks should be supplemented with other treatments such as beacons, medians, curb extensions, traffic islands, or enhanced overhead lighting was added. Figures were added for raised mid-block crosswalks and crosswalks with pedestrian hybrid beacons or rectangular rapid flashing beacons. A new section on pedestrian railroad crossings was added. The references were updated.

- **Chapter 9 – Bicycle Facilities (Annette Brennan)**

Ms. Brennan presented the proposed changes for the chapter, as shown in the draft dated March 25, 2015. Criteria was added for recommended spacing of bicycle lane markings, use of bicycle lane signs, minimum widths of wide outside lanes and paved shoulders adjacent to a barrier, and the need to evaluate, adjust, and mark drainage grates. Criteria for buffered and green bicycle lanes was added, along with a link to the FDOT APL list for green pavement marking products. A table was added with dimensions for reducing travel lane widths in resurfacing projects to provide bicycle lanes or wider outside lanes. The guidance for the placement of shared lane markings was revised and criteria for Bicycles May Use Full Lane Signs added.

The Shared Use Path section was updated to include criteria for width, shoulder area, accessibility, and the separation between the roadway and path. Information on when physical barriers or railings are needed adjacent to slopes or drop offs was added. Guidance was added to require that signs and pavement markings be consistent with the MUTCD (proper application, pattern, size and elevation) and offset from the path laterally and horizontally. A new reference section was added.

- **Chapter 15 – Traffic Calming (Steve Neff)**

Mr. Neff presented the proposed changes for the chapter, as shown in the draft dated March 23, 2015. These updates include a requirement that all signing, marking and channelization be in accordance with the MUTCD, AASHTO Policy on Geometric Design, and FHWA's Roundabout Guide. Illustrations were added for raised crosswalks, speed humps, chicanes, roundabouts, curb extensions, and crosswalks with yield condition pavement markings. Dimension descriptions for the traffic calming options were updated. The sources and reference sections were updated.

Subcommittee Breakout Meetings for Final Drafting of Proposed 2015 Revisions

The Committee broke out into subcommittee groups to discuss in more detail the revisions proposed in the meeting package and to follow up on the comments from the morning's chapter presentations. The following subcommittees met:

- Chapter 6 – Roadway Lighting
- Chapter 8 – Pedestrian Facilities and Chapter 9 – Bicycle Facilities
- Chapter 11 – Work Zone Safety
- Chapter 15 – Traffic Calming.

Chapter Reports and Approval of Updates for 2015 Greenbook

- **Chapter 6 – Lighting (Bernie Masing)**

Mr. Masing presented an overview of the proposed revisions to the draft following the Roadway Lighting subcommittee breakout meeting. These include:

- Revise the chapter title to "Roadway".
- Update Section C to use the term "places of assembly" rather than "churches".

- Add introductory language to "D Types of Illumination".
- Update the table titles to reflect Chapter 6.
- Revise the lighting levels for mid-block crossings in Section E to 2.0 foot candles. Revise the 2nd paragraph in Section E to "When adding ….glare. Illuminance in roadway lighting is a measure of the light at the pavement surface. Luminance in roadway lighting is a measure of the reflected light from the pavement surface that is visible to the motorist's eye. See Table 6 - 1 for ranges of illumination." Move the remainder of the 3rd paragraph and Table 7.2 Road Surface Classifications to follow Table 7.1.
- Revise the 3rd paragraph in Section F to "It is also …corridor. Mixing of different types of lighting may reduce the lighting uniformity. As we transition to LED, it is acceptable to have mixed lighting segments along the same corridor."
- Revise the 2nd paragraph in Section G to read "Lighting of …basis. Considerations include the likelihood of night time use, the role …travel."
- Revise Section H to read "Some locations …provided. FHWA's publication The Guidelines for the Implementation of Reduced Lighting on Roadways describes a process by which an agency …existing lighting guidelines."
- Add Section I Overhead Sign Lighting and include the following paragraph; "It is recommended that the level of illumination for overhead signs not be less than guidelines found in Table 6-3 Illuminance and Luminance for Sign Lighting. Add Table 6.3.
- Revise lettering sequence of subsequent sections.
- Revise the 2nd paragraph in new Section K to read; "Light poles …Non-frangible light poles should be placed outside of the clear zone. They should be …ground level. Revise the 4th paragraph to read; "The placement …sight distance or visibility of …control devices."

Moved by Annette Brennan to approve the changes, seconded by Nelson Bedenbaugh. The changes were approved unanimously.

- **Chapter 8 – Pedestrian Facilities (Annette Brennan)**

Ms. Brennan presented an overview of the proposed revisions to the draft following the Pedestrian Facilities subcommittee breakout meeting. These include:

- Revise the figure in Section C illustrating the shoulder point to include the location of a sidewalk.
- Delete the third paragraph in Section D.1 beginning with "Longitudinal barriers shall be designed..." In the same section, add a figure illustrating the pipe rail detail for guardrails adjacent to a sidewalk or path.
- Revise Figure 8.4 in Section E to remove the center 5 ft. height measurement.

- Update Section G to use the term "Pedestrian Hybrid Beacon (PHB)" rather than "Hybrid Actuated Beacons (HAWKS)". Reword the paragraph under Rail Crossings to clarify that roadways, sidewalks and shared use paths may cross rail corridors, and clarifying that the rail corridor likely pre-existed the public crossing. Add a reference for the Federal Railroad Administration and guidance that they may impose additional requirements for the design and management of public rail crossings.
- Update "bus stops" to "transit stops" in Section H.
- Update Section I References.

Moved by Andre Garganta to approve the changes, seconded by Richard Baier. The changes were approved unanimously.

- **Chapter 9 – Bicycle Facilities (Annette Brennan)**

Ms. Brennan presented an overview of the proposed revisions to the draft following the Bicycle Facilities subcommittee breakout meeting. These include:

- Add 4th detail to Figure 9-1 showing minimum width of paved shoulder to serve as a bicycle facility when adjacent to a barrier.
- Remove the bike lane dimensions from the figures.
- Revise Section C to include guidance for an 18 mph design speed with a maximum 4% grade. For speeds higher or grades steeper refer reader to AASHTO's Guide for the Development of Bicycle Facilities.
- Revise flush shoulder illustrations to remove paved shoulder markings (\\\).

Moved by Chris Mora to approve the changes, seconded by Charles Ramdatt. The changes were approved unanimously.

- **Chapter 11 – Work Zone Safety (Chris Tavella)**

Mr. Tavella presented an overview of the proposed revisions to the draft following the Work Zone Safety subcommittee breakout meeting. These include:

- Add sentence to Section A; "Any activity within the highway right of way shall be subjected to the requirements of work zone safety."
- Revise the first paragraph in Section E to read "The achievement …of any roadwork. The planning objective is to develop a comprehensive temporary traffic control plan that includes the following considerations."
- Revise the title of Section E.1.a.3 to "Planned Operations" and the revise the paragraph to read "Planned operations are scheduled roadwork projects, neither routine nor time-sensitive in nature, that are occasionally required to maintain or upgrade a street or highway."
- Insert "temporary traffic control into the first sentence of Section E.1.b.

- Revise the first paragraph in Section E.1.c to read "The nature of …zone safety. The development of the temporary traffic control plan should include consideration of the following factors:"
    - Revise the third bullet to read "Distribution of traffic with respect to peak traffic periods (seasonal, day of week, time of day, etc.)."
    - Revise the ninth bullet to read "Impacts of detours and diversions to business and residential community."
    - Revise the tenth bullet to read "Pedestrian and bicycle accommodations."
- Revise Section E.4 to read "To ensure safe and efficient roadwork operations, the temporary traffic control plan should be developed and executed in cooperation with all interested individuals and agencies including the following:"
- Change the Title for Chapter 6 to "Lighting".

Moved by Gail Woods to approve the changes, seconded by Andy Tilton. The changes were approved unanimously.

- **Chapter 15 – Traffic Calming (Steve Neff)**

Mr. Neff presented an overview of the proposed revisions to the draft following the Traffic Calming subcommittee breakout meeting. These include:

- Add the following to the third paragraph in Section B, "Traffic calming …tools may be considered, as well as coordinated effort with law enforcement."
- In the "Do the following" list of Section B, revise the second bullet to read "Have an organized program including public involvement. Plans and policies should be approved and supported…residential streets." Also added a new bullet which reads "Consider appropriate landscape treatments as part of the traffic calming design and implementation."
- Revise the first sentence in Section C.1 to read "Unwarranted stop signs should not be used for traffic calming for the following reasons:" and revise the last sentence in the section to read "Stop signs shall be used only when warranted per the MUTCD.
- In Section C.2 retain the original height dimension for speed bumps and revise the dimension from 1 to 2 feet wide to 1 to 2 feet long.
- In Section C.3 delete the text; "dear crossing (meaning loved one)".
- Add Speed Cushions to the types of treatments included in Table 15-1.

Moved by Gaspar Miranda to approve the changes, seconded by Keith Bryant. The changes were approved unanimously.

The meeting adjourned at 5:00 PM.

Friday, March 27, 2015

Members in Attendance

Bernie Masing, Ramon D. Gavarrete, Andy Tilton, Steven M. Neff, Nelson Bedenbaugh (for Kathy Thomas), Gene Howerton, David Cerlanek, John Fowler (for District 3 DDE), Rick Hall, Keith Bryant, Howard Webb, Robert Behar, Christopher R. Mora, George T. Webb, Annette Brennan, Gail Woods, Charles Ramdatt, Richard Baier, Chris Tavella, Andres Garganta, Gaspar Miranda, Richard Moss, Peter R. Brett, Margaret Smith

Associate Members in Attendance

Joy Puerta, Mark V. Massaro, David F. Kuhlman, Frederick J. Schneider

FDOT Staff, Technical Advisors and Public in Attendance

Duane Brautigam, Michael Shepard, Mary Anne Koos, Paul Hiers, Billy Hattaway, Chester Henson, Fred Heery, DeWayne Carver, George Borchik

The meeting reconvened at 8:00 AM. A request was made and approved to reopen discussion on Chapter 11 – Work Zone Safety for additional changes.

Chapter 11 – Work Zone Safety - Continued (Chris Tavella)

- Revise Section E.1.a to read “Roadwork operations may be further classified as routine, unplanned, or planned operations.”
- In Section E.1.a.2, replace “time-sensitive” with “unplanned”

Moved by Andre Garganta to approve the changes, seconded by Robert Behar. The changes were approved unanimously.

Future Greenbook Revisions and Chapter Chairs

- **Goals (Michael Shepard)**

Mr. Shepard thanked the committee for all the work that was accomplished on Thursday. He explained that we would forgo the presentation on PPM changes and bulletins and the parking lot discussion to allow for more time to discuss the Joint Administrative Procedures Committee (JAPC) revisions and plan for the 2016 meeting.

- **JAPC Revisions (Mary Anne Koos)**

The revisions to the Introduction and Chapters 3, 6, 7, 8, 9, 10, 11, 17 and 20 that have been made in response to comments from JAPC were reviewed.

- **Chapter Chairs (Mary Anne Koos)**

The list of Chapter Chairs was reviewed and finalized, with the chapter chairs as follows:

- Chapter 1 - Planning, Rick Hall
- Chapter 2 - Land Development, Margaret Smith
- Chapter 3 - Geometric Design, Howard Webb
- Chapter 4 - Roadside Design, Charles Ramdatt
- Chapter 5 - Pavement Design and Construction, Richard Moss
- Chapter 6 - Lighting, Bernie Masing
- Chapter 7 - Rail-Highway Grade Crossings, Chris Tavella
- Chapter 8 - Pedestrian Facilities, Annette Brennan
- Chapter 9 - Bicycle Facilities, Annette Brennan
- Chapter 10 - Maintenance and Resurfacing, Richard Moss
- Chapter 11 - Work Zone Safety, Chris Tavella
- Chapter 12 - Construction, Ramon Gavarrete
- Chapter 13 - Public Transit, Charles Ramdatt
- Chapter 14 - Design Exceptions, Ramon Gavarrete
- Chapter 15 - Traffic Calming, Steve Neff
- Chapter 16 - Residential Street Design, Richard Baier
- Chapter 17 - Bridges and Other Structures, Keith Bryant
- Chapter 18 - Signing and Marking, Gail Woods
- Chapter 19 - Traditional Neighborhood Development, Rick Hall
- Chapter 20 - Drainage, George Webb

- **Selection of Chapters for Future Work (Mary Anne Koos)**

The Committee identified the chapters that they would like to work on for the 2016 meeting. They agreed that Chapter 2 – Land Development, Chapter3 – Geometric Design, Chapter 7 – Rail-Highway Grade Crossings, and Chapter 14 –Design Exceptions should be their focus for the coming year. The committee moved into breakout sessions to review the chapters and determine their future scope of work. Following the breakout session the group reconvened in the FHP Auditorium and summarized their subcommittee discussions.

Chapter Chair Reports for Future Greenbook Revisions and Discussion

- **Chapter 3 – Geometric Design (Howard Webb)**

The subcommittee will review for consistency across chapters and the introduction, especially related to the definitions and terms used to describe the highway or roadway. The intent is not to change existing definitions but choose appropriate language and create definitions for new terms. They will also review outstanding issues including earlier proposed revisions for stopping and passing sight distance. The subcommittee would like to base their review on a draft of the Greenbook that includes all of the proposed changes for the 2013 edition, plus changes approved in the 2014 and 2015 meetings, and the JAPC changes. Their plans are to meet via Go-To-Meeting starting in May, with a possible face to face meeting in January 2016 to finalize the draft.

- **Chapter 14 – Design Exceptions (Ramon Gavarrete)**

Review for changes in terms such as lateral clearance, provision for adoption provided with Greenbook statute, references of 1994 publication from AASHTO, conceptual concurrence versus procedural from FDOT, and LAP projects and process. Plan is to begin with a conference call in May.

- **Chapter 2 – Land Development (Margaret Smith)**

Update the chapter to include language on the variety of land use patterns and contexts that need to be considered (compact urban/suburban/rural; greenfield/new versus infill/redevelopment), reflect contemporary markets and development patterns, and address complete streets. Recognize the differences between greenfield versus infilling, greenfield-grey field-brown field; Traditional Neighborhood Design (TND) and Transit Oriented Development (TOD). Look at the role of speed as a control within the various contexts (context-based speed. Also consider available parking for users, traffic control, selecting the operating speed concepts for the community, adequate access for fire & rescue emergencies, proper placement of utilities, adequate drainage facilities, landscaping &street trees, levels of service for transportation balance – autos, walkable, bikes, fire codes (20' clear), and where appropriate shared lane conditions for cyclists.

They identified the need to harmonize with Chapter 1 and other chapters in the Greenbook and that the Committee should consider also working on Chapter 1. They would like to begin work in June.

- **Chapter 1 – Planning (Rick Hall)**

The committee discussed whether Chapter 1 – Planning should be eliminated from the Greenbook or merge with Chapter 2. It was decided to retain Chapter 1 as a separate chapter and it was added to the list of chapters to work on for the 2016 meeting.

- **Chapter 7 – Rail-Highway Grade Crossings (Chris Tavella)**

  The subcommittee agreed the chapter needs to be updated, and should address high speed rail, signal preemption, quiet zones, pedestrian and bicyclist crossings, school bus routes, compliance with MUTCD, possibility of a sealed corridor, and expand to address high speed rail. Update the references. Update the diagrams to include high speed rail, the tables in the chapter currently have a maximum speed of 90 mph. Review station design, rail crossing safety inspections, communication, inspection and maintenance of crossings, parallel routes, special signage and storage for certain types of trucks. Look at the Rail Handbook as resource. A teleconference will be held in early summer.

2016 Greenbook Meeting

Members asked that we hold the meeting in February, in a location where we can experience good urban design and have more affordable hotel rates. They prefer to concentrate on Greenbook business rather than having extra presentations. For the 2016 meeting, members would like to receive a copy of the current adopted Florida Greenbook, with proposed changes in redline format.

The Committee would like to work this summer on a 2015 draft for rulemaking to harmonize Chapter 3 with Chapters 8 and 9, and any other chapters that would benefit from consistent highway terminology. The 2015 addition should also include the approved changes from the 2014 and 2015 meetings. Their goal is to submit for rulemaking at the end of the summer, and create a 2015 edition. The work of the other chapters would be submitted in future rulemaking efforts, possibly with a new edition every two years.

Members felt more work was needed to promote the Greenbook, especially with cities, developers and consulting engineers. As examples, they suggested FDOT develop short articles for engineering newsletters and announce updates via our contact mailer.

The committee asked that staff clarify the standing of the Greenbook as it applies to city streets, or where the public is invited to travel and review ***Florida Statutes*** as they apply to the Greenbook.

The Meeting adjourned at 11:45 AM.

Rulemaking and Sunshine Law

RULEMAKING – 2015

PROCESS

Notice of Development of Rulemaking
-Advised publish NDR in FAR at least 21 days before publishing NPR – in case workshop is requeted

NDR / NRD MUST INCLUDE (120.54(2)(a)):
-Subject area to be addressed
-Explain purpose and effect of proposed rule
-Specific legal authority
-Text of rule (if avail), or statement how to get a copy
-Agency contact person
-Place, date, time of Workshop
Courtesy copy to JAPC

WORKSHOP REQUIREMENTS:
- If Requested OR if Agency elects to hold workshop, at least 14 days notice published in FAR
-Agency staff available to answers questions about the draft rule
-Convenient, accessible location – possibility for video or teleconferencing.

1. NOTICE OF PROPOSED RULE
-Agency head approval required (120.54(3))
-Publish in the FAR (120.54(2)(a))
-Docs to be sent to JAPC (120.54(3)(a)4.)
-Schedule rule hearing (i.e., public meeting) if requested (120.54(2)(c))

NPR MUST INCLUDE (120.54(3)(a)1.):
-A short, plain explanation of the purpose and effect of the proposed rule
-Full text of proposed rule or amendment, and a summary
-Reference to rulemaking authority
-Reference. to statute being implemented / interpreted
-A statement of estimated regulatory costs (SERC) (120.541(2), F.S.) **OR** a statement that the Agency has determined a SERC is not required (rule not expected to increase regulatory costs in excess of $200,00 in first year) **and** a statement whether legislative ratification is required
- Statement inviting interested persons to provide additional SERC info (within 21 after pub. of the notice)
-Process for requesting a public hearing on the proposed rule
-Reference to date that NRD was published

2. NOTICE OF CHANGE
Notice of Change / Withdrawal
-Based on public comments or JAPC comments
-Pub. in the FAR at least **21 days before Adoption**
-Agency may modify draft as recommended by JAPC, withdraw entire rule, or refuse to modify the rule 120.54(3)(d)1.

OTHER NOTES:
- Possible to incorporate material in rule by reference. 120.54(1)(i)
- "Negotiated rulemaking" an option. 120.54(2)(d)
- Rule may be challenged in a DOAH hearings as vague, arbitrary or outside legislative authority.

3. ADOPTION
Notice of Adoption
-Agency head approval required (120.54(3)(e)1.)
-Rule becomes effective 20 days after filing (120.54(3)(e)6.)

FILE WITH DEPARTMENT OF STATE:
-Three copies of the rule plus 1 CD copy
-One copy of materials incorporated by reference in the rule (e.g., forms), certified by the agency
-Summary of the rule
-Summary of any hearings held on the rule
-Written summary of facts and circumstances justifying the rule 120.54(3)(e)1., F.S.

TIMELINE

1. NOTICE OF PROPOSED RULE — 2. NOTICE OF CHANGE — 3. NOTICE OF RULE ADOPTION FILED

EO 11-72 OFFAR Review of Notices and Pre-Approval Required

- Agency may schedule a hearing in the NPR
- Public May Request a Hearing **within 21 days** of the posting. 120.54(2)(c) and (3)(c)1.

- **JAPC Comments** / Objections Received
- Agency Response to JAPC Comments – **30 Days**. 120.545(3).

If changes are warranted based on public hearing, comments from the public, or JAPC comments or objection, modify draft via **Notice of Change**. Scope of allowable changes limited. 120.54(3)(d)1.

Advance Notice mailed to Requestors **14 days** before adoption date, and file with JAPC **7 days** before adoption date. 120.54(3)(a)3 and (3)(d)1.

File with JAPC **at least 21 days before proposed adoption date**: Rule copy, materials incorporated by reference, rule justification, SERC, Fed / other rule relation statement, and NPR notice. 120.54(3)(a)4

21 Days

14 Days

RULE MAY NOT BE FILED FOR ADOPTION:

1. Less than 28 days after posting of the NPR or more than 90 days after posting of the NPR (62 day window)
2. Until 21 days after the Notice of Change (if any)
3. Until 14 days after the final public hearing (if any)
4. Until 21 days after a SERC required under 120.541, F.S., has been provided to all persons who submitted a lower cost regulatory alternative and made available to the public
5. Until the ALJ has rendered a decision under 120.56(2)

WHICHEVER APPLIES. 120.54(3)(e)2., F.S.

EVENTS THAT IMPACT TIME RULES MAY BE FILED FOR ADOPTION:
120.54(3)(e)2., F.S.
- If a notice of change is filed the time to file for adoption is extended to 45 days after the date of publication, but not file sooner than 21 days. 120.54(3)(d)1.
- Filing of a Public Hearing (i.e., Public Meeting)
- Administrative hearing

FLORIDA'S GOVERNMENT-IN-THE SUNSHINE LAW

1. THE LAW

Florida's Sunshine Law is found in Article I, Section 24, Florida Constitution and Chapter 286, Florida Statutes (F.S.), and applies to state agencies. The Sunshine Law is to be liberally construed; its exemptions are to be narrowly construed. Two or more people who are tasked with making a decision or recommendation constitute a "Board or Commission" under the Sunshine Law and are subject to its provisions. Section 286.011(1), F.S., states:

> All meetings of any board or commission of any state agency . . . at which official acts are to be taken are declared to be public meetings open to the public at all times, and no resolution, rule, or formal action shall be considered binding except as taken or made at such meeting. **Members may discuss such business matters only at a public meeting**. . . .

The use of third persons or other means to evade the Sunshine Law is prohibited. The Sunshine Law does not generally apply to individual decision makers, fact finding, or general staff meetings.

2. BASIC PUBLIC MEETING REQUIREMENTS

A. Open, Accessible, Non-Discriminatory, Technology.

1) Pursuant to Section 286.26, F.S., public meetings must be open to the public, made accessible to individuals with physical handicaps, and held at locations that are easy to reach.

2) Pursuant to Section 286.011(6), F.S., public meetings are prohibited from being held at any location that discriminates on the basis of sex, race, age, creed, color, origin, or economic status, or operates in a manner as to unreasonably restrict public access.

3) Public meetings may include the use of teleconference, video, webinar, or other technology, but the public must be provided points of access. See Rule Chapter 28-109, F.A.C., regarding conducting proceedings by communications media technology.

B. Reasonable Notice. Pursuant to Section 286.011(1), F.S., reasonable notice of public meetings must be provided. Public meeting notices are published on the agency's website and other sources needed to reach affected persons. Less than 24 hours will not be considered reasonable notice except for emergency actions. Pursuant to Section 286.0105, F.S., notices of meetings must advise the public that a record of the meeting is required for an appeal of any decision made at the meeting, and that the person who wants to appeal a decision may need to ensure there is a verbatim record of the meeting. Meetings subject to Chapter 120, F.S., the Administrative Procedures Act, must also be published in the Florida Administrative Register no less than 7 days in advance. An agenda and recording is advisable.

C. Minutes. Pursuant to Section 286.011(2), F.S., minutes of public meetings must be taken, promptly recorded, and available for public inspection. The minutes may be posted or provided upon request. Recordings or transcripts are not required, but persons attending are permitted to record or videotape the meeting.

3. EXEMPTIONS

There are a limited number of exemptions to public meetings requirements under Section 286.0113, F.S.:

A. Meetings in which all or part of a security system plan would be revealed.

B. Procurements under Section 287.057, F.S., in which there are negotiations with a vendor or there are oral questions and answers of a vendor. As required by Section 286.0113(2), F.S., a complete recording of the negotiations or oral presentations must be made and no portion may be off the record. The recordings will be exempt from the public records requirement of Section 119.071(3)(a), F.S., until a notice of decision or intended decision is provided or 30 days after the bids, proposals, or final replies are opened.

4. CONSEQUENCES OF SUNSHINE LAW VIOLATIONS

There are a number of consequences for failure to comply with the Sunshine Law:

A. Noncriminal penalties. A violation constitutes a noncriminal infraction and violators are subject to the imposition of a fine not to exceed $500. Section 286.011(3)(a), F.S.

B. Criminal penalties. A knowing violation, occurring either within or outside the state, is a second degree misdemeanor, punishable under Section 775.082 or 775.083, F.S., which provide for up to 60 days in jail or a fine of $500. Sections 286.011(3)(b) and (c), F.S.

C. Attorney’s fees. In an action to enforce the Sunshine Law or to invalidate actions taken in violation of the Sunshine Law, attorney’s fees will be assessed against the agency and may be assessed against individual members of the board or commission, including attorney’s fees on appeal. Anyone filing such an action found to have done so in bad faith may also be assessed with attorney’s fees. Section 286.011(4), F.S.

D. Injunctions. Circuit courts have jurisdiction to issue injunctions to enforce the Sunshine Law. Section 286.011(2), F.S.

E. Action Void. Actions taken at a meeting where the Sunshine Law was violated are void. Section 286.011(1), F.S. Only a full open hearing, meeting, or workshop can cure a Sunshine Law violation; a perfunctory ratification of actions taken will not suffice.

F. Removal from office. Section 112.52, F.S.

G. Loss of public confidence.

2011 AASHTO Greenbook

TO THE ATTENTION OF DIVISION ADMINISTRATORS, ASSISTANT DIVISION ADMINISTRATORS, AND FEDERAL LANDS DIRECTORS

DUE DATE: EFFECTIVE November 12, 2015

The FHWA published the Final Rule to Title 23 Code of Federal Regulations Part 625 (attached) in the Federal Register on October 13, 2015 **[Docket No. FHWA-2015-0003 or https://federalregister.gov/a/2015-25931]**.

Background: The rule modifies regulations governing new construction, reconstruction, resurfacing (except for maintenance resurfacing), restoration, and rehabilitation projects on the NHS (including the Interstate system), by incorporating by reference the current versions of design standards and standard specifications previously adopted and incorporated by reference under 23 CFR 625.4, and removing the outdated or superseded versions of these standards and specifications. Several of these design standards and standard specifications were established by the American Association of State Highway and Transportation Officials (AASHTO) and the American Welding Society (AWS) and were previously adopted by FHWA through rulemaking.

The revisions include referencing current versions of:

- AASHTO A Policy on Geometric Design of Highways and Streets (Green Book, 2011 edition)
    - *Note that deviations from criteria contained in the standards for projects on the NHS, but which are not one of the thirteen controlling criteria, should be documented by the STA in accordance with State laws, regulations, directives, and safety standards.*
- AASHTO's Load and Resistance Factor Design (LRFD) Bridge Design Specifications
- LRFD Movable Highway Bridge Design Specifications
- Standard Specifications for Structural Supports of Highway Signs, Luminaires and Traffic Signals
- AWS Bridge Welding Code and the Structural Welding Code—Reinforcing Steel

Please note that FHWA is currently soliciting public comments on a proposal to revise the Thirteen Controlling Criteria for Design in a Notice in the Federal Register [https://federalregister.gov/a/2015-25526]. The Notice also clarifies when design exceptions would be required and the documentation that is expected to support such requests. The comment period on the Notice closes on December 7, 2015. Any changes to the Thirteen Controlling would not be anticipated until after the closing date.

Should you or your staff have questions, please contact Michael Matzke, Design Program Manager, 202-366-4658, Michael.Matzke@dot.gov.

Tom

Thomas D. Everett, P.E. | FHWA
Director, Office of Program Administration

Proposed Revisions for 2016 Greenbook

Introduction

INTRODUCTION

The purpose of this Manual is to provide uniform minimum standards and criteria for the design, construction, and maintenance of all public streets, roads, highways, bridges, sidewalks, curbs and curb ramps, crosswalks (where feasible), bicycle facilities, underpasses, and overpasses used by the public for vehicular and pedestrian traffic as directed by Sections 20.23(4)(a), 334.044(10)(a), 334.048(3) and 336.045, F.S.

In the following statutory excerpts, the term "Department" refers to the Florida Department of Transportation.

Section 20.23, F.S. Department of Transportation. There is created a Department of Transportation which shall be a decentralized agency.

(3)(a) The central office shall establish departmental policies, rules, procedures, and standards and shall monitor the implementation of such policies, rules, procedures, and standards in order to ensure uniform compliance and quality performance by the districts and central office units that implement transportation programs. Major transportation policy initiatives or revisions shall be submitted to the commission for review.

Section 334.044, F.S. Department; powers and duties. The department shall have the following general powers and duties:

(10)(a) To develop and adopt uniform minimum standards and criteria for the design, construction, maintenance, and operation of public roads pursuant to the provisions of Section, 336.045, **F.S**.

Section 334.048, F.S. Legislative intent with respect to department management accountability and monitoring systems. The department shall implement the following accountability and monitoring systems to evaluate whether the department's goals are being accomplished efficiently and cost-effectively, and ensure compliance with all laws, rules, policies, and procedures related to the department's operations:

(3) The central office shall adopt policies, rules, procedures, and standards which are necessary for the department to function properly, including establishing accountability for all aspects of the department's operations.

Section 336.045, F.S. Uniform minimum standards for design, construction, and maintenance; advisory committees.

(1) The department shall develop and adopt uniform minimum standards and criteria for the design, construction, and maintenance of all public streets, roads, highways, bridges, sidewalks, curbs and curb ramps, crosswalks, where feasible, bicycle ways, underpasses and overpasses used by the public for vehicular and pedestrian traffic. In developing such standards and criteria, the department shall consider design approaches which provide for the compatibility of such facilities with the surrounding natural or manmade environment; the safety and security of public spaces; and the appropriate aesthetics based upon scale, color, architectural style, materials used to construct the facilities, and the landscape design and landscape materials around the facilities.

(4) All design and construction plans for projects that are to become part of the county road system and are required to conform with the design and construction standards established pursuant to subsection (1) must be certified to be in substantial conformance with the standards established pursuant to subsection (1) that are then in effect by a professional engineer who is registered in this state.

These standards are intended to provide basic guidance for developing and maintaining a highway system with reasonable operating characteristics and a minimum number of hazards.

Standards established by this Manual are intended for use on all new and resurfacing construction projects off the state highway and federal aid systems. Unless specified otherwise herein, iIt is understood that the standards herein cannot be applied completely to all reconstruction and maintenance type projects. However, the standards shall be applied to reconstruction and maintenance projects to the extent state or federal statute requires and that economic and environmental considerations and existing development will allow.

When this Manual refers to guidelines and design standards given by current American Association of State Highway and Transportation Officials (AASHTO) publications, these guidelines and standards shall generally be considered as minimum criteria. The Department may have standards and criteria that differ from the minimum presented in this Manual or by AASHTO for streets and highways under its jurisdiction. A county or municipality may substitute standards and criteria adopted by the Department for some or all portions of design, construction, and maintenance of their facilities. Department standards, criteria, and manuals must be used when preparing projects on the state highway system or the national highway system.

Criteria and standards set forth in other manuals, which have been incorporated by reference, shall be considered as requirements within the authority of this Manual.

This Manual is intended for use by qualified engineering practitioners for the communication of standards and criteria (including various numerical design values and use conditions). The design, construction, and maintenance references for the infrastructure features contained in this Manual recognize many variable and often complex process considerations. The engineering design process, and associated use of this Manual, incorporates aspects of engineering judgment, design principles, science, and recognized standards towards matters involving roadway infrastructure.

Users of this Manual are cautioned that the strict application of exact numerical values, conditions or use information taken from portions of the text may not be appropriate for all circumstances. Individual references to design values or concepts should not be used out of context or without supporting engineering judgment.

The contents of this Manual are reviewed annually by the Florida "Greenbook" Advisory Committee. Membership of this committee is established by the above referenced Section 336.045(2), F.S. Comments, suggestions, or questions may be directed to any committee member.

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POLICY

Specific policies governing the activities of planning, design, construction, reconstruction, maintenance, or operation of streets and highways are listed throughout this Manual. All agencies and individuals involved in these activities shall be governed by the following general policies:

- Each public street and highway, and all activatesactivities thereon, shall be assigned to the jurisdiction of some highway agency. Each highway agency should establish and maintain a program to promote safety in all activities on streets and highways under its jurisdiction.

- Highway safety shall be considered and given a high priority in order to promote the achievement of the maximum safety benefits for given expenditures and efforts.

- The provision for safe, high-quality streets and highways, and maximum transit opportunities should take priority over the provision for the maximum highway mileage obtainable for the available funds.

OBJECTIVES

The planning, design, construction, reconstruction, maintenance, and operation of streets and highways should be predicated upon meeting the following objectives:

- Develop and maintain a highway system that provides the safest practicable environment for motorists, cyclists, pedestrians, and workers.

- Establish and maintain procedures for construction, maintenance, utility, and emergency operations that provide for safe highway and transit operating conditions during these activities.

- Provide streets and highways with operating characteristics that allow for reasonable limitations upon the capabilities of vehicles, drivers, cyclists, pedestrians, and workers.

- Provide uniformity and consistency in the design and operation of streets and highways.

- Provide for satisfactory resolution of conflicts between the surface transportation system and social and environmental considerations to aid neighborhood integrity.

- Reconstruct or modify existing facilities to reduce the hazard to the highway users.

- Reduce the deaths, injuries, and damage due to highway crashes.

Additional general and specific objectives related to various topics and activities are listed throughout this Manual. Where specific standards or recommendations are not available or applicable, the related objectives shall be utilized as general guidelines.

DEFINITIONS OF TERMS

The following terms shall, for the purpose of this Manual, have the meanings respectively ascribed to them, except instances where the context clearly indicates a different meaning. The ***Manual of Uniform Traffic Control Devices (2009 Edition with Revision Numbers 1 and 2, May 2012, MUTCD)*** includes additional information on terms used in conjunction with the application of the MUTCD.

(Source, Hierarchy for new or revised definitions – AASHTO, MUTCD, FDOT Project Traffic Forecasting Handbook, Florida Statutes,). Preference to define terms as used in this document to be relevant to Greenbook.

Text in Green is text the Committee has already approved in earlier meetings. The base document is the 2013 Greenbook. Source for new definitions is provided in parentheses..

ALLEY	A narrow right of way to provide access to the side or rear of individual land parcels. (AASHTO)
ANNUAL AVERAGE DAILY TRAFFIC (AADT)	The total volume of traffic on a highway segment for one year, divided by the number of days in the year. This volume is usually estimated by adjusting a short-term traffic count with weekly and monthly factors. (FDOT Project Traffic Forecasting Handbook)
AVERAGE DAILY TRAFFIC (ADT)	The total traffic volumetraffic volume during a given time period (more than a day, less than a year) divided by the number of days in that time period. (FDOT Project Traffic Forecasting Handbook) Average daily two-way volume of traffic.
AUXILIARY LANE	A designated width of roadway pavement marked to separate speed change, turning, passing, and climbing maneuvers from through traffic. It may provide short capacity segment.

AVERAGE RUNNING SPEED	For all traffic, or component thereof, the summation of distances divided by the summation of running times.
BICYCLE LANE (BIKE LANE)	A portion of a roadway ~~(typically 4-5 ft.) which~~ that has been designated for preferential use by bicyclists by pavement markings, and if used, signs. They are one-way facilities that typically carry traffic in the same direction as adjacent motor vehicle traffic.
BOARDING AND ALIGHTING (B&A) AREA ~~US STOP PAD~~	A firm, stable, slip resistant surface that accommodates passenger movement on or off a bus.
CLEAR ZONE	The ~~total~~ roadside border area, starting at the edge of the ~~motor vehicle~~ traveled way~~lane~~, available for safe use by errant vehicles. This area may consist of a shoulder, ~~a~~ recoverable slope, ~~a~~ non-recoverable slope, ~~, and/or a~~ clear runout area, or combination thereof. The desired width is dependent upon the traffic volumes and speeds, and on the roadside geometry. Note: The aforementioned "border area" is not the same as "border width". Also, see Horizontal Clearance. (edits to align with AASHTO)
CORRIDOR	A strip of land between two termini within which traffic, topography, environment, population, access management, and other characteristics are evaluated for transportation purposes. (an abbreviated version of AASHTO)
CROSSWALK	Portion of the roadway at an intersection included within the connections of lateral lines of the sidewalks on opposite sides of the highway, measured from the curbs or in the absence of curbs from the traversable roadway. Crosswalks may also occur at an intersection or

elsewhere distinctly indicated for pedestrian crossing.

DESIGN HOUR VOLUME (DHV)

Traffic volume expected to use a highway segment during the design hour of the design year. The DHV is related to the AADT by the "K" factor. Total traffic in both directions of travel. Design hourly two-way volume of traffic. (Project Traffic Forecasting Handbook w/ Committee edits)

DIRECTIONAL DESIGN HOUR VOLUME (DDHV)

Traffic volume expected to use a highway segment during the design hour of the design year in the peak direction. (Project Traffic Forecasting Handbook)

DESIGN SPEED

A selected speed rate of travel used to determine the various geometric design features of the roadway. The selected design speed should be a logical one with respect to the topography, anticipated operating speed, adjacent land use, and functional classification of the highway. (AASHTO)

DRIVEWAY

An access from a public way to adjacent property. (AASHTO)

EXPRESSWAY

A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at major intersections. (AASHTO)

FEDERAL AID HIGHWAY

A highway eligible for assistance under the United States Code Title 23 other than a highway classified as a local road or rural minor collector. (AASHTO)

FREEWAY/LIMITED ACCESS HIGHWAY

An expressway with full control of access.

FRONTAGE ROAD/STREET A street or highway constructed adjacent to a higher classification street or other roadway network for the purpose of serving adjacent property or control access.

GRADE SEPARATION A crossing of two roadways or a roadway and a railroad or pedestrian pathway at different levels.

HIGH SPEED Speeds of 50 mph or greater.

HIGH-SPEED RAIL Intercity passenger rail service that is reasonably expected to reach speeds of at least 110 miles per hour. (49 US Code)

HIGHWAY, STREET, OR ROAD General terms, denoting a public way for purposes of traffic, both vehicular and pedestrian, including the entire area within the right of way. The term street is generally used for urban or suburban areas.

HORIZONTAL CLEARANCE Lateral distance from edge of motor vehicle travel lane to a roadside object or feature.

INTERSECTION The general area where two or more streets or highways join or cross.

MAY A permissive condition. Where "may" is used, it is considered to denote permissive usage.

MAINTENANCE A strategy of treatments to an existing roadway system that preserves it, retards future deterioration, and maintains or improves the functional condition.

NEW CONSTRUCTION The construction of any public way~~road facility~~ (paved or unpaved) where none previously existed, or the act of paving any previously unpaved road, except as provided in Chapter 3, Section A of these standards.

OPERATING SPEED The rate of travel at which vehicles are observed traveling during free-flow conditions.

PARAUBLIC TRANSIT Comparable transportation service required by the ADA for individuals with disabilities who are unable to use fixed route transportation systems.Passenger transportation service, local or regional in nature, that is available to any person. Public transit includes bus, light rail, and rapid transit. (FTA)

PEDESTRIAN ACCESS ROUTE A continuous and unobstructed path of travel provided for pedestrians with disabilities within or coinciding with a pedestrian circulation path. (US Access Board)

PEDESTRIAN CIRCULATION PATH A prepared exterior or interior surface provided for pedestrian travel in the public right-of-way. (US Access Board)

PREFERENTIAL LANE A street or highway lane reserved for the exclusive use of one or more specific types of vehicles or vehicles with at least a specific number of occupants. (MUTCD)

PUBLIC WAY All public streets, roads, highways, bridges, sidewalks, curbs and curb ramps, crosswalks (where feasible), bicycle facilities, underpasses, and overpasses used by the public for vehicular and pedestrian traffic (FS)

RAMP 1) Includes all types, arrangements, and sizes of turning roadways that connect two or more legs at an interchange. 2) A combined ramp and landing to accomplish a change in level at a curb (curb ramp). (AASHTO Greenbook, US Access Board)

RECONSTRUCTION Any road construction other than new construction.

RECOVERY AREA A Generally synonymous with clear zone that includes the total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. (AASHTO).

RESIDENTIAL STREETS Streets primarily serving residential access to the commercial, social, and recreational needs of the community. These are generally lower volume and lower speed facilities than the primary arterial and collector routes of the local system "or as adopted by local government ordinance".

RESURFACING Work to place additional layers of surfacing on highway pavement, shoulders, and bridge decks, and necessary incidental work to extend the structural integrity of these features for a substantial time period.

RIGHT OF WAY A general term denoting land, property or interest therein, usually in a strip, acquired or donated for transportation purposes. More specifically, land in which the State, the Department, a county, a transit authority, or a municipality owns the fee or has an easement devoted to or required for use as a public road.

ROADWAY The portion of a street or highway, including shoulders, for vehicular use. A divided highway has two or more roadways. (AASHTO)

RURAL AREAS Those areas outside of urban boundaries. Urban area boundary maps based upon the 2010 Census are located on the Department's Roadway Design web page.

SHALL/MUST	A mandatory condition. (When certain requirements are described with the "shall" or "must" stipulation, it is mandatory these requirements be met.)
SHARED STREET	Specially designed residential or commercial street where space is shared by all users and alignment supports slower vehicle speeds and the perception of shared space. (NACTO)
SHARED ROADWAY	A roadway that is open to both bicycle and motor vehicle travel. This may be an existing roadway, street with wide curb lanes, or road with paved shoulders. (AASHTO)
SHARED USE PATH	Paved facilities physically separated from motorized vehicular traffic by an open space or barrier. May be within the highway right of way or an independent right of way, with minimal cross flow by motor vehicles. Users are non-motorized and may include: pedestrians, bicyclists, skaters, people with disabilities, and others.
SHOULD	An advisory condition. Where the word "should" is used, it is considered to denote advisable usage, recommended but not mandatory.
SLOPES	The relative steepness of the terrain, expressed as a ratio or percentage. Slopes may be categorized as positive (backslopes) or negative (foreslopes) and as parallel or cross slopes in relation to the direction of traffic. Iin this manual slope isare expressed as a ratio of vertical to horizontal (V:H). (AASHTO, Florida Greenbook)
SURFACE TRANSPORTATION SYSTEM	Network of highways, streets, and/or roads. Term can be applied to local system or expanded to desired limits of influence.

TRADITIONAL NEIGHBORHOOD DEVELOPMENT (TND) TND refers to the development or redevelopment of a neighborhood or town using traditional town planning principles. Projects should include a range of housing types and commercial establishments, a network of well-connected streets and blocks, civic buildings and public spaces, and include other uses such as stores, schools, and places of worship within walking distances of residences.

TRAFFIC Pedestrians, bicyclists, motor vehicles, streetcars and other conveyances either singularly or together while using for purposes of travel any highway or private road open to public travel.

TRAFFIC LANE Traffic lanes include travel lanes, auxiliary lanes, turn lanes, weaving, passing, and climbing lanes.

TRAVEL LANE A designated width of roadway pavement marked to carry through traffic and to separate it from opposing traffic or traffic occupying other traffic lanes. Generally, travel lanes equate to the basic number of lanes for a facility.

TRAVELED WAY The portion of the roadway for the movement of vehicles, exclusive of shoulders, berms, sidewalks and parking lanes.

TURNING ROADWAY A connecting roadway for traffic turning between two intersection legs.

URBAN AREA A geographic region comprising as a minimum the area inside the United States Bureau of the Census boundary of an urban place with a population of 5,000 or more persons, expanded to include adjacent developed areas as provided for by Federal Highway Administration regulations. Urban area boundary maps based upon the 2010 Census are located on the Department's Roadway Design web page

URBANIZED AREA — A geographic region comprising as a minimum the area inside an urban place of 50,000 or more persons, as designated by the United States Bureau of the Census, expanded to include adjacent developed areas as provided for by Federal Highway Administration regulations. Urban areas with a population of fewer than 50,000 persons which are located within the expanded boundary of an urbanized area are not separately recognized.

VEHICLE — Every device upon, or by which any person or property is or may be transported or drawn upon a traveled way, excepting devices used exclusively upon stationary rails or tracks. Bicycles are defined as vehicles per Section 316.003, Florida Statutes.

VERY LOW-VOLUME ROAD — A road that is functionally classified as a local road and has a design average daily traffic volume of 400 vehicles per day or less. (AASHTO)

WIDE OUTSIDECURB LANE — Through lanes that provide a minimum of 14' in width. A portion of the roadway which can be used by bicycles and motorized traffic, characterized by a curb lane, which is of such width that bicycle and motorized traffic can be accomplished in the same lane. This lane should always be the through lane closest to the curb (when a curb is provided) or the shoulder edge of the road when a curb is not provided.

Proposed Revisions for 2016 Greenbook

Chapter 3 – Geometric Design

CHAPTER 3

GEOMETRIC DESIGN

TABLES

FIGURES

CHAPTER 3

GEOMETRIC DESIGN

A INTRODUCTION

Geometric design is defined as the design or proportioning of the visible elements of the street or highway. The geometry of the street or highwayroadway is of central importance since it provides the framework for the design of other highway elements. In addition, the geometric design establishes the basic nature and quality of the vehicle path, which has a primary effect upon the overall safety characteristics of the street or highway.

The design of roadway geometry must be conducted in close coordination with other design elements of the street or highway. These other elements include: pavement design, roadway lighting, traffic control devices, transitdevices, transit, drainage, and structural design. The design should consider safe roadside clear zones, pedestrian safety, emergency response, and maintenance capabilities.

The safety characteristics of the design should be given primary consideration. The initial establishment of sufficient right of way and adequate horizontal and vertical alignment is not only essential from a safety standpoint, but also necessary to allow future upgrading and expansion without exorbitant expenditure of highway funds.

The design elements selected should be reasonably uniform but should not be inflexible.

The minimum standards presented in this chapter should not automatically become the standards for geometric design. The designer should consider use of a higher level, when practical, and consider cost-benefits as well as consistency with adjacent facilities. Reconstruction and maintenance of facilities should, where practical, include upgrading to these minimum standards.

In restricted or unusual conditions, it may not be possible to meet the minimum standards. In such cases, the designer shall must obtain an exception in accordance with CHAPTER 14 – DESIGN EXCEPTIONS from the reviewing or permitting organization. However, every effort should be made to obtain the best possible alignment, grade, sight distance, and proper drainage consistent with the terrain, the development, safety, and fund availability. The concept of roadhighway users has expanded in recent years creating additional considerationscerns for the designer.

In making decisions on the standards to be applied to a particular project, the designer must also now address the needs of pedestrians, transit, bicyclists, elder road and transit users, people with disabilitiesthe disabled, freight movement and other users and uses. This is true for both urban and rural facilities.

The design features of urban local streets are governed by practical limitations to a greater extent than those of similar roads in rural areas. The two dominant design controls are: (1) the type and extent of urban development and its limitations on rights of way and (2) zoning or regulatory restrictions. Some streets primarily are land service streets in residential areas. In such cases, the overriding consideration is to foster a safe and pleasing environment. Other streets are land service only in part, and features of traffic and public transit service may be predominant.

The selection of the type and exact design details of a particular streetroadway or highway requires considerable study and thought. When reference is made to guidelines and design details given by current American Association of State Highway and Transportation Officials (AASHTO) publications, these guidelines and standards should generally be considered as minimum criteria. For the design of recreational roads, local service roads[JM1], and alleys[JM2], see AASHTO Greenbook and other publications.[JM3]

Right of way and pavement width requirements for new construction may be reduced for the paving of certain existing unpaved subdivision[WH4] streets[JM5][MAK6] and very low volume rural roads provided all of the conditions listed below are satisfied:

- The road is functionally classified as a local road.
- The 20-year projected ADT is less than or equal to 400 750[MAK7] vehicles per day and the design year projected peak hourly volume is 100 vehicles per hour or less. Note: The design year may be any time within a range of the present to 20 years in the future, depending on the nature of the improvement.
- The road has no foreseeable probability of changing to a higher functional classification through changes in land use, extensions to serve new developing land areas, or any other use which would generate daily or hourly traffic volumes greater than those listed above.
- There is no reasonable possibility of acquiring additional right of way without:
    - Incurring expenditures of public funds in an amount which would be excessive compared to the public benefits achieved

- Causing substantial damage or disruption to abutting property improvements to a degree that is unacceptable considering the local environment

B OBJECTIVES

The major objective in geometric design is to establish a vehicle path and environment providing a reasonable margin of safety for the motorist, transit, bicyclist, and pedestrian under the expected operating conditions and speed. It is recognized that Florida's design driver is aging and tourism is our major industry. This gives even more emphasis to focus on simplicity and easily understood geometry. The design of and street or highwayroadway[JM8] features should consider. The achievement of this objective may be realized by meeting certain specific objectives, which include the following[KM9]:

- Provide the most simple geometry attainable, consistent with the physical constraints
- Provide a design that has a reasonable and consistent margin of safety at the expected operating speed
- Provide a design that is safe at night and under adverse weather conditions
- Provide a facility that is adequate for the expected traffic conditions and transit needs
- Allow for reasonable deficiencies in the driver, such as:
  - Periodic inattention
  - Reduced skill and judgment
  - Slow reaction and response
- Provide an environment that minimizes hazards, is as hazard free as practical, and is "forgiving" to a vehicle that has deviated from the travel path or is out of control.

C DESIGN ELEMENTS

C.1 Design Speed

Design speed is a selected speed used to determine the various geometric design features of the street or highway. Selection of an appropriate design speed must consider the anticipated operating speed, topography, existing and future adjacent land use, and functional classification. Consideration must also be given to pedestrian and bicycle usage.

Many critical design features such as sight distance and curvature are directly related to, and vary appreciably with, design speed. For this reason, the selected design speed should be consistent with the speeds that drivers are likely to expect on a given street or highway facility and must not be less than the expected posted or legal speed limit. Once the design speed is selected, all pertinent highway features should be related to it to obtain a balanced design.

Above minimum design criteria for specific design elements such as flatter curves and longer sight distances should be used where practical, particularly on high speed facilities. On lower speed facilities, use of above minimum values may encourage travel at speeds higher than the design speed.

The design speed utilized should be consistent over a given section of street or highway. Required changes in design speed should be effected in a gradual fashion. When isolated reductions in design speed cannot reasonably be avoided, appropriate speed signs should be posted.

The AASHTO Policy on Geometric Design of Streets and Highways (2011) may be referenced for a more thorough discussion of design speed.

Recommended values for design speed are provided in ***Table 3-1 Recommended Design Speed***. These values should be considered as general guidelines only.

High speed facilities are defined as those facilities with design speeds 50 mph and greater. Low speed facilities are defined as those facilities with design speeds 45 mph and less.

The design speed is defined as a selected rate of travel used to determine the various geometric features of the street or highwayroadway[JM10]. The basic purpose in using the design speed concept is to achieve consistency in the various design elements that influence vehicle operations. Since many critical design features (e.g., sight distance and curvature) are predicated upon design speed, the selection of the proper value is essential to allow for the safe design of a street or highway.

The selection of an appropriate design speed is dependent on the predicted driver behavior and is, therefore, rather complex. This selection of design speed should receive considerable preliminary investigation and thought so safety will be realized from the design.

The primary basis for selecting the design speed should be a rational prediction of the probable maximum operating speed (by approximately 90 percent of the vehicles) on the street or highway. The "average running speed" is not acceptable as a design speed.[KM11]

In selecting design speeds, consideration should also be given to pedestrians and bicycle usage and to the present and future adjacent land use.

Recommended minimum values for design speed are given in Table 3 - 1. These values should be considered as general guidelines only. The maximum normal operating speed is dependent on many variables including:

- Topography
- General roadway[JM12] geometry
- Mix of users (e.g. pedestrians, bicyclists, transit vehicles, trucks)
- Surrounding land use
- Degree of access
- Frequency of traffic signals or other traffic control devices
- Posted speed limit and the degree of enforcement

The driver does not necessarily adjust speed to the classification of importance (or lack of it) of the street or highway.

The design speed shall not be less than the expected posted or legal speed limit. A design speed 5 mph to 10 mph greater than the posted speed limit will compensate for a slight overrunning of the speed limit by some drivers.

The use of the higher design speed (no speed restrictions) given in Table 3 - 1 is recommended for the following situations:

- Topography allowing or encouraging higher operating speeds
- Roadway geometry permitting high speeds
- Long uninterrupted sections of roadway

The design speed utilized should be consistent over a given section of street or highway[JM13]. Required changes in design speed should be effected in a gradual fashion. When isolated reductions in design speed cannot reasonably be avoided, appropriate speed signs should be posted.

Table 3 – 1

Recommended MINIMUM Design Speed [JM14][KM15](mph)

Facility[1]		AADT (vpd)	Design Speed (mph)
Freeways	Rural	All	70
	Urban	All	50 – 70[2]
Arterials	Rural	All	55 – 70
	Urban	All	30 – 60[3]
Collectors	Rural	≥ 400	55 – 65 (50 mph min for AADT 400 to 2000)
		< 400	40 – 60
	Urban	All	30 – 50[3]
Local	Rural	≥ 400	50 – 60
		< 400	40 – 60 (30 mph min for Rolling Terrain or AADT < 250)
	Urban	All	20 – 30[4]

Footnotes:

1. Urban design speeds are applicable to streets and highways located within designated urban boundaries as well as those streets and highways within small communities and urban like developed areas in designated rural areas (outside designated urban boundaries). Rural design speeds are applicable to all other rural areas.
2. A design speed of 70 mph should be used for urban freeways when practical. Lower design speeds should only be used in highly developed areas with closely spaced interchanges. For these areas a minimum design speed of 60 mph is recommended unless it can be shown lower speeds will be consistent with driver expectancy.
3. Lower speeds apply to central business districts and in more developed areas while higher speeds are more applicable to outlying and developing areas.
4. Since the function of urban local streets is to provide access to adjacent property, all design elements should be consistent with the character of activity on and adjacent to the street, and should encourage speeds generally not exceeding 30 mph.

TYPE OF ROADWAY	URBAN		RURAL[MAK16][KM17]	
	*SPEED RESTRICTIONS		*SPEED RESTRICTIONS	
	WITH	WITHOUT	WITH	WITHOUT
Freeway or Expressway	50 - 60		70	
Arterial (Major)	040 - 4555		55 70	
Arterial (Minor)	3550		5570	
Collector (Major)	203545		50065	
Collector (Minor)	3040		4060	
Local **	152030		3050	

Source: 2004 AASHTO Greenbook, Design Controls and Criteria, Design Speed, Pages 67 – 72, 420

* Speed restrictions are features of the design which would effectively limit the operating speed, such as:

a. Short length of roadway (i.e., dead-end street)
b. Closely spaced stop signs, traffic signals or other control devices
c. Locations that would by nature of the surrounding development or land use, indicate to the driver that lower speeds were necessary

** Design speeds lower that 30 mph may be used for local, subdivision type roads and streets. Streets with a design speed less than 30 mph shall be posted with appropriate legal speed limit signs.

C.2 Design Vehicles

A "design vehicle" is a selected motor vehicle whose weight, dimensions, and operating characteristics are used to establish street and highway[JM18] design controls to accommodate vehicles of a designated type. For the purpose of geometric design, the design vehicle should be one with dimensions and minimum turning radii larger than those of almost all vehicles in its class. Design vehicles are listed in Table 3 -2 Design Vehicles[JM19][KM20]. One or more of these vehicles should be used as a control in the selection of geometric design elements. In certain industrial (or other) areas, special service vehicles may have to be considered in the design. Fire equipment and emergency vehicles should have reasonable access to all areas.

If a significant number or percentage (5 percent of all the total traffic) of vehicles of those classes larger than passenger vehicles are likely to use a particular street or highway, that class should be used as a design control. The design of major[WH21][JM22] arterial streets and highways should normally be adequate to accommodate all design vehicles. The decision as to which of the design vehicles (or other special vehicles) should be used as a control is complex and requires careful study. Each situation must be evaluated individually to arrive at a reasonable estimate of the type and volume of expected traffic.

- Design criteria significantly affected by the type of vehicle include:
- Horizontal and vertical clearances
- Alignment
- Lane widening on curves
- Shoulder width requirements
- Turning roadway and intersection radii
- Intersection sight distance
- Acceleration criteria

Particular care should be taken in establishing the radii at intersections, so vehicles may enter the street or highway without encroaching on adjacent travel lanes or leaving the pavement. It is acceptable for occasional trucks or buses to make use of both receiving lanes, especially on side streets.

Table 3 - 2
Design Vehicles[JM23][KM24][KM25][MAK26][JM27]

DESIGN VEHICLE		DIMENSIONS IN FEET					
Type	Symbol	Wheelbase	Overhang		Overall Length	Overall Width	Height
			Front	Rear			
Passenger Car	P	11	3	5	19	7	4.325
Single Unit Truck	SU-30	20	4	6	30	8	11-13.5
Single Unit Truck – 3 Axle	SU-40	25	4	10.5	39.5	8	11-13.5 [JM28]
City Transit Bus	CITY-BUS	25	7	8	40	8.5	10.5
Conventional School Bus (65 passenger)	S-BUS 11	21.3	2.5	12.0	35.8	8.0	10.5
Articulated Bus	A-BUS	22+19.4=41.4	8.6	10	60	8.5	11
Motor Home	MH	20	4	6	30	8	12
Car & Camper Trailer	P/T	11+5+17.79=335.7**	3	120	48.7	8	10
Car & Boat Trailer	P/B	11+5+15=31**	3	8	42	8	---
Intermediate Semitrailer	WB-40	12.5+257.5=3840	3	42.5	45.5	8	13.5
Intermediate Semitrailer	WB-50	14.6+35.4=50	3	2	55	8.5	13.5
Interstate Semitrailer	WB-62	19.521.6+410.4=602.5	4	42.5	698.5	8.5	13.5
Florida Interstate Semitrailer	WB-62FL	19.5+41=60.5	4	9	73.5	8.5 [KM29]	13.5
Interstate Semitrailer	WB-65	21.6+43.4=65	4	4.5	73.5	8.5	13.5
Interstate Semitrailer	WB-67	21.6+45.4=67	4	2.5	73.5	8.5	13.5 [JM30]
"Double-Bottom"-Semitrailer/Trailer Combination	WB-67D[JM31]	11+23+10*+22.53=667.5	2.33	3.0	72.3.3	8.5	13.5

Source: 20042011 AASHTO Greenbook, Design Controls and Criteria, Exhibit 2-1Table 2-1b.

* Distance between rear wheels of front trailer and front wheels of rear trailer

** Distance between rear wheels of trailer and front wheels of car

C.3 Sight Distance

The provision for adequate horizontal and vertical sight distance is an essential factor in the development of a safe street or highway. An unobstructed view of the upcoming roadway is necessary to allow time and space for the safe execution of passing, stopping, intersection movements, and other normal and emergency maneuvers. It is also important to provide as great a sight distance as possible to allow the driver time to plan for future actions. The driver is continuously required to execute normal slowing, turning, and acceleration maneuvers. If he can plan in advance for these actions, traffic flow will be smoother and less hazardous. Unexpected emergency maneuvers will also be less hazardous if they are not combined with uncertainty regarding the required normal maneuvers. The appropriate use of lighting (CHAPTER 6 - ROADWAY LIGHTING) may be required to provide adequate sight distances for night driving.

Future obstruction to sight distance that may develop (e.g., vegetation) or be constructed should be taken into consideration in the initial design. Areas outside of the roadhighway[WH32][JM33] right of way that are not under the highway agency's jurisdiction should be considered as points of obstruction. Planned future construction of median barriers, guardrails, grade separations, or other structures should also be considered as possible sight obstructions.

C.3.a Stopping Sight Distance

Safe stopping sight distances shall be provided continuously on all streets and highways. The factors, which determine the minimum distance required to stop, include:

- Vehicle speed
- Driver's total reaction time
- Characteristics and conditions of the vehicle
- Friction capabilities between the tires and the roadway surface
- Vertical and horizontal alignment of the roadway

It is desirable that the driver be given sufficient sight distance to avoid an object or slow moving vehicle with a natural, smooth maneuver rather than an extreme or panic reaction.

The determination of available stopping sight distance shall be based on a height of the driver's eye equal to 3.50 feet and a height of obstruction to be avoided equal to two feet (20.50 feet). It would, of course, be desirable to use a height of obstruction equal to zero (coincident with the roadway surface) to provide the driver with a more positive sight condition. Where horizontal sight distance may be obstructed on curves, the driver's eye and the obstruction shall be assumed to be located at the centerline of the trafficvel [JM34]lane on the inside of the curve.

The stopping sight distance shall be no less than the values given in Table 3-3 Stopping Sight Distances.

Table 3 – 3
Stopping Sight DistancesAND LENGTHS OF VERTICAL CURVES [MAK35]

MINIMUM STOPPING SIGHT DISTANCES (feetFEET[MAK36]) (For application of stopping sight distance, use an eye height of 3.50 feet and an object height of 2 feet6 inches above the road surface)												
Design Speed (mphMPH)	15	20	25	30	35	40	45	50	55	60	65	70
Stopping Sight Distance (feetFEET)	80	115	155	200	250	305	360	425	495	570	645	730

ROUNDED K VALUES FOR MINIMUM LENGTHS VERTICAL CURVES[JM37][KM38] L = KA L = LENGTH OF VERTICAL CURVE A = ALGEBRAIC DIFFERENCE OF GRADES IN PERCENT												
Design Speed (MPH)	15	20	25	30	35	40	45	50	55	60	65	70
K Values for Crest Vertical Curves[MAK39]	5	710	12 19	19 31	29 47	44 70	61 98	84 136	114 185	151 245	193 313	247 401
K Values for Sag Vertical Curves	10	17	26	37	49	64	79	96	115	136	157	181

- The length of vertical curve must never be less than three times the design speed of the highway
- Curve lengths computed from the formula L = KA should be rounded upward when feasible
- The minimum lengths of vertical curves to be used on COLLECTORS, ARTERIALS AND FREEWAYS major highways are shown in the table below

MINIMUM LENGTHS FOR VERTICAL CURVES ON COLLECTORS, ARTERIALS, AND FREEWAYSMAJOR HIGHWAYS (FEET[MAK40])			
Design Speed (MPH)	50	60	70
Crest Vertical Curves (FEET)	300	400	500
Sag Vertical Curves (FEET)	200	300	400

MINIMUM PASSING SIGHT DISTANCES [JM41][KM42][KM43](FEET[MAK44]) (For application of passing sight distance, use an eye height of 3.50 feet and an object height of 3.50 feet above the road surface)											
Design Speed (MPH)	20	25	30	35	40	45	50	55	60	65	70
Minimum Passing Sight Distance (FEET[MAK45])	710	900	1090	1280	1470	1625	1835	1985	2135	2285	2480

Source: 201104 AASHTO Greenbook, Table 3-1Exhibits 3-72 and 3-73, page 272.

C.3.b Passing Sight Distance

The passing maneuver, which requires occupation of the opposing travel lane, is inherently dangerous. The driver is required to make simultaneous estimates of time, distance, relative speeds, and vehicle capabilities. Errors in these estimates result in frequent and serious crashes.

Streets or hHighways[JM46] with two or more travel lanes in a given direction are not subject to requirements for safe passing sight distance. Two-lane, two-way highways should be provided with safe passing sight distance for as much of the highway as feasible. The driver demand for passing opportunity is high and serious limitations on the opportunity for passing reduces the capacity and safe characteristics of the highway.

The distance traveled after the driver's final decision to pass (while encroaching into the opposite travel path) is that which is required to pass and return to the original travel lane in front of the overtaken vehicle. In addition to this distance, the safe passing sight distance must include the distance traveled by an opposing vehicle during this time period, as well as a reasonable margin of safety. Due to the many variables in vehicle characteristics and driver behavior, the passing sight distance should be as long as is practicable.

The determination of passing sight distance shall be based on a height of eye equal to 3.50 feet and a height of object passing equal to 3.50 feet. Where passing is permitted, the passing sight distance shall be no less than the values given in Table 3-4 Passing Sight Distances3.

Table 3 – 4
Passing Sight Distances[MAK47]

MINIMUM PASSING SIGHT DISTANCES [JM48][KM49][KM50](feet[MAK51]) (For application of passing sight distance, use an eye height of 3.50 feet and an object height of 3.50 feet above the road surface)											
Design Speed (mph)	20	25	30	35	40	45	50	55	60	65	70
Minimum Passing Sight Distance (feet[MAK52])	710 400	900 450	1090 500	1280 550	1470 600	1625 700	1835 800	1985 900	2135 1000	2285 1100	2480 1200

Source: 2011 AASHTO Greenbook, Table 3-4.

C.3.c Sight Distance at Decision Points

It is desirable to provide sight distances exceeding the minimum at changes in geometry, approaches to intersections, entrances and exits, and other potential decision points or hazards. The sight distance should be adequate to allow the driver sufficient time to observe the upcoming situation, make the proper decision, and take the appropriate action in a normal manner.

Minimum stopping distance does not provide sufficient space or time for the driver to make decisions regarding complex situations requiring more than simple perception-reaction process. In many cases, rapid stopping or lane changing may be extremely undesirable and cause hazardous maneuvers (i.e., in heavy traffic conditions); therefore, it would be preferable to provide sufficient sight distance to allow for a more gradual reaction.

The sight distance on a freeway preceding the approach nose of an exit ramp[JM53][MAK54] should exceed the minimum by 25 percent or more. A minimum sight distance of 1000 feet, measured from the driver's eye to the road surface is a desirable goal. There should be a clear view of the exit terminal including the exit nose.

C.3.d Intersection Sight Distance

Sight distances for intersection movements are given in the general intersection requirements (C.9 Intersection Design, this chapter).

C.4 Horizontal Alignment

C.4.a General Criteria

The standard of alignment selected for a particular section of street or highway[JM55] should extend throughout the section with no sudden changes from easy to sharp curvature. Where sharper curvature is unavoidable, a sequence of curves of increasing degree should be utilized.

Winding alignment consisting of sharp curves is hazardous, reduces capacity, and should be avoided. The use of as flat a curve as possible is recommended. Flatter curves are not only less hazardous, but also frequently less costly due to the shortened roadway.

Maximum curvature should not be used in the following locations:

- High fills or elevated structures. The lack of surrounding objects reduces the driver's perception of the roadway alignment.
- At or near a crest in grade
- At or near a low point in a sag or grade
- At the end of long tangents
- At or near intersections, transit stops, or points of ingress or egress
- At or near other decision points

The "broken back" arrangement of curves (short tangent between two curves in the same direction) should be avoided. This is acceptable only at design speeds of 30 mph or less. This arrangement produces an unexpected and hazardous situation.

When reversals in alignment are used and superelevation is required, a sufficient length of tangent between the reverse curves is required for adequate superelevation transition.

Compound curves should be avoided, especially when curves are sharp. They tend to produce erratic and dangerous vehicle operations. When compound curves are necessary, the radius of the flatter curve should not be more than 50 percent greater than the sharper curve.

The transition between tangents and curves should normally be accomplished by the use of appropriate straight-line transitions or spirals. This is essential to assist the driver in maintaining his vehicle in the proper travel path.

For small deflection angles, curves should be suitably lengthened to avoid the distracting appearance of a kink. Curves should be at least 900 feet long for a central angle of 1 degree or 500 feet long for a central angle of 5 degrees. Gently flowing alignment is generally more pleasing in appearance, as well as, superior from a safety standpoint.

C.4.b Superelevation

In the design of street and highway[JM56] curves, it is necessary to establish a proper relationship between curvature of the roadway and design speed. The use of superelevation (rotation of the roadway about its axis) is employed to counteract centrifugal force and allow drivers to comfortably and safely travel through curves at the design speed.

The superelevation rates for rural highways, urban freeways, and high speed urban highwaysarterials[JM57] are shown in Figure 3 - 1 Rural Highways, Urban Freeways and High Speed Urban Highways. These rates are based on a maximum rate of 0.10 foot per foot of roadway width. Additional superelevation details, given in the Department's Design Standards, may be considered.

The superelevation rates recommended for urban highways[JM58] and high speed urban streets are shown in Figure 3 -2 Superelevation Rates (e) For Urban Highways and High Speed Urban Streets. These rates are based on a maximum superelevation rate of 0.05 foot per foot of roadway width[JM59] and are recommended for arterials and collectorsmajor streets[JM60] in built up areas. Additional information regarding superelevation, given in the Department's Design Standards, and ***AASHTO – "A Policy on Geometric Design of Highways and Streets" -201101***, may be considered[KM61].

Although superelevation is advantageous for traffic operations, various factors combine to make its use impractical in many built-up areas. Such factors include:

- Wide pavement areas
- Need to meet grade of adjacent property
- Surface drainage considerations
- Frequency of cross streets, alleys, and driveways

Therefore, horizontal curves on lower speed streets in residentialsubdivision and urban areas are usually designed without superelevation, only side friction being used to counteract the centrifugal force. Figure 3 - 3 Maximum Safe Speed for Horizontal Curves Urban-

Lower Speed Streets[MAK62][MAK63] 2 may be used for determination of the maximum safe speed for horizontal curves on lower speed urban streets.

Figure 3 - 1
Rural Highways, Urban Freeways
and High Speed Urban Highways ARTERIALS[JM64][KM65]

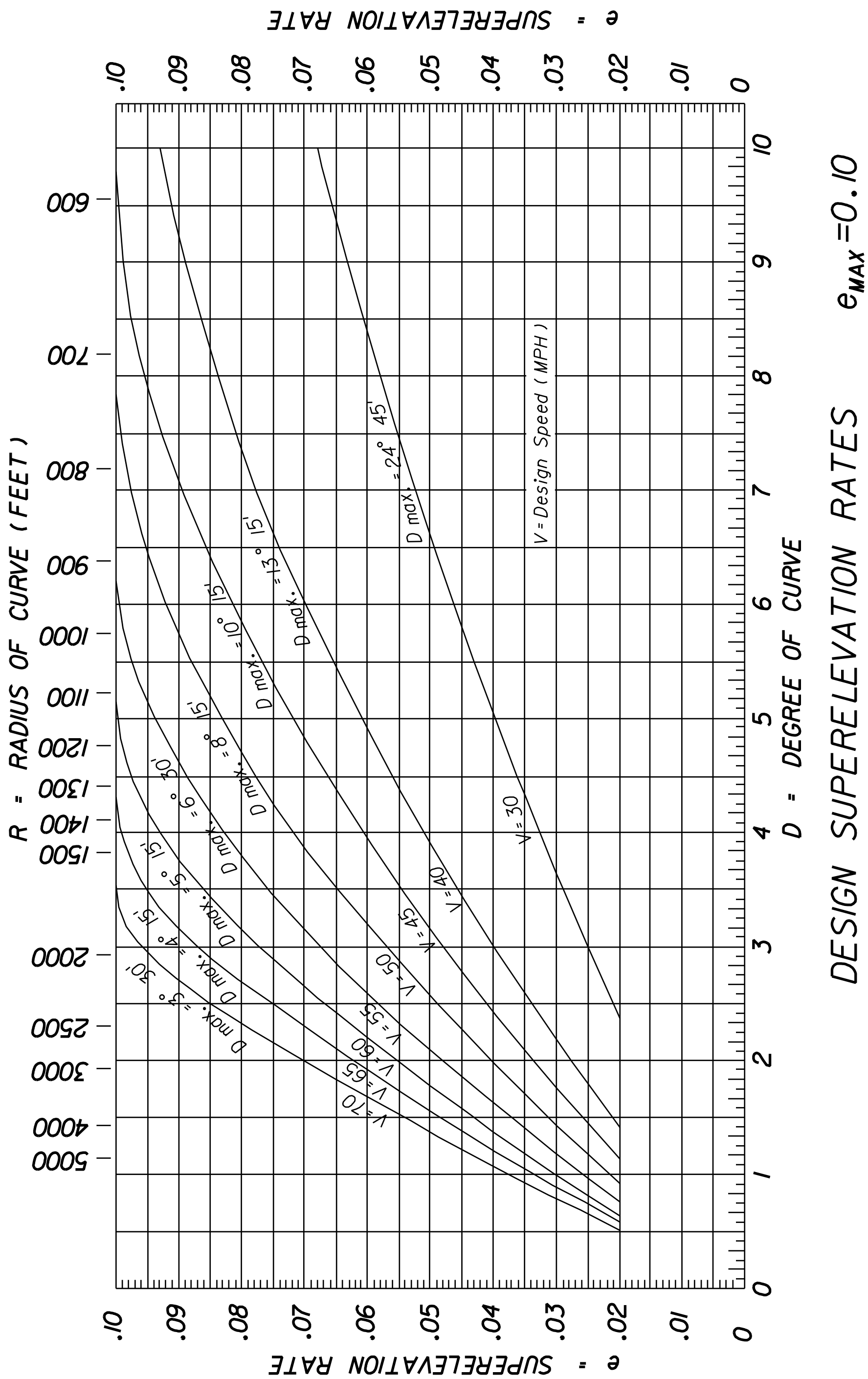
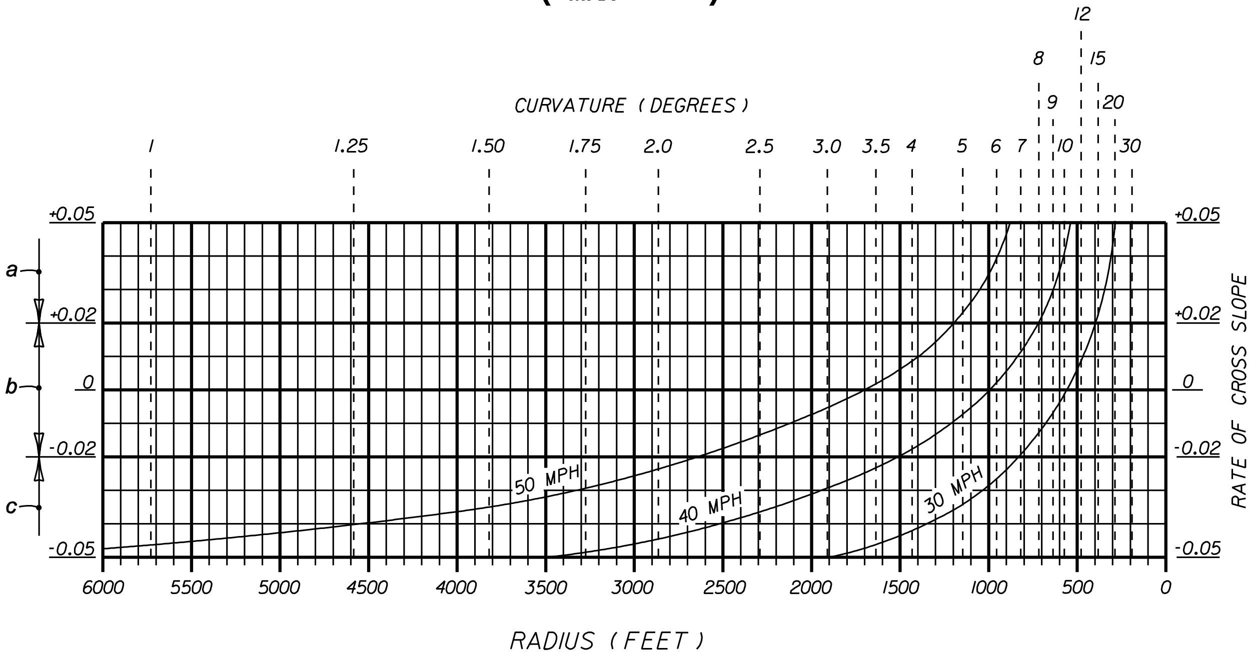


Figure 3 - 2
Superelevation Rates (e) For Urban Highways And High Speed Urban Streets
(e_{MAX} =0.05)



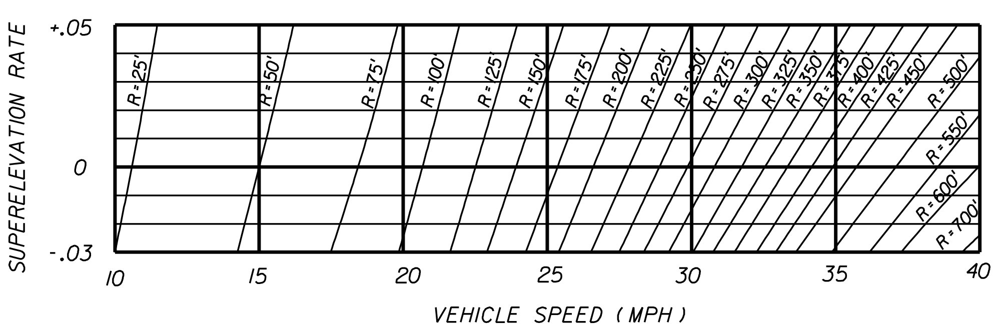
a. When the speed curves and the degree of curve lines intersect above this line, the pavement is to be superelevated (positive slope) at the rates indicated at the lines intersecting points.

b. When the speed curves and the degree of curve lines intersect between these limits, the pavement is to be superelevated at the rate of 0.02 (positive slope).

c. When the speed curves and the degree of curve lines intersect below this line, the pavement is to have normal crown (typically 0.02 and 0.03 downward slopes).

SUPERELEVATION RATES (e) FOR URBAN HIGHWAYS AND HIGH SPEED URBAN STREETS (e MAX = 0.05[MAK66])

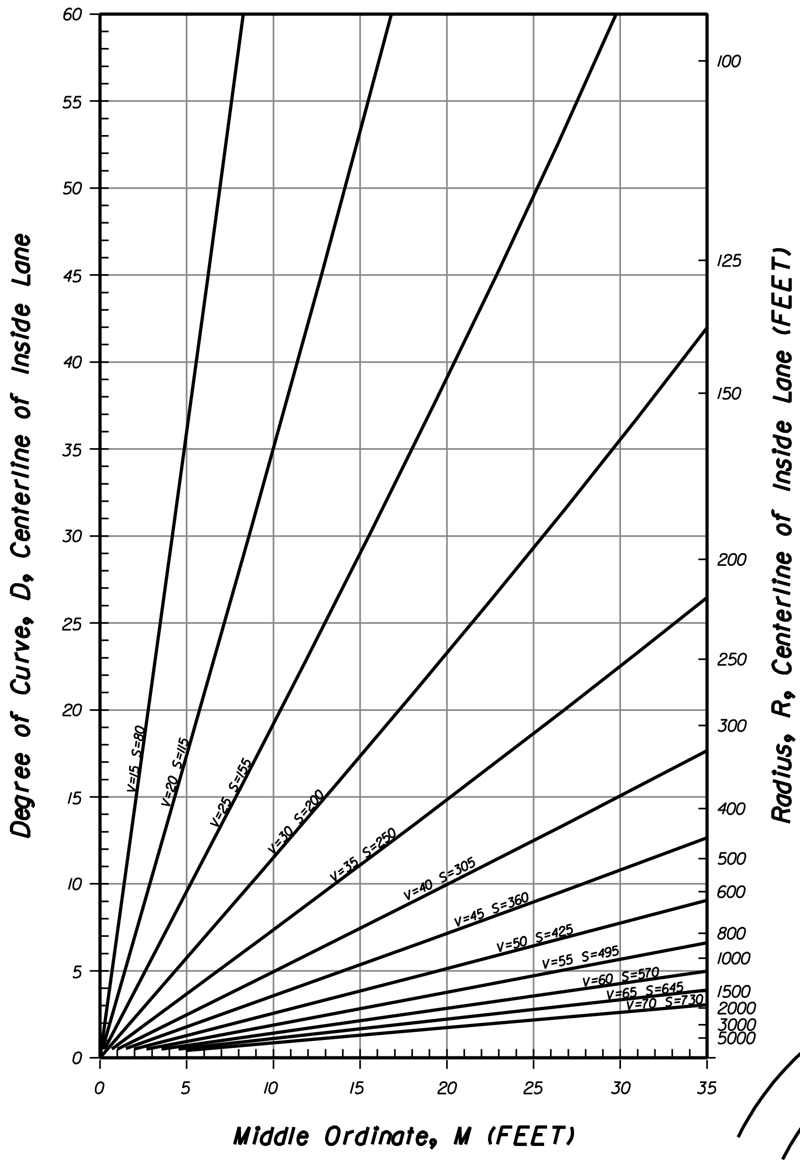
Figure 3 - 3 -Maximum Safe Speed For Horizontal Curves
Urban-Lower Speed Streets[MAK67][MAK68]



MAXIMUM SAFE SPEED FOR HORIZONTAL CURVES

URBAN-LOWER SPEED STREETS

Figure 3 – 42A
Sight Distance on Curves[MAK69][KM70]



$$M = \frac{5730}{D}\left(1 - \mathrm{Cos}\frac{SD}{200}\right)$$

$$R = \frac{5730}{D} \quad \text{and} \quad \theta = \frac{SD}{200}$$

$$M = R\,(1 - \mathrm{Cos}\,\theta)$$

$$M = R\left(1 - \mathrm{Cos}\,\frac{28.65\,S}{R}\right)$$

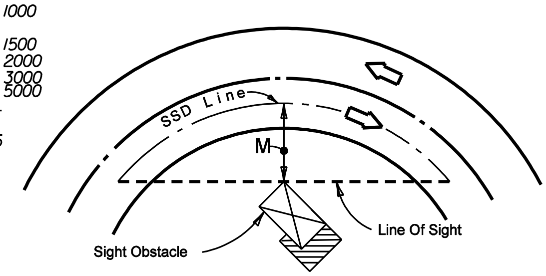
Where

S = Stopping Sight Distance (FEET)

D = Degree of Curve

M = Middle Ordinate (FEET)

R = Radius (FEET)



RELATION BETWEEN DEGREE OF CURVE AND VALUE OF MIDDLE ORDINATE NECESSARY TO PROVIDE STOPPING SIGHT DISTANCE ON HORIZONTAL CURVES UNDER OPEN ROAD CONDITIONS.

C.4.c Curvature

Where a directional change in alignment is required, every effort should be made to utilize the smallest degree (largest radius) curvature possible. The use of the maximum degree of curvature should be avoided when possible. Design speed maximum degree of curvature relationships are given in Table 3 - 5 Horizontal Curvature. The use of sharper curvature for the design speeds shown in Table 3 - 5 would call for superelevation beyond the limit considered practical or for operation with tire friction beyond safe or comfortable limits or both. The maximum degree of curvature is a significant value in alignment design.

Table 3 – 54
Horizontal Curvature

RURAL Based on e_{MAX} = 0.10			URBAN High-Speed Highways and Streets Based on e_{MAX} = 0.05		
Design Speed (MPH)	Max. Degree of Curvature	Min. Radius (FEET)	Design Speed (MPH)	Max. Degree of Curvature	Min. Radius (FEET)
15	104° 45'	55	---	---	---
20	57° 45'	100	---	---	---
25	36° 15'	160	---	---	---
30	24° 45'	230	30	20° 00'	285
35	17° 45'	320	35	14° 15'	400
40	13° 15'	430	40	10° 45'	535
45	10° 15'	555	45	8° 15'	695
50	8° 15'	695	50	6° 30'	880
55	6° 30'	880	55	5° 00'	1125
60	5° 15'	1095	---	---	---
65	4° 15'	1345	---	---	---
70	3° 30'	1640	---	---	---

LOW-SPEED URBAN STREETS				
Design Speed (MPH)	With e_{MAX} = 0.05		Without Superelevation (e_{MAX} = -0.02)	
	Max. Degree of Curvature	Min. Radius (FEET)	Max. Degree of Curvature	Min. Radius (FEET)
15	144° 45'	40	118° 15'	50
20	75° 00'	75	60° 00'	95
25	41° 30'	140	31° 45'	180
30	25° 45'	225	19° 15'	300

(TABLE CONTINUES ON NEXT PAGE)

Table 3 – 54
Horizontal Curvature
(Continued)

LATERAL CLEARANCE FROM EDGE[WH71] OF TRAVELED WAYPAVEMENT[JM72] TO OBSTRUCTION FOR MAXIMUM CURVATURE (DEGREES), BASED ON LINE OF SIGHT ON INSIDE LANE (Lateral Clearance = M $_{Inside\ Lane}$ – 6') Based on e_{MAX} = 0.10		
Design Speed (mphMPH)	Maximum Curvature	Clearance (feetFEET)
20	57° 45'	11[KM73][KM74]
25	36° 15”	13
30	24° 45'	16
35	17° 45'	19
40	13° 15'	21
45	10° 15'	23
50	8° 15'	27
55	6° 30'	29
60	5° 15'	31
65	4° 15'	33
70	3° 30'	35

C.4.d Superelevation Transition (superelevation runoffs plus tangent runoff)

Superelevation runoff is the general term denoting the length of street or highway[JM75] needed to accomplish the change in cross slope from a section with the adverse crown removed (level) fully superelevated section, or vice versa. Tangent runoff is the general term denoting the length of street or highway[JM76] needed to accomplish the change in cross slope from a normal cross section to a section with the adverse crown removed, or vice versa. Spiral curves can be used to transition from the tangent to the curve. Where the spiral curve is employed, its length is used to make the entire superelevation transition.

The Department's Design Standards show in detail superelevation transitions for various sections and methods for determining length of transition.

C.4.e Lane Widening on Curves

The traveled waylane[JM77] should be widened on sharp curves due to the increased difficulty for the driver to follow the proper path. Trucks and transit vehicles experience additional difficulty due to the fact that the rear wheels may track considerably inside the front wheels thus requiring additional width. Adjustments to traveled waylane[JM78] widths for mainline and turning roadways are given in Tables 3 - 65A Calculated and Design Values for Traveled Way Widening on Open Highway Curves (Two-Lane Highways, One-Way or Two-Way and 3 - 65B Adjustments or Traveled Way Widening Values on Open Highway Curves (Two-Lane Highways, One-Way or Two-Way. A transition length shall be introduced in changing to an increased/decreased lane width. This transition length shall be proportional to the increase/decrease in traveled waypavement[JM79] width in a ratio of not less than 50 feet of transition length for each foot of change in lane width.

Table 3 – 65A
Calculated and Design Values for Traveled Way Widening on Open Highway Curves
(Two-Lane Highways, One-Way or Two-Way)

Radius of Curve (FEET)	Roadway width = 24 feet. Design Speed (MPH)							Roadway width = 22 feet. Design Speed (MPH)							Roadway width = 20 feet. Design Speed (MPH)						
	30	35	40	45	50	55	60	30	35	40	45	50	55	60	30	35	40	45	50	55	60
7000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.7	0.7	0.8	0.9	0.9	1.6	1.6	1.7	1.7	1.8	1.9	1.9
6500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.7	0.8	0.8	0.9	1.0	1.6	1.7	1.7	1.8	1.8	1.9	2.0
6000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.8	0.8	0.9	1.0	1.0	1.6	1.7	1.8	1.8	1.9	2.0	2.0
5500	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.7	0.7	0.8	0.9	0.9	1.0	1.1	1.7	1.7	1.8	1.9	1.9	2.0	2.1
5000	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.7	0.8	0.9	0.9	1.0	1.1	1.1	1.7	1.8	1.9	1.9	2.0	2.1	2.1
4500	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.8	0.8	0.9	1.0	1.1	1.1	1.2	1.8	1.8	1.9	2.0	2.1	2.1	2.2
4000	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.8	1.9	2.0	2.1	2.2	2.2	2.3
3500	0.0	0.0	0.1	0.2	0.3	0.3	0.4	0.9	1.0	1.1	1.2	1.3	1.3	1.4	1.9	2.0	2.1	2.2	2.3	2.3	2.4
3000	0.0	0.1	0.2	0.3	0.4	0.5	0.6	1.0	1.1	1.2	1.3	1.4	1.5	1.6	2.0	2.1	2.2	2.3	2.4	2.5	2.6
2500	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.2	2.3	2.4	2.5	2.6	2.7	2.8
2000	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.4	1.5	1.6	1.7	1.8	2.0	2.1	2.4	2.5	2.6	2.7	2.8	3.0	3.1
1800	0.5	0.6	0.8	0.9	1.0	1.1	1.2	1.5	1.6	1.8	1.9	2.0	2.1	2.2	2.5	2.6	2.8	2.9	3.0	3.1	3.2
1600	0.7	0.8	0.9	1.0	1.2	1.3	1.4	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.7	2.8	2.9	3.0	3.2	3.3	3.4
1400	0.8	1.0	1.1	1.2	1.4	1.5	1.6	1.8	2.0	2.1	2.2	2.4	2.5	2.6	2.8	3.0	3.1	3.2	3.4	3.5	3.6
1200	1.1	1.2	1.4	1.5	1.7	1.8	1.9	2.1	2.2	2.4	2.5	2.7	2.8	2.9	3.1	3.2	3.4	3.5	3.7	3.8	3.9
1000	1.4	1.6	1.7	1.9	2.0	2.2	2.4	2.4	2.6	2.7	2.9	3.0	3.2	3.4	3.4	3.6	3.7	3.9	4.0	4.2	4.4
900	1.6	1.8	2.0	2.1	2.3	2.5		2.6	2.8	3.0	3.1	3.3	3.5		3.6	3.8	4.0	4.1	4.3	4.5	
800	1.9	2.1	2.2	2.4	2.6	2.8		2.9	3.1	3.2	3.4	3.6	3.8		3.9	4.1	4.2	4.4	4.6	4.8	
700	2.2	2.4	2.6	2.8	3.0			3.2	3.4	3.6	3.8	4.0			4.2	4.4	4.6	4.8	5.0		
600	2.7	2.9	3.1	3.3	3.5			3.7	3.9	4.1	4.3	4.5			4.7	4.9	5.1	5.3	5.5		
500	3.3	3.5	3.7	3.9				4.3	4.5	4.7	4.9				5.3	5.5	5.7	5.9			
450	3.7	3.9	4.1					4.7	4.9	5.1					5.7	5.9	6.1				
400	4.2	4.4	4.7					5.2	5.4	5.7					6.2	6.4	6.7				
350	4.8	5.1	5.3					5.8	6.1	6.3					6.8	7.1	7.3				
300	5.6	5.9						6.6	6.9						7.6	7.9					
250	6.8							7.8							8.8						
200	8.5							9.5							10.5						

Notes: Values shown are for WB-50[JM80] design vehicle and represent widening in feet. For other design vehicles, use adjustments in Table 3-620B.

Values less than 2.0 feet may be disregarded.
For 3-lane roadways, multiply above values by 1.5.
For 4-lane roadways, multiply above values by 2.

Table 3 – 65B
Adjustments for Traveled Way Widening Values on Open Highway Curves (Two-Lane Highways, One-Way or Two-Way)

Radius of Curve (FEET)	Design Vehicle						
	SU	WB-40	WB-62	WB-65	WB-67D	WB-100T	WB-109D
7000	-1.1	-1.1	0.1	0.1	0.0	0.0	0.3
6500	-1.1	-1.1	0.1	0.1	0.0	0.1	0.3
6000	-1.2	-1.1	0.1	0.2	0.0	0.1	0.3
5500	-1.2	-1.1	0.1	0.2	0.0	0.1	0.4
5000	-1.2	-1.1	0.1	0.2	0.0	0.1	0.4
4500	-1.2	-1.1	0.1	0.2	0.0	0.1	0.5
4000	-1.2	-1.2	0.2	0.2	-0.1	0.1	0.5
3500	-1.3	-1.2	0.2	0.3	-0.1	0.1	0.6
3000	-1.3	-1.2	0.2	0.3	-0.1	0.1	0.7
2500	-1.4	-1.2	0.3	0.4	-0.1	0.1	0.8
2000	-1.5	-1.3	0.3	0.5	-0.1	0.2	1.0
1800	-1.5	-1.3	0.4	0.5	-0.1	0.2	1.1
1600	-1.6	-1.4	0.4	0.6	-0.1	0.2	1.3
1400	-1.7	-1.4	0.5	0.6	-0.2	0.2	1.5
1200	-1.8	-1.5	0.5	0.8	-0.2	0.3	1.7
1000	-2.0	-1.6	0.6	0.9	-0.2	0.3	2.0
900	-2.1	-1.7	0.7	1.0	-0.2	0.4	2.3
800	-2.2	-1.8	0.8	1.1	-0.3	0.4	2.6
700	-2.4	-1.9	0.9	1.3	-0.3	0.5	2.9
600	-2.6	-2.0	1.1	1.5	-0.4	0.6	3.4
500	-2.9	-2.2	1.3	1.8	-0.4	0.7	4.1
450	-3.2	-2.4	1.4	2.0	-0.5	0.7	4.6
400	-3.4	-2.5	1.6	2.3	-0.5	0.8	5.1
350	-3.8	-2.8	1.9	2.6	-0.6	1.0	5.9
300	-4.3	-3.0	2.2	3.0	-0.7	1.1	6.9
250	-4.9	-3.5	2.6	3.7	-0.9	1.4	8.3
200	-5.9	-4.1	3.3	4.6	-1.1	1.7	10.5

Notes: Adjustments are applied by adding to or subtracting from the values in Table 3-620A
Adjustments depend only on radius and design vehicle; they are independent of traveled wayroadway[JM81] width and design speed.
For 3-lane roadways, multiply above values by 1.5.
For 4-lane roadways, multiply above values by 2.0.

C.5 Vertical Alignment

C.5.a General Criteria

The selection of vertical alignment should be predicated to a large extent upon the following criteria:

- Obtaining maximum sight distances
- Limiting speed differences (particularly for trucks and buses) by reducing magnitude and length of grades
- A "hidden dip" which would not be apparent to the driver must be avoided.
- Steep grades and sharp crest vertical curves should be avoided at or near intersections.
- Flat grades and long gentle vertical curves should be used whenever possible.

C.5.b Grades

The grades selected for vertical alignment should be as flat as practical, and should not be greater than the value given in Table 3 - 76 Recommended Maximum Grades In Percent.

For streets and highways requiring long upgrades, the maximum grade should be reduced so the speed reduction of slow-moving vehicles (e.g., trucks and buses) is not greater than 10 mph. The critical lengths of grade for these speed reductions are shown in Figure 3 -– 5 Critical Length Versus Upgrade 3. Where reduction of grade is not practical, climbing lanes[JM82] should be provided to meet these speed reduction limitations.

The criteria for a climbing lane and the adjacent shoulder are the same as for any travel lane except that the climbing lane should be clearly designated by the appropriate pavement markings. Entrance to and exit from the climbing lane shall follow the same criteria as other merging traffic lane[JM83]s; however, the climbing lane should not be terminated until well beyond the crest of the vertical curve. Differences in superelevation should not be sufficient to produce a change in pavement cross slope between the climbing lane and through lane in excess of 0.04 feet per foot.

Recommended minimum gutter grades:

Rolling terrain - 0.5%   Flat terrain - 0.3%

Table 3 – 76
Recommended Maximum Grades in Percent

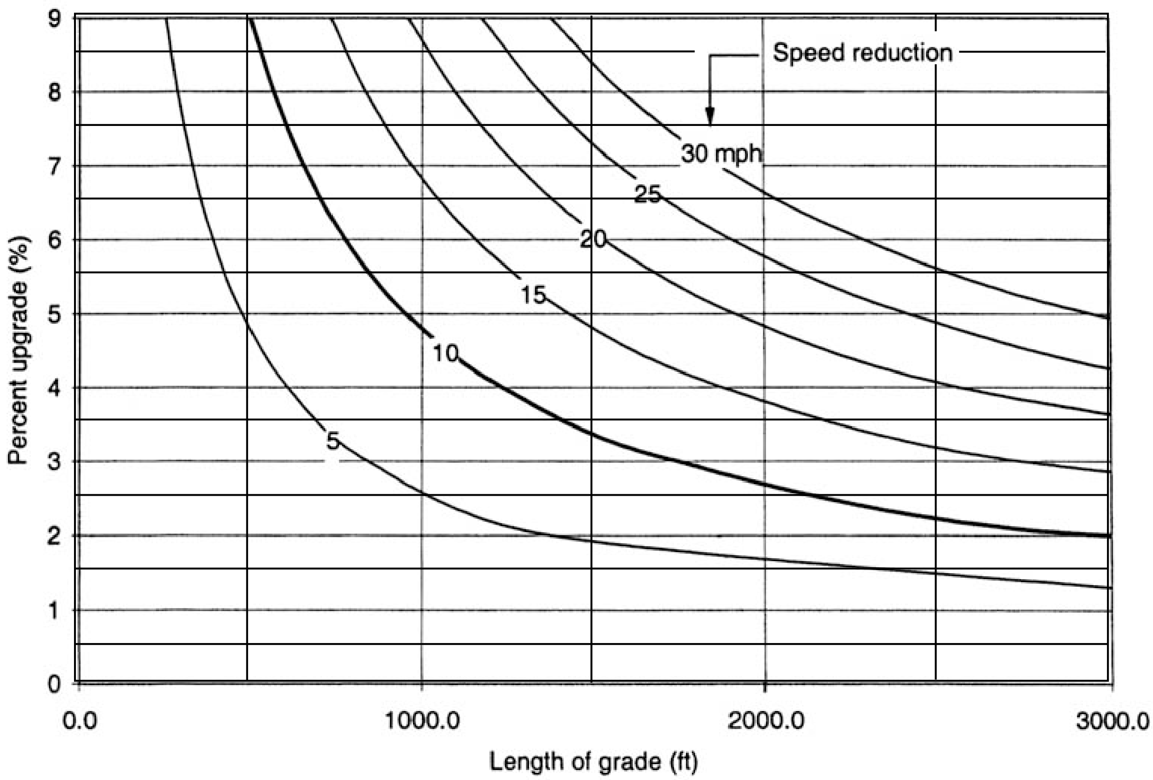
TYPE OF ROADWAY		FLAT TERRAIN												ROLLING TERRAIN											
		DESIGN SPEED (MPH)												DESIGN SPEED (MPH)											
		15	20	25	30	35	40	45	50	55	60	65	70	15	20	25	30	35	40	45	50	55	60	65	70
Freeway		---	---	---	---	---	---	---	4	4	3	3	3	---	---	---	---	---	---	---	5	5	4	4	4
Arterial*	Rural	---	---	---	---	---	5	5	4	4	3	3	3	---	---	---	---	---	6	6	5	5	4	4	4
	Urban	---	---	---	8	7	7	6	6	5	5	---	---	---	---	---	9	8	8	7	7	6	6	---	---
Collector*	Rural	---	7	7	7	7	7	7	6	6	5	---	---	---	10	10	9	9	8	8	7	7	6	---	---
	Urban	---	9	9	9	9	9	8	7	7	6	---	---	---	12	12	11	10	10	9	8	8	7	---	---
Local*		9	8	7	7	7	7	7	6	6	5	---	---	12	11	11	10	10	10	9	8	7	6	---	---
Industrial**		---	---	---	4	4	4	4	3	3	3	---	---	---	---	---	5	5	5	5	4	4	4	---	---

* May be increased by 2 percent for urban streets under extreme conditions.

** Local and collector streets with significant (15% or more) truck traffic.

For short sections less than 500' and for one-way downgrades, the maximum gradient may be 1% steeper.

Figure 3 – 543
Critical Length Versus Upgrade



Critical Lengths of Grade for Design[JM84][KM85], Assumed Typical Heavy Truck of 200 lb/hp, Entering Speed = 70 mph

(REF: Figure 3-28Exhibit 3-63, AASHTO A Policy on Geometric Design of Highways and Streets 201101)

C.5.c Vertical Curves[JM86]

Changes in grade should be connected by a parabolic curve (the vertical offset being proportional to the square of the horizontal distance). Vertical curves are required when the algebraic difference of intersecting grades exceeds the values given in Table 3 - 87 Maximum Change In Grade Without Using Vertical Curve. Table 3 – 98 Rounded K Values for Minimum Lengths Vertical Curves provides additional information. The length of vertical curve on a crest, as governed by stopping sight distance, is obtained from Figure 3 - 64 Length of Crest Vertical Curve (Stopping Sight Distance). The minimum length of a crest vertical curve to obtain minimum passing sight distance is given in Figure 3 - 75 Length of Crest Vertical Curve (Passing Sight Distance). The minimum length of a sag vertical curve, as governed by vehicle headlight capabilities, is obtained from Figure 3 - 86 Length of Sag Vertical Curve (Headlight Sight Distance).

Wherever feasible, curves longer than the minimum should be considered to improve both aesthetic and safety characteristics.

Table 3 – 87
Maximum Change in Grade
Without Using Vertical Curve

Design Speed (MPH)	15	20	25	30	35	40	45	50	55	60	65	70
Maximum Change in Grade in Percent	1.30	1.20	1.10	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20

Table 3-98 Rounded K Values for Minimum Lengths Vertical Curves

ROUNDED K VALUES FOR MINIMUM LENGTHS VERTICAL CURVES[JM87]

(Based upon an eye height of 3.50 feet and an object height of 2 feet above the road surface)

L = KA

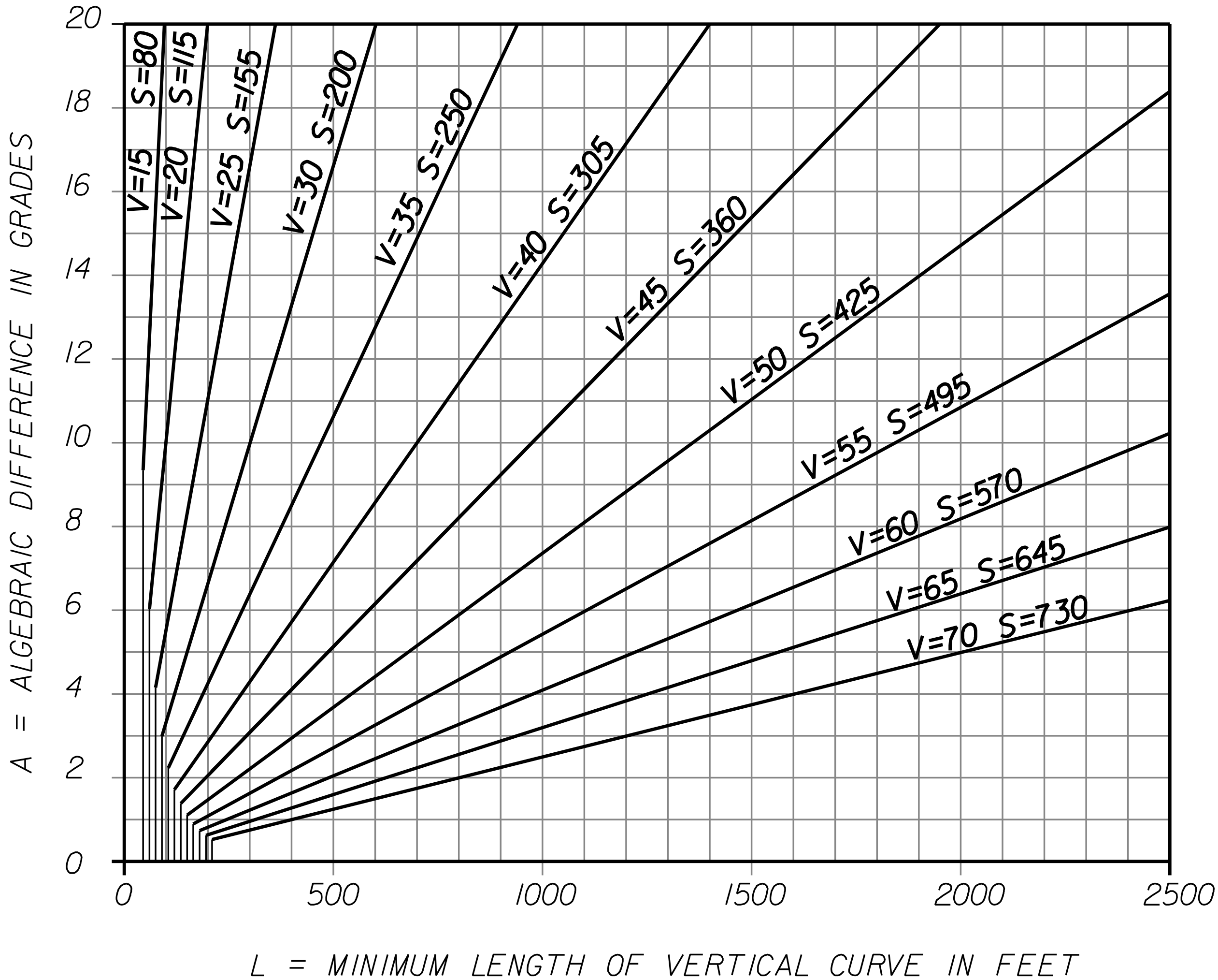
L = LENGTH OF VERTICAL CURVE A = ALGEBRAIC DIFFERENCE OF GRADES IN PERCENT

Design Speed (MPH)		20	25	30	35	40	45	50	55	60	65	70
K Values for Crest Vertical Curves[MAK88]		7	12	19	29	44	61	84	114	151	193	247
K Values for Sag Vertical Curves		17	26	37	49	64	79	96	115	136	157	181

- The length of vertical curve must never be less than three times the design speed of the highway
- Curve lengths computed from the formula L = KA should be rounded upward when feasible
- The minimum lengths of vertical curves to be used on collectors, arterials and freeways are shown in the table below:

MINIMUM LENGTHS FOR VERTICAL CURVES ON COLLECTORS, ARTERIALS, AND FREEWAYS (feet[MAK89])			
Design Speed (MPH)	50	60	70
Crest Vertical Curves (FEET)	300	400	500
Sag Vertical Curves (FEET)	200	300	400

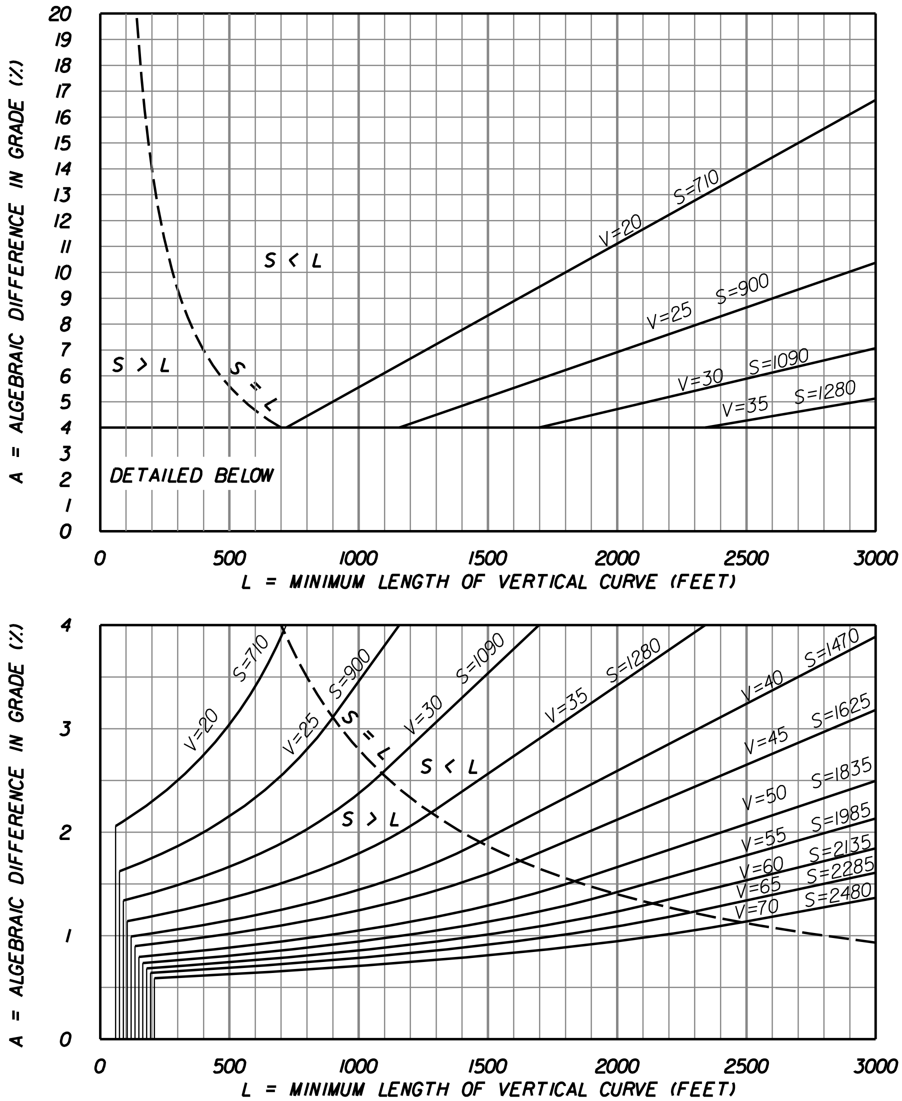
Figure 3 – 654
Length of Crest Vertical Curve
(Stopping Sight Distance)



Lengths of vertical curves are computed from the formula: $L = \frac{AS^2}{1329}$

A = Algebraic Difference In Grades In Percent
S = Sight Distance
L = Minimum Length of Vertical Curve In Feet

Figure 3 – 7~~65~~
Length Of Crest Vertical Curve
(Passing Sight Distance)



The sight distance is computed from the following formulas:

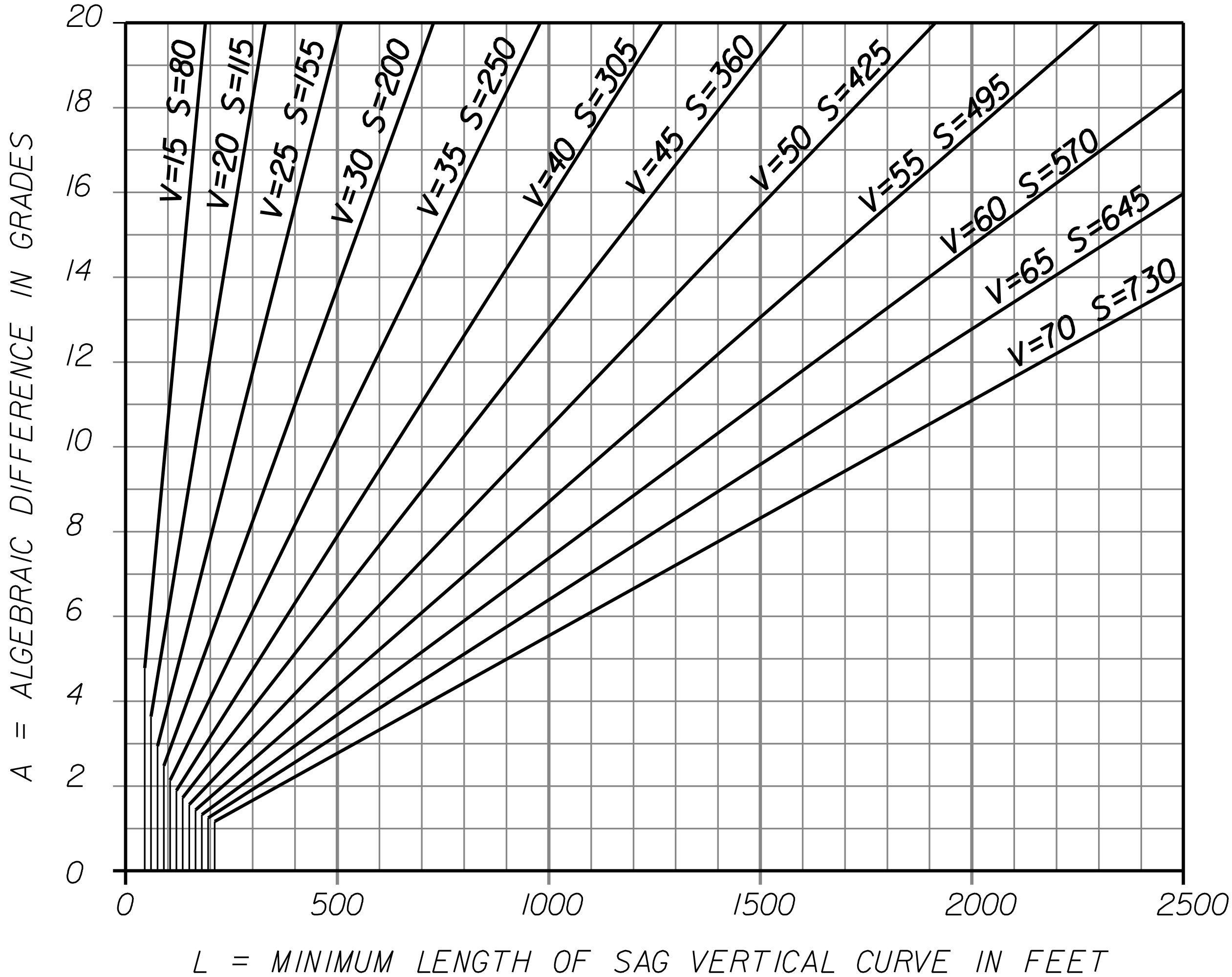
$S < L, \quad L = \frac{AS^2}{2800} \qquad S > L, \quad L = 2S - \frac{2800}{A}$

A = Algebraic Difference in Grades, Percent
S = Sight Distance
L = Length of Vertical Curve

Figure 3 – 876
Length Of Sag Vertical Curve
(Headlight Sight Distance)

Lengths of vertical curves are computed from the formula:

$$L = \frac{AS^2}{400 + 3.5(S)}$$



C.6 Alignment Coordination

Horizontal and vertical alignment should not be designed independently. Poor combinations can spoil the good points of a design. Properly coordinated horizontal and vertical alignment can improve appearance, enhance community values, increase safety, and encourage uniform speed. Coordination of horizontal and vertical alignment should begin with preliminary design, during which stage adjustments can be readily made.

Proper combinations of horizontal alignment and profile can be obtained by engineering study and consideration of the following general controls:

- Curvature and grades should be in proper balance. Tangent alignment or flat curvature with steep grades and excessive curvature with flat grades are both poor design. A logical design is a compromise between the two conditions. Wherever feasible the roadway should "roll with" rather than "buck" the terrain.
- Vertical curvature superimposed on horizontal curvature, or vice versa, generally results in a more pleasing facility, but it should be analyzed for effect on driver's view and operation. Changes in profile not in combination with horizontal alignment may result in a series of disconnected humps to the driver for some distance.
- Sharp horizontal curvature should not be introduced at or near the top of a pronounced crest vertical curve. Drivers cannot perceive the horizontal change in alignment, especially at night. This condition can be avoided by setting the horizontal curve so it leads the vertical curve or by making the horizontal curve longer. Suitable design can be made by using design values well above the minimums.
- Sharp horizontal curvature should not be introduced at or near the low point of a pronounced sag vertical curve to prevent an undesirable distorted appearance. Vehicle speeds are often high at the bottom of grades and erratic operation may result, especially at night.
- On divided highways, variation of the median width and the use of independent vertical and horizontal alignment should be considered. Where right of way is available, a superior design without significant additional costs can result from the use of independent alignment.

- Horizontal alignment and profile should be made as flat as possible at interchanges and intersections where sight distance along both highways is important. Sight distances above the minimum are desirable at these locations.
- Alignment should be designed to enhance scenic views for the motorists.
- In residential areas, the alignment should be designed to minimize nuisance to the neighborhood.

C.7 Cross Section Elements

The design of the street or highway[JM90] cross section should be predicated upon the design speed, terrain, adjacent land use, classification, and the type and volume of traffic expected. The cross section selected should be uniform throughout a given length of street or highway without frequent or abrupt changes.

C.7.a Number of Lanes

The number of travel lanes is determined by several interrelated factors such as capacity, level of service, and service volume. ((AASHTO "A Policy on Geometric Design of Highways and Streets" - latest edition, and the current Highway Capacity Manual)

C.7.b Pavement

The paved surface of roadwaysall travel lanes[JM91] shall be designed and constructed in accordance with the requirements set forth in CHAPTER 5 - PAVEMENT DESIGN AND CONSTRUCTION.

C.7.b.1 Pavement Width

Minimum lane widths for travel lanes, speed change lanes, turn lanes and passing lanes are provided in Table 3 - 108 Minimum Lane Widths*[MAK92][KM93]*. On multilane urban curb and gutter streets where there is insufficient space for a separate bicycle lane, consideration should be given to using unequal-width lanes. In such cases, the wider lane is located on the outside (right). This provides more space for large vehicles that usually occupy that lane, provides more space for bicycles, and allows drivers to keep their vehicles at a greater distance from the right edge. See CHAPTER 9 – BICYCLE FACILITIES.Traffic lanes[JM94][KM95] should be 12 feet in width, but shall not be less than 10 feet in width. Streets and highways with significant truck/bus traffic should have 12 feet wide traffic lanes. For minimum lane widths, see Table 3 - 8 and Table 3 - 9. If additional lane width is required for bicycles, see CHAPTER 9 – BICYCLE FACILITIES.

Table 3 – 108
Minimum Lane Widths[MAK96][KM97]

Facility		ADT (vpd)	Design Speed (mph)	Divided/ Undivided	Lane Width - FT			
					Travel Lanes[1]	Speed Change Lanes	Turn Lanes[5] (LT/RT/MD)	Passing Lanes
Freeway	Rural	All	All	All	12	12	--	--
Freeway	Urban	All	All	All	12	12	--	--
Arterial	Rural	All	All	All	12	12	12	12
Arterial	Urban	All	> 45	All	12	12	12	12
Arterial	Urban	All	≤ 45	Undivided	12	12	12[6]	12
Arterial	Urban	All	≤ 45	Divided	11	11	11[6]	11
Collector	Rural	> 1500	All	All	12	12	12	12
Collector	Rural	400 to 1500	All	All	11	11	11	--
Collector	Rural	< 400	> 45	All	11	11	11[6]	--
Collector	Rural	< 400	≤ 45	All	10	10	10	--
Collector	Urban	All	All	All	11[2,3]	11[2]	11[6]	--
Local	Rural	> 1500	All	All	12	12	12	12
Local	Rural	400 to 1500	All	All	11	--	11	--
Local	Rural	< 400	> 50	All	11	--	11	--
Local	Rural	< 400	45 to 50	All	10	--	10	--
Local	Rural	< 400	< 45	All	9	--	9	--
Local	Urban	All	All	All	10[2,4]	--	10[7]	--

Footnotes

1. A minimum traveled way width equal to the width of two adjacent travel lanes (one way or two way) shall be provided on all rural facilities.
2. 12' in industrial areas and where truck volumes are significant, but may be reduced 11' where right of way severely limited.
3. 10' may be used in constrained areas where truck and bus volumes are low and speeds less than 35 mph.
4. 9' may be used in residential areas where right of way is severely limited.
5. Median turn lane widths shall not exceed 15'.
6. Turn Lane width should be same as Travel Lane width. May be reduced to 10' where right of way is constrained.
7. Turn Lane width should be same as Travel Lane width. May be reduced to 9' where truck volumes are low.

	Minimum Lane Width (FEET)	
Freeways	12	
Major Arterials	11	
Minor Arterials	11	
Collectors (Major and Minor)	11	
Local Roads *	10	
Auxiliary Lanes	10	

* Pavement widths may be reduced for the paving of certain existing unpaved subdivision streets and low volume rural roads. See CHAPTER 3, SECTION A for conditions.

Table 3 – 9
Minimum Widths Of Pavement And Shoulders
For Two (2) Lane Rural Highways[MAK98][KM99]

DESIGN SPEED (MPH)	AVERAGE DAILY TRAFFIC (2 - WAY)				
	250	0250 - 400	400 - 750	750 - 1,600	ABOVE 1,600
	MINIMUM WIDTH OF PAVEMENT (FEET)				
20					
30	20	20	22	22	24
35	20	20	22	22	24
40	20	20	22	22	24
45	20	20	22	22	24
50	20	20	22	24	24
55	20	22	22	24	24
60	20	22	22	24	24
65	20	22	24	24	24
MINIMUM WIDTH OF SHOULDER (FEET)					
ALL	6[KM100]	26[KM101]	6	8	8

C.7.b.2 Traveled WayPavement Cross Slope[JM102] (not in superelevation)

The selection of traveled waypavement cross slope should be a compromise between meeting the drainage requirements and providing for smooth vehicle operation. The recommended traveled waypavement cross slope is 0.02 feet per foot. When three lanes in each direction are necessary, the outside lane should have a cross slope of 0.03 feet per foot. The cross slope shall not be less than 0.015 feet per foot or greater than 0.04 feet per foot. The change in cross slope between adjacent through travel lanes should not exceed 0.04 feet per foot.

C.7.c Shoulders

The primary functions of a shoulder are to provide emergency parking for disabled vehicles and an alternate path for vehicles during avoidance or other emergency maneuvers. In order to fulfill these functions satisfactorily, the shoulder should have adequate stability and surface characteristics. The design and construction of shoulders shall be in accordance with the requirements given in CHAPTER 5 - PAVEMENT DESIGN AND CONSTRUCTION.

Shoulders should be provided on all streets and highways incorporating open drainage. The absence of a contiguous emergency travel or storage lane is not only undesirable from a safety standpoint, but also is disadvantageous from an operations viewpoint. Disabled vehicles that must stop in a through lane impose a severe safety hazard and produce a dramatic reduction in traffic flow. Shoulders should be free of abrupt changes in slope, discontinuities, soft ground, or other hazards that would prevent the driver from retaining or regaining vehicle control.

Paved shoulders [JM103][KM104][KM105]are required for high speed mulitilane highways and freeways. They are recommended for added safety to the motorist, public transit and pedestrians, for accommodation of bicyclists, reduced shoulder maintenance costs, and improved drainage.

C.7.c.1 Shoulder Width[JM106][KM107]

Since the function of the shoulders is to provide an emergency storage or travel path, the desirable width of all shoulders should be at least 10 feet. Where economic or practical constraints are severe, it is permissible, but not desirable, to reduce the shoulder width. Outside shoulders shall be provided on all streets and highways with open drainage and should be at least 6 feet wide. Facilities with a heavy traffic volume or a significant volume of truck traffic SHOULD have outside shoulders at least 8 feet wide. The width of outside shoulders for two-lane, two-way shoulders shall not be less than the values given in Table 3 - 119 Shoulder Widths for Rural Highways..

Median shoulders are desirable on all multi-lane, non-curb and gutter divided streets and highways. For shoulder widths on multi-lane divided highways see Table 3 - 1110.

Table 3 – 1110
Shoulder Widths for Multilane Rural Divided Highways[KM108]

Two Lane

Design Speed (mph)	Average Daily Traffic (2 – Way)		
	0 - 400	400 - 750	750 - 1600
All	2 feet	6 feet	8 feet

Multilane Divided

NUMBER OF LANES EACH DIRECTION	SHOULDER WIDTH (FEET)			
	OUTSIDE		MEDIAN	
	ROADWAY	BRIDGE	ROADWAY	BRIDGE
2	10 (minimum)	10	6 (minimum)	6
3 or more	10 (minimum)	10	10 (minimum)	10

C.7.c.2 Shoulder Cross Slope

The shoulder serves as a continuation of the drainage system, therefore, the shoulder cross slope should be somewhat greater than the adjacent traffic~~vel~~[JM109][MAK110] lane. The cross slope of shoulders should be within the range given in Table 3 – 12 Shoulder Cross Slope. ~~shall not be less than 0.03 feet per foot or greater than 0.08 feet per foot.~~ ~~For local subdivision type streets, a maximum cross slope of 0.12 feet per foot may be used.~~[JM111][MAK112]

Table 3 – 12
Shoulder Cross Slope

	Shoulder Type		
	Paved	Gravel or Crushed Rock	Turf[JM113]
Shoulder Cross Slope (Percent)	2 to 6%	4 to 6%	6 to 8%

Notes: 1.- Existing shoulder cross-slope (paved and unpaved) ≤ 12% may remain.

Source – 201104 AASHTO Greenbook, Section 4.4.3 Shoulder Cross Sections.

Whenever possible, shoulders should be sloped away from the traveled way~~ffic lanes~~[JM114] to aid in their drainage. The combination of shoulder cross slope and texture should be sufficient to promote rapid drainage and to avoid retention of surface water. The maximum algebraic difference ~~change in cross slope~~ between the~~a~~ traveled way~~ffic~~[JM115] ~~lane~~ and adjacent shoulder should not be greater than 0.07 feet per foot.~~,~~ ~~except on local subdivision streets where the change in cross slope should not exceed 0.10 feet per foot.~~ [JM116] Shoulders on the outside of superelevated curves should be rounded (vertical curve) to avoid an excessive break in cross slope and to divert a portion of the drainage away from the adjacent traveled way~~lanes~~[JM117].

C.7.d Sidewalks

The design of sidewalks is affected by many factors, including, but not limited to, pedestrian volume, roadway type, characteristics of vehicular traffic, and other design elements. CHAPTER 8 - PEDESTRIAN FACILITIES of this Manual and the ***AASHTO – "A Policy on Geometric Design of Highways and Streets***," present the various factors that influence the design of sidewalks and other pedestrian facilities.

Sidewalks should be constructed in conjunction with new construction and major reconstruction in or within one mile of an urban area. As a general rule, sidewalks should be constructed on both sides of the roadway. Exceptions may be made where physical barriers (e.g., a canal paralleling one side of the roadway) would substantially reduce the expectation of pedestrian use of one side of the roadway. Also, if only one side is possible, sidewalks should be availableused onin the same side of the road as such features as transit stops or other pedestrian generators.

The decision to construct a sidewalk in a rural area should be based on engineering judgment, after observation of existing pedestrian traffic and expectation of additional demand, should a sidewalk be made available.

~~The minimum sidewalk width shall be 5 feet when separated from the back of curb by a buffer strip. The minimum sidewalk width may be reduced to 4 feet when physical constraints exist. See Section C.10.a.3 of this chapter for additional clear width criteria. When sidewalks must be constructed adjacent to the curb, the minimum width shall be 6 feet~~[KM118]~~.~~

Sidewalks should be constructed as defined in this Manual - CHAPTER 8 - PEDESTRIAN FACILITIES. In areas of high use, refer to the ***Highway Capacity Manual, Volume 3, Chapter 23, Off-Street Pedestrian and Bicycle Facilities***~~Chapter 18 of the Highway Capacity Manual~~ for calculation of appropriate additional width. ~~Excessively wide sidewalks may not necessarily add to pedestrian and bicycle safety. Wide sidewalks may encourage higher speed bicycle use and can increase the potential for conflict with motor vehicles at intersections and driveways, as well as with pedestrians and fixed objects.~~

~~Maximum cross slope shall be 2%, and grades shall not exceed 8.33%.~~ Curb ramps shall be provided at all intersections with curb (***Section 336.045***

(3), Florida Statutes). In addition to the design criteria provided in this chapter, the ***2006 Americans with Disabilities Act Standards for Transportation Facilities*** as required by 49 C.F.R 37.41 or 37.43 and the ***2012 Florida Accessibility Code for Building Construction*** as required by 61G20-4.002 impose additional requirements for the design and construction of pedestrian facilities.

C.7.e Medians

Median separation of opposing traffic lanes provides a beneficial safety feature and should be used wherever feasible. Separation of the opposing traffic also reduces the problem of headlight glare, thus improving safety and comfort for night driving. When sufficient width of medians is available, some landscaping is also possible.

The use of medians often aids in the provision of drainage for the roadway surface, particularly for highways with six or more traffic lanes. The median also provides a vehicle refuge area, improves the safety of pedestrian crossings, provides a logical location for left turn storage[WH119][JM120] lanesauxiliary lanes, and provides the means for future addition of traffic lanes and mass transit. In many situations, the median strip aids in roadway delineation and the overall highway aesthetics.

Median separation is required on the following streets and highways:

- Freeways
- All streets and highways, rural and urban, with 4 or more travel lanes and with a design speed of 40 mph or greater

Median separation is desirable on all other multi-lane roadways to enhance pedestrian crossings.

The nature and degree of median separation required is dependent upon the design speed, traffic volume, adjacent land use, and the frequency of access. There are basically two approaches to median separation. The first is the use of horizontal separation of opposing lanes to reduce the probability of vehicles crossing the median into incoming traffic. The second method is to attempt to limit crossovers by introducing a positive median barrier structure.

In rural areas, the use of wide medians is not only aesthetically pleasing, but is often more economical than barriers. In urban areas where space and/or economic constraints are severe, the use of barriers is permitted to fulfill the requirements for median separation.

Uncurbed medians should be free of abrupt changes in slope, discontinuities, soft ground, or other hazards that would prevent the driver from retaining or regaining control of the vehicle. Consideration should be given to increasing the width and decreasing the slope of medians on horizontal curves. The requirements for a hazard free median environment are given in CHAPTER 4 - ROADSIDE DESIGN, and shall be followed in the design and construction of medians.

C.7.e.1 Type of Median

A wide, gently depressed median is the preferred design. This type allows a reasonable vehicle recovery area and aids in the drainage of the adjacent shoulders and travel lanes. Where space and drainage limitations are severe, narrower medians, flush with the roadway, or raised medians, are permitted. Raised medians should be used to support pedestrian crossings of multi-laned streets and highways[JM121].

C.7.e.2 Median Width

The median width is defined as the horizontal distance between the inside (median) pavement[WH122] edges[JM123][MAK124] of travel lanes of the opposing roadways. The selection of the median width for a given type of street or highwayroadway[JM125] is primarily dependent on design speed and traffic volume. Since the probability of crossover crashes is decreased by increasing the separation, medians should be as wide as practicable. Median widths in excess of 30 feet to 35 feet reduce the problem of disabling headlight glare from opposing traffic.

The minimum permitted widths of freeway medians are given in Table 3 - 131 Median Width For Freeways (Urban And Rural). Where the expected traffic volume is heavy, the widths should be increased over these minimum values. Median barriers shall be used on freeways when these minimum values are not attainable.

The minimum permitted median widths for multi-lane rural highways are given in Table 3 - 142 Median Width For Rural Highways (Multilane Facilities). On urban streets, the median widths shall not be less than the values given in Table 3 - 142. Where median openings or access points are frequent, the median width should be increased.

The minimum median widths given in these Tables may have to be increased to meet the requirements for cross slopes, drainage, and turning movements (C.9 Intersection Design, this chapter). The median area should also include adequate additional width to allow for expected additions of through lanes and left turn storage[JM126] lanesauxiliary lanes. Where the median width is sufficient to produce essentially two separate, independent roadways, the left side of each roadway shall meet the requirements for roadside clear zone. Changes in the median width should be accomplished by gently flowing horizontal alignment of one or both of the separate roadways.

Table 3 – 131 [JM127]
Median Width for Freeways
(Urban And Rural)

DESIGN SPEED (MPH)	MINIMUM PERMITTED MEDIAN WIDTH (FEET)
60 and Over	60 **
Under 60	40 *

* Applicable for urban areas ONLY.

** Applicable for new construction ONLY.
(40 feet minimum allowed when lanes added to median)

Table 3 – 142 [JM128]
Median Width for Rural Highways
(Multilane Facilities)

DESIGN SPEED (MPH)	MINIMUM WIDTH (FEET)
55 and Over[JM129]	40
Under 55	22

Median Width for Urban Streets[JM130][KM131]

DESIGN SPEED (MPH)	MINIMUM WIDTH (FEET)
50[JM132]	19.5
45 [JM133]and LESS	15.5

Paved medians with a minimum width of 10 feet may be used for two-way turn lanes and painted or raised medians when design speeds are 40 mph or less.

C.7.e.3 Median Slopes

A vehicle should be able to transverse a median without turning over and with sufficient smoothness to allow the driver a reasonable chance to control the vehicle. The transition between the median slope and the shoulder (or pavement) slope should be smooth, gently rounded, and free from discontinuities.

The median cross slope should not be steeper than1:6 (preferably not steeper than 1:10). The depth of depressed medians may be controlled by drainage requirements. Increasing the width of the median, rather than increasing the cross slope, is the proper method for developing the required median depth.

Longitudinal slopes (median profile parallel to the roadway) should be shallow and gently rounded at intersections of grade. The longitudinal slope, relative to the roadway slope, shall not exceed a ratio of 1:10 and preferably 1:20. The change in longitudinal slope shall not exceed 1:8 (change in grade of 12.5 %).

C.7.e.4 Median Barriers

The primary objective for placing a barrier structure in the median is to prevent vehicles from entering the opposing traffic stream, either accidentally or intentionally. Median barriers may also be used to reduce the glare produced by oncoming vehicle headlights. When selecting the type of barrier, care should be exercised to avoid headlight flicker through barriers.

The use of median barriers to reduce horizontal separation is permitted on facilities with substantially full control of access. Frequent openings in the barrier for intersections or crossovers expose the barrier end, which constitute severe hazard at locations with an inherently high crash potential and should be shielded. Median barriers may be considered for urban freeways and high speedmajor[WH134][JM135] arterials with controlled access.

Median barriers shall be used on controlled access facilities if the median width is less than the minimum permitted values given in Table 3 - 131. The median barrier should not be placed closer than 10 feet[JM136][KM137] from the inside pavement edge of traveled way[JM138]. Further requirements for median barriers are given in CHAPTER 4 - ROADSIDE DESIGN.

C.7.f Roadside Clear Zone

The roadside clear zone is that area outside the traveled way available for use by errant vehicles. Vehicles frequently leave the traveled way during avoidance maneuvers, due to loss of control by the driver (e.g., falling asleep) or due to collisions with other vehicles. The primary function of the clear zone is to allow space and time for the driver to retain control of his vehicle and avoid or reduce the consequences of collision with roadside objects. This area also serves as an emergency refuge location for disabled vehicles.

The design of the roadway must also provide for adequate drainage of the roadway. Drainage swales within the clear zone should be gently rounded and free of discontinuities. Where large volumes of water must be carried, the approach should be to provide wide, rather than deep drainage channels. Side slopes and drainage swales that lie within the clear zone should be free of protruding drainage structures (CHAPTER 4 - ROADSIDE DESIGN, D.6.c. Culverts).

In the design of the roadside, the designer should consider the consequences of a vehicle leaving the traveled way at any location. It should always be the policy that protection of vehicles and occupants shall take priority over the protection of roadside objects. Further criteria and requirements for safe roadside design are given in CHAPTER 4 - ROADSIDE DESIGN.

C.7.f.1 Roadside Clear Zone Width

The clear zone width is defined as follows:

- Flush ShoulderRural[WH139] [JM140]SSections - measured from the edge of the outside motor vehicular traveled way
- Urban[WH141] Curbed [JM142]SSections ≤ 45 mph - measured from the face of the curb

The minimum permitted widths are provided in Table 3 - 153 Minimum Width of Clear Zone. These are minimum values only and should be increased wherever practical.

In rural areas, it is desirable, and frequently economically feasible, to increase the width of the clear zone. Where traffic volumes and speeds are high, the width should be increased. The clear zone on the outside of horizontal curves should be increased due to the possibility of vehicles leaving the roadway at a steeper angle.

Table 3 – 153
Minimum Width of Clear Zone

Type of Facility	DESIGN SPEED (MPH)							
	25 and Below	30	35	40	45	50	55	60 and Above
	MINIMUM CLEAR ZONE (FEET)							
Flush Shoulder Rural• [KM143]	6	6 Local 10 Collectors 14 Arterials	6 Local 10 Collectors 14 Arterials	10 Collectors 14 Arterials	14 Arterials and Collectors ADT < 1500 18 Arterials and Collectors ADT ≥ 1500	14 Arterials and Collectors ADT < 1500 18 Arterials and Collectors ADT ≥ 1500	18 Arterials and Collectors ADT < 1500 24 Arterials and Collectors ADT ≥ 1500	18 Arterials and Collectors ADT < 1500 30 Arterials and Collectors ADT ≥ 1500
Curbed Urban*	1 ½	4**	4**	4**	4 ** [JM144] [KM145]	N/A••	N/A••	N/A••

* From face of curb.

** On projects where the 4 foot minimum offset cannot be reasonably obtained and other alternatives are deemed impractical, the minimum may be reduced to 1 ½'.

• Use rural for urban facilities when no curb and gutter is present. Measured from the edge of through travel lane on rural section.

•• Curb and gutter not to be used on facilities with design speed > 45mph.

NOTE: ADT in Table 3-153 refers to Design Year ADT.

C.7.f.2 Roadside Slopes

The slopes of all roadsides should be as flat as possible to allow for safe traversal by out of control vehicles. A slope of 1:4 or flatter should be used[JM146][KM147]. The transition between the shoulder and adjacent side slope should be rounded and free from discontinuities. The adjacent side slope, within the clear zone, shall not be steeper than 1:3. The side slopes should be reduced flatter on the outside of horizontal curves.

Where roadside ditches or cuts require backslope, these slopes should not exceed 1:3 in steepness within the clear zone. The desirable backslope is 1:4. Ditch bottoms should be at least 4 feet wide and can be flat or gently rounded.

C.7.f.3 Criteria for Guardrail

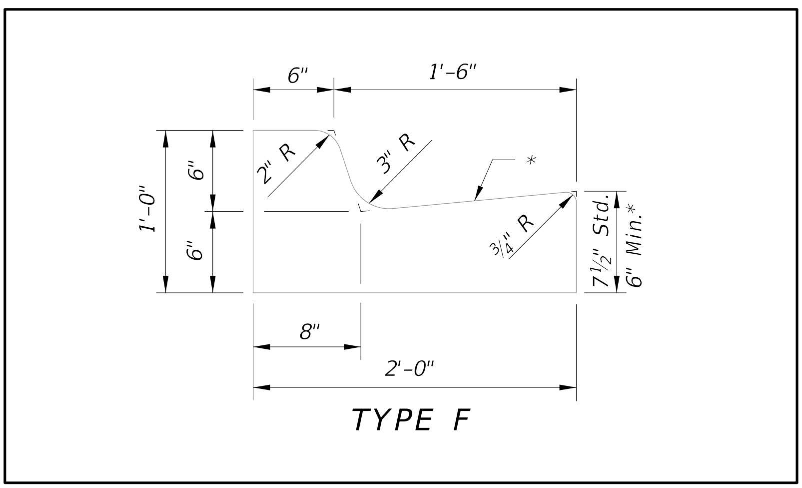
If space and economic constraints are severe, it is permissible, but not desirable, to use guardrails in lieu of the requirements for width and slope of clear zone. Where the previously described requirements for clear zone are not met, guardrails (or other longitudinal barriers) should be considered. Guardrails should also be considered for protection of pedestrian pathways or protection from immovable roadside hazards.

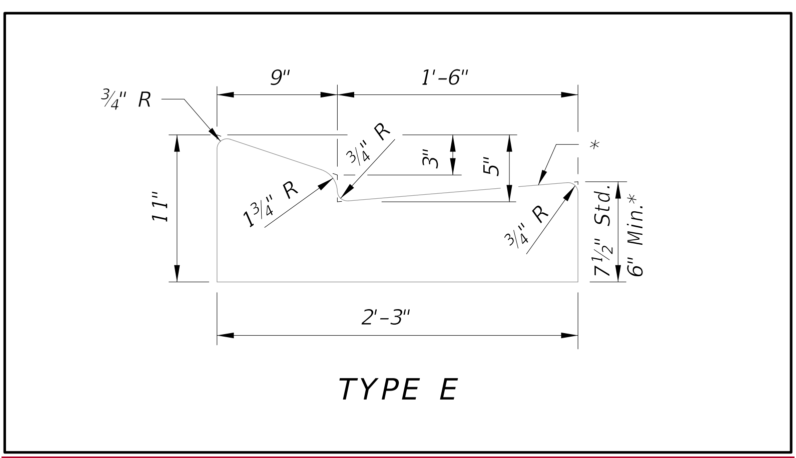
The general policy to be followed is that guardrails should be used if impact with the guardrail is less likely or considered less severe than impact with roadside objects. Further requirements and design criteria for guardrails are given in CHAPTER 4 - ROADSIDE DESIGN.

C.7.g Curbs

Curbs may be used to provide drainage control and to improve delineation of the roadway. Curbs are generally designed with a gutter to form a combination curb and gutter section. Sloping cCurbs ~~with nearly vertical faces~~[JM148] are used along the outside edge of the roadway to discourage vehicles from leaving the roadway. In Florida, the standard curb of this type is 6 inches in height. [JM149] See Figure 3. 9 Standard Detail for FDOT Type F and E Curbs for examples of sloping curbs. These curbs are not to be used on facilities with design speeds greater than 45 mph.

Figure 3 - 9 Standard Detail for FDOT Type F and E Curbs





C.7.h Parking

When on-street parking is to be an element of design, parallel parking should be considered. Under certain circumstances, angle parking is an allowable form of street parking. The type of on-street parking selected should depend on the specific function and width of the street, the adjacent land use, traffic volume, as well as existing and anticipated traffic operations.

It can generally be stated that on-street parking decreases through capacity, impedes traffic flow, and increases crash potential. However, where parking is needed, and adequate off-street parking facilities are not available or feasible, on-street parking may be necessary.

C.7.i Right of Way

The acquisition of sufficient right of way is necessary in order to provide space for a safe street or highway. The width of the right of way required depends on the design of the roadway, the arrangement of bridges, underpasses and other structures, and the need for cuts or fills. The right of way acquired should be sufficient to:

- Allow development of the full cross section, including adequate medians and roadside clear zones. Determination of the necessary width requires that adequate consideration also be given to the accommodation of utility poles beyond the clear zone.
- Allow the layout of safe intersections, interchanges, and other access points.
- Allow adequate sight distance at all points, particularly on horizontal curves, at an intersection, and other access points.
- Allow, where appropriate, transit bus bays, additional buffer zones to improve roadside safety, noise attenuation, and the overall aesthetics of the street or highway.
- Allow adequate space for placement of pedestrian and bicycle facilities, including curb ramps, bus baysstorage turning areas[JM150], and transit shelters, where applicable.

- Allow for future lane additions, increases in cross section, or other improvement. Frontage roads should also be considered in the ultimate development of many high volume facilities.
- Allow treatment of stormwater runoff.
- Allow construction of future grade separations or other intersection improvements at selected crossroads.
- Allow corner cuts for upstream corner crossing drainage systems and placement of poles, boxes, and other visual screens out of the critical sight triangle.
- Allow landscaping and irrigation as required for the project.

The acquisition of wide rights of way is costly, but it may be necessary to allow the construction and future improvement of safe streets and highways. The minimum right of way should be at least 50 feet for all two-lane roads. For pre-existing conditions, when the existing right of way is less than 50 feet, efforts should be made to acquire the necessary right of way.

Local cul-de-sac and dead end streets[JM151][MAK152] having an ADT of less than or equal to 400250[KM153], and a length of 600 feet or less, may utilize a right of way of less than 50 feet, if all elements of the typical section meet the standards included in this Manual.[KM154]

The right of way for frontage roads may be reduced depending on the typical section requirements and the ability to share right of way with the adjacent street or highway[JM155] facility.

C.7.j Changes in Typical Section

C.7.j.1 General Criteria

Changes in cross section should be avoided. When changes in widths, slopes, or other elements are necessary, they should be affected in a smooth, gradual fashion.

C.7.j.2 Lane Deletions and Additions

The addition or deletion of traffic or bicycle lanes[JM156] should be undertaken on tangent sections of roadways. The approach to lane deletions and additions should have ample advance warning and sight distance.

The termination of lanes (including auxiliary lanes) shall meet the general requirements for merging lanes[JM157]. See Section C.9.c.1 for additional information.

Where additional lanes are intermittently provided on two-lane, two-way highways, median separation should be considered.

C.7.j.3 Preferential Special Use Lanes[JM158][MAK159]

To increase the efficiency and separation of different vehicle movements, preferentialspecial use lanes, such as bike lanes and bus lanes, should be considered. These lanes are often an enhancement to corridor[JM160] safety and increase the horizontal clearance to roadside aboveground fixed objects. The ***MUTCD, Chapter 3D*** provides further information on preferential lane markings. See CHAPTER 9 – BICYCLE FACILITIES for information on marking bicycle lanes.

C.7.j.4 Structures

The pavement, median, and shoulder width, and sidewalks should be carried across structures such as bridges and box culverts. Shoulder widths for multi-lane rural divided highway bridges may be reduced as shown in Table 3 - 110. The designer should evaluate the economic practicality of utilizing dual versus single bridges for roadway sections incorporating wide medians.

The minimum roadway width for bridges on urban streets with curb and gutter shall be the same as the curb-to-curb width of the approach roadway. Sidewalks on the approaches should be carried across all structures. Curbed sidewalks should not be used adjacent to traffic lanes when design speeds exceed 45 mph. When the bridge rail (barrier wall) is placed between the traffic and sidewalk, it should be offset a minimum distance of 2½ feet from the edge of the travel lane, wide curb lane or bicycle lane. For long (500 feet or greater), and/or high level bridges, it is desirable to provide an offset distance that will accommodate a disabled vehicle. The transition from the bridge to the adjacent roadway section may be made by dropping the curb at the first intersection or well in advance of the traffic barrier, or reducing the curb in front of the barrier to a low slopingmountable[JM161] curb with a gently sloped traffic face. See CHAPTER 17 – BRIDGES AND OTHER STRUCTURES for additional requirements.

C.7.j.4.(a) Horizontal Clearance[JM162][KM163]

Supports for bridges, barriers, or other structures should be placed at or beyond the required shoulder. Where possible, these structures should be located outside of the required clear zone.

C.7.j.4.(b) Vertical Clearance

Vertical clearance should be adequate for the type of expected traffic. Freeways and major [JM164]arterials shall have a vertical clearance of at least 16 feet-6 inches (includes 6 inch allowance for future resurfacing). Other streets and highways should have a clearance of 16 feet unless the provision of a reduced clearance is fully justified by a specific analysis of the situation (14 feet minimum). The minimum vertical clearance for a pedestrian or shared use bridge over a roadway is 17 feet. The minimum vertical clearance for a bridge over a railroad is 23 feet; however additional clearance may be required by the rail owner.

C.7.j.4.(c) End Treatment

The termini of guardrails, bridge railings, abutments, and other structures should be constructed to protect vehicles and their occupants from serious impact. Requirements for end treatment of structures are given in CHAPTER 4 - ROADSIDE DESIGN.

C.8 Access Control

All new facilities (and existing when possible) should have some degree of access control, since each point of access produces a traffic conflict. The control of access is one of the most effective, efficient, and economical methods for improving the capacity and safety characteristics of streets and highways. The reduction of the frequency of access points and the restriction of turning and crossing maneuvers, which should be primary objectives, is accomplished more effectively by the design of the roadway geometry than by the use of traffic control devices. Design criteria for access points are presented under the general requirements for intersection design.

C.8.a Justification

The justification for control of access should be based on several factors, including safety, capacity, economics, and aesthetics.

C.8.b General Criteria

C.8.b.1 Location of Access Points

All access locations should have adequate sight distance available for the safe execution of entrance, exit, and crossing maneuvers.

Locations of access points near structures, decision points, or the termination of street or highway[JM165] lighting should be avoided.

Driveways[JM166][KM167] should not be placed near intersections or other points that would tend to produce traffic conflict.

C.8.b.2 Spacing of Access Points

The spacing of access points should be adequate to prevent conflict or mutual interference of traffic flow.

Separation of entrance and exit ramps[JM168][KM169] should be sufficient to provide adequate distance for required weaving maneuvers.

Adequate spacing between access and decision points is necessary to avoid burdening the driver with the need for rapid decisions or maneuvers.

Frequent median openings should be avoided.

The use of a frontage road or other auxiliary roadways is recommended on minor[JM170] arterials and higher classifications where the need for direct driveway or minor road access is frequent.

C.8.b.3 Restrictions of Maneuvers

Where feasible, the number and type of permitted maneuvers (crossing, turning slowing, etc.) should be restricted.

The restriction of crossing maneuvers may be accomplished by the use of grade separations and continuous raised medians.

The restriction of left turns is achieved most effectively by continuous medians.

Channelization should be considered for the purposes of guiding traffic flow and reducing vehicle conflicts.

C.8.b.4 AuxiliaryTurn[JM171] Lanes[JM172]

Deceleration lanes for right turn exits (and left turns, where permitted) should be provided on all high-speed facilities. These turn lanes should not be excessive or continuous, since they complicate pedestrian crossings and bicycle/motor vehicle movements.

Storage (or deceleration lanes) to protect turning vehicles should be provided, particularly where turning volumes are significant.

Acceleration lanes are desirable for entrance maneuvers onto high-speed streets and highways.

Special consideration should be given to the provisions for deceleration, acceleration, and storage lanes in commercial or industrial areas with significant truck/bus traffic.

C.8.b.5 Grade Separation

Grade separation interchange design should be considered for junctions of high volume major[JM173] arterial streets and highways.

Grade separation (or an interchange) should be utilized when the expected traffic volume exceeds the intersection capacity.

Grade separation should be considered to eliminate conflict or long waiting periods at potentially hazardous intersections.

C.8.b.6 Roundabouts

Roundabouts have proven safety and operational characteristics and should be evaluated as an alternative to conventional intersections whenever practical. Modern roundabouts, when correctly designed, are a proven safety countermeasure to conventional intersections, both stop controlled and signalized. In addition, when constructed in appropriate locations, drivers will experience less delay with modern roundabouts. NCHRP Report 672. Roundabouts: An Informational Guide, is adopted by FHWA and establishes criteria and procedures for the justification, operational and safety analysis of modern roundabouts in the United States. The modern roundabout is characterized by the following:

- A central island of sufficient diameter to accommodate vehicle tracking and to provide sufficient deflection to promote lower speeds
- Entry is by gap acceptance through a yield condition at all legs
- Speeds through the intersection are 25 mph or less

Roundabouts should be considered under the following conditions:

1 New construction

2. Reconstruction

3. Traffic Operations improvements

4. Resurfacing (3R) with Right of Way acquisition

5. Need to reduce frequency and severity of crashes

C.8.c Control for All Limited Access Highways[JM174][KM175]

Entrances and exits on the right side only are highly desirable for all limited access highways. Acceleration and deceleration lanes are mandatory. Intersections shall be accomplished by grade separation (interchange) and should be restricted to connect with arterials or collector roads.

The control of access on freeways should conform to the requirements given in Table 3 - 164 Access Control for All Limited Access Highways. The spacing of exits and entrances should be increased wherever possible to reduce conflicts. Safety and capacity characteristics are improved by restricting the number and increasing the spacing of access points.

Table 3 – 164
Access Control for All Limited Access Highways

	URBAN	RURAL
MINIMUM SPACING		
Interchanges	1 to 3 miles	3 to 25 miles[KM176]
MANEUVER RESTRICTIONS		
Crossing Maneuvers	Via Grade Separation Only	
Exit and Entrance	From Right Side Only	
Turn Lane Required	Acceleration Lane at all Entrances Deceleration Lane at all Exits	

C.8.d Control of Urban and Rural Streets and Highways

The design and construction of urban, as well as rural, highways[JM177] should be governed by the general criteria for access control previously outlined. In addition, the design of urban streets should be in accordance with the criteria listed below:

- The general layout of local and collector streets should follow a branching network, rather than a highly interconnected grid pattern.
- The street network should be designed to reduce, consistent with origin/destination requirements, the number of crossing and left turn maneuvers.
- The design of the street layout should be predicated upon reducing the need for traffic signals.
- The use of a public street or highway as an integral part of the internal circulation pattern for commercial property should be discouraged.
- The number of driveway access points should be restricted as much as possible through areas of strip development.
- Special consideration should be given to providing turn lanes (auxiliary lane for turning maneuvers) where the total volume or truck/bus volume is high.

- Major traffic generators may be exempt from the restrictions on driveway access if the access point is designed as a normal intersection adequate to handle the expected traffic volume.

These are minimum requirements only; it is generally desirable to use more stringent criteria for control of access.

C.8.e Control for Rural Highways

The design of rural highways should be in accordance with the general criteria for access control for urban streets. The use of acceleration and deceleration lanes on all high-speed highways, particularly if truck and bus traffic is significant, is strongly recommended.

C.8.ef Land Development

It should be the policy of each agency with responsibility for street and highway[JM178] design, construction, or maintenance to promote close liaison with utility, lawmaking, zoning, building, and planning agencies. Cooperation should be solicited in the formulation of laws, regulations, and master plans for land use, zoning, and roadhighway[JM179] construction. Further requirements and criteria for access control and land use relationships are given in CHAPTER 2 - LAND DEVELOPMENT.

C.9 Intersection Design

Intersections increase traffic conflicts and the demands on the driver, and are inherently hazardous locations. The design of an intersection should be predicated on reducing motor vehicle, bicycle, and pedestrian conflicts, minimizing the confusion and demands on the driver for rapid and/or complex decisions, and providing for smooth traffic flow. The location and spacing of intersections should follow the requirements presented in C.8 Access Control, this chapter. Intersections should be designed to minimize time and distance of all who pass through or turn at an intersection.

The additional effort and expense required to provide a high quality intersection is justified by the corresponding safety benefits. The overall reduction in crash potential derived from a given expenditure for intersection improvements is generally much greater than the same expenditure for improvements along an open roadway. Properly designed intersections increase capacity, reduce delays, and improve safety.

One of the most common deficiencies that may be easy to correct is lack of adequate left turn storage.

The requirements and design criteria contained in this section are applicable to all driveways, intersections, and interchanges. All entrances to, exits from, or interconnections between streets and highways are subject to these design standards.

C.9.a General Criteria

The layout of a given intersection may be influenced by constraints unique to a particular location or situation. The design shall conform to sound principles and criteria for safe intersections. The general criteria include the following:

- The layout of the intersection should be as simple as is practicable. Complex intersections, which tend to confuse and distract the driver, produce inefficient and hazardous operations.

- The intersection arrangement should not require the driver to make rapid or complex decisions.

- The layout of the intersection should be clear and understandable so a proliferation of signs, signals, or markings is not required to adequately inform and direct the driver.

- The design of intersections, particularly along a given street or highway, should be as consistent as possible.

- The approach roadways should be free from steep grades and sharp horizontal or vertical curves.

- Intersections with driveways or other roadways should be as close to right angle as possible.

- Adequate sight distance should be provided to present the driver a clear view of the intersection and to allow for safe execution of crossing and turning maneuvers.

- The design of all intersection elements should be consistent with the design speeds of the approach roadways.

- The intersection layout and channelization should encourage smooth flow and discourage wrong way movements.

- Special attention should be directed toward the provision of safe roadside clear zones.

- The provision of auxiliaryspecial turn[JM180] lanes should be in conformance with the criteria set forth in C.8 Access Control, this chapter.

- The requirements for bicycle and pedestrian movements should receive special consideration.

C.9.b Sight Distance

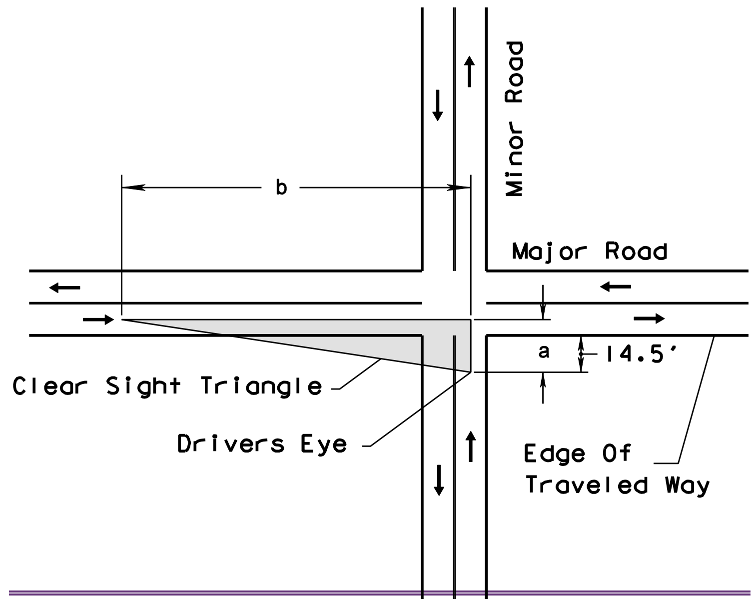
Inadequate sight distance is a contributing factor in the cause of a large percentage of intersection crashes. The provision of adequate sight distance at intersections is absolutely essential and should receive a high priority in the design process.

C.9.b.1 General Criteria

General criteria to be followed in the provision of sight distance include the following:

- Sight distance exceeding the minimum stopping sight distance should be provided on the approach to all intersections (entrances, exits, stop signs, traffic signals, and intersecting roadways). The use of proper approach geometry free from sharp horizontal and vertical curvature will normally allow for adequate sight distance.
- The approaches to exits or intersections (including turn, storage, and deceleration lanes) should have adequate sight distance for the design speed and also to accommodate any allowed lane change maneuvers.
- Adequate sight distance should be provided on the through roadway approach to entrances (from acceleration or merge lanes, stop or yield signs, driveways or traffic signals) to provide capabilities for defensive driving. This lateral sight distance should include as much length of the entering lane or intersecting roadway as is feasible. A clear view of entering vehicles is necessary to allow through traffic to aid merging maneuvers and to avoid vehicles that have "run" or appear to have the intention of running stop signs or traffic signals.
- Approaches to school or pedestrian crossings and crosswalks should have sight distances exceeding the minimum values. This should also include a clear view of the adjacent pedestrian pathways or shared use paths.
- Sight distance in both directions should be provided for all entering roadways (intersecting roadways and driveways) to allow entering vehicles to avoid through traffic. See Section C.9.B.4 for further information.Refer to Figures 3 - 7 and 3 - 8.[JM181][KM182]
- Safe stopping sight distances shall be provided throughout all intersections, including turn lanes, speed change lanes, and turning roadways.
- The use of lighting (CHAPTER 6 - ROADWAY LIGHTING) should be considered to improve intersection sight distance for night driving.

Figure 3 – 7[KM183]
Departure Sight Triangle
(Traffic Approaching From Left Or Right)



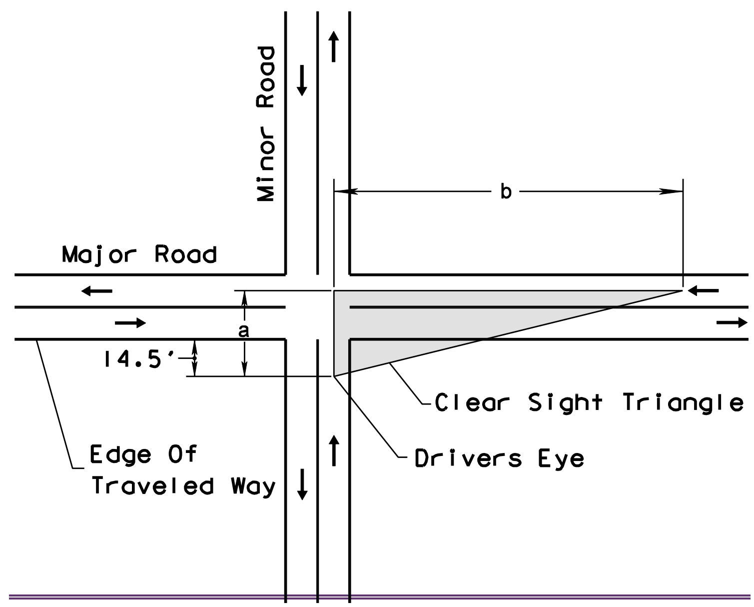
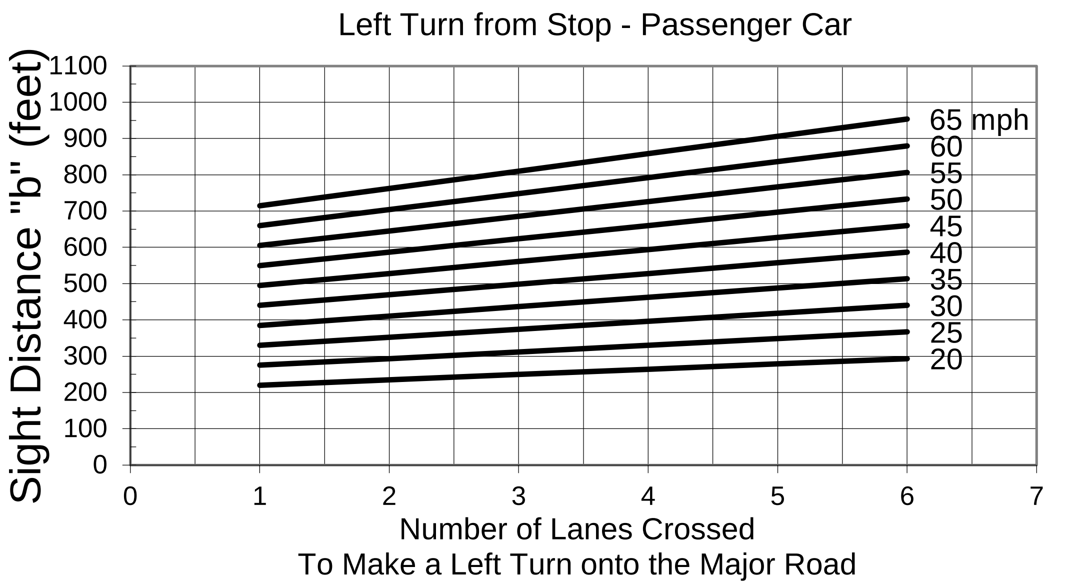
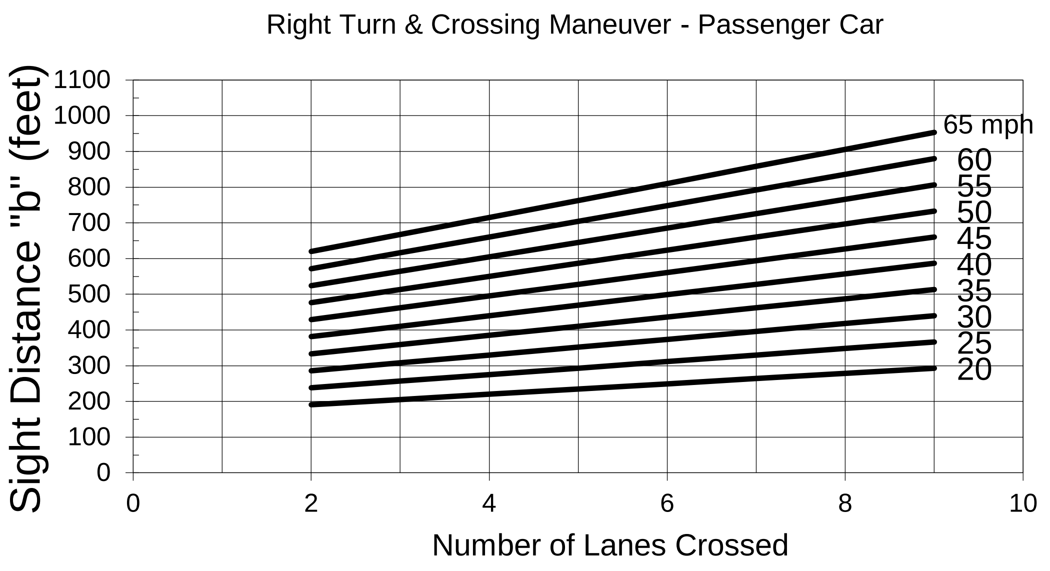


Figure 3 – 8
Intersection Sight Distance[KM184]



A vehicle crosses one lane to make a left turn onto a two lane-two way road; crosses two lanes on a four lane undivided road; and so forth. For divided highways, convert median widths to equivalent number of lanes. For medians 25' and greater a two step maneuver may be considered - see text.



For right turn maneuver use distance based on 2 lanes crossed.
For crossing divided highways, convert median widths to equivalent number of lanes. For medians 25' and greater a two step maneuver may be considered - see text.

C.9.b.2 Obstructions to Sight Distance[MAK185]

The provisions for sight distance are limited by the street or highway[JM186] geometry and the nature and development of the area adjacent to the roadway. Where line of sight is limited by vertical curvature or obstructions, stopping sight distance shall be based on the eye height of 3.50 feet and an object height of 20.50 feet. At exits or other locations where the driver may be uncertain as to the roadway alignment, a clear view of the pavement surface should be provided. At locations requiring a clear view of other vehicles or pedestrians for the safe execution of crossing or entrance maneuvers, the sight distance should be based on a driver's eye height of 3.50 feet and an object height of 3.00 feet (preferably 1.50 feet). The height of eye for truck traffic may be increased for determination of line of sight obstructions for intersection maneuvers. Obstructions to sight distance at intersections include the following:

- Any property not under the highway agency's jurisdiction, through direct ownership or other regulations, should be considered as an area of potential sight distance obstruction. Based on the degree of obstruction, the property should be considered for acquisition by deed or easement.
- Areas which contain vegetation (trees, shrubbery, grass, etc.) that cannot easily be trimmed or removed by regular maintenance activity should be considered as sight obstructions.
- Parking lanes shall be considered as obstructions to line of sight. Parking shall be prohibited within clear areas required for sight distance at intersections.
- Large (or numerous) poles or support structures for lighting, signs, signals, or other purposes that significantly reduce the field of vision within the limits of clear sight shown in Figure 3 - 117 Departure Sight Triangle in Section C.9.b.4. may constitute sight obstructions. Potential sight obstructions created by poles, supports, and signs near intersections should be carefully investigated.

In order to ensure the provision for adequate intersection sight distance, on-site inspections should be conducted before and after construction, including placement of signs, lighting, guardrails, or other objects and how they impact intersection sight distance.

C.9.b.3 Stopping Sight Distance

The provision for safe stopping sight distance at intersections and on turning roadways is even more critical than on open roadways. Vehicles are more likely to be traveling in excess of the design or posted speed and drivers are frequently distracted from maintaining a continuous view of the upcoming roadway.

C.9.b.3.(a) Approach to Stops

The approach to stop signs, yield signs, or traffic signals should be provided with a sight distance no less than values given in Table 3 - 175 Sight Distance for Approach to Stops . These values are applicable for any street, highway, or turning roadway. The driver should, at this required distance, have a clear view of the intersecting roadway, as well as the sign or traffic signal.

Where the approach roadway is on a grade or vertical curve, the sight distance should be no less than the values shown in Figure 3 - 109 Sight Distances for Approach to Stop on Grades. In any situation where it is feasible, sight distances exceeding those should be provided. This is desirable to allow for more gradual stopping maneuvers and to reduce the likelihood of vehicles running through stop signs or signals. Advance warnings for stop signs are desirable.

Table 3 – 17
Sight Distance for Approach to Stops
(Rounded Values[MAK187])

DESIGN SPEED (mph)	20	25	30	35	40	45	50	55	60	65	70
STOPPING SIGHT DISTANCE (feet) (Minimum)	115	155	200	250	305	360	425	495	570	645	730

C.9.b.3.(b) On Turning Roads

The required stopping sight distance at any location on a turning roadway (loop, exit, etc.) shall be based on the design speed at that point. Ample sight distance should be provided since the driver is burdened with negotiating a curved travel path and the available friction factor for stopping has been reduced by the roadway curvature. The minimum sight distance values are given in Table 3 - 175 or Figure 3 - 109. Due to the inability of vehicle headlights to adequately illuminate a sharply curved travel path, roadway lighting should be considered for turning roadways.

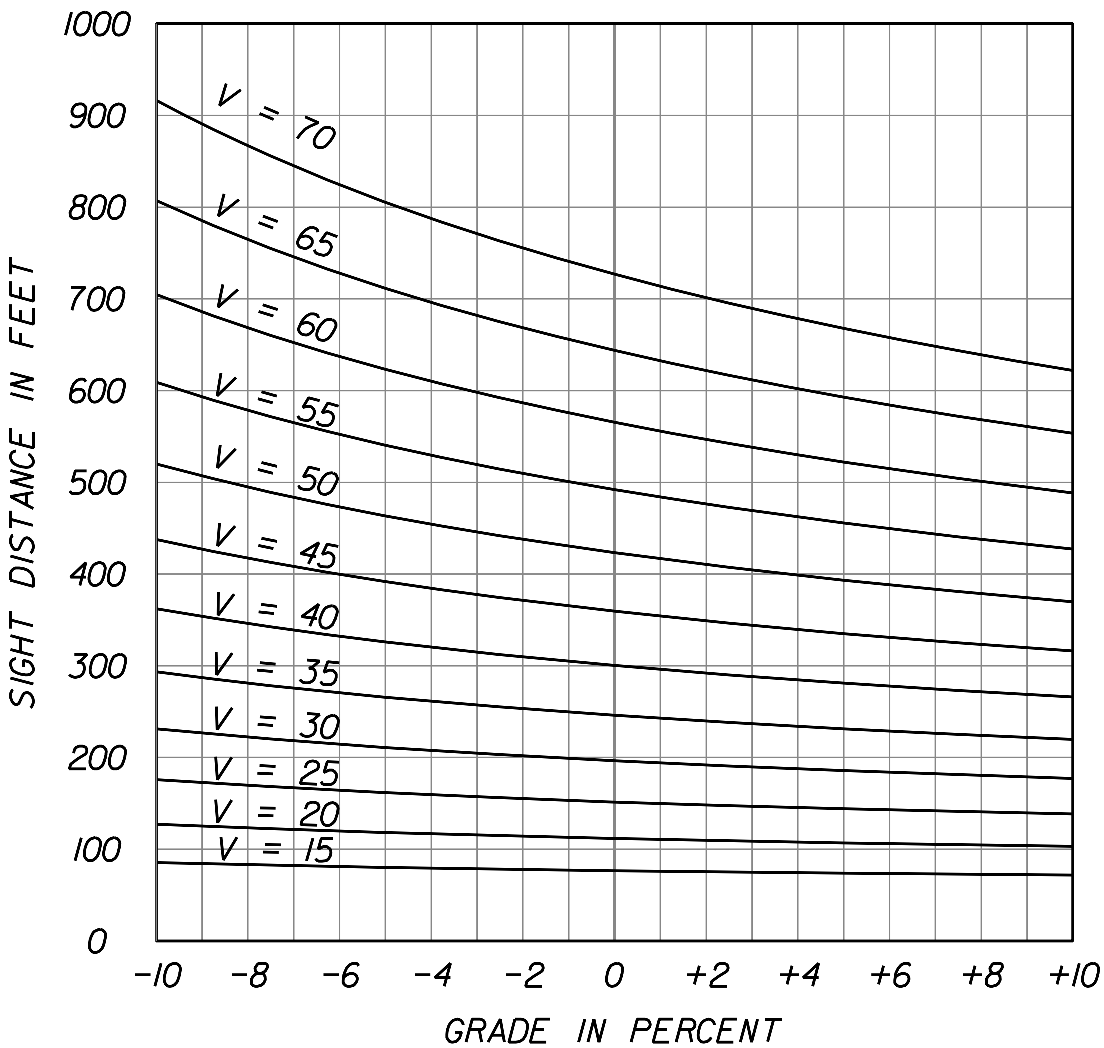
Table 3 – 15

Sight Distance For Approach To Stops

(Rounded Values[MAK188]**)**

DESIGN SPEED (MPH)	10	15	20	25	30	35	40	45	50	55	60	65	70
STOPPING SIGHT DISTANCE (FEET) (Minimum)	50	80	115	155	200	250	305	360	425	495	570	645	730

Figure 3 – 109
Sight Distances for Approach to Stop on Grades



$$S = 3.675V + \frac{V^2}{30(0.3478 \pm G)}$$

S = Sight Distance
V = Design Speed
G = Grade

C.9.b.4 Sight Distance for Intersection Maneuvers

Sight distance is also provided at intersections to allow the drivers of stopped vehicles a sufficient view of the intersecting street or highway[JM189] to decide when to enter or cross the intersecting street or highway.[JM190] Sight triangles, which are specified areas along intersection approach legs and across their included corners, shall, where practical, be clear of obstructions that would prohibit a driver's view of potentially conflicting vehicles. Departure sight triangles shall be provided in each quadrant of each intersection approach controlled by stop signs.

Figures 3 - 117 Departure Sight Triangle(Traffic Approaching from Left or Right) and 3 - 128 Intersection Sight Distance*[KM191]* show typical departure sight triangles to the left and to the right of the location of a stopped vehicle on a minor road[JM192] (stop controlled) and the intersection sight distances for the various movements.

Distance "a" is the length of leg of the sight triangle along the minor road. This distance is measured from the driver's eye in the stopped vehicle to the center of the nearest lane on the major road[JM193] (through road) for vehicles approaching from the left, and to the center of the nearest lane for vehicles approaching from the right.

Distance "b" is the length of the leg of the sight triangle along the major road measured from the center of the minor road entrance lane. This distance is a function of the design speed and the time gap in major road traffic needed for minor road drivers turning onto or crossing the major road. This distance is calculated as follows:

$$ISD = 1.47 V_{major} t_g$$

Where:

ISD=Intersection Sight Distance (ft.) – length of leg of sight triangle along the major road.

V_{major}= Design Speed (mph) of the Major Road

t_g= Time gap (sec.) for minor road vehicle to enter the major road.

Time gap values, t_g, to be used in determination of ISD are based on studies and observations of the time gaps in major road traffic actually accepted by drivers turning onto or across the major road. Design time gaps will vary and depend on the design vehicle, the type of the maneuver, the crossing distance involved in the maneuver, and the minor road approach grade.

For intersections with stop control on the minor road, there are three maneuvers or cases that must be considered. ISD is calculated for each maneuver case that may occur at the intersection. The case requiring the greatest ISD will control. Cases that must be considered are as follows (Case numbers correspond to cases identified in the AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011):

Case B1 – Left Turns from the Minor (stop controlled) Road

Case B2 – Right Turns from the Minor (stop controlled) Road

Case B3 – Crossing the Major Road from the Minor (stop controlled) Road

See Sections C.9.b.4.(c) and (d) for design time gaps for Case B.

For Intersections with Traffic Signal Control see Section C.9.b.4.(e) (AASHTO Case D).

For intersections with all way stop control see Section C.9.b.4.(f) (AASHTO Case E).

For left turns from the major road see Section C.9.b.4.(g) (AASHTO Case F).

Figure 3 – 11[KM194][KM195]
Departure Sight Triangle
(Traffic Approaching from Left or Right)

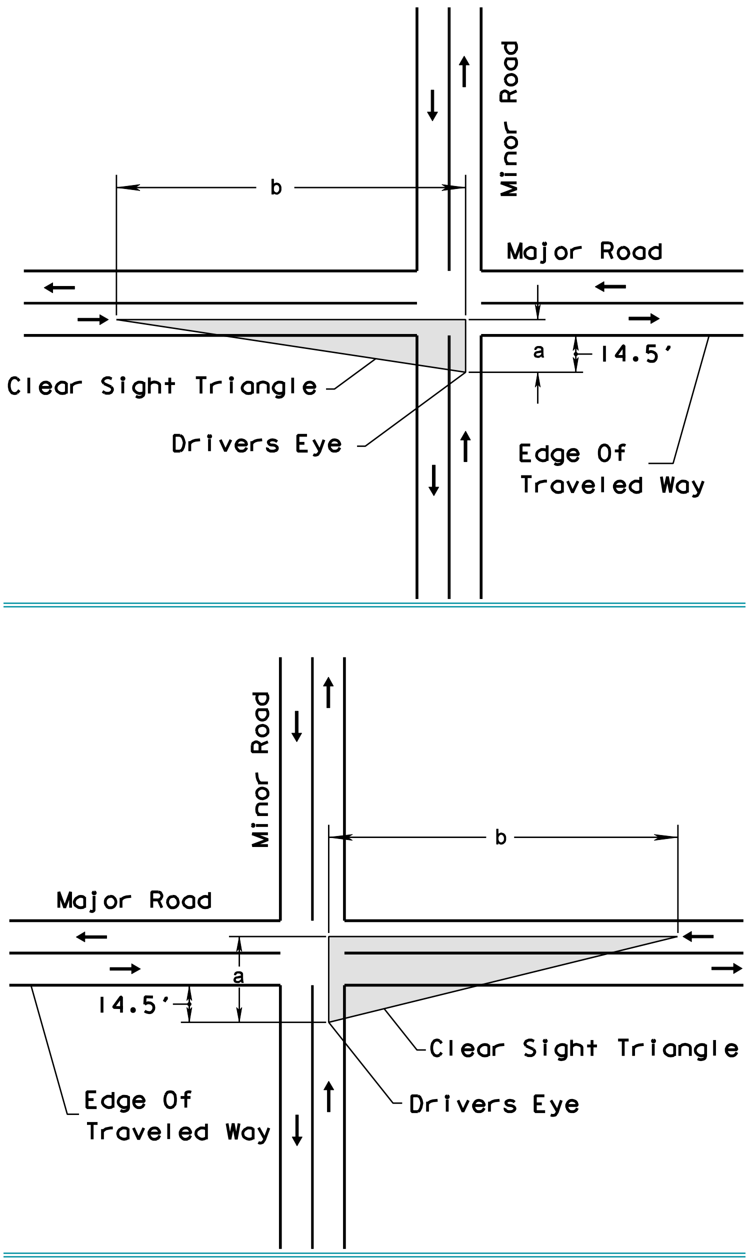
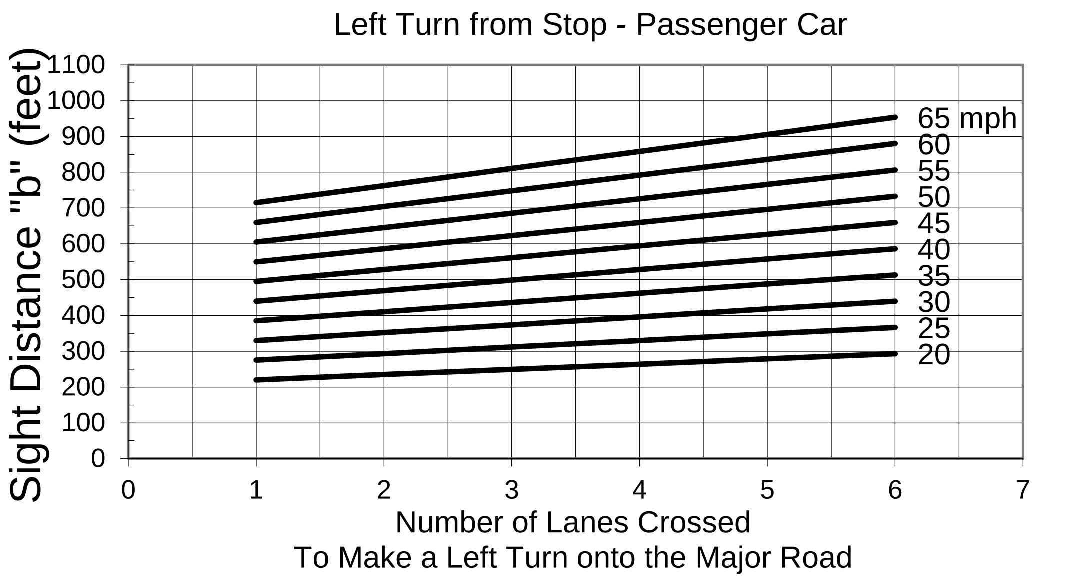
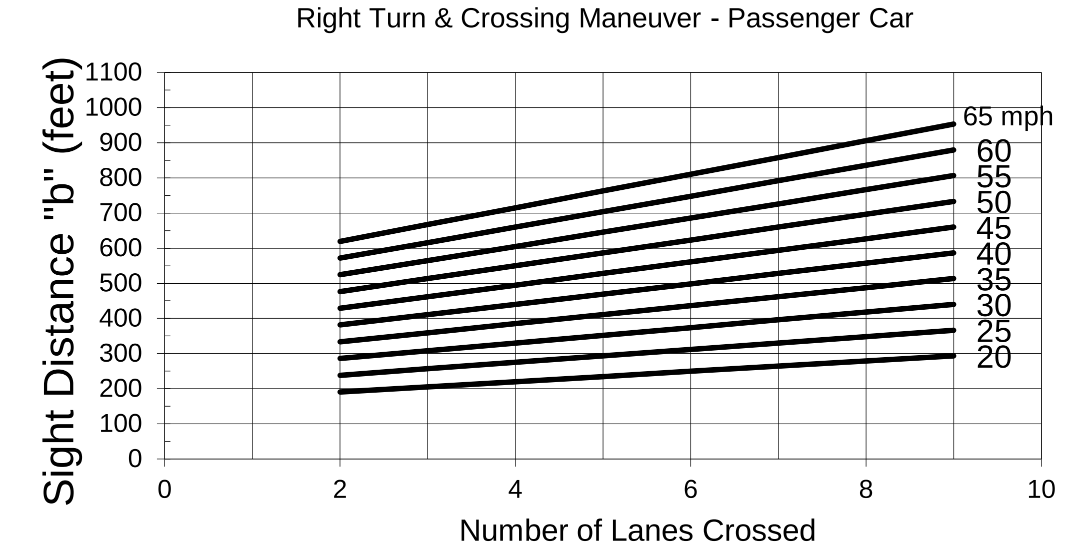


Figure 3 – 12
Intersection Sight Distance[KM196]



A vehicle crosses one lane to make a left turn onto a two lane-two way road; crosses two lanes on a four lane undivided road; and so forth. For divided highways, convert median widths to equivalent number of lanes. For medians 25' and greater a two step maneuver may be considered - see text.



For right turn maneuver use distance based on 2 lanes crossed.
For crossing divided highways, convert median widths to equivalent number of lanes. For medians 25' and greater a two step maneuver may be considered - see text.

C.9.b.4.(a) Driver's Eye Position and Vehicle Stopping Position

The vertex (decision point or driver's eye position) of the departure sight triangle on the minor road shall be a minimum of 14.5 feet from the edge of the major road traveled way. This is based on observed measurements of vehicle stopping position and the distance from the front of the vehicle to the driver's eye. Field observations of vehicle stopping positions found that, where necessary, drivers will stop with the front of their vehicle 6.5 feet or less from the edge of the major road traveled way. Measurements of passenger cars indicate that the distance from the front of the vehicle to driver's eye for the current U.S. passenger car fleet is almost always 8 feet or less.

When executing a crossing or turning maneuver after stopping at a stop sign, stop bar, or crosswalk as required in Section 316.123, Florida Statutes, it is assumed that the vehicle will move slowly forward to obtain sight distance (without intruding into the crossing travel lane) stopping a second time as necessary.

C.9.b.4.(b) Design Vehicle

Dimensions of clear sight triangles are provided for passenger cars, single unit trucks, and combination trucks stopped on the minor road. It can usually be assumed that the minor road vehicle is a passenger car. However, where substantial volumes of heavy vehicles enter the major road, such as from a ramp[JM197][KM198] terminal, the use of tabulated values for single unit or combination trucks should be considered.

C.9.b.4.(c) Case B1 - Left Turns From the Minor Road

Design time gap values for left turns from the minor road onto two lane two way major highway are as follows:

Design Vehicle	Time Gap (t_g) in Seconds
Passenger Car	7.5
Single Unit Truck	9.5
Combination Truck	11.5

If the minor road approach grade is an upgrade that exceeds 3 percent, add 0.2 seconds for each percent grade for left turns.

For multilane streets and highways[JM199] without medians wide enough to store the design vehicle with a clearance of 3 feet on both ends of the vehicle, add 0.5 seconds for passenger cars or 0.7 seconds for trucks for each additional lane from the left, in excess of one, to be crossed by the turning vehicle. The median width should be included in the width of additional lanes. This is done by converting the median width to an equivalent number of 12 foot lanes.

For multilane streets and highways[JM200] with medians wide enough to store the design vehicle with a clearance of 3 feet on both ends of the vehicle a two step maneuver may be assumed. Use case B2 for crossing to the median.

C.9.b.4.(d) Case B2 - Right Turns From the Minor Road and Case B3 – Crossing Maneuver From the Minor Road

Design time gap values for a stopped vehicle on a minor road to turn right onto or cross a two lane highway are as follows:

Design Vehicle	Time Gap (t_g) in Seconds
Passenger Car	6.5
Single Unit Truck	8.5
Combination Truck	10.5

If the approach grade is an upgrade that exceeds 3 percent, add 0.1 seconds for each percent grade.

For crossing streets and highways[JM201] with more than 2 lanes, add 0.5 seconds for passenger cars or 0.7 seconds for trucks for each additional lane to be crossed. Medians not wide enough to store the design vehicle with a clearance of 3 feet on both ends of the vehicle should be included in the width of additional lanes. This is done by converting the median width to an equivalent number of 12 foot lanes.

For crossing divided streets and highways[JM202] with medians wide enough to store the design vehicle with a clearance of 3 feet on both ends of the vehicle, a two step maneuver may be assumed. Only the number of lanes to be crossed in each step are considered.

C.9.b.4.(e) Intersections with Traffic Signal Control (AASHTO Case D)

At signalized intersections, the first vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches. Left turning vehicles should have sufficient sight distance to select gaps in oncoming traffic and complete left turns. Apart from these sight conditions, no other sight triangles are needed for signalized intersections. However, if the traffic signal is to be placed on two-way flashing operation in off peak or nighttime conditions, then the appropriate departure sight triangles for Cases B1, B2, or B3, both to the left and to the right, should be provided. In addition, if right turns on red are to be permitted, then the appropriate departure sight triangle to the left for Case B2 should be provided to accommodate right turns.

C.9.b.4.(f) Intersections with All-Way Stop Control (AASHTO Case E)

At intersections with all-way stop control, the first stopped vehicle on one approach should be visible to the drivers of the first stopped vehicles on each of the other approaches. There are no other sight distance criteria applicable to intersections with all-way stop control.

C.9.b.4.(g) Left Turns from the Major Road (AASHTO Case F)

All locations along a major roadhighway[JM203] from which vehicles are permitted to turn left across opposing traffic shall have sufficient sight distance to accommodate the left turn maneuver. In this case, the ISD is measured from the stopped position of the left turning vehicle (see Figure 3 - 130 Sight Distance for Vehicle Turning Left from Major Road).

Design time gap values for left turns from the major road are as follows:

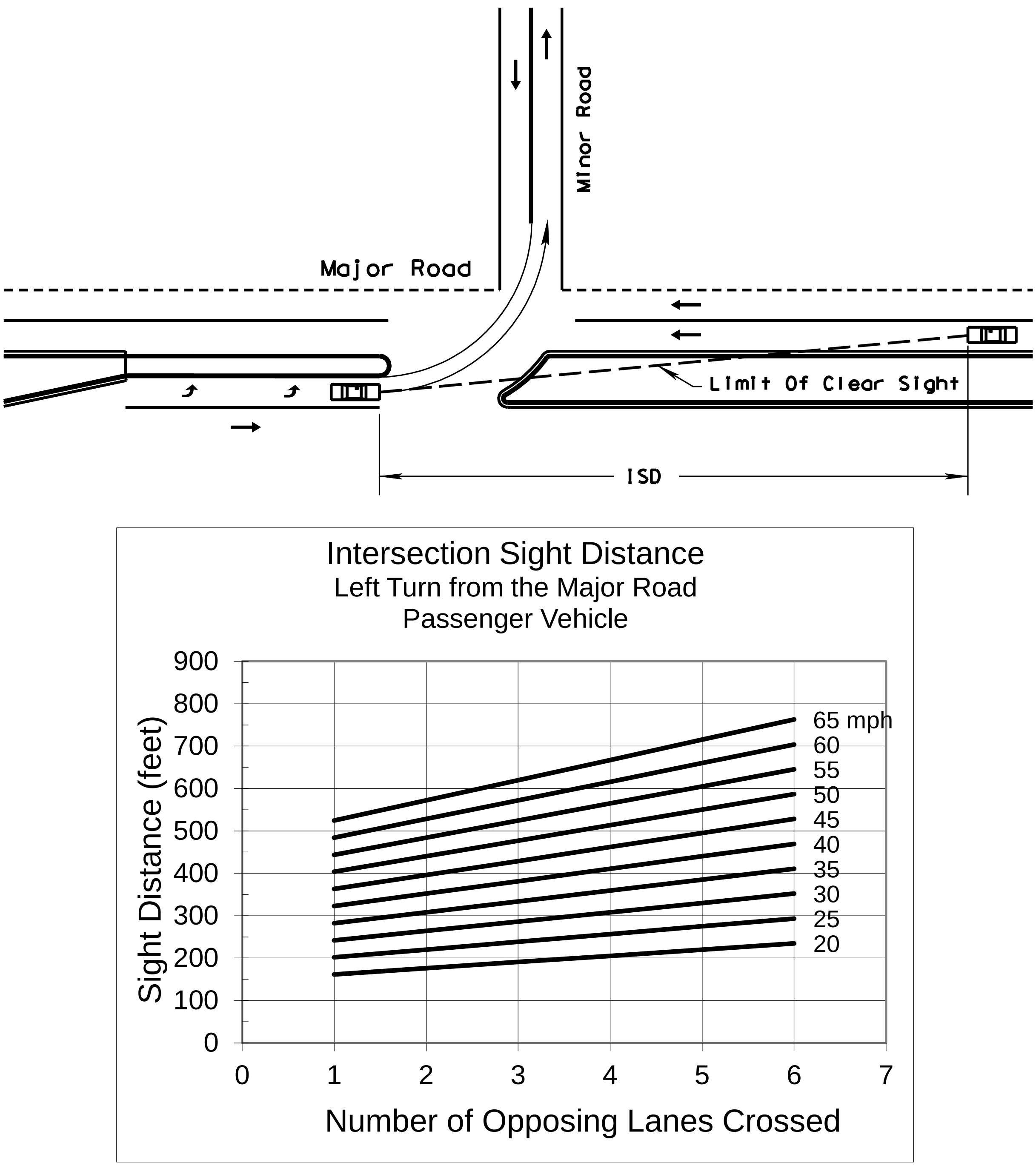
Design Vehicle	Time Gap (t_g) in Seconds
Passenger Car	5.5
Single Unit Truck	6.5
Combination Truck	7.5

For left turning vehicles that cross more than one opposing lane, add 0.5 seconds for passenger cars and 0.7 seconds for trucks for each additional lane to be crossed.

C.9.b.4.(h) Intersection Sight Distance References

The Department's Design Standards, Index 546, provides ISD values for several basic intersection configurations based on Cases B1, B2, B3, and D, and may be used when applicable. For additional guidance on Intersection Sight Distance, see the AASHTO Green Book.

Figure 3 – 130
Sight Distance for Vehicle Turning Left from Major Road



C.9.c Auxiliary Lanes

Auxiliary lanes are desirable for the safe execution of speed change maneuvers (acceleration and deceleration) and for the storage and protection of turning vehicles. Auxiliary lanes for exit or entrance turning maneuvers shall be provided in accordance with the requirements set forth in C.8 Access Control, this chapter. The pavement width and cross slopes of auxiliary lanes should meet the minimum requirements shown in Table 8 Minimum Lane Widthsfor all travel lanes.

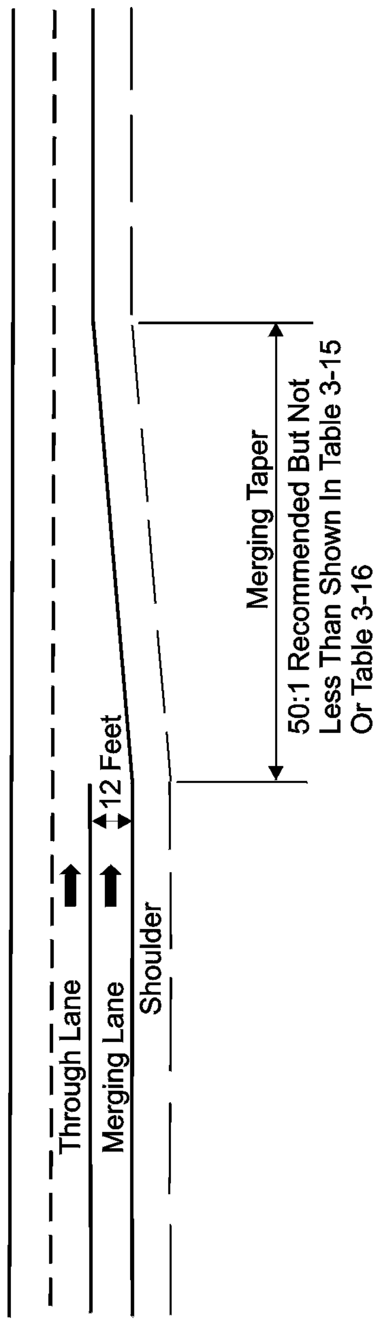
C.9.c.1 Merging Maneuvers

Merging maneuvers occur at the termination of climbing lanes, lane drops, entrance acceleration, and turning lanes. The location provided for this merging maneuver should, where possible, be on a tangent section of the roadway and should be of sufficient length to allow for a smooth, safe transition. The provision of ample distance for merging is essential to allow the driver time to find an acceptable gap in the through traffic and then execute a safe merging maneuver. It is recommended that a merging taper be on a 1:50 transition, but in no case shall the length be less than set forth in Table 3 - 186 Length of Taper for Use In Conditions With Full Width Speed Change Lanes. The termination of this lane should be clearly visible from both the merging and through lane and should correspond to the general configuration shown in Figure 3 - 141 Termination of Merging Lanes. Advance warning of the merging lane termination should be provided. Lane drops shall be marked in accordance with ***Section 14-15.010, F.A.C. Manual on Uniform Traffic Control Devices (MUTCD)***.

Table 3 – 186
Length of Taper for Use In Conditions With Full Width Speed Change Lanes

DESIGN SPEED (MPH)	15	20	25	30	35	40	45	50	55	60	65	70
LENGTH OF DECELERATION TAPER (FEET)	80	110	130	150	170	190	210	230	250	270	290	300
LENGTH OF ACCELERATION TAPER (FEET)	60	80	100	120	140	160	180	210	230	250	260	280

Figure 3 – 141
Termination of Merging Lanes



C.9.c.2 Acceleration Lanes

Acceleration lanes are required for all entrances to expressway and freeway[JM204] ramps[JM205][KM206]. Acceleration lanes may be desirable at access points to any street or highway with a large percentage of entering truck traffic.

The distance required for an acceleration maneuver is dependent on the vehicle acceleration capabilities, the grade, the initial entrance speed, and the final speed at the termination of the maneuver. The distances required for acceleration on level roadways for passenger cars are given in Table 3 - 197 Design Lengths of Speed Change Lanes Flat Grades. Where acceleration occurs on a grade, the required distance is obtained by using Tables 3 - 197 and 3 - 2018 Ratio of Length of Speed Change Lane on Grade to Length on Level.

The final speed at the end of the acceleration lane, should, desirably, be assumed as the design speed of the through roadway. The length of acceleration lane provided should be at least as long as the distance required for acceleration between the initial and final speeds. Due to the uncertainties regarding vehicle capabilities and driver behavior, additional length is desirable. The acceleration lane should be followed by a merging taper (similar to Figure 3 - 141 Termination of Merging Lanes), not less than that length set forth in Table 3 - 186. The termination of acceleration lanes should conform to the general configuration shown for merging lanes in Figure 3 - 141. Recommended acceleration lanes for freeway entrance terminals are given in Table 3 - 2119 Minimum Acceleration Lengths for Entrance Terminals.

Table 3 – 19~~7~~
Design Lengths of Speed Change Lanes
Flat Grades - 2 Percent or Less

Design Speed of turning roadway curve (MPH)		Stop Condition	15	20	25	30	35	40	45	50
Minimum curve radius (FEET)		---	55	100	160	230	320	430	555	695
Design Speed of Highway (MPH)	Length of Taper (FEET)*	Total length of DECELERATION LANE, including taper, (FEET)								
30	150	385	350	320	290	---	---	---	---	---
35	170	450	420	380	355	320	---	---	---	---
40	190	510	485	455	425	375	345	---	---	---
45	210	595	560	535	505	460	430	---	---	---
50	230	665	635	615	585	545	515	455	405	---
55	250	730	705	690	660	630	600	535	485	---
60	270	800	770	750	730	700	675	620	570	510
65	290	860	830	810	790	760	730	680	630	570
70	300	915	890	870	850	820	790	740	690	640
Design Speed of Highway (MPH)	Length of Taper (FEET)*	Total length of ACCELERATION LANE, including taper (FEET)								
30	120	300	260	---	---	---	---	---	---	---
35	140	420	360	300	---	---	---	---	---	---
40	160	520	460	430	370	280	---	---	---	---
45	180	740	670	620	560	460	340	---	---	---
50	210	930	870	820	760	660	560	340	---	---
55	230	1190	1130	1040	1010	900	780	550	380	---
60	250	1450	1390	1350	1270	1160	1050	800	670	430
65	260	1670	1610	1570	1480	1380	1260	1030	860	630
70	280	1900	1840	1800	1700	1630	1510	1280	1100	860

* For urban street auxiliary lanes, shorter tapers may be used due to lower operating speeds. Refer to Figure 3-16~~3~~ for allowable taper rates.

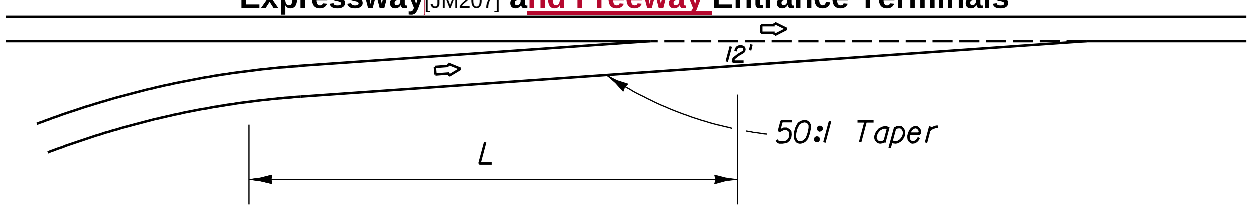
Table 3 – 2018
Ratio of Length of Speed Change Lane on Grade To Length on Level

DECELERATION LANE			ACCELERATION LANE					
	Design Speed of Turning Roadway (MPH)			Design Speed of Turning Roadway (MPH)				
Design Speed of Highway (MPH)	All Speeds 3% -4% Upgrade	All Speeds 3%-4% Downgrade	Design Speed of Highway (MPH)	20	30	40	50	All Speeds
				3% - 4% Upgrade				3% - 4% Downgrade
All Speeds	0.9	1.2	40	1.3	1.3	---	---	0.7
			45	1.3	1.35	---	---	0.675
			50	1.3	1.4	1.4	---	0.65
			55	1.35	1.45	1.45	---	0.625
			60	1.4	1.5	1.5	1.6	0.6
			65	1.45	1.55	1.6	1.7	0.6
			70	1.5	1.6	1.7	1.8	0.6
	5% - 6% Upgrade	5% - 6% Downgrade		5% - 6% Upgrade				5% - 6% Downgrade
All Speeds	0.8	1.35	40	1.5	1.5	---	---	0.6
			45	1.5	1.6	---	---	0.575
			50	1.5	1.7	1.9	---	0.55
			55	1.6	1.8	2.05	---	0.525
			60	1.7	1.9	2.2	2.5	0.5
			65	1.85	2.05	2.4	2.75	0.5
			70	2.0	2.2	2.6	3.0	0.5
Ratios in this table multiplied by the values in Table 3-186 give the length of speed change lane for the respective grade.								

Table 3 – 2119
Minimum Acceleration Lengths for Entrance Terminals

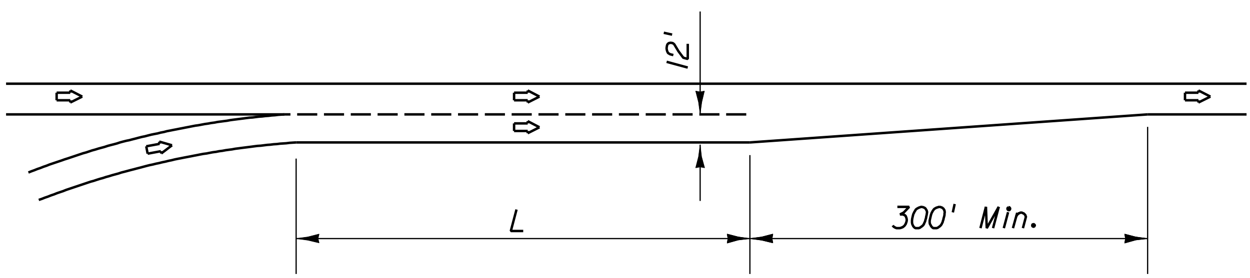
Highway Design Speed (MPH)	L = Acceleration Length (FEET)								
	For Entrance Curve Design Speed (MPH)								
	Stop Condition	15	20	25	30	35	40	45	50
30	180	140	---	---	---	---	---	---	---
35	280	220	160	---	---	---	---	---	---
40	360	300	270	210	120	---	---	---	---
45	560	490	440	380	280	160	---	---	---
50	720	660	610	550	450	350	130	---	---
55	960	900	810	780	670	550	320	150	---
60	1200	1140	1100	1020	910	800	550	420	180
65	1410	1350	1310	1220	1120	1000	770	600	370
70	1620	1560	1520	1420	1350	1,230	1000	820	580

Expressway[JM207] and Freeway Entrance Terminals



TAPER TYPE

Recommended when design speed at entrance curve is 50 MPH or greater.



PARALLEL TYPE

Recommended when design speed at entrance curve is less than 50 MPH.

C.9.c.3 Exit Lanes

Auxiliary lanes for exiting maneuvers provide space outside the through lanes for protection and storage of decelerating vehicles exiting the facility.

- Deceleration Lanes - The primary function of deceleration lanes is to provide a safe travel path for vehicles decelerating from the operating speed on the through lanes. Deceleration lanes are required for all freeway exits and are desirable on high-speed (design speed greater than 50 mph) streets and highways.

The distance required for deceleration of passenger cars is given in Table 3 - 19~~7~~.

The required distance for deceleration on grades is given in Tables 3 - 19~~7~~ and 3 - 20~~18~~.

The length of deceleration lanes shall be no less than the values obtained from Tables 3 - 19~~7~~ and 3 - 20~~18~~, and should be increased wherever feasible. The initial speed should, desirably, be taken as the design speed of the highway. The final speed should be the design speed at the exit (e.g., a turning roadway) or zero, if the deceleration lane terminates at a stop or traffic signal. A reduction in the final speed to be used is particularly important if the exit traffic volume is high, since the speed of these vehicles may be significantly reduced.

The entrance to deceleration (and climbing) lanes should conform to the general configuration shown in Figure 3 - 15~~2~~ Entrance for Deceleration Lane. The initial length of straight taper, shown in Table 3 - 19~~7~~, may be utilized as a portion of the total required deceleration distance. The pavement surface of the deceleration lane should be clearly visible to approaching traffic, so drivers are aware of the maneuvers required. Recommended deceleration lanes for exit terminals are given in Table 3 - 22~~0~~ Minimum Deceleration Lengths for Exit Terminals.

- Storage Lanes - Where exit lanes are required (C.8 Access Control, this chapter), or desirable on low speed streets and highways, storage lanes may be used in place of or in conjunction with deceleration lanes. Storage lanes should be considered on all facilities. Although the primary function of storage lanes is to provide protection and storage for turning vehicles, it is desirable to provide sufficient length to allow for deceleration capabilities. Storage lanes should conform to the general configuration shown in Figure 3 - 163 Typical Storage Lane*[MAK208]*.

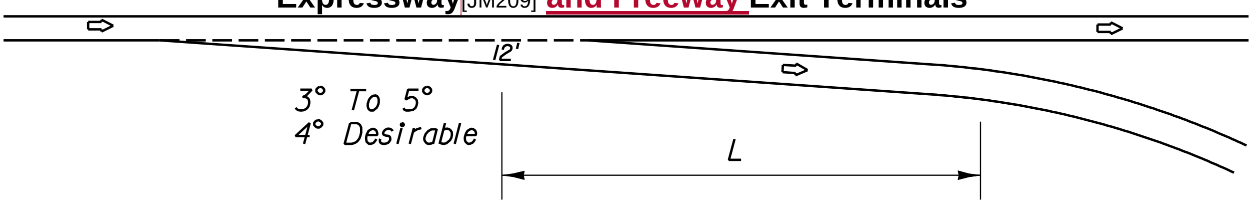
The length of storage lanes for unsignalized intersections may be obtained from the table in Figure 3 - 163. The full width portion of storage lanes should, where possible, be increased to allow for expected storage of vehicles (Table 3 - 2 for vehicle lengths). As a minimum requirement, storage for at least two passenger cars (40 - 50 feet) should be provided.

On collector or arterial streets (design speed 45 mph or less), tapers preceding storage lanes and approaching intersections at grade may be shorter than those given in Table 3 - 197 (AASHTO for recommended lengths).

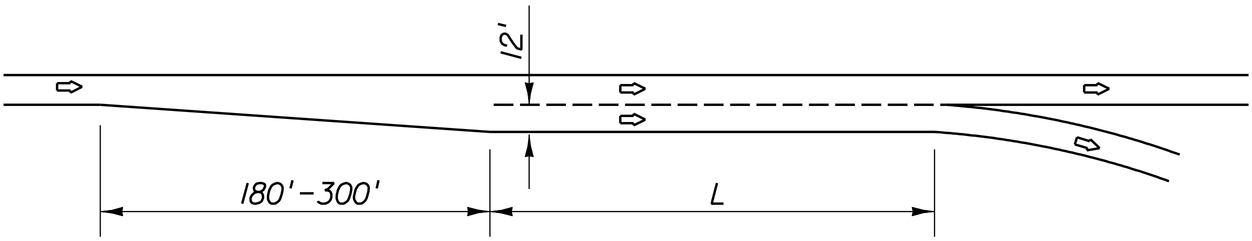
Table 3 – 220
Minimum Deceleration Lengths for Exit Terminals

Highway Design Speed (MPH)	L = Deceleration Length (FEET)								
	For Design Speed of Exit Curve (MPH)								
	Stop Condition	15	20	25	30	35	40	45	50
30	235	200	170	140	---	---	---	---	---
35	280	250	210	185	150	---	---	---	---
40	320	295	265	235	185	155	---	---	---
45	385	350	325	295	250	220	---	---	---
50	435	405	385	355	315	285	225	175	---
55	480	455	440	410	380	350	285	235	---
60	530	500	480	460	430	405	350	300	240
65	570	540	520	500	470	440	390	340	280
70	615	590	570	550	520	490	440	390	340

Expressway[JM209] and Freeway Exit Terminals



TAPER TYPE
Recommended when design speed at exit curve is 50 MPH or greater and when approach visibility is good.



PARALLEL TYPE
Recommended when design speed at exit curve is less than 50 MPH or when approach visibility is not good.

Figure 3 – 152
Entrance for Deceleration Lane

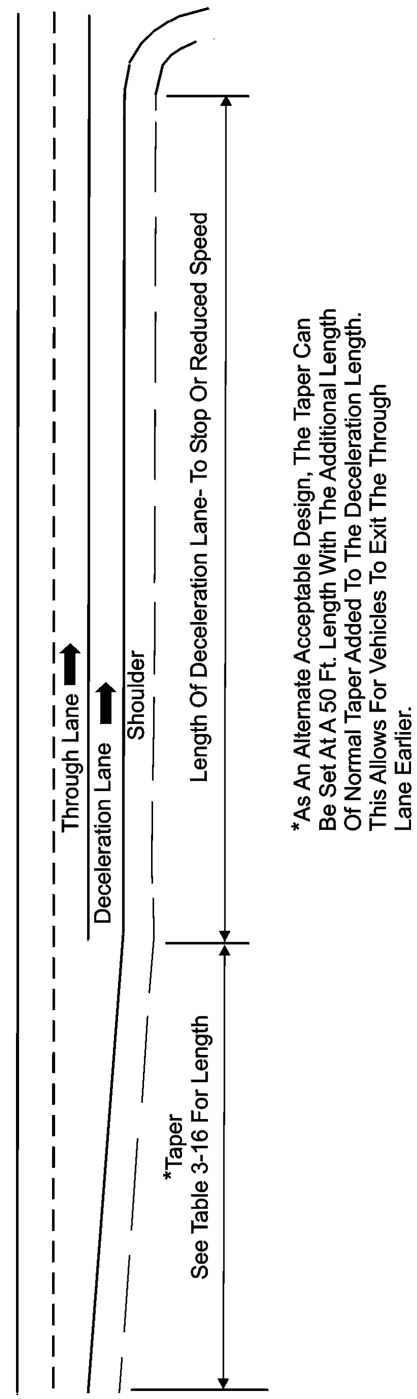
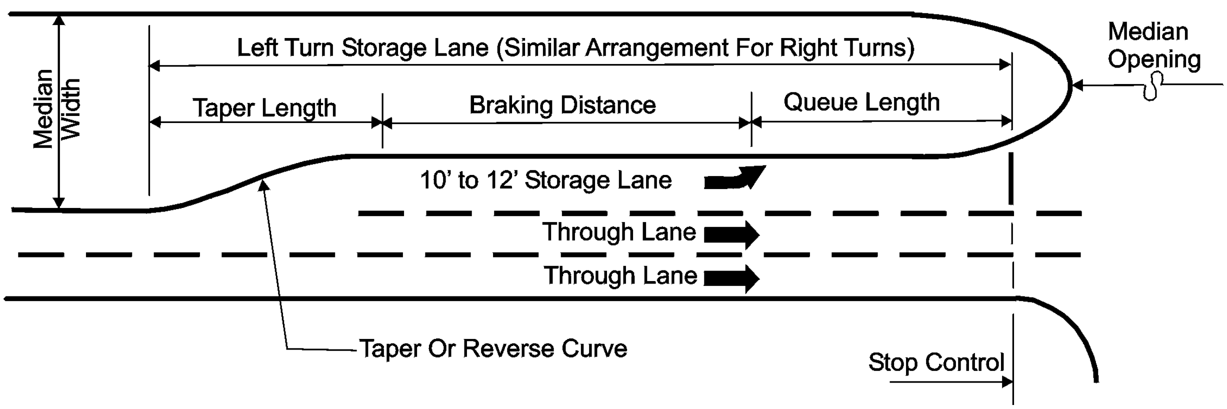


Figure 3 – 163
Typical Storage Lane[MAK210]



Storage Queue Length - Unsignalized Intersections

Turning Vehicles Per Hour	30	60	100	200	300
Required Storage Length (FEET)	25	50	100	175	250

At signalized intersections, the required queue length depends on the signal cycle length, the signal phasing arrangement, and rate of arrivals and departures of turning vehicles.

In absence of a turning movement study, it is recommended that 100 ft. of queue length be provided in urban/suburban areas and 50 ft. of queue length be provided in rural/town areas as a minimum.

Taper Length And Braking Distance (FEET)

Highway Design Speed (MPH)	Storage Entry Speed* (MPH)	Taper Length	Brake To Stop	
			Urban**	**Rural*****
35	25	70	75	---
40	30	80	75	---
45	35	85	100	---
50	40/44	105	135	215
55	48	125	---	260
60	52	145	---	310
65	55	170	---	350

* Reaction Precedes Entry
** Minimum Braking Distance, Wet Conditions
*** Customary Braking Distance, Wet Conditions

The storage lane may be in place of or in addition to deceleration length (See Section C.9.c.3).

C.9.d Turning Roadways at Intersections

The design and construction of turning roadways shall meet the same general requirements for through roadways, except for the specific requirements given in the subsequent sections.

C.9.d.1 Design Speed

Lanes for turning movements at grade intersections may, where justified, be based on a design speed as low as 10 mph. Turning roadways with design speeds in excess of 40 mph shall be designed in accordance with the requirements for through roadways.

A variable design speed may be used to establish cross section and alignment criteria for turning roadways that will experience acceleration and deceleration maneuvers.

C.9.d.2 Horizontal Alignment

- Curvature - The minimum permitted radii (maximum degree) of curvature for various values of superelevation are given in Table 3 - 231 -Superelevation Rates for Curves at Intersections. These should be considered as minimum values only and the radius of curvature should be increased wherever feasible. Further information contained in ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 201101***, should also be considered.

Table 3 – 231
Superelevation Rates for Curves at Intersections

	Design Speed (MPH)							
	10	15	20	25	30	35	40	45
Minimum Superelevation Rate	0.00*	0.00*	0.02	0.04	0.06	0.08	0.09	0.10
Minimum Radius (FEET)	25	50	90	150	230	310	430	540

The rate of 0.02 is considered the practical minimum for effective drainage across the surface.

Note: Preferably use superelevation rates greater than these minimum values.

- Superelevation Transition - Minimum superelevation transition (runoff) rates (maximum relative gradients) are given in Tables 3 - 242 Maximum Rate of Change in Pavement Edge Elevation for Curves at Intersections and 3 - 253 Maximum Algebraic Difference in Pavement Cross Slope at Turning Roadway Terminals. Other information given in ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 201101***, should also be considered.

Table 3 – 242
Maximum Rate of Change in Pavement Edge Elevation for Curves at Intersections

Design Speed (MPH)	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**
Maximum relative gradients for profiles between the edge of two lane pavement and the centerline (PERCENT)	0.78	0.74	0.70	0.66	0.62	0.58	0.54	0.50	0.47	0.45	0.43	0.40

Table 3 – 253
Maximum Algebraic Difference in Pavement Cross Slope at Turning Roadway Terminals

Design Speed of Exit or Entrance Curve (MPH)	**Maximum Algebraic Difference in Cross Slope at Crossover Line (PERCENT)**
20 and under	5.0 to 8.0
25 and 30	5.0 to 6.0
35 and over	4.0 to 5.0

C.9.d.3 Vertical Alignment

Grades on turning roadways should be as flat as practical and long vertical curves should be used wherever feasible. The length of vertical curves shall be no less than necessary to provide minimum stopping sight distance. Minimum stopping sight distance values are given in Table 3 - 175. For additional guidance on vertical alignment for turning roadways, see ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 201101***.

C.9.d.4 Cross Section Elements

- Number of Lanes - One-way turning roadways are often limited to a single trafficvel[JM211] lane. In this case, the total width of the roadway shall be sufficient to allow traffic to pass a disabled vehicle. Two-way, undivided turning roadways should be avoided. Medians or barriers should be utilized to separate opposing traffic on turning roadways.

- Lane WidthTravel Lanes[JM212] - The width of all traffictravel[JM213] lanes should be sufficient to accommodate (with adequate clearances) the turning movements of the expected types of vehicles. The minimum required lane widths for turning roadways are given in Table 3-28b Derived Pavement Widths for Turning Roadways for Different Design Vehicle in ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011***Table 3 - 24. Changes in lane widths should be gradual and should be accomplished in coordination with adequate transitions in horizontal curvature.

- Shoulders - On one-lane turning roadways, serving expressways and other principal[JM214] arterials (e.g., loops, ramps), the right hand shoulder should be at least 6 feet wide. The left hand shoulder should be at least 6 feet wide in all cases. On two-lane, one-way roadways, both shoulders should be at least 6 feet wide. Where guardrails or other barriers are used, they should be placed at least 8 feet from edge of travel lane. Guardrails should be placed 2 feet outside the normal shoulder width.

- Clear Zones - Turning roadways should, as a minimum, meet all open highway criteria for clear zones on both sides of the roadway. The areas on the outside of curves should be wider and more gently sloped than the minimum values for open highways. Guardrails or similar barriers shall be used if the minimum width and slope requirements cannot be obtained.

Further criteria and requirements for roadway design are given in

CHAPTER 4 - ROADSIDE DESIGN.

Table 3 – 24
Design Widths of Pavements for Turning Roadways

Pavement Width (FEET)

Radius on Inner Edge of Pavement R (FEET)	Case I One-Lane, One-Way Operation - No Provision for Passing a Stalled Vehicle			Case II One-Lane, One-Way Operation - With Provision for Passing a Stalled Vehicle			Case III Two-Lane Operation - Either One-Way or Two-Way		
	Design Traffic and Conditions								
	A	B	C	A	B	C	A	B	C
50	18	18	23	20	26	30	31	36	45
75	16	17	20	19	23	27	29	33	38
100	15	16	18	18	22	25	28	31	35
150	14	15	17	18	21	23	26	29	32
200	13	15	16	17	20	22	26	28	30
300	13	15	15	17	20	22	25	28	29
400	13	15	15	17	19	21	25	27	28
500	12	15	15	17	19	21	25	27	28
Tangent	12	14	14	17	18	20	24	26	26

Width Modification Regarding Edge of Pavement Treatment:

	Case I	Case II	Case III
No stabilized shoulder	None	None	None
Sloping curb	None	None	None
Vertical curb:			
one side	Add 1 ft	None	Add 1 ft
two sides	Add 2 ft	Add 1 ft	Add 2 ft
Stabilized shoulder, one or both sides	Lane width for Conditions B & C on tangent may be reduced to 12 ft where shoulder is 4 ft or wider	Deduct shoulder width; minimum pavement width as under Case I	Deduct 2 ft where shoulder is 4 ft or wider

Note:
Traffic Condition A = predominately P vehicles, but some consideration for SU trucks.
Traffic Condition B = sufficient SU vehicles to govern design, but some consideration for semitrailer combination trucks.
Traffic Condition C = sufficient bus and combination-trucks to govern design.

C.9.e At Grade Intersections

C.9.e.1 Turning Radii

Where right turns from through or turn lanes will be negotiated at low speeds (less than 10 mph), the minimum turning capabilities of the vehicle may govern the design. It is desirable that the turning radius and the required lane width be provided in accordance with the criteria for turning roadways. The radius of the inside pavement edge of traveled way[JM215] should, however, be sufficient to allow the expected vehicles to negotiate the turn without encroaching the shoulder or adjacent traffictravel[JM216] lanes.

Where turning roadway criteria are not used, the radius of the inside insidepavement edge of traveled way [JM217]should be no less than 25 feet. The use of three-centered compound curves is also a reasonable practice to allow for transition into and out of the curve. The recommended radii and arrangement of compound curves instead of a single simple curve is given in ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 201101***[KM218].

C.9.e.2 Cross Section Correlation

The correlation of the cross section of two intersecting roadways is frequently difficult. A careful analysis should be conducted to ensure changes in slope are not excessive and adequate drainage is provided. At stop-controlled intersections, the through roadway cross section should be carried through the intersection without interruption. Minor roadways should approach the intersection at a slightly reduced elevation so the through roadwaymain highway[JM219][KM220] cross section is not disturbed. At signalized intersections, it is sometimes necessary to remove part of the crown in order to avoid an undesirable hump in one roadway.

Intersections of grade or cross slope should be gently rounded to improve vehicle operation. Pavement generally should be sloped toward the intersection corners to provide superelevation for turning maneuvers and to promote proper drainage.

Where islands are used for channelization, the width of traffictravel[JM221] lanes for turning movements shall be no less than the widths recommended by AASHTO.

C.9.e.3 Median Openings

Median openings should be restricted in accordance with the requirements presented in C.8 Access Control, this chapter. Where a median opening is required, the length of the opening shall be no less than 40 feet. Median curbs should be terminated gradually without the exposure of abrupt curb ends. The termination requirements are given in CHAPTER 4 - ROADSIDE DESIGN.

C.9.e.4 Channelization

Channelization of at grade intersections is the regulation or separation of conflicting movements into definite travel paths by islands, markings, or other means, to promote safe, orderly traffic flow. The major objective of channelization is to clearly define the appropriate paths of travel and thus assist in the prevention of vehicles deviating excessively or making wrong maneuvers. Channelization may be used effectively to define the proper path for exits, entrances, and intersection turning movements. The methods used for channelization should be as simple as possible and consistent in nature. The channelized intersection should appear open and natural to the approaching driver. Channelization should be informative rather than restrictive in nature.

The use of low slopingeasily mounted[JM222] curbs and flush medians and islands can provide adequate delineation in most cases. Islands should be clearly visible and, in general, should not be smaller than 100 square feet in area. The use of small and/or numerous islands should be avoided.

Pavement markings are a useful and effective tool for providing delineation and channelization in an informative rather than restrictive fashion. The layout of all traffic control devices should be closely coordinated with the design of all channelization.

C.9.f Driveways[JM223][KM224]

Direct driveway access within the area of influence of the intersection should be discouraged.

Driveways from major traffic generators (greater than 400 vpd), or those with significant truck/bus traffic, should be designed as normal intersections.

C.9.g Interchanges

The design of interchanges for the intersection of a freeway with a major street or highway[JM225], collector/distributor road, or other freeway is a complex problem. The location and spacing of intersections should follow the requirements presented in C.8 Access Control, this chapter. The design of interchanges shall follow the general intersection requirements for deceleration, acceleration, merging maneuvers, turning roadways, and sight distance.

Interchanges, particularly along a given freeway, should be reasonably consistent in their design. A basic principle in the design should be to develop simple open interchanges that are easily traversed and understandable to the driver. Complex interchanges with a profusion of possible travel paths are confusing and hazardous to the motorist and are generally inefficient.

Intersections with minor streets or highways[JM226] or collector/distributor roads may be accomplished by simple diamond interchanges. The intersection of exit and entrance ramps[JM227] with the crossroad shall meet all intersection requirements.

The design of freeway exits should conform to the general configurations given in Table 3 - 220. Exits should be on the right and should be placed on horizontal curves. Where deceleration on an exit loop is required, the deceleration alignment should be designed so the driver receives adequate warning of the approaching increase in curvature. This is best accomplished by gradually increasing the curvature and the resulting centrifugal force. This increasing centrifugal force provides warning to the driver that he must slow down. A clear view of the exit loop should also be provided. The length of deceleration shall be no less than the values shown in Table 3 - 220.

Entrances to freeways should be designed in accordance with the general configurations shown below Table 3 - 2119. Special care should be taken to ensure vehicles entering from loops are not directed across through travel lanes. The entering roadway should be brought parallel (or nearly so) to the through lanes before entry is permitted. Where acceleration is required, the distances shown in Table 3 - 2119 shall, as a minimum, be provided. Exits and entrances to all high-speed facilities (design speed greater than 50 mph), should, where feasible, be designed in accordance with Tables 3 - 220 and 3 - 2119. The lengths obtained from Tables 3 - 220 and 3 - 2119 should be adjusted for grade by using the ratios in Table 3 - 2018.

The selection of the type and exact design details of a particular interchange requires considerable study and thought. The guidelines and design details given in ***AASHTO "A Policy on Geometric Design of Highways and Streets" - 201101***, should generally be considered as minimum criteria.

C.9.h Clear Zone

The provisions of ample clear zone or proper redirection of energy absorbing devices is particularly important at intersections. Every effort should be made to open up the area around the intersection to provide adequate clear zone for vehicles that have left the traveled way. Drivers frequently leave the proper travel path due to unsuccessful turning maneuvers or due to the necessity for emergency avoidance maneuvers. Vehicles also leave the roadway after intersection collisions and roadside objects should be removed to reduce the probability of second impacts. The roadside areas at all intersections and interchanges should be contoured to provide shallow slopes and gentle changes in grade.

The roadside clear zone of intersecting roadways should be carried throughout intersections with no discontinuities or interruptions. Poles and support structures for lights, signs, and signals should not be placed in medians or within the roadside clear zone.

The design of guardrails or other barriers should receive particular attention at intersections. Impact attenuators should be used in all gore and other areas where structures cannot be removed.

Particular attention should be given to the protection of pedestrians in intersection areas - CHAPTER 8 - PEDESTRIAN FACILITIES. Further criteria and requirements for clear zone and protection devices at intersections are given in CHAPTER 4 - ROADSIDE DESIGN.

C.10 Other Design Factors

C.10.a Pedestrian Facilities

The layout and design of the street and highway[JM228] network should include provisions for pedestrian traffic in urban areas. All pedestrian crossings and pathways within the roadhighway[JM229] right of way should be considered and designed as in integral part of any street or urban highway.

C.10.a.1 Policy and Objectives - New Facilities

The planning and design of new streets and highways shall include provisions for the safe, orderly movement of pedestrian traffic. Provisions for pedestrian traffic outside of the roadhighway[JM230] right of way should be considered.

The overall objective is to provide a safe, secure, continuous, convenient, and comfortable trip continuity and access environment for pedestrian traffic.

C.10.a.2 Accessibility Requirements

Pedestrian facilities, such as walkways and sidewalks, shall be designed to accommodate physically disabled persons whose mobility is dependent on wheelchairs and other devices. In addition to the design criteria provided in this chapter, the ***2006 Americans with Disabilities Act Standards for Transportation Facilities*** as required by 49 C.F.R 37.41 or 37.43 and the ***2012 Florida Accessibility Code for Building Construction*** as required by 61G20-4.002 impose additional requirements for the design and construction of pedestrian facilities.

C.10.a.3 Sidewalks

Sidewalks should provide a safe, comfortable space for pedestrians. The width of sidewalks is dependent upon the roadside environment, volume of pedestrians, and the presence of businesses, schools, parks, and other pedestrian attractors. The minimum width for sidewalks is covered in CHAPTER 8 – PEDESTRIAN FACILTIES and Section C.7.d of this chapter. To ensure compliance with federal and state accessibility requirements:, sidewalk design shall meet the following criteria:

Minimum clear width	-	36 inches[1, 2] [JM231][KM232]
Maximum cross slope	-	2.0%
Maximum slope		1:20[3]

- 1 Sidewalks less than 60 inches wide must have passing spaces of at least 60 inches by 60 inches, at intervals not to exceed 200 feet.
- 2 The minimum clear width may be reduced to 32 inches for a short distance. This distance must be less than 24 inches long, and separated by 5-foot long sections with 4836 inches of clear width.
- 3 Sidewalks not constrained within the roadway right of way with slopes greater than 1:20 are considered ramps and must be designed as such.

Sidewalks 5 feet wide or wider will provide for two adults to walk comfortably side by side.

C.10.a.4 Curb Ramps

In areas with sidewalks, curb ramps must be incorporated at locations where crosswalks adjoin the sidewalks. The basic curb ramp type and design application depends on the geometric characteristics of the intersection or other crossing location.

Typical curb ramp width shall be a minimum of 43 feet with 1:102 curb transitions on each side when pedestrians must walk across the ramp[KM233][KM234][KM235]. Ramp slopes shall not exceed 1:102 and shall have a firm, stable, slip resistant surface texture. Ramp widths equal to crosswalk widths are encouraged.

Curb ramps at marked crossings shall be wholly contained within the crosswalk markings excluding any flared sides.

If diagonal ramps must be used, any returned curbs or other well-defined edges shall be parallel to the pedestrian flow. The bottom of diagonal curb ramps shall have 48-inch minimum clear space within the crosswalk[KM236][KM237]. Curb ramps whose sides have returned curbs provide useful directional cues where they are aligned with the pedestrian street crossing and are protected from cross travel by landscaping or street, street furniture, or railings.If diagonal curb ramps have flared sides, they shall also have at least a 24-inch long segment of straight curb located on each side of the curb ramp and within the marked crossing.

It is important for to visually impaired persons using the sidewalk that the location of the ramps be as uniform as possible. Detectable warnings are required at all curb ramps and flush transitions where sidewalks or shared use paths meet a roadway. A contrasting surface texture should be used. On sections without curb and gutter, a contrasting surface texture should be used on the approach to crosswalks.

The Department's ***Design Standards, Index 304***, provides additional information on the design of accessible sidewalks and shared use paths.which addresses the design of curb ramps, may be considered. Designers should keep in mind there are many variables involved, possibly -requiringmaking each street intersection to have a unique designspecial problem. For this reason, standard guidelines will not fit all situations and cannot replace the need for the use of sound engineering judgment in the design of curb ramps.

Two ramps per corner are preferred to minimize the problems with entry angle and to decrease the delay to people in wheel chairs or visually impaired pedestrians entering and exiting the roadway.

C.10.a.5 Additional Considerations

For additional information on pedestrian facilities design, including physical separation from the roadway, over- and underpasses, pedestrian crossings, traffic control, sight distance and lighting, refer to CHAPTER 8 – PEDESTRIAN FACILITIES.

C.10.b Bicycle Facilities

Provisions for bicycle traffic should be incorporated into the street ororiginal highway [JM238]design. All new roadways and major corridor[JM239] improvements, except limited access highways, should be designed and constructed under the assumption they will be used by bicyclists. Roadway conditions should be favorable for bicycling. This includes appropriate safe drainage grates, pavement markings, and railroad crossings, smooth pavements, and signals responsive to bicycles. In addition, facilities such as bicycle lanes, bicycle routes, shared use paths, and paved shoulder improvements[JM240], should be included to the fullest extent feasible. All flush shoulderrural arterial and collector roadwayssections should be given consideration for the construction of 4-foot or 5-foot paved shoulders. In addition, all curb and gutterurban arterial and collector sections should be given consideration for designated 4-foot bicycleke lanes.

For additional information on bicycle facilities design and the design of shared use paths, refer to CHAPTER 9 – BICYCLE FACILITIES.

C.10.c Bridge Design Loadings

The minimum design loading for all new and reconstructed bridges shall be in accordance with CHAPTER 17 – BRIDGES AND OTHER STRUCTURES.

C.10.d Dead End Streets and Cul-de-Ssacs[JM241]

The end of a dead end street should permit travel return with a turn around area, considering backing movements, which will accommodate single truck or transit vehicles without encroachment upon private property. Recommended treatment for dead end streets and cul-de-sacs is given in Figure 5-1 Types of Cul-de-Sacs and Dead-End Streets Exhibit 5-8 of ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 201101***[KM242].

C.10.e Bus Benches and Transit Shelters

Due to the length of exposure and discomfort from traffic, Bbus benches should be set back at least 10 feet from the travel lane[JM243] in curbed sections with a design speed of 45 mph or less, and outside the clear zone (Table 3 - 153) in flush shouldernon curbed sections.

Any bus bench or transit shelter located adjacent to a sidewalk within the right of way of any street or highwayroad on the State Highway or County Road System shall be located so as to leave at least 4836[KM244] inches of clearance for pedestrians and persons in wheelchairs. An additional one foot of clearance is required when any side of of the sidewalk is adjacent to a curb or barrier. Such clearance shall be measured in a direction perpendicular to the centerline of the road. A separate bench pad or sidewalk flareout that provides a 30 inch wide by 48 inch deep wheelchair space adjacent to the bench shall be provided. Transit shelters should be set back, rather than eliminated during roadway widening.

AdditonalAdditional information on the design of transit facilities is found in CHAPTER 13 – PUBLIC TRANSIT and ***Rule Chapter 14-20.003, Florida Administrative Code*** and ***Rule Chapter 14-20.0032, .F.A.C***.

C.10.f Traffic Calming

Often there are community concerns with controlling travel speeds impacting the safety of a street or highwaycorridor[JM245] such as in areas of concentrated pedestrian activities, those with narrow right of way, areas with numerous access points, on street parking, and other similar concerns. Local authorities may elect to use traffic calming design features that could include, but not be limited to, the installation of speed humps, speed tables, chicanes, or other pavement undulations. Roundabouts are also another method of dealing with this issue at intersections. For additional details and traffic calming treatments, refer to CHAPTER 15 – TRAFFIC CALMING.

C.11 Reconstruction

C.11.a Introduction

The reconstruction (improvement or upgrading) of existing facilities may generate equal or greater safety benefits than similar expenditures for the construction of new streets and highways. Modifications to increase capacity should be evaluated for the potential effect on the highway safety characteristics. The long-range objectives should be to bring the existing network into compliance with current standards.

C.11.b Evaluation of Streets and Highways

The evaluation of the safety characteristics of streets and highways should be directed towards the identification of undesirable features on the existing system. Particular effort should be exerted to identify the location and nature of features with a high crash potential. Methods for identifying and evaluating hazards include the following:

- Identification of any geometric design feature not in compliance with minimum or desirable standards. This could be accomplished through a systematic survey and evaluation of existing facilities.
- Review of conflict points along a corridor[JM246].
- Information from maintenance or other personnel.
- Review of crash reports and traffic counts to identify locations with a large number of crashes or a high crash rate.
- Review for expected pedestrian and bicycle needs.

C.11.c Priorities

A large percentage of street and highway[JM247] reconstruction and improvements is directed toward increasing efficiency and capacity. The program of reconstruction should be based, to a large extent, upon priorities for the improvement of safety characteristics.

The priorities for safety improvements should be based on the objective of obtaining the maximum reduction in crash potential for a given expenditure of funds. Elimination of conditions that may result in serious or fatal crashes should receive the highest priority in the schedule for reconstruction.

Specific high priority problem areas that should be corrected by reconstruction include the following:

- Obstructions to sight distance which can be economically corrected. The removal of buildings, parked vehicles, vegetation, large poles or groups of poles that significantly reduce the field of vision, and signs to improve sight distance on curves and particularly at intersections, can be of immense benefit in reducing crashes. The purchase of required line of sight easements is often a wise expenditure of highway funds. The establishment of sight distance setback lines is encouraged.
- Roadside and median hazards which can often be removed or relocated farther from the traveled way. Where removal is not feasible, objects should be shielded by redirection or energy absorbing devices. The reduction of the roadside hazard problem generally provides a good return on the safety dollar. Details and priorities for roadside hazard reduction, which are presented in CHAPTER 4 - ROADSIDE DESIGN, should be incorporated into the overall priorities of the reconstruction program.
- Poor pavement surfaces which have become hazardous should be maintained or reconstructed in accordance with the design criteria set forth in CHAPTER 5 - PAVEMENT DESIGN AND CONSTRUCTION, and CHAPTER 10 – MAINTENANCE AND RESURFACING.
- Specific design features which could be applied during reconstruction to enhance the operations and safety characteristics of a roadway include the following:
    - Addition of roadway lighting.

- ~~The provision of f~~Frontage roads. ~~of other alternate paths~~[JM248]. ~~This~~ may be utilized to improve the efficiency and safety of streets and highways with poor control of access.
- Widening of pavements and shoulders. This is often an economically feasible method of increasing capacity and reducing traffic hazards. Provision of median barriers (CHAPTER 4 - ROADSIDE DESIGN) can also produce significant safety benefits.
- The removal, streamlining, or modification of drainage structures.
- Alignment modifications are usually extensive and require extensive reconstruction of the roadway. Removal of isolated sharp curves is a reasonable and logical step in alignment modification. If major realignment is to be undertaken, every effort should be made to bring the entire facility into compliance with the requirements for new construction.
- The use of traffic control devices. This is generally an inexpensive method of alleviating certain highway defects.
- Median opening modifications.
- Addition of median, channelized islands, and mid-block pedestrian crossings.
- Auxiliary lanes.
- Existing bridges that fail to meet current design standards which are available to bicycle traffic, should be retrofitted on an interim basis as follows: As a general practice, bridges 125 feet in length or longer, bridges with unusual sight problem, steep gradients (which require the cyclist longer time to clear the span) or other unusual conditions should display the standard W11-1 caution sign with an added sign "On Bridge" at either end of the structure. Special care should be given to the right most portion of the roadway, where bicyclists are expected to travel, assuring smoothness, pavement uniformity, and freedom from longitudinal joints, and to ensure cleanliness. Failure to do so forces bicyclists farther into the center portion of the bridge, reducing traffic flow and safety.
- Addition of bicycle facilities.~~ke accommodations designated or undesignated.~~[JM249]

- Addition of transit facilities, sidewalks, crosswalks, and other pedestrian features.

C.12 Design Exceptions

See CHAPTER 14 - DESIGN EXCEPTIONS for the process to use when the standard criteria found in this Manual cannot be met.

C.13 Very Low-Volume Local Roads (ADT ≤ 400)

Where criteria is not specifically provided in this section, the design guidelines presented in Chapter 4 of the ***AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400), 1st Edition (2001)*** may be used in lieu of the policies in Chapter 5 of the AASHTO Policy on Geometric Design of Highways and Streets. See Table 3-10 for lane widths for very low volume roads.

C.13.a Bridge Width

Bridges are considered functionally obsolete when the combination of ADT and bridge width is used in the National Bridge Inventory Item 68 for Deck Geometry to give a rating of 3 or less. To accommodate future traffic and prevent new bridges from being classified as functionally obsolete, the minimum roadway width for new two lane bridges on very low--volume roads with 20 year ADT between 100 and 400 vehicles/day shall be a minimum of 22 feet. If the entire roadway width (traveled way plus shoulders) is paved to a width greater than 22 feet, the bridge width should be equal to the total roadway width. If significant ADT increases are projected beyond twenty years, a bridge width of 28 feet should be considered. One-lane bridges may be provided on single-lane roads and on two-lane roads with ADT less than 100 vehicles/day where a one-lane bridge can operate effectively. The roadway width of a one-lane bridge shall be 15 ft. One-lane bridges should have pull-offs visible from opposite ends of the bridge where drivers can wait for traffic on the bridge to clear.

C.13.b Roadside Design

Bridge traffic barriers on very low-–volume roads must have been successfully crash tested to a Test Level 2 (minimum) in accordance with NCHRP Report 350 or Manual for Assessing Safety Hardware (MASH).

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Proposed Revisions for 2016 Greenbook

Chapter 7 – Rail-Highway Grade Crossings

CHAPTER 7

RAIL-HIGHWAY GRADE CROSSINGS

TABLES

FIGURES

CHAPTER 7

RAIL-HIGHWAY GRADE CROSSINGS

A INTRODUCTION

The basic design for grade crossings should be similar to that given for highway intersections in ***Chapter 3***HAPTER 3 -– ***Geometric Design***EOMETRIC DESIGN. Rail-highway grade crossings should be limited in number and should, where feasible, be accomplished by grade separations. Where at-grade crossings are necessary, adequate traffic control devices and proper crossing design are required to limit the probability of crashes.

B OBJECTIVE AND PRIORITIES

The primary objective in the design, construction, maintenance, and reconstruction of rail-highway crossings is to provide for continuous flow of traffic in a safety for both rail and roadway vehicles in a feasible and efficient manner. The achievement of this objective may be realized by utilizing the following techniques in the listed sequence of priority.

B.1 Conflict Elimination

The elimination of at grade rail-highway conflicts is the most desirable procedure for promoting safe and efficient traffic operations. This may be accomplished by the closing of a crossing or by utilizing a grade separation structure.

B.2 Hazard Reduction

The design of new at-grade crossings should consider the objective of hazard reduction. In addition, an effective program of reconstruction should be directed towards reducing crash potential at existing crossings.

The regulation of intersections between railroads and all public streets and highways in Florida is vested in the ***Florida Administrative Code, (Rule 14-5746): Railroad Safety and Clearance Standards, and Public Railroad-Highway Grade Crossings***. This rule contains minimum requirements for all new grade crossings.

The Department's rail office has other documents available that contain additional guidance for the design, reconstruction, and upgrading of existing rail-highway railroad grade crossings, and may be contacted for further information.

C B.3 RAIL-HIGHWAY GRADE CROSSING NEAR OR WITHIN PROJECT LIMITS

Federal-aid projects must be reviewed to determine if a rail-highway grade crossing is within the limits of or near the terminus of the project. If such rail-highway grade crossing exists, the project must be upgraded to meet the latest **MUTCD** requirements in accordance with ***Title 23, United States Code (U.S.C.), Chapter 1, Section 109(e)*** *and* ***23 C.F.R. 646.214(b)***.

These requirements are located in ***Chapter 8*** of the ***MUTCD***. "Near the terminus" is defined as being either of the following:

- If the project begins or ends between the crossing and the MUTCD-mandated advanced placement distance for the advanced (railroad) warning sign. See ***MUTCD, Table 2C-4 (Condition B, column "0" mph)*** for this distance.

- An intersection traffic signal within the project is linked to the crossing's flashing light signal and gate.

DC DESIGN OF RAIL-HIGHWAY GRADE CROSSINGS

The primary requirement for the geometric design of a grade crossing is that it provides adequate sight distance for the motorist vehicle operator to make an appropriate decision as to stop or proceed at the crossing.

C.1 Sight Distance

The minimum sight distance requirements for streets and highways at rail-highway grade crossings are similar to those required for highway intersections (***Chapter 3HAPTER 3 -– Geometric DesignEOMETRIC DESIGN***).

C.1.a Stopping Sight Distance

The approach roadways at all rail-highway grade crossings should consider stopping sight distance no less than the values given in ***Chapter 3, Table 3 -– 314, Stopping Sight Distances*** or ***Figure 3 - 7*** for the approach to stop signs. This distance shall be measured to a stopping point prior to gates or stop bars at the crossing, but not less than 15 feet from the nearest track. All traffic control devices shall be visible from the driver eye height of 3.50 feet.

C.1.b Sight Triangle

At grade crossings without train activated signal devices, a sight triangle should be provided.

The provision of the capability for defensive driving is an important aspect of the design of rail-highway grade crossings. An early view of an approaching train is necessary to allow the driver time to decide to stop or to proceed through the crossing.

The size of this sight triangle, which is shown in ***Figure 7 - 1 Visibility Triangle at Rail-Highway Grade Crossings***, is dependent upon the train speed limit, the highway design speed, and the highway approach grade. The minimum distance along the highway (d_H), includes the requirements for stopping sight distance, the offset distance (D) from the edge of track to the stopped position (15 feet), and the eye offset (d_e) from the front of vehicles (8 feet); (***Figure 7 - 1**, **Case A***). The required distance (d_T) along the track, given in ***Table 7 - 1**, **Sight Distance at Rail-Highway Grade Crossings***, is necessary to allow a vehicle to stop or proceed across the track safely. Where the roadway is on a grade, the lateral sight distance (d_T) along the track should be increased as noted (***Table 7 - 1***). This lateral sight distance is desirable at all crossings. In other than flat terrain it may be necessary to rely on speed control signs and devices and to predicate sight distance on a reduced speed of operation. This reduced speed should never be less than 15 mph and preferably 20 mph.

C.1.c Crossing Maneuvers

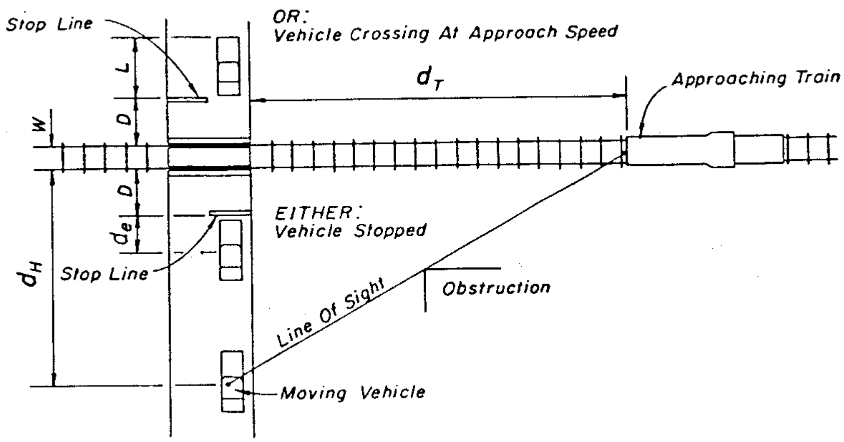
The sight distance required for a vehicle to cross a railroad from a stop is essentially the same as that required to cross a highway intersection as given in ***Chapter 3***HAPTER 3 -– ***Geometric Design***EOMETRIC DESIGN.

An adequate clear distance along the track in both directions should be provided at all crossings. This distance, when used, shall be no less than the values obtained from ***Figure 7 - 1 Visibility Triangle at Rail-Highway Grade Crossings*** and ***Table 7 - 1 (Case B), Sight Distance at Rail-Highway Grade Crossings***. Due to the greater stopping distance required for trains, this distance should be increased wherever possible.

The crossing distance to be used shall include the total width of the tracks, the length of the vehicle, and an initial vehicle offset. This offset shall be at least 10 feet back from any gates or flashing lights, but not less than 15 feet from the nearest track. The train speed used shall be equal to or greater than the established train speed limit.

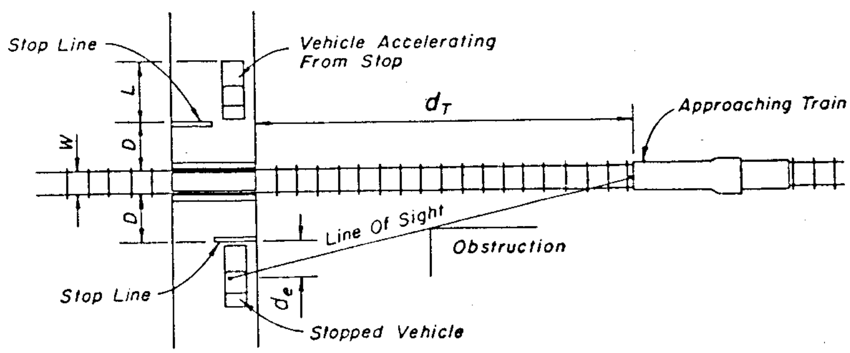
The setback for determining the required clear area for sight distance (similar to that shown in ***Figure 3 - 11***) should be at least 10 feet more than the vehicle offset. Care should be exercised to ensure signal supports and other structures at the crossing do not block the view of drivers preparing to cross the tracks.

Figure 7 – 1
Visibility Triangle at Rail~~road~~-Highway Grade Crossings[MAK1][MAK2][MAK3]



CASE A

APPROACHING VEHICLE TO SAFELY CROSS OR STOP AT RAILROAD CROSSING



CASE B

VEHICLE DEPARTING FROM STOPPED POSITION TO SAFELY CROSS RAILROAD TRACK

For d_H and d_T values and crossing conditions see Table 7-1.

[MAK4]

Table 7 – 1
Sight Distance at Rail~~road~~-Highway Grade Crossings[MAK5][MAK6]

DESIGN SIGHT DISTANCES FOR COMBINATIONS OF TRAIN AND HIGHWAY VEHICLE SPEEDS ~~CONDITIONS: SINGLE TRACK 90° CROSSING~~ ~~DESIGN VEHICLE WB-67D (L=73.3' d_e=8[KM7]')~~ ~~FLAT HIGHWAY GRADES~~ ~~NO TRAIN ACTIVATED WARNING DEVICES~~ ~~TRACK WIDTH (W) = 5'~~ ~~VEHICLE STOP POSITION (D) = 15'~~								
TRAIN SPEED (mph~~MPH~~)	CASE B VEHICLE DEPARTURE FROM STOP	CASE A MOVING VEHICLE						
	VEHICLE SPEED (mph~~MPH~~)							
	0	10	20	30	40	50	60	70
	d_t (feet~~FEET~~) SIGHT DISTANCE ALONG RAILROAD TRACK							
10	254 255	155 155	110 110	102 102	102 102	106 106	112 112	119 119
20	509 509	309 310	220 220	203 203	204 205	213 213	225 225	239 239
30	763 794 764	464 465	330 331	305 305	307 307	319 319	337 337	358 358
40	1018 1019	619 619	440 441	407 407	409 409	426 426	450 450	478 478
50	1272 1273 1274	773 774	550 551	508 509	511 511	532 532	562 562	597 597
60	1526 1528	928 929	661 661	610 610	613 614	638 639	674 675	716 717
70	1781 1783	1083 1084	771 771	712 712	716 716	745 745	787 787	836 836
80	2035 2037 2038	1237 1239	881 882	813 814	818 818	851 852	899 899	955 956
90	2289 2292	1392 1394	991 992	915 915	920 920	958 958	1012 1012	1075 1075
100	2547	1548	1102	1017	1023	1064	1124	1194
110	2802	1703	1212	1119	1125	1171	1237	1314
120	3057	1858	1322	1221	1227	1277	1349	1433

130	3311	2013	1433	1322	1329	1384	1461	1553
d_H (FEET) SIGHT DISTANCE ALONG HIGHWAY[KM8]								
		69	135	220	324	447	589	751

Continued on Next Page

Conditions: Single Track 90° Crossing
Design Vehicle WB-67 (L=73.5' d_e=8[KM9]')
Flat Highway Grades
No Train Activated Warning Devices
Track Width (W) = 5'
Vehicle Stop Position (D) = 15'

Source: Developed from TableExhibit 9-32104, A Policy on Geometric Design of Highway and Streets, AASHTO (2004) AASHTO (2011).

Notes: 1Sight) Sight distances are required in all quadrants of the crossing.

2) Corrections must be made for conditions other than shown in the table, such as, multiple rails, skewed angle crossings, ascending and descending grades, and curvature of highways and rails. For condition adjustments and additional information refer to Railroad-Highway Grade Crossings under Chapter 9 of "***A Policy on Geometric Design of Highways and Streets", AASHTO (201101)***. Additional information is available on FHWA's website for ***Highway-Rail Grade Crossing Surfaces*** and ***NCHRP Synthesis 250 Highway – Rail Grade Crossing Surfaces, TRB, (1998).*** "."

C.2 Approach Alignment

The alignment of the approach roadways is a critical factor in developing a safe grade crossing. The horizontal and vertical alignment, and particularly any combination thereof, should be as gentle as possible.

C.2.a Horizontal Alignment

The intersection of a highway and railroad should be made as near to the right angle (90 degrees) as possible. Intersection angles less than 70 degrees should be avoided. The highway approach should, if feasible, be on a tangent, because the use of a horizontal curve tends to distract the driver from a careful observation of the crossing. The use of superelevation at a crossing is normally not possible, since this would prevent the proper grade intersection with the railroad.

C.2.b Vertical Alignment

The vertical alignment of the roadway on a crossing is an important factor in safe vehicle operation. The intersection of the tracks and the roadway should constitute an even plane. All tracks should, preferably, be at the same elevation, thus allowing a smooth roadway through the crossing. Where the railroad is on a curve with superelevation, the vertical alignment of the roadway shall coincide with the grade established by the tracks.

Vertical curvature on the crossing should be avoided. This is necessary to limit vertical motion of the vehicle.

The vertical alignment of the approach roadway should be adjusted when rail elevations are raised to prevent abrupt changes in grade and entrapment of low clearance vehicles.

The roadway approach to crossing should also coincide with the grade established by the tracks. This profile grade, preferably zero, should be extended a reasonable distance (at least two times the design speed in feet) on each side of the crossing. Where vertical curves are required to approach this section, they should be as gentle as possible. The length of these vertical curves shall be of sufficient length to provide the required sight distance.

C.3 Highway Cross Section

Preserving the continuity of the highway cross section through a grade crossing is important to prevent distractions and to avoid hazards at an already dangerous location.

C.3.a Pavement

The full width of all travel lanes shall be continued through grade crossings. The crown of the pavement shall be removed transitioned gradually to meet the cross sectional grade of the tracks. This pavement cross slope transition shall be removed in conformance with the requirements for superelevation runoff. The lateral and longitudinal pavement slopes should normally be designed to direct drainage away from the tracks.

C.3.b Shoulders

All shoulders shall be carried through rail-highway grade crossings without interruption.

The use of full-width paved shoulders is required at all new crossings to maintain a stable surface for emergency maneuvers. The shoulders should be paved a minimum distance of 50 feet on each side of the crossing, measured from the outside rail. It is desirable to pave 100 feet on either side to permit bicycles to exit the travelvehicle lane, slow for their crossing, and then make an adequate search before selecting a gap for a return to the travel lane. See ***Chapter 3, Table 3-x Minimum Widths of Pavement and Shoulders for Two Lane Rural Highways*** and ***Table 3 – x Shoulder Width for Multilane Rural Divided Highways*** for further information on shoulder width.

C.3.c Medians

It is recommended that tThe full median width on a divided highways should be continued through the crossing. The median should be contoured to provide a smooth transition on the tracks.

A raised median or in the case of a flush median tThe use of signs and channelizing devicesroadside delineation is recommended to discourage driving around lowered automatic gatesuse of a flushthe median or pavement to cross the tracks[MAK10][MAK11]. (Photo?) Signals and automatic gate assemblies should be installed in the median only when gate arms of 3638 feet will not adequately span the approach roadway.

C.3.d Sidewalks and Shared Use Paths

To provide an accessible route for pedestrians at grade railroad-highway crossings, new or existing sidewalks and shared use paths shall be continued across the rail crossings. The surface of the crossing shall be:

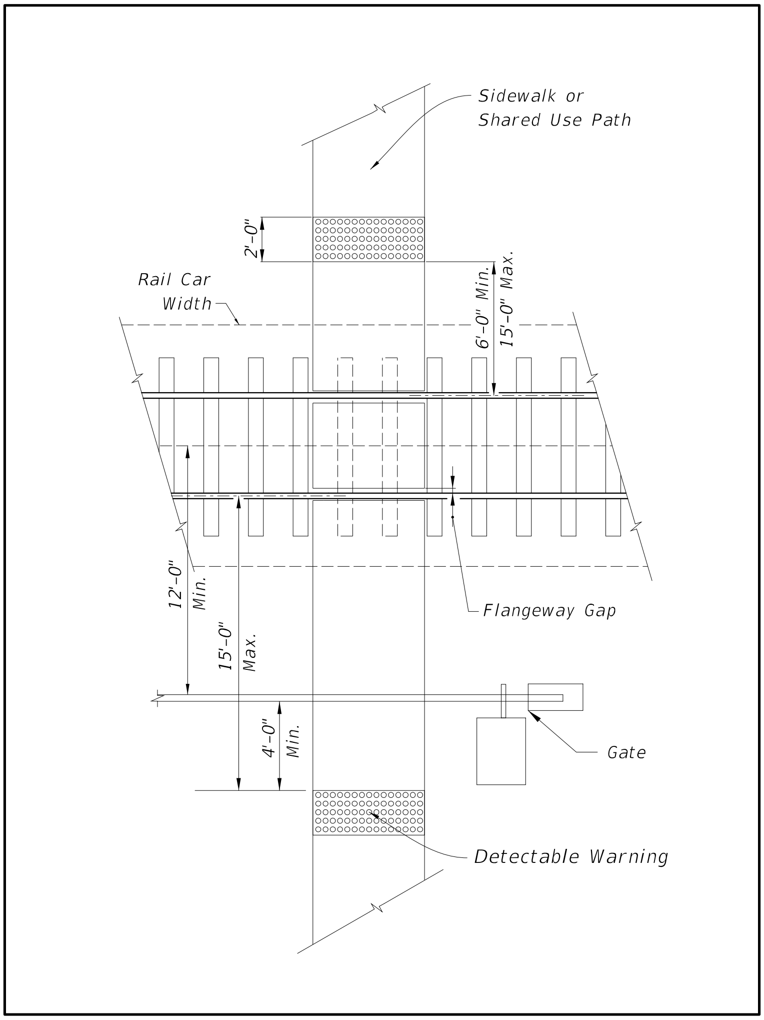
- firm, stable and slip resistant,
- level and flush with the top of rail at the outer edges of the rails, and
- area between the rails align with the top of rail.

Detectable warnings shall be placed on each side of the rail crossing, extend 2.0 feet in the direction of pedestrian travel and the full width across the sidewalk or shared use path, as shown in ***Figure 7 – 2 Pedestrian Crossings.***

The edge of the detectable warning nearest the rail crossing shall be 6.0 to 15.0 feet from the centerline of the nearest rail. Where pedestrian gates are provided, detectable warnings shall be placed a minimum~~.~~ of 4.0 feet from the side of the gates opposite the rail, and within 15.0 feet of the centerline of the nearest rail.

If traffic control signals are in operation at a crossing that is used by pedestrians or bicyclists, an audible device such as a bell shall also be provided and operated in conjunction with the traffic control signals. See *MUTCD, Chapters 8B and 8C* for further information and to determine if additional signals, signs, or pedestrian gates should be included. See ***MUTCD, Chapter 8D*** for additional information on designing crossings for shared use paths.

Figure 7 - 2 Pedestrian Crossings[KM12]



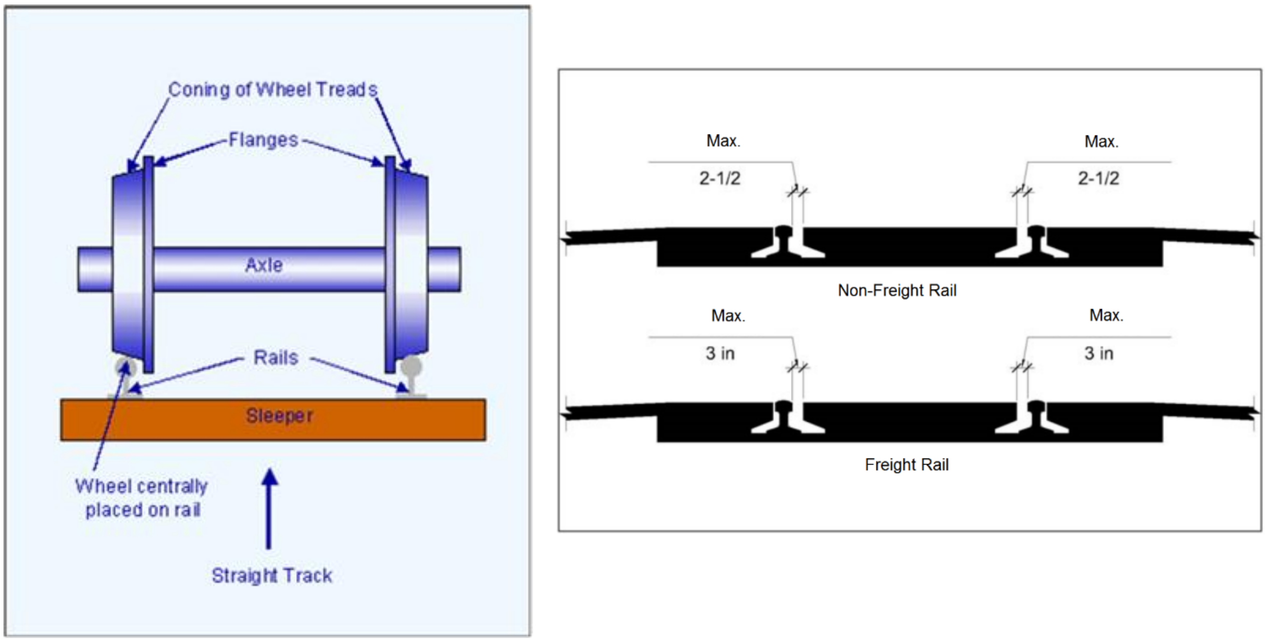
Notes: Pedestrian gates may be installed on the outside of the sidewalk/shared use path or in the utility strip.

Flangeway gaps are necessary to allow the passage of train wheel flanges; however, they pose a potential hazard to pedestrians who use wheelchairs because the gaps can entrap the wheelchair casters. Flangeway gaps at pedestrian at-grade rail crossings shall be 2 ½" maximum on non-freight rail track and 3" maximum on freight rail track.

Figure 7 - 3 Flangeways and Flangeway Gaps illustrates where the flanges are located on the wheel, how they interact with the rails, and the

maximum gap allowed.

Figure 7 - 3 Flangeways and Flangeway Gaps



See ***Chapter 8 – Pedestrian Facilities*** and ***Chapter 9 – Bicycle Facilities*** for further information on designing sidewalks and shared use paths. The ***2006 Americans with Disabilities Act – Standards for Transportation Facilities*** and the ***2012 Florida Accessibility Code*** impose additional requirements for the design and construction of pedestrian facilities.

C.3.ed Roadside Clear Zone

Although it is often not practical to maintain the full width of the roadside clear zone, the maximum clear area feasible should be provided. This clear zone shall conform to the requirements for slope and change in grade for roadside clear zones.

C.3.fe Auxiliary Lanes

Auxiliary lanes are permitted but not encouraged at signalized rail-highway grade crossings that have a large volume of bus or truck traffic required to stop at all times. These additional lanes should be restricted for the use of these stopping vehicles. The approaches to these auxiliary lanes shall be designed as storage for deceleration lanes. The exits shall be designed as acceleration lanes.

C.4 Roadside Design

The general requirements for roadside design given in ***Chapter 3 - Geometric Design*** and ***Chapter 4 – Roadside Design***, should be followed at rail-highway grade crossings. Supports for traffic control devices may be required within the roadside recovery area. Due to the structural requirements and the necessity for continuous operation, the use of a breakaway design is not recommended. The use of a guardrail or other longitudinal barrier is also not recommended, because an out of control vehicle would tend to be directed into the crossing.

In order to reduce the hazard to errant vehicles, all support structures should be placed as far from the traveled way as practicable.

C.5 Vertical Clearance

Minimum vertical clearances for grade separated rail-highway crossings are shown in ***Table 7–2 Minimum Vertical Clearances for New Bridges***. Minimum vertical clearance is the least distance between the bottom of the superstructure and the top of the highest rail utilized anywhere within the horizontal clearance zone.

Table 7 - 2 Minimum Vertical Clearances for New Bridges

Facility Type	Clearance
Railroad over Roadway	16'-6"
Roadway over Railroad[1]	23'-6"
Pedestrian over Railroad[1]	23'-6"

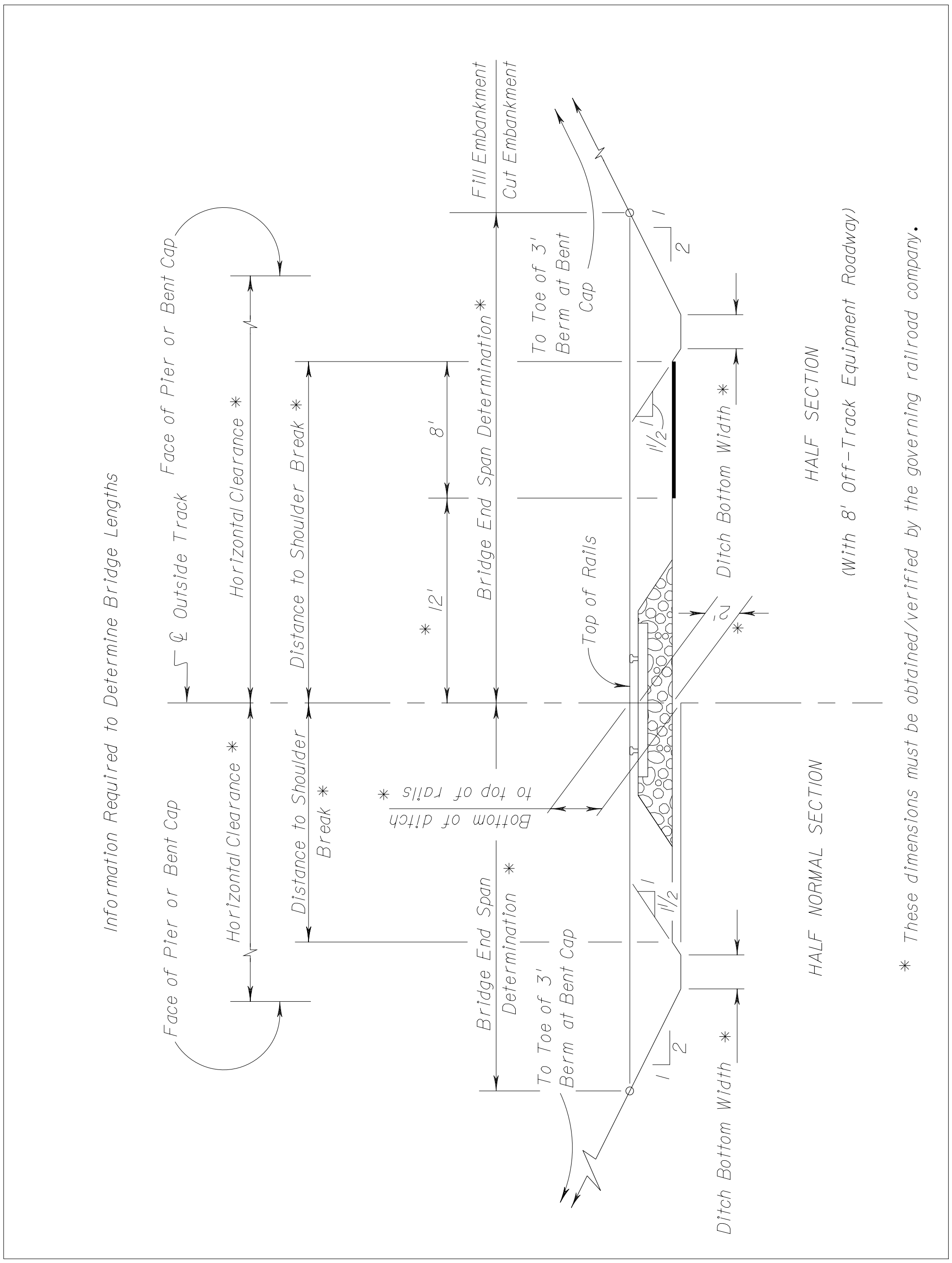
1. Over High Speed Rail Systems, see the latest version of ***American Railway Engineering and Maintenance-of-Way Association (AREMA***) guidelines, or the design office of the high-speed rail line of interest for specific guidelines and specifications. Over Electrified Railroad, the minimum vertical clearance shall be 24 feet 3 inches. (See ***Department Topic No. 000-725-003: South Florida Rail Corridor Clearance***.)

For any construction affecting existing bridge clearances (e.g., bridge widenings or resurfacing) vertical clearances less than 16'-0" shall be maintained or increased. If reducing the design vertical bridge clearance to a value between 16'-0" and 16'-2", the design vertical clearance dimension in the plans shall be stated as a minimum.

C.6 Horizontal Clearance

Horizontal clearances shall be measured in accordance with ***Figure 7 - 4 Track Section***. The governing railroad company occasionally may accept a waiver from normal clearance requirements if justified; i.e., for designs involving widening or replacement of existing overpasses. The Department's District Rail Coordinator[KM13] should be consulted if such action is being considered for FDOT owned rail corridors. For other rail crossings, coordinate with the owner of the rail corridor.

Figure 7 - 4 Track Section[KM14]



The minimum horizontal clearances measured from the centerline of outermost existing or proposed tracks to the face of pier cap, bent cap, or any other adjacent structure are shown in ***Table 7 - 3 Horizontal Clearances for Railroads*** but must be adjusted for certain physical features and obstructions such as track geometry and physical obstructions.

Table 7 - 3 Horizontal Clearances for Railroads

Minimum Clearance Requirements	Normal Section[1]	With 8' Required Clearance for Off-Track[2]	Temporary Falsework Opening
With Crash Walls	18 ft.	22 ft.	10 ft.
Without Crash Walls	25 ft.	25 ft.	N/A

[1] Any proposed structure over the South Florida Rail Corridor shall be designed and constructed to provide a horizontal clear span of a minimum of 100 feet but not less than 25 feet from the center line of the outermost existing or proposed tracks. (See ***Department Topic No. 000-725-003-j: South Florida Rail Corridor Clearance.***[KM15])

[2] The additional 8 ft. horizontal clearance for off-track equipment shall be provided only when specifically requested in writing by the railroad.

C.6.a Adjustments for Track Geometry

When the track is on a curve, the minimum horizontal clearance shall be increased at a rate of 1.5 inches for each degree of curvature. When the track is superelevated, clearances on the inside of the curve will be increased by 3.5 inches horizontally per inch of superelevation. For extremely short radius curves, the AREMA requirements shall be consulted to assure proper clearance.

C.6.b Adjustments for Physical Obstructions

Columns or piles should be kept out of the ditch to prevent obstruction of drainage. Horizontal clearance should be provided to avoid the need for crash walls unless extenuating circumstances dictate otherwise.

Figure 7 – 4 Track Sections shows horizontal dimensions from the centerline of track to the points of intersection of a horizontal plane at the rail elevation with the embankment slope. These criteria may be used to establish the preliminary bridge length, which normally is also the length of bridge eligible for FHWA participation; however, surrounding topography, hydraulic conditions, and economic or structural considerations may warrant a decrease or an increase of these dimensions. These dimensions must be coordinated with the governing railroad company.

The ***Department's Structures Design Guidelines, Section 2.6.7*** provide additional information on the design of structures over or adjacent to railroad and light rail tracks.

C.75 Access Control

The general criteria for access control in (***ChapterHAPTER 3 - GeometricEOMETRIC DesignESIGN***) for streets and highways should be maintained in the vicinity of rail-highway grade crossings. Private driveways should not be permitted within 150 feet, nor intersections within 300 feet, of any grade crossing. Index no. 17882, Design Standards should also be considered.

C.86 Parking

When feasible, Nno parking shall be permitted within the required clear area for the sight distance visibility triangle.

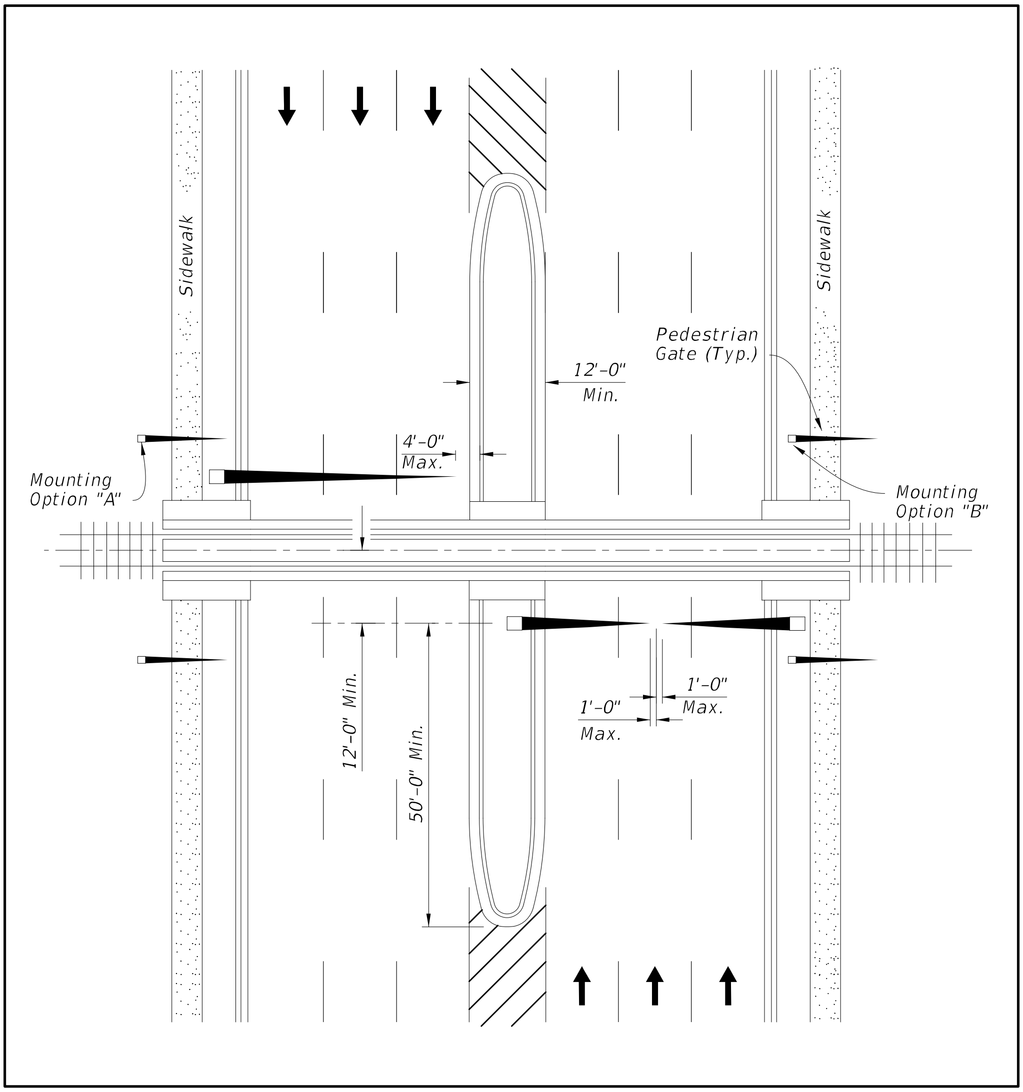
C.97 Traffic Control Devices

The proper use of adequate advance warning and traffic control devices is essential for all grade crossings. Advance warning should include pavement markings and two or more signs on each approach. Each new crossing should be equipped with train-activated flashing signals.

Automatic gGates, when used, should ideally extend across all lanes, but shall at least block one-half of the inside travel lane[MAK16][MAK17].. Traffic control devices shall be installed in agreement with the for Streets and Highways. It is desirable to include crossing arms acrossadjacent sidewalks and pedestrian orshared use paths facilities.

Traffic control devices shall meet the requirements of the MUTCD. See ***Section E*** of this chapter for additional requirements for traffic control devices in Quiet Zones. ***Figure 7 – 5 Median Signal Gates for Multilane Curbed Sections*** provides an example of gate installation when a median is present.

Figure 7 – 5 Median Signal Gates for Multilane Curbed Sections



C.108 Rail-Highway Grade Crossing Surface

Each crossing surface should be compatible with highway user requirements and railroad operations at the site. When installing a new rail-highway crossing or reworking an existing at-grade crossing, welded rail should be placed the entire width from shoulder point to shoulder point. Surfaces should be selected to be as maintenance free as possible.

C.119 Roadway Lighting

The use of roadway lighting at grade crossings should be considered to provide additional awareness to the driver. Illumination of the tracks can also be a beneficial safety aid.

C.1210 Crossing Configuration

A Rrecommended layouts for a simple grade crossings areis shown in ***Figures 7 -– -62 Grade Crossing Configuration (Passive Crossing) and 7 -– 7 Grade Crossing Configuration (Active Crossing)***2. The distance “A” in the Figures is determined by speed and shown in the ***MUTCD, Table 2C – 4. Guidelines for the Advance Placement of Warning Signs***. Although the design of each grade crossing must be "tailored" to fit the existing situation, the principles given in this section should be followed in the design of all crossings. Additional information on the design of rail-highway crossings can be found in tThe Department’s ***Design Standards, Index 17881 and 17882***, should also be considered.

FIGURE 7 – 2
GRADE CROSSING CONFIGURATION

RURAL

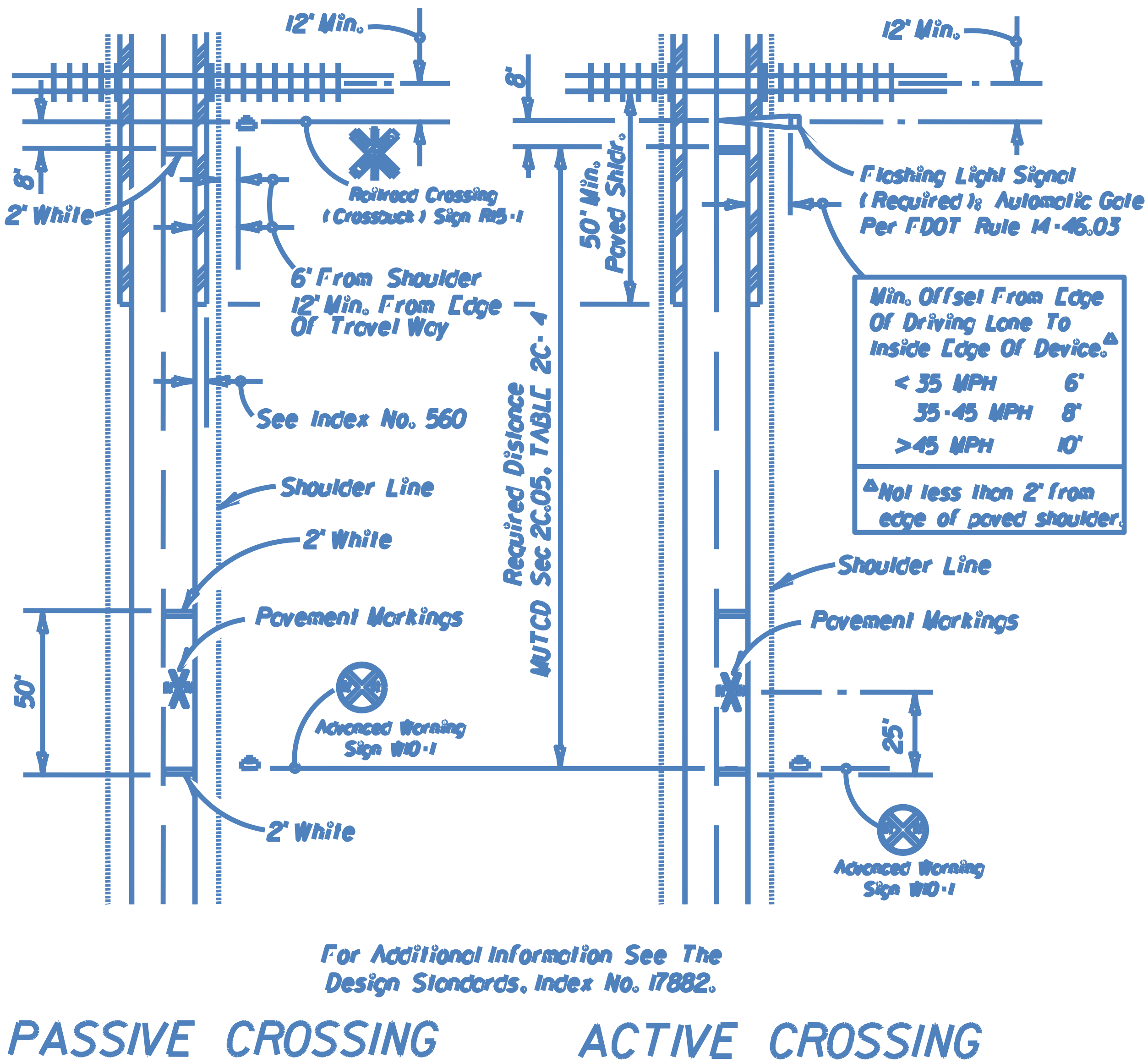


Figure 7 – 6 Grade Crossing Configuration (Passive Crossing)

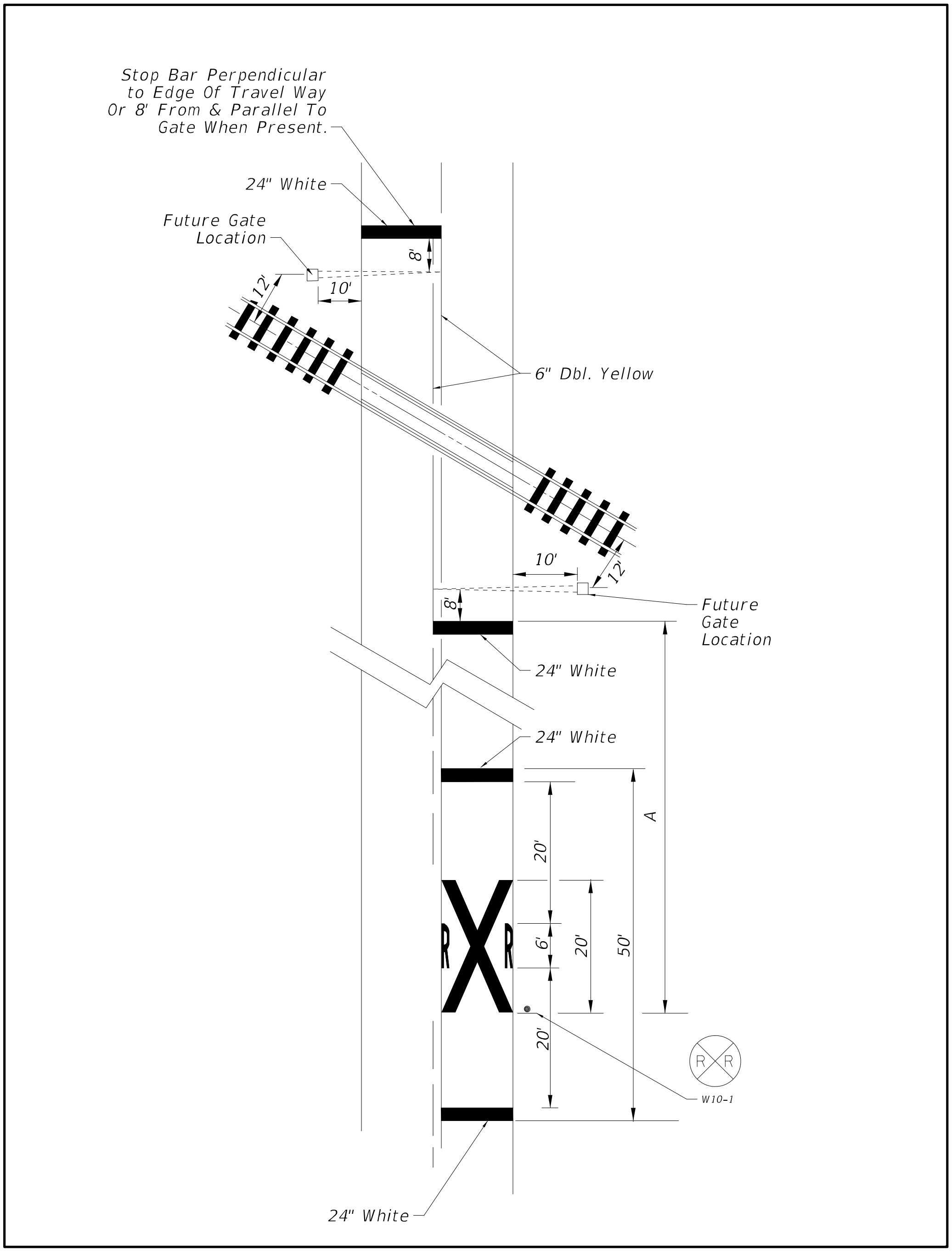
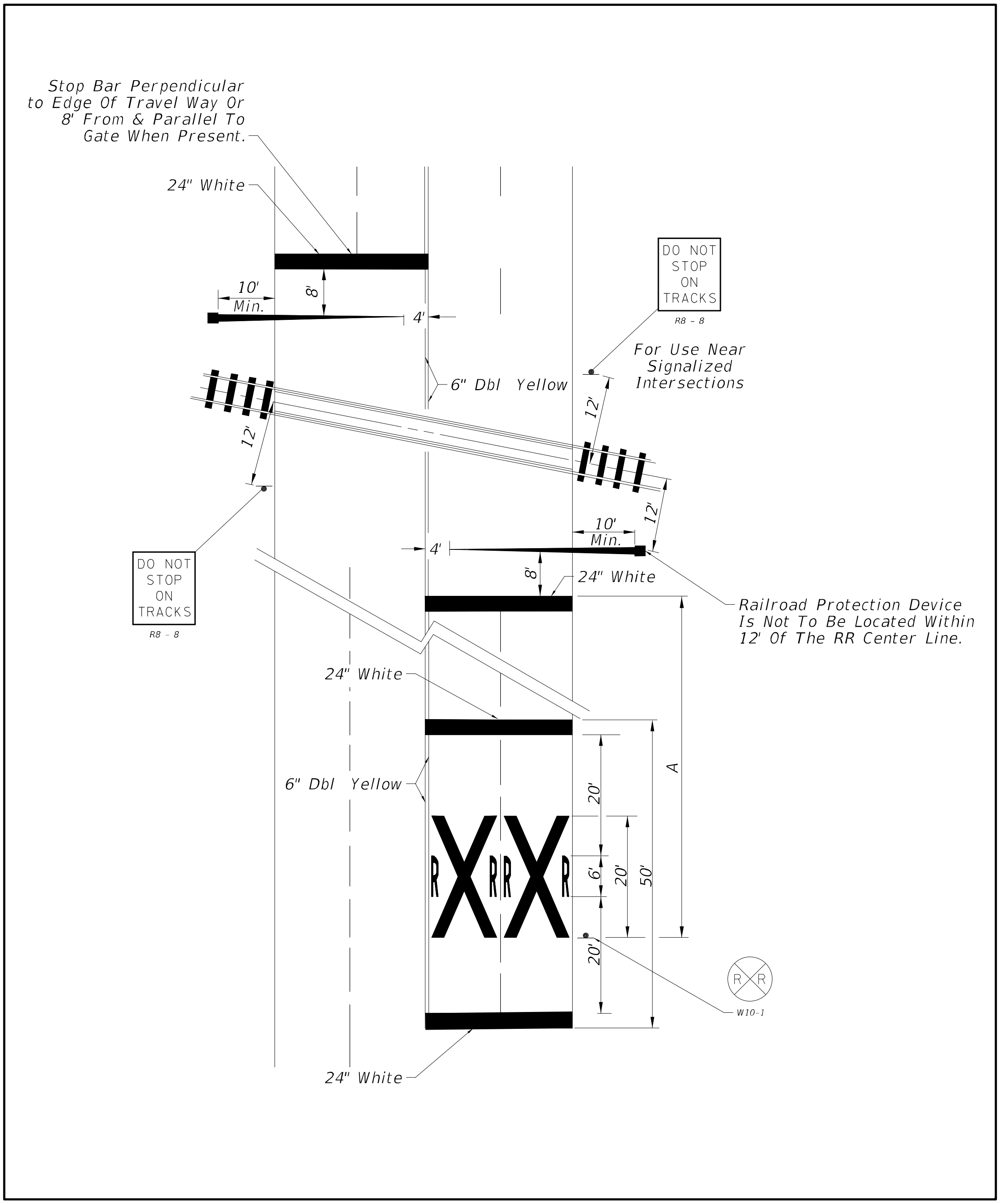


Figure 7 – 7 Grade Crossing Configuration (Active Crossing)



EC.13 QUIET ZONES

Quiet Zone means a segment of a rail line that includes public rail-highwayl crossings at which locomotive horns are not routinely sounded. The Federal Railroad Administration (FRA) has established guidelines the applying jurisdiction must follow for approval of quiet zones. Applying entities can go to the FRA's website and the ***Code of Federal Regulations (CFR), Title 49, Subtitle B, Chapter II, Part 222*** for further information on the process for approval of Quiet Zones.

Coordinate with the Department's District Rail Coordinator to determine if crossings are located within designated Quiet Zones for State owned rail corridors or crossings of state highways. State owned rail corridors include the ***Central Florida Rail Corridor*** and ***South Florida Rail Corridor***. For other rail crossings, coordinate with the local government who maintains the crossing roadway, sidewalk or shared use path to determine if the location has been approved by the FRA for a Quiet Zone.

For a crossing within a Quiet Zone that requires supplemental safety measures, approved supplemental safety measures include:

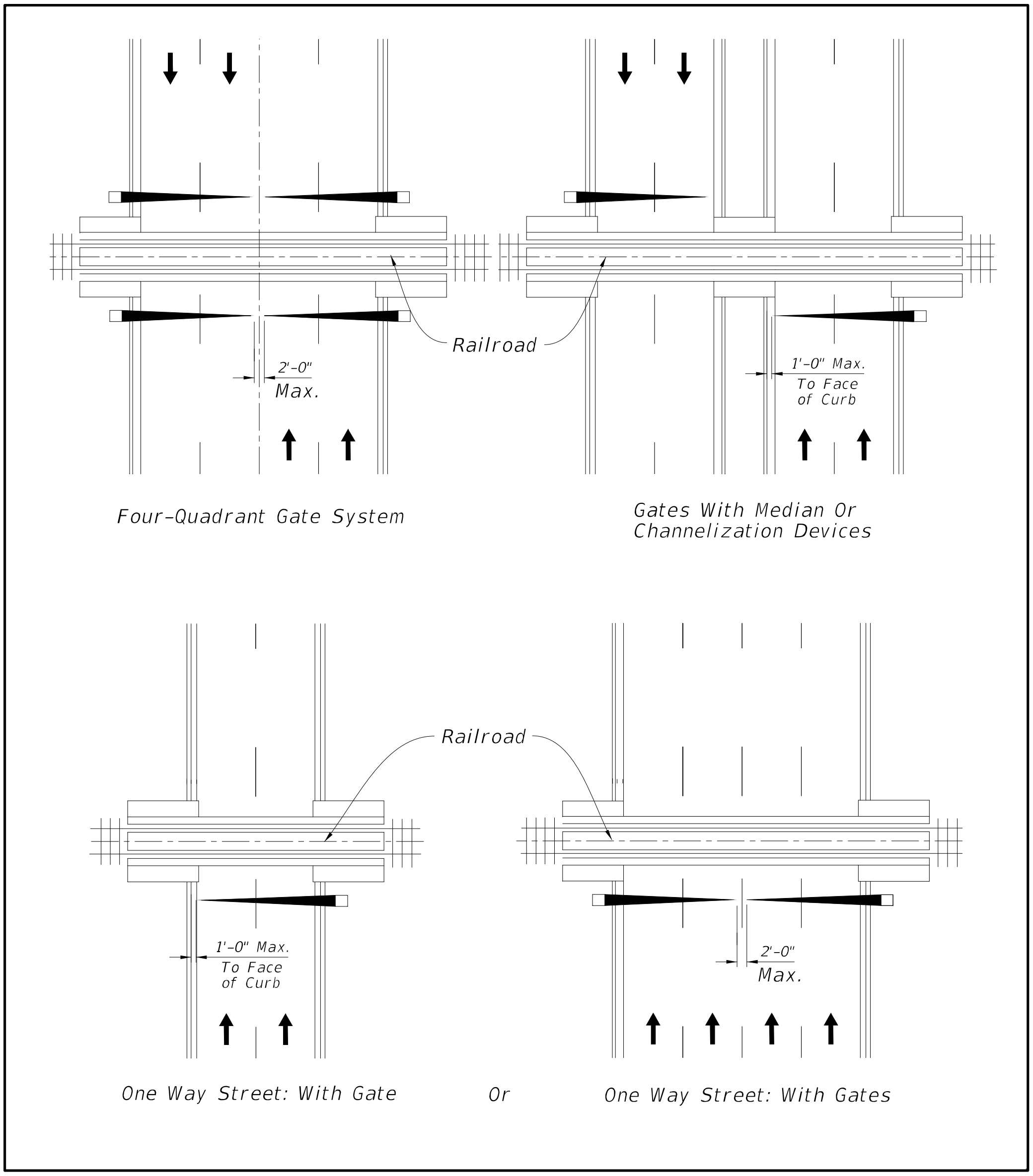
- Temporary closure of a public railroad-highway-rail grade crossing;
- Four-quadrant gate systems;
- Gates with medians or channelization devices;
- One way street with gate(s); and
- Permanent closure of a public highway-rail grade crossing.

The ***CFR, Title 49, Chapter II, Part 222, Appendix A, Approved Supplemental Safety Measures*** provides additional information on the design of Quiet Zones to meet federal approval. The ***CFR*** also requires that any traffic control device and its application where used as part of a Quiet Zone shall comply with all applicable provisions of the ***MUTCD.*** See ***MUTCD, Part 8, Traffic Control for Railroad and Light Rail Transit Grade Crossings*** for further information. Pedestrian gates, audible device, and detectable warnings are required when a sidewalk or shared use path is present or proposed.

For Quiet Zones that cross state owned rail corridors, the Department's ***Plans Preparation Manual, Volume 1, Chapter 6*** provides additional design criteria.

Figure 7 – 8 Gate Configurations for Quiet Zones illustrates the maximum gap allowed for gates at rail-highway crossings within Quiet Zones, based upon ***CFR, Title 49, Chapter II, Part 222.***

Figure 7 – 8 Gate Configuration for Quiet Zones



D HIGH SPEED RAIL

The establishment of high-speed rail service is governed by ***49 U.S. Code 26106 – High-Speed Rail Corridor Development***.

The ***High- Speed Rail (HSR) Strategic Plan*** divides potential operations into four categories or generic descriptions:

- HSR – Express. Frequent express service between major population centers 200 - 600 miles apart, with few intermediate stops. Top speeds of at least 150 mph on completely grade-separated, dedicated rights-of-way (with the possible exception of some shared track in terminal areas). Intended to relieve air and highway capacity constraints.

- HSR – Regional. Relatively frequent service between major and moderate population centers 100 - 500 miles apart, with some intermediate stops. Top speeds of 110 - 150 mph, grade-separated, with some dedicated and some shared track (using positive train control (PTC) technology). Intended to relieve highway and, to some extent, air capacity constraints.

- Emerging HSR. Developing corridors of 100 - 500 miles, with strong potential for future HSR Regional and/or Express service. Top speeds of up to 80 - 110 mph on primarily shared track (eventually using PTC technology), with advanced grade crossing protection or separation. Intended to develop the passenger rail market and provide some relief to other modes.

- Conventional Rail. Traditional intercity passenger rail services of more than 100 miles with as little as 1 to as many as 7 - 12 daily frequencies; may or may not have strong potential for future high-speed rail service. Top speeds of up to 79 mph generally on shared track. Intended to provide travel options and to develop the passenger rail market for further development in the future.

Further information on the implementation of high-speed rail service can be found on the Federal Railroad Administration's website ***High Speed Rail Overview***.

ED MAINTENANCE AND RECONSTRUCTION

The inspection and maintenance of all features of rail-highway grade crossings shall be an integral part of each highway agency's and railroad company's regular maintenance program (***ChapterHAPTER 10 -– MaintenanceAINTENANCE AndND ResurfacingESURFACING***). Items that should be given a high priority in this program include: pavement stability and skid resistance, clear sight distance, and all traffic control and protective devices.

The improvement of all substandard or hazardous conditions at existing grade crossings is extremely important and should be incorporated into the regular highway reconstruction program. The objective of this reconstruction program should be to upgrade each crossing to meet these standards. The priorities for reconstruction should be based upon the guidelines set forth by the Department.

F REFERENCES

The following is a list of publications that for further guidance:

- Federal Highway Administration Railroad-Highway Grade Crossing Handbook, Revised Second Edition, -August 2007
  http://safety.fhwa.dot.gov/xings/com_roaduser/07010/

- Code of Federal Regulations (CFR), Title 49 Transportation, Part 222, Use of Locomotive Horns at Public Highway-Rail Grade Crossings
  http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title49/49cfr222_main_02.tpl

- The Train Horn Rule and Quiet Zones
  https://www.fra.dot.gov/Page/P0104

- MUTCD, Part 8, Section 8A.07 Quiet Zone Treatments at Highway-Rail Grade Crossings
  http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part8.pdf

- The American Railway Engineering and Maintenance-of-Way Association (AREMA)
  https://www.arema.org/

- Florida Administrative Code, (Rule 14-57: Railroad Safety and Clearance Standards, and Public Railroad-Highway Grade Crossings
  https://www.flrules.org/gateway/RuleNo.asp?title=RAILROAD SAFETY AND CLEARANCE STANDARDS, AND PUBLIC RAILROAD-HIGHWAY GRADE CROSSINGS&ID=14-57.011

- Florida Department of Transportation Rail Contacts
  http://www.dot.state.fl.us/rail/contacts.shtm