1.1 ~~A~~ CONTEXT-BASED PLANNING AND DESIGN

In 1996, the Federal Highway Administration (FHWA) released guidance encouraging context-based transportation planning and design. Since then, many regional and local transportation agencies in Florida and throughout the ~~U.S.~~ United States have adopted context-based planning and design policies and practices. Context-based planning and design offers a flexible approach to using existing tools in creative ways to address multimodal needs in different contexts. The approach also considers:

- C~~c~~ommunity needs,
- T~~t~~rade-offs between those needs, and
- A~~a~~lternatives to achieve multiple objectives.

The Florida Greenbook's c~~C~~ontext-b~~B~~ased d~~D~~esign policy captures ~~three~~these core concepts:

- Serve the needs of transportation system users of all ages and abilities, including pedestrians, bicyclists, transit riders, motorists, and freight handlers.
- Design streets and highways based on local and regional land development patterns that reflect existing and future context.
- Promote safety, quality of life, and economic development.

- Give s~~S~~pecial attention ~~should be given~~ to pedestrians with varying abilities, including the elderly, children, and persons with disabilities. This is particularly important in ~~specific~~ context classifications where a higher level of pedestrian activity is expected.

- Apply c~~C~~ontext classification ~~should be applied~~ throughout the entire project development lifecycle:~~, from~~
    - P~~p~~lanning, ~~to~~
    - D~~d~~esign,
    - C~~c~~onstruction, and
    - O~~o~~peration.

~~This Context-Based approach builds on flexibility and innovation to e~~

- Ensure that all streets and highways are developed based on their context classification ~~, as determined by the local jurisdiction~~ to the maximum extent feasible. ~~With a Context-Based approach,~~

Plan and design e~~e~~very non-limited access transportation project~~,~~ (including those on the Strategic Intermodal System (SIS) or part of a residential, commercial, industrial development) ~~is uniquely planned and designed~~ to serve the context of that roadway and to promote the safety, comfort, and mobility of all users.

Wider travel lanes with paved shoulders are appropriate i~~I~~n ~~a~~ high-speed rural contexts, where higher truck ~~traffic is~~ volumes are anticipated, and walking and bicycling are infrequent~~, wider travel lanes with paved shoulders are appropriate~~. Shared use paths may also be needed as part of a regional trail system or for access to schools ~~or~~ and parks~~ may also be needed~~. Roadways i~~I~~n urban contexts~~, where~~ with higher volumes of pedestrians, bicyclists, and transit users ~~are expected or desired, a roadway~~ should include: ~~features such as~~

- W~~w~~ide sidewalks,
- B~~b~~icycle facilities,
- T~~t~~ransit stops, and
- F~~f~~requent~~,~~ pedestrian crossing opportunities.

Limited-access (LA) highways may incorporate elements of context-based design where they connect to the non-limited-access roadway system.

Holistic community p~~P~~lanning ~~for communities~~ occurs at several levels:~~, including the~~

- R~~r~~egion,
- C~~c~~ounty,
- C~~c~~ity/town,
- C~~c~~ommunity,
- B~~b~~lock, ~~and, finally,~~
- S~~s~~treet, and
- B~~b~~uilding.

~~Planning should be holistic, looking carefully at~~ Consider the relationship between land use, buildings, and transportation in an integrated fashion ~~. This approach, and the use of form based codes, can~~ to create development patterns and transportation networks that balance walking, bicycling, and transit with motor vehicle transportation.

1.2 ~~B~~ CLASSIFICATION

~~Designs for t~~Transportation design ~~projects are~~ is based on established design controls for the various elements: ~~of the project such as~~

- W~~w~~idths,
- S~~s~~ide slopes,
- H~~h~~orizontal and vertical alignments,
- D~~d~~rainage,
- A~~a~~ccessibility, and
- I~~i~~ntersection considerations.

The design ~~criteria~~ controls ~~presented in this manual~~ provided herein are based on:

- Functional Classification,
- Context Classification, and
- Design Speed.

~~A determination of t~~The local government agency with jurisdiction over a street or highway should consult with other local agencies to determine the functional and context-based design classifications~~ of each facility is determined by the local government with jurisdiction over the street or highway. There should be consultation among local governments in determining the classification. The determination is required prior to~~ before beginning the ~~actual~~ design.

1.2.1~~B.1~~ Functional Classification

Functional classification is the grouping of highways by the character of service and connectivity they provide ~~in relation to~~ within the ~~total~~ overall road network. See Table 1.2.1 ~~– 1 Functional Classification Types summarizes~~ for the primary characteristics of each functional classification.

See ***Section 334.03 F.S.*** for f~~F~~unctional road classifications ~~for~~ in Florida~~ are defined in~~

~~***Section 334.03 F.S***~~. See t~~T~~he ***AASHTO*** publication ***A Policy on Geometric Design of Highways and Streets (2011)*** ~~presents~~ for an excellent discussion of~~n~~ highway functional classifications.

Table 1.2.1~~ – 1~~ Functional Classification Types

Functional Classification	Primary Characteristics
Limited Access (LA) Facility~~ies~~	• Limited access • Through traffic movements • Primary freight routes • Guided by FHWA Design Standards for Highways (NHS)
Principal Arterial	• Through traffic movements • Longer distance traffic movements • Primary freight routes • Access to public transit • Pedestrian and bicycle travel
Minor Arterial	• Connections between local areas and network principal arterials • Connections for through traffic between arterial streets or highways • Access to public transit and through movements • Pedestrian and bicycle travel
Collector	• Carry traffic with trips ending in a specific area • Access to commercial and residential centers • Access to public transit • Pedestrian and bicycle travel
Local Road~~s~~	• Direct property access—residential and commercial • Pedestrian and bicycle travel

1.2.2~~B.2~~ Context Classification

~~Following context based design,~~ Context-based projects are planned and designed to be in harmony with the surrounding land use characteristics and the intended uses of the street or highway. ~~To this end, a~~ A context-based classification system comprising eight context classifications has been adopted for this purpose. See Figure 1.2.1~~—1 Context Classifications describes~~ for descriptions of these context classifications that will ~~determine~~ help to establish the key design criteria ~~elements~~. Criteria for ~~limited access~~ LA facilities are independent of the adjacent land uses.~~; therefore,~~ The context classifications ~~shown~~ in Figure 1.2.1~~—1~~ do not apply to ~~these~~ LA facilities.

~~For state and federal facilities and planning activities, u~~Urban and rural designations are based on population densities ~~y gathered~~ obtained from the most recent census and mapped as urban area boundaries. Urban areas ~~are considered to~~ have *dense* development patterns, while rural areas ~~are considered to~~ have *sparse* development patterns. The FDOT~~'s~~ ***Urban Area 1-Mile Buffer Maps*** identify urban and rural areas based on the census data and regional travel patterns.

Florida cities and counties may use ~~the state and federal~~ these urban and rural definitions as guidance. Local comprehensive plans ~~and other studies~~ may provide more precise context designations for urban, suburban, and rural areas.

See the FDOT ***Context Classification Document*** for a~~A~~dditional information on context classifications ~~and guidance on the determination of the context classification is provided in the FDOT~~ ~~***Context Classification Document***~~. Local governments are encouraged to apply these same definitions to local land areas off the S~~s~~tate High~~road~~way S~~s~~ystem~~.~~ ~~They may also be~~ based upon local context and analysis.

~~To meet local needs and travel demands,~~ D~~d~~eviations in design criteria may be appropriate for urban streets to meet local needs and travel demands. See Chapter 3 – Geometric Design, Chapter 8 – Pedestrian Facilities, Chapter 9 – Bicycle Facilities, Chapter 13 – Transit, Chapter 15 – Traffic Calming, Chapter 16 – Residential Street Design ~~, and Chapter 19 – Traditional Neighborhood Development provide~~ for additional information for ~~the~~ designing ~~of~~ urban streets.

Figure 1.2.1~~ – 1~~ Context Classifications

C1 – Natural

Lands preserved in a natural or wilderness condition, including lands unsuitable for settlement due to natural conditions.

C2 – Rural

Sparsely settled lands; may include agricultural land, grassland, woodland, and wetlands.

C2T – Rural Town

Small concentrations of developed areas immediately surrounded by rural and natural areas; includes many historic towns.

C3R – Suburban Residential

Mostly residential uses within large blocks and a disconnected or sparse roadway network.

Figure 1.2.1~~—1~~ Context Classifications (continued)

C3C – Suburban Commerical

Mostly non-residential uses with large building footprints and large parking lots. Buildings are within large blocks and a disconnected or sparse roadway network.

C4 – Urban General

Mix of uses set within small blocks with a well-connected roadway network. May extend long distances. The roadway network usually connects to residential neighborhoods immediately along the corridor or behind the uses fronting the roadway.

C5 – Urban Center

Mix of uses set within small blocks with a well-connected roadway network. Typically concentrated around a few blocks and identified as part of the community, town, or city of a civic or economic center.

C6 – Urban Core

Areas with the highest densities and with building heights typically greater than four floors. Many are regional centers and destinations. Buildings have mixed uses, are built up to the roadway, and are within a well-connected transportation network.

A new context classification for special districts, industrial, warehouse, or port roads should be considered when relevant

1.2.3B.3 Design Speed

See ***Chapter 3, Section C.1 Design Speed*** for information on establishing appropriate design speeds.

1.3C CONSIDERATIONS FOR DESIGN

Consider and resolve tThe following criteria below shall be considered and resolved in the initial planning and design of streets and highways. These criteria are not listed in order of priority. , and Base the weighting of each criterion should be based on the context of a the project, the available resources, and the users.

1.3.1C.1 Safety

Functional and context classification play an important role in setting expectations and measuring safety outcomes for safety. Since agencies consider the type of street or highway in evaluating the significance of crash rates, Consider these classifications in reviewing crash rates for can be used as part of evaluating relative safety and the implementingation of safety improvements and programs.

1.3.2C.2 Economic Constraints

In determining the benefit/cost ratio for any proposed facility, the economic evaluation should go Look beyond the actual expenditure of highway funds and the capacity and efficiency of the facility in determining a project's benefit/cost ratio. Overall costs and benefits of various alternatives should include an evaluation of Evaluate all known environmental, community, and social impacts and the quality and cost of the project.

Allocation of Allocate sufficient funds to properly establish for obtaining the proper corridor and the initial alignment and R/W needs for the project adequate right of way and alignment should receive the initial priority. Future alignment changes and acquisition of additional R/W right of way and major changes in alignment are often can be economically prohibitive. This can result in substandard streets and highways that don't support the community's vision. Reconstruction or modification under traffic may can be expensive, inconvenient, or and hazardous to the travelling public user. A good preliminary design minimizes future costs. This increase in costs, hazards, and inconvenience can be limited by initial development of quality facilities.

~~This~~ A good preliminary design ~~ensures that the project scope~~ defines the full scope of ~~all necessary~~ improvements and ~~that~~ ensures the budget is adequate for design, R/W acquisition ~~right-of-way~~, and construction. The proper application of context classification can significantly enhance regional and local planning. ~~By identifying and inventorying user needs and expectations,~~ Local government agencies can ~~generate~~ establish more realistic ~~long-term~~ cost estimates by identifying and inventorying user needs and expectations.

1.3.3~~C.3~~ Access Requirements

The d~~D~~egree and type of access ~~permitted~~ allowed on a given facility ~~is~~ depends ~~ent~~ upon its intended function and context. ~~and should conform to~~ Comply with the guidelines in ***Chapter 3*** ~~***– Geometric Design***~~. Exercise r~~R~~easonable access control ~~must be exercised~~ to allow a street or highway to fulfill its function. The proper layout of the highway network and ~~the utilization of~~ effective land use controls ~~can~~ should provide the basis for regulating access.

1.3.4~~C.4~~ Measures of Level of Service (LOS)

Level of service (LOS) is ~~essentially~~ a measure of the quality of the operating characteristics of a street or highway for each travel mode. Factors involved in determining the ~~level of service~~ LOS include:

- S~~s~~peed and safety, ~~as well as~~
- T~~t~~ravel time,~~;~~
- T~~t~~raffic conflicts and interruptions,~~;~~
- F~~f~~reedom to maneuver,~~;~~
- C~~c~~onvenience and comfort,~~;~~ and
- O~~o~~perating costs.

~~Level of service~~ LOS is also dependent upon ~~actual~~ traffic volumes and composition ~~of traffic~~ (motor vehicles, trucks, transit, bicyclists, and pedestrians).

See t~~T~~he ***Highway Capacity Manual, 6th Edition*** ~~provides further~~ for ~~information on~~ assessing the traffic and environmental ~~effects~~ impacts of highway projects.

1.3.5~~C.5~~ Maintenance Capabilities

Include provisions for performing future maintenance in the initial p~~P~~lanning and design of streets and highways ~~should include provisions for the performance of required maintenance~~. ~~The planning of the expected maintenance program should be coordinated with~~ Consider future maintenance needs ~~the initial highway design~~ to ensure maintenance activities ~~may~~ can be conducted without excessive impacts to highway users ~~traffic conflicts or hazards~~.

1.3.6~~C.6~~ Utility and Transit Operations

Accommodating u~~U~~tilities ~~y accommodation~~ within public R/W ~~rights of way~~ is generally ~~considered to be~~ in the public's best interest. ~~, since rights of way frequently~~ Public R/W typically offers the most practical engineering, construction, and maintenance solutions for utility services to businesses and residences. Select u~~U~~tility and transit facility locations ~~should be carefully chosen~~ to optimize operations and safety ~~of the transportation facility~~. See ***Chapter 13*** for ~~Additional information on the~~ designing ~~of~~ transit facilities ~~can be found in ***Chapter 13 – Transit***~~.

1.3.7~~C.7~~ Emergency Response

~~Development of a~~An effective emergency response program ~~is dependent upon the nature of~~ relies upon the highway network and its operations ~~the effectiveness of the operation of the system~~. Include p~~P~~rovisions for emergency access and communication ~~should be considered~~ in the initial planning and design of all streets and highways. Include l~~L~~ocal emergency response personnel ~~should be included~~ in ~~primary~~ design activities.

1.3.8~~C.8~~ Environmental Impact

The c~~C~~onstruction and operation of streets and highways ~~frequently~~ tend to ~~produces an adverse effect upon~~ negatively impact the environment. ~~Early consideration and resolution of~~ Resolve environmental concerns early ~~issues can avoid~~ to prevent costly delays and ~~modifications that may~~ compromises ~~the~~ in quality and efficiency ~~of operation~~. ~~Specific topics often encountered~~ Typical environmental concerns include ~~the following~~:

- Air Quality.
- Coastal Zone Resources.
- Farmlands.
- Floodplains.
- Hazardous Waste and Brownfields.
- Noise.
- Roadside V~~v~~egetation.
- Safe Drinking Water Act.
- Water Quality.

- Watershed~~s~~ Management.
- Wetlands.
- Wild and Scenic Rivers and Wilderness Areas.
- Wildlife and Threatened and Endangered Species.
- Wildlife, Habitat and Ecosystems.

1.3.9~~C.9~~ Community and Social Impact

The q~~Q~~uality ~~and value~~ of a community is ~~directly~~ influenced by the layout and design of its streets and highways. The q~~Q~~uality of the network ~~determines the~~ establishes freedom and efficiency of movement. Inadequate network design ~~of the network~~ and poor land use practices can lead to undesirable community division~~separation and deterioration~~. ~~Specific~~ The proper design of streets and highways ~~has a large effect upon the~~ improves its overall aesthetics~~ value which is important to the motorist and resident~~. Consider these factors w~~W~~hen using federal funds for transportation projects~~, the following considerations should be addressed~~:

- Corridor Preservation.
- Historical and Archaeological Preservation.
- Scenic Byways.
- ***Section 4 (f)*** Properties (parks, refuges, and historic sites).
- ***Section 6 (f)*** P~~p~~roperties.
- Visual Impacts.

1.4 ~~D~~ LANE REPURPOSING

~~A l~~Lane repurposing ~~project is a way to~~ reassigns roadway space to achieve other purposes~~ such as~~, e.g., safety, economic development, and mobility for all users. Use the information below ~~This section serves as a resource for local transportation agency planners and engineers~~ to analyze potential lane repurposing projects~~ and includes the potential factors to be considered prior to design and implementation~~.

~~A typical goal for l~~Lane repurposing projects typically strive to ~~is better~~ manage~~ing~~ motor vehicular traffic ~~in order~~ to make~~ the area~~ transportation corridors more amenable to ~~people who walk/bicycle or~~ pedestrians, bicyclists, and at-risk populations, ~~such as~~ e.g. children and older adults. ~~A l~~Local government agencies may want to create an exclusive lane for transit service. Early coordination with the respective transit agency is critical f~~F~~or lane repurposing projects ~~that involve facilities for~~ involving transit-related services~~, additional discussion and coordination with their respective transit agencies should take place as early as possible~~.

See t~~T~~he FDOT~~'s~~ ***Lane Repurposing Guidebook, August 2020*** ~~provides additional~~ for information and tools ~~on how to~~ for implementing lane repurposing projects~~, along with several detailed case studies~~.

1.4.1~~D.1~~ Data Needs

Significant amounts of data can be needed in e~~E~~valuating the potential success of a lane repurposing project~~application process may require significant amounts of data, depending on the nature of the project~~. ~~A lane repurposing project that has future or existing low~~ Lane repurposing on corridors with low current and future Annual Average Daily Traffic (AADT) ~~and simply~~ may only require~~s~~ pavement restriping. ~~to implement, will be~~ Such projects are less data intensive than a project which requires reconstruction of curbs, gutters, and medians. ~~Examples of~~ The types of data needed may include:

- Existing and ~~long-range~~ future AADT (the latter based on historical growth and the regional travel demand model).
- Consistency with the local government's comprehensive plan and capital improvements program, MPO's Long-Range Transportation Plan (LRTP), Transportation Improvement Program (TIP), Transit Development Plan (TDP), master plans, visions, and context-based design initiatives.
- Status of the roadway as an e~~E~~vacuation r~~R~~oute, freight route, ~~and~~or part of the Strategic Intermodal System (SIS).
- Status of the roadway as a major transit corridor per the LRTP or TDP.
- Proposed R/W use(s) ~~for the right-of-way~~ after the lanes are repurposed ~~eliminated~~ (e.g., widened sidewalks, bicycle lanes, landscaping, on-street parking, transit lanes).
- Impact on bicycle/pedestrian infrastructure and connectivity.
- Impact on parking.
- Impact on transit routes, stop locations (including appropriateness of turning radii and lane widths), ~~include~~and the total number of stops and routes in the area.
- Existing ~~right-of-way~~ R/W width and any proposed changes ~~to the right-of-way~~

in R/W width.

- Anticipated changes in jurisdictional or maintenance responsibilit ies~~y for ownership or maintenance of the roadway~~.
- Anticipated changes in functional classification, context classification, and/or access management classification.
- Public i~~I~~nvolvement, including agency outreach and endorsement.
- Existing design and posted speeds.
- Existing and future typical section.
- Target speed with anticipated changes in design or posted ~~speed limits and design~~ speeds.
- Need for D~~d~~esign V~~v~~ariations or D~~d~~esign E~~e~~xceptions.
- Plan for obtaining input ~~and review~~ from businesses, residents, and other stakeholders.
- Plan for receiving endorsement from elected officials.
- Funding source and cost estimates.
- Size of impact area~~:~~ (parallel and cross streets).
- Potential implementation strategy and partnering commitments.
- Impact on school and midblock crossing locations~~ and midblock crossing~~.
- Need to add, remove, or modify traffic signals.
- Existing and proposed near and long-~~-~~range multimodal level of service (LOS). ~~and~~
- Q~~q~~ueuing analysis for intersections and segments in the impact area.
- Mitigation to address ~~the~~ potentially significant adverse impacts on other ~~local and state~~ nearby roads and the regional transportation system.
- Crash data summary and analysis for the segment and intersections~~ in the project limit~~.
- Case-specific ~~special~~ considerations~~ to be determined~~ (e.g., railroad crossing improvements).

1.4.1.1~~D.1.a~~ Multidisciplinary Review Team

~~The~~ Use a multi-disciplinary review team with expertise in planning, environmental management, modal development, roadway design, traffic operations, construction, and maintenance to evaluate ~~ion of~~ potential lane repurposing projects ~~benefit from a multi-disciplinary review team. The team may include expertise from planning, environmental management, modal development, roadway design, traffic operations, construction, and maintenance~~.

Engage in continuous coordination with governmental bodies, emergency services, and utility providers to ~~ensure a holistic understanding and~~ addressing ~~of~~ all potential impacts and requirements throughout the project lifecycle.

1.4.1.2~~D.1.b~~ Concept Reports

Lane repurposing projects involve changes to the roadway cross section and/or restriping of existing travel lanes for either a roadway segment or an entire corridor. These changes may include: ~~design modifications such as~~

- R~~r~~educed lane widths,
- M~~m~~edian changes,
- P~~p~~edestrian refuge islands,
- A~~a~~ccess management modifications,
- B~~b~~icycle lanes,
- N~~n~~ew or wider sidewalks,
- S~~s~~hared-use paths,
- L~~l~~andscaping,
- O~~o~~n-street parking,
- T~~t~~ransit~~-~~-only lanes, or
- C~~c~~urb zones and loading/transportation network company (TNC) zones.

Evaluate t~~T~~raffic operation improvements and design enhancements such as turn lanes and improved turning radii ~~must be evaluated for all lane repurposing projects~~. ~~Additionally, these projects should consider the~~ Consider incorporating ~~on of~~ additional features to improve ~~the~~ mobility ~~or~~ and aesthetics ~~of an area, as well as~~ and to address community needs such as transit accommodations, pedestrian enhancements, on-street parking (including accessible parking), and landscaping. Lane repurposing c~~C~~oncept report~~s~~ should include a project description~~,~~ and a discussion of the proposed modifications, traffic forecasts, and safety analysis.

1.4.1.3~~D.1.c~~ Project Description

A project description is critical in ~~informing on~~ describing the current roadway conditions ~~of the roadway~~ and the proposed changes ~~to be made~~. ~~A~~ The project description should also ~~includes information as to~~ explain why a roadway should undergo lane repurposing. Include the following:

- Project purpose, ~~which~~ clearly ~~state~~ describing the purpose and goals of the proposed lane repurposing ~~project~~.
- Project location, including a map series showing the location of the project and nearby roads~~,~~ and land uses and ~~other~~ information relevant ~~information~~ to ~~aid~~ reviewers in understanding the context of the proposed project.
- Area of influence and information on how the project may impact surrounding roadways and features during and after ~~its~~ construction.
- Existing conditions, including:
    - R~~r~~oadway typical section,
    - F~~f~~unctional classification,
    - C~~c~~ontext classification (if available),
    - E~~e~~vacuation route and~~,~~ SIS designations,
    - P~~p~~osted speed limits and average speeds,
    - T~~t~~raffic data,
    - C~~c~~rash history,
    - S~~s~~ignalized intersections,
    - U~~u~~tilities,
    - L~~l~~evels of service (LOS), ~~and~~
    - A~~a~~ccess management,
    - ~~-~~T~~t~~ransit, and
    - P~~p~~arking circulation ~~plans~~.

1.4.1.4~~D.1.d~~ Proposed Modifications

~~As part of the concept report,~~ Provide a detailed ~~review~~ description of the proposed roadway modifications in the concept report ~~to the roadway that is being studied should~~

~~be provided. This conceptual design should~~ including~~e~~:

- Typical sections and intersection designs.
- Proposed changes to the design speed ~~limits~~ or posted speed limits.
- Consistency with local plans.
- Potential D~~d~~esign V~~v~~ariations or E~~e~~xceptions.

1.4.1.5~~D.1.e~~ Traffic Analysis

Lane repurposing projects ~~will~~ affect traffic conditions by ~~altering~~ removing travel lanes and lowering the capacity of the roadway ~~via removal of one or more lanes~~. The change ~~is effect~~ may impact only the study corridor ~~only~~ or it may ripple to adjacent roadways. The purpose of the project ~~will~~ influences how traffic impacts are prioritized ~~when~~ in evaluating performance. ~~Since traffic analysis can require a substantial amount of time and resources, i~~It is important to develop an analysis approach since traffic analysis can require a substantial amount of time and resources. This section describes ~~attributes of~~ Consider these components in the traffic analysis for lane repurposing projects ~~to help streamline the analysis. Components to consider include~~:

- Existing and future traffic patterns and ~~potential~~ growth ~~of traffic~~ in the study area which allows ~~for~~ a comparison between the Build and No-Build scenarios for existing and future conditions.
- Establishment of a “de minimis” (minimal impacts) level. A level of 3% of existing and projected roadway ~~segment vehicle~~ capacity is suggested.
- Size of the study area ~~under study~~ and the required level of accuracy ~~needed~~. These ~~two~~ elements ~~will~~ determine the ~~intensity~~ extent of the data collection and analysis ~~processing~~. A minimum radius of 1 mile in all directions per ~~1-~~mile ~~segment proposed for~~ of lane repurposing is recommended.
- Corridor and intersection Level of Service (LOS) a~~A~~nalysis of the Build ~~vs.~~ and No-Build ~~Alternatives~~ scenarios. ~~that provide~~ Include the user experience as a metric for how well a roadway is performing ~~. It should include~~ with a~~n~~ separate analysis for pedestrians and bicyclists~~, as well as motor vehicles~~.
- Study person throughput f~~F~~or projects that serve a transit corridor~~, person throughput should be studied~~.

- Existing and proposed truck routes, ingress, and egress to port facilities and intermodal centers, and delivery zones and loading areas.
- Effects upon adjacent neighborhoods, communities, and other jurisdictions.

- Performance mMetrics and eEvaluation: Define performance metrics and conduct post-implementation evaluations to measure the effectiveness and impacts of the lane repurposing, aiding in future planning and community engagement.

- ***ADD Language*** Performance Metrics. Six months after completion and 1 year or during peak traffic season.

1.4.1.6~~D.1.f~~ Safety Analysis

Lane repurposing projects~~, in general,~~ have been ~~demonstrated~~ shown to reduce crashes~~,~~ (including fatalities ~~by~~ for all users)~~,~~ while slowing average speeds and reducing traffic exposure. Conduct a~~A~~ 5-year crash analysis of the corridor ~~should be conducted~~. Projects are typically proposed on corridors with ~~which demonstrate some of the following characteristics related to safety~~:

- High crash numbers and rates.
- High crash locations by type.
- Rear-end crashes from left-turning vehicles.
- Left-turning vehicles stopped in the inside travel lane.
- Sideswipe and angle crashes due to lane changes.
- Pedestrian and bicycle crashes.
- Wide crossing distances for pedestrians and bicyclists.
- High differential in speeds in travel lanes.

1.4.1.7~~D.1.g~~ Public Involvement

~~Support by the local c~~ Community support is crucial to the ~~long-term~~ success of a lane repurposing project. The process ~~to~~ of building consensus for the roadway changes ~~reconfiguration of a roadway in a community~~ can involve ~~some~~ misperceptions. ~~For example, l~~ Lane repurposing projects can initially be perceived as increasing delay, but at the same time, they improve safety and accessibility for multiple users. ~~Therefore, c~~ Community engagement requires a commitment to ~~a~~ strong partnerships and the public involvement process ~~throughout the process~~. Public involvement tools may include:

- S~~s~~ocial media,
- W~~w~~eb pages,
- W~~w~~orkshops, and
- I~~i~~mplementation of small demonstration projects with ~~polling~~ before and after polling.

Implement educational and awareness campaigns to inform the community of ~~about~~ the benefits and changes brought about by lane repurposing, fostering a better understanding and acceptance of the project.

1.4.1.8~~D.1.h~~ Maintenance Plan

Develop a comprehensive maintenance plan ~~covering~~ for routine maintenance, emergency repairs, and long-term upkeep to ensure the sustainability and operational efficiency of the lane repurposing project.

1.4.1.9~~D.1.i~~ Economic Impact Analysis (Consider)

Conduct an economic impact analysis to assess the potential benefits to local businesses and economic development, fostering support from the local business community and other stakeholders.

1.4.1.10~~D.1.j~~ Cost-Benefit Analysis (Consider)

Undertake a cost-benefit analysis to evaluate the economic feasibility and long-term benefits of the lane repurposing project~~s~~, aiding in informed decision-making.

1.4.1.11~~D.1.k~~ Historical and Cultural Considerations

Consider the historical and cultural aspects of the project area to ensure community acceptance and preservation of local heritage, aligning the project with the broader community values.

1.5 ~~E~~ LAND DEVELOPMENT

Land d~~D~~evelopment controls ~~are needed to~~ aid in ~~the~~ establishing~~ment of~~ safe streets and highways that ~~will~~ retain their efficiency and economic worth;~~.~~ but t~~T~~here may be legal, social, and economic challenges~~ in land use controls~~. ~~Proper~~ Effective coordination ~~among~~ with the public, ~~various~~ local government~~al~~ agencies~~bodies~~, ~~and~~ public transit and other highway agencies can ~~provide~~ facilitate solutions to ~~many of~~ these challenges. Implementation of responsible land use and development regulations along with intergovernmental respect for the goals and objectives of each~~, will~~ promotes a high-quality long-term transportation network.

Land development practices should promote ~~high quality street networks that provide~~ interconnectivity and access control. Design t~~T~~he street network ~~shall be designed~~ for the safety of all ~~road~~ users: –

- P~~p~~edestrians,
- B~~b~~icyclists,

- T~~t~~ransit, and
- M~~m~~otor vehicle operators and their passengers.

~~The design of~~ Design the street network and features ~~shall~~ to be consistent with the desired context and to meet the criteria in this m~~M~~anual. Context based street design dictates that ~~incorporates the following elements~~:

- Streets are sized and designed ~~tailed~~ to ~~equitably~~ serve the needs of the intended ~~road~~ users equitably and to support the target speed.
- Flow patterns are designed to interconnect neighborhoods while discouraging through motorized traffic on local street networks.
- Sufficient right of way is provided, including space ~~allocations~~ for stormwater facilities, utilities, signing and lighting.
- Public transit is supported through a high level of connectivity and attractive facilities (stops, shelters, hubs).
- Energy, infrastructure, and automobile uses ~~is~~ are reduced through a compact form.
- Provides for aesthetic and environmental compatibility.
- Building size and character spatially define streets and squares.

1.5.1~~E.1~~ Development Types and Guidelines

There are many variables ~~involved~~ in land development. Consider t~~T~~he ~~following~~ principles and guidelines below ~~should be utilized~~ in the design of the road network, in the control of access, and in the land-use controls and space allocation that ~~would~~ affect vehicular and pedestrian uses.

1.5.1.1~~E.1.a~~ Conventional Suburban Design (CSD)

~~This development type~~ CSD was common practice through the 20th century~~. It~~ and is characterized by automobile-dominant design and segregated land uses. The street patterns channel local traffic onto collector and arterial streets to reach most destinations. ~~Although~~ While destinations are oftentimes in close proximity, ~~adjacent to one another, this conventional suburban design~~ CSD does not typically connect to them directly, ~~. This makes~~ making walking an inefficient form of transportation~~ in this development type~~.

1.5.1.2~~E.1.b~~ Traditional Neighborhood Design (TND)

~~This refers to the development or redevelopment of a neighborhood or town using~~ TND uses traditional town planning principles. ~~Projects should~~ TND communities include:

- Aa~~a~~ range of housing types and commercial establishments,
- A~~a~~ network of well-connected streets and blocks, civic buildings, and public spaces, and
- ~~include~~ O~~o~~ther uses such as stores, schools, and worship within walking distances of residences.

TND communities rely on a strong integration of land use and transportation.

1.5.1.3~~E.1.c~~ Transit–Oriented Design (TOD)

~~This development type~~ TOD is a compact, mixed-~~-~~use area within one half mile of a transit stop or station that is characterized by streetscapes and an urban form oriented to pedestrians to promote walking trips to stations and varied other uses within station areas. ~~Transit-supportive development~~ TOD enables ~~citizens~~ people to use a variety of transportation modes for at least one or more of their daily trips between home, work, shopping, school, or services. ~~These concepts are often called~~ TOD development is often referred to as “new urbanism”.

~~For more information on Conventional Suburban, TND and TOD, refer to~~ See the ***21st Century Land Development Code*** for more information on CSD, TND, and TOD ~~and the FDOT's~~ ~~***Traditional Neighborhood Development Handbook (2011)***~~.

1.5.1.4~~E.1.d~~ Integration with Other Planning Efforts

Ensure seamless integration with other regional and local planning efforts, including housing, economic development, historical preservation, affordable housing, and environmental sustainability ~~plans~~ to create a cohesive growth strategy.

1.5.1.5~~E.1.e~~ Multi-modal Transportation Networks

Enhance multi-modal transportation networks to facilitate seamless transitions between different modes of transportation, fostering a more connected and accessible urban environment.

1.5.2~~E.2~~ Space Allocation

~~The provisions for~~ Providing adequate space ~~and proper location of various activities~~ is essential to ~~promote~~ safety and efficiency. ~~The following~~ Use these guidelines ~~should be utilized~~ in land use planning:

- Provide a~~A~~dequate corridors and space ~~should be considered~~ for utilities.
- Select u~~U~~tility locations ~~should be carefully chosen~~ to minimize interference with ~~the operation of the~~ streets, highways, and bicycle and pedestrian facilities.
- Provide a~~A~~dequate space for drainage facilities ~~should be provided~~. Locate o~~O~~pen drainage facilities ~~should be located~~ well clear of the traveled way.
- Ensure r~~R~~ight of way and setback requirements ~~should be adequate to~~ that provide ample sight distance at all intersections.
- Provide adequate s~~S~~pace ~~allocation~~ for street lighting (existing or planned) ~~should be incorporated~~ in~~to~~ the initial plan. Locate lighting s~~S~~upports ~~for this lighting should be located~~ outside of the required clear zone (unless they are ~~clearly of a~~ breakaway ~~type,~~ or are ~~guarded~~ shielded by ~~adequate~~ protective devices).
- Provide~~Sufficient~~ adequate right of way ~~should be provided~~ for future street widening, modification, or expansion ~~of the street and highway network~~.
- Provide adequate ~~Adequate~~ space for ~~desired or required~~ landscaping, shade trees, and greenways ~~should be provided~~.
- Provide a~~A~~dequate space for ~~appropriate~~ public transit facilities ~~should be provided~~.

1.5.3~~E.3~~ Access Control

~~The utilization of p~~Proper control ~~over~~ of access is one of the most effective and economical means ~~for maintaining~~ of promoting ~~the~~ safety and operations ~~utility of streets and highways~~. ~~The following~~ Use these principles ~~should be utilized in the formation of land use controls~~ for managing access:

- Adhere to t~~T~~he standards ~~presented~~ in ***Chapter 3 – Geometric Design, C.8 Access Control***~~, should provide the basis for establishing land development criteria~~ for control of access.

- Prohibit tThe use of an arterial or major collector as an integral part of the internal circulation pattern on private property should be prohibited.
- Locate aAccess to sites which generate major significant traffic (motor vehicular, pedestrian, and bicycle), should be located to provide minimize um conflicts with other traffic generators, including: . These generators include
  - Sschools,
  - Sshopping centers,
  - Bbusiness establishments,
  - Iindustrial areas, and
  - Eentertainment facilities, etc.
- Prohibit cCommercial strip development, with the associated and its proliferation of driveways, should be eliminated. Encourage vVehicular and pedestrian interconnections should be encouraged.
- Establish tThe spacing and location of access points should be predicated upon to reduce ing conflicts between and among motor vehicles, drivers, pedestrians, and bicyclists. Limit cCrossing and left- turn maneuvers may be controlled by using continuous median separation.
- Promote pedestrian access should be provided, with frequent crossing opportunities for crossings.

1.5.4E.4 Control Techniques

The implementation of a sound highway transportation plan requires certain controls. A lLogical network design, adequate access controls, and proper access and land use controls are dependent upon and foster proper good land development practices. Techniques that may be utilized to for establishing these necessary proper controls include the following:

1.5.4.1E.4.a Right of Way Acquisition

The acquisition of sufficient right of way is essential to allow for the construction of streets and highways as specified in this manual. The provision of Provide sufficient space for:

- Ttravel lanes,
- Iintersections,

- B~~b~~icycles,
- P~~p~~edestrians, ~~and~~
- T~~t~~ransit facilities,
- L~~l~~andscaping,
- S~~s~~hade trees,
- B~~b~~uffer zones,
- D~~d~~rainage facilities, and
- F~~f~~uture expansion.~~ is necessary to develop and maintain safe streets and highways.~~

1.5.4.2~~E.4.b~~ Regulatory Authority

The ~~regulatory authority of~~ local ~~highway~~ government agency ~~ies (and other related agencies)~~ should ~~be sufficient~~ have the regulatory authority to implement the necessary land use controls. ~~The following~~ Consider these general regulatory requirements and specific areas of control~~ should be considered~~ (at a ~~as~~ minimum):

1.5.4.2.1~~E.4.b.1~~ General Regulatory Requirements

~~The necessary~~ Incorporate elements for achieving these ~~following~~ transportation goals ~~should be incorporated~~ into all land use and zoning ordinances:

- General highway transportation plans should be created and implemented.
- Determination and acquisition of transportation corridors for future expansions is essential.
- Development plans clearly showing all street and highway layouts, transit facilities, pedestrian and bicycle facilities, and utility corridors should be required. The execution of these plans should be enforceable.
- Development plans, building permits, and zoning should be reviewed by the appropriate agency.

1.5.4.2.2~~E.4.b.2~~ Specific Control

The s~~S~~pecific ~~areas of~~ controls needed ~~necessary to develop~~ for adequate and efficient roadways include~~ the following~~:

- Land use control and development regulations,
- Control of access,
- Driveway design,
- Street and highway layouts,
- Location of vehicular and pedestrian generators,
- Location of transit, pedestrian, and bicycle facilities,
- Right of way and setback requirements for sight distances and clear zone, and
- Provisions for drainage.

1.5.5~~E.5~~ Contracts and Agreements

Contractual arrangements or agreements with individuals can be beneficial w~~W~~here land purchase or regulatory authority is not available or appropriate~~, the use of contractual arrangements or agreements with individuals can be beneficial~~. ~~Negotiations~~ Consider obtaining agreements with developers, builders, and private individuals ~~should be used~~, where appropriate, to ~~aid in the~~ implement~~ation of~~ the necessary controls.

1.5.6~~E.6~~ Education

Educating ~~on of~~ the public, developers, and governmental agencies ~~bodies can be~~ is beneficial in promoting proper land development controls. Emphasize t~~T~~he need for future planning, access control, and design standards clearly and consistently ~~should be clearly and continuously emphasized~~. ~~Successful solidification of the cooperation of~~ Partner with the public and with other government~~al~~ agencies ~~bodies depends upon clear presentation of the necessity for~~ to promote reasonable land development controls.

1.6~~F~~ OPERATION

~~The concept of o~~Operating the existing street and highway network as a system is essential ~~to~~ in promoting~~e~~:

- S~~s~~afety,
- E~~e~~fficiency,
- M~~m~~obility, and
- E~~e~~conomy.

This requires comprehensive planning and coordination of all activities, including: ~~on each street and highway. These activities would include~~

- M~~m~~aintenance,
- C~~c~~onstruction,
- U~~u~~tility operations,
- P~~p~~ublic transit operations,
- T~~t~~raffic control, and
- E~~e~~mergency response operations.

~~The behavior of travelers should be considered as an integral part of the operation of streets and highways.~~ Coordinate ~~ion of~~ the planning and supervision of ~~each~~ these activities ~~y on each facility is necessary~~ to achieve safety and efficient operation of the total system. Consider user behavior as an integral part of the operation of streets and highways.

1.6.1~~F.1~~ Policy

Each ~~transportation~~ local government agency with general responsibility for ~~existing~~ streets and highways should establish and maintain an operations department. Each existing street ~~or~~and highway should be ~~assigned to~~ under the jurisdiction of the operations department. The operations department ~~shall be responsible for~~ must plan~~ning~~, supervise~~ing~~, and coordinate~~ing~~ all activities affecting ~~the operating characteristics of~~ the system under its jurisdiction.

1.6.2~~F.2~~ Objectives

The primary objective of an operations department ~~shall be~~ is to maintain ~~or~~ and improve the safety, capacity, and level of service ~~operating characteristics~~ of the system under its jurisdiction. ~~These characteristics include safety, capacity, and level of service~~. ~~The p~~Preserving ~~ation of~~ the function of each facility~~, which would~~ (including~~e~~ access control), is necessary to maintain and improve these characteristics and the overall ~~general~~ value of ~~a~~ the street or highway.

1.6.3~~F.3~~ Activities

~~The a~~Achieving~~ement of~~ these objectives requires the operations department to perform~~ance of~~ a variety of coordinated activities ~~by the operations department~~. ~~The following activities should be c~~Considered~~ed~~ the activities below as the minimum ~~as minimal~~ for promoting the safe and efficient operations ~~of a system~~.

1.6.3.1~~F.3.a~~ Maintenance and Reconstruction

Maintaining ~~or~~ and upgrading ~~the quality of~~ existing facilities is ~~an~~ essential ~~factor~~ in preserving desirable operating characteristics. The operations department must coordinate the planning and ~~execution~~ performance of maintenance and reconstruction activit~~y~~ies ~~on existing facilities must be closely coordinated~~ with all other operational activities ~~and, therefore, should be under the general supervision of the operations department~~.

~~All~~ Conduct maintenance activities ~~work should be conducted~~ in accordance with the requirements of ***Chapter 10*** ~~***– Maintenance and Resurfacing***~~. ~~The priorities and procedures utilized should be directed toward improvement of the existing system.~~ Use t~~T~~he standards ~~set forth~~ in this m~~M~~anual ~~should be used~~ as guidelines for establishing maintenance and reconstruction objectives. Plan a~~A~~ll maintenance and reconstruction projects ~~should be planned~~ to minimize traffic control conflicts ~~and hazards~~.

1.6.3.2~~F.3.b~~ Work Zone Safety

~~An important responsibility of~~ T~~t~~he operations department is responsible for ~~the~~ promoting ~~on of~~ work zone safety ~~on the existing system~~. Include provisions for the safety of motorists, bicyclists, pedestrians, and workers ~~The planning and execution of maintenance, construction, and other activities shall include provisions for the safety of motorists, bicyclists, pedestrians, and workers~~. Conduct a~~A~~ll work ~~shall be conducted~~ in accordance with the requirements of ~~presented in~~ ***Chapter 11*** ~~***– Work Zone Safety and Mobility***~~.

1.6.3.3~~F.3.c~~ Traffic Control

~~Traffic engineering is a vital component of highway operations. The planning and~~ Coordinate the design of traffic control devices ~~should be carried out in conjunction~~ with the overall design of the street or highway ~~and highway user~~. ~~The~~ Use traffic control devices and procedures that are ~~utilized for traffic control should be predicated upon developing~~ uniform~~ity~~ throughout the system and compatible ~~ility~~ with adjacent jurisdictions.

Safe, orderly traffic flow is the ~~A~~ primary objective ~~to be followed in establishing traffic control procedures is the promotion of safe, orderly traffic flow~~. ~~The cooperation of~~ Coordinate with police agencies and ~~coordination with~~ local transit providers ~~is essential for the~~ to achieve~~ment of~~ this objective. Give special consideration to t~~T~~raffic control during maintenance, construction, utility, ~~or~~ and emergency response operations ~~should receive special consideration~~.

1.6.3.4~~F.3.d~~ Emergency Response

~~The~~ Coordinate emergency response activities (i.e., emergency maintenance and traffic control) ~~of the operations department should be~~ closely ~~coordinated~~ with the work of:

- P~~p~~olice,
- F~~f~~ire,
- A~~a~~mbulance,
- M~~m~~edical, and
- O~~o~~ther emergency response agencies.

~~The~~ Include provisions for emergency access and communications ~~should be included in~~ during the initial planning ~~for these activities~~.

1.6.3.5~~F.3.e~~ Coordination and Supervision

Coordination and supervision ~~of~~ activities ~~on the system~~ should include ~~the following~~:

- Supervise ~~ion~~ and~~/or~~ coordinate ~~ion of~~ all activities of the operations department and other agencies, ~~to promote safe and efficient operation~~
- Coordinate ~~ion of~~ all activities to ~~provide~~ ensure consistency within a ~~given~~ jurisdiction,
- Coordinate ~~ion~~ with adjacent jurisdictions to ~~develop~~ ensure compatible highway systems, and
- Coordinate ~~ion~~ with other transportation modes to promote overall ~~transportation~~ efficiency.

1.6.3.6~~F.3.f~~ Inspection and Evaluation

~~The actual operation of streets and highways~~ Existing roadway operations can provide~~s~~ valuable insight ~~experience and information regarding~~ into the effectiveness of its features ~~various activities~~. ~~Each~~ The operations department should maintain a complete inventory of its existing system and should continuously inspect and evaluate ~~the~~ its priorities, procedures, and techniques ~~utilized in all activities on the existing system under its jurisdiction~~. The operations department should supervise all aA~~A~~ctivities by other agencies~~, as well as any agency, should be subjected to this supervision~~.

~~Promotion of transportation safety should be aided by including~~ The operations department should have a safety office (or officer) to aid in promoting transportation safety~~as an integral part of the operations department~~. ~~Functions of this office would include the identification~~ The safety office should identify and inventory ~~of~~ hazardous locations and develop procedures for improving ~~the~~ highway safety characteristics~~ of highway operations~~.

Use the r~~R~~esults of the~~is~~ inspection and evaluation program ~~should be utilized~~ to implement ~~make the modification necessary to~~ changes that promote safety and efficiency~~t operation~~. ~~Feedback for modifying~~ Use the lessons learned from this program to update current design criteria~~ should be generated by this program~~. Use the e~~E~~xperience and data obtained from operating the existing system~~ should be utilized as a basis for~~ to recommend~~ing~~ regulatory changes. Cooperation ~~of~~ with legislative, law enforcement, and regulatory agencies is essential~~ to develop the regulation of vehicles, driver behavior, utility, emergency response activities, and the access land use practices necessary for the safe and efficient operation of the highway system~~.

1.7~~G~~ REFERENCES FOR INFORMATIONAL PURPOSES

- Florida Transportation Plan
  http://floridatransportationplan.com/
- Florida Growth Management and Comprehensive Planning Laws (DEO)
  http://www.floridajobs.org/community-planning-and-development
- 1000 Friends of Florida
  http://www.1000fof.org/
- Florida Metropolitan Planning Organization Advisory Council (MPOAC)
  http://www.mpoac.org/
- Understanding Sprawl, A Citizen’s Guide
  http://www.urbancentre.utoronto.ca/pdfs/elibrary/Suzuki.pdf
- Traditional Neighborhood Development Handbook
  http://www.fdot.gov/roadway/FloridaGreenbook/TND-Handbook.pdf
- Highway Functional Classification: Concepts, Criteria and Procedures, 2013 Edition (FHWA)
  http://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/section00.cfm

- Quality/Level of Service Handbook (FDOT, 2020)
  https://www.fdot.gov/planning/systems/documents/sm/default.shtm
- Manual on Uniform Traffic Studies (Topic No. 750-020-007)
  https://pdl.fdot.gov/api/procedures/downloadProcedure/550-030-101
- Surveying Procedure (Topic No. 550-030-101)
  https://pdl.fdot.gov/api/procedures/downloadProcedure/550-030-101

CHAPTER 3

GEOMETRIC DESIGN

A 3.1 INTRODUCTION

Geometric design is defined as the design or proportioning of the visible elements of the a street or highwayroadway. The roadway geometry of the street or highway is of central importance since it provides the framework for the design of all other highway roadway elements, including:

- Pavement,
- Drainage,
- Signing and pavement markings,
- Lighting,
- Signalization
- Transit, and
- Structures. . In addition, t

he 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.

Coordinate tThe roadway geometry design of roadway geometry must be conducted in close coordination with the design of all these other design elements, considering: of the street or highway. These other elements include pavement design, roadway lighting, traffic control devices, transit, drainage, and structural design. The design should consider

- Ssafe roadside clear zones,
- Ppedestrian safety,
- Eemergency response, and
- Long-term maintenance capabilities.

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

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

Do not automatically default to t~~T~~he minimum standards provided ~~presented~~ in this chapter ~~should not automatically become the standards for geometric design~~. ~~The designer should consider use of a~~ Use higher standards ~~level, (~~where~~n~~ practical~~)~~. ~~, and c~~Consider costs and ~~-~~benefits ~~as well as~~ and consistency with adjacent facilities. Reconstructing ~~on~~ and maintaining ~~enance of~~ existing facilities ~~where practical,~~ includes~~s~~ upgrading to these minimum standards (where practical).

~~In restricted or unusual conditions, i~~ It may not be possible to meet these minimum standards in constrained conditions. ~~In such cases, the designer shall o~~ Obtain a Design ~~n e~~Exception or Design Variation from the jurisdictional agency in such cases ~~in accordance with~~ (see ***Chapter 14***). ~~– ***Design Exceptions and Variations*** from the reviewing or permitting organization~~. ~~However,~~ Make e~~e~~very effort ~~should be made~~ to ~~obtain~~ achieve the best possible:

- Horizontal and vertical alignments~~, grade~~,
- S~~s~~ight distances, ~~and proper~~
- Roadside slopes,
- D~~d~~rainage ~~consistent with the terrain, the development,~~ , and
- Safety for all users ~~safety, and fund availability~~.

The concept of road users has expanded in recent years, ~~-~~creating important additional design considerations ~~for the designer~~.

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~~In making decisions on the standards to be applied to a particular project, the designer must also a~~ Select the appropriate standards to address the needs of:

- P~~p~~edestrians,
- B~~b~~icyclists,
- E~~e~~lder road users, ~~and~~
- T~~t~~ransit users,
- P~~p~~eople with disabilities,
- F~~f~~reight movement, and
- O~~o~~ther users ~~and uses~~.

This ~~is true for~~ applies to all facilities (~~both~~ urban and rural) ~~facilities~~.

The design ~~features~~ of urban local streets ~~are~~ may be governed by practical limitations to a greater extent than ~~those of~~ similar roads in rural areas. The ~~two dominant~~ primary design controls are:

(1) ~~(1)~~ T~~t~~he type and extent of urban development, ~~and its~~
(2) R/W limitations, ~~on rights of way and~~
(3) ~~(2) z~~Zoning, ~~or~~ and
(4) R~~r~~egulatory restrictions.

Some streets are primarily ~~are~~ land service streets in residential areas (where ~~. In such cases, the overriding consideration is to foster~~ fostering a safe and pleasing environment is paramount). Other streets are land service ~~only~~ in part only ~~, and~~ (where ~~features of~~ traffic and public transit service ~~may be~~ are paramount ~~predominant~~).

The selection of ~~the type and exact~~ roadway design parameters ~~details of a particular street or highway~~ requires considerable study ~~and thought~~. ~~When specific criteria are not provided in this Manual and reference is made to~~ Use the requirements ~~guidelines and design details given by~~ provided in current American Association of State Highway and Transportation Officials (AASHTO) publications as minimum criteria (when specific criteria is not provided herein) ~~, these guidelines and standards should generally be considered as minimum criteria~~. See ***A Policy on Geometric Design of Highways and Streets (AASHTO, 2011)***, also known as (a.k.a., the ***AASHTO Greenbook***) f~~F~~or ~~the~~ designing: ~~of~~

- R~~r~~ecreational roads,
- L~~l~~ocal service roads, and
- A~~a~~lleys~~, see **A Policy on Geometric Design of Highways and Streets (AASHTO, 2011)**, also known as the **AASHTO**~~

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Greenbook (2011) and other publications.

Right of way Standard R/W and pavement width requirements for new construction may be reduced for the paving of certain existing unpaved streets and very low volume rural roadways provided all the as long as these 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 vehicles per day. and
- Tthe design year projected peak hourly volume is less than 100 vehicles per hour or less. Note: (tThe 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:
  - Lland use,
  - Eextensions to serve new developing land areas, or
  - Aany other use which would generate daily or hourly traffic volumes greater than those listed above.
- There is no reasonable possibility of acquiring additional R/Wright of way without.
- Incurring expenditures of spending more public funds in an amount which would be excessive compared to than the public benefits achieved.

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- Causing substantial damage ~~or disruption~~ to abutting propert~~y~~ies ~~improvements~~ to a degree that is unacceptable ~~considering~~ for the local environment.

Commented [KK1]: Not sure what this "condition" is meant to imply.

B OBJECTIVES

The ~~major~~ primary objective ~~in~~ of geometric design is to establish a vehicle path and environment providing a reasonable margin of safety for ~~the~~ drivers ~~motorist~~, transit users, bicyclists, and pedestrians under the expected speeds and ~~operating~~ operating conditions ~~and speed~~. ~~It is recognized that~~ Florida's design driver is aging. ~~, and t~~ Tourism is our ~~major~~ largest industry. ~~. This gives~~ These factors place even more emphasis on simple~~icity and easily understood~~ geometry. ~~The design of street or highway features should c~~Consider providing ~~the following~~:

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

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C DESIGN ELEMENTS

C.1 Design Speed

Design speed is a selected speed used to ~~determine~~ establish ~~the various~~ roadway geometric design features ~~of the street or highway~~. Selection of an appropriate design speed must consider ~~the~~:

- A~~a~~nticipated operating speed,
- Pedestrians and bicyclists,

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- T~~t~~opography,
- E~~e~~xisting and future adjacent land uses, and
- F~~f~~unctional classification.

~~Consideration must also be given to pedestrian and bicycle usage.~~

Many critical design features ~~such as~~ (e.g., sight distance and curvature) ~~are directly related to, and~~ vary appreciably with~~,~~ changes in design speed. ~~For this reason, the selected~~ Select a design speed ~~should be~~ that is consistent with the speeds that drivers are likely to expect

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~~on a given street or highway facility~~. The design speed ~~shall~~ cannot be less than the ~~expected~~ posted ~~or legal~~ speed limit. ~~Once the design speed is selected, a~~ All pertinent highway features should ~~be related to~~ accommodate the selected design speed ~~it to obtain~~ (for a balanced design).

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

The selected design speed ~~utilized~~ should be consistent over a given section of ~~street or highway~~ roadway. Implement r~~R~~equired changes in design speed ~~should be effected in a~~ gradually ~~fashion~~. ~~When isolated reductions in design speed cannot reasonably be avoided, a~~ Install appropriate speed signings ~~s~~ where isolated reductions in design speed cannot reasonably be avoided ~~should be posted~~.

See Table 3 – 1 for m~~M~~inimum and maximum ~~values for~~ design speeds ~~are given in Table 3 – 1 Minimum and Maximum Design Speed~~.

- High-~~-~~speed facilities are ~~defined as those facilities~~ those with design speeds of 50 mph and more~~greater~~.
- Low-~~-~~speed facilities are ~~defined as those facilities~~ those with design speeds of 45 mph and less.
- The posted speed ~~shall~~ must be less than or equal to the design speed.

See t~~T~~he ***AASHTO Greenbook (2011)*** ~~provides additional~~ for information on design speed.

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Table 3 – 1 Minimum and Maximum Design Speed (mph)

Facility[1]		AADT (vpd)	Terrain	Design Speed (mph)
Freeways	Rural	All	Level and Rolling	70
	Urban	All	Level and Rolling	50 – 70[2]
Arterials	Rural	All	Level	60 – 70
			Rolling	50 – 70
	Urban	All	All	30 – 60[3]
Collectors	Rural	≥ 400	Level	60 – 65 (50 mph min for AADT 400 to 2000)
			Rolling	50 – 65 (40 mph min for AADT 400 to 2000)
		< 400	Level	40 – 60
			Rolling	30 – 60
	Urban	All	All	30 – 50[3]
Local	Rural	≥ 400	Level	50 – 60
			Rolling	40 – 60
		< 400	Level	30 – 50
			Rolling	20 – 40
	Urban	All	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 outside designated urban boundaries yet~~ and within small communities or urban~~-~~ like developed areas. Rural design speeds are applicable ~~to~~ within all other rural areas.
2. Use a~~A~~ design speed of 70 mph ~~should be used~~ for urban freeways when practical. U s e l~~L~~ower design speeds ~~should~~ only ~~be used~~ within highly developed areas with closely spaced interchanges. ~~For these areas a~~ A minimum design speed of 60 mph is recommended unless it can be shown that lower speeds ~~will be~~ are consistent with driver expectancy.
3. Lower speeds apply to central business districts and ~~in~~ more developed areas, while higher speeds ~~are more applicable~~ apply to outlying and developing areas.
4. Since ~~the function of~~ urban local streets ~~is to~~ provide access to adjacent propertie~~y~~s, all design elements should be consistent with the ~~character of~~ activities ~~y~~ on and adjacent to the street~~,~~ and should encourage speeds ~~generally not exceeding~~ below 30 mph.

C.2 Design Vehicles

A "design vehicle" is a vehicle with representative weight, dimensions, and operating characteristics, ~~, used to~~ used for establishing ~~street and highway~~ design controls ~~for~~for accommodating~~ing~~ vehicles of designated classes. ~~For the purpose of geometric design, t~~ 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~~ (see Table 3 – 2 ~~Design Vehicles~~). Use ~~O~~ one or more of these vehicles ~~should be used as a control~~ in ~~the~~ selecting ~~on of~~ geometric design elements. ~~In certain industrial (or other) areas,~~ Consider s~~s~~pecial service vehicles ~~may have to be considered~~ in ~~the desig~~ industrial areas~~n~~. Fire equipment and emergency vehicles should have reasonable access to all areas. ~~Additional information on the maximum width, height and length of vehicles in Florida can be found in~~ See ***Section 316.515, F.S.*** ~~***Motor Vehicles; Maximum***~~ ***width, height,*** ~~***length***~~ for the maximum width, height and length of vehicles in Florida.

Use the larger class as the design control ~~If~~ when a significant ~~number or~~ percentage (5 percent ~~of all the total traffic~~) of larger vehicles ~~of those classes larger than passenger vehicles~~ are likely to use a particular ~~street or highway~~ roadway~~, that class should be used as a design control~~. ~~The design of a~~ Arterial ~~streets~~ roadways ~~and highways~~ should ~~normally be adequate to~~ accommodate all design vehicles. The decision as to which ~~of the~~ design vehicle~~s~~ (or other special vehicle~~s~~) ~~should be~~ to used~~d~~ as a control is complex ~~and requires careful study~~. Evaluate each situation ~~must be evaluated~~ individually to ~~arrive at a reasonable~~ estimate ~~of~~ the type and volume of traffic expected ~~traffic~~.

- The ~~D~~design criteria below are significantly affected by the type of design vehicle ~~include~~:
    - Horizontal and vertical clearances,
    - Alignment,
    - Lane widening on curves,
    - Shoulder width requirements,
    - Turning roadway and intersection radii,
    - Intersection sight distance, and
    - Acceleration criteria.

~~Particular~~ Take special care ~~should be taken~~ in establishing intersection corner ~~the~~ radii ~~at intersections, so~~ to allow vehicles ~~may~~ to enter the ~~street or highway~~ roadway without encroaching into~~on~~ adjacent travel lanes or leaving the pavement. ~~It is~~

~~acceptable for occasional t~~ Trucks andor buses ~~to~~ can occasionally encroach into adjacent travel lanes ~~make use of both receiving lanes,~~ (especially on side streets).

Table 3 – 2 Design Vehicles

Design Vehicle		Dimensions (feet)					
Type	Symbol	Wheelbase	Overhang		Overall Length	Overall Width	Height
			Front	Rear			
Passenger Car	P	11	3	5	19	7	4.3
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
City Transit Bus	CITY-BUS	25	7	8	40	8.5	10.5
Conventional School Bus (65 passenger)	S-BUS 36	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+17.7=33.7**	3	12	48.7	8	10
Car & Boat Trailer	P/B	11+5+15=31**	3	8	42	8	---
Intermediate Semitrailer	WB-40	12.5+25.5=38	3	4.5	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	19.5+41=60.5	4	4.5	69	8.5	13.5
Florida Interstate Semitrailer***	WB-62FL	19.5+41=60.5	4	9	73.5	8.5	13.5
Interstate Semitrailer***	WB-67	21.6+45.4=67	4	2.5	73.5	8.5	13.5
"Double-Bottom"-Semitrailer/Trailer Combination	WB-67D	11+23+10*+22.5= 66.5	2.3	3.0	72.3	8.5	13.5

Source: 2011 AASHTO Greenbook, Design Controls and Criteria, Table 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

*** The term “iInterstate” does not imply the vehicle is restricted to only interstate and limited access (LA) highways only.

See Table 3 – 3 for ~~T~~the minimum turning radii of the various design vehicles ~~is presented in Table 3 – 3 Minimum Turning Radii of Design Vehicles~~. The primary~~ncipal~~ dimensions affecting design are the:

- ~~, the m~~ Minimum centerline turning radius~~, the~~
- ~~o~~Out-to-out track width~~, the~~
- W~~w~~heelbase, and ~~the~~
- P~~p~~ath of the inner rear tire.

A turning ~~The~~ speed ~~of the turning vehicle is assumed to be less than~~ under 10 mph is assumed.

The outside boundaries of the turning path for the sharpest turns of each design vehicle ~~for its sharpest turns~~ are established by the outer ~~trace of the~~ front overhang and ~~path of~~ the inner~~ner~~ rear wheel. This sharpest turn assumes that the outer front wheel follows ~~the circular arc defining~~ the minimum centerline turning radius ~~as determined by the vehicle steering mechanism~~.

See ***AASHTO Greenbook (2011), Chapter 2*** for f~~F~~igures illustrating the minimum turning radii for a variety of vehicles. ~~along with additional information can be found in the **_AASHTO Greenbook (2011), Chapter 2 – Design Controls and Geometrics_**.~~

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Table 3 – 3 Minimum Turning Radii of Design Vehicles

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Design Vehicle		Dimensions In Feet		
Type	Symbol	Minimum Design Turning Radius	Centerline Turning* Radius	Minimum Inside Radius
Passenger Car	P	23.8	21.0	14.4
Single Unit Truck	SU-30	41.8	38.0	28.4
Single Unit Truck – 3 Axle	SU-40	51.2	47.4	36.4
City Transit Bus	CITY-BUS	41.6	37.8	24.5
Conventional School Bus (65 passenger)	S-BUS 36	38.6	34.9	23.8
Articulated Bus	A-BUS	39.4	35.5	21.3
Motor Home	MH	39.7	36.0	26.0
Car & Camper Trailer	P/T	32.9	30.0	18.3
Car & Boat Trailer	P/B	23.8	21.0	8.0
Intermediate Semitrailer	WB-40	39.9	36.0	19.3
Intermediate Semitrailer	WB-50	45	41	17.0
Interstate Semitrailer	WB-62	44.8	41.0	7.4
Florida Interstate Semitrailer***	WB-62FL	44.8	41.0	7.4
"Double-Bottom"-Semitrailer/Trailer Combination	WB-67D	44.8	40.9	19.1

Source: 2011 AASHTO Greenbook, Design Controls and Criteria, Table 2-2b.

* The turning radius assumed by a designer when investigating possible turning paths and is (set at the centerline of the front axle of a vehicle). If the minimum turning path is assumed, the centerline turning radiusCTR approximately equals the minimum design turning radius minus one-half the front width of the vehicle.

C.3 Sight Distance

~~The p~~Providing ~~sion for~~ adequate horizontal and vertical sight distances is ~~is an~~ essential for roadway safety ~~factor in the development of a safe street or highway~~. An unobstructed view of the upcoming roadway ~~is necessary to~~ allows time and safe space for: ~~the safe execution of~~

- Normal operations,
- P~~p~~assing,
- S~~s~~topping,
- I~~i~~ntersection movements, and ~~other normal and~~
- E~~e~~mergency maneuvers.

~~It is also important to p~~Provide as ~~great a~~ much sight distance as possible to allow the driver ~~time~~ to plan ~~for~~ future maneuvers ~~actions~~. The driver is continuously required to perform~~execute~~ normal slowing, turning, and acceleration maneuvers. ~~If he can plan in advance for these actions, t~~Traffic flow ~~will be~~ is smoother and less hazardous when drivers can plan these maneuvers in advance. Unexpected emergency maneuvers ~~will~~ are also ~~be~~ less hazardous ~~if they are~~ when not combined with uncertainty regarding ~~the required~~ normal maneuvers. ~~The appropriate use of~~ L~~l~~ighting (***Chapter 6*** ~~***– Lighting***~~) may be required to ~~provide~~provide adequate sight distances for night driving.

Consider the potential for f~~F~~uture obstructions to sight distance that may develop (e.g., vegetation) or may be constructed ~~should be taken into consideration in the initial design~~. Consider a~~A~~reas outside of the road R/W ~~right of way~~ that are not under the highway agency'~~'~~s jurisdiction ~~should be considered as points of~~ as potential sight distance obstructions. Consider ~~Planned~~ future construction of median barriers, guardrails, grade separations, or other structures ~~should also be considered~~ as ~~possible~~ potential sight distance obstructions.

~~C.3.a~~C.3.b Stopping Sight Distance

Provide continuous s~~S~~afe stopping sight distances ~~shall be provided continuously on~~ along all ~~streets and highways~~roadways. ~~The f~~Factors~~,~~ ~~which~~which determine ~~the~~ minimum stopping sight distances ~~required to stop,~~ include:

- Vehicle speed,

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- Driver's total reaction time,
- Vehicle cCharacteristics and conditionss of the vehicle,
- Friction capabilities between the tires and the roadway surface, and
- Roadway vVertical and horizontal alignments of the roadway.

It is desirable that the driver be given Provide drivers with sufficient sight distance to avoid an object or slow-moving vehicle withwith – a natural, smooth maneuver (rather than an extreme or panicked reaction).

The determination of available Sstopping sight distance is shall be based on a driver's eye height of the driver's eye equal to 3.50 feet and an obstruction height of obstruction to be

~~avoided equal to~~ of 2.0 feet. ~~It would, of course, be desirable~~ Attempt to use an obstruction height of ~~obstruction equal to~~ zero (~~coincident with~~ at the roadway surface) to provide ~~the driver with a~~ even more ~~positive~~ sight distance ~~condition~~. ~~Where horizontal sight distance may be obstructed on curves, t~~ Assume the driver's eye and ~~the~~ obstruction ~~shall be assumed to be located~~ are at the centerline of the innermost traffic lane in horizontal curves ~~on the inside of the curve~~.

~~The~~ See Table 3 – 4 for minimum stopping sight distances ~~shall be no less than the values given in Table 3 – 4 Minimum Stopping Sight Distance~~ for level and rolling roadways.

Table 3 – 4 Minimum Stopping Sight Distance

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Design Speed (mph)	Stopping Sight Distance (feet)						
	Level (≤ 2%)	Downgrades			Upgrades		
		3%	6%	9%	3%	6%	9%
20	115	116	120	126	109	107	104
25	155	158	165	173	147	143	140
30	200	205	215	227	200	184	179
35	250	257	271	287	237	229	222
40	305	315	333	354	289	278	269
45	360	378	400	427	344	331	320
50	425	446	474	507	405	388	375
55	495	520	553	593	469	450	433
60	570	598	638	686	538	515	495
65	645	682	728	785	612	584	561
70	730	771	825	891	690	658	631

Source: 2011 AASHTO Greenbook, Table 3-1 ~~Stopping Sight Distance on Level Roadways~~ and Table 3-2 ~~Stopping Sight Distance on Grades~~.

~~C.3.b~~C.3.c Decision Sight Distance

Decision sight distance is the distance drivers need~~ed for a driver~~ to detect an unexpected or ~~otherwise~~ difficult to perceive ~~information source or~~ condition in a visually cluttered roadway environment~~ that may be visually cluttered~~. Decision sight distance ~~It~~ allows the driver to:

- R~~r~~ecognize the condition ~~or its potential threat,~~
- S~~s~~elect an appropriate speed and path, and
- I~~i~~nitiate and complete complex maneuvers.

M~~M~~inimum stopping distance does not provide~~provide sufficient space or~~ time for ~~the~~ drivers to make complex decisions ~~regarding complex situations requiring more than~~ exceeding the simple perception-reaction process.

~~Examples of critical locations where a~~ Additional sight distance is needed ~~include~~ at critical locations:

- I~~i~~nterchanges and intersection locations~~,~~ where unusual and ~~or~~ unexpected maneuvers occur ~~are needed,~~
- C~~c~~hanges in typical section~~s~~ ~~such as toll plazas or~~ (e.g., lane drops)~~,~~ and
- A~~a~~reas of concentrated demand where there is visual noise from competing sources~~ of information~~, such as:
  - R~~r~~oadway elements
  - T~~t~~raffic~~,~~
  - T~~t~~raffic control devices and
  - A~~a~~dvertising signs.

Use ~~The~~the decision sight distances in Table 3 – 5 ~~Decision Sight Distance may be used (1)~~ to:

- P~~p~~rovide ~~values for~~ sight distances that may be appropriate at critical locations, and ~~(2) to~~
- S~~s~~erve as criteria for evaluating the suitability of the available sight distances at these locations.

~~If it is not practical to provide decision sight distance because of horizontal or vertical curvature or if relocation of decision points is not practical, special attention should be given to~~ Consider using appropriate traffic control devices providing advance warning ~~of the conditions that are likely to be encountered~~ where decision sight distance is limited by horizontal or vertical curvature and relocating decision points is not practical.

Table 3 – 5 Decision Sight Distance

Design Speed (mph)	Decision Sight Distance (feet) Level Avoidance Maneuver				
	A	B	C	D	E
20	130	305	300	355	410
25	170	395	375	445	515
30	220	490	450	535	620
35	275	590	525	625	720
40	330	690	600	715	825
45	395	800	675	800	930
50	465	910	750	890	1030
55	535	1030	865	980	1135
60	610	1150	990	1125	1280
65	695	1275	1050	1220	1365
70	780	1410	1105	1275	1445

Source: 2011 AASHTO Greenbook, Table –3 - 3 Decision Sight Distance

Notes:
1. Avoidance Maneuver A: Stop on rural road – (t = 3.0 s).
2. Avoidance Maneuver B: Stop on urban road – (t = 9.1 s).
3. Avoidance Maneuver C: Speed/path/direction change on rural road – (t varies between 10.2 and 11.2 s).
4. Avoidance Maneuver D: Speed/path/direction change on suburban road – (t varies between 12.1 and 12.9 s).
5. Avoidance Maneuver E: Speed/path/direction change on urban road – (t varies between 14.0 and 14.5 s).

~~The~~ Freeway decision sight distances ~~on a freeway~~ preceding the approach nose of an exit ramp should exceed the minimums in **Table 3 – 5** ~~-~~by at least 25 percent ~~or more. A minimum sight distance of~~ (1000 feet ~~,~~ measured from the driv~~v~~'er's eye to the roadway surface is desired) ~~is a desirable goal~~. ~~There should be~~ Provide a clear view of the exit terminal ~~including~~ and the exit nose.

~~C.3.c~~C.3.d Passing Sight Distance

The passing maneuver is inherently dangerous~~,~~ (~~which~~ requiring ~~es~~ occupying ~~ation of~~ the opposing travel lane)~~, is inherently dangerous~~. ~~The d~~Drivers ~~is required to~~ must make simultaneous estimates of:

- T~~t~~ime,
- D~~d~~istance,
- R~~r~~elative speeds, and
- V~~v~~ehicle capabilities.

Errors in these estimates can result in ~~frequent and~~ very serious crashes.

~~Streets or highways with two or more travel lanes in a given direction are not subject to requirements for safe passing sight distance~~. Provide as much safe passing sight distance as possible on t~~T~~wo-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 on two-lane, two-way roadways ~~opportunity is~~ can be high, ~~and serious~~ such that limiting ~~ations on the~~ opportunities~~y~~ for passing reduces ~~the~~ capacity and safety ~~characteristics of the highway~~. Passing sight distance requirements do not apply to roadways with at least two travel lanes in each direction.

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

~~The determination of p~~ Passing sight distance ~~shall be~~ is based on an eye height of ~~eye equal to~~ 3.50 feet and an object height of ~~object passing equal to~~ 3.50 feet. ~~Where passing is permitted, the p~~ See Table 3 – 6 for minimum Passing sight distances ~~shall be no less than the values given in Table 3 – 6 Minimum Passing Sight Distances~~.

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Table 3 – 6 Minimum Passing Sight Distance

(~~For application of passing sight distance, u~~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)	400	450	500	550	600	700	800	900	1000	1100	1200

Source: 2011 AASHTO Greenbook, Table 3-4~~ Passing Sight Distance for Design of Two-Lane Highways~~.

~~C.3.d~~C.3.e Intersection Sight Distance

See Section C.9 of this chapter for intersection s~~S~~ight 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

Design t~~T~~he ~~standard of~~ roadway alignment ~~selected for a particular section of street or highway should extend throughout the section~~ with no sudden changes from ~~easy~~ flat to sharp curvature. Use as flat a curve as possible. ~~Where sharper curvature is unavoidable,~~ Use a sequence of increasing degree curves ~~of increasing degree~~ where sharper curvature is unavoidable ~~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.~~

Avoid using m~~M~~aximum curvature ~~should not be used~~ in these ~~following~~ locations:

- High fills ~~or~~ and elevated structures. The lack of surrounding objects reduces the driver's perception of the roadway alignment.
- At or near a crest (high point) in~~ grade~~ the profile.
- At or near a sag (low point) in the profile ~~a sag or grade~~.

- At the end of long tangents.
- At or near:
  - I~~i~~ntersections,
  - T~~t~~ransit stops, ~~or~~
  - P~~p~~oints of ingress and ~~or~~ egress, and
  - Other decision points.

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- ~~At or near other decision points.~~

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Avoid using ~~The~~ "broken back" ~~arrangement of~~ curves (short tangents between ~~two~~ curves in the same direction)~~ should be avoided~~. Use "broken back" curves ~~This is acceptable only at~~ only with design speeds of 30 mph and~~or~~ less.~~ This arrangement produces unexpected and hazardous situations.~~

~~When reversals in alignment are used and superelevation is required,~~ Provide ~~a~~ sufficient ~~length of~~ tangent between ~~the~~ superelevated reverse curves ~~is required for adequate~~ to achieve both superelevation transitions.

Avoid using c~~C~~ompound curves ~~should be avoided,~~ (especially ~~when~~ with sharp curvature ~~es~~)~~ are sharp~~. ~~They tend to produce erratic and dangerous vehicle operations. When compound curves are necessary, t~~ The radius of the flatter curve should ~~not~~ be no more than 50 percent ~~greater~~ more than the sharper curve (where compound curves are necessary).

Accomplish ~~The~~ superelevation transitions ~~between tangents and curves should normally be accomplished by the use of~~ using appropriate straight-line transitions or spirals~~. This is essential~~ (to assist ~~the~~ drivers in maintaining ~~his vehicle in~~ the proper travel path).

C.4.b Maximum Deflections in Alignment without Curves

The point where tangents intersect is ~~known as~~ the point of intersection (PI). ~~Although the use of a PI with no horizontal curve is discouraged, there may be conditions where it is necessary. The~~ The m~~m~~aximum deflections ~~criteria~~ without ~~a~~ horizontal curves are~~ as follows~~:

- 2° 00' 00" for f~~F~~lush shoulder and curbed roadways with design speeds of 40 mph and less~~ is 2° 00' 00"~~.
- 0° 45' 00" for f~~F~~lush shoulder roadways with design speeds of 45 mph and more ~~greater is 0° 45' 00"~~.
- 1° 00' 00" for c~~C~~urbed roadways with design speeds of 45 mph and more ~~greater is 1° 00' 00"~~.
- 0° 45' 00" for h~~H~~igh~~-~~speed curbed roadways with design speeds of 50 mph and more ~~greater is 0° 45' 00"~~.

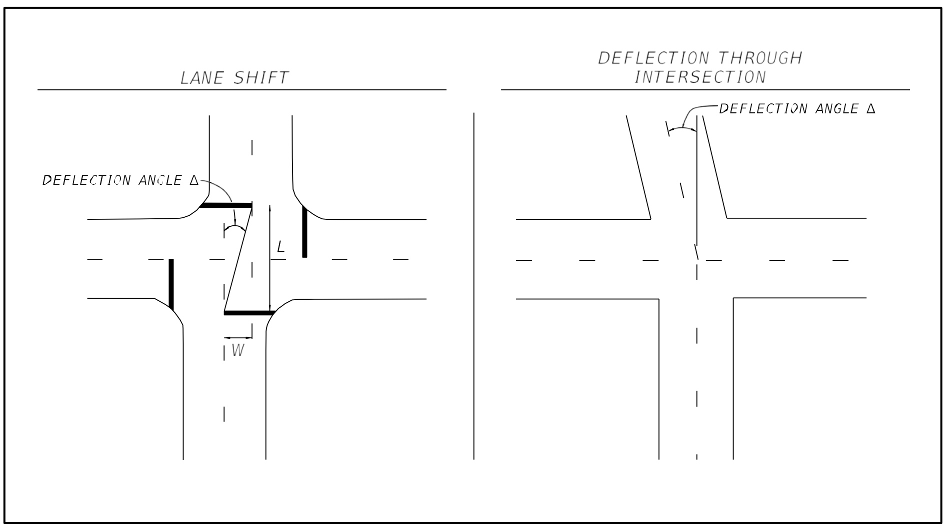
~~Although d~~Deflections through intersections are sometimes necessary. ~~are discouraged, there may be conditions where it is necessary. The~~

See Table 3 – 7 for m maximum deflections through intersections angles at

~~intersections to be used in establishing the horizontal alignment are given in Table 3 – 7 Maximum Deflection Angle Through Intersection~~.

Table 3 – 7 Maximum Deflection Angle Through Intersection

Design Speed (mph)					
≤ 20	25	30	35	40	45
16°~~ 00'~~	11°~~ 00'~~	8°~~ 00'~~	6°~~ 00'~~	5°~~ 00'~~	3°~~ 00'~~



Notes 1. The deflection angle ~~used is not to~~ cannot cause a lane shift (W) of more than 6 feet from stop bar to stop bar.

Roadway c~~C~~urves ~~on main roadways~~ should be ~~sufficiently~~ long enough to avoid ~~the appearance of~~ looking like a kink. Gently flowing alignment is ~~generally~~ more safe and more aesthetically pleasing ~~in appearance, as well as, superior from a safety standpoint~~. Flatter curvature with shorter tangents is preferable to sharper curvature ~~es connected by~~ with longer tangents~~,~~ (i.e., avoid using minimum horizontal curve lengths). S e e Table 3-8 ~~Minimum Lengths of Horizontal Curves provides~~ for minimum horizontal curve lengths ~~that should be used in~~ for ~~establishing the horizontal~~ mainline alignments.

Table 3 – 8 Minimum Lengths of Horizontal Curves

Curve Length Based on Design Speed										
Design Speed (mph)	25	30	35	40	45	50	55	60	65	70
Arterials, Collectors (Length in feet = 15 x Design Speed, but not less than 400 feet)	400	450	525	600	675	750	825	900	975	1050
Freeways - Mainline (Length in feet = 30 x Design Speed)	--	--	--	--	--	1500	1650	1800	1950	2100

Curve Length Based on Deflection Angle					
Deflection Angle (degrees)	5°	4°	3°	2°	1°
Curve Length (feet)	500	600	700	800	900

Notes:

1. Horizontal curve length should be the greater of the length~~s~~ based on design speed and ~~length based on~~ deflection angle.
2. If the minimum curve lengths for arterials and collectors cannot be attained, provide the greatest attainable length possible, but not less than 400 feet.
3. If the minimum curve lengths for mainline freeways cannot be attained, provide the greatest attainable length possible, but not less than the lengths ~~used~~ for arterials and collectors.
4. Curve length ~~shall~~ must ~~provide for~~ allow at least 200 feet of full superelevation within the curve ~~of not less than 200 ft.~~ (r~~R~~ural) or 100 feet~~.~~ (u~~U~~rban).

Compound curves are sometimes used for turning roadways at intersections. A 2:1 ratio is acceptable between compound curve radii (where the flatter radius precedes the sharper radius in the direction of travel) ~~For turning roadways and intersections a ratio of 2:1 (where the flatter radius precedes the sharper radius in the direction of travel) is acceptable~~. See Table 3 – 9 for ~~The arc~~ compound curve arc lengths ~~of compound curves~~ for turning roadways (when followed by a curve of one-half radius or preceded by a curve of double radius) ~~should be as shown in Table 3 – 9 Length of Compound Curves on Turning Roadways~~.

Table 3 – 9 Length of Compound Curves on Turning Roadways

Radius (feet)	**100**	**150**	**200**	**250**	**300**	**400**	**≥ 500**
Desirable Arc Length (feet)	65	70	100	120	150	180	200
Minimum Arc Length (feet)	40	50	65	85	100	120	150

C.4.c Superelevation

~~In the design of street and highway curves, it is necessary to e~~ Establish a proper relationship between the roadway curvature ~~of the roadway~~ and the design speed. ~~The use of~~ Employ ~~s~~ superelevation (rotation of the roadway cross slope ~~about its axis~~) ~~is employed~~ where necessary to counteract centrifugal force and allow drivers to ~~comfortably and safely~~ travel comfortably through curves at the design speed.

The terms "r~~R~~ural" and "u~~U~~rban" ~~used in this section~~ reflect the location of the project. ~~In addition to the criteria provided below, additional information regarding superelevation given in~~ See the ***FDOT Design Manual***, and ***A Policy on Geometric Design of Highways and Streets (AASHTO, 2011)*** ~~, may be considered~~ for additional information.

C.4.c.1 Rural Highways, Urban Freeways and High-~~-~~Speed Urban Highways

See Table 3 – 10 for ~~The~~ superelevation rates for high-~~-~~speed (50 mph or greater) roadways ~~are provided in Table 3 – 10 Superelevation Rates for Rural Highways, Urban Freeways and High-Speed Urban Highways (e max =0.10)~~. These rates are based on Method 5 from the ***2011 AASHTO Greenbook*** using a maximum rate of 0.10 feeoot per foot of

~~roadway width~~. See Table 3 – 10 ~~also provides~~ for the minimum radius allowed ~~required~~ for normal crown without superelevation.

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C.4.c.2 Low-Speed Urban Roadways

~~For low speed (45 mph and less) roadways in urban areas, various factors~~ Several conditions combine to prevent ~~make~~ superelevation for low-speed (45 mph and less) urban roadways, ~~difficult, if not impractical, in many built-up areas. Such factors~~ includinge:

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

~~Superelevation rates for low speed urban roadways therefore rely more heavily on side friction than rates used for high speed roadways and t~~ The maximum superelevation rate for low-speed urban roadways is ~~set at~~ 0.05 feeoot per foot. ~~Separate c~~Criteria ~~are provided~~ for low-speed lLocal rRoads and~~vs.~~ lLow-speed aArterials and cCollectors are ~~as follows~~:

Low-Speed Urban Arterials and Collectors: See Table 3 – 11 for sSuperelevation rates for low-speed urban arterials and collectors ~~are provided in Table 3 – 11 Superelevation Rates for Low Speed Arterials and Collectors (emax = 0.05). These rates are~~ (based on ~~the~~ FDOT~~'s~~ superelevation criteria). ~~for low speed arterials and collectors.~~ See Table 3 – 11 ~~also provides~~ for the minimum radius ~~required~~ allowed for normal crown without superelevation.

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Low-Speed Local Roads: See Table 3 – 12 for mMinimum radii and ~~for design~~ superelevation rates for low-speed local roads ~~are provided in Table 3 – 12 Minimum Radii (feet) for Design Superelevation Rates, Low Speed Local Roads (emax = 0.05). These rates are~~ (based on Method 2 from the 2011 AASHTO Greenbook). See Table 3 – 12 ~~also provides~~ for the minimum radius allowed~~required~~ for normal crown ~~(-0.02 ft/ft)~~ without superelevation.

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Table 3 – 10 Superelevation Rates for Rural Highways, Urban Freeways and High-Speed Urban Highways (e max = 0.10)

Degree of Curve (degree)	Radius R (feet)	Tabulated Values – Design Speed (mph) 30	35	40	45	50	55	60	65	70
0° 15'	22,918	NC	NC	NC	NC	NC	NC	NC	NC	NC
0° 30'	11,459	NC	NC	NC	NC	NC	NC	RC	RC	RC
0° 45'	7,639	NC	NC	NC	NC	RC	RC	0.023	0.025	0.028
1° 00'	5,730	NC	NC	NC	RC	0.021	0.025	0.030	0.033	0.037
1° 15'	4,584	NC	NC	RC	0.022	0.026	0.031	0.036	0.041	0.046
1° 30'	3,820	NC	RC	0.021	0.026	0.031	0.037	0.043	0.048	0.054
	*R_{NC}									
2° 00'	2,865	RC	0.022	0.028	0.034	0.040	0.048	0.055	0.062	0.070
	*R_{RC}									
2° 30'	2,292	0.021	0.028	0.034	0.041	0.049	0.058	0.067	0.075	0.085
3° 00'	1,910	0.025	0.032	0.040	0.049	0.057	0.067	0.077	0.087	0.096
3° 30'	1,637	0.029	0.037	0.046	0.055	0.065	0.075	0.086	0.095	0.100
4° 00'	1,432	0.033	0.042	0.051	0.061	0.072	0.083	0.093	0.099	Dmax = 3° 30'
5° 00'	1,146	0.040	0.050	0.061	0.072	0.083	0.094	0.098	Dmax = 4° 15'	
6° 00'	955	0.046	0.058	0.070	0.082	0.092	0.099	Dmax = 5° 15'		
7° 00'	819	0.053	0.065	0.078	0.089	0.098	Dmax = 6° 30'			
8° 00'	716	0.058	0.071	0.084	0.095	0.100				
9° 00'	637	0.063	0.077	0.089	0.098	Dmax = 8° 15'				
10° 00'	573	0.068	0.082	0.094	0.100					
11° 00'	521	0.072	0.086	0.097	Dmax = 10° 15'					
12° 00'	477	0.076	0.090	0.099						
13° 00'	441	0.080	0.093	0.100						
14° 00'	409	0.083	0.096	Dmax = 13° 15'						
15° 00'	382	0.086	0.098							
16° 00'	358	0.089	0.099							
18° 00'	318	0.093	Dmax = 17° 45'							
20° 00'	286	0.097								
22° 00'	260	0.099								
24° 00'	239	0.100								
		Dmax = 24° 45'								

* NC/RC and RC/e Break Points (Radius in feet)

Break Points	Design Speed (mph) 30	35	40	45	50	55	60	65	70
R_{NC}	3349	4384	5560	6878	8337	9949	11709	13164	14714
R_{RC}	2471	3238	4110	5087	6171	7372	8686	9783	10955

e = NC *if* R ≥ R_{NC} e = RC *if* R < R_{NC} *and* R ≥ R_{RC}

NC = Normal Crown (-0.02) RC = Reverse Crown (+0.02)

R_{NC}= Minimum Radius for NC R_{RC} = Minimum Radius for RC

Interpolate sRates for intermediate D and R's ~~are to be interpolated~~.

Table 3 – 11 Superelevation Rates for Low-Speed Arterials and Collectors (e_{max} = 0.05)

Tabulated Values					
Degree of Curve D (degrees)	Radius R (feet.)	Design Speed (mph)			
		30	35	40	45
2° 00'	2,865	NC	NC	NC	NC
2° 15'	2,546				
2° 45'	2,083				NC
3° 00'	1,910				RC
3° 45'	1,528			NC	
4° 00'	1,432			RC	
4° 45'	1,206				
5° 00'	1,146		NC		
5° 15'	1,091		RC		
5° 30'	1,042				
5° 45'	996				
6° 00'	955				RC
6° 15'	917				0.022
6° 30'	881				0.024
6° 45'	849				0.027
7° 00'	819	NC			0.030
7° 15'	790	RC			0.033
7° 30'	764				0.037
7° 45'	739				0.041
8° 00'	716			RC	0.045
8° 15'	694			0.022	0.050
8° 30'	674			0.025	Dmax = 8° 15'
8° 45'	655			0.027	
9° 00'	637			0.030	
9° 30'	603			0.034	
10° 00'	573			0.040	
10° 30'	546		RC	0.047	
11° 00'	521		0.023	Dmax = 10° 45'	
11° 30'	498		0.026		
12° 00'	477		0.030		
13° 00'	441		0.036		
14° 00'	409	RC	0.045		
15° 00'	382	0.023	Dmax = 14° 15'		
16° 00'	358	0.027			
17° 00'	337	0.032			
18° 00'	318	0.038			
19° 00'	302	0.043			
20° 00'	286	0.050			
		Dmax = 20° 00'			

NC = Normal Crown (-0.02) RC = Reverse Crown (+0.02)

Interpolate rRates for intermediate D and R's ~~are to be interpolated~~.

**Table 3 – 12 Minimum Radii (feet) for Design Superelevation Rates
Low-- Speed Local Roads (e_{max} = 0.05)**

e - ft/ft	Design Speed (mph)							
	10	15	20	25	30	35	40	45
0.05	16	41	83	149	240	355	508	675
0.045	16	41	85	152	245	363	520	692
0.04	16	42	86	154	250	371	533	711
0.035	16	42	87	157	255	380	547	730
0.03	16	43	89	160	261	389	561	750
0.025	16	43	90	163	267	398	577	771
0.02	17	44	92	167	273	408	593	794
0.015	17	45	94	170	279	419	610	818
0.01	17	45	95	174	286	430	627	844
0.005	17	46	97	177	293	441	646	871
0	18	47	99	181	300	454	667	900
-0.01	18	48	103	189	316	480	711	964
-0.02	19	50	107	198	333	510	762	1038
-0.03[1]	19	52	111	208	353	544	821	1125
-0.04[1]	20	54	116	219	375	583	889	1227
-0.05[1]	20	56	121	231	400	628	970	1350

1. Use nNegative superelevation values rates (beyond -0.02 feet per foot) should be used only for unpaved surfaces such as gravel, crushed stone, and earth.

C.4.d Maximum Curvature/Minimum Radius

~~Where a directional change in alignment is required, every effort should be made to utilize~~ Use the smallest degree ~~(largest radius)~~ of curvature~~ature~~ (largest radius) possible for changes in direction. Avoid using ~~The use of~~ the maximum degree of curvature~~ature should be avoided~~ (when possible). ~~Design speed m~~ See Tables 3 – 10, 3 – 11, and 3 – 12 for maximum degree of curve ~~ature or~~ (minimum radius) for the maximum superelevation rates ~~are provided in Tables 3 – 10 Superelevation Rates for Rural Highways, Urban Freeways and High- Speed Urban Highways, 3 – 11 Superelevation Rates for Low Speed Arterials and Collectors, and 3 – 12 Minimum Radii (feet) for Design Superelevation Rates Low Speed Local Roads~~. ~~The use of~~ S~~s~~harper curvature ~~would call for~~ would require superelevation beyond the limit considered practical, ~~or for operation with tire friction beyond~~ safe, or comfortable ~~limits or both~~. The maximum degree of curvature ~~or~~ (minimum radius) is an important factor ~~significant value~~ in alignment design.

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

Superelevation runoff is ~~the general term denoting~~ the length of ~~street or highway~~roadway needed to transition the ~~change in~~ cross slope from ~~a section with the~~ adverse crown removed (RC ~~level~~) to ~~the~~ full~~y~~ superelevation~~ed section~~ and ~~, or~~ vice versa. Tangent runoff is ~~the general term denoting~~ the length of ~~street or highway~~roadway needed to transition the cross slope ~~accomplish the change in cross slope~~ from ~~a~~ normal crown (NC) to ~~cross section to a section with the~~ adverse crown removed (RC) ~~, or~~ and vice versa.

The standard superelevation transition places 80% of the transition on the tangent and 20% i~~o~~n the curve. ~~In transition sections where the travel lane(s) cross slope is less than 1.5 %,~~ Meet one of these ~~following~~ longitudinal grade criteria in transitions where the roadway cross slope is less than 1.5% ~~should be applied~~:

- Maintain a minimum longitudinal profile grade of 0.5%~~, or~~
- Maintain a minimum longitudinal edge of pavement grade of 0.2% (0.5% for curbed roadways).

~~When superelevation is required for curves in opposite directions on a common tangent (reverse curves), a~~ A suitable tangent length ~~distance~~ is required between the curves in opposite directions . This suitable tangent length should be determined as follows:

- Locate 80% of the transition for each curve should be located on the tangent.

- ~~The~~ A suitable tangent length is the sum of the two 80% distances, (or more) ~~greater~~.
- ~~Where alignment constraints dictate a less than desirable tangent length between curves, an adjustment of t~~ The 80/20 superelevation transition can be adjusted where alignment constraints dictate a less than desirable tangent length between curves ~~treatment is allowed~~ (~~where~~ up to 50% of the transition ~~may~~ can be ~~placed~~placed ~~i~~o~~o~~n the curve).

See Table 3 – 13 for s~~S~~uperelevation transition slope rates for computing transition lengths ~~used to compute transition lengths are provided in Table 3 – 13 Superelevation Transition Slope Rates~~. See t~~T~~he 2011 AASHTO Greenbook and the FDOT ***Standard Plans for Road and Bridge Construction***~~provides~~ for additional information on superelevation transitions ~~design~~.

~~The FDOT's **_Standard Plans for Road and Bridge Construction_** provide additional information on superelevation transitions for various sections and methods for determining length of transition.~~

Table 3 – 13 Superelevation Transition Slope Rates

Number of Lanes in One Direction	High Speed Roadways				Low Speed Roadways		
	Design Speed (mph)				Design Speed (mph)		
	25-40	45-50	55-60	65-70	25-35	40	45
1-Lane & 2-Lane	1:175	1:200	1:225	1:250	1:100	1:125	1:150
3-Lane	---	1:160	1:180	1:200			
4-Lane or more	---	1:150	1:170	1:190			

High-~~ ~~Speed Roadways:

1. Determine t~~T~~he length of superelevation transition ~~is to be determined~~ by the relative slope rate between the travel way edge of pavement and the profile grade line~~,~~ (~~except that~~ the minimum length of transition is 100 feet).
2. ~~For additional information on transitions, s~~ See the ***Standard Plans***, ***Index 000-510*** for additional information on transitions.

Low-~~ ~~Speed Roadways:

1. Determine t~~T~~he length of superelevation transition ~~is to be determined~~ by the relative slope rate between the travel way edge of pavement and the profile grade line~~,~~ (~~except that~~ the minimum length of transition is 50 feet for design speeds 25-35 mph and 75 feet~~.~~ for design speeds 40-45 mph).
2. A slope rate of 1:125 may be used for design speeds of 45 mph under restricted conditions.
3. ~~For additional information on transitions, s~~ See the ***Standard Plans***, ***Index 000-511*** for additional information on transitions.

Spiral curves may be used to transition from ~~the~~ a tangent to ~~the~~ a curve. ~~Where the spiral curve is employed, its~~ Accomplish the entire superelevation transition within the spiral curve ~~length is used to make the entire superelevation transition~~. See the ***2011 AASHTO Greenbook*** f~~F~~or additional information on ~~the use of~~ spiral curves~~, see the *2011 AASHTO Greenbook*~~.

C.4.f Sight Distance on Horizontal Curves

An adjustment in typical section or alignment may be needed Where there are where the removal of sight obstructions (such as walls, cut slopes, buildings, and longitudinal barriers) on the insides of curves is impractical (e.g., walls, slopes, buildings, or longitudinal barriers). or the inside of the median lane.

on divided highways and their removal to increase sight distance is impractical, a design may need adjustment in the normal highway cross section or alignment. With sight distance for the design speed as a control, m Make the appropriate adjustments to provide ensure adequate stopping sight distance. See Figures 3 – 1A and 3 – 1B Horizontal Sight Line Offset Distances for Stopping Sight Distance on Horizontal Curves and Figure 3 – 1B Diagram Illustrating Components for Determining Horizontal Sight Distance show the for horizontal sight line offsets needed for clear sight areas that satisfy the stopping sight distance criteria provided presented in Table 3 – 3 Minimum Stopping Sight Distances for horizontal curves of radii on flat grades.

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Figure 3 – 1A Horizontal Sight Line Offset Distances for Stopping Sight Distance on Horizontal Curves

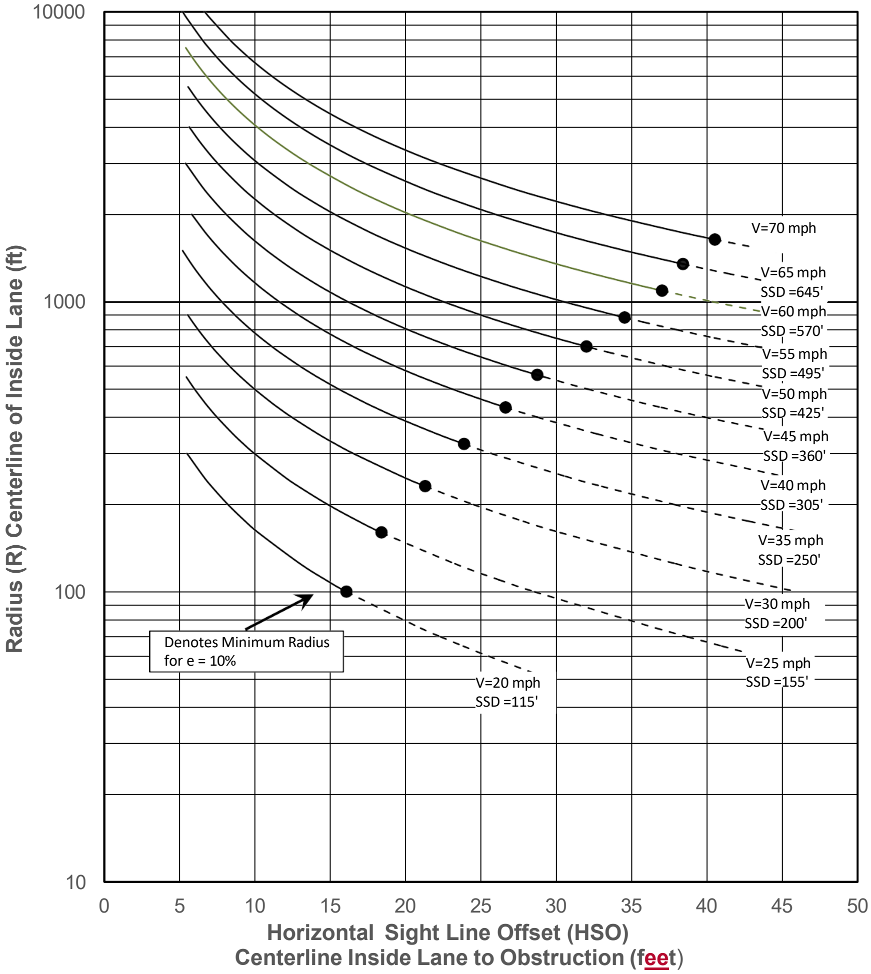
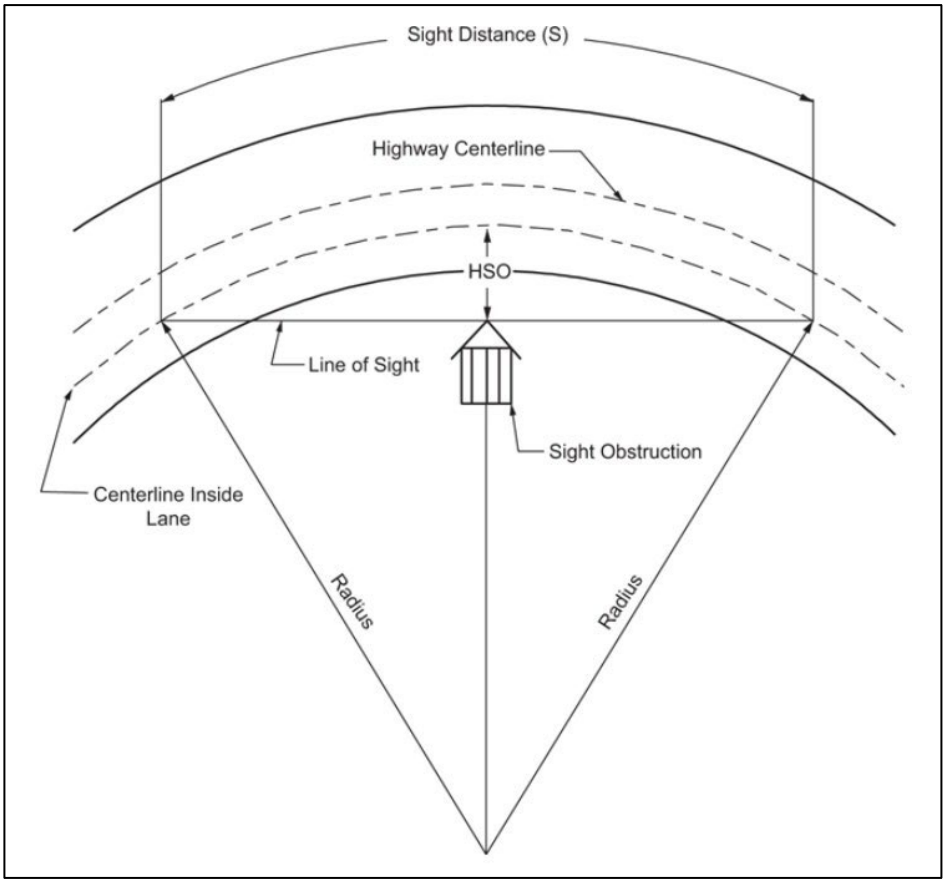


Figure 3 – 1B Diagram Illustrating Components for Determining Horizontal Sight Distance



HSO – Horizontal Sight Distance

Source: 2011 AASHTO Greenbook, Figure 3 – 23. ~~Diagram Illustrating Components for Determining Horizontal Sight Distance~~

Table 3 – 14 Horizontal Curvature

Lateral Clearance from Edge of Traveled Way to Obstruction f~~F~~or Maximum Curvature (Degrees), Based on Line of Sight ~~On~~ for the Inside Lane (Lateral Clearance = $M_{\text{Inside Lane}}$ – 6 feet~~'~~) Based on e_{MAX} = 0.10		
Design Speed (mph)	**Maximum Curvature**	**Clearance (feet)**
20	57° 45’	11
25	36° 15’	13
30	24° 45'	16
35	17° 45'	19
40	13° 30'	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.g Lane Widening on Curves

Increase tThe traveled way width should be widened along small-radius harp curves to accommodate wider turning vehicle paths 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 The rear wheels may of trucks and transit vehicles track considerably inside their front wheels thus requiring additional width. See Tables 3 – 15A and 3 – 15B for Adjustments to traveled way width adjustments for mainline and turning roadways. are given in Tables 3 – 15A Calculated and Design Values for Traveled Way Widening on Open Highway Curves (Two-Lane Highways, One-Way or Two-Way and 3 – 15B Adjustments or Traveled Way Widening Values on Open Highway Curves (Two-Lane Highways, One-Way or Two-Way. Use a A 50:1 minimum transition length shall be introduced in changing to an increased/decreased to increase or decrease lane width. This transition length shall be proportional to the increase/decrease in traveled way width in a ratio of not less than 50 feet of transition length for each foot of change in lane width.

Table 3 – 15A 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	0.7	0.7	0.8	0.8	0.9	1.0	1.0	1.7	1.7	1.8	1.8	1.9	2.0	2.0
6500	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.7	1.8	1.8	1.9	2.0	2.0	2.1
6000	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	2.0	2.1
5500	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.8	0.9	0.9	1.0	1.1	1.1	1.2	1.8	1.9	1.9	2.0	2.1	2.1	2.2
5000	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.9	0.9	1.0	1.1	1.1	1.2	1.3	1.9	1.9	2.0	2.1	2.1	2.2	2.3
4500	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.9	1.0	1.1	1.1	1.2	1.3	1.4	1.9	2.0	2.1	2.1	2.2	2.3	2.4
4000	0.0	0.1	0.2	0.2	0.3	0.4	0.5	1.0	1.1	1.2	1.2	1.3	1.4	1.5	2.0	2.1	2.2	2.2	2.3	2.4	2.5
3500	0.1	0.2	0.3	0.4	0.5	0.5	0.6	1.1	1.2	1.3	1.4	1.5	1.5	1.6	2.1	2.2	2.3	2.4	2.5	2.5	2.6
3000	0.3	0.4	0.4	0.5	0.6	0.7	0.8	1.3	1.4	1.4	1.5	1.6	1.7	1.8	2.3	2.4	2.4	2.5	2.6	2.7	2.8
2500	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.5	2.6	2.7	2.8	2.9	3.0	3.1
2000	0.7	0.9	1.0	1.1	1.2	1.3	1.4	1.7	1.9	2.0	2.1	2.2	2.3	2.4	2.7	2.9	3.0	3.1	3.2	3.3	3.4
1800	0.9	1.0	1.1	1.3	1.4	1.5	1.6	1.9	2.0	2.1	2.3	2.4	2.5	2.6	2.9	3.0	3.1	3.3	3.4	3.5	3.6
1600	1.1	1.2	1.3	1.5	1.6	1.7	1.8	2.1	2.2	2.3	2.5	2.6	2.7	2.8	3.1	3.2	3.3	3.5	3.6	3.7	3.8
1400	1.3	1.5	1.6	1.7	1.9	2.0	2.1	2.3	2.5	2.6	2.7	2.9	3.0	3.1	3.3	3.5	3.6	3.7	3.9	4.0	4.1
1200	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	4.1	4.2	4.4	4.5
1000	2.1	2.3	2.4	2.6	2.7	2.9	3.0	3.1	3.3	3.4	3.6	3.7	3.9	4.0	4.1	4.3	4.4	4.6	4.7	4.9	5.0
900	2.4	2.6	2.7	2.9	3.1	3.2		3.4	3.6	3.7	3.9	4.1	4.2		4.4	4.6	4.7	4.9	5.1	5.2	
800	2.7	2.9	3.1	3.3	3.5	3.6		3.7	3.9	4.1	4.3	4.5	4.6		4.7	4.9	5.1	5.3	5.5	5.6	
700	3.2	3.4	3.6	3.8	4.0			4.2	4.4	4.6	4.8	5.0			5.2	5.4	5.6	5.8	6.0		
600	3.8	4.0	4.2	4.4	4.6			4.8	5.0	5.2	5.4	5.6			5.8	6.0	6.2	6.4	6.6		
500	4.6	4.9	5.1	5.3				5.6	5.9	6.1	6.3				6.6	6.9	7.1	7.3			
450	5.2	5.4	5.7					6.2	6.4	6.7					7.2	7.4	7.7				
400	5.9	6.1	6.4					6.9	7.1	7.4					7.9	8.1	8.4				
350	6.8	7.0	7.3					7.8	8.0	8.3					8.8	9.0	9.3				
300	7.9	8.2						8.9	9.2						9.9	10.2					
250	9.6							10.6							11.6						
200	12.0							13.0							14.0						

Source: 2011 AASHTO Greenbook, Table 3 – 26b ~~Calculated and Design values for Traveled Way Widening on Open Highway Curves~~.

Notes: 1. Values ~~shown~~ are for WB-62 design vehicle and represent widening in feet. ~~For other design vehicles, u~~ Use the adjustments in Table 3-15B for other design vehicles.

2. Values less than 2.0 feet may be disregarded. ~~, For 3-lane roadways~~ ~~For 3-lane roadways, m~~ Multiply these values ~~above values~~ by 1.5 for 3-lane roadways.

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Table 3 – 15B 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-30	WB-40			WB-67	WB-67D
7000	-1.2	-1.2			0.1	-0.1
6500	-1.3	-1.2			0.1	-0.1
6000	-1.3	-1.2			0.1	-0.2
5500	-1.3	-1.2			0.1	-0.2
5000	-1.3	-1.3			0.1	-0.2
4500	-1.4	-1.3			0.1	-0.2
4000	-1.4	-1.3			0.1	-0.2
3500	-1.5	-1.4			0.1	-0.3
3000	-1.6	-1.4			0.1	-0.3
2500	-1.7	-1.5			0.2	-0.4
2000	-1.8	-1.6			0.2	-0.5
1800	-1.9	-1.7			0.2	-0.5
1600	-2.0	-1.8			0.2	-0.6
1400	-2.2	-1.9			0.3	-0.6
1200	-2.4	-2.1			0.3	-0.8
1000	-2.7	-2.3			0.4	-0.9
900	-2.8	-2.4			0.4	-1.0
800	-3.1	-2.6			0.5	-1.1
700	-3.4	-2.9			0.6	-1.3
600	-3.8	-3.2			0.7	-1.5
500	-4.3	-3.6			0.8	-1.8
450	-4.7	-3.9			0.9	-2.0
400	-5.2	-4.3			1.0	-2.3
350	-5.8	-4.7			1.1	-26
300	-6.6	-5.4			1.3	-3.0
250	-7.7	-6.3			1.6	-3.6
200	-9.4	-7.6			2.0	-4.6

Source: 2011 AASHTO Greenbook, Table 3 - 27 ~~Adjustments for Traveled Way Widening Values on Open Highway Curves~~.

Notes:
1. Apply adjustments ~~are applied~~ by adding to or subtracting from the values in Table 3-15A.
2. Adjustments depend ~~only~~ on radius and design vehicle only~~; they~~ and are independent of traveled way width and design speed.
3. ~~For 3-lane roadways, m~~ Multiply these values ~~above values~~ by 1.5 for 3-lane roadways.
4. ~~For 4-lane roadways, m~~ Multiply these values ~~above values~~ by 2.0 for 4-lane roadways.

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C.5 Vertical Alignment

C.5.a General Criteria

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

- Obtaining Provide maximum sight distances,
- Limiting speed differences (particularly for trucks and buses) by reducing the magnitude and length of steeper grades,
- Avoid "hidden dips" which might would not be apparent to the driver must be avoided,.
- Avoid sSteep grades and sharp crest vertical curves should be avoided at or near intersections, and.
- Use fFlat grades and long gentle vertical curves should be used whenever possible.

C.5.b Grades

See Table 3 – 16 for maximum profile The grades selected for vertical alignment should be as flat as practical, and should not be greater than the value given in Table 3 – 16 Maximum Grades in Percent.

For streets and highways requiring long upgrades, t The maximum grade of long upgrades should be as small as possible reduced so the to limit the speed reduction of of slow-moving vehicles (e.g., trucks and buses) is not greater to less than 10 mph (see Figure 3 – 2). The critical lengths of grade for these speed reductions are shown in Figure 3 – 2 Critical Length Versus Upgrade. Where reduction of grade is not practical, Provide climbing lanes should be provided to meet address these speed reduction limitations where reducing upgrades is not practical.

The criteria for a climbing lane and shoulders and the adjacent shoulder are are the same as for any travel lane. except that Designate the climbing lane should be clearly designated by the with appropriate pavement markings. Use the same criteria for eEntrances to and exits from the climbing lane shall follow the same criteria as for other merging maneuvers. traffic lanes; however, Avoid terminating the a climbing lane should not be terminated until well beyond the crest of the a vertical curve. Differences in superelevation (or cross slope) should not be sufficient to produce a change in pavement cross slope between the climbing lane and through lane should not be ~~in excess of~~ more than 0.04 feet per foot.

Recommended minimum gutter grades:

Rolling terrain - 0.5% Flat terrain - 0.3%

Table 3 – 16 Maximum Grades (in Percent)

Type of Roadway		Level Terrain											Rolling Terrain										
		Design Speed (mph)											Design Speed (mph)										
		20	25	30	35	40	45	50	55	60	65	70	20	25	30	35	40	45	50	55	60	65	70
Freeway[1]		---	---	---	---	---	---	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[2]	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[3]	Rural	8	7	7	7	7	7	6	6	5	---	---	11	11	10	10	10	9	8	7	6	---	---

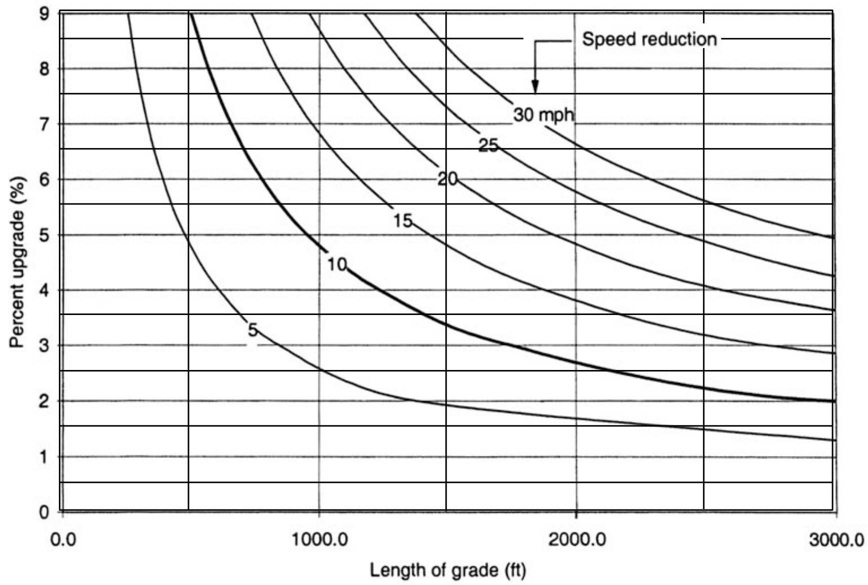
Source: 2011 AASHTO Greenbook, Tables 5–2, 6–2, 6–8, 7–2, 7–4, 8–1.

Notes: 1. Profile g~~G~~rades 1% steeper than these values are allowed ~~shown may be provided~~ in urban areas with ~~right of way~~ R/W constraints.

2. Short lengths ~~of grade~~ (≤ 500 feet ~~in length~~)~~,~~ of one-way downgrades, ~~,~~ and grades on low-~~-~~volume collectors may be ~~up to~~ 2% steeper than these grades ~~shown above~~.

3. Residential street profiles ~~grade~~ should be as level as practical, consistent with the surrounding terrain, and less than 15%. Street profiles ~~s~~ in commercial ~~or~~ and industrial areas should ~~have grades~~ be less than 8%~~, and~~ (flatter grades are ~~should be~~ encouraged).

Figure 3 – 2 Critical Length Versus Upgrade



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

Source: 2011 AASHTO Greenbook, Figure 3-28.

C.5.c Vertical Curves

Accomplish c~~C~~hanges in grade that exceed the values in Table 3 – 17 ~~should be connected by a~~ with parabolic curves (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 – 17 Maximum Change in Grade Without Using Vertical Curve.~~ See Table 3 – 18 ~~Rounded K Values for Minimum Lengths Vertical Curves provides~~ for additional information.

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Establish t~~T~~he length of crest vertical curve~~s~~s to provide ~~on a crest, as governed by~~ the minimum stopping sight distances ~~, is obtained from~~ required by Figure 3 – 3 ~~Length of Crest Vertical Curve (Stopping Sight Distance)~~. Use the K-values in Table

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3 – 19 The to calculate the minimum length for passing sight distance on crest vertical curves shall be based on the K-values as shown in Table

~~3 – 19 Design Controls for Crest Vertical Curves (Passing Sight Distance)~~. See Figure 3 – 4 for ~~The~~ minimum sag vertical curve lengths ~~of a sag vertical curve~~ (as dictated by vehicle headlight capabilities)~~on open road conditions, as governed by vehicle headlight capabilities, is obtained from Figure 3 – 4 Length of Sag Vertical Curve (Headlight Sight Distance)~~.

~~Wherever feasible,~~ Consider longer vertical curves ~~longer than the minimum should be considered~~ (where feasible) to improve ~~both~~ aesthetics and safety ~~characteristics~~.

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Table 3 – 17 Maximum Change in Grade Without Using Vertical Curve

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

Table 3 – 18 Rounded K Values for Minimum Vertical Curve Lengths ~~Vertical Curves~~
(Stopping Sight Distance)

(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 (feet), A = Algebraic Difference of Grades (%) ~~in Percent~~

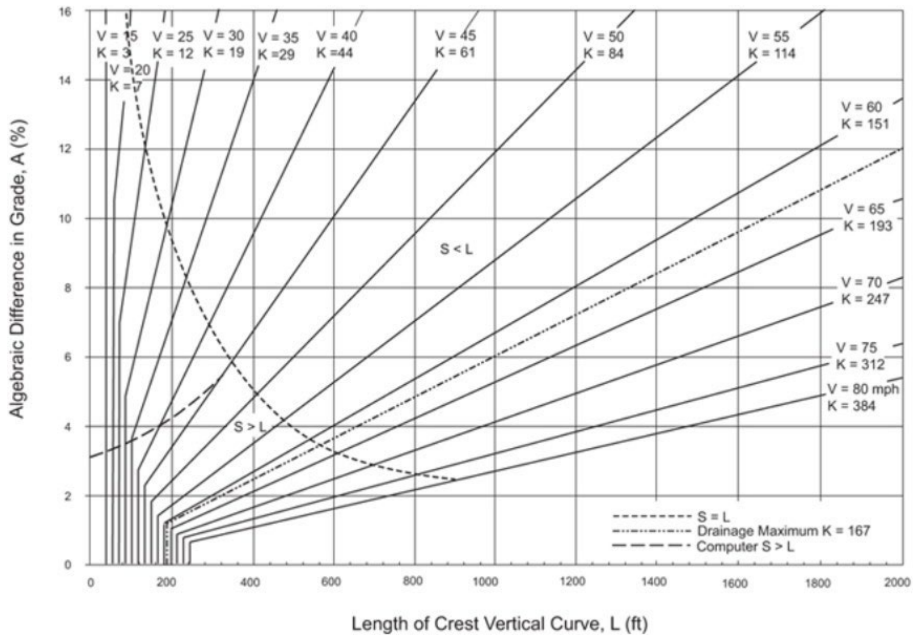
Design Speed (mph)	20	25	30	35	40	45	50	55	60	65	70
K Values for Crest Vertical Curves	7	12	19	29	44	61	84	114	151	193	247
K Values for Sag Vertical Curves	17	26	37	49	64	79	96	115	136	157	181

- The length of vertical curve ~~must never~~ cannot be less than three times the roadway design speed ~~of the highway~~.
- Round c~~C~~urve lengths computed from the formula L = KA ~~should be rounded~~ upward when feasible.
- See t~~T~~he table below for minimum lengths of vertical curves ~~to be used on~~ for collectors, arterials and freeways ~~are shown in the table below~~:

Minimum Lengths of ~~for~~ Vertical Curves
on Collectors, Arterials, and Freeways (feet)

Design Speed (mph)	50	60	70
Crest Vertical Curves (feet)	300	400	500
Sag Vertical Curves (feet)	200	300	400

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



Source: Figure 3-43 ~~Design Controls for Crest Vertical Curves – Open Road Conditions~~, 2011 AASHTO Greenbook

Compute ~~Lengths of c~~ crest vertical curve lengths ~~s are computed~~ ~~from~~ using these formulas:

When S is less than L, $L=AS^2/2158$

When S is ~~greater~~ more than L, L=2S – (2158/A)

A = Algebraic Difference i~~I~~n Grades (%)~~In Percent~~
S = Sight Distance (feet)
L = Minimum Length of Vertical Curve ~~In~~ (f~~F~~eet)

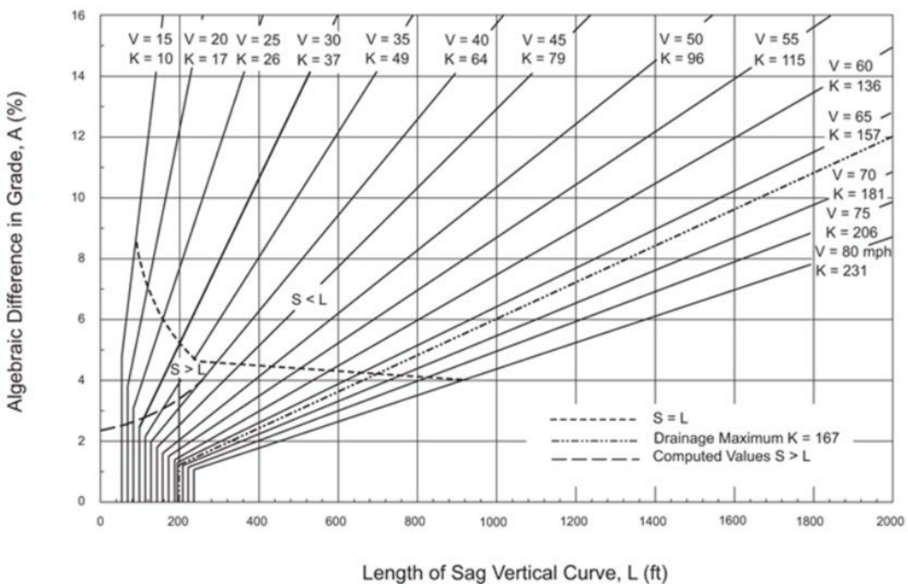
Table 3 – 19 Design Controls for Crest Vertical Curves (Passing Sight Distance)

Based upon an eye height of 3.50 feet and an object height of **3.5** feet above the road surface.)		
L = KA L = Length of Vertical Curve (feet), A = Algebraic Difference of Grades (%) in Percent		
Design Speed (mph)	Passing Sight Distance (feet)	Rate of Vertical Curvature, K[a]
20	400	57
25	450	72
30	500	89
35	550	108
40	600	129
45	700	175
50	800	229
55	900	289
60	1000	357
65	1100	432
70	1200	514
[a] The rRate of vertical curvature, (K), is the length of curve (L) per percent divided by the algebraic difference in intersecting grades (A), K = L/A.		

Source: Table 3-35 Design Controls for Crest Vertical Curves Based on Passing Sight Distance, 2011 AASHTO Greenbook.

For further information on both crest and sag vertical curves, s See Section 3.4.6 Vertical Curves of the ***AASHTO Greenbook (2011)*** for additional information on crest and sag vertical curves.

Figure 3 – 4 Length of Sag Vertical Curve (Open Road Conditions)



Source: Figure 3-44 ~~Design Controls for Sag Vertical Curves – Open Road Conditions~~, 2011 AASHTO Greenbook.

Compute ~~Lengths of~~ sag vertical curve lengths ~~s are computed from~~ using these formulas:

When S is less than L, $L=AS^2/(400 + 3.5S)$

When S is more ~~greater~~ than L, $L=2S – ((400 + 3.5S)/A)$

L = Length of Sag Vertical Curve (~~,~~ feet)
A = Algebraic Difference in Grades~~,~~ (percent)
S = Light Beam Distance~~,~~ (feet)

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C.6 Alignment Coordination

Design h~~H~~orizontal and vertical alignments ~~should not be designed~~ in unison ~~independently~~. ~~Poor combinations can spoil the good points of a design.~~ Properly ~~coordinated~~ coordinated horizontal and vertical alignments: ~~can~~

- I~~i~~mprove appearance,
- E~~e~~nhance community cohesion~~values~~,
- I~~i~~ncrease safety, and
- E~~e~~ncourage uniform travel speeds.

Begin c~~C~~oordinating ~~on of~~ the horizontal and vertical alignments ~~alignment should begin with~~ during preliminary design~~, during which stage~~ (when adjustments can be ~~readily~~ made more easily).

Consider these general controls for achieving p~~P~~roper combinations of horizontal and vertical alignments ~~and profile can be obtained by engineering study and consideration of the following general controls~~:

- Curvature and grades should be in proper balance. Tangent horizontal alignment ~~or flat curvature~~ with steep grades, and excessive curvature with flat grades are both undesirable. ~~poor design. A logical design is a compromise between the two conditions. Wherever feasible t~~ The roadway should "roll with" rather than "buck" the terrain where feasible.
- Superimposing the v~~V~~ertical curvature ~~superimposed~~ on the horizontal curvature~~, or vice versa, generally~~ typically yields ~~results in~~ a more pleasing facility~~, but it should be analyzed for effect on driver's view and operation~~. Changes in ~~profile~~ vertical alignment that are not ~~in co~~ coordinated ~~mbination~~ with horizontal alignment ~~may result in~~ may yield a series of disconnected humps ~~to the driver for some distance~~.
- Avoid introducing s~~S~~harp 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~~ Avoid this condition by establishing ~~setting the~~ horizontal curve ~~e so it~~ to lead~~s~~ the vertical curve or by ~~making~~ lengthening the horizontal curve ~~longer~~. ~~Suitable design can be made by using design values well~~ Use dimensions that ~~above~~ exceed the minimums where possible.
- Avoid introducing s~~S~~harp horizontal curvature ~~should not be introduced at or~~ near the ~~low point~~ bottom of a ~~pronounced~~ sag vertical curve ~~to prevent an~~

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~~undesirable distorted appearance. Vehicle~~ as travel speeds are ~~often~~ typically higher at the bottom of downgrades ~~and erratic operation may result, especially at night~~.

- ~~On divided highways,~~ Consider varying ~~iation of~~ the median width of divided roadways ~~and~~ or ~~the~~ using ~~e of~~ independent vertical and horizontal alignments ~~should be considered~~. ~~Where right of way is available,~~ Independent alignments can provide a superior design without significant additional costs (where R/W allows) ~~can result from the use of independent alignment~~.
- Make vertical and h~~H~~orizontal alignments ~~and profile should be made~~ as flat as possible at interchanges and intersections where sight distance is critical ~~along both highways is important~~. Provide s~~S~~ight distances ~~above~~ exceeding the minimums ~~are desirable at~~ in these locations.

- Design a~~A~~lignments ~~should be designed~~ to enhance scenic views ~~for the motorists~~.
- ~~In residential areas,~~ Design ~~the~~ alignments ~~should be designed to~~ to minimize ~~nuisance~~ impacts to ~~the~~ residential neighborhoods.

C.7 Cross Section Elements

~~The design of the street or highway~~ Base the design of the roadway cross section on: ~~should be predicated upon the~~

- D~~d~~esign speed,
- T~~t~~errain,
- A~~a~~djacent land uses,
- Functional classification,
- Context classification, and
- T~~t~~he type and volume of traffic expected.

The proposed cross section ~~selected~~ should be uniform ~~throughout a given length of street or highway~~ without frequent or abrupt changes. See ***Chapter 4*** ~~***– Roadside Design***~~ for ~~design~~ criteria for:

- R~~r~~oadside design,
- C~~c~~lear zone,
- L~~l~~ateral offset, and
- R~~r~~oadside ditches located within the clear zone.

~~C.7.a~~C.7.b Number of Lanes

Establish t~~T~~he number of travel lanes ~~is determined by several interrelated factors such as~~ based on capacity, LOS~~level of service~~, and service volume. ~~Further information on determining the optimum number of travel lanes can be found in~~ See ***A Policy on Geometric Design of Highways and Streets (AASHTO, 2011)***, and the ***Highway Capacity Manual (TRB, 2010)*** for determining the optimum number of travel lanes.

~~C.7.b~~C.7.c Pavement

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Design t~~T~~he paved roadway surface ~~of roadways shall be designed and constructed in accordance~~ to comply with the requirements ~~set forth~~ in ***Chapter 5*** ~~***- Pavement Design and Construction***.~~

~~C.7.b.1~~C.7.c.1 Pavement Width

See Table 3 – 20 for m~~M~~inimum ~~lane~~ widths ~~for~~ of:

- T~~t~~ravel lanes,
- S~~s~~peed change lanes,
- T~~t~~urn lanes, and
- P~~p~~assing lanes ~~are provided in Table 3 – 20 Minimum Lane Widths~~.

The table applies to both divided and undivided facilities. ~~For Information on parking lanes, s~~ See Section C.7.h ~~Parking~~ of this chapter for parking lanes ~~of this Chapter~~.

~~On existing multilane curbed streets where there is insufficient space for a separate bicycle lane, consideration should be given to using unequal-width~~ Consider providing wider outside lanes~~s~~ on multilane curbed roadways where there is not enough space for a separate bicycle lane, thereby: ~~. In such cases, the wider lane is located on the outside (right). This provides~~

- Providing m~~m~~ore space for the larger vehicles that usually occupy that lane~~, provides~~
- Providing m~~m~~ore space for bicycles, and
- A~~a~~llowing ~~s~~ drivers to stay further ~~keep their vehicles at a greater distance~~ from the right edge.

See ***Chapter 9*** ~~***– Bicycle Facilities***~~.

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Table 3 – 20 Minimum Lane Widths

Facility		ADT (vpd)	Design Speed (mph)	Lane Width – (feet)		
				Travel Lanes[1]	Turn Lanes[6] (LT/RT/MD)	Passing Lanes
Freeway	Rural	All	All	12	--	--
	Urban	All	All	12	--	--
Arterial	Rural	All	All	12[9]	12[9]	12[9]
	Urban	All	≥ 50	12	12	12
		All	≤ 45	11[3, 4]	11[3, 4, 7]	11[3, 4]
Collector	Rural	> 1500	All	12[9]	12[9]	12[9]
		401 to 1500	All	11[3, 4]	11[3, 4]	--
		≤ 400	≥ 50	11	11[7]	--
			≤ 45	10	10	--
	Urban	All	All	11[2, 3, 4]	11[2, 7]	--
Local	Rural	> 1500	All	12[9]	12[9]	12[9]
		401 to 1500	All	11[3, 4]	11[3, 4]	--
		≤ 400	≥ 55	11[3]	11[3, 4]	--
			45 to 50	10	10	--
			≤ 40	9	9	--
	Urban	All	All	10[2, 5]	10[8]	--
See Footnotes on next page						

Footnotes

1. Provide a~~A~~ minimum ~~traveled~~ roadway width equal to the width of two adjacent travel lanes (one way or two way) ~~shall be provided~~ on all rural facilities.

2. Provide 12-foot wide travel lanes i~~I~~n industrial areas and where truck volumes are significant~~, 12' lanes should be provided, but~~ (may be reduced to 11 feet~~'~~ where ~~right of way~~ R/W is constrained).

3. 10-foot wide travel lanes can be used i~~I~~n constrained areas where truck volumes are low and design speeds are < 35 mph~~, 10' lanes may be used~~.

4. Provide 11-foot wide minimum outside travel lanes o~~O~~n roadways with a transit route~~, a minimum of 11' outside lane width is required~~.

5. 9-foot wide travel lanes can be used i~~I~~n residential areas where ~~right of way~~ R/W is severely limited~~, 9' may be used~~.

6. Turn lane widths in raised or grass medians ~~shall not~~ cannot exceed 14 feet~~'~~. Two-way left~~-~~turn lanes should be 11 to~~–~~ 14 feet~~'~~ wide and ~~may~~ can only be used on 3-lane and 5-lane typical sections with design speeds ≤ 40 mph. ~~On projects with right of way constraints, the minimum~~ Turn lane widths can ~~may~~ be reduced to 10 feet for projects with R/W constraints. ~~'.~~ Two-way left~~-~~turn lanes ~~shall~~ must include sections of raised or restrictive median for pedestrian refuge.

7. Turn l~~L~~ane widths should be the same as the t~~T~~ravel l~~L~~anes~~ width. M~~ (but may be reduced to 10 feet~~'~~ where ~~right of way~~ R/W is constrained and to 9 feet where truck volumes are low).~~.~~

~~8. Turn Lane width should be same as Travel Lane width. May be reduced to 9' where truck volumes are low.~~

~~9.~~8. 11-foot lane widths are acceptable f~~F~~or design speeds ~~below~~below 50 mph~~, lane widths of 11 feet are acceptable~~.

~~C.7.b.2~~C.7.c.2 Traveled Way Cross Slope (not in superelevation)

The ~~selection of~~ traveled way cross slope should be a compromise between:

- M~~m~~eeting ~~the~~ pavement drainage requirements, and
- P~~p~~roviding for smooth vehicle operation.

The recommended traveled way cross slope is 0.02 feet per foot. ~~When three lanes in each direction are necessary, t~~ The outside lanes of a 6-lane roadway should have ~~a~~ cross slopes of 0.03 feet per foot. ~~The~~ Pavement cross slope ~~shall~~ cannot be less than 0.015 feet per foot or ~~greater~~ more than 0.04 feet per foot. The change in

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cross slope between adjacent through ~~travel~~ lanes should not exceed 0.04 feet per foot.

~~C.7.c~~C.7.dShoulders

The primary functions of ~~a~~ shoulder**s** are: ~~to provide~~

- E~~e~~mergency parking for disabled vehicles and
- A~~a~~n alternate path for vehicles during avoidance ~~or other~~ and emergency maneuvers. ~~In order to fulfill these functions satisfactorily, t~~

The shoulder should have adequate stability and surface characteristics to serve these functions~~. The design and construction of shoulders shall be in accordance with the requirements given in~~ See ***Chapter 5*** ~~***- Pavement Design and Construction***~~ for shoulder design and construction requirements.

~~Shoulders should be provided~~ Provide shoulders on all ~~streets and highways incorporating open drainage~~ uncurbed roadways to promote safety and operations. ~~. 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 c~~w~~ould prevent ~~the~~ a driver from retaining or regaining vehicle control.

Provide p~~P~~aved outside shoulders ~~are required for~~ on rural high~~-~~speed multilane roadways to: ~~highways and freeways. They~~

- Improve pavement drainage,
- P~~p~~rovide added safety for~~to~~ all users, and ~~the motorist, public transit and pedestrians, for accommodation of bicyclists,~~
- R~~r~~educe~~d~~ shoulder maintenance costs~~, and improved drainage~~.

~~C.7.c.1~~C.7.d.2 Shoulder Width

A shoulder is the portion of the roadway contiguous with the traveled way that:

- A~~a~~ccommodates stopped vehicles, ~~,~~
- Accommodates emergency uses, and
- P~~p~~rovides lateral support of the subbase, base and surface courses. ~~In some cases, the s~~

Shoulders may also accommodate pedestrians ~~or~~ and bicyclists. Shoulders may be ~~surfaced~~ fully or partially paved ~~either full or partial width~~ and may include turf, gravel, shell, and asphalt or concrete pavements.

~~The minimum width of outside and median shoulders is provided in~~

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See Table 3 – 21 Minimum Shoulder Widths for Flush Shoulder Highways for minimum shoulder widths (left/outside and right/median). Minimum sShoulder widths for two-lane, two-way highways are based upon traffic volumes. Minimum sShoulder widths for multi-lane highways are based upon the number of travel lanes in each direction. Where bicyclists or pedestrians are to be accommodated on the shoulder, a Provide a minimum 4-foot wide minimum outside usable paved shoulder width of 4 feet is required (5 feet if adjacent to a barrier) where pedestrians and bicyclists are anticipated. On approaches to narrow bridges where the paved shoulder is reduced, See the FDOT's ***Standard Plans*** provide information on for signing and pavement markings where shoulder widths are reduced approaching narrow bridges the approaching shoulder.

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Table 3 – 21 Minimum Shoulder Widths for Flush Shoulder Highways

Two Lane Undivided

Design Speed (mph)	Average Daily Traffic (2 – Way)		
	0 - ≤400	401 - 750	>750 -
All	2 feet	6 feet	8 feet

Multilane Divided

Number of Lanes Each Direction	Shoulder Width (feet)			
	Outside		Median	
	Roadway	Bridge	Roadway	Bridge
2	8 (min~~.~~)	8	4 (min~~.~~)	4
3 or more	10 (min~~.~~)	10	6 (min~~.~~)	6

~~C.7.c.2~~C.7.d.3 Shoulder Cross Slope

~~The s~~ Shoulder cross slopes should be steeper than the adjacent travel lane to promote pavement drainage ~~serves as a continuation of the drainage system; therefore, the shoulder cross slope should be somewhat greater than the adjacent traffic lane~~. ~~The~~ Shoulder cross slopes ~~of shoulders~~ should be within the ranges s ~~given~~ provided in Table 3 – 22 ~~Shoulder Cross Slope~~.

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Table 3 – 22 Shoulder Cross Slope

	Shoulder Type		
	Paved	**Gravel or Crushed Rock**	**Turf**
Shoulder Cross Slope ~~(Percent)~~	2% to 6%	4% to 6%	6% to 8%

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

Source – 2011 AASHTO Greenbook, Section 4.4.3 ~~Shoulder Cross~~

~~Sections~~.

~~Whenever possible, s~~ Slope shoulders ~~should be sloped~~ away from the traveled way where possible ~~to aid in their drainage~~. The combination of shoulder cross slope and surface texture ~~should be sufficient to~~ should promote ~~rapid~~ drainage and ~~to avoid~~ prevent the retention of surface water. The maximum algebraic difference in cross slope between the traveled way and adjacent shoulder should not be ~~greater~~ more than 0.07 feet per foot. Round the s~~S~~houlders on the outsides of superelevated roadways ~~curves~~ (using vertical curves) ~~should be rounded (vertical curve)~~ to avoid an excessive break in cross slope and to divert ~~a portion~~ some of the shoulder drainage away from the adjacent traveled way.

~~C.7.d~~C.7.e Sidewalks and Shared Use Paths

The design of sidewalks and shared use paths is affected by: ~~many factors, including~~

- T~~t~~raffic characteristics,
- P~~p~~edestrian volumes, and
- R~~r~~oadway type~~, and other design elements~~.

See ***Chapter 8*** ~~***- Pedestrian Facilities***~~ and ***Chapter 9*** ~~***– Bicycle Facilities***~~ of this m~~M~~anual and ***A Policy on Geometric Design of Highways and Streets (AASHTO, 2011)***~~, present~~ for ~~the various~~ factors that influence the design of sidewalks and other pedestrian facilities.

Provide s~~S~~idewalks and/or shared use paths ~~should be constructed in conjunction with~~ for new construction and major reconstruction projects ~~in or~~ within one mile of an urban area. ~~As a general rule,~~ S~~s~~idewalks should generally be ~~constructed~~ provided on both sides of the roadway. Exceptions ~~may~~ can be made where physical barriers (e.g., a canal or railroad ~~paralleling~~ along one side ~~of the roadway~~) ~~would substantially~~ reduce the expectation of pedestrian use ~~of one~~ along that side ~~of the roadway~~. ~~Also, if only one side is possible,~~ Provide ~~s~~ a sidewalk~~s should be available on~~ along the same side of the road as transit stops and~~or~~ other pedestrian generators (when only one side is possible).

Base t~~T~~he decision to ~~construct~~ provide a sidewalk or shared use path in ~~a~~ rural areas ~~should be based~~ on:

- E~~e~~ngineering judgment, ~~, after~~
- O~~o~~bservation of existing pedestrian traffic, or ~~expectation of additional~~
- Expected future demand.

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Construct sSidewalks and shared use paths shall be constructed as defined described in this mManual. See ***Chapter 8 – Pedestrian Facilities*, *Chapter 10 – Maintenance and Resurfacing*** and ***Section C.10.a.3 – Sidewalks and Curb Ramps*** of this chapter provide for additional detailed information. See ***AASHTO's Guide for the Planning, Design and Operation of Pedestrian Facilities (2004)***, and ***Section 4.17.1 Sidewalks*** of ***AASHTO's Policy on Geometric Design of Highways and Streets (2011)*** provide for additional information.

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See t~~T~~he ***Highway Capacity Manual, Volume 3, Chapter 23*~~*, Off-Street Pedestrian and Bicycle Facilities*~~ *(2010)*** ~~includes further information on how~~ for determining optimal widths ~~can be determined~~.

~~C.7.e~~C.7.f Medians

Median separation of opposing traffic lanes enhances safety ~~provides a beneficial safety feature~~ and should be ~~used~~ provided where~~ver~~ feasible. The s~~S~~eparation ~~of the opposing traffic also~~ reduces opposing ~~the problem of~~ headlight glare, ~~thus~~ improving safety and comfort for nighttime driving. ~~When sufficient width of medians is available, some l~~ Landscaping can be installed where the median width is sufficient ~~is also possible.~~

~~The use of m~~ Medians ~~often~~ aid~~s~~ in ~~the~~ providing ~~sion of~~ roadway drainage ~~for the roadway surface,~~ (particularly for ~~highways with~~ six and~~or~~ more traffic lanes). The median ~~also~~ alsoprovides~~:~~ ~~a~~

- Provides v~~v~~ehicle refuge area,
- I~~i~~mproves the safety of pedestrian crossings,~~-~~
- P~~p~~rovides ~~a logical location~~ space for left turn ~~auxiliary~~ lanes, and~~, and provides~~
- Provides the means for future addition of traffic lanes ~~and~~ or mass transit.

~~In many situations, the m~~ Medians ~~strip~~ also aid~~s~~ in roadway delineation and ~~the~~ overall highway aesthetics.

Median separation is desirable on all multi-lane roadways (to enhance pedestrian crossings) and is required on ~~the following streets and highways~~:

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

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

The ~~nature and degree of~~ required amount of median separation ~~required~~ is ~~dependent~~ based upon: ~~the~~

- D~~d~~esign speed~~,~~
- T~~t~~raffic volumes~~,~~
- A~~a~~djacent land use, and
- ~~the f~~Frequency of access.

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. There are basically two approaches to median separation. The first is the use of Medians provide horizontal separation of between opposing travel lanes to that reduces the probability risk of vehicles crossing the median into incoming traffic. . The second method is to attempt to limit Medians can also include median barriers that prevent crossovers by introducing a positive median barrier structure.

In rural areas, the use of w Wider medians is not only are more aesthetically pleasing in rural areas pleasing, but is and often are typically more economical than barriers. In urban areas where space and/or economic constraints are severe, the use of b Median barriers is permitted can be used in urban areas where constraints are severe to fulfill the comply with median separation requirements for median separation.

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Uncurbed medians should be free of abrupt changes in slope, discontinuities, soft ground, ~~or~~ and other hazards that c~~w~~ould prevent ~~the~~ a driver from retaining or regaining control of their vehicle. Consider ~~ation should be given to~~ increasing the width and decreasing the slope of medians i~~o~~n horizontal curves. ~~The requirements for a hazard free median environment are given in~~ See ***Chapter 4*** ***~~- Roadside Design~~***~~,~~ for the requirements for a hazard-free median ~~and shall be followed in the design and construction of medians~~.

~~C.7.e.1~~C.7.f.2 Type of Median

A wide, gently depressed median is ~~the~~ preferred ~~design. This type to allows~~ provide a reasonable vehicle recovery area and ~~aids in the~~ drainage of the adjacent shoulders and travel lanes. ~~Where space and drainage limitations are severe, n~~ Narrower~~-~~ flush and ~~medians, flush with the roadway, or~~ raised medians~~,~~ are allowed where space is limited ~~permitted~~. Use r~~R~~aised medians ~~should be used to~~to support pedestrian crossings of multi-lane~~d~~ ~~streets and highways~~ roadways.

~~C.7.e.2~~C.7.f.3 Median Width

~~The m~~ Median width is ~~defined as~~ the horizontal distance between the inside (median) edges of the opposing travel lanes. ~~of the opposing roadways. The selection of the median width for a given type of street or highway~~ Median width is primarily dependent on design speed and traffic volumes. ~~Since the probability of crossover crashes is decreased by increasing the separation, m~~ Medians should be as wide as practicable to reduce the risk of crossover crashes. Median widths in excess of 30 ~~feet to 35~~ feet also reduce ~~the problem of disabling~~ headlight glare from opposing traffic.

~~The minimum permitted widths of freeway medians are given in~~ See Table 3 – 23 ~~Minimum Median Width~~ for minimum freeway median widths. ~~Where the expected traffic volume is heavy,~~ Increase these widths for heavy traffic volumes ~~should be increased over these minimum values~~. Provide m~~M~~edian barriers ~~shall be used~~ on freeways when these minimum values cannot be attained ~~are not attainable~~.

~~The minimum permitted median widths for multi-lane rural highways are also given in~~ See Table 3 – 23 ~~Minimum Median Width~~ for

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minimum median widths for multi-lane rural highways. On urban streets, the median widths shall not be less than the values given in See Table 3 – 23 for minimum median widths for urban roadways. Increase these median widths wWhere median openings or access points are frequent, the median width should be increased.

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The minimum median widths ~~given~~ in these t~~T~~ables may ~~have~~ need to be increased to meet the requirements for:

- C~~c~~ross slopes,
- D~~d~~rainage, and
- T~~t~~urning movements (see Section C.9 ~~Intersection Design,~~ of this chapter).

The median ~~area~~ should ~~also~~ include adequate additional width to allow for ~~expected~~ future additions of through lanes and left turn lanes. ~~Where the median width is sufficient to produce essentially two separate, independent roadways,~~ Only the left side of each roadway ~~shall~~ must meet the requirements for roadside clear zone where the median width is sufficient to create two separate independent roadways. Accomplish c~~C~~hanges in ~~the~~ median width ~~should be accomplished by~~ with gently-flowing horizontal ~~alignment~~ transitions (of one or both ~~of the separate~~ roadways).

Table 3 – 23 Minimum Median Width

Type of Facility	Width (feet)
Freeways	
Freeways, Without Barrier	---
Design Speed ≥ 60 mph	60
Design Speed < 60 mph	40
All, With Barrier, All Design Speeds	26 [1]
Arterial and Collectors	
Design Speed ≥ 50 mph	40
Design Speed ≤ 45 mph	22 [2]
Paved and Painted for Left Turns	See Table 3 – 20 ~~Minimum Lane Widths~~

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Median width is the distance between the inside (median) edge ~~of the travel lane~~ of each roadway.

Footnotes:

1. Based on a 2 foot~~.~~ wide~~,~~ concrete median barrier and 12-~~-~~foot~~.~~ shoulders.
2. ~~On projects where right of way is constrained, t~~ The minimum median width may be reduced on projects where R/W is constrained to 19.5 feet~~.~~ for design speeds~~=~~ of 45 mph~~,~~ and to 15.5 feet~~.~~ for design speeds ≤ 40 mph.

~~C.7.e.3~~C.7.f.4 Median Slopes

A vehicle should be able to traverse a median ~~without turning over and~~ with sufficient smoothness to allow the driver a reasonable chance to control their vehicle. The transition between the median ~~slope~~ and the shoulder (or pavement) cross slope should be:

- Ssmooth,
- Ggently rounded, and
- Ffree from discontinuities.

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~~The m~~Median cross slopes should ~~not~~ be ~~steeper~~ less than 1:6 (preferably ~~not steeper than~~ less than 1:10). Drainage requirements may dictate tThe depth of depressed medians ~~may be controlled by drainage requirements~~. IIncreasinging the median width ~~of the median, rather than~~ to develop the required median depth is better than increasinging the cross slope~~, is the proper method for developing the required median depth~~.

Longitudinal median slopes/profiles ~~(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~~ Median profiles cannot exceed ~~a ratio of~~ 1:10 ~~and~~ (preferably 1:20). ~~The~~ CChanges in longitudinal slope ~~shall~~ cannot exceed 1:8 ~~(change in grade of 12.5 %)~~.

~~C.7.e.4~~C.7.f.5 Median Barriers

See ***Chapter 4*** ***~~– Roadside Design~~*** for criteria ~~on~~ for median barriers. See tThe ***AASHTO Roadside Design Guide*** ~~provides~~ for additional information and guidelines on ~~the use of~~ using median barriers.

~~C.7.f~~C.7.g Islands

An island is an ~~defined~~ area between traffic lanes ~~used for~~used to control ~~of~~ vehicle movements. Most islands ~~combine~~ accommodate ~~two or more of~~ these primary functions:

1. Channelization — To control ~~and direct~~ traffic movements~~,~~ (usually turning).
2. Division — To divide ~~opposing or same direction~~ traffic streams~~,~~ (usually through movements)~~;~~ and
3. Refuge — To provide refuge for pedestrians.

Islands ~~generally~~ are ~~either~~ usually elongated or triangular in shape and ~~situated~~ are located in areas not ~~un~~used ~~for~~ by vehicle~~ path~~s. Design i~~I~~slands ~~should be located and designed~~ to ~~offer little~~ create minimal obstruction ~~to vehicles and~~ but to be commanding enough that drivers ~~motorists~~

~~will~~ do not drive over them. ~~The placement of~~ Avoid installing mast arms in channelizion ~~ng~~ islands ~~is discouraged~~. Mast arms are not ~~permitted~~ allowed in medians ~~islands~~.

~~The~~ Island dimensions and details depend on the intersection design (as illustrated in Figure 3 – 5) ~~General Types and Shapes of Islands and Medians. They~~ and should conform to the general principles below ~~that follow~~.

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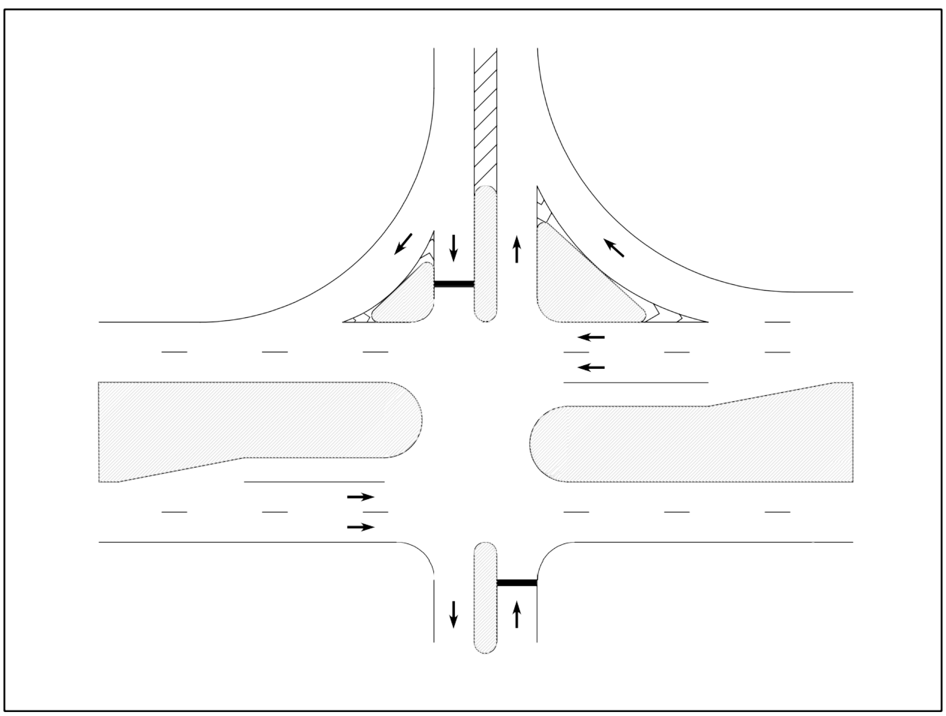
Figure 3 – 5 General Types and Shapes of Islands and Medians



Curbed islands ~~are sometimes~~ can be difficult to see at night. ~~Where curbed islands are used, the i~~ Intersections with curbed islands should have fixed–source lighting or appropriate delineation. ~~Under certain conditions,~~ P~~p~~ainted ~~, flush medians and~~ islands ~~or traversable type medians may be~~ are preferable to ~~the~~ raised curbed ~~type~~ islands under certain conditions, including:~~. These conditions include the following:~~

- Lightly developed areas that ~~will~~ are not ~~be~~ considered for access management.
- Intersections where approach speeds are relatively high.
- Areas ~~where there is~~ with little pedestrian traffic.
- Areas where fixed-source lighting is not provided.
- ~~Median or corner islands~~ Areas where signals, signs, ~~or~~ and luminaire supports are not needed; and
- Extensively developed a~~A~~reas ~~where extensive development exists and may demand~~ with frequent left-~~-~~turn lanes ~~into many entrances~~.

Painted islands ~~may be used~~ can be located at the edge of the traveled way ~~edge~~. ~~At some intersections,~~ B~~b~~oth curbed and painted islands may be desirable at some intersections. All island pavement markings should be reflectorized. ~~The use of~~ T~~t~~hermoplastic pavement markings~~striping~~, raised dots, spaced and raised retroreflective markers, and other forms of long-life markings ~~also~~ may also be desirable. See ***Section 9.6.3*** of the ***2011 AASHTO Greenbook*** and the ***MUTCD, Part 3*** for additional information on islands ~~on the design and marking of islands~~.

~~The central area of l~~ Large channelizing islands ~~in most cases~~ often have~~s~~ ~~a~~ turf or other vegetative cover. ~~As space and the overall character of the highway determine, l~~ Low plant material ~~may~~ can be installed where space allows ~~included, but it should~~ (do not obstruct sight distances). Ground cover ~~or~~ and plant growth~~, such as~~ (e.g., turf, vines, and shrubs)~~,~~ can be used for channelizing islands. ~~and~~ Ground cover provides excellent contrast with ~~the~~ paved areas~~, assuming the ground cover is cost-effective and can be properly maintained~~. See ~~The~~ ***FDOT Design Manual, Chapter 212*** ~~***Intersections***~~ ~~provides additional information on designing~~ for median and intersection landscaping ~~in medians or at intersections~~.

Small~~,~~ curbed islands: ~~may~~

- Can be mounded, but
- Should be depressed, and , ~~where pavement cross slopes are outward, large islands should be depressed to avoid draining water across the pavement. For small, curbed islands and in areas where growing conditions are not favorable, some type of paved surface may be used on the island.~~
- Can be paved where growing conditions are unfavorable.

Give special attention ~~Careful consideration should be given~~ to the location and type of plantings. ~~Plantings,~~ (particularly in narrow islands~~,~~ which are difficult to maintain). ~~may create problems for maintenance activities~~. Plantings and other landscaping ~~features in channelization areas may constitute~~ can be roadside obstacles and should be consistent with the requirements ~~in~~ of Section C.9.b of this chapter ~~Sight Distance~~. See t~~T~~he ***AASHTO Roadside Design Guide (2011)*** ~~provides~~ for additional information on ~~landscaping of~~ island landscaping ~~s~~.

~~C.7.f.1~~C.7.g.1 Channelizing Islands

Channelizing islands ~~may~~ can be ~~of~~ many shapes and sizes~~, depending on the conditions and dimensions of the intersection. A common form is the corner t~~Triangular corner islands ~~shape that~~ separate~~s~~ right-turning traffic from through traffic. Central islands ~~may serve as~~ can be a guide ~~around which~~ for turning vehicles ~~operate~~.

Locate c~~C~~hannelizing islands ~~should be placed so that~~ to make the ~~proper course of~~ travel path: ~~is~~

- I~~i~~mmediately obvious,
- E~~e~~asy to follow, and
- O~~o~~f unquestionable continuity. ~~Where islands separate turning traffic from through traffic, the~~

The radii of curved islands ~~of curved portions~~ should ~~equal or~~ exceed the minimum required for the ~~turning~~ expected turning speed~~s~~ ~~expected~~. Avoid using c~~C~~urbed islands ~~generally should not be used~~ in rural areas ~~and at isolated locations~~ unless the intersection is lighted and the curb~~s~~ ~~are~~ is delineated.

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Islands should be ~~sufficiently~~ large enough to command attention~~,~~ ~~with~~ (100 ft^2 preferred). ~~The smallest c~~ Curbed intersection corner islands should ~~have an area of~~ be at least 50 ft^2 ~~for~~ (urban) and 75 ft^2 ~~for~~ (rural) ~~intersections~~. ~~A~~ Each side of a ~~corner~~ triangular island should be at least 15 feet ~~on a side~~ (12 foot~~.~~ minimum) after ~~the~~ rounding ~~of~~ the corners.

~~While~~ When mast arms must be located ~~are discouraged~~ within channelizing islands, ~~when they are used~~ provide the minimum lateral offset ~~as shown~~ in Chapter 4~~, Roadside Design~~ Table 4 – 2 ~~Lateral Offset shall be provided~~. Mast arm foundation diameters vary from 3.5 feet to 5.0 feet. ~~The minimum~~

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~~lateral offset for 45 mph and less should be based on minimum offset to a hazard from curb face – 4 feet standard, 1.5 feet absolute minimum.~~

~~Details of curbed corner island designs used in conjunction with turning roadways are shown in~~ See Figures 3 – 6 ~~Channelization Island for Pedestrian Crossings (Curbed)~~, 3 – 7 ~~Details of Corner Island for Turning Roadways (Curbed)~~ and 3 – 8 for curbed corner islands for turning roadways ~~Details of Corner Island for Turning Roadways (Flush Shoulder)~~. Design t~~T~~he approach corner of ~~each~~ a curbed island ~~is designed~~ with an approach nose treatment.

~~Further information on the pavement markings that can be used with islands can be found in the~~ See FDOT~~'s~~ ***Standard Plans, Index 711-001*** for island pavement markings.

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Figure 3 – 6 Channelization Island for Pedestrian Crossings (Curbed)

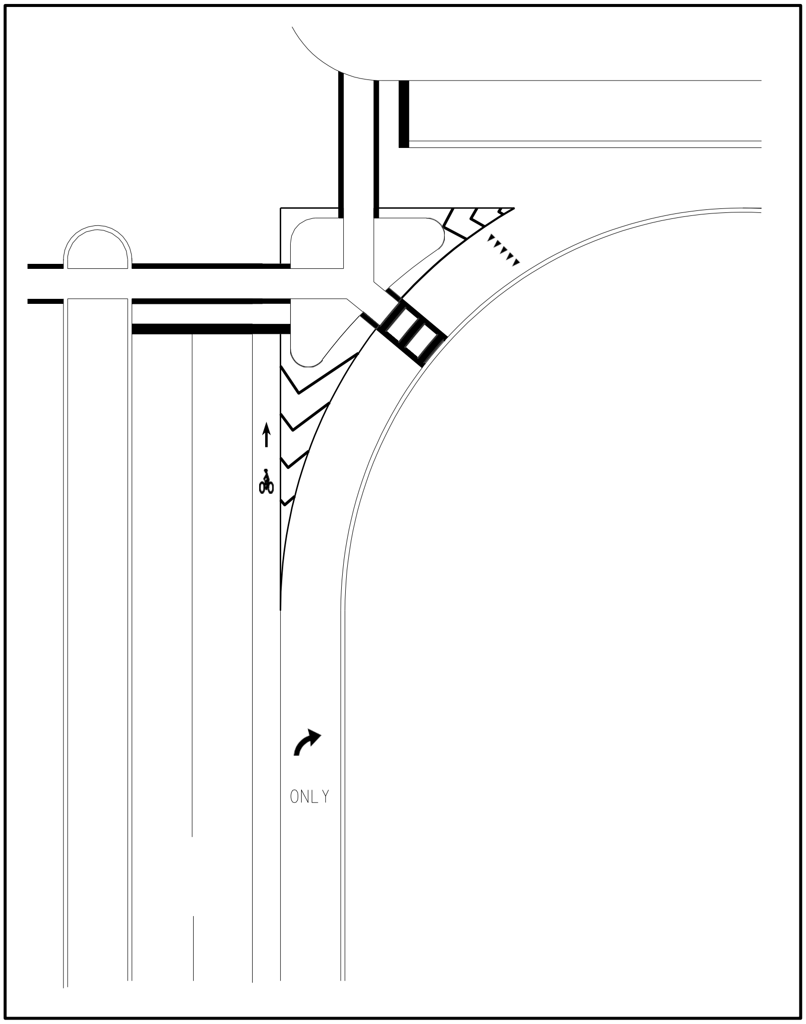
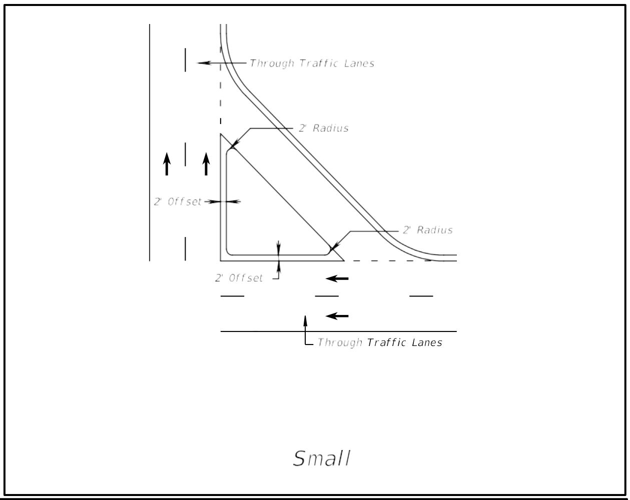


Figure 3 – 7 Details of Corner Island for Turning Roadways (Curbed)



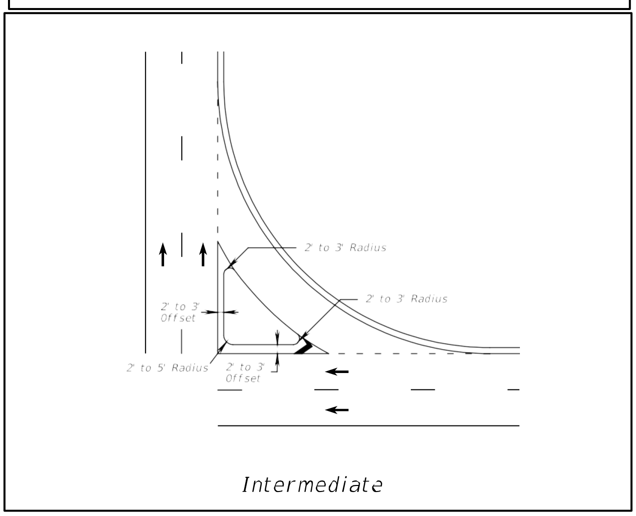
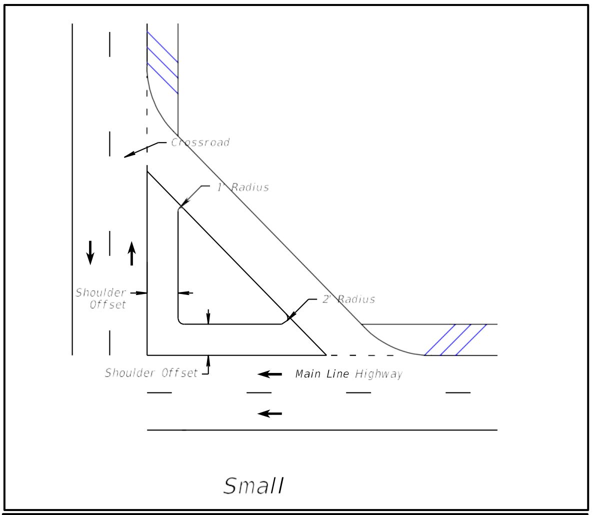
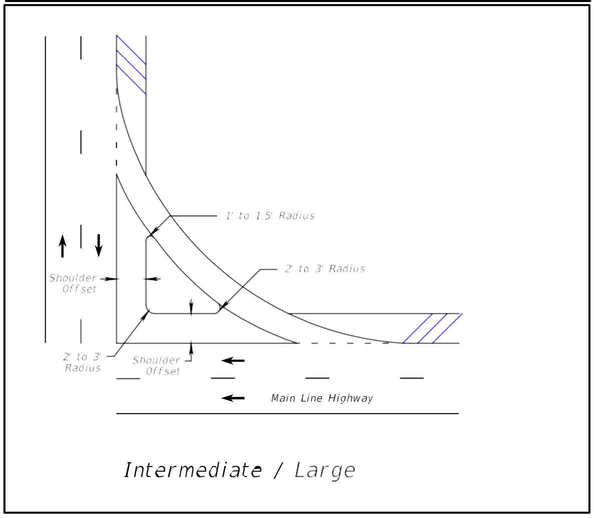


Figure 3 – 8 Details of Corner Island for Turning Roadways (Flush Shoulder)





~~C.7.f.2~~C.7.g.2 Divisional Islands

Divisional islands ~~often~~ are sometimes used ~~introduced on~~ at intersections on undivided ~~high~~roadways ~~at intersections. They~~ to alert drivers to the crossroad ahead and regulate traffic through the intersection. ~~These~~ Divisional islands are particularly beneficial ~~advantageous~~ in controlling left~~-~~turns at skewed intersections and ~~at locations~~ where separate roadways are provided for right-turning traffic.

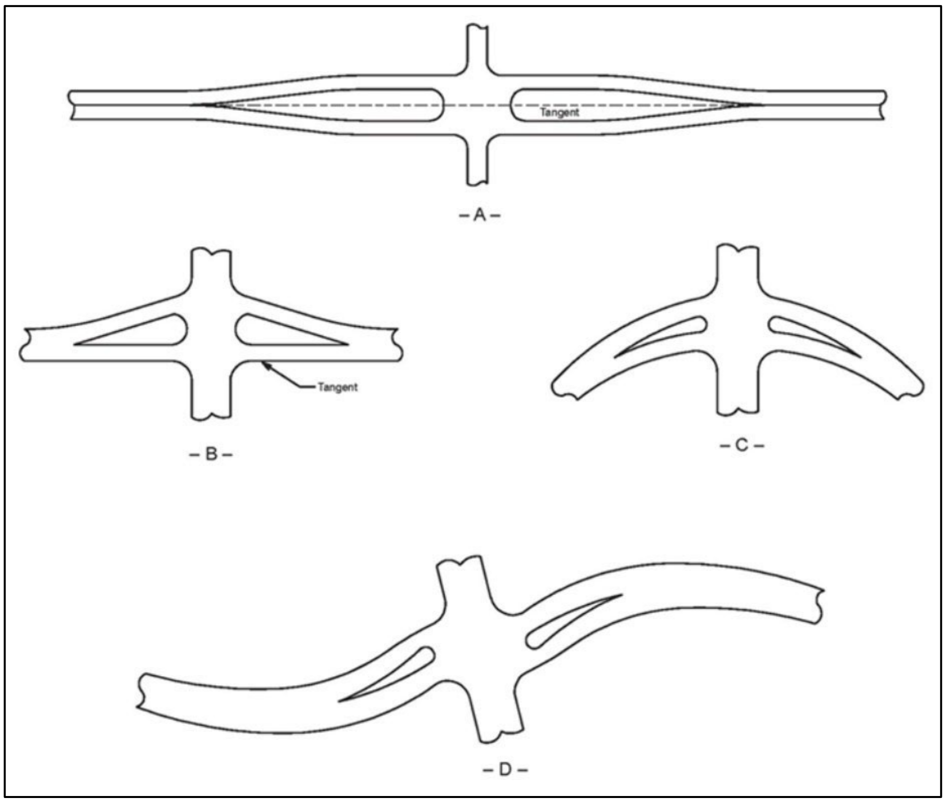
Widening a roadway to ~~include~~ add a divisional island should ~~be done in such a manner~~ ensure that ~~the~~ proper travel paths ~~to follow~~ are ~~unmistakably~~ clearly evident ~~to drivers~~. The alignment should not require ~~no~~ any appreciable conscious steering effort ~~in vehicle steering~~.

Elongated ~~or~~ divisional islands should be ~~not less than~~ at least 4 feet wide and 20 to 25 feet long. ~~In general, introducing~~ Installing curbed divisional islands at ~~isolated~~ intersections on high-speed highways is generally undesirable unless ~~special attention is directed to providing high~~ island visibility ~~for the islands~~ is prioritized. Curbed divisional islands ~~introduced~~ at ~~isolated~~ intersections on high-speed highways should be at least 100 feet long. ~~or more in length. When situated in the vicinity of a high point in the roadway profile or at or near the beginning of a horizontal curve,~~ Extend the approach end of ~~the~~ a curbed island ~~should be extended~~ to be clearly visible to approaching drivers when near the profile high point or the beginning of a horizontal curve.

Provide two full lanes on each side of an intersection divisional island ~~Where an island is introduced at an intersection to separate opposing traffic~~ to separate opposing traffic on a four-lane roadway or ~~on~~ a major two-lane highway ~~carrying~~ with high traffic volumes ~~, two full lanes should be provided on each side of the dividing island~~ (particularly where future conversion to a wider ~~high~~roadway is likely). Narrower roadways can be used i~~I~~n other instances~~instances, narrower roadways may be used~~. ~~For moderate volumes,~~ The roadway widths ~~shown~~ in Table 3 – 34 under Case II (one-lane, one-way operation with provision for passing a stalled vehicle) ~~in Table 3 – 34 Derived Pavement Widths for Turning Roadways for Different Design Vehicles~~ are appropriate for moderate traffic volumes, ~~.~~ The widths under Case I may be used f~~F~~or light traffic volumes and ~~where~~

for smaller islands. ~~are needed., widths on each side of the island corresponding to Case I in Table 3 – 34 may be used.~~

Figure 3 – 9 Alignment for Divisional Islands at Intersections



~~C.7.f.3~~C.7.g.3 Refuge Islands

A refuge island ~~for pedestrians at or near a crosswalk or shared use path crossing~~ aids pedestrians and bicyclists ~~who~~ in crossing the roadway. Raised-curb corner islands and center channelizing and ~~or~~ divisional islands can be used as refuge areas. Refuge islands ~~for pedestrians and bicyclists~~ are primarily used in urban areas for:

- C~~c~~rossing a wide ~~street~~ roadway, ~~for~~
- L~~l~~oading ~~or~~ and unloading transit riders, and ~~or~~
- ~~for~~ W~~w~~heelchair ramps ~~are used primarily in urban areas~~.

See Figures 3 – 10 ~~Pedestrian Refuge Island~~, ~~Figure~~ 3 – 11

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Pedestrian Crossing with Refuge Island (Yield Condition), and Figure 3 – 12

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~~Pedestrian Crossing with Refuge Island (Stop Condition) show~~ for divisional islands ~~that~~ supporting a midblock crosswalk with stop and yield conditions. The distance A ~~shown in the figures~~ is based upon the ***MUTCD***~~,~~ (and shown following the figures).

The~~-~~ size and location of refuge islands are influenced by:

- The ~~l~~location and width of crosswalks, ~~the~~
- The ~~l~~location and size of transit loading zones, and
- ~~the p~~The provision of curb ramps ~~influence the size and location of refuge islands~~.

Refuge islands should be ~~a minimum of~~ at least 6 feet wide. Pedestrians and bicyclists should have a clear path through the island ~~and should not be~~ (unobstructed by poles, sign posts, utility boxes, etc). Sidewalk and shared use path curb ramps in islands ~~shall~~ must meet the requirements ~~found~~ in ***Section*** ***C.10.a.3*** of this chapter and ***Chapter 8*** ~~***– Pedestrian Facilities***~~***.*** Curb ramps that are part of a shared use path ~~shall~~ must also meet the requirements of ***Chapter 9*** ~~***– Bicycle Facilities***~~***.***

Figure 3 – 10 Pedestrian Refuge Island

North Main Street, Gainesville, FL

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Figure 3 – 11 Pedestrian Crossing with Refuge Island (Yield Condition)

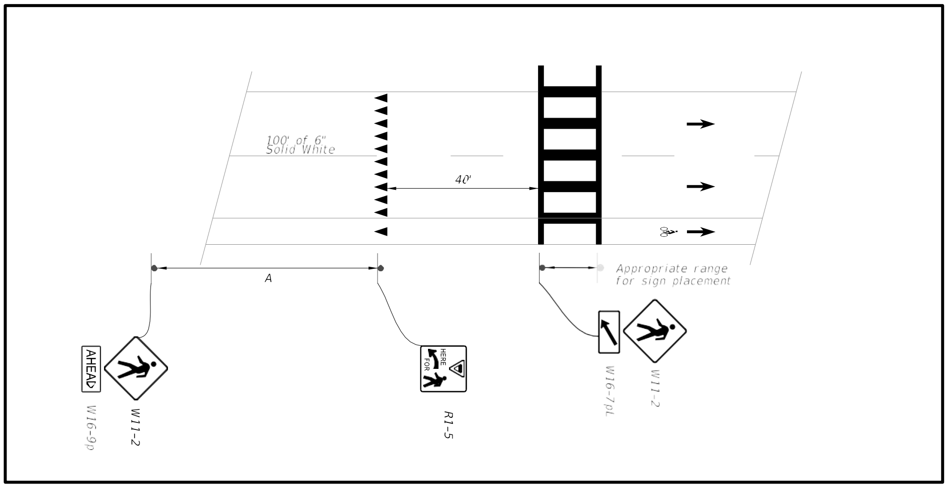
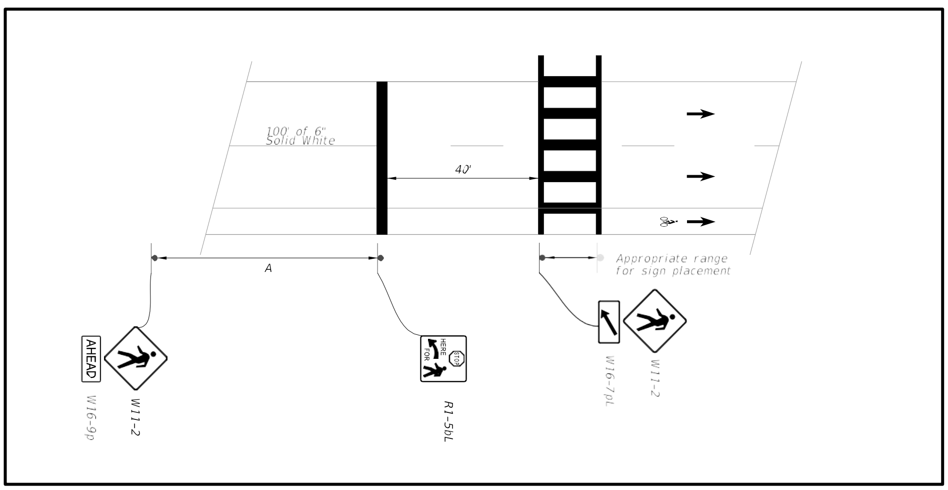


Figure 3 – 12 Pedestrian Crossing with Refuge Island (Stop Condition)



Note: 1. See following page for distance A.

The distance A shown in ***Figures* 3 – 11** and ***3 – 12*** for the advance warning sign should be:

Posted Speed (mph)	Advance Placement Distance (feet)
25 or Less	100
26 to 35	100
36 to 45	175

Source: 2009 MUTCD, with 2012 Revisions, Table 2C-4. Guidelines for Advance Placement of Warning Signs. Typical condition is the warning of a potential stop condition.

See Figure 3 – 13 for aAn example of a pedestrian crossing through a refuge island is shown in Figure 3 – 13 Pedestrian Crossing in Refuge Island. See the FDOT **Standard Plans 522-002** for Other additional options are shown in the FDOT's *Standard Plans 522-002 Detectable Warnings and Sidewalk Curb Ramps.*

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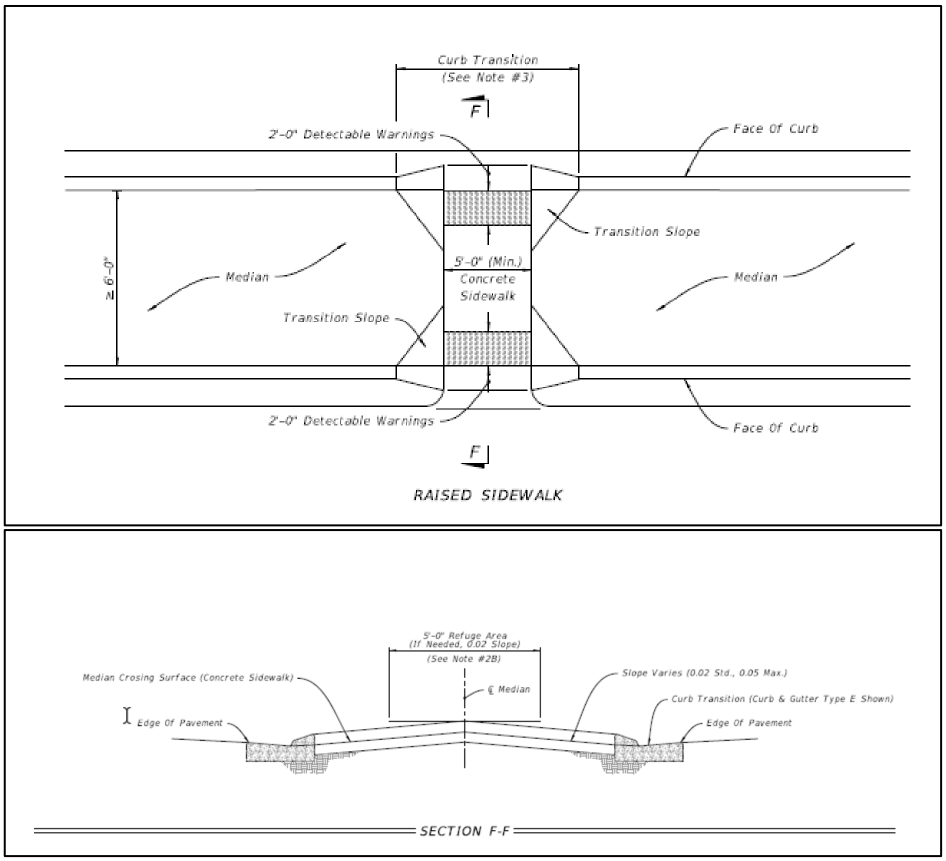
Figure 3 – 13 Pedestrian Crossing in Refuge Island



~~C.7.g~~C.7.h Curbs

Curbs~~s~~ ~~may be used to~~ provide drainage control and ~~to~~ improve roadway delineation~~ of the roadway~~. Curbs ~~are~~ generally include gutters ~~designed with a gutter to form a combination~~ (referred to as curb and gutter) ~~section~~. ~~In Florida, t~~ The standard curb ~~of this type~~ in Florida is 6 inches high ~~in height~~. See Figure 3 – 14 ~~Standard Detail for FDOT Type F and E Curbs~~ for examples of sloping curbs. Do not use ~~These~~ sloping curbs ~~are not to be used~~ on facilities with design speeds ~~greater than~~ over 45 mph. See ***Chapter 4*** ~~***– Roadside Design***~~ for additional ~~design~~ criteria ~~on the use of~~ for using curbs.

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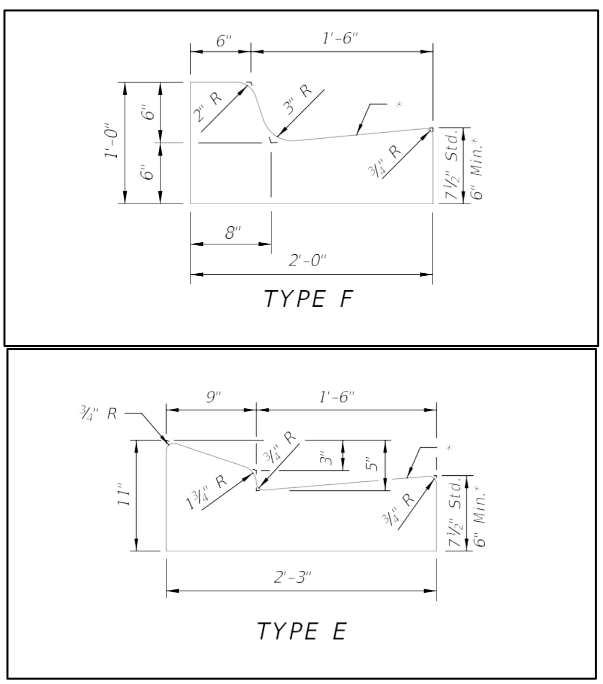
Figure 3 – 14 ~~Standard Detail for~~ FDOT Type F and E Curbs



~~C.7.h~~C.7.i Parking

~~Where parking is needed, and adequate off-street parking facilities are not available or feasible, on-street parking may be necessary.~~ On-street parking is only allowed on facilities with posted speeds of 35 mph and~~or~~ less. ~~. It~~ On-street parking is typically located at the outside edge of the roadway between the traveled way and the sidewalk. ~~On streets with a posted speed of 25 mph or less,~~ On-street parking ~~may~~ can be ~~located~~ within the median in downtown urban centers with posted speeds of 25 mph and less. On-~~-~~street parking ~~may~~ can be either parallel or angle (traditional or reverse).

On-street parking provides separation between the sidewalk and travel lanes ~~may~~ and helps with managing~~e~~ traffic speeds; ~~, and provides separation between the sidewalk and travel lanes~~ but may~~. It may~~ also decrease through capacity, reduce traffic flow, and increase crash potential.

~~C.7.h.1~~C.7.i.1 Parallel Parking Lanes

~~Minimum parking lane widths for parallel parking are provided in~~ See Table 3 – 24 for minimum parallel parking lane widths ~~Minimum Parallel Parking Lane Width~~.

~~If on-street parking is provided adjacent to a bike lane, a~~ Provide a 3-foot minimum (4-foot preferred) buffer zone ~~should be provided~~ between on-street parking and an adjacent bicycle lane to reduce the ~~potential for~~ risk of ~~a~~ car doors opening into the bicycle ~~ke~~ lane (door zone). ~~The buffer zone between the bike lane and on-street parking should be at least 3' wide, however 4' is preferred.~~ See Figure 9 – 18 ~~Buffered Bicycle Lane Markings with On-Street Parking~~ for ~~more~~ additional information.

Table 3 – 24 Minimum Parallel Parking Lane Width

Facility	Posted Speed ~~(mph)~~	Parallel Parking Lane Width[1] (feet)
Arterial	≤ 35 mph	8[2]
Collector	≤ 35 mph	8[2,3]
Local	≤ 35 mph	8[2,3]

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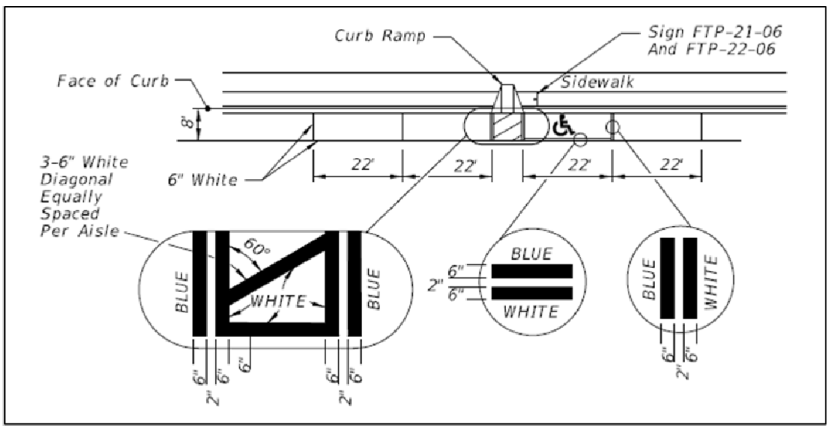
1. Width measured to face of curb.
2. A parking lane width of 10 to 12 feet is desirable where delivery trucks need to be accommodated.
3. May be reduced to 7 feet ~~minimum~~ in residential areas ~~or~~ with posted speeds 25 mph ~~or~~ and less~~,~~ (where only passenger vehicles need to be accommodated).

See ***Figure* 3 – 15** for examples ~~details for the~~ of signing and marking of parallel parking spaces. See ~~T~~the ***MUTCD*** provides for additional examples for marking ~~of how~~ on-street parking ~~may be marked~~.

Figure 3 – 15 Signing and Marking of Parallel Parking Spaces



~~C.7.h.2~~C.7.i.2 Angle Parking

~~Under certain circumstances, a~~ Angle parking is ~~an allowable form of street parking~~ allowed under certain conditions. Give special c~~C~~onsideration ~~must be given~~ to the:

- ~~the s~~Specific function and width of the ~~street~~roadway, ~~the~~
- ~~-~~A~~a~~djacent land uses,
- T~~t~~raffic volumes, ~~and~~
- P~~p~~osted speed, ~~as well as~~ and
- Current and forecasted ~~existing and anticipated~~ traffic operations.

Angle parking is especially ~~presents special problems~~ challenging ~~because of~~ due to ~~the~~ varying vehicle lengths ~~of vehicles~~ and ~~the~~ sight distance limitations ~~problems associated with~~ (e.g., vans and recreational vehicles). The extra vehicle length ~~of such vehicles may interfere with~~ can encroach on the traveled way. ~~When reverse angle parking is proposed for on-street parking~~, A~~a~~ raised median ~~may~~ can be used with reverse angle parking ~~to discourage front in parking and~~ to prevent front-in access from the opposite side~~direction of travel~~.

Angle parking typically requires at least ~~minimum of~~ 17 to 18 feet from

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between the curb face (or edge of pavement) to the and traveled way.

See ***Figures* *3 – 16*** ~~Signing and Marking of 45 degree Forward-In Angle Parking~~ and ~~Figure~~ 3 – 17 ~~Signing and Marking of 45 degree Reverse-In Angle Parking~~ for examples of angle parking.

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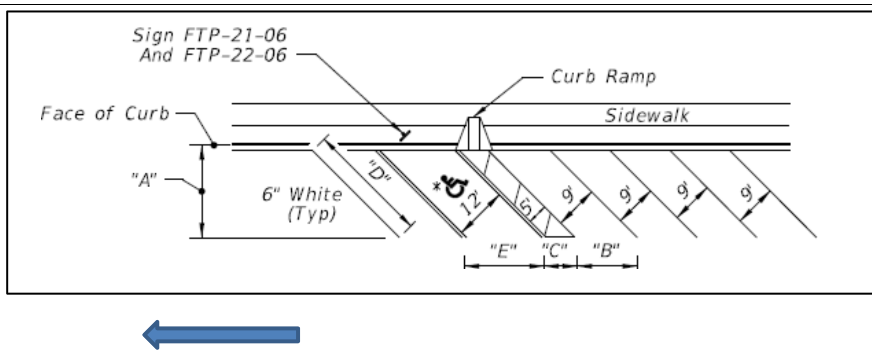
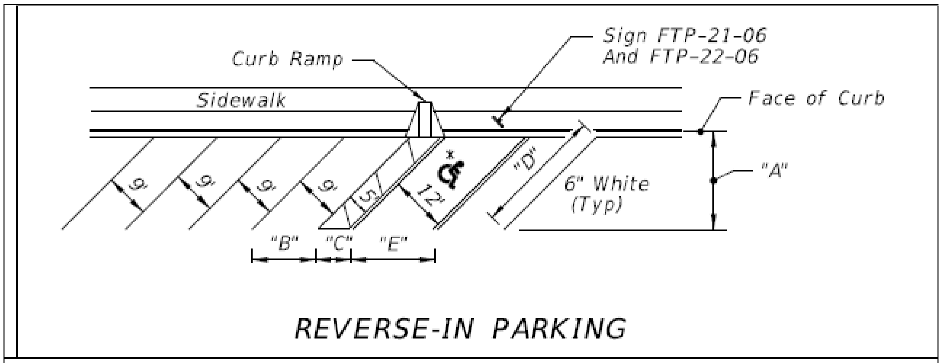
Figure 3 – 16 Signing and Marking for 45-degree ~~Forward~~Front-In Angle Parking



Direction of Travel

Dimensions				
“A”	“B”	“C”	“D”	“E”
17’ 0”	12’ 9”	7’ 0”	24’ 0”	17’ 0”

Figure 3 – 17 Signing and Marking for 45~~-~~ degree Reverse-In Angle Parking



Direction of Travel				
Dimensions				
"A"	"B"	"C"	"D"	"E"
17' 0"	12' 9"	7' 0"	24' 0"	17' 0"

~~C.7.h.3~~C.7.i.3 Cross Slope

Parking lane c~~C~~ross slopes ~~on parking lanes may be~~ can vary from 0.015 to 0.05 feet per foot. ~~-~~The p~~P~~ortions of parking lanes ~~that are~~ reserved for ~~parking and access isles for~~ people with disabilities ~~are to~~ cannot have cross slopes ~~not~~ exceeding 0.02 feet per foot ~~2%~~. See Section C.7.h.4 for additional ~~further information on~~ accessibility requirements.

The functionality of on-street parking can be affected by:

- ~~The~~ Curb height ~~of the curb~~,
- P~~p~~avement cross slope,
- U~~u~~tilities,
- S~~s~~treet furniture, and
- L~~l~~andscaping. ~~can all affect the functionality of on-street parking.~~

A bilevel sidewalk can ~~help~~ mitigate ~~the~~ elevation differences ~~in diverse elevations~~ between the roadway, on-street parking, and access to buildings.

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~~C.7.h.4~~C.7.i.4 ADA Requirements

~~In addition to the criteria provided in this section,~~ Provide accessible parking spaces ~~shall be included with on-street parking~~ in accordance with the requirements of the ***2006 Americans with Disabilities Act Standards for Transportation Facilities*** as required by 49 C.F.R 37.41 or 37.43 and the ***2020 Florida Building Code, Accessibility (7th Edition)*** as required by 61G20-4.002. ~~Additionally, t~~ See the ***U.S. Access Board's (Proposed Public Rights-of-Way Accessibility Guidelines, Section R309*** ~~***On-Street Parking***~~ ~~provides the latest direction on~~ for additional accessibility ~~le design~~ requirements ~~that should be followed~~.

See Figures 3 – 16 ~~Signing and Marking for 45 degree Forward-In Angle Parking~~ and ~~Figure~~ 3 – 17 ~~Signing and Marking for 45 degree Reverse-In Angle Parking provide~~ for examples of on-street parking dimensions and ~~,~~ signing and pavement markings ~~of on-street parking~~ (including accessible parking spaces). See t~~T~~he FDOT~~'s~~ ***Standard Plans*** ~~provide further information on~~ for the Universal Symbol of Accessibility (Accessible Parking Pavement Marking) and the required signage designating accessible parking spaces.

~~C.7.h.5~~C.7.i.5 Parking Restrictions

Establish o~~O~~n-street parking space boundaries ~~shall be established~~ in accordance with ~~the restrictions identified in~~ ***F.S. 316.1945***, ~~,~~ which restricts parking near:

- D~~d~~riveways,
- I~~i~~ntersections,
- C~~c~~rosswalks,
- R~~r~~ailroad crossings,
- F~~f~~ire hydrants, and
- F~~f~~ire stations.

Locate o~~O~~n-street parking ~~shall be located~~ no closer to driveways and intersections than the distances provided in Table 3 – 25 ~~Parking Restrictions for Driveways, Intersections, and Mid-Block Crosswalks~~. This requirement ~~includes~~ applies to mid-block crossings and roundabout approaches. Provide curb extensions or bulb-outs at m~~M~~idblock crossings on ~~streets~~ roadways with parking ~~should include curb extensions or bulb-outs~~ to improve ~~a~~ the driver's and pedestrian's ~~ability to see~~ view of each other. See Chapter 15 ~~– Traffic Calming~~ for more information.

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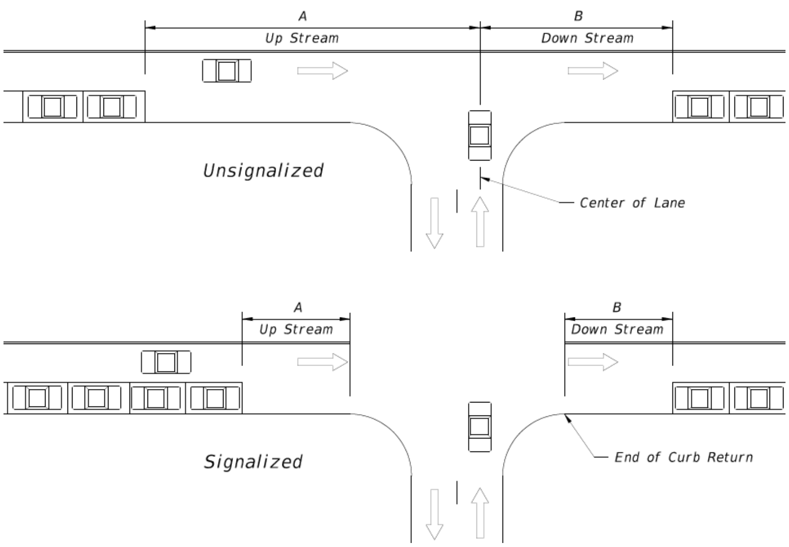
Table 3 – 25 Parking Restrictions for Driveways, Intersections and Mid-Block Crosswalks

Control Type	Posted Speed (mph)	A Up Stream (feet)	B Down Stream (feet)	
			2- Lane	4-Lane or More
Unsignalized	< 35	90	60	45
	35	105	70	50
Signalized and 4-Way Stop Controlled	< 35	30	30	30
	35	50	50	50



Notes:

1. ~~For entrances to one-way streets, t~~ The downstream restriction (B) may be reduced to 20 feet for entrances to one-way roadways.
2. Do not ~~place~~ locate parking within 20 feet of the nearest edge of a marked crosswalk.

~~C.7.h.6~~C.7.i.6 Signing and Pavement Marking

The s~~S~~igning and pavement markings ~~of~~ for on-street parking ~~shall~~ must conform to the **MUTCD**, *and* ~~as well as~~ the ADA requirements ~~identified~~ in Section C.7.h.4 of this chapter.

~~C.7.i~~C.7.j Right of Way (R/W)

Acquire enough R/W ~~The acquisition of sufficient right of way is necessary in order~~ to provide space for a safe ~~street or highway~~roadway. ~~The width of the~~ The required R/W width ~~right of way required~~ generally depends on:

- T~~t~~he design of the roadway,
- T~~t~~he arrangement of bridges, underpasses and other structures, and
- T~~t~~he need for cuts and~~or~~ fills.

Acquire enough R/W ~~The right of way acquired should be sufficient~~ to:

- Allow ~~development of~~ the full cross section to be developed, including adequate medians and roadside clear zones. Give special attention ~~Determination of the necessary width requires that adequate consideration also be given~~ to ~~the~~ accommodating ~~on of~~ utilities and utility poles beyond the clear zone.
- Allow the layout of safe intersections, interchanges, and other access points.
- Allow adequate sight distances ~~at all points,~~ (particularly on horizontal curves, ~~,~~ at ~~an~~ intersections, ~~,~~ and at other access points).
- Allow ~~, where appropriate,~~ additional buffer zones to improve roadside safety, noise attenuation, and the overall roadway aesthetics ~~of the street or highway~~(where appropriate).
- Allow adequate space for ~~placement of~~ pedestrian and bicycle facilities, including curb ramps, bus bays, and transit shelters~~,~~ (where applicable).
- Allow for future lane additions, increases in cross section, ~~or~~ and other improvements. Consider f~~F~~rontage roads ~~should also be considered~~ in the ultimate development of ~~many~~ high-~~-~~volume facilities.
- Allow treatment of stormwater runoff.

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- Allow ~~for construction of~~ future intersection improvements ~~, such as~~ (e.g., turn lanes, bicycle and pedestrian facilities, ~~or~~ and over and underpasses).
- 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~~ R/W acquisition ~~of wide rights of way~~ is costly, but ~~it may be~~ necessary ~~to allow the~~ for the construction and future ~~improvement~~ widening of safe roadways ~~streets and highways~~. The minimum R/W width for a two-lane roadway is ~~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~~ Attempt to acquire ~~the necessary~~ additional R/W width ~~right of way~~ where the existing R/W width is less than 50 feet.

R/W widths can be less than 50 feet for l~~L~~ocal cul-de-sac and dead~~-~~end roadways ~~streets~~ which are less than 600 feet long ~~having~~ with an ADT ~~of less than or equal to~~ below 400. ~~and a length of 600 feet or less, may utilize a right of way of less than 50 feet, if all elements of the~~ All other typical section elements must comply with this manual ~~typical section meet the standards included in this Manual~~.

The R/W width ~~right of way~~ for frontage roads may be reduced ~~depending on the typical section requirements and the ability to share right of way~~ by sharing R/W with the adjacent ~~street or highway~~ roadway ~~facility~~.

~~C.7.j~~C.7.k Changes in Typical Section

~~C.7.j.1~~C.7.k.1 General Criteria

Avoid c~~C~~hanging ~~es in~~ cross section elements~~should be avoided~~. ~~When changes in widths, slopes, or other elements are necessary, they should be affected~~ Affect any required changes to widths, slopes, and other elements in a smooth, gradual fashion.

~~C.7.j.2~~C.7.k.2 Lane Deletions and Additions

~~The addition or deletion of~~ Add or delete traffic ~~or~~ and bicycle lanes ~~should be undertaken~~ along tangent sections of roadways (not in curves). ~~The approach to lane deletions and additions should have~~ Provide ample advance warning and sight distance.

~~The t~~Terminate ~~ion of~~ traffic lanes (~~including~~ and auxiliary lanes) ~~shall meet~~ in accordance with the general requirements for merging lanes. See Section C.9.c.1 for additional information.

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~~Where additional lanes are intermittently provided on two-lane, two-way highways,~~ Consider median separation where additional traffic lanes are introduced intermittingly on two-lane, two-way roadways

~~should be considered~~.

~~C.7.j.3~~C.7.k.3 Preferential Use Lanes

~~To increase the efficiency and separation of different vehicle~~

~~movements,~~ Consider providing preferential use lanes~~, such as~~ (e.g., bicycle~~ke~~ lanes and bus lanes) to increase the efficiency and separation of different uses~~, should be considered~~. These lanes ~~are often an~~ can enhance ~~ment to~~ corridor safety and increase the horizontal clearance to ~~roadside~~ aboveground fixed objects. ~~The~~ See ***MUTCD, Chapter 3D*** ~~provides further information on~~ for preferential use lane pavement markings. See ***Chapter** 9 ~~**– Bicycle Facilities**~~* for ~~information on~~ marking bicycle lanes.

~~C.7.j.4~~C.7.k.4 Structures

Extend t~~T~~he pavement, median, ~~and~~ shoulder, ~~width,~~ and sidewalk widths along the approach roadway ~~should be carried~~ across structures ~~such as~~ (e.g., bridges and box culverts). Shoulder widths for multi-lane rural divided highway bridges may be reduced as provided~~shown~~ in Table 3 – 20 ~~Minimum Shoulder Widths for Flush Shoulder Rural Highways~~. ~~The designer should evaluate~~ Compare the economic practicality of ~~utilizing~~ constructing two narrower bridges versus one wider bridge ~~dual versus single bridges for roadway sections incorporating~~ (for wide medians).

The minimum roadway width for bridges on urban ~~streets~~ roadways with curb and gutter ~~shall be the same as~~ is the curb-to-curb width of the approach roadway. Extend the s~~S~~idewalks on the approaches ~~should be carried~~ across all structures. Do not use raised c~~C~~urbed sidewalks ~~should not be used~~ adjacent to traffic lanes ~~when~~ with design speeds ~~exceed~~over 45 mph. ~~When the bridge rail (barrier wall) is placed between the traffic and sidewalk, it~~ Offset bridge rails and concrete barriers (between traffic and a sidewalk) ~~should be offset a minimum distance of~~ at least 2½ feet from the edge of ~~the~~ a:

- T~~t~~ravel lane,
- W~~w~~ide curb lane, ~~-~~or
- B~~b~~icycle lane. ~~For long (500 feet or greater), and/or high level bridges, it is desirable to provide a~~

Consider an offset distance that ~~that will~~ accommodates a disabled vehicle for long (over 500 feet) and high-level bridges. The transition from the bridge to the ~~adjacent~~ approach roadway ~~section~~ can ~~may~~ be ~~made~~ accomplished by dropping the curb at the first intersection ~~or well in advance of the traffic barrier,~~ or by reducing the curb in front of the barrier to a low sloping curb with a gently-sloped traffic face. See ***Chapter** 17 ~~**– Bridges and Other Structures**~~* for additional requirements.

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C.7.j.4.(a) Lateral Offset

Locate the s~~S~~upports for bridges, barriers, ~~or~~ and other structures ~~should be placed at or beyond~~ outside the ~~required~~ shoulder~~. Where possible, these structures should be located and~~ outside ~~of~~ the ~~required~~ clear zone where possible. See ***Chapter 4*** ~~***– Roadside Design***~~ for additional information on lateral offsets for structures.

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

Vertical clearance should be adequate for the expected type of expected traffic. Vertical clearances over fFreeways and arterials shall must have a vertical clearance of be at least 16.5 feet 6 inches (which includes a 6- inch allowance for future resurfacing). Vertical clearances over oOther streets and highways roadways should have a clearance of be at least 16 feet; unless the provision of a reduced clearance is fully justified by a site-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 a Additional vertical clearance may be required by the railroad companyowner.

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

Construct tThe ends termini of guardrails, bridge railings, abutments, and other structures should be constructed to protect vehicles and their occupants from serious impact. See ***Chapter 4*** for rRequirements for structure end treatments of structures are given in ***Chapter 4 - Roadside Design***.

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C.8 Access Control

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

Additional information on access management can be found in See ***Rule Chapter 14- 97 State Highway System Access Control Classification System, Florida Administrative Code*** and the FDOT ***Access Management Guidebook (2019)*** for additional information on access management. The FDOT's ***Access Management Guidebook (2019)*** provides further information on designing

~~roadways and connections to support access management.~~

C.8.a Justification

The justification for controlling ~~of~~ access ~~should be~~ should be based on:~~ several factors, including~~

- S~~s~~afety,
- C~~c~~apacity,
- E~~e~~conomics, and
- A~~a~~esthetics.

C.8.b General Criteria

C.8.b.1 Location of Access Points

~~All a~~ Access locations should have adequate sight distance ~~available for the safe execution~~ to perform ~~of~~ entrance, exit, and crossing maneuvers safely.

Avoid l~~L~~ocating ~~ons of~~ access points near:

- S~~s~~tructures,
- D~~d~~ecision points, and
- Where roadway lighting ends ~~or the termination of street or highway lighting should be avoided~~.

Do not locate driveways ~~should not be placed~~ within ~~the~~ intersection influence zones ~~of intersections~~ or where traffic conflicts may occur ~~other points that would tend to produce traffic conflict~~.

C.8.b.2 Spacing of Access Points

~~The spacing of~~ Space access points ~~should be adequate~~ to:

- P~~p~~revent conflicts ~~or mutual~~,
- Prevent interference with ~~of~~ traffic flow,
- Not require drivers to make quick decisions and maneuvers.

Separate ~~ion of~~ entrance and exit ramps ~~should be sufficient~~ to provide adequate weaving distances ~~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.~~

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Avoid fFrequent median openings should be avoided.

The use of a Consider providing frontage roads or other auxiliary roadways or other auxiliary roadways is recommended alalong arterials and higher classifications where the need for direct driveway or minor road access is access points are frequent.

C.8.b.3 Restrictions of Maneuvers

Where feasible, Restrict tthe number and type of permitted maneuvers (e.g., crossing, turning, ~~-~~slowing, etc.) ~~should be restricted~~ where feasible~~.~~

Grade separation and continuous raised medians prevent ~~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 c~~ Continuous raised medians restrict left-turns best.

Consider channelization ~~should be considered~~ for ~~the purposes of~~ guiding traffic ~~flow~~ and reducing vehicle conflicts.

C.8.b.4 Auxiliary Lanes

Provide d~~D~~eceleration lanes for right-~~-~~turn exits ~~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~~ or complicate pedestrian crossings ~~and bicycle/motor vehicle movements~~.

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

Give s~~S~~pecial consideration ~~should be given~~ to ~~the~~ providing ~~sions for~~ deceleration, acceleration, and storage lanes in commercial ~~or~~ and industrial areas with significant truck/bus traffic.

C.8.b.5 Grade Separation

Consider g~~G~~rade separation~~ion~~ ~~interchange design should be considered~~ for junctions of high-volume arterials and highways ~~streets and highways~~.

Use g~~G~~rade separation ~~(or an interchange) should be utilized~~ when ~~the~~ expected traffic volumes exceed~~s~~ the capacity of an intersection ~~capacity~~.

Consider g~~G~~rade separation ~~should be considered~~ to eliminate conflicts and~~or~~ long intersection 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 where~~enever~~ practical. Properly designed ~~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 m~~ Modern roundabouts create less delay when constructed in appropriate locations. The FHWA adopted ***NCHRP Report 672 Roundabouts: An Informational Guide*** ~~, is adopted by FHWA and~~ to establish~~es~~ criteria and procedures for the justification and ~~,~~ operational and safety analysis of modern roundabouts ~~in the United States~~. ~~The~~ A modern roundabout is characterized by ~~the following~~:

- A central island ~~of~~ creating sufficient deflection to promote lower speeds and with 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~~ of 20 to~~-~~ 25 mph,~~,~~ and
- Single ~~or~~ and multilane configurations~~.~~

Consider r~~R~~oundabouts ~~should be considered under~~ for ~~the following conditions~~:

1. New construction projects,
2. Reconstruction projects,
3. Traffic o~~O~~peration~~s~~ improvements,
4. Resurfacing (3R) projects with ~~Right of Way~~ R/W acquisition, and
5. ~~Need to r~~Reducing ~~e~~ crash frequency and severity ~~of crashes~~.

C.8.c Control for ~~All~~ Limited Access (LA) Highways

Right-hand e~~E~~ntrances and exits ~~on the right side only~~ are highly desirable ~~for all~~ on limited access (LA) facilities ~~highways~~. Acceleration and deceleration lanes are mandatory. Intersections ~~shall~~ must be ~~accomplished by~~ grade separated ~~ion (interchange)~~ and interchanges should ~~be restricted to~~ only connect ~~with~~ to arterials ~~or~~ and collectors ~~roads~~.

See Table 3 – 26 for The controlling of access on freeways should conform to the requirements given in Table 3 – 26 Access Control for All Limited Access Highways. The

Increase the spacing of exits and entrances ~~should be increased~~ wher~~ever~~ possible to reduce conflicts. Safety and capacity ~~characteristics~~ are improved by ~~restricting the number and~~ increasing the spacing of access points.

Table 3 – 26 Access Control for ~~All~~ Limited Access (LA) Highways

	Urban	Rural
Minimum Spacing		
Interchanges	1 mile to 3 miles	3 miles to 25 miles
Maneuver Restrictions		
Crossing Maneuvers	Via Grade Separation Only	
Exit and Entrance	From Right-hand 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~~Roadways

~~The design and construction of u~~ Urban~~, as well as~~ and rural ~~, highways should be~~ roadways are both governed by the same general criteria for access control ~~previously outlined~~. ~~In addition, the design of~~ Design urban ~~streets~~ roadways ~~should be in accordance with~~ using the criteria ~~listed~~ below ~~:~~as minimum requirements. It is generally desirable to use more stringent criteria.

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- ~~The general layout of l~~Local and collector roadways ~~streets~~ should ~~follow~~ form a branching network~~,~~ (~~rather than~~ in lieu of a highly interconnected grid) ~~pattern~~.
- Design t~~T~~he street network ~~should be designed~~ to reduce~~, consistent with origin/destination requirements,~~ the number of crossings and left-turn maneuvers (consistent with origin/destination requirements)~~.~~
- ~~The d~~Design ~~of~~ the ~~street~~ roadway ~~layout~~ network ~~should be predicated upon~~ to reduce ~~ing~~ the need for traffic signals.

- ~~The use of~~ Avoid using a ~~a~~ public ~~street or highway~~ roadway as an integral part of the internal circulation ~~pattern for~~ of a commercial property ~~should be discouraged~~.

- Limit t~~T~~he number of driveways ~~access points should be restricted as much as possible~~ through areas of strip development.
- Give s~~S~~pecial attention ~~consideration should be given~~ to providing turn lanes ~~(auxiliary lane for turning maneuvers)~~ where ~~the total~~ traffic volumes (or truck/bus volumes) ~~is~~ are high.
- Access to m~~M~~ajor traffic generators ~~may~~ can be exempt from ~~the~~ driveway restrictions ~~on driveway access if the access point is~~ when designed as a normal intersection (~~adequate to handle~~ for the expected traffic volumes).

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

~~The design of~~ Design rural highways ~~should be in accordance with~~ using the ~~general criteria for~~ access control criteria for urban ~~streets~~roadways. ~~The use of~~ Providing a~~a~~cceleration and deceleration lanes is strongly recommended on all high-speed roadways ~~highways,~~ (particularly ~~if~~ where truck and bus volumes are ~~traffic is~~ significant)~~, is strongly recommended~~.

C.8.e Land Development

It should be the policy of each agency with responsibility for ~~street and highway~~street and highway ~~–~~design, construction, or maintenance to promote close liaison with:

- U~~u~~tility,
- L~~l~~awmaking,
- Z~~z~~oning,
- B~~b~~uilding, and
- P~~p~~lanning agencies.

Cooperation should be solicited in the ~~formulation~~ creation of laws, regulations, and master plans for land use, zoning, and road construction~~.~~ ~~Further requirements and criteria for access control and land use relationships are given in~~ See ***Chapter 1*** ~~***– Planning and Land Development***~~ for additional requirements for access control and land use relationships.

C.9 Intersection Design

Intersections increase traffic conflicts and ~~the~~ demands on the driver~~,~~ and are inherently hazardous locations. ~~The d~~Design ~~of an~~ intersections to: ~~should be predicated on~~

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- R~~r~~educe ~~ing~~ motor vehicle, bicycle, and pedestrian conflicts,
- M~~m~~inimize ~~ing the~~ confusion and demands on the driver ~~for rapid and/or complex decisions~~, and
- P~~p~~rovide ~~ing for~~ smooth traffic flow.

Comply with the requirements of Section C.8 of this chapter for ~~The~~ locating ~~on~~ and spacing ~~of~~ intersections ~~should follow the requirements presented in Section C.8 Access Control, this chapter~~. ~~Intersections should be~~ D~~d~~esign intersections ~~ed~~ to minimize time and distance for all users ~~of all who pass through or turn at an intersection~~.

The additional effort and expense ~~required to~~ required to provide~~e~~ a high-~~-~~quality intersection ~~is~~ are justified by the corresponding safety benefits. The overall reduction in crash

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- I~~i~~ncrease capacity,
- R~~r~~educe delays, and
- I~~i~~mprove safety.

Inadequate left-turn storage ~~One of the most~~ is a very common deficiency that may be easy to correct ~~ies that may be easy to correct is lack of adequate left turn storage~~.

The requirements and design criteria ~~contained~~ provided in this section are applicable to all:

- D~~d~~riveways,
- I~~i~~ntersections,~~ and~~
- I~~i~~nterchanges, and ~~. All~~
- E~~e~~ntrances to, exits from, ~~or~~ and interconnections between ~~streets~~ roadways~~and highways are subject to these design standards~~.

~~C.9.a~~C.9.b General Criteria

The layout of an ~~given~~ intersection may be influenced by constraints unique to thata ~~a~~ particular location ~~or situation~~. The design ~~shall~~ must 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~~ practical~~ble~~. Complex intersections~~, which~~ tend to confuse and distract the driver~~,~~ and produce inefficient and hazardous operations.
- The layout of the intersection~~ arrangement~~ should not require the driver to make rapid or complex decisions.
- The ~~layout of the~~ layout of the intersection should be clear and understandable so that a proliferation of signs, signals, ~~or~~ and pavement markings is not required to ~~adequately~~ inform and direct the driver.
- ~~The design of i~~Intersection~~s~~ designs should be as consistent as

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possible , (particularly along a given street or highwayroadway), should be as consistent as possible.

- The approach roadway approachess should be free from steep grades and sharp horizontal or and vertical curves.
- Intersections angles with driveways or other roadways should be as close to right angle 90 degrees as possible.
- Adequate sight distance should be provided to present allow the driver a clear view of the intersection and to allow for for safe execution of crossing and turning maneuvers.

- The design of all intersection elements should be consistent with the design speeds of the roadway approaches~~ roadways~~.
- The intersection layout ~~and channelization~~ should encourage smooth flow and discourage wrong-~~-~~way movements.
- Give s~~S~~pecial attention ~~should be~~ to ~~directed toward the~~ providing~~sion of~~ safe roadside clear zones.
- ~~The provision of~~ Provide a~~a~~uxiliary lanes ~~should be~~ in conformance with the criteria ~~set forth~~ in Section C.8 ~~Access Control~~ of~~,~~ this chapter.
- Give special attention to t~~T~~he requirements for bicycle and pedestrian movements~~ should receive special consideration~~.

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~~C.9.b~~C.9.c Sight Distance

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

~~C.9.b.1~~C.9.c.1 General Criteria

Comply with the criteria below for providing sight distance ~~General criteria to be followed in the provision of sight distance include the following~~:

- Provide s~~S~~ight 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~~ Using proper approach geometry (free from sharp horizontal and vertical curvature) ~~will normally allow for~~ typically provides adequate sight distance.
- The approaches to exits and~~or~~ intersections (including turn, storage, and deceleration lanes) should ~~have~~ provide adequate sight distance ~~for the design speed and also to accommodate any allowed~~ for all lane changing~~e~~ maneuvers.
- Provide a~~A~~dequate 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~~ to allow ~~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~~ traffic ~~is necessary to~~ allows through traffic ~~to aid merging maneuvers and~~ to avoid vehicles that have "run" or ~~appear to~~ may run ~~have the intention of running~~ stop signs ~~or~~ and traffic signals.

- Provide sight distances exceeding the minimums for a~~A~~pproaches to school and~~or~~ pedestrian crossings and crosswalks. ~~should have sight distances exceeding the minimum values. This should also include~~ Provide a clear view of ~~the~~ adjacent pedestrian pathways ~~or~~ and shared use paths.
- Provide s~~S~~ight distance in both directions ~~should be provided for all~~ for entering roadways (intersecting roadways and driveways) to allow entering vehicles to avoid through traffic. See Section C.9.B.4 for additional~~further~~ information.

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- Provide s~~S~~afe stopping sight distances ~~shall be provided throughout~~ for all intersections~~, including~~ (including turn lanes, speed change lanes, and turning roadways).
- ~~The use of~~ Consider lighting (***Chapter 6*** ~~***– Lighting***~~) ~~should be considered~~ to improve intersection sight distances for night-time driving.

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~~C.9.b.2~~C.9.c.2 Obstructions to Sight Distance

~~The provisions for~~ S~~s~~ight distances can be ~~are limited~~ obstructed by the ~~street or highway~~ roadway geometry and the nature and development of ~~the~~ adjacent properties ~~area adjacent to the roadway~~. Where line of sight is limited ~~by vertical curvature or obstructions~~, base the stopping sight distance ~~shall be based~~ on ~~the~~ an eye height of 3.50 feet and an object height of 2.0 feet. A clear view of the pavement surface should be provided a~~A~~t exits and~~or~~ other locations where the driver may be uncertain ~~as to~~ of the roadway alignment~~, a clear view of the pavement surface should be provided~~. Sight distance should be based on an eye height of 3.50 feet and an object height of 3.00 feet (preferably 1.50 feet) ~~At locations requiring~~ where a clear view of other vehicles ~~or~~ and pedestrians ~~for the safe execution of~~ is needed for 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 height for truck traffic may be increased for ~~determination of~~ assessing line-~~–~~of-~~–~~sight obstructions for intersection maneuvers. Obstructions to sight distance at intersections may 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 is a potential sight distance obstruction.

~~Based on the degree of obstruction,~~ Consider acquiring the property ~~should be considered for acquisition~~ by deed or easement based on the degree of obstruction.

- Areas ~~which contain~~ with vegetation (trees and ~~,~~ shrubbery, ~~grass, etc.)~~ that cannot ~~easily~~ be easily trimmed or removed by regular maintenance activities ~~y should be considered as~~ are potential sight obstructions~~s~~.
- Parking lanes ~~shall be considered as~~ are sight obstructions ~~to line of sight~~. Prohibit parking ~~shall be prohibited within clear areas~~ where required for clear sight distance at intersections.
- Large (or numerous) poles ~~or~~ and 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 – 19*** ~~Departure Sight Triangle~~ in Section C.9.b.4 ~~may constitute~~ are potential sight obstructions. Investigate ~~p~~Potential sight obstructions created by poles, supports, and signs near intersections ~~should be carefully investigated~~.

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

~~C.9.b.3~~C.9.c.3 Stopping Sight Distance

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

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

~~The~~ Provide sight distances no less than those in Table 3 – 25 on a~~a~~pproaches to stop signs, yield signs, and~~or~~ traffic signals. ~~should be provided with a sight distance no less than values given in Table 3 – 25 Minimum Stopping Sight~~

~~Distance (Rounded Values).~~ These ~~values~~ distances are ~~applicable~~ appropriate for any ~~street, highway, or~~ turning roadway. ~~The driver should, at this required distance,~~ The driver should have a clear view of the intersecting roadway~~,~~ ~~as well as~~ and the sign or traffic signal.

Sight distance where the approach roadway is on a grade or vertical curve should be no less than the distances in ***Figure 3 – 18*** ~~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 – 18_** Sight Distances for Approach to Stop on Grades. In any situation where it is feasible,~~ Exceed these sight distances where feasible ~~exceeding those should be provided. This is desirable~~ to allow for more gradual stopping ~~maneuvers~~ and to reduce the ~~likelihood~~ risk of vehicles running through stop signs ~~or~~ and signals. Advance warnings for stop signs are desirable.

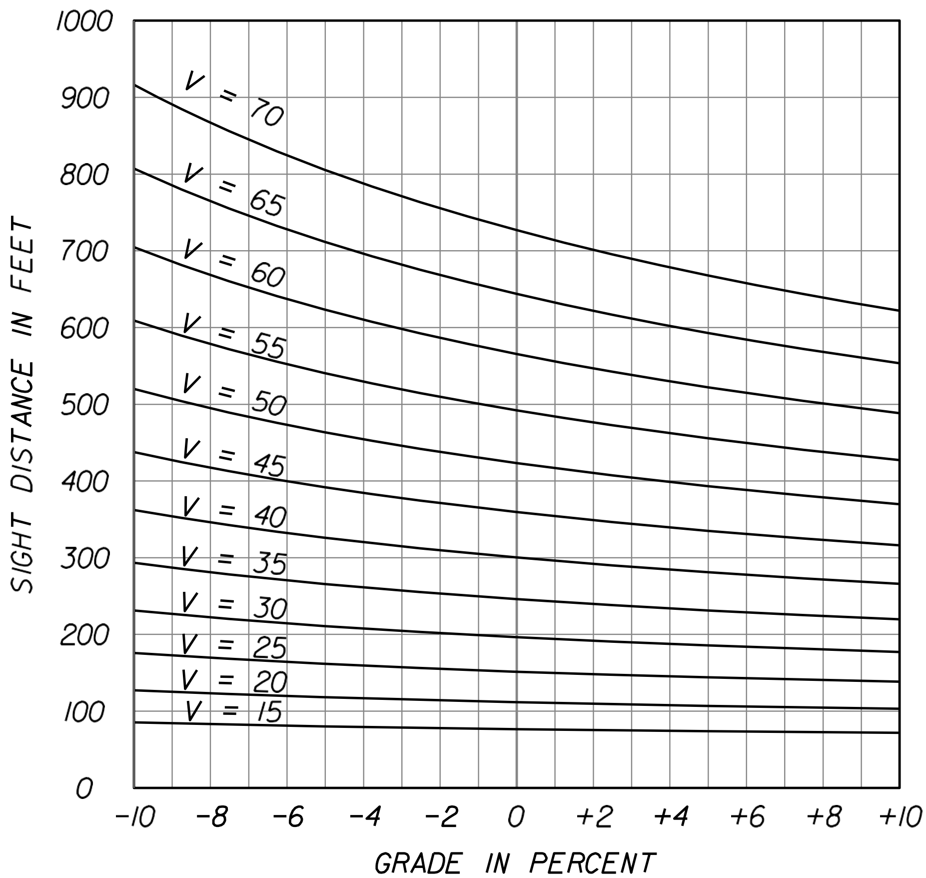
Table 3 – 27 Minimum Stopping Sight Distance (Rounded Values)

Design Speed (mph)	20	25	30	35	40	45	50	55	60	65	70
Stopping Sight Distance (feet)	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 along a turning roadway (loop, exit, etc.) ~~shall be~~ is based on the design speed at that location ~~point~~. Provide a~~A~~mple 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~~ is reduced by the ~~roadway~~ curvature. ~~The~~ See ***Table 3 – 27*** and ***Figure 3 – 18 for*** ~~m~~minimum sight distances ~~values are given in **_Table 3 – 27_** Minimum Stopping Sight Distance (Rounded Values) or **_Figure 3 – 18_** Sight Distances for Approach to Stop on Grades~~. Consider providing roadway lighting for turning roadways since ~~Due to the inability of~~ vehicle headlights ~~to~~ do not adequately ~~adequately~~ illuminate ~~a sharply~~ the curved ~~travel~~ path~~, roadway lighting should be considered for turning roadways~~.

Figure 3 – 18 Sight Distances for Approach to Stop on Grades



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

S = Sight Distance (feet)

V = Design Speed (mph)

G = Grade (percent)

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

Provide s~~S~~ight distance ~~is also provided~~ at intersections to allow ~~the drivers of~~ stopped vehicles a sufficient view of the intersecting ~~street or highway~~ roadway to decide when to enter/~~ or~~ cross ~~the intersecting street or highway~~. S~~S~~ight triangles~~, which are specified areas~~ along intersection approach legs and ~~across~~ their included corners~~, shall, where practical,~~ must be clear of obstructions that ~~would~~ prohibit a driver's view of potentially conflicting vehicles (where practical). Provide d~~D~~eparture sight triangles ~~shall be provided~~ in each quadrant of each intersection approach controlled by stop signs.

See Figures 3 – 19 ~~Departure Sight Triangle (Traffic Approaching from Left or Right)~~ and 3 – 20 ~~Intersection Sight Distance show~~ for typical departure sight triangles to the left and ~~to the~~ right of ~~the location of~~ a stopped vehicle on a minor road (stop controlled) and ~~the~~ for various intersection sight distances~~ for the various movements~~.

Distance "a" is the length of ~~leg of~~ the sight triangle along the minor roadway~~. This distance is~~ measured from the stopped driver's eye: ~~'s eye in the stopped vehicle to the~~

- To the center of the nearest lane on the major through roadway ~~(through road)~~ for vehicles approaching from the left, and
- T~~t~~o 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 entrance lane from the minor road ~~entrance lane~~. This distance is a function of the design speed and the major road time gap ~~in major road traffic~~ needed for minor road drivers to turn~~ing~~ onto or cross~~ing~~ the major road. Calculate t~~T~~his distance ~~is calculated~~ as~~ follows~~:

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

Where:

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

V_{major}= Design Speed (mph) of the m~~M~~ajor r~~R~~oad

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

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The time gaps values, (t_g,) to be used in determining ation of ISD are based on studies and observations of ~~the~~ actual major road time gaps ~~in major road traffic actually~~ accepted by minor road drivers turning onto or crossing ~~drivers turning onto or across~~ the major road. ~~Design t~~ Time gaps ~~will~~ vary ~~and~~ depending on the:

- D~~d~~esign vehicle, ~~the~~
- T~~t~~ype of ~~the~~ maneuver, ~~the~~
- C~~c~~rossing distance ~~involved in the maneuver~~, and ~~the~~
- Profile grade of the minor road ~~approach grade~~.

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

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) of this chapter for the design time gaps for Case B~~Case B~~.

See Section C.9.b.4.(e) (AASHTO Case D) f~~F~~or i~~I~~ntersections with t~~T~~raffic s~~S~~ignal c~~C~~ontrol. ~~see Section C.9.b.4.(e) (AASHTO Case D).~~

See Section C.9.b.4.(f) (AASHTO Case E) f~~F~~or intersections with all-way stop control. ~~see Section C.9.b.4.(f) (AASHTO Case E).~~

See Section C.9.b.4.(g) (AASHTO Case F) f~~F~~or left~~-~~turns from the major road. ~~see Section C.9.b.4.(g) (AASHTO Case F).~~

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Figure 3 – 19 Departure Sight Triangle
(Traffic Approaching from Left or Right)

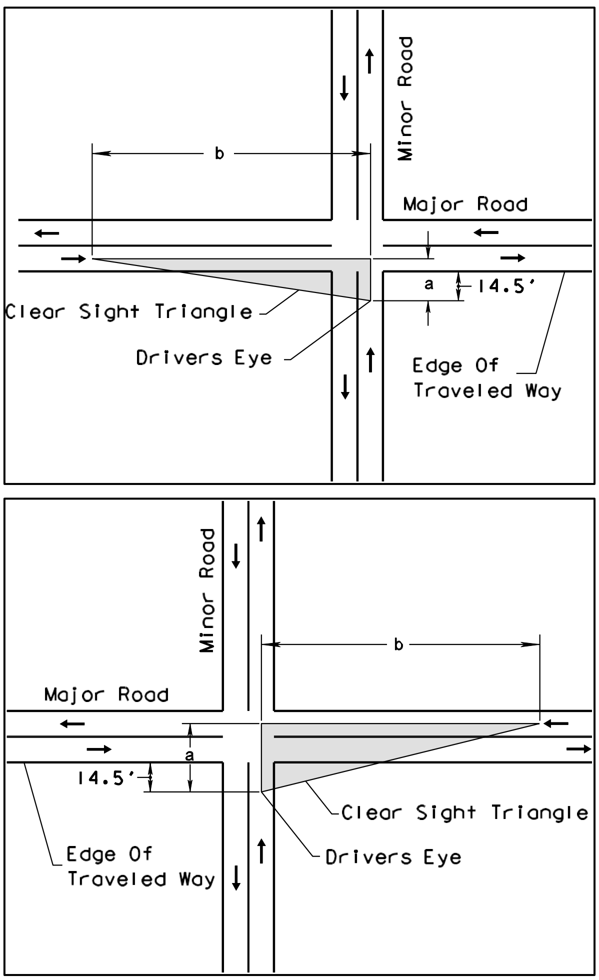
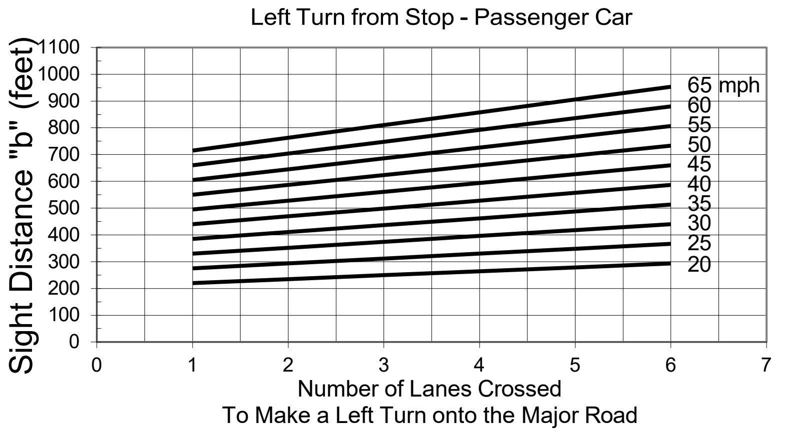
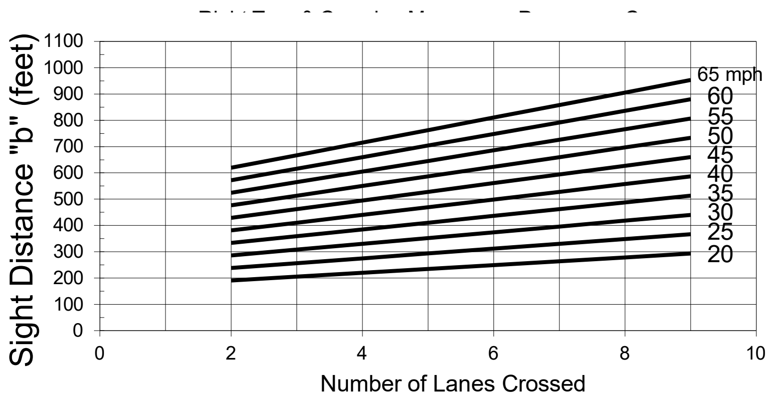


Figure 3 – 20 Intersection Sight Distance



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



~~For right turn maneuver~~ U~~u~~se a distance based on 2 lanes crossed for the right turn maneuver.
~~For crossing divided highways,~~ C~~c~~onvert median widths to equivalent number of lanes for crossing divided highways. ~~For medians 25' and greater~~ A~~a~~ two~~-~~step maneuver may be considered for median

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~~ must be ~~a minimum of~~ at least 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~~ show that ~~, where necessary,~~ drivers ~~will~~ stop with the front of their vehicle less than 6.5 feet ~~or less~~ from the edge of the major road traveled way; and ~~. Measurements of passenger cars indicate that~~ that the distance from the front of the vehicle to the driver's eye ~~for the current U.S. passenger car fleet~~ is ~~almost always~~ typically less than 8 feet ~~or less~~.

When performing a crossing or turning maneuver after stopping at a stop sign, stop bar, or crosswalk as required in ***Section 316.123, F.S.***, ~~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_**, i~~ It is assumed that the ~~vehicle will~~ driver moves slowly forward to obtain sight distance (without intruding into the crossing travel lane) stopping ~~ping~~ a second time as necessary.

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

The d~~D~~imensions of clear sight triangles are provided for passenger cars, single unit trucks, and combination trucks stopped on the minor road. It ~~can~~ is usually ~~be~~ assumed that the minor road vehicle is a passenger car. ~~However,~~ However, consider using the tabulated distances for single unit and combination trucks where substantial ~~volumes~~ numbers of ~~heavy~~ large vehicles enter the major road~~,~~ (such as from a ramp 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~~ The minimum time gaps ~~values~~ for left~~-~~-turns from ~~the~~ a minor road onto a two~~-~~-lane, ~~-~~two~~-~~-way major road ~~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 upgrade of the minor road approach ~~grade is an upgrade that~~ exceeds 3 percent, add 0.2 seconds for each percent for left turns ~~grade for left turns~~.

For multilane ~~streets~~ roadways ~~and highways~~ with~~out~~ median~~s~~ widths ~~wide enough~~ insufficient to store the design vehicle with ~~a~~ 3 feet of clearance ~~of 3 feet~~ on both ends ~~of the vehicle~~, add 0.5 seconds for passenger cars ~~or~~ and 0.7 seconds for trucks for each additional lane (in excess of one) to be crossed from the left~~,~~ ~~in excess of one, to be crossed~~ by the turning vehicle. Include the width of t~~T~~he 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.

Assume a two-step maneuver f~~F~~or multilane ~~streets~~ roadways ~~and highways~~ with median widths ~~s wide enough~~ sufficient to store the design vehicle with ~~a~~ 3 feet of clearance ~~of 3 feet~~ on both ends ~~of the vehicle a two-step maneuver may be assumed~~. Use C~~c~~ase B2 for crossing ~~to~~ to the median.

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

~~Design~~ The minimum time gap ~~values~~ for a ~~stopped~~ vehicle stopped on a minor road to turn right onto or cross a two~~-~~-lane ~~highway~~ road 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, a~~ Add 0.1 seconds for each percent of up~~-~~grade when the upgrade is more than 3 percent.

~~For crossing streets and highways with more than 2 lanes, a~~ Add 0.5 seconds for passenger cars ~~or~~ and 0.7 seconds for trucks for crossing each additional lane of roads with more than 2 lanes ~~to be crossed~~. Include the width of the m~~M~~edian~~s~~ in the width of additional lanes when the median width is ~~not wide enough~~ insufficient ~~to~~ for storing ~~e~~ the design vehicle with ~~a~~ 3 feet of 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.

Assume a two-step maneuver f~~F~~or crossing divided ~~streets and highways~~ roadways with medians widths ~~wide enough to~~ sufficient for storinge~~e~~ the design vehicle with ~~a~~ 3 feet of clearance ~~of 3 feet~~ on both ends. ~~of the vehicle, a two-step maneuver may be assumed. Only~~ Consider 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, t~~ The first vehicle stopped ~~on one approach~~ at signalized intersections should be visible to the driver of the first vehicle stopped on all ~~each of the~~ other approaches. Left-~~-~~turning ~~vehicles~~ drivers should have sufficient sight distance to select gaps in oncoming traffic and to complete the left-~~-~~turns. ~~Apart from these sight conditions, n~~ No other sight triangles are needed for signalized intersections. However, provide the appropriate departure sight triangles for Cases B1, B2, or B3 (to the left and to the right) ~~if~~ where the traffic signal ~~is to~~ may be placed on two-way flashing operation ~~in~~ during 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,~~ Provide the appropriate departure sight triangle to the left for Case B2 ~~if~~ (where right turns are permitted 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, t~~ The first vehicle stopped ~~vehicle~~ at intersections with all-way stop control ~~on one approach~~ should be visible to ~~the drivers of~~ the first vehicle stopped ~~vehicles~~ on ~~each of the~~ all other approaches. ~~There are n~~ No other sight distance criteria apply ~~applicable to~~ 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 road from which vehicles are ~~permitted~~ allowed to turn left across opposing traffic ~~shall~~ must have sufficient sight distance to accommodate that~~e left turn~~ maneuver. ~~In this case, t~~ Measure the ISD ~~is measured~~ from the ~~stopped~~ position of the stopped left-~~-~~turning vehicle in such cases (see Figure ,3 – 21 ~~Sight Distance for Vehicle Turning Left from Major Road~~).

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~~Design~~ The minimum time gaps ~~values~~ for left-~~-~~turns from the major road are ~~as follows~~:

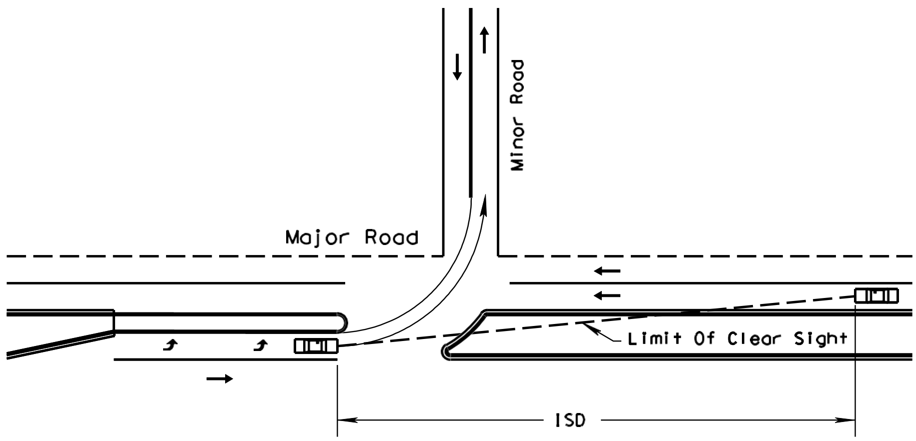
Design Vehicle	Time Gap (t_g) in Seconds
Passenger Car	5.5
Single Unit Truck	6.5
Combination Truck	7.5

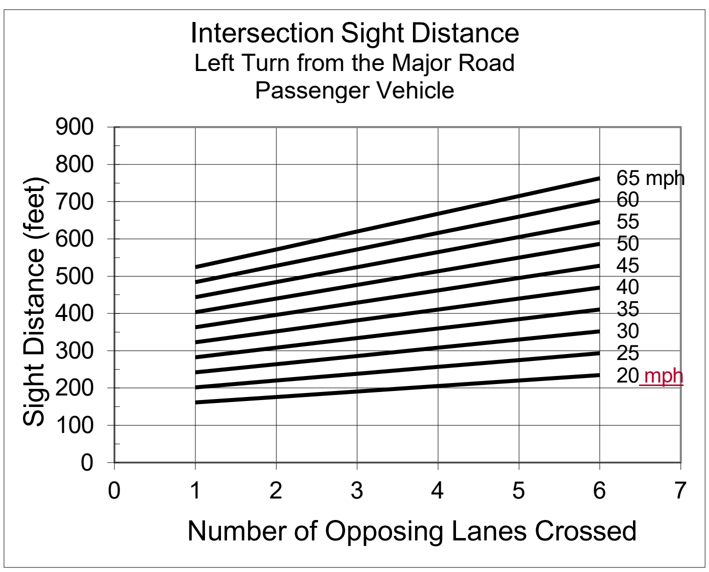
~~For left turning vehicles that cross more than one opposing lane, a~~ Add 0.5 seconds for passenger cars and 0.7 seconds for trucks for each additional lane (beyond 1) ~~to~~ being crossed by left-turning vehicles.

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

See ~~The~~ ***FDOT Design Manual, Chapter 212*** ~~***Intersections***, provides~~ for ISDs ~~values~~ for several basic intersection configurations based on Cases B1, B2, B3, and D~~, and may be used when applicable~~. See the ***AASHTO Green Book*** f~~F~~or additional guidance on ISD. ~~ntersection Sight Distance, see the **AASHTO Green Book (2011)**.~~

Figure 3 – 21 Sight Distance for Vehicle Turning Left from Major Road





~~C.9.c~~C.9.d Auxiliary Lanes

Auxiliary lanes are desirable for ~~the safe execution of~~ speed change maneuvers (acceleration and deceleration) and for ~~the~~ storing ~~age~~ and ~~protecti~~ protecting ~~on of~~ turning vehicles. Provide a~~A~~uxiliary lanes for exit and~~or~~ entrance turning maneuvers ~~shall be provided~~ in accordance with the requirements ~~set forth~~ in Section C.8 ~~Access Control,~~ of this chapter. Comply with the minimum requirements for ~~The~~ pavement width and cross slope ~~s of auxiliary lanes should meet the minimum requirements~~ provided ~~shown~~ in Table 3 – 20 ~~Minimum Lane Widths~~.

~~C.9.c.1~~C.9.d.1 Merging Maneuvers

Locate m~~M~~erging 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 where possible ~~and should be of~~ with sufficient length ~~to allow~~ for a smooth, safe transition. ~~The provision of ample~~ Provide sufficient merging distance ~~for merging is essential~~ to allow ~~the driver~~ time to find an acceptable gap in the through traffic and ~~then~~ to execute a safe merging maneuver. ~~It is recommended that a~~ Design the merging taper ~~be on~~ with a 1:50 transition ~~, but in no case, shall the length be~~ (no less than the distances ~~set forth~~ in Table 3 – 28). ~~Length of Taper for Use in Conditions with Full Width Speed Change Lanes.~~ The ~~termination of this lane~~ merging taper should be clearly visible from ~~both~~ the merging lane and the through lane and should adhere ~~correspond~~ to the general configuration depicted ~~shown~~ in Figure 3 – 22 ~~Termination of Merging Lanes~~. Provide a~~A~~dvance warning of the end of the merging lane ~~termination should be provided~~. Mark l~~L~~ane drops ~~shall be marked~~ in accordance with ***Section 14-15.010, F.A.C. Manual on Uniform Traffic Control Devices (MUTCD)***.

Table 3 – 28 Length of Taper for Use in Conditions with Full-~~ ~~Width Speed Change Lanes

Design Speed (mph)	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**
Length of Deceleration Taper (feet)	110	130	150	170	190	210	230	250	270	290	300
Length of Acceleration Taper (feet)	80	100	120	140	160	180	210	230	250	260	280

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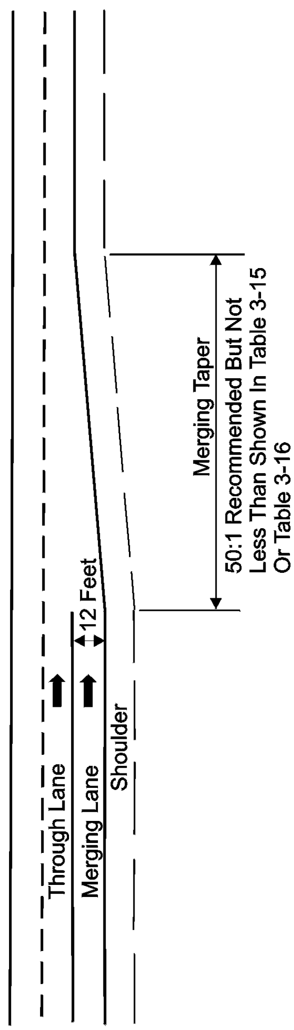
Figure 3 – 22 Termination of Merging Lanes



C.9.c.2C.9.d.2 Acceleration Lanes

Provide aAcceleration lanes are required for all entrances to expressway and freeway ramps. Consider providing aAcceleration lanes for entrances to may be desirable at access points to any street or highway roadways with a large percentage of entering significant truck traffic.

The Acceleration distances are required for an acceleration maneuver is dependent on the:

- Vvehicle acceleration capabilities, the
- Profile grade, the
- -Iinitial speed, and
- Final entrance speed.

, and the final speed at the termination of the maneuver. The See Table 3 – 29 for acceleration distances for passenger cars required for acceleration on level roadways for passenger cars are given in Table 3 – 29 Design Lengths of Speed Change Lanes Flat Grades. Where acceleration occurs on a grade, the required distance is obtained by using See Tables 3 – 30 and 3 – 31 for determining acceleration distances for upgrades and downgrades Ratio of Length of Speed Change Lane on Grade to Length on Level and Table 3 – 31 Minimum Acceleration Lengths for Entrance Terminals.

The final speed at the end of the acceleration lane, should , desirably, be assumed as be the design speed of the through roadway. The length of acceleration lane provided should be at least as long as the distance required needed to for accelerate ion between from the initial and to the final speeds. Due to the uncertainties regarding vehicle capabilities and driver behavior, a Additional length is desirable to accommodate vehicle capabilities and driver behavior. The acceleration lane should be followed by Provide a merging taper at the end of an acceleration lane (similar to see Figure 3 – 23 Termination of Merging Lanes). , not less than that length set forth in See Table 3 – 28 for minimum taper lengths. Length of Taper for Use in Conditions with Full Width Speed Change Lanes. The termination of acceleration lanes should conform to the general configuration shown for merging lanes in See Figure 3 – 22 for a typical merging lane tapers Termination of Merging Lanes. Recommended acceleration lanes for freeway entrance terminals are given in See Table 3 – 29 for recommended acceleration and deceleration lengths for freeways with level terrain (less than 2%) Minimum Acceleration Lengths for Entrance Terminals.

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Table 3 – 29 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, s~~ Shorter tapers may be used for urban auxiliary lanes with ~~due to~~ lower operating speeds. Refer to Figure 3-16 for allowable taper rates.

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Table 3 – 30 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
Multiply the r~~R~~atios in this table ~~multiplied~~ by the values in Table 3 – 26 ~~give~~ to obtain the length of speed change lane for the respective profile grade.								

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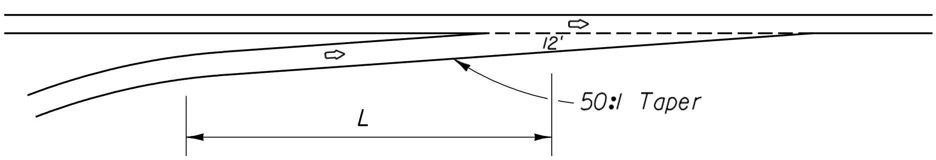
Table 3 – 31 Minimum Acceleration Lengths for Entrance Terminals

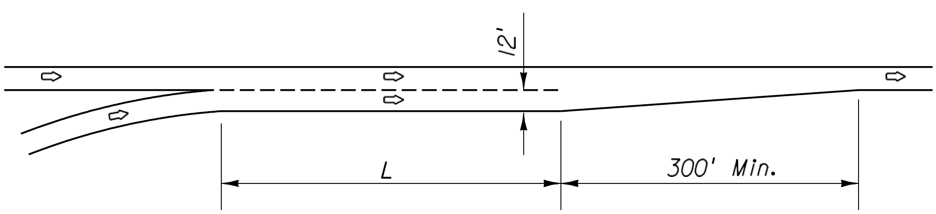
Highway Design Speed (mph)	L = Acceleration Length (feet)								
	For Entrance Curve Design Speed (mph)								
	Stop Condition	15	20	25	30	35	40	45	50
30	180	140	---	---	---	---	---	---	---
35	280	220	160	---	---	---	---	---	---
40	360	300	270	210	120	---	---	---	---
45	560	490	440	380	280	160	---	---	---
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 and Freeway Entrance Terminals



TAPER TYPE

Recommended when the design speed ~~at~~ of the entrance curve is 50 mph or more~~greater~~.



PARALLEL TYPE

Recommended when the design speed of the ~~at~~ entrance curve is less than 50 mph.

~~C.9.c.3~~C.9.d.3 Exit Lanes

Auxiliary lanes for exiting maneuvers provide space outside the ~~through~~through ~~-~~lanes for storing and protecting~~on 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 mainline operating speed ~~on the through lanes~~. Deceleration lanes are required for all freeway exits and are desirable ~~on~~ for high-speed (design speed ~~greater than~~ over 50 mph) roadways ~~streets and highways~~.

See Table 3 – 32 for ~~The~~ deceleration distances for ~~required for deceleration of~~ passenger cars ~~is given in Table 3 – 32 Minimum Deceleration Lengths for Exit Terminals~~.

See Tables 3 – 29 and 3 – 30 for ~~The~~ minimum deceleration distances ~~required distance for deceleration~~ on level terrain and with profiles grades ~~is given in Tables 3 – 29 Design Lengths of Speed Change Lanes Flat Grades - 2 Percent or Less and 3 – 30 Ratio of Length of Speed Change Lane on Grade to Length on Level~~.

These lengths ~~of deceleration lanes shall be no less than the values obtained from Tables 3 – 29 and 3 – 30~~ are minimums and should be increased where~~ever~~ feasible. The initial speed should be ~~, desirably, be taken as~~ the highway design speed ~~of the highway~~. The final speed should be:

- T~~t~~he design speed ~~at~~ of the exit (e.g., a turning roadway) or
- Z~~z~~ero~~, if~~if ~~-~~ the deceleration lane terminates at a stop or traffic signal. ~~A reduction in the~~

Use a lower final speed ~~to be used is particularly important if~~ where the exit ~~traffic~~ volume is high ~~since~~ 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 – 23 ~~Entrance for Deceleration Lane~~. See Table 3 – 31 for t~~T~~he initial length of straight taper~~, shown in Table 3 – 31 Minimum Acceleration Lengths for Entrance Terminals, may be utilized~~ as a portion of the total required deceleration distance. The ~~pavement surface of the~~ deceleration lane pavement should be clearly visible to approaching traffic~~, so~~ to make drivers ~~are~~ aware of the maneuvers required. See Table 3 –

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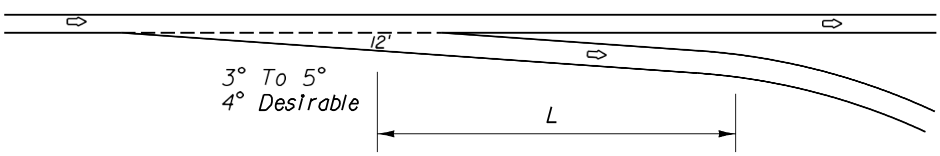
32 for rRecommended deceleration lengths anes for exit terminals are given in Table 3 – 32 Minimum Deceleration Lengths for Exit Terminals.

Table 3 – 32 Minimum Deceleration Lengths for Exit Terminals

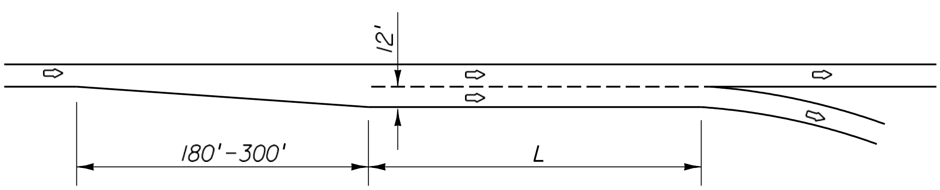
Highway Design Speed (mph)	L = Deceleration Length (feet)								
	~~For~~ Design Speed of Exit Curve (mph)								
	Stop Condition	15	20	25	30	35	40	45	50
30	235	200	170	140	---	---	---	---	---
35	280	250	210	185	150	---	---	---	---
40	320	295	265	235	185	155	---	---	---
45	385	350	325	295	250	220	---	---	---
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 and Freeway Exit Terminals



TAPER TYPE

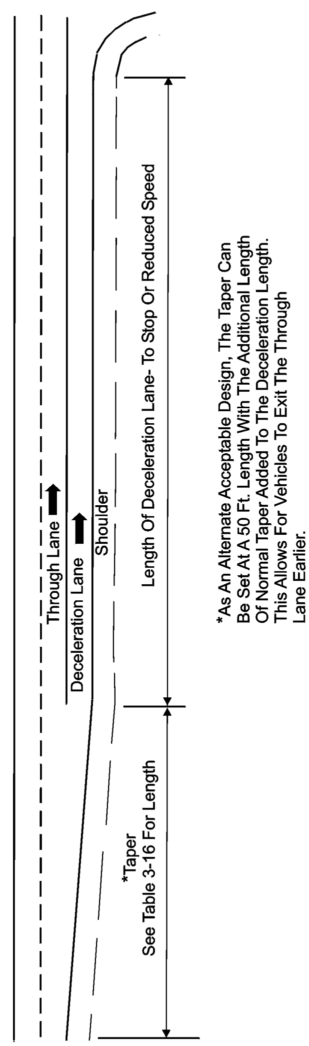
Recommended when the design speed of the ~~at~~ exit curve is 50 mph or ~~greater~~ more and ~~when~~ the approach visibility is good.



PARALLEL TYPE

Recommended when the design speed of the ~~at~~ exit curve is less than 50 mph ~~or~~ or ~~when~~ the approach visibility is not good.

Figure 3 – 23 Entrance for Deceleration Lane



~~C.9.c.4~~C.9.d.4 Auxiliary Lanes at Intersections

The primary function of auxiliary lanes at intersections is to:

- Aaccommodate speed changes and ~~maneuvering of~~ turning movements, ~~traffic. They are typically added to~~ ,
- I~~i~~ncrease~~e~~ through lane capacity, and~~/or reduc~~
- Reduce ~~e~~ crashes ~~at an intersection~~. ~~Auxiliary lanes for deceleration and storage of queuing vehicles are used preceding intersections and median openings for left-turning and right-turning movements. In some cases, a~~

Auxiliary lanes are sometimes used for acceleration ~~are used~~ following right-~~-~~turning movements.

C.9.c.4.(a) Widths of Auxiliary Lanes

See Table 3 – 20 for ~~The~~ minimum auxiliary lane widths ~~for auxiliary lanes are given in Table 3 – 20 Minimum Lane Widths~~.

C.9.c.4.(b) Lengths of Auxiliary Lanes for Deceleration

See Figure 3 – 24 and Table 3 – 33 for ~~Recommended~~ auxiliary lane lengths ~~for auxiliary lanes~~ for deceleration ~~(turn lanes)~~ at intersections ~~are provided in Figure 3 – 24 Auxiliary Lanes for Deceleration at Intersections (Turn Lanes) and Table 3 – 33 Turn Lanes – Curbed and Uncurbed Medians~~. ~~These lengths are based on FDOT criteria. As shown in~~ See Figure 3 – 24 for the ~~total length of turn lanes consists of~~ three components of a turn lane:~~,~~
(1) Deceleration Length,
(2) Storage or Queue Length, and
(3) Entering Taper.
It is common practice to accept ~~a moderate~~ some amount of deceleration ~~with~~in the through lane~~s~~ and to ~~consider~~ include the taper as part of the deceleration length. The required length ~~criteria for each~~ of each ~~the~~ auxiliary lane component~~s~~ is ~~are explained as follows~~:

Deceleration Length

The ~~required total deceleration~~ length ~~is that~~ needed for a safe

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and comfortable stop from the design speed of the highway. See Figure 3 – 24 for mMinimum deceleration lengths (including taper) for auxiliary lanes are provided in Figure 3 – 24 and are based on minimum stopping sight distance.

Storage (Queue) Length

The auxiliary lane should also be ~~sufficiently~~ long enough to:

- S~~s~~tore the number of vehicles likely to accumulate, ~~during a critical period. The storage length should be sufficient to~~

- ~~avoid the possibilities of~~ Avoid having turning vehicles queuing~~stopping~~ in the through lanes, and

- ~~or the entrance to the auxiliary lane being blocked by~~ Avoid having through vehicles blocking access to the turn lane ~~queuing in the through lanes~~.

~~At unsignalized intersections the s~~ Storage lengths for unsignalized intersections ~~,~~ (exclusive of taper)~~, may~~ can be based on the estimated number of turning vehicles ~~likely to arrive~~ in an average two-minute period within the peak hour. ~~For low volume intersections where a traffic study is not justified,~~ Provide at least ~~a minimum~~ 50 ~~-~~fee~~oo~~t of queue length (2 vehicles) ~~should be provided~~ on low-volume rural intersections where a traffic study is not justified. ~~highways~~. ~~A minimum~~ Provide at least 100 ~~-~~fee~~oo~~t of queue length (4 vehicles) ~~should be provided~~ in urban areas. ~~Locations with over 10% truck traffic should accommodate~~ Provide at least one car and one truck of queue length where truck traffic exceeds 10%.

~~At signalized intersections, the required s~~ Storage lengths for signalized intersections are ~~is~~ determined by traffic study based ~~and depends~~ on the:

- S~~s~~ignal cycle length
- ~~, the~~ S~~s~~ignal phasing arrangement~~,~~ and ~~the~~
- R~~r~~ate of arrivals and departures of turning vehicles~~.~~

The storage length is a function of the probability of occurrence of events and should be based on 1.5 to 2 times the average number of vehicles ~~that would store~~ predicted per cycle ~~that is predicted in the design volume~~.

~~Where dual turning lanes are used,~~ Reduce the ~~required~~ storage length required for a single-lane turn by ~~is reduced to~~ approximately one-half for a two-lane turn ~~of that required for single-lane operation~~.

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Approach End Taper

~~The FDOT's criteria for approach end taper lengths for~~ A single turn lane taper should be ~~s are~~ 50 feet long. ~~for a single turn lane and~~ A double turn ~~-~~lane taper should be 100 feet long ~~for a double turn lane, as shown in~~ See Figure 3 ~~–~~ – 24 ~~Auxiliary Lanes for Deceleration at Intersections (Turn Lanes)~~ and Table 3 – 33) ~~Turn Lanes – Curbed and Uncurbed Medians~~. Use t~~T~~hese taper lengths ~~apply to~~ for all roadways and all design speeds ~~and are recommended for use on turn lanes on all roads~~. These s~~S~~hort tapers ~~lengths are intended to provide approaching road users with positive~~

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clearly identifyication of an the added auxiliary lane and provide additional low-speed storage and results in a longer full width auxiliary lane than use of longer taper lengths based on the path that road users actually follow. The clearance distances L_1 and L_3 account for the approximate travel path full transition lengths a road user will use to enter the auxiliary lane for various speed conditions assumed for design.

It is acceptable to lengthen the taper up to L_1 f(for single lefts) turns and L_3 f(for double lefts) turns where a traffic study can establishes that left- turn queues vehicles are adequately provided for accommodated within the design queue length and through vehicle queues will do not block left-turn lane access to the left turn lane(s).

Figure 3 – 24 Auxiliary Lanes for Deceleration at Intersections (Turn Lanes)

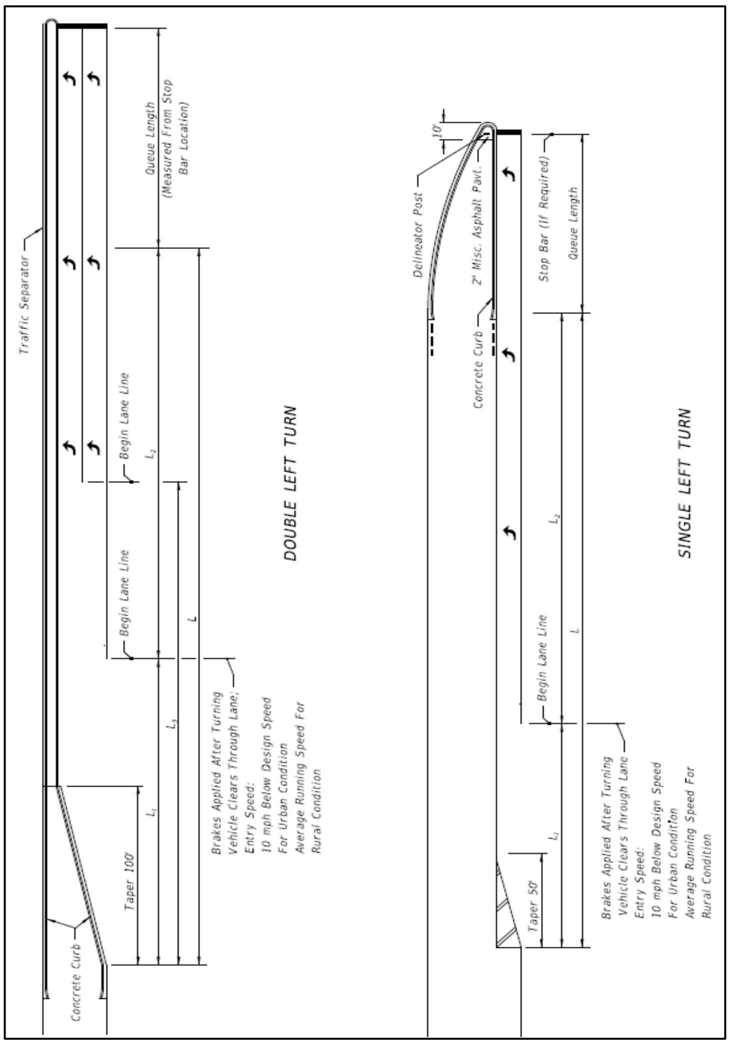

Table 3 – 33 Turn Lanes – Curbed and Uncurbed Medians

Design Speed (mph)	Entry Speed (mph)	Clearance Distance L_1 (feet)	Urban Conditions			Rural Conditions		
			Brake to Stop Distance L_2 (feet)	Total Decel. Distance L (feet)	Clearance Distance L_3 (feet)	Brake to Stop Distance L_2 (feet)	Total Decel. Distance L (feet)	Clearance Distance L_3 (feet)
≤ 30	≤ 25	60	75	135	100			
35	25	70	75	145	110	----	----	----
40	30	80	75	155	120	----	----	----
45	35	85	100	185	135	----	----	----
50	40/44	105	135	240	160	185	290	160
55	48	125	----	----	----	225	350	195
60	52	145	----	----	----	260	405	230
65	55	170	----	----	----	290	460	270

Note: Right-turn lane tapers and distances are identical to left-turn lanes under stop control conditions. For free flow or yield control conditions, t Taper lengths and distances are site specific for free-flow and yield conditions.

C.9.c.4.(c) Lengths of Auxiliary Lanes for Acceleration

Acceleration lanes (similar to those used for freeways and expressways) are sometimes used at intersections. They are not always desirable at stop-controlled intersections where entering drivers can wait for an opportunity to merge without disrupting through traffic. Acceleration lanes are advantageous on roads without stop control and on all high-volume roads (even with stop control) where peak-hour openings between vehicles in the peak-hour traffic streams are infrequent and short. When used, acceleration lanes at intersections should be designed using Use the criteria provided in Section C.9.c.2 for designing acceleration lanes at intersections Acceleration Lanes.

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~~C.9.d~~C.9.e Turning Roadways at Intersections

~~The design and construction of t~~Turning roadways ~~shall~~ must meet the same general design requirements ~~for~~ as through roadways, ~~,~~ except for the specific requirements below~~given in the subsequent sections~~.

~~C.9.d.1~~C.9.e.1 Design Speed

~~Lanes for~~ Intersection t~~t~~urning movements ~~at grade intersections~~ ~~may~~ can (~~,~~ where justified)~~,~~ be based on a design speed as low as 10 mph. Design t~~T~~urning roadways with design speeds ~~in excess of~~ over 40 mph ~~shall be designed~~ in accordance with the requirements for through roadways.

Use a ~~A~~ varying ~~iable~~ design speed ~~may be used to establish cross section and alignment criteria for~~ along turning roadways that ~~will~~ experience acceleration or ~~and~~ deceleration ~~maneuvers~~.

~~C.9.d.2~~C.9.e.2 Horizontal Alignment

- Curvature ~~–~~ – See Table 3 – 34 for t~~T~~he minimum ~~permitted~~ curve radii ~~i (maximum degree) of curvature~~ for various ~~values~~ rates of superelevation ~~are given in Table 3 – 34 Superelevation Rates for Curves at Intersections~~. ~~These should be considered as~~ Consider these values as minimums. ~~values only and~~ Increase these radii ~~us of curvature should be increased~~ where~~ever~~ feasible. ~~Further information contained in~~ See ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011***~~,~~ for additional information ~~should also be considered~~.

Table 3 – 34 Superelevation Rates for Curves at Intersections

	Design Speed (mph)					
	20	**25**	**30**	**35**	**40**	**45**
Minimum Superelevation Rate	0.02	0.04	0.06	0.08	0.09	0.10
Minimum Radius (feet)	90	150	230	310	430	540

~~The~~ A rate of 0.02 is considered the practical minimum for effective pavement drainage. ~~across the surface. Note: Preferably use s~~ Superelevation rates greater than these minimum values are preferred.

- Superelevation Transition – – See Tables 3 – 35 and 3 – 36 for mMinimum superelevation transition (runoff) rates (maximum relative gradients) are given in Tables 3 – 35 Maximum Rate of Change in Pavement Edge Elevation for Curves at Intersections and 3 – 36 Maximum Algebraic Difference in Pavement Cross Slope at Turning Roadway Terminals. Other information given in See ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011***, for additional information should also be considered.

Table 3 – 35 Maximum Rate of Change in Pavement Edge Elevation for Curves at Intersections

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

Table 3 – 36 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.3C.9.e.3 Vertical Alignment

Longitudinal profile gGrades on turning roadways should be as flat as practical. and Use long vertical curves should be used where ever feasible. The length of v Vertical curves shall must be long enough no less than necessary to provide minimum stopping sight distance. See Table 3 – 4 for mMinimum stopping sight distances values are given in Table 3 – 4 Minimum Stopping Sight Distances. See ***AASHTO – "A Policy on Geometric Design of Highways and Streets" – 2011*** fFor additional guidance on vertical alignments for turning roadways, see ***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011***.

~~C.9.d.4~~C.9.e.4 Cross Section Elements

- Number of Lanes - One-way turning roadways are typically ~~often limited to~~ a single traffic lane~~. In this case,~~ such that the ~~total~~ width of the roadway ~~shall~~ must ~~be sufficient to~~ allow ~~traffic to~~ for passing a disabled vehicle. Undivided t~~T~~wo-way~~, undivided~~ turning roadways should be avoided. Medians or barriers should be used ~~tilized~~ to separate opposing traffic on turning roadways.
- Lane Width ~~-~~ - Travel lane widths ~~he width of all traffic lanes~~ should ~~be sufficient to~~ accommodate (with adequate clearances) ~~the~~ turning ~~movements of~~ by the expected types of vehicles. See Table 3 – 37 for t~~T~~he minimum required lane widths for turning roadways ~~are given in Table 3 – 37 Derived Pavement Widths for Turning Roadways for Different Design Vehicles~~. Accomplish c~~C~~hanges in lane widths gradually ~~should be gradual and should be accomplished in coordination~~ with adequate transitions ~~in horizontal curvature~~.
- Shoulders - ~~On~~ The outside (right) shoulder of one-lane turning roadways~~,~~ serving expressways and ~~other~~ arterials (e.g., loops, ramps)~~, the right hand shoulder~~ should be at least 6 feet wide. The ~~left hand~~ inside (left) shoulder should also be at least 6 feet wide~~ in all cases~~. ~~On two- lane, one-way roadways, b~~ Both shoulders of a two-lane, one-way roadway should be at least 6 feet wide. ~~Where guardrails or other barriers are used, they~~ Place guardrails (and other barriers) ~~should be placed~~ at least 8 feet from the 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~~ Areas outside ~~of~~ horizontal curves should be wider and more gently sloped than ~~the minimum values for~~ for open highways. Use g~~G~~uardrails (or ~~similar~~ other barriers) ~~shall be used if~~ when ~~the minimum width~~ clear zone and slope requirements cannot be met ~~obtained~~.

See ***Chapter 4*** for additional ~~Further~~ criteria and requirements ~~for roadway design are given in~~
~~***Chapter 4 - Roadside Design***~~.

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Table 3 – 37 Derived Pavement Widths for Turning Roadways for Different Design Vehicles

Radius ofn Inner Edge of Pavement, R (feet)	Case 1, One-Lane Operation, No Provision for Passing a Stalled Vehicle												
	P	**SU-30**	**Su-40**	**City Bus**	**S-Bus-36**	**A-Bus**	**WB-40**	**WB-62**	**WB-67**	**WB-67D**	**MH**	**P/T**	**P/B**
50	13	18	21	21	18	22	23	44	57	29	18	19	18
75	13	17	18	19	17	19	20	30	33	23	17	17	17
100	13	16	17	18	16	18	18	25	28	21	16	16	16
150	12	15	16	17	16	17	17	22	23	19	15	16	15
200	12	15	16	16	15	16	16	20	21	18	15	15	15
300	12	15	15	16	15	16	15	18	19	17	15	15	15
400	12	15	15	15	15	15	15	17	18	16	15	15	14
500	12	14	15	15	14	15	15	17	17	16	14	14	14
Tanrget	12	14	14	15	14	15	14	15	15	15	14	14	14

Table 3 – 37 Derived Pavement Widths for Turning Roadways for Different Design Vehicles (Con't)

Radius on Inner Edge of Pavement, R (feet)	Case II, One-Lane, One-Way Operation, with Provision for Passing a Stalled Vehicle by Another of the Same Type												
	P	**SU-30**	**SU-40**	**City Bus**	**S-Bus-36**	**A-Bus**	**WB-40**	**WB-62**	**WB-67**	**WB-67D**	**MH**	**P/T**	**P/B**
50	20	30	36	38	31	40	39	81	109	50	30	30	28
75	19	27	30	32	27	34	32	53	59	39	27	27	26
100	18	25	27	30	25	30	29	44	48	34	25	25	24
150	18	23	25	27	23	27	26	36	38	29	23	23	23
200	17	22	24	25	23	26	24	32	34	27	22	22	22
300	17	22	22	24	22	24	23	28	30	25	22	22	21
400	17	21	22	23	21	23	22	26	27	24	21	21	21
500	17	21	21	23	21	23	22	25	26	23	21	21	21
Tangent	17	20	20	21	20	21	20	21	21	21	20	20	20

Radius on Inner Edge of Pavement, R (feet)	Case III, Two-Lane Operation, Either One- or Two-Way (Same Type Vehicle in Both Lanes)												
	P	**SU-30**	**SU-40**	**City Bus**	**S-Bus-36**	**A-Bus**	**WB-40**	**WB-62**	**WB-67**	**WB-67D**	**MH**	**P/T**	**P/B**
50	26	36	42	44	37	46	45	87	115	56	36	36	34
75	25	33	36	38	33	40	38	59	65	45	33	33	32
100	24	31	33	35	31	36	35	50	54	40	31	31	30
150	24	29	31	33	29	33	32	42	44	35	29	29	29
200	23	28	30	31	29	32	30	38	40	33	28	28	28
300	23	28	28	30	28	30	29	34	36	31	28	28	27
400	23	27	28	29	27	29	28	32	33	30	27	27	27
500	23	27	27	29	27	29	28	31	32	29	27	27	27
Tangent	23	26	26	27	26	27	28	27	27	27	26	26	26

Source – 2011 AASHTO Greenbook, Table 3-28b ~~Derived Pavement Widths for Turning Roadways for Different Design Vehicle~~

~~C.9.e~~C.9.f At~~-~~ Grade Intersections

~~C.9.e.1~~C.9.f.1 Turning Radii

~~Where right turns from through or turn lanes will be negotiated at low speeds (less than 10 mph), t~~ The minimum vehicle turning capabilities ~~of the vehicle may~~ typically govern the design of low-speed (below 10 mph) right-turns. ~~It is desirable that the turning radius and the required lane width be provided~~ Provide lane widths and turning radii ~~in accordance with~~ in accordance with the criteria for turning roadways. The radius of the inside edge of traveled way should ~~be sufficient to~~ allow the expected vehicles to negotiate the turn without encroaching onto the shoulder or into adjacent traffic lanes.

~~Where turning roadway criteria are not used, t~~The radius of the inside edge of traveled way should be no less than 25 feet (when turning roadway criteria are not used). ~~The use of t~~ Three-centered compound curves can be used ~~is also a reasonable practice~~ to ~~allow for~~ transition into and out of the curve. See ***AASHTO – "A Policy on Geometric Design of Highways and Streets" – 2011*** for t~~T~~he ~~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" - 2011**~~.

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~~C.9.e.2~~C.9.f.2 Cross Section ~~Correlation~~Transitions

The intersection of two roadways typically requires cross slope transitions along one or both of the roadways. ~~Correlation of the cross section of two intersecting roadways is frequently difficult. A careful analysis should be conducted to e~~ Ensure that changes in profile and cross slope are not excessive and that positive ~~adequate~~ drainage is provided. ~~At stop-controlled intersections, the through roadway~~ Carry the mainline roadway profile and cross section ~~should be carried~~ through ~~the~~ stop-controlled intersections (without interruption). Minor roadways should then approach the intersection at a slightly reduced elevation ~~so the through roadway cross section is not disturbed~~. ~~At signalized intersections, it is sometimes necessary to~~ Consider removing ~~e~~ part of the roadway crown at signalized intersections ~~in order~~ to avoid an undesirable hump in ~~one~~ either roadway.

Round these profiles and ~~Intersections of grade or~~ cross slopes ~~should be gently rounded~~ gently to improve vehicle operations.

I n t e r s e c t i o n s Pavement generally should generally be sloped towards the intersection their corners to provide some superelevation for turns ing maneuvers and to promote proper drainage.

Where islands are used for channelization, the width of traffic Turn lane widths adjacent to channelization islands for turning movements shall must be no less than the widths recommended by AASHTO.

~~C.9.e.3~~C.9.f.3 Median Openings

Restrict m~~M~~edian openings ~~should be restricted~~ in accordance with the requirements ~~presented~~ in Section C.8 ~~Access Control,~~ of this chapter. ~~Where a median opening is required, the length of the~~ Median opening lengths (where required) ~~shall be no less than~~ must be at least 40 feet. End any m~~M~~edian curb~~s should be terminated~~ gradually without ~~the~~ exposing ~~ure of~~ abrupt ~~curb~~ ends. ~~The termination requirements are given in~~ See ***Chapter 4*** ~~***- Roadside Design***~~ for curb end requirements.

~~C.9.e.4~~C.9.f.4 Channelization

Channelization ~~of at grade intersections~~ is the regulation or separation of conflicting traffic movements into defined~~ite travel~~ paths (using ~~by~~ islands, markings, or other means) to: ~~, to~~

- P~~p~~romotes safe and ~~,~~ orderly traffic flow, ~~. The major objective of channelization is to clearly~~
- D~~d~~efine the appropriate paths clearly, and ~~of travel and thus assist in the~~
- P~~p~~revent ~~i on of vehicles deviating excessively or making~~ wrong-way maneuvers.

Channelization ~~may~~ can be used ~~effectively~~ to define ~~the proper~~ proper paths, for exits, entrances, and intersection turning movements. ~~The~~ Select channelization methods ~~used for channelization should be~~ that are as simple as possible and consistent with others ~~in nature~~. ~~The~~ A channelized intersection should appear open and natural ~~latural~~ to the approaching driver. Channelization should be informative rather than restrictive ~~in nature~~.

~~The use of l~~Low-sloping curb~~s~~ 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~~ at least 100 square feet in area. ~~The use of~~ Avoid using small and/or numerous islands ~~should be avoided~~.

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

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~~C.9.f~~C.9.g Driveways

Avoid having d~~D~~irect driveway access within the area of influence of ~~the~~ an intersection ~~should be discouraged~~.

Design d~~D~~riveways from major traffic generators (~~greater than~~ over 400 vpd)~~,~~ or ~~those~~ with significant truck/bus traffic~~, should be designed~~ as ~~normal~~ typical roadway intersections.

~~C.9.g~~C.9.h Interchanges

The design of interchanges ~~for the intersection~~ of a freeway with a major ~~street or highway~~ roadway ~~, collector/distributor road,~~ or other freeway is a complex process ~~problem~~. See Section C.8 of this chapter for ~~The~~ locating ~~on~~ and spacing ~~of~~ intersections ~~should follow the requirements presented in C.8 Access Control, this chapter~~. ~~The design of~~ Design interchanges ~~shall follow the~~ to comply with ~~general~~ basic intersection requirements for:

- D~~d~~eceleration,
- A~~a~~cceleration,
- M~~m~~erging maneuvers,
- T~~t~~urning roadways, and
- S~~s~~ight distance.

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

Intersections with minor roadways ~~streets or highways or~~ and collector/distributor roads ~~may~~ can be ~~accomplished by~~ simple diamond interchanges. ~~The intersection of~~ The exit and entrance ramp~~s~~ connections ~~with~~ to the crossroad ~~shall~~ must meet all intersection requirements.

See Table 3 – 32 for ~~The~~ designing ~~of~~ exits from freeways ~~exits should conform to the general configurations given in Table 3 – 32 Minimum Deceleration Lengths for Exit Terminals~~. Exits should be on the outside (right) and should not be ~~placed~~ located within ~~on~~ horizontal curves. ~~Where deceleration on an exit loop is required, the~~ Implement deceleration ~~alignment~~ along an exit loop by gradually increasing the curvature and the resulting centrifugal force ~~should be designed so~~ to provide the driver ~~receives~~ with adequate warning of the ~~approaching~~ increasing ~~e in~~ curvature ~~. This is best accomplished by gradually increasing the curvature and the resulting centrifugal force~~. The~~is~~ increasing centrifugal force ~~provides~~ warns~~ing to~~ the driver that they ~~he~~ must slow down. Provide a~~A~~ clear view of the exit loop ~~should also be provided~~. See Table 3 – 29 for

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minimum The deceleration lengths of deceleration shall be no less than the values shown in Table – 29.

Design freeway eEntrances to freeways should be designed in accordance with the general configurations shown below Table 3 – 31 Minimum Acceleration Lengths for Entrance Terminals. Take sSpecial care should be taken to ensure that vehicles entering from loops are not directed across through travel lanes. Bring tThe entering roadway should be brought parallel (or nearly so) to the mainline travel lanes. through

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~~lanes before entry is permitted~~. Provide the minimum distances from Table 3 – 31 w~~W~~here acceleration is required. ~~, the distances shown in Table 3 – 31 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~~ Design exits and entrances to high-speed facilities (design speeds over 50 mph) in accordance with Tables 3 – 32 and 3 – 31. Use the ratios in Table 3 – 30 to adjust t~~T~~he lengths ~~obtained~~ from Tables 3 – 32 and 3 –31 ~~should be adjusted~~ for the profile grade ~~by using the ratios in Table 3 – 30~~.

~~The selection of~~ Selecting the type and ~~exact~~ design ~~details~~ of a particular interchange requires ~~considerable~~ study ~~and thought~~. Use t~~T~~he guidelines and design details ~~given~~ in ***AASHTO "A Policy on Geometric Design of Highways and Streets" - 2011*** ~~, should generally be considered~~ as minimum criteria.

~~C.9.h~~C.9.i Clear Zone

~~The provisions of a~~Ample clear zone ~~or proper redirection of energy absorbing devices~~ is particularly important at intersections. Make e~~E~~very effort ~~should be made~~ to open ~~up~~ the area around the intersection to provide adequate clear zone for errant vehicles ~~that have left the traveled way~~. ~~Drivers frequently~~ Vehicles sometimes leave the proper travel path due to: ~~unsuccessful turning~~

- Driver error, ~~, maneuvers or due to the necessity for~~
- Crash ~~emergency~~ avoidance maneuvers, and ~~maneuvers~~. ~~Vehicles also leave the roadway~~
- A~~a~~fter ~~intersection~~ collisions. ~~and~~

Removing roadside objects ~~should be removed to~~ can prevent ~~reduce the probability of~~ secondary impacts. ~~The~~ Contour roadside areas at ~~all~~ intersections and interchanges ~~should be contoured~~ to ~~provide~~ create shallow slopes and gentle grade changes ~~in grade~~.

~~The roadside~~ Carry the roadside clear zones ~~of intersecting roadways should be carried~~ through ~~out~~ the intersection~~s~~ (with ~~no dis~~continuity) ~~ies or interruptions~~. Do not locate p~~P~~oles ~~and~~ or support structures for lights, signs, ~~and~~ or signals ~~should not be placed~~ in medians or within the roadside clear zone.

Give particular attention to ~~The design of~~ guardrails ~~or~~ and other barriers ~~should receive particular attention~~ at intersections. Provide i~~I~~mpact attenuators ~~should be used~~ in ~~all~~ gore ~~and other~~ areas where structures cannot be removed.

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Give p~~P~~articular attention ~~should be given~~ to ~~the~~ protecting ~~on of~~ pedestrians in intersections ~~areas -~~ (see ***Chapter 8***). ~~- ***Pedestrian Facilities***.~~ See ***Chapter 4*** *for* additional ~~Further criteria and~~ requirements for roadside clear zone and intersection protection devices ~~at intersections are given in ***Chapter 4 - Roadside Design***~~.

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C.10 Other Design Factors

C.10.a Pedestrian Facilities

~~The layout and design of the street and highway~~ Roadways in urban areas ~~network~~ should include provisions for pedestrians ~~traffic in urban areas~~. ~~All~~ Design pedestrian crossings and pathways within the road R/W ~~right of way should be considered and designed~~ as a~~i~~n integral part of ~~any~~ the urban roadway ~~street or urban highway~~.

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

~~The planning and design of new streets and highways shall i~~ I Include provisions on all roadways for the:

- S~~s~~afe,
- Continuous,
- Convenient,
- Comfortable, and
- O~~o~~rderly movement of pedestrians ~~traffic~~.

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~~The overall objective is to provide a safe, continuous, convenient, and comfortable trip for pedestrian traffic.~~

C.10.a.2 Accessibility Requirements

Design p~~P~~edestrian facilities ~~, such as~~ (e.g., sidewalks, shared use paths, underpasses, overpasses, and transit boarding and alighting areas) ~~shall be designed~~ to accommodate people with disabilities. ~~In addition to the design criteria provided in this Manual,~~ See the ***United States Department of Transportation ADA Standards for Transportation Facilities (2006)*** and ***Department of Justice ADA Standards (2010)*** as required by 49 C.F.R 37.41 or 37.43; and the ***2020 Florida Building Code – Accessibility, 7th Edition*** as required by ***Rule Chapter 61G20-4.002, Florida Administrative Code*** ~~impose~~ for additional requirements for ~~the design and construction of~~ pedestrian facilities. See t~~T~~he ***Proposed Public Rights- of-Way Accessibility Guidelines (PROWAG)*** ~~provides~~ for additional information on ~~the~~ designing ~~of~~ accessible pedestrian facilities.

C.10.a.3 Sidewalks and Shared Use Paths

Sidewalks should ~~provide~~ be a safe~~,~~ and comfortable space for pedestrians. ~~The width of s~~Sidewalk widths ~~s is~~ should depend~~ent~~ ~~up~~on the:

- R~~r~~oadside environment,
- V~~v~~olume of pedestrians, and
- T~~t~~he presence of:
  - B~~b~~usinesses,
  - S~~s~~chools,
  - P~~p~~arks, and
  - O~~o~~ther pedestrian attractors.

See ***Chapter 8*** and ***Chapter 9*** of this manual.

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~~The~~ for minimum and recommended widths ~~for~~ of sidewalks and shared use paths ~~is covered in ***Chapter 8 – Pedestrian Facilities*** and ***Chapter 9 –***~~

~~***Bicycle Facilities.***~~ . To ensure compliance with federal and state sidewalk accessibility requirements ~~for sidewalks~~:

- Sidewalks less than 60 inches wide must have 60-inch by 60-inch (minimum) passing spaces ~~of at least 60 inches by 60 inches,~~ at intervals not ~~to~~ exceeding 200 feet.
- The minimum sidewalk clear width may be reduced to 32 inches for a short distance. This distance must be less than 24 inches ~~long,~~ and be separated by 5-foot long sections with 48 inches of clear width.
- Sidewalks not constrained within the roadway R/W ~~right of way~~ with profile grades ~~slopes greater than~~ over 1:20 are considered ramps and must be designed accordingly ~~as such~~.

C.10.b Bicycle Facilities

Incorporate p~~P~~rovisions for bicycle traffic ~~should be incorporated~~ into the ~~the street or highway~~ roadway design. Assume that a~~A~~ll new roadways and major corridor improvements~~,~~ (except ~~limited access~~ LA Facilities) ~~highways, should be designed and constructed under the assumption they will be~~ will be used by bicyclists. Roadway conditions should be favorable for bicycling. ~~. This includes appropriate~~ Provide drainage grates, pavement markings, ~~and~~ railroad crossings, smooth pavements, and signals responsive to bicycles (as appropriate). ~~In addition, facilities such as~~ Include bicycle lanes, shared use paths, and paved shoulders ~~, should be included~~ to the fullest extent practical ~~feasible~~. Consider providing 5-foot paved shoulders on a~~A~~ll flush shoulder arterials and collectors ~~roadway sections should be given consideration for the construction of 4-foot or 5-foot paved shoulders~~. ~~In addition,~~ Consider including bicycle lanes on all curbed arterials and collectors ~~sections should be given consideration for bicycle lanes~~.

See ***Chapter 9*** of this manual ~~For additional information on~~ for designing bicycle facilities ~~design~~ and ~~the design of~~ shared use paths~~, refer to **Chapter 9 – Bicycle Facilities**~~.

C.10.c Bridge Design Loadings

Comply with ***Chapter 17*** of this manual for t~~T~~he minimum design loading for ~~all~~ new and reconstructed bridges ~~shall be in accordance with ***Chapter 17 – Bridges and Other Structures***~~.

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C.10.d Dead-End ~~Streets~~ Streets and Cul-de-Sacs

The end of a dead-end ~~street~~street ~~-~~should ~~permit travel return with~~ include a turnaround ~~- area,~~ (considering backing movements). ~~, which will~~ The turnaround should accommodate ~~e~~ single unit trucks and ~~or~~ transit vehicles~~s~~ without encroaching~~ment~~ upon private property. See Figure 5-1 of ***AASHTO – "A Policy on Geometric Design of Highways and Streets" – 2011*** for the r~~R~~ecommended treatment for dead-end ~~streets~~streets ~~-~~ and cul-de-sacs ~~is given in Figure 5-1 Types of Cul-de-Sacs and Dead-End Streets of~~ ~~***AASHTO – "A Policy on Geometric Design of Highways and Streets" - 2011***~~.

C.10.e Bus Benches and Transit Shelters

Locate b~~B~~us benches ~~should be set back~~ at least 10 feet from the travel lane of curbed roadways with design speeds of 45 mph and less. ~~in curbed sections with a design speed of 45 mph or less, and~~ Locate bus benches outside the clear zone of flush shoulder roadways ~~in flush shoulder sections~~. See ***Chapter 4*** ~~***– Roadside Design***,~~ , Table 4 – 2 ~~Lateral Offset~~ for additional ~~further~~ information.

~~Any~~ Locate bus benches and ~~or~~ transit shelters adjacent to a sidewalk within the ~~right of way~~ road R/W of any ~~street or highway shall be located so as~~ to leave at least 48 inches of clear sidewalk ~~ance~~ for pedestrians and persons in wheelchairs. ~~An~~ Provide one additional ~~one~~ foot of clearance (measured perpendicular to the roadway centerline) ~~is required~~ when ~~any side 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~~. Provide a~~A~~ separate bench pad or sidewalk flare out ~~that provides~~ with a 30-inch-wide by 48-inch-deep wheelchair space adjacent to ~~the~~ a bus bench ~~shall be provided~~. Transit shelters should be set back~~,~~ (rather than eliminated) during roadway widening.

~~Additional information on the design of transit facilities is found in~~ See ***Chapter 13*** of this manual ~~***– Public Transit***~~ for designing transit facilities.

C.10.f Traffic Calming

~~Often there are c~~ Communities ~~y~~ are sometimes concerned with ~~s with~~ the safety impacts of controlling travel speeds ~~impacting the safety of a street or highway such as~~ in areas with: ~~of~~

- C~~c~~oncentrated pedestrian activities, ~~those with~~

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- N~~n~~arrow R/W~~right of way~~, ~~areas with~~
- N~~n~~umerous access points,
- O~~o~~n-~~-~~street parking, and
- ~~-~~O~~o~~ther similar features ~~concerns~~.

Local agencies can ~~authorities may elect to~~ use traffic calming ~~design~~ features such as: ~~that could include, but not be limited to, the installation of~~

- S~~s~~peed humps,
- S~~s~~peed tables,
- C~~c~~hicanes, ~~or~~
- Roundabouts, and
- Similar ~~other~~ alignment restrictions. ~~pavement undulations.~~

~~Roundabouts are also another method of dealing with this issue at intersections.~~ See ***Chapter 15*** of this chapter f~~F~~or additional ~~details and~~ traffic calming treatments ~~treatments, refer to~~ ~~***Chapter 15 – Traffic Calming***~~.

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C.11 Reconstruction

C.11.a Introduction

~~The r~~Reconstructing ~~on (improvement or~~ and upgrading ~~) of~~ existing roadways ~~facilities may generate~~ can sometimes generate ~~equal or greater~~ more safety benefit ~~benefits~~ than similar expenditures for new ~~the~~ construction ~~of new streets and highways~~. Evaluate capacity improvements ~~Modifications to increase capacity should be evaluated~~ for ~~the~~ potential impacts to ~~effect on the~~ highway safety ~~characteristics~~. ~~The long-range objectives should be to~~ Attempt to bring the existing network into compliance with current standards.

C.11.b Evaluation of Roadways ~~Streets and Highways~~

Direct t~~T~~he safety evaluation ~~of the safety characteristics of streets and highways should be directed~~ towards ~~the identification of~~ identifying undesirable features ~~on the existing system. Particular effort should be exerted to identify the~~ and locations ~~and nature of features~~ with ~~a~~ high crash rates by ~~potential. Methods for identifying and evaluating hazards include the following~~:

- ~~Identification of any~~ Identifying geometric design features that do not comply ~~not in compliance~~ with minimum ~~or desirable~~ standards, ~~. This could be accomplished through a systematic survey and evaluation of existing facilities.~~
- Reviewing ~~of~~ conflict points, ~~along a corridor.~~
- ~~Information from~~ Coordinating with maintenance staff, ~~or other personnel.~~
- ~~Review of crash reports and traffic counts to I~~identifying high-crash locations, and ~~with a large number of crashes or a high crash rate.~~
- Reviewing ~~for~~ expected pedestrian and bicycle needs.

C.11.c Priorities

A large percentage of ~~street and highway~~ roadway reconstruction funding ~~and improvements~~ is spent on ~~directed toward~~ increasing efficiency and capacity. The reconstruction program ~~of reconstruction~~ should also be based~~,~~ (to a large extent)~~,~~ ~~upon priorities for the improvement of~~ on improving safety ~~characteristics~~.

~~The priorities for~~ Prioritize safety improvements ~~should be based on the objective of~~ to obtain~~ing~~ the maximum reduction in crash potential per dollar ~~for a given expenditure of funds~~. E~~E~~liminating ~~on of~~ conditions that may result in serious or fatal crashes ~~should receive~~ is the highest priority ~~in the schedule for reconstruction~~.

Some types of ~~pecific~~ high-~~-~~priority reconstruction opportunities include:

~~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~~ Purchasing line of sight easements ~~is often a~~ can be a wise investment ~~expenditure of highway funds~~. ~~The e~~ Establishing ~~ment 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,~~ Shield objects when removal is not feasible ~~should be shielded by redirection or energy absorbing devices~~. ~~The reduction of the~~ Eliminating roadside hazards ~~problem generally~~ provides a good return on the safety dollar. Incorporate the d~~D~~etails ~~and priorities~~ for roadside hazard reduction provided in ***Chapter 4*** in the reconstruction priorities~~, which are presented in *Chapter 4 – Roadside Design*, should be incorporated into the overall priorities of the reconstruction program~~.

- Resurface or reconstruct ~~Poor~~ bad pavement surfaces ~~which have become hazardous should be maintained or reconstructed in accordance with the design criteria set forth~~ as provided 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:~~

- Add ~~ition of~~ corridor and/or intersection lighting.

    - Provide f~~F~~rontage roads where access

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control is poor ~~may be utilized to~~ to improve ~~the efficiency and safety of~~ mainline roadway operations ~~streets and highways with poor control of access~~.

- Widen~~ing of~~ existing pavements and shoulders ~~. This is often an economically feasible method of~~ to increase ~~ing~~ capacity and ~~and reducing~~ remove traffic hazards. ~~Provision of~~ Add median barrier. ~~s (***Chapter 4 - Roadside Design***) can also produce significant safety benefits~~.

- ~~The removal, streamlining,~~ Remove or modify ~~ication of~~ existing drainage structures.

- Alignment modifications ~~are~~ usually ~~extensive and~~ require extensive roadway reconstruction ~~of the roadway~~. Removing~~al of~~ isolated sharp curves is a reasonable type of ~~and logical step in~~ alignment modification. ~~If major realignment is to be undertaken, every effort should be made~~ Make every effort to bring the entire facility into compliance with ~~the requirements for~~ new construction criteria.

- ~~The use of t~~Traffic control devices ~~. This is generally an inexpensive method of~~ can alleviate~~ing~~ certain highway deficiencies~~ects~~.

- Modify existing median openings~~ modifications~~.

- Add ~~ition of~~ medians, channelized islands, and mid-block pedestrian crossings.

- Provide a~~A~~uxiliary lanes.

- Retrofit e~~E~~xisting bridges that ~~fail to~~ do not meet current design standards ~~which~~ but ~~-~~are available to bicycle traffic ~~, should be retrofitted~~ on an interim basis as follows:

  - ~~As a general practice, b~~Bridges over 125 feet long, ~~in length or longer,~~
  - B~~b~~ridges with unusual sight problems, and
  - Bridges with steep grades. ~~ients (which require the cyclist longer time to clear the span) or~~

Bridges with other unusual conditions should display the standard W11-1 caution sign with an ~~added sign~~ "On Bridge" sign at ~~either~~ both ends ~~of the structure~~.

- ~~-~~Give s~~S~~pecial ~~care should be given~~ attention to the right~~-~~most portion of the roadway~~,~~ where bicyclists are expected to travel to assure: ~~, assuring~~

  - S~~s~~moothness,
  - P~~p~~avement uniformity,~~ and~~
  - F~~f~~reedom from longitudinal joints, and ~~to ensure~~
  - C~~c~~leanliness. ~~Failure to do so forces~~

Otherwise, bicyclists tend to ride in the travel lanes ~~farther into the center portion of the bridge~~, thereby reducing traffic flow and safety. ~~.~~

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~~Addition of bicycle facilities.~~

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

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C.12 Design Exceptions

See ***Chapter 14*** ***~~- Design Exceptions and Variations~~*** for the process to use when the ~~standard~~ criteria ~~found~~ in this m~~M~~anual cannot be met.

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

~~Where criteria is not specifically provided in this section,~~ Use the design guidelines provided ~~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 (for criteria not included herein). See Table 3 – 20 ~~Minimum Lane Widths~~ for lane widths for very low-~~-~~volume roads.

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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, t~~ 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~~ must be ~~a minimum of~~ at least 22 feet to accommodate future traffic and to avoid becoming functionally obsolete. ~~If the entire roadway width (traveled way plus shoulders) is paved to a width greater than 22 feet, t~~ The bridge width should ~~be~~ equal ~~to~~ the total roadway width when the entire paved roadway (travel lanes plus shoulders) is wider than 22 feet. ~~If significant ADT increases are projected beyond twenty years,~~ Consider a 28-foot bridge width ~~of 28 feet~~ when significant ADT increases are projected beyond 20 years~~should be considered~~. One-lane bridges ~~may be provided on~~ are acceptable for single-lane roads and ~~on~~ for two-lane roads with ADT below ~~less than~~ 100 vehicles/day (where a one-lane bridge can operate effectively). The minimum roadway width of a one-lane bridge is ~~shall be~~ 15 feet. One-lane bridges should have pull-offs (visible from ~~opposite~~ both ends of the bridge) where drivers can wait for opposing 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).

CHAPTER 4

ROADSIDE DESIGN

A INTRODUCTION

This chapter ~~presents~~ provides guidelines and standards for roadside designs ~~intended to~~ which reduce the likelihood and/or consequences of roadside crashes. Due to the variety of causative factors, the designer should review crash reports for vehicles leaving the traveled way at any location. ~~On average, l~~ Lane departure crashes in Florida represent approximately 33% ~~1/3~~ of all crashes and almost 50% of all highway fatalities. Constructing ~~on and~~ maintaining ~~enance of~~ safe medians and roadsides are of vital importance ~~in the development of~~ for safe streets and highways. See the FDOT ***Florida Strategic Highway Safety Plan*** ~~More information on~~ for information on lane departure crashes in Florida ~~can be found in the FDOT's~~ ~~***Florida Strategic Highway Safety Plan***~~.

Many of the standards ~~presented~~ in ***Chapter*** ***3*** ~~– ***Geometric Design***~~ are intended ~~predicated to a large extent upon~~ to reduce ~~ing~~ the probability of vehicles leaving the proper travel path. The ~~intent of~~ standards in this chapter ~~is~~ are intended to reduce the consequences ~~of crashes by~~ when vehicles do leave~~ing~~ the roadway. ~~The d~~ Design ~~of~~ the roadside beyond the shoulder ~~should be considered and conducted~~ as an integral component ~~part~~ of the ~~total~~ highway design.

The general objective of roadside design is to provide an environment that ~~will~~ reduces the likelihood and/or consequences of crashes by vehicles that have left the traveled way. T~~he achievement of t~~his ~~general~~ objective is best achieved by~~will be aided by the following~~:

- Roadside areas ~~adequate to~~ which allow reasonable space and time for a driver to regain or retain control of the vehicle and stop or return to the traveled way safely.
- Shoulders, medians, and roadsides that ~~may~~ can be traversed safely without the vehicle vaulting or overturning.
- Locating ~~on of~~ roadside fixed objects and hazards as far from the traveled way ~~lane~~ as ~~is~~ economically feasible.
- Roadsides that accommodate ~~necessary~~ maintenance vehicles, emergency maneuvers and emergency parking.
- A~~Providing a~~dequate shielding of hazards where appropriate.
- ~~and c~~Compatible with vehicle speeds and other design variables.

~~Prior to any other consideration, T~~The designer~~er~~ should first attempt to~~,~~ (in order of preference)~~, attempt to~~:

1. Eliminate the hazard
    a. Remove the hazard
    b. Redesign the hazard so it can be safely traversed
    c. Relocate the hazard outside the clear zone
2. Make the hazard crashworthy
3. Shield the hazard with a longitudinal barrier or crash cushion.
4. Delineate the hazard and leave ~~the hazard~~ it unshielded. Select t~~T~~his treatment ~~is taken~~ only when a ~~the~~ barrier or crash cushion is more hazardous than the hazard. See Section E.5 for ~~information on~~ making this determination.

This chapter ~~contains~~ provides guidelines and standards ~~and general guidelines~~ for situations commonly encountered in roadside design ~~due to the variety and complexity of possible situations encountered~~. ~~In addressing roadside hazards, the designer should~~ Use ~~utilize~~ the ~~following as~~ basic guidelines below ~~to~~ to develop a safe roadside design.

B ROADSIDE TOPOGRAPHY AND DRAINAGE FEATURES

B.1 Roadside Slopes, Clear Zone, and Lateral Offset

Providing a sufficient amount of recoverable slope ~~or~~ and clear area ~~zone~~ adjacent to the roadway~~,~~ (free of obstacles and hazards) ~~provides an opportunity for~~ can allow an errant vehicle to safely recover. The m~~M~~inimum standards for roadside slopes, clear zone and lateral offsets ~~to hazards~~ are provided below ~~as follows~~.

B.1.a Roadside Slopes and Clear Zone

~~The~~ Roadside slopes ~~of all roadsides~~ should be as flat as possible to allow for safe traversal by out-~~-~~of-~~-~~control vehicles. Limit the maximum ~~A~~ roadside slope ~~of~~ to 1:4 (1:6 desirable) ~~or flatter should be used, desirably 1:6 or flatter~~. The transition between the shoulder and the adjacent ~~side~~ slope should be rounded and free from discontinuities. A ~~slope as steep as~~ 1:3 slope ~~may~~ can be used within the clear zone if the clear zone width is ~~adjusted~~ widened to ~~provide~~ include a clear runout area (see below)~~as described below~~. ~~If sufficient right of way exists, u~~Use flatter ~~side~~ roadside slopes on the outside of horizontal curves where R/W allows.

Clear zone is the unobstructed, traversable area beyond the edge of the traveled way for the recovery of errant vehicles. The clear zone includes roadway shoulders and bicycle lanes. ~~The clear zone shall follow the requirements for~~ Comply with the clear zone and lateral offset ~~shown~~ requirements provided in this manual. Clear zone width requirements are ~~dependent~~ based on:

- AADT,
- D~~d~~esign speed, and
- R~~r~~oadside slope conditions.

~~With regard to~~ Regarding the ability of an errant vehicle to traverse a roadside slope, slopes are classified as ~~follows~~:

1. Recoverable ~~Slope~~ – Traversable s~~S~~lopes 1:4 ~~or~~ and flatter. ~~Motorists~~ Drivers who encroach on recoverable front ~~fore~~slopes ~~generally~~ can stop their vehicles or slow them enough to return to the roadway safely.

2. Non-Recoverable ~~Slope~~ – Traversable s~~S~~lopes steeper than 1:4 ~~and~~ but flatter than 1:3. Non-recoverable front ~~fore~~slopes are traversable but most vehicles ~~will~~ are not ~~be~~ able to stop or return to the roadway easily. Vehicles on such slopes ~~typically~~ can typically be expected to reach the bottom.

3. Critical Slope – Non-tTraversable sSlopes steeper than 1:3. A critical front foreslope is one on which where an errant vehicle has a higher propensity to overturn.

See Table 4 – 1 for cClear zone widths for recoverable front foreslopes (1V:4H and flatter). are provided

~~in Table 4 – 1 Minimum Width of Clear Zone~~. See Figures 4 – 1 and 4 – 2 for c~~C~~lear zone illustrations ~~is applied as shown in Figures 4 – 1 Clear Zone Plan View and 4 – 2 Basic Clear Zone Concept. Clear zone is~~ (measured from the edge of the traveled way).

~~On non-recoverable slopes steeper than 1:4 and flatter than 1:3, a high~~ A large percentage of encroaching vehicles ~~will~~ reach the toe of non-recoverable slopes that are steeper than 1:4 but flatter than 1:3 ~~these slopes~~. ~~Therefore, t~~ As such, the clear zone width ~~distance~~ cannot logically end at the toe of a non-~~-~~recoverable slope. Provide additional clear zone width ~~When such~~ where non-recoverable slopes are present within the clear zone widths ~~provided~~ in Table 4 – 1~~, additional clear zone width is required~~. The minimum amount of additional clear zone width ~~provided~~ provided at the toe of a non-recoverable slope must equal the width of the non-recoverable slope and be no less than 10 feet (see Figure 4 – 3) ~~with no less than 10 feet of recoverable slope provided at the toe of the non-recoverable slope~~. ~~See Figure 4 – 3 Adjusted Clear Zone Concept.~~

~~When clear zone requirements cannot be met, s~~See ***Sections C, D*** and ***E*** of this chapter for requirements for roadside barriers and other treatments where clear zone requirements cannot be met ~~for safe roadside design~~. ~~In addition,~~ See the ***AASHTO Roadside Design Guide (2011),*** and ***AASHTO Guidelines for Geometric Design of Very Low Volume Local Roads (ADT ≤ 400) (2001)*** ~~may be referenced~~ for a more thorough discussion of roadside design.

Table 4 – 1 Minimum Width of Clear Zone (feet)[1] (Curbed and Flush Shoulder Roadways)

Design Speed mph	AADT ≥ 1500			AADT < 1500		
	Travel Lanes & Multilane Ramps		Aux Lanes and Single Lane Ramps	Travel Lanes & Multilane Ramps		Aux Lanes and Single Lane Ramps
	1V:6H or flatter	1V:5H to 1V:4H	1V:4H or flatter	1V:6H or flatter	1V:5H to 1V:4H	1V:4H or flatter
≤ 40	14	16	10	10[2]	12[2]	10[2]
45 – 50	20	24	14	14	16	14
55	22	26	18	16	20	14
60	30	30[3]	24	20	26	18
65 – 70	30	30[3]	24	24	28	18

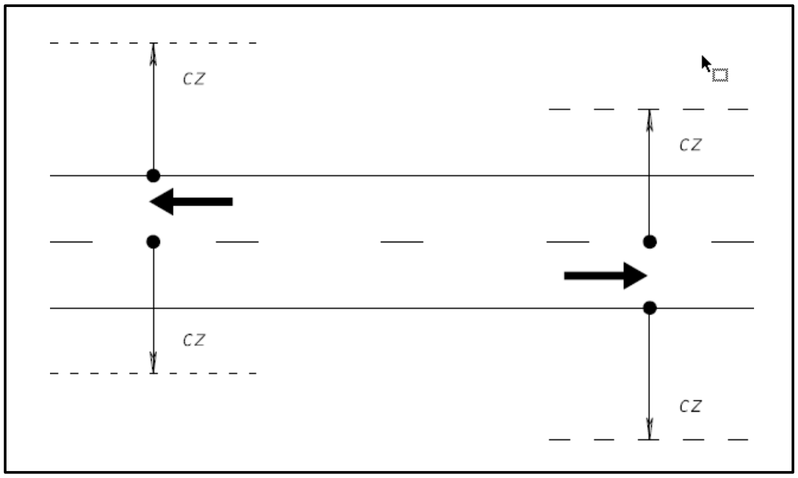
1. Clear z~~Z~~one for roads functionally classified as l~~L~~ocal r~~R~~oads with a design AADT ≤ 400 vehicles per day:
   a. Provide a~~A~~ clear zone width of 6 feet or more ~~in width must be provided if~~ where it can be done ~~so~~ with minimum social/environmental impacts.
   b. Clear zone widths below 6 feet can be used w~~W~~here ~~constraints of~~ cost, terrain, right of way (R/W), or potential social/environmental impacts make ~~the~~ providing ~~sion of~~ a 6~~-~~foo~~ee~~t clear zone impractical~~, clear zones less than 6 feet in width may be used, including designs with 0 feet clear zone~~.
   c. ~~In all cases,~~ Tailer clear zone widths ~~must be tailored~~ to site-specific conditions~~,~~ (considering cost-effectiveness and safety tradeoffs). ~~The use of adjustable clear zone widths, such as wider clear zone dimensions~~ Increase clear zone widths (where possible) ~~at~~ along sharp horizontal curves ~~where there is~~ with a history of run-off-road crashes, ~~or~~ and where there is evidence of vehicle encroachments ~~such as~~ (e.g., scarring of trees or utility poles) ~~, may be appropriate~~. Lower ~~esser values of~~ clear zone widths ~~may~~ can be appropriate on tangent sections of the same roadway.
   d. Consider additional ~~Other~~ factors ~~for consideration in analyzing the need for providing clear zones include the~~ including crash history, ~~the expectation for~~ future increases in traffic volumes ~~growth on the facility~~, and the presence of vehicles wider than 8.5 feet ~~and vehicles with~~ (e.g., wide loads ~~, such as~~ and farm equipment).
2. ~~May~~ Can be reduced to 7 feet ~~for a design~~ where AADT < 750 vehicles per day.
3. ~~Greater~~ Larger clear zone widths provide additional safety for higher speed and higher volume roads. See Section 3.1 of the ***AASHTO Roadside Design Guide*** ***(2011)*** for additional~~further~~ information.

Source: Table 3 – 1, ~~Suggested Clear Zone Distances in Feet from the Edge of the Travel~~

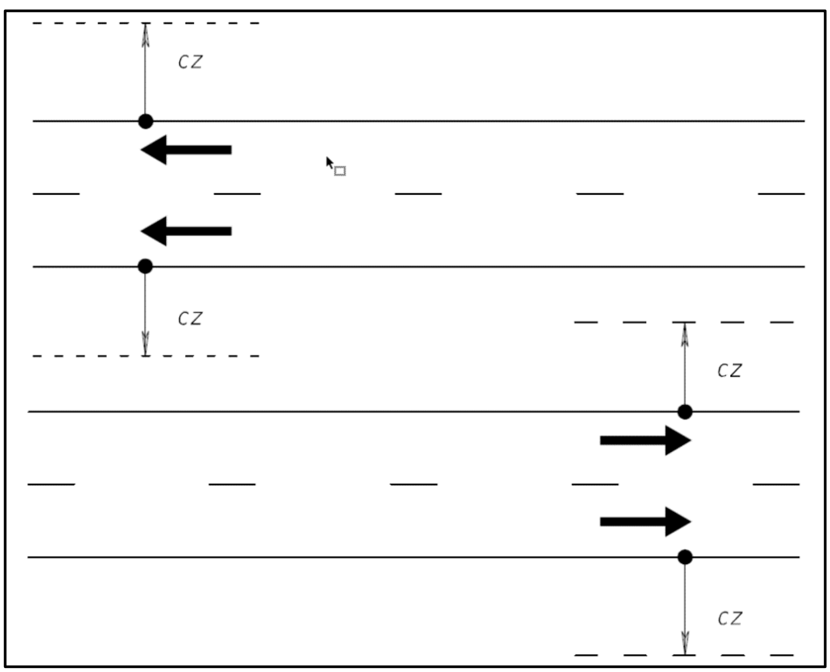
~~Lane~~, 2011 AASHTO Roadside Design Guide.

Figure 4 – 1 Clear Zone Plan View

Two-Lane, Two-Way Roadway



Multi-Lane Two-Way Roadway



Note: 1. Lateral offset is measured outward from the ~~centerline of roadway and~~ edge of traveled way or face of curb to a roadside object or feature.

Figure 4 – 2 Basic Clear Zone Concept

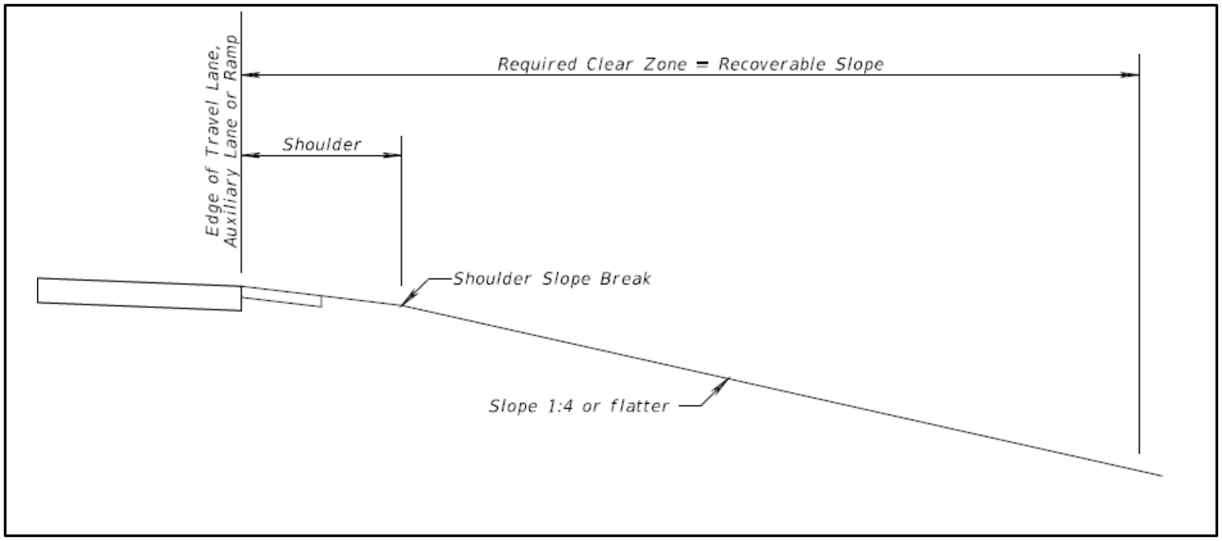
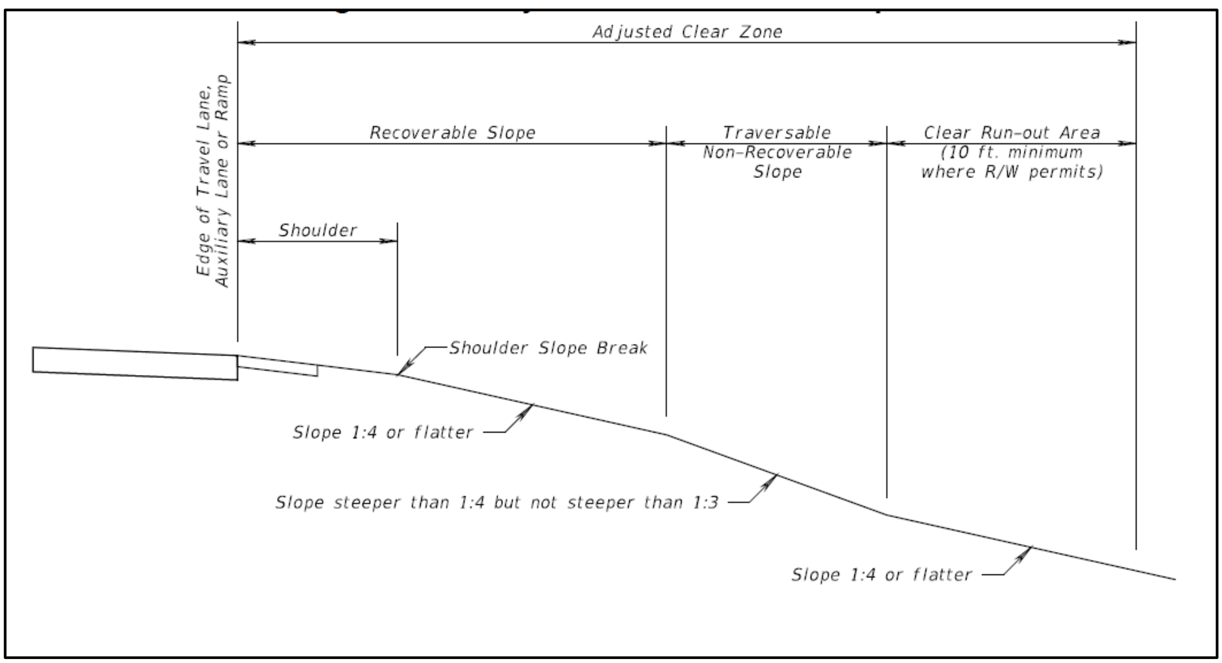
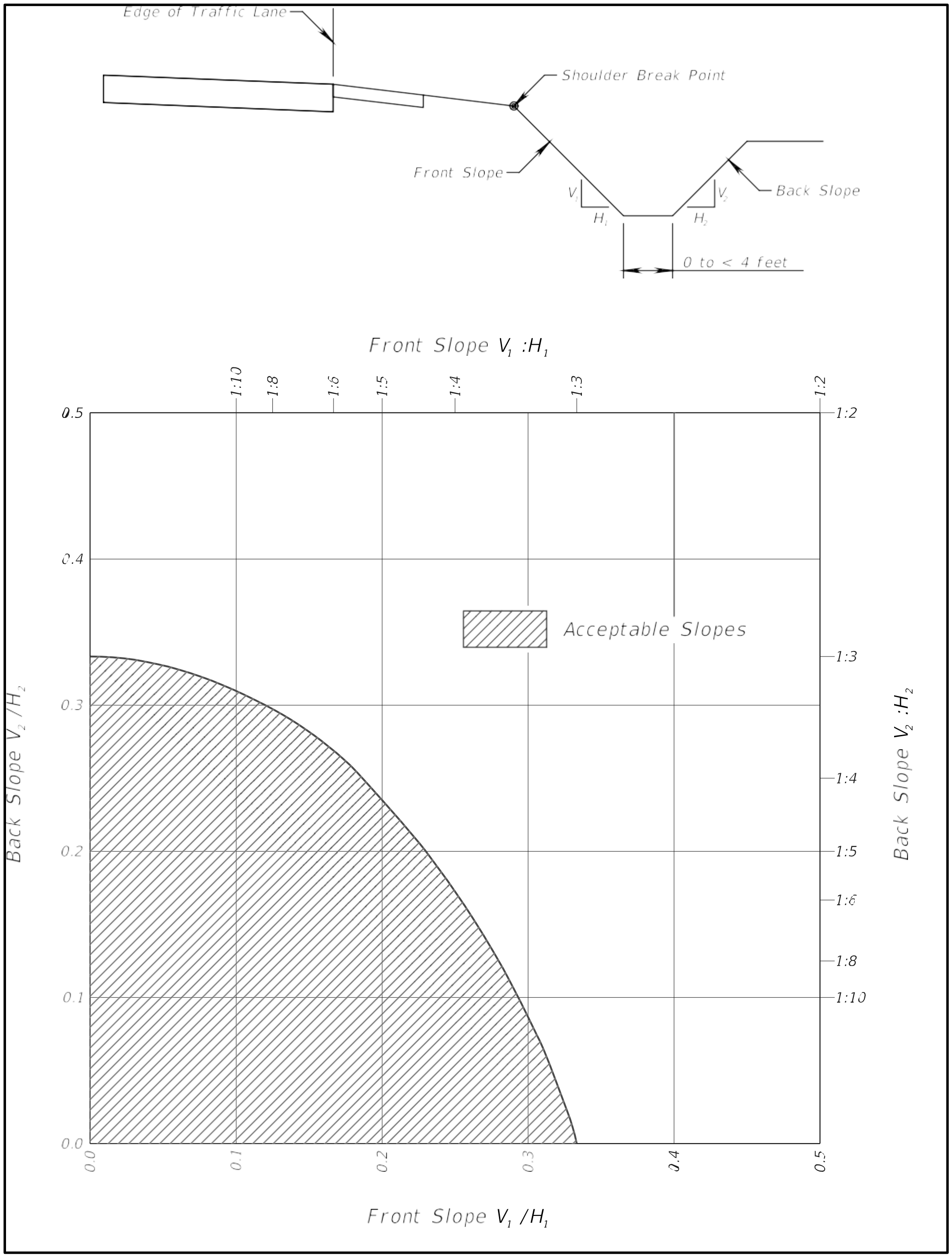


Figure 4 – 3 Adjusted Clear Zone Concept



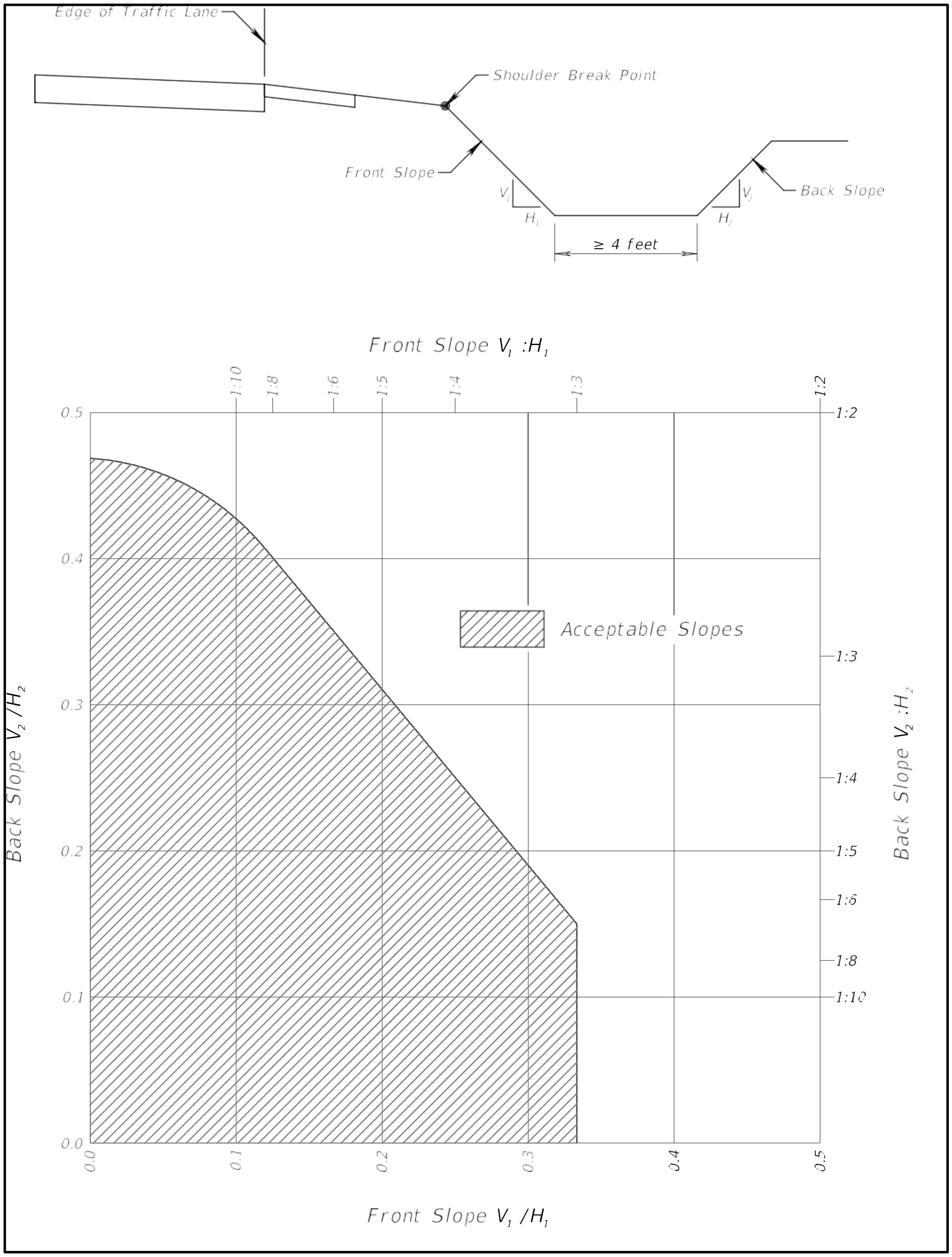
Roadside ditches ~~may~~ can be ~~included~~ located inside ~~within~~ the clear zone where ~~if properly~~ designed to be traversable. See Figures 4 – 4 and 4 – 5 for ~~Acceptable~~ maximum ditch cross ~~section~~ slopes ~~criteria for roadside ditches within~~ within the clear zone ~~is provided in Figure 4 – 4 Roadside Ditches – Bottom Width 0 to < 4 Feet and Figure 4 – 5 Roadside Ditches – Bottom Width ≥ 4 Feet~~. The~~se~~ roadside ditch configurations in these figures are considered traversable.

Figure 4 – 4 Roadside Ditches – Bottom Width 0 to < 4 Feet



Source: Figure 3 – 6, 2011 AASHTO Roadside Design Guide.

Figure 4 – 5 Roadside Ditches – Bottom Width ≥ 4 Feet



Source: Figure 3 – 6, 2011 AASHTO Roadside Design Guide.

B.1.b Lateral Offset

Lateral offset is the distance from a specified point on the roadway to a roadside hazard. Lateral offset to the roadside hazard is measured~~ as follows~~:

- From the face of curb for c~~C~~urbed roadways~~ - from face of curb~~.
- From the outside edge of traveled way for f~~F~~lush shoulder and high-speed curbed roadways~~ - from outside edge of traveled way~~.

Lateral offset~~s~~ requirements apply~~y~~ to all roadways ~~and are determined~~ based ~~on~~on the ~~the following~~:

- Type of facility~~,~~ (i.e., flush shoulder or curbed roadway).
- Design speed.
- Design element.
- Project type~~,~~ (i.e., New Construction~~,~~ or Resurfacing (RRR)).

Flush shoulder roadways typically have sufficient R/W ~~right of way~~ to provide the required clear zone~~ widths~~. Therefore, the minimum lateral offset for these roadways is based on maintaining a clear roadside for errant vehicles to recover (i.e., maintaining clear zone width provided in Table 4 – 1 ~~Minimum Width of Clear Zone~~).

Lateral offsets for curbed roadways should be based on clear zone criteria; however, curbed roadways typically do not have sufficient R/W~~right of way~~ to provide the required clear zone~~ widths~~. Therefore, the minimum lateral offset for curbed ~~on these~~ roadways is based on the offset needed for normal operation of the roadway.

~~At times, it may be~~ It is sometimes necessary to ~~place~~ locate poles (e.g., signal, light, sign) within the sidewalk. Refer to Chapter 8 ~~– Pedestrian Facilities~~ for minimum unobstructed sidewalk widths ~~requirements~~. See Table 4 – 2 ~~Lateral Offset provides~~ for minimum lateral offsets ~~criteria~~ for roadside features and roadside hazards ~~typically encountered and~~ considered functionally necessary for normal roadway operations~~ of the roadway, ~~(e.g., signing, lighting, landscaping, and utilities).

For crashworthy objects, meet or exceed comply with the minimum lateral offsets criteria provided in Table 4 – 2 Lateral Offset. Locate objects that are not crashworthy as close to the right of way R/W line as practical and (no closer than the minimum lateral offset) criteria provided. When a roadside hazard is placed behind a barrier that is justified for other reasons, tThe minimum lateral offset to a roadside hazard located behind a barrier that was justified for other reasons the object equals the setback requirements (deflection distance) of the barrier. See ***FDOT Design Manual, Chapter 215*** Additional information on for barrier placement and permissible attachments can be found in the ***FDOT Design Manual, Chapter 215***.

Table 4 – 2 Lateral Offset (feet)

Roadside Feature	Urban Curbed Roadways Design Speed ≤ 25 (mph)	Urban Curbed Roadways Design Speed ≤ 45 (mph)	All Other
Above Ground Objects[1]	1.5 feet~~.~~ from Face of Curb[3,4]	4 feet~~.~~ from Face of Curb[2,4]	Clear Zone Width
Drop Off Hazards[5]	Clear Zone Width	Clear Zone Width	Clear Zone Width
Water Bodies	Clear Zone Width	Clear Zone Width	Clear Zone Width
Canal Hazards	See Section B.2.c	See Section B.2.c	See Section B.2.c

1. Above-~~ ~~ground objects are anything ~~greater~~ more than 4 inches high ~~in height and~~ that is~~are~~ firm and unyielding or does not meet crashworthy or breakaway criteria. For urban curbed areas ≤ 45 mph, this also includes crashworthy ~~or~~ and breakaway objects (except those necessary for the safe operation of the roadway).
2. ~~May~~ Can be reduced to 1.5 feet~~.~~ from the f~~F~~ace of c~~C~~urb on roads functionally classified as l~~L~~ocal s~~S~~treets and, on all roads, where the 4 foot~~.~~ minimum offset cannot be reasonably obtained and other alternatives are deemed impractical. ~~For very low-volume roads, ≤ 400 vpd, a minimum of~~ At least 1.5 feet of clearance is desirable but ~~may~~ for very low-volume roads (≤ 400 vpd). The 1.5 feet can be reduced to 6 inches~~"~~ from the face of curb where the corridor is constrained. See ***AASHTO's Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400), 2001*** ~~provides~~ for additional information.
3. ~~May~~ Can only be used ~~in areas~~ where development patterns and land use would qualify as an u~~U~~rban c~~C~~enter or u~~U~~rban c~~C~~ore c~~C~~ontext c~~C~~lassification.
   a. Urban Center - Mix of uses set within small blocks with a well-connected roadway network. Typically concentrated around a few blocks and identified as part of the community, town, or city of a civic or economic center.
   b. Urban Core - Areas with the highest densities and with building heights typically ~~greater~~more than four floors. Many are regional centers and destinations. Buildings have mixed uses, are built up to the roadway, and are within a well-connected transportation network.
4. A D~~d~~esign V~~v~~ariation for failure to meet clear zone criteria is not required for existing, low speed, curbed roadways if the requirements for ~~the~~ placing ~~ement of~~ above ground fixed objects are met.
5. Drop-~~ ~~off hazards are:
   a. Any vertical faced structure with a drop off (e.g., retaining wall, wing-wall, etc.) located within the c~~C~~lear z~~Z~~one.
   b. Slopes steeper than 1:3 located within the c~~C~~lear z~~Z~~one.
   c. Drop-offs with significant crash history.

B.2 Drainage Features

Drainage design is ~~an~~ important ~~aspect of the~~ to long-term roadway performance ~~of a roadway~~. ~~, and to achieve an effective design, d~~ Many drainage features need ~~are necessary in close proximately to~~ to be close to the travel lanes: ~~. These features include~~ (e.g., ditches, curbs, ~~and drainage structures (e.g.,~~ transverse/parallel pipes, culverts, endwalls, wingwalls, and inlets). Evaluate t~~T~~he placement of these features ~~is to be evaluated~~ as part of roadside safety design. ~~Refer to~~ See ***Chapter 20*** ~~***– Drainage***~~ for ~~information regarding proper~~ hydraulic design.

~~When evaluating the design of roadside topography and drainage features~~, ~~consider the~~ Consider future maintenance needs when designing roadside slopes and drainage features ~~implications of the facility~~. Routine maintenance ~~or~~ and repairs ~~needed to ensure the continued function of the roadway slopes or drainage may lead to long-term expenses and activities, which~~ can disrupt~~s~~ traffic flow and expose~~s~~ maintenance staff~~personnel~~ to traffic conditions.

B.2.a Roadside Ditches

See Section B.1.a of this chapter for m~~M~~inimum standards for side slopes and bottom widths of roadside ditches ~~and channels~~ within the clear zone ~~are provided in Section B.1.a~~.

B.2.b Drainage Structures

Roadway d~~D~~rainage structures and ~~their associated~~ end treatments ~~located along the roadside~~ should ~~be implemented~~ use~~ing~~ ~~either~~ a traversable design or be located outside the ~~required~~ clear zone. ~~The various drainage inlets and pipe end treatments needed for an efficient drainage design typically~~ Roadway drainage systems may include: ~~contain~~

- C~~c~~urb inlets,
- D~~d~~itch bottom inlets,
- E~~e~~ndwalls,
- W~~w~~ingwalls,
- H~~h~~eadwalls,
- F~~f~~lared end sections and~~/or~~

- M~~m~~itered end sections.

~~If not adequately designed or properly located, t~~These drainage structures ~~features~~ can create hazardous conditions ~~(e.g., abrupt deceleration or rollovers)~~ when not properly located ~~for vehicles~~. See the ***AASHTO Roadside Design Guide*** f~~F~~or ~~detailed background information concerning~~ information on traversable designs~~, refer to the **_AASHTO_ _Roadside Design Guide_**~~.

See the FDOT ***Standards Plans*** for s~~S~~tandard details for drainage structures and end treatments ~~commonly used in Florida are provided the in the FDOT's **_Standards Plans_**~~. These d~~D~~rainage structures ~~features shown in the FDOT's **_Standard Plans_** have the~~ can potentially ~~for~~ conflict with ~~a motor vehicle~~ drivers and ~~or~~ bicyclists ~~either departing the roadway or within a commonly traversed section of a roadway~~. See t~~T~~he FDOT~~'s~~ ***Drainage***

Manual ~~identifies those standard~~ for drainage structures which can be used ~~are acceptable for use within~~ inside the clear zone.

B.2.c Canals and Waterb~~B~~odies

Eliminate r~~R~~oadside canals and other bodies of water ~~close to~~ located close to ~~the~~ a roadway ~~should be eliminated~~ (where~~ver~~ feasible). Wher~~n~~ not feasible, ~~they should be~~ locate~~d~~ these waterbodies outside of the minimum clear zones ~~as shown~~ in Table 4 – 1 ~~Minimum Width of Clear Zone~~. Additional lateral offset is required along arterial and collector roadways ~~If the~~ for waterbod~~y of water meets the definition of~~ies defined as ~~a~~ canal hazards. ~~, additional lateral offset is required for arterial and collector roadways.~~

A canal hazard is defined as an open ditch parallel to ~~the~~ a roadway for ~~a minimum distance of~~ at least 1,000 feet ~~and~~ with a seasonal water depth ~~more than~~ exceeding 3 feet for extended periods of time (over 24 hours ~~or more~~). Evaluate all o~~O~~ther roadside hazards ~~conditions shall be evaluated~~ using the clear zone criteria in Table 4 - 1~~conditions~~.

Canal hazard lateral offset is the distance from the edge of a travel lane, auxiliary lane, or ramp to the top of the canal bank ~~side slope~~ nearest the roadway. Minimum ~~required~~ lateral offsets ~~distances~~ are ~~as follows~~:

- ~~Not less than~~ 60 feet for flush shoulder and curbed roadways with design speeds of 50 mph and more ~~or greater~~.
- ~~Not less than~~ 50 feet for flush shoulder roadways with design speeds of 45 mph and~~or~~ less.
- ~~Not less than~~ 40 feet for curbed roadways with design speeds of 45 mph ~~or~~ and less.

See ~~also~~ Figure 4 – 6 ~~Minimum Offsets for Canal Hazards (Flush Shoulders)~~ and Figure 4 – 7 ~~Minimum Offsets for Canal Hazards (Curb and Curb and Gutter)~~. ~~On new alignments and/or for new canals, greater~~ Provide more distance~~s~~ along new alignments and new canals ~~should be provided~~ to accommodate future roadway widening ~~of the roadway~~.

~~On fill sections,~~ For roadways in fill sections, provide a flat berm (at least 20 feet wide ~~maximum~~ with a 1:10 maximum slope) ~~no less than 20 feet in width~~ between the toe of the roadway front slope and the top of the canal bank ~~side slope~~ nearest the roadway ~~should be provided~~.

No flat berm is required wWhen the slope between the roadway and the "extended period of time" water surface is 1:6 or flatter. , the The minimum distance can be measured from the edge of the travel lane, auxiliary lane, or ramp to the "extended period of time" water surface in such cases. A berm is not required.

~~On sections~~ For roadways with ditch cuts, ~~a minimum of~~ provide at least 20 feet between the toe of the front slope and the top of the canal ~~side slope~~ bank nearest the roadway ~~should be provided~~.

~~When the required minimum lateral offset cannot be met, the~~ Shield canal hazards ~~shall be shielded~~ with ~~a~~ crashworthy roadside barriers when these minimum lateral offsets cannot be provided. Locate such b~~B~~arriers ~~shall be located~~ outside the clear zone and as far from the traveled way as practical. ~~When shielding canal hazards the barrier shall be located outside the clear zone where possible.~~ Locate g~~G~~uardrail ~~shall be located no closer than~~ at least 6 feet from the canal bank ~~front slope~~. ~~and h~~ Locate high-tension cable barrier ~~shall be no closer than~~ at least 15 feet from the canal bank~~front slope~~.

Figure 4 – 6 Minimum Offsets for Canal Hazards (Flush Shoulders)

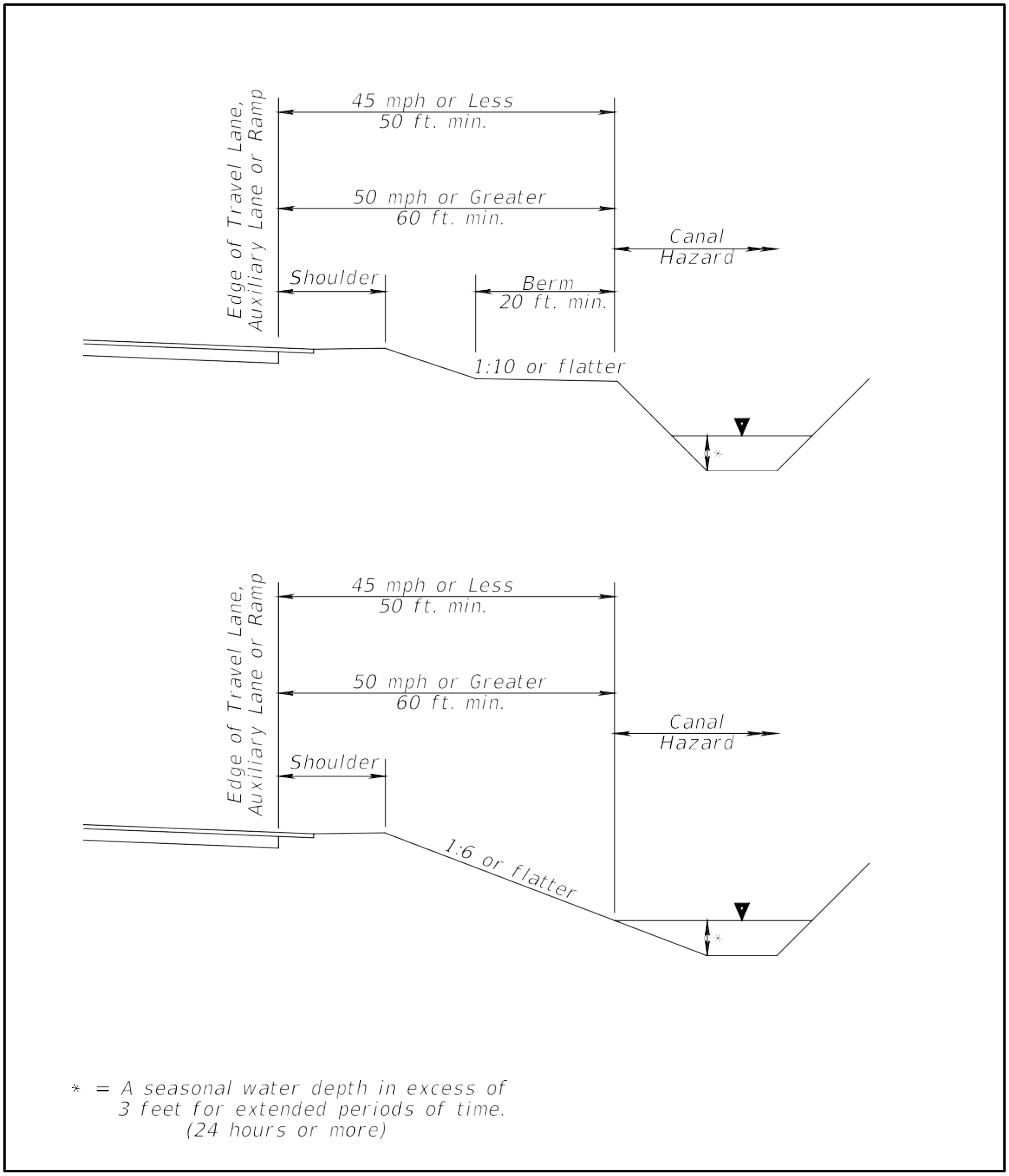
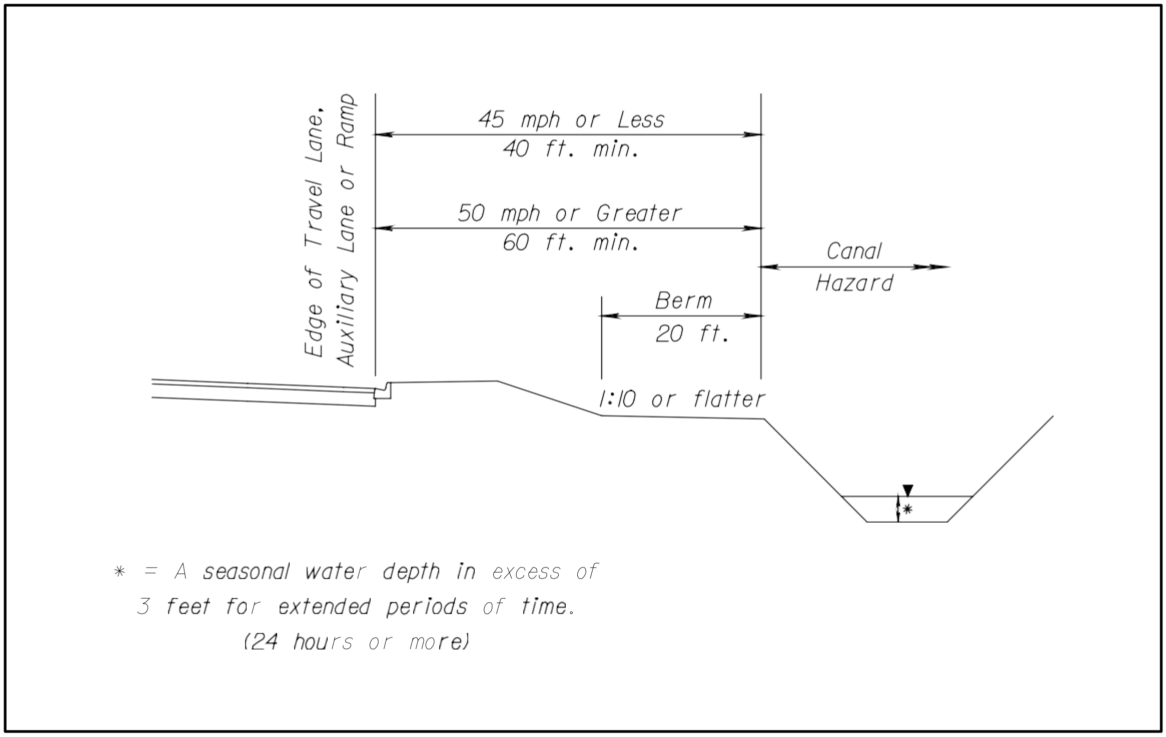


Figure 4 – 7 Minimum Offsets for Canal Hazards (Curbed)



B.2.d Curb

Curbing ~~s with~~ and closed drainage systems are typically used in urban areas to minimize R/W requirements ~~the amount of right of way needed~~. Curbing ~~s~~ also provides a tangible definition of the roadway edges ~~limits~~ and ~~delineation of~~ access connections ~~points~~. ~~These functions are~~ This is important in urban areas due to~~because of the following typical characteristics~~:

- Low design speed (~~Design Speed~~ ≤ 45 mph).
- Dense abutting development.
- Closely spaced intersections and access connections ~~es to property~~.
- Higher number of motorized vehicles, bicyclists, and pedestrians ~~volumes~~.
- Limited ~~Restricted~~ R/W~~right of way~~.

See ***Chapter 3*** ~~– ***Geometric Design*** provides criteria on the~~ of thismanual for using ~~e of~~ curbing ~~s~~. ~~It should be noted that curbs have~~ Curbing has no redirective ~~onal~~ capability ~~ies~~ except at very low speeds ~~; less than the lowest design speeds~~ (lower than ~~typically~~ used for urban streets). ~~Therefore,~~ As such, curbing ~~s are~~ is not ~~considered to be~~ effective ~~in~~ for shielding ~~a~~ hazards and ~~are not to~~ cannot be used to reduce lateral offset requirements.

See t~~T~~he FDOT~~'s~~ ***Standard Plans*** ~~provide details~~ for standard curb types ~~shapes commonly used in Florida~~. Use Type E and Type F curbs ~~Typical applications~~ for urban roadways ~~include Type E and Type F curbs~~. Both ~~curb~~ types have a sloped face~~; however~~, ~~the~~ but Type E has a flatter face ~~to~~ allowing vehicles to traverse it more easily. Shoulder gutter can be ~~is also frequently~~ used along roadway fill sections and bridge approaches to prevent ~~excessive~~ stormwater from running ~~off~~ down embankment slopes. See t~~T~~he FDOT~~'s~~ ***Drainage Manual*** ~~may be referenced~~ for ~~direction on the use of~~ using shoulder gutter.

~~Curb types such as~~ Type E curb ~~(height 5" or less with a sloping face equal to or flatter than the Type F) may~~ can be used on high-speed roadways in the ~~following~~ cases below ~~on high speed roadways.~~ (with t~~T~~he face of ~~the~~ curb ~~shall be placed no closer to the edge of the traveled way than~~ located outside the required shoulder width):~~.~~

- High-~~-~~speed multilane divided highways with design speeds of 55 mph and less. ~~For examples s~~See the ***FDOT Design Manual, Chapter 210*** ~~***Arterials and Collectors***~~ for examples.
- Directional m~~M~~edian o~~O~~penings. ~~For examples s~~See the ***FDOT Design Manual, Chapter 212*** for examples ~~***Intersections.***~~
- Transit s~~S~~tops (harmonize with flush shoulder accessible transit stops).

C ROADSIDE SAFETY FEATURES AND CRASH TEST CRITERIA

Some roadway elements (by function) must be located close to the traveled way: ~~While a traversable and unobstructed roadside is highly desirable from a safety standpoint, some appurtenances near the traveled way are necessary. Man-made fixed objects that frequently occupy road rights-of-way include~~

- T~~t~~raffic signs,
- T~~t~~raffic signals,
- R~~r~~oadway lighting,
- R~~r~~ailroad warning devices,
- I~~i~~ntelligent transportation systems (ITS),
- U~~u~~tility poles, ~~and~~
- M~~m~~ailboxes,
- Drainage features
- Etc.~~.~~

~~Other features include safety hardware such as barriers, end treatments and crash cushions which are often necessary to shield errant motorists from a variety of roadside hazards.~~

These features are in addition to trees and other vegetation. ~~often present, either naturally occurring or as part of landscaping~~. Applicable criteria for each of these features is provided ~~esented~~ in the ~~following~~ sections below. Certain features are required to meet specific crash test criteria involving full scale crash testing.

~~C.1~~C.2 Crash Test Criteria

Crash test criteria for roadside safety features has ~~been in~~ existed ~~ence~~ since 1962. ***NCHRP Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features~~,~~*** (published in 1993)~~,~~ has been the accepted criteria for safety hardware device testing for many years. Changes ~~have occurred~~ in vehicle design, hardware performance, and testing methodologies~~, which~~ have led to improvements in crash barrier and roadside design.

More recently, the ***AASHTO Manual for Assessing Safety Hardware (MASH)*** was published and has superseded ***NCHRP Report 350*** as the most current criteria. Safety hardware for new construction and reconstruction projects must meet ***NCHRP Report 350*** crash test criteria (as a minimum) t~~T~~o allow adequate time for the testing and development of features under MASH criteria~~, safety hardware installed on new and reconstruction projects shall meet **_NCHRP Report 350_** crash test criteria as a minimum~~. ~~For projects on the National Highway System, a~~ A schedule has been established for implementing requirements for devices meeting MASH criteria for projects on the National Highway System. ~~For more information~~ S~~s~~ee FHWA's web site for ***Roadway Departure Safety*** ~~.~~for more information. New construction and reconstruction projects not on the National Highway System ~~are not required to conform to~~ do not need to comply with this implementation schedule~~,~~ (but should ~~comply~~ to the extent practical).

The FDOT maintains standard details, specifications, and approved products for ~~all~~ many types of roadside applications ~~devices commonly used in Florida that~~ which meet the ~~required~~ crash test criteria~~,~~ and ~~are acceptable for~~ can be used on all public roadways. See the FDOT ***Standard Plans*** for standard n~~N~~on-proprietary~~, standardized~~ devices~~ are detailed in the FDOT's **_Standard Plans._**~~

Proprietary products are included on the FDOT~~’s~~ ***Approved Product List (APL).*** These devices address the majority of roadside needs~~ for all roads in Florida~~. Use t~~T~~he most current version of the ***Standard Plans*** and ***APL***. ~~should be used as t~~ The FDOT maintains and updates these publications ~~as necessary~~ to comply with ~~required~~ mandatory implementation dates for ~~changes in~~ updated crash test criteria.

~~For cases where a device may be needed that is not covered by the FDOT’s standards and approved products, t~~The ~~Federal Highway Administration (~~FHWA~~)~~ maintains lists of additional eligible crashworthy devices~~, which can be found~~ on their website for ***Roadway Departure Safety***. ~~In addition, t~~The AASHTO-Associated General Contractors of America (AGC}-American Road and Transportation Builders Association (ARTBA)***, Task Force 13 Guide to Standardized Roadside Safety Hardware*** also provides ~~provides engineering drawings for a multitude~~ a variety of barrier components and systems.

The criteria for crash testing ~~specified~~ in ***NCHRP Report 350*** and ***AASHTO MASH*** provide~~s~~ six Test Levels (TL-1 thru TL-6) for ~~the~~ evaluating~~on of~~ roadside hardware suitability. ~~A t~~These test levels ~~is~~ are based on: ~~defined by~~

- I~~i~~mpact speed~~ and~~ ,
- A~~a~~ngle of approach~~,~~ and
- T~~t~~he type of test vehicle.

Test vehicles range in size from a small car to a loaded tractor trailer truck. Each t~~T~~est l~~L~~evel provides an increasing level of service ~~level of service~~ in ascending numerical order.

See Tables 4 – 3 ~~Test Levels for Barriers, Approach Terminals, Crash Cushions~~ and 4 – 4 ~~Test Levels for Breakaway Devices, Work Zone Traffic Control Devices summarize the~~ for vehicle types, vehicle mass, test speeds and impact angles ~~used in~~ tested ~~ing~~ for each test level. Tables 4 – 3 and 4 – 4 also show the differences in vehicle mass between MASH and ***NCHRP Report 350*** criteria for the small car, pickup, and single unit truck test vehicles.

In addition to differences in vehicle mass, MASH test criteria incorporated several other changes that differ from ***NCHRP Report 350***. ~~For additional information on crash test criteria, refer to~~ See the ***AASHTO MASH, NCHRP Report 350***, the ***AASHTO Roadside Design Guide,*** and the FHWA web site for ***Roadway Departure Safety*** for additional crash test criteria.

Table 4 – 3 Test Levels for Barriers, Approach Terminals, Crash Cushions

Test Level	Test Vehicle Type	Vehicle Designation and Mass		Test Conditions MASH	
		NCHRP 350 (poundslbs.)	**MASH** (poundslbs.)	**Impact Speed** (mph)	**Impact Angle (for Barriers)** (degrees)
1	Passenger Car Pickup Truck	820C 1800 2000P 4400	1100C 2420 2270P 5000	31 31	25 25
2	Passenger Car Pickup Truck	820C 1800 2000P 4400	1100C 2420 2270P 5000	44 44	25 25
3	Passenger Car Pickup Truck	820C 1800 2000P 4400	1100C 2420 2270P 5000	62 62	25 25
4	Passenger Car Pickup Truck Single-Unit Truck	820C 1800 2000P 4400 8000S 17640	1100C 2420 2270P 5000 10000S 22000	62 62 56	25 25 15
5	Passenger Car Pickup Truck Tractor-Van Trailer	820C 1800 2000P 4400 36000V 79300	1100C 2420 2270P 5000 36000V 79300	62 62 50	25 25 15
6	Passenger Car Pickup Truck Tractor-Tank Trailer	820C 1800 2000P 4400 36000V 79300	1100C 2420 2270P 5000 36000V 79300	62 62 50	25 25 15

Note: Test Levels 1, 2, and 3 apply to end terminals and crash cushions. , while a All 6 Test Levels apply to barriers.

Table 4 – 4 Test Levels for Breakaway Devices, Work Zone Traffic Control Devices

Test Level	Feature	Test Vehicle Type	Vehicle Designation and Mass		Impact Speeds		Impact Angle (degrees)
			NCHRP 350 (pounds~~lbs.~~)	MASH (pounds~~lbs.~~)	Low Speed (mph)	High Speed (mph)	
2	Support Structures and Work Zone Traffic Control Devices	Passenger Car Pickup Truck	820C 1800 Not Required	1100C 2420 2270P 5000	19 19	44 44	0 – 20 0 – 20
	Breakaway Utility Poles	Passenger Car Pickup Truck	820C 1800 Not Required	1100C 2420 2270P 5000	31 31	44 44	0 – 20 0 – 20
3	Support Structures and Work Zone Traffic Control Devices	Passenger Car Pickup Truck	820C 1800 Not Required	1100C 2420 2270P 5000	19 19	62 62	0 – 20 0 – 20
	Breakaway Utility Poles	Passenger Car Pickup Truck	820C 1800 Not Required	1100C 2420 2270P 5000	31 31	62 62	0 – 20 0 – 20
Note: Criteria for Test Levels 2 and 3 are provided for support structures, work zone traffic control devices and breakaway utility poles. Test Level 3 is the ~~basic~~ test level used for most devices.							

~~As noted in Tables 4 – 3 and 4 – 4,~~ T~~T~~est l~~L~~evels 1, 2 and ~~through~~ 3 are limited to passenger vehicles. ~~while~~ T~~T~~est l~~L~~evels 4, 5 and ~~through~~ 6 incorporate heavy trucks. The test speeds and impact angles ~~used for testing~~ represent approximately 92.5% of real word crashes. As implied by ~~the information in~~ Tables 4 – 3 and 4 – 4:

1. Use Test Level 1 devices ~~should be used~~ only on facilities with design speeds of 30 mph and less.
2. Use Test Level 2 devices ~~should be used~~ only on facilities with design speeds of 45 mph and less.

3. Test Level 3, 4, 5 and ~~through Test Level~~ 6 devices are ~~considered~~ acceptable for all design speeds.
4. Test Level 3 devices are ~~generally considered~~ acceptable for all types of facilities ~~of all types~~ and most roadside conditions.
5. Consider Test Levels 4, 5 and ~~through~~ 6 ~~should be considered on~~ for facilities with high volumes of heavy trucks and/or where penetration beyond the barrier ~~would result in high risk to~~ could impact the public or surrounding facilities.

See the ***AASHTO Roadside Design Guide*** f~~F~~or ~~additional information regarding~~ the appropriate application of t~~T~~est l~~L~~evels ~~refer to the **AASHTO Roadside Design Guide**.~~

~~C.2~~C.3 Safety Hardware Upgrades

~~On new construction and reconstruction projects existing~~ Upgrade or replace o~~o~~bsolete safety hardware ~~shall be upgraded or replaced~~ with hardware meeting the crash test criteria ~~as described~~ above on new construction and reconstruction projects.

~~For existing roadways, h~~Highway agencies should upgrade existing ~~highway~~ safety hardware to comply with current crash test criteria ~~either~~ when ~~it becomes~~ damaged beyond repair~~,~~ and~~or~~ when ~~an individual agency's maintenance~~ required by their policies ~~require an upgrade to the safety hardware~~.

See t~~T~~he ***FDOT Design Manual, Chapter 215*** ~~***Roadside Safety*** provides a list of considerations when investigating the need~~ for considerations for upgrading barriers and other hardware. See t~~T~~he FDOT~~'s~~ ***Standard Plans*** ~~provide~~ for ~~standard details for transitioning new barriers to~~ transitions to connect to existing barriers. See t~~T~~he ***AASHTO Roadside Design Guide*** ~~also provides~~ for guidelines for upgrading hardware.

D SIGNS, SIGNALS, LIGHTING SUPPORTS, UTILITY POLES, TREES, AND SIMILAR ROADSIDE ELEMENTS ~~FEATURES~~

D.1 General

~~This section provides criteria for traffic sign supports, signal supports, lighting supports, utility poles, trees, and similar roadside features.~~

~~Generally, those~~ These roadside appurtenances and elements must meet breakaway criteria ~~features that~~ when they cannot be removed or located outside the clear zone ~~must meet breakaway criteria to reduce impact severity~~. ~~For those features located within the clear zone where it is not practical to meet breakaway criteria,~~ Consider s~~s~~hielding when it is not practical to meet breakaway criteria. ~~may be warranted and shall be considered~~.

D.2 Performance Requirements for Breakaway Devices

~~The term b~~Breakaway supports ~~refers to traffic sign, highway lighting, and other supports that~~ are designed to yield, fracture, or separate when impacted by a vehicle. The release mechanism ~~may~~ can be a:

- S~~s~~lip plane,
- P~~p~~lastic hinge,
- F~~f~~racture element, or
- C~~c~~ombination thereof.

See Section C of this chapter for c~~C~~rash test criteria ~~applicable to~~ for breakaway devices ~~are presented in Section C~~. ~~Additional requirements for breakaway supports are provided in~~ See the ***AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals*** for additional requirements ~~.~~ and the ***AASHTO Roadside Design Guide*** f~~F~~or a more detailed discussion ~~on breakaway supports, refer to the *AASHTO Roadside Design Guide*.~~

See Section C of this chapter for ~~references that provide~~ additional information ~~and details~~ on crash-~~-~~tested breakaway supports.

D.3 Sign Supports

Traffic signs and sign supports ~~shall~~ must meet the requirements ~~provided~~ in the ***Manual on Uniform Traffic Control Devices (MUTCD)*** ~~as stated in~~ and ***Chapter 18.*** ~~***18 – Signing and Marking***~~. The ***MUTCD*** requires ~~all~~ sign supports within the clear zone to be shielded or breakaway. See Section B of this chapter for clear zone requirements. Use a traffic barrier or crash cushion to shield sign supports~~Only~~ only when ~~the use of~~ using breakaway supports is not practicable ~~should a traffic barrier or crash cushion be used exclusively to shield sign supports~~. ~~In addition,~~ Locate s~~s~~ign supports ~~should be located~~ where they are least likely to be hit. ~~Where possible,~~ Locate signs ~~should be placed behind~~ outside the design deflection distance of existing roadside barriers ~~beyond the design deflection distance~~ or on existing structures (where possible).

See t~~T~~he FDOT~~'s~~ ***Standard Plans*** ~~provide details~~ for breakaway supports for single and multi-post ground-~~-~~mounted signs ~~that are acceptable~~ for use within the clear zone. Use t~~T~~he most current version of the~~se~~ ***Standard Plans***. ~~details should be used as t~~ The FDOT ~~maintains and~~ updates these details ~~as necessary~~ to comply with ~~required~~ implementation dates for ~~changes in~~ updated crash test criteria.

Overhead signs and cantilever signs require ~~relatively~~ large ~~size~~ support systems ~~.~~ ~~The potential safety consequences of these systems falling necessitate a fixed-base design that~~ which cannot be ~~made~~ breakaway. ~~Overhead sign and cantilever sign supports therefore are required to~~ As such, they must be located outside the clear zone ~~(Section B)~~ or be shielded with a crashworthy barrier (see Section E). ~~Where possible, these supports~~ They should be located behind traffic barriers ~~shielding nearby overpasses~~ (or other existing structures) ~~,~~ or ~~the signs should~~ be mounted on ~~the~~ a nearby structure (where possible). See t~~T~~he FDOT~~'s~~ ***Standard Plans*** ~~provide~~ for details and instructions for ~~the design of~~ designing these systems.

D.4 Traffic Signal Supports

Traffic signal supports ~~commonly used in Florida are fixed base~~ are fixed base and ~~shall~~ must meet ~~the required~~ lateral offset and clear zone criteria ~~provided in Section B~~. Do not locate t~~T~~raffic signal supports ~~should not be located~~ within medians. See t~~T~~he FDOT~~'s~~ ***Standard Plans*** ~~provide~~ for details and instructions for ~~the~~ designing ~~of~~ traffic signal supports.

D.5 Lighting Supports

Lateral offsets ~~criteria~~ for lighting supports depend on whether the support is breakaway or fixed-~~-~~base (see ~~as discussed~~ below). See ***Chapter 6*** ~~***- Lighting***~~ for additional lighting ~~design~~ criteria ~~for lighting~~.

D.5.a Conventional Lighting

Supports for conventional lighting (~~heights~~ up to 60 feet high) ~~shall~~ must be breakaway: ~~which are typically~~

- F~~f~~rangible bases (cast aluminum transformer bases),
- S~~s~~lip bases, or
- F~~f~~rangible couplings (couplers).

See tThe FDOT's ***Standard Plans*** provide further information for acceptable breakaway lighting supports which are acceptable for use. Generally, a b Breakaway lighting supports will usually fall near the line of the path of thean impacting vehicle; but not into other traffic lanes, except where located in the median. The mast arm usually rotates and points away from the roadway. when resting on the ground. For poles located on the outside of the roadway (not in medians), this action generally results in the pole not falling into other traffic lanes. However, the designer

~~should remain aware that these falling poles may endanger other motorists or bystanders such as pedestrians and bicyclists.~~ See t~~T~~he ***AASHTO Roadside Design Guide*** ~~may be referenced~~ for additional discussion of~~n~~ breakaway lighting supports.

~~On curbed roadways with design speeds 45 mph or less,~~ Locate breakaway lighting supports ~~shall be located~~ along curbed roadways with design speeds of 45 mph and less to meet lateral offset requirements ~~provided in~~ (see Section B, Table 4 – 2).

~~On flush shoulder roadways,~~ Locate breakaway lighting supports along flush shoulder roadways ~~shall be located a minimum of~~ at least 20 feet from the nearest travel lane~~,~~ (14 feet from ~~the nearest~~ auxiliary lanes), or outside the clear zone provided in Section B, Table 4 – 1, (whichever is less)~~ss~~. The front ~~fore~~slope ~~shall~~ must be 1:6 or flatter ~~in cases~~ where supports are located ~~with~~inside the clear zone.

Do not locate l~~L~~ighting ~~should not be located~~ in medians~~,~~ (except in conjunction with barriers ~~that are~~ justified for other reasons).

D.5.b High-Mast Lighting

High-~~ ~~mast ~~or~~ and high-level lighting supports are fixed-base ~~support systems that~~ and do not yield or break~~-~~away on impact. Locate h~~H~~igh-mast lighting supports ~~shall be located~~ outside the clear zone ~~provided in~~ (see Section B, Table 4 – 1). Do not locate h~~H~~igh-~~ ~~mast lighting ~~shall not be located~~ in medians (except in conjunction with barriers ~~that are~~ justified for other reasons). See t~~T~~he FDOT~~'s~~ ***Standard Plans*** ~~provide~~ for additional information.

D.6 Utility Poles

Locate u~~U~~tility poles ~~shall be located~~ to meet lateral offset and clear zone ~~requirements~~ requirements ~~provided in Section B~~ and ~~be located~~ as close ~~as practical~~ to the ~~right of way~~ R/W line as practical~~. They should be installed per the permitting~~ (per the utility agency's requirements). See t~~T~~he ***AASHTO Roadside Design Guide*** ~~provides additional discussion and~~ for guidance on utility poles.

~~In accordance with Section 337.403, F.S., e~~Relocate any existing utility poles ~~must be relocated when~~ unreasonably interfering with the "convenient, safe, or continuous use, or the maintenance, improvement, extension, or expansion" of public roads (per Section 337.403, F.S.). Consider relocating existing uUtility poles adjacent to road improvement projects, (but not directly interfering with construction) , should be considered for relocation, to the extent they can be

~~relocated, to achieve the~~ to meet lateral offset requirements ~~of~~ (see Table 4 – 2) ~~Lateral Offset~~. Obtain Design Variations or Exceptions for any u~~U~~tility poles that cannot be relocated and ~~will~~ must remain within the clear zone ~~, should be approved through the exception process prescribed in~~ (see ***Chapter 14***) ~~***- Design Exceptions and Variations***~~.

D.7 Trees

Trees ~~with a diameter greater than~~ over 4 inches in diameter (measured 6 inches above grade) ~~shall~~ must be located to meet lateral offset and clear zone requirements ~~in~~ (see Section B, Tables 4 – 1 and 4 – 2). See t~~T~~he ***AASHTO Roadside Design Guide*** ~~provides additional discussion and~~ for additional guidance on trees.

D.8 Miscellaneous

D.8.a Fire Hydrants

Most fire hydrants ~~are made of cast iron and are expected to~~ will fracture upon impact;~~,~~ however, crash testing ~~meeting current criteria~~ has not been ~~done~~ conducted to verify that hydrant designs meet breakaway criteria. ~~For this reason,~~ Locate fire hydrants ~~should be located~~ as far from the traveled way as practical ~~and~~ (preferably outside lateral offset and ~~/~~clear zone requirements) ~~in Section B, yet~~ but where they are ~~still~~ readily accessible to ~~and usable by~~ emergency personnel. Any portion of ~~the~~ hydrants not designed to break~~-~~away should be ~~within~~ less than 4 inches ~~of~~ above ~~the~~ ground.

D.8.b Railroad Crossing Warning Devices

See ***Chapter 7*** ~~***– Rail-Highway Crossings***~~ for ~~location requirements~~ for locating railroad crossing warning devices.

D.8.c Mailbox Supports

Mailbox~~es and their~~ locations ~~are subject to~~ must meet US Postal Service requirements~~. They~~ and are ~~often~~ typically located within the clear zone ~~and pose a potential hazard~~. ~~However, with proper design and placement, t~~ The severity of mailbox impacts ~~with mailboxes~~ can be reduced with proper design. ~~To achieve consistency, it is recommended e~~ Each highway agency should adopt regulations for ~~the~~ designing and ~~plac~~ locating ~~ement of~~ mail boxes within the ~~right of way~~ public R/W (for consistency)~~of public highways~~.

See tThe ***AASHTO Roadside Design Guide*** provides a model for a sample regulation that is compatible with US Postal Service requirements.

The ~~following~~ requirements below apply to mailbox installations on public roadways:

~~No~~ Do not locate m~~m~~ailboxes ~~will be permitted~~ where access is ~~obtained~~ from a freeway or ~~where access is otherwise~~ prohibited by law or regulation. Locate m~~M~~ailboxes ~~shall be located as follows~~:

- On the right-hand side of the roadway ~~in the carrier's direction of travel~~ (or on the left-hand side of ~~except on~~ one-way streets)~~, where they may be placed on the left-hand side~~.
- ~~Where a mailbox is located at a driveway entrance, it shall be placed o~~ On the far side of ~~the~~ driveway entrances ~~in the carrier's direction of travel~~.
- ~~Where a mailbox is located at an intersecting road, it shall be located a minimum of~~ At least 200 feet beyond the center of ~~the~~ intersecting roadways ~~in the carrier's direction of travel. This distance may be decreased to~~ (100 feet ~~on~~ for very low volume roadways).
- ~~When a mailbox is installed in the vicinity of an existing guardrail, it should, when practical, be placed b~~Behind existing ~~the~~ guardrail (when practical).

Set t~~T~~he bottom of the box ~~shall be set~~ at a height established by the U~~.~~ S~~.~~ Postal Service~~,~~ (usually ~~from~~ 41 to 45 inches above the roadway surface).

~~On flush shoulder roadways,~~ Offset the roadside face of ~~the~~ boxes along flush shoulder roadways no less than the greater of ~~should be offset from the edge of the traveled way a distance no less than the greater of the following~~:

- 8 feet from the traveled way (where no paved shoulder exists and the shoulder cross slope is less than 10 percent ~~or flatter~~)~~, or~~or
- The shoulder width ~~of the shoulder present~~ plus 6 to 8 inches~~, or~~or
- The width of a turnout (specified by the jurisdiction) plus 6 to 8 inches~~.~~

The offset can be reduced to 6 feet from the traveled way ~~On~~ along very low-~~-~~volume low-speed flush shoulder roadways. ~~with low operating speeds the offset may be reduced to 6 feet from the traveled way.~~

~~On curbed streets,~~ Set the roadside face of the ~~mail~~box ~~should be set back from the face of the curb~~ 6 to 8 inches outside the face of curb along curbed roadways. Set the roadside face of the box 8 to 12 inches outside the edge of pavement On along low-volume low-speed residential streets (without curbs or all-weather shoulders). that carry low traffic volumes operating at low speeds, the roadside face of the mailbox should be offset between 8 inches and 12

~~inches behind the edge of the pavement~~.

~~Design~~ Comply with the criteria below for ~~the~~ mailboxes located within the clear zone~~support structure when located within the clear zone should consist of the following~~:

- Mailboxes ~~shall~~ must be of light sheet metal or plastic construction conforming to the requirements of the U~~.~~S~~.~~ Postal Service. Newspaper delivery boxes ~~shall~~ must be of light metal or plastic construction of minimum dimensions ~~suitable for holding~~ for a newspaper.
- Mount n~~N~~o more than two mailboxes ~~may be mounted~~ on a single support structure (unless crash tests have shown the support structure and mailbox arrangement to be safe). ~~However, l~~Light-weight newspaper boxes ~~may~~ can be mounted to the side of the support (below the mailbox)~~ on the side of the mailbox support~~.
- Mailbox supports can be embedded no more than 24 inches into the ground and can be:
    - A single 4-~~-~~inch by 4-~~-~~inch ~~square~~ or 4-~~-~~inch diameter wooden post, ~~; or~~
    - A metal post, or
    - A 2-inch Schedule 40 ~~, 2 inch~~ (normal size IPS (external diameter 2-~~-~~3/8 inch) (wall thickness 0.154 inches) or smaller)~~, embedded no more than 24 inches into the ground, shall be acceptable as a mailbox support.~~

~~A m~~Metal posts ~~shall~~ cannot ~~be fitted with an~~ have anchor plates, but ~~it may~~ can have ~~an~~ anti-twist devices ~~that~~ extendings ~~no more than~~ up to 10 inches ~~below~~ into the ground ~~surface~~.

- Avoid using: ~~Unyielding supports such as~~
    - H~~h~~eavy metal pipes,
    - C~~c~~oncrete posts,
    - B~~b~~rick,
    - S~~s~~tone or
    - O~~o~~ther rigid foundation structure or encasement).~~ should be avoided.~~
- The post-to-box attachment ~~details~~ should be ~~of~~ sufficiently strong ~~strength to prevent the box from separating from the post top if the installation is~~ to stay intact if struck by a vehicle. The ~~exact support~~

hardware dimensions and design ~~may~~ can vary ~~, such as having~~ (e.g., a two-piece platform bracket or alternative slot-and-hole locations). The ~~product~~ hardware must ~~result in a satisfactory~~ attach ~~ment of~~ the mailbox to the post satisfactorily.~~, and a~~ All components must fit together properly.

- ~~The minimum spacing between the centers of~~ Adjacent mailboxes should be separated by at least ~~support posts should be~~ the height of the exposed support ~~height of the posts above the ground line~~. Other m~~M~~ailbox support designs ~~not described in this regulation~~ are acceptable if approved by the jurisdiction.

See t~~T~~he FDOT~~'s~~ ***Standard Plans*** and the ***AASHTO Roadside Design Guide*** ~~provide details on~~ for hardware, supports~~s~~ and attachments ~~details acceptable for mailboxes~~ located within~~within~~ the clear zone.~~ which conform to the above~~

requirements.

See the ***United States Postal Service's Delivery Growth Management*** web page forAdditional information on the designing and constructing on of residential and commercial mailboxes , including (including outdoor cluster boxes) can be found on the ***United States Postal Service's Delivery Growth Management*** web page.

D.8.d Bus Benches and Shelters

See ***Chapters 3 and 13 – Geometric Design*** for location criteria for locating bus benches and shelters. Additional criteria are provided in ***Chapter 13 – Public Transit***.

E BARRIERS, APPROACH TREATMENTS, AND CRASH CUSHIONS

E.1 Roadside Barriers

Roadside barriers ~~are~~ are used to:

- ~~shield motorists from~~ Protect drivers from roadside hazards ~~and in some cases are used to~~
- P~~p~~rotect bystanders, pedestrians, bicyclists and/~~or~~ workers from vehicular traffic and~~. In still other cases, roadside barriers are used~~
- ~~to p~~Protect bridge piers from vehicle impacts.

Median barriers are ~~similar to~~ like roadside barriers but ~~are~~:

- Are d~~d~~esigned for vehicle impacts from both sides, ~~striking either side and are~~
- Are p~~p~~rimarily used to separate opposing traffic on ~~a~~ divided highways, ~~. Median barriers also may~~
- Can be used ~~on heavily traveled roadways~~ to separate through traffic from local traffic, and~~or~~
- Can be used to separate high occupancy vehicle (HOV) and managed lanes from general-purpose lanes.

Barriers are further classified as:

- R~~r~~igid,
- S~~s~~emi-rigid, and
- F~~f~~lexible ~~which are discussed in more detail below~~.

Use b~~B~~arrier transition sections ~~are used~~ between adjoining barriers ~~that have~~ with significantly different deflection characteristics. ~~For example,~~ Provide a transition section ~~is needed~~ where a semi-rigid guardrail attaches to ~~the approach end of~~ a rigid concrete bridge railing ~~, or~~ and wher~~e~~n a barrier must be stiffened to shield fixed objects (for example).

~~Requirements for bridge railings are provided in~~ See ***Chapter 17*** for bridge railing requirements ~~***– Bridges and Other Structures***~~***.***

E.2 End Treatments

End treatments include:

- T~~t~~railing anchorages,
- A~~a~~pproach terminals, and
- C~~c~~rash cushions.

Use t~~T~~railing anchorages ~~are used~~ to anchor a flexible or semi-rigid barrier to the ground ~~to develop its tensile strength during an impact~~. Trailing anchorages are:

- N~~n~~ot ~~designed to be~~ crashworthy for head-~~-~~on impacts, ~~. They are~~
- T~~t~~ypically used on the trailing end of a roadside barrier on one-way roadways, ~~, or~~ and
- ~~on~~ Sometimes used on ~~the approach or trailing~~ the approach or trailing end of a flexible or semi-rigid barrier ~~that is~~ located outside the clear zone (or ~~that is~~ shielded by another barrier system). ~~Trailing anchorages are discussed in more detail below.~~

Approach terminals are ~~basically~~ crashworthy end treatments ~~anchorages~~. Use a~~A~~pproach terminals ~~are used~~ to anchor a flexible or semi-rigid barrier that is inside the clear zone and exposed to approaching traffic to the ground ~~at the end of a barrier that is within the minimum clear zone and exposed to approaching traffic~~. Most approach terminals are designed for vehicular impacts from only one side. ~~of the barrier~~; ~~, however s~~ Some are designed for median applications with ~~where there is~~

potential ~~for~~ impacts from either side.~~ Approach terminals are discussed in more detail below.~~

E.3 Crash Cushions

Crash cushions ~~, sometimes referred to as~~ (a.k.a. impact attenuators)~~,~~ are crashworthy end treatments typically attached at the approach end of median barriers, roadside barriers, bridge railings ~~or~~ and other rigid fixed objects ~~, such as~~ (e.g., bridge piers). Crash cushions ~~may~~ can be used in a median, a ramp terminal gore, ~~or~~ and for other roadside applications.~~ Crash cushions are discussed in more detail below.~~

E.4 Performance Requirements

Roadside barriers, transitions, approach terminals, and crash cushions must be crashworthy as determined by full scale crash testing ~~in accordance with specific crash test criteria discussed in~~ (see Section C). See Section C and below for ~~Descriptions of~~ devices ~~commonly~~ used ~~devices~~ in Florida ~~are described below. Section C also provides references where more~~to and for additional information ~~can be found~~ on crashworthy devices.

E.5 Warrants

~~The determination~~ Make decisions as to when shielding is warranted ~~for given hazardous roadside feature must be made~~ on a case-by-case basis ~~, and generally requires~~ using engineering judgment. ~~It should be noted that the installation of~~ Installing a roadside barrier~~s~~ presents a hazard in and of itself. ~~, and as such, the designer must a~~Analyze whether ~~the~~ installing ~~ation of~~ a barrier ~~presents~~ is a greater risk than the feature it is intended to shield. ~~The analysis should be completed~~ Conduct the analysis using the ***Roadside Safety Analysis Program (RSAP)*** or ~~in accordance with~~ the ***AASHTO Highway Safety Manual (HSM)***.

S~~Please s~~ See Section A for ~~the considerations to be included when determining~~ deciding when to shield a roadside hazard.

The ~~following~~ hazards below (when located inside ~~within~~ the clear zone) are typically ~~normally~~ considered more hazardous than a roadside barrier:

E.5.a Above-Ground Hazards

See Table 4 – 2 for the definition of a~~A~~bove-ground hazard ~~s are defined~~

~~in Section B, Table 4 – 2 Lateral Offset~~. Examples ~~They~~ include ~~but are not limited to~~:

1. Bridge piers, abutments, and railing ends.
2. Parallel retaining walls with protrusions or other potential snagging. features
3. Non-breakaway sign and lighting supports.
4. Utility p~~P~~oles.
5. Trees ~~greater than~~ with diameters exceeding 4~~"~~ inches ~~in diameter~~ (measured ~~6"~~ 6 inches above ground).

E.5.b Drop-Off Hazards

See Table 4 – 2 for the definition of d~~D~~rop-off hazard ~~s are defined in Section B, Table 4 – 2 Lateral Offset~~.

E.5.c Canals and Waterb ~~B~~odies

See Section B.2.c ~~Criteria~~ for ~~addressing~~ canal and wate~~r~~ body hazards ~~is provided in Section B.2.c~~.

E.6 Warrants for Median Barriers

Provide m~~M~~edian barriers ~~shall be used~~ on high~~-~~ speed, limited access (LA) facilities ~~where the~~ with median widths ~~is less than~~ below the minimum values ~~given~~ in ~~Chapter 3, Geometric Design,~~ Table 3 – 23 ~~Minimum Median Widths~~. ~~For locations where median widths are equal to or greater than the minimum, m~~Median barriers are not normally ~~considered~~ provided where median widths satisfy Table 3 – 23 except in special circumstances ~~, such as a location with~~ (e.g., a significant history of cross median crashes). ~~Any determination to use a median barrier on limited access facilities must c~~ Consider the need for appropriately spaced barrier openings along LA facilities ~~for median crossovers that are appropriately spaced to avoid excessive~~ to minimize travel distances ~~by~~ for emergency ~~vehicles~~, law enforcement ~~vehicles~~, and maintenance vehicles. See t~~T~~he FDOT Design Manual (FDM) ~~may be referenced for additional criteria and guidelines~~ for locating and designing median crossovers on ~~limited access~~ LA facilities.

~~On high speed divided arterials and collectors, m~~ Median barriers are not normally used along high-speed divided arterials and collectors due to ~~several~~ factors ~~that are very difficult, if not impractical, to address. Such factors~~ includ~~ing: e~~ ~~right-of-way~~

- R/W constraints,
- P~~p~~roperty access needs, ~~presence of~~

- A~~a~~t-grade intersections and driveways,
- A~~a~~djacent commercial development,
- I~~i~~ntersection sight distances and
- B~~b~~arrier end terminals ~~ation~~. ~~However, provided~~

Median barriers can be used where median widths are below minimums where these factors are properly addressed (or where justified based on significant crossover crash history) ~~these factors can be properly addressed, median barriers for these type facilities may be considered where median widths are less than minimum or where justified based on significant crossover crash history~~.

~~See Section E for median barrier types and proper end treatment requirements.~~ See t~~T~~he ***AASHTO Roadside Design Guide*** and ~~the~~ ***FDOT Design Manual, Chapter 215*** ~~***Roadside Safety***~~ and the ***Standards Plans*** ~~provide additional information and~~ for guidelines ~~on the~~ for using ~~e of~~ median barriers.

E.7 Temporary Barriers in Work Zones

See Section G of this chapter ~~Roadside Design in Work Zones~~ for criteria ~~on the~~ for using ~~e of~~ temporary barriers in work zones.

E.8 Barrier Types

Roadside barriers are classified as rigid, semi-rigid and flexible ~~, semi-rigid and rigid depending~~ based on their impact deflection characteristics ~~when impacted~~. Flexible systems deflect the most ~~have the greatest deflection characteristics.~~ and are generally more forgiving than rigid and semi-rigid systems since ~~Given~~ much of the ~~impact~~ energy is dissipated by ~~the~~ the barrier deflection ~~of the barrier~~ (imposing ~~and~~ lower ~~impact~~ forces ~~are imposed~~ on the vehicle)~~, flexible systems are generally more forgiving than rigid and semi-rigid systems~~. Rigid barriers ~~, on the other hand, are assumed to exhibit no deflection under~~ do not deflect upon impact ~~conditions~~ such that~~e~~ the crash severity ~~will~~ is ~~likely be~~ typically the highest ~~of the three classifications~~.

~~In the following sections are basic~~ See the FDOT ***Standard Plans,*** the ***FDOT Design Manual*** and the sections below for descriptions of the barrier types ~~commonly used in Florida~~ for each ~~these~~ these ~~classifications~~classifications and the proper use of these systems. ~~These commonly used barriers are those that are addressed in the FDOT's~~ ~~***Standard Plans***~~ ~~and~~ ~~***FDOT Design Manual***~~~~. Those documents should be referenced for additional details and discussion on the proper use of these systems.~~

These documents are t~~T~~he basis for the FDOT~~'s~~ systems ~~and devices, as well as~~ and many other generic and proprietary guardrail systems meeting ***NCHRP Report 350*** and/or MASH criteria~~, can be found in the following documents~~:

- ***AASHTO Roadside Design Guide***
- ***Federal Highway Administration (FHWA) Countermeasures that Reduce Crash Severity***
- ***AASHTO-Associated General Contractors of America (AGC}-American Road and Transportation Builders Association (ARTBA) Joint Committee Task Force 13*** report, ***A Guide to Standardized Highway Barrier Hardware***

available at

(?)

E.8.a Guardrail

The W-beam guardrail (a.k.a. TL-3 guardrail) detailed in the FDOT ***Standard Plans*** is t~~T~~he most commonly used barrier on new construction projects~~ in Florida is the w-beam guardrail system detailed in the FDOT's *Standard Plans* referenced as "General TL-3 Guardrail"~~. ~~This w-beam~~ W-beam guardrail ~~system,~~ (~~sometimes~~ also referred to as a strong post guardrail~~ system~~)~~,~~ is a semi-rigid system~~, uses posts at~~ with a;

- 6'-3" post spacing,
- 8" offset blocks,~~ and~~
- mid-span splices, and ~~with~~
- 2'-1" ~~a~~ rail height ~~of 2'-1"~~ to the center of the panel.

This system was developed based on the 31" Midwest Guardrail System (MGS)~~ and~~ meeting ~~s~~ MASH Test Level 3 criteria. Compatible proprietary components ~~may~~ can be referenced by the 31" height. This system can be used as a roadside barrier or in a double-~~-~~face configuration as a median barrier. See ***FDOT Design Manual, Chapter 215*** for d~~D~~eflection distance ~~space~~ requirements for this system~~ are provided in the *FDOT Design Manual, Chapter 215 Roadside Safety*~~.

The current 31" height system replaces the 27" height system (1'-9" to the center of the panel) that ~~had been used for many years and~~ still exists along ~~present on~~ roadways throughout Florida. See Section C.3 ~~addresses~~ for requirements for upgrading existing 27" height systems.

See t~~T~~he FDOT~~'s~~ ***Standard Plans*** ~~also provide~~ for details for a similar W~~w~~-beam guardrail system (referenced as "Low Speed, TL-2 Guardrail")~~,~~ with ~~posts at~~ a 12'-~~-~~6" post spacing ~~which~~ meeting ~~s~~ MASH Test Level 2 criteria. While this TL-~~-~~2 system ~~may~~ can be used on low-~~-~~speed roadways (45 mph ~~or~~ and less), it is ~~preferably should~~ preferably only ~~be~~ used ~~only~~ on roadways with design speeds of 35 mph and less ~~-~~(to account for ~~the potential for~~ changes in ~~posted~~ speed limit~~s~~ and~~/or~~ for vehicles exceeding the ~~design~~ speed limit).

~~To achieve a minimum level of crash performance, g~~Guardrail installations ~~shall~~ for speeds over 45 mph must ~~have a minimum length of~~ be at least 75 feet long to perform properly ~~with design speeds greater than 45 mph~~.

E.8.b Concrete Barrier

See the FDOT ***Standard Plans*** for The most commonly used concrete barriers in Florida are detailed in the FDOT's ***Standard Plans***. Details are provided for:

- Mmedian applications,
- Sshoulder applications and
- Ppier protection.

See ***FDOT Design Manual, Chapter 215*** Additional for information on these barriers is provided in the ***FDOT Design Manual, Chapter 215 Roadside Safety***.

The FDOT~~’s~~ 32” ~~height~~ F-s~~S~~hape concrete barrier ~~wall system that~~ has been ~~in~~ used for many years and meets ***NCHRP Report 350*** Test Level 4 criteria and MASH Test Level 3 criteria. The FDOT has~~is~~ replaced~~ing~~ this 32” F-s~~S~~hape ~~system~~ with a 38” high~~eight~~ single-~~-~~slope concrete barrier ~~system which~~ meeting ~~s~~ MASH Test Level 4 criteria. ~~In addition to improved crash test performance, th~~this ~~e~~ single-~~-~~slope ~~face~~ barrier is easier to construct and performs better in crash tests. ~~provides for simpler construction~~.

~~While shielding bridge piers to protect motorists from a hazard within the clear zone is often necessary, s~~Some bridge piers ~~may~~ need to be shielded~~ing for protection~~ from potential vehicular impact ~~damage due to design limitations (i.e., piers~~ because they were not designed for ~~vehicular~~ collision forces~~)~~. Coordinate ~~ion~~ with the Structural ~~Engineer of Record~~ EOR ~~is required~~ to determine if pier protection is warranted. See t~~T~~he FDOT~~’s~~ ***Standard Plans*** ~~provides details~~ for crashworthy p~~P~~ier p~~P~~rotection barriers and ~~the~~ ***FDOT Design Manual, Chapter 215*** ~~***Roadside Safety***~~ ~~provides a process~~ for determining the appropriate level of pier protection. ~~As with median and shoulder concrete barrier walls, t~~The FDOT has ~~is~~ also replaced~~ing~~ ~~the~~ the F-s~~S~~hape pier protection barriers ~~that have been in use for several years~~ with a single-~~-~~slope pier protection barrier ~~face systems~~.

E.8.c High Tension Cable Barrier

There are a variety of crash tested flexible barrier ~~barrier~~ and cable barrier systems ~~using w-beam and cable, but they historically have not been in common use in Florida~~. ~~In recent years~~ S~~s~~everal proprietary high-tension cable barrier (HTCB) systems ~~have been developed~~ that meet ***NCHRP Report 350*** and MASH criteria have been developed in recent years. ~~These~~ HTCB systems are installed with ~~a~~ significantly greater cable tension ~~in the cables~~ than the ~~generic~~ low-tension systems ~~that have been~~ used in some states ~~for many years~~. HTCB ~~igh tension cable barrier~~ systems ~~may~~ can be used for ~~both~~ median and roadside applications. Deflection distance ~~space~~ requirements are dependent on the system, the system length and the post spacing ~~,~~ and are significantly greater than semi-rigid systems.

HTCB ~~igh tension cable barrier~~ has ~~shown to have~~ several advantages over other types of flexible barrier systems. ~~One advantage is they~~HTCB tends to result in less damage when impacted and~~. Another is that certain~~ some systems have been tested ~~for use~~ on slopes as steep as 1:4. In addition, ~~Still another advantage is that in many cases,~~ the cables tend to remain at the proper height after an impact that damages several posts. While no manufacturer claims their barrier remains functional in this condition, ~~there is the potential that this~~ it does offer~~s~~ a residual safety value under certain crash conditions. Posts are typically lightweight and can be installed ~~in cast or driven sockets in the ground~~ to facilitate removal and replacement. One disadvantage is that ~~each~~ vendors use~~s a~~ different post designs and cable arrangements~~,~~ ~~and therefore~~ such that posts are not interchangeable between systems ~~manufactured by different vendors~~.

The FDOT has used ~~High Tension Cable Barrier (~~HTCB systems~~) in selected locations~~ and continues to install them~~se systems~~ using the FDOT~~'s~~ ***Developmental Design Standards and Developmental Specifications (DDS)*** process. See the FDOT ***DDS*** website for ~~Detailed information on the usage requirements and design criteria of~~ using HTCB ~~can be found on the FDOT's~~ ~~***DDS***~~ ~~website~~, including~~.~~

~~It includes the following:~~

- ***Developmental Standard Plans Instructions D 540-001***
- ***Developmental Standard Plans Index D 540-001***
- ***Developmental Specification, Dev540***

E.8.d Temporary Barrier

~~As stated in Section E.5.e, t~~ Temporary barriers are primarily used ~~primarily~~ in work zones ~~for several purposes~~. The most ~~used~~ common temporary barriers ~~in Florida~~ are those adopted for use by the FDOT, ~~. The FDOT's temporary barriers~~ including~~e~~:

Low Profile Barrier – Standard Plans, Index 102-120 (TL-2, NCHRP 350)

Type K Barrier – Standard Plans, Index 102-110 (TL-3, NCHRP 350)

Proprietary Temporary Barrier –Standards Plans, Index 102-100 and the ***Approved Products List (APL)*** (TL-2 & TL-3, NCHRP 350)

See the ***FDOT Design Manual*** and the vendor drawings on the ***APL*** for ~~Additional information on~~ the proper use of these barriers ~~is provided in the~~ ~~***FDOT Design Manual***~~ ~~and the Vendor drawings on the FDOT's~~ ~~***Approved Products List***~~.

See the ***Manual for Assessing Safety Hardware*** and the ***AASHTO Roadside Design Guide*** ~~Additional information on~~ for temporary barrier systems meeting ***NCHRP Report 350*** and/or MASH criteria ~~can be found in the~~ ~~***Manual for Assessing Safety Hardware***~~ ~~and the~~ ~~***AASHTO Roadside Design Guide***~~.

E.8.e Selection Guidelines

~~The evaluation of~~ Evaluate ~~numerous~~ these factors ~~is required to ensure that~~ in selecting the appropriate barrier type ~~is selected for a~~ for each specific ~~given~~ application~~. Consideration should be given to the following factors when evaluating each site~~:

- Barrier placement requirements (see Section E.6.f)
- Traffic characteristics (e.g., vehicle types/percentages, volume, and growth)
- Site characteristics (e.g., terrain, alignment, geometry, access ~~facility~~ type, access locations, design speed, etc.)
- Expected frequency of impacts
- Initial and replacement/repair costs
- Ease of maintenance
- Exposure of workers when conducting repairs/maintenance
- Aesthetics

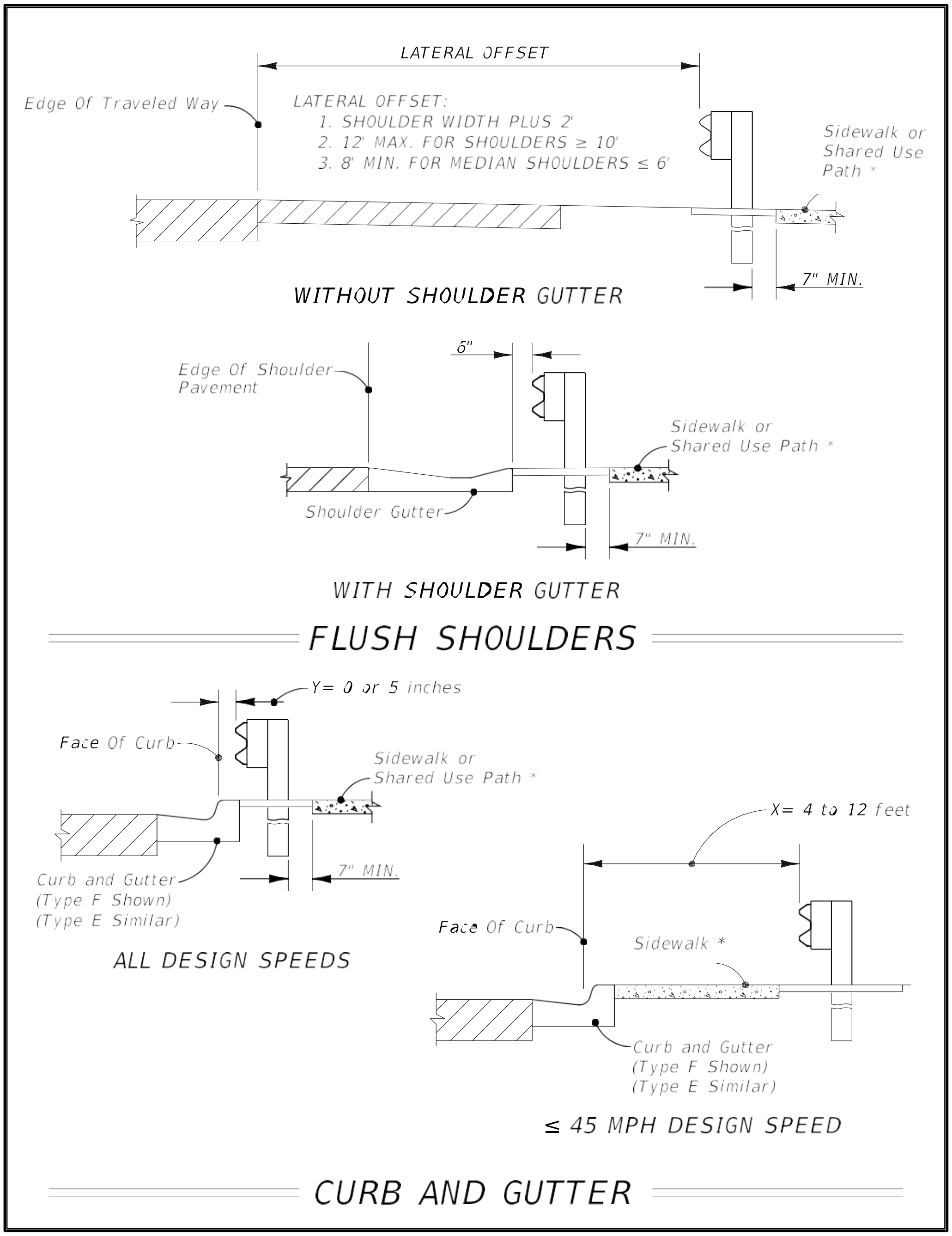
See the ***AASHTO Roadside Design Guide*** f~~F~~or additional information ~~about~~ on ~~considerations for~~ barrier selection~~s refer to the *AASHTO Roadside Design Guide*~~. Document all b~~B~~arrier ~~type~~ selection decisions and warrants~~ should be documented~~.

E.8.f Placement

E.8.f.1 Barrier Offsets

Offset r~~R~~oadside barriers ~~should be offset~~ as far from the travel lanes as practical~~ with consideration for maintaining the proper performance of the barrier~~. ~~For the barriers described above~~ S~~s~~ee the ***FDOT*** ***Design Manual, Chapter 215*** ~~***Roadside Safety***~~ and ***Standard Plans*** for proper barrier placement. See Figure 4 – 8 ~~Location of Guardrail provides information on the~~ for offsets to~~of~~ guardrail on curbed and flush shoulder roadways.

Figure 4 – 8 Location of Guardrail



* When a sidewalk is present or planned. See Chapter 8 ~~– Pedestrian Facilities~~ and Chapter 9 ~~– Bicycle Facilities~~ for criteria for sidewalks and shared use paths (e.g., width of the facility ~~plus clear,~~ and clear graded areas adjacent to the path or sidewalk).

E.8.f.2 Deflection Space and Zone of Intrusion

~~In addition to travel lane lateral offset considerations,~~ Provide an adequate setback ~~must be provided~~ behind the barrier to ensure proper function.~~ For flexible and semi-rigid barriers,~~ T~~t~~he setback for flexible and semi-rigid barriers is based on deflection tolerances and is required to prevent the barrier from ~~contacting~~ impacting aboveground objects.

~~For rigid barriers, t~~ The setback for rigid barriers is required to keep the area above and behind the barrier face free of obstructions that could penetrate or damage the vehicle compartment. This requirement is based on the Zone of Intrusion (ZOI) concept ~~as~~ described in the ***AASHTO Roadside Design Guide***.

These requirements do not apply to devices located within the setback distances detailed in the FDOT’~~s~~ ***Standard Plans*** (e.g., pedestrian/bicycle railing, fencing, noise walls, etc.).

E.8.f.3 Grading

The ~~terrain effects~~ ground between the traveled way and a barrier can ~~have a~~ significantly impact ~~on~~ whether ~~a~~ the barrier ~~will~~ performs as intended. Proper grading ~~around a barrier will~~ ensures that ~~as~~ an approaching vehicle’s ~~approaches a barrier its~~ suspension is not affected, ~~is not dramatically affected,~~ causing~~ing~~ the vehicle to underride or override ~~a~~ the barrier.

E.8.f.4 Curbs

~~As with grading, t~~The presence of curb in combination with barriers ~~deserves~~ also requires special attention. A vehicle which traverses ~~traverses~~ a curb ~~prior to impact may~~ can override a ~~the~~ barrier ~~if it is~~ (due to being partially airborne at ~~the moment of~~ impact). ~~Conversely, the~~ A vehicle ~~may~~ can also "submarine" ~~under the rail element of~~ a guardrail system and snag on the support posts if it strikes ~~the barrier~~ too low.

E.8.f.5 Flare Rate

A flared roadside barrier is ~~when it is~~ not parallel to the edge of the traveled way. ~~A flared~~ Flaring a barrier ~~may~~ can be necessary to~~for~~

~~several reasons~~:

- ~~To locate~~Locate ~~-~~the barrier terminal farther from the roadway
- M~~To m~~inimize the ~~a~~ driver's reaction ~~to an obstacle near the road~~ by gradually introducing a parallel barrier ~~installation~~
- ~~To t~~Transition ~~a roadside barrier~~ to an obstacle nearer the roadway such as a bridge parapet or railing
- ~~To r~~Reduce the total length of barrier needed~~.~~
- ~~To r~~Reduce the potential for ~~barrier a~~ end terminal impacts and provide additional ~~roadside~~ space for an errant driver ~~motorist~~ to recover~~.~~

~~A concern with flaring a section of roadside barrier is that~~ T~~t~~he greater the flare rate, the higher the angle at which the barrier can be impacted~~hit~~. As the angle of impact increases, the crash severity increases~~,~~ (particularly for rigid and semi-rigid barrier systems). Another disadvantage to flaring a barrier ~~installation~~ is the increased likelihood that a vehicle ~~will be~~ is redirected back into or across the roadway ~~following an~~ after impact.

~~For the barriers described above,~~ S~~s~~ee ~~the~~ ***FDOT Design Manual, Chapter 215*** ~~***Roadside Safety***~~ for acceptable flare rates for the barriers above. See the ***AASHTO Roadside Design Guide*** ~~Additional information on~~ for additional information on flare rates ~~are provided in the **AASHTO Roadside Design Guide**~~.

E.8.f.6 Length of Need

The length of need for a particular barrier ~~type~~ is calculated based on ~~several~~ factors including:

- T~~t~~he length of the hazard,
- T~~t~~he lateral area of concern, and
- The run out length ~~and other factors~~.

The l~~L~~ength of need must consider traffic from both directions.

A spreadsheet ~~tool~~ for calculating the length of need is provided on the FDOT~~'s~~ ***Standard Plans*** web page~~,~~ in the ***Design Tools*** column adjacent to ***Index 536-001*** ~~in the **Design Tools** column~~. See the ***AASHTO Roadside Design Guide*** ~~Additional information on~~ for additional information on length of need ~~is provided in the **AASHTO Roadside Design Guide**~~.

E.8.g Barrier Transitions

Guardrail transitions are necessary ~~whenever~~ where standard W-b~~B~~eam guardrail ~~converges~~ connects with rigid barriers. The ~~purpose of the~~ transition ~~is to~~ provides a gradual stiffening of the ~~overall~~ approach ~~to a rigid barrier so that~~ to prevent vehicular pocketing, snagging, ~~or~~ and penetration ~~is reduced or avoided at any position along the transition~~. Guardrail transitions ~~must~~ must include:

- S~~s~~ound structural connections,
- N~~n~~ested panels, and
- A~~a~~dditional posts for increased stiffness.

See t~~T~~he FDOT~~'s~~ ***Standard Plans*** ~~provide details~~ for several transitions ~~for both permanent and rigid barriers~~ that meet MASH criteria. See ***FDOT Design Manual, Chapter 215*** and the ***AASHTO Roadside Design Guide*** ~~Additional information on~~ for additional information on transitions ~~is provided in the~~ ~~***FDOT Design Manual, Chapter 215 Roadside Safety***~~ ~~and the~~ ~~***AASHTO Roadside Design Guide***~~.

E.8.h Attachments to Barriers

Attachments to barriers ~~such as~~ (e.g., signs, light poles, and other objects) ~~will~~ affect crash performance and should be avoided ~~where practical~~. Attachments not meeting the requirements ~~discussed~~ in Section E.6.f ~~Placement,~~ should meet crash test criteria. See ~~the~~ ***FDOT Design Manual, Chapter 215*** ~~***Roadside Safety***~~ for ~~additional information on~~ attachments to barriers.

E.9 End Treatments and Crash Cushions

~~As previously discussed, e~~End treatments include trailing anchorages, approach terminals, and crash cushions. See the FDOT ***Standard Plans*** and the ***APL*** ~~Details~~ for end treatments for each barrier ~~type~~ described above ~~are detailed in the FDOT's~~ ~~***Standard Plans***~~ ~~and the~~ ~~***Approved Products List (APL)***~~.

E.9.a End Treatments for Guardrail

End treatments for guardrail are categorized as ~~follows~~:

1. Approach terminals – required for guardrail ends within the clear zone of approaching traffic. Guardrail approach ~~end~~ terminals are proprietary devices listed on the ***APL***. MASH compliant approach terminals are classified by Test Level (TL-2 for dDesign sSpeeds ≤ 45 mph ~~or~~ and TL-3~~, which is acceptable~~ for all dDesign sSpeeds) and as follows:

   a. Flared – preferred ~~terminal for locations~~ where sufficient space is available to offset the barrier end from approaching traffic.

b. Parallel – use only when sufficient space is not available for a flared terminal.

c. Double-~~ ~~f~~F~~ace – preferred ~~end treatment ~~for double-~~ ~~faced guardrail installations.

2. Crash Cushions – s~~S~~ee Section E.7.e.

3. Trailing Anchorages (Type II) – required for anchoring ~~of the~~ guardrail trailing ends~~ of guardrail~~. Trailing anchorages are non-crashworthy and are not allowed as an approach end treatment ~~, and are not permitted as an approach end treatment, on the approach end within the Clear Zone,~~ unless shielded by another ~~run of~~ barrier. The FDOT~~'s~~ Type II Trailing Anchorage~~,~~ is detailed in the FDOT Standard Plans.

Figures 4-9A and 4-9B below illustrate how to determine when an approach terminal, trailing anchorage or crash cushion should be selected ~~when~~ for use with ~~using~~ guardrail~~ to provide protection for a hazard~~.

Figure 4 – 9A End Treatment Usage w~~W~~hen the End of Guardrail is w~~W~~ithin the Clear Zone of the Approaching Near Lane

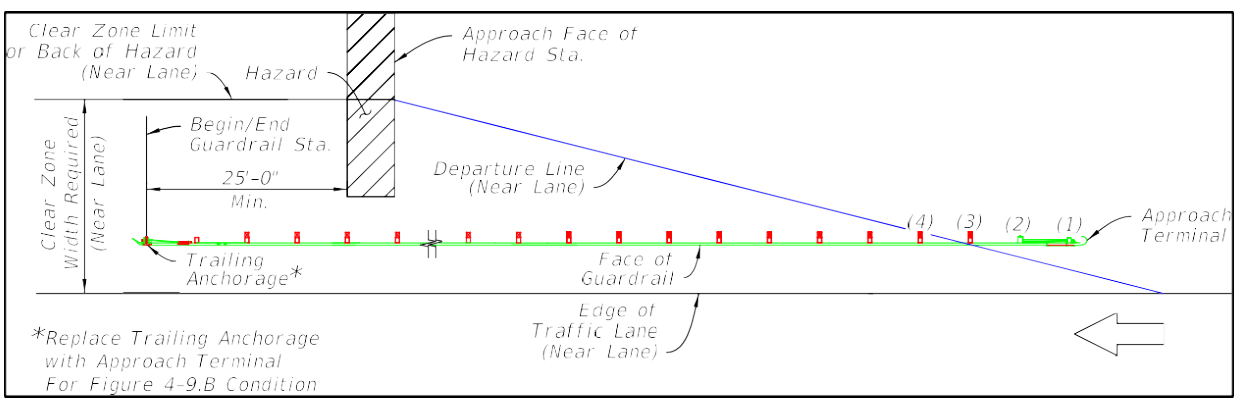
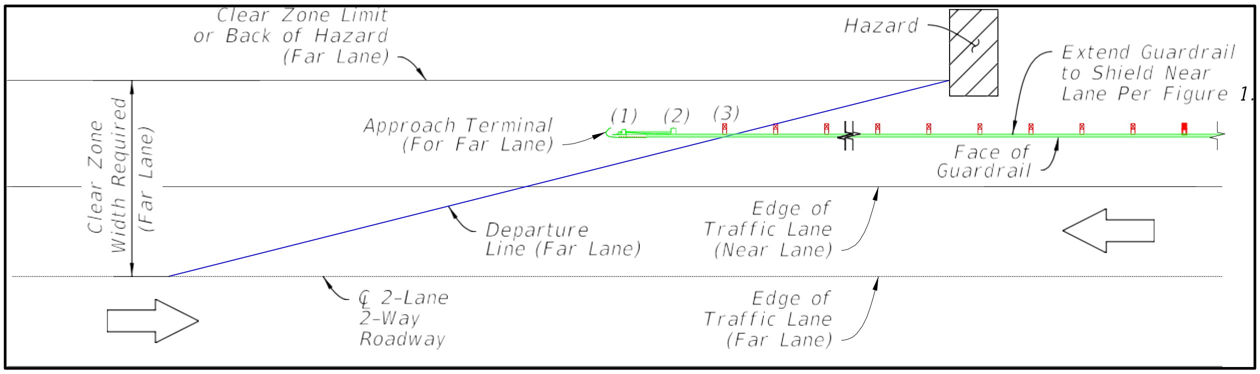


Figure 4 – 9B Approach Terminal Usage w~~W~~hen the End of Guardrail is w~~W~~ithin the Clear Zone of the Approaching Far Lane (2-Lane, 2-Way Road Shown)



See ***FDOT Design Manual, Chapter 215*** ~~Additional information on~~ for guardrail end treatments ~~is provided in the *FDOT Design Manual, Chapter 215 Roadside Safety*~~.

E.9.b End Treatments for Rigid Barrier

Terminate r~~R~~igid b~~B~~arrier ends ~~must be terminated~~ by ~~either~~ transitioning into another barrier system (e.g., guardrail)~~,~~ or by shielding with a c~~C~~rash c~~C~~ushion~~. Details are provided in the~~ (see the FDOT~~'s~~ ***Standard Plans)***. No t~~T~~reatment is required for ~~of~~ the trailing end of rigid barriers ~~is not required~~ unless:

- A~~a~~dditional hazards exist beyond the rigid barrier, or
- T~~t~~he barrier is within the clear zone of opposing traffic.

E.9.c End Treatments for High Tension Cable Barrier (HTCB)

End treatments for ~~high tension cable barrier~~ HTCB are vendor specific. See the FDOT developmental design standards f~~F~~or ~~additional~~ information ~~regarding~~ on ~~the~~ HTCB end treatments~~ of HTCB, refer to the FDOT's developmental design standards discussed above.~~

E.9.d End Treatments for Temporary Barrier

Details for end treatments for ~~the FDOT's~~ t~~T~~emporary b~~B~~arriers are provided in the FDOT~~T's~~ ***Standard Plans*** and include:

1. Connecting to an existing barrier. Smooth, structural connections are required. See the FDOT ***Standard Plans*** and the ***APL*** Information on connections can be found in the FDOT's ***Standard Plans*** and ***APL***.

2. Shielding ~~end~~ with a crash cushion ~~as~~ detailed in the FDOT~~'s~~ ***Standard Plans*** or ***APL*** for the specific type of t~~T~~emporary b~~B~~arrier (i.e., portable concrete barrier, steel, or water-~~-~~filled).
3. Attaching or t~~T~~ransitioning to a crashworthy end treatment~~ as described above~~.
4. Flaring to outside of the w~~W~~ork z~~Z~~one c~~C~~lear z~~Z~~one.

E.9.e Crash Cushions

Crash cushions are classified based on Test Level and d~~D~~esign s~~S~~peed ~~which is~~ as shown for each system on each vendor's respective drawings ~~posted on the FDOT's *APL*~~.

~~The design of a~~ A crash cushion ~~system must~~ cannot create a hazard to opposing traffic. See t~~T~~he APL drawings ~~provide details~~ for transitions for optional barrier types (~~with and without bi-directional~~ for one-way and two-way traffic).

A~~n impacting~~ vehicle should strike the system~~s~~ at normal height~~,~~ (with ~~the vehicle's~~ its suspension system neither collapsed nor extended). As such ~~Therefore~~, the terrain surrounding crash cushions must be 1:10 or flatter ~~relatively flat (i.e., 1:10 or flatter)~~ in advance of and along the entire ~~design~~ length of the system. Curbs should not be located within the approach ~~area of~~ to a crash cushion.

See ~~The~~ ***FDOT Design Manual, Chapter 215*** ~~***Roadside Safety***~~ ~~provides additional information on~~ for permanent and temporary crash cushions.

F BRIDGE RAILS

See ***Chapter 17*** ~~***- Bridges and Other Structures***~~ for bridge rail requirements ~~for bridge rails~~. See ~~The~~ ***FDOT Design Manual, Chapter 215*** ~~***Roadside Safety***~~ ~~may be referenced~~ for additional information and typical applications.

G ROADSIDE DESIGN IN WORK ZONES

Use the same ~~The~~ roadside design concepts provided~~presented~~ in ~~the~~ previous sections ~~shall be applied to~~ for work zones (as allowed by ~~as appropriate for the type of work being done and to the extent~~ existing ~~roadside~~ conditions) ~~allow~~. ~~This includes providing~~ Provide clear zone widths and use ~~ing~~ traffic control devices and safety appurtenances that are crashworthy (or properly shielded) ~~with crashworthy devices~~. However, because work zones are temporary and often involve ~~restricted or~~ limited space, modified criteria for clear zones, drop-off conditions and above- ~~-~~ground hazards are provided below. ~~as follows.~~

G.1 Clear Zone Width in Work Zones

~~Clear zone is defined in Section B Roadside Topography and Drainage Features.~~ Clear zone widths for work zones ~~, as a minimum, shall be~~ are the lessor of the clear zone requirements provided in Table 4 – 1 ~~Minimum Width of Clear Zone~~, Table 4 – 5 ~~Clear Zone Width Requirements for Work Zones~~, and~~or~~ the existing clear zone ~~width. Clear zone widths in work zones are~~ (measured from the edge of t~~T~~raveled w~~W~~ay).

Table 4 – 5 Clear Zone Width Requirements for Work Zones

Work Zone Posted Speed (mph)	**Travel Lanes & Multilane Ramps** (feet)	**Auxiliary Lanes & Single Lane Ramps** (feet)
Curbed		
≤ 45 mph	4 feet~~'~~ Behind the Face of Curb	4 feet~~'~~ Behind the Face of Curb
> 45 mph	Same as Flush Shoulder	Same as Flush Shoulder
Flush Shoulder		
≤ 40	14	10
45 – 50	18	10
55	24	14
60 – 70	30	18
Note: These ~~above~~ clear zone widths apply to medians and roadsides ~~conditions~~ (other than ~~for~~ roadside canals). ~~Where roadside canals are present,~~ Canal clear zone widths ~~are to conform with~~ must meet the canal lateral offset distances ~~to canals~~ described in this c~~C~~hapter.		

The clear zone must be free of:

- A~~a~~bove-ground fixed objects,
- W~~w~~ater bodies, ~~and~~
- N~~n~~on-traversable ~~edge~~ drop-offs, and~~or~~
- C~~c~~ritical slopes.

G.2 Above Ground Hazards in Work Zones

An above-ground hazard ~~in work zones~~ is any object, material, or feature ~~equipment~~ (other than temporary traffic control devices) that is: ~~greater~~

- More than 4 inches high ~~in height~~,
- Ffirm and unyielding, that ~~and~~
- Eencroaches ~~upon~~ into the clear zone.

~~During working hours,~~ Treat above-ground hazards in ~~the~~ a work zone with appropriate precautions during working hours ~~should be treated with appropriate precautions~~.

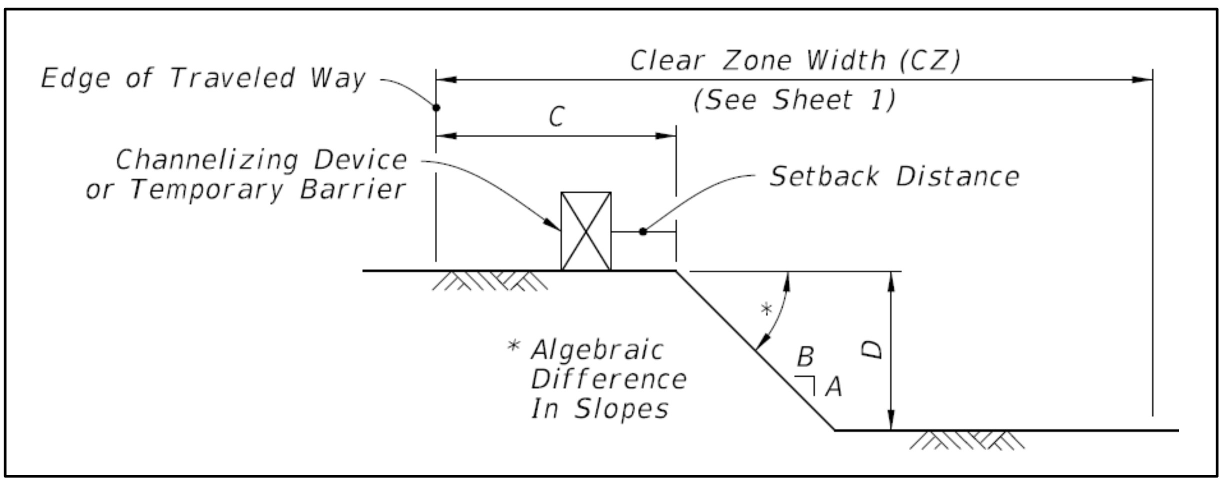
~~During nonworking hours, all o~~Objects, materials, and features ~~equipment~~ that constitute an above-~~-~~ground hazard must be ~~stored/placed~~ moved to outside of the clear zone or ~~be~~ be properly shielded during non-working hours ~~by a barrier or crash cushion~~.

G.3 Non-Traversable Edge Drop-Offs, Critical Slopes and Roadside Excavations

Address n~~N~~on-traversable edge drop-offs, critical slopes and roadside excavations located within the clear zone ~~are to be addressed~~ as follows:

A drop-off is ~~defined as~~ a drop in elevation over 3 inches, parallel to the adjacent travel lanes, ~~greater than 3"~~ with a slope ~~(A:B)~~ steeper than 1:4. ~~In superelevated sections, t~~ The algebraic difference in slopes in superelevated sections should not exceed 0.25 (see Figure 4 – 10)~~(See Figure 4 – 10 Drop-off Condition Detail~~.

Figure 4 – 10 Drop-Off Condition Detail



~~When an edge drop-off condition occurs within the clear zone,~~ Provide channelizing devices or temporary barriers for drop-offs inside the clear zone (see Table 4 – 6) ~~shall be provided in accordance with Table 4 – 6 Device Requirements for Edge Drop-Offs~~.

Drop-offs ~~may~~ can be mitigated by placing slopes of optional base material. See ~~the~~ FDOT~~'s~~ ***Standard Specifications, Section 285*** for additional~~further~~ information. Use s~~S~~lopes ~~shallower~~ flatter than 1:4 ~~may be required~~ to avoid ~~an~~ algebraic slope differences ~~in slopes greater than~~ over 0.25.

Table 4 – 6 Device Requirements for Edge Drop-Offs

Condition	D (inches)	C (feet)	Device Required
1	>3	2 - 12	Temporary Barrier
2	>3 to ≤5	12 - CZ	Channelizing Device
3	>5	2 - 12	Temporary Barrier
4	Removal of Bridge or Retaining Wall Barrier		Temporary Barrier
5	Removal of portions of Bridge Deck		Temporary Barrier

Footnotes:

1. Do not allow any drop-off conditions ~~greater than~~ over 3 inches within two feet of a traveled way.
2. For Conditions 1 and 3, channelizing devices and ~~placement of~~ optional base material slopes 1:4 ~~or~~ and flatter ~~constructed of base material~~ (per ~~the~~ ***FDOT Specifications Section 285***) ~~may~~ can be used in lieu of temporary barriers. Use s~~S~~lopes flatter ~~shallower~~ than 1:4 ~~may be required~~ to avoid algebraic slope differences ~~in slopes greater than~~ over 0.25.
3. For Conditions 1 and 3, any drop-off ~~condition that is~~ created and restored within the same work period ~~will not be subject to the use of~~ does not require temporary barriers. However, channelizing devices ~~will be~~ are required.
4. No channelization devices are required w~~W~~hen permanent curb heights are 6 inches or more ~~≥ 6", no channelizing device will be required~~.

Provide~~A~~ setback distances appropriate for the type of barrier ~~selected shall be provided~~. See the FDOT ***Standard Plans*** ~~For further information on~~ for setback requirements for various types of barriers. ~~, see the FDOT's~~ ~~***Standard Plans.***~~

Protect d~~D~~rop-offs adjacent to pedestrian facilities ~~shall be provided~~ with pedestrian longitudinal channelizing devices, temporary barrier ~~wall~~, or approved handrail. Drop-offs a~~A~~djacent to pedestrian facilities ~~, a drop-off is~~ are defined as:

a) ~~a~~An elevation ~~-~~ drop ~~in elevation~~ over 10 inches ~~greater than 10" that is~~ located closer than 2 feet from the edge of the sidewalk or shared use path~~, or~~

~~b) a~~ A slope steeper than 1:2 that begins closer than 2 feet from the edge of the sidewalk or shared use path (~~when the total~~ for drop-offs ~~is greater than~~ over 60 inches)~~".~~

G.4 Temporary Barriers in Work Zones

~~When clear zone widths cannot be met, the use of~~ Consider using temporary barriers when clear zone widths cannot be provided ~~shall be considered~~. Temporary barriers in work zones can ~~serve several functions~~:

- Shield edge drop-offs and roadside excavations~~ –~~ (see Section G.1).
- Shield above-~~-~~ground hazards, including roadside structures, falsework for bridges, material storage sites and~~/or~~ other exposed objects.
- Provide positive protection for workers.
- Separate two-way traffic.
- Separate pedestrians from vehicular traffic.

~~The decision to u~~Use engineering judgement for decisions on using temporary barriers for conditions not ~~specifically~~ addressed in Section G.1 ~~should be based on engineering judgement and analysis~~. There are many factors affecting barrier needs in work zones, ~~,~~including:

- T~~t~~raffic volumes, ~~traffic~~
- O~~o~~perating speed,
- O~~o~~ffset, and
- Work d~~d~~urations~~, that affect barrier needs within work zones~~.

See t~~T~~he FDOT~~'s~~ ***Standard Plans,*** the ***MUTCD*** and the ***AASHTO Roadside Design Guide*** ~~provide additional information and~~ for guidance on ~~the~~ using ~~e of~~ temporary barriers in work zones.

H REFERENCES FOR INFORMATIONAL PURPOSES

~~The following is a list of~~ Refer to these publications ~~that may be referenced~~ for additional~~further~~ guidance:

- AASHTO Roadside Design Guide
  https://store.transportation.org/Item/CollectionDetail?ID=105/
- Task Force 13 Guide to Standardized Roadside Safety Hardware
  http://www.tf13.org/Guides/
- FHWA Web Site
  http://safety.fhwa.dot.gov/roadway_dept/
- FDOT Design Manual (FDM)
  http://www.fdot.gov/roadway/FDM/
- FDOT Standard Plans for Road and Bridge Construction (Standard Plans)

http://www.fdot.gov/design/standardplans/

- *FDOT Structures Design Guidelines (SDG)*
- ***http://www.fdot.gov/structures/StructuresManual/CurrentRelease/StructuresM anual.shtm***
- FDOT Drainage Manual, ***http://www.fdot.gov/roadway/Drainage/ManualsandHandbooks.shtm***
- Florida Strategic Highway Safety Plan ***https://www.fdot.gov/safety/shsp/shsp.shtm***

This is a working document
that has not been adopted.

Style Definition: Title

CHAPTER 4

ROADSIDE DESIGN

4.1 ~~A~~ INTRODUCTION

This chapter presents guidelines and standards for roadside designs intended to reduce the likelihood and/or consequences of roadside crashes. Due to the variety of causative factors, the designer should review crash reports for vehicles leaving the traveled way at any location. On average, lane departure crashes in Florida represent approximately 1/3 of all crashes and almost 50% of all highway fatalities. Construction and maintenance of safe medians and roadsides are of vital importance in the development of safe streets and highways. More information on lane departure crashes in Florida can be found in the FDOT's ***Florida Strategic Highway Safety Plan***.

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Many of the standards presented in ***Chapter 3 – Geometric Design*** are predicated to a large extent upon reducing the probability of vehicles leaving the proper travel path. The intent of this chapter is to reduce the consequences of crashes by vehicles leaving the roadway. The design of the roadside beyond the shoulder should be considered and conducted as an integral part of the total highway design.

The general objective of roadside design is to provide an environment that will reduce the likelihood and/or consequences of crashes by vehicles that have left the traveled way. The achievement of this general objective will be aided by the following:

- Roadside areas adequate to allow reasonable space and time for a driver to regain or retain control of the vehicle and stop or return to the traveled way safely.
- Shoulders, medians, and roadsides that may be traversed safely without vehicle vaulting or overturning.
- Location of roadside fixed objects and hazards as far from the travel lane as is economically feasible.
- Roadsides that accommodate necessary maintenance vehicles, emergency maneuvers and emergency parking.
- Providing adequate shielding of hazards where appropriate and compatible with vehicle speeds and other design variables.

Prior to any other consideration, the designer should, in order of preference, attempt to:

1. Eliminate the hazard
    a. Remove the hazard
    b. Redesign the hazard so it can be safely traversed
    c. Relocate the hazard outside the clear zone
2. Make the hazard crashworthy
3. Shield the hazard with a longitudinal barrier or crash cushion.
4. Delineate the hazard and leave the hazard unshielded. This treatment is taken only when the barrier or crash cushion is more hazardous than the hazard. See Section 4.5.5 ~~E.5~~ for information on making this determination.

This chapter contains standards and general guidelines for situations encountered in roadside design due to the variety and complexity of possible situations encountered. In addressing roadside hazards, the designer should utilize the following as basic guidelines to develop a safe roadside design.

4.2 ~~B~~ ROADSIDE TOPOGRAPHY AND DRAINAGE FEATURES

4.2.1~~B.1~~ Roadside Slopes, Clear Zone, and Lateral Offset

Providing a sufficient amount of recoverable slope or clear zone adjacent to the roadway, free of obstacles and hazards provides an opportunity for an errant vehicle to safely recover. Minimum standards for roadside slopes, clear zone and lateral offsets to hazards are provided as follows.

4.2.1.1 ~~B.1.a~~ Roadside Slopes and Clear Zone

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, desirably 1:6 or flatter. The transition between the shoulder and adjacent side slope should be rounded and free from discontinuities. A slope as steep as 1:3 may be used within the clear zone if the clear zone width is adjusted to provide a clear runout area as described below. If sufficient right of way exists, use flatter side slopes on the outside of horizontal curves.

Clear zone is the unobstructed, traversable area beyond the edge of the traveled way for the recovery of errant vehicles. The clear zone includes shoulders and bicycle lanes. The clear zone shall follow the requirements for clear zone and lateral offset shown in this manual. Clear zone width requirements are dependent on AADT, design speed, and roadside slope conditions. With regard to the ability of an errant vehicle to traverse a roadside slope, slopes are classified as follows:

1. Recoverable Slope – Traversable Slope 1:4 or flatter. Motorists who encroach on recoverable front ~~fore~~slopes generally can stop their vehicles or slow them enough to return to the roadway safely.
2. Non-Recoverable Slope – Traversable Slope steeper than 1:4 and flatter than 1:3. Non-recoverable front ~~fore~~slopes are traversable but most vehicles will not be able to stop or return to the roadway easily. Vehicles on such slopes typically can be expected to reach the bottom.
3. Critical Slope – Non-Traversable Slope steeper than 1:3. A critical front ~~fore~~slope is one on which an errant vehicle has a higher propensity to overturn.

Clear zone widths for recoverable front ~~fore~~slopes 1V:4H and flatter are provided in Table 4.2.1~~ – 1~~ Minimum Width of Clear Zone. Clear zone is applied as shown in Figures 4.2.1~~ – 1~~ Clear Zone Plan View and 4.2.2~~ – 2~~ Basic Clear Zone Concept. Clear zone is measured from the edge of the traveled way.

On non-recoverable slopes steeper than 1:4 and flatter than 1:3, a high percentage of encroaching vehicles will reach the toe of these slopes. Therefore, the clear zone distance cannot logically end at the toe of a non-recoverable slope. When such non-recoverable slopes are present within the clear zone width provided in Table 4.2.1~~ – 1~~, additional clear zone width is required. The minimum amount of additional width provided must equal the width of the non-recoverable slope with no less than 10 feet of recoverable slope provided at the toe of the non-recoverable slope. See Figure 4.2.3~~ – 3~~ Adjusted Clear Zone Concept.

When clear zone requirements cannot be met, see ***Sections 3, 4, and 5*** ~~***C, D*** and ***E***~~ for requirements for roadside barriers and other treatments for safe roadside design. In addition, the ***AASHTO Roadside Design Guide (2011),*** and ***AASHTO Guidelines for Geometric Design of Very Low Volume Local Roads (ADT ≤ 400) (2001)*** may be referenced for a more thorough discussion of roadside design.

Table 4.2.1 ~~– 1~~ Minimum Width of Clear Zone (feet)[1] (Curbed and Flush Shoulder Roadways)

Design Speed mph	AADT ≥ 1500			AADT < 1500		
	Travel Lanes & Multilane Ramps		Aux Lanes and Single Lane Ramps	Travel Lanes & Multilane Ramps		Aux Lanes and Single Lane Ramps
	1V:6H or flatter	1V:5H to 1V:4H	1V:4H or flatter	1V:6H or flatter	1V:5H to 1V:4H	1V:4H or flatter
≤ 40	14	16	10	10[2]	12[2]	10[2]
45 – 50	20	24	14	14	16	14
55	22	26	18	16	20	14
60	30	30[3]	24	20	26	18
65 – 70	30	30[3]	24	24	28	18

1. Clear Zone for roads functionally classified as Local Roads with a design AADT ≤ 400 vehicles per day:
   a. A clear zone of 6 feet or more in width must be provided if it can be done so with minimum social/environmental impacts.
   b. Where constraints of cost, terrain, right of way, or potential social/environmental impacts make the provision of a 6 feet clear zone impractical, clear zones less than 6 feet in width may be used, including designs with 0 feet clear zone.
   c. In all cases, clear zone must be tailored to site-specific conditions, considering cost-effectiveness and safety tradeoffs. The use of adjustable clear zone widths, such as wider clear zone dimensions at sharp horizontal curves where there is a history of run-off-road crashes, or where there is evidence of vehicle encroachments such as scarring of trees or utility poles, may be appropriate. Lesser values of clear zone width may be appropriate on tangent sections of the same roadway.
   d. Other factors for consideration in analyzing the need for providing clear zones include the crash history, the expectation for future traffic volume growth on the facility, and the presence of vehicles wider than 8.5 feet and vehicles with wide loads, such as farm equipment.
2. May be reduced to 7 feet for a design AADT < 750 vehicles per day.
3. Greater clear zone widths provide additional safety for higher speed and volume roads. See Section 3.1 of the ***AASHTO Roadside Design Guide* (2011)** for further information.

Source: Table 3 – 1, Suggested Clear Zone Distances in Feet from the Edge of the Travel Lane, 2011 AASHTO Roadside Design Guide.

Commented [KM3]: Flush Shoulder, consider extracting very low volume criteria as a section, discuss additional guidance for lower speeds, TND?

Commented [KM4R3]: Consider for future Greenbook, 2020?

Commented [KM5]: Yellow is correction for 2018, remainder is correction for 2021.

Commented [KM6]: Consider revising to include guidance in its own section, rather than a footnote in the table.

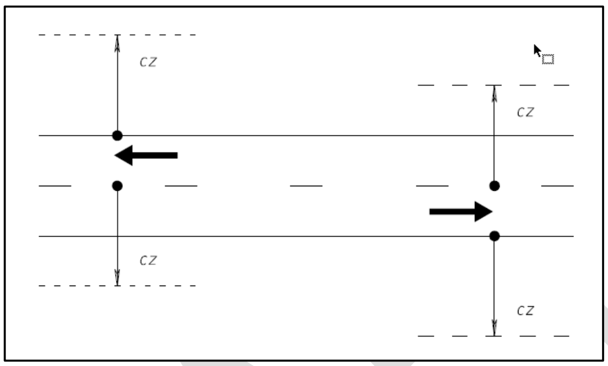
Commented [KM7R6]: For 2020 Greenbook.

Commented [KM8]: Should this be ≤, rather than just <?

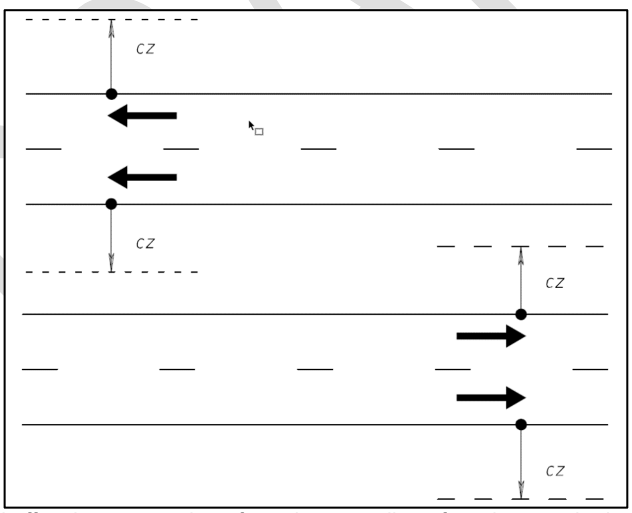
Commented [KM9R8]: AASHTO Roadside Design Guide uses < 750.

Figure 4.2.1 — 1 Clear Zone Plan View

Two Lane, Two -Way Roadway



Multi-Lane Two-Way Roadway



Note: 1. Lateral offset is measured out from the centerline of roadway and edge of traveled way or face of curb to a roadside object or feature.

Figure 4.2.2—2 Basic Clear Zone Concept

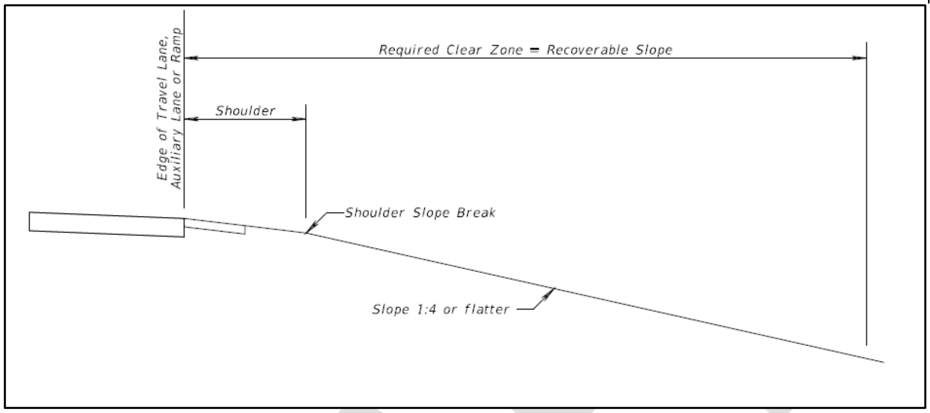
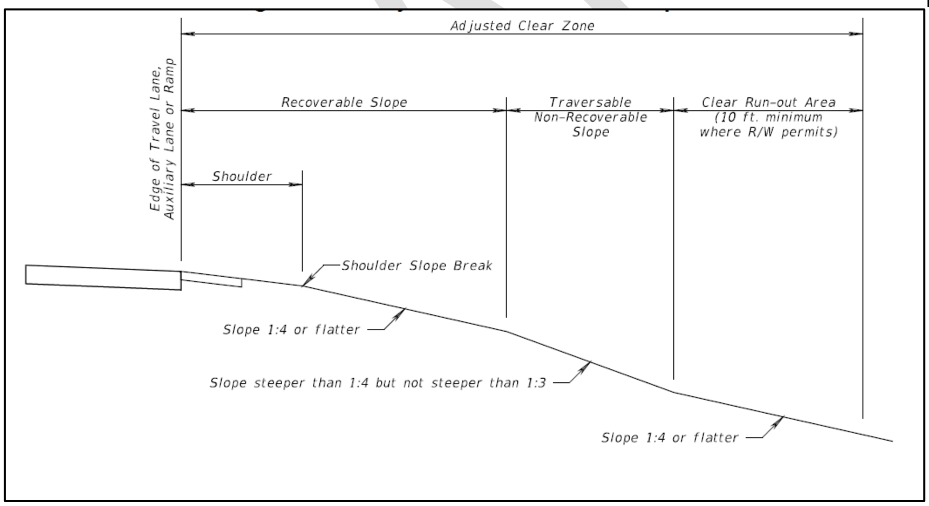
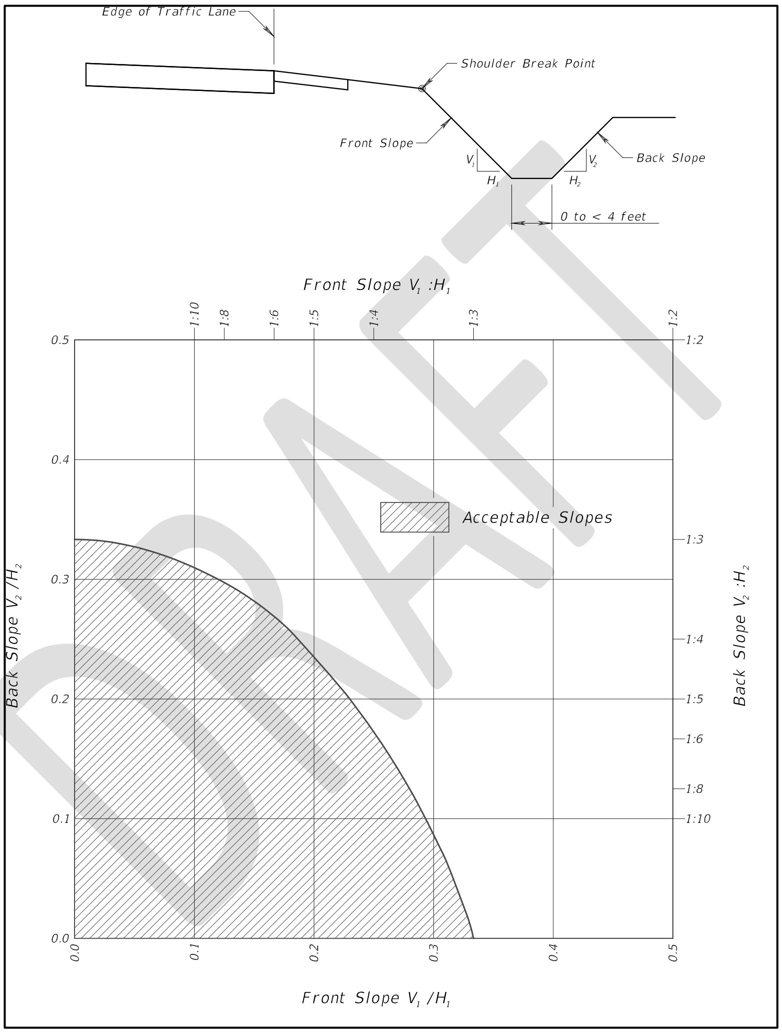


Figure 4.2.3—3 Adjusted Clear Zone Concept



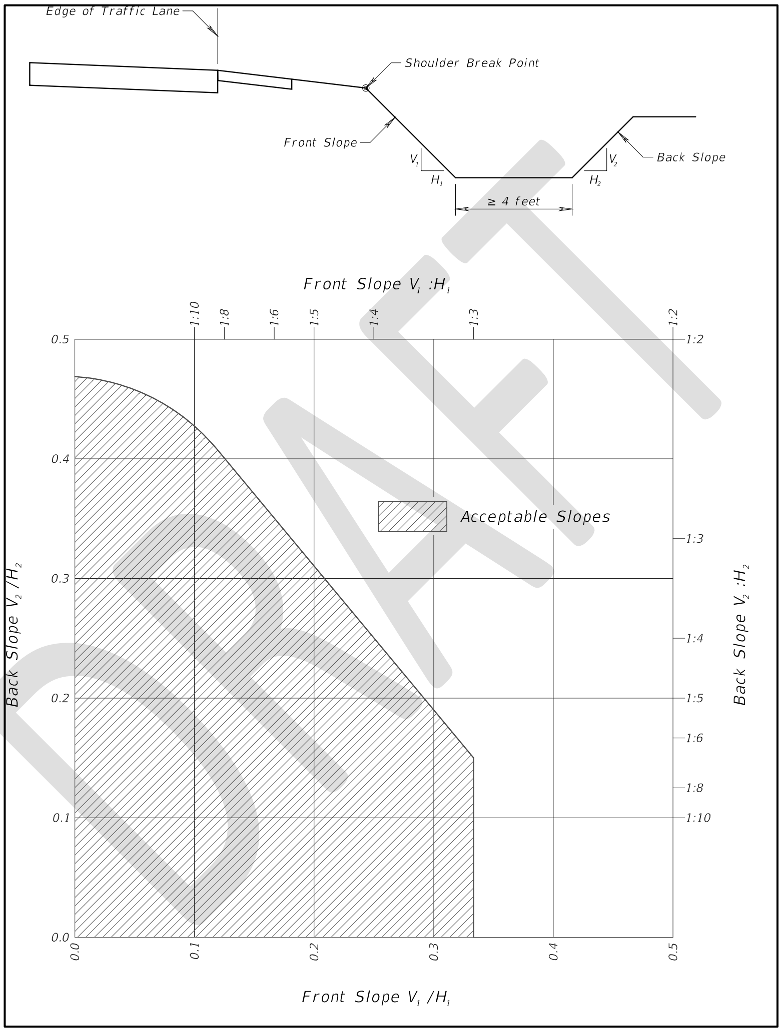
Roadside ditches may be included within the clear zone if properly designed to be traversable. Acceptable cross section slope criteria for roadside ditches within the clear zone is provided in Figure 4.2.4~~ — 4~~ Roadside Ditches – Bottom Width 0 to < 4 Feet and Figure 4.2.5~~—5~~ Roadside Ditches – Bottom Width ≥ 4 Feet. These roadside ditch configurations are considered traversable.

Figure 4.2.4~~ — 4~~ Roadside Ditches – Bottom Width 0 to < 4 Feet



Source: Figure 3 – 6, 2011 AASHTO Roadside Design Guide.

Figure 4.2.5 — 5 Roadside Ditches – Bottom Width ≥ 4 Feet



Source: Figure 3 – 6, 2011 AASHTO Roadside Design Guide.

4.2.1.2 ~~B.1.b~~ Lateral Offset

Lateral offset is the distance from a specified point on the roadway to a roadside hazard. Lateral offset to the roadside hazard is measured as follows:

• Curbed roadways - from face of curb.

• Flush shoulder and high-speed curbed roadways - from outside edge of traveled way.

Lateral offsets apply to all roadways and are determined based on the following:

• Type of facility, i.e., flush shoulder or curbed roadway.

• Design speed.

• Design element.

• Project type, i.e., New Construction, Resurfacing (RRR).

Flush shoulder roadways typically have sufficient right of way to provide the required clear zone widths. Therefore, minimum lateral offset for these roadways is based on maintaining a clear roadside for errant vehicles to recover (i.e., maintaining clear zone width provided in Table 4.2.1~~–1~~ Minimum Width of Clear Zone.

Lateral offsets for curbed roadways should be based on clear zone criteria; however, curbed roadways typically do not have sufficient right of way to provide the required clear zone widths. Therefore, minimum lateral offset on these roadways is based on offset needed for normal operation of the roadway.

At times, it may be necessary to place poles (e.g., signal, light, sign) within the sidewalk. Refer to Chapter 8 – Pedestrian Facilities for minimum unobstructed sidewalk width requirements. Table 4.2.2~~–2~~ Lateral Offset provides minimum lateral offset criteria for roadside features and roadside hazards typically encountered and considered functionally necessary for normal operation of the roadway, e.g., signing, lighting, landscaping, and utilities.

For crashworthy objects, meet or exceed the minimum lateral offset criteria provided in Table 4.2.2 – 2 Lateral Offset. Locate objects that are not crashworthy as close to the right of way line as practical and no closer than the minimum lateral offset criteria provided. When a roadside hazard is placed behind a barrier that is justified for other reasons, the minimum lateral offset to the object equals the setback requirements (deflection distance) of the barrier. Additional information on barrier placement and permissible attachments can be found in the ***FDOT Design Manual, Chapter 215***.

Table 4.2.2 — 2 Lateral Offset (feet)

Roadside Feature	Urban Curbed Roadways Design Speed ≤ 25 (mph)	Urban Curbed Roadways Design Speed ≤ 45 (mph)	All Other
Above Ground Objects[1]	1.5 ft. from Face of Curb[3,4]	4 ft. from Face of Curb[2,4]	Clear Zone Width
Drop Off Hazards[5]	Clear Zone Width	Clear Zone Width	Clear Zone Width
Water Bodies	Clear Zone Width	Clear Zone Width	Clear Zone Width
Canal Hazards	See Section 4.2.2.3B.2.c	See Section 4.2.2.3B.2.c	See Section 4.2.2.3B.2.c

1. Above ground objects are anything greater than 4 inches in height and are firm and unyielding or do not meet crashworthy or breakaway criteria. For urban curbed areas ≤ 45 mph this also includes crashworthy or breakaway objects except those necessary for the safe operation of the roadway.
2. May be reduced to 1.5 ft. from Face of Curb on roads functionally classified as Local Streets and, on all roads, where the 4 ft. minimum offset cannot be reasonably obtained and other alternatives are deemed impractical. For very low-volume roads, ≤ 400 vpd, a minimum of 1.5 feet of clearance is desirable but may be reduced to 6" from the face of curb where the corridor is constrained. ***AASHTO's Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400), 2001*** provides additional information.
3. May only be used in areas where development patterns and land use would qualify as an Urban Center or Urban Core Context Classification.
   a. Urban Center - Mix of uses set within small blocks with a well-connected roadway network. Typically concentrated around a few blocks and identified as part of the community, town, or city of a civic or economic center.
   b. Urban Core - Areas with the highest densities and with building heights typically greater than four floors. Many are regional centers and destinations. Buildings have mixed uses, are built up to the roadway, and are within a well-connected transportation network.
4. A design variation for failure to meet clear zone criteria is not required for existing, low speed, curbed roadways if the requirements for the placement of above ground fixed objects are met.
5. Drop off hazards are:
   a. Any vertical faced structure with a drop off (e.g., retaining wall, wing-wall, etc.) located within the Clear Zone.
   b. Slopes steeper than 1:3 located within the Clear Zone.
   c. Drop-offs with significant crash history.

Commented [MK10]: Propose to replace Table 4-2 in Greenbok with Table 215.2.2 Minimimum Lateral Offset from FDM. Task is to develop an internal cross reference of the criteria in FDM table to identify anythng that might be missing from the Greenbook.

Commented [KM11R10]: Bridge abutments and piers are address are in Greenbook, but needs further work re 1.5 lateral offset. Should be more offset. Need to address permissions in RRR regarding design exceptions and variations.

Greenbook doesn't address RRR needs regarding reduced criteria.

Commented [KM12]: Consider a note to say that if we meet above ground fixed objects and low speed curbed, a design variation is not required.

Commented [KM13]: Consider column in table for curbed roadway 25mph or less. Many roadways in Florida are 25 mph or less. Supports context sensitive design. With 1.5 feet offset from 25 mph or less, describe land use.

Commented [KM14]: Consider a note to say that if we meet above ground fixed objects and low speed curbed, a design variation is not required.

Commented [KM15]: Consider column in table for curbed roadway 25mph or less. Many roadways in Florida are 25 mph or less. Supports context sensitive design. With 1.5 feet offset from 25 mph or less, describe land use.

Commented [KM16]: FHWA Mitigation strategies allows 1.5 feet. In PPM, 3R are allowed to remain at 1.5 feet in most cases for curb and gutter. Flush shoulder is + clear zone, usually.

Commented [KM17]: FHWA Mitigation strategies allows 1.5 feet. In PPM, 3R are allowed to remain at 1.5 feet in most cases for curb and gutter. Flush shoulder is + clear zone, usually.

Commented [MK18]: Reconciliation needed between AASHTO Low Volume Guide and AASHTO Roadside Design Guide before adopting.

4.2.2~~B.2~~ Drainage Features

Drainage design is an important aspect of the long-term performance of a roadway, and to achieve an effective design, drainage features are necessary in close proximately to travel lanes. These features include ditches, curbs, and drainage structures (e.g., transverse/parallel pipes, culverts, endwalls, wingwalls, and inlets). The placement of these features is to be evaluated as part of roadside safety design. Refer to ***Chapter 20 – Drainage*** for information regarding proper hydraulic design.

When evaluating the design of roadside topography and drainage features, consider the future maintenance implications of the facility. Routine maintenance or repairs needed to ensure the continued function of the roadway slopes or drainage may lead to long-term expenses and activities, which disrupts traffic flow and exposes maintenance personnel to traffic conditions.

4.2.2.1~~B.2.a~~ Roadside Ditches

Minimum standards for side slopes and bottom widths of roadside ditches and channels within the clear zone are provided in Section 4.2.1.1~~B.1.a~~.

4.2.2.2~~B.2.b~~ Drainage Structures

Drainage structures and their associated end treatments located along the roadside should be implemented using either a traversable design or located outside the required clear zone. The various drainage inlets and pipe end treatments needed for an efficient drainage design typically contain curb inlets, ditch bottom inlets, endwalls, wingwalls, headwalls, flared end sections and/or mitered end sections. If not adequately designed or properly located, these features can create hazardous conditions (e.g., abrupt deceleration or rollovers) for vehicles. For detailed background information concerning traversable designs, refer to the ***AASHTO Roadside Design Guide***.

Standard details for drainage structures and end treatments commonly used in Florida are provided the in the FDOT's ***Standards Plans***. Drainage features shown in the FDOT's ***Standard Plans*** have the potential for conflict with a motor vehicle or bicyclist either departing the roadway or within a commonly traversed section of a roadway. The FDOT's ***Drainage***

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Manual identifies those standard drainage structures which are acceptable for use within the clear zone.

4.2.2.3 ~~B.2.c~~ Canals and Water Bodies

Roadside canals and other bodies of water close to the roadway should be eliminated wherever feasible. When not feasible, they should be located outside of the clear zone as shown in Table 4.2.1~~ – 1~~ Minimum Width of Clear Zone. If the body of water meets the definition of a canal hazard, additional lateral offset is required for arterial and collector roadways.

A canal hazard is defined as an open ditch parallel to the roadway for a minimum distance of 1,000 feet and with seasonal water depth more than 3 feet for extended periods of time (24 hours or more). Other conditions shall be evaluated using clear zone conditions.

Canal hazard lateral offset is the distance from the edge of travel lane, auxiliary lane, or ramp to the top of the canal side slope nearest the road. Minimum required lateral offset distances are as follows:

- Not less than 60 feet for flush shoulder and curbed roadways with design speeds of 50 mph or greater.
- Not less than 50 feet for flush shoulder roadways with design speeds of 45 mph or less.
- Not less than 40 feet for curbed roadways with design speeds of 45 mph or less.

See also Figure 4.2.6~~ – 6~~ Minimum Offsets for Canal Hazards (Flush Shoulders) and Figure 4.2.7~~ – 7~~ Minimum Offsets for Canal Hazards (Curb and Curb and Gutter). On new alignments and/or for new canals, greater distances should be provided to accommodate future widening of the roadway.

On fill sections, a flat berm (maximum 1:10 slope) no less than 20 feet in width between the toe of the roadway front slope and the top of the canal side slope nearest the roadway should be provided.

When the slope between the roadway and the "extended period of time" water surface is 1:6 or flatter, the minimum distance can be measured from the edge of the travel lane, auxiliary lane, or ramp to the "extended period of time" water surface. A berm is not required.

On sections with ditch cuts, a minimum of 20 feet between the toe of the front slope and the top of the canal side slope nearest the roadway should be provided.

When the required minimum lateral offset cannot be met, the canal hazard shall be shielded with a crashworthy roadside barrier. Barriers shall be located as far from the traveled way as practical. When shielding canal hazards the barrier shall be located outside the clear zone where possible. Guardrail shall be located no closer than 6 feet from the canal front slope and high tension cable barrier shall be no closer than 15 feet from the canal front slope.

This is a working document
that has not been adopted.

Figure 4.2.6 – 6 Minimum Offsets for Canal Hazards (Flush Shoulders)

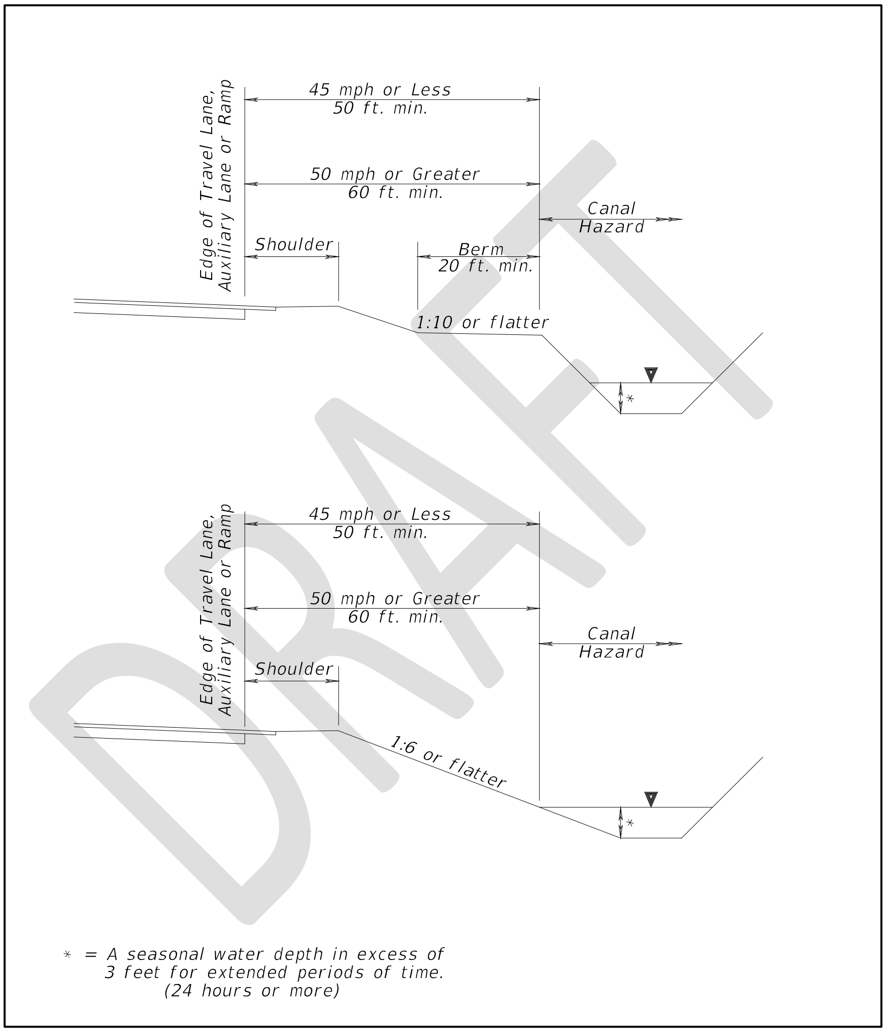
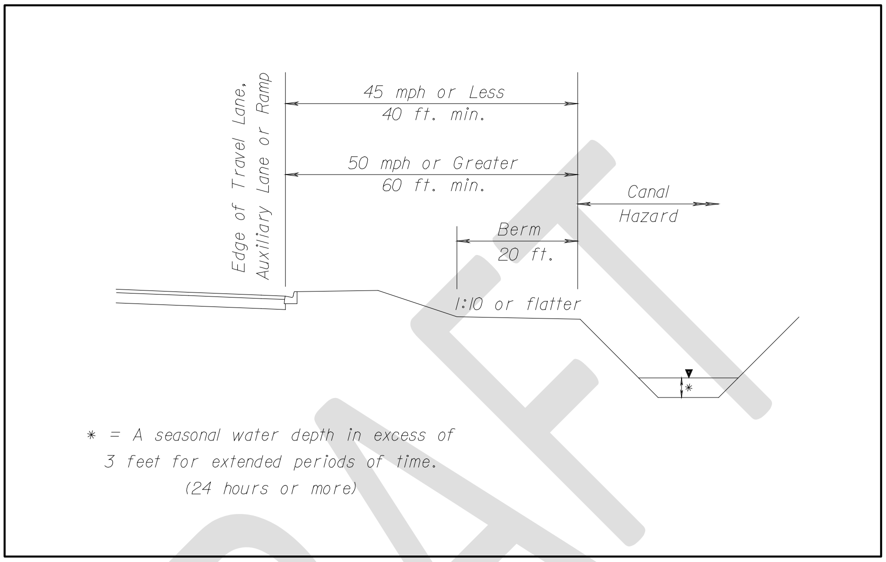


Figure 4.2.7 — 7 Minimum Offsets for Canal Hazards (Curbed)



4.2.2.4 B.2.d Curb

Curbs with closed drainage systems are typically used in urban areas to minimize the amount of right of way needed. Curbs also provide a tangible definition of the roadway limits and delineation of access points. These functions are important in urban areas because of the following typical characteristics:

- Low design speed (Design Speed ≤ 45 mph).
- Dense abutting development.
- Closely spaced intersections and accesses to property.
- Higher number of motorized vehicles, bicyclist, and pedestrian volumes.
- Restricted right of way.

Chapter 3 – Geometric Design provides criteria on the use of curbs. It should be noted that curbs have no redirectional capabilities except at very low speeds; less than the lowest design speeds typically used for urban streets. Therefore, curbs are not considered to be effective in shielding a hazard and are not to be used to reduce lateral offset requirements.

The FDOT's ***Standard Plans*** provide details for curb shapes commonly used in Florida. Typical applications for urban roadways include Type E and Type F curbs. Both curb types have a sloped face; however, the Type E has a flatter face to allow vehicles to traverse it more easily. Shoulder gutter is also frequently used along roadway fill sections and bridge approaches to prevent excessive runoff down embankment slopes. The FDOT's ***Drainage Manual*** may be referenced for direction on the use of shoulder gutter.

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Curb types such as Type E (height 5" or less with a sloping face equal to or flatter than the Type F) may be used in the following cases on high speed roadways. The face of the curb shall be placed no closer to the edge of the traveled way than the required shoulder width.

- High speed multilane divided highways with design speeds of 55 mph and less. For examples see the ***FDOT Design Manual, Chapter 210 Arterials and Collectors***.
- Directional Median Openings. For examples see the ***FDOT Design Manual, Chapter 212 Intersections.***
- Transit Stops (harmonize with flush shoulder accessible transit stops).

4.3 ~~C~~ ROADSIDE SAFETY FEATURES AND CRASH TEST CRITERIA

While a traversable and unobstructed roadside is highly desirable from a safety standpoint, some appurtenances near the traveled way are necessary. Man-made fixed objects that frequently occupy road rights-of-way include traffic signs, traffic signals, roadway lighting, railroad warning devices, intelligent transportation systems (ITS), utility poles, and mailboxes. Other features include safety hardware such as barriers, end treatments and crash cushions which are often necessary to shield errant motorists from a variety of roadside hazards.

These features are in addition to trees and other vegetation often present, either naturally occurring or as part of landscaping. Applicable criteria for each of these features is presented in the following sections. Certain features are required to meet specific crash test criteria involving full scale crash testing.

4.3.1~~C.1~~ Crash Test Criteria

Crash test criteria for roadside safety features has been in existence since 1962. ***NCHRP Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features,*** published in 1993, has been the accepted criteria for safety hardware device testing for many years. Changes have occurred in vehicle design, hardware performance, and testing methodologies, which have led to improvements in crash barrier and roadside design.

More recently, the ***AASHTO Manual for Assessing Safety Hardware (MASH)*** was published and has superseded ***NCHRP Report 350*** as the most current criteria. To allow adequate time for the testing and development of features under MASH criteria, safety hardware installed on new and reconstruction projects shall meet ***NCHRP Report 350*** crash test criteria as a minimum. For projects on the National Highway System, a schedule has been established for implementing requirements for devices meeting MASH criteria. For more information see FHWA's web site for ***Roadway Departure Safety***. New and reconstruction projects not on the National Highway System are not required to conform to this implementation schedule, but should comply to the extent practical.

The FDOT maintains standard details, specifications, and approved products for all types of roadside devices commonly used in Florida that meet the required crash test criteria, and are acceptable for use on all public roadways. Non-proprietary, standardized devices are detailed in the FDOT's ***Standard Plans.***

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Proprietary products are included on the FDOT's ***Approved Product List*** ***(APL).*** These devices address the majority of roadside needs for all roads in Florida. The most current version of the ***Standard Plans*** and ***APL*** should be used as the FDOT maintains and updates these publications as necessary to comply with required implementation dates for changes in crash test criteria.

For cases where a device may be needed that is not covered by the FDOT's standards and approved products, the Federal Highway Administration (FHWA) maintains lists of eligible crashworthy devices, which can be found on their website for ***Roadway Departure Safety***. In addition, the AASHTO-Associated General Contractors of America (AGC)-American Road and Transportation Builders Association (ARTBA)***, Task Force 13 Guide to Standardized Roadside Safety Hardware*** provides engineering drawings for a multitude of barrier components and systems.

The criteria for crash testing specified in ***NCHRP Report 350*** and ***AASHTO MASH*** provides six Test Levels (TL-1 thru TL-6) for the evaluation of roadside hardware suitability. A test level is defined by impact speed and angle of approach, and the type of test vehicle. Test vehicles range in size from a small car to a loaded tractor trailer truck. Each Test Level provides an increasing level of service in ascending numerical order.

Tables 4.3.1~~—3~~ Test Levels for Barriers, Approach Terminals, Crash Cushions and 4.3.2~~—4~~ Test Levels for Breakaway Devices, Work Zone Traffic Control Devices summarize the vehicle types, vehicle mass, test speeds and impact angles used in testing for each test level. Tables 4.3.1~~—3~~ and 4.3.2~~—4~~ also show the differences in vehicle mass between MASH and ***NCHRP Report 350*** criteria for the small car, pickup, and single unit truck test vehicles.

In addition to differences in vehicle mass, MASH test criteria incorporated several other changes that differ from ***NCHRP Report 350***. For additional information on crash test criteria, refer to the ***AASHTO MASH, NCHRP Report 350***, the ***AASHTO Roadside Design Guide,*** and the FHWA web site for ***Roadway Departure Safety***.

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Table 4.3.1 — 3 Test Levels for Barriers, Approach Terminals, Crash Cushions

Test Level	Test Vehicle Type	Vehicle Designation and Mass		Test Conditions MASH	
		NCHRP 350 (lbs.)	**MASH** (lbs.)	**Impact Speed** (mph)	**Impact Angle (for Barriers)** (degrees)
1	Passenger Car Pickup Truck	820C 1800 2000P 4400	1100C 2420 2270P 5000	31 31	25 25
2	Passenger Car Pickup Truck	820C 1800 2000P 4400	1100C 2420 2270P 5000	44 44	25 25
3	Passenger Car Pickup Truck	820C 1800 2000P 4400	1100C 2420 2270P 5000	62 62	25 25
4	Passenger Car Pickup Truck Single-Unit Truck	820C 1800 2000P 4400 8000S 17640	1100C 2420 2270P 5000 10000S 22000	62 62 56	25 25 15
5	Passenger Car Pickup Truck Tractor-Van Trailer	820C 1800 2000P 4400 36000V 79300	1100C 2420 2270P 5000 36000V 79300	62 62 50	25 25 15
6	Passenger Car Pickup Truck Tractor-Tank Trailer	820C 1800 2000P 4400 36000V 79300	1100C 2420 2270P 5000 36000V 79300	62 62 50	25 25 15

Note: Test Levels 1, 2, and 3 apply to end terminals and crash cushions, while all 6 Test Levels apply to barriers.

Table 4.3.2~~–4~~ Test Levels for Breakaway Devices, Work Zone Traffic Control Devices

Test Level	Feature	Test Vehicle Type	Vehicle Designation and Mass: NCHRP 350 (lbs.)	Vehicle Designation and Mass: MASH (lbs.)	Impact Speeds: Low Speed (mph)	Impact Speeds: High Speed (mph)	Impact Angle (degrees)
2	Support Structures and Work Zone Traffic Control Devices	Passenger Car Pickup Truck	820C 1800 Not Required	1100C 2420 2270P 5000	19 19	44 44	0 – 20 0 – 20
	Breakaway Utility Poles	Passenger Car Pickup Truck	820C 1800 Not Required	1100C 2420 2270P 5000	31 31	44 44	0 – 20 0 – 20
3	Support Structures and Work Zone Traffic Control Devices	Passenger Car Pickup Truck	820C 1800 Not Required	1100C 2420 2270P 5000	19 19	62 62	0 – 20 0 – 20
	Breakaway Utility Poles	Passenger Car Pickup Truck	820C 1800 Not Required	1100C 2420 2270P 5000	31 31	62 62	0 – 20 0 – 20

Note: Criteria for Test Levels 2 and 3 are provided for support structures, work zone traffic control devices and breakaway utility poles. Test Level 3 is the basic test level used for most devices.

As noted in Tables 4.3.1~~–3~~ and 4.3.2~~–4~~, Test Levels 1 through 3 are limited to passenger vehicles while Test Levels 4 through 6 incorporate heavy trucks. The test speeds and impact angles used for testing represent approximately 92.5% of real word crashes. As implied by the information in Tables 4.3.1~~–3~~ and 4.3.2~~–4~~:

1. Test Level 1 devices should be used only on facilities with design speeds 30 mph and less.
2. Test Level 2 devices should be used only on facilities with design speeds 45 mph and less.

3. Test Level 3 through Test Level 6 devices are considered acceptable for all design speeds.
4. Test Level 3 devices are generally considered acceptable for facilities of all types and most roadside conditions.
5. Test Levels 4 through 6 should be considered on facilities with high volumes of heavy trucks and/or where penetration beyond the barrier would result in high risk to the public or surrounding facilities.

For additional information regarding appropriate application of Test Levels refer to the ***AASHTO Roadside Design Guide***.

4.3.2~~C.2~~ Safety Hardware Upgrades

On new construction and reconstruction projects existing obsolete safety hardware shall be upgraded or replaced with hardware meeting crash test criteria as described above.

For existing roadways, highway agencies should upgrade existing highway safety hardware to comply with current crash test criteria either when it becomes damaged beyond repair, or when an individual agency's maintenance policies require an upgrade to the safety hardware.

The ***FDOT Design Manual, Chapter 215 Roadside Safety*** provides a list of considerations when investigating the need for upgrading barriers and other hardware. The FDOT's ***Standard Plans*** provide standard details for transitioning new barriers to existing barriers. The ***AASHTO Roadside Design Guide*** also provides guidelines for upgrading hardware.

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4.4 ~~D~~ SIGNS, SIGNALS, LIGHTING SUPPORTS, UTILITY POLES, TREES, AND SIMILAR ROADSIDE FEATURES

4.4.1~~D.1~~ General

This section provides criteria for traffic sign supports, signal supports, lighting supports, utility poles, trees, and similar roadside features.

Generally, those roadside appurtenances and features that cannot be removed or located outside the clear zone must meet breakaway criteria to reduce impact severity. For those features located within the clear zone where it is not practical to meet breakaway criteria, shielding may be warranted and shall be considered.

4.4.2~~D.2~~ Performance Requirements for Breakaway Devices

The term breakaway support refers to traffic sign, highway lighting, and other supports that are designed to yield, fracture, or separate when impacted by a vehicle. The release mechanism may be a slip plane, plastic hinge, fracture element, or combination thereof. Crash test criteria applicable to breakaway devices are presented in Section 3~~C~~. Additional requirements for breakaway supports are provided in the ***AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals***. For a more detailed discussion on breakaway supports, refer to the ***AASHTO Roadside Design Guide***.

See Section 3~~C~~ for references that provide additional information and details on crash tested breakaway supports.

4.4.3~~D.3~~ Sign Supports

Traffic signs and sign supports shall meet the requirements provided in the ***Manual on Uniform Traffic Control Devices (MUTCD)*** as stated in ***Chapter 18 – Signing and Marking***. The ***MUTCD*** requires all sign supports within the clear zone to be shielded or breakaway. See Section 2~~B~~ for clear zone requirements. Only when the use of breakaway supports is not practicable should a traffic barrier or crash cushion be used exclusively to shield sign supports. In addition, sign supports should be located where they are least likely to be hit. Where possible, signs should be placed behind existing roadside barriers beyond the design deflection distance or on existing structures.

Commented [KM30]: Standard details for ground mounted sign supports.

The FDOT's ***Standard Plans*** provide details for breakaway supports for single and multi-post ground mounted signs that are acceptable for use within the clear zone. The most current version of these ***Standard Plans*** details should be used as the FDOT maintains and updates these details as necessary to comply with required implementation dates for changes in crash test criteria.

Overhead signs and cantilever signs require relatively large size support systems. The potential safety consequences of these systems falling necessitate a fixed-base design that cannot be made breakaway. Overhead sign and cantilever sign supports therefore are required to be located outside the clear zone (Section 2~~B~~) or be shielded with a crashworthy barrier (Section 5~~E~~). Where possible, these supports should be located behind traffic barriers shielding nearby overpasses or other existing structures, or the signs should be mounted on the nearby structure. The FDOT's ***Standard Plans*** provide details and instructions for the design of these systems.

4.4.4~~D.4~~ Traffic Signal Supports

Traffic signal supports commonly used in Florida are fixed base and shall meet the required lateral offset and clear zone criteria provided in Section 2~~B~~. Traffic signal supports should not be located within medians. The FDOT's ***Standard Plans*** provide details and instructions for the design of traffic signal supports.

4.4.5~~D.5~~ Lighting Supports

Lateral offset criteria for lighting supports depend on whether the support is breakaway or fixed base as discussed below. See ***Chapter 6 - Lighting*** for additional design criteria for lighting.

4.4.5.1 ~~D.5.a~~ Conventional Lighting

Supports for conventional lighting (heights up to 60 feet) shall be breakaway which are typically frangible bases (cast aluminum transformer bases), slip bases, or frangible couplings (couplers). The FDOT's ***Standard Plans*** provide further information for breakaway lighting supports which are acceptable for use. Generally, a breakaway lighting support will fall near the line of the path of an impacting vehicle. The mast arm usually rotates and points away from the roadway when resting on the ground. For poles located on the outside of the roadway (not in medians), this action generally results in the pole not falling into other traffic lanes. However, the designer

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On curbed roadways with design speeds 45 mph or less, breakaway lighting supports shall be located to meet lateral offset requirements provided in Section 2~~B~~, Table 4.2.1~~—2~~.

On flush shoulder roadways, breakaway lighting supports shall be located a minimum of 20 feet from the nearest travel lane, 14 feet from the nearest auxiliary lane or outside the clear zone provided in Section 2~~B~~, Table 4.2.1~~—1~~, whichever is less. The front ~~fore~~slope shall be 1:6 or flatter in cases where supports are located within the clear zone.

Lighting should not be located in medians, except in conjunction with barriers that are justified for other reasons.

4.4.5.2 ~~D.5.b~~ High Mast Lighting

High mast or high-level lighting supports are fixed-base support systems that do not yield or break away on impact. High mast lighting supports shall be located outside the clear zone provided in Section 2~~B~~, Table 4.2.1~~—1~~. High mast lighting shall not be located in medians except in conjunction with barriers that are justified for other reasons. The FDOT's ***Standard Plans*** provide additional information.

4.4.6~~D.6~~ Utility Poles

Utility poles shall be located to meet lateral offset and clear zone requirements provided in Section 2~~B~~ and be located as close as practical to the right of way line. They should be installed per the permitting agency's requirements. The ***AASHTO Roadside Design Guide*** provides additional discussion and guidance on utility poles.

In accordance with Section 337.403, F.S., existing utility poles must be relocated when unreasonably interfering with the "convenient, safe, or continuous use, or the maintenance, improvement, extension, or expansion" of public roads. Utility poles adjacent to road improvement projects, but not directly interfering with construction, should be considered for relocation, to the extent they can be

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relocated, to achieve the lateral offset requirements of Table 4.2.2~~-2~~ Lateral Offset. Utility poles that cannot be relocated and will remain within the clear zone, should be approved through the exception process prescribed in ***Chapter 14 - Design Exceptions and Variations.***

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4.4.7~~D.7~~ Trees

Trees with a diameter greater than 4 inches measured 6 inches above grade shall be located to meet lateral offset and clear zone requirements in Section 2~~B~~, Tables 4.2.1~~-1~~ and 4.2.2~~-2~~. The ***AASHTO Roadside Design Guide*** provides additional discussion and guidance on trees.

4.4.8~~D.8~~ Miscellaneous

4.4.8.1 ~~D.8.a~~ Fire Hydrants

Most fire hydrants are made of cast iron and are expected to fracture upon impact, however, crash testing meeting current criteria has not been done to verify that designs meet breakaway criteria. For this reason, fire hydrants should be located as far from the traveled way as practical and preferably outside lateral offset/clear zone requirements in Section 2~~B~~, yet where they are still readily accessible to and usable by emergency personnel. Any portion of the hydrant not designed to break away should be within 4 inches of the ground.

4.4.8.2 ~~D.8.b~~ Railroad Crossing Warning Devices

See ***Chapter 7 – Rail-Highway Crossings*** for location requirements for railroad crossing warning devices.

4.4.8.3 ~~D.8.c~~ Mailbox Supports

Mailboxes and their location are subject to US Postal Service requirements. They are often located within the clear zone and pose a potential hazard. However, with proper design and placement, the severity of impacts with mailboxes can be reduced. To achieve consistency, it is recommended each highway agency adopt regulations for the design and placement of mail boxes within the right of way of public highways. The ***AASHTO Roadside Design Guide*** provides a model regulation that is compatible with US Postal Service requirements.

The following requirements apply to mailbox installations on public roadways:

No mailbox will be permitted where access is obtained from a freeway or where access is otherwise prohibited by law or regulation. Mailboxes shall be located as follows:

- On the right-hand side of the roadway in the carrier's direction of travel except on one-way streets, where they may be placed on the left-hand side.
- Where a mailbox is located at a driveway entrance, it shall be placed on the far side of the driveway in the carrier's direction of travel.
- Where a mailbox is located at an intersecting road, it shall be located a minimum of 200 feet beyond the center of the intersecting road in the carrier's direction of travel. This distance may be decreased to 100 feet on very low volume roads.
- When a mailbox is installed in the vicinity of an existing guardrail, it should, when practical, be placed behind the guardrail.

The bottom of the box shall be set at a height established by the U. S. Postal Service, usually from 41 to 45 inches above the roadway surface.

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On flush shoulder roadways, the roadside face of the box should be offset from the edge of the traveled way a distance no less than the greater of the following:

- 8 feet (where no paved shoulder exists and shoulder cross slope is 10 percent or flatter), or
- width of the shoulder present plus 6 to 8 inches, or
- width of a turnout specified by the jurisdiction plus 6 to 8 inches.

On very low volume flush shoulder roads with low operating speeds the offset may be reduced to 6 feet from the traveled way.

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On curbed streets, the roadside face of the mailbox should be set back from the face of the curb 6 to 8 inches. On residential streets without curbs or all-weather shoulders that carry low traffic volumes operating at low speeds, the roadside face of the mailbox should be offset between 8 inches and 12 inches behind the edge of the pavement.

Design criteria for the mailbox support structure when located within the clear zone should consist of the following:

- Mailboxes shall be of light sheet metal or plastic construction conforming to the requirements of the U. S. Postal Service. Newspaper delivery boxes shall be of light metal or plastic construction of minimum dimensions suitable for holding a newspaper.
- No more than two mailboxes may be mounted on a support structure unless crash tests have shown the support structure and mailbox arrangement to be safe. However, light-weight newspaper boxes may be mounted below the mailbox on the side of the mailbox support.
- A single 4 inch by 4 inch square or 4 inch diameter wooden post; or metal post, Schedule 40, 2 inch (normal size IPS (external diameter 2-3/8 inch) (wall thickness 0.154 inches) or smaller), embedded no more than 24 inches into the ground, shall be acceptable as a mailbox support. A metal post shall not be fitted with an anchor plate, but it may have an anti-twist device that extends no more than 10 inches below the ground surface.
- Unyielding supports such as heavy metal pipes, concrete posts, brick, stone or other rigid foundation structure or encasement should be avoided.
- The post-to-box attachment details should be of sufficient strength to prevent the box from separating from the post top if the installation is struck by a vehicle. The exact support hardware dimension and design may vary, such as having a two-piece platform bracket or alternative slot-and-hole locations. The product must result in a satisfactory attachment of the mailbox to the post, and all components must fit together properly.
- The minimum spacing between the centers of support posts should be the height of the posts above the ground line. Mailbox support designs not described in this regulation are acceptable if approved by the jurisdiction.

The FDOT's ***Standard Plans*** and the ***AASHTO Roadside Design Guide*** provide details on hardware, supports and attachment details acceptable for mailboxes located within the clear zone which conform to the above requirements.

Additional information on the design and construction of residential and commercial mailboxes, including outdoor cluster boxes can be found on the ***United States Postal Service's Delivery Growth Management*** web page.

4.4.8.4D.8.dBus Benches and Shelters

See ***Chapter 3 – Geometric Design*** for location criteria for bus benches and shelters. Additional criteria are provided in ***Chapter 13 – Public Transit***.

4.5 ~~E~~ BARRIERS, APPROACH TREATMENTS, AND CRASH CUSHIONS

4.5.1~~E.1~~ Roadside Barriers

Roadside barriers are used to shield motorists from roadside hazards and in some cases are used to protect bystanders, pedestrians, cyclists and/or workers from vehicular traffic. In still other cases, roadside barriers are used to protect bridge piers from vehicle impacts. Median barriers are similar to roadside barriers but are designed for vehicles striking either side and are primarily used to separate opposing traffic on a divided highway. Median barriers also may be used on heavily traveled roadways to separate through traffic from local traffic or to separate high occupancy vehicle (HOV) and managed lanes from general-purpose lanes. Barriers are further classified as rigid, semi-rigid and flexible which are discussed in more detail below.

Barrier transition sections are used between adjoining barriers that have significantly different deflection characteristics. For example, a transition section is needed where a semi-rigid guardrail attaches to the approach end of a rigid concrete bridge rail, or when a barrier must be stiffened to shield fixed objects.

Requirements for bridge railings are provided in ***Chapter 17 – Bridges and Other Structures.***

4.5.2~~E.2~~ End Treatments

End treatments include trailing anchorages, approach terminals, and crash cushions. Trailing anchorages are used to anchor a flexible or semi-rigid barrier to the ground to develop its tensile strength during an impact. Trailing anchorages are not designed to be crashworthy for head on impacts. They are typically used on the trailing end of a roadside barrier on one-way roadways, or on the approach or trailing end of a flexible or semi-rigid barrier that is located outside the clear zone or that is shielded by another barrier system. Trailing anchorages are discussed in more detail below.

Approach terminals are basically crashworthy anchorages. Approach terminals are used to anchor a flexible or semi-rigid barrier to the ground at the end of a barrier that is within the minimum clear zone and exposed to approaching traffic. Most approach terminals are designed for vehicular impacts from only one side of the barrier, however some are designed for median applications where there is potential for impact from either side. Approach terminals are discussed in more detail below.

4.5.3~~E.3~~ Crash Cushions

Crash cushions, sometimes referred to as impact attenuators, are crashworthy end treatments typically attached at the approach end of median barriers, roadside barriers, bridge railings or other rigid fixed objects, such as bridge piers. Crash cushions may be used in a median, a ramp terminal gore, or other roadside application. Crash cushions are discussed in more detail below.

4.5.4~~E.4~~ Performance Requirements

Roadside barriers, transitions, approach terminals, and crash cushions must be crashworthy as determined by full scale crash testing in accordance with specific crash test criteria discussed in Section 3~~C~~. Descriptions of commonly used devices in Florida are described below. Section 3~~C~~ also provides references where more information can be found on crashworthy devices.

4.5.5~~E.5~~ Warrants

The determination as to when shielding is warranted for given hazardous roadside feature must be made on a case-by-case basis, and generally requires engineering judgment. It should be noted that the installation of roadside barriers presents a hazard in and of itself, and as such, the designer must analyze whether the installation of a barrier presents a greater risk than the feature it is intended to shield. The analysis should be completed using the ***Roadside Safety Analysis Program (RSAP)*** or in accordance with the ***AASHTO Highway Safety Manual (HSM)***.

Please see Section 1~~A~~ for the considerations to be included when determining when to shield a roadside hazard.

The following hazards located within the clear zone are normally considered more hazardous than a roadside barrier:

4.5.5.1~~E.5.a~~ Above Ground Hazards

Above ground hazards are defined in Section 2~~B~~, Table 4.2.2~~ – 2~~ Lateral Offset. They include but are not limited to:

1. Bridge piers, abutments, and railing ends
2. Parallel retaining walls with protrusions or other potential snagging features
3. Non-breakaway sign and lighting supports
4. Utility Poles
5. Trees greater than 4” in diameter measured 6” above ground.

4.5.5.2E.5.b Drop-Off Hazards

Drop-off hazards are defined in Section 2B, Table 4.2.2—2 Lateral Offset.

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4.5.5.3E.5.c Canals and Water Bodies

Criteria for addressing canal and water body hazards is provided in Section 4.2.2.3B.2.c.

4.5.6E.6 Warrants for Median Barriers

Median barriers shall be used on high speed, limited access facilities where the median width is less than the minimum values given in Chapter 3, Geometric Design, Table 3.??—23 Minimum Median Widths. For locations where median widths are equal to or greater than the minimum, median barriers are not normally considered except in special circumstances, such as a location with significant history of cross median crashes. Any determination to use a median barrier on limited access facilities must consider the need for barrier openings for median crossovers that are appropriately spaced to avoid excessive travel distances by emergency vehicles, law enforcement vehicles, and maintenance vehicles. The FDOT Design Manual may be referenced for additional criteria and guidelines for locating and designing median crossovers on limited access facilities.

Commented [KM42]: Errata for 2018 Greenbook

On high speed divided arterials and collectors, median barriers are not normally used due to several factors that are very difficult, if not impractical, to address. Such factors include right-of-way constraints, property access needs, presence of at-grade intersections and driveways, adjacent commercial development, intersection sight distance and barrier end termination. However, provided these factors can be properly addressed, median barriers for these type facilities may be considered where median widths are less than minimum or where justified based on significant crossover crash history.

See Section 5~~E~~ for median barrier types and proper end treatment requirements. The ***AASHTO Roadside Design Guide*** and the ***FDOT Design Manual, Chapter 215 Roadside Safety*** and ***Standards Plans*** provide additional information and guidelines on the use of median barriers

4.5.7~~E.7~~ Temporary Barriers in Work Zones

See Section 7~~G~~ Roadside Design in Work Zones for criteria on the use of temporary barriers in work zones.

4.5.8~~E.8~~ Barrier Types

Roadside barriers are classified as flexible, semi-rigid and rigid depending on their deflection characteristics when impacted. Flexible systems have the greatest deflection characteristics. Given much of the impact energy is dissipated by the deflection of the barrier and lower impact forces are imposed on the vehicle, flexible systems are generally more forgiving than rigid and semi-rigid systems. Rigid barriers, on the other hand, are assumed to exhibit no deflection under impact conditions so crash severity will likely be the highest of the three classifications.

In the following sections are basic descriptions of the barrier types commonly used in Florida for each these classifications. These commonly used barriers are those that are addressed in the FDOT's ***Standard Plans*** and ***FDOT Design Manual***. Those documents should be referenced for additional details and discussion on the proper use of these systems.

The basis for the FDOT's systems and devices, as well as many other generic and proprietary guardrail systems meeting ***NCHRP Report 350*** and/or MASH criteria, can be found in the following documents:

- ***AASHTO Roadside Design Guide***
- ***Federal Highway Administration (FHWA) Countermeasures that Reduce Crash Severity***
- ***AASHTO-Associated General Contractors of America (AGC}-American Road and Transportation Builders Association (ARTBA) Joint Committee Task Force 13*** report, ***A Guide to Standardized Highway Barrier Hardware*** available at

Commented [KK43]: @Morris, Jacqueline should be all one link...FDOT Design Manual...

Commented [KM44]: Work with Jim Mills on refining. Need to find requirement for 10-foot offset. What about a median would warrant having a barrier?

Possibly needs to discuss if you don't meet the width requirements for medians in Chapter 3, what would be needed for a barrier.

Commented [KM45R44]: Moved language from Geometric Design C.7.e.

Commented [KK46]: @Morris, Jacqueline all one link..

Commented [KK47]: @Morris, Jacqueline changed from "department"

4.5.8.1E.8.a Guardrail

The most commonly used barrier on new construction projects in Florida is the w-beam guardrail system detailed in the FDOT's ***Standard Plans*** referenced as "General TL-3 Guardrail". This w-beam guardrail system, sometimes referred to as a strong post guardrail system, is a semi-rigid system, uses posts at 6'-3" spacing, 8" offset blocks, and mid-span splices with a rail height of 2'-1" to center of the panel. This system was developed based on the 31" Midwest Guardrail System (MGS) and meets MASH Test Level 3 criteria. Compatible proprietary components may be referenced by the 31" height. This system can be used as a roadside barrier or in a double face configuration as a median barrier. Deflection space requirements for this system are provided in the ***FDOT Design Manual, Chapter 215 Roadside Safety***.

Commented [KK48]: @Morris, Jacqueline "in the FDOT's".....unbold and add the word "the"

The current 31" height system replaces the 27" height system (1'-9" to center of panel) that had been used for many years and still present on roadways throughout Florida. Section 3.3C.3 addresses requirements for upgrading existing 27" height systems.

The FDOT's ***Standard Plans*** also provide details for a similar w-beam guardrail system referenced as "Low Speed, TL-2 Guardrail", with posts at 12'- 6" spacing which meets MASH Test Level 2 criteria. While this TL 2 system may be used on low speed roadways 45 mph or less, it preferably should be used only on roadways with design speeds 35 mph and less to account for the potential for changes in posted speed limits and/or vehicles exceeding the design speed.

To achieve a minimum level of crash performance, guardrail installations shall have a minimum length of 75 feet with design speeds greater than 45 mph.

4.5.8.2E.8.b Concrete Barrier

The most commonly used concrete barriers in Florida are detailed in the FDOT's ***Standard Plans***. Details are provided for median application, shoulder application and pier protection. Additional information on these barriers is provided in the ***FDOT Design Manual, Chapter 215 Roadside Safety***.

The FDOT's 32" height F-Shape concrete barrier wall system that has been in use for many years meets ***NCHRP Report 350*** Test Level 4 criteria and MASH Test Level 3 criteria. The FDOT is replacing this 32" F-Shape system with a 38" height single slope concrete barrier system which meets MASH Test Level 4 criteria. In addition to improved crash test performance, the single slope face provides for simpler construction.

While shielding bridge piers to protect motorists from a hazard within the clear zone is often necessary, some bridge piers may need shielding for protection from damage due to design limitations (i.e., piers not designed for vehicular collision forces). Coordination with the Structural Engineer of Record is required to determine if pier protection is warranted. The FDOT's ***Standard Plans*** provides details for crashworthy Pier Protection barriers and the ***FDOT Design Manual, Chapter 215 Roadside Safety*** provides a process for determining the appropriate level of pier protection. As with median and shoulder concrete barrier walls, the FDOT is replacing the F-Shape pier protection barriers that have been in use for several years with single slope face systems.

4.5.8.3~~E.8.c~~ High Tension Cable Barrier

There are a variety of crash tested flexible barrier systems using w-beam and cable, but they historically have not been in common use in Florida. In recent years several proprietary high-tension cable barrier (HTCB) systems have been developed that meet ***NCHRP Report 350*** and MASH criteria. These systems are installed with a significantly greater tension in the cables than the generic low-tension systems that have been used in some states for many years. High tension cable barrier systems may be used for both median and roadside application. Deflection space requirements are dependent on the system, system length and post spacing, and are significantly greater than semi-rigid systems.

High tension cable barrier has shown to have several advantages over other types of flexible barrier systems. One advantage is they tend to result in less damage when impacted. Another is that certain systems have been tested for use on slopes as steep as 1:4. Still another advantage is that in many cases, the cables remain at the proper height after an impact that damages several posts. While no manufacturer claims their barrier remains functional in this condition, there is the potential that this offers a residual safety value under certain crash conditions. Posts are typically lightweight and can be installed in cast or driven sockets in the ground to facilitate removal and replacement. One disadvantage is that each vendor uses a different post design and cable arrangement, and therefore posts are not interchangeable between systems manufactured by different vendors.

The FDOT has used High Tension Cable Barrier (HTCB) in selected locations and continues to install these systems using the FDOT's ***Developmental Design Standards and Developmental Specifications (DDS)*** process. Detailed information on the usage requirements and design criteria of HTCB can be found on the FDOT's ***DDS*** website.

It includes the following:

- ***Developmental Standard Plans Instructions D 540-001***
- ***Developmental Standard Plans Index D 540-001***
- ***Developmental Specification, Dev540***

4.5.8.4~~E.8.d~~ Temporary Barrier

As stated in Section 4.5.5.5~~E.5.e~~, temporary barriers are used primarily in work zones for several purposes. The most used temporary barriers in Florida are those adopted for use by the FDOT. The FDOT's temporary barriers include:

Low Profile Barrier – Standard Plans, Index 102-120 (TL-2, NCHRP 350)

Type K Barrier – Standard Plans, Index 102-110 (TL-3, NCHRP 350)

Proprietary Temporary Barrier –Standards Plans, Index 102-100 and the ***Approved Products List (APL)*** (TL-2 & TL-3, NCHRP 350)

Additional information on the proper use of these barriers is provided in the ***FDOT Design Manual*** and the Vendor drawings on the FDOT's ***Approved Products List***.

Additional information on temporary barrier systems meeting ***NCHRP Report 350*** and/or MASH criteria can be found in the ***Manual for Assessing Safety Hardware*** and the ***AASHTO Roadside Design Guide***.

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4.5.8.5~~E.8.e~~ Selection Guidelines

The evaluation of numerous factors is required to ensure that the appropriate barrier type is selected for a given application. Consideration should be given to the following factors when evaluating each site:

- Barrier placement requirements (see Section 4.5.6.6 (?)~~E.6.f~~)
- Traffic characteristics (e.g., vehicle types/percentages, volume, and growth)
- Site characteristics (e.g., terrain, alignment, geometry, access facility type, access locations, design speed, etc.)
- Expected frequency of impacts
- Initial and replacement/repair costs
- Ease of maintenance
- Exposure of workers when conducting repairs/maintenance
- Aesthetics

For additional information about considerations for barrier selections refer to the ***AASHTO Roadside Design Guide***. Barrier type selection decisions and warrants should be documented.

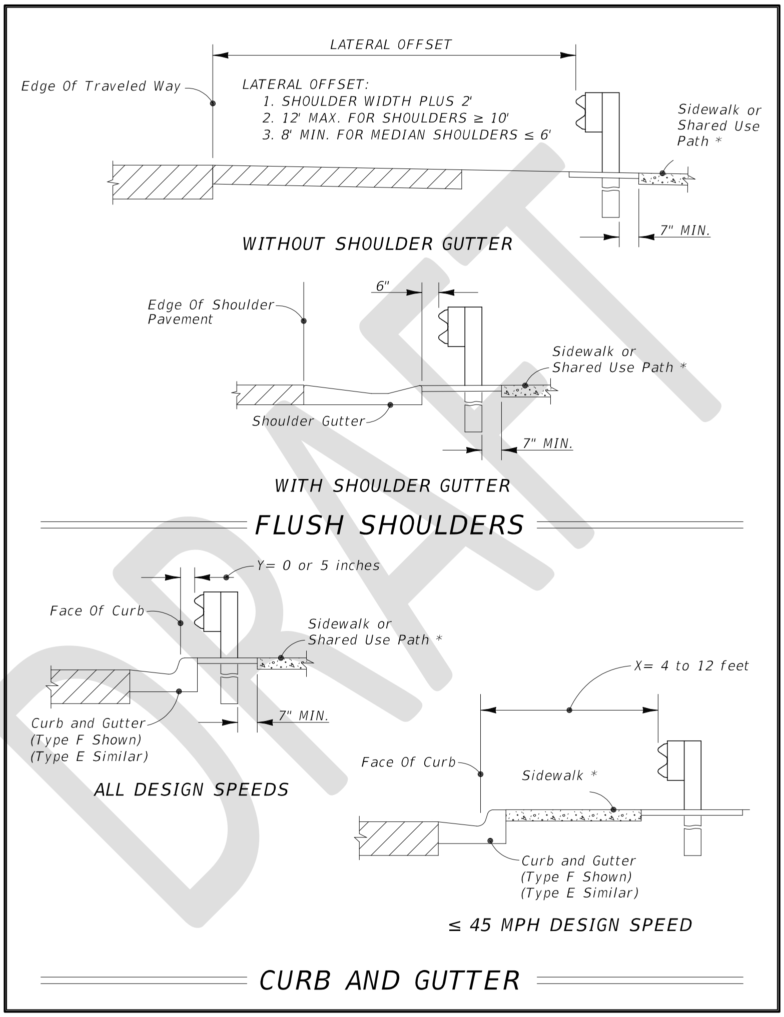
4.5.8.6~~E.8.f~~ Placement

4.5.8.6.1~~E.8.f.1~~ Barrier Offsets

Roadside barriers should be offset as far from the travel lanes as practical with consideration for maintaining the proper performance of the barrier. For the barriers described above see the ***FDOT Design Manual, Chapter 215 Roadside Safety*** and ***Standard Plans*** for proper barrier placement. Figure 4.5.1~~–8~~ Location of Guardrail provides information on the offset of guardrail on curbed and flush shoulder roadways.

This is a working document that has not been adopted.

Figure 4.5.1 — 8 Location of Guardrail



* When a sidewalk is present or planned. See Chapter 8 – Pedestrian Facilities and Chapter 9 – Bicycle Facilities for criteria for sidewalks and shared use paths (e.g., width of facility plus clear, graded areas adjacent to the path or sidewalk).

Commented [KM51]: Need to revise figure to show dimension from sidewalk in all scenarios, and find how we name it otherwise.

Commented [KM52R51]: Revised.

Commented [KM53R51]: Revise optional to "Where Present" for sidewalks, shared use path.

Add; language in Chapter 8 to see Chapter 4 for placement of sidewalk relative to the guardrail, Chapter 9 for shared use path.

4.5.8.6.2~~E.8.f.2~~ Deflection Space and Zone of Intrusion

In addition to travel lane lateral offset considerations, an adequate setback must be provided behind the barrier to ensure proper function. For flexible and semi-rigid barriers, the setback is based on deflection tolerances and is required to prevent the barrier from contacting aboveground objects.

For rigid barriers, the setback is required to keep the area above and behind the barrier face free of obstructions that could penetrate or damage the vehicle compartment. This requirement is based on the Zone of Intrusion (ZOI) concept as described in the ***AASHTO Roadside Design Guide***.

These requirements do not apply to devices located within the setback distances detailed in the FDOT's ***Standard Plans*** (e.g., pedestrian/bicycle railing, fencing, noise walls, etc.).

Commented [KM54]: Talk with Derwood about which Indexes to include.

4.5.8.6.3~~E.8.f.3~~ Grading

The terrain effects between the traveled way and a barrier can have a significant impact on whether a barrier will perform as intended. Proper grading around a barrier will ensure that as a vehicle approaches a barrier its suspension is not dramatically affected, causing the vehicle to underride or override a barrier.

4.5.8.6.4~~E.8.f.4~~ Curbs

As with grading, the presence of curb in combination with barriers deserves special attention. A vehicle which traverses a curb prior to impact may override the barrier if it is partially airborne at the moment of impact. Conversely, the vehicle may "submarine" under the rail element of a guardrail system and snag on the support posts if it strikes the barrier too low.

4.5.8.6.5~~E.8.f.5~~ Flare Rate

A flared roadside barrier is when it is not parallel to the edge of the traveled way. A flared barrier may be necessary for several reasons:

- To locate the barrier terminal farther from the roadway
- To minimize a driver's reaction to an obstacle near the road by gradually introducing a parallel barrier installation
- To transition a roadside barrier to an obstacle nearer the roadway such as a bridge parapet or railing
- To reduce the total length barrier needed.
- To reduce the potential for barrier and terminal impacts and provide additional roadside space for an errant motorist to recover.

A concern with flaring a section of roadside barrier is that the greater the flare rate, the higher the angle at which the barrier can be hit. As the angle of impact increases, the crash severity increases, particularly for rigid and semi-rigid barrier systems. Another disadvantage to flaring a barrier installation is the increased likelihood that a vehicle will be redirected back into or across the roadway following an impact.

For the barriers described above, see the ***FDOT Design Manual, Chapter 215*** ***Roadside Safety*** for acceptable flare rates. Additional information on flare rates are provided in the ***AASHTO Roadside Design Guide***.

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4.5.8.6.6~~E.8.f.6~~ Length of Need

The length of need for a particular barrier type is calculated based on several factors including the length of the hazard, the lateral area of concern, run out length and other factors. Length of need must consider traffic from both directions.

A spreadsheet tool for calculating length of need is provided on the FDOT's ***Standard Plans*** web page, adjacent to ***Index 536-001*** in the ***Design Tools*** column. Additional information on length of need is provided in the ***AASHTO Roadside Design Guide***.

4.5.8.7~~E.8.g~~ Barrier Transitions

Guardrail transitions are necessary whenever standard W-Beam guardrail converges with rigid barriers. The purpose of the transition is to provide a gradual stiffening of the overall approach to a rigid barrier so that vehicular pocketing, snagging, or penetration is reduced or avoided at any position along the transition. Guardrail transitions must include sound structural connections, nested panels, and additional posts for increased stiffness. The FDOT's ***Standard Plans*** provide details for several transitions for both permanent and rigid barriers that meet MASH criteria. Additional information on transitions is provided in the ***FDOT Design Manual, Chapter 215 Roadside Safety*** and the ***AASHTO Roadside Design Guide***.

4.5.8.8~~E.8.h~~ Attachments to Barriers

Attachments to barriers such as signs, light poles, and other objects will affect crash performance and should be avoided where practical. Attachments not meeting the requirements discussed in Section E.6.f Placement, should meet crash test criteria. See the ***FDOT Design Manual, Chapter 215 Roadside Safety*** for additional information on attachments to barriers.

4.5.9~~E.9~~ End Treatments and Crash Cushions

As previously discussed, end treatments include trailing anchorages, approach terminals, and crash cushions. Details for end treatments for each barrier type described above are detailed in the FDOT's ***Standard Plans*** and the ***Approved Products List (APL)***.

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4.5.9.1~~E.9.a~~ End Treatments for Guardrail

End treatments for guardrail are categorized as follows:

1. Approach terminals – required for guardrail ends within the clear zone of approaching traffic. Guardrail approach end terminals are proprietary devices listed on the ***APL***. MASH compliant approach terminals are classified by Test Level (TL-2 for Design Speeds ≤ 45 mph or TL-3, which is acceptable for all Design Speeds) and as follows:
    a. Flared – preferred terminal for locations where sufficient space is available to offset barrier end from approaching traffic.

b. Parallel – use only when sufficient space is not available for a flared terminal.

c. Double Face – preferred end treatment for double faced guardrail installations.

2. Crash Cushions – See Section 4.5.7.5~~E.7.e~~.

3. Trailing Anchorages (Type II) – required for anchoring of the trailing ends of guardrail. Trailing anchorages are non-crashworthy as an approach end treatment, and are not permitted as an approach end treatment, on the approach end within the Clear Zone, unless shielded by another run of barrier. The FDOT's Type II Trailing Anchorage, is detailed in the Standard Plans.

Figures 4.5.2~~-9A~~ and 4.5.3~~-9B~~ below illustrate how to determine when an approach terminal, trailing anchorage or crash cushion should be selected when using guardrail to provide protection for a hazard.

Figure 4.5.2~~ – 9A~~ End Treatment Usage When End of Guardrail is Within Clear Zone of Approaching Near Lane

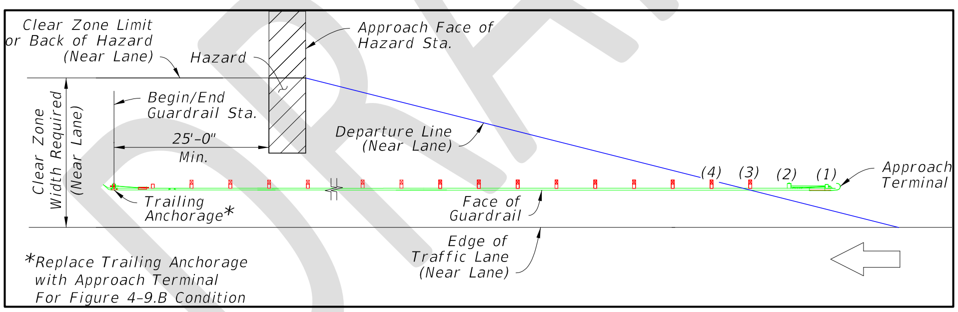
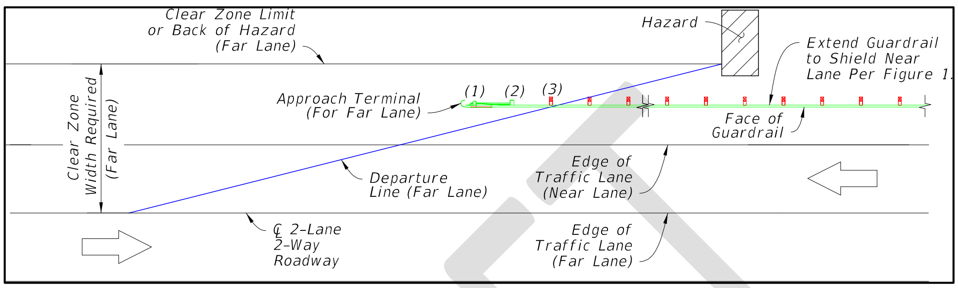


Figure 4.5.3~~ — 9B~~ Approach Terminal Usage When End of Guardrail is Within Clear Zone of Approaching Far Lane (2-Lane, 2-Way Road Shown)



Additional information on guardrail end treatments is provided in the ***FDOT Design Manual, Chapter 215 Roadside Safety***.

4.5.9.2~~E.9.b~~ End Treatments for Rigid Barrier

Rigid Barrier ends must be terminated by either transitioning into another barrier system (e.g., guardrail), or by shielding with a Crash Cushion. Details are provided in the FDOT's ***Standard Plans***. Treatment of the trailing end of rigid barriers is not required unless additional hazards exist beyond the rigid barrier or the barrier is within the clear zone of opposing traffic.

4.5.9.3~~E.9.c~~ End Treatments for High Tension Cable Barrier (HTCB)

End treatments for high tension cable barrier are vendor specific. For additional information regarding the end treatment of HTCB, refer to the FDOT's developmental design standards discussed above.

4.5.9.4~~E.9.d~~ End Treatments for Temporary Barrier

Details for end treatments for the FDOT's Temporary Barrier are provided in the FDOT's ***Standard Plans*** and include:

1. Connecting to an existing barrier. Smooth, structural connections are required. Information on connections can be found in the FDOT's ***Standard Plans*** and ***APL***.
2. Shield end with a crash cushion as detailed in the FDOT's ***Standard Plans*** or ***APL*** for the specific type of Temporary Barrier (i.e., portable concrete barrier, steel, or water filled).
3. Attaching or Transitioning to a crashworthy end treatment as described above.
4. Flaring outside of the Work Zone Clear Zone.

4.5.9.5~~E.9.e~~ Crash Cushions

Crash cushions are classified based on Test Level and Design Speed which is shown for each system on each vendor's respective drawings posted on the FDOT's ***APL***.

The design of a crash cushion system must not create a hazard to opposing traffic. The APL drawings provide details for transitions for optional barrier types with and without bi-directional traffic.

An impacting vehicle should strike the systems at normal height, with the vehicle's suspension system neither collapsed nor extended. Therefore, the terrain surrounding crash cushions must be relatively flat (i.e., 1:10 or flatter) in advance of and along the entire design length of the system. Curbs should not be located within the approach area of a crash cushion.

The ***FDOT Design Manual, Chapter 215 Roadside Safety*** provides additional information on permanent and temporary crash cushions.

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Commented [MJ60R59]: Corrected

Commented [KK61]: @Morris, Jacqueline make this all blue?

4.6~~F~~ BRIDGE RAILS

See ***Chapter 17 - Bridges and Other Structures*** for requirements for bridge rails. The ***FDOT Design Manual*****, *****Chapter 215 Roadside Safety*** may be referenced for additional information and typical applications.

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4.7~~G~~ ROADSIDE DESIGN IN WORK ZONES

The roadside design concepts presented in the previous sections shall be applied to work zones as appropriate for the type of work being done and to the extent existing roadside conditions allow. This includes providing clear zone and using traffic control devices and safety appurtenances that are crashworthy or properly shielded with crashworthy devices. However, because work zones are temporary and often involve restricted or limited space, modified criteria for clear zones, drop-off conditions and above ground hazards are provided as follows.

4.7.1~~G.1~~ Clear Zone Width in Work Zones

Clear zone is defined in Section 2~~B Roadside Topography and Drainage Features~~. Clear zone widths for work zones, as a minimum, shall be the lessor of clear zone requirements provided in Table 4.2.1~~—1~~ Minimum Width of Clear Zone, Table 4.7.1~~—5~~ Clear Zone Width Requirements for Work Zones, or existing clear zone width. Clear zone widths in work zones are measured from the edge of Traveled Way.

Table 4.7.1 — 5 Clear Zone Width Requirements for Work Zones

Work Zone Posted Speed (mph)	Travel Lanes & Multilane Ramps (feet)	Auxiliary Lanes & Single Lane Ramps (feet)
Curbed		
≤ 45 mph	4' Behind Face of Curb	4' Behind Face of Curb
> 45 mph	Same as Flush Shoulder	Same as Flush Shoulder
Flush Shoulder		
≤ 40	14	10
45 – 50	18	10
55	24	14
60 – 70	30	18
Note: The above clear zone widths apply to medians and roadside conditions other than for roadside canals. Where roadside canals are present, clear zone widths are to conform with the lateral offset distances to canals described in this Chapter.		

Commented [KM63]: Do we need this to say flush shoulder?

Commented [KM64R63]: The values reflect Index 102-600. The Roadside Design Guide, Table 9-1 has 35 mph or less = 10, 40 mph = 15, 45 – 55 mph =20, 60 mph or greater = 30.

The clear zone must be free of above ground fixed objects, water bodies and non-traversable edge drop-offs or critical slopes.

4.7.2G.2 Above Ground Hazards in Work Zones

An above ground hazard in work zones is any object, material, or equipment other than temporary traffic control devices that is greater than 4 inches in height, firm and unyielding, and encroaches upon the clear zone. During working hours, above ground hazards in the work zone should be treated with appropriate precautions.

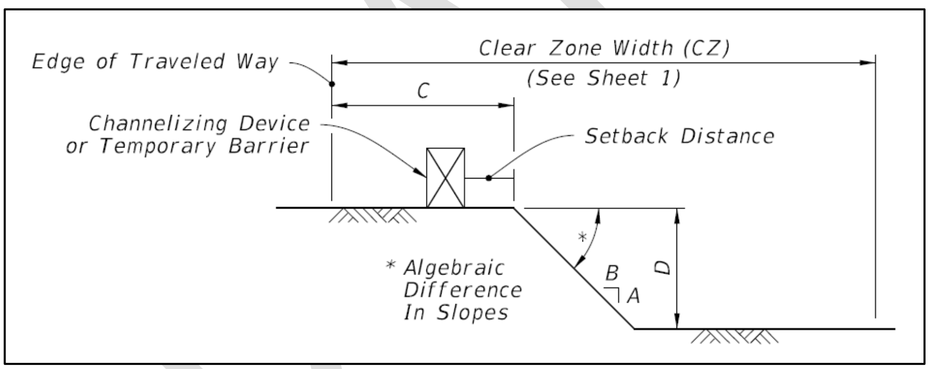
During nonworking hours, all objects, materials, and equipment that constitute an above ground hazard must be stored/placed outside of the clear zone or be shielded by a barrier or crash cushion.

4.7.3~~G.3~~ Non-Traversable Edge Drop-Offs, Critical Slopes and Roadside Excavations

Non-traversable edge drop-offs, critical slopes and roadside excavations located within the clear zone are to be addressed as follows:

A drop-off is defined as a drop in elevation, parallel to the adjacent travel lanes, greater than 3" with slope (A:B) steeper than 1:4. In superelevated sections, the algebraic difference in slopes should not exceed 0.25 (See Figure 4.7.1~~—10~~ Drop-off Condition Detail.

Figure 4.7.1~~—10~~ Drop-Off Condition Detail



When an edge drop-off condition occurs within the clear zone, channelizing devices or temporary barriers shall be provided in accordance with Table 4.7.2~~—6~~ Device Requirements for Edge Drop-Offs.

Drop-offs may be mitigated by placing slopes of optional base material. See the FDOT's ***Standard Specifications, Section 285*** for further information. Slopes shallower than 1:4 may be required to avoid an algebraic difference in slopes greater than 0.25.

Table 4.7.2 ~~— 6~~ Device Requirements for Edge Drop-Offs

Condition	D (inches)	C (feet)	Device Required
1	>3	2 - 12	Temporary Barrier
2	>3 to ≤5	12 - CZ	Channelizing Device
3	>5	2 - 12	Temporary Barrier
4	Removal of Bridge or Retaining Wall Barrier		Temporary Barrier
5	Removal of portions of Bridge Deck		Temporary Barrier

Footnotes:

1. Do not allow any drop-off conditions greater than 3 inches within two feet of traveled way.
2. For Conditions 1 and 3, channelizing devices and placement of slopes 1:4 or flatter constructed of base material per the ***FDOT Specifications Section 285*** may be used in lieu of temporary barriers. Slopes shallower than 1:4 may be required to avoid algebraic difference in slopes greater than 0.25.
3. For Conditions 1 and 3 any drop-off condition that is created and restored within the same work period will not be subject to the use of temporary barriers. However, channelizing devices will be required.
4. When permanent curb heights are ≥ 6", no channelizing device will be required.

A setback distance appropriate for the type of barrier selected shall be provided. For further information on setback requirements for various types of barriers, see the FDOT's ***Standard Plans.***

Drop-offs adjacent to pedestrian facilities shall be provided with pedestrian longitudinal channelizing devices, temporary barrier wall, or approved handrail. Adjacent to pedestrian facilities, a drop-off is defined as:

a) a drop in elevation greater than 10" that is closer than 2 feet from the edge of the sidewalk or shared use path, or

b) a slope steeper than 1:2 that begins closer than 2 feet from the edge of the sidewalk or shared use path when the total drop-off is greater than 60".

Commented [KM65]: Does this apply to when work is underway Clarify intent?

Commented [KM66R65]: Yes, in all conditions. Some situations allow temporary channelizing devices if workers attending, if unattended, need barrier or restore drop off, add pavement wedge.

Commented [MK67]: Should we define work period. Construction determines this to be a work shift, assumed to be 12 /16 hours. When work is active for period not to exceed 12 hours. Devices must be maintained, work zone has to be active so that the channelizing devices can be maintained.

Commented [KM68R67]:

4.7.4G.4 Temporary Barriers in Work Zones

When clear zone widths cannot be met, the use of temporary barriers shall be considered. Temporary barriers in work zones can serve several functions:

- Shield edge drop-offs and roadside excavations – see Section 4.7.1G.1.
- Shield above ground hazards, including roadside structures, falsework for bridges, material storage sites and/or other exposed objects.
- Provide positive protection for workers.
- Separate two-way traffic.
- Separate pedestrians from vehicular traffic.

The decision to use temporary barriers for conditions not specifically addressed in Section 4.7.1G.1 should be based on engineering judgement and analysis. There are many factors, including traffic volume, traffic operating speed, offset, and duration, that affect barrier needs within work zones. The FDOT's ***Standard Plans, MUTCD*** and the ***AASHTO Roadside Design Guide*** provide additional information and guidance on the use of temporary barriers in work zones.

4.8~~H~~ REFERENCES FOR INFORMATIONAL PURPOSES

The following is a list of publications that may be referenced for further guidance:

- AASHTO Roadside Design Guide
  https://store.transportation.org/Item/CollectionDetail?ID=105/
- Task Force 13 Guide to Standardized Roadside Safety Hardware
  http://www.tf13.org/Guides/
- FHWA Web Site
  http://safety.fhwa.dot.gov/roadway_dept/
- FDOT Design Manual
  http://www.fdot.gov/roadway/FDM/
- FDOT Standard Plans for Road and Bridge Construction (Standard Plans)
  http://www.fdot.gov/design/standardplans/
- *FDOT Structures Design Guidelines*
  http://www.fdot.gov/structures/StructuresManual/CurrentRelease/StructuresManual.shtm
- FDOT Drainage Manual,
  http://www.fdot.gov/roadway/Drainage/ManualsandHandbooks.shtm
- Florida Strategic Highway Safety Plan
  https://www.fdot.gov/safety/shsp/shsp.shtm

CHAPTER 5

PAVEMENT DESIGN AND CONSTRUCTION

A INTRODUCTION

The function of the pPavement or roadway surface is to provides a firm, safe and efficient travel path riding surface for vehicles using the streets andor highways. The pavement should provide a good riding surface with a minimum amount of distraction to the driver. The pavement friction characteristics should be such that develop adequate longitudinal and lateral forces between the vehicle tires and the pavement can be developed to allow provide a margin of safety for required vehicle maneuvers. These characteristics should be provided at the highest reasonable level for the the expected pavement surface, weather conditions, and the anticipated operational characteristics of the facility. Resurfacing of the existing pavement is discussed and included underin See ***Chapter 10 – Maintenance and Resurfacing*** of this manual for resurfacing existing pavements.

In order for the pavement to perform its function properly, tConsider these following objectives shall be considered in the design and construction of the pavement:

- Provide sufficient pavement structure and the proper pavement material strength to prevent pavement distress prior to the end of throughout the design period.

- Develop and maintain adequate skid resistance qualities to allow for safe execution of braking, cornering, accelerating, and other vehicle maneuvers.

- Provide drainage to promote quick drying and to t o reduce the likelihood of hydroplaning and splashing.

B PAVEMENT DESIGN

B.1 Pavement Type Selection

~~For new construction and major reconstruction projects, the designer should~~ D~~d~~etermine the type of pavement to use for new construction and major reconstruction projects ~~to be constructed utilizing~~ based upon formal analysis of existing and anticipated conditions. High-~~ ~~volume roadways ~~where a~~ with significant ~~amount of~~ truck traffic (>10%) ~~exists may~~ may warrant considering ~~ation for~~ special asphalt pavement ~~designs~~ and ~~for~~ rigid pavement designs. The FDOT uses ~~has~~ a ~~documented~~ procedure patterned after the ***AASHTO Guide for Design of Pavement Structures, Appendix B*** ~~. This procedure may be found~~ located in the FDOT~~'s~~ ***Pavement Type Selection Manual (2019)***.

B.1.a Unpaved Roadway Material Selection

The material ~~chosen~~ should be locally available when possible. Evaluate the f~~F~~requency of grading and replacement ~~of material from loss~~ due to erosion ~~should be evaluated~~. Perform a~~A~~ life-~~ ~~cycle ~~economic~~ cost analysis ~~should be performed~~ to identify ~~determine~~ suitable materials ~~type~~. ~~For example:~~ R~~R~~eclaimed asphalt pavement~~s~~ (RAP) resulting from milling operations ~~provide for~~ is a suitable all-~~ ~~weather material ~~and can be considered~~ for unpaved roads.

The selected material ~~chosen~~ should exhibit low potential for losses ~~due to~~ from wind, traffic and water erosion. See EPA~~'s~~ P~~p~~ublication AP-42 ~~contains methodology~~ for estimating the dust generation potential ~~for~~ of unpaved road surfaces. Proper gradation ~~of the chosen material~~ is critical for ~~its~~ the success of the surface. ~~Designers should consider flexible or rigid~~ Consider asphalt and concrete pavement~~s~~ where stormwater runoff ~~from unpaved roads may~~ could impact surface waters.

~~Designers may consult with~~ Refer to AASHTO's ***Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400), 2001*** and ***FHWA's Gravel Roads Construction and Maintenance Guide, August 2015*** for additional~~further~~ guidance ~~regarding~~ on material selection.

B.2 Structural Design

Design t~~T~~he pavement ~~shall be designed and constructed so the~~ to maintain the required surface texture ~~is maintained~~ and ~~its structure retains~~ an adequate level of serviceability throughout ~~for~~ the design period. The pavement strength ~~of the~~

~~pavement materials shall~~ must be sufficient to maintain the ~~desired~~ roadway cross section without ~~the formation of~~ ruts or ~~other~~

depressions~~ which would impede drainage~~. Subgrade strength and subgrade drainage are critical ~~major factors to be considered in pavement design~~. ~~Where high ground water conditions are present,~~ Provide adequate clearance between the seasonal high groundwater table and~~to~~ the bottom of the pavement base ~~is necessary for good~~ to optimize pavement performance and ~~to~~ achieve~~e~~ the required compaction and stability~~ during construction operations~~.

The FDOT~~'s pavement design manuals, including the~~ ***Flexible Pavement Design Manual, 2021*** and ***Rigid Pavement Design Manual, 2021***~~,~~ are recommended as ~~a~~ guides for ~~both~~ flexible and rigid pavement designs. ~~Other design procedures are available including~~ T~~t~~he ***AASHTO Guide for Design of Pavement Structures***, and the procedures ~~which have been~~ developed by the Portland Cement Association, the American Concrete Pavement Association, and the Asphalt Institute provide additional guidance. The ~~selection~~ choice of ~~the~~ design procedure and ~~the~~ development of the design ~~data~~ must be managed by professional staff who are ~~personnel~~ competent to make these evaluations.

B.3 Skid Resistance

Design p~~P~~avements ~~shall be designed and constructed~~ to maintain adequate skid resistance for as long ~~a period~~ as the ~~available~~ materials, technology, and economic restraints allow ~~will permit, thus~~ to minimize maintenance costs ~~eliminating cost and~~ and hazardous maintenance operations.

~~The results of relevant experience and testing (i.e., tests conducted by the FDOT's Materials Office) should be used in the~~ Incorporate prior experience and testing conducted by the FDOT Materials Office in selecting the: ~~on of~~

- A~~a~~ggregates, ~~and other materials, the pavement~~
- M~~m~~ix design, ~~the~~
- M~~m~~ethod of placement, and ~~the~~
- T~~t~~echniques ~~used~~ for finishing the pavement surface. ~~The~~

Monitor D~~d~~esign mixes ~~should be monitored by~~ through continuous field-testing during construction. Changes to the mix design~~ mix~~ or construction procedures must be made by qualified pavement designers and laboratory personnel ONLY.

~~The use of t~~Transverse grooving in concrete pavements ~~frequently~~ improves ~~the~~ wet weather skid resistance and decreases the ~~likelihood~~ risk of hydroplaning. ~~This technique~~ Consider transverse grooving ~~should be considered for~~ in locations requiring frequent vehicle maneuvers (curves, intersections, etc.) ~~or~~ and where heavy traffic volumes ~~or~~ and high speeds ~~will be~~ are expected~~encountered~~. The depth, width, and spacing of the grooves should ~~be such that~~ not hinder control of the vehicle~~ is not hindered~~.

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B.4 Drainage

Provide aAdequate drainage of the roadway and shoulder surfaces should be provided.

The f~~F~~actors affecting ~~involved in the general~~ drainage of the pavement ~~drainage pattern~~ include ~~pavement~~ longitudinal and cross slopes, surface texture, shoulder slopes ~~and surface texture~~, curbing ~~placement~~, and the location and design of drainage collection structures. The selection of pavement cross slope~~s~~ should ~~receive particular attention to~~ achieve ~~the~~ a proper balance between drainage requirements and vehicle operating requirements. The use of curbing on high-speed facilties ~~s or other drainage controls adjacent to the roadway surface~~ should be avoided~~, particularly on high-speed facilities~~. ~~Specific~~ The requirements for cross slopes and curb placement are provided ~~given~~ in ***Chapter* 3 ~~– Geometric Design~~**.

B.4.a Unpaved Roadway Drainage

Properly graded unpaved roadways require less maintenance and suffer less material loss. ~~Designers should strive to p~~ Provide adequate cross slopes and ~~,~~ shoulder and swale profiles ~~wherever possible~~. ~~Typical c~~ Cross slopes should be 2% ~~with~~ (1.5% minimum). ~~During maintenance grading, the operator should e~~Ensure ~~that~~ the ~~final~~ shoulder does not become higher than the travel lane edge during maintenance grading to prevent water ponding on the roadway ~~to prevent ponding of water on the roadway~~.

~~Designers may consult with~~ Refer to AASHTO's publication ***Guidelines for Geometric Design of Very Low-Volume Roads (ADT < 400), 2001*** and FHWA's ***Gravel Roads Construction & Maintenance Guide, August 2015*** for additional~~further~~ guidance ~~regarding~~ on ~~proper~~ cross slopes and profiles for unpaved roads.

B.5 Shoulder Treatment

~~The primary function of the~~ S~~s~~houlders ~~is to~~ provide an alternate travel path for vehicles ~~in an~~ in emergency situations. Shoulders should ~~be capable of~~ provide~~ing~~ a safe path for vehicles traveling at roadway speed~~, and should be designed and constructed to provide~~ with a firm and uniform surface ~~capable of~~ to support~~ing~~ vehicles in distress. ~~Particular attention shall be given to~~ P~~p~~rovide a smooth transition from the traveled way ~~pavement~~ to the shoulder. Shoulders ~~pavement may~~ can be paved ~~be provided~~ to:

- I~~i~~mprove roadway drainage ~~of the roadway~~,
- P~~p~~rovide lateral support of the roadway pavement, ~~to~~
- S~~s~~erve bicyclists, pedestrians~~,~~ and transit users, and ~~to~~

- Mminimize shoulder maintenance.

See ***Chapter 3*** ***– Geometric Design*** for additional information and criteria for shoulders.

Safety eEdge is a technology that mitigates vertical drop offs at the edge of pavement, . The Safety Edge provides a higher increasing the probability of a vehicle that errant vehicles can returning safely to the traveled way lane when it drifts off the pavement. See ***Chapter 10 – Maintenance and Resurfacing***, ***Section C.3.a Pavement Safety Edge*** for additional information and requirements for s~~S~~afety e~~E~~dge.

C PAVEMENT CONSTRUCTION

Conduct ~~A regular program of~~ sufficient inspection during construction ~~and evaluation should be conducted~~ to ensure that~~e~~ pavement criteria are satisfied~~ during the construction process~~. ~~Any regular~~ The inspection program should include~~ the following~~:

- ~~The use of~~ Using standard testing procedures, ~~such as~~ including AASHTO and the American Society for Testing and Materials (ASTM).
- ~~The use of~~ Using qualified personnel to perform testing and inspection.
- ~~The use of~~ Using an independent assurance procedure to validate the program.

~~After construction, the~~ Inspect pavement surfaces ~~shall be inspected~~ after construction to verify ~~determine the~~ that required surface texture and cross slopes were ~~as~~ achieved ~~and the surface has the specified slopes~~. Consider s~~S~~pot~~-~~ checking skid resistance ~~by~~ using approved methods ~~should be considered~~. Conduct p~~P~~eriodic reinspection ~~should be undertaken in conformance with the guidelines~~ as described in Chapter 10 ~~– Maintenance and Resurfacing~~.
~~After construction, the pavement surface shall be inspected to determine the required surface texture was achieved and the surface has the specified slopes. Spot checking skid resistance by approved methods should be considered. Periodic reinspection should be undertaken in conformance with the guidelines described in **_Chapter 10 – Maintenance and Resurfacing_**.~~

~~The major reason for~~ Highway l~~l~~ighting ~~streets and highways is to~~ improve~~s~~s safety for vehicular and pedestrian traffic. Improvements in nighttime sight distance ~~and reduction of confusion and distraction for nighttime driving can reduce the~~ reduces hazard potential ~~on streets and highways~~. ~~There is evidence indicating that highway~~ Highway lighting improves: ~~will produce an~~

- ~~increase in~~ H~~h~~ighway capacity, ~~as well as improve the~~
- E~~e~~conomics,
- S~~s~~afety, and
- A~~a~~esthetics ~~characteristics of highways~~.

~~Experience and technical improvements have resulted in improved design of lighting for streets and highways.~~ Photometric data provides a basis for calculating ~~on of the~~ illumination at any location along a roadway ~~point~~ for various combinations of ~~selected~~ luminaire type~~s~~, height~~s~~, and location~~s~~. Lighting engineers can ~~develop~~ design lighting systems that ~~will~~ comply with ~~the~~ requirements for level and uniformity of illumination; however, ~~some uncertainties~~ certain variables preclude ~~the adoption of~~ rigid design standards. Among these ~~uncertainties~~ variables is the ~~lack of understanding of~~ driver response and behavior under various lighting conditions. The design of new lighting ~~for new streets and highways, as well as improvements on~~ and modifications to existing systems ~~facilities,~~ should ~~be accompanied by careful~~ consider ~~ation of~~ the variables ~~involved~~ in driver behavior and the problems ~~peculiar to~~ associated with specific ~~particular~~ locations.

~~Rights of way with pedestrian~~ Roadways with sidewalks and~~/or~~ bikeways ~~adjacent to the roadway~~ should first address lighting requirements for the roadway ~~to assure it is continuously illuminated~~. Additional lighting may be needed for a sidewalk or shared use path ~~may be necessary if it is substantially~~ that is set back from the roadway. Coordinate with the maintaining agency. ~~, at the discretion of the responsible/maintaining agency~~. ~~Pedestrian~~ Do not illuminate s~~s~~idewalks and~~/or~~ bikeways ~~should not be illuminated in lieu of~~ without lighting the adjacent roadway to avoid glare and ~~or potential lighting~~ distractions to drivers.

See ***Chapter 17*** ~~***– Bridges and Other Structures***~~***, Section C.6*** for structural requirements for lighting.

B OBJECTIVES

~~The objective for providing l~~Lighting ~~is to~~ improves overall ~~the~~ safety ~~of roadways, sidewalks, and shared use paths~~ and visibility ~~of signs~~ for all roadway users (drivers, pedestrians, and bicyclists)~~. The achievement of this objective will be aided by meeting these specific goals~~ by:

- Providing~~e~~ an improved view of the ~~general~~ highway geometry and ~~the~~ adjacent environment.
- Increasing~~e~~ ~~the~~ sight distances to improve driver response to hazards and decision points.
- Eliminating~~e~~ "blind" spots unique to travel at night ~~or~~ and in low-light conditions.
- Providing~~e~~ a clearer overall view ~~of the general situation during~~ of police, emergency, maintenance, and construction operations.
- Providing~~e~~ delineation ~~assistance in~~ of the roadway, sidewalks ~~or~~ and paths ~~delineation~~, particularly in the presence of confusing background lighting (i.e., ~~surrounding street and other area~~ background lighting on an unlighted roadway can confuse~~s~~ ~~the~~ drivers ~~on an unlighted street or highway~~).
- Minimizing~~e~~ glare ~~that is discomforting or disabling~~.
- Reducing~~e~~ abrupt changes in light intensity.
- ~~Avoid the introduction of roadside hazards resulting from improper placement of light poles, pull boxes, etc. (as covered under ***Chapter 3 – Geometric Design*** and ***Chapter 4 – Roadside Design***).~~

C WARRANTING CONDITIONS

~~Although precise warrants for the provision of roadway lighting are difficult to determine, criteria for lighting is established and should be followed for new and reconstruction projects and for improvement of existing facilities. The following locations should be considered as a basis for~~ Roadway lighting can be warranted for ~~ing roadway lighting~~:

C.1 Criteria Based u~~U~~pon Crash History

- Locations ~~that, by a crash investigation program, have been~~ shown (by crash investigation) to be hazardous due to inadequate lighting.
- Locations where the night/day ratio of serious crashes is higher than the average of similar locations.
- ~~Specific~~ L~~l~~ocations that have a significant number of night-~~ ~~time crashes ~~and~~ where a large percentage ~~of these night time crashes~~ result in injuries or fatalities.

C.2 Criteria Based u~~U~~pon Analysis and Investigation

- Locations requiring a rapid sequence of decisions by the road user.
- Locations ~~where night sight distance problems exist, with consideration to~~ with headlight limitations (i.e., ~~where~~ with vertical and/or horizontal curvature ~~adversely affect illumination by headlamps~~).
- Locations ~~having~~ with discomforting or disabling glare.
- Locations where background lighting ~~exists, particularly if this could be~~ can be distracting or confusing ~~to the road user~~.
- Locations where improved delineation of the road~~high~~way alignment is needed.

C.3 General Criteria

- Roundabouts and signalized intersections.
- Urban streets~~,~~ (particularly with high nighttime speeds~~,~~ ~~high~~ volumes~~, or~~ and ~~frequent~~ turning movements).
- ~~Urban streets of any category experiencing high night time volumes or speeds or that have frequent signalization or turning movements.~~
- Congested a~~A~~reas ~~frequently congested with~~ (vehicular and/or pedestrian traffic).
- Pedestrian and bicyclist crossings (intersections ~~or~~ and mid-block locations).
- Transit stops and hubs~~,~~ and passenger rail stations.
- ~~Areas such as e~~Entertainment districts, sporting arenas, shopping centers, beach access points, parks, and ~~other~~ locations ~~that generate~~ with higher pedestrian volumes ~~of pedestrian activity~~.
- Schools, places of assembly, and~~or~~ other pedestrian or bicyclist generators.
- High-~~-~~density land use areas.
- Central business districts.
- ~~Junctions~~ Intersections of major highways in rural areas.
- Rest areas, ~~/~~picnic shelters, ~~/~~trail heads and ~~/~~recreational facilities.

D TYPES OF LUMINAIRES

~~Examples of c~~The most common types of lighting are ~~identified and discussed~~ described below. Other types of lighting ~~may~~ can be ~~desired and currently in~~ used for specific applications.

- Light Emitting Diode (LED) – is the preferred light source for street lighting. Light produced by LED lamps have a correlated color temperature (CCT) of 4000°K to 6000°K ~~which is~~ (a white to bluish color). The average rated life for LED ~~can~~ varies ~~y~~ from 50,000 to 100,000 hours. ~~To provide sufficient lumen levels for roadway applications, m~~ Most LED fixtures for roadway applications have an initial luminous efficiency ~~of~~ around 75 lumens per watt.

- High Pressure Sodium (HPS) ~~Lamps~~ – l~~L~~ight produced by HPS lamps have~~s~~ a ~~correlated color temperature (~~CCT~~)~~ around 2100°K ~~which is~~ (a warm yellow color). The average rated life for ~~an~~ HPS ~~lamp is~~ varies from 24,000 to 30,000 hours. HPS lamps have a very high initial luminous efficiency ~~of over~~ over~~-~~ 100 lumens per watt.

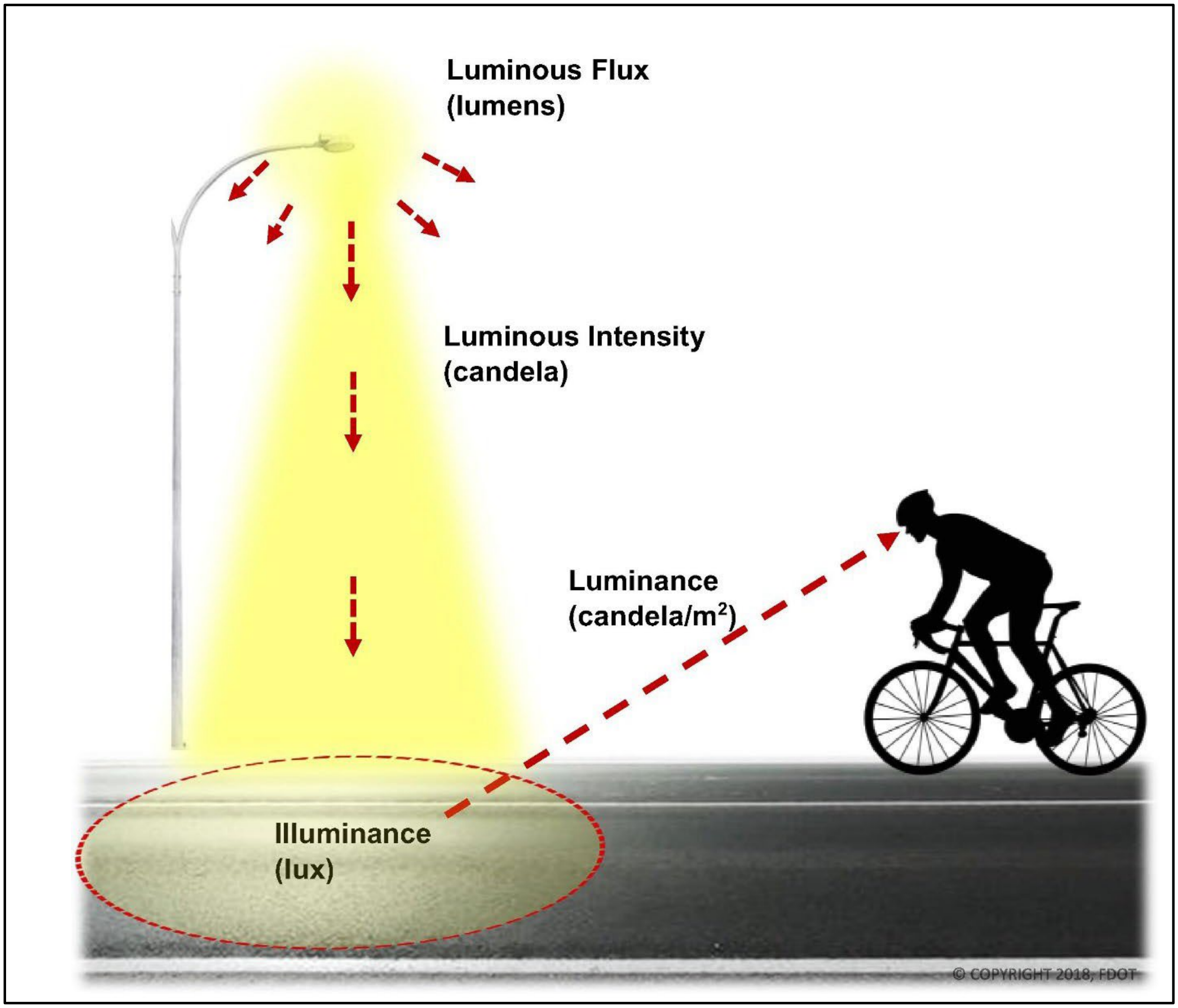
- Metal Halide (MH) ~~Lamps~~ – is used for ~~overhead~~ lighting ~~of~~ commercial parking lots, sports facilities, retail stores and street lighting. Light produced by MH lamps have~~s~~ a CCT of 3800°K to 4000°K ~~which is~~ (a white color). The average rated life for ~~of a~~ MH ~~lamp can~~ varies ~~y~~ from 9,000 to 20,000 hours. MH lamps have a high initial luminous efficiency ~~of~~ around 75 - 100 lumens per watt.

E LIGHTING DESIGN TECHNIQUES

The accepted methods for achieving ~~a given~~ lighting standards ~~condition~~ are known as either level of illuminance or level of luminance. Both methods ~~of calculation are~~ depend~~ent upon~~ on light being reflected toward the observer's eye. Horizontal illuminance is used for intersections and interchanges and includes a variable for surface type. Horizontal and vertical illuminance i~~s the~~ are preferred ~~method~~ for pedestrian areas. The luminance method can be used for straight roadways ~~and streets,~~ and is based upon the appropriate choice of surface type.

See Figure 6 – 1 ~~Illuminance and Luminance illustrates how~~ for measuring illuminance and luminance ~~are measured~~. Illuminance is the measure of the amount of light flux falling on a surface ~~and is~~ (measured in foot candles). Luminance is a measure of the amount of light flux leaving a surface ~~and is~~ (measured in candelas per square meter ~~squared~~).

Figure 6 – 1 Illuminance and Luminance



E.1 Illuminance

The illuminance method determines the amount of light falling on the roadway surface or on vertical surfaces~~ from the roadway lighting system~~. Different illuminance levels are needed for each type of standard roadway surface ~~Because~~ because the amount of light seen by the driver is the portion that reflects from the pavement ~~towards the driver~~, and ~~because~~ because different pavements ~~exhibit varied~~ have different reflectance characteristics~~, different illuminance levels are needed for each type of standard roadway surface~~. Illuminance is easily calculated and measurable and is not observer or pavement dependent.

E.2 Luminance

The luminance method determines how "bright" the roadway is by determining the amount of light reflected from the pavement~~ in the direction of the driver. It~~ using~~es~~ the reflective characteristics (R-classification) noted in Table 6 – 1 ~~Road Surface Classifications~~ for the standard roadway surface types and a specific driver~~observer~~ position.

The R-classification system is a measure of the a roadway surface's lightness (white to black) and specularity (shininess)~~ of roadway surfaces~~. ~~A system of pavement reflectance values divides the p~~ Pavement characteristics are divided into four categories~~:~~ (R1, R2, R3 and R4) ~~. These categories are~~ based upon the ***American National Standard Practice for Roadway Lighting*** ~~and have been~~ as adopted by ***AASHTO*** in their ***Roadway Lighting Design Guide.***

Table 6 – 1 Road Surface Classifications

Class	Q0*	Description	Mode of Reflectance
R1	0.10	Portland cement concrete roadway surface. Asphalt roadway surface with ~~a minimum of~~ at least 12% of the aggregates composed of artificial brightener or aggregates.	Mostly diffuse
R2	0.07	Asphalt roadway surface with an aggregate composed of ~~minimum~~ at least 60% gravel (~~size greater than~~ over 0.4 inches~~.~~). Asphalt roadway surface with 10 to 15% artificial brightener in aggregate mix. (Not normally used in North America).	Mixed (diffuse and specular)
R3	0.07	Asphalt roadway surface (regular and carpet seal) with dark aggregates (e.g., trap rock, blast furnace slag); rough texture after some months of ~~use~~ typical highway uses~~s)~~.	Slightly specular~~.~~
R4	0.08	Asphalt roadway surface with very smooth texture.	Mostly specular~~.~~

* Q_0 = representative mean luminance coefficient.

E.3 Lighting Design Levels

See Table 6 – 2 for ~~The level of~~ minimum illumination levels for streets and highways ~~should not be less than those shown in Table 6 – 2 Illuminance and Luminance Design Values~~. ~~When adding supplemental lighting for pedestrian activity, e~~Ensure that supplemental lighting for pedestrians is compatible with ~~any~~ existing corridor lighting ~~in the corridor~~ and minimizes glare.

These lighting design levels are for ~~the purpose of~~ highway safety ~~and do not apply to lighting levels required~~ (not for crime reduction). ~~Further information may be found in the~~ See the ***AASHTO Roadway Lighting Design Guide (2005)*** for additional information.

Table 6 – 2 Illuminance and Luminance Design Values

Roadway and Walkway Classification	Off-Roadway Light Sources	Illuminance Method					Luminance Method			Additional Values (both Methods)
		Average Maintained Illuminance (Horizontal)				Illuminance Uniformity Ratio	Average Maintained Luminance			Veiling Luminance Ratio
		R1	R2	R3	R4		Lavg	Uniformity		
	General Land Use	(foot -candles) (min)	(foot-candles) (min)	(foot-candles) (min)	(foot-candles) (min)	avg/min (max) (6)	cd/m2 (min)	Lavg/Lmin (max)	Lmax/Lmin (max)	Lv(max)/Lavg (max)(3)
Principal Arterials (partial or no control of access)	Commercial	1.1	1.6	1.6	1.4	3:1	1.2	3:1	5:1	0.3:1
	Intermediate	0.8	1.2	1.2	1.0	3:1	0.9	3:1	5:1	0.3:1
	Residential	0.6	0.8	0.8	0.8	3:1	0.6	3.5:1	6:1	0.3:1
Minor Arterials	Commercial	0.9	1.4	1.4	1.0	4:1	1.2	3:1	5:1	0.3:1
	Intermediate	0.8	1.0	1.0	0.9	4:1	0.9	3:1	5:1	0.3:1
	Residential	0.5	0.7	0.7	0.7	4:1	0.6	3.5:1	6:1	0.3:1
Collectors	Commercial	0.8	1.1	1.1	0.9	4:1	0.8	3:1	5:1	0.4:1
	Intermediate	0.6	0.8	0.8	0.8	4:1	0.6	3.5:1	6:1	0.4:1
	Residential	0.4	0.6	0.6	0.5	4:1	0.4	4:1	8:1	0.4:1
Local	Commercial	0.6	0.8	0.8	0.8	6:1	0.6	6:1	10:1	0.4:1
	Intermediate	0.5	0.7	0.7	0.6	6:1	0.5	6:1	10:1	0.4:1
	Residential	0.3	0.4	0.4	0.4	6;1	0.3	6:1	10:1	0.4:1
Alleys	Commercial	0.4	0.6	0.6	0.5	6:1	0.4	6:1	10:1	0.4:1
	Intermediate	0.3	0.4	0.4	0.4	6:1	0.3	6:1	10:1	0.4:1
	Residential	0.2	0.3	0.3	0.3	6:1	0.2	6:1	10:1	0.4:1

Continued next page

Table 6 – 2
Illuminance and Luminance Design Values
(Continued)

Sidewalks	Commercial	0.9	1.3	1.3	1.2	3:1	Use illuminance requirements
	Intermediate	0.6	0.8	0.8	0.8	4:1	
	Residential	0.3	0.4	0.4	0.4	6:1	
Pedestrian Ways and Bicycle Ways(2)	All	1.4	2.0	2.0	1.8	3.1	

Notes

1. Meet either the Illuminance design method requirements or the Luminance design method requirements and meet veiling luminance requirements for both l~~I~~lluminance and Luminance design methods.
2. Assumes a separate facility. Use roadway design values f~~F~~or p~~P~~edestrian w~~W~~ays and b~~B~~icycle w~~W~~ays adjacent to roadway~~, use roadway design values~~. Use R3 requirements for walkway/bikeway surface materials other than the pavement types shown.
3. Lv (max) refers to the maximum point along the pavement~~,~~ (not the maximum in lamp life). The m~~M~~aintenance factor applies to both the Lv term and the Lavg term.
4. There ~~may~~ can be situations when a higher illuminance level ~~of illuminance~~ is justified. The higher values for freeways ~~may~~ can be justified when deemed advantageous ~~by the agency~~ to mitigate off-roadway sources.
5. Physical roadway conditions ~~may~~ can require adjustment of spacing determined from the base levels of illuminance indicated above.
6. Higher uniformity ratios are acceptable for elevated ramps near high-mast poles.
7. See AASHTO publication entitled, “A Policy on Geometric Design of Highways and Streets” for roadway and walkway classifications.
8. R1, R2, R3 and R4 are Road Surface Classifications~~,~~ defined in the AASHTO Roadway Lighting Design Guide and ~~further~~ described in Table 6.2.

F UNIFORMITY OF ILLUMINATION

Maintain illumination uniformity over the roadway t~~T~~o avoid vision problems ~~due to~~ resulting from varying illumination ~~, it is important to maintain illumination uniformity over the roadway~~. ~~It is~~ The recommended ~~the~~ ratio of the average to the minimum initial roadway illumination ~~on the roadway~~ is ~~be~~ between 3:1 ~~to~~ and 4:1.

Do not exceed a~~A~~ maximum to minimum uniformity ratio of 10:1 ~~should not be exceeded. It is important~~ to allow time for the driver's eye to adjust to lower light levels. Locate t~~T~~he first light poles ~~should be located~~ on the side of the incoming traffic approaching the illuminated area. The eye can adjust to increased ~~or~~ and increasing light levels more quickly. ~~In t~~Transition gradually from a lighted portion to an unlighted portion of a ~~the~~ highway~~s, the level should be gradually reduced from the level maintained on the lighted section~~. This ~~may~~ can be accomplished by locating ~~having~~ the last light pole ~~occur~~ on the opposite roadway. ~~The~~ Keep the roadway section following lighting termination ~~should be~~ free of hazards ~~or~~ and decision points. Do not terminate lighting ~~Lighting should not be terminated before~~ before changes in background lighting or roadway geometry, or ~~at the~~ locations of traffic control devices.

~~It is also important to e~~Ensure color consistency ~~when~~ for lighting a highway/pedestrian corridor. Mixing ~~of~~ different types of lighting ~~may~~ can reduce ~~the~~ lighting uniformity. ~~As we transition to LED, it is acceptable to have m~~ Mixed lighting segments along the same corridor are acceptable as the industry transitions over time to LED.

~~The use of~~ Consider providing spot lighting at unlit intersections with ~~a~~ historie ~~y~~ of nighttime crashes ~~is an option~~.

~~Close coordination between the Engineer of Record and~~ The Lighting Engineer must coordinate with the ~~responsible local governmental~~ local maintaining agency ~~is essential~~.

G UNDERPASSES AND OVERPASSES

Analyze the difference in roadway illumination under and outside an underpass to determine requirements for underpass lighting~~One of the criteria to be followed to determine requirements for underpass lighting is the relative level between illumination on the roadway inside and outside of the underpass~~. The amount of light penetration below an underpass is a function of the height, width, and length of the underpass~~ determines the amount of light penetration from the exterior~~.

Evaluate t~~T~~he need for lighting ~~of~~ independent sidewalks and~~or~~ shared use paths ~~should be evaluated~~ on a ~~project specific~~ case by case basis, considering: ~~. Considerations include~~

- T~~t~~he likelihood of night-~~-~~time use,
- T~~t~~he role of the facility in the community's bicycle and pedestrian network, and
- W~~w~~hether other alternatives are available for night-~~-~~time travel.

~~When lighting an underpass, u~~Use ~~a~~ wall-mounted underpass luminaires ~~that is~~ attached to a pier, pier cap, or ~~the~~ wall coping~~s~~ under~~neath~~ the bridge.

G.2 Daytime Lighting

Provide a~~A~~ gradual decrease in ~~the~~ illumination level from daytime level on the roadway, sidewalk or path to the underpass~~ should be provided~~. Consider daytime lighting for vehicles in underpasses ~~greater than~~ over 80 feet long ~~in length~~.

Consider s~~S~~upplemental ~~lighting of~~ sidewalk~~s~~ ~~or~~ and shared use path~~s~~ lighting ~~in roadway~~ of underpasses less than 80 feet long ~~in length should be considered~~. Sidewalks and shared use paths on independent alignments with little natural light should be illuminated, especially if the exit is not visible upon entry.

G.3 Night Lighting

Provide ~~The~~ nighttime underpass illumination levels ~~in the underpass of the roadway should be maintained~~ near the ~~nighttime~~ levels of the approach roadway. Consider underpass l~~L~~ighting of sidewalks ~~or~~ and shared use paths~~ adjacent to roadways in underpasses should be considered~~. Illuminate s~~S~~idewalks and shared use paths on independent alignments open ~~to travel~~ during darkness ~~should be illuminated~~. ~~Due to relatively low luminaire mounting heights in underpasses,~~ Use care ~~should be exercised~~ to avoid glare due to low luminaire mounting heights.

H DECORATIVE ROADWAY LIGHTING

Decorative and~~or~~ architectural roadway lighting is acceptable ~~provided it~~ when it meets the minimum design criteria and ~~the~~ objectives ~~contained~~ provided herein~~in this Manual~~. Examples include:

- A~~a~~rchitectural lighting posts,
- C~~c~~ross arms,
- W~~w~~all brackets,
- B~~b~~ollards, and
- L~~l~~ight fixtures.

I ADAPTIVE LIGHTING

Some locations ~~such as~~ (e.g., coastal roadways where sea turtles ~~may~~ may be affected) ~~,~~ ~~may~~ can require lower lighting levels and different colors ~~than what might normally be provided~~. See FHWA~~'s~~ publication ***The Guidelines for the Implementation of Reduced Lighting on Roadways*** ~~describes a process by which an agency or a lighting designer can~~ (which supplements existing lighting guidelines) to select ~~the required~~ roadway lighting levels ~~for a road or street~~ and implement adaptive lighting for an ~~lighting~~ installation or ~~lighting~~ retrofit ~~. This document supplements existing lighting guidelines~~.

J WILDLIFE-SENSITIVE LIGHTING

The lighting on some coastal roadways ~~may~~ can affect ~~wildlife, including~~ sea turtles, and ~~may~~ can require:

- L~~l~~ower lighting levels,
- A~~a~~djusting the direction of luminaires, and
- D~~d~~ifferent types and colors of lighting ~~installations than what might normally be provided~~.

Sea turtles and ~~their habitat (~~nesting beaches~~)~~ are afforded protection ~~in accordance with~~ under ***Florida's Marine Turtle Protection Act (379.2431, F.S.)*** which ~~restricts~~ prohibits the take, possession, disturbance, mutilation, destruction, selling, transference, molestation, and harassment of marine turtles, nests ~~or~~ and eggs.

The state of Florida developed the ***Model Lighting Ordinance for Marine Turtle Protection Rule (62B-55, F.A.C.)*** to guide local governments in creating lighting ordinances. See the Municipal Code Corporation web site for a list of c~~C~~ounties and municipalities in Florida ~~that~~ which have passed ordinances prohibiting light from reaching the beach ~~can be found on the Municipal Code Corporation web site~~. Coordinate with ~~the~~ nearby local agencies ~~in proximity to the project~~ for additional requirements ~~and guidance on providing~~ for permanent lighting ~~or~~ and lighting in work zones.

Contact the Florida Fish and Wildlife Conservation Commission (FWC) at ***MarineTurtle@MyFWC.com*** regarding w~~W~~ildlife areas of concern ~~can be determined by contacting the Florida Fish and Wildlife Conservation Commission (FWC) at *MarineTurtle@MyFWC.com*~~. See the ***FDOT Office of Environmental Management "OEM Resources"*** web page (under Turtle Lighting) for KMZ layers and s~~S~~hape files ~~illustrating areas where~~ for wildlife sensitive areas ~~occur can be found~~ are provided on ~~the *FDOT's Office of Environmental Management "OEM Resources"* web page, under Turtle Lighting~~.

See the ***Florida Geographic Data Library (FGDL)*** for a~~A~~n interactive map of wildlife sensitive areas ~~can also be found in the *Florida Geographic Data Library (FGDL),* and will show areas of the state~~ where wildlife sensitive lighting measures should be implemented. Use the key word "turtle" in the search function. Direct links ~~for download from~~ to the ***FGDL*** layers are:

- ***https://download.fgdl.org/pub/state/trtl_sen_light_jul20.zip***
- ***https://download.fgdl.org/pub/state/trtl_drksky_light_jul20.zip***

See the ***FWC Sea Turtle Lighting Guidelines*** website for a~~A~~dditional information ~~can be found on~~ ~~***FWC's Sea Turtle Lighting Guidelines***~~ ~~website~~.

Implement the design requirements below f~~F~~or conventional lighting near a wildlife area of concern ~~, incorporate the following design requirements~~:

1. ~~Where feasible, o~~Orient luminaires away from the wildlife area of concern (where feasible).

2. Design the lighting system using luminaires ~~that~~ meeting these ~~following~~ requirements:

   a. The luminaire light source ~~for the luminaires~~ must be true red, orange, or amber light-~~-~~emitting diodes (LEDs) with no more than 1.75% of the spectral power distribution below 560 nm.

   b. The optics must have an IP 66 rating.

   c. The luminaire mounting assembly must be a slip fitter type designed to accommodate a nominal 2-~~-~~inch pipe size (2-3/8 inch O.D.) arm or a pole top mounting assembly designed to accommodate a 2-3/8 inch pole top tenon.

   d. Luminaires must have an IESNA light distribution curve (IES LM-79) designated by an EPA-recognized laboratory.

   e. Luminaires must ~~meet a minimum pole~~ be spaced ~~ing of~~ at 50 feet or more.

See the FDOT ***APL*** (the Wildlife-Sensitive Conventional Lighting category) and the FWC ***Certified Wildlife Lighting Guidelines*** ~~Further information on~~ for luminaires ~~which~~ meeting the criteria for wildlife sensitive lighting ~~may be found on the FDOT's~~ ~~***Approved Product List (APL)***~~ ~~in the Wildlife-Sensitive Conventional Lighting category or FWC's~~ ~~***Certified Wildlife Lighting Guidelines***~~. The AGi32 lighting optimization tool~~,~~ (used ~~in accordance with~~per the settings provided~~shown~~ in the FDOT ***Standard Specifications for Road and Bridge Construction, 992-2.4 Luminaires for Wildlife Sensitive Lighting***) ~~,~~ ~~may~~ can be used to design appropriately spaced lighting.

~~J.1~~J.2 Work Zones in Wildlife Sensitive Areas

For temporary lighting of nighttime work night work along coastal roadways where sea turtles may may be affected , incorporate the following for temporary lighting of work zone operations:

1. Direct all work zone lighting away from the beach to avoid illumination of ~~or~~ and direct visibility from the beach.

2. Shield luminaires to avoid lighting areas outside of the immediate construction area.

K OVERHEAD SIGN LIGHTING

Provide overhead sign lighting ~~If the~~ when sign visibility ~~of the sign~~ is inadequate due to roadway geometry or inadequate sign panel retro~~-~~reflectivity ~~of the sign sheeting is inadequate, overhead sign lighting should be provided~~. ~~It is recommended that~~ T~~t~~he level of illumination for overhead signs should not be less than ~~guidelines~~ provided ~~found~~ in Table 6 – 3 ~~Illuminance and Luminance Levels for Sign Lighting~~. See ***Chapter 18*** – ~~***Signing and Marking***~~ for ~~signage~~ retroreflectivity requirements.

Table 6 – 3 Illuminance and Luminance Levels for Sign Lighting

Ambient Luminance	**Sign Illuminance**		**Sign Luminance***	
	Footcandles	**Lux**	**Candelas per Square Meter**	**Candelas per Square Foot**
Low	10 - 20	100 - 200	22 - 44	2.2 – 4.4
Medium	20 - 40	200 - 400	44 - 89	4.4 – 8.9
High	40 - 80	400 - 800	89 - 78	89 – 178

Source: AASHTO Roadway Lighting Design Guide (October 2005), Table 10 – 1 ~~Illuminance and Luminance Levels for Sign Lighting~~.

*Based upon a maintained reflectance of 70 percent for white sign letters.

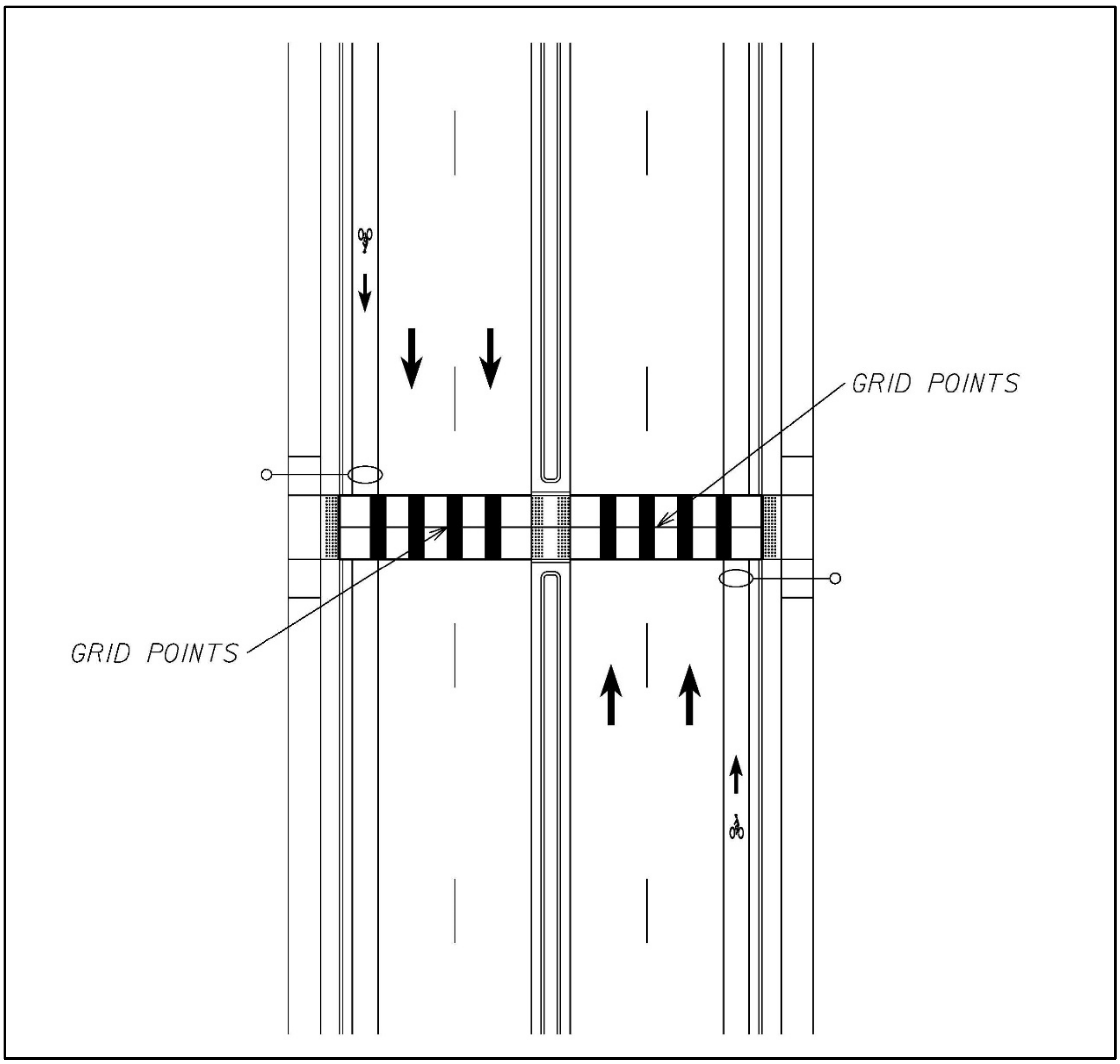
L ROUNDABOUTS

Roundabouts should be supplemented with roadway lighting. ~~Where pedestrians are expected, p~~ Provide additional lighting of 2.0-foot candles of maintained vertical illumination~~,~~ (measured at 5 feet ~~from~~ above the roadway surface) where pedestrians are expected. Calculate the vertical illuminance for the crosswalk on each near side approach entering and exiting the roundabout.

M MIDBLOCK CROSSWALKS

~~At midblock pedestrian crossings, p~~Provide 2.0-foot candles of maintained vertical illumination~~,~~ (measured at 5 feet ~~from~~ above the roadway surface) at midblock pedestrian crossings. Calculate the vertical illuminance for the crosswalk on each near side approach.

Figure 6 – 2 Horizontal and Vertical Illuminance for Mid-Block Crosswalk



N MAINTENANCE

Establish a ~~A program of~~ regular preventive maintenance program ~~should be established~~ to ensure levels of illumination do not drop~~go~~ below required values. ~~The program should be c~~Coordinate the program ~~d~~ with the lighting design to ~~determine~~ establish the maintenance period. Consider f~~F~~actors ~~for consideration~~ including: ~~e~~

- A~~a~~ decrease in lamp output,
- L~~l~~uminaire components becoming dirty, and
- T~~t~~he physical deterioration of the reflector or refractor.

Incorporate ~~The maintenance of~~ roadway lighting maintenance ~~should be incorporated~~ in the overall maintenance program ~~specified in~~ (see ***Chapter 10***) ~~– ***Maintenance and Resurfacing***~~.

O LIGHT POLES

Do not locate l~~L~~ight poles ~~should not be placed~~ in ~~the~~ a sidewalk where ~~n~~ adequate ~~right of way~~ R/W is available beyond the sidewalk. ~~Placement of lighting structures and achieved illumination may~~ Illumination levels can be limited by existing conditions ~~such as~~ (e.g., driveways, overhead and underground utilities, drainage structures, and R/W availability) ~~of right of way~~.

Do not locate l~~L~~ight poles ~~should not be placed~~ so as to ~~provide~~ be a hazard to errant vehicles. Locate n~~N~~on-~~-~~frangible light poles: ~~should be placed~~

- O~~o~~utside of the clear zone~~. They should be~~ ,
- A~~a~~s far ~~removed~~ from the travel lane as possible, or~~or~~
- B~~b~~ehind ~~adequate~~ guardrail or other barriers~~s~~.

Locate l~~L~~ight poles ~~should be placed~~ on the inside of ~~the~~ roadway curves (when feasible).
Light pole f~~F~~oundations ~~or light poles~~ and rigid auxiliary lighting components that are not located behind suitable barriers should be constructed flush with or below the ground surface ~~level~~.

~~The use of h~~Consider using High-~~-~~mast lighting ~~should be considered, particularly~~ for ~~lighting~~ interchanges and other large plaza areas. ~~This use~~ High-mast lighting tends to:

- P~~p~~roduce a more uniform illumination level,
- R~~r~~educe~~s~~ glare, and
- A~~a~~llow~~s~~ placement ~~of the light poles~~ farther from the roadway.

Consider a~~A~~dditional emphasis lighting ~~should be considered~~ to illuminate ~~specific and desired~~ pedestrian crossings.

The placement of Locate light poles should not to avoid interfering e with the driver's sight distances or and the visibility of signs, signals, andor other traffic control devices. In addition, tThe ***National Electrical Code (NEC)*** also requires a working area around light poles for safety purposes around the poles. See Chapter 4 of this manual for additional Further criteria regarding the placement of roadside structures, including for locating light poles , is specified in ***Chapter 4 – Roadside Design***.

P REFERENCES FOR INFORMATIONAL PURPOSES

The publications referenced in this chapter can be obtained at ~~the following web sites.~~:

- Roadway Lighting, ANSI/RP-8-21
https://blog.ansi.org/ansi-ies-rp-8-21-design-roadway-lighting/#gref

- Design Guide for Residential Street Lighting (2015), Illuminating Engineering Society
https://www.ies.org/store/design-guides/design-guide-for-residential-street-lighting/

- AASHTO - Roadway Lighting Design Guide (October 2005)
https://highways.dot.gov/safety/other/visibility/roadway-lighting-resources

- Guidelines for the Implementation of Reduced Lighting on Roadways PUBLICATION NO. FHWA-HRT-14-050 JUNE 2014
http://www.fhwa.dot.gov/publications/research/safety/14050/14050.pdf

- The Lighting Handbook, 10th Edition, Illuminating Engineering Society (IESA)
https://www.ies.org/store/lighting-handbooks/lighting-handbook-10th-edition/

- National Electric Code (NEC)
https://www.nfpa.org/NEC/About-the-NEC/Free-online-access-to-the-NEC-and- other-electrical-standards

CHAPTER 7

RAIL-HIGHWAY CROSSINGS

A INTRODUCTION

The basic design criteria for rail-highway grade crossings should be is similar to that given for high roadway intersections in (see ***Chapter* 3)** ***3 – Geometric Design***. Limit the number of rRail-highway grade crossings. should be limited in number and should, where feasible, be accomplished by Use grade separations where feasible. Where at-grade crossings are necessary, provide adequate traffic control devices and proper crossing designs are required to limit the probability risk of crashes.

B OBJECTIVE AND PRIORITIES

The primary objective in tThe design, construction, maintenance, and reconstruction of rail-highway crossings is to must promote vide safety for both railroad and roadway vehicles in a reasonable feasible and efficient manner. The achievement of this objective may be realized by utilizing Use the following techniques below (in order of priority) to achieve this objective: in the listed sequence of priority.

B.1 Conflict Elimination

Closing an existing grade crossing or constructing a new grade separation eliminates the conflict entirely (which is most desirable) 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 should consider the objective of prioritize hazard reduction. In addition, an effective program of RReconstruction projects should focus on 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 Chapter 14-57: Railroad Safety and Clearance Standards, and Public Railroad-Highway Grade Crossings***. This rule contains provides minimum requirements for all new grade crossings.

Contact t~~T~~he FDOT~~'s~~ Freight and R~~r~~ail O~~o~~ffice~~ has other documents available that contain ~~ for additional guidance ~~for the~~ on designing, reconstructing~~on~~, and upgrading ~~of~~ existing rail-highway grade crossings~~, and may be contacted for further information~~.

C RAIL-HIGHWAY GRADE CROSSING NEAR OR WITHIN PROJECT LIMITS

Review f~~F~~ederal-aid projects ~~must be reviewed~~ to determine if a rail-highway grade crossing is within or near the terminus ~~the limits of or near the terminus~~ of the project. If so, ~~such rail-highway grade crossing exists,~~ the project must ~~be upgraded to~~ meet the requirements of the ***Manual on Uniform Traffic Control Devices (2009 Edition with Revision Numbers 1 and 2, ~~May~~ May 2012) (MUTCD)*** ~~in accordance with~~per ***Title 23, United States Code (U.S.C.), Chapter 1, Section 109(e)*** *and* ***23 C.F.R. 646.214(b).***

See ***Chapter 8*** of the ***MUTCD*** for t~~T~~hese requirements~~ are located in **Chapter 8** of the **MUTCD**~~. “Near the terminus” is defined as ~~being~~ either~~ of the following~~:

- T~~If t~~he 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.

- A~~n intersection~~ traffic signal within the project limits ~~is~~ communicates with ~~linked to~~ the crossing’s flashing light signal and gate.

D DESIGN OF RAIL-HIGHWAY CROSSINGS

The ~~primary requirement for the~~ geometric design of a ~~-~~grade crossing ~~is that it~~ must provide~~s~~ adequate sight distance~~s~~ for ~~the motorist~~ drivers to decide ~~make an appropriate decision as~~ to stop or proceed~~ at the crossing~~.

D.1 Sight Distance

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

D.1.a Stopping Sight Distance

~~The approach roadways at all rail-highway grade crossings should consider~~ Provide roadway stopping sight distances for approaches to stop signs no less than those ~~e values given~~ in ***Chapter 3,*** Table 3 – 3 ~~Minimum Stopping Sight Distances for the approach to stop signs~~. This distance ~~shall be~~ is measured to a stopping point ~~prior to~~ before the crossing gates and ~~or~~ stop bars~~ at the crossing, but not less than~~ (at least 15 feet from the nearest track). All traffic control devices ~~shall~~ must be visible from ~~the~~ a driver's eye height of 3.50 feet.

D.1.b Sight Triangle

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

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

The size of the~~is~~ sight triangle (see Figure 7 – 1) ~~, which is shown in~~ depends upon:

~~Figure 7 – 1 Visibility Triangle at Rail-Highway Grade Crossings, is dependent upon~~

- T~~t~~he train speed limit,
- T~~t~~he highway design speed, and
- T~~t~~he highway approach grade.

The minimum distance along the highway (d_H)~~,~~ includes the requirements for:

- The sstopping sight distance, the
- The ooffset distance (D) from the edge of track to the stopped position (15 feet), and
- TThe eye offset (d_e) from the front of the vehicles (8 feet); (see Figure 7 – 1, Case A).

The required distance (d_T) along the track , given in (see Table 7 – 1) Sight Distance at Rail-Highway Grade Crossings, is necessary to allows a the vehicle driver to stop or proceed safely across the

~~track safely~~. Increase the lateral sight distance (d_T) along the track (see Table 7 – 1) w~~W~~here 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~~ It can be necessary (in other than flat terrain) to rely on speed control signs and devices and to predicate sight distance on a reduced speed of operation. This reduced speed should not ~~ever~~ be less than 15 mph~~ and~~ (preferably 20 mph).

D.1.c Crossing Maneuvers

The sight distance required for a vehicle to cross a railroad from a stop is ~~essentially the same as~~ similar to that required to cross a highway intersection ~~as given in~~ (see ***Chapter 3***)~~ – **_Geometric Design_**~~.

Provide a~~A~~n adequate clear distance along the track in both directions ~~should be provided~~ at all crossings. This distance~~, when used, shall~~ must be no less than the values ~~obtained from~~ in 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,~~ Increase this distance ~~should be increased~~ where~~ver~~ possible due to longer train stopping distances.

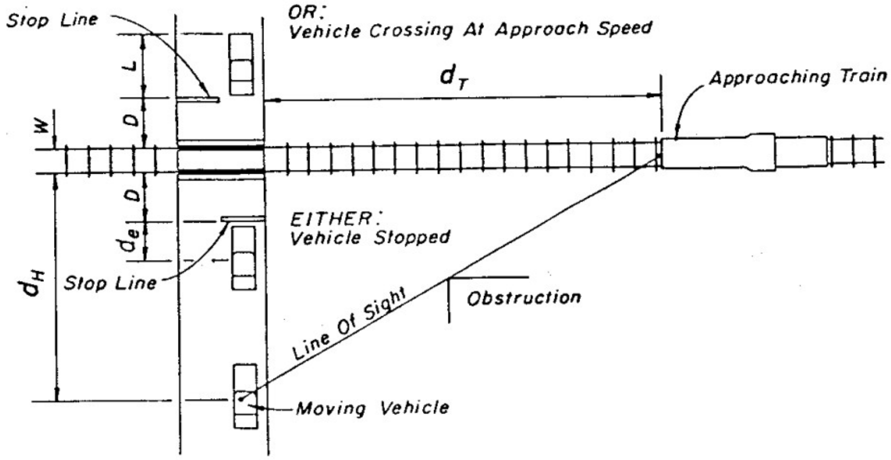
Use a ~~The~~ crossing distance ~~to be used shall~~ that includes:

- T~~t~~he total width of the tracks,
- T~~t~~he length of the vehicle, and
- A~~a~~n initial vehicle offset~~. This offset shall be~~ of at least 10 feet back from any gates or flashing lights, ~~but~~ but not less than 15 feet from the nearest track.

Use a ~~The~~ train speed ~~used shall be~~ equal to or above ~~greater than~~ the established train speed limit.

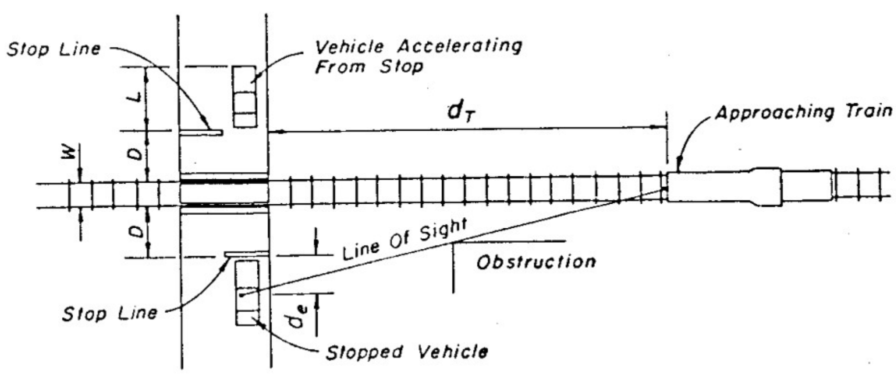
The setback for determining the required clear area for sight distance should be at least 10 feet more than the vehicle offset. ~~Care should be exercised to~~ E~~e~~nsure that signal supports and other structures at the crossing do not block the view of drivers preparing to cross the tracks.

Figure 7 – 1 Visibility Triangle at Rail-Highway Grade Crossings



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.**

Table 7 – 1 Sight Distance at Rail-Highway Grade Crossings

Design Sight Distances for Combinations of Train and Highway Vehicle Speeds Conditions:								
Single Track 90° Crossing Design Vehicle WB-62FL and WB-67 (L=73.5 feet d_e=8 feet) Flat Highway Grades			Track Width (W) = 5 feet Vehicle Stop Position (D) = 15 feet No Train Activated Warning Devices					
Train Speed (mph)	Case B Vehicle Departure From Stop	Case A Moving Vehicle						
	Vehicle Speed (mph)							
	0	10	20	30	40	50	60	70
	d_t (feet) Sight Distance Along Railroad Track							
10	255	155	110	102	102	106	112	119
20	509	310	220	203	205	213	225	239
30	764	465	331	305	307	319	337	358
40	1019	619	441	407	409	426	450	478
50	1274	774	551	509	511	532	562	597
60	1528	929	661	610	614	639	675	717
70	1783	1084	771	712	716	745	787	836
80	2038	1239	882	814	818	852	899	956
90	2292	1394	992	915	920	958	1012	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

(Continued on Next Page)

Table 7 – 1 Sight Distance at Rail-Highway Grade Crossings (Cont')

d_H (feet) Sight Distance Along Highway							
	69	135	220	324	447	589	751

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

2. Corrections must be made for conditions other than provided~~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~~ See Railroad-Highway Grade Crossings under ***Chapter 9*** of "***A Policy on Geometric Design of Highways and Streets", AASHTO (2011)*** for condition adjustments and additional information. ~~Additional information is available on~~ See the FHWA~~'s~~ website for ***Highway-Rail Grade Crossing Surfaces*** and ***NCHRP Synthesis 250 Highway – Rail Grade Crossing Surfaces, TRB, (1998)*** for additional information.~~"~~

Source: Developed from ***Table 9 – 32, A Policy on Geometric Design of Highway and Streets, AASHTO (2011).***

D.2 Approach Alignment

The alignment of the approach roadway~~s~~ is ~~a~~ critical ~~factor~~ in designing ~~veloping~~ a safe grade crossing. ~~The~~ Use horizontal and vertical alignments ~~, and particularly any combination thereof, should be~~ that are as gentle as possible (especially when in combination).

D.2.a Horizontal Alignment

The intersection angle of a highway and railroad should be ~~made~~ as near to ~~the right angle (~~90 degrees~~)~~ as possible. Avoid i~~I~~ntersection angles ~~less than~~ below 70 degrees ~~should be avoided~~. The highway approach should ~~, if feasible,~~ be on a tangent ~~, because the use of a~~ as horizontal curves can interfere with the driver's attention to ~~tends to distract the driver from a careful observation of~~ the crossing. In addition, the roadway could not be superelevated while matching the tracks ~~The use of superelevation at a crossing is normally not possible since this would prevent the proper grade intersection with the railroad~~.

D.2.b Vertical Alignment

The roadway vertical alignment ~~of the roadway on a crossing~~ is ~~an~~ important

~~factor in~~ to safe vehicle operation. The intersection of the tracks and the roadway should ~~constitute~~ be on an even plane. All tracks should~~, preferably,~~ be at the same elevation, ~~thus allowing~~ to achieve a smooth roadway ~~through the~~ crossing. ~~Where the railroad is on a curve with superelevation, t~~ The roadway vertical alignment ~~of the roadway~~ ~~shall~~ must match ~~coincide with~~ the grade ~~established by~~ of the tracks, including when the railroad is superelevated.

~~Vertical curvature on the crossing should be avoided. This is necessary to limit vertical motion of the vehicle.~~

Transition t~~T~~he roadway vertical alignment ~~of the approach roadway should be~~ to meet the higher ~~adjusted when~~ rail elevations ~~are raised~~ to ~~prevent abrupt~~ prevent abrupt grade changes ~~in grade~~ ~~and entrapment of~~ (which can trap low-~~-~~clearance vehicles). Avoid using vertical curvature.

The roadway approach ~~to crossing~~ should ~~also coincide with~~ match the grade ~~established by~~ of the tracks. Extend t~~T~~his flat 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~~ Any roadway vertical curvature should be as gentle as possible~~. The length of these vertical curves shall be of sufficient length to~~ and long enough to provide the required sight distances.

D.3 Highway Cross Section

Preserve ~~ing~~ the continuity of the highway cross section through ~~a~~ the grade crossing ~~is important~~ to prevent distractions ~~and to avoid hazards~~ at an already dangerous location.

D.3.a Pavement

Continue t~~T~~he full width of all travel lanes ~~shall be continued~~ through the grade crossing~~s~~. Transition t~~T~~he crown of the pavement ~~shall be transitioned~~ gradually to meet the cross-sectional grade of the tracks~~. This pavement cross slope transition shall be~~ (in conformance with the requirements for superelevation runoff). Design t~~T~~he lateral and longitudinal pavement slopes ~~should be designed~~ to direct drainage away from the tracks.

D.3.b Shoulders

Continue a~~A~~ll shoulders ~~shall be carried~~ through ~~rail-highway~~ the grade crossings (without interruption).

The use of Provide full-width paved shoulders is required at all new crossings to maintain create a stable surface for emergency maneuvers. Pave tThe shoulders should

~~be paved a minimum distance of~~ for at least 50 feet on each side of the crossing~~,~~ (measured from the outside rail). ~~It is desirable to~~ Consider paving~~e~~ the shoulders for 100 feet on ~~either~~ each side to better accommodate bicyclists ~~permit bicycles to exit the travel 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 – 11*** ***~~Shoulder Widths for Rural Highways~~*** ~~for further information on~~ for shoulder widths.

D.3.c Medians

~~It is recommended that~~ Continue the full median width ~~on~~ of divided highways ~~should be continued~~ through the grade crossing. Contour t~~T~~he median ~~should be contoured~~ to ~~provide~~ create a smooth transition to ~~on~~ the tracks.

A raised median ~~is the ideal deterrent to~~ discourages ~~motorists~~ drivers from driving around the gates ~~to cross the tracks or~~ and making ~~a~~ U-turns ~~prior to~~ before the tracks. Use channelization devices with f~~F~~lush medians ~~should have channelization devices~~ (as a similar deterrent). Locate r~~R~~ailroad signals ~~s~~ and gate assemblies ~~should be installed~~ in the median ~~only~~ ONLY when 36-foot outside gate arms ~~of 36 feet will~~ do not ~~adequately~~ span the roadway approach ~~roadway~~.

Figure 7 – 2 Flush Median Channelization Devices

Alexander Street, SR 39A, Plant City, FL 1

D.3.d Sidewalks and Shared Use Paths

Continue sidewalks and shared use paths through the grade crossing t~~T~~o provide an accessible route for pedestrians~~ at grade rail-highway crossings, new or existing sidewalks and shared use paths shall be continued across the rail crossing~~. The surface of the crossing ~~shall~~ must be:

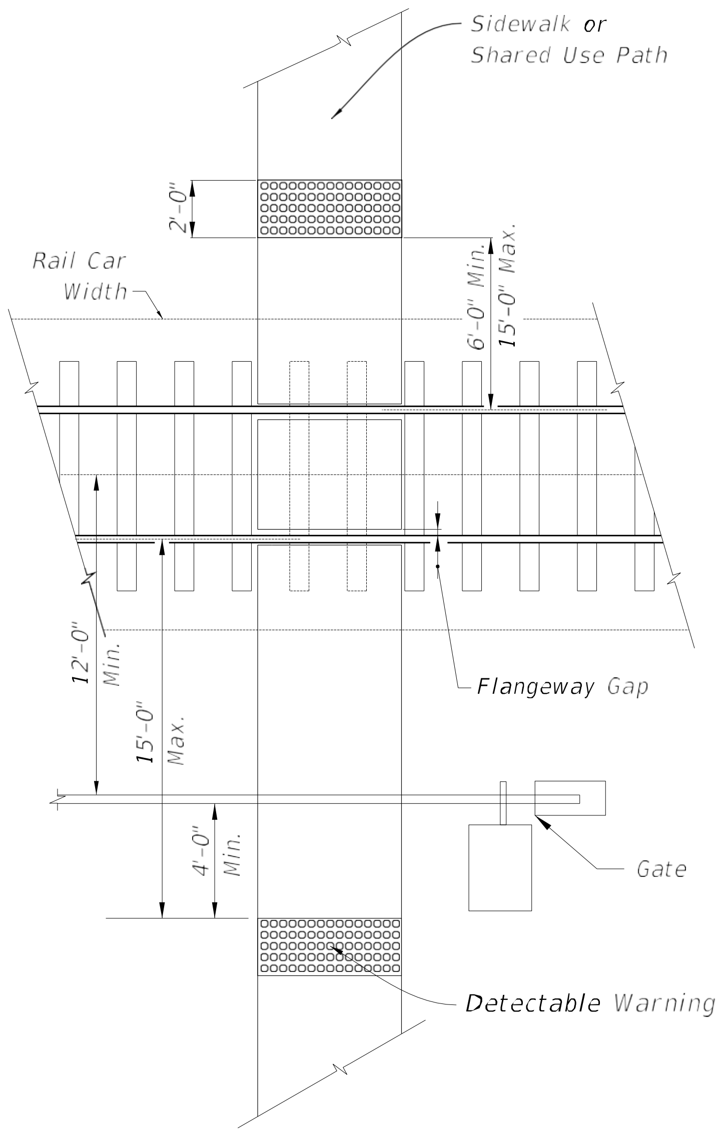
- F~~f~~irm, stable and slip resistant,
- L~~l~~evel and flush with the top of ~~rail at~~ the outer edges of the rails~~, and~~
- A~~a~~rea between the rails aligns with the top of the rails~~.~~

Place d~~D~~etectable warnings ~~shall be placed~~ on each side of the~~ rail-highway~~ grade crossing, ~~, extend~~ 2.0 feet deep in the direction of pedestrian travel and across the full width ~~across~~ of the sidewalk or shared use path ~~, as shown in~~ (see Figure 7 – 3)~~ Pedestrian Crossings~~.

Locate t~~T~~he edge of the detectable warning nearest the rail crossing ~~shall be~~ between 6 and 15 feet ~~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~~ Place the detectable warning at least 4~~.0~~ feet from the side of any pedestrian ~~the~~ gates ~~s~~ (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,~~ Provide an audible device such as a bell ~~shall also be provided and operated in conjunction with the~~ to operate in conjunction with traffic control signals (when in operation) at intersections used by pedestrians or bicyclists. See ***MUTCD, Chapters 8B and 8C*** for additional~~further~~ information and to determine if additional signals, signs, or pedestrian gates should be included~~cluded~~. See ***MUTCD, Chapter 8D*** for ~~additional information on~~ designing crossings for shared use paths.

Figure 7 – 3 Pedestrian Crossings

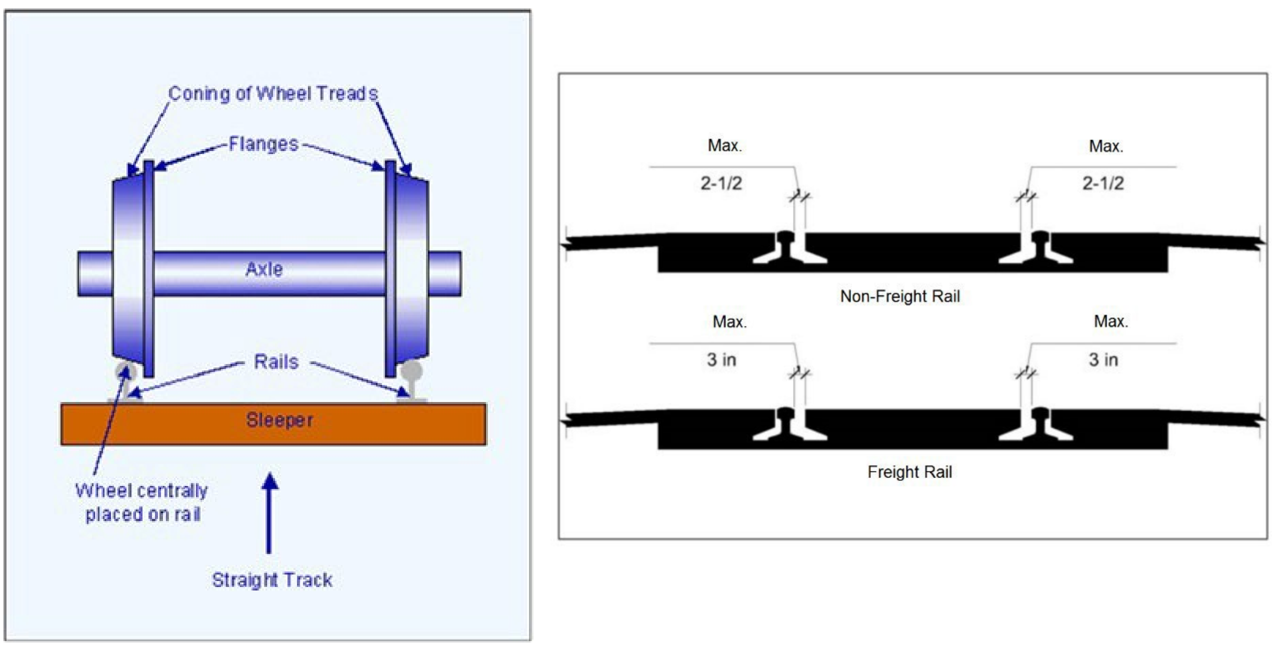


Note: Pedestrian gates ~~may~~ can be installed on the outside of the sidewalk/shared use path or in the utility strip.

Flangeway gaps ~~are necessary to~~ allow the passage of train wheel flanges~~; however, they~~ but 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~~ must be 2~~-~~½" maximum on non-freight rail tracks and 3" maximum on freight rail tracks.

See Figure 7 – 4 ~~Flangeways and Flangeway Gaps illustrates~~ for where the flanges are located on the wheel, how they interact with the rails, and the maximum gap allowed.

Figure 7 – 4 Flangeways and Flangeway Gaps



See ***Chapter 8*** ~~***– Pedestrian Facilities***~~ and ***Chapter 9*** ~~***– Bicycle Facilities*** for further information on~~ for designing sidewalks and shared use paths. See t~~T~~he ***2006 Americans with Disabilities Act – Standards for Transportation Facilities*** and the ***2020 Florida Building Code, Accessibility 7th Edition*** ~~impose additional requirements~~ for the design and construction of pedestrian facilities.

D.3.e Roadside Clear Zone

~~Although i~~I It is ~~ofte~~n typically not practical to maintain the full width of the roadside clear zone. Provide the maximum clear area feasible~~, the maximum clear area feasible should be provided~~. ~~This clear zone shall conform to~~ Comply with the clear zone requirements for side slopes and changes in grade~~ for roadside clear zones~~.

D.3.f Auxiliary Lanes

Auxiliary lanes are ~~permitted~~ allowed (but not encouraged) at signalized ~~rail-highway~~ grade crossings ~~that have a~~ with large volumes of bus or truck traffic ~~required to always~~ (that must always stop). Restrict t~~T~~hese ~~additional~~ auxiliary lanes ~~should be restricted~~ for the use of these stopping ~~stopping~~ vehicles. Design t~~T~~he approaches to these auxiliary lanes ~~shall be designed~~ as storage for deceleration lanes. Design t~~T~~he exits ~~shall be designed~~ as acceleration lanes.

D.4 Roadside Design

Comply with t~~T~~he ~~general~~ roadside design requirements of Chapters 3 and 4 of this manual ~~for roadside design given in **_Chapter 3 – Geometric Design_** and **_Chapter 4 – Roadside Design_**, should be followed at rail-highway~~ in designing grade crossings. ~~Supports for t~~Traffic control devices ~~may be required~~ must sometimes be located within the roadside recovery area. ~~Due to the structural requirements and the necessity for continuous operation, the use of a b~~ Breakaway designs are~~is~~ not recommended due to structural requirements. ~~The use of a guardrail or other longitudinal barrier is also~~ Longitudinal barriers are also not recommended~~, because an~~ as out-~~-~~of-~~-~~control vehicles~~ would tend to~~ can be directed into the crossing.

~~To reduce the hazard to errant vehicles, all~~ Locate support structures ~~should be placed~~ as far from the traveled way as practicable to minimize the hazard to errant vehicles.

D.5 Vertical Clearance

See Table 7 – 2 for m~~M~~inimum 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"

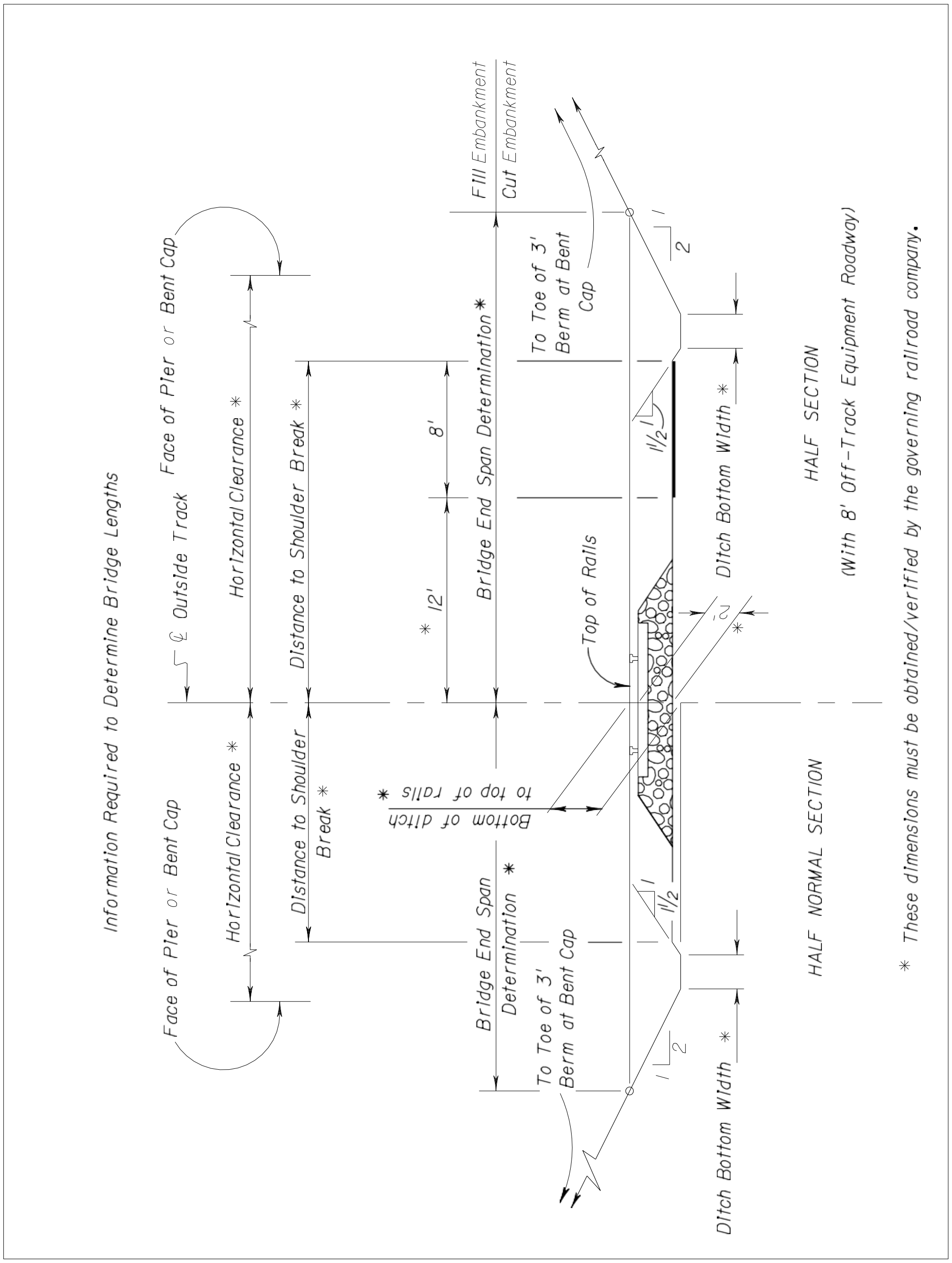
1. ~~Over High Speed Rail Systems, s~~See the latest version of ***American Railway Engineering and Maintenance-of-Way Association (AREMA)*** guidelines~~, or the~~ and coordinate with railroad design office for specific guidelines and specifications for high-speed rail systems~~of the high-speed rail line of interest for specific guidelines and specifications~~. ~~Over Electrified Railroad, t~~The minimum vertical clearance ~~shall be~~ over electrified railroads is 24 feet 3 inches~~.~~ (s~~S~~ee ***Department Topic No. 000-725-003: South Florida Rail Corridor Clearance***.)

Maintain or increase vertical clearances which are less than 16 feet f~~F~~or any construction affecting the existing ~~bridge~~ clearance~~s~~ (e.g., bridge widenings or resurfacing below) ~~vertical clearances less than 16' - 0" shall be maintained or increased~~. State the minimum bridge vertical clearance dimension in the plans i~~I~~f reducing the dimension ~~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~~.

D.6 Horizontal Clearance

Measure h~~H~~orizontal clearances ~~shall be measured in accordance with~~ per Figure 7 – 5~~ Track Section~~. The governing railroad company ~~occasionally may~~ may accept a waiver from normal clearance requirements if justified~~,~~ (i.e., for ~~designs involving~~ widening or replacing ~~ement of~~ existing overpasses). Coordinate with t~~T~~he ***FDOT District Rail Coordinator*** ~~should be consulted~~ if ~~such action is being~~ considering ~~ed~~ this for FDOT-~~-~~owned rail corridors. ~~For other rail crossings, c~~Coordinate with the governing ~~owner of the~~ railroad company for other rail crossings ~~corridor~~.

Figure 7 – 5 Track Section



,

See Table 7 – 3 for ~~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~~ A~~a~~djust~~ed~~ these clearances 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-foot ~~'~~ Required Clearance for Off-Track[2]	Temporary Falsework Opening
With Crash Walls	18 feet~~.~~	22 feet~~.~~	10 feet~~.~~
Without Crash Walls	25 feet~~.~~	25 feet~~.~~	N/A

[1] Any proposed structure over the South Florida Rail Corridor ~~shall~~ must ~~be designed and constructed to~~ provide ~~a~~ at least 100 feet of horizontal clear span ~~of a minimum of 100 feet but not less than~~

and 25 feet of clearance from the center line of the outermost existing or proposed rail ~~tracks.~~ (s~~S~~ee ***Department Topic No. 000-725-003: South Florida Rail Corridor Clearance~~.~~***).

[2] Provide an~~The~~ additional 8 feet~~.~~ of horizontal clearance for off-track equipment ~~shall be provided only~~ when specifically requested in writing by the governing railroad company.

D.6.a Adjustments for Track Geometry

~~When the track is on a curve,~~ Increase the minimum horizontal clearance ~~shall be increased at a rate of~~ by 1.5 inches for each degree of curvature for railroads on a curve. ~~When the track is superelevated,~~ Increase the minimum horizontal clearance~~s~~ on the inside of the curve ~~will be increased~~ by 3.5 inches ~~horizontally~~ per inch of superelevation for superelevated railroads. ~~For extremely short radius curves, the~~ Use ***AREMA*** requirements ~~shall be consulted~~ to assure proper clearances for short radius curves.

D.6.b Adjustments for Physical Obstructions

Avoid locating c~~C~~olumns and~~or~~ piles ~~should be kept out of~~ in the roadside ditch (to ~~prevent obstruction of~~ ensure positive drainage). Provide minimum h~~H~~orizontal clearances ~~should be provided~~ to avoid the need for crash walls (unless extenuating circumstances dictate otherwise).

See Figure 7 – 5 ~~Track Sections shows~~ for horizontal dimensions from the centerline of the track to the points of intersection of a horizontal plane at the rail elevation with the embankment slope. Use t~~T~~hese criteria ~~may be used~~ to establish ~~the~~ preliminary bridge length, which is normally ~~is~~ also the ~~length~~ portion of bridge eligible for FHWA participation. These dimensions may need to be increased or decreased ~~; however,~~ to accommodate surrounding topography, hydraulic conditions, and economic ~~or~~ and structural considerations ~~may warrant a decrease or an increase of these dimensions~~. Coordinate t~~T~~hese dimensions ~~must be coordinated~~ with the governing railroad company.

See ~~The~~ FDOT ***Structures Design Guidelines, Section 2.6.7*** ~~provide additional information on~~ for ~~the~~ designing ~~of~~ structures over or adjacent to railroads and light rail tracks.

D.7 Access Control

Use t~~T~~he ~~general~~ criteria in Chapter 3 of this manual for access control ~~in ***Chapter 3 – Geometric Design*** for streets and highways should be maintained in the vicinity of rail-highway~~ near grade crossings. Do not allow:

- P~~P~~rivate driveways ~~should not be permitted~~ within 150 feet of any grade crossing
- ~~, nor i~~Intersections within 300 feet~~,~~ of any grade crossing.

D.8 Parking

~~No~~ Do not allow parking ~~shall be permitted~~ within the required clear area ~~for~~ of the sight distance ~~visibility~~ triangle.

D.9 Traffic Control Devices

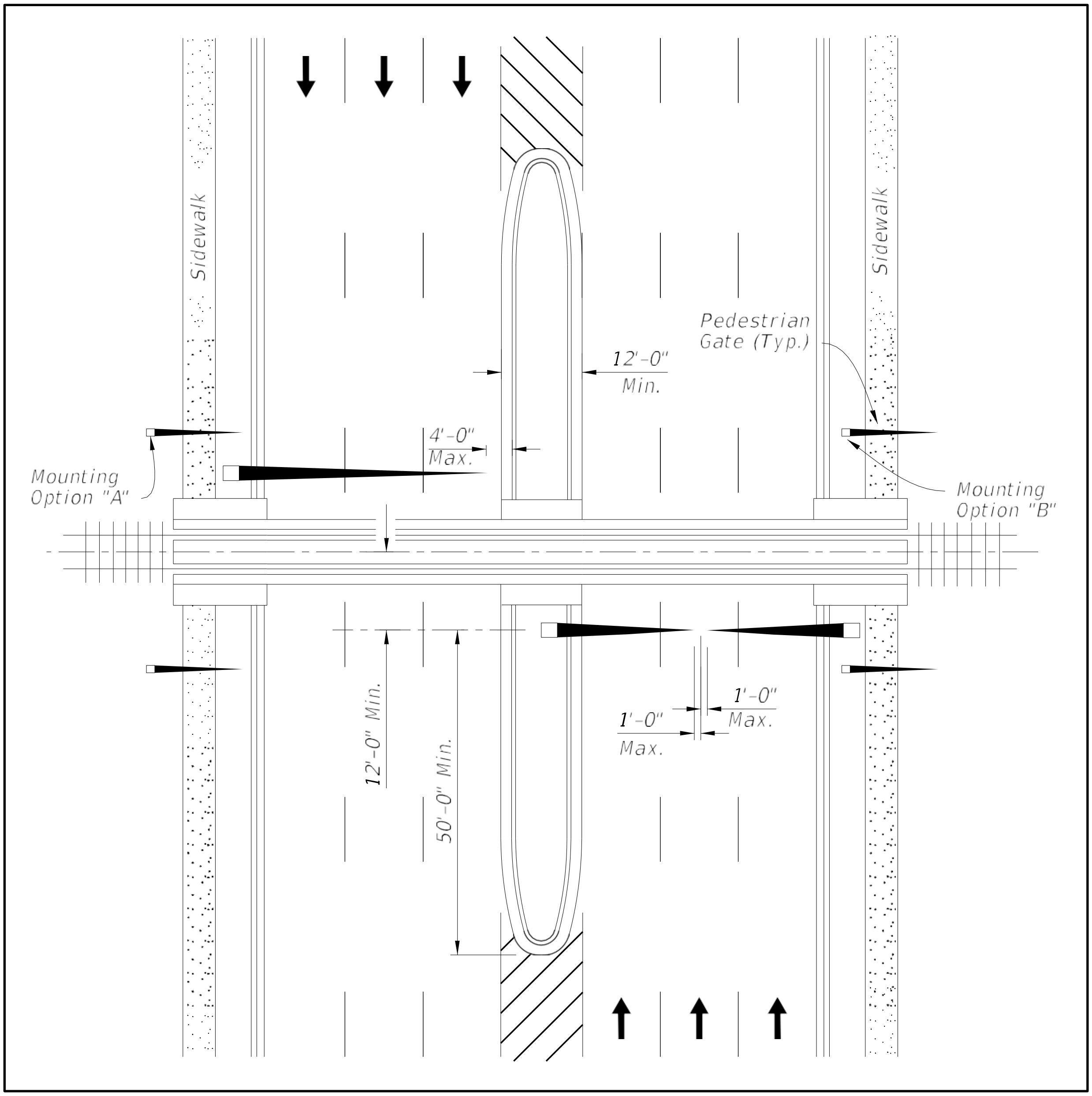
The proper use of ~~adequate~~ advance warning and traffic control devices is essential for all grade crossings. Advance warning should include pavement markings and two or more signs on each approach. ~~Each~~ Equip new crossings ~~should be equipped~~ with train-activated flashing signals.

Automatic gates~~,~~ (when used)~~,~~ should ~~ideally~~ extend across all travel lanes~~,~~ and ~~but shall at least~~ must block at least one-half of the inside travel lane. ~~It is desirable to include~~ Providing crossing arms across sidewalks and shared use paths is desirable.

Traffic control devices ~~shall~~ must meet the requirements of the ***MUTCD***. See

Section E of this chapter for additional requirements for traffic control devices in qQuiet zZones. See Figure 7 – 6 Median Signal Gates for Multilane Curbed Sections provides for an example of gate installation when a median is present.

Figure 7 – 6 Median Signal Gates for Multilane Curbed Sections



D.10 Rail-Highway Grade Crossing Surface

~~Each~~ The 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,~~ Provide welded rail ~~should be placed the entire width~~ from outside shoulder point to outside shoulder point for new crossings and for reworking existing crossings. ~~S~~Use surfaces ~~should be selected to be~~ which are as maintenance-~~-~~free as possible.

D.11 Roadway Lighting

~~The use of~~ Consider providing roadway lighting at grade crossings ~~should be considered~~ to ~~provide additional~~ improve awareness and safety ~~to the driver~~. ~~Illumination of the tracks can also be a beneficial safety aid.~~

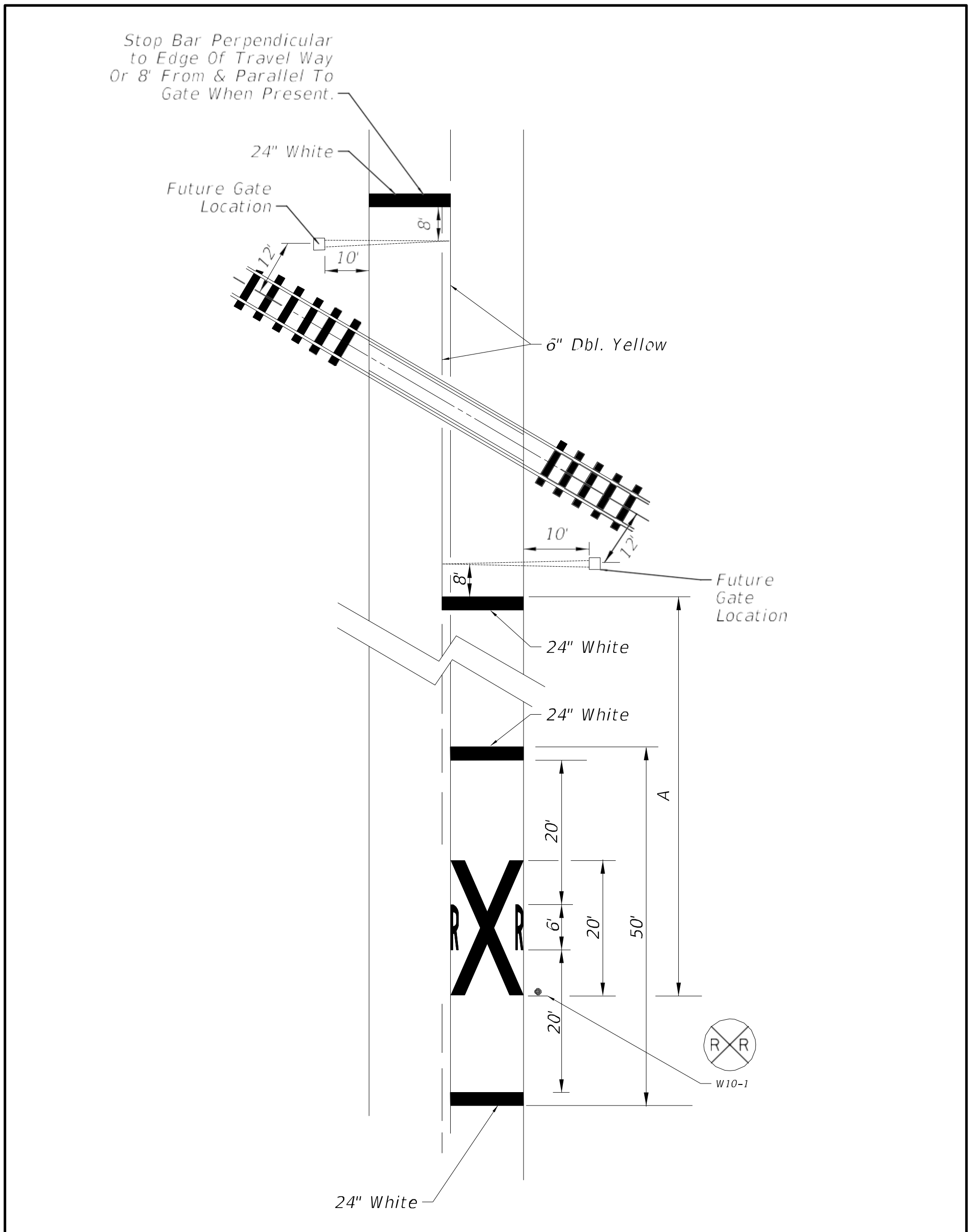
D.12 Crossing Configuration

See Figures 7 – 7 and 7 – 8 for r~~R~~ecommended grade crossing layouts ~~for grade crossings are shown in Figures 7 – 7 Passive Rail-Highway Grade Crossing Configuration and 7 – 8 Active Rail-Highway Grade Crossing Configuration~~. The distance "A" ~~in the Figures~~ is ~~determined by~~ based on speed and ~~shown~~ is included in ~~the~~ ***MUTCD, Table 2C – 4. Guidelines for the Advance Placement of Warning Signs***. ~~Although the design of each~~ Design grade crossings ~~must be "tailored" to fit the~~ to accommodate existing conditions. ~~situation,~~ Comply with the principles ~~given~~ in this section ~~should be followed in the design of all crossings~~ to the extent practical. See the FDOT Standard Plans for ~~Additional information on the~~ designing ~~of rail-highway~~ grade crossings ~~can be found in the FDOT's Standard Plans~~.

Passive ~~rail-highway~~ grade crossings include traffic control devices that provide static warning and guidance messages; ~~-of warning, guidance, and, in some instances,~~ and mandatory actions in some instances ~~for the driver.~~ *(~~Source:~~ see the **FHWA Railroad-Highway Grade Crossing Handbook**).*

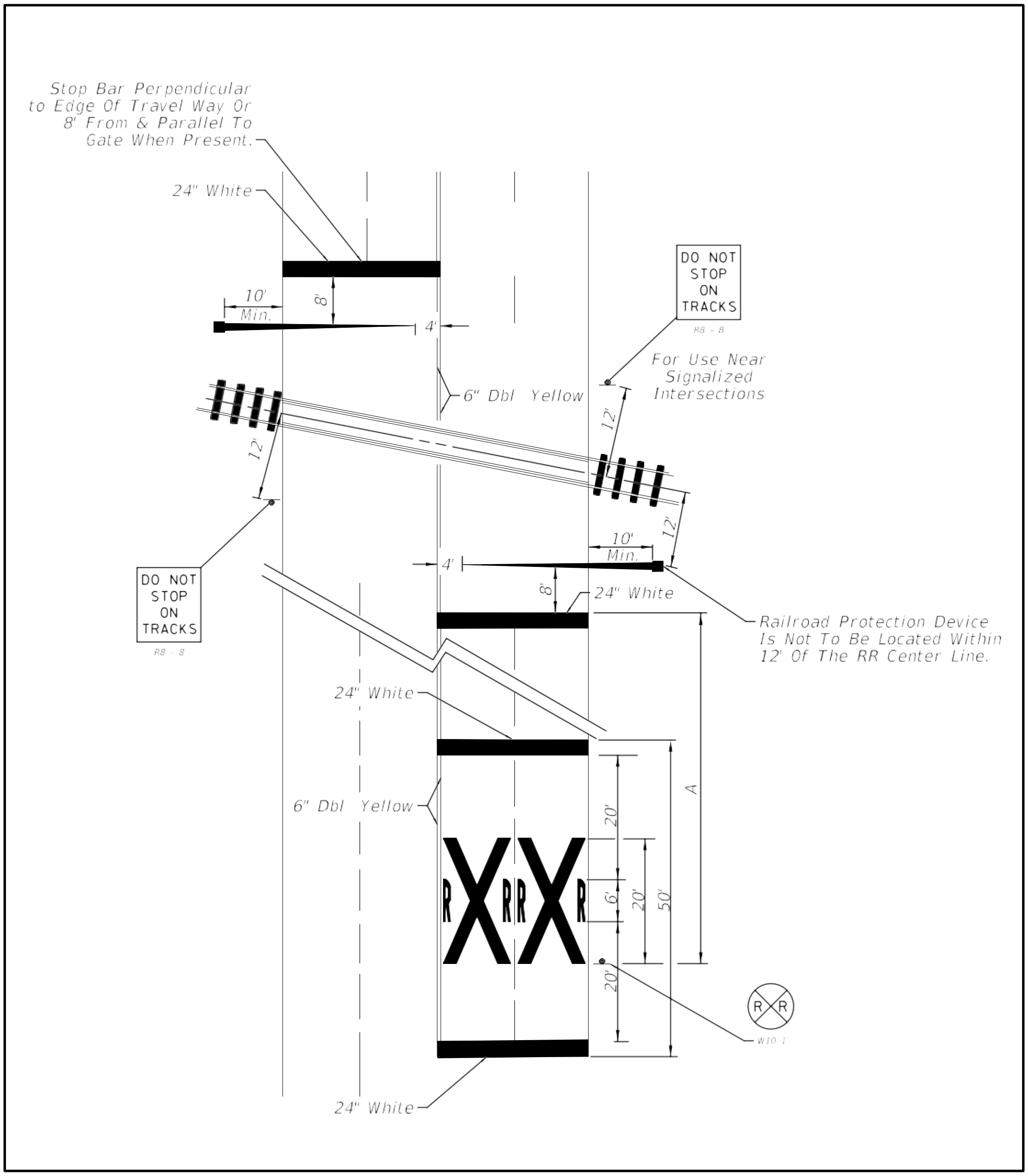
Active ~~rail-highway~~ grade crossings include traffic control devices that ~~give~~ provide advance notice of ~~the~~ an approaching ~~of a~~ train. *(~~Source:~~ see the **FHWA Railroad-Highway Grade Crossing Handbook**).*

Figure 7 – 7 Passive Rail-Highway Grade Crossing Configuration



Note: The distance “A” is ~~determined by~~ based on speed ~~and shown in the~~ (see ***MUTCD, Table 2C – 4***). ~~***Guidelines for the Advance Placement of Warning Signs***~~.

Figure 7 – 8 Active Rail-Highway Grade Crossing Configuration



Note: The distance “A” is ~~determined by~~ based on speed ~~and shown in the~~ (see ***MUTCD, Table 2C – 4***). ~~***Guidelines for the Advance Placement of Warning Signs.***~~

D.13 Railroad Dynamic Envelope Pavement Marking and Signage

Use Railroad Dynamic Envelope pavement markings ~~should be used~~ to delineate the area around ~~at-~~grade ~~railroad~~ crossings where vehicles should not stop. The United~~.~~ States~~.~~ Department of Transportation's (U.S. DOT) Volpe Center found that adding ~~the addition of the~~ dynamic envelope pavement markings and modified signage:

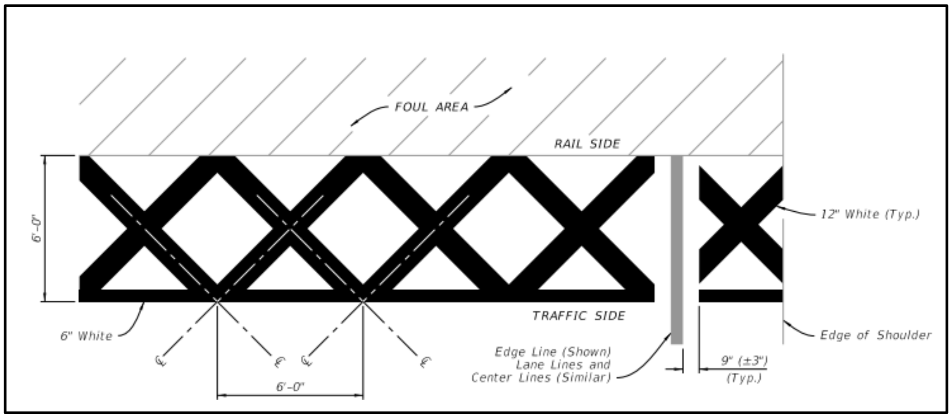
- R~~r~~educed the number of vehicles that stopped within the dynamic envelope zone and
- I~~i~~ncreased the number of vehicles that stopped behind the stop bar~~line~~.

The research ~~was published as a presentation and called~~ is titled ***Evaluation of Pavement Markings within the Dynamic Envelope***. Coordinate~~ion~~ with the governing railroad company~~is necessary~~. See ***Part 8 of the MUTCD*** for additional signing requirements ~~for signage~~.

Provide Railroad Dynamic Envelope pavement markings w~~W~~here local roads cross state~~-~~owned rail corridors.~~, the railroad dynamic envelope pavement marking is required.~~

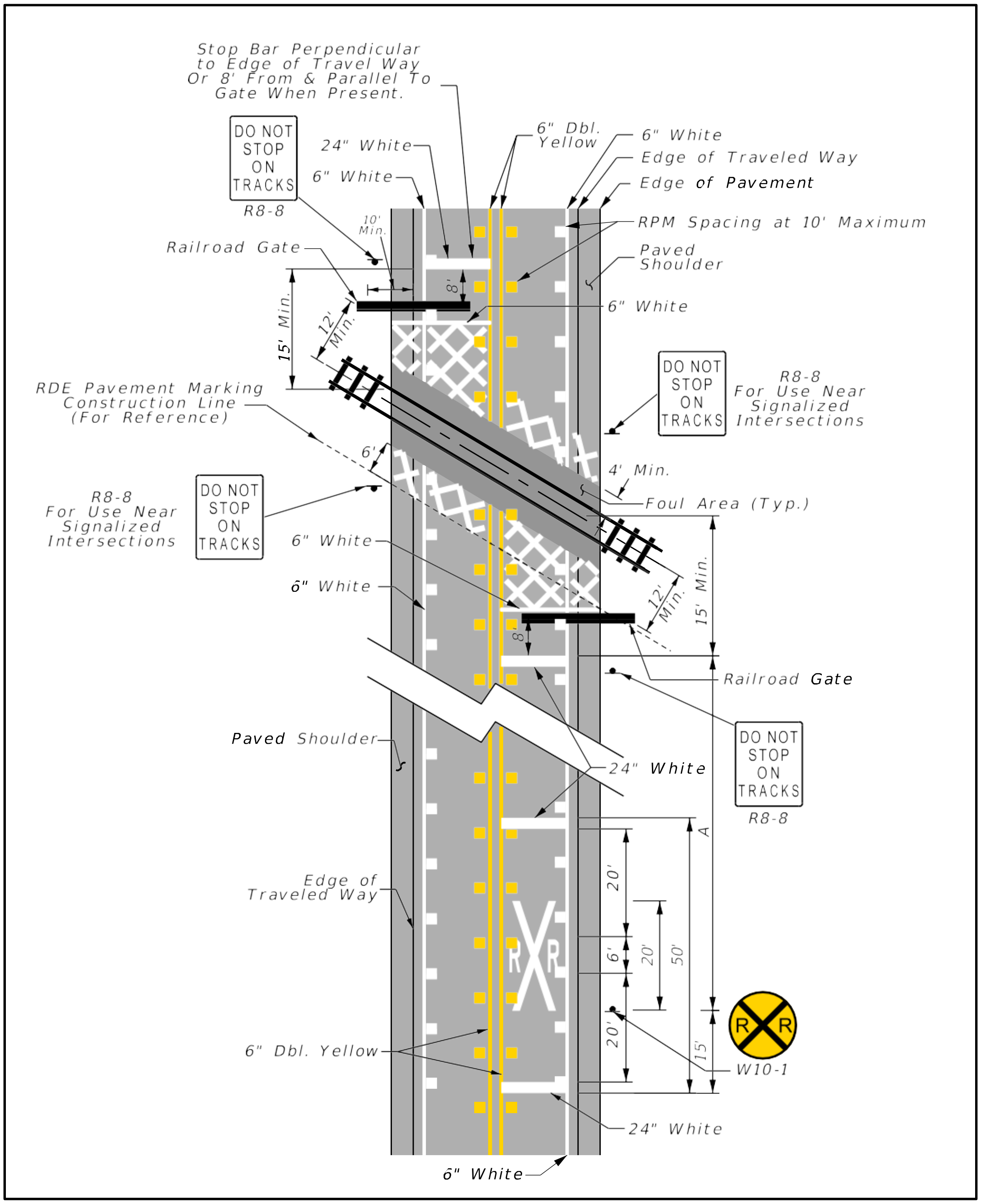
See Figures 7 – 9, 7 – 10, 7 – 11, and 7 – 12 ~~Railroad Dynamic Envelope Pavement Marking Detail, Figure 7 – 10 Railroad Crossing at 2-Lane Roadway, Figure 7 – 11 Railroad Crossing at Multilane Roadway, and Figure 7 – 12 Railroad Crossing at Multilane Roadway with Right Turn Lane provide~~ for examples of signing and marking ~~how~~ for R~~r~~ailroad D~~d~~ynamic E~~e~~nvelopes ~~can be signed and marked for at-grade rail crossings~~. See Table 7 – 4 ~~Location of "Do Not Stop on Tracks" Signage for Railroad Crossings Using the Rail Dynamic Envelope shows~~ for the distance between the RR Warning Sign (W10-1) and the Do Not Stop on Tracks (R8-8) sign. See the FDOT ***Standard Plans*** f~~F~~or additional information ~~see the FDOT's *Standard Plans*~~.

Figure 7 – 9 Railroad Dynamic Envelope Pavement Marking Detail



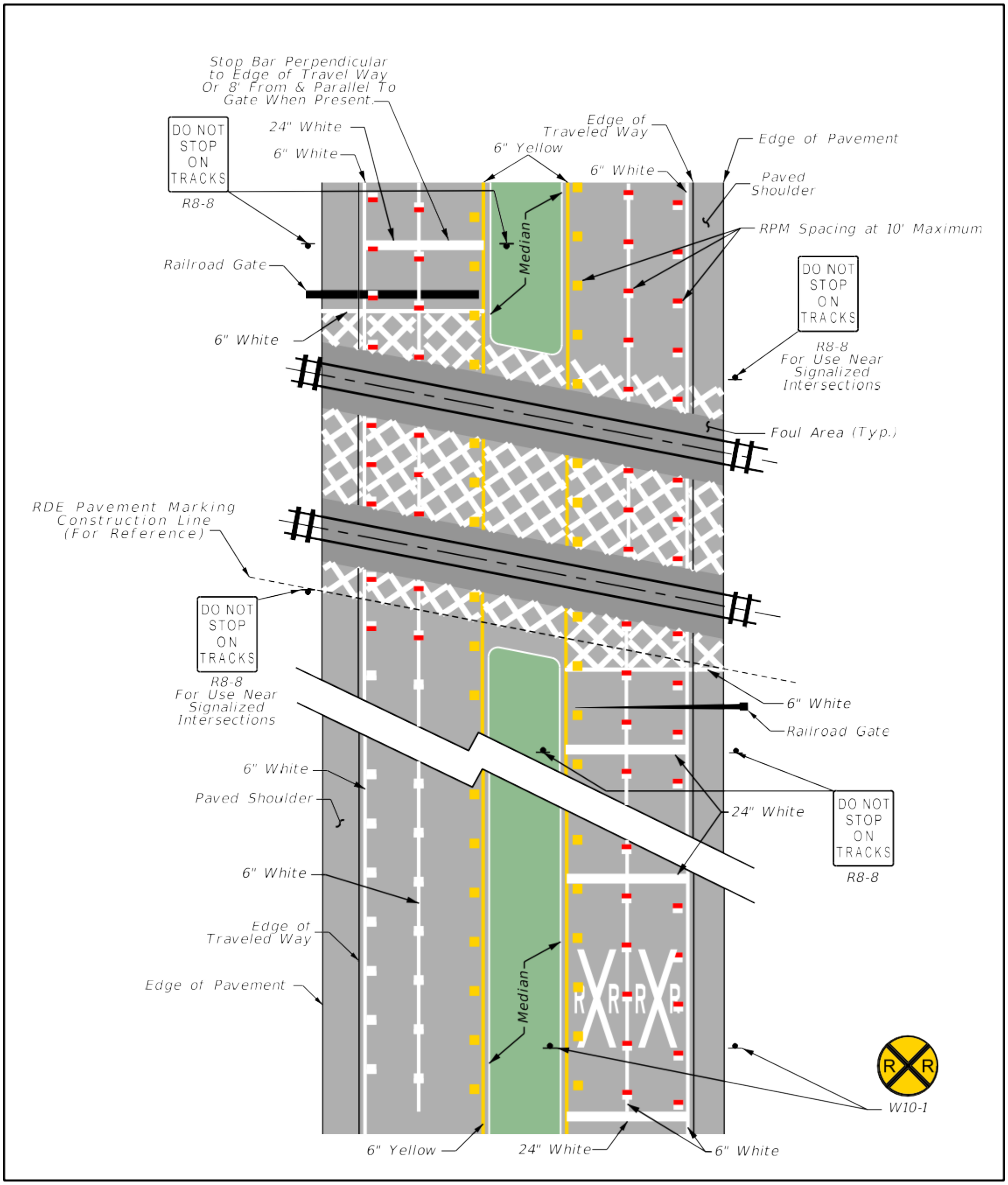
Notes: 1. The pavement markings ~~shall~~ must begin ~~a minimum of~~ at least 4 feet~~'~~ from the edge of the nearest rail or outside the foul area~~,~~ (as determined by the governing railroad company)~~owner~~.

Figure 7 – 10 Railroad Crossing at 2-Lane Roadway



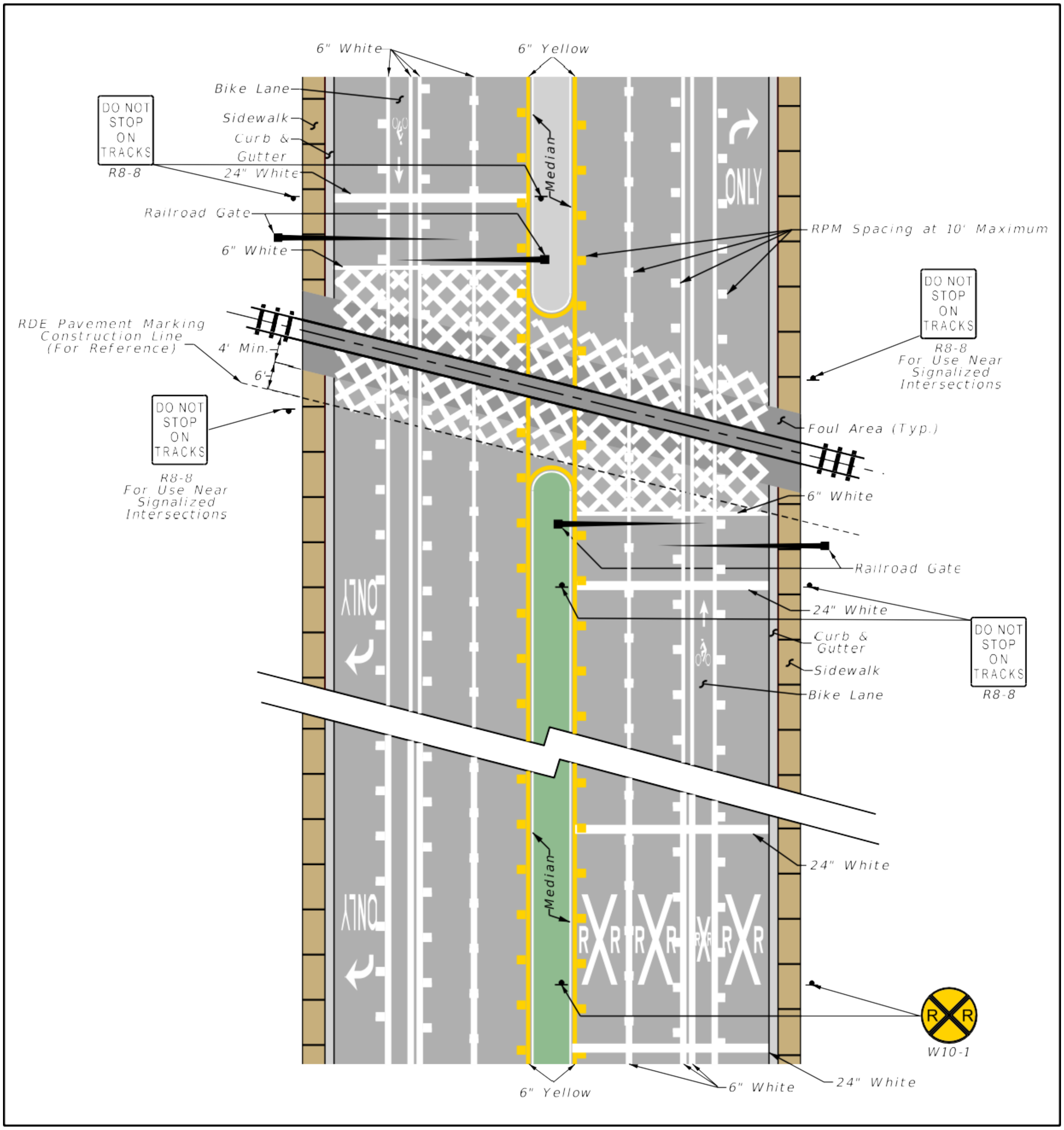
Note: 1. For distance “A”, see Table 7 – 4 Location of “Do Not Stop on Tracks” Signage for Railroad Crossings Using the Rail Dynamic Envelope.

Figure 7 – 11 Railroad Crossing at Multilane Roadway



Note: 1. Dimensions not shown for clarity, see Figure 7 – 10 Railroad Crossing at 2 Lane Roadway.

Figure 7 – 12 Railroad Crossing at Multilane Roadway with Right Turn Lane



Note: 1. Dimensions not shown for clarity, see Figure 7 – 10 ~~Railroad Crossing at 2 Lane Roadway~~.

Table 7 – 4 Location of "Do Not Stop on Tracks" Signage for Railroad Crossings Using the Rail Dynamic Envelope

Design Speed (mph)	Distance "A" (feet)
60	400
55	325
50	250
45	175
40	125
35	100
Curbed	85 Minimum

.

E QUIET ZONES

A q~~Q~~uiet z~~Z~~one ~~means~~ is a segment of ~~a~~ rail line near a grade crossing ~~that includes public rail-highway crossings at which~~ where locomotive horns are not routinely sounded. The Federal Railroad Administration (FRA) has established guidelines ~~the applying jurisdiction must~~ to follow for the approval of quiet zones. ~~Applying entities can go to~~ See 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 the approval of ~~al of~~ q~~Q~~uiet z~~Z~~ones.

Coordinate with the FDOT~~'s~~ District Rail Coordinator to determine if crossings are located within designated q~~Q~~uiet z~~Z~~ones ~~for~~ of s~~S~~tate-~~-~~owned rail corridors ~~or~~ and crossings of state highways. ~~State owned rail corridors include t~~The Central Florida Rail Corridor and the South Florida Rail Corridor are state-owned rail corridors. ~~For other rail crossings, c~~Coordinate with the local government who maintains the crossing roadway, sidewalk, or shared use path at other grade crossings to determine if the location has been approved by the FRA as~~for~~ a q~~Q~~uiet z~~Z~~one.

~~For a crossing within a Quiet Zone that requires supplemental safety measures, a~~Approved supplemental safety measures for grade crossings in quiet zones include:

- Temporary closure~~ of a public railroad-highway-rail grade crossing~~.
- Four-quadrant gate systems.
- Gates with medians or channelization devices.
- One way streets with gate(s); and
- Permanent closure~~ of a public highway-rail grade crossing~~.

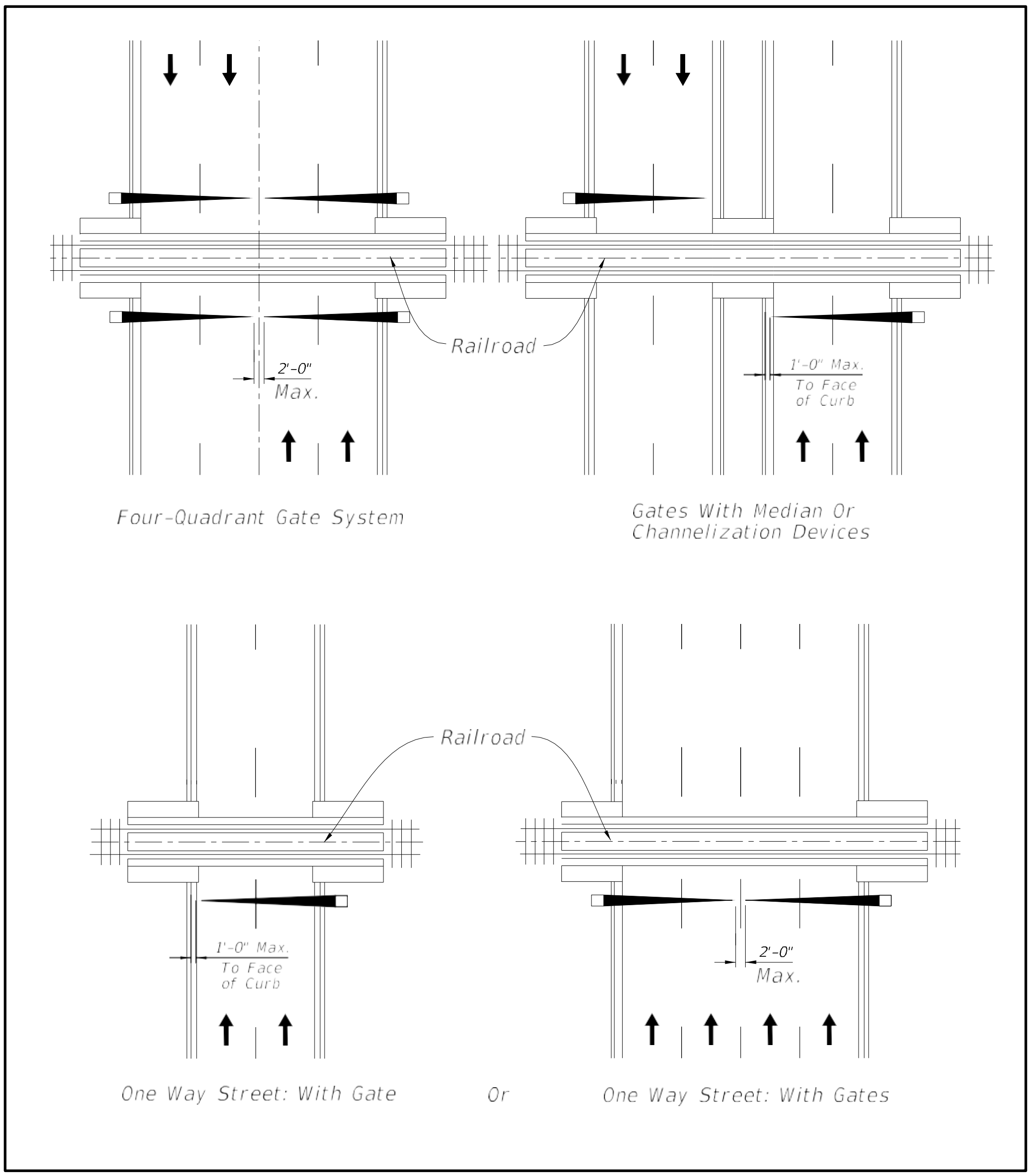
See ~~The~~ ***CFR, Title 49, Chapter II, Part 222, Appendix A~~, Approved Supplemental Safety Measures~~*** ~~provides additional information on the design of~~ for designing q~~Q~~uiet z~~Z~~ones to meet federal approval. The ***CFR*** also requires that any traffic control device ~~and its application where~~ used as part of a q~~Q~~uiet z~~Z~~one ~~shall~~ comply with all applicable provisions of the ***MUTCD.*** See ***MUTCD, Part 8, Traffic Control for Railroad and Light Rail Transit Grade Crossings*** for additional~~further~~ information. Pedestrian gates, audible devices, and detectable warnings are required when a sidewalk or shared use path is present or proposed.

See ***FDOT Design Manual, Chapter 220*** for additional information f~~F~~or q~~Q~~uiet z~~Z~~ones ~~that~~ crossing state-~~-~~owned rail corridors~~, the *FDOT Design Manual,*~~

~~***Chapter 220 Railroads*** provides additional information~~.

See Figure 7 – 13 ~~Gate Configurations for Quiet Zones illustrate~~s for the maximum gap allowed for gates at ~~rail-highway~~ grade crossings within q~~Q~~uiet z~~Z~~ones~~,~~ (based upon ***CFR, Title 49, Chapter II, Part 222***).

Figure 7 – 13 Gate Configuration for Quiet Zones



F HIGH SPEED RAIL

~~The e~~Establishing ~~ment 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 these 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~~ few as 1 to as many as 7 - 12 daily frequencies.~~;~~
  - ~~may or may not~~ May have strong potential for future ~~high-speed rail~~ HSR 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.

See the FRA website ***High Speed Rail Overview*** ~~Further information on the implementation of high-speed rail~~ for implementing HRS service ~~can be found on the Federal Railroad Administration's website~~ ~~***High Speed Rail Overview***~~.

G MAINTENANCE AND RECONSTRUCTION

The inspection and maintenance of all ~~features of rail-highway~~ grade crossing~~s~~ elements ~~shall~~ must be an integral part of the regular maintenance program of each highway agency~~'s~~ and railroad company ~~'s regular maintenance program~~ (see ***Chapter 10*** ~~***– Maintenance and Resurfacing***~~). ~~Items that should be given a high priority in this program include~~ Give a high priority to:

- P~~p~~avement stability and skid resistance,
- C~~c~~lear sight distance, and
- A~~a~~ll traffic control and protective devices.

~~The improvement of all~~ Improving substandard ~~or~~ and hazardous conditions at existing grade crossings is extremely important. ~~and should be i~~ Incorporate~~d~~ such improvements into the regular highway reconstruction program with~~.~~ t~~T~~he objective ~~of this reconstruction program should be to~~ of upgrading ~~e~~ each crossing to meet these standards. Base t~~T~~he priorities for reconstruction ~~should be based upon the~~ on FDOT guidelines ~~set forth by the FDOT~~.

H REFERENCES FOR INFORMATIONAL PURPOSES

~~The following is a list of~~ Refer to the publications below ~~that~~ for additional ~~further~~ guidance:

- FHWA ~~ederal Highway Administration~~ Railroad-Highway Grade Crossing Handbook, Revised Second Edition, August 2007
  https://rosap.ntlhttps://rosap.ntl.bts.gov/view/dot

- 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, Traffic Control for Railroad and Light Rail Transit 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

- FDOT~~lorida Department of Transportation~~ Rail Contacts
  https://www.fdot.gov/rail/contacts/staff.shtm

CHAPTER 8

PEDESTRIAN FACILITIES

A INTRODUCTION

Give full consideration to establishing p~~P~~edestrian facilities ~~shall be given full consideration~~ in ~~the~~ planning and developing ~~ment of~~ transportation facilities. ~~, including the~~ I~~i~~ncorporate ~~ion of such~~ pedestrian facilities into state, regional, and local transportation plans and programs, recognizing ~~under the assumption~~ that transportation facilities ~~will be~~ are used by pedestrians. Establish p~~P~~edestrian facilities ~~should be considered~~ in conjunction with the construction~~,~~ or reconstruction~~, or other significant improvement~~ of any transportation facility~~. Special emphasis should be given to~~ (especially ~~projects in or~~ those within 1 mile of an urban area). ~~Examples of p~~Pedestrian facilities can include:

- S~~s~~idewalks,
- S~~s~~hared use paths,
- O~~o~~verpasses ~~and~~
- U~~u~~nder~~-~~passes,
- C~~c~~urb ramps,
- M~~m~~edian refuge~~s~~, and
- C~~c~~rosswalks.

~~In addition to the design criteria provided in this manual, the following~~ Refer to these documents ~~provide criteria and guidance in the~~ for designing ~~of~~ pedestrian facilities:

- ***United States Department of Transportation ADA Standards for Transportation Facilities (2006)*** and as required by ***49 C.F.R 37.41 or 37.43***.
- ***United States Department of Justice ADA Standards (2010) as required by 28 C.F.R 35 (title II) and 36 (title III).***
- ***Public Rights-of-Way Accessibility Guidelines (PROWAG)*** ~~provides additional information for the design of pedestrian facilities~~.

The ***2020 Florida Building Code, Accessibility, 7th Edition*** as required by ***61G20-4.002*** ~~contains~~ provides ADA requirements for accessibility by people with disabilities to:

- S~~s~~ites,
- F~~f~~acilities,
- B~~b~~uildings, and
- E~~e~~lements ~~by people with disabilities~~.

Each transportation agency ~~responsible for a system of streets and highways~~ should establish and maintain a program for implementing pedestrian facilities~~,~~ and for maintaining existing pedestrian facilities.

B TYPES OF PEDESTRIAN FACILITIES

There are several roadway elements ~~ways in which~~ which accommodate pedestrians ~~can be accommodated~~ in the public R/W~~right of way~~.

B.1 Sidewalks

Sidewalks are walkways parallel to the roadway ~~and designed~~ for use by pedestrians. Provide s~~S~~idewalks ~~should be provided~~ along both sides of roadways that are ~~in or~~ within one mile of an urban area. ~~If sidewalks are constructed on the approaches to bridges, they~~ Sidewalks along approaches to bridges should be continued across the structure. ~~If continuous sidewalks are constructed on only one side of the street, pedestrians should be provided~~ Provide pedestrian access to facilities and services located on the opposite side of ~~the~~ streets with continuous sidewalks along only one side. Newly constructed, reconstructed, ~~or~~ and altered sidewalks ~~shall~~ must be accessible ~~to~~ and usable by persons with disabilities.

The minimum width of any sidewalk ~~shall be~~ is 5 feet ~~on both curb and gutter and flush shoulder roadways~~. ~~The minimum separation for a~~ A 5-foot wide sidewalk must be at least 2 feet ~~from~~ behind the back of a curb ~~is 2 feet~~. Sidewalks located at the back of a curb must be at least 6 feet wide. ~~If the sidewalk is located adjacent to the curb, the minimum width of sidewalk is 6 feet.~~ Provide at least ~~minimum~~ 1-foot ~~wide~~ of level graded area (~~with a~~ maximum 1:6 slope) ~~of 1:6~~ along both sides of ~~the~~ a sidewalk ~~. This would not apply to the side of the sidewalk located immediately~~ (except those adjacent to a curb, structure or ~~the right of way~~ R/W line). Consider w~~W~~ider sidewalks ~~should be considered~~ in ~~Central B~~business d~~D~~istricts and ~~in areas~~ where heavy two-way pedestrian traffic is expected.

~~A~~ Provide a 5-foot wide ~~(minimum)~~ sidewalk ~~that~~ to connect~~s a~~ transit stops to ~~or facility with an existing~~ sidewalks ~~or~~ and shared use paths ~~shall be included~~ to comply with ADA accessibility standards~~.~~ (see ***Chapter 13*** of this manual ~~– Transit provides~~ for illustrations ~~of the connection between the sidewalk and transit facility~~.

~~Particular~~ Give special attention ~~shall be given~~ to pedestrian accommodations at ~~the~~ both termini of each project. ~~If full accommodations cannot be provided due to the limited scope or phasing of a roadway project or an existing sidewalk is not present at the termini,~~ Consider extending ~~an extension of the sidewalk~~ a sidewalk or shared use path to the next appropriate pedestrian crossing or access point (when full accommodations do not exist and cannot be provided) ~~should be considered~~.

If pedestrian facilities are provided, they shall be connected with Connect existing and proposed pedestrian facilities (e.g., sidewalks, shared use paths, and crosswalks) to those on the adjoining projects.

For new construction and reconstructed roadways, Profile grades on for sidewalks or and shared use paths on new construction and reconstruction projects shall can not exceed 5%, unless:

- Aaccessible ramps and landings are provided, or

Provided

- Mirroring the grade of the adjacent roadway. . However, in a roadway right of way, the grade of sidewalks or shared use paths is permitted to equal the general grade established for the adjacent street or highway.

Sidewalk and shared use path cross slopes should allow positive drainage; but CANNOT exceed 2% There should be enough sidewalk or path cross slope to allow for adequate drainage, however the maximum shall be no more than 2% to comply with ADA requirements.

Where eExisting physical constraints can make it impracticable for altered elements, spaces, or facilities to fully comply with the requirements for new construction. , cCompliance is required to the extent practicable within the scope of the project in such cases. Existing physical constraints can include: , but are not limited to,

- Uunderlying terrain, right- of-way
- R/W availability,
- Uunderground structures,
- Aadjacent developmented facilities,
- Ddrainage, andor
- Tthe presence of a notable natural or historic features.

Locate new and relocated utility/light poles The location of new poles or relocated poles shall to provide at least 48 inches" of minimum unobstructed sidewalk width.

Evaluate existing driveways and turnouts for compliance withto ADA requirements. Nonconforming driveways do not need are not required to be upgraded if it is not feasible within the scope of the project.

Edge drop-offs should be avoided, removed or shielded Edge drop-offs should be avoided. When drop-offs cannot be avoided, they should be shielded as discussed in per Section F of this chapter , Drop-Off Hazards for Pedestrians.

See ***Section C.7.d*** of ***Chapter 3*** fFor additional information concerning the designing of sidewalks., refer to ***Section C.7.d*** of ***Chapter 3 – Geometric Design***.

B.2 Shared Use Paths

Shared use pPaths are usually set back from the roadway and separated by a green area, ditch, swale~~s~~, or trees. Shared use paths are intended ~~for the~~ to be used by ~~both~~ pedestrians and bicyclists and ~~shall~~ must be accessible.

~~-~~See ***Chapter 9*** f~~F~~or ~~additional information concerning the~~ designing ~~of~~ shared-use paths.~~, refer to~~ ~~***Chapter 9 – Bicycle Facilities***~~~~.~~

B.3 Shared Streets

~~Shared uses of a s~~Streets that are used by ~~for~~ people walking, bicycling, and driving are referred to as shared streets. These are usually ~~specially designed spaces such as pedestrian streets which are~~ local urban streets with extremely low vehicle speeds.

B.4 Shoulders

Highway shoulders are not intended for ~~frequent~~ pedestrian use ~~by pedestrians,~~ but ~~do~~ can accommodate occasional pedestrian traffic. ~~Highway shoulders often have~~ Shoulder cross slopes ~~which~~ typically exceed 2% and are not ~~; consequently, they are not considered or~~ expected to ~~fully~~ meet ADA criteria.

C MINIMIZING CONFLICTS

~~The planning and design of n~~ New streets and highways ~~shall~~ must include provisions that support pedestrian travel and minimize vehicle-pedestrian conflicts, such as ~~. These may include~~:

- Sidewalks and~~/or~~ shared use paths parallel to the roadway,
- Marked pedestrian crossings,
- Raised median ~~or~~ and refuge islands,
- Pedestrian signal features such as pedestrian signal heads and detectors,
- Transit stops and shelters.

~~In some situations, it may be~~ It is sometimes possible to eliminate a vehicle-pedestrian conflict ~~through close coordination with the planning of~~ by including pedestrian facilities with other ~~and~~ activities~~y~~ outside ~~of~~ the highway R/W~~right of way. Care should be exercised to~~ Use care to ensure ~~the~~ that eliminating ~~on of a given~~ one conflict ~~point~~ does not create ~~transfer the problem~~ conflicts elsewhere ~~to a different location~~. ~~Any effort to minimize or eliminate conflict points must c~~Consider ~~the~~ pedestrian mobility in efforts to minimize or eliminate conflict points ~~needs of the pedestrian.~~ to avoid:

- Interrupting t~~T~~he desired travel path, ~~should not be severed and~~
- Increasing the number of required crossing points, ~~and/or~~
- Increasing walking distances ~~should not be significantly increased~~.

Some crossings should be redesigned rather than eliminated or relocated.

C.1 General Needs

Minimizing vehicle-pedestrian conflicts can be accomplished by providing adequate horizontal, physical, or vertical (primarily for crossings) separation between the roadway and the pedestrian facility.

C.2 Horizontal Separation

~~The development of~~ Creating independent systems for drivers and pedestrians ~~and motor vehicular traffic is the preferred method~~ is best for providing ~~adequate~~ horizontal separation.

C.2.a General Criteria

Locate n~~N~~ew sidewalks ~~should be placed~~ as far from the roadway as practical in this ~~e following~~ sequence of desirability:

1. As near the ~~right of way~~ R/W line as possible~~.~~ (ideally, allow 3 feet ~~of width should be provided behind~~ outside the sidewalk for above-ground utilities).
2. Outside of the clear zone.
3. Sufficiently off-set from the back of curb in urban locations to allow: ~~for the placement of~~
   - S~~s~~treet trees,
   - S~~s~~igns,
   - U~~u~~tilities,
   - P~~p~~arking meters,
   - B~~b~~enches, or
   - O~~o~~ther street furniture~~ outside of the sidewalk in urban locations (e.g., town center, business, or entertainment district)~~.

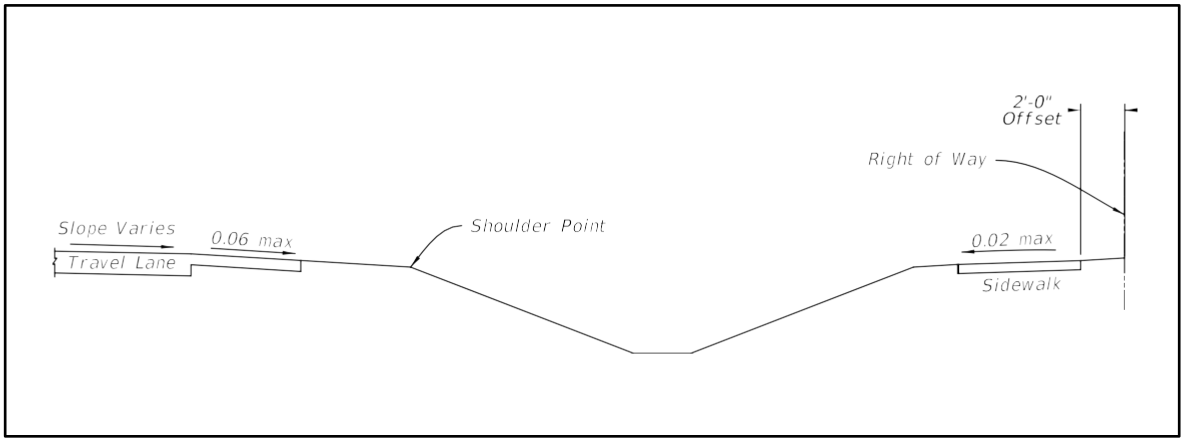
~~3.~~4. ~~Five~~ 5 feet from the shoulder point on flush shoulder roadways.

~~4.~~5. At the grass shoulder point of flush shoulder roadways.

See Figure 8 – 1 ~~Shoulder Point with Sidewalk provides~~ for an illustration of ~~the location of~~ the shoulder point.

~~On arterial or collector roadways, sidewalks shall not be constructed~~ Sidewalks along arterials and collectors cannot be contiguous with ~~to~~ the roadway pavement~~,~~ (unless a curb or other barrier is provided). ~~Nearing intersections, the s~~Transition sidewalks on approaches to intersections ~~should be transitioned as necessary~~ to ~~provide~~ a ~~more~~ functional crossing location ~~that also~~ meeting ~~s~~ driver expectations. See ***MUTCD, Part 3*** ~~Further guidance on the placement of~~ for locating stop bars, ~~or~~ yield lines and crosswalks ~~is provided in the *MUTCD, Part 3*~~.

Figure 8 – 1 Shoulder Point with Sidewalk


2'-0"
Offset
Right of Way
Slope Varies
0.06 max
Shoulder Point
Travel Lane
0.02 max
Sidewalk

C.2.b Buffer Widths

~~Providing a b~~Buffers can improve pedestrian safety and enhance the overall walking experience. Buffer width is ~~defined as~~ the space between the sidewalk and the edge of the traveled way. On-street parking ~~or~~ and bicycle~~ke~~ lanes ~~can also act as~~ are an additional buffer. Provide a 6-foot wide ~~The~~ planting ~~strip~~ or buffer strip ~~should be 6 feet~~ (where practical) ~~to eliminate the need~~ to avoid narrowing or rerouting ~~e~~ sidewalks around driveways. With this wider buffer strip, locate the sidewalk ~~is placed~~ far enough back so ~~that~~ the driveway slope does not ~~have to~~ encroach into the sidewalk.

C.3 Other Considerations

~~When designing urban highways, the following~~ Consider the measures below ~~measures may be considered~~ to ~~help increase the~~ improve safety and efficiency ~~t operation of the highway~~ for pedestrians along urban highways:

- Use narrower lanes ~~and~~
- I~~i~~ntroduce raised medians to provide pedestrian refuge areas
- Provide pedestrian signal features and detectors
- Prohibit right-turn-on-red
- Control, reduce, or eliminate ~~left and/or right~~ turns
- Prohibit free-flow right-turns ~~movements~~
- Reduce the number of lanes

D BARRIER SEPARATION

Barriers ~~may~~ can be used to ~~to assist in the~~ separate ~~ion of~~ motorized traffic ~~vehicular and~~ from pedestrian traffic.

D.1 Longitudinal Barriers

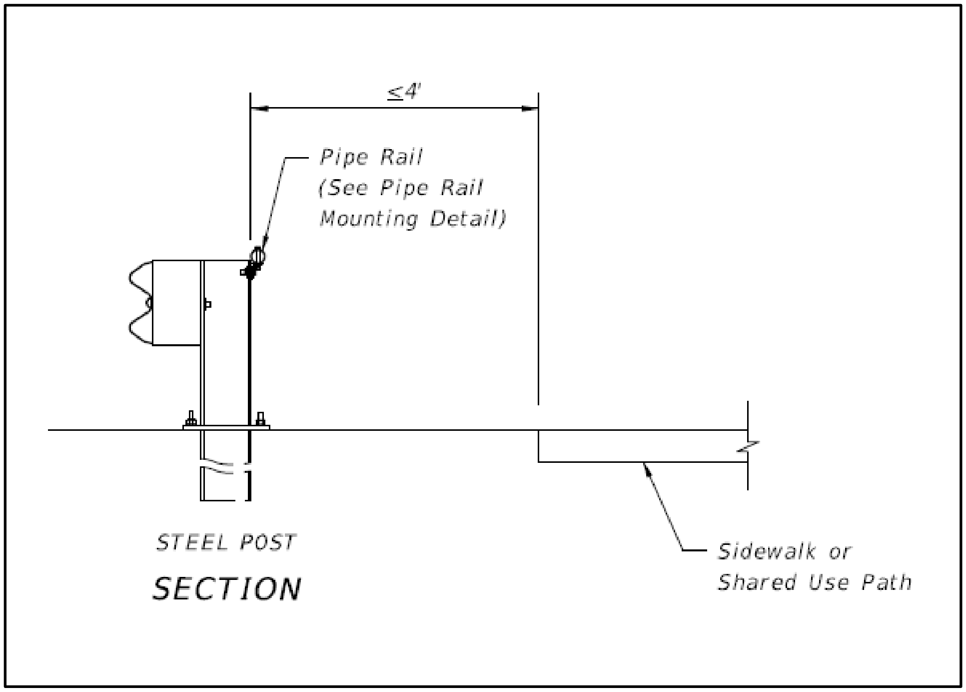
Use lLongitudinal barriers ~~such as~~ (e.g., guardrails, rigid barriers, and bridge railings) ~~are designed primarily to~~ to:

- Rredirect errant vehicles away from roadside hazards, and~~. These barriers can also be used to provide valuable protection of~~
- Shield pedestrian facilities from errant vehicles ~~out-of-control vehicles~~.

Longitudinal barriers can be used wWhere adequate horizontal separation is not feasible~~, or~~ and where there is a significant ~~hazard from~~ risk of out-of-control vehicles~~, longitudinal barriers may be utilized. If electing to use barriers,~~ Give sspecial consideration ~~should be made~~ to ensuringe proper sight distances near driveways and intersections ~~is maintained~~. See Chapter 4, Figure 4 – 8 ~~Location of Guardrail for information on the correct placement of~~ for positioning a sidewalk ~~in conjunction with~~ along a guardrail.

~~When a new sidewalk or shared use path is within 4 feet of the back of a guardrail with steel posts,~~ Install a pipe rail ~~shall be installed on~~ along the back of ~~the~~ steel guardrail posts when new sidewalks or shared use paths are within 4 feet of the back of guardrail. ~~For a guardrail with timber posts,~~ Trim the bolt ends of timber post guardrails to be ~~shall be trimmed~~ flush or recessed ~~with the post or recessed~~. See Figure 8 – 2 ~~Guardrail with Pipe Rail Detail~~ for ~~an illustration of~~ when a pipe rail is needed. See the FDOT ***Standard Plans*** ~~Additional information on the~~ for designing ~~of~~ guardrails adjacent to a sidewalk or shared use path ~~can be found in the FDOT~~ ~~***Standard Plans.***~~

Figure 8 – 2 Guardrail with Pipe Rail Detail



D.2 Fencing, Pedestrian Channelization Devices or Landscaping

Fencing, pedestrian channelization devices ~~or~~ and landscaping ~~may~~ can be used ~~to discourage pedestrian access to the roadway and aid in~~ to channel~~ing~~ pedestrian traffic to ~~the~~ proper crossing locations ~~points~~. ~~These should not be considered~~ Do not consider these devices as a substitute for longitudinal barriers ~~, but may be used in conjunction with redirection devices~~.

E GRADE SEPARATION

Consider using g~~G~~rade separation (overpasses and underpasses) for: ~~may be selectively utilized to support the crossing of~~

- L~~l~~arge pedestrian volumes, ~~across highways where the~~
- Heavy traffic volumes, ~~on the roadway is at or near capacity or~~ and
- High traffic speeds ~~where speeds are high~~.

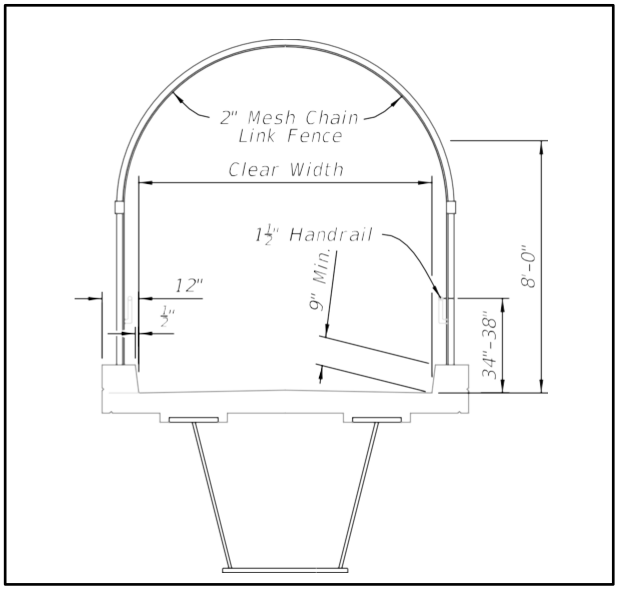
~~Overpasses or underpasses may~~ Grade separation can sometimes be justified at major pedestrian generators such as:

- S~~s~~chools,
- S~~s~~hopping centers,
- S~~s~~ports and amusement facilities,
- T~~t~~ransit centers,
- C~~c~~ommercial buildings,
- P~~p~~arks and playgrounds,
- H~~h~~ospitals, and
- P~~p~~arking facilities.

The minimum clear width ~~of any~~ of stand-alone pedestrian overpasses and~~or~~ underpasses on ~~a~~ pedestrian accessible routes is 8 feet. ~~However, if the contiguous sidewalk or path is greater than 8 feet wide, t~~ The clear width ~~of the overpass or underpass~~ should match the~~at~~ width of wider approaching sidewalks and paths. The minimum clear height of ~~a~~ pedestrian overpasses ~~or~~ and underpasses is 8 feet. See Figure 8 – 3 ~~Pedestrian Bridge Typical Section~~ for an example of a pedestrian bridge typical section.

~~The~~ See FDOT ***Structures Manual - Volume 1 - Structures Design Guidelines (SDG), Section 10*** ~~provide additional~~ for guidance on engineered steel and concrete pedestrian bridges.

Figure 8 – 3 Pedestrian Bridge Typical Section



Notes: 1. Pedestrian handrails ~~may~~ may be required. See the ***2006 Americans with Disabilities Act Standards for Transportation Facilities***.

2. Other superstructure configurations ~~may~~ can be used ~~provided an~~ as long as at least 8 feet~~.~~ ~~minimum~~ of headroom is maintained.

E.1 Overpasses

Pedestrian overpasses are typically bridge structures over major roadways or railroads. Overpasses should provide elevator access if they ~~are~~ do not ~~designed to~~ provide accessible ramps with compliant slopes, level landings, and handrails on both sides. Bridges over roadways should be covered or screened to ~~reduce the likelihood of~~ prevent objects from being dropped or thrown ~~below~~. The area adjacent to the overpass~~es~~ ~~may~~ can be fenced to prevent unsafe crossings and to channel pedestrians to the overpass ~~structure~~.

E.2 Underpasses

Pedestrian underpasses (or tunnels) perform the same function as overpasses ~~.~~ ~~Their use is convenient~~ and may be preferred when the roadway is elevated above the surrounding terrain.

Underpasses should be ~~adequately~~ maintained to address: ~~reduce potential problems in~~

- L~~l~~ighting,
- C~~c~~leaning,
- P~~p~~olicing, ~~and~~
- F~~f~~looding, and
- ~~to maximize~~ S~~s~~afety.

The area adjacent to the underpass~~es~~ ~~may~~ can be fenced to prevent unsafe crossings and to channel pedestrians to the underpass ~~structure~~.

F DROP-OFF HAZARDS FOR PEDESTRIANS

Drop-off hazards are ~~defined as~~ steep or abrupt downward slopes that can be perilous to pedestrians and bicyclists. Consider shielding any drop-off determined to be a hazard. Take special c~~C~~are ~~should be taken when~~ for using p~~P~~edestrian/b~~B~~icycle r~~R~~ailings or fencing near intersections or driveways as they can~~ould~~ obstruct the driver's line of sight. ~~To reduce the need for railings as a sidewalk or shared use path approaches an intersection, c~~Consider extending cross drains and side drains on intersection approaches to minimize sidewalk and shared use path drop-offs and reduce the need for railings.

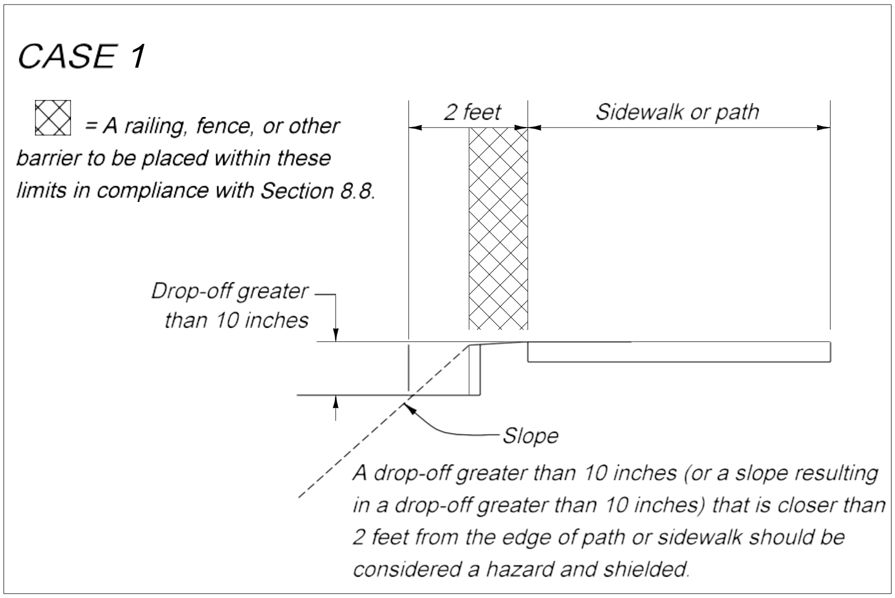
See Figure 8 – 4 for ~~There are~~ two cases that require shielding ~~as shown in Figure 8 – 4 Drop-Off Hazards for Pedestrians and Bicyclists~~. ~~Depending on the depth of the drop-off and severity of the conditions below, s~~ Shielding ~~may~~ can be needed for other caes based on the amount of drop-off and the severity of the conditions below ~~necessary for cases other than described above~~.

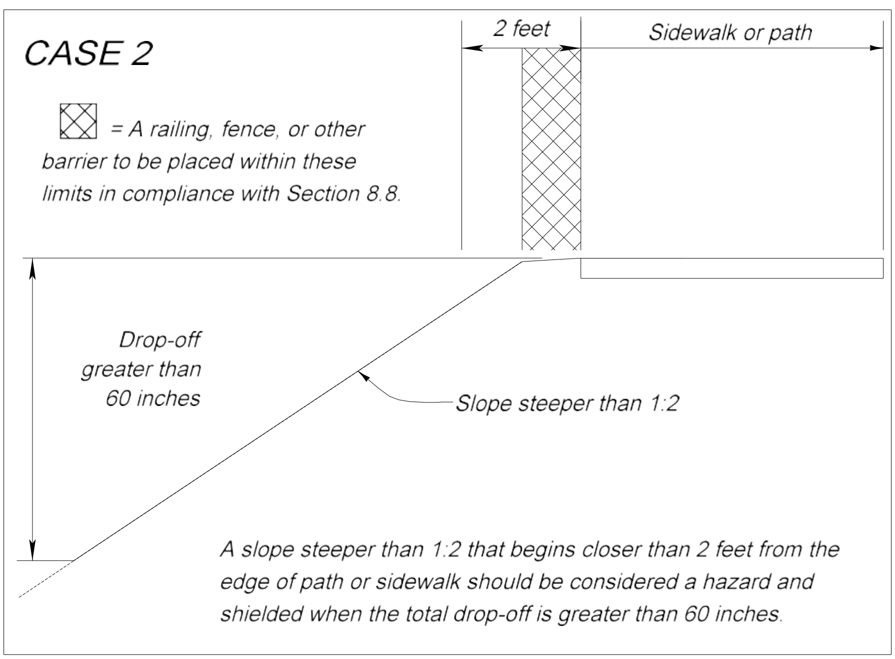
Provide r~~R~~ailings or fences ~~should be provided~~ for ~~vertical~~ drop-off hazards ~~or~~ and where shielding is required. The standard ~~height for a~~ pedestrian/bicycle railing is 42 inches high. Use a~~A~~ 48-inch ~~tall~~ pedestrian/bicycle railing ~~should be used~~ when sidewalk grades are steeper than 5% and bicycle travel is expected. A standard railing is ~~generally~~ usually appropriate ~~intended~~ for:

- U~~u~~rbanized areas, ~~,~~
- ~~locations a~~ Attachments ~~ing~~ to bridge rails, and ~~or~~
- A~~a~~long concrete walkways.

Fencing is generally appropriate ~~intended for use in rural areas~~ along paths and trails in rural areas.

Figure 8 – 4 Drop-Off Hazards for Pedestrians and Bicyclists





G PEDESTRIAN CROSSINGS

The design of pedestrian crossings and parallel pathways within the R/W ~~right of way shall be considered~~ is an integral part of the overall roadway design~~ of a street or highway~~.

~~The development of protection at any remaining crossings or conflict points must be adequate to achieve a total pedestrian transportation mode that is reasonably safe.~~

G.1 Crosswalks

~~The d~~Design~~ of~~ pedestrian crosswalks ~~shall be based~~ based on these ~~following~~ requirements:

- Crosswalks should be placed at locations with sufficient sight distances
- ~~At crossings, t~~The roadway (at the crossing) should be free from changes in alignment or cross section
- The entire length of crosswalks ~~shall~~ must be visible to drivers at a sufficient distance to allow for ~~a~~ stopping ~~maneuver~~
- Provide s~~S~~top bars, ~~or~~ yield markings~~,~~ ~~in conjunction with~~ and ~~the~~ appropriate signing~~, shall be provided~~ at all marked crosswalks
- Crosswalks ~~shall~~ must be easily identified and clearly delineated~~, in accordance with~~ (see the ***Manual on Uniform Traffic Control Devices (MUTCD)*** ***and Rule 14-15.010, F.A.C***).

G.1.a Marked Crosswalks

Marked crosswalks ~~are one tool to~~ allow pedestrians to cross ~~the~~ roadways safely~~. They~~ and are often used in combination with: ~~other treatments (~~

- S~~s~~igns,
- F~~f~~lashing beacons,
- C~~c~~urb extensions,
- P~~p~~edestrian signals,
- R~~r~~aised medians, ~~or~~
- R~~r~~efuge islands, and
- E~~e~~nhanced overhead lighting~~)~~.

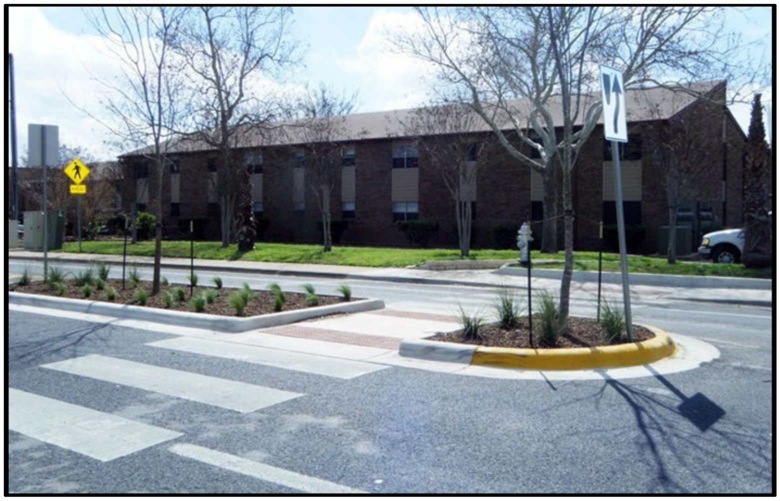
Marked crosswalks ~~serve two purposes~~:

1) ~~to i~~ Inform ~~motorists~~ drivers of ~~the~~ pedestrian crossing locations ~~of a pedestrian crossing~~ so ~~that~~ they have time to lawfully yield to or stop for a crossing pedestrian; and
2) ~~to~~ A~~a~~ssure ~~the~~ pedestrians that a legal crosswalk exists at a

particular location.

See Figure 8 – 5 ~~Pedestrian Median Refuge with Curb Extensions~~ for an example of a pedestrian median refuge with a curb extension.

Figure 8 – 5 Pedestrian Median Refuge with Curb Extension



Urban Street Design Guide,
National Association of City Transportation Officials (NACTO)

Supplement m~~M~~arked crosswalks on ~~an~~ uncontrolled intersection legs ~~of an intersection or a~~ and mid-block locations:) ~~shall be supplemented with other treatments (such as signing, beacons, curb extensions, raised medians, raised traffic islands, or enhanced overhead lighting) when any of the following conditions exist:~~

1. Where posted speeds are ~~greater than~~ over 40 mph.
2. On ~~a~~ roadways with 4 or more lanes (with~~out a~~ no raised median or raised traffic island) ~~that has an~~ with ADT's ~~of~~ over 12,000 ~~or greater~~.
3. On ~~a~~ roadways with 4 or more lanes (with a raised median or raised traffic island) ~~that has or is~~ projected to have ~~(within 5 years) an~~ ADT's ~~of~~ over 15,000 ~~or greater~~ within 5 years.

Supplement these marked crosswalks and mid-block locations with treatments like:

- Signing,
- Beacons,
- Curb extensions,
- Raised medians,
- Raised traffic islands, or
- Enhanced overhead lighting.

See ***Chapter* 6** of this manual ~~–~~ ~~***Lighting***~~ ~~for information on illuminating~~ for lighting crosswalks and pedestrian facilities.

~~Additional guidance on marked crosswalks can be found in~~ See the ***AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities*** and ***FHWA's Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines*** for additional guidance on pedestrian facilities.

Marked crosswalks can also be used to create midblock crossings.

G.1.b Midblock Crosswalks

Midblock crosswalks ~~facilitate~~ allow crossings to places that people want to go ~~but~~ that are not well served by the existing sidewalk or path network, such as: ~~. These pedestrian crossings commonly occur at~~

- S~~s~~chools,
- P~~p~~arks,
- M~~m~~useums,
- W~~w~~aterfronts, and
- O~~o~~ther destinations.

~~Designers should study both~~ Examine existing and projected pedestrian volumes in assessing warrants for midblock crossings ~~to account for latent demand~~.

Consider these factors in locating m~~M~~idblock crossings: ~~are located according to a number of factors including~~

- P~~p~~edestrian volumes,
- T~~t~~raffic volumes,
- R~~r~~oadway width,
- T~~t~~raffic speed and type,
- D~~d~~esired pedestrian paths ~~for pedestrians~~,
- L~~l~~and use, and
- ~~to accommodate~~ T~~t~~ransit connectivity.

Do not install m~~M~~idblock crossings ~~should not be installed~~ where driver or pedestrian sight ~~distance or sight~~ lines are limited ~~for either the motorist or pedestrian~~.

See the ***MUTCD*** for signing and pavement markings for m~~M~~idblock crossings ~~should be marked and signed in accordance with the~~ ~~***MUTCD***.~~ See Figure 8 – 6 ~~Raised Midblock Crosswalks~~ for an example of a midblock crosswalk.

Figure 8 – 6 Raised Midblock Crosswalk

Suwannee Street, Tallahassee, Florida

Crosswalks ~~may~~ can be supplemented with Pedestrian Hybrid Beacons (PHB) ~~or~~ and Rectangular Rapid Flashing Beacons (RRFBs). Evaluate ~~Illumination should be evaluated~~ lighting if night-time pedestrian activity is expected. See ***Chapter 6*** ~~***– Lighting***~~ for additional~~further~~ information.

A PHB is ~~a special type of beacon~~ used to warn and control traffic at an unsignalized location to assist pedestrians in crossing ~~a street or highway~~ at a marked crosswalk. See ***Chapter 4F.*** ~~***Pedestrian Hybrid Beacons,***~~ ***MUTCD*** ~~provides additional information regarding~~ regarding their installation. See Figure 8 – 7 ~~Pedestrian Hybrid Beacon~~ for an example of a PHB ~~pedestrian hybrid beacon~~.

Figure 8 – 7 Pedestrian Hybrid Beacon (PHB)

16th Street South, St. Petersburg, Florida

~~The~~ An RRFB uses rectangular~~-shaped~~ high-intensity LED-based indications, flashes rapidly in a wig-wag "flickering" flash pattern, and is mounted immediately between the crossing sign and ~~the sign's~~ its supplemental arrow plaque. Limit the u~~U~~se of PHBs ~~should be limited~~ to locations with the most critical safety concerns~~, such as~~ (e.g., pedestrian and school crosswalks across uncontrolled approaches).

~~The use of~~ Using RRFBs requires interim approval from FHWA. See t~~T~~he ***MUTCD*** ~~provides further information on~~ for obtaining ***interim approval*** ~~for the use of~~ ~~***RRFBs.***~~ See Figure 8 – 8 ~~Pedestrian Median Refuge with Rectangular Rapid Flashing Beacon~~ for an example of an ~~Rectangular Rapid Flashing Beacon (~~ RRFB~~)~~.

Figure 8 – 8 Pedestrian Median Refuge with Rectangular Rapid Flashing Beacons (RRFB)

4th Street North, St. Petersburg, Florida

G.2 Curb Ramps and Blended Transitions

Provide a~~A~~ continuous accessible pedestrian route ~~, including~~ (with curb ramps and blended transitions) ~~is needed~~ along pedestrian networks. Blended transitions are raised pedestrian street crossings, depressed corners, or similar connections between pedestrian access routes. Blended transitions can be:

- A~~a~~t the level of the sidewalk or shared use path, ~~and~~ or
- At the level of the ~~pedestrian~~ street crossing ~~that have~~ (with a grade of 5% or less).

Blended transitions can be used when the geometry ics and allocated space doesn't do not allow for separated curb ramps.

Provide c~~C~~urb ramps ~~shall be provided~~ at all intersections with curb (***Section 336.045 (3), Florida Statutes***). Each crossing should have separate curb ramps~~,~~ which are perpendicular with the curb~~,~~ and ~~landing~~ located within the crosswalk. Include sidewalk curb ramps~~ at the following locations~~:

- At curbed returns for intersections and turnouts.
- On curbed roadways between intersections where a crosswalk has been established ~~, such as~~ (e.g., midblock crossings and side streets).

Relocate or adjust pull boxes, manholes and other types of existing surface features to meet the ADA requirements for:

- N~~n~~onslip ~~top~~ surfaces,
- ¼~~-~~ inch maximum height protrusion, and ~~slopes~~
- F~~f~~lush with the surrounding surface.

~~On sidewalks, the c~~Curb ramps for sidewalks must be at least 4 feet wide. ~~width shall be a minimum of 4 feet; c~~Curb ramp widths equal to crosswalk widths are encouraged. ~~For shared use paths, the curb ramp shall~~ Curb ramps for shared use paths must be at least as wide as the approaching ~~width of the~~ path. Curb ramp slopes ~~shall~~ cannot exceed 1:12 and ~~shall~~ must have a firm, stable, slip resistant surface texture.

Align c~~C~~urb ramps ~~should be in line~~ with its ~~the~~ crossing. ~~At intersections where more than one road is crossed, p~~Provide separate curb ramps at both ends of each crossing where more than one road is crossed. Two ramps per corner are preferred to ~~minimize the problems with~~ accommodate the entry angle and to ~~decrease the delay to~~ reduce pedestrian delay ~~s entering and exiting the roadway~~.

Crossings ~~are required to~~ must meet ~~the same~~ sidewalk grade and cross slope requirements ~~as sidewalks~~. ~~Where criteria for maximum cross slope of the crossing cannot be met, p~~ Provide the minimum attainable cross slope where cross slope criteria cannot be met. ~~When following the profile grade of the roadway, c~~Curb ramps are not required to exceed 15 feet in length when following the roadway profile.

Curb ramps ~~whose sides have returned~~ with curbed ~~s on the~~ outside edges provide useful channelization ~~directional cues~~ when ~~they are~~ aligned with the crosswalk ~~pedestrian street crossing and are~~ and protected from cross travel ~~by a~~ (with a buffer area or landscaping).

Provide transition slopes (flared sides) where curb ramps are located within a pedestrian circulation path crosses the curb ramp. Use a The maximum transition slope of transition slopes is 1:10 , measured (parallel with and adjacent to the curb line).

Provide aA minimum 4-foot by 4-foot turning space at least 4 feet by 4 feet wide shall be provided at the top of the curb ramps. The turning space and shall be permitted to can overlap other turning spaces and clear spaces. Where the turning space is constrained at the back-of-sidewalk, the turning space must ~~shall~~ be at least 4 feet by 5 feet ~~.~~ (with t~~T~~he 5-foot dimension ~~shall be provided~~ in the direction of the ramp run).

A 1:10 maximum longitudinal slope (with a maximum 6-inch rise) can be used ~~When~~ for altering ~~an~~ existing pedestrian facilities ~~y and~~ when conditions preclude using a 1:12 slope ~~the accommodation of a curb ramp slope of 1:12, provide a slope from 1:12 to 1:10 with a maximum rise of 6 inches~~.

See the FDOT ***Standard Plans*** ~~Further information on~~ for curb ramps, landings and blended transitions ~~is provided in the FDOT **Standard Plans**~~.

G.3 Detectable Warnings

Install detectable warnings ~~to cover~~ 2-feet deep across the full width of the walking surface of sidewalks and shared use paths at these locations ~~and 2 feet in length. They are required on sidewalks and shared use paths at the following locations~~:

- Curb ramps and blended transitions at street crossings,
- Cut-through pedestrian refuge islands, ~~or~~
- M~~m~~edians six feet wide and more, ~~or greater~~
- Pedestrian at-grade rail crossings,
- Commercial driveways with a stop sign, yield sign or traffic signal,
- Boarding and alighting areas adjacent to the roadway at bus stops where there is an at-grade connection to the roadway, and
- Edges of rail boarding platforms not protected by screens or guards.

Detectable warnings are not required where sidewalks intersect~~s~~ urban flared turnouts or ~~sidewalks that~~ run continuously through driveways. Do not place detectable warnings on transition slopes or ~~over~~ across grade breaks.

The detectable warning systems on the FDOT ~~Department's **Approved Product List** (~~**APL**~~)~~ ~~are designed to work with~~ are for concrete surfaces. ~~In areas where the pedestrian facility has an asphalt surface, such as a shared use path, s~~ Specify an appropriate detectable warning system for asphalt surfaces (e.g., shared use paths) ~~. In these cases,~~ or consider ~~including~~ providing a short section of concrete surface ~~that will accommodate any system~~.

See the FDOT ***Standard Plans*** ~~Further information on~~ for detectable warnings ~~are provided in the FDOT **Standard Plans**~~.

G.4 Curb Extensions

Curb extensions (a.k.a., bulb-outs) ~~may~~ can be used in conjunction with on-street parking (at intersections ~~or~~ and midblock locations) where there is a crosswalk, provided there is adequate width for existing traffic movements. Curb extensions shorten the crossing distance~~,~~ and provide additional space at intersections, allowing pedestrians to see and be seen before entering a crosswalk. ~~The design of curb extensions must take into consideration~~ Consider the needs of transit vehicles, drainage, and bicyclists.

G.5 Pedestrian Signals

Use s~~S~~igns, signals, and pavement markings to ~~should be utilized to provide the necessary~~ inform~~ation~~ and direct~~ion~~ ~~for~~ pedestrians. All directions and regulations should be:

- C~~c~~lear,
- C~~c~~onsistent, and
- L~~l~~ogical, and
- ~~should, at a minimum, c~~ Conform to the requirements ~~given~~ provided in the ***MUTCD*** (at a minimum).

Consider using~~The installation of~~ accessible pedestrian signals ~~that include~~ (e.g., audible, ~~and/or~~ vibro-tactile, and visual signals) ~~should be considered~~.

~~Where pedestrian facilities are provided or planned, include provisions (e.g., conduit, conductors, signal cables, push button pedestals, curb ramps) needed~~ Include provisions for future installation of a~~A~~ccessible p~~P~~edestrian s~~S~~ignal (APS) devices (e.g., conduit, conductors, signal cables, push button pedestals, curb ramps) on all new and reconstructed signalized intersections and ~~signalized~~ crossings ~~locations~~ where pedestrian facilities are provided or planned.

Provide a level landing (with a 30-inch by 48-inch clear area) at the base of all pedestrian pushbutton locations. ~~The landing must provide a clear area of 30 inches by 48 inches (in either direction)~~ Locate the landing directly in front of and centered on~~,~~ the pedestrian pushbutton to allow persons using a wheeled mobility device to actuate the button while remaining stationary.

G.6 Sight Distance

See ***Chapter 3*** of this manual for tThe general requirements for driver sight distances for the driver are given in ***Chapter 3***

- Geometric Design.

Provide sStopping sight distances greater than over the minimums should be provided at all pedestrian crossings. These sight distances should include a clear view of the pedestrian approach pathway. Where parallel pedestrian pathways are within the roadside recovery area, or where casual pedestrian crossings are likely, the normal required The stopping sight distance should also include a clear view of the entire roadside recovery area where parallel pedestrian pathways are within the roadside recovery area and where casual pedestrian crossings are likely.

Base s~~S~~ight distances on ~~shall be based upon a~~ the driver's eye and object height ~~as~~ discussed in ***Chapter 3*** ***~~– Geometric Design~~***. ~~Due to the small size of some pedestrians (particularly children), they~~ Smaller pedestrians (e.g., children) are generally easy to confuse with other background objects.

Prohibit on-street p~~P~~arking ~~shall be prohibited~~ where it ~~would~~ interferes with the required sight distance. ~~Particular care should be exercised~~ Give special attention to ~~ensure~~ providing ample mutual sight distances ~~are provided~~ at all intersections and driveways.

G.7 Rail Crossings

Roadways, sidewalks, and shared use paths ~~at grade may~~ may cross:

- L~~l~~ight rail,
- S~~s~~treet car rail,
- P~~p~~assenger rail, and
- F~~f~~reight railroads.

Include s~~S~~pecial design considerations ~~are needed for these pedestrian intersections so that~~ to warn pedestrians ~~are warned~~ of the crossing and the potential presence of a train. ~~In addition, these crossings have specific~~ Comply with the accessibility requirements ~~relating to~~ for surface continuity ~~which must be met~~. See ***Chapter 7*** of this manual ***~~– Rail-Highway Crossings~~*** for additional ~~further~~ information. The ***Federal Railroad Administration*** ~~may~~ may impose additional requirements ~~for the design and construction of rail crossings~~.

H LIGHTING

Roadway l~~L~~ighting~~ of the roadway itself is not only~~ is important for the safety of all roadway users ~~vehicular traffic, but also valuable for the protection of pedestrians~~. Consider lighting pedestrian crossings since v~~V~~ehicle headlamps ~~often~~ do not provide sufficient lighting to ~~achieve the~~ accommodate required stopping sight distances (especially during turning maneuvers). ~~Since this requirement is of vital importance at any potential pedestrian crossing point, lighting of the crossing should be considered.~~ Roadway l~~L~~ighting ~~a street or highway is~~ also ~~valuable in~~ improves ~~ing~~ the pedestrian's view of oncoming vehicles. ~~At intersections or other locations with vehicle turning maneuvers, vehicle headlights may not be readily visible to the pedestrian.~~

Provide l~~L~~ighting ~~shall be provided~~ in pedestrian underpasses. ~~and should be c~~Consider providing lighting ~~ed on~~ for pedestrian overpasses. All pedestrian lighting ~~shall~~ must be vandal-~~-~~resistant. ~~The installation of~~ Providing daytime lighting is warranted when underpass ~~user~~ visibility requirements are not met with sunlight. ~~Pedestrian underpass and overpass lighting should conform to~~ Comply with the general lighting requirements provided ~~given~~ in the American Association of State Highway and Transportation Officials (AASHTO) Roadway Lighting Design Guide.

See ***Chapter 6*** of this manual for ~~The~~ the general requirements for roadway lighting ~~on streets and highways are given in~~ ~~***Chapter 6 – Lighting***~~. Do not light p~~P~~athways adjacent to a roadway ~~street or highway should not be illuminated~~ to a level more than twice that of the roadway~~ itself~~.

~~In general, lighting should be considered as warranted when it is necessary, at night, to~~ Lighting is warranted ~~provide the~~ for accommodating the mutual sight distance capabilities described in ~~the preceding~~ ***Chapter 3*** ~~***– Geometric Design***~~. Consider lighting the roadway and adjacent pedestrian facility(s) at l~~L~~ocations with significant night-~~-~~time pedestrian traffic, ~~that should be considered for lighting of the roadway and adjacent pedestrian facilities include the following~~including:

- Any street or highway that meets the warranting criteria provided, ~~given~~ in ***Chapter 6*** ~~***– Lighting***~~
- Streets and highways with speed limits ~~more than~~ over 40 mph that do not have adequate pedestrian conflict elimination,
- Sections of highway with minimal separation to ~~of~~ parallel pedestrian pathways,
- Intersections, access and decision points, and ~~areas adjacent to~~ changes in alignment or cross section~~s~~,
- Areas ~~adjacent to~~ near pedestrian generators,

- Transit stops and other mass transit transfer locations,
- Parking facilities,

- Entertainment districts, sports/recreation complexes, schools, and other activity centers generating night-time travel,
- Pedestrian crossings,
- Any location where improving ~~ement of~~ night-time sight distances~~ will~~ reduces ~~the hazard of~~ vehicle-pedestrian conflicts.

See ***Chapter 6*** ~~– ***Lighting*** for further information on~~ for lighting ~~of~~ pedestrian facilities and shared use paths.

I REFERENCES FOR INFORMATIONAL PURPOSES

- F~~DOT~~~~lorida Department of Transportation~~ Transit Facility Design ***https://www.fdot.gov/fdottransit/transitofficehome/transitplanning.shtm/ne wtransitfacilitiesdesign.shtm***
- USDOT/FHWA ADA Standards for Accessible Design (ADAAG) ***http://www.access-board.gov/guidelines-and-standards/buildings-and- sites/about-the-ada-standards/ada-standards***
- 2006 Americans with Disabilities Act Standards for Transportation Facilities ***https://www.access-board.gov/files/ada/ADAdotstandards.pdf***
- 2012 Florida Accessibility Code for Building Construction ***http://floridabuilding.org/fbc/committees/accessibility/aac/Changes_to_Law/Florida_Accessibility_Code_2012_ICC_FINAL.pdf***
- ***AASHTO – Guide for the Planning, Design, and Operation of Pedestrian Facilities https://store.transportation.org/***
- AASHTO – Roadway Lighting Design Guide ***https://store.transportation.org/***
- NACTO Urban Streets Design Guide ***https://nacto.org/publication/urban-street-design-guide/***
- ***Designing Walkable Urban Thoroughfares (CNU and ITE) https://www.cnu.org/our-projects/cnu-ite-manual***
- FHWA Policy Memo for Flexibility in Pedestrian and Bicycle Facility Design ***https://nacto.org/wp-content/uploads/2013/09/design_flexibility_memorandum_092013.pdf***
- AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, 6h Edition, (2012) with 2013 Interim Revisions ***https://store.transportation.org/***
- Federal Railroad Administration General Manual - Policies, Procedures, and General Technical Bulletins (July 2014) ***https://railroads.dot.gov/about-fra/about-fra***

CHAPTER 9
BICYCLE FACILITIES

A INTRODUCTION

Give full consideration to establishing b~~B~~icycle facilities ~~shall be given full consideration~~ in ~~the~~ planning and developing ~~ment of~~ transportation facilities. ~~, including the i~~ Incorporate~~ion~~ ~~of such~~ bicycle facilities into state, regional, and local transportation plans~~,~~ and programs, ~~-~~recognizing ~~under the assumption~~ that transportation facilities ~~will be~~ are used by bicyclists. Establish b~~B~~icycle facilities ~~should be established~~ in conjunction with the construction~~,~~ or reconstruction~~, or other change~~ of any transportation facility ~~and special emphasis should be given to projects in or~~ (especially those within 1 mile of an urban area). ~~The provision for bicycle facilities is also desirable for~~ Consider establishing bicycle facilities in conjunction with resurfacing, restoration & rehabilitation (RRR-type) projects.

Bicycle and pedestrian facilities are not required ~~to be established~~:

1. Where their establishment ~~would be~~ is contrary to public safety.
2. When their cost ~~would be~~ is excessively disproportionate to their need or probable use; or
3. Where other available means or factors can replace their ~~indicate an absence of~~ need.

~~Appropriately~~ Properly designed and located bicycle facilities play an important role in supporting bicycle travel. Consider b~~B~~icyclists ~~shall be considered~~ in all phases of transportation planning, design, construction, and maintenance activities. ~~Emphasis should be~~ G~~g~~ive special attention ~~n~~ to new construction, reconstruction, intersection improvement, and transit projects. Bicycle facilities can include:

- B~~b~~icycle lanes,
- P~~p~~aved shoulders,
- W~~w~~ide curb lanes,
- S~~s~~hared lanes,
- S~~s~~hared use paths, and
- B~~b~~icycle parking facilities.

~~In addition to the design criteria provided in this chapter, s~~ Design shared use paths and structures that include provisions for pedestrians ~~shall be designed~~ to be accessible to persons with disabilities. ~~For more information on accessible design requirements, s~~See Chapter 8 for accessible design requirements~~– Pedestrian Facilities~~.

B ON-STREET FACILITIES

Incorporate p~~P~~rovisions for bicycle travel ~~ffic should be incorporated~~ into the original roadway design. Design, construct, and maintain a~~A~~ll roadways ~~, except where bicycle use is prohibited by law, should be designed, constructed, and maintained under the assumption~~ recognizing they will be used by bicyclists (except where bicycle use is prohibited by law). Roadway conditions should be favorable for bicycling, with smooth pavement and limited elevation changes ~~in elevation~~ along edge lines. Design any drainage inlets ~~and~~ or utility covers that cannot be moved ~~out of~~ from the travel way ~~shall be designed~~ to be flush with grade~~,~~ and well seated~~, and make use of~~ with bicycle-compatible grates ~~and~~ or covers.

Bicycling across diagonal r~~R~~ailroad ~~grade~~ crossings can be difficult ~~on a diagonal can cause steering difficulties for bicyclists~~. Bicycle c~~C~~rossings ~~for bicycle facilities~~ should be perpendicular to the rail. ~~This can be accomplished with~~ Consider using a widened shoulder or bicycle lane~~,~~ or separate path. Also c~~C~~onsider ~~ation shall be given to~~ improving the smoothness of the crossing and reducing the width and depth of the flangeway opening. Flangeway fillers can be used ~~on~~ along heavy rail lines to minimize ~~the size of~~ the opening ~~adjacent to the rail~~.

Include b~~B~~icycle lanes, paved shoulders, wide curb lanes, ~~or~~ and shared lanes ~~should be included~~ to the fullest extent feasible. ~~The appropriate selection of a~~ Select the appropriate bicycle facility based upon:~~depends on many factors, including~~

- M~~m~~otor vehicle and bicycle traffic characteristics,
- A~~a~~djacent land use, ~~-~~and
- E~~e~~xpected growth patterns.

Include bicycle lanes on a~~A~~ll new ~~– or~~ and reconstructed arterials and collectors ~~roadways, in and~~ within ~~one~~ 1 mile of an urban area~~, should include bicycle lanes~~.

Rumble strips used in a traffic lane to alert ~~operators~~ drivers to conditions ahead (e.g., stop signs, traffic signals or curves) should provide clear space (free of rumble strips) for bicyclists. This clear space may be a paved shoulder or ~~if no paved shoulder is present,~~ a minimum of 1.5 feet of clear space at the outermost portion of the lane (if no paved shoulder exists).

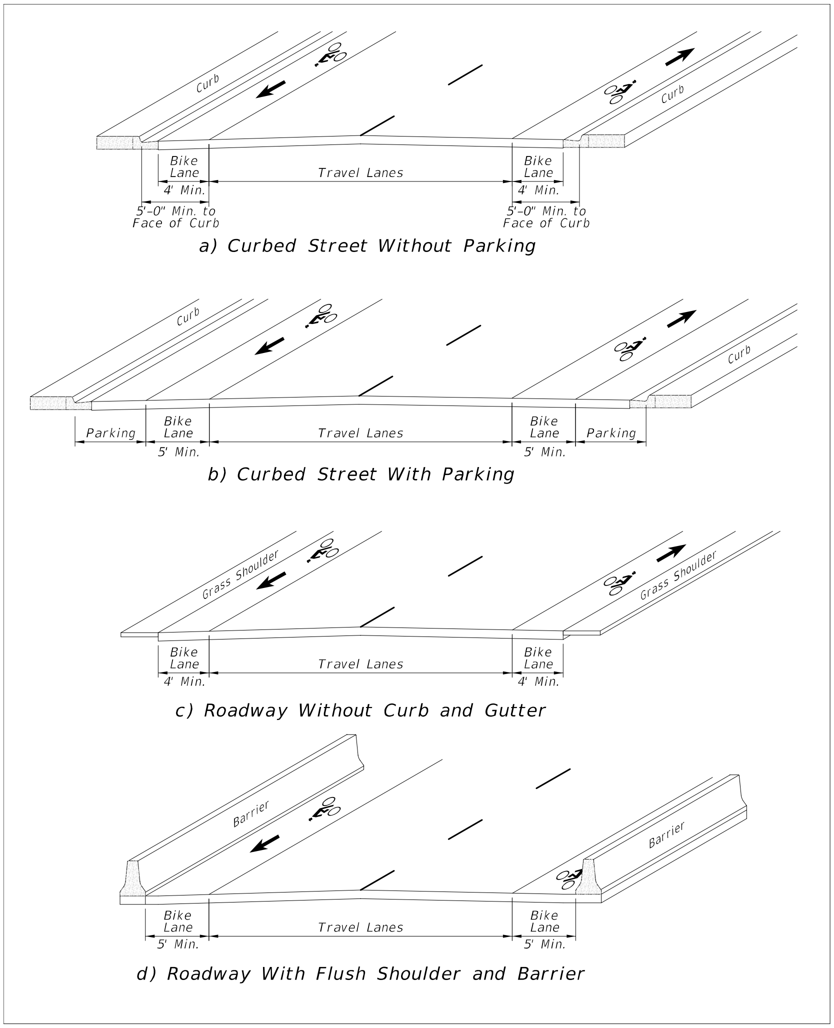
B.1 Bicycle Lanes

Bicycle lanes delineate available roadway space for preferential bicycle use~~ by bicyclists~~, ~~providing~~ establishing more predictable movements by motorists and bicyclists. Bicycle lanes also ~~help~~ increase the ~~total~~ capacity of highways ~~carrying mixed~~ with bicycle and motor vehicle traffic. Bicycle lanes ~~shall~~ must have a minimum functional width of 4 feet. Provide a~~A~~t least 1-foot of additional width~~ is needed~~ where: ~~n the bicycle lane is~~

- A~~a~~djacent to a curb or other barrier,
- O~~o~~n-street parking is present,
- T~~t~~here is substantial truck traffic (>10%), or
- P~~p~~osted speeds exceed 50 mph.

~~Minimum bicycle lane widths are illustrated in~~ See Figure 9 – 1 for minimum bicycle lane widths ~~Minimum Widths for Bicycle Lanes~~. The 4-foot bicycle lane ~~shown~~ depicted in the flush shoulder typical section assumes the grass portion of the shoulder ~~provides~~ accommodates emergency maneuvering~~ room~~.

Figure 9 – 1 Minimum Widths for Bicycle Lanes



Bicycle lanes are one-way facilities~~ and~~ which carry bicycle traffic in the same direction as the adjacent motor vehicle traffic. Delineate ~~A~~ bicycle lanes ~~should be delineated~~ from the travel lanes with a solid white line and ~~be marked~~ with the bicycle symbol and arrow ~~as shown~~ depicted in Figure 9 – 2~~ Detail of Bicycle Lane Markings~~. ~~The dimensions for e~~Each pavement marking is 72” long with a 72” space~~, separated by 72”~~.

~~The recommended placement of~~ Place the bicycle lane markings~~ is~~:

a) At the beginning of a bicycle lane,

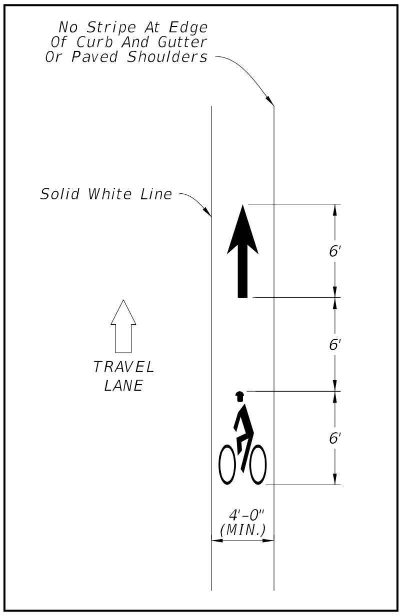
b) O~~o~~n the far side of major intersections, ~~and~~

~~a)~~c) P~~p~~rior to and within the bicycle lane between a through lane and turn lane, and~~.~~

d) Along the roadway ~~as needed to provide~~ with a maximum spacing of:

- a. 1,320 for posted speeds ~~less than or equal to~~ of 45 mph and less.
- ~~a.~~b. ~~,~~2,640 feet for ~~a~~ posted speeds of 50 mph and more~~or greater~~.

Figure 9 – 2 Detail of Bicycle Lane Markings



If used, place bike lane signs and plaques: ~~should be placed in advance of~~

- Before the upstream end of the bicycle lane,
- A~~a~~t the downstream end of the bicycle lane, and
- A~~a~~t periodic intervals based upon:
  - P~~p~~revailing speed of bicycle and other traffic,
  - B~~b~~lock length, and
  - D~~d~~istances from adjacent intersections~~, and other considerations~~.

~~They should only be used~~ Use bike lane signs only in conjunction with marked bicycle lanes. Bike lane signs are not required.

Figure 9 – 3 Bicycle Lanes

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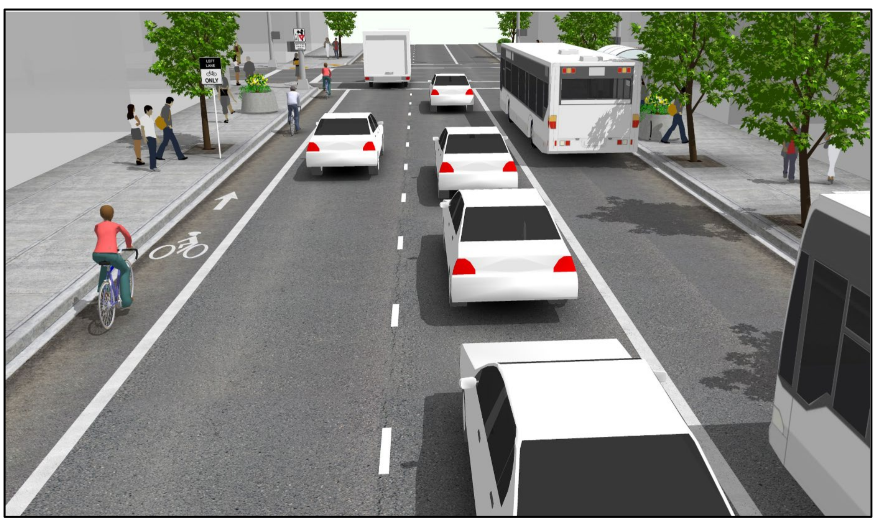
Do not locate a~~A~~ through bicycle lane ~~shall not be positioned~~ to the right of a right-turn-~~-~~only lane or to the left of a left-~~-~~turn-~~-~~only lane. ~~For new construction, reconstruction, and traffic operations projects, where b~~Bicycle lanes ~~are provided~~ between ~~the~~ a through lane and right turn lane, bus bay or parking lane on new construction, reconstruction, and traffic operations projects they shall be a minimum of must be at least 5 feet wide. For bicycle lanes adjacent to parking lanes, if the parking volume is substantial or the turnover is high a width of 6-7 feet is desirable adjacent to parking lanes (in the "door zone") where parking turnover is highto avoid opening vehicle doors.

~~On one-way streets, b~~Bicycle lanes should ~~generally~~ be ~~placed~~ located on the right side of ~~the~~ one-way streets. ~~A bicycle lane on the left side of the street can be c~~Consider the left side ~~ed~~ when ~~a bicycle lane on the left~~ it will substantially decrease the ~~number of~~ conflicts~~, such as those~~ caused by:

- F~~f~~requent bus traffic,
- H~~h~~eavy right-~~-~~turning movements,
- H~~h~~igh-turnover parking lanes, or
- ~~if there are a~~ A significant ~~number~~ amount of left-~~-~~turning bicyclists.

See Figure 9 – 4 ~~Left Side Bicycle Lanes~~ for an illustration.

Figure 9 – 4 Left Side Bicycle Lanes



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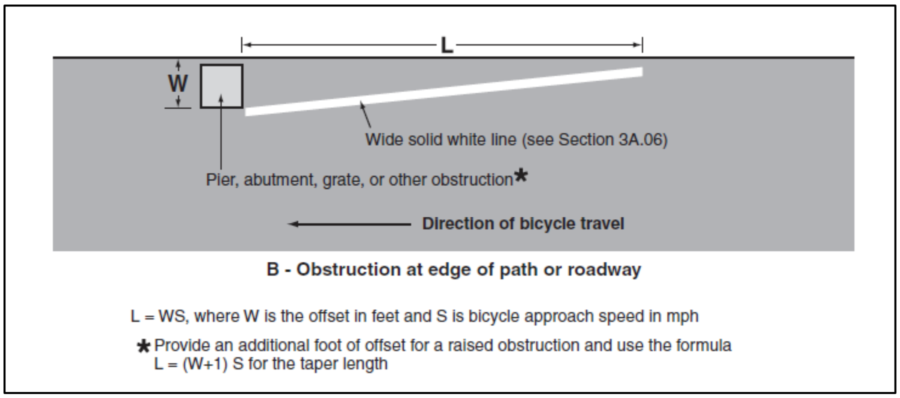
Do not provide b~~B~~icycle lanes ~~shall not be provided~~ on the circular roadway of a roundabout. ~~, and shall be t~~ Transition bicycle lanes ~~ed~~ prior to the roundabout in accordance with the MUTCD.

Evaluate existing drainage inlets, grates and utility covers ~~shall be evaluated as to whether~~ to determine if they ~~present~~ are an obstruction to bicyclists~~,~~ and should be relocated ~~out of the cyclist's path of travel. Drainage inlets, grates and utility covers~~

~~to remain should be adjusted~~ or adjusted to be flush. ~~with the adjacent pavement surface, utilize a~~ Use grates that are suitable ~~recommended~~ for bicycles. ~~travel, and may be marked as an obstruction.~~

See ***MUTCD Part 9*** for~~Advance~~ pavement marking warning of an inlet or other obstruction ~~may be provided as shown in the ***MUTCD, Part 9***~~. ~~Additional information on appropriate drainage inlets in or near pedestrian and bicycle facilities can be found in the~~ See FDOT~~'s~~ ***Drainage Manual, Section 3.7.4 Inlet Placement, (2022)*** for information on inlets near pedestrian and bicycle facilities.

Figure 9 – 5 Example of Obstruction Pavement Markings



Traffic signals should be responsive to bicyclists. Prioritize r~~R~~egular maintenance of bicycle lanes ~~should be a priority,~~ since bicyclists ~~are unable to~~ do not use ~~a~~ lanes with potholes, debris, or broken glass.

~~In conjunction with resurfacing projects,~~ Redistribute the overall roadway width ~~shall be redistributed~~ during resurfacing projects ~~when practical~~ to ~~provide for~~ create bicycle facilities (when practical). ~~The types of b~~Bicycle facilities ~~considered for implementation~~ can include:

- B~~b~~uffered bicycle lanes,
- B~~b~~icycle lanes,
- W~~w~~ide outside lanes, and
- S~~s~~hared lanes.

Consider reducing l~~L~~ane widths on urban multilane roadways and two-lane curb and gutter roadways ~~may be reduced as shown in~~ (see Table 9 – 1) ~~Lane Widths~~ to ~~provide for~~ create bicycle facilities.

Table 9 – 1 Lane Widths for Urban Multilane or Two-Lane with Curb and Gutter

Design Year AADT	Design Speed (mph)	Minimum Thru Lane (feet~~.~~)	Minimum Turn Lane (feet~~.~~)	Minimum Parking Lane (feet~~.~~)
ALL	ALL	10 [1]	9 [2]	7 [3]

1. 11 feet~~.~~ where either of the following conditions exist:
   - a) Trucks are more than ~~>~~10% of Design Year Traffic.
   - b) Design Speed is 40 mph or greater.
2. 10 feet~~.~~ for 2-~~-~~Way Left-~~-~~Turn Lanes.
3. A minimum width of 7 feet~~. measured~~ from face of curb may remain ~~be left in place~~. Otherwise, ~~-~~provide at least 8 feet~~. minimum, measured~~ from face of curb.

See Figures 9 – 6 through 9 – 23 for v~~V~~arious configurations of bicycle lanes ~~on~~ with curb and gutter and flush shoulders ~~typical sections are illustrated in Figures 9 – 6 to 9 – 23~~.

Figure 9 – 6 Bicycle Lane Markings

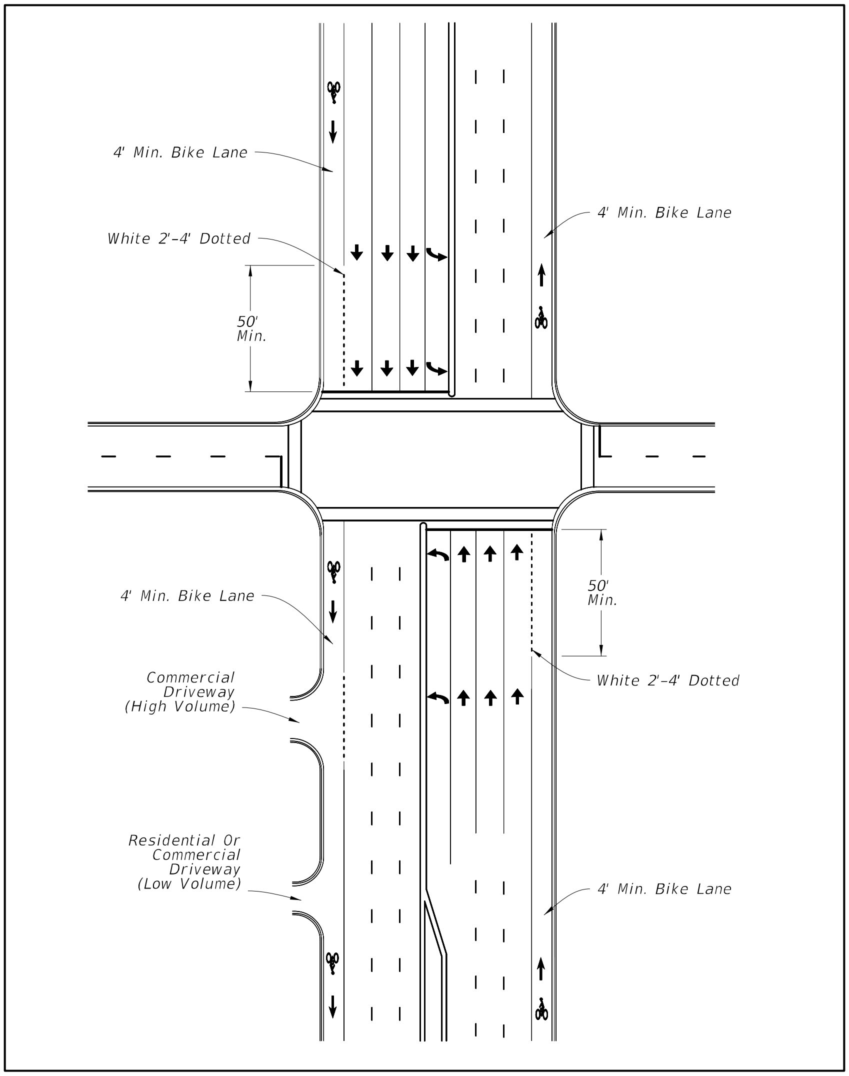


Figure 9 – 7 Bicycle Lanes with Separate Right-Turn Lane (Curb and Gutter)

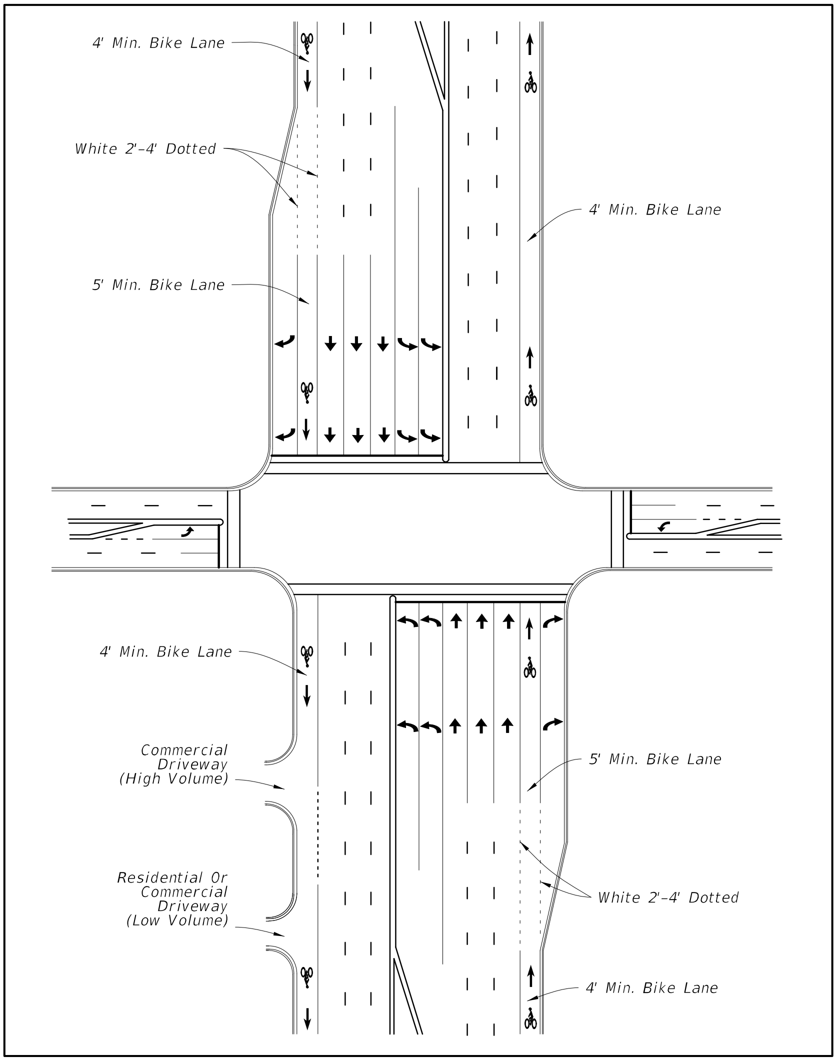


Figure 9 – 8 Bicycle Lanes with On-Street Parking, No Right-Turn Lane (Curb and Gutter)

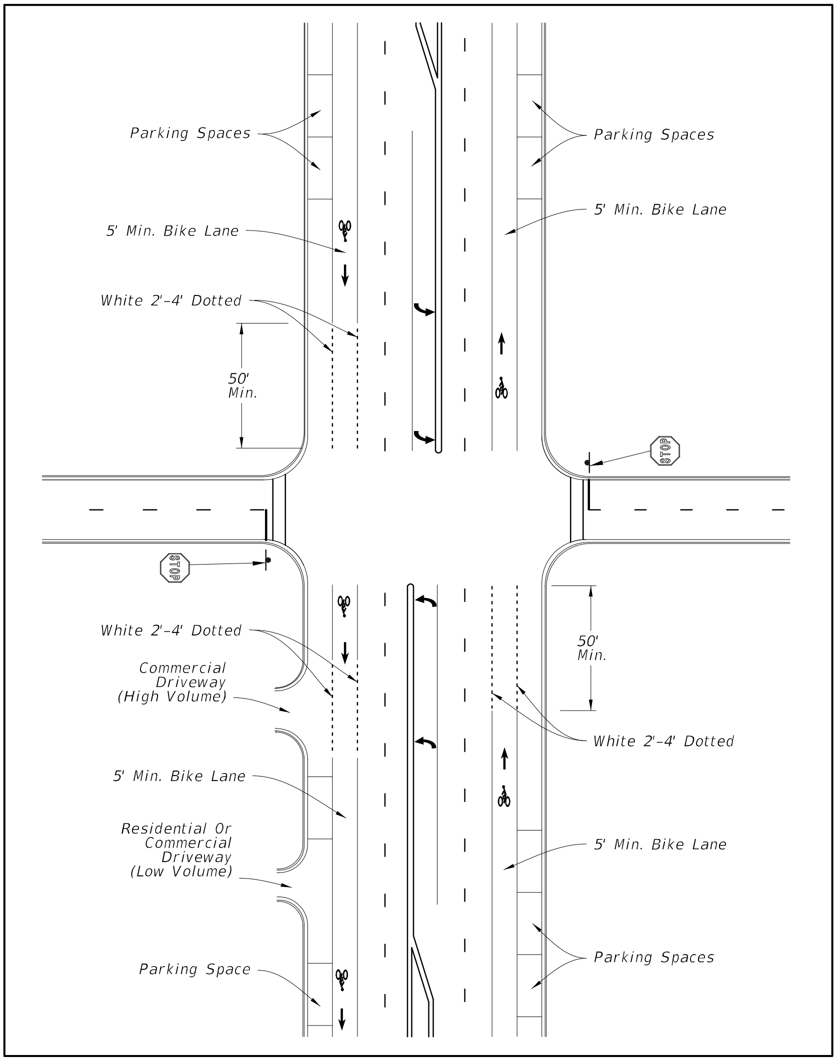


Figure 9 – 9 Bicycle Lane with Right-Turn Drop Lane (Curb and Gutter)

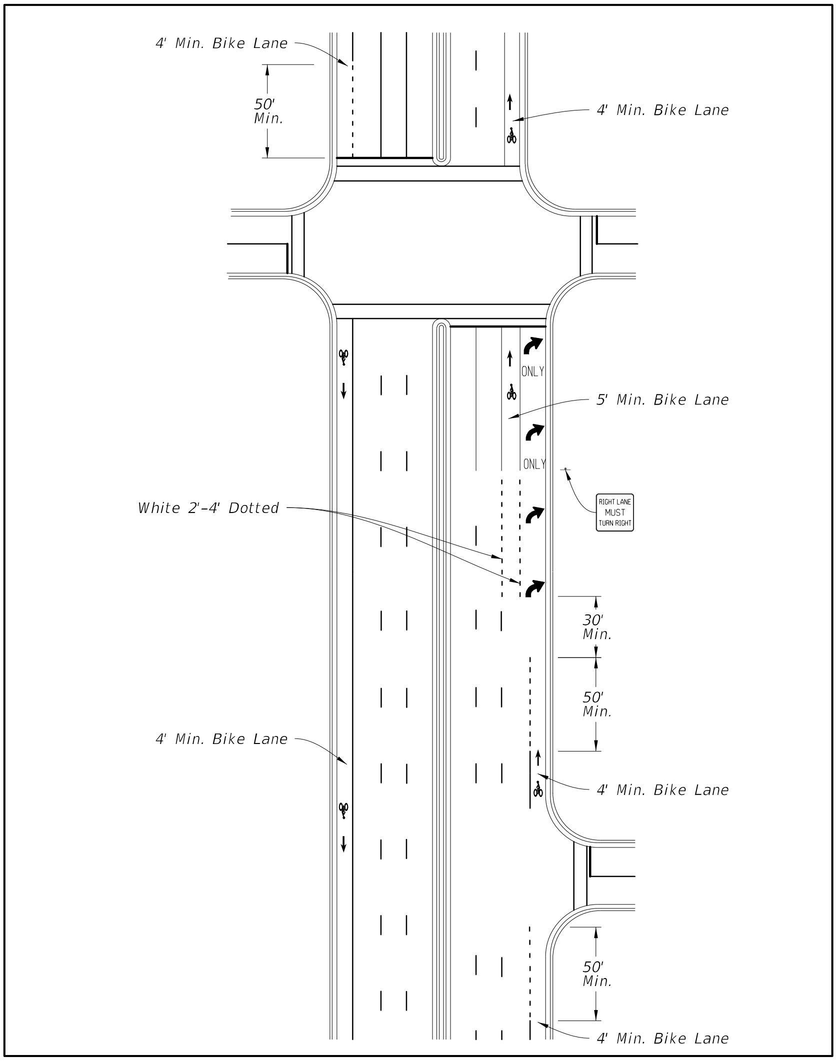


Figure 9 – 10 "Tee" Intersection with Bicycle Lane, Separate Right and Left-Turn Lanes (Curb and Gutter)

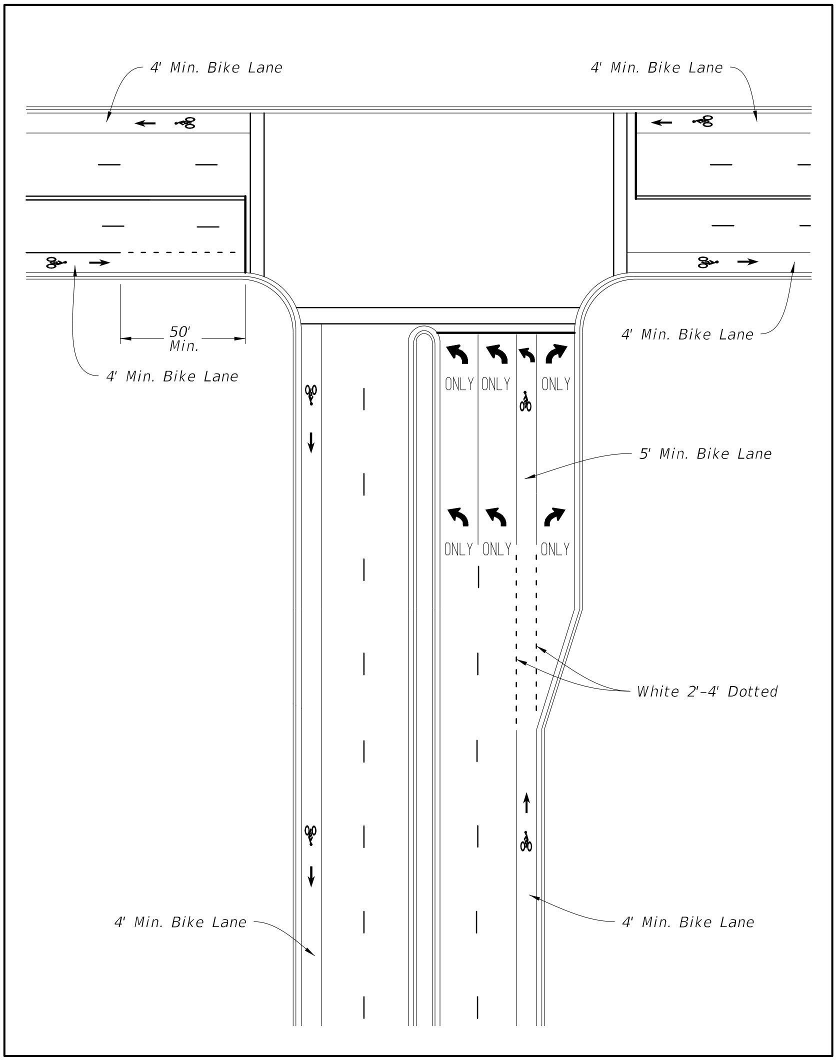


Figure 9 – 11 "Tee" Intersection with Bicycle Lanes, Left-Turn Lane and Right-Turn Drop Lane (Curb and Gutter)

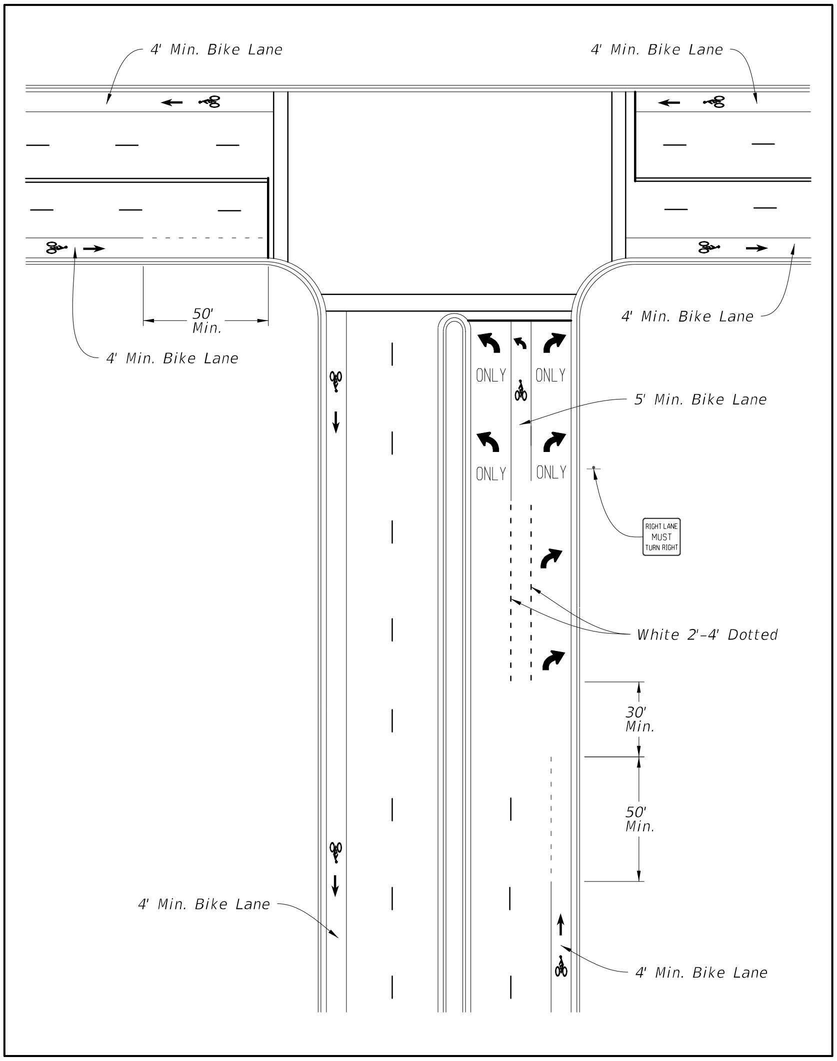


Figure 9 – 12 Bicycle Lanes with No Right-Turn Lane (Flush Shoulder)

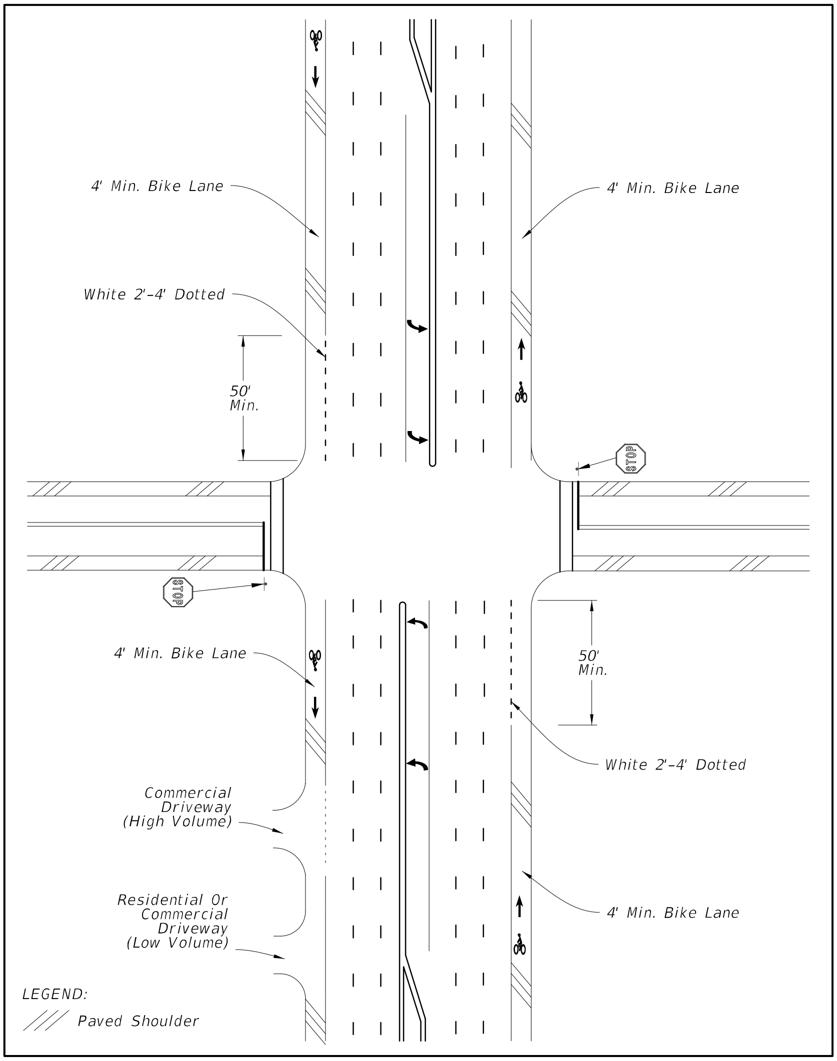


Figure 9 – 13 Bicycle Lane with Separate Right-Turn Lane (Flush Shoulder)

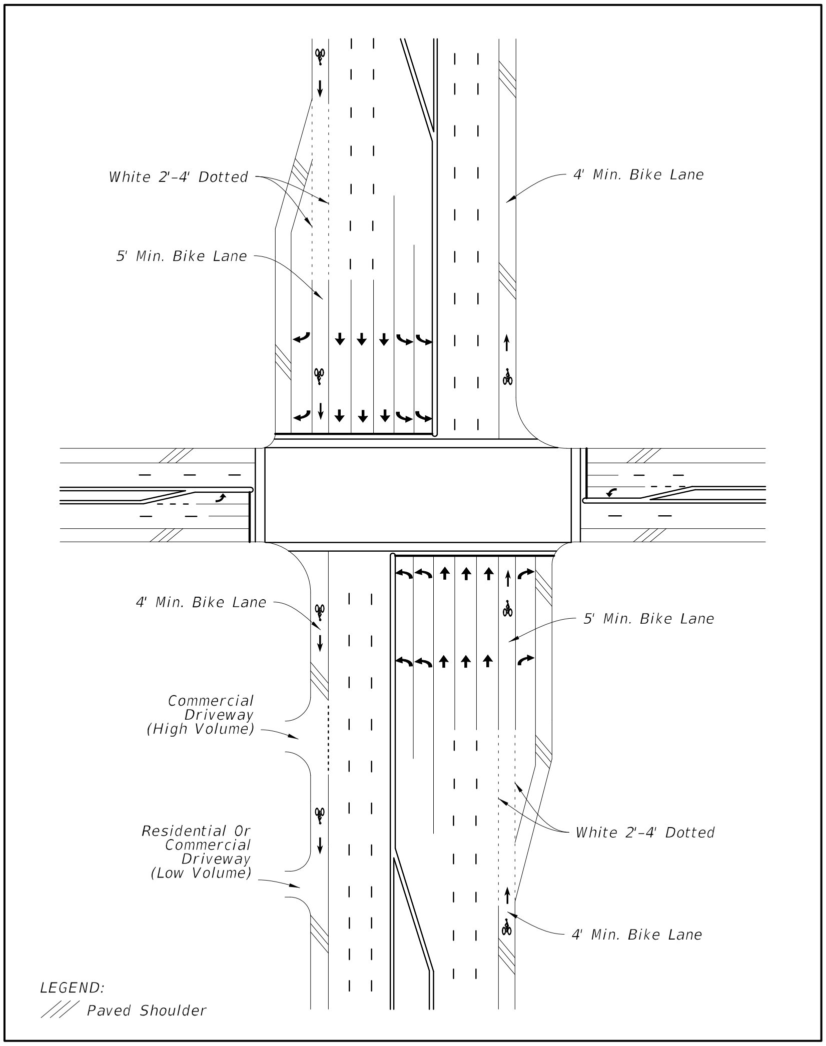


Figure 9 – 14 Bicycle Lanes with Bus Bay, No Right-Turn Lane (Curb and Gutter)

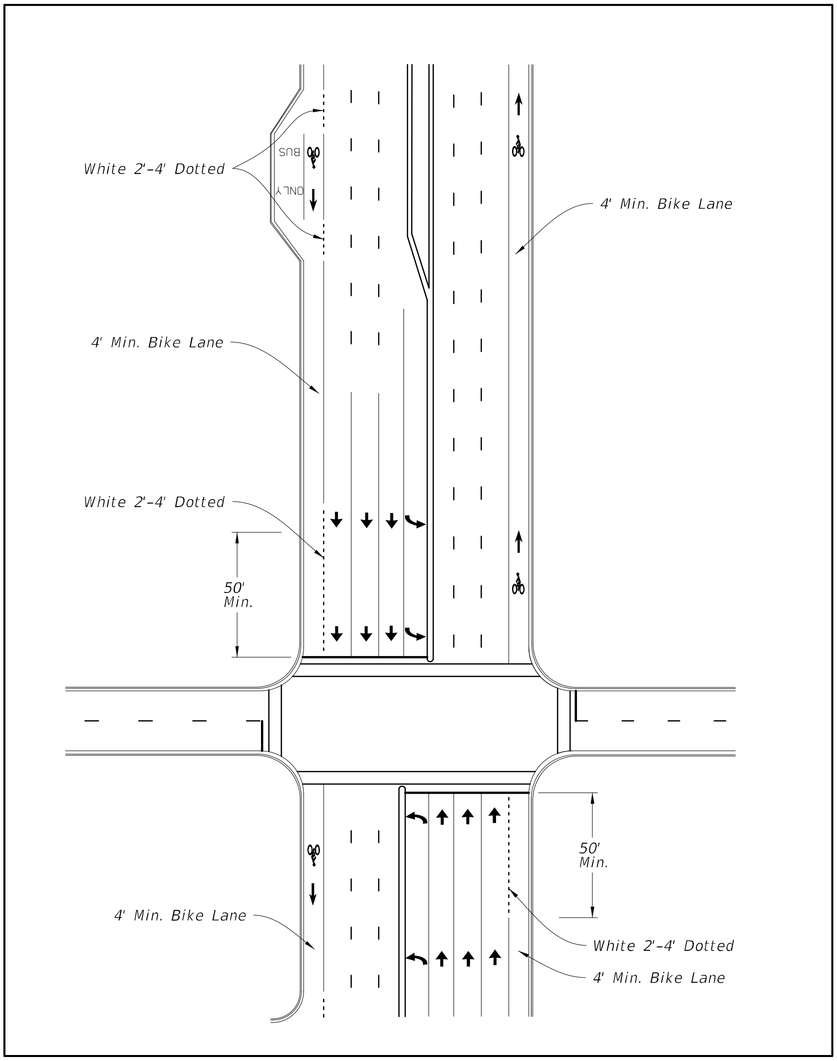
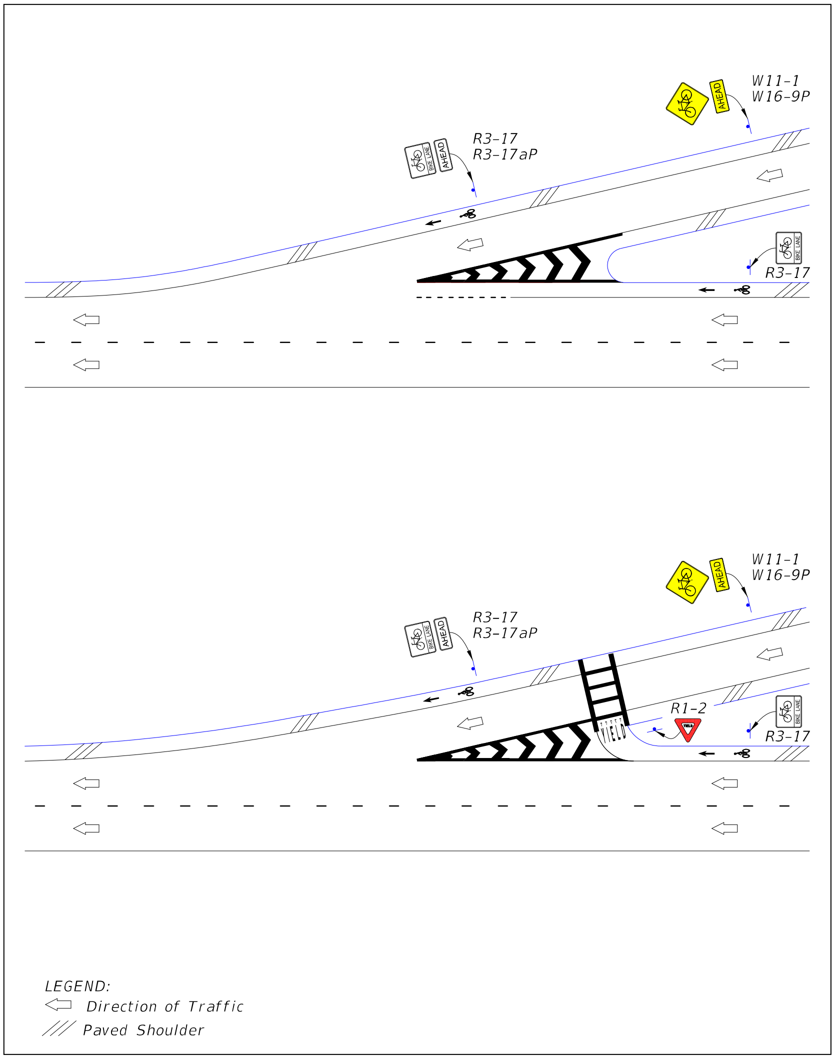


Figure 9 – 15 Bicycle Lanes on Interchange Ramps (Flush Shoulder)



B.2 Buffered Bicycle Lanes

Buffered bicycle lanes are bicycle lanes that are separated from ~~either~~ the adjacent travel lane or parking lane with a marked buffer area. They provide ~~greater~~ more ~~shy distance~~ separation between motor vehicles and bicyclists and encourage bicyclists to ride outside of the "door zone" of parked cars. Typical applications include streets with:

- H~~h~~igh travel speeds,
- H~~h~~igh traffic volumes,
- H~~h~~igh amounts of truck or transit traffic, or
- W~~w~~here there are underutilized travel lanes or extra pavement width.

Use t~~T~~he bicycle lane symbol and arrow markings ~~shall be used, along with~~ and longitudinal lines to create the buffer. There are several options for marking the buffer area: ~~, including~~

- A~~a~~ wide solid double line (crossing prohibited),
- A wide solid single line (crossing discouraged), ~~,~~ or
- A wide dotted single line (crossing permitted to make right hand turn).

Place chevron markings in the buffer area w~~W~~here the buffer ~~space~~ is wider than 4 feet and crossing the buffer is prohibited~~, chevron markings should be placed in the buffer area~~.

~~At an intersection approach,~~ Transition the buffer striping ~~should transition~~ to a wide dotted ~~stripe using~~ line with a 2/4 skip ~~pattern~~ approaching intersections. Begin t~~T~~he transition ~~should begin~~ 150 feet ~~in advance of an~~ before the intersection to ~~provide~~ allow ~~sufficient distance for~~ an automobile or truck to merge into the bicycle lane before turning right. See Figures 9 – 16, 17 and 18 ~~provide~~ for examples of buffered bicycle lanes. See ***Chapter 3D. Markings for Preferential Lanes of the MUTCD*** ~~provides additional information on the~~ for striping ~~of~~ buffered bicycle lanes.

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Figure 9 – 16 Buffered Bicycle Lane Adjacent to On-Street Parking

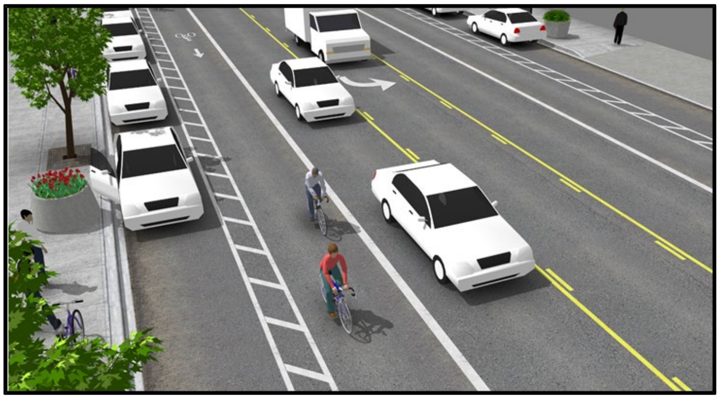

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Figure 9 – 17 Buffered Bicycle Lane Markings

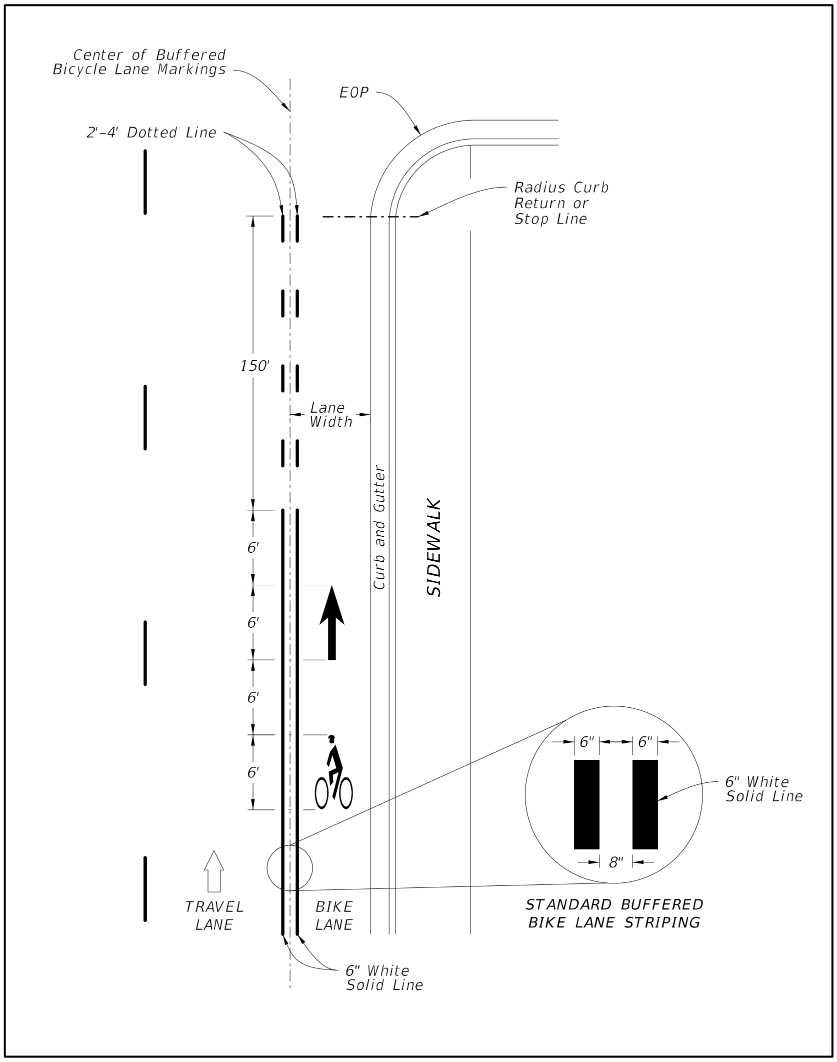
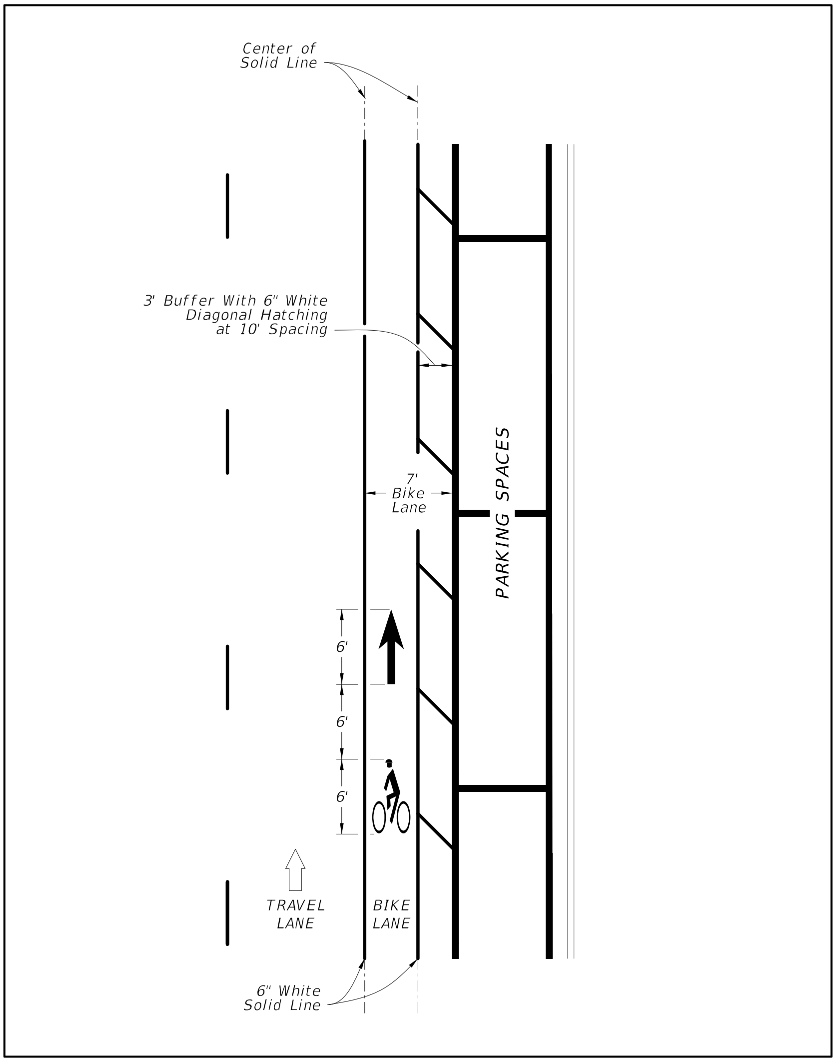


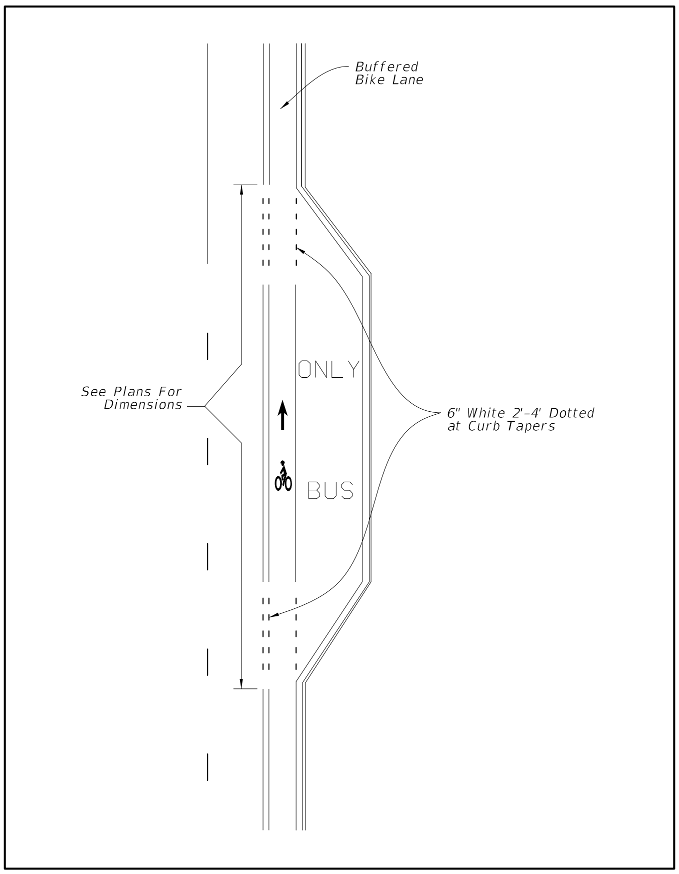
Figure 9 – 18 Buffered Bicycle Lane Markings with On-Street Parking



B.3 Bicycle Lane with Bus Bay

~~When a bus bay is provided on roadways with bicycle lanes, the~~ Continue bicycle lanes ~~shall be continued~~ adjacent to ~~the~~ bus bays. See Figure 9 – 19 ~~Buffered Bicycle Lane with Bus Bay Marking provides~~ for an example ~~of a buffered bicycle lane with a bus bay~~.

Figure 9 – 19 Buffered Bicycle Lane with Bus Bay Marking (Curb and Gutter)



B.4 Separated Bicycle Lanes

Separated bicycle lanes use ~~a combination of~~ horizontal separation (buffer ~~distance~~space) and sometimes vertical separation ~~(e.g., flex posts, parked cars, medians, traffic separators, or curbs)~~ to separate ~~people~~ bicyclists~~ng~~ from motor vehicle traffic. The combination of lateral ~~separation distance~~ and vertical separation ~~elements (such as flexible delineators, curbs or height differences, or vehicle parking) can~~ improves the bicyclist's comfort level ~~of bicycling~~. ~~They may be designed to~~

Separated bicycle lanes can support both one-way and two-way traffic. One-way separated bicycle lanes should be 7 feet wide (6-foot minimum). Two-way facilities should be 12 feet wide (10-foot minimum).

Horizontal separation is required. Maintain the horizontal separation through intersections. Vertical separation is also desirable.

For posted speeds of 35 mph and less:

- 6 feet of separation from the travel lanes is preferred
- 3 feet of separation from the travels lanes is the minimum
- 2 feet of separation is allowed if using tubular markers or a similar type of lane delineator or raised median

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For posted speeds of 40 to 45 mph:

- 8 feet of separation is preferred
- 3 feet of separation is the minimum

3 feet of horizontal separation is required adjacent to on-street parking.

Increase the amount of separation for higher traffic volumes and speeds.

Vertical separation can be achieved with:

- Curbs,
- Changes in elevation,
- Tubular markers, delineators, or flex posts,
- Raised medians,
- Traffic separators,
- On-street parking, and

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- Rigid barriers (with appropriate end treatments).

Raised medians, traffic separators or rigid barriers are required with posted speeds of 40 to 45 mph.

support either one-way or two-way traffic.

The amount of separation tends to increase as adjacent motor vehicle traffic volumes and speed increase.

Required features of a separated bicycle lane include:

A separated bicycle lane Iis a preferential use lane. , signed and marked Install signing and pavement markings as required by the ***MUTCD***. Include the bicycle lane symbol and arrow markings at the beginning of the lane and at periodic intervals.

- A horizontal separation is required, vertical elements may be added when required or desired.
- Types of vertical elements include changes in elevation, tubular markers, or similar type of lane delineator, raised medians, traffic separators, on-street parking, and rigid barriers (with appropriate end treatments). For posted speeds of 40 to 45 mph, raised medians, traffic separators or rigid barriers are required.
- The widths of separation are:
  1. A minimum of 3 feet separation is required if adjacent to on-street parking.
  2. If adjacent to travel lanes:
     - Posted speeds of 35 mph or less – a 6 feet minimum separation is preferred, 3 feet minimum (unless using tubular markers or similar type of lane delineator or raised median; then 2 feet minimum).
     - Posted speeds of 40 to 45 mph – an 8 feet minimum separation is preferred, 3 feet minimum.
- For one-way separated bicycle lanes, 7 feet is the preferred width, 6 feet is the minimum allowed. For two-way separated bicycle lanes, 12 feet is the preferred width, 10 feet is the minimum allowed.
- Separation is maintained between bicycle and motorized vehicle traffic through intersections.
- Conflict points are minimal and mitigated through pavement markings, color or other treatment.

For additional information on planning and designing separated bike lanes, please s See ***FHWA's Separated Bike Lane Planning and Design Guide*** for additional information.

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B.5 Green Colored Bicycle Lanes

The Federal Highway Administration (FHWA) has issued an ***Interim Approval*** for the use of green colored pavement in bicycle lanes and in extensions of bicycle lanes through intersections and other traffic conflict areas. Colored pavements shall not replace or be used in lieu of required markings for bike lanes as defined in the ***MUTCD***, but shall only supplement such markings. Traffic conflict areas include where the:

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- bicycle lane crosses a right turn lane,
- traffic in a right turn lane crosses a bike lane, or
- bicycle lane is adjacent to a dedicated bus bay.

The Interim Approval may be found at the following website and provides further information on how to submit a written request to use green colored pavement:

http://mutcd.fhwa.dot.gov/res-interim_approvals.htm

The effectiveness of green colored pavement is maximized if the treatment is used only where the path of bicyclists and other road users cross and yielding must occur. Because colored pavements are addressed in the 2009 MUTCD, they are a traffic control device whose need should be demonstrated before they are used. A need for this treatment can be demonstrated by either of the following:

1. A history of 3 or more motor vehicle-bicycle crashes exists at or adjacent to the traffic conflict area over the most recent three-year period, or
2. A government agency has observed and documented conflicts (failure of the motor vehicle to yield to the bicyclist) between bicyclists and motor vehicles at an average rate of two per peak hour. The documentation for conflicts shall include observations from a minimum of two separate data collection periods, conducted on different days in a one month period, and include at least one weekday and one weekend count period during peak bicycle travel times. Each period should be at least 2 hours in duration. Peak times vary by region and surrounding land use, but are typically:

   - Weekday, 11:00 AM to 1:00 PM
   - Weekday, 5:00 PM to 7:00 PM
   - Saturday, 8:00 AM to 2:00 PM

When used in conjunction with white skip lines, such as when extending a bike lane across a right turn lane or access to a bus bay, the transverse colored marking shall match the 2’-4’ white skip line pattern of the bike lane extension. The green colored pavement should begin as a solid pattern 50 feet in advance of the skip striping, match the 2’ 4’ skip through the conflict area, and then resume the solid color for 50’ after the conflict area, unless such an extent is interrupted by a stop bar or an intersection curb radius. Details of each installation and associated pavement markings shall be shown in the plans. Figures 9 –

20, 21, 22 and 23 illustrate how the green portion of the bicycle lane may be marked.

Materials permitted to color the bike lane green shall be non-reflective and fall within the color parameters defined by FHWA in their interim approval. Materials which have been tested to meet these requirements can be found in the FDOT's ***Product Application and Tracking System (PATH)*** which includes products on both the FDOT's ***Approved Product List (APL), Specification 523, Patterned Pavement*** or the FDOT's ***Innovative Products List (IPL), Dev-714 Green-Colored Pavement Markings***.

Figure 9 – 20 Green Bicycle Lane with Separate Right-Turn Lane

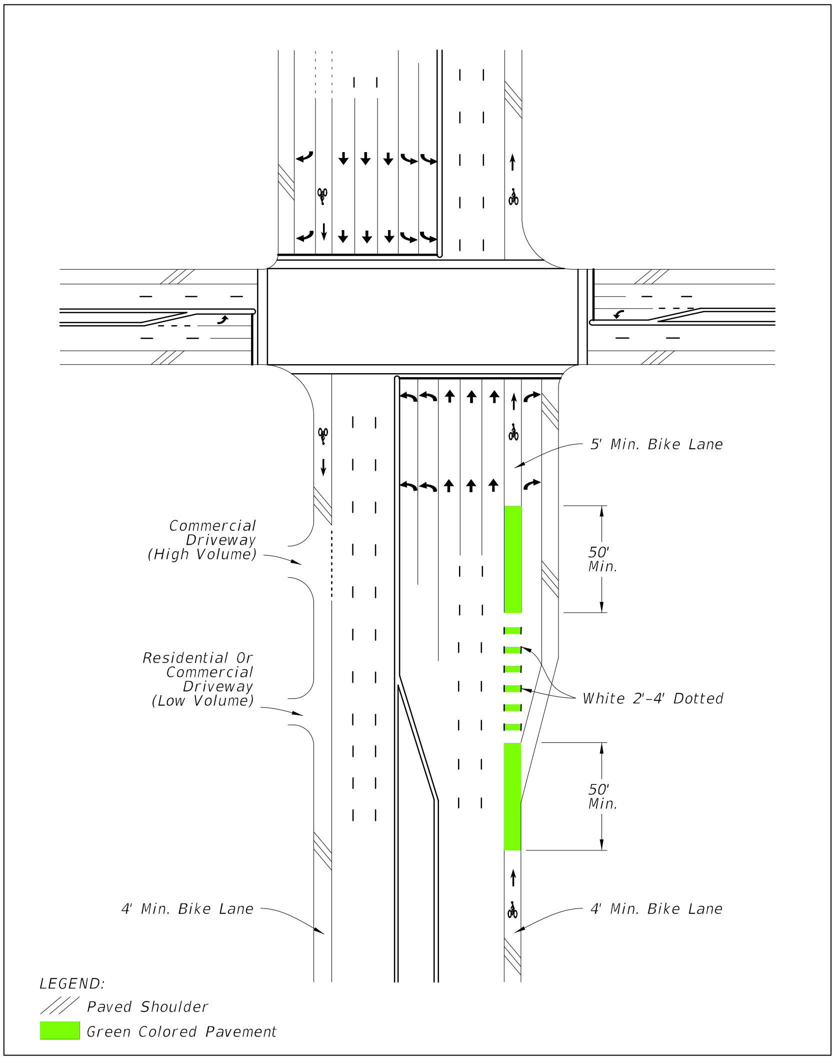


Figure 9 – 21 Green Bicycle Lane with Right-Turn Drop Lane

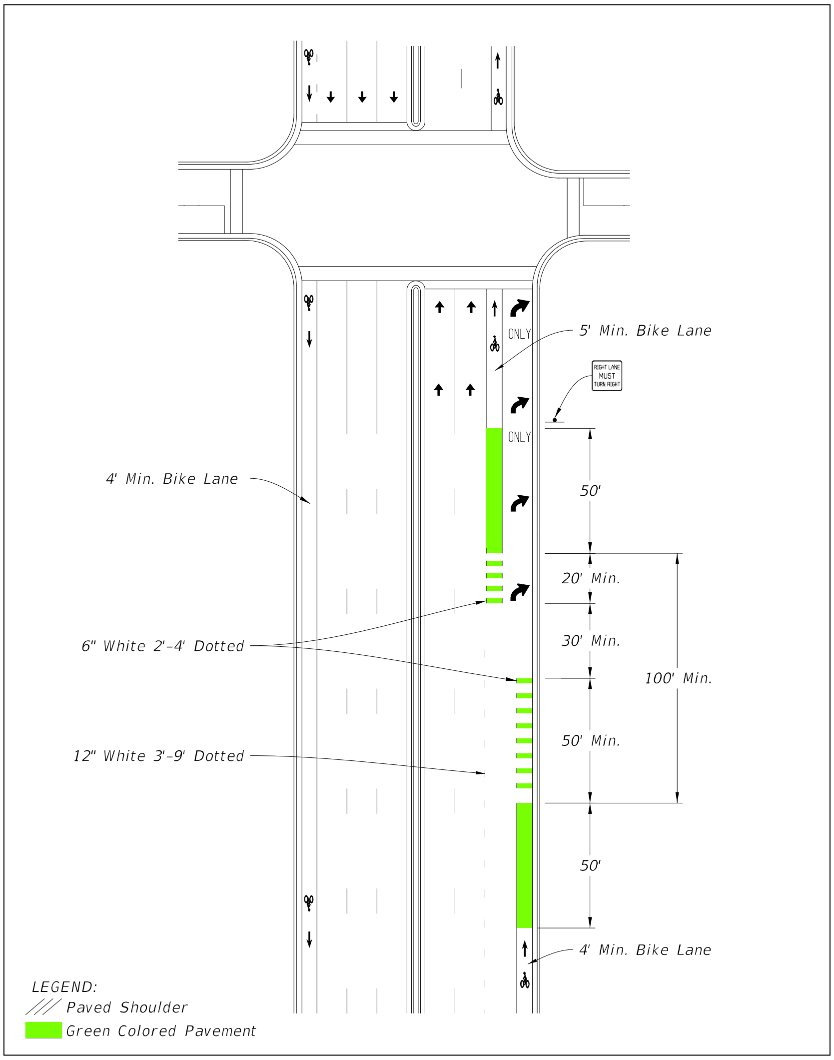


Figure 9 – 22 Green Bicycle Lane with Channelized Right-Turn Lane

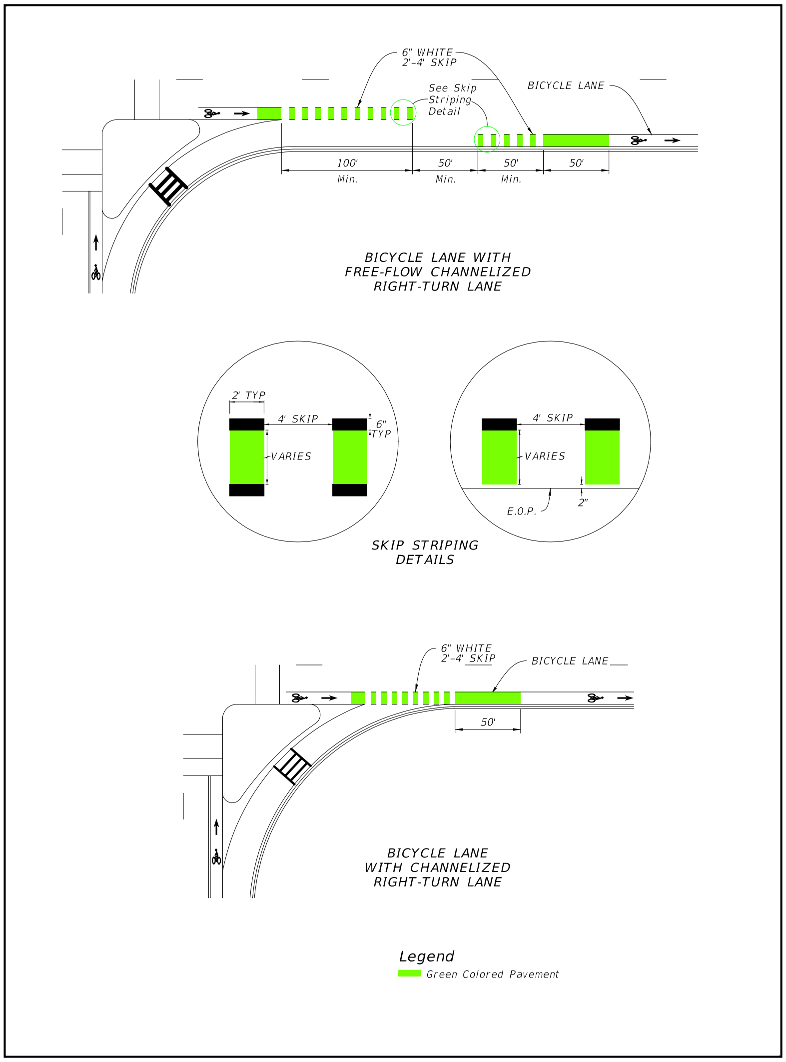
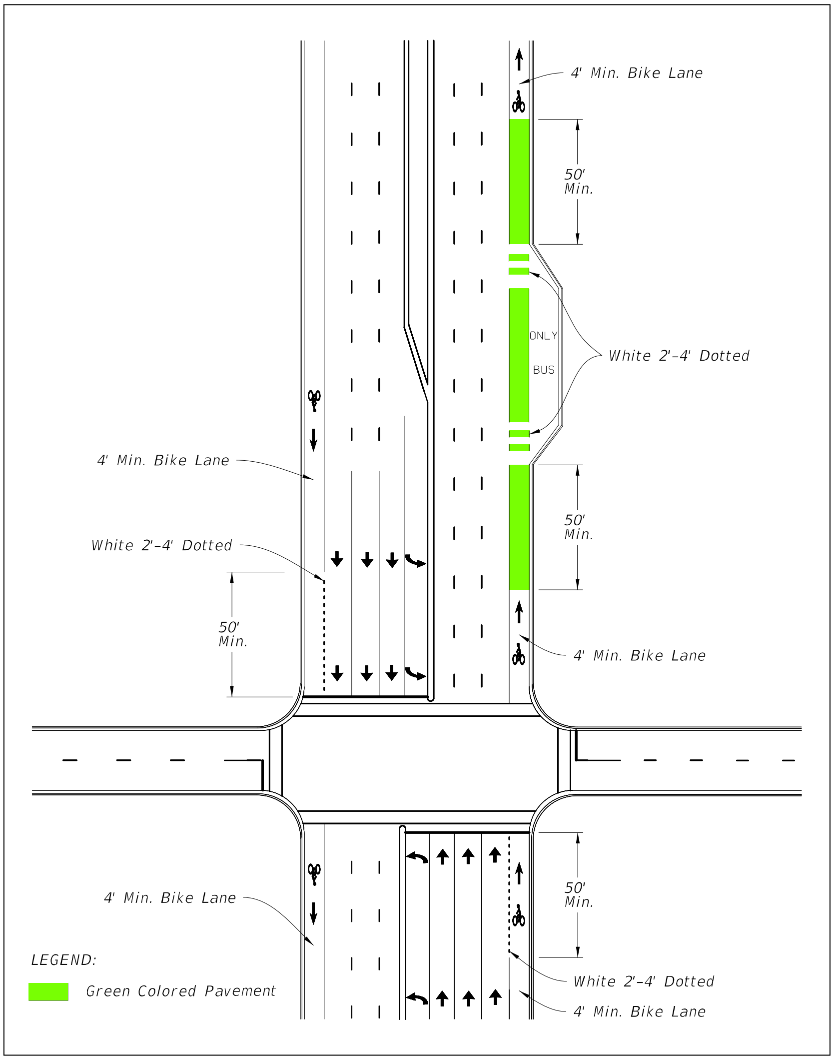


Figure 9 – 23 Green Bicycle Lane with Bus Bay



B.6 Paved Shoulders

A paved shoulder is ~~a~~ the portion of the roadway ~~which has been~~ typically delineated by edge line striping. Adding, widening ~~or~~ and improving paved shoulders are often ~~can be an~~ acceptable ways to accommodate bicyclists. ~~However, w~~When a paved shoulder is adjacent to a curb or other roadside barrier and is intended to serve as a bicycle facility, ~~and is adjacent to a curb, guardrail or other roadside barrier, a minimum 5-foot~~ at least 5 feet of clear width is required ~~between the traveled way and~~ to the face of ~~the~~ barrier ~~is required~~. Additional paved shoulder width is desirable if the posted speed exceeds 50 mph~~,~~ or the ~~percentage~~ volume of trucks, buses, ~~or~~ and recreational vehicles exceeds ~~is~~ 10%~~high (>10%)~~.

Do not install g~~G~~round-in rumble strips ~~should not be included~~ in paved shoulders ~~if a minimum clear width of~~ unless at least 4 feet of clear width can be provided outside of the rumble strips ~~cannot be provided~~.

B.7 Wide Outside Lanes

Wide outside lanes on curbed roadways are through lanes that are typically ~~provide a minimum of~~ 14 feet wide~~in width~~, ~~which~~ allowing ~~s~~ most motor vehicles to pass bicyclists safely ~~within the travel lane~~. Bicycle lanes are preferred for arterial and collector roadways, however, ~~in some conditions, such as resurfacing projects,~~ wide outside lanes are sometimes~~may be~~ the only practical option for a bicycle facility.

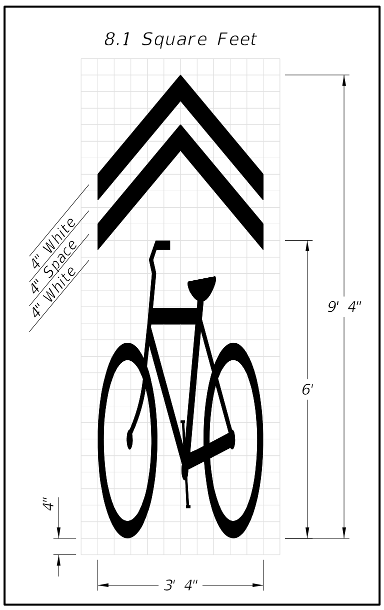
B.8 Shared Lane Markings

The shared lane marking is an optional pavement marking for roadways where:

- ~~-~~No bicycle lane or paved shoulder exists or is feasible,
- B~~b~~icyclists and motor vehicles are intended to share the lane, and
- The posted speed is 35 mph or less ~~and no bicycle lane or paved shoulder exists or is feasible~~.

~~Shared lane markings should be limited to roadways with a posted speed of 35 mph or less.~~ They are not intended ~~to be placed~~ on every roadway without bicycle facilities or on shared use paths.

Shared lane markings provide guidance to bicyclists on their lateral positioning, especially on roadways with on-street parking or lanes that are too narrow to share side-~~-~~by-~~-~~side with a motor vehicle. They also ~~help to~~ discourage wrong-~~-~~way riding and encourage safer passing of bicyclists by motorists. Shared lane markings may also be used to identify an alternate route as part of an approved temporary traffic control plan. See Figure 9 – 24 ~~provides~~ for the dimensions ~~for~~ of shared lane markings.



Place s~~S~~hared lane markings ~~should be placed~~ as follows:

Figure 9 – 24 Shared Lane Marking

- ~~If used on a~~ Centered in the outside travel lane of roadways without on-street parking that have ~~s~~ an outside travel lane that is 14 feet wide or less~~, the Shared Lane Markings should be centered in the travel lane~~ (see Figure 9 – 25).
- ~~If used on a~~ Centered in the outside travel lane of roadways with on-street parking~~, the Shared Lane Markings should be centered in the travel lane~~ (see Figure 9 – 26).
- ~~Shared Lane Markings should be placed i~~Immediately after ~~an~~ intersections and ~~spaced~~ at intervals

not greater than 250 feet thereafter.

Figure 9 – 25 Shared Lane Marking Placement (No Designated Parking, Lane Width ≤ 14 Feet)

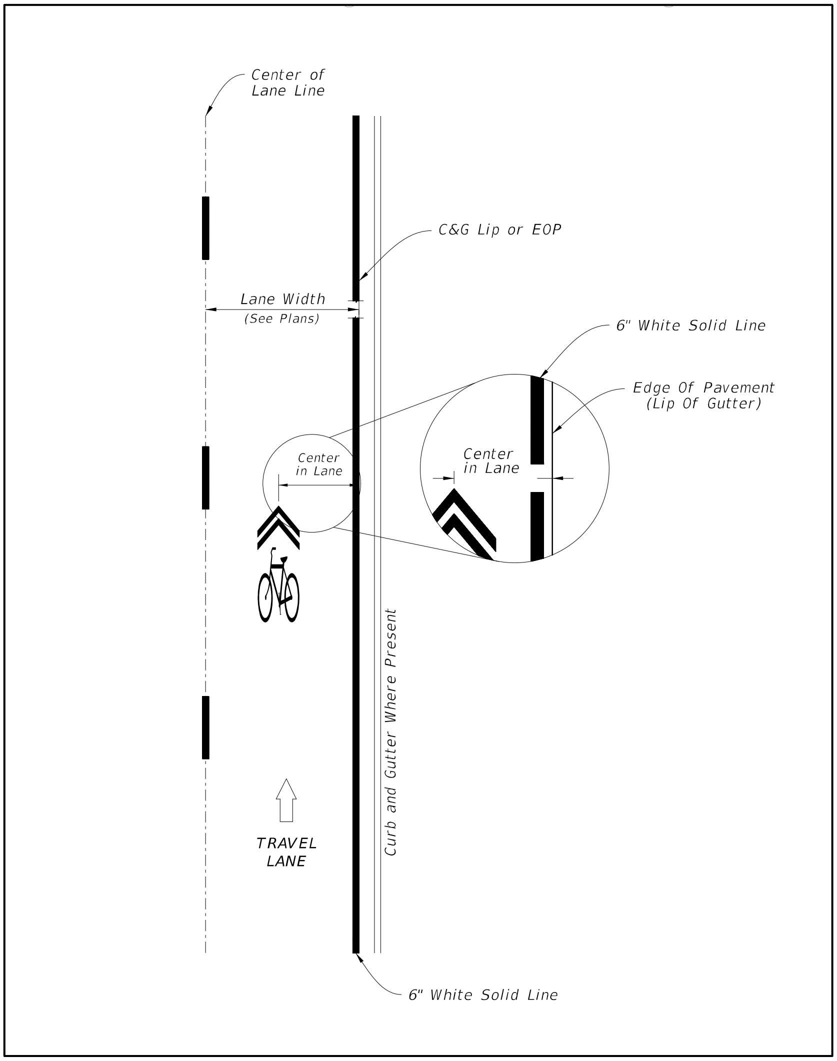
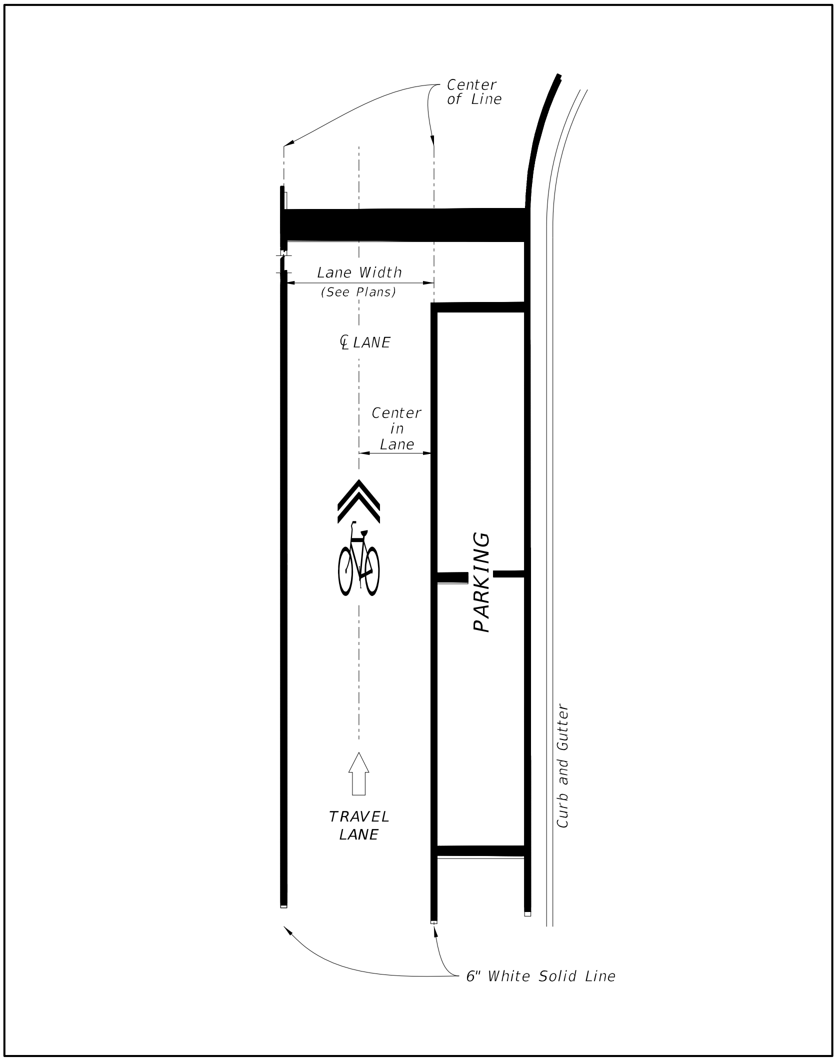


Figure 9 – 26 Shared Lane Marking Placement (With On-Street Parking)



B.9 Bicycles May Use Full Lane Sign

The Bicycle May Use Full Lane sign (R4-11) may be used on roadways where no bicycle lanes or adjacent shoulders useable by bicyclists are present and where the outside travel lanes are less than 14~~'~~ feet wide. See t~~T~~he ***MUTCD*** ~~provides~~ for additional information on ~~the~~ using~~e of~~ the sign.

C SHARED USE PATHS

Shared use paths are paved facilities which are:

- P~~p~~hysically separated from motor~~ized~~ vehicle ~~ular~~ traffic by an open space or barrier,
- ~~and~~ E~~e~~ither within the highway R/W~~right of way~~ or an independent R/W~~right of way~~,
- ~~with minimal cross flow by motor vehicles. They are~~ U~~u~~sed by bicyclists, pedestrians, runners, skaters, and in some cases equestrians ~~.~~ with minimal cross flow by motor vehicles.

The design of shared use paths is governed by bicycle~~'s~~ operating characteristics ~~will govern the design of shared use paths, along with~~ and by the requirements for accessibility since they also serve as pedestrian facilities.

~~In addition to the design criteria provided in this manual, the following~~ These documents provide additional criteria and guidance ~~in the~~ for designing ~~of~~ shared use paths:

- ***United States Department of Transportation ADA Standards for Transportation Facilities (2006)*** and as required by ***49 C.F.R 37.41 or 37.43.***
- ***United States Department of Justice ADA Standards (2010)*** as required by ***28 C.F.R 35 (title II) and 36 (title III).***
- ***Public Rights-of-Way Accessibility Guidelines (PROWAG)*** provides additional information for the design of pedestrian facilities.

See t~~T~~he ***2020 Florida Building Code, Accessibility, 7th Edition*** (as required by ***61G20-4.002***) ~~contains~~ for ADA requirements for accessibility by people with disabilities to sites, facilities, buildings, and elements ~~by people with disabilities~~.

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Shared use paths serve ~~a variety of purposes. They can provide~~ as an alternative to busy roadways for ~~a~~ school age children, ~~a~~ recreational bicyclists, ~~or a person~~ and people with a disabilitiesy an alternative to busy roadways. Shared use paths can be located along former railroad corridors, the banks of rivers or and canals, and through parks and forests. Shared use paths can also provide access to areas otherwise served only by Llimited Aaccess highways. For transportation purposes, they should be thought of They serve as an extension of the roadway network for transportation by non-motorized users. The inclusion of a Do not consider shared use paths should not be considered as an alternative to providing on-street facilities, but, rather, as a supplement.

For additional information on shared use path design, refer to See the ***AASHTO Guide for the Development of Bicycle Facilities (2012, 4th Edition)*** for additional information on shared use paths.

C.1 Width and Clearance

The useable width and horizontal clearance for a shared use path are primary design considerations. Paved widths typically range from 10 to 14 feet. The minimum paved width for of a two-way path is 10 feet. Typically, widths range from 10 to 14 feet, with the wider values applicable to Use wider paths:

- o In aareas with high heavy use or a wider variety of users,
- o Oon steep grades,
- o Tthrough curves, or
- o -Where used by larger maintenance vehicles.

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In very rare circumstances, a A minimum reduced path width of 8 feet is allowed in rare circumstancesmay be used where these following conditions prevail:

- Bicycle traffic use is expected to be low, even on peak days or and during peak hours.
- Pedestrian use of the facility is not expected to be more than occasional.
- Horizontal and vertical alignments provide allow frequent, well-designed passing and resting opportunities.
- The path will not be regularly subjected to used by maintenance vehicles loading conditions that which cwould cause pavement edge damage.

In addition, a A minimum path width of 8 feet may also be used for a short distance to avoiddue to a physical constraint such as an environmental feature, bridge abutment, utility structure, or fence.

A minimum Provide at least 2- feet oot wide of graded, clear area (with a maximum 1:6 slope) ~~shall be maintained adjacent to~~ along both sides of the path. ~~; however,~~ At least 3 feet ~~or more~~ is desirable ~~to provide~~ for clearance from trees, poles, walls, fences, guardrails, ~~or~~ and other lateral obstructions. See Chapter 8, Section D ~~Barrier Separation~~ and Chapter 4, ~~– Roadside Design,~~ Figure 4 – 8 ~~Location of Guardrail~~ for ~~information on when and how~~ the use of longitudinal barriers. ~~should be utilized,~~

Consider a wider separation w~~W~~here ~~the~~ a path is adjacent to a canal~~s~~, ditch~~es~~, or slope~~s~~ steeper than 1:3~~, a wider separation should be considered. A minimum 5 foot separation from the edge of the path pavement to~~ (5 feet from the top of the slope is desirable). Consider providing a railing or chain link fence ~~Depending~~ based on the height of the embankment and/or the condition at the bottom~~, a physical barrier, such as a railing or chain link fence may need to be provided~~.

Physical barriers or railings are recommended w~~W~~here the clear area ~~adjacent to the shared use path~~ is less than 5 feet wide for slopes which are~~, physical barriers or rails are recommended in the following situations~~:

- ~~Slopes~~ 1:3 and~~or~~ steeper, with a drop of 6 feet or more~~greater~~.
- ~~Slopes~~ 1:3 and~~or~~ steeper, ~~adjacent to~~ along a parallel body of water or other substantial obstacle,
- ~~Slopes~~ 1:2 and~~or~~ steeper, with a drop of 4 feet or more~~greater~~; and
- ~~Slopes~~ 1:1 and~~or~~ steeper, with a drop of 1 foot or more~~greater~~.

See t~~T~~he ***AASHTO Guide for the Development of Bicycle Facilities (2012, 4th Edition)*** ~~provides additional information on the~~ for design~~ing~~ ~~of~~ barriers ~~or~~ and railings.

Provide 10 feet of vertical clearance (8-foot minimum in constrained areas). ~~The desirable vertical clearance to obstructions is 10 feet.~~ Fixed objects should not ~~be permitted to~~ protrude within the vertical or horizontal clearance of a shared use path. ~~The recommended minimum vertical clearance that can be used in constrained areas is 8 feet. In some situations,~~ A vertical clearance ~~greater than~~ over 10 feet may be needed ~~to permit passage of~~ for maintenance and emergency vehicles.

C.2 Separation Between Shared Use Paths and Roadways

~~When~~ Provide at least 5 feet of separation between a shared use path~~s are located adjacent to~~ and a parallel roadway~~, a separation shall be provided. This~~ to demonstrate~~s~~ to both ~~path~~ users ~~and motorists~~ that the shared use path is a separate facility. More than 5 feet of separation is desirable along high-speed roadways.

~~The minimum distance between a path and roadway shall be 5 feet. On roadways with curb, the distance is measured~~ The 5 feet of separation is from the face of curb to the nearest path edge ~~of the path~~ along curbed roadways. ~~On~~ Along flush shoulder roadways ~~with flush shoulders~~, this separation is measured from the:

- ~~Paved shoulder - o~~Outside edge of a ~~the~~ paved shoulder, ~~to the inside edge of the path~~
- ~~Unpaved shoulders - o~~Outside edge of the travel lane for unpaved shoulders~~ed way to the inside edge of the path~~

Provide a barrier or railing between the path and the roadway w~~W~~here the separation is less than 5 feet~~, a physical barrier or railing should be provided between the path and the roadway~~.

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Design the~~A~~ barrier or railing to minimize the potential for injury to bicyclists and errant drivers and to ~~between the path and adjacent highway should~~ not impair sight distances at intersections~~, and should be designed to limit the potential for injury to errant motorists or bicyclists~~. The barrier or railing need not be ~~of size and strength~~ able to redirect errant vehicles~~motorists~~ back toward the roadway, unless other conditions ~~indicate~~ warrant ~~the need for~~ a crashworthy barrier.

Outside ~~Barriers or~~ railings ~~at the outside of a structure or steep fill embankment that not only define the edge of the path but also~~ that prevent bicyclists from falling over the railing to a substantially lower elevation should be ~~a minimum of~~ at least 42 inches~~"~~ high. Other b~~B~~arriers and railings ~~at other locations~~ that ~~serve only to~~ separate ~~the area for~~ motor vehicles from the path should ~~generally have a minimum height equivalent to the height of~~ be as high as a standard guard~~-~~rail.

~~When a path is placed along a high-speed highway, a separation greater than 5 feet is desirable.~~

C.3 Design Speed

Use a design speed of 18 mph~~For paths~~ in relatively flat areas (grades up ~~less than or equal~~ to 4%)~~, a design speed of 18 mph shall be used~~. ~~When a sustained downgrade greater than 4% exists, refer to~~ See the ***AASHTO Guide for the Development of Bicycle Facilities (2012, 4th Edition)*** for downgrades over 4%. ~~further guidance,~~

C.4 Horizontal Alignment

Use t~~T~~he typical adult bicyclist ~~is the~~ to design ~~user for~~ the horizontal alignment. ~~Please refer to~~ See the ***AASHTO Guide for the Development of Bicycle Facilities (2012, 4th Edition)*** for ~~further information on~~ determining the minimum curve radius ~~of curves on shared use paths~~.

Transition s~~S~~hared use paths ~~should be transitioned as necessary~~ towards the roadway at intersections ~~to provide~~ for a more functional crossing location that ~~also~~ meets driver expectation.

C.5 Accessibility

~~Since nearly all s~~Shared use paths ~~are intended to be used by pedestrians, they fall under~~ must meet the accessibility requirements of the Americans with Disabilities Act. ~~Where a shared use path is contained within a street or highway right of way,~~ T~~t~~he grade of ~~the~~ a shared use path that is contained within the roadway R/W ~~shall~~ cannot exceed the general grade established by the roadway ~~for the adjacent street or highway~~. ~~Where a shared use path is not contained within a street or highway right of way, t~~The grade of ~~the~~ a shared use path that is not within the roadway R/W cannot exceed ~~shall be~~ 5% ~~percent maximum~~.

Compliance with this maximum grade criteria is required to the extent feasible w~~W~~here full compliance ~~with the maximum grade requirements for shared use paths~~ is not practicable due to existing terrain or infrastructure, right-of-way availability, a notable natural feature, or similar existing physical constraints~~, compliance is required to the extent practicable~~.

The cross slope of a shared use path cannot exceed 2%~~shall be 2% maximum~~.

Relocate p~~P~~ull boxes, manholes ~~(and other utility covers)~~, and other types of utility covers ~~existing surface features in the location of a~~ away from proposed curb ramps and ~~or~~ detectable warnings ~~should be relocated~~ when feasible. ~~When relocation is not feasible,~~ Adjust the feature ~~shall be adjusted~~ to meet the ADA requirements ~~for surfaces~~ when relocation is not feasible ~~(including the provision of a~~ (e.g., nonslip top surface~~,~~ and ~~adjustment to be~~ flush with ~~and at the same slope as~~ the adjacent surface).

~~The d~~Detectable warning systems are designed ~~to work with~~ for concrete surfaces. When the path has an asphalt surface, specify an appropriate detectable warning system ~~In areas where the path has an asphalt surface, the engineer must specify an appropriate detectable warning system. In these cases, consider including~~ or include a short section of concrete that ~~will~~ accommodates any system.

~~If~~ Any c~~c~~urb ramps ~~or~~ and blended transitions ~~are included in the path design, they shall~~ must be parallel to and the full width of the approaching path ~~width~~. ~~Shared use path crossings shall m~~ Meet the same profile grade and cross slope ~~requirements~~ criteria as sidewalks (5% maximum and 2% maximum) ~~where the grade should not exceed 5%, and the maximum cross slope shall be no more than 2%~~.

~~Project design shall include an evaluation of~~ Evaluate existing driveways to determine ~~if it is feasible to upgrade~~ nonconforming driveways can be upgraded ~~turnouts~~ to meet the maximum cross slope criteria. Nonconforming driveways ~~are not required~~ do not need to be upgraded if ~~it is~~ not feasible within the project scope ~~of the project~~.

See ***Chapter 8*** ~~***– Pedestrian Facilities*** provides additional information~~ regarding the accessible design of shared use paths.

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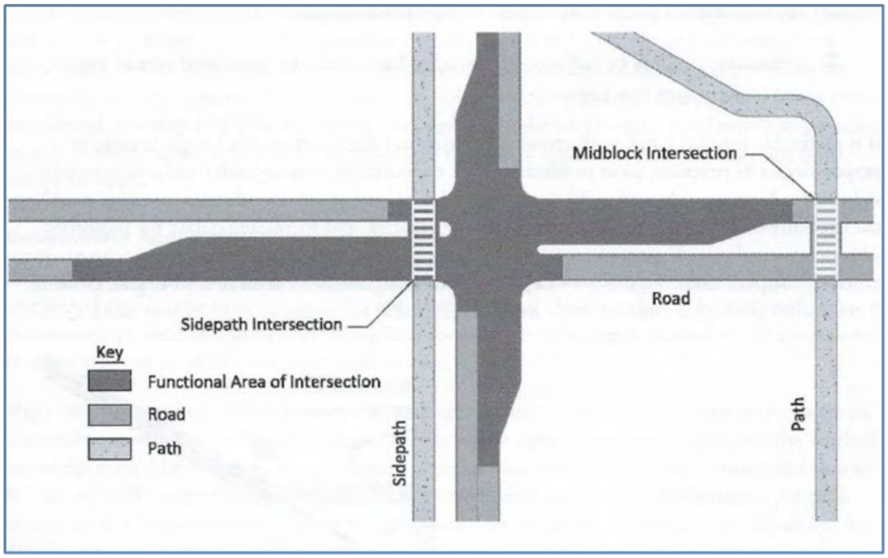
C.6 ~~Shared Use Path –~~ Roadway Intersections

Shared use path crossings fall into ~~three~~ these basic categories:

- Grade Separated ~~Crossings~~ – ~~Crossings~~ consisting of either a bridge over the roadway or an underpass beneath the roadway.
- Sidepath/Intersection ~~Crossings~~ – ~~Crossings that are~~ located within the functional area of an intersection of two or more roadways ~~and~~ with the path ~~is~~ running parallel ~~with~~ to one of the the roadways. ~~Sidepath crossings are typically parallel to one of the intersecting roadways. S~~(see Figure 9 – 27). ~~Mid-Block and Sidepath Crossings Relative to Intersection Functional Area.~~
- Midblock ~~Crossings~~ – ~~Crossings that are~~ located outside the functional area of an intersection ~~. S~~(see Figure 9 – 27). ~~Mid-Block and Sidepath Crossings Relative to Intersection Functional Area~~

Figure 9 – 27 Mid-Block and Sidepath Crossings Relative to

Intersection Functional Area



Source: 2012 AASHTO Guide to Bicycle Facilities

C.6.a Grade Separated Crossings

Grade separated crossings ~~involve considerable~~ are expensive but may be warranted in certain locations. Base t~~T~~he need for a grade separated crossing ~~should be based~~ on:

a) A~~a~~n engineering analysis ~~to assess~~ of existing and future path user characteristics and volumes,
b) M~~m~~otor vehicle traffic volumes and speeds,
c) O~~o~~pportunities~~y~~ for improved at-grade crossings in close proximity,
d) F~~f~~easibility of accessible design,
e) C~~c~~onsistency with existing and future surrounding land use and activities, and
f) L~~l~~ong~~-~~term maintenance costs and responsibilities~~y~~.

~~For further information on conducting such an analysis, s~~See ~~the~~ ***AASHTO Guide to Bicycle Facilities, 4th Edition Section 5.2.10*** and the discussion of grade-separated crossings in the ***AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities*** for conducting such an analysis.

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C.6.b Sidepath Crossings

Sidepath crossings have unique operational and design requirements ~~challenges~~. ~~One key factor that must be addressed is~~ Ensure proper intersection sight distances. ~~Given their proximity to motor vehicle intersections, sidepath intersection sight distance requirements must c~~Consider ~~both what is~~ the sight distances needed ~~for~~ by ~~the~~ drivers ~~of motor vehicles~~ crossing in each direction as well as bicyclists and pedestrians. Sidepath crosswalks must be marked.

~~In cases w~~Where a shared use path is ~~located~~ parallel to and within the roadway corridor, the traffic control on the sidepath ~~shall~~ must be consistent with that on the parallel roadway. Align t~~T~~he path ~~shall be aligned~~ to allow the ~~placement of the~~ stop bar on the side street~~s a minimum of~~ to be at least 4 feet in advance of the crosswalk~~, and crosswalks shall be marked~~. The crosswalk must be at least as wide as ~~width shall be equal to or greater than~~ the approaching path ~~width of the path~~.

Consider moving the crossing away from the intersection to a midblock location w~~W~~here a shared use path is ~~located~~ parallel to a high-~~-~~speed roadway and crossing an access or exit ramp or lane~~, moving the crossing away from the intersection to a midblock location may be considered~~. This allows drivers ~~for motorists~~ to ~~first~~ enter or exit the high-~~-~~speed roadway and then turn attention to the pathway crossing. ~~When this is done, care should be taken to i~~Ensure that the midblock location is clearly outside the functional area of the intersection and is designed accordingly.

See ~~the~~ ***AASHTO Guide to Bicycle Facilities, 4th Edition, Sections 5.2.2 and 5.3.4*** ~~which covers these operational issues in detail and provides several factors to be considered~~ for additional ~~proper~~ design ~~for further~~ information.

C.6.c Midblock Shared Use Path Crossings

The design of a midblock shared use path crossing is similar ~~in many ways~~ to ~~designing~~ a multi-leg intersection. ~~As with sidepath crossings, a key design element is~~ Ensure proper intersection sight distances. ~~The basic criteria for establishing intersection sight distance for shared use path crossings is based on~~ Use the same methodology presented in the ***AASHTO Greenbook*** for conventional intersections but with adjustments to account for the design vehicle and design speed of the shared use path. ~~As with conventional intersections, t~~The dimensions of the clear sight triangles ~~are dependent~~ depend on the type of traffic control.

~~The~~See ***AASHTO Guide to Bicycle Facilities, 4th Edition Section 5.3.2*** ~~provides additional information on the details and methodology~~ for the proper design of midblock crossings~~ including~~ (with several examples).

C.6.c.1 Intersections with Yield Control

The ***AASHTO Guide to Bicycle Facilities*** prefers that ~~indicates that it is preferable to provide~~ shared use path intersection sight distance for midblock crossings be based on yield control~~ for all midblock crossings~~. ~~See~~ Use Figure 9 – 28 ~~Yield Sight Triangles~~ and Table 9 – 2 ~~Formulas for Lengths of Roadway and Path Legs – Yield Condition and the formulas~~ to compute the lengths of the roadway leg (a) and path leg (b) for yield control. See Table 9 – 3 ~~Intersection Sight Distance Calculated Lengths of Roadway and Path Lengths provides~~ for calculated sight distance values based on Figure 9 – 28 and Table 9 – 2 for a range of roadway design speeds~~ and a shared use path design speed of 18 mph~~.

Figure 9 – 28 Yield Sight Triangles

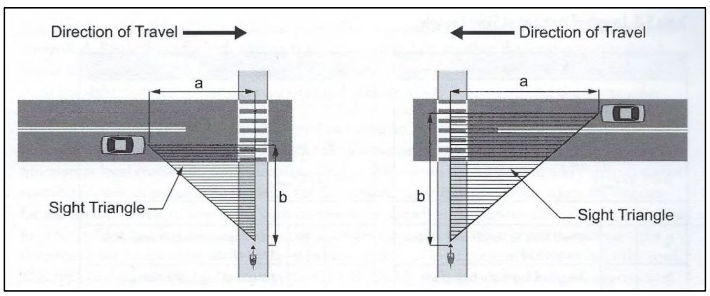


Table 9 – 2 Formulas for Lengths of Roadway and Path Legs – Yield Condition

Length of Roadway Leg (a)		Length of Path Leg (b)	
	$t_a = \frac{S}{1.47\ V_{path}}$ $t_g = t_a + \frac{w + L_a}{1.47\ V_{path}}$ $a = 1.47\ V_{road}\ t_g$		$t_a = \frac{1.47\ V_e - 1.47\ V_b}{a_i}$ $t_g = t_a + \frac{w + L_a}{0.88\ V_{road}}$ $b = 1.47\ V_{path}\ t_g$
t_g	= Travel time to reach and clear the path (seconds)	t_g	= Travel time to reach and clear the path (seconds)
a	= length of leg sight triangle along the path approach (feet)	b	= Length of leg sight triangle along the path approach (feet)
t_a	= Travel time to reach the road from the decision point for a path user that does not stop (seconds)	t_a	= Travel time to reach the path from the decision point for a motorist that does not stop (seconds).
w	= Width of the intersection to be crossed (feet)	V_e	= Speed at which the motorist would enter the

L_a	=	Typical bicycle length = 6 feet (see AASHTO Guide for other design users)
V_{path}	=	Design speed of the path (mph)
V_{road}	=	Design speed of the road (mph)
S	=	Stopping sight distance for the path user traveling at design speed (feet).

		intersection after deceleration (mph) (assumed 0.60 x road design speed)
V_b	=	Speed of which braking by the motorist begins (mph) (same as road design speed)
a_i	=	Motorist deceleration rate (ft/s^2) on intersection approach when braking to a stop not initiated (assume 5.0 ft/s^2)
w	=	Width of intersection to be crossed (feet)
L_a	=	Length of the design vehicle (feet)
V_{path}	=	Design speed of the path (mph)
V_{road}	=	Design speed of the road (mph)

Table 9 – 3 Intersection Sight Distance
Calculated Lengths of Roadway and Path Lengths

Roadway Design Speed (mph)	Length of Roadway Leg a (feet)		Length of Path Leg b (feet)
	Length for Crossing 2 Roadway Traffic Lanes	Additional Length for each Additional Traffic Lane Crossed	
20	182	13	109
25	228	17	115
30	273	20	124
35	319	23	136
:40	364	27	148
45	410	30	161
50	456	33	174
55	501	37	188
60	547	40	202

Notes:

1. Above lengths a and b are based on:
   - Design Speed of Path = 18 mph
   - Stopping Sight Distance for path user = 134 feet
   - Shared Use Path Width at Roadway Crossing = 12 feet
   - Path Design Vehicle Length = 6 feet (bicycle)
   - Road Width = 2 traffic lanes @ 12 feet each = 24 feet
   - Roadway Design Vehicle Length = 19 feet (passenger vehicle)
   - Roadway Approach Grade ≤ 3.0%
   - Path Approach Grade = 0.0%

   For other design conditions sSee AASHTO Guide to Bicycle Facilities for other design considerations.
2. The line of sight is measured at 2.7 feet above the surface of the path and roadway.

C.6.c.2 Intersections with Signal ~~Control~~ or Stop Control

Consider signal or stop control w~~W~~here intersection sight distance based on yield control cannot be provided~~, signal control or stop control should be considered~~. For midblock crossings with signal control or stop control on either the roadway or the path, the roadway and path approaches ~~shall~~ must provide the minimum stopping sight distance to obey the control and execute a stop before entering the intersection. An unobstructed view of a path user located at the stopped position on the path should be visible to the motorist and vice versa. See t~~T~~he ***AASHTO Guide for the Development of Bicycle Facilities*** ~~provides additional details~~ for ~~the proper~~ designing ~~of~~ signal control and stop control intersections.

C.7 Structures

The minimum clear width on structures ~~shall~~ must be the same as the ~~approach~~ width of the approaching shared use path, plus a minimum 2-~~-~~foot wide clear area ~~on each side~~ should be provided on each side. Consider a~~A~~ccess by emergency, patrol and maintenance vehicles ~~should be considered~~ in establishing ~~the~~ structure design clearances ~~of structures on~~ for shared use paths. ~~Where practical, a~~ A path vertical clearance of 10 feet (on the structure) is desirable where practical ~~for adequate vertical shy distance~~.

Where compliance with the requirement for a maximum running slope of 5% is not practicable due to existing terrain or infrastructure, right-of-way availability, a notable natural feature, or similar existing physical constraints, compliance is required to the extent practicable.

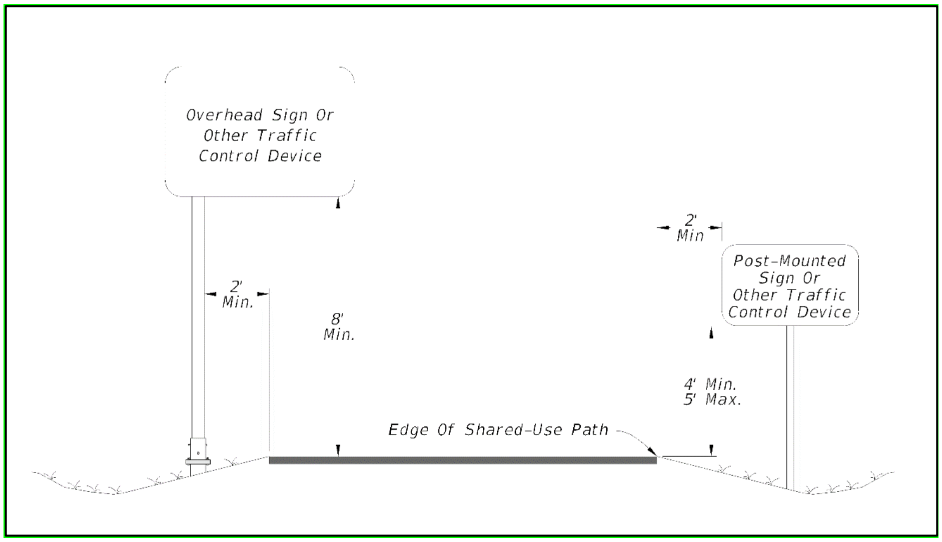
Ramps on new structures that are part of a shared use path and serve as the accessible route ~~shall~~ must have a running slope between 5% minimum and 8.3% maximum. The cross slope cannot exceed 2% ~~of ramp runs shall be 2% maximum.~~. Provide l~~L~~andings ~~are required~~ at the top and the bottom of each ramp run.

Commented [KK2]: For ramp profiles exceeding 5%, don't we need a level landing every 30 inch vertical? Should we clarify here?

C.8 Pavement Markings and Signage

The MUTCD regulates the design and use of all traffic control devices on shared use paths. See Figure 9 – 29 ~~Sign Placement on Shared Use Paths provides~~ for the ~~minimum~~ criteria for ~~the placement of~~ placing signs along ~~or~~ and over a shared use path. The maximum height ~~from~~ above the outside edge of the path to the bottom ~~elevation~~ of a sign is five feet. ~~Signs on shared use paths should follow the dimensions provided in~~ See ***Table 9B-1 Bicycle Sign and Plaque Sizes, MUTCD*** for the dimensions of signs for shared use paths. See ***MUTCD, Part 3*** for g~~G~~uidance on ~~the placement of~~ placing stop or yield lines and crosswalks on roadways intersecting with shared use paths ~~is provided in the **MUTCD, Part 3**~~.

Figure 9 – 29 Sign Placement on Shared Use Paths



D RAILROAD CROSSINGS

Railroad-highway grade crossings should ideally be at ~~a right angle~~ 90-degrees to the rails, ~~. This can be accomplished~~ either as a separate path or a widened shoulder. As the crossing angle deviates from 90-degrees, the potential increases for a bicycle ~~The greater the crossing deviated from this ideal crossing angle, the greater is the potential for a bicyclist's~~ front wheel to be trapped in the flangeway~~, causing loss of steering control~~. If the crossing angle is less than approximately 45 degrees, provide an additional paved shoulder of sufficient width ~~should be provided~~ to permit the bicyclist to cross the track at a safer angle~~,~~ (preferably 90-degrees)~~e perpendicularly~~. Where this is not possible, and where train speeds are low, commercially available compressible flangeway fillers may enhance bicyclist operation. It is ~~also important that~~ best for the roadway approaches to be at the same elevation as the rails. ~~For more information, s~~See Figure 4 – 28 Correction for Skewed Railroad Grade Crossing – Separate Pathway in the ***AASHTO Guide for the Development of Bicycle Facilities*** for more information.

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E STRUCTURES

Design a~~A~~ll new bridges over roadways and shared use paths ~~shall be designed~~ to meet the vertical clearance standards ~~specified~~ in ***Chapter 3, Section C.7.j.4.(b)***, and ***Chapter 17, Section C.3.b.***

Provide pedestrian accommodations and design considerations that meet the provisions of the ADA on aAll bridges that include provisions for pedestrians shall provide pedestrian accommodations and design considerations that meet the provisions of the ADA.

Bridges over roadways should be covered or screened to reduce the likelihood of objects being dropped or thrown below. If the bridge is enclosed, the visual tunnel effect may require widening the bridge to provide a feeling of security for all bridge users. Consider fencing tThe area adjacent to overpasses may be fenced to prevent unsafe crossings and to channel pedestrians to the vertical separation structure.

F REFERENCES FOR INFORMATIONAL PURPOSES

- USDOT/FHWA ADA Standards for Accessible Design (ADAAG) ***https://www.fhwa.dot.gov/programadmin/pedestrians.cfm***
- AASHTO – Guide for the Development of Bicycle Facilities, 2012, 4th Edition ***https://store.transportation.org/Common/DownloadContentFiles?id=1096***
- NACTO Urban Streets Design Guide ***http://nacto.org/usdg***
- FHWA Policy Memo for Flexibility in Pedestrian and Bicycle Facility Design ***https://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/***
- Drainage Handbooks, Florida Department of Transportation, ***https://www.fdot.gov/roadway/drainage/manualsandhandbooks.shtm***
- Manual on Uniform Traffic Control Devices, May 2012 ***http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm***
- NACTO, Urban Bikeway Design Guide

  https://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/

CHAPTER 10

MAINTENANCE AND RESURFACING

A INTRODUCTION

~~In order t~~ Maintain all aspects of the road and R/W at the highest reasonable level of safety ~~o provide for the safe and efficient movement of~~ for all modes of traffic ~~, it is essential to maintain all aspects of the road and right of way at the highest reasonable level of safety~~. ~~Improvements consistent with~~ U~~u~~pgrading safety characteristics ~~standards or accommodating changes in traffic are also required~~ is essential in~~to~~ maintaining ~~the facility in~~ a quality condition. Maintenance and resurfacing are costly operations. ~~; therefore,~~ Make every effort ~~should be made~~ to ~~provide~~ achieve the maximum safety benefit ~~from each operation~~. ~~The fact that a major portion of the maintenance effort is necessary to merely~~ Do not justify neglecting maintenance and resurfacing needs on the basis of cost ~~preserve the economic investment in a facility should not be considered as justification for sacrificing the requirements for maintaining or improving the safety characteristics of a street or highway~~.

B MAINTENANCE

B.1 Objectives

Prioritize t~~T~~hese ~~major~~ objectives ~~of a maintenance program include the following~~:

- Maintain all highway features and components in the best possible condition.
- Improve~~e~~ sub-standard elements ~~features, with the ultimate goal to at least~~ to meet minimum standards.
- Minimize ~~Provide for minimum~~ traffic disruptions and hazards ~~to traffic~~ during maintenance operations.
- ~~Location~~ Identify and report~~ing of~~ inadequate safety features.

B.2 Policy

Each highway maintaining agency ~~responsible for maintenance shall~~ must develop and maintain a program of highway maintenance for the entire ~~highway~~ network under its jurisdiction. This program should ~~include the following activities~~:

- Identify needs,

- Establish priorities,
- Establish procedures, and
- Establish and maintain a regular program of maintenance of ~~for~~ all components ~~aspects~~

Evaluate and update t~~T~~he program ~~should be~~ regularly ~~evaluated and suitably modified~~ to provide ~~mote~~ the ~~maintenance of streets and highways that result in the~~ best practicable conditions.

B.3 Identification of Needs

The first step in any successful maintenance program involves identifying conditions which are unsafe and/or substandard ~~identification of maintenance needs is the first stage in the development of a successful maintenance program, and is required when any portion of the highway system is in a sub-standard condition. Action is also required to correct any situation which is~~ Analyze conditions which are hazardous or ~~may~~ may become hazardous ~~in the near future. This may be accomplished by both~~ through regular inspection ~~of the highway network~~ and ~~proper~~ analysis of crash records.

B.3.a Inspection

Conduct ~~Periodic and systematic~~ regular inspections of the entire highway network ~~under each agency's jurisdiction is required~~ to identify conditions ~~situations~~ requiring improvements, ~~and~~ corrections ~~or~~ and repairs. ~~These inspections should be conducted by~~ These inspections should be conducted by maintenance and~~or~~ traffic operations staff ~~personnel, or other qualified personnel who are~~ who are trained in ~~the aspects of~~ highway safety and maintenance ~~requirements~~.

B.3.b Crash Records

Establish a~~A~~ regular program of crash ~~investigations, record keeping, and~~ analysis ~~should be established~~ to ~~provide information for recommended highway modification and~~ identify corrective maintenance requirements. ~~Cooperation among maintenance,~~ Coordinate with traffic operations~~,~~ and police agencies ~~is required, and activities of these agencies should be coordinated in accordance with~~ per the guidelines ~~set forth~~ provided in the ***National Highway Traffic Safety Administration (NHTSA) Program Guideline No. 21 (II), Identification and Surveillance of Crash Locations***. Use i~~I~~nspection ~~of the highway network~~ and ~~analysis of~~ crash analysis to ~~records should be utilized to provide feedback for~~ identify appropriate modifications ~~of~~ to standard design and construction procedures.

B.4 Establishment of Priorities

~~The m~~Prioritize maintenance activities towards: ~~determined to be necessary by the identification program should be carried out on a priority basis. The establishment of priorities should be based, to a large extent, upon the objective of~~

- P~~p~~romoting highway safety,
- Promoting efficient traffic operations, and
- Preserving highway investments.

~~A h~~ Give a high priority ~~should be given~~ to ~~the~~ improving ~~ement~~ conditions ~~or correction of situations that may result in~~ related to fatal or serious crashes. ~~Preservation of highway investment and promotion of efficient traffic operations are important maintenance objectives.~~ Make e~~E~~very effort ~~should be made~~ to ensure the best ~~highest~~ safety benefit ~~payoff~~ for~~rom~~ the maintenance dollar.

B.5 Establishment of Procedures

Establish s~~S~~tandard maintenance procedures which promote ~~and methods for maintenance operations should be established for~~ efficient, rapid, and safe completion ~~of the required work~~. Conduct a~~A~~ll maintenance work ~~shall be conducted in accordance with~~per the s~~S~~tandards ~~set forth~~ provided in ***Chapter 11*** ~~***– Work Zone Safety***~~. Each maintenance agency should develop its own m~~M~~aintenance m~~M~~anual or should use ~~utilize the~~ FDOT m~~M~~aintenance m~~M~~anuals ~~of the FDOT~~. ~~Such~~ Maintenance manuals should specify the methods, procedures, equipment, personnel qualifications, and other aspects of the work necessary to ensure successful completion of maintenance operations. ~~Procedures should be d~~Develop~~ed~~ procedures for emergency, routine, and special operations.

B.5.a Emergency Maintenance

Emergency maintenance operations are those required to immediately restore the highway to a safe condition. Emergency maintenance work should be ~~carried out~~conducted by personnel who are specially trained and qualified~~. Work units, which should be~~ , available on a ~~twenty-four~~ 24-hour basis, ~~should be~~ using an ~~connected with the~~ emergency response communications system. Emergency operations c~~w~~ould include ~~the following~~:

1. ~~The~~ R~~r~~emoval of debris from crashes, cargo spill~~s~~age, ~~or~~ and other causes~~. This activity~~ , which should be conducted ~~in accordance with~~per the guidelines ~~set forth~~ provided in the ***NHTSA Program Guideline No.***

16, Debris Hazard Control and Cleanup.

2. Replacement of inoperative traffic control devices.

3. Repair or replacement of damaged highway safety components such as lighting, traffic control devices, redirectiveon devices, and energy absorbing devices.

3. Repair or correction of any situation that provides an immediate or unexpected hazard to the public.
4. Assistance with~~in~~ any activity during emergency response operations.

B.5.b Routine Maintenance

Routine maintenance operations are those that ~~may~~ can be predicted and planned in advance. These operations~~,~~ (which ~~may~~ can be preventive or corrective ~~in nature~~)~~,~~ should be conducted on a regularly scheduled basis using standard procedures. Proper scheduling ~~of these operations should be utilized to~~ should ~~provide~~ result in minimum disruption~~s~~ and hazard~~s~~ to the ~~driving~~ traveling public. Routine maintenance ~~may~~ can include ~~operations such as~~:

1. Cleaning and debris removal from the r o a d w a y ~~pavement~~, shoulders, and roadside clear zones.
2. Mowing and other vegetation control operations to provide a smooth recovery area and ~~to~~ maintain proper sight distances.
3. Cleaning and inspection of gutters, ditches, and other drainage structures.
4. Structural inspection and preventive maintenance of~~n~~ bridges and other structures.
5. Cleaning, replacement, and maintenance of roadway lighting fixtures.
6. Replacement and maintenance of traffic control devices.
7. Inspection and maintenance of:
    - R~~r~~edirective~~on~~ and energy absorbing devices (see ***Chapter 4*** ~~***– Roadside Design***~~).
    - ~~Inspection and maintenance of~~ E~~e~~mergency response communication systems and access facilities.

    ~~Inspection and maintenance of~~

    - P~~p~~avement and shoulders~~,~~ with particular emphasis on maintaining shoulders flush with the pavement (see ***Chapter 5*** ~~***– Pavement Design and Construction***~~).

    ~~Inspection and maintenance of~~

    - A~~a~~ll highway components and safety features.
8. ~~Inspection and maintenance of~~
    - P~~p~~edestrian surfaces ~~pavements,~~ and crossings, ~~etc.,~~ with

particular emphasis on:

- S~~s~~idewalk cracks,
- J~~j~~oint separations,
- A~~a~~ccumulated debris,
- A~~a~~djacent landscape materials~~, etc.)~~.

9. Thin pavement overlays ~~that is intended~~ to:

- P~~p~~reserve the pavement,
- R~~r~~etard ~~its~~ future deterioration, and
- M~~m~~aintain ~~its~~ functional condition.

B.5.c Special Maintenance

Special maintenance operations are ~~defined as~~ those ~~projects~~ that are neither urgent nor routine ~~in nature~~, but are occasionally required to ~~improve or~~ maintain ~~a street or highway in~~ a quality condition. ~~Since these projects can be planned in advance of the initiation of any work,~~ Develop procedures in advance ~~that~~ that provide for efficient, rapid, and safe maintenance operations. ~~can be developed. To avoid continuing disruptions of traffic, the quality and durability of these improvements, corrections, and repairs should be maintained at the highest practicable level.~~ Special maintenance should include ~~the~~ upgrading ~~of the highway~~ safety features~~, as well as the~~ and repairing or replacing ~~ement of~~ damaged/~~ or~~ deteriorated highway components. Design t~~T~~hese operations ~~should be designed~~ to ~~upgrade or~~ maintain the street or highway ~~in accordance with~~per the s~~S~~tandards provided~~presented~~ in this m~~M~~anual.

B.5.d Pavement Maintenance

The primary purpose of pavement maintenance is to ensure the pavement characteristics prescribed in ***Chapter 5*** ~~***– Pavement Design And Construction***, are reasonably maintained~~. Each maintaining agency ~~with responsibility for maintenance of streets and highways shall~~ must establish a meaningful pavement maintenance program~~system~~ (including shoulders and drainage structures) for the entire system under its jurisdiction. This program should include:

1. A process that monitors the serviceability of ~~the~~ existing streets and highways and identifies ~~the~~ pavement sections that are inadequate.

2. A systematic plan ~~of maintenance activities designed~~ to correct structural deficiencies and ~~to~~ prevent rapid deterioration.

3. A preservation program~~,~~ (with assigned priorities)~~, designed~~ to resurface, reconstruct, or replace pavements when they are no longer structurally serviceable.

Pavement maintenance preserves highway safety and requires a substantial portion of the total maintenance budget for streets and highways. It is necessary to ensure highway safety. The reduction of Reducing hydroplaning and splashing is essential for in promoting safe and efficient operations during wet weather conditions. The elimination of Eliminating driver~~ing~~ discomfort, and vehicle damage caused by deteriorated pavements ~~, provides additional~~ is economic justification for maintaining ~~the~~ pavements in a ~~fully~~ serviceable condition.

~~It is recognized that a~~ C~~c~~omprehensive ~~preservation~~ maintenance programs are ~~is~~ expensive. Prioritize a~~A~~dequate funding ~~inancing is required~~ to ~~successfully~~ conduct ~~arry out~~ these activities. ~~The establishment of appropriate budget priorities and careful planning can assist in developing and conducting a pavement~~ Develop the pavement maintenance and preservation program to ~~hat will, within a reasonable number of years,~~ bring substandard pavements up to the required level of serviceability and ~~will~~ maintain the adequacy of the entire system.

C RESURFACING

~~In addition to the design criteria provided in this chapter,~~ See the ***United States Department of Transportation ADA Standards for Transportation Facilities (2006)*** as required by ***49 C.F.R 37.41 or 37.43, United States Department of Justice ADA Standards (2010)*** as required by ***28 C.F.R 35 (title II) and 36 (title III)*** and the ***2020 Florida Building Code, Accessibility, 7th Edition*** as required by ***61G20-4.002*** ~~contains~~ for ADA requirements for accessibility in the public R/W~~right of way~~, for transportation facilities, and for sites, facilities, buildings, and elements ~~by~~ for people with disabilities.

See t~~T~~he ***Public Rights-of-Way Accessibility Guidelines (PROWAG)*** ~~provides additional information~~ for ~~the~~ designing ~~of~~ pedestrian facilities.

C.1 Accessibility Requirements

Design ~~If~~ new sidewalks and driveway connections ~~construction or reconstruction is included~~ on resurfacing projects ~~they shall be designed~~ to meet the requirements of ***Section C.7.d*** of ***Chapter 3*** ~~***– Geometric Design***~~ and ***Chapter 9*** of this manual ~~***– Pedestrian Facilities***~~. ~~Project design should include an~~ Ee~~E~~valuate~~ion of~~ existing driveways to determine if ~~it is feasible to upgrade~~ nonconforming driveways can feasibly be upgraded.

Bring e~~E~~xisting ~~detectable warnings and~~ curb ramps and detectable warnings ~~shall be brought~~ into compliance~~. This~~ includinges installing new curb ramps and detectable warnings ~~for both flush shoulder and curbed roadway connections and signalized driveways~~ where none exist and~~or~~ where existing features do not meet current requirements. Install n~~N~~ew curb ramps ~~shall be provided~~ on curbed roadways where none exist.~~ and~~ Replace e~~e~~xisting substandard curb ramps ~~shall be replaced~~. Retrofit e~~E~~xisting curb ramps ~~not meeting detectable warning requirements~~ (which ~~otherwise~~ comply with orientation, slope and width criteria) ~~shall be retrofitted~~ with new detectable warnings (where necessary).

~~Where existing right of way is inadequate or conflicts occur with existing features that cannot be practicably relocated or adjusted (e.g. driveways, drainage inlets, signal poles, pull boxes, utility poles, etc.),~~ Provide pedestrian accessibility ~~shall be provided~~ to the maximum extent feasible where existing R/W is inadequate and where conflicts with existing features (e.g. driveways, drainage inlets, signal poles, pull boxes, utility poles, etc.) cannot be eliminated~~,~~ (with appropriate documentation signed and sealed by a Professional Engineer (EOR)). Other than meeting detectable warning and curb ramp requirements, existing sidewalks and driveways ~~are not required~~ do not need to be upgraded ~~for the sole purpose of meeting~~ just to meet accessibility requirements ~~for accessibility~~ (unless included in the project scope).

C.2 Railroad-Highway Grade Crossing Near or Within Project Limits

Review fFederal-aid projects must be reviewed to determine if a railroad-highway grade crossing is ~~within the limits of or~~ near ~~the~~ either project terminus~~of the project~~. If so, ~~such railroad- highway grade crossing exists, the project must be upgraded to~~ meet the requirements of the ***Manual on Uniform Traffic Control Devices (2009 Edition with Revision Numbers 1 and 2, ~~May~~ May 2012) (MUTCD)*** ~~in accordance with~~per ***Title 23, United States Code (U.S.C), Chapter 1, Section 109(e)*** and ***23 C.F.R. 646.214(b)***. R~~Please r~~efer to Section C of ***Chapter 7*** of this manual~~ – *Rail-Highway Crossings*~~ for additional~~further~~ information.

C.3 Safety Improvements

Local maintaining agencies should ~~strive to~~ upgrade the safety of their facilities during scheduled maintenance ~~intervals~~ and especially during pavement resurfacing projects. Give special ~~Particular~~ attention ~~should be paid~~ to:

- I~~i~~mproving pedestrian and bicyclist safety, and ~~using strategies such as crosswalks and bicycle facilities. Investments should also be made in improved~~

- Improving guardrail end treatments and bridge-end transitions on high-speed facilities ~~on high speed facilities~~.

C.3.a Pavement Safety Edge

~~Many~~ The pavement safety edge is a low-cost strategy ~~ies exist to~~ for improvinge~~e~~ the long-term safety of streets and highways, ~~. One such strategy is the pavement Safety Edge. The Safety Edge provides a higher~~ increasing the probability ~~of a~~ that errant vehicles will returning~~ing~~ safely to the travel lane ~~when it drifts off the pavement~~. ~~It~~ The pavement safety edge is a wedge-shaped transition ~~of~~ between the ~~structural~~ pavement ~~to the~~ and an unpaved shoulder. The wedge shape eliminates tire scrubbing ~~against the pavement edge~~ and improves vehicle stability as it crosses the~~a~~ drop-off.

The s~~S~~afety e~~E~~dge is particularly effective ~~when providing a smooth transition from pavement to shoulder when~~ for vertical drop-offs exceeding 2 inches. Construction of the s~~S~~afety e~~E~~dge typically includes ~~initially~~ pulling the unpaved shoulder ~~for pavement structural course,~~ and ~~then~~ backfilling ~~onto the Safety Edge~~ with ~~installation of~~ sod or turf. The s~~S~~afety e~~E~~dge is very effective in mitigating the severity of road-departure crashes ~~should the unpaved shoulder erode away~~ caused by erosion between maintenance intervals.

Install the~~A~~ s~~S~~afety e~~E~~dge treatment ~~should be provided~~ adjacent to the travel lane on roadways:

- Wwithout curb or paved shoulders,
- Wwith a posted speeds of 45 mph and more or greater, and

- With a history of lane departure crashes.

See Figures 10 – 1 and 10 – 2 for d~~D~~etails ~~for~~ of the s~~S~~afety e~~E~~dge treatment ~~are included in Figures 10 – 1 Two Lane Road with Safety Edge and 10 – 2 Safety Edge Detail (No Paved Shoulder)~~.

See the ***FHWA's Office of Safety – Safety Edge*** ~~Additional~~ for additional information ~~on Safety Edge can be found at *FHWA's Office of Safety – Safety Edge*, ~~(including a Design and Construction Guide, Guide Specification, Safety Evaluation Tech Brief and Case Studies). See the ***FHWA's Crash Modification Factors Clearinghouse*** ~~also provides information on~~ for the performance of safety edge. ~~The~~ Use FDOT ~~has a~~ ***Developmental Specification for Safety Edge – Dev330SE*** ~~on the FDOT's web site which may be used if~~ when approved by the maintaining agency ~~having jurisdiction~~.

Figure 10 – 1 Two Lane Road with Safety Edge

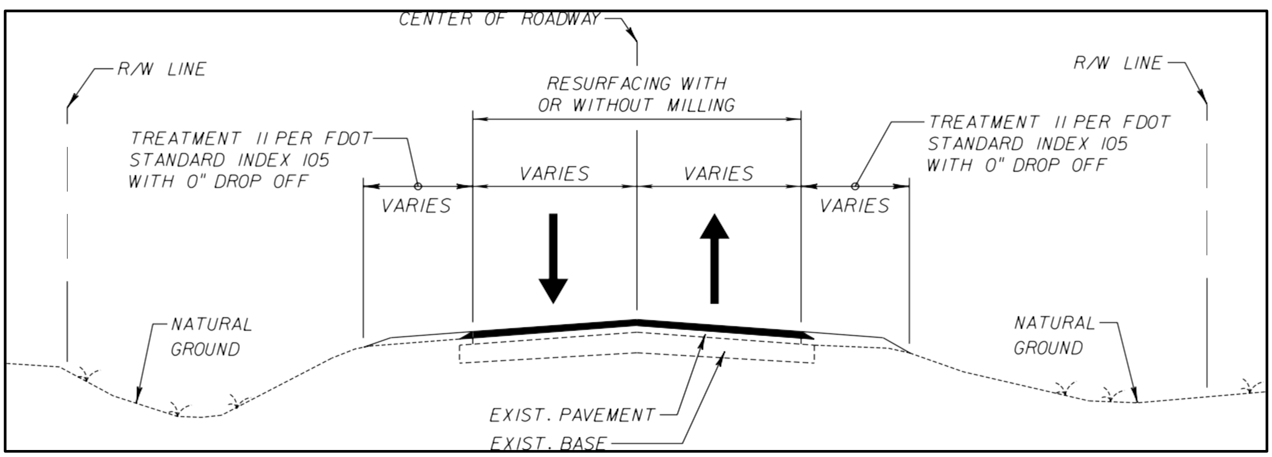
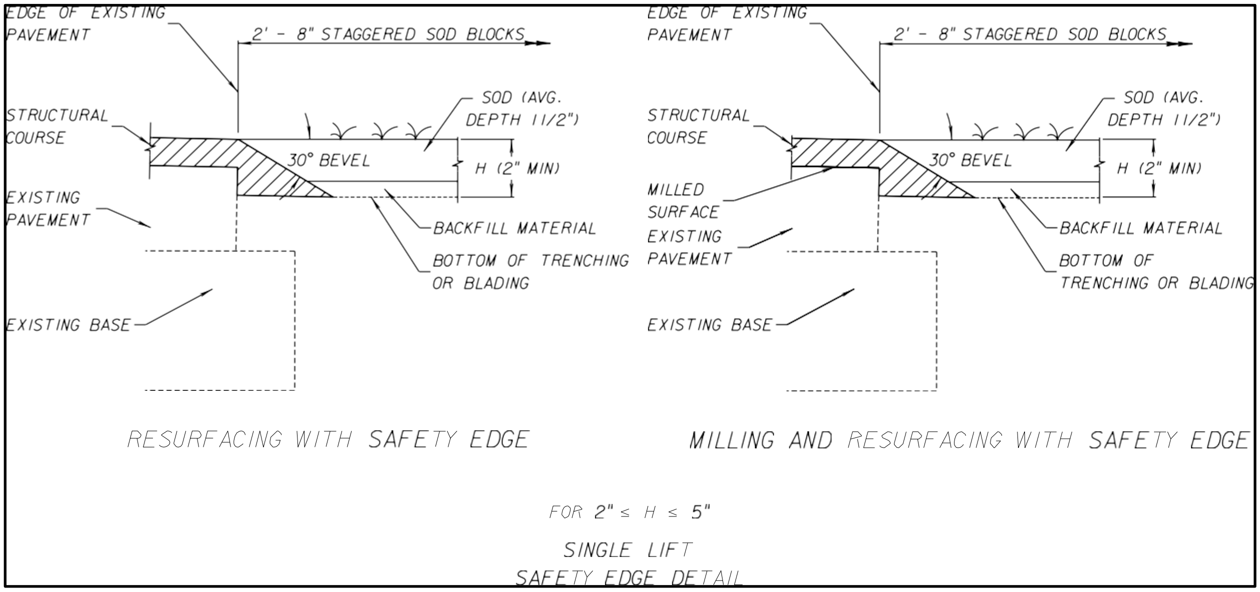


Figure 10 – 2 Safety Edge Detail (No Paved Shoulders)



C.4 Federal Aid Project Requirements

~~The following are the minimum requirements that a local highway resurfacing project scope must contain for~~ Projects using federal-aid assistance ~~-~~(including the Local Agency Program) ~~including projects in the Local Agency Program (LAP)~~ must:

1. Rework shoulders to be flush with the roadway pavement and establish turf along the pavement edge.

2. Upgrade or replace existing roadside hardware (guardrail) ~~as necessary~~ to ~~for~~ comply ~~iance~~ with f~~F~~ederal criteria for 3R projects (as summarized in the ***FDOT Design Manual, Chapter 215 Roadside Safety)***.

3. Meet the ***Manual on Uniform Traffic Control Devices (2009 Edition with Revision Numbers 1 and 2, ~~May~~ May 2012) (MUTCD)*** standards for signing and pavement marking.

4. Construct or reconstruct ~~, as appropriate,~~ curb cuts and ramps to meet current accessibility requirements.

5. Upgrade ~~the~~ safety ~~of the project~~ by mitigating the impact of crashes involving vehicles, bicycles, and pedestrians.

   Note: The ~~local~~ maintaining agency ~~may~~ should contact the FDOT District Safety Office ~~and~~to determine project locations within the project with crash rates higher than average for similar facilitiesy type. The local maintaining agency may can then identify the causes of the crashes from a review of crash report data provided by the FDOT District Safety Office. Based on this analysis, the local agency may then specify the and then implement appropriate crash mitigation strategies measures (additional e.g., guardrail, signing, vibratory/audible pavement markings, designated crosswalks, or and other prudent safety-enhancing strategies).

6. Upgrade railroad crossings to meet the ***Manual on Uniform Traffic Control Devices (2009 Edition with Revision Numbers 1 and 2, May Can 2012) (MUTCD)*** requirements in accordance withper ***Title 23, United States Code (U.S.C), Chapter 1, Section 109(e)*** and ***23 C.F.R. 646.214(b).*** Please refer to See ***Section C*** of ***Chapter 7*** of this manual – ***Rail-Highway Crossings*** for additionalfurther information.

D REFERENCES FOR INFORMATIONAL PURPOSES

Refer to these The following is a list of publications that may be referenced for fu additional guidance rther guidance:

- FHWA Pavement Preservation Definitions, HIAM-20, September 12, 2005, ***http://www.fhwa.dot.gov/pavement/preservation/091205.cfm***
- NCHRP Synthesis 417: Geometric Design Practices for Resurfacing, Restoration, and Rehabilitation, ***https://www.trb.org/Publications/Blurbs/165650.aspx***
- FHWA Center for Accelerating Innovation – Safety Edge ***https://www.fhwa.dot.gov/innovation/everydaycounts/edc-1/safetyedge.cfm***

CHAPTER 11

WORK ZONE SAFETY AND MOBILITY

A INTRODUCTION

Construction, maintenance, ~~and~~ utility work,~~ along with~~ and traffic incident management ~~,~~ ~~are operations that may~~ can create: ~~highway safety and mobility challenges~~,

- Changes to normal traffic flow,
- Introduction of unexpected travelling conditions,
- Highway safety and mobility challenges,
- Hazardous situations, and
- Serious traffic conflicts.

~~The changes to normal traffic flow and the introduction of unexpected travelling conditions at many work zones may generate hazardous situations and serious traffic conflicts.~~ A comprehensive plan for work zone safety (a.k.a. Transportation Management Plan or TMP) is required to minimize the risks and effects of these operations. ~~These comprehensive plans are known as transportation management plans.~~ Any activity within a street, highway or shared use path corridor ~~shall~~ must comply with ~~follow~~ the requirements of this chapter.

The ~~general objective~~ goal of a ~~transportation management plan~~ TMP is to protect workers, traffic incident responders, pedestrians, bicyclists, and ~~motorists~~ drivers during work zone operations ~~. This may be achieved by meeting the following~~ by:

- Providing~~e~~ adequate advance warning and information about upcoming work zones
- Promoting~~e~~ the use of the appropriate traffic control and protection devices
- Providing~~e~~ clear information for pedestrians, bicyclists, and ~~motorists~~ drivers ~~clear information to understand how to~~ to navigat~~e~~e through or around the work zone
- Providing~~e~~ accessible and continuous routes for pedestrians through~~, in,~~ and~~/or~~ around ~~construction or maintenance~~ the work zone~~s~~ to at least ~~to~~ the same level ~~of accessibility~~ that existed ~~prior to~~ before the project
- Reducing~~e~~ the consequences of an out-of-control vehicle
- Providing~~e~~ safe access and storage for construction equipment and materials
- Promoting~~e~~ the speedy completion of projects (including thorough cleanup~~ of the site~~)

B REGULATORY REQUIREMENTS

~~Each a~~Agencies ~~y with~~ responsible ~~ilities~~ for construction, maintenance, utility, or traffic incident management ~~, or any roadwork operations~~ on streets and highways ~~shall~~ must develop and maintain a program of work zone safety, as ~~set forth~~ provided in the ***Manual on Uniform Traffic Control Devices, 2009 Edition (MUTCD)***~~,~~ *and* adopted by ***Rule 14 – 15.010, F.A.C.*** ~~Additional requirements related to all highway construction projects financed in whole or in part with federal-aid highway funds are provided in~~ See ***Title 23 Code of Federal Regulations (CFR) 630 Subpart J*** ~~, more commonly known as~~ (a.k.a. the ***Work Zone Safety and Mobility Rule***) ~~,~~ and ***Temporary Traffic Control Devices Rule (Subpart K)*** for additional requirements for highway projects using federal funds. ~~,~~

Where there is ~~n~~ an existing pedestrian facility ~~is in place~~, provide an accessible and continuous route for pedestrians through ~~, in, and/~~or around construction and ~~or~~ maintenance work zones ~~must be provided,~~ in compliance with the ***2006 Americans with Disabilities Act Standards for Transportation Facilities*** as required by ***49 C.F.R 37.41 – Construction of Transportation Facilities by Public Entities*** or ***37.43 - Alteration of Transportation Facilities by Public Entities***. See t~~T~~he ***2017 Florida Accessibility Code*** ~~also includes~~ for additional work zone requirements ~~that apply to work zones,~~ (as required by ***F.A.C. 61G20-4.002***).

C TRANSPORTATION MANAGEMENT PLAN (TMP)

A ~~Transportation Management Plan (~~TMP~~)~~ lays out a set of strategies for managing work zone impacts~~ of a project~~. ~~The ~~A TMP ~~helps to expand mitigation of work zone impacts beyond traffic safety and control to also~~ addresses mobility for all users. The required scope ~~and content~~ of the TMP ~~required for a project are~~ is based on: ~~the~~

- W~~w~~ork zone policies~~policies,~~
- E~~e~~xpected work zone impacts~~ of the project~~, and
- W~~w~~hether a project is determined to be significant.

~~For all projects, ~~T~~t~~he TMP ~~will contain ~~includes a Temporary Traffic Control Plan (TTCP) for all projects, ~~that~~ addressing ~~es~~ traffic safety and control through the work zone and is consistent with the provisions ~~under~~ of Part 6 of the ***MUTCD.***

~~If a project is expected to be significant, ~~T~~t~~he TMP ~~for that project ~~must also ~~contain both~~ include transportation operations and public information components for projects determined to be significant. The Transportation Operations Plan (TOP) addresses operations and management of the transportation system in the work zone impact area. Examples of TOP strategies include:

- T~~t~~ravel demand management,
- S~~s~~ignal retiming,
- U~~u~~se of Intelligent Transportation Systems (ITS),
- S~~s~~peed enforcement, and
- T~~t~~raffic incident management.

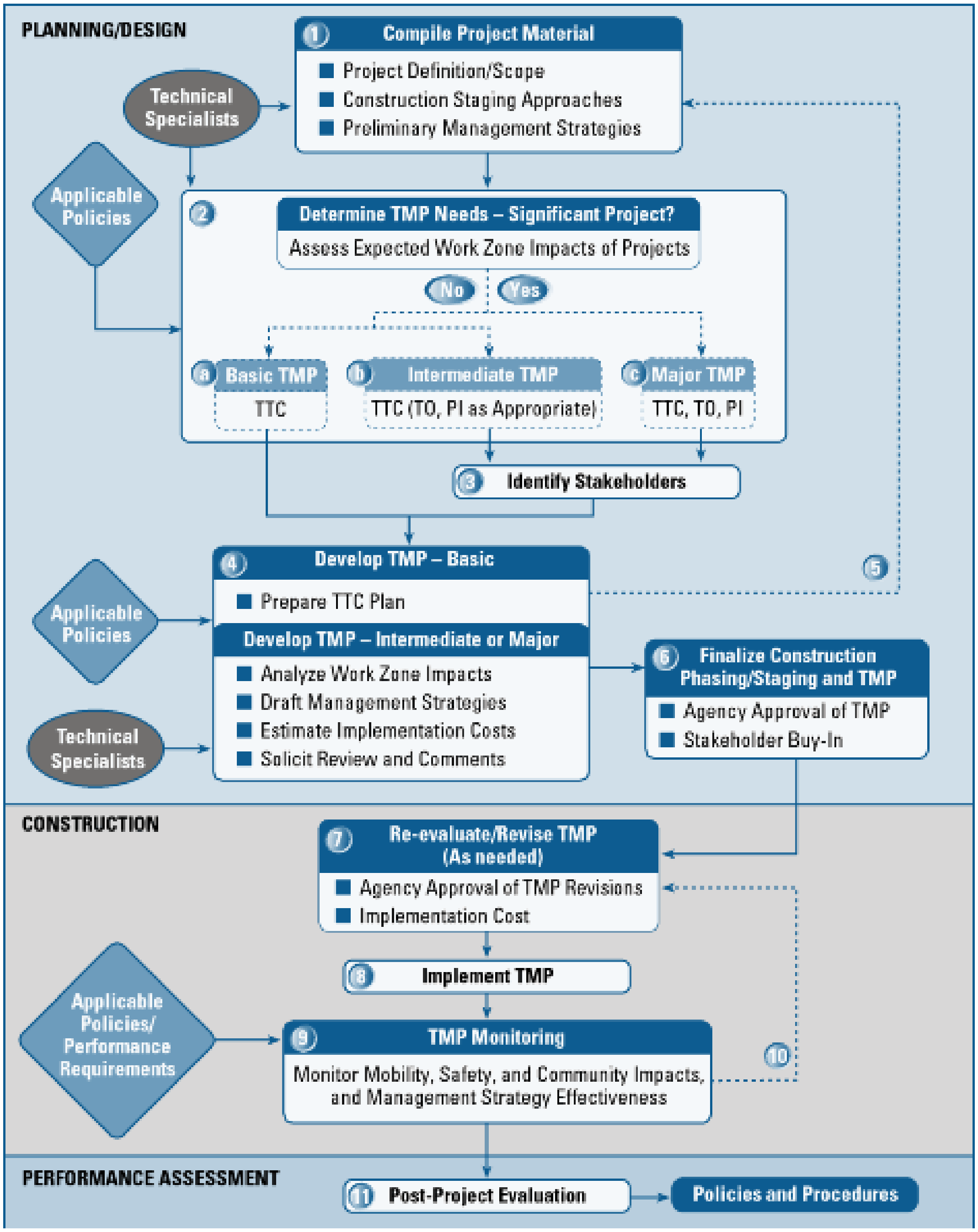
The Public Information Plan (PIP) addresses communications with the public and concerned stakeholders (before and during the project) ~~, both before and during the project, ~~about ~~the project, ~~what to expect in and around the work zone ~~, and ~~including any available travel alternatives. ~~Examples of ~~Consider using the PIP strategies below to share work zone information (both pre-trip and in-route)~~include using~~:

- B~~b~~rochures,
- W~~w~~eb sites,
- R~~r~~adio, and/or
- V~~v~~ariable message signs~~ to disseminate this information both pre-trip and in-route~~.

A significant project is ~~defined as~~ one that alone or in combination with other concurrent projects nearby is anticipated to cause sustained work zone impacts that are greater than what is considered tolerable based on policy or engineering judgement.

See Figure 11 – 1 ~~TMP Development provides~~ for an overview of the steps to take~~n~~ in developing a TMP~~ransportation Management Plan~~. See the ***FHWA's Work Zone Management*** web page ~~Further information on~~ for developing TMPs ~~for projects can be found on~~ ~~***FHWA's Work Zone Management***~~ ~~web page~~.

Figure 11 – 1 TMP Development



Source: FHWA Figure 6.1 ~~Transportation Management Plans~~

D TEMPORARY TRAFFIC CONTROL PLAN (TTCP)

~~The achievement of~~ W~~w~~ork zone safety requires ~~careful and complete~~ advance planning ~~prior to the initiation of any work. The planning objective is to develop~~ and a comprehensive Temporary Traffic Control Plan (TTCP) that ~~includes~~ considers ~~the following considerations~~:

- Type of Operation
- Nature of Work Zone
- TTCP Details
- Work Scheduling
- Coordination

D.1 Type of Operation

The type of operation ~~may~~ can be ~~further~~ classified as:

- R~~r~~outine,
- U~~u~~nplanned, or
- P~~p~~lanned ~~operations~~.

Routine operations ~~would involve projects such as~~ include regular mowing, street cleaning, and preventive maintenance operations ~~conducted on a regularly scheduled basis~~.

Unplanned operations require prompt~~,~~ and efficient action to restore the facility to a safe condition~~. These include traffic incident management~~ such as:

- C~~c~~learing vehicle crash or storm debris,
- A~~a~~ddressing hazardous material~~s~~ spills,
- R~~r~~epairing or replacing damaged safety components and
- R~~r~~estoring inoperative traffic control devices.

Planned operations are scheduled projects~~,~~ (neither routine nor time-sensitive ~~in nature~~)~~,~~ that are occasionally required to maintain or upgrade a street, highway, sidewalk, or path.

D.2 Nature of the Work Zone

The development of the TTCP for work zone safety should consider ~~include consideration of the following factors~~:

- Length of the project
- Duration and complexity of the work
- Hazards that may may be created (e.g., long term drop-offs)
- Necessity for storing equipment or material in the facilityproject R/Wright of way
- Traffic characteristics and patterns

- Effects on nearby businesses and residences, (especially during ~~when~~ detours~~ing~~)
- Site conditions that ~~may~~ may be confusing or distracting
- Limitations on sight distance
- Decreased visibility associated with nighttime operations
- Reasonableness of detour length and complexity

D.3 TTCP Details

Plans should include work zone protection ~~at work zones~~ when work is in progress and when operations have been halted (e.g., ~~such as during the~~ at night, special events or restrictions, and holidays). The TTCP should provide for~~include provisions for the following~~:

- Work zone traffic signs
- Channelizing devices
- Temporary barriers (see ***Chapter 4 ~~– Roadside Design~~***)
- ~~The usage of f~~Flaggers or temporary traffic signals
- Access and accommodations for pedestrians, bicyclists, and transit users
- Lane widths (see ***Section D.6 ~~Number and Width of Travel Lanes, Bike Lanes, Sidewalks, and Shared Use Paths~~***)
- Drop-off hazards (see ***Chapter 4 ~~– Roadside Design~~***)
- Above-~~ ~~ground hazards (see ***Chapter 4 ~~– Roadside Design~~***)
- Clear zone (see ***Chapter 4 ~~– Roadside Design~~***)
- Sight distance (intersection, stopping)
- Temporary drainage
- Work zone speed
- Lane closure restrictions
- Bus stops, boarding and alighting areas, shelters, lighting
- Traffic control officers and law enforcement
- Adequate work zone space for construction vehicles, workers and materials
- Nighttime safety (see ***Chapter 6 ~~– Lighting~~***)

- Traffic control and protective devices – including short- -term transverse rumble strips and temporary raised rumble strip sets (see ***Section D.3.1 Short Term Transverse Rumble Strips***, ***Section, D.3.2 Temporary Raised Rumble Strip Sets***, and ***Chapter 18 – Signing and Marking***)
- Detours, (including for pedestrians and bicyclists)
- Special events

D.3.a Short- -Term Transverse Rumble Strips

In locations with existing raised rumble strip sets (e.g., intersections, approaches to horizontal curves, toll plazas), mMaintain or or replace the any existing raised rumble strip sets throughout construction. Provide short-term raised rumble strip sets when existing raised rumble strip sets are removed for construction activities, (until the permanent raised rumble strip sets are installed). Install sShort-term raised rumble strip sets must be installed prior to before opening the road to traffic. ; therefore, q Quantities may may include multiple applications due to construction phasing. See The ***FDOT's Standard Plans, Index 546-001*** and ***Standard Specifications, Section 546*** provide additional information on for short- -term raised rumble strips.

Example of Transverse Rumble Strips

D.3.b Temporary Raised Rumble Strip Sets

Temporary raised rumble strip sets are used to warn drivers ~~vehicular traffic~~ of ~~the~~ an upcoming work zone. They ~~may~~ can be used to supplement ~~the required~~ signs, channelizing devices, and flagging operations~~ in the work zone. They are most often used~~ and when both of these ~~following~~ conditions occur:

- Lane closure on a two-lane, two-way roadway
- Existing posted speed ~~prior to construction~~ is 55 mph or more ~~greater~~

See ~~The~~ FDOT~~'s~~ ***Standard Plans, Index 102-603*** ~~provide additional information on~~ for temporary raised rumble strips.

D.4 Work Scheduling

Proper work scheduling and sequencing ~~of operations will~~ promotes efficiency and ~~, but also improve the~~ safety~~ aspects~~. ~~Where feasible, routine operations and special projects should be c~~Conducted~~ed~~ work during low traffic periods (when feasible) of low traffic volume to reduce conflicts. ~~Projects~~ Schedule work activities that ~~may~~ can be conducted ~~arried out~~ concurrently at the same site ~~should be scheduled~~ to occur simultaneously to eliminate successive traffic disruptions ~~of traffic~~.

Coordinate and sequence m~~M~~ajor projects ~~that impede or restrict traffic flow should be coordinated and sequenced~~ with similar adjacent projects to ~~in adjacent areas, to produce a minimum of~~ minimize disruption to ~~orderly~~ traffic flow in the overall network. The scheduling of work at a given location should ~~include~~ consider~~ation of~~ traffic generation (including special events)~~, as well as~~ and traffic restrictions by work activities on the surrounding network.

D.5 Coordination

To ensure safe and efficient roadwork operations, Develop and execute the TTCP ~~should be developed and executed~~ in cooperation with interested individuals and agencies, ~~which may~~ includ~~ing~~ ~~e the following~~:

- Transportation agencies
- Police and sheriff's departments
- Emergency responders
- Contractors
- Utilities
- Building departments
- Mass transit providers
- Traffic generators
- Residents and businesses
- Neighboring jurisdictions
- School b~~B~~oards
- Postal s~~S~~ervices
- Media
- Trash and recycling pick ups

D.6 Number and Width of Travel Lanes, Bicycle~~ke~~ Lanes, Sidewalks, and Shared Use Paths

Maintain t~~T~~he existing number and width of travel lanes, sidewalks, shared use paths, and bicycleke lanes

~~should be maintained~~ through work zones. ~~The m~~Minimum work zone widths ~~for work zone travel lanes, sidewalks, shared use paths, and bike lanes shall be~~ are ~~as follows~~:

- Freeways – 11 feet
- Arterials – 10 feet (~~except on~~ with a 10.5-foot outside travel lane for transit and ~~or~~ truck routes) ~~, where a minimum width outside through lane of 10.5 feet is required~~
- Collectors – 10 feet
- Local – 10 feet~~,~~ (~~or to~~ match existing ~~lane widths~~ if less than 10 feet)
- Sidewalks – 5 feet
- Shared Use Paths – 8 feet
- Bicycle~~ke~~ Lanes – 4 feet (plus a 1-foot ~~'~~ offset from a barrier or curb)

Do not allow traffic control and warning devices to encroach on open travel lanes, bicycle~~ke~~ lanes, paved shoulders, sidewalks, ~~and~~ or shared use paths ~~open for travel~~.

D.7 Clear Zones, Above-Ground Hazards, Drop-Offs, and Temporary Barriers

Protection devices can be required w~~W~~hen above-ground hazards or drop-offs occur within the clear zone or adjacent to pedestrian facilities due to construction or maintenance activities~~, protection devices may be needed~~. See ***Chapter 4*** ~~***– Roadside Design***~~ for requirements.

D.8 Work Affecting Pedestrian and Bicycle Facilities

D.8.a Pedestrian Facilities

~~When an accessible sidewalk or shared use path is temporarily closed to pedestrians by construction, alterations, maintenance operations, or other conditions,~~ Provide an alternate pedestrian access route complying with Sections 6D.01, 6D.02, and 6G.05 of the ***MUTCD*** when an accessible sidewalk or shared use path is closed by:

- Construction,
- Alterations,

- Maintenance operations, or

- Other activities shall be provided. Where provided, p Pedestrian barricades and channelizing devices shall must comply with sections 6F.63, 6F.68, and 6F.71 of the ***MUTCD***. The A temporary sidewalk or shared use paths shall must maintain the same level of accessibility (or more) as the existing facility or greater. Minimize diversions and detour lengths.

Provide a 5-foot minimum width for a temporary sidewalk For a temporary sidewalk, provide a minimum width of 5 feet. In constrained conditions, provide a 4-foot minimum width for a temporary sidewalk~~a minimum sidewalk width of 4 feet may be provided,~~ with a 5-foot by~~' x~~ 5-foot~~'~~ passing section ~~at least~~ every 200 feet (or less).

Provide an 8-foot minimum width for a temporary shared use path ~~For a temporary shared use path, provide a minimum width of 8 feet~~. ~~Both~~ Provide a 0.02 maximum cross slope and a 5% maximum running slope for sidewalks and shared use paths; except that the running slope can mirror (but not exceed) the slope established by an adjacent street or highway. ~~shall have a maximum cross slope of 0.02 and running slope of 5%. If the temporary sidewalk or shared use path is contained within a street or highway right of way the maximum running slope shall not exceed the general grade established for the adjacent street or highway.~~

~~When temporary sidewalks or shared use paths intersect with streets or driveways, e~~Ensure that all curb ramps ~~or~~ and blended transitions meet ADA requirements where temporary sidewalks and shared use paths intersect with streets and driveways. Provide d~~D~~etectable warnings ~~shall be provided~~ at intersections with all streets and ~~signalized or stop sign controlled~~ driveways. Detectable warnings are not required for curb ramps or blended transitions diverting pedestrian traffic into a closed lane.

See ***Chapter 8*** ~~***– Pedestrian Facilities***~~ and ***Chapter 9*** ~~***– Bicycle Facilities***~~ for additional~~further~~ information. See the ***United States Access Board's*** web page and the ***(Proposed) Public Rights-of-Way Accessibility Guidelines (PROWAG)*** ~~Additional information on~~ for designing accessible sidewalks and shared use paths ~~can be found on the **United States Access Board's** web page, including the **(Proposed) Public Rights-of-Way Accessibility Guidelines (PROWAG).**~~

D.8.b Bicycle Facilities

Maintain t~~T~~he continuity of ~~a~~ all bicycle facilities, ~~y should be maintained through the work zone. Continuity through the work zone is particularly important~~ particularly where bicyclists have been traveling on a shoulder, bicycle~~ke~~ lane, or shared-use path ~~prior to~~ approaching the work zone and adjacent to a lane ~~having~~ with a posted speed ~~limit ≥~~ of 35 mph or more ~~iles per hour~~. Provide a separate bicycle facility or detour route when ~~If~~ a bicycle lane, paved shoulder, or shared use path is closed on a roadway with ~~having~~ a posted speed ~~limit~~ of 35 mph or more ~~higher is closed a separate bicycle facility or detour route should be provided~~. Consider closing one or more lanes of a multi-lane roadway to ~~To maintain~~ provide room for bicycle lanes, paved shoulders, or ~~a~~ shared use paths through the work zone ~~on a multi-lane~~

roadway, one or more travel lanes could be closed.

On roadways where bicyclists currently share lanes with motor vehicle traffic, the TTCP and The typical applications for general traffic will are usually be adequate for bicyclists on roadways where bicyclists currently share lanes with motor vehicles as well.

If a bicycle facility detour is unavoidable, it Any required bicycle facility detour should be as short and direct as practical, using roadways where conditions are appropriate for bicycling. Do not direct oOn-road bicyclists should not be directed onto a sidewalk unless no practical alternative is available (e.g., ~~such as might be the case on~~ a bridge ~~in the course of a~~ rehabilitation project or a roadway with environmental or R/W~~right of way~~ constraints). ~~If directing cyclists onto a sidewalk;~~ Widen sidewalks ~~should be widened~~ to ~~be~~ at least 6 feet~~,~~ (7 feet when back of curb) when directing bicyclists onto the sidewalk.

Develop and implement a full detour plan when closing ~~If~~ a portion of a bicycle facility ~~is to be closed~~ due to construction activities ~~and~~ where the detoured facility follows a complex path (not in the ~~original~~ existing corridor)~~, then a full detour plan should be developed and implemented~~. ~~The TTCP for the detour of the bicycle facility should i~~ Include all necessary advance warning (W21 series) signs, detour (W4-9 series) signs, and ~~any~~ other TTCP devices needed ~~cessary~~ to guide bicyclists along the detour route.

Use the Bicycles May Use Full Lane (R4-11) sign and the shared lane pavement markings ~~If an on-street~~ when reducing a 14-foot outside lane ~~bicycle facility had a wide outside through travel lane (lanes having a width of at least 14 feet) prior to construction, and construction activities reduce the lane width~~ to less than 14 feet through the work zone~~, then the Bicycles May Use Full Lane (R4-11) sign and Shared Lane Marking should be used~~.

See ***Part 6 of the MUTCD*** for a~~A~~dditional requirements for ~~providing for and managing~~ bicycle accommodations ~~travel~~ in work zones ~~is found in **Part 6 of the MUTCD**~~. See ***Table 9B-1*** of the ***MUTCD*** for ~~The~~ minimum TTCP sign and plaque sizes for shared-use paths ~~shall conform to those shown in **Table 9B-1 Bicycle Facility Sign and Plaque Minimum Sizes of the MUTCD**~~. ~~The m~~See ***Chapter 6F of the MUTCD*** for minimum TTCP sign and plaque sizes for on-street bicycle facilities ~~shall conform to **Chapter 6F of the MUTCD**~~.

D.9 Typical Application Examples

Several examples of typical work zone applications are illustrated in the figures listed below. ~~The following figures provide examples of typical applications. Typical applications should be used~~ Use these typical applications to develop ~~a~~ site-specific TTCPs ~~. Examples are provided for the following scenarios~~:

Figure 11 – 2 Two-Lane Roadway, Single Lane Closure Using Flaggers~~Lane (Closure Using Flaggers)~~

Figure 11 – 3 Multi-Lane Roadway, Single Lane Closure~~Lane~~

~~(Single Lane Closure)~~

Figure 11 – 4 Sidewalk/Shared Use Path Diversion (Temporary Sidewalk/Shared Use Path)

Figure 11 – 5 Sidewalk/Shared Use Path Detour (Closure with Reroute)

Figure 11 – 6 Bicycle Lane Closure w~~W~~ithout Detour

Figure 11 – 7 Bicycle Lane Closure w~~W~~ith On-Road

Detour Figure 11 – 8 Shared Use Path Closure with a

Diversion Figure 11 – 9 On-Road Detour for Shared Use

Path

Figure 11 – 10 Paved Shoulder Closure with Bicycle Diversion onto Temporary Path

See Tables 11 – 1, 11 – 2, 11 – 3, and 11 – 4 for ~~The~~ recommended work zone device spacings ~~for work zone details in the Figures below are provided in Tables 11 – 1 Work Zone Sign Spacing “X”, Table 11 – 2 Taper Length “L”, Table 11 – 3 Buffer Length “U”, and Table 11 – 4 Channelizing Device Spacing~~. ~~The ***MUTCD*** provides additional information;~~ See ***Table 6H-3*** of the ***MUTCD*** for work zone sign spacing, ~~see ***Table 6H- 3***;~~ ***Table 6H-4*** for taper length, ~~see ***Table 6H-4***, and~~ and ***Table 6C-2*** for buffer length~~, see ***Table 6C-2***~~***.*** Provide pavement markings ~~in accordance with~~ per ***Section 6F-78*** of the ***MUTCD***. The FDOT~~'s~~ ***Standard Plans*** provide~~s~~ additional information and modifications of the typical applications ~~found~~ provided in the ***MUTCD***.

Table 11 – 1 Work Zone Sign Spacing “X”

Road Type	Minimum Spacing (feet)
Arterials and collectors with Work Zone Speed ≤ 40 mph	200
Arterials and collectors with Work Zone Speed ≥ 45 mph	500
Freeways/Limited Access (LA) Roadways	1,500

Table 11 – 2 Taper Length “L”

Work Zone Speed (mph)	Minimum Length (feet)
≤ 40	$L = WS^2/60$
≥ 45	$L = WS$
Note: Where W = width of offset in feet S = speed in mph	

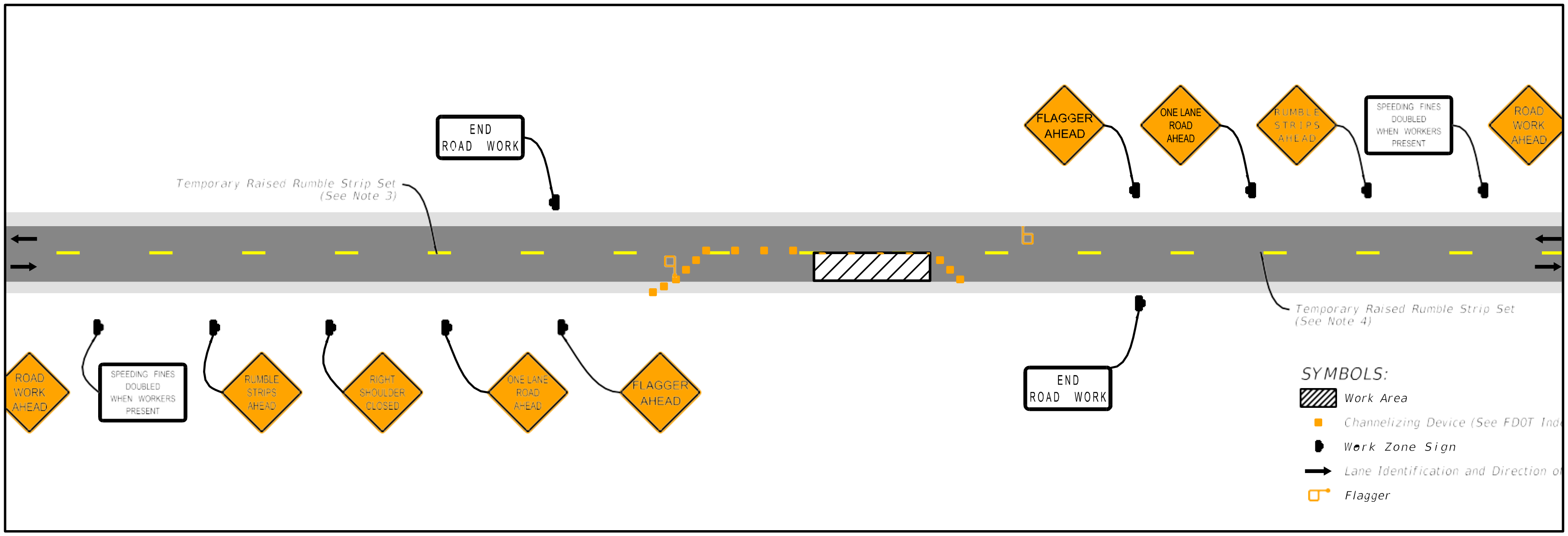
Table 11 – 3 Buffer Length "U"

Work Zone Speed (mph)	Min. Length (feet)
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730
Note: When b~~B~~uffer l~~L~~ength "U" cannot be attained due to geometric constraints, ~~use~~ provide the greatest length possible~~, but~~ (not less than 155 feet).	

Table 11 – 4 Channelizing Device Spacing

Speed (mph)	Maximum~~.~~ Distance Between Devices (feet)			
	Tubular Markers		Vertical Panels or Opposing Traffic Lane Divider	
	Taper	Tangent	Taper	Tangent
25	25	50	25	50
30 to 45	25	50	30	50
50 to 70	25	50	50	100

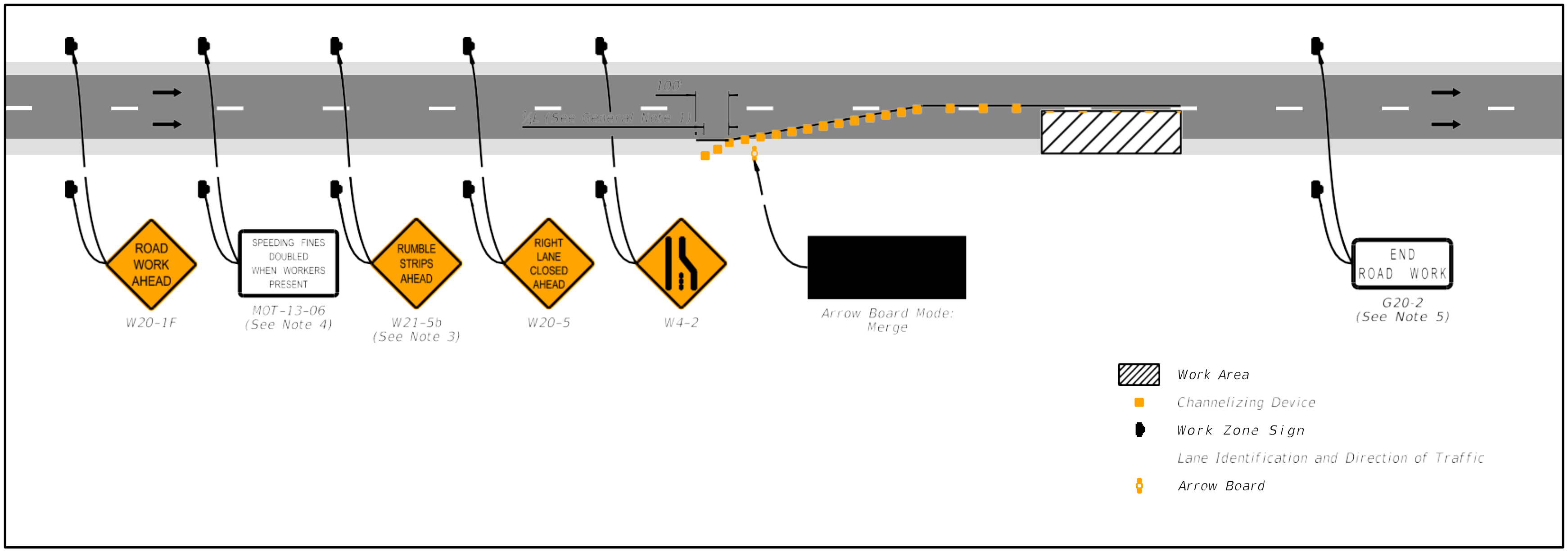
Figure 11 – 2 Two-Lane Roadway, Single Lane Closure Using Flaggers



Notes:

1. X = Work Zone Sign Spacing, L = Taper Length, U = Buffer Length, see Tables 11 – 1, 11 – 2, and 11 – 3 of this chapter and the MUTCD.
2. See Table 11 – 4 for the required spacing of channelizing devices.
3. ~~If temporary rumble strips are used, i~~Include “Rumble Strips Ahead” signs and associated sign spacing distance when using temporary rumble strips.
4. “Speeding Fines Doubled When Workers Present” signs ~~may~~ can be used.~~,~~
5. “End Road Work” signs ~~may~~ can be included when the work zone is in place for ~~greater~~ more than 24 hours.
6. Temporary p~~P~~avement m~~M~~arkings are required for work zones ~~greater than~~ over 24 hours in duration.
7. Refer to FHWA Standards for Highway Signs and Markings f~~F~~or general sign codes ~~refer to FHWA Standards for Highway Signs and Markings~~. ~~For special signs beginning with MOT-xx,~~ See the FDOT~~'s~~ Special Sign Details in the ***Standard Plans*** for special signs beginning with MOT-xx ~~provide additional information~~.

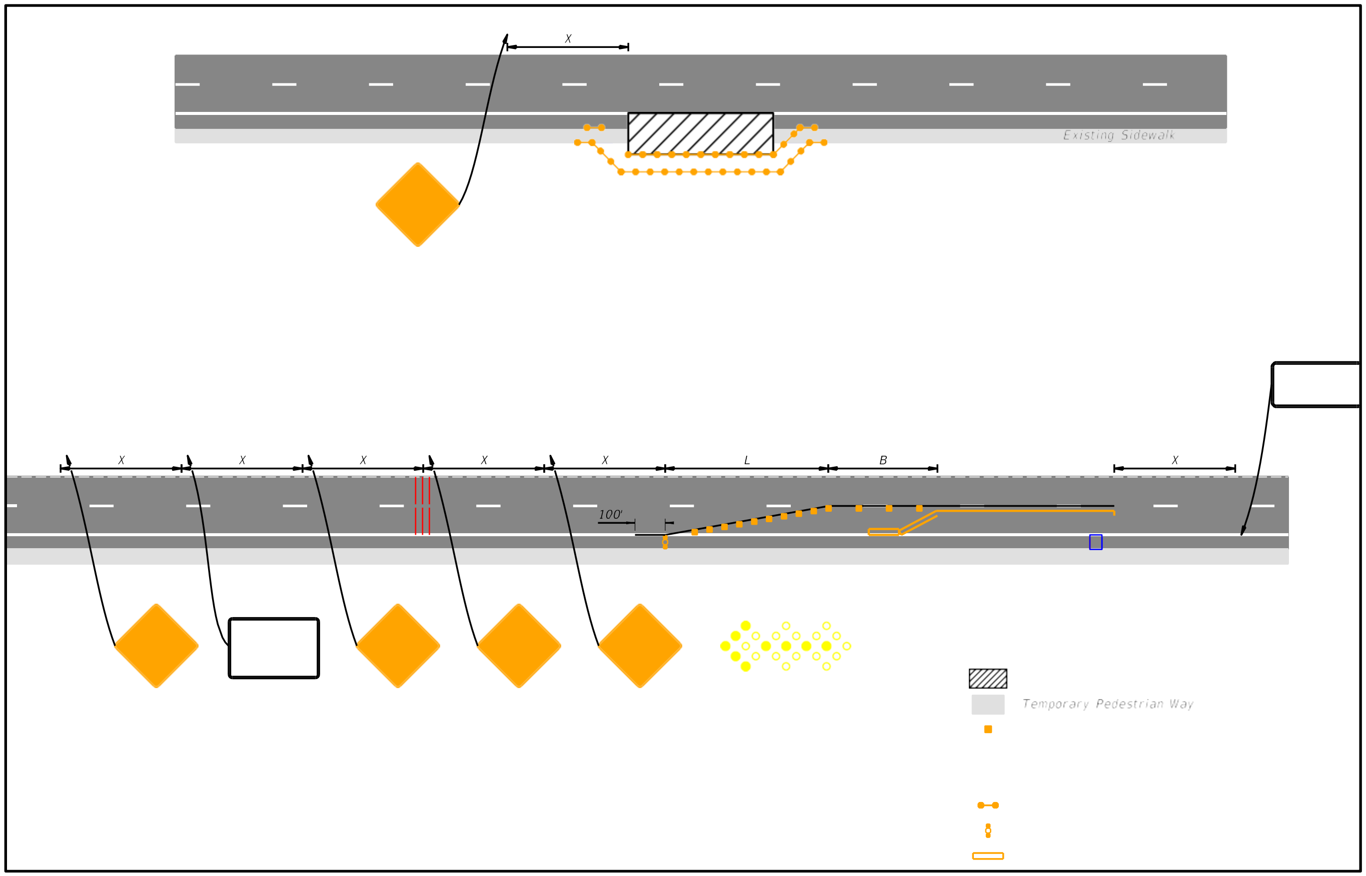
Figure 11 – 3 Multi-Lane Roadway, Single Lane Closure



Notes:

1. X = Work Zone Sign Spacing, L = Taper Length, U = Buffer Length, see Tables 11 – 1, 11 – 2, and 11 – 3 of this chapter and the MUTCD.
2. See Table 11 – 4 for the required spacing of channelizing devices.
3. If temporary rumble strips are used, include “Rumble Strips Ahead” signs and associated sign spacing distance.
4. “Speeding Fines Doubled When Workers Present” signs ~~may~~ can be used.~~,~~
5. “End Road Work” signs ~~may~~ can be included when the work zone is in place for more~~greater~~ than 24 hours
6. Temporary p~~P~~avement m~~M~~arkings are required for work zones more~~greater~~ than 24 hours in duration.
7. For general sign codes refer to FHWA Standards for Highway Signs and Markings. For special signs beginning with MOT-xx, FDOT~~'s~~ Special Sign Details in the Standard Plans provide additional information.

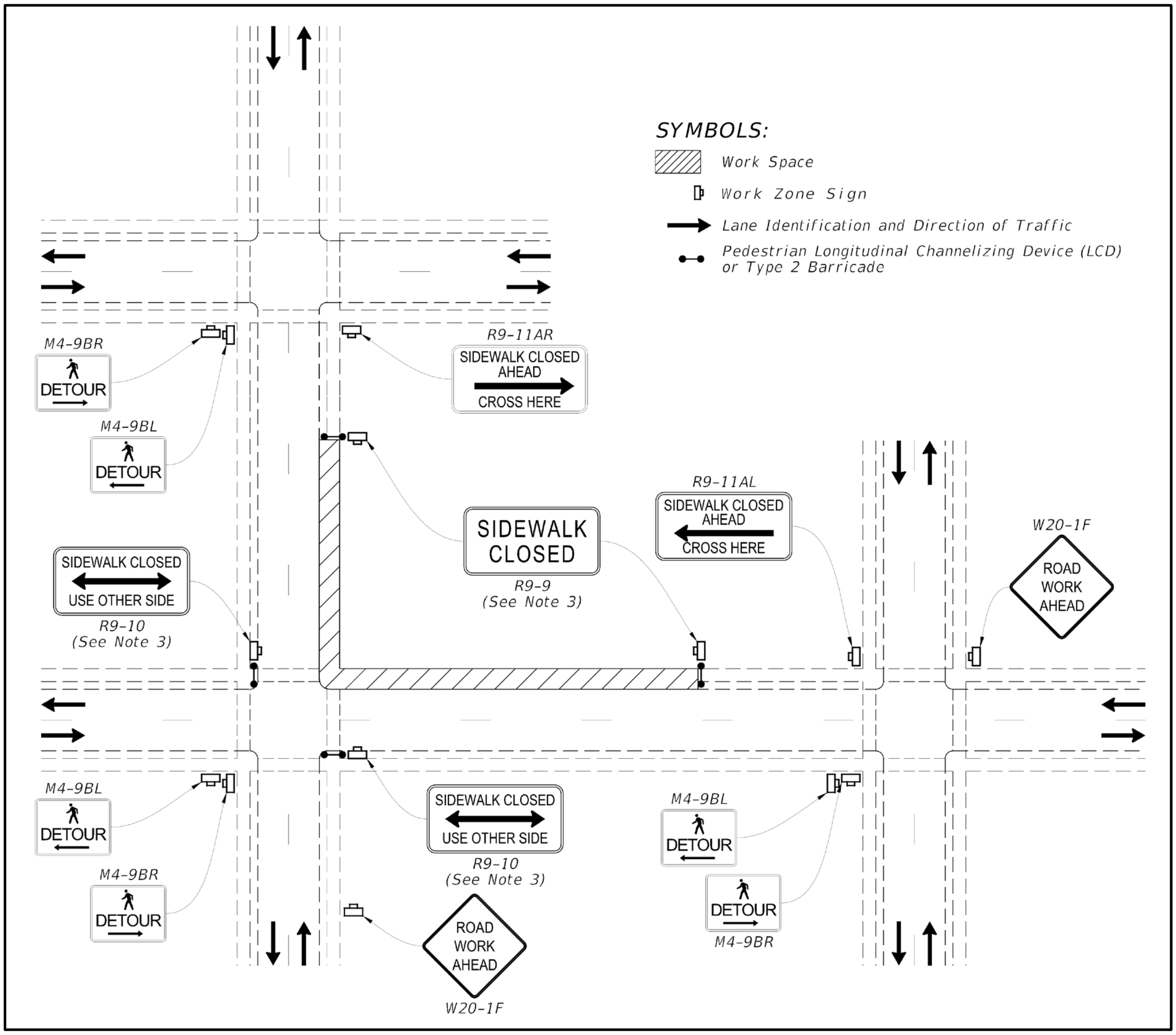
Figure 11 – 4 Sidewalk/Shared Use Path Diversion (Temporary Sidewalk/Shared Use Path)



Notes: See ~~following~~ next page.

1. X = Work Zone Sign Spacing, L = Taper Length, U = Buffer Length, see Tables 11 – 1, 11 – 2, and 11 – 3 of this chapter and the MUTCD.
2. See Table 11 – 4 for the required spacing of channelizing devices.
3. Temporary sidewalks and shared use paths ~~shall~~ must have a maximum cross-slope of 0.02. Provide curb ramps or blended transitions with detectable warnings.
4. If temporary rumble strips are used, include “Rumble Strips Ahead” signs and associated sign spacing distance.
5. “Speeding Fines Doubled When Workers Present” signs ~~may~~ can be used.
6. “End Road Work” signs ~~may~~ can be included when the work zone is in place for more ~~greater~~ than 24 hours.
7. Temporary p~~P~~avement m~~M~~arkings are required for work zones more~~greater~~ than 24 hours in duration.
8. For general sign codes refer to FHWA Standards for Highway Signs and Markings. For special signs beginning with MOT-xx, FDOT~~'s~~ Special Sign Details in the ***Standard Plans*** provide additional information.

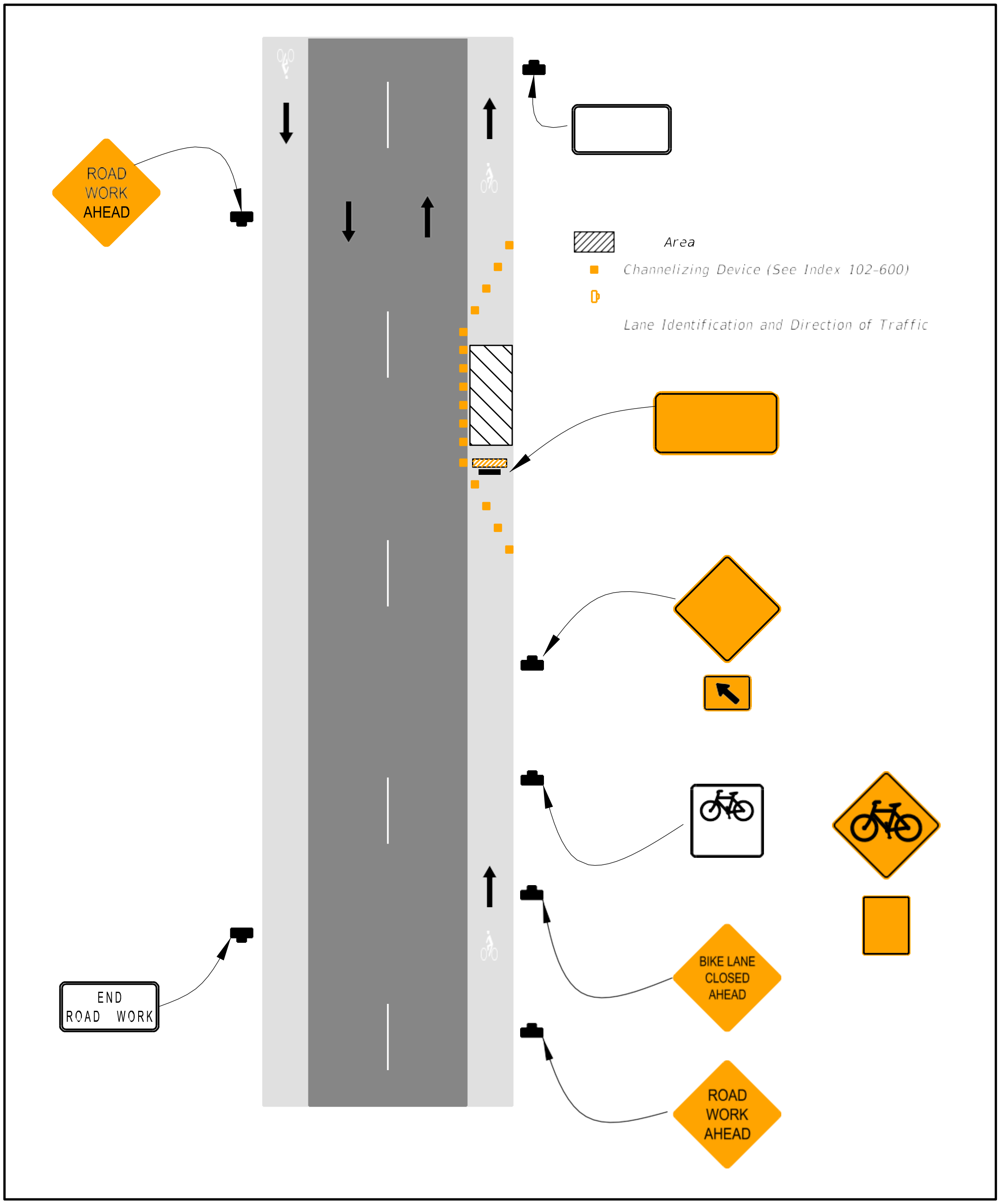
Figure 11 – 5 Sidewalk/Shared Use Path Detour (Closure with Reroute)



Notes:

1. Cover or deactivate pedestrian traffic signal display(s) for ~~controlling~~ closed crosswalks.
2. Place pedestrian longitudinal channelizing devices (LCD) across the full width of the closed crosswalk.
3. "Sidewalk Closed" signs (R9-xx) ~~may~~ can be mounted on pedestrian LCDs ~~in accordance with~~per the manufacturer's instructions.

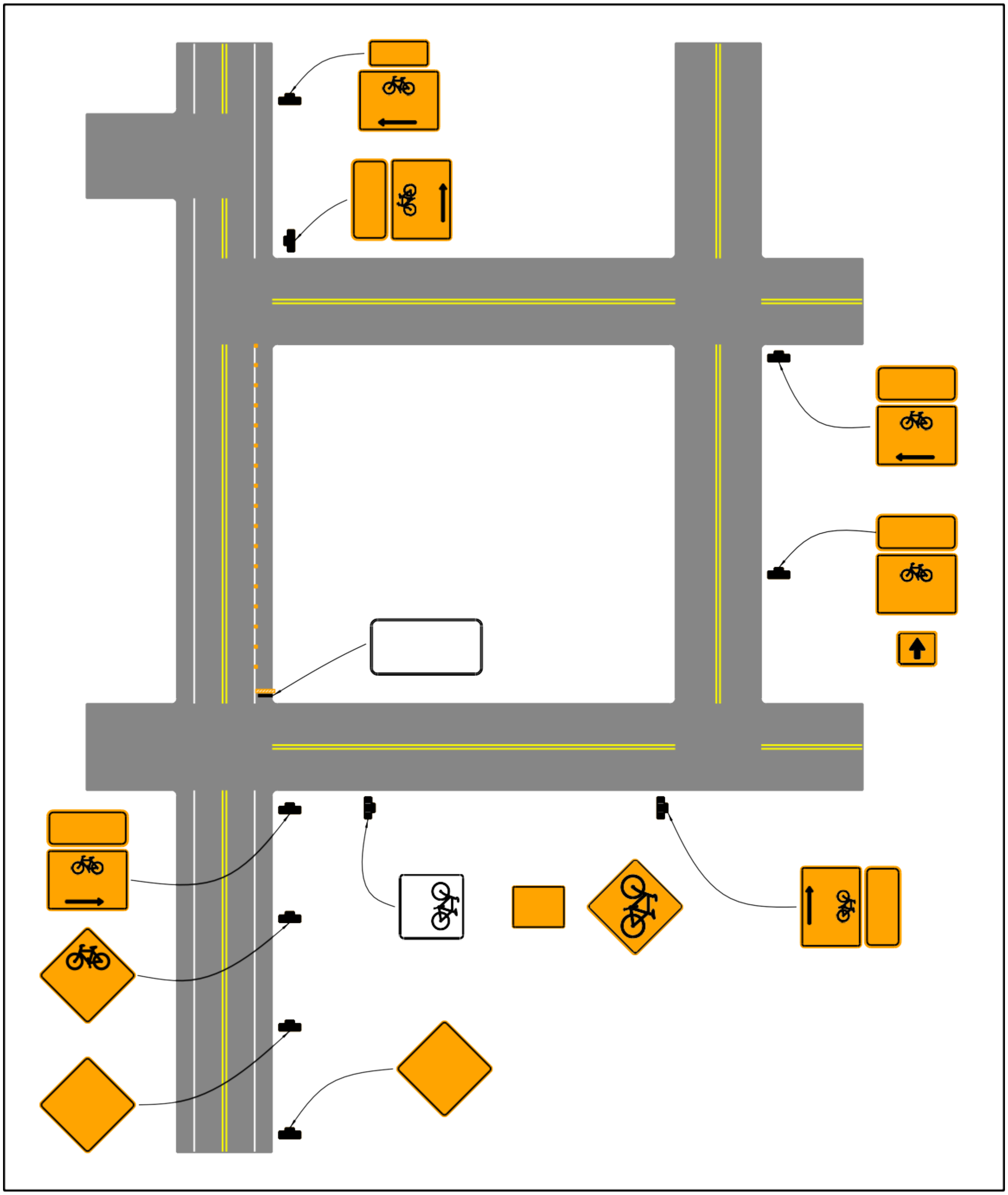
Figure 11 – 6 Bicycle Lane Closure Without Detour



Notes: See ~~following~~next page.

1. See Table 6H-3 ~~Meaning of Letter Codes~~ of the MUTCD for the distances A, B and C between signs.
2. See Table 6-H-4 ~~Formulas~~ of the MUTCD for d~~D~~etermining t~~T~~aper l~~L~~ength for the distance L. Speeds shall be posted speeds.
3. See Table 11 – 4 for the required spacing of channelizing devices.
4. If the posted speed limit is ≤ 35 mph, and the outside through travel lane is < 14 feet wide, ~~then~~ Bicycles ~~May~~ MayUse Full Lane (R4-11) signs should be used.
5. If the posted speed limit is ≤ 35 mph, and the outside through travel lane is ≥ 14 feet wide throughout the work zone, then Bicycle Warning (W11-1) signs in association with SHARE THE ROAD (W16-1) plaques should be used.

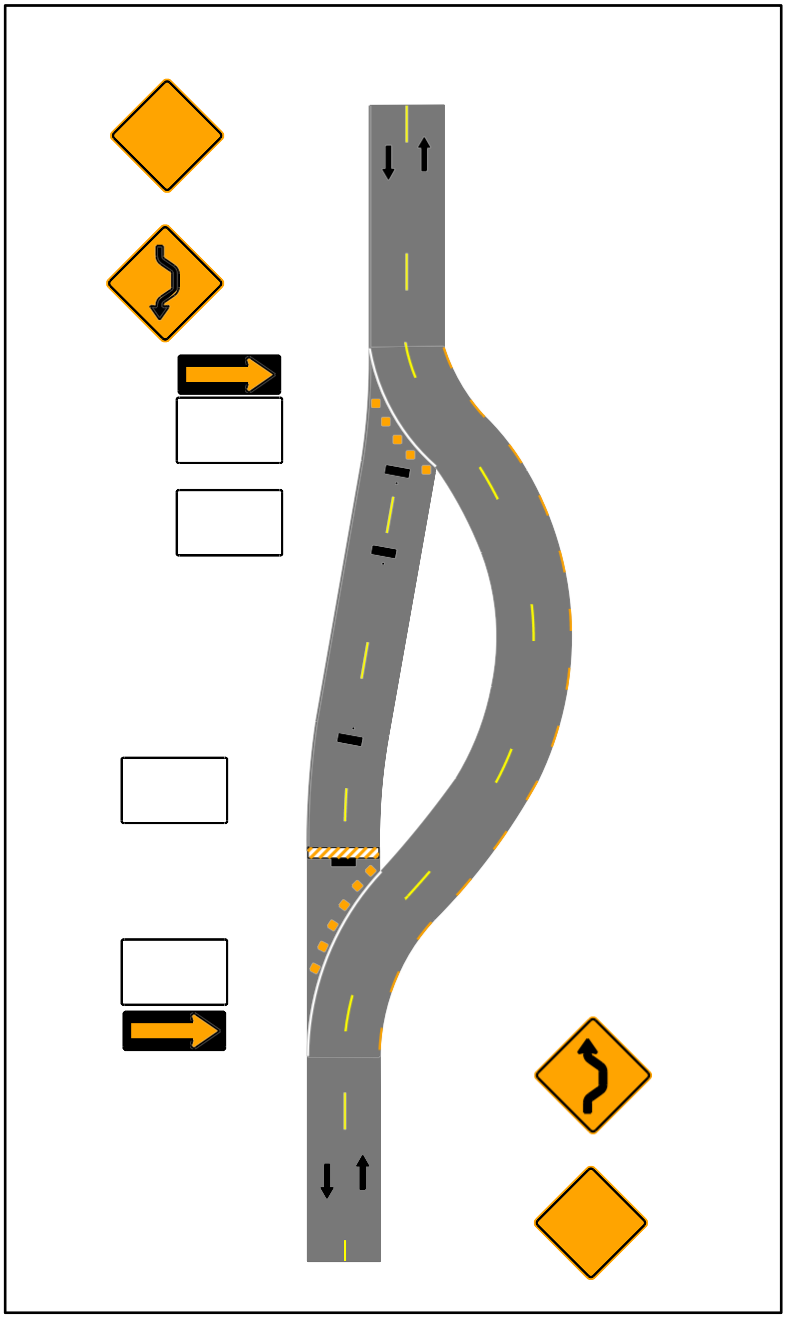
Figure 11 – 7 Bicycle Lane Closure with On-Road Detour



Notes: See ~~following~~ next page.

1. See Table 6H-3 ~~Meaning of Letter Codes~~ of the MUTCD for the distances A, B and C between signs.
2. If the posted speed limit is ≤ 40 mph, and the outside through travel lane is < 14 feet wide, then Bicycles ~~May~~ MayUse Full Lane (R4-11) signs should be used.
3. See Table 11 – 4 for the required spacing of channelizing devices.
4. If the posted speed limit is ≤ 40 mph, and the outside through travel lane is ≥ 14 feet wide throughout the work zone, then Bicycle Warning (W11-1) signs in association with SHARE THE ROAD (W16-1) plaques should be used.
5. A Street Name sign or Bike Route Name sign should be mounted with the Bike Detour sign. Where used, the Street Name sign or Bike Route Name sign ~~shall~~ must be placed above the Bike Detour sign. The Street Name sign or Bike Route Name sign ~~may~~ can be either white on green or black on orange.

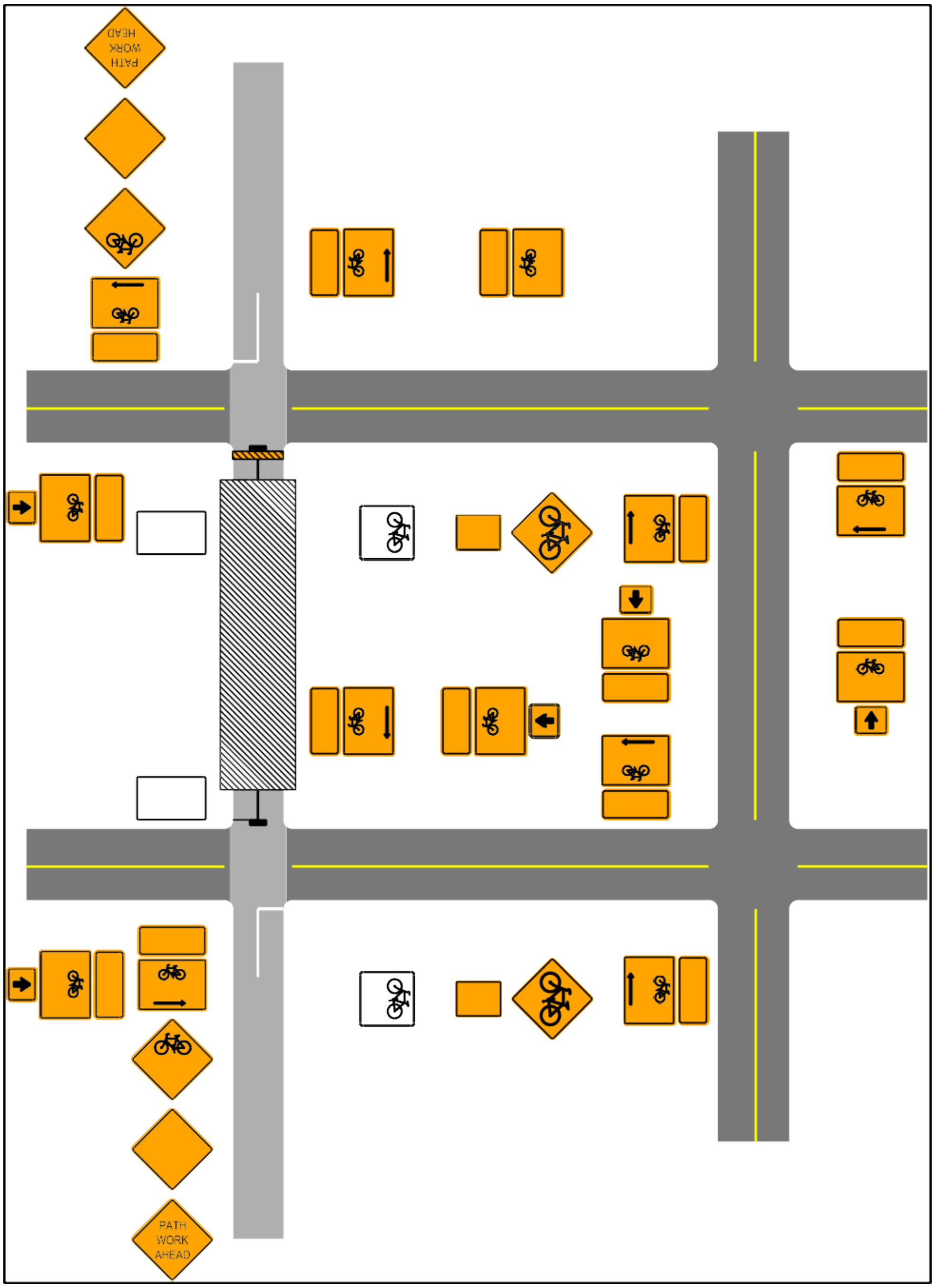
Figure 11 – 8 Shared Use Path Closure with a Diversion



Notes:

1. See MUTCD Table 6H-2 Meaning of Symbols foron tTypical aApplication dDiagrams.
2. See Table 11 – 4 for the required spacing of channelizing devices.

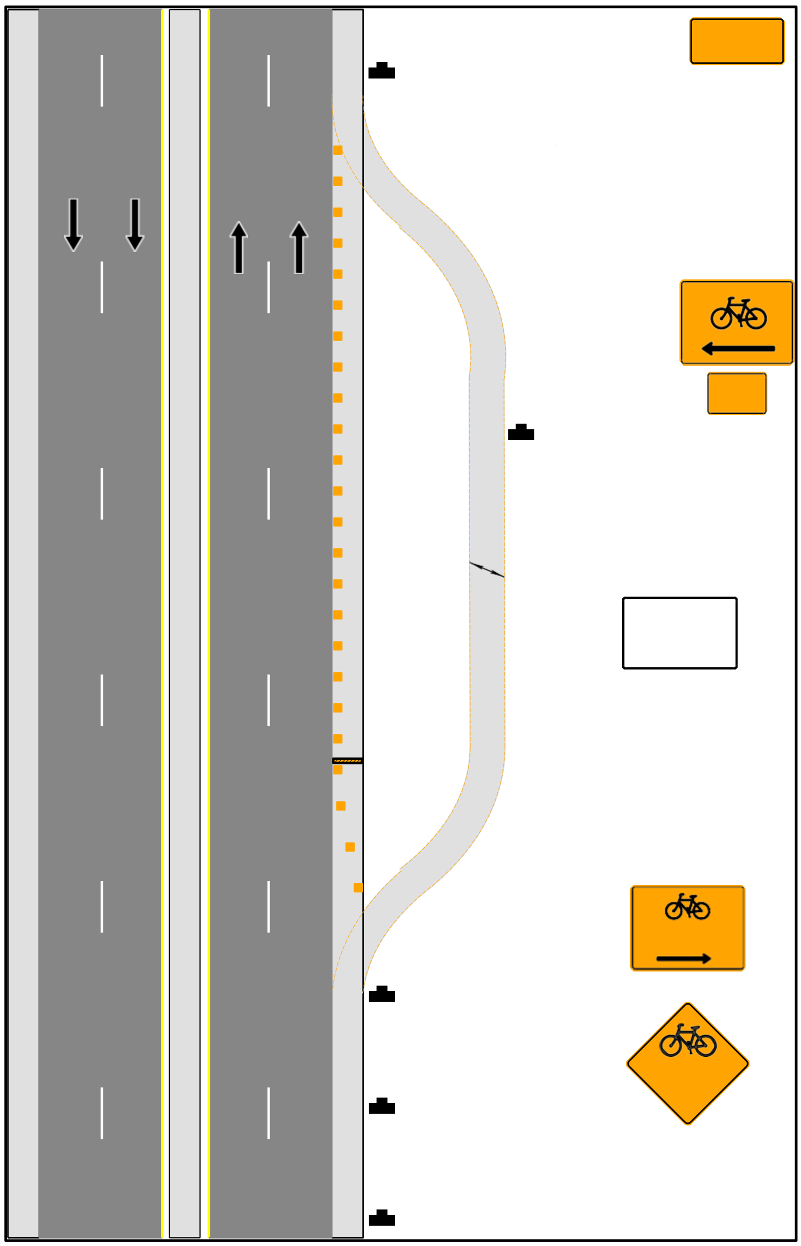
Figure 11 – 9 On-Road Detour for Shared Use Path



Notes:

1. See MUTCD Tables 6H-2 and 6H-3 for the meaning of the symbols and letter codes used.

Figure 11 – 10 Paved Shoulder Closure with Bicycle Diversion onto Temporary Path



Notes:

1. See Table 6H-3 ~~Meaning of Letter Codes~~ of the MUTCD for the distances A, B and C between signs.
2. See Table 6-H-4 ~~Formulas~~ of the MUTCD for d~~D~~etermining t~~T~~aper l~~L~~ength for the distance L. ~~Speeds shall be~~ Use posted speeds.
3. See Table 11 – 4 for the required spacing of channelizing devices.

E TRANSPORTATION OPERATIONS PLAN

The Transportation Operations Plan (TOP) addresses operations and management of the transportation system in the work zone impact area. Manage~~ment of~~ construction, maintenance, and emergency response operations ~~shall~~ to support the TTCP.

E.1 Contracts and Permits

Include details in the plans for the: ~~The~~

- G~~g~~eneral work zone layout,~~;~~
- P~~p~~lanned detours,
- T~~t~~raffic control and protection procedures,~~;~~
- O~~o~~ccupational safety and health requirements,~~;~~ and
- S~~s~~pecific traffic control devices ~~required should be incorporated in the contract plans and specifications~~.

E.1.a Utilities

Obtain a permit from the agency with jurisdiction for all n~~N~~ew utility installations in public R/W ~~rights of way are prohibited unless a permit by the appropriate agency with jurisdiction over the facility is issued~~. The agency with jurisdiction determines the requirements for p~~P~~ermits for:

- R~~r~~outine maintenance (e.g., deteriorated pole/equipment replacement),
- M~~m~~inor alterations (e.g., changes in cable, wire, or transformer size),
- S~~s~~ervice drops, and ~~or~~
- E~~e~~mergency work ~~will be determined by the agency with jurisdiction over the facility~~.

Consider ***Occupational Safety and Health Administration (OSHA)*** regulations for work zone safety ~~should be reviewed prior to~~ before any utility construction ~~by utility companies involving~~ which encroaches ~~ment~~ into ~~the~~ a transportation ~~facility~~ R/W ~~right of way by~~ (workers, equipment, or materials).

E.1.b Wildlife Sensitive Lighting

See ***Section J* of *Chapter 6*** for requirements ~~If~~ where lighting is provided in a work zone along coastal roadways where sea turtles ~~may~~ may be affected~~, see **Section J** of **Chapter 6 – Lighting** for requirements and further information~~. ~~In addition to the resources in **Chapter 6**,~~ ~~c~~Coordinate with the local agencies for additional guidance ~~with~~for providing lighting in work zones.

E.2 Inspection and Supervision

Establish and conduct a~~A~~ regular program of inspection and supervision of all construction and maintenance projects~~ shall be established and executed~~.

F PUBLIC INFORMATION PLAN

~~During construction, t~~The Public Involvement Plan (PIP) ~~serves a public information role,~~ informs ~~ing~~ people before and during construction about:

- W~~w~~ork zone limits,
- S~~s~~idewalk, shared use path ~~or~~ and travel lane closures,
- M~~m~~edian changes,
- D~~d~~etours,
- B~~b~~usiness access impacts,
- W~~w~~ork hours, and
- G~~g~~rand openings.

~~A major function is to~~ The PIP must provide up-to-date information ~~and solicit concerns~~ to minimize ~~the~~ project disruptions to residents, businesses, and the traveling public~~ during the construction phase~~.

~~Some agencies may hold~~ Consider conducting pre-construction open houses~~, which can either be~~ as formal meetings ~~held in enclosed spaces~~ and/or as ~~or~~ informal meetings near the project site ~~activities conducted within the project corridor~~.

Consider including these strategies ~~Below is a summary of activities which could be included~~ in the~~a~~ PIP:

- Determine the need for a project-~~-~~specific public information officer (~~prior to~~before the scope for construction engineering and inspection)
- Handoff meeting from design to construction (after L~~l~~etting)
- Mass-~~-~~mailing of project information flyer/brochure (2~~two~~ to 4~~four~~ weeks ~~prior to~~before construction)
- Project information meeting/open house (2~~two~~ to 4 ~~four~~ weeks ~~prior to~~before construction)
- Presentations to ~~other~~ local governments, community groups, and the ~~or~~ general public (as needed)
- Construction notices included in weekly traffic report (~~one~~ 1 week ~~prior~~ before and throughout construction)

~~In addition to traditional public information meetings, s~~Some projects ~~may~~ may also benefit from ~~other methods such as~~ one-on-one meetings, an up-to-date project website, and social media. Consider using v~~V~~ariable message signs (VMS) ~~are routinely used~~ to communicate lane closures and changes in access.

~~All reasonable effort should be made to i~~Inform the public of the location, duration, and nature of ~~impending~~ all upcoming work. Provide t~~T~~ransit agencies ~~should be given~~ with advance notice of planned operations so they can ~~make~~ adjust ~~ments in service or~~ routes ~~if needed,~~ and coordinate with passengers (if necessary).

G EVALUATION OF PROGRAM

Evaluate and revise tThe entire work zone safety program for work zone safety should be periodically evaluated and revised to provide the safest practicable environment for workers, pedestrians, bicyclists, and motorists drivers during operations.

CHAPTER 12

CONSTRUCTION

A INTRODUCTION

~~The purpose of t~~This chapter ~~is to~~ establishes guidelines for field procedures ~~, as they pertain to control of~~ for managing construction projects, supervision, and contract administration. All construction projects require an inspection program ~~cess~~ to ~~administer the contract, to~~ certify the project has been constructed within reasonable conformance with the plans/specifications~~,~~ and ~~the~~ that all materials ~~which were incorporated into the project~~ were properly tested/certified.

All construction projects require:

- An inspection procedure to administer the contract
- Certification

The Engineer of Record (EOR) is the~~a~~ Professional Engineer registered in the State of Florida ~~that~~ who develops the criteria and concept for the project, performs the analysis, and is responsible for the preparation of the p~~P~~lans and s~~S~~pecifications. The Maintaining Authority's EOR~~ngineer of Record~~ ~~may~~ can be in-house staff or a consultant.

The Construction Engineer (CE) is the~~a~~ Professional Engineer registered in the State of Florida ~~that~~ who supervises the construction of the project. The Maintaining Authority's CE~~onstruction Engineer~~ (or their d~~D~~esignee) ~~may~~ can assign in-house staff or a consultant to act on their behalf.

B OBJECTIVES

The design and c~~C~~onstruction of street and highway facilities are~~is~~ accomplished by ~~the result of the effort of the~~ an engineer, ~~the~~ a contractor, and an~~the~~ owner. Comply with m~~M~~inimum construction standards ~~shall be followed~~ to ~~provide for~~ ensure proper implementation of the design. ~~The following~~ Incorporate these general objectives ~~for roadway construction should be followed to ensure proper construction~~:

- All construction performed and ~~all~~ materials used ~~tilized shall~~ must be in reasonably close conformance ~~ity~~ with the ~~construction~~ plans and contract documents.

- Clearly identify tt~~T~~he responsibilities and obligations of the owner, engineer, and contractor~~ should be clearly defined~~.
- Provide a~~A~~ safe working environment ~~shall be provided in accordance with~~ in accordance with~~ -~~ ***Chapter* 11** of this manual.~~ – Work Zone **_Safety and Mobility_**~~.
- Implement a~~A~~dequate sampling and testing procedures (through established methods) ~~of sampling and testing shall be implemented to provide~~ for the control and placement of materials.

C CONTROL OF THE WORK

C.1 Plans and Contract Documents

Provide t~~T~~he c~~C~~ontractor ~~will be furnished~~ with an appropriate number of copies of the plans and contract documents ~~special provisions as required for the particular project~~. T~~T~~he c~~C~~ontractor ~~shall~~ must have one copy of all plans, design standards, specifications and special provisions available at the work site at all times ~~, at all times, one copy each of the plans (including relevant Design Standards), Specifications, and Special Provisions~~.

C.1.a Plans

~~The plans furnished consist of general drawings showing such details which are necessary to give a comprehensive idea of the construction contemplated.~~ Roadway plans ~~will~~ generally include details and dimensions of the roadway work contemplated, including: ~~show, in general,~~

- A~~a~~lignment,
- P~~p~~rofile grades,
- T~~t~~ypical cross sections, and
- G~~g~~eneral cross sections~~ as necessary~~.

Structure plans ~~, in general, will show in detail~~ generally include ~~all~~ details and dimensions of the structure work contemplated.

C.1.b Alterations in Plans

~~No changes shall be made on~~ Do not change any plan or drawing after it is approved by the EOR, except as authorized in writing by the EOR. The CE can approve m~~M~~inor changes ~~may be approved by the~~

Construction Engineer in consultation with the EOR.

All authorized alterations affecting the requirements and information given on changes to the approved plans shall must be in writing.

C.1.c Working Drawings (for Structures)

C.1.c.1 General

The cContractor shall must prepare and provide furnish such working, shop, and erection drawings~~,~~ (as ~~may be~~ required)~~,~~ to construct ~~mplete~~ the structure in compliance with the plans and contract documents ~~design shown on the plans~~.

C.1.c.2 Submission of Working, Shop, and Erection Drawings

The contractor must review, approve and sign a~~A~~ll of their working, shop, and erection drawings ~~prepared by the Contractor or his agents (subcontractor, fabricator, supplier, etc.) shall be reviewed, dated, stamped, approved, and signed by the Contractor prior to~~ before submitting ~~ssion~~ them to the EOR for review. The c~~C~~ontractor's signed approval ~~of drawings submitted shall~~ must confirm ~~he/she~~that they ~~-~~haves verified the:

- W~~w~~ork requirements,
- F~~f~~ield measurements,
- C~~c~~onstruction criteria,
- S~~s~~equence of assembly and erection,
- A~~a~~ccess and clearances,
- C~~c~~atalog numbers, and
- O~~o~~ther similar data.

Each series of drawings ~~shall~~ must indicate the specification section(s) and ~~page or drawing~~ the plan sheet number(s) ~~of the contract plans~~ to which the submission applies. The c~~C~~ontractor ~~shall~~ must indicate any ~~on the working, shop, and erections drawings all~~ deviations from the contract drawings on their drawings, and ~~shall~~ must itemize ~~all~~ any such deviations in their ~~his~~ transmittal letter ~~of transmittal~~.

C.1.c.3 Responsibility for Accuracy of Working Drawings

~~It is understood that a~~EOR approval of the contractor's drawings ~~by the EOR of the Contractor's working drawings~~ does not relieve the c~~C~~ontractor ~~of~~ from any contractor responsibility for accuracy ~~of~~ or conformance with dimensions and details ~~, or for conformity of dimensions and details~~. The c~~C~~ontractor ~~shall be~~ is solely responsible for ~~agreement and conformity of his~~ their working drawings conforming with the approved plans and specifications.

C.2 Coordination of Plans, Specifications, and Special Provisions

The plans, specifications, plans, and special provisions, (and all other supplemental documents) are integral parts of the contract. , and a A requirement occurring in one is as binding as though occurring in all. They are to be complementary towards the completed project and to describe and provide for a complete work.

In cases of discrepancy, the governing order of the documents shall be as follows is:

- Special Provisions
- Plans
- Standard Drawings
- Specifications

C.3 Conformity of Work with Plans

All work performed and all materials furnished shall must be in reasonably close conformity with the plans and specifications, including:

- Llines,
- Ggrades,
- Ccross sections,
- Ddimensions, and
- Mmaterial requirements, (including tolerances), shown on the plans or indicated in the specifications.

The CE must determine (using engineering judgement) whether any materials or finished products are not in reasonably close conformance with the plans or specifications (but are reasonably close) can be accepted and remain in place. In the event the CE finds the materials or the finished product in which the materials are used not within reasonably close conformity with the plans and specifications, but reasonably acceptable work has been produced, he/she shall then make a determination if the work shall be accepted and remain in place. In this event, tThe CE will must document the basis of such an acceptance by contract modification which will provide for and must process an appropriate adjustment in the contract price for such work or materials~~ as he deems necessary to conform to his determination based on engineering judgment~~.

~~In the event the CE finds the materials, or the finished product in which the materials are used, or the work performed, are~~ The contractor must remove and replace (or otherwise correct) any materials or finished products determined by the CE to not be in reasonably close conformity with the plans and specifications ~~and have~~ ~~resulted~~ resulting in an inferior or unsatisfactory product (at their own expense) ~~, the work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor~~.

C.4 Conformity of Work Shown in Regulatory Permits

All work ~~shall~~ must ~~be accomplished in accordance with~~ comply with the special conditions of the regulatory permits.

C.5 Authority of the Construction Engineer (CE)

All work ~~shall~~ must be performed to the satisfaction of the CE.

C.6 Engineering and Layout

C.6.a Control Points Furnished

Provide h~~H~~orizontal and vertical control points ~~are required~~ at appropriate intervals along ~~the line of~~ the project to facilitate ~~the~~ proper layout of the work. The c~~C~~ontractor ~~shall~~ must preserve all control points~~ furnished~~.

C.6.b Layout of Work

~~Utilizing the control points furnished, all~~ The contractor must establish all horizontal and vertical controls needed to construct the entire project (using the control points provided) ~~shall be established as necessary to construct the~~ including: ~~work in conformance with the plans and specifications. The work shall include~~

- P~~p~~erforming all required calculations, ~~required and~~
- S~~s~~etting all stakes~~ needed~~:
  - ~~, such as~~ G~~g~~rade stakes,
  - O~~o~~ffset stakes,
  - R~~r~~eference point stakes,
  - S~~s~~lope stakes, and
  - O~~o~~ther reference marks ~~or~~ and points.

~~necessary to provide lines and grades for construction of all roadway, bridge, and miscellaneous items.~~

C.6.c Personnel, Equipment, and Record Requirements

The c~~C~~ontractor ~~shall~~ must employ only competent personnel and use ~~tilize~~ only suitable equipment in performing that layout work.

Keep a~~A~~dequate field notes and records ~~shall be kept as~~ in performing the layout work ~~is accomplished~~. Make t~~T~~hese field notes and records ~~shall be~~ available for review by the CE as the work progresses. ~~and~~ Provide copies ~~shall be furnished~~ to the CE when the project is completed ~~at the time of completion of the project~~. Any inspection or checking or acceptance of the c~~C~~ontractor's field notes or layout work by the CE, ~~and the acceptance of all or any part thereof, shall~~ does not relieve the c~~C~~ontractor of ~~his~~ full responsibility to achieve the lines, grades, and dimensions provided~~shown~~ in the plans and specifications.

C.7 Contractor's Supervision

C.7.a Prosecution of Work

The c~~C~~ontractor ~~shall~~ must give the work the constant attention necessary to assure the scheduled progress and ~~shall~~ must cooperate fully with the CE and with other contractors ~~at~~ working in the vicinity.

C.7.b Contractor's Superintendent

The c~~C~~ontractor ~~shall~~ must have a competent superintendent on the worksite at all times ~~have on the work site,~~ (as ~~his/her~~their agent). ~~, a competent superintendent~~ The superintendent must be capable of thoroughly interpreting the plans and specifications and thoroughly experienced in the type of work being performed. ~~, and who~~ This superintendent ~~shall~~ must receive the instructions from the CE or ~~his/her~~ their authorized representative(s). This ~~e~~ superintendent ~~shall~~ must have full authority to execute the ~~orders or~~ directions of the CE and to promptly supply ~~promptly~~ any materials, tools, equipment, labor, and incidentals ~~which may be~~ required. Furnish this ~~Such~~ superintendence ~~shall be furnished~~ regardless of the amount of work sublet.

C.7.c Supervision for Emergencies

The c~~C~~ontractor ~~shall~~ must have a responsible person available at or reasonably near the work~~-~~site (24 hours – 7 days) ~~on a twenty-four hour basis, seven days a week, in order that he/she may~~ who can be contacted in emergencies and ~~in cases~~ where immediate action is required ~~must be taken~~ to maintain traffic or ~~to~~ handle any other problems ~~that might arise~~. The c~~C~~ontractor ~~shall be~~ is responsible for initiating, installing, and maintaining all traffic control devices ~~as~~ described in ***Chapter 11*** ~~***– Work Zone Safety and Mobility***~~ and in the plans.

C.8 General Inspection Requirements

C.8.a Cooperation by Contractor

Do not perform any work or use any materials ~~No work shall be done nor materials used~~ without suitable supervision or inspection by the CE. The c~~C~~ontractor ~~shall~~ must furnish the CE with ~~every~~ reasonable facility for ascertaining whether the work performed and materials used ~~are in accordance with~~ comply with the requirements ~~and intent~~ of the plans and specifications.

C.8.b Failure of Construction Engineer to Reject Work During Construction

If~~, during or prior to construction operations,~~ the CE ~~should~~ fails to reject defective work or materials before or during construction~~,~~ (whether from lack of discovery ~~of such defect~~ or for any reason), such initial failure to reject ~~shall~~ in no way prevents their ~~his/her~~ later rejection, ~~-~~when such defect is discovered.

C.8.c Qualifications for Services for FDOT Administered Projects

~~For projects administered by a local government that are wholly or partially funded by the FDOT, t~~There are limitations on ~~who may~~ which companies can perform design~~,~~ and Construction Engineering and Inspection services (CEI) for projects using FDOT funds. See ***F.S. 337.14 (7) Application for qualification; certificate of qualification; restrictions, request for hearing*** for more information.

C.9 Final Construction Inspection Maintenance until Final Acceptance

The c~~C~~ontractor ~~shall~~ must maintain all work in first-class condition until it has been completed as a whole and ~~has been~~ accepted by the CE. ~~When all materials have been furnished, all work has been performed, and the construction contemplated by the contract has been satisfactorily completed, t~~ The CE ~~will~~ will ~~make~~ conduct the final inspection after:

- All materials have been furnished,
- All work has been performed, and
- All work required by the contract has been satisfactorily completed.

D CONTROL OF MATERIALS

D.1 Source of Supply and Quality Requirements

D.1.a Only Approved Materials to be Used

Use o~~O~~nly materials conforming to the requirements of the plans and specifications and approved by the CE ~~Engineer shall be used in the work~~.

The CE can inspect or test aAny project materials proposed for use may be inspected or tested at any time during their preparation and use. The contractor cannot use anyNo materials which, (after approval), have s in any way become unfit for use in any way , shall be used in the work.

D.2 Inspection and Tests at Source of Supply

D.2.a General

The CE ~~may undertake the inspection of~~ can inspect materials at the source of supply.

D.2.b Cooperation by Contractor

The c~~C~~ontractor ~~shall assure~~ must provide the CE ~~has~~ with free access ~~entry~~ at all times to facilities ~~such parts of the plant as concern the~~ which manufacture or produce~~tion of the~~ project materials. ~~ordered, and shall~~ The contractor must also bear all costs incurred in providing ~~all~~ reasonable access to all facilities ~~to assist in~~ for determining whether ~~the~~ the materials proposed ~~furnished~~ comply~~ies with the~~ with the project requirements ~~of the specifications~~.

D.3 Control by Samples and Tests

D.3.a Materials to be Tested, Samples

The CE ~~may~~ can require any or all materials to be ~~subjected to~~ tested~~s~~ by ~~means of~~ samples or otherwise, at production points, or after delivery, or both~~,~~ (as ~~he/she~~ the CE ~~may~~ determines).

D.3.b Applicable Standards

Sampling and testing m~~M~~ethods ~~of sampling and testing materials shall~~ must ~~conform to~~ meet the CE's requirements and ~~should~~ should comply with ~~be in accordance with~~ ***Florida Sampling and Testing Methods (FSTM)*** (where applicable) ~~so far as covered therein~~. ~~Otherwise, t~~They should otherwise comply ~~be in accordance with~~ the s~~S~~tandards of AASHTO, ASTM, or other criteria (as ~~specifically~~ designated by the CE). Where an AASHTO, ASTM, or other non-Florida Method is designated, but a similar Florida Method ~~which is similar~~ exists, conduct the sampling and testing ~~should be in accordance with~~ using the Florida Method.

~~Whenever in these Specifications,~~ Use the most current version at the time of construction advertisement (including interims and addendums) of FSTM, AASHTO, ASTM, ~~or~~ and other standards. ~~are referenced without identification of the specific time of issuance, the reference should be construed to mean the most current issuance, including interims or~~

~~addendums thereto, at the time of advertisement for bids for a project.~~

D.4 Quality Control System

D.4.a General Requirements

The c~~C~~ontractor ~~shall~~ must furnish and maintain a quality control system that ~~will~~ provides reasonable assurance that all materials and products submitted for acceptance conform to the contract requirements~~,~~ (whether ~~manufactured or processed~~ provided by the c~~C~~ontractor or procured from suppliers or subcontractors). The c~~C~~ontractor ~~shall~~ must perform (or have performed) the inspection and tests required to substantiate product ~~conformance to~~ compliance with contract requirements. ~~and shall~~ The contractor must also perform (or have performed) all inspections and tests ~~otherwise~~ required by the contract.

D.4.b Documentation

The c~~C~~ontractor ~~shall~~ must maintain adequate records of all inspections and tests. The records ~~shall~~ must indicate ~~the~~:

- The nature and number of tests, ~~made, the~~
- The number and type of deficiencies, ~~found, the~~
- The quantities approved and rejected, and
- T~~t~~he ~~nature of~~ corrective actions taken~~, as~~ (where applicable) ~~appropriate~~.

D.4.c Corrective Actions

The c~~C~~ontractor ~~shall~~ must take prompt action to correct any errors, equipment malfunctions, process changes, or other assignable causes which have resulted or could result in the submission of materials, products, and completed construction ~~which do~~ not in compliance with ~~conform to the requirements of~~ the plans and specifications.

CHAPTER 13

PUBLIC TRANSIT

A INTRODUCTION

Consider a~~A~~ll modes of transportation (autos, trucks, transit vehicles, rails, aircraft, water craft, bicycles ~~ists~~, and pedestrians) ~~shall be considered when~~ in planning, designing, and constructing the surface transportation system. Where there is a demand for highways ~~to serve~~ for motor vehicles, there can~~ould~~ also be a demand for public transit ~~or~~ and public transportation. Consider p~~P~~ublic transit ~~should be considered~~ in all phases of a project, including planning, preliminary design and engineering, design, construction, and maintenance. Coordinate~~ion~~ with the appropriate public transit provider(s) on a project-by-project basis ~~will help~~ to decide on ~~termine~~ the need for transit~~-~~related infrastructure ~~on a project-by-project basis~~. ~~The integration of~~ Integrate public transit ~~street side~~ facilities ~~along~~ with pedestrian and bicycle facilities~~ furthers the implementation of this goal~~.

~~Planning and designing for p~~Public transit ~~is important because it~~ is an integral part of the overall surface transportation system. Public transit is defined as passenger transportation service, local or regional in nature, which is available to any person. It operates on established schedules along designated routes ~~or lines~~ with specific stops and is designed to move relatively large numbers of people at one time. Public transit can include~~s~~:

- Bus,
- Li~~li~~ght rail,
- S~~s~~treet cars,
- B~~b~~us rapid transit, and
- P~~p~~aratransit.

With rising levels of congestion ~~resulting in the use of~~ leading to new strategies to ~~effectively and efficiently~~ manage mobility effectively, there is an increased demand for accessible, ~~and~~ user~~-~~friendly public transit. New strategies include increased emphasis on public transit and new emphasis on Transportation System Management (TSM)~~, as well as~~ and Transportation Demand Management (TDM). TSM ~~is the~~ uses~~ of~~ low~~-~~cost capital improvements to increase ~~the~~ roadway efficiencies ~~y of roadways and transit services~~ such as retiming traffic signals ~~or~~ and predestinating traffic flow. TDM focuses on people reducing their~~ number of~~ personal vehicle trips, especially during peak periods. TDM ~~includes the~~ promotes ~~ion of~~ alternatives to the single occupant vehicle, including:

- P~~p~~ublic transportation,
- C~~c~~arpooling,

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- V~~v~~anpooling,
- B~~b~~icycling,
- W~~w~~alking,~~ and~~
- T~~t~~elecommuting, and
- ~~as well as o~~Other methods for reducing peak hour travel.

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Federal and s~~S~~tate legislation ~~provide the~~ stimulate ~~us for~~ planning, designing, and constructing a fully-~~ ~~integrated transportation system benefiting the traveling public and the environment. Examples of legislation include ***Fixing America's Surface Transportation Act (FAST Act)***, ***Americans with Disabilities Act of 1990 (ADA)***, and ***Clean Air Act Amendment of 1990 (CAAA)***. ~~In response to this legislation, t~~The surface transportation system should ~~provide for~~ accommodate concurrent use by automobiles, public transit and rail, bicycles, and pedestrians.

B OBJECTIVE

There are several methods to efficiently develop a coordinated surface transportation system. Coordinate ~~ion among~~ with the appropriate transit agency(s)~~agencies is necessary~~ during the planning and design stages to~~:~~

~~i~~ncorporate specific transit agency needs and requirements (e.g., shelter installations). ~~and~~ Continue to coordinate with the transit agency(s) during~~ the~~ construction~~ phase~~ for re-routing bus (and complementary pedestrian) movements.~~, and~~

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- ~~for actual transit agency specific requirements (e.g., bus stop sign replacement, shelter installations, etc.).~~

~~For planning purposes,~~ Refer to the state and local Transportation Improvement Program (TIP) for planning purposes. ~~should be referenced~~. ~~Additionally, i~~Individual transit agencies ~~authorities have~~ maintain 10-~~ten~~-year Transit Development Plans (TDPs) ~~that are~~ which they updated~~d~~ annually. Use t~~T~~he TDP~~ can be used~~ as a guide for ~~planned~~ transit needs along existing and new transportation corridors. ~~so~~ Incorporate transit considerations and ~~transit~~ enhancements ~~can be incorporated~~ where appropriate.

C TRANSIT COMPONENTS

C.1 Boarding and Alighting (B&A) Areas

Boarding and Alighting (B&A) areas help to create an accessible bus stop by providing a raised platform that is bus-compatible ~~with a bus~~ and that kneels or extends a ramp. A B&A area has a firm, stable and slip-resistant surface with: ~~a~~

- An 8-foot minimum clear length ~~of 8.0 feet~~ (~~measured~~ perpendicular to the curb or roadway edge), and
- A 5-foot ~~a~~ minimum clear width ~~of 5.0 feet~~ (~~measured~~ parallel to the roadway).

Provide f~~F~~irm, stable, and slip resistant B&A areas ~~are required~~ if amenities such as benches or shelters are added to a bus stop. Coordinate with the appropriate public transit provider(s) to ensure compatibility with their equipment and transit vehicles. B&A areas are not required at bus stops along flush shoulder roadways where only a bus stop sign is provided. ~~Coordinate with the appropriate public transit provider(s) to determine compatibility with equipment and transit vehicles.~~

The slope of the B&A area must be the same as the roadway ~~parallel to the roadway shall~~ to the extent practicable~~, be the same as the roadway~~. ~~For water drainage, a~~ A maximum 2% slope ~~of 2% perpendicular to~~ away from the roadway is allowed for drainage. Do not place b~~B~~enches and other site amenities ~~shall not be placed~~ on the B&A area. Locate t~~T~~he B&A area ~~can be located~~ either within or outside the shelter. ~~, and shall be c~~Connect~~ed~~ the B&A area to streets, sidewalks, ~~or~~ and pedestrian circulation paths ~~by~~ with an accessible route.

~~On flush shoulder roadways, a~~ The B&A area may be ~~constructed~~ located at the shoulder point on flush shoulder roadways ~~(~~or the edge of the paved shoulder ~~pavement~~ on roadways with ~~a~~ design speeds of 45 mph and~~or~~ less ~~) as shown in~~ (see Figures 13 – 1 and 13 – 2) ~~Boarding and Alighting Area for Flush Shoulder Roadways~~. Use a~~A~~ Type "E" curb (5" curb height) ~~should be used~~.

~~A s~~Sidewalks and~~/or~~ ramps provided with ~~the~~ B&A areas ~~shall be a minimum of~~ must be at least 5 feet wide. ~~in width, and the r~~Ramp slopes cannot ~~shall not~~ exceed ~~a slope of~~ 1:12. Provide a~~A~~ detectable warning ~~is required~~ where a sidewalk ~~associated with~~ for a B&A area connects to ~~the~~ a roadway at grade. ~~Except for the area adjacent to the 5" curb,~~ Ensure the areas surrounding the B&A area ~~shall be~~ are flush with the adjacent shoulder and side slopes and ~~designed to be~~ traversable by errant vehicles (except adjacent to the 5-inch curb). ~~On the upstream side of the platform, a maximum slope of 1:12~~ The area on the upstream side of the platform ~~should be provided, and~~ may be grass or a hardened surface with a 1:12 maximum slope. The B&A area (and ramp and level landing ~~if needed~~)

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Figure 13 – 1 Boarding and Alighting Area for Flush Shoulder Roadways with Connection to the Roadway

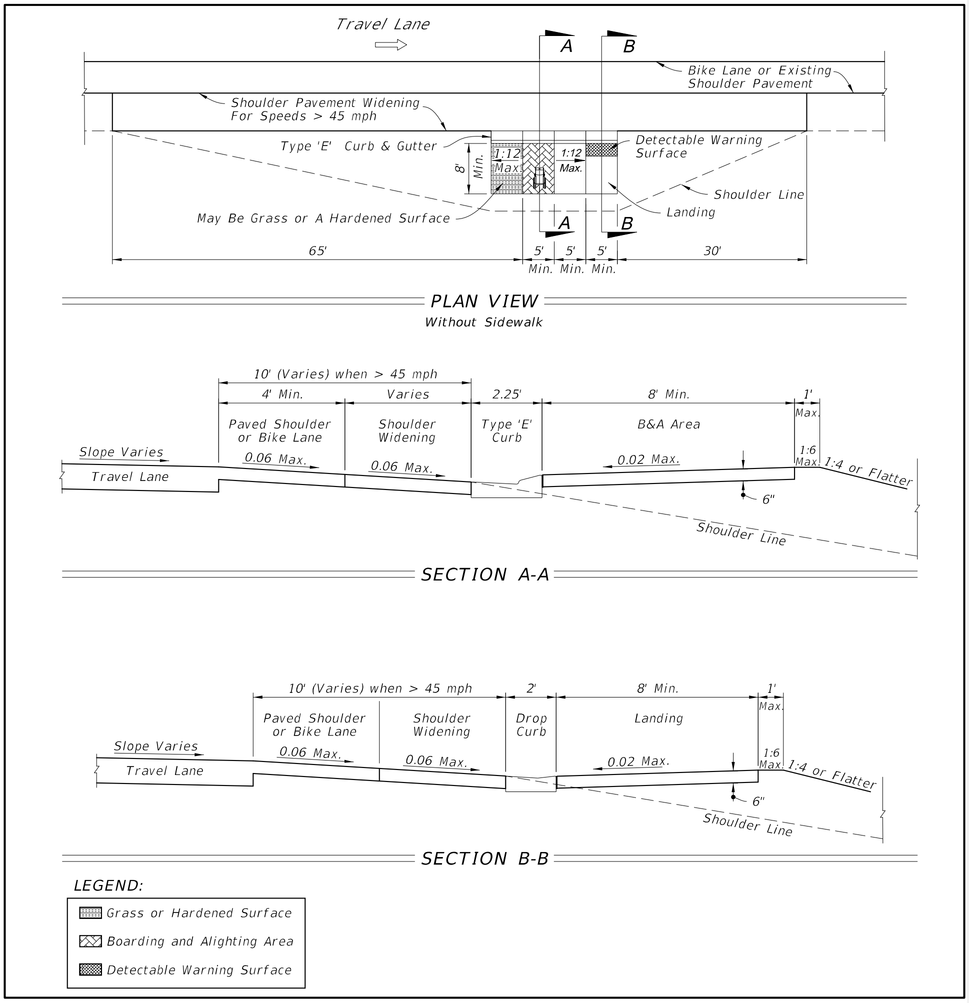
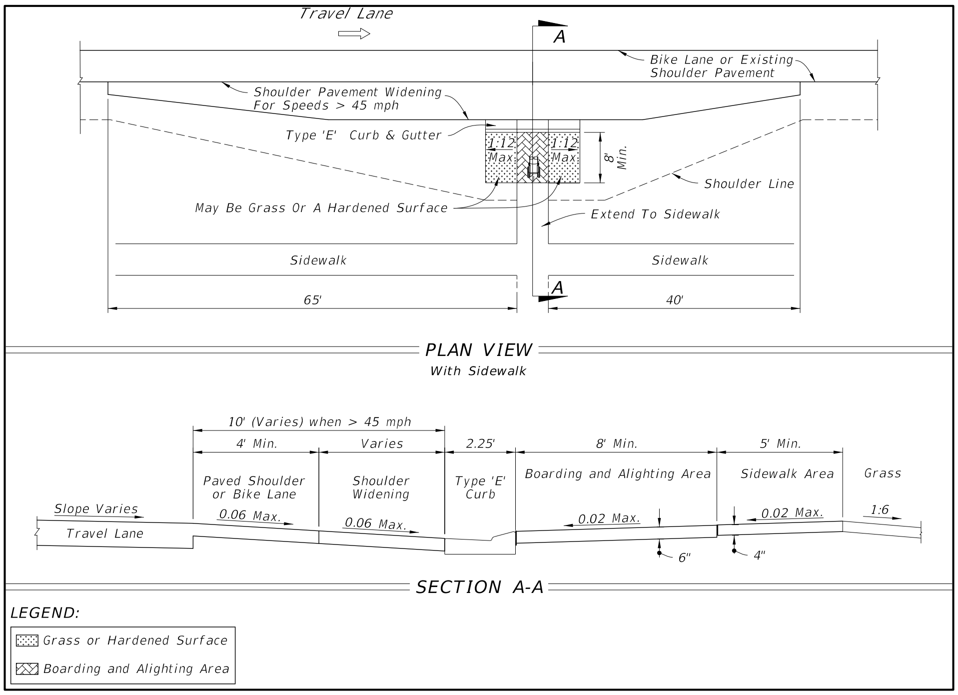


Figure 13 – 2 Boarding and Alighting Area for Flush Shoulder Roadways with Connection to the Sidewalk

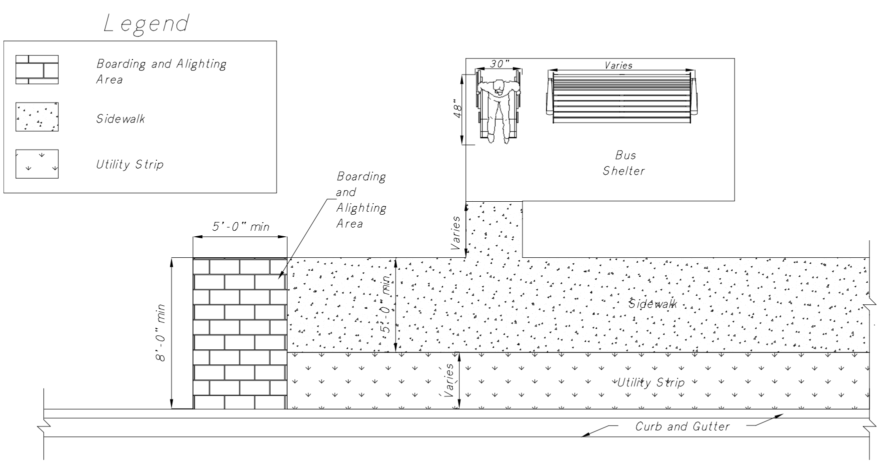


C.2 Shelters

E<u>ach</u> ~~very~~ public transit system has different needs ~~with regards to~~ <u>for</u> shelters and corresponding amenities (e.g., benches, information kiosks, leaning posts, trash receptacles, etc.). <u>The s</u>~~S~~helter foundation and associated pad size vary ~~from stop to stop~~ based on right of way availability, line of sight, and facility usage. <u>Position n</u>~~N~~ew <u>and</u>~~or~~ replaced bus shelters ~~shall be installed or positioned~~ to provide an accessible route from the public way (sidewalk or roadway) to ~~reach~~ a location ~~that has~~ <u>with</u> a minimum clear floor ~~area~~ of 30 inches by 48 inches~~,~~ <u>(</u>entirely within the perimeter of the shelter<u>)</u>.

<u>Connect s</u>~~S~~helters ~~shall be connected by an accessible route~~ to a B&A area <u>with an accessible route</u>. Coordinate with the appropriate public transit provider(s). ~~Where feasible, shelters should p~~<u>P</u>rovide a location for a bicycle rack <u>where feasible</u>. Shelters should be installed at locations <u>Provide shelters</u> where demand warrants installation and in accordance with <u>the</u> clear zone criteria in ***Chapter 3 –*** ~~***Geometric Design,***~~ ***Section C.10.e*** ~~Bus Benches and Transit Shelters~~ and ***Chapter 4 –*** ~~***Roadside Design,***~~ Table 4 – 2 ~~Lateral Offset of this Manual~~.

Figure 13 – 3 Bus Shelter Location



C.3 Benches

If ~~a bench is~~ provided, ~~it~~ benches should be on an accessible route, out of the sidewalk travel path~~ of travel on a sidewalk~~. ~~Benches shall have~~ Provide a~~n~~ ~~adjacent~~ firm, stable and slip-resistant adjacent surface at least 30 inches wide and 48 inches deep to allow a ~~user of a~~ wheelchair ~~to sit~~ next to the bench, ~~permitting~~ allowing the user shoulder-to-shoulder seating with a companion. Provide c~~C~~onnection between the bench, the sidewalk and~~/or bus~~ the B&A area ~~shall be provided~~. Coordinate with the ~~local~~ appropriate public transit provider(s).

C.4 Stops and Station Areas

Locate t~~T~~ransit stops ~~should be located so that~~ where there is a level and stable surface for boarding~~ vehicles~~. Locating transit stops at signalized intersections ~~increases the usability for~~ benefits pedestrians with disabilities.

C.5 Bus Bays (Pullout or Turnout Bays)

Bus bays may be needed due to: ~~for transit vehicles may be necessary (e.g.,~~

- E~~e~~xtended dwell time,
- L~~l~~ayover needs,
- S~~s~~afety reasons,
- H~~h~~igh volumes or
- High s~~s~~peeds~~ of traffic.)~~.

Bus bays can be designed for one or more buses. Coordinate with the ~~local~~ appropriate public transit provider(s) to ~~determine~~ decide on the need for bus bays. ~~When possible, bus bays should be l~~Locate bus bays~~d~~ on the far side of~~ a~~ signalized intersections when possible. The traffic signal ~~will~~ creates ~~the critical~~ gaps~~ needed~~ for bus re-entry into traffic. ~~There are several publications available which provide additional design information for transit system applications~~. The FDOT District Public Transportation Office(s) maintains a library of publications with design information for transit system applications~~these publications~~.

C.6 Red-Colored Pavement for Transit Lanes

FHWA has issued an interim approval for the optional use of red-colored pavement to enhance the conspicuity of station stops, travel lanes, or other locations in the roadway that are reserved for (1) the exclusive use by public transit vehicles or (2) multi-modal facilities where public transit is the primary mode (***MUTCD – Interim 1A-22***). Contact FHWA's Office of Transportation Operations for approval to use red-colored pavement in transit lanes.

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Commented [KK1]: This will need to be rewritten since red-colored pavement is included in the new MUTCD.

D PUBLIC TRANSIT FACILITIES

~~When a project includes a public transit route,~~ Consider providing curb-side and street-side transit facilities for bus stops along public transit routes. ~~should be considered in the roadway design process~~. Transit facilities ~~shall~~ must comply with ***Chapter 14-20, Florida Administrative Code***.

See ~~The~~ "Accessing Transit: Design Handbook for Florida Bus Passenger Facilities" ~~provides guidance relating to provisions~~ for curb-side and street-side facilities.

D.1. Curb-Side Facilities

Curb-side facilities are the most common, simple, and convenient form of facilities at a bus stop, which include: ~~. These include~~

- B~~b~~us stop signs,
- S~~s~~helters, ~~bus stop~~
- B&A areas,
- B~~b~~enches,
- B~~b~~ike racks,
- L~~l~~eaning rails, and
- S~~s~~helter lighting.

See "Accessing Transit" ~~provides~~ for additional details ~~and guidelines~~ for each type of transit facility. Coordinate with the appropriate public transit provider(s) to ~~determine~~ decide on the appropriate type and placement of amenities.

D.2 Street-Side Facilities

Bus stop locations can be categorized as:

- F~~f~~ar side,
- N~~n~~ear side and
- M~~m~~id-block ~~stops~~.

Bus stops ~~may be designed with~~ can include a bus bay or pullout to allow buses to pick up and discharge passengers ~~in an area~~ from outside of the travel lane, ~~. This design feature~~ allowing ~~s~~ traffic to flow freely ~~without the obstruction of stopped buses~~. Far side bus stops and bus bays are preferred. See ***Accessing Transit, Version 3 (2013)*** and ***Accessing Transit Update (2017)*** for ~~a~~ more ~~detailed discussion of~~ information on~~the~~ locating ~~on of the~~ bus stops and ~~or~~ bus bays.

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Bus bays can be:

- C~~c~~losed-ended,
- O~~o~~pen-ended, or
- N~~n~~ubs/bulbs,

Bus bays ~~and~~ can be positioned

- N~~n~~ear-side,
- F~~f~~ar-side, or
- M~~m~~id-block ~~in relation to an intersection, as illustrated in~~ (see Figure 13 – 3) ~~Bus Shelter Location~~.

~~The total length of the bus bay should allow~~ Provide at least enough space ~~room~~ for an entrance taper, a stopping area, and an exit taper ~~as a minimum~~. ~~However, in some cases it may be appropriate to c~~Consider providing acceleration and deceleration lanes depending on ~~the~~site-specific traffic volumes and speeds ~~of the through traffic~~. ~~This decision should be based upon site specific conditions.~~ See "Accessing Transit" ~~provides detailed~~ for bus bay dimensions ~~for consideration~~ with various ~~right of way~~ R/W and access conditions.

D.3 Bus Stop Lighting

Bus stop l~~L~~ighting ~~design for bus stops~~ should meet the same criteria applied to the adjacent roadway for ~~minimum~~ illumination levels, uniformity ratios and max-to-min ratios ~~that are being applied to the adjoining roadway based on~~ (see ***Chapter 6***) ~~– ***Lighting*** of this Manual~~. If the adjacent roadway is not lighted, ~~lighting is not provided for the adjoining roadway~~, coordinate with the transit agency to ~~determine~~decide if the bus stop should be lighted ~~lighting should be provided for the bus stop area~~, particularly when night transit services are provided. ~~A decision to install lighting for the adjoining bus stop area may include illumination of~~ Consider also lighting the bus bay pavement areas in such cases. ~~The use of~~ Consider using solar-powered ~~panel~~ lighting ~~for bus stops is another option that should be considered~~.

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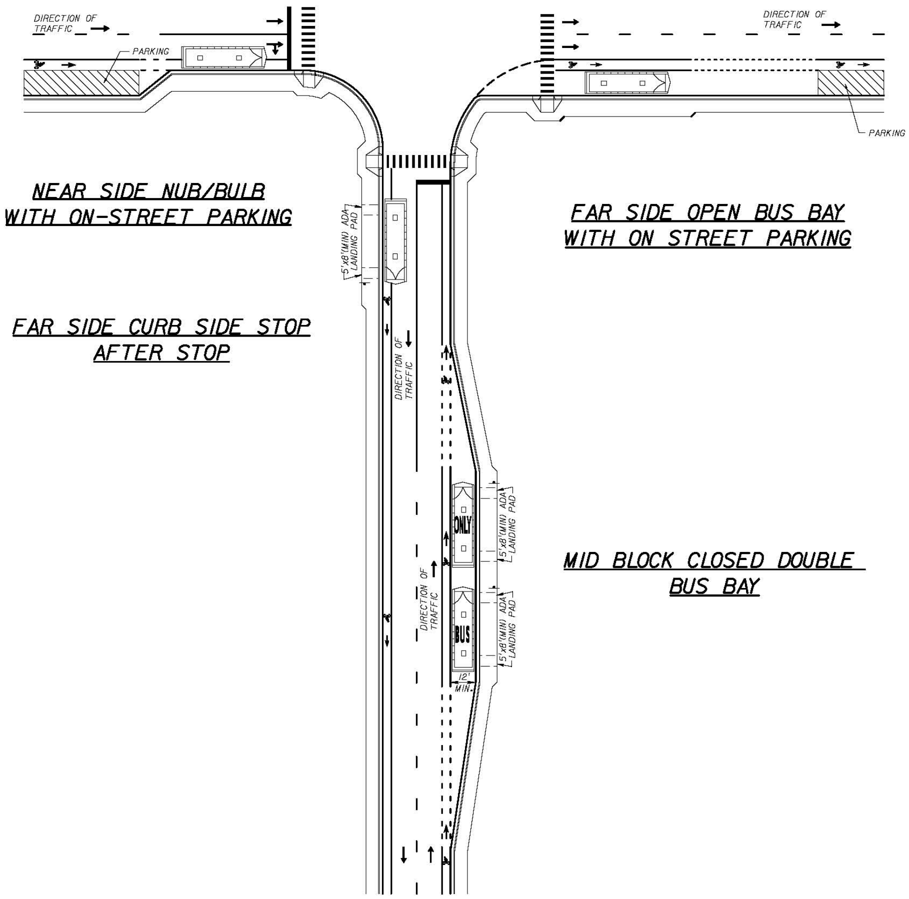
Figure 13 – 4 Bus Stop Locations



E REFERENCES FOR INFORMATIONAL PURPOSES

These are ~~following is a list of~~ publications that may be referenced for further guidance:

- FDOT's Accessing Transit, Design Handbook for Florida Bus Passenger Facilities, Version III, 2013 ***http://www.fdot.gov/transit/***
- TCRP Report 155 – Track Design Handbook for Light Rail Transit, Second Edition ***http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_155.pdf***
- Central Florida Commuter Rail Transit Project, Design Criteria – Phase 2 South RFP ***https://corporate.sunrail.com/wp-content/uploads/2015/06/P2S-RFP-Design-Criteria-06-15-15.pdf***
- Transit facilities shall comply with Chapter 14-20, Florida Administrative Code, Private Use of Right of Way ***https://www.flrules.org/gateway/ChapterHome.asp?Chapter=14-20***

CHAPTER 14

DESIGN EXCEPTIONS AND VARIATIONS

A GENERAL

The u~~U~~niform minimum standards for design, construction, and maintenance for streets and highways ~~are contained~~ included in this m~~M~~anual ~~and~~ meet or exceed ~~the~~ minimum AASHTO requirements ~~values established by AASHTO. Consequently, the values given~~ and govern the design process. ~~When it becomes necessary to deviate from the Manual's criteria, e~~ Early documentation and approval are required for deviations from these standards.

~~Design Exceptions are required when existing or proposed design elements are below both the criteria in this Manual and AASHTO's new construction criteria for the following Controlling Design Elements.~~

For projects using safety funds and developed to improve specific safety problems:~~,~~

- ~~o~~Only the elements identified ~~under~~ in the scope of work for the safety improvement project are subject to these approval processes.
- Existing non-compliant features~~,~~ within the limits of a safety improvement project do not require approval to remain if the project does not create a non-compliant condition. ~~The~~
- A s~~S~~afety s~~S~~tudy must identify all applicable Design Exceptions and Variations required based on the proposed scope.
- ~~For these projects, a~~All applicable Design Exceptions and Variations must be approved ~~prior to~~ before ~~the~~ beginning ~~of~~ the design phase of these projects.

For drainage projects:~~,~~

- O~~o~~nly the elements identified in the scope of ~~services~~ work for the drainage project are subject to these approval processes.
- Existing non-compliant features within the limits of a drainage project ~~The existing features, within the limits of the drainage project that do not meet design criteria,~~ do not require approval to remain ~~(~~if the project does not create a non-compliant ~~conforming~~ condition~~)~~.

For landscape-only projects:,

- I~~i~~ntersection sight distance Design Variations ~~may~~ can be processed by the

Responsible Landscape Architect of Record.

- ~~For design projects with landscaping, i~~ Intersection sight distance Design Variations for roadway projects that include landscaping must be processed by a Professional Engineer.
- Stopping sight distance Design Exceptions ~~In cases~~ (where intersection sight distance falls below stopping sight distance) ~~, a Design Exception for stopping sight distance~~ must be processed by the respective professional.

Maintenance Resurfacing, Ride Only (a.k.a., Ride Rehabilitation) and Skid Hazard Projects do not require Design Exceptions or Variations other than for accessible curb ramp ~~or~~ and blended transition requirements. Obtain a Design Variation i~~I~~f complying ~~iance~~ with accessible curb ramp or blended transition requirements is ~~determined to be~~ technically infeasible~~, documentation as a Design Variation is required~~.

Design Exceptions are required when existing or proposed design elements are below the criteria in this manual and AASHTO's new construction criteria for the 10 Controlling Design Elements

~~The 10 Controlling Design Elements~~ for high-~~-~~speed roadways (d~~D~~esign s~~S~~peed ≥ 50 mph)~~ roadways are~~:

- Design Speed
- Lane Width
- Shoulder Width
- Horizontal Curve Radius
- Superelevation Rate
- Stopping Sight Distance
- Maximum Grade
- Cross Slope
- Vertical Clearance
- Design Loading Structural Capacity

The 2 Controlling Design Elements for low-~~-~~speed roadways (d~~D~~esign s~~S~~peed < 50 mph) ~~roadways~~ are:

- Design Speed
- Design Loading Structural Capacity

The Responsible Professional Engineer must document any proposed deviations from the criteria in this manual (other than for any Controlling Design Element) with sufficient detail and justification to obtain a Design Variation from the appropriate municipality or county. ~~When proposed design elements other than the Controlling Elements do not meet the criteria contained in this Manual, sufficient detail and justification of such deviations must be documented by the Responsible Professional Engineer as a Design Variation and submitted to the municipality or county.~~

This chapter ~~provides~~ describes the process for documenting ~~ation~~ and approving ~~al of~~ Design Exceptions and Variations. Include ~~The~~ approved Design Exceptions ~~or~~ and Variations ~~submittal should be included~~ in the project file. ~~to clearly document~~ Clearly indicate the action taken and the approval given.

B RECOMMENDATIONS FOR APPROVAL

Design Exceptions and Variations are recommended by the Professional Engineer responsible for the project design element (Responsible Professional Engineer). All Design Exceptions and Variations require approval from the Maintaining Authority's Professional Engineer (or their d~~D~~esignee).

See ***FDOT Design Manual, Chapter 122*** ~~For additional information on the process to be followed for a~~ for Design Exceptions and ~~or~~ Variations ~~that~~ involving~~es~~ a state facility or ~~located on~~ on the National Highway System (NHS).~~,~~

~~please see the ***FDOT Design Manual, Chapter 122 Design Exceptions and Design Variations***.~~

C COORDINATION

Identify potential Design Exceptions and Variations as early in the planning phase as possible ~~In order~~ to allow time to research alternatives and ~~begin~~ conduct analysis ~~and documentation activities, it is critical that Design Exceptions and Variations be identified as early in the process as possible. This is preferably done during the planning phases of projects~~ (or as soon as possible during initial design).

~~When the need for a Design Exception or Variation has been determined, t~~ The Responsible Professional Engineer ~~must~~ coordinates with the Maintaining Authority's Professional Engineer (or their d~~D~~esignee) and the FDOT (if applicable) and provides the requested documentation ~~, to obtain~~ to obtain conceptual concurrence ~~and provide any requested documentation~~.

FDOT ~~will be~~ is involved only if ~~the~~ a proposed local roadway design ~~on the local~~ (Non-State Highway System ~~(SHS)~~) ~~roadway~~ is part of an FDOT project, such as: ~~. For example,~~

- A~~a~~n FDOT project ~~for a roadway~~ on the SHS includes work on ~~the~~ an adjacent local roadway~~s~~, or
- A~~a~~n FDOT project is exclusively on a local roadway (Non-SHS) ~~roadway~~.

~~In these cases,~~ Include the FDOT District Design Engineer (DDE) ~~FDOT District Design Engineer will be listed~~ for "concurrence" ~~in~~ with the Design Exception or Variation ~~request letter~~ in such cases.

D JUSTIFICATION FOR APPROVAL

Provide s~~S~~ufficient detail, ~~and~~ explanation, and justification ~~must be given in order~~ for the Maintaining Authority's Professional Engineer (or their d~~D~~esignee) to approve the request for ~~a~~ the Design Exception or Variation. The 10 Controlling Design Elements ~~are considered to~~ have significant effects on safety. ~~and~~ Provide the strongest ~~case~~ justification possible ~~must be made if the designer is not able to meet~~ if the~~se~~ requirements for the 10 Controlling Design Elements cannot be met. All deviations below the minimum criteria and standards in this m~~M~~anual must be uniquely identified~~, located,~~ and justified.

A strong case can be made if it ~~can be~~ is shown that:

- The required criteria are not applicable to the site-~~-~~specific conditions.
- The project can be as safe by not following the criteria.
- The needs of the environmental or community ~~needs~~ prohibit meeting criteria.

~~Most often a~~ A case ~~is~~ can also be made by showing the required criteria are impractical and the proposed design wisely balances all design impacts, including: ~~. The impacts required for documentation are:~~

- Safety and o~~O~~perational performance
- LOS~~evel of Service~~
- R/W~~ight of Way~~ impacts
- Community impacts
- Environmental impacts
- Costs
- Usability by all modes of transportation
- Long-~~-~~term ~~and~~ cumulative ~~effects~~ impacts on adjacent ~~sections of~~ roadways

A case should not be made based solely on ~~the basis that~~:

- Money can be saved.
- Time can be saved.
- The proposed design is similar to other designs.

E DOCUMENTATION FOR APPROVAL OF DESIGN EXCEPTIONS

Include all s~~S~~upporting documentation ~~that is~~ generated during the approval process ~~is to accompany~~ with each submittal. Requests for Design Exceptions should include ~~the following documentation~~:

1. Submittal/Approval Letter (~~Example shown in~~ see Exhibit 14-A)

2. Project Description:

   a) General project information:~~,~~
      - L~~l~~ocation map,
      - E~~e~~xisting roadway characteristics,
      - P~~p~~roject limits (mileposts),
      - C~~c~~ounty section number,
      - W~~w~~ork mix,
      - O~~o~~bjectives, and
      - O~~o~~bstacles.

   b) Limitations a~~A~~ssociated ~~or future limitations that exist as a result of~~ with public or legal commitments.

3. Project Schedule and Lifespan:

   a) Letting D~~d~~ate and other important production dates ~~associated with the project~~.

   b) Discussion of whether the deficiency is ~~a~~ temporary or permanent ~~condition~~.

   c) Future work planned ~~or programmed~~ to address the condition.

4. Exception Description:

   a) The s~~S~~pecific design criteria ~~that will~~ not being met (AASHTO, Florida Greenbook). ~~and~~

   ~~a)~~b) A~~a~~ detailed explanation of why the criteria ~~or standard~~ cannot be met ~~complied with~~ or is not applicable.

   ~~b)~~c) The p~~P~~roposed criteria ~~value for the project or location~~ and why it is appropriate.

   ~~c)~~d) A p~~P~~lan view~~, plan sheet,~~ or aerial photo of the location ~~, showing right of way~~ including R/W lines and ~~parcel lines of~~ adjacent property lines~~y~~.

   ~~d)~~e) A p~~P~~hoto of the area of the deficiency.

e)f) A tTypical section or cross-section.

f)g) The mMilepost or station location.

5. Alternative Designs Considered:

a) Meeting AASHTO or Florida Greenbook criteria,
b) Ppartial correction, and
a) Tthe no-build (existing) condition.

~~build (existing) condition.~~

6. Impacts of the Exception:

a) Safety Performance:

- Anticipated impact on safety:
  - ~~,~~ L ~~l~~ong-term,
  - ~~and~~ S~~s~~hort- ~~-~~term, ~~effects~~ and ~~of~~
  - ~~any anticipated~~ C~~c~~umulative ~~effects~~.
- Summary of the most recent 5-year crash history. ~~including any~~
- P~~p~~ertinent crash reports.

b) Operational Performance:

- Description of the anticipated impacts on operations:
  - Long-term,
  - Short-term, and ~~(long and short term effects) and any anticipated~~
  - C~~c~~umulative ~~effects~~.
- Summary of the ~~amount~~ volume and character of traffic using the facility.
- Compatibility of the design with adjacent roadway sections ~~of roadway~~.
- Effects on capacity and LOS~~evel of Service~~ (proposed criteria vs. AASHTO).

c) R/W~~ight-of-way~~.

d) Community.

e) Environment.

f) Usability by all modes of transportation.

7. Anticipated Costs:

a) Description of the anticipated costs (design, R / W ~~right of way~~, construction, maintenance).

8. Mitigation Measures:

a) Practical mitigation measures or alternatives that were considered and any ~~selected~~ treatments implemented ~~on the project~~.

9. Summary and Conclusions:

~~When preparing a Design Exception, the Responsible Professional Engineer should c~~Consider potential mitigation strategies ~~that may reduce the~~ to minimize adverse impacts to highway safety and traffic operations. ~~Please~~ Rrefer to the ***FHWA Mitigation Strategies for Design Exceptions (July 2007)*** for examples of mitigation strategies. See tThe ***Highway Safety***

Manual (HSM) and ***Highway Capacity Manual*** provide information on for quantifying and evaluating highway safety performance.

Benefit/Cost Analysis:

Calculate Perform a benefit/cost analysis which estimates the cost effectiveness of correcting or mitigating thea substandard design element. The "benefit" is the expected reduction in future crash costs and the "cost" is includes the direct construction and maintenance costs associated with the design. Calculate and annualize tThese costs are calculated and annualized so that direct to achieve a fair comparison of alternate designs can be made.

A benefit/cost ratio equal to or greater than over 1.0 indicates it may may be cost effective to implement a particular design. ; however, the final decision is a management decision which Management should considers all factors and applies use sound engineering judgement to reach a final decision. Key factors in the analysis includeare:

a) Evaluation of crashes by type and cause,

b) Estimate of crash costs (based on property damage and severity of injuries),

c) Selection of a crash reduction factor based on a proposed mitigation strategy,

d) Selection of a discount rate (typically 4% for roadway projects),

e) Estimate of construction and maintenance costs,

f) Selection of service life of the improvements.

NOTE: The ***FDOT Design Manual, Chapter 122*** ***Design Exceptions and Design Variations*** provides guidance can be used for the benefit/cost analysis, and may be used. FDOT provides a useful tool, called The FDOT ***Benefit Cost Analysis Spreadsheet Tool*** (BCAnalysis.xlsm), to can aid in determining the benefit/cost ratio.

Conclusion and Recommendation:

a) The cumulative effect of other all deviations from design criteria,

b) Safety mitigating measures considered and implementedprovided,

c) Summarize specific proposed course of action.

F DOCUMENTATION FOR APPROVAL OF DESIGN VARIATIONS

The Responsible Professional Engineer must provide sufficient detail and justification for Design Variations for deviations from the criteria in this manual When proposed design elements (other than for the Controlling Design Elements). do not meet the criteria contained in this Manual, sufficient detail and justification of such deviations must be documented by the Responsible Professional Engineer as a Design Variation and submitted to Submit the request to the municipality or county. The documentation, submittal and approval requirements for Design Variations are similar to those described in this chapter at for Design Exceptions described in this chapter.

Design Variations requests should include:

a) Design criteria versus proposed criteria.

b) Reason the design criteria are not appropriate.

c) Justification for the proposed criteria.

d) Review and evaluation of the most recent 5 years of crash history (where appropriate).

e) Background information which documents andor justifies the request.

G FINAL PROCESSING OF DESIGN EXCEPTIONS AND VARIATIONS

After receiving conceptual approval from the ~~designated Professional Engineer representative of the~~ municipality or county, the Responsible Professional Engineer must sign and seal and submit the documentation justifying the Design Exception or Variation ~~shall be signed and sealed by the Responsible Professional Engineer~~ and ~~delivered~~ to the municipality or county. See ***Exhibit 14-A*** ~~***Sample Request Letter for Design Exception or Variation***~~ ~~provides~~ for an example of ~~an~~ the appropriate format~~ and should be included with the signed and sealed supporting documents~~. Review t~~T~~he Design Exception or Variation ~~will be reviewed~~ for completeness and ~~adherence to~~ compliance with the requirements of this c~~C~~hapter.

If the Design Exception request ~~satisfies~~ meets all requirements, ~~the acknowledgment of receipt will be signed by~~ the Maintaining Authority's Professional Engineer (or their d~~D~~esignee) signs an acknowledgement of receipt; ~~,~~ and ~~, if applicable,~~ forwards the request~~ed~~ to the FDOT DDE ~~FDOT District Design Engineer~~ for concurrence (if applicable).

~~When all signatures are obtained, t~~The Design Exception or Variation ~~will be~~ is returned to the Responsible Professional Engineer after all signatures are obtained. The original ~~will be~~ is retained by the municipality or c~~C~~ounty ~~and~~ with a copy retained ~~kept~~ by the FDOT~~,~~ (if applicable).

CHAPTER 15

TRAFFIC CALMING

A INTRODUCTION

~~As Florida continues to grow, m~~More and more of ~~the~~ Florida's major highways ~~in its communities~~ are becoming congested, ~~. This has~~ causing ~~ed~~ many drivers to ~~seek~~ use less congested ~~crowded~~ local ~~residential~~ streets as alternatives ~~to get to their destinations. In many cases, this has meant the use of~~ (including local residential streets) ~~as bypasses~~. The increase in traffic ~~intrusion,~~ volumes~~,~~ and speeds on residential streets has degraded ~~the~~ Florida's neighborhood livability standards: ~~of various neighborhoods in Florida and as a result many residents complain about their~~

- E~~e~~nvironment (noise, air pollution),
- L~~l~~ivability (quality of life, traffic intrusion, excessive traffic volumes~~,~~ and speeds ~~of traffic~~),
- S~~s~~afety ~~(as well as safety~~ of their children, pets, and property,~~)~~ and
- P~~p~~hysical characteristics (absence of sidewalks, etc.).

This chapter provides ~~some~~ guidance ~~to Florida roadway planners, designers, and traffic engineers on how to address~~ for:

- Accommodating these concerns ~~about maintaining or enhancing the quality of life in residential neighborhoods by~~
- B~~b~~alancing ~~the need for~~ safety for all roadway users, and ~~and adjacent property owners of the street network and~~

M~~m~~aintaining the integrity of the entire highway~~s~~ network~~s as a whole~~.

B PLANNING CRITERIA

Traffic calming involves ~~is the combination of~~ implementing primarily ~~mainly~~ physical improvements ~~measures that~~ aimed at:

- R~~r~~educing~~e~~ the negative effects of motor vehicle traffic~~use~~,
- A~~a~~ltering driver behavior, and
- I~~i~~mproving~~e~~ conditions for other road ~~non- motorized street~~ users.

~~Communities~~ Local jurisdictions must develop traffic calming program details and employ ~~undertaking a traffic calming program shall have~~ a procedure for ~~planning~~ deciding which neighborhoods and roadways qualify ~~for~~ to participate ~~ion in the program~~. ~~Specifics of these methods shall be developed by the local jurisdictions. The~~ Some details can ~~methods will likely~~ vary from locality to locality~~. However~~, while some ~~issues~~ should be addressed ~~in~~ in all communities:

- ~~Through the public involvement process,~~ Include adjacent residents and road users who are impacted ~~by the situation should be included~~ in identifying ~~the~~ concern(s) through a public involvement process.
- Include emergency response, transit, school, and other impacted entities in the review.
- Confirm t~~T~~he need for traffic-calming measures ~~should be confirmed~~ through ~~by~~ appropriate study~~ies~~ (license plate survey, speed, volume, crash analyses) ~~studied~~.
- ~~Once the concerns are clearly identified and confirmed by traffic studies, and documented, it will~~ The identification and confirmation of traffic concerns serve as ~~provide the focus~~ the basis for developing and ~~possible solution,~~ prioritizing ~~, and development of~~ appropriate traffic calming measures ~~. It will also help determine the~~ which best ~~approach to~~ address those ~~e~~ concerns.
- ~~When developing traffic calming measures, in addition to the affected property owners, emergency response, transit, school, and sanitation officials and any other entities impacted by the installation of such devices should be included in the review process.~~

Traffic calming ~~may~~ may not be ~~the~~ appropriate ~~method in all cases to address vehicle speeds, volumes, and safety~~ in all cases. Consider a~~A~~lternative solutions, ~~or~~ educational tools, ~~may be considered, as well as~~ and coordination ~~ed effort~~ with law enforcement.

~~The application of traffic calming measures should c~~Consider access management and ~~possible~~ potential network impacts ~~network and access issues~~. Perform a~~A~~ system impact analysis ~~should be performed as part of the development process~~. Consider ~~Vehicular~~

- Traffic and pedestrian volumes ~~and pedestrian counts~~,
- S~~s~~peed data, ~~and~~
- C~~c~~rash history ~~of the streets under evaluation should be reviewed~~.
- Storm water and environmental impacts ~~also need to be addressed~~, as well as
- F~~f~~acility type,
- U~~u~~rban and rural design factors, and
- D~~d~~riveway densities.

~~Design details for each t~~Traffic calming design ~~measure may~~ can vary ~~depending on~~ based on local conditions, including: ~~. Factors to be considered include both~~

- Geometrics,
- H~~h~~orizontal and vertical deflection,
- Operational considerations.
- E~~e~~ase of use,
- E~~e~~mergency vehicle accessibility,
- E~~e~~ase of maintenance, and
- F~~f~~acility type.

~~Operational considerations and geometrics are critical factors to consider as well.~~ See the end of this section for ~~A list of~~ some traffic calming ~~references and~~ resources . ~~to consider in providing more detailed design factors and information can be found at the end of this section~~. It ~~may~~ can be ~~desirable~~ prudent to begin with less restrictive measures and progress to more restrictive measures ~~ones~~ in stages.

~~Listed~~ See below ~~are~~ for some "Do's" and "Don'ts" ~~of the planning process for~~ for traffic calming. ~~which may be helpful in working through the design process.~~

Do's and Don’ts of the Planning Process

Do ~~the following~~:

- Install temporary traffic calming features and monitor them ~~for a period of time~~ before installing ~~the~~ permanent features. Testing temporary features ~~on site prior to~~ before installing permanent features ~~installation will~~ can relieve ~~resident~~ public anxiety about ~~the~~ impacts to ~~on their own~~ driving patterns and ~~driving~~ behaviors ~~will adjust to the new route circumstances~~.
- ~~Have~~ Conduct an organized ~~program including~~ public involvement program. The local government should approve and support the p~~P~~lans and policies ~~should be approved and supported by the local government~~. Emphasize that the temporary features will be monitored ~~selected treatments(s) will be initially in a “test” mode, with~~ and that the permanent ~~cy~~ features will be based on those observations ~~pending the outcome measurement~~. ~~Be able to d~~Describe measures ~~what is being done to~~ being implemented to keep traffic off residential streets.

- Channel public resources by prioritizing traffic calming ~~request~~ measures ~~according to~~ based on documentable criteria, setting thresholds of volume, speed, etc., to merit treatment.
- Involve ~~the~~ local services ~~agencies, including~~ (fire, police, and emergency medical) ~~services personnel,~~ from the beginning ~~start~~.
- Consult with fire ~~department~~ and EMS personnel ~~to develop~~ on the preferred design~~,~~ (particularly ~~with~~ for speed humps and traffic circles). Set up traffic circles with cones and have fire trucks and ~~other emergency~~ EMS vehicles drive around them~~; this will~~ to help determine what radius is best for ~~the~~ vehicles used in ~~a given~~ that location~~area~~. Use ~~Th~~this ~~e~~ same process ~~can be used in the~~ for ~~design of~~ speed humps.
- Review neighborhood traffic patterns ~~in the neighborhood~~ as a whole. Avoid solving a ~~the~~ problem on one neighborhood street by ~~just~~ shifting ~~the~~ the traffic to another neighborhood street.
- Consider appropriate landscape treatments ~~as part of~~ with the traffic calming measures ~~design and implementation~~.

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- Make certain Ensure that all signing, pavement markings, and channelization is in accordance with comply with the ***Manual on Uniform Traffic Control Devices (MUTCD), the AASHTO Policy on Geometric Design of Highways and Streets***, and ***Roundabouts: An Informational Guide, Second Edition, National Cooperative Highway Research Program (NCHRP 672)***.
- Check sight distances for all users (vehicles, pedestrians, and bicyclists). . Sight distance should be consistent with the dimensions shown in See ***Chapters 3 – Geometric Design or Chapter and 16) – Residential Street Design.***
- Become familiar with the Research traffic calming features used in other communities and assemble references so that residents can be directed inform residents where to see them.
- Coordinate with neighborhood residents in dDeciding e on a safe design speed beforehand and in consultation with neighborhood residents.
- Check sight distances by visiting the site before and after installation.
  - Do parked cars obstruct sight distances?
  - Do landscaping or other features obstruct sight distances?
- Review the nighttime illumination at night.
  - Are additional street lights needed?
  - Does landscaping block the light?
  - Is there a shadow on one side of a median or traffic circle that might hide pedestrians from view?
- Review Observe the traffic calming measures channelization during the at day and night.
  - Is thereit a clear approach from all directions?
  - Can it be seen at night?
  - Watch the traffic: Is the driving public Are drivers confused by the signing orand channelization?
  - Make adjustments as needed.
- Review the site for utility conflicts.
  - Is there a fire hydrant?
  - Does it need to be moved?
  - Are there conflicting existing utilities in the way?
- Check the storm-water drainage.
  - Will Does the storm drain system need to be moved or

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adjusted~~revised~~?

- ~~-~~Can the runoff flow through or around the traffic calming installation~~device~~?

- Review on-street parking.
  - ~~Will~~ Do parked cars block ~~the access of~~ emergency vehicle access ~~s through or around~~ within the ~~proposed~~ neighborhood ~~traffic control devices~~? ~~Add~~
  - Create additional no parking zones where needed.
  - ~~Additional e~~ Enforce ~~ment of~~ parking restrictions ~~may be required~~ to keep ~~the~~ traveled paths clear.
- ~~Include~~ Consider weekend~~s~~ ~~in~~ traffic. ~~counts, as r~~ Residential streets ~~may~~ may have unique travel patterns and high use periods.

Don't~~ do the following~~:

- Install neighborhood traffic calming features:
    - W~~w~~ithout ~~a well-engineered program~~ public and local government support~~ed by the local government and public~~.
    - On arterial streets.
    - On streets without curbs (unless providing supplemental features to keep vehicles within the traveled way).
    - On streets with profile grades over 10 percent.
    - On major truck routes.
    - On primary emergency routes:
        - Contact local fire, emergency service, and police departments to determine these routes.
        - Consider secondary access routes on a case-by-case basis.
    - On curving or winding roads with limited sight distance (unless reducing speed limits and providing adequate warning signs).
    - In front of driveways.
- ~~Install neighborhood traffic calming features on arterial streets (See Section 1.C.2 for a discussion of roadway classifications). Typically,~~
- Install physical devices ~~are not installed~~ on:
    - S~~s~~treets with volumes ~~greater than~~ over 3,000 vehicles per day,
    - Streets ~~or~~ with posted or operating speeds ~~of greater than~~ over 30 mph~~MPH~~.
    - Adjacent parallel routes (which can hinder emergency response).
- ~~Install neighborhood traffic calming features on streets without curbs unless supplemental features or other design considerations are included to keep vehicles within the traveled way.~~

    ~~Install neighborhood traffic calming features on street with grades of greater than 10 percent.~~

    ~~Install neighborhood traffic calming features on major truck routes.~~

    ~~Install neighborhood traffic calming features on primary emergency routes. Contact local fire, emergency service, and police departments to determine these routes. Secondary access routes should be considered on a case-by-case basis.~~

    ~~Install neighborhood traffic calming features on curving or winding roads with limited sight distance, unless reduced speed limits and adequate warning signs are used in conjunction with the devices.~~

    ~~Place neighborhood traffic calming features in front of driveways.~~
- Neglect to check for conflicting utilities ~~or~~ and drainage considerations.

~~Install physical features on adjacent parallel routes, unless feasible design alternatives have been agreed upon, as this prevents or hinders emergency response.~~

C INAPPROPRIATE TRAFFIC CALMING TREATMENTS

C.1 Stop Signs

Do not use u~~U~~nwarranted stop signs ~~should not be used~~ for traffic calming since they may ~~for the following reasons~~:

- Increase midblock speeds ~~along the street because of~~ (due to drivers trying to make up for lost time),
- Increase noise (due to ~~because of~~ quick acceleration~~s~~ and deceleration)~~s~~,
- Increase pollution,
- Reduce drivers' expectation of a uniform flow,
- Relocate the problem,
- Create ~~ause~~ driver and bicyclist disrespect for stop signs.

~~by drivers and bicyclists~~.

Use s~~S~~top signs ~~shall be used~~ only when warranted ~~per~~ by the

MUTCD.

C.2 Speed Bumps

Do not install s~~S~~peed bumps ~~shall not be used~~ on public streets. Speed bumps are severe deflections ~~treatments~~ (3 to 6 inches high and 1 to 2 feet long) that slow drivers to ~~speeds of less than~~ below 10 mph. ~~Due to their abrupt rise and required low speed they can be a hazard to motorists and bicyclists.~~ Do not confuse s~~S~~peed *humps*~~, as~~ (~~described in~~ see Section D under vertical deflection) ~~, should not be confused~~ with speed *bumps*.

C.3 Other Inappropriate Treatments

~~There are some o~~Other treatments (including those listed below) ~~that have been shown to be~~ are ineffective at reducing the speed and volume of traffic on local roadways. While a temporary improvement ~~may~~ may result, ~~long-term improvement is not likely; consequently,~~ their use is discouraged. ~~These treatments include the following:~~

- Novelty signs - ~~While signs such as~~ CHILDREN AT PLAY, SENIORS CROSS

HERE and SLOW DEAF CHILD signs may might make an infrequent roadway user aware of a specific local population, but most regular users of the roadway are unaffected by the signs.

- Odd speed limit signs - NEIGHBORHOOD SPEED LIMIT 23 MPH and other odd similar odd speed limit signs place a high dependence on police to monitor speeders and are not consistent with the national practice required by the ***MUTCD*** of posting speeds limits in 5 mph increments.

- Crosswalks – Standard crosswalks marked only with signs and pavement markings do not affect ~~motorists'~~ drivers' speeds and should not be used by themselves as traffic calming measures~~treatments~~.
- Bicycle lanes – Standard bicycle lanes are not traffic calming measures ~~treatments. They can be used to provide space for bicyclists between the sidewalk and travel lanes but~~ and should not be used by themselves for traffic calming.
- Speed trailers – While speed trailers can be used ~~as part of a traffic calming program~~ for educational awareness, they have no lasting effect on driver ~~motorists'~~ behavior.
- Reduced speed limit signs – Reduced speed limits without physical traffic calming measures do not slow drivers and should not be used for traffic calming.
- Rumble strips – ~~These applications~~ Rumble strips require ~~have high~~ extensive maintenance ~~requirements and can cause severe~~ , increase noise ~~problems. Also, they~~ and can be ~~an~~ obstacles to bicyclists.

D APPROPRIATE TRAFFIC CALMING TREATMENTS

~~The following sections describe some of the available traffic calming strategies.~~ The ~~is list~~ traffic calming strategies described below~~is not exhaustive, nor do the treatments necessarily~~ do not fall ~~exclusively~~ into only one category.

Use various types of strategies ~~In a typical traffic calming plan various types of treatments will be used. These plans will be~~ based upon neighborhood preferences ~~combined with~~ and sound engineering judgment.

Design details for traffic calming treatments ~~will~~ vary with application. Determine s~~S~~pecific designs ~~will need to be determined~~ based upon the objective of the installation~~s~~.

D.1 Vertical Treatments

Vertical treatments are those that depend upon use a change in vertical alignment to persuade cause drivers to slow down. When properly used, these Vertical treatments can be effective in reducing speeds and crashes when used properly. However, consideration should be given to Consider potential impacts on emergency responders, buses, and, to some extent, bicyclists, and motorcyclists.

Traffic calming features that alter the vertical alignment Do not install vertical treatments should not be installed near fire hydrants or mailboxes.

See the ***Manual on Uniform Traffic Control Devices (MUTCD)*** Information on for signing and pavement markings for vertical deflections can be found in the ***Manual on Uniform Traffic Control Devices (MUTCD)***.

Table 15 – 1 Vertical Treatments

Treatment	Description	Effect	Concerns	Cost
Raised Intersection	A raised plateau where roads intersect. Plateau is (generally 4 inches above surrounding streets).	Slows vehicles entering intersection and improves pedestrian safety.	Increases turning difficulty of making a turn.	Medium to High
Raised Crosswalk	Raised pedestrian crossing used in mid-block locations. Crosswalks installed on flat-top portion of speed table. See Figure 15 – – 1.	Reduces speed and is an effective pedestrian amenity, makinges pedestrians more visible.	May Can be a problem for emergency vehicles and vehicles with trailers.	Low to Medium
Speed Humps	Speed humps are parabolic, curved, or sinusoidal in profile, 3 to 4 inches in height and up to 14 feet long. Comfortable speeds limited to 15 to 20 mph. See Figure 15 - 2.	Reduces speed.	May Can cause delays for emergency vehicles and impact patient comfort. May Can have greater impacts on longer wheelbase cars.	Low
Speed Tables	Speed tables are flat-topped speed humps, also 3 to 4 inches high but with a sloped approach taper on each side of a flat top. They are generally 20 to 24 feet long. Comfortable speeds limited to 20 to 25 mph.	Reduces speed.	May Can cause delays for emergency vehicles and impact patient comfort.	Low
Speed Cushions/ Pillows	Signed speed humps as described above.	Reduces speed.	May May not slow all vehicles.	Low

Figure 15 – 1 Raised Crosswalk

Suwannee Street, Tallahassee, Florida

Figure 15 – 2 Speed Hump

Inside Loop Road, Orange County, Florida

D.2 Horizontal Treatments

Horizontal deflection treatments are ~~often~~ typically:

- M~~m~~ore expensive than vertical deflection treatments, ~~. However, they~~
- H~~h~~ave less ~~of an~~ impact on emergency responders and large vehicles with multiple axles. They ~~generally do not create~~
- Are not problem~~s~~atic for bicyclists and motorcyclists. Because pavement area is usually reduced, additional landscaping ~~may~~ can be possible, making horizontal deflections ~~treatments~~ useful as part of neighborhood beautification projects.

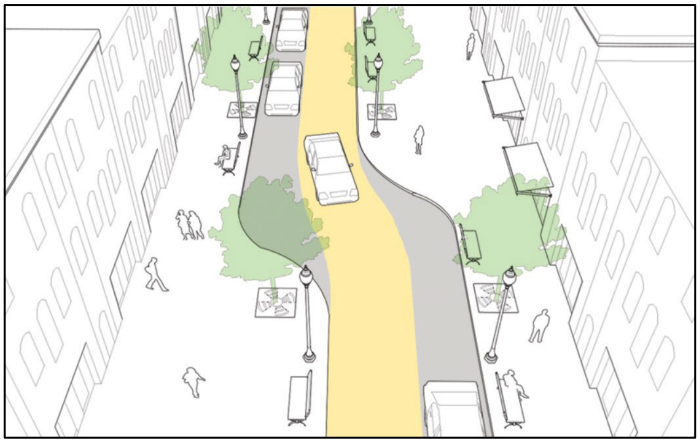
See the ***MUTCD*** ~~Information on striping and~~ for signing and pavement markings for roundabouts ~~can be found in the **MUTCD**~~.

Table 15 – 2 Horizontal Treatments

Treatment	Description	Effect	Concerns	Cost
Angled Slow Point	Angled deviation to ~~deter~~ the path of travel so ~~that~~ the street is not a straight line	Reduces speed and pedestrian crossing distance.	Control l~~L~~andscaping ~~must be controlled~~ to maintain visibility. Conflicts ~~may~~ can occur with opposing drivers.	Medium to High
Chicanes	Mainline deviation to ~~deter~~ the path of travel so ~~that~~ the street is not a straight line. See Figure 15 - 3.	Reduces speed and pedestrian crossing distance.	~~A chicane design may~~ May warrant additional signing and pavement markings ~~striping~~ to ensure that drivers are aware of a the slight bend ~~in the roadwa~~y. Increases ~~the~~ areas ~~possible~~ available for landscaping.	Medium to High
Mini-Circles	A raised circular island in the center of an existing intersection, typically 15 to 20 feet in diameter. ~~May~~ Can have mountable truck apron to accommodate large vehicles.	Reduces speed and ~~both~~ the number and severity of crashes.	~~May~~ Can restrict larger vehicles. ~~May~~ Can cause ~~some~~ confusion when not signed properly. Some communities have documented May increase~~d~~ crashes when ~~mini-circles~~ replacing ~~ed~~ all-way stop intersections.	Low to Medium

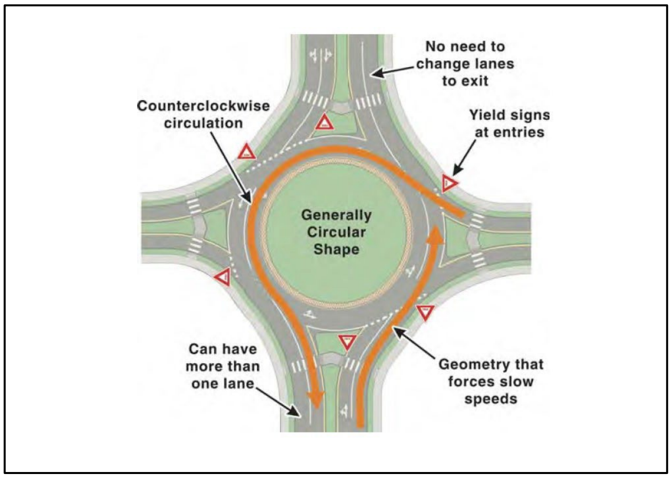
Roundabouts	A circular intersection with specific design and traffic control features, including yield control of all entering traffic, channelized approaches, geometric curvature. ~~May~~ Can be ~~appropriate at locations as~~ an alternative to a traffic signal. See Figure 15 - 4.	Reduces ~~vehicle~~ speed~~s~~ and reinforces a change in the driving environment in transition areas.	~~May~~ Can require more space at the intersection itself than other intersection treatments. ~~While Roundabouts have~~ Though sometimes ~~been~~ considered traffic calming features, they are primarily traffic control measures.	High

Figure 15 – 3 Chicanes



NACTO Urban Street Design Guide, National Association of City Transportation Officials

Figure 15 – 4 Key Roundabout Characteristics



NCHRP Report 672: Roundabouts: An Informational Guide, Second Edition

D.3 Neighborhood Entry Control

Neighborhood entry control treatments include partial street closures and gateway type tools. They are used to reduce speeds and volume at neighborhood access points and ~~may~~ can be used in conjunction with neighborhood beautification ~~or~~ and enhancement projects and residential area identification.

Table 15 – 3 Neighborhood Entry Control

Treatment	Description	Effect	Concerns	Cost
Chokers	Midblock street reduction ~~of the street~~ to a single travel lane for both directions.	Reduces speed and volume.	Costs increase if drainage needs to be rebuilt.	Medium to High
Gateway Treatment or Entrance Features	Treatment to a street that includes a sign, banner, landscaping, and roadway narrowing or other structure that helps to communicate a sense of neighborhood identity.	Reduces entry speed and pedestrian crossing distance. Discourages intrusion by cut through vehicles and identifies the area as residential.	Maintenance responsibility. ~~May~~ Can lose some on-street parking.	Medium to High
Curb Extensions or Bulb-outs	Realignment of curb at intersection or mid-point of a block to decrease pavement width. See Figure 15 - 5.	Visually and physically narrows the roadway, shortens pedestrian crossing distance, increases space for plantings, street furniture.	~~May~~ Can impact sight distance, parking, and drainage.	Medium to High
Midblock Median, Slow Point	An island or barrier in the center of a street that separates traffic.	Provides refuge for pedestrians and bicyclists.	Landscaping ~~may~~ may impede sight distance.	Varies
Lane Narrowing	Street physically narrowed to expand sidewalks and landscaping areas. Could include median, on street parking etc.	Improves~~d~~ pedestrian safety.	~~May~~ May create conflict with opposing drivers in narrow lanes.	Medium to High
One-Way In or One-Way Out Channelization	Intersection reduction of the street to single travel lane with channelization. Also called half road closure.	Reduces speed and traffic.	Costs increase if drainage must be rebuilt. Transfers additional vehicles to other ingress/egress points.	Medium to High
Textured Pavement	A change in pavement texture, and color (e.g., asphalt to brick), that helps make drivers aware of a change in driving environment.	Enhances pedestrian crossings, bicycle~~ke~~ lanes, ~~or~~ and on-street parking.	Increases maintenance. ~~May~~ May increase noise.	Low to Medium

Figure 15 – 5 Curb Extension or Bulb Out

First and Lee Streets, Ft. Myers, Florida

D.4 Diverters

A diverter ~~consists of~~ is an island or curbed closure~~,~~ which prevents certain intersection movements ~~at intersections,~~ and reduces speeds and volumes. D~~By~~ ~~d~~iverting ~~motorists~~ drivers within a neighborhood ~~, they~~ can ~~significantly~~ reduce cut-~~-~~through traffic significantly.

Diverters must be carefully planned ~~with care~~ because they ~~will~~ primarily impact the residents ~~people who live in~~ of the neighborhood ~~more than anyone else~~. ~~Trip lengths increase, creating~~ Their increased trip lengths are an inconvenience ~~to residents~~. Coordinate with e~~E~~mergency responders ~~must also be considered when~~ prior to using diverters~~diverting traffic~~.

Provide b~~B~~icycle ~~ists~~ and pedestrian~~s~~ ~~should be provided~~ access through traffic diverters.

Table 15 – 4 Diverters

Treatment	Description	Effect	Concerns	Cost
Diagonal Diverters	Barrier placed diagonally across an intersection, interrupting traffic flow forcing drivers to make turns.	Eliminates through traffic.	~~May inhibit~~ May hinder access by emergency vehicles and residents and increase trip lengths.	Medium
Forced Turn Barrier/Diverters	Small traffic islands installed at inter-sections to restrict specific turning movements.	Reduces cut-through traffic.	Could impact emergency vehicle~~s~~ response time.	Low to Medium
Road Closures, Cul-de-sac	One or more legs of the intersection closed to traffic.	Eliminates through traffic improving safety for all street users.	~~May~~ May ~~i~~ncrease volumes on other streets in the area. Access restriction ~~may~~ may cause concerns for emergency responders. Additional R/W ~~right of way~~ for proper turnaround at dead ends ~~may~~ may be required.	Low to Medium
Median Closures	Small median islands installed at cross streets to prevent through movements and restrict left turns.	Reduces cut-through traffic.	Could impact emergency vehicle responses, hinder ~~inhibit~~ access, ~~and~~ increase trip lengths, or transfer volumes to other streets.	Low to Medium

D.5 Other Treatments

These treatments are most effective when used in combination with other physical traffic calming measures~~features~~, and should therefore be used as supplements.

Table 15 – 5 Other Treatments

Treatment	Description	Effect	Concerns	Cost
Pavement Markings	Highlighting various area of a road to increase driver's awareness of certain conditions such as bicycle~~ke~~ lanes ~~or~~ and crosswalks. See Figure 15 - 6.	Inexpensive and ~~may~~ can reduce speed.	~~May~~ May not be as effective as a structure such as a curb.	Low
Traversable Barriers	A barrier placed across any portion of a street that is traversable by pedestrians, bicycles, and emergency vehicles but not by motor vehicles.	Eliminates cut-through traffic.	Inconvenience to some residents.	Medium
Colored Bicycle~~ke~~ Lanes or Shoulders	A bicycle~~ke~~ lane or shoulder painted, covered with a surface treatment, or constructed of a pigmented pavement ~~designed~~ to contrast with the adjacent pavement.	Visually narrows the roadway and ~~may~~ can reduce speeds.	~~May~~ May not be effective on roadways with 12-foot lanes.	Low to medium

Figure 15 – 6 Bicycle Lane, Advance Yield Bar, and Crosswalk

Franklin Blvd, Tallahassee, Florida

E REFERENCES FOR INFORMATIONAL PURPOSES

The publications ~~listed~~ below are ~~additional sources, of information~~ related to the topics presented in this chapter. Also, s~~S~~earch the i~~I~~nternet ~~Web~~ for up-to-date resources using "traffic+calming" as key words.

- Speed Management Safety, FHWA
  https://safety.fhwa.dot.gov/speedmgt/
- Traffic Calming Measures - Institute of Transportation Engineers
  https://www.ite.org/technical-resources/traffic-calming/traffic-calming-measures/
- Canadian Guide to Traffic Calming - Second Edition (2018), Transportation Association of Canada
  https://www.tac-atc.ca/en/publications/ptm-trafcalm18-e
- Primer on Traffic Calming, Canadian Institute of Transportation Engineers and Transportation Association of Canada, January 2018
  http://www.tac-atc.ca/sites/default/files/site/doc/Bookstore/traffic_calming_-_second_edition.pdf
- National Cooperative Highway Research Program (NCHRP) Report 672, Roundabouts: An Informational Guide, Second Edition, (2010)
  http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_672.pdf

CHAPTER 16

RESIDENTIAL STREET DESIGN

A INTRODUCTION

The street is a public way designed to ~~for the purposes of~~ serv~~e~~ing motor vehicles, bicycles, pedestrians, and transit vehicles. The primary function of residential streets is to provide access to the homes that front those streets. ~~The primary consideration, therefore, of r~~ Residential street design should prioritize ~~be to foster~~ a safe and pleasant environment for the street's residents ~~that live along the street,~~ and safe traveling conditions for ~~motorists~~drivers, bicyclists and pedestrians. ~~The c~~ Convenience ~~of~~ to drivers ~~motorists~~ is ~~a~~ secondary ~~consideration~~.

Residential ~~The~~ street design should create an environment that cautions drivers that they are in a residential area where they must safely share the travel~~ing~~ space with pedestrians and bicyclists~~, both~~ (young and old)~~child and adult~~. Some v~~V~~isual cues which alert drivers to the need for lower speeds include: ~~such as~~

- M~~m~~eandering streets,
- S~~s~~idewalks,
- L~~l~~andscaping,
- S~~s~~ignage,
- N~~n~~arrowed streets,
- C~~c~~hanges in pavement texture (such as brick, stamped, or textured surfaces), ~~,~~ and
- R~~r~~aised crosswalks. ~~all serve to heighten drivers' awareness for the need to maintain lower speeds.~~

Incorporating such features into residential street design at inception ~~will reduce or eliminate~~ can prevent the need for traffic calming retrofits.

See ***Section B*** of this chapter ~~discusses~~ for the primary objectives of r~~R~~esidential s~~S~~treet d~~D~~esign ~~in more detail,~~ and to aid ~~the designer~~ in ~~the~~ selecting ~~on of~~ the proper criteria. See ***Section C*** ~~sets forth specific~~ for design criteria for residential streets.

B OBJECTIVES

The basic principles of residential street design are based on these factors based on four factors:

1. Safety
2. Efficiency of Service
3. Livability and Amenities
4. Economy of Land Use,
5. Construction, and
4.6. Maintenance

The following 17 principles incorporate these factors. These principles below incorporate these factors but are not intended as absolute criteria (since they sometimes conflict). , since instances may occur where certain principles conflict. The Use these principles should therefore be used as concepts for proper layout of proper street systems.

1. Provide aAdequate vehicular and pedestrian access should be provided to all parcels.
2. Design lLocal street systems should be designed to minimize through traffic movements (unless it is specifically desired by the cCounty or municipality to connect residential developments).
3. Street patterns should minimize excessive vehicular travel through through connectivity between adjacent residential developments, and to larger street networks.
4. Local street systems should be logical and comprehensible, and systems of street names and house numbers should be simple, consistent, and understandable.
5. Local circulation systems and land-development patterns should not detract from the efficiency of adjacent major streets due to lack of connectivity.
6. Elements inof the local circulation system should not have need to rely on extensive traffic regulations and or enforcement in order to function efficiently and safety.
7. Consider tTraffic generators within residential areas should be considered in the local circulation pattern.
8. The planning and construction of Design and construct residential streets should to clearly indicate their local function. The street's residential nature should be obvious to drivers those driving on them.

9. Design t~~T~~he street system should ~~be designed~~ for a relatively uniform low volume ~~-~~of traffic.

10. Design l~~L~~ocal streets ~~should be designed~~ to discourage excessive speeds.

11. Minimize conflict points for all roadway users~~Pedestrian-vehicular conflict points should be minimized~~.

12. Minimize t~~T~~he amount of space ~~in the land development~~ devoted to motor vehicles ~~uses should be minimized~~.

13. Use s~~S~~maller block sizes ~~may be used~~ to encourage walking ~~or~~ and bicycling. See ***Chapter 19*** ~~***– Traditional Neighborhood Development***~~ for more information.

14. ~~The arrangement of l~~ Local streets patterns should ~~permit~~ promote economical and practical patterns, shapes, and sizes of development parcels and provide interconnectivity without ~~using~~ accessing arterials or collectors.

15. ~~Local streets should consider and utilize~~ Use existing topography from the standpoint of ~~both~~ economics and amenities.

16. Include a~~A~~ppropriate provisions for transit service within residential areas ~~should be included~~.

17. ~~Street design should c~~Consider horizontal and vertical compatibility and connectivity with sidewalks, bicycle lanes, and pedestrian walkways.

C DESIGN ELEMENTS

C.1 Design Speed

Design speeds of 15 to 30 mph are appropriate f~~F~~or local residential streets~~, design speeds of 15 to 30 mph are appropriate~~, depending on the adjacent development, terrain, available R/W~~right of way~~, and other ~~area~~ controls. Alleys and narrow roadways intended to function as shared spaces (~~that is,~~ e.g., could be used to access driveways, for garbage pickup, and travel by walking or bicycling) ~~may~~ can have design speeds as low as 10 mph. Design speeds ~~greater than~~ over 30 mph ~~in residential areas~~ require increased sight distances and radii ~~which~~ and are contrary to the function of a local residential street.

C.2 Sight Distance

C.2.a Stopping Sight Distance

See Table 16 – 1 for m~~The m~~inimum stopping sight distances for residential streets ~~is shown in Table 16 – 1 Minimum Stopping Sight Distance for Residential Streets~~.

Table 16 – 1 Minimum Stopping Sight Distance for Residential Streets

Design Speed (mph)	Stopping Sight Distance (feet)
10	45
15	75
20	125
25	150
30	200

C.2.b Passing Sight Distance

Do not encourage pPassing should not be encouraged on local residential streets, and design for (passing sight distance is seldom applicable) on these streets. If longer straight sections and higher design and posted speeds support passing, the Design longer straight sections of higher-speed roadways that support passing using the criteria street shall be designed under the design criteria provided established in ***Chapter 3 – Geometric Design***.

C.2.c Intersection Sight Distance

Design iIntersections shall be designed with adequate corner sight distance as set forth in (see Table 16 – 2) Minimum Corner Intersection Sight Distance for Residential Streets. Intersection design should take into consideration Consider future growth of landscaping and other amenities. Where a local residential street intersects connects to a higher-order street, use the design criteria of the higher-order street shall control within the R/W right of way of the higher-order street.

Table 16 – 2 Minimum Corner Intersection Sight Distance for Residential Streets

Design Speed (mph)	Corner Intersection Sight Distance * (feet)
10	110
15	160
20	210
25	260
30	310

* Corner sight distance measured from a point on the minor road at least 14.5 feet from the edge of the major road pavement and measured from a eye height of eye at
3.5 feet on the minor road to an object height of object at 3.5 feet on the major road.

Where stop or yield control is not used, Provide at least 300 feet of the corner sight distance where stop or yield control is not provided should be a minimum of 300 feet. If restrictions are unavoidable, a minimum of Provide at least 200 feet is allowed (if restrictions are unavoidable) along with proper warning signage found provided in the ***Manual on Uniform Traffic Control***

Devices (MUTCD) such as an intersection warning sign (W2 series) or cross traffic does not stop here plaque (W4-4P). ~~To maintain the minimum sight distance,~~ Restrictions may be needed on ~~height of~~ embankment heights, building locations ~~of buildings~~, and screening fences to maintain the minimum sight distance ~~may be~~

~~necessary~~. Any landscaping in the sight distance triangle should be low-~~-~~growing~~,~~ and ~~should~~ not ~~be~~ higher than 3 feet above the level of the intersecting street pavement~~s~~. Trim tree overhangs ~~should be trimmed~~ to at least 8 feet above the level of the intersecting street pavement~~ons~~.

Intersections ~~ng streets~~ should ~~meet~~ be at approximately 90 degrees ~~right angles~~. Avoid using intersections ~~ngles of~~ less than 60 degrees ~~should be avoided~~.

C.3 Horizontal Alignment

C.3.a Minimum Centerline Radius

See Table 16 – 3 for ~~The~~ minimum horizontal curve radii ~~for horizontal curves are given in Table 16 – 3 Minimum Centerline Radii for Residential Streets~~. ~~Typically,~~ Do not use s~~s~~uperelevation ~~should not be utilized~~ on local residential streets. ~~Where superelevation is appropriate or required, the street shall be designed under~~ Use the design criteria ~~established~~ provided in ***Chapter 3*** when superelevation is appropriate and required. ~~– Geometric Design~~.

Table 16 – 3 Minimum Centerline Radii for Residential Streets

Design Speed (mph)	Min. Centerline Radius (feet)
10	25
15	50
20	89
25	166
30	275

C.3.b Minimum Curb Return Radius

~~Where there are substantial pedestrian movements,~~ Use a 15-foot minimum curb return (or outside pavement edge) radius where there are many pedestrians ~~the minimum radius of curb return where curbs are used, or the outside edge of pavement where curbs are not used shall be 15 feet~~. A 25-foot minimum radius ~~of 25 feet is desirable to accommodate~~ is better for ~~turning movements of~~ turning service vehicles.

C.4 Vertical Alignment

C.4.a Vertical Curves

Design v~~V~~ertical curves ~~shall be designed for a~~ for a minimum stopping sight distance ~~using the design criteria of~~ for 30 mph ~~established in~~ (see ***Chapter 3***) ~~***– Geometric Design***~~***.***

C.5 Cross Section Elements

C.5.a Width of Roadway

~~The minimum width of a t~~Two-way residential roadways should be at least 20 feet wide from edge-of-pavement to edge-of-pavement (excluding curbs and gutters). Travel lanes should be ~~a minimum of~~ at least 10 feet wide~~, and~~ (wider where practicable). ~~Under constrained conditions or in some very rural areas,~~ Travel lanes can be 9~~-~~feet wide (or narrower) under constrained conditions and in some very rural areas ~~may be used~~. ~~Refer to~~ See ***Chapter 4*** of the ***AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400).*** ~~L~~Travel lanes narrower than 9 feet are prohibited ~~in the absence of~~ without a Design Exception ~~as provided for in~~ (see ***Chapter 14***) ~~***– Design Exceptions and Variations***~~.

~~When parking lanes are provided on one or both sides of the roadway, they shall~~ Parallel parking lanes must be at least 7 feet wide including the gutter section (where applicable).

~~Where curb and gutter sections are used, the~~ A roadway ~~may~~ can be narrowed to just the travel lane width (plus bicycle~~ke~~ lane if present) at curb and gutter intersections to: ~~. This will~~

- P~~p~~revent parking close to the intersection,
- R~~r~~educe pedestrian crossing distances ~~for pedestrians~~,
- P~~p~~rovide space for curb ramps, and
- R~~r~~educe turning speeds. ~~,~~

The visual width of the roadway can be reduced ~~By providing~~ with intersection curb extensions~~, the visual width of the roadway can be reduced~~.

C.5.b Medians

~~When used in residential areas, m~~Comply with Chapter 3 or Chapter 19 for medians ~~or~~ and traffic separators in residential areas~~should conform to~~ ~~***Chapter 3*** or ***Chapter 19***.~~

C.6 Cul-de-sacs and Turnarounds

C.6.a Turning Area

A residential street ~~more than~~ over 100 feet long and open at one end only ~~shall~~ must have a ~~special~~ turning area at the closed end. This turning area should be circular ~~and have~~ with an ~~radius~~ appropriate radius ~~to the types of~~ for the vehicles expected (30-foot minimum). ~~The minimum outside radius of a cul-de-sac shall be 30 feet.~~ ~~In constrained circumstances, o~~Other turning configurations (e.g., a hammerhead) ~~such as a "hammerhead" may~~ can be considered in constrained conditions. Cul-de-sacs can detract from connectivity if used excessively or inappropriately.

C.7 Pedestrian Considerations

C.7.a Sidewalks

~~In residential areas,~~ S~~s~~idewalks should be provided on both sides of ~~the~~ streets in residential areas. The sidewalks should be located as far as practicable from the travel lanes and usually close to the R/W ~~right of way~~ line. Sidewalks only on one side can be considered in ~~In~~ certain circumstances~~, such as~~ (e.g., where lots are very large or there are environmental limitations)~~, sidewalk on only one side may be considered~~. ~~Along collector roadways~~ S~~s~~hared use paths ~~may~~ can be provided in lieu of sidewalks along collector roadways. Connectivity to and between existing public sidewalks and ~~or~~ shared use paths ~~facilities~~ is desired.

Provide pedestrian access ~~should be provided~~ to schools, day care facilities, parks, churches, shopping areas, and transit stops in residential areas ~~within or adjacent to the residential development~~. Design p~~P~~edestrian access ~~to these destinations and throughout the neighborhood shall be designed~~ for safe and convenient pedestrian circulation. Use s~~S~~idewalks ~~or~~ and shared use paths between houses ~~or to~~ and connecting cul-de-sacs ~~may be used where necessary to provide~~ for direct access (where appropriate).

Construct s~~S~~idewalks, crosswalks and mid-block crossings ~~shall be constructed under the criteria set forth~~ in compliance with ***Section C.7.d*** of ***Chapter 3*** ~~***– Geometric Design***~~, and ***Chapter 8*** ~~***– Pedestrian Facilities***~~.

C.8 Bicyclist Considerations

C.8.a Bicycle Facilities

Residential roadways are generally sufficient to accommodate bicycle traffic. ~~When s~~Specific bicycle facilities ~~are desired, they~~ should connect to existing facilities and comply with ~~be designed in accordance with~~ ***Chapters 3*** and ***9*** ~~– ***Geometric Design*** and ***Chapter 9 – Bicycle Facilities***~~. See ***Chapter 9*** f~~F~~or bicycle~~ke~~ lane transitions~~, see **Chapter 9**~~.

C.9 Shared Use Paths

Shared use paths ~~may~~ can be provided in lieu of sidewalks along collectors ~~roads in accordance with~~per ***Section C.7.a***. ~~When s~~ Shared use paths ~~are desired, they~~ should connect to:

- O~~o~~ther pedestrian and bicycle facilities, ~~within or adjacent to the residential area, and connect to~~
- S~~s~~chools,
- D~~d~~ay care facilities,
- P~~p~~arks,
- C~~c~~hurches,
- S~~s~~hopping areas, and
- T~~t~~ransit stops.

Design s~~S~~hared use paths ~~shall be designed in accordance with~~ to comply with ***Section C*** of ***Chapter 9*** ~~– ***Bicycle Facilities***~~. Shared use paths ~~may~~ can be used by golf carts ~~in certain areas,~~ under certain circumstances ~~in accordance with~~per ***Sections 316.212, 316.2125 and 316.2126, F.S.***.

C.10 Clear Zone

See Tables 4 – 1 and 4 – 2 for c~~C~~lear zone requirements for residential streets ~~shall be based on **Chapter 4 – Roadside Design**, Table 4 – 1 Minimum Width of Clear Zone and Table 4 – 2 Lateral Offset~~.

D REFERENCES FOR INFORMATIONAL PURPOSES

~~The following is a list of~~ These publications ~~that may be referenced for~~ provide additional ~~further~~ guidance:

- AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400): ***https://aashtojournal.org/2019/05/31/aashto-issues-second-edition-of-low- volume-roads-guidelines/***

- Manual on Uniform Traffic Control Devices (MUTCD) ***Manual on Uniform Traffic Control Devices (MUTCD) - FHWA (dot.gov)***

CHAPTER 17

BRIDGES AND OTHER STRUCTURES

A INTRODUCTION

Bridges provide safe passage for multimodal traffic over ~~various~~ other ~~obstacles~~ corridors and features ~~along a road or path~~. This chapter ~~presents~~ provides guidelines ~~and standards~~ for designing, constructing, inspecting, and maintaining bridges ~~as well as~~ and other structures ~~such as~~ (e.g., walls and supports for signs, lights, and traffic signals). These ~~standards and~~ criteria are necessary ~~due to~~ for the critical function these structures serve ~~to communities~~ throughout their lifespan. This chapter establishes uniform minimum standards and criteria for all bridges used by the public for vehicular and/or pedestrian traffic ~~as well as~~ and other structures such as (e.g., walls and supports for signs, lights, and traffic signals). ~~The geometry of structures shall follow the standards and criteria set forth in~~ See ***Chapters 3, 8, 9***, and ***13*** for geometry criteria. Document e~~E~~xceptions to these standards and criteria ~~must be processed in accordance with the procedures~~ as described in ***Chapter 14***.

~~In addition to the design criteria provided in this chapter, t~~ The ***United States Department of Transportation ADA Standards for Transportation Facilities (2006), United States Department of Justice ADA Standards (2010)***, as required by ***49 C.F.R 37.41 or 37.43*** and the ***2020 Florida Building Code – Accessibility, 7th Edition*** as required by ***61G20-4.002*** impose additional requirements for the design and construction of pedestrian and bicycle facilities on bridges ~~or~~ and other structures. ~~Examples of facilities include sidewalks and shared use paths, and drainage grates and inlets in or near the accessible route.~~ Significant ADA design considerations exist for all facilities with running slopes ~~grades that exceed~~ over 5%. See t~~T~~he ***Public Rights-of-Way Accessibility Guidelines (PROWAG)*** ~~provide additional information~~ for ~~the~~ designing ~~of~~ pedestrian facilities.

Note: This chapter applies to all bridges under local government control, except ~~for bridges~~ those ~~constructed~~ on or over the FDOT~~'s~~ system. Use FDOT policies, procedures, standards, and specifications f~~F~~or bridges ~~constructed~~ on or~~and~~ over the FDOT~~'s~~ system, ~~as well as~~ and all bridges that ~~will be~~ are maintained by the FDOT~~, FDOT policies, procedures, standards, and specifications will apply~~.

B OBJECTIVES

The objectives of this chapter are to~~ as follows~~:

- ~~To p~~Prescribe uniform criteria ~~with respect to ~~for the design and geometric layout of bridges and miscellaneous structures~~ design and geometric layout~~.
- ~~To a~~Alert owners to ~~the various ~~federal and state requirements for ~~to be included in~~ the design, construction, maintenance, and inspection of ~~their ~~bridges and other structures.
- ~~To p~~Provide practical suggestions (specific to Florida) on prudent structural engineering based on experience with statutes, standards, and criteria.

C DESIGN

A licensed Professional Engineer must lead t~~T~~he design of bridges and other structures ~~shall be led by a licensed professional engineer who shall ~~and must assume responsible charge of the work. The standards and criteria included herein ~~are directed only toward specific considerations that shall ~~are specific considerations which must be followed. Other considerations ~~are necessary to create a comprehensive bridge design ~~allow~~ing~~ owners and ~~their ~~engineer~~'~~s some design flexibility~~y~~ ~~in design~~.~~ All bridges and other structures shall be designed in accordance with~~per~~ specifications (including guide specifications) published by the American Association of State Highway and Transportation Officials (AASHTO).~~

C.1 Bridges - General

All bridges and other structures must ~~shall ~~be designed ~~in accordance with~~in accordance with ~~the~~specifications (including guide specifications) published by the American Association of State Highway and Transportation Officials (AASHTO). ~~At a minimum, ~~Use t~~t~~he ***AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, 9th Edition (2020)*** ~~shall be used~~ at a minimum. Design a~~A~~ny bridge reconstruction (i.e., lengthening, widening, and/or major component replacement) ~~shall be designed~~ as specified in this section. Maintain r~~R~~ecords of such reconstruction ~~shall be maintained~~ as specified in Section D of this chapter. Consider t~~T~~he remaining design life ~~should be considered~~ in the design.

C.2 Bridge Live Loads

In addition to the na~~o~~tional (HL - 93) design load specified in ***LRFD***, bridges ~~shall~~ must also require a FL 120 permit load rating ~~greater than~~ over 1 (as defined in the

FDOT's ***Structures Manual, Volume 1 – Structures Design Guidelines, 2022 (SDG))***.

This vehicle allows ~~for~~ a more consistent load rating comparison considering the current bridge inventory.

C.3 Bridge Superstructure

The bridge superstructure ~~of a bridge~~ is that portion of the structure that spans between its supports or piers. Incorporate the design c~~C~~onsiderations ~~that shall be incorporated~~ below into the design of all superstructures. ~~will include the following:~~

C.3.a Girder Transportation

The ~~Engineer of Record (~~EOR~~)~~ ~~is responsible for~~ must investigate ~~ing the~~ transportation feasibility ~~of transportation~~ for heavy, long and/or deep girder field sections. ~~In general, t~~The EOR should consider these ~~following~~ aspects during ~~the~~ design ~~phase~~:

- Whether or not multiple routes exist between the bridge site and a major transportation facility.
- The transportation of field sections longer than 130 feet or weighing more than 160,000 pounds requires coordination through the FDOT~~'s~~ Permit Office during ~~the~~ design ~~phase of the project~~. Shorter and/or lighter field sections ~~may~~ may be required if access to the bridge site is limited by roadway(s) with sharp horizontal curvature or weight restrictions.
- ~~On~~ Design and detail "Optional Field Splices" in the plans for steel superstructures~~,~~ where field splice locations required by design result in lengths ~~greater than~~ over 130 feet~~, design, and detail "Optional Field Splices" in the plans~~.
- ~~For curved steel box girders, prefabricated trusses, and integral pier cap elements, s~~ Size field sections for curved steel box girders, prefabricated trusses, and integral pier cap elements ~~pieces~~ such that the total hauling width does not exceed 16 feet.

C.3.b Vertical Clearance

Design a~~A~~ll new bridges over roadways and shared use paths ~~shall be designed~~ to meet the vertical clearance requirements ~~standards specified~~ in ***Chapter 3, Section C.7.j.4.(b)***, and ***Chapter 9, Section C.6***.

Design a~~A~~ll new bridges over water ~~shall be designed~~ to meet these ~~following~~ vertical clearance requirements ~~standards~~:

- ~~To allow debris to pass without causing damage~~, ~~the~~ Provide at least 2 feet of vertical clearance between the design flood stage and the bridge's low member to allow debris to pass without causing damage ~~of bridges shall be a minimum of two feet~~. This standard does not apply to culverts ~~and~~ and bridge-culverts.

- ~~For crossings subject to boat traffic, T~~The minimum vertical navigation clearance for crossings with boat traffic should be:

Tidewater bays and streams	6 feet above Mean High Water *
Freshwater rivers, streams, non-regulated/controlled canals, and lakes	6 feet above Normal High Water
Regulated/controlled lakes and canals	6 feet above the control elevation

* ~~For locations subject to tidal salt / brackish water splashing,~~ Consider a~~a~~ 12-foot vertical navigation clearance above Mean High Water ~~should be considered~~ for locations subject to tidal salt/brackish water splashing (for bridge durability ~~reasons~~).

Higher vertical navigation clearances apply for crossings over legislated channels under the control of the United ~~.~~States~~.~~ Coast Guard (USCG). ~~Designers should also c~~Consider future navigation needs ~~demands~~ and future shared use path needs ~~demands~~ in establishing ~~setting the~~ bridge vertical clearance ~~of a bridge~~.

C.3.c Railings

All traffic, pedestrian, and bicycle railings ~~shall~~ must comply with the requirements in ***Section 13*** of ***LRFD***. Traffic railings ~~shall~~ must meet the crash requirements of at least Test Level 3 (TL-3) for bridges with design speeds ~~greater than~~ over 45 mph and at least TL-2 for bridges with design speeds ~~less than or equal to~~ of 45 mph and less.

~~For p~~ Pedestrian/bicycle railings, two-pipe guiderails~~,~~ (and details similar to those in the FDOT~~'s~~ ***Standard Plans*** ~~-~~) ~~may~~ can be mounted on walls or other structures where drop-offs ~~hazards~~ are 5 feet or less. Use c~~C~~oncrete, aluminum or steel railings and details similar in strength and geometry to those in the FDOT~~'s~~ ***Standard Plans*** ~~-~~) ~~shall be used~~ (or modified to suit environmental runoff concerns) where drop-offs ~~hazards~~ are ~~greater~~ more than 5 feet. See ***Standard Plans Instructions*** for ~~more~~ additional information.

C.3.d Expansion Joints

Minimize t~~T~~he number of joints ~~should be minimized~~ to reduce bridge ~~the~~ inspection and maintenance needs ~~of the bridge~~.

C.3.e Drainage

All bridge designs ~~shall~~ must include a site-specific drainage design ~~that is specific to its site~~. Design bridge c~~C~~onveyance ~~of drainage off the bridge roadway should be designed~~ to meet the spread ~~standards contained~~ requirements in the FDOT~~'s~~ ***Drainage Manual, (2022)***. ~~and may~~ Bridge conveyance may ~~include~~ be open systems (i.e., scuppers) or closed systems (i.e., inlets and pipes) based on environmental permitting restrictions. Do not allow bridge drainage ~~from the bridge should not drop~~ to fall onto traffic below. Avoid attaching l~~L~~ongitudinal conveyance piping ~~attached~~ to bridges ~~is expensive and maintenance-intensive, and should be avoided~~ (whenever possible) since it is expensive and maintenance-intensive.

Design drainage c~~C~~onveyance ~~of drainage off~~ from pedestrian facilities ~~shall be designed to provide~~ to ensure an accessible route for pedestrians. See the current version of ***FHWA Publication HEC-21, "Design of Bridge Deck Drainage"*** for additional~~Further~~ guidance on ~~the design of~~ bridge deck drainage. ~~may be found in the current version of~~ ~~***FHWA Publication HEC-21, "Design of Bridge Deck Drainage."***~~

C.3.f End Treatments

See ***Chapter 4*** for r~~R~~equirements for end treatments ~~of structures are given in~~ ~~***Chapter 4 – Roadside Design***~~. Design b~~B~~ridge barriers ~~shall be designed~~ to accommodate the connection of a guardrail transition or energy absorbing system.

C.4 Bridge Substructure

The bridge substructure ~~of a bridge consists of~~ includes all elements below the superstructure (including ~~its~~ bearings, piers, and foundations). ~~For guidance on bridges vulnerable to coastal storms,~~ S~~s~~ee ***SDG, Section 2.5*** for guidance on bridges vulnerable to coastal storms. Incorporate the c~~C~~onsiderations below ~~that shall be incorporated~~ into ~~the~~ all substructure designs. ~~of all substructures include the following~~:

C.4.a Scour

Perform a~~A~~ hydrologic/hydraulic analysis ~~shall be performed~~ to ~~quantify expected~~ estimate stages and flows at the bridge site. Develop the a~~A~~nticipated substructure scour ~~shall be developed~~ for these ~~following~~ conditions:

Hydraulic Design Flood Frequency	Scour Design Flood Frequency	Scour Design Check Flood Frequency
Q_{10}	Q_{25}	Q_{50}
Q_{25}	Q_{50}	Q_{100}
Q_{50}	Q_{100}	Q_{500}
Notes: "Q" is the ~~common term used for~~ flow rate, an expression of volume of fluid which passes per unit of time. "x" is the return period in years (10, 25, 50, 100, 500).		

Any exceptions to ~~the~~ these standards ~~above hydrologic/hydraulic and scour analysis requirements shall~~ must be approved in writing by the FDOT District Drainage Engineer. Comply with the guidelines in the FDOT ***Drainage Manual (2022)*** ~~Methodology~~ for computing bridge hydrology/hydraulics and bridge scour ~~should follow the guidelines set forth in the FDOT's~~ ~~***Drainage Manual (2022).***~~ Additional~~Further~~ guidance and training are available ~~may be obtained~~ through ***FHWA Hydraulic Engineering Circulars (HEC) "HEC-18"*** and ***"HEC-20"*** and the FDOT~~'s~~ training courses on these topics. ~~Additionally,~~ Coordinate with the FDOT District Drainage Engineer for case-specific guidance for larger bridges (>120,000 square~~.~~ feet~~t.~~)~~,~~ ~~hydraulic~~ drainage~~designers may wish to consult with the FDOT District Drainage Engineer for case-specific guidance~~. See ~~The~~ ***SDG, Sections 2.11*** and ***2.12*** and the FDOT~~'s~~ ***Drainage Manual, (2022)*** ~~provide~~ for guidance on scour load combinations with other loads.

C.4.b Navigation Aids and Vessel Collision

Provide bridge fender systems and consider potential vessel collisions for a~~A~~ll bridges over USCG designated navigable waterways ~~shall include bridge fender systems and consideration for potential vessel collision~~.

See ***SDG Section 314*** f~~F~~or guidance on navigation aids and bridge fender system design~~, see~~ ~~***SDG Section 314***~~. See ***SDG, Section 2.11*** and ***LRFD, Section 3.14*** f~~F~~or guidance on vessel collision design ~~see~~ ~~***SDG, Section 2.11***~~ ~~and~~ ~~***LRFD, Section 3.14***~~.

C.4.c Pier Locations

Offset substructure supports from vehicular traffic lanes for a~~A~~ll bridges over roadways ~~shall have substructures supports set back from vehicular traffic lanes in accordance with~~ per ***Chapter 3, Section C.7.j.4.(a)***.

Locate substructure supports for bridges over water to comply with the horizontal clearance requirements below. ~~All bridges over water shall have substructure supports located with horizontal clearance requirements as listed below. In this case, h~~ Horizontal clearance is ~~defined as~~ the clear distance (normal to the flow) between piers, fender systems, or culvert walls~~, etc., projected by the bridge normal to the flow~~.

- Provide at least 10 feet of horizontal clearance f~~F~~or crossings subject to boat traffic ~~a minimum horizontal clearance of 10 feet shall be provided~~.
- ~~Where no boat traffic is anticipated,~~ Provide a minimum horizontal clearance ~~shall be provided~~ consistent with debris conveyance needs and structure economy (where boat traffic is not anticipated).

C.4.d Wildlife Crossing Features

Consider ~~the use of~~ providing wildlife connectivity features (e.g. shelves and wildlife fencing) ~~in accordance with~~ per the FDOT ***Wildlife Crossing Guidelines*** to enhance wildlife mobility and reduce motor vehicle collisions with wildlife. Wildlife crossing features ~~help~~ maintain habitat connectivity, promote wildlife diversity, and enhance ~~motorist~~ driver safety. Adding shelves into the bridge abutment design is a low-~~-~~cost technique ~~which allows~~ for ~~better~~ improved wildlife connectivity and ~~makes~~ safer bridge inspections ~~safer~~.

Wildlife crossing feature~~(~~s~~)~~ ~~may~~may ~~-~~include new or modified structures ~~,~~ ~~such as~~ (e.g., bridges, bridges with shelves, specially designed culverts, enlarged culverts ~~or drainage culverts~~ and/or exclusionary devices such as fencing, walls, ~~or~~ other barriers~~,~~ or some combination thereof) ~~of these features~~. Wildlife refers to listed, protected, or otherwise regulated species ~~that~~ for which the United States Fish and Wildlife Service (USFWS) and/or Florida Fish and Wildlife Conservation Commission (FWC) have jurisdiction ~~over~~.

See t~~T~~he National Transportation Library ~~provides additional~~ for information on ***Wildlife Crossing Structures.***

Figure 17 – 1 Bridge with Shelves for Wildlife

C.5 Retaining and Noise Walls

Comply with the requirements of ***LRFD Section11*** ~~The~~ in designing ~~of~~ retaining wall structures (conventional, anchored, mechanically stabilized, and prefabricated modular). ~~retaining wall structures shall meet the requirements of~~ ~~***LRFD Section***~~

~~***11.***~~ ~~Local agencies should c~~ Consider using only wall types approved by the FDOT ~~. These are~~ as described in ***Section 3.12*** of the ***SDG***. ~~Local agencies should also follow~~ Comply with the design criteria for retaining walls ~~found~~ in ***Section 3.13*** of the ***SDG***.

Comply with the requirements of ***SDG, Section 3.16*** ~~The~~ for designing ~~of~~ noise walls ~~should meet the requirements of the~~ ~~***SDG, Section 3.16***~~. Comply with the requirements below for the design and/or protection ~~For~~ of noise walls within the clear zone ~~, their design and/or protection should comply with the following~~:

- For noise walls attached to the top of traffic railings only u Use only crash-tested systems consistent with the design speed of the facility for noise walls on top of traffic railings. The FDOT has provides standards for TL-4 systems that comply with meet the requirements of ***NCHRP Report 350*** ***or the Manual for Assessing Safety Hardware (MASH)***.
- Non-crash- -tested noise walls may can be attached to structures (whenif located behind an approved traffic railing) and mounted at least five 5 feet from the face of the traffic railing at deck level.

Potential Accommodate any eexisting off-site stormwater inflows (through the proposed wall location) should be verified in the field and considered in the wall design. See ***Section C.3.c.*** fFor railings on top of walls, see ***Section C.3.c. Railings***.

C.6 Sign, Lighting, and Traffic Signal Supports

The design of sign, lighting, and traffic signal support structures shall meet Comply with the requirements of ***AASHTO's LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 1st Edition, with 2017, 2018, 2019 and 2020 Interim Revisions*** and the FDOT ***Structures Manual Volume 3 - FDOT Modifications to LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (LRFDLTS-1)*** for designing sign, lighting, and traffic signal support structures.

C.7 Pedestrian Bridges

See ***SDG Chapter 10*** fFor guidance on pedestrian bridges, see ***SDG Chapter 10***.

D CONSTRUCTION

Take appropriate safety precautions for protecting the public d~~D~~uring the construction of a bridge or any structure at, over, or near a public facility~~, safety awareness is necessary and precautions shall be taken to protect the public~~. Such p~~P~~rovisions ~~for protecting the public during construction shall be in accordance with~~ must comply with the ***MUTCD (2009 Edition with Revision Number 1 and 2, ~~May~~ May 2012)*** work zone traffic control procedures and the ~~standards and~~ criteria ~~described~~ provided in ***Chapter 11*** ~~***– Work Zone Safety and Mobility***~~. Worker safety is the contractor's responsibility ~~of the contractor~~. Install t~~T~~emporary barriers ~~shall be installed~~ on all bridges being widened and ~~or~~ where~~ose~~ new construction is phased. Consider the s~~S~~pread of stormwater on the bridge deck ~~should be considered~~ in planning temporary travel lanes ~~ffic routing~~.

~~During the construction of a bridge or any structure~~, Document and maintain records ~~to be kept and maintained~~ during the construction of a bridge or any structure ~~throughout its life shall~~ including ~~e~~ foundation construction records (pile driving records, shaft tip elevations, borings) and as-built plans. These records are critical ~~provide critical information necessary~~ for future:

- I~~i~~nspection,
- M~~m~~aintenance,
- E~~e~~mergency management,
- E~~e~~nhancement,
- R~~r~~econstruction, and/or
- D~~d~~emolition ~~of these structures~~.

Deliver t~~T~~hese records ~~shall be delivered~~ to the FDOT~~'s local~~ District Structures Maintenance Engineer~~s~~.

Any proposed changes to ~~the~~ construction details or specifications ~~shall~~ must be signed, sealed, and dated by a Florida-licensed P~~p~~rofessional E~~e~~ngineer ~~licensed in the State of Florida~~.

E ROUTINE INSPECTION AND MAINTENANCE

Title 23, Code of Federal Regulations, Part 650, Subpart C~~,~~ sets forth the ***National Bridge Inspection Standards (NBIS)*** for bridges on all public roads. ***Section 650.3*** defines bridges, specifies inspection procedures and frequencies, and indicates minimum personnel qualifications~~ for personnel~~. Each state ~~is permitted to~~ can modify its bridge inspection standards to deviate from the NBIS standards (but only ~~following~~ with approval from the FHWA).

Section 335.074, F.S.~~,~~ mandates safety inspection of bridges. Bridge inspectors ~~shall~~ must be certified ~~in accordance with~~ per ***Chapter 14-48, F.A.C.*** Conduct bridge s~~S~~afety inspections ~~of bridges shall be conducted in accordance with~~ per ***Chapter 14-48, F.A.C.***

The FDOT inspects all bridges in Florida~~,~~ (~~both~~ on-system and off-system) and provides copies of its inspection reports to each local government~~ with copies of its inspection reports~~. ~~Each l~~Local governments should maintain these reports to be responsive to Metropolitan Planning Organization requests for bridge rehabilitation, replacement, or enhancement designations.~~ Please~~ S~~s~~ee the ~~following for further information:~~ ***Bridge and Other Structures Reporting Manual 850-010-030*** ~~.~~ for additional information.

The FDOT assigns a bridge number to a~~A~~ll bridges (on-system and off-system) ~~bridges are assigned a Bridge Number by the FDOT~~. ~~For new bridges,~~ L~~l~~ocal governments ~~agencies shall~~ must contact the FDOT ~~'s local~~ District Structures Maintenance Engineer~~s~~ to have a number assigned for all new bridges.

F BRIDGE LOAD RATING AND POSTING

Section 335.074, F.S. Safety Inspection of Bridges requires that bridges on a public transportation facility be inspected for structural soundness and safety at regular intervals. The inspection ~~shall~~ must consider:

- The age of the bridge,
- T~~t~~raffic characteristics,
- S~~s~~tate of maintenance, and
- K~~k~~nown deficiencies ~~of the bridge~~.

The local governmental ~~entity having~~ responsible for maintenance ~~responsibility for any such bridge shall be~~ is also responsible for having inspections performed and reports prepared.

~~As required by **_Section 335.074, F.S._**,~~ ***Section 335.074, F.S.*** requires that e~~e~~ach inspection ~~shall be reported~~ be reported to the FDOT~~,~~ using the Bridge Load Rating Summary Table form ~~shown~~ provided in the FDOT ***Bridge Load Rating Manual***~~.~~. ~~-~~See the FDOT ***Office of Maintenance, Bridge Load Rating*** web site ~~Further information~~ for preparing ~~a~~ the bridge load rating summary ~~and fillable form may be found on the FDOT's **_Office of Maintenance, Bridge Load Rating_** web site~~.

~~Upon receipt of an inspection report that recommends reducing the weight limit on a bridge, t~~ The local governmental ~~entity having maintenance responsibility for~~ responsible for bridge maintenance ~~the bridge shall~~ must load post ~~the~~ a bridge within 30 days of receiving an inspection report that recommends reducing the bridge weight limit (in accordance FS 335.074(5)). See ***Section 316.555 F.S.*** ~~Further~~ for additional requirements for reporting and posting ~~of~~ weight, size or speed limits on bridges ~~are found in this statute, **_Section 316.555 F.S. Weight, load, speed limits may be lowered_**.~~ ~~The~~ Promptly install the a~~a~~ppropriate signage ~~shall be promptly installed~~ ~~in accordance with~~ dictated by the ***MUTCD***.

~~For new construction or reconstruction projects, t~~The bridge owner ~~is responsible for~~ must provide~~ing~~ the FDOT with a load rating and completed Bridge Load Rating Summary Table for new construction and reconstruction projects within 90 days of opening (for on-system bridges) or 180 days (for off-system bridges). The bridge owner should ~~consider~~ require~~ing~~ the EOR~~engineer of record~~ to perform the load rating.

G RECOMMENDATIONS

- Involve the public in determining "*the appropriate aesthetics based upon scale, color, and architectural style, materials used to construct the facility, and the landscape design and landscape materials around the facility…" (Section 336.045, F.S.).*
- Consider ~~the potential for~~ the potential future expansion of a bridge's capacity (vehicular, ~~-~~transit and pedestrian) in its layout and bridge-type selection.
- Use the FDOT~~'s~~ objective construction unit prices (~~contained~~ provided in the Structures Design Guidelines, Sections 9.2 and 9.3) to select bridge type(s) to consider ~~for~~ in final design.

H REFERENCES FOR INFORMATIONAL PURPOSES

The publications below have been referenced in this chapter can be obtained from the following websites.

- FDOT Publications may be found are located at:
  http://www.fdot.gov/publications/

- AASHTO , all publications may can be ordered atfrom:
  bookstore.transportation.org

- FHWA “HEC-18” and “HEC-20” may be found are located at:
  http://www.fhwa.dot.gov/engineering/hydraulics/library_listing.cfm

- 2006 Americans with Disabilities Act Standards for Transportation Facilities
  https://www.access-board.gov/files/ada/ADAdotstandards.pdf

  - 2017 Florida Accessibility Code for Building Construction
    https://codes.iccsafe.org/public/document/FAC2017

CHAPTER 18

SIGNING AND MARKING

A INTRODUCTION

Signing and pavement markings ~~help~~ improve highway safety by providing guidance ~~information~~ to road users. ~~Both~~ S~~s~~igns and pavement markings should ~~provide~~ be sufficiently visibility to meet ~~the~~ user~~'s~~ needs. The design of signs and pavement markings should complement the ~~basic~~ highway design. ~~Designers and engineers should also be aware of~~ Consider the needs and capabilities ~~and needs~~ of seniors. ~~, and consider~~ Include appropriate measures to ~~better~~ meet their needs and capabilities.

See Sections C and D of this chapter ~~specifically discuss~~ for traffic control devices ~~for both signing and pavement marking that~~ which accommodate ~~not only~~ the needs of all ~~types of~~ road users ~~, but also~~ and the special needs of seniors.

B BACKGROUND

Section 316.0745, F.S.~~,~~ requires the FDOT to compile and publish a manual of uniform traffic control devices for use on ~~the~~ Florida's streets and highways. ~~of the state. To comply with this statute, t~~ The ~~Federal Highway Administration's (~~FHWA~~)~~ ***Manual on Uniform Traffic Control Devices (MUTCD)*** ~~has been adopted~~ has been adopted for use in ***Rule 14-15.010, F.A.C.*** to comply with this statute. ~~:~~ All references in this chapter ~~are in conformance~~ comply with the ***MUTCD***. ~~:~~

The ***Manual on Speed Zoning for Highways, Roads, and Streets in Florida (2019),*** ~~is adopted~~ is adopted for use by the State of Florida under ***Rule 14-15.012, F.A.C.*** The FDOT prepared this manual ~~is prepared by the FDOT~~ (in compliance with ***Chapter 316, F.S.***~~,~~) to promote uniformity in ~~the~~ establishing ~~ment of~~ state, municipal, and county speed and school zones ~~throughout the State~~.

C SIGNS

C.1 Advance Street Name Signs

~~The use of a~~Advance street name signs provide~~s~~ advance notice ~~fication~~ to road users to ~~assist them in making~~ promote safe roadway decisions. Provide advance street name s~~S~~igns ~~should be used~~ for:

- S~~s~~ignalized and~~or~~ non-signalized intersections that are classified as ~~a~~ minor arterial or higher, ~~or~~
- ~~a c~~ Cross streets that provide~~s~~ access to a traffic generator, and~~or~~
- Cross streets ~~possesses other comparable~~ (with similar physical or traffic characteristics) deemed to be critical or significant.

C.1.a Standards

The words Street, Boulevard, Avenue, etc.~~,~~ ~~may~~ can be abbreviated, deleted, or reduced in size to ~~conserve~~ minimize sign panel length. ~~However, if~~ Do not delete these words where confusion ~~would~~ could result ~~due to~~ due to similar street names in the area ~~, the deletion should not be made~~.

~~Use of~~ T~~t~~he local name is preferred ~~on advance street name signs~~. When a cross street ~~has a different~~ has different names on each side of ~~the~~ an intersection, show both names ~~shall be shown~~ with ~~an~~ arrows ~~beside each name to~~ designating ~~e~~ their respective directions. Additional legend ~~such as~~ (e.g., NEXT SIGNAL or XX FEET) ~~may~~ can be added.

C.1.b Installation

Install a~~A~~dvance street name signs ~~should be installed~~ in advance of ~~the~~ intersections ~~in accordance with~~ by the distances provided~~shown~~ in "Condition A" of ***Table 2C-4~~. Guidelines for Advance Placement of Warning Signs~~ of the MUTCD***. Measure t~~T~~hese distances ~~are~~ from the beginning of the taper for the longest intersection turn lane ~~to be considered the minimum for a single lane change maneuver, and should be measured from the begin taper point for the longest auxiliary lane designed for the intersection~~. Consider t~~T~~he ~~degree~~ amount of traffic ~~congestion~~ and ~~the~~ potential number of lane changes ~~maneuvers that may be required should also be considered when~~ in determining the advance placement distance.

C.1.c Sign Design

Design a~~A~~dvance street name signs ~~shall be designed in accordance with~~ to comply with ***Part 2 Signs*** of the ***MUTCD***. The lettering ~~for the signs shall~~ must be ~~composed of~~ a combination of lower-~~-~~case ~~letters~~ with initial upper-case~~ letters~~.

Letter height should conform to Table 18 – 1~~ Design Guidelines for Advance Street Name Signs~~. ~~Various layouts for~~ See Figure 18 – 1 for example layouts of advance street name signs~~ are shown in Figure 18 – 1 Examples of Advance Street Name Signs~~.

Table 18 – 1 Design Guidelines for Advance Street Name Signs

Posted Speed Limit	Street Name Legend Letter Size (inches) Series E Modified (EM) Upper/Lower Case Letters	Next Signal or Intersection Letter Size (inches) Series D (D) Upper Case Letters
35 mph or less	8 EM	6 D
40 mph or ~~greater~~more	10.67 EM	8 D

Figure 18 – 1 Examples of Advance Street Name Signs

C.2 Advance Traffic Control Signs

Install a~~A~~dvance t~~T~~raffic c~~C~~ontrol signs~~,~~ (i.e., Stop Ahead~~ (W3-1)~~, Yield Ahead ~~(W3-2)~~, and Signal Ahead~~ (W3-3~~)~~ signs, shall be installed~~ on ~~an~~ approaches to ~~a~~ primary traffic control devices that ~~is~~ are not visible for a sufficient distance to ~~permit~~ allow the driver to respond~~ to the device~~. The visibility criteria for traffic signals ~~shall be~~ is based on ~~having~~ a continuous view of at least two signal faces for the distances specified in ***Table 4D-2***~~.~~ ~~***Minimum Sight Distance for Signal Visibility***~~ of the ***MUTCD***.

Consider using~~An~~ a~~A~~dvance t~~T~~raffic c~~C~~ontrol signs ~~may be used~~ for additional emphasis~~ of the primary traffic control device~~, even whe~~n~~re ~~the~~ device visibility ~~distance to the device~~ is satisfactory.

C.3 Overhead Street Name Signs

Use o~~O~~verhead street name signs (with mixed-case lettering) ~~should be used~~ at major multi-lane intersections ~~(with multi-lane approaches)~~ as a supplement to post~~-~~mounted street name signs.

C.3.a Standards

Use o~~O~~verhead street name signs ~~shall only be used~~ to identify cross streets~~,~~ (not destinations such as cities or facilities). Ensure the minimum maintained retro-reflectivity specified in ***Table 2A-3*** of the ***MUTCD*** t~~T~~o avoid the need for sign lighting~~ of overhead signs, they should have a minimum maintained retroreflectivity value as shown in~~ ~~***Table 2A-3. Minimum Maintained Retroreflectivity Levels, MUTCD***~~. Consider r~~R~~oadway geometry and forward sight distance ~~will also influence the~~ in assessing the need for overhead sign lighting.

The words Street, Boulevard, Avenue, etc.~~,~~ ~~may~~ can be abbreviated, deleted, or reduced in size to ~~conserve~~ minimize sign panel length. Omit t~~T~~he sign border ~~should be eliminated on overhead street name signs~~ to minimize sign panel size. ~~When a cross street is known by both a route number and a local name, use of the~~ The cross street's local name is preferred over its route number.

Two options are allowed w~~W~~hen a cross street has a different name on each side of an ~~the~~ intersection~~, two options are permitted~~:

- ~~When two sign panels are used, i~~ Install one sign panel on the left side of the signal heads and ~~the~~ another ~~sign panel~~ on the right, ~~side of the signal heads;~~ or

- ~~When one sign panel is used,~~ Display the left name ~~should be displayed~~ over the right name. Include aArrows ~~should be provided to~~ indicatinge ~~which~~ the side ~~of the intersection the~~ that each street name applies.

C.3.b Installation

~~Due to the possibility of hurricane strength winds,~~ Do not install o~~o~~verhead street name signs ~~should not be installed~~ on span wires (due to the potential for strong winds). ~~but should be m~~ Mount~~ed~~ them to the strain pole or mast arm instead.

The sign location ~~of the overhead street name sign on a signal strain pole and/or mast arm may~~ can vary~~. However, it shall~~ but cannot interfere with the ~~motorist's~~ driver's view of the signal heads. See the FDOT ***Standard Plans*** for t~~T~~he preferred location ~~is shown in the FDOT's *Standard Plans*.~~ ~~In the case of separate~~ Where there are different street names on each side, ~~of the street, where separate signs are used, one sign should be~~ place~~d~~ one sign to the right of the signal heads and the other ~~sign~~ to the left of the signal heads.

C.3.c Sign Design

~~On roadways with speeds of 40 mph or above, the s~~Sign panels for roadways with speeds of 40 mph and more should be at least 24 inches high ~~in height~~ (with ~~the~~ length determined by text). ~~At a minimum,~~ U~~u~~se 8-inch upper case and 6-inch lower case minimum lettering ~~for the street name~~. ~~If block numbering text is included,~~ U~~u~~se 6-inch all upper case lettering on the second line if block numbering text is included. The preferred font is Series E-Modified. ~~; however,~~ Series E ~~may~~ can be used ~~to accommodate the amount of legend so as not to~~ to avoid exceeding the 96-inch maximum sign length.

~~Where structurally possible,~~ Design o~~o~~verhead street name signs ~~should be designed in~~ to comply ~~iance~~ with ~~the~~ FHWA ~~recommendations~~ guidance for older drivers, using ~~a minimum lettering size of~~ 10-inch upper case ~~with~~ and 9-inch lower case lettering where structurally possible.

C.3.d Internally-Illuminated Overhead Street Name Signs

~~An~~ I~~i~~nternally~~-~~ illuminated overhead street name signs ~~may be used to~~ improve night-time visibility~~. Internally illuminated overhead street name signs~~ and should be ~~have a standardized height of~~ 24 ~~-~~inches high and ~~a length not to exceed~~ no more than 108 ~~-~~inches (nine feet) long.

~~A~~ Use Series E~~-~~Modified font or Series E font (to accommodate more text) ~~font, which may vary to accommodate the amount of text on the panel should be used~~.

The sign design must ~~shall be in accordance with~~ comply with the ***MUTCD***. ~~When possible, the text should utilize the following text~~ Use these text attributes in descending order (when possible) to limit ~~the maximum~~ sign length ~~width~~:

- 10-inch upper case with 8-inch lower case~~,~~ (Type EM font)
- 10-inch upper case with 8-inch lower case~~,~~ (Type E font)
- 8-inch upper case with 6-inch lower case~~,~~ (Type EM font)
- 8-inch upper case with 6-inch lower case~~,~~ (Type E font)

Internally illuminated overhead street name signs ~~shall~~ must be on the FDOT~~'s~~
~~Approved Products List (~~APL~~)~~.

C.4 Community Wayfinding Guidance

Community wayfinding guide signs should be developed and approved through local resolution ~~with~~ using the destination criteria ~~for the destinations~~ shown on the community wayfinding guide sign system plan. ~~Any wayfinding guide sign should~~ Comply with ~~be used in accordance with~~ ***Rule 14-51.030, F.A.C.*** ~~The intent is to~~ Wayfinding signs provide guidance ~~and navigation information~~ to local:

- C~~c~~ultural,
- H~~h~~istorical,
- R~~r~~ecreational, and
- T~~t~~ourist destinations~~activities~~.

Advertisements are prohibited ~~No destination should be displayed for the purpose of advertising~~.

C.5 Dynamic Message Signs (DMS) Overview

~~The main purpose of dynamic message signs (DMS) is to~~ DMS convey timely ~~and~~ important en-route ~~and~~ roadway ~~side~~ information to ~~motorist~~ drivers ~~and travelers~~. S e e the FDOT policy on ***Displaying Messages on Dynamic Message Signs Permanently Mounted on the State Highway System*** ~~Further information on how~~ for using DMS signs ~~may be used can be found in the FDOT's policy on~~ ***~~Displaying Messages on Dynamic Message Signs Permanently Mounted on the State Highway System.~~***

C.6 Design Details for Signs

The ***MUTCD*** ~~shall~~ governs all sign details. ~~At a minimum,~~ Use t~~t~~he “Conventional Road” size (at a minimum) ~~shall be used on~~ for signs intended for motor vehicle operations ~~ors~~.

Comply with the “Shared-Use Path” sizing in the MUTCD for s~~S~~hared use path sign sizes ~~ing for traffic control shall follow the “Shared-Use Path” sizing and height shown in the MUTCD~~. See ***Chapter 9*** ~~***– Bicycle Facilities***~~ for additional requirements ~~on the signing of shared use paths~~.

D PAVEMENT MARKINGS

D.1 Pavement Markings

Use 6-inch wide pavement markings ~~should be used~~ for all: ~~pavement~~

- C~~c~~enter~~-~~lines,
- L~~l~~ane ~~separation~~ lines, and
- E~~e~~dge lines ~~markings~~.

See ~~The~~ ***FDOT Design Manual, Chapter 230*** ~~provides~~ for additional information~~,~~ (~~including~~ and material options).

D.2 Reflective Pavement Markers

~~To provide greater emphasis and increase visibility to the pavement markings, especially during wet/night conditions,~~ Use r~~R~~aised p~~P~~avement m~~M~~arkers (RPMs) ~~should be used~~ to provide more emphasis and visibility to the pavement markings (especially during wet/night conditions). ~~More information on~~ See ***FDOT Standard Plans, Index 76-001*** for RPM configurations ~~is shown in the FDOT's~~ ~~***Standard Plans, Index 76-001.***~~

E AUDIBLE AND VIBRATORY TREATMENTS

E.1 Longitudinal Audible Vibratory Treatments

Longitudinal a~~A~~udible ~~and~~ v~~V~~ibratory t~~T~~reatments (AVTs) are an effective low-cost countermeasure ~~to~~ for reducinge~~e~~ the ~~severity and~~ frequency and severity of lane departure crashes.

~~Audible Vibratory Treatments (~~ Provide AVTs ~~) shall be provided~~ for edge lines and center~~-~~lines on flush-shoulder roadways with ~~a~~ posted speeds of 50 mph ~~or~~ and ~~greater~~ more and lane widths of 11 feet ~~or~~ and more~~greater~~. Include s~~S~~ections ~~where~~ with lower advisory speeds ~~are used due to~~ for restricted horizontal and/or vertical geometry ~~shall not be excluded~~. Do not locate AVTs ~~shall not be placed~~ within the limits of a crosswalk~~s~~.

See FDOT ***Standard Plans, Index 546-010*** and ***FDOT Design Manual, Chapter 210*** ~~More information on~~ for more information on these types of treatments ~~are shown in the FDOT's~~ ~~***Standard Plans, Index 546-010***~~ ~~and~~ ~~***FDOT Design Manual, Chapter 210 Arterials and Collectors.***~~ AVT options include:

- S~~s~~inusoidal ground-in rumble strips and

- Pprofiled thermoplastic.

The sinusoidal ground-in rumble strip option provides the most economical and durable solution with less noise pollution.

E.2 Transverse Rumble Strips

Transverse rumble strips alert the drivers in rural areas to upcoming stops conditions or and abrupt alignment changes in alignment. Consider fFactors influencing their use including e crash history, roadway geometry and surrounding land use (noise pollution). They should not be Do not locate transverse rumble strips placed within the limits of a crosswalks or bicycle facilityies. On roadways open to bicycle travel, a minimum Maintain at least 4 feet of clear path of 4 feet on the outside edge for roadways open to bicycles should be provided. See ***Sections 3J.02 Transverse Rumble Strip Markings*** and ***6F.87 Rumble Strips, MUTCD***

~~provide further information on the use of~~ for using transverse rumble strips.

See ***Chapter 11*** ~~***– Work Zone Safety and Mobility*** for requirements~~ for installing ~~ation of~~ short-~~-~~term transverse rumble strips during construction ~~activities~~.

F RAILROAD DYNAMIC ENVELOPE PAVEMENT MARKING AND SIGNAGE

Railroad d~~D~~ynamic e~~E~~nvelope pavement markings ~~are used to~~ delineate the areas around at-grade railroad crossings where vehicles should not stop. See ***Chapter*** ***7*** ~~***– Rail-Highway Crossings***~~ for guidance on the design and installation of railroad dynamic envelope pavement markings and signage.

CHAPTER 19

TRADITIONAL NEIGHBORHOOD DEVELOPMENT

A INTRODUCTION

Florida is a national leader in the planning, design and construction of Traditional Neighborhood Development (TND) communities, and in the renovation of downtown neighborhoods and business districts. 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, with ~~and include other uses such as~~ stores, schools, and worship within walking distances of residences.

~~They~~ TND communities represent patterns of development aligned with the state's growth management, smart growth and sprawl containment goals. This approach~~,~~ (with its greater focus on pedestrian, bicycle and transit mobility)~~;~~ is distinct from c~~C~~onventional s~~S~~uburban d~~D~~evelopment (CSD). CSDs are comprised largely of subdivision and commercial strip development.

TND communities rely on a strong integration of land use and transportation. A TND has the clearly defined characteristics and design features ~~that are~~ necessary to achieve the goals for compact and livable development patterns reinforced by a context-sensitive transportation network. The treatment of land use, development patterns and transportation networks necessary for successful TND communities is a major departure from those same elements currently utilized in other ~~Greenbook~~ chapters herein.

To ~~provide a design that~~ accomplish~~es~~ the goals ~~set out in~~of this chapter, designers ~~will be~~are guided by the context of the built environment~~,~~ (established or desired)~~, for a portion of the communities~~ because TND communities rely on a stronger integration of land use and transportation than CSD communities. This chapter provides criteria that ~~may~~ can be used for the design of streets within a TND ~~when such features are desired, appropriate and feasible. This involves providing~~ for a balance between mobility and livability. This chapter ~~may~~ can be used in planning and designing new construction, urban infill, and redevelopment projects.

Section B of this chapter discusses the primary objectives of TND in more detail to aid the designer in the selection of proper criteria. Section C sets forth specific provides design criteria for the transportation system within TND.

The FDOT Department's ***Traditional Neighborhood Development Handbook (2011)*** provides designers guidance in the successful application of this cChapter.

B APPLICATION

A project or community ~~plan may~~ can be considered a TND when at least the first seven ~~of the~~ following principles are included:

1. Has a compact, pedestrian-oriented scale that can be traversed in a five to ten-minute walk from center to edge.
2. Is designed with low speed, low volume, interconnected streets with short block lengths, 150 to 500 feet, and cul-de-sacs only where no alternatives exist. Cul-de-sacs ~~, if necessary,~~ should have walkway and bicycle connections to other sidewalks and streets to provide connectivity within and to adjacent neighborhoods.
3. Orients buildings at the back of sidewalk~~,~~ (or close to the street) with off-street parking located to the side or back of buildings, as not to interfere with pedestrian activity.
4. Has building designs that emphasize higher intensities, narrow street frontages, connectivity of sidewalks and paths, and transit stops to promote pedestrian activity and accessibility.
5. Incorporates a continuous bike and pedestrian network with wider sidewalks in commercial, civic, and core areas, but ~~at a minimum~~ has sidewalks at least five feet wide on both sides of the street at a minimum. Accommodates pedestrians with short street crossings, ~~which may include~~ mid-block crossings, bulb-outs, raised crosswalks, specialty pavers, or pavement markings.
6. Uses on-street parking adjacent to the sidewalk to calm traffic, and offers diverse parking options ~~, but planned so~~ that i~~t~~ do~~es~~ not obstruct access to transit stops.
7. Varies residential densities, lot sizes, and housing types~~,~~ while maintaining an average net density of at least eight dwelling units per acre, with ~~and~~ higher densit~~y~~ies in the center.
8. Integrates at least ten percent of the developed area for nonresidential ~~and~~ civic uses~~, as well as~~ and open spaces.
9. ~~Has~~ Provides only the minimum ~~right of way~~ R/W necessary for the street, median, planting strips, sidewalks, utilities, and maintenance ~~that are~~ appropriate to the adjacent land uses and building types.
10. Locates arterials ~~highways~~, ~~major~~ collectors ~~roads~~, and other high-volume corridors at the edge of the TND and not through the TND.

The design criteria in this chapter ~~shall~~ are only ~~be~~ applicable within the area defined as TND.

C PLANNING CRITERIA

Planning for TND communities occurs at several levels, including the region, the city/town, the community, the block~~,~~ and ~~,~~ finally, the street and building. Planning should be holistic, looking carefully at the relationship between land use, buildings, and transportation in an integrated fashion. This approach~~,~~ (and the use of form-~~ ~~based codes)~~,~~ can create development patterns that balance walking~~pedestrian~~, bicycling, and transit with motor vehicle transportation.

C.1 LAND USE

~~In addition to its importance in calculating trip generation, t~~The Institute of Transportation Engineers (ITE) recognizes land use as fundamental to establishing context, design criteria, cross-section elements, and ~~right of way~~ R/W allocation in addition to its importance in calculating trip generation. The pedestrian travel ~~that is~~ generated by the land uses is ~~also~~ important to the design process for various facilities.

A well-integrated~~,~~ (or "fine grained")~~,~~ land use mix within buildings and blocks is essential. These buildings and blocks aggregate into neighborhoods, which should be designed with a mix of uses to form a comprehensive planning unit that aggregates into larger villages, towns, and regions. Except at the regional scale, each of these requires land uses to be designed at a pedestrian scale and to be served by "complete streets" that safely and attractively accommodate ~~many~~ all modes of travel.

~~The p~~Proposed land uses, residential densities, building size and placement, ~~proposed~~ parking (on-street and off-street) and circulation, the ~~location and~~ use of open space, and the ~~development~~ overall phasing are all considerations in ~~facility~~ the design ~~for~~ of TNDs. ITE recommends a high level of connectivity, short blocks that provide many choices of routes to destinations, and a fine-grained urban land use and lot pattern. Higher residential density and nonresidential intensity~~,~~ (as measured by floor area ratios of building area to site area)~~,~~ are ~~required~~ essential to ~~for~~ well-designed TNDs.

C.2 NETWORKS

Urban networks are ~~frequently~~ typically characterized as either traditional or conventional. Traditional networks are typically characterized by a relatively non-hierarchical pattern of short blocks and straight streets with a high density of intersections that support all modes of travel in a balanced fashion.

Figure 19 – 1 Traditional Network

New York, NY **Savannah, GA**

(Source: VHB)

In contrast, ~~The~~ a typical conventional street network~~, in contrast, often~~ includes a framework of widely-spaced arterial roads with limited connectivity provided by a system of large blocks, curving streets and a branching hierarchical pattern, often terminating in cul-de-sacs.

Figure 19 – 2 Conventional Network

Walnut Creek, CA
(Source: VHB)

Traditional and conventional networks differ in three easily measurable respects: (1) block size~~,~~ (2) degree of connectivity and (3) degree of curvature. While ~~the~~ degree of curvature ~~last~~ does not significantly impact network performance, block size and connectivity create very different performance characteristics.

Some a~~A~~dvantages of traditional networks include:

Distribution of traffic over a network of streets, reducing the need for ~~to~~ wider~~n~~ roads;

A highly interconnected network providing a choice of multiple routes of travel for all modes, including emergency services;

More direct routes between origin and destination points, ~~which~~ generating~~e~~ fewer vehicle miles of travel (VMT) than conventional suburban networks;

Smaller block sizes in a network that is highly supportive ~~to~~ of pedestrian, bicycle, and transit modes of travel;

A block structure that provides ~~greater~~ increased flexibility for land uses to evolve over time.

It is important in TND networks to have a highly interconnected network of streets with smaller block sizes than in conventional networks. There are several ways to ensure ~~that~~ these goals are achieved.

One method is based upon the physical dimensions used to layout streets and blocks. The following list identifies those parameters:

1. Limit block size to an average perimeter of approximately 1,320 feet.
2. Encourage an average intersection spacing for local streets of 300-400 feet.
3. Limit maximum intersection spacing for local streets to approximately 600 feet.
4. Limit maximum spacing between pedestrian/bicycle connections to approximately 300 feet (~~that is, it~~ creating~~es~~ mid-block paths and pedestrian shortcuts).

D OBJECTIVES

The basic objectives of ~~a Traditional Neighborhood Development~~ TND are:

1. Safety
2. Mobility of all users (vehicles, pedestrians, bicyclists and transit)
3. Compact and livable development patterns
4. Context-sensitive transportation network

TND features are based upon ~~the~~ consideration of the following concepts. These concepts are not intended as absolute criteria ~~since~~ and certain concepts ~~may~~ may conflict. The concepts should ~~therefore~~ be used for the layout of proper street systems.

1. Strong integration of land use and transportation.
2. Very supportive of pedestrian, bicycle, and transit modes.
3. Smaller block sizes to improve walkability~~,~~ and ~~to~~ create a fine network of streets accommodating bicyclists and pedestrians~~, and~~ providing a variety of routes for all users.
4. On-street parking is favored over surface parking lots.
5. Limited use of one-~~ ~~way streets.
6. Speeds for motor vehicles are ideally kept in the range of 20-35 mph ~~through~~ via ~~the~~ design of the street, curb extensions, ~~use of~~ on-street parking, and the creation of enclosure through building and tree placement.
7. Street geometry (narrow streets and compact intersections), adjacent land uses, and other elements within a TND must support a high level of transit, pedestrian and bicycle activity.
8. Provide access ~~to~~ for emergency services, transit, waste management, and delivery trucks.
9. Provide access to property.

This approach to street design requires ~~close~~ special attention to the operational needs of transit, fire and rescue, waste collection, and delivery trucks. As such ~~For this reason~~, early coordination with transit, fire and rescue, waste collection, and other stakeholder groups is essential. ~~For fire and rescue, determination of the importance of that corridor for community~~ A~~a~~ccess for fire and rescue should be determined~~,~~ (e.g. primary and~~or~~ secondary access).

More regular An increased encroachment of turning vehicles into opposing lanes will occurs at intersections. Therefore, frequency the amount of transit service, the traffic volumes, and the speeds at those intersections must all be considered when in designing intersections.

Creativity and special attention to pedestrian and bicyclist safety must be balanced with the operational needs of motor vehicles When in designing features and streets for TND communities, creativity and careful attention to safety for pedestrians and bicyclists must be balanced with the operational needs of motor vehicles.

Finally, iIt is very important (whenwhen designing in TND communities) to ensure that a continuous network is created for pedestrians, bicyclists, and transit throughout the community to create higher levels of mobility that are less dependent on motor vehicle automobile travel.

E DESIGN ELEMENTS

The criteria provided in this chapter ~~shall~~ require the approval of the maintaining authority's designated Professional Engineer representative~~ with project oversight or general compliance responsibilities~~. Approval ~~may~~ can be given based upon a roadway segment or a specific area.

The criteria provided in this chapter are generally in agreement with AASHTO guidelines with a special emphasis on urban, low-speed environments. TND d~~D~~esign elements ~~within TND projects~~ not meeting the requirements of this chapter are subject to the requirements for Design Exceptions ~~found~~ provided in ***Chapter 14*** of this manual.

E.1 Design Controls

E.1.a Design Speed

The application of design speed for TND communities is philosophically different than for ~~conventional transportation and~~ CSD communities. Traditionally, the approach ~~for setting~~ to establishing design speed was to use as high a design speed as practical.

In contrast~~ to this approach~~, the goal for TND communities is to establish a design speed that creates a safer and more comfortable environment for pedestrians and bicyclists~~,~~ and is appropriate for the surrounding context.

Design speeds of 20 to 35 mph are desirable for TND streets. Alleys and narrow roadways intended ~~to function~~ as shared spaces ~~may~~ can have design speeds as low as 10 mph.

E.1.b Movement Types

Movement types are used to describe the expected driver experience on a given thoroughfare, and the design speed for pedestrian safety and mobility established for each of these movement types. ~~They~~ Movement types are also used to establish the components and criteria for the design of streets in TND communities.

Yield: Has a design speed of less than 20 mph. Drivers must proceed slowly with caution~~extreme care,~~ and must yield to pass a parked car or approaching vehicle. This is the functional equivalent of traffic calming. This type should accommodate bicycle routes~~ through the use of~~ via shared lanes.

Slow: Has a design speed of 20-25 mph. Drivers can proceed cautiously~~arefully~~ and stop ~~, with an~~ occasionally ~~stop~~ to allow a pedestrian to cross or another car to park. Drivers should feel uncomfortable exceeding the design speed due to the presence of parked cars, enclosure, small ~~tight~~ turning radii, and other design elements. This type should also accommodate bicycle routes ~~through the use of~~ via shared lanes.

Low: Has a design speed of 30-35 mph. Drivers can expect to travel at the design speed ~~generally~~ without delay ~~at the design speed,~~ and the street design supports safe pedestrian movements at the higher design speed. This type is appropriate for thoroughfares ~~designed to~~ traversing~~e~~ longer distances~~,~~ or that connect to higher intensity locations. This type should accommodate bicycle routes ~~through the use of~~ via bicycle~~ke~~ lanes.

Design speeds higher than 35 mph should not normally be used in TND communities due to the concerns for pedestrian and bicyclist safety and comfort. There ~~may~~ may be locations where planned TND communities border~~,~~ (or are divided by)~~,~~ existing corridors with posted/design speeds higher than 35 mph. ~~In those locations,~~ C~~c~~oordination with the ~~regulating~~ maintaining agency should occur for such locations, with the ~~a~~ goal of~~to~~ re-designing the corridor and reducing~~e~~ the speed to 35 mph or less. The increase in motor vehicle~~ist~~ travel time due to the speed reduction is usually insignificant because TND communities are generally compact.

When the speed reduction cannot be achieved, measures to improve pedestrian crossing safety ~~for those crossing the corridor~~ should be evaluated and installed where~~n~~ appropriate.

E.1.c Design Vehicles

~~There is a need to understand that~~ A TND street design with narrow streets and compact intersections requires ~~designers to pay close~~ special attention to the operational needs of transit, fire and rescue, waste collection, and delivery trucks. ~~For this reason,~~ E~~e~~arly coordination with transit, fire and rescue, waste collection, and other stakeholders ~~groups~~ is essential.

~~Regular~~ An increased encroachment of turning vehicles into opposing lanes ~~will~~ occurs at intersections. Therefore, the amount of ~~frequency of~~ transit service, the traffic volumes, and the speeds ~~at those intersections~~ must be considered ~~when~~ in designing intersections. For fire and rescue, ~~determination of~~ the importance of the street for ~~community~~ access should be determined~~,~~ (e.g. primary or secondary access).

The designer should evaluate intersections using turning templates or turning movement analysis software to ensure ~~that~~ adequate operations. ~~of vehicles can occur. Treatment of~~ O~~o~~n-street parking near~~around~~ intersections should be evaluated ~~during this analysis~~ to identify potential conflicts between turning vehicles and on-street parking.

E.2 Sight Distance

See ***Chapter 3*** ~~***– Geometric Design***~~***, C.3*** ~~***Sight Distance***~~***.***

E.2.a Stopping Sight Distance

See ***Chapter 3*** ~~***– Geometric Design***~~***, C.3.a*** ~~***Stopping Sight Distance***~~.

E.2.b Passing Sight Distance

Due to the importance of low speeds and ~~concerns for~~ pedestrian comfort and safety, passing should be discouraged or prohibited.

E.2.c Intersection Sight Distance

Sight distance should be calculated ~~in accordance with~~per ***Chapter 3, Section C.9.b***~~,~~ using the appropriate design speed~~s for the street being evaluated~~. When executing a crossing or turning maneuver after stopping (at a stop sign, stop bar, or crosswalk, as required in ***Section 316.123, F.S.***)~~,~~ it is assumed ~~that~~ the vehicle ~~will~~ moves slowly forward to obtain sight distance (without intruding into the crossing travel lane), ~~-~~stopping a second time as necessary.

Therefore, when curb extensions are used~~,~~ or on-street parking exists~~is in place~~, the vehicle can be assumed to move forward~~ on the second step movement~~, stopping just shy of the travel lane, increasing the driver's ~~potential to see~~ vision further than when stopped at the stop bar. The ~~resulting~~ increased sight distance provided by the two-~~-~~step movement allows parking to be located closer to the intersection.

The ***MUTCD*** requires that on-street parking be located at least 20 feet from crosswalks. The minimum stopping sight distance is 60 feet for low volume (< 400 ADT) streets. Even on ~~s~~low speed, low volume urban streets, the combination of curb return, crosswalk width and 20-foot setback to the first parking space ~~may~~ may not ~~meet~~ achieve the minimum stopping distance. Justification for locating parking spaces 20 feet from crosswalks ~~may~~ can be achieved based on community history with existing installations.

E.3 Horizontal Alignment

E.3.a Minimum Centerline Radius

See ***Chapter 3~~ – Geometric Design~~, C.4 ~~Horizontal Alignment~~*** and Table 3 – 12 ~~Minimum Radii (feet) for Design Superelevation Rates Low Speed Local Roads ((e_{max} = 0.05)~~.

E.3.b Minimum Curb Return Radius

Curb return radii should be kept small to keep intersections compact. The use of on-street parking and/or bicycle~~ke~~ lanes increases the effective size of the curb radii, further improving the ability of design vehicles to negotiate turns without running over the curb return.

Table 19 – 1 Curb Return Radii

Movement Type	Design Speed	Curb Radius w/Parallel Parking*
Yield	Less than 20 mph	5-10 feet
Slow	20-25 mph	10-15 feet
Low	30-35 mph	15-20 feet

* Dimensions with parking on each leg of the intersection. Both tangent sections adjacent to the curb return must provide for on-street parking or ~~else~~ the curb radii must be evaluated using "design vehicle" and either software or turning templates.

E.4 Vertical Alignment

See ***Chapter 3*** ~~***– Geometric Design***~~***, C.5*** ~~***Vertical Alignment***~~.

E.5 Cross Section Elements

E.5.a Introduction

As discussed earlier in this chapter, TND street design places importance on how ~~the~~ streets are treated since they are part of the public realm. The street portion of the public realm is shaped by the features and cross section elements used in creating the street. For this reason, ~~it is necessary~~ the designer needs to give ~~pay~~ more attention to what features are included, where they are placed, and how the cross section elements are assembled.

E.5.b Lane Width

Travel lane widths should be based on the context and desired speed for the area where the street is located. Table 19-2 ~~shows~~ provides travel lane widths and a~~ssociated~~ appropriate speeds. It is ~~important to~~ noted that lane widths are typically measured to the curb face instead of the edge of the gutter pan in low speed urban environments~~, lane widths are typically measured to the curb face instead of the edge of the gutter pan~~. ~~Consequently,~~ As such, the travel and parking lanes include the width of the gutter pan whe~~n~~re curbs ~~sections~~ with gutter pans are used~~, the motor vehicle and parking lanes include the width of the gutter pan~~.

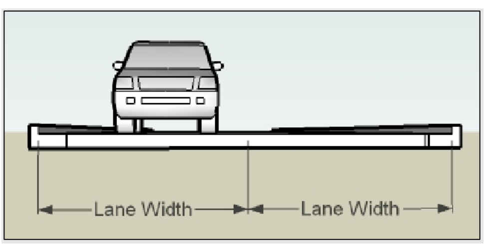
Table 19 – 2 Minimum Lane Width

Movement Type	Design Speed	Travel Lane Width
Yield*	Less than 20 mph	N/A
Slow	20-25 mph	9-10 feet
Low	30-35 mph	10-11 feet

* Yield streets are typically residential two-way streets with parking on one or both sides. When the street is parked both sides, the remaining space between parked vehicles (10 feet minimum) is adequate for one vehicle to pass through. The m~~M~~inimum width ~~for~~ of a yield street with parking on both sides should be 24 feet curb face to curb face. The m~~M~~inimum width ~~for~~ of a yield street with parking on one side should be 20 feet curb face to curb face, allowing for two 10-foot lanes when the street is not parked.

Figure 19 – 3 Lane Widths shows a typical measurement.

Figure 19 – 3 Lane Width



(Source: VHB)

~~In order for drivers to understand the appropriate driving speeds~~, L~~l~~ane widths should create some level of discomfort when driving too fast for drivers to understand the appropriate driving speed. The presence of on-street parking is important in achieving the speeds ~~shown~~ provided in Table 19 – 2 ~~Minimum Lane Widths~~. There is more room for vehicles (and buses) to operate w~~W~~here~~n~~ bicycle lanes or multi-lane configurations are used~~, there is more room for vehicles, such as buses, to operate~~. However, car drivers ~~may feel more~~ be comfortable driving faster than desired.

Alleys and narrow roadways that act as shared spaces can have design speeds as low as 10 mph~~,~~ as noted in ***Chapter 16*** ~~***– Residential Street Design***~~.

Alleys can be designed as either one-~~-~~way or two-~~-~~way. The ~~Right of way~~ R/W width should be a minimum of 20 feet with no permanent structures ~~within the right of way~~ that would interfere with vehicle access to garages or parking spaces, access for trash collection, and other operational needs. The p~~P~~avement width should be a minimum of 12 feet. The c~~C~~oordination ~~with local municipalities~~ of~~n~~ operational requirements with local municipalities is essential to ensure that trash collection and fire protection services can be conducted~~mpleted~~.

E.5.c Medians

Medians on ~~used in~~ low-speed urban thoroughfares accommodate ~~provide for~~ access management, turning traffic, safety, pedestrian refuge, landscaping, lighting, and utilities. These medians are usually raised with raised curb.

Landscaped medians can enhance the street or help create a gateway entrance into a community. Medians can be used to create tree canopies over travel lanes for multi-lane roadways, contributing to a sense of enclosure.

Medians vary in width depending on available R/W~~right of way~~ and function. Because medians require a wider R/W~~right of way~~, the designer must weigh the benefits of a median versus ~~with the issues of~~ pedestrian crossing distances, speed, context, and available roadside width.

Table 19 – 3 Recommended Median Width

Median Type	Minimum Width	Recommended Width
Median for access control	4 feet	6 feet
Median for pedestrian refuge	6 feet	8 feet
Median for trees and lighting	6 feet [1]	10 feet [2]
Median for single left turn lane	10 feet [3]	14 feet [4]

Table Notes:

[1] Six feet measured curb face to curb face is generally considered the minimum width for the proper growth of small caliper trees (less than 4 inches)~~,~~

[2] Wider medians provide room for larger caliper trees and more extensive landscaping~~,~~

[3] A ten~~-~~foot ~~lane~~ median provides for a turn lane without a concrete traffic separator~~,~~

[4] Fourteen feet provides for a turn lane with a concrete traffic separator~~.~~

E.5.d Turn Lanes

The need for turn lanes for vehicle mobility should be balanced with the need to manage vehicle speeds and the ~~potential impact on the~~ border ~~width, such as~~ and sidewalk width. Turn lanes tend to allow through vehicles to maintain higher speeds through intersections, since turning vehicles can move over and slow in the turn lane.

Left turn lanes are ~~considered to be~~ acceptable in an urban environment since ~~there are negative impacts to~~ roadway capacity is degraded when left turning vehicles~~s~~ block ~~the~~ through movements ~~of vehicles~~. ~~The installation of~~ A~~a~~ left turn lane can be ~~beneficial when~~ used to facilitate ~~perform~~ a road diet ~~such as~~ by reducing a four~~-~~lane section to three, ~~lanes~~ with the center lane allowing left turn ~~providing for turning~~ movements. ~~In urban areas,~~ N~~n~~o more than one left turn lane should be provided in urban areas.

Right turns from through lanes do not block through movements~~,~~ but do ~~create a~~ reduce~~tion in~~ speeds due to the slowing of turning vehicles. Right turn lanes ~~are used to~~ maintain through speeds, ~~through intersections, and to~~ reduce the potential for rear end crashes,~~.~~ ~~However, the installation of~~

right turn lanes but increases the crossing distances for pedestrians. and the speed of

~~vehicles, therefore the use of~~ E~~e~~xclusive right turn lanes are rarely used except at “T” intersections.

E.5.e Parking

On-street parking is important in the urban environment for ~~the success of those~~ retail businesses ~~that line the street, to provide~~ as a buffer for ~~the~~ pedestrians, and to help calm traffic speeds. ~~When~~ For angle parking ~~is proposed for on-street parking~~, designers should consider ~~the use of~~ back-in angle parking in lieu of front-~~-~~in angle parking.

Table 19 – 4 Parking Lane Width

Movement Type	Design Speed	Parking Lane Width
Slow	20-25 mph	(Angle) 17-18 feet
Slow	20-25 mph	(Parallel) 7 feet
Low	30-35 mph	(Parallel) 7-8 feet

E.6 Cul-de-sacs and Turnarounds

Cul-de-sacs should only be used where no other alternatives exist. Cul-de-sacs should have walkway or bicycle connections to other sidewalks and streets to provide connectivity ~~within and~~ to adjacent neighborhoods.

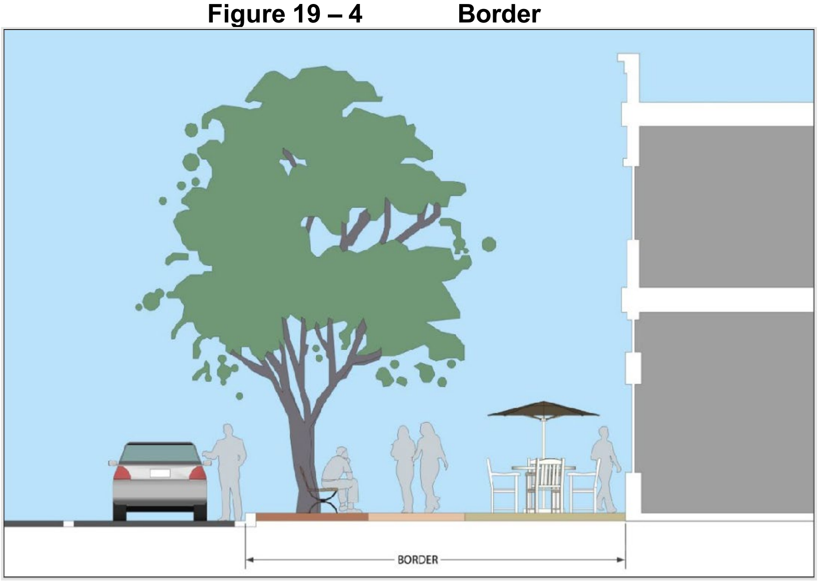
E.6.a Turning Area

~~A residential street open at one end only should have a special turning area at the closed end.~~ A residential street more than 100 feet long and open at one end only ~~shall~~ must have a special turning area at the closed end. This turning area should be circular ~~and have~~ with a radius appropriate ~~to~~ for the ~~types of~~ vehicle types expected. The minimum outside radius of a cul-de-sac ~~shall be~~ is 30 feet. In constrained conditions~~circumstances~~, other turning configurations (such as a “hammerhead”) ~~may~~ can be considered.

E.7 Pedestrian Considerations

In urban environments, the ~~"~~border~~," or~~ (area between the face of a building or ~~right of way~~ R/W line and the curb face)~~,~~ serves as the pedestrian realm ~~because it is the place for which~~ where pedestrian activity is conducted ~~provided,~~ including space to walk, socialize, places for street furniture, landscaping, and outdoor cafes. ~~In an urban environment, the~~ An urban border ~~border consists of~~ includes ~~the~~ furniture, walking and shy zones.

Figure 19 – 4 Border



(Source: VHB)

E.7.a Furniture Zone

The furniture zone can be located adjacent to the building face, but ~~more commonly~~ is typically adjacent to the curb ~~face~~. The furniture zone ~~contains~~ accommodates parking meters, lighting, tree planters, benches, trash receptacles, magazine and newspaper racks, and other street furniture. The furniture zone is separate from the walking/pedestrian and shy zones to ~~keep the~~ maintain a walking zone~~area~~ clear for pedestrians, including ~~proper~~ access to transit stops.

E.7.b Walking/Pedestrian Zone

Chapter 8 addresses considerations for pedestrians. In an ~~properly designed~~ urban environment, where buildings are at the back of the sidewalk and vehicle speeds are low, the separation from traffic is normally provided by on-street parking, which also helps to calm traffic. The minimum width of the walking/pedestrian zone should be ~~at least~~ four feet and should be increased based on expected pedestrian activity.

E.7.c Shy Zone

The shy zone is the area adjacent to buildings and fences that pedestrians typically~~generally~~ "shy" away from. At least ~~minimum of~~ one foot of shy zone is ~~provided~~ included as part of the sidewalk width. This space ~~should~~ is not ~~be~~ included in the ~~normal~~ walking zone ~~of the sidewalk~~.

E.7.d Mid-Block Crossings

Properly designed TND communities ~~will~~ do not normally require mid-block crossings due to ~~the use of~~ shorter block sizes. ~~When mid-block crossings are necessary, the use of~~ C~~c~~urb extensions ~~or~~ and bulbouts should be considered to reduce the crossing distance for pedestrians when mid-block crossings are needed.

E.7.e Curb Extensions

Curb extensions are helpful ~~tools for~~ in reducing the crossing distance for pedestrians, providing a location for transit stops, managing the location of parking, providing unobstructed access to fire and rescue, and increasing space for landscaping and street furniture.

Designers should coordinate with public works staff to ensure their equipment can conduct ~~that~~ street cleaning ~~can be achieved with their equipment,~~ and that adequate drainage can be provided to prevent ~~avoid~~ ponding ~~at curb extensions~~.

E.8 Bicyclist Considerations

E.8.a Bicycle Facilities

See ***Chapter 9*** ~~contains information on~~ for bicycle facilities. This section is ~~directed to designing~~ for bicycle~~ke~~ facilities in TND communities~~. Designing for bicycles on thoroughfares in TND communities should be as follows:~~ where bicycles and motor vehicles should share lanes on thoroughfares with design speeds of ~~twenty five~~ 25 mph ~~or~~ and less. It is important to recognize that the addition of bicycle~~ke~~ lanes ~~does~~ increases roadway widths and can increase the tendency for drivers to speed.

~~When bicycle lanes are used in TND communities, they~~ Bicycle lanes in TND communities should be at least ~~minimum of~~ 5 feet wide and be designated as bicycle~~ke~~ lanes. ~~On curb and gutter roadways,~~ A 4-foot ~~a~~ minimum ~~4-foot~~ width (measured from the lip of the gutter) is required on curbed roadways. The gutter width ~~should not be~~ is not considered ~~part of the~~ rideable surface ~~area~~, but ~~this width~~ does provide~~s~~ useable clearance to the curb face. Drainage inlets, grates, and utility covers are potential ~~problems~~ hazards for bicyclists. ~~When a roadway is designed,~~ A~~a~~ll such grates and covers should be kept out of the bicyclists' expected path~~. If drainage inlets are located in the expected path of bicyclists, they~~ or at a minimum, should be flush with the pavement, well seated, ~~and have~~ with bicycle~~-~~compatible grates.

Where parking is present, t~~, t~~he bicycle lane should be ~~placed~~ located between the parking lane and the travel lane ~~, and have~~ (with a ~~minimum~~ 5-foot minimum width) ~~of 5 feet~~. ~~Designers should~~ C~~c~~onsider increasing the bicycle lane width to 6 feet (in lieu of increasing the parallel parking width from 7 to 8 feet)~~. This helps~~ to encourage vehicles to park closer to the curb, ~~and~~ providing~~es~~ more room for door swing, thereby ~~, potentially~~ reducing conflicts with bicyclists.

Shared lane markings~~, or~~ ("sharrows~~,~~") can be used instead of bicycle lanes adjacent to on-street parking. ~~The~~ The ~~-~~ sharrow allows ~~the~~ a bicyclist to occupy the travel lane, ~~and therefore~~ thereby ~~avoids~~ not placing bicyclists in the "door zone", ~~and does not require~~ without any increase in lane or R/W width ~~or ROW width for the thoroughfare~~. See ***Chapter 9*** and the ***MUTCD*** for g~~G~~uidance on the ~~for~~ use of the shared lane marking ~~is included in **_Chapter 9 – Bicycle Facilities_** and the~~ ***MUTCD***. See Figure 9 –24 ~~– Shared Lane Marking~~ in ***Chapter 9*** for a sketch ~~detailed drawing~~ of a shared lane

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marking.

E.8.b Shared Use Paths

Greenways, waterfront walks, and other civic spaces should include shared use paths, and provide for bicycle storage or parking. Bicycle storage or parking should also be included in areas near transit facilities to maximize connectivity between the modes.

E.9 Transit

See ***Accessing Transit, Design Handbook for Florida Bus Passenger Facilities, Version III, 2013*** for information.

E.10 Clear Zone

In urban areas, horizontal clearances~~,~~ based on clear zone requirements for rural highways~~,~~ are not practical.~~ because~~ U~~u~~rban areas are characterized by lower speed, higher volumes, more dense abutting development, closely~~,~~ spaced intersections and driveways ~~accesses to property~~, ~~higher traffic volumes,~~ more bicyclists and pedestrians, and restricted R/W~~right of way~~. The minimum horizontal clearance ~~shall be~~ is 1.5 feet measured from the face of curb.

Streets with curb~~,~~ (or curb and gutter)~~,~~ in urban areas where ~~right of way~~R/W is restricted do not have sufficient roadside widths ~~of sufficient widths~~ to provide clear zones; therefore, while there are specific horizontal clearance requirements for these streets, they are based on clearances for normal operation and not based on maintaining a clear roadside for errant vehicles. It ~~should be~~ is noted that curb has essentially no redirectional capability; therefore, curb should not be considered effective in shielding a hazard.

F REFERENCES FOR INFORMATIONAL PURPOSES

The following publications were either used in ~~the preparation of~~ developing this chapter, or ~~may~~ can be helpful in designing TND c~~C~~ommunities and understanding the flexibility in AASHTO design criteria:

- Designing Walkable Urban Thoroughfares: A Context Sensitive Approach: An ITE Recommended Practice, 2010

  https://www.ite.org/technical-resources/topics/complete-streets/
- SmartCode 9.2
  http://www.smartcodecentral.org/
- A Guide for Achieving Flexibility in Highway Design, AASHTO, ~~May~~ May 2004 https://store.transportation.org/Common/DownloadContentFiles?id=305
- Accessing Transit, Design Handbook, 2017, FDOT Public Transit Office: https://www.fdot.gov/fdottransit/transitofficehome/transitplanning.shtm/newtransitfacilitiesdesign.shtm
- Safe Routes to Schools Program, FDOT Safety Office: http://www.dot.state.fl.us/safety/2A-Programs/Programs.shtm

CHAPTER 20

DRAINAGE

A INTRODUCTION

~~This chapter recognizes that~~ Florida is regularly affected by adverse weather conditions. ~~As such, t~~The proper design of a roadway's drainage system is critical to ~~its~~ the roadway's function and to the safety of its users ~~the motoring public as well as~~ (e.g., pedestrians, bicyclists, drivers, and transit) ~~and other users of these facilities~~. Water s~~S~~tanding ~~water~~ on the ~~a~~ roadway is hazardous ~~can not only create a hazard but could also impede~~ and can impede the flow of traffic.

~~This chapter represents~~ Use the minimum standards provided in this chapter ~~that should be used when~~ for designing roadway drainage systems. ~~As is the case for all elements in a facility's design, the designer must c~~Consider ~~site~~ project-specific conditions in~~and~~ determining~~e~~ the ~~proper~~ level of service ~~the facility's~~ that a drainage system should provide~~. The design of drainage facilities should not only consider the system's~~ (e.g., its ability to handle and then recover from the design event) ~~storm, but also consider the system's recovery time during an event which exceed the design storm~~.

B OBJECTIVES

The objective of this chapter is to establish the minimum standards to which a roadway~~'s~~ drainage system is ~~to be~~ designed. ~~In order for the drainage system to function properly, the below guidelines should be used in the design, construction and maintenance of these systems.~~

Design ~~and maintain~~ drainage systems to ~~quickly~~ move water ~~out of~~ quickly away from the travel lanes ~~in order provide a safer environment for users of a facility~~ (to improve safety during adverse weather conditions).

Design drainage systems ~~by taking into consideration the~~ to facilitate future maintenance activities (promoting the safety of ~~of said system to avoid creating hazardous conditions to~~ drivers and maintenance staff) ~~during routine servicing~~.

Refer to t~~T~~he FDOT~~'s~~ ***Drainage Design Guide (DDG)*** ~~is a reference for designers, providing~~ for guidelines and examples for accomplishing ~~of how~~ these objectives ~~can be accomplished~~. The DDG provides information on ~~the following areas of drainage design~~:

- Hydrology
- Open Channel Flow
- Culverts
- Bridge Hydraulics
- Storm Drains
- Exfiltration (French Drain) Systems
- Optional Pipe Materials
- Stormwater Management Facilitiesy
- Temporary Drainage Design

C REGULATORY REQUIREMENTS

C.1 Chapter 62-330, Florida Administrative Code

Chapter 62-330, F.A.C. ~~,~~ rules of the Florida Department of Environmental Protection (FDEP), implements the comprehensive, statewide environmental resource permit (ERP) program under ***Section 373.4131, F.S.*** The ERP program governs ~~the following:~~ the construction, alteration, operation, maintenance, repair, abandonment, and removal of stormwater management systems, dams, impoundments, reservoirs, appurtenant works, and works (including docks, piers, structures, dredging, and filling located in, on or over wetlands or other surface waters)~~,~~ as defined and delineated in ***Chapter 62-340, F.A.C.***. ~~***Chapter 62-25 F.A.C.*** has been repealed.~~

C.2 Chapter 62-40, Florida Administrative Code

Chapter 62-40, F.A.C. ~~,~~ rules of the FDEP~~lorida Department of Environmental Protection~~ outline~~s~~ basic goals and requirements for surface water protection and management to be implemented and enforced by the FDEP~~lorida Department of Environmental Protection~~ and the Water Management Districts (WMD's).

C.3 National Pollutant Discharge Elimination System

The ***National Pollutant Discharge Elimination System (NPDES)*** permit program is administered by the United~~.~~ States~~.~~ Environmental Protection Agency and delegated to the FDEP~~lorida Department of Environmental Protection~~ in Florida. This program requires permits for stormwater discharges into waters of the United States from industrial activities; and from large and medium municipal separate storm sewer systems (MS4s). Construction projects are defined as ~~within the definition of an~~ an industrial activity.

D STORMWATER MANAGEMENT STRATEGIES

D.1 Watershed Approach to Evaluate Regional Stormwater Solutions (WATERSS)

WATERSS is a regional stormwater management process that promotes collaboration with state and local agencies, water resource managers and stakeholders to implement innovative stormwater management practices. The process is scalable depending on the type, size, complexity, context, and geographic location of the project. It enables the comparison of innovative solutions and partnerships with traditional solutions. See Figure 20 – 1 for t~~T~~he 12 steps ~~detailing~~ of the WATERRS process ~~is shown in Figure 20 – 1 WATERSS Process Flow Chart~~.

The WATERSS process identifies potential cost savings ~~or~~ and ~~additional~~ environmental benefits for implementing feasible, non-traditional stormwater management solutions. Innovative practices can include:

- R~~r~~egional ponds,
- J~~j~~oint-use ponds,
- S~~s~~tormwater harvesting,
- L~~l~~and use modifications,
- U~~u~~pstream compensatory treatment,
- B~~b~~asin~~, or~~ and resource improvements,
- W~~w~~ell injection, and
- B~~b~~io-sorption activated media (BAM).

See Table 20 – 1 for t~~T~~hese types of practices ~~along with~~ and examples of other opportunities~~ that can be leveraged by this process are found in Table 20 – 1 Matrix of Typical Innovative Stormwater Management Practices~~.

Investigating stormwater management partnership opportunities requires c~~C~~ollaboration with external partners~~ is essential for the discovery of stormwater management partnership opportunities~~. This ~~may~~ can take ~~involve more~~ more time and effort than traditional stormwater pond design~~,~~ (which focuses only on the project itself) ~~isolated activities and design of individual ponds. However, collaborative stormwater management solutions have proven to~~ Collaboration can ~~result in~~ provide ~~substantial~~ environmental and cost ~~investment~~ benefits across a watershed or region.

Figure 20 – 1 WATERSS Process Flowchart

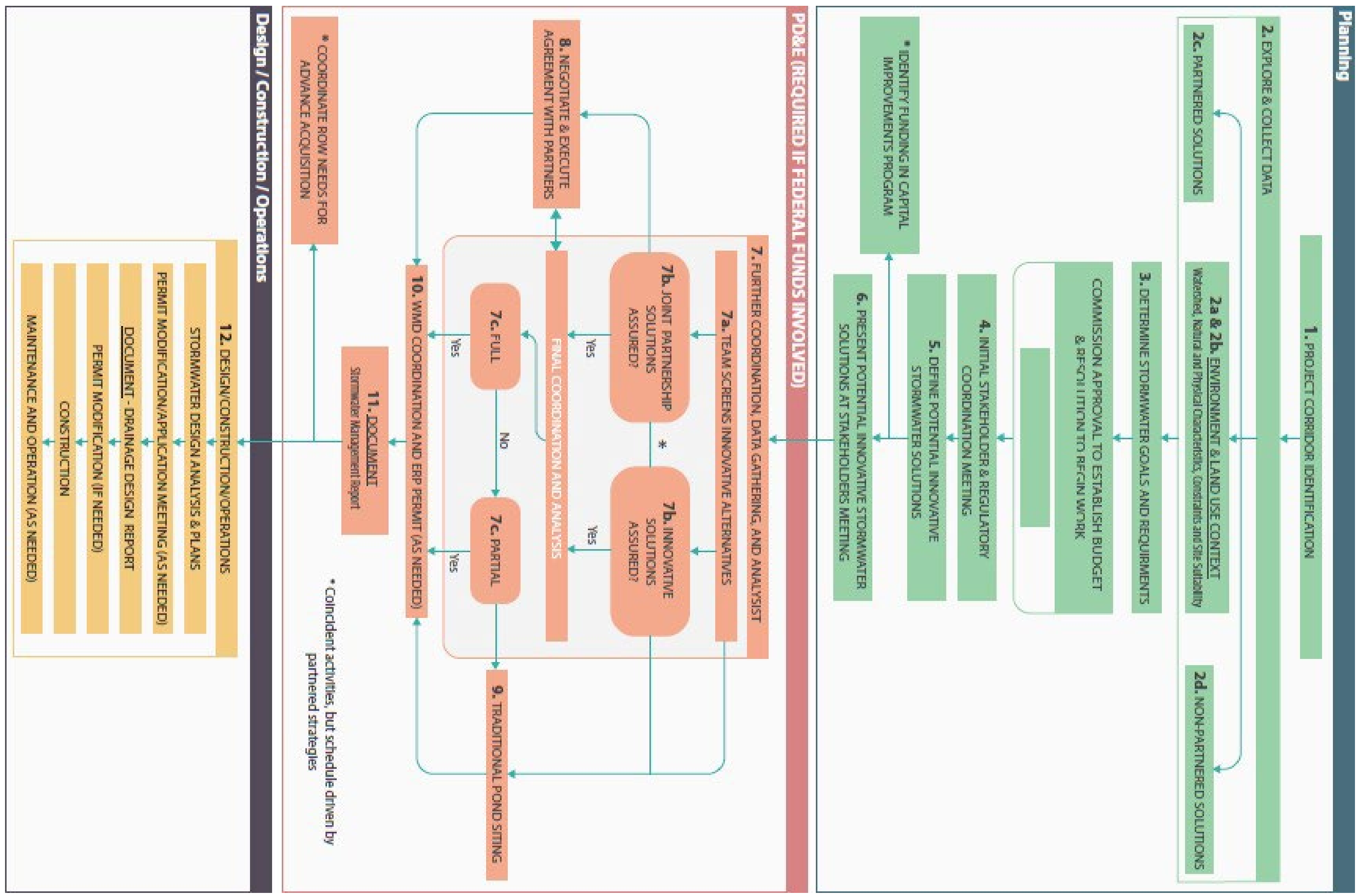

Table 20 – 1 Matrix of Typical Innovative Stormwater Management Practices

Best Management Practice (BMP)	Specific Characteristics	Applicability	Goals	Effectiveness in Meeting Stormwater Quality and Quantity Goals	Pros and Cons	Permitting Hurdles	Costs	Schedule	Design Constraints
Surface Water BMPs									
Regional Pond	Downstream pond sized to accommodate runoff from the upstream basin rather than only onsite runoff ~~from the development~~.	Desirable when pond Right of Way (R/~~O~~W) costs are high or land for ponds is unavailable.	Reduce long-term pond costs and improve downstream water quality.	Highly effective in that offsite lands ~~beyond the onsite project is~~ are treated and attenuated.	Pros: ~~I~~improved water quality and attenuation, reduced long-term costs. Cons: (1) ~~D~~difficult to coordinate agreements and permit; and (2) possible long piped outfalls.	Minor increase in pollutants to waters of the state immediately downstream between the roadway and the regional pond.	Potential increased R/~~O~~W costs are offset by local government ~~recouped by giving away~~ maintenance ~~to local municipalities~~.	Longer production schedule ~~may be needed~~ to accommodate negotiations with local municipalities and potential ~~overcoming~~ permitting hurdles.	~~Sometimes p~~Pre-treatment is may be required onsite, ~~perhaps~~ possibly trapping sediments.
Joint-Use Pond	Pond designed to accommodate runoff from two or more landowners. A formal agreement is crafted to outline terms of cooperation.	(1) Often occurs at the request of adjacent property owners to better integrate proposed pond locations into their properties; (2) sometimes initiated by the FDOT to store runoff in downstream golf courses; and (3) sometimes adjacent developments are required to take the FDOT runoff as a condition of county approvals.	Reduce pond R/~~O~~W acquisition and long-term maintenance costs.	Standard Environmental Resource Permit (ERP) water quality rules are satisfied.	Pros: ~~C~~combining ponds into a single pond reduces costs due to economy of scale; ~~typically,~~ the other party typically performs the maintenance ~~is assumed by the party other than the FDOT~~. Cons: (1) co-mingling runoff can expose agency to NPDES responsibilities for offsite runoff; and (2) can be difficult to coordinate agreements	(1) Permits must be obtained/modified for all parties involved; (2) phased construction must be coordinated for future roadway or development expansion; and (3) legal agreement must address the FDOT's right to maintain the pond (or hold another public agency as surety) if the developer defaults on their ~~his~~ responsibilities.	Combining ponds into a single pond reduces R/~~O~~W costs due to economy of scale; the other party typically performs the maintenance ~~is often assumed by the offsite party~~.	Longer production schedule ~~may be needed~~ to accommodate negotiations with the other ~~cooperating~~ party.	The overflow from the combined pond must be able to adequately drain both upstream properties.

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Best Management Practice (BMP)	Specific Characteristics	Applicability	Goals	Effectiveness in Meeting Stormwater Quality and Quantity Goals	Pros and Cons	Permitting Hurdles	Costs	Schedule	Design Constraints
Stormwater Harvesting	Stormwater is collected and harvested for irrigation, raw water supply, wetland re-hydration, MFLs, or some other beneficial usage.	Useful when a high demand exists for non-potable water.	Reduce downstream pollutant loadings and provide an alternate water supply.	Highly effective in that land downstream discharge volume is reduced, lowering pollutant loading; usually has only minimal reduction in attenuating peak flow.	Pros: improved water quality and water supply. Cons: difficult to match with water consumers; partners can pull out late in the production schedule.	None, unless water consumer tries to negotiate CUP credits as part of the harvesting.	~~May~~ May need to design storage facility, but could assume the pond and pumping/ infrastructure costs are borne by the water consumer.	Longer production schedule ~~may~~ can be needed to discover and negotiate with the water consumer.	(1) No privately-owned pumping/piping infrastructure within L/A R/~~O~~W; (2) re-use with potential human contact must provide filtration; and (3) avoid the need for a Consumptive Use Permit (CUP) by avoiding the pumping of groundwater.
Land Use Modification	Changing existing land usage to a usage generating less of the pollutant of concern, usually nutrients.	Desirable when pond R/~~O~~W costs are high or land for ponds is unavailable.	Cost savings.	Standard ERP water quality rules are satisfied due to a reduced pollutant loading.	Pros: cost savings. Cons: involves negotiating with external property owners.	(1) Potential adverse impacts to adjacent properties; and (2) will require additional coordination for the specific permit language and conditions.	Costs are reduced by avoiding expensive R/~~O~~W adjacent to the highway.	Additional production time ~~may~~ can be needed to negotiate with land owners – no R/~~O~~W condemnation authority.	None.
Upstream Compensatory Treatment	Treating upstream offsite runoff in lieu of onsite runoff.	Desirable when pond R/~~O~~W costs are high or land for ponds is unavailable.	Cost savings.	Standard ERP water quality rules are satisfied.	Pros: cost savings. Cons: permitting hurdles.	(1) Potential adverse impacts to adjacent properties; and (2) will require additional coordination for the specific permit language and conditions.	Costs are reduced by the selection of an alternate treatment site.	Additional production time ~~may~~ can be needed to find and design a suitable upstream treatment alternative.	Requires design of offsite treatment BMP.

Best Management Practice (BMP)	Specific Characteristics	Applicability	Goals	Effectiveness in Meeting Stormwater Quality and Quantity Goals	Pros and Cons	Permitting Hurdles	Costs	Schedule	Design Constraints
Basin/Resource Improvements	In lieu of onsite stormwater treatment, modifications to the basin or downstream resource (e.g., septic tank conversions, circulation enhancements, etc.) are constructed to improve the waterbody's health.	Desirable (1) when pond R/~~O~~W costs are high or land for ponds is unavailable; and/or (2) when greater environmental benefit is sought.	Potential cost savings and improved downstream environmental benefit.	Highly effective due to significantly increased environmental benefit.	Pros: improved environmental benefit and reduced costs. Cons: significant amount of permitting coordination.	With no specific rules to address this approach, regulatory leadership must provide strong evidence of the improvement's effectiveness.	Significant cost savings can be realized in comparison with pond R/~~O~~W acquisition.	Longer production schedule ~~may~~ can be needed to accommodate discussions with the permitting agencies and/or municipality.	Specialty design services ~~may~~ can be required depending on the mitigation strategy.
Groundwater BMPs									
Well Injection (not District 6 coastal zone)	Injecting runoff into the ground via a pipe rather than discharging it downstream.	Useful in springsheds and other areas where groundwater recharge is desirable; typically targets pond bleed down flows.	Increase groundwater recharge; decrease pollutant loadings to surface waters.	Effective in increasing groundwater recharge and reducing downstream surface water pollutant loadings by reducing discharge volume.	Pros: improved groundwater recharge; decreased surface water pollutant loadings. Cons: ~~may~~ may need to include a special BAM design within the discharge well.	UIC permitting rules to allow this option are very restrictive. ~~May~~ Can require additional monitoring efforts and coordination for the specific permit language and conditions.	Additional costs are incurred to construct the injection system; currently, the WMDs offer no incentives such as reduced treatment requirements.	Separate permitting process with independent timelines.	Requires treatment and well injection design downstream of overflow weir.
Bio-sorption Activated Media (BAM)	Media provides a carbon source to promote the cultivation of denitrifying bacteria; also removes phosphorus, though infrequently used for that nutrient.	Useful in springsheds and coastal areas to denitrify during infiltration; useful to treat phosphorus within impaired basins.	Remove nutrients from runoff; eliminate R/~~O~~W for ponds by using BAM within	Highly effective in removing nutrients.	Pros: improved groundwater quality; can eliminate the need for stormwater ponds in rural typical sections. Cons: design and specifications for BAM are not yet codified	Design practice is new to most WMDs, though included in the BMPTRAINS program; performance measures/expectations are not well established.	Additional costs for BAM material which is sometimes offset by reduced pond R/~~O~~W; when used to remove phosphorus, the design life of the media is predicted	Longer production schedule ~~may~~ can be needed to coordinate design with UCF.	Required residence time within BAM layer ~~may~~ can require additional storage in ditches or retention ponds.

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Best Management Practice (BMP)	Specific Characteristics	Applicability	Goals	Effectiveness in Meeting Stormwater Quality and Quantity Goals	Pros and Cons	Permitting Hurdles	Costs	Schedule	Design Constraints
			roadside ditches.		into Manuals and Specifications.		to be about 20 years and may may then need replacement.		

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Step 1 – Project Corridor Identification

Identify the overall project characteristics including:

- Pproject location,
- Eenvironment, and
- Lland use context (urban versus. rural project),
- Ffacility type,
- Aalternatives being considered, and
- Ppotential stormwater needs.

Outcome: Watershed issues and concerns, conditions of the corridor(s), and potential stormwater needs.

Step 2 – Explore and Collect Data

A. Identify existing stormwater-related conditions on the project corridor and conduct an initial, desktop-level discovery review of potential partnerships and innovative stormwater solutions available. Explore pPotential partnerships and initiatives are explored by using Geographic Information System (GIS) support tools, and by querying the National Pollutant Discharge Elimination System (NPDES) Coordinator for regarding ongoing Total Maximum Daily Load (TMDL) and Basin Management Action Plan (BMAP) activities. Include Ththis e following information should be included:

- Previous planning studies.
- Existing roadway plans – (as-built).
- Corridor's context classification.
- Soil types, depth, slope and infiltration rates from natural resources conservation service soil surveys and existing geotechnical data from previous projects.
- Proposed alternative alignments and conceptual typical sections.
- Available topographic data and aerial photography (include local data sources).
- Existing and future land use maps.
- Tax maps & and land-owner information (can be provided as part of through public involvement research).
- Existing right of way R/W maps.

- Copies of any previous stormwater studies ~~or~~ and watershed masterplans.
- ~~Available~~ C~~c~~opies of permits for nearby projects ~~within the vicinity~~.

- ~~Existing~~ Previous agreements (Joint Participation Agreements (JPAs), easements, maintenance agreements, etc.).
- Water supply planning regions.
- Identified springsheds (as appropriate).
- Springs Priority Focus Areas (PFA).
- Water Management District (WMD) ~~mean~~ flow limitations.
- Aquifer storage and recharge wells.
- Parks, golf courses, irrigation, ~~or~~ and water storage/recharge opportunities.
- BMAP~~s~~'s.
- TMDLs with allocations.
- Identified public lands.
- Floodplains.
- Government-owned lands (schools, prisons, WMD lands, etc.).
- Developments of regional impacts (DRIs) and Sector Plans.

B. Investigate and document watershed information, environmental characteristics and constraints that ~~may~~ may affect the suitability of potential stormwater management solutions. ~~The following~~ Use these ~~list is provided~~ as guidance:

- What are the characteristics of the watershed?
  - □ ~~Is the watershed f~~Fully developed?
  - □ Mostly rural?
  - □ A combination?
- Is the project area within a springshed/impaired basin?
  - □ If so, is there a TMDL or BMAP for the area?
- What types of soils ~~are~~ exist in the project area?
- Is there an Outstanding Florida Water (OFW) ~~located~~ within the watershed?
- Is the project located in a floodplain?
- Are there wetlands in the vicinity~~area~~?
- Are there threatened or endangered species or designated habitat which ~~may~~ may cause certain types or locations of treatment to be ~~not~~ unsuitable for stormwater management?

- Are there contamination concerns which ~~will cause a~~ make the site ~~to be not~~ unsuitable for treatment?
- Is there land that is a Section 4(f) protected resource?
- Is there land that is protected by conservation easements?
- Is the project ~~located~~ near a designated Wild and Scenic River?
- Are there historic resources in the vicinity~~area~~?
- Is the project ~~located~~ within an area with a coastal management program?
- Is the project ~~located~~ near Essential Fish Habitat?
- Is the project ~~located~~ within the boundaries of a designated Sole Source Aquifer?
    - There are two ~~defined~~ in Florida:
        - Volusia-Floridan Aquifer, and
        - Biscayne Aquifer~~s~~.

C. Identify potential innovative stormwater solutions and partners. ~~If the project is in an impaired basin, c~~Contact the NPDES Coordinator if a project is in an impaired basin to obtain the BMAP stakeholder information (https://floridadep.gov/dear/water-quality-restoration/content/basin-management-action-plans-bmaps) and discuss a list of potential partners and available projects for funding. Pursue city, county, National Estuary Program, Water Management District, and developer partners for ~~. Examples are listed below~~:

- Regional p~~P~~onds: ~~If~~ Where sub-basins ~~are draining~~ flow to the same outfall or future watershed development is expected ~~in the watershed~~.
- Additional offsite inflows: ~~If~~ Where new or additional offsite stormwater inflows ~~of stormwater or wastewater~~ are ~~being~~ proposed.
- Stormwater re-use: ~~In urban or suburban areas, c~~Contact local governments ~~or~~ and golf courses in urban/suburban areas ~~regarding~~ regarding ~~-~~ their ~~interest in~~ use of stormwater as a raw water supply or for irrigation.
- Joint-use p~~P~~onds: ~~Determine if there are l~~Large ~~existing or proposed~~ developments (residential or commercial) along the highway ~~that~~ might exchange storage on their property for an outfall.
- Springsheds: If the project is in a springshed Priority Focus Area (PFA), ~~then additional scrutiny will be given from regulators on~~ regulators will scrutinize groundwater discharges (dry retention ponds) as opposed to surface water

discharges where denitrification can occur.

- Is the groundwater contaminated with nitrates?
  ~~Is the groundwater beneath the project~~

~~contaminated with nitrates or~~

- Aare there sources of nitrogen ~~adjacent to~~ near the project?
  - If so, the nitrogen-laden water ~~may~~may be pumped directly into the underground Bioabsorption Activated Media (BAM) layer to achieve large removals.

- Tidal or lLake cCirculation iImprovements: Consider improving a roadway crossing with a new or larger bridge or culvert to provide additional flushing iIf a BMAP identifies tidal or lake flushing issues~~, consider improving a roadway crossing with a new or larger bridge or culvert to provide additional flushing~~.

D. Identify potential innovative stormwater solutions for which a partner is not typically needed, such as ~~. Examples are listed below~~:

- Regional pPond: A regional pond could reduce on-site pond requirements ~~If~~ where a substantial portion of the project drains to a single water body ~~a regional pond would allow reduction of typical on-site ponds~~.
  - Would a downstream pond location reduce or increase ~~downstream have equal or fewer~~ community impacts?
    - Oor other benefits over on-site ponds?
  - Could ~~nsider if~~ the increased project runoff ~~would~~ create or worsen flooding or erosion ~~issues~~ concerns between the project and the pond location.~~?~~
    - Could the runoff be piped~~,~~ or the conveyance improved ~~, given the number of parcels and the length of piping required~~?

- Springsheds: Consider using a nutrient removal product such as BAM for additional treatment fFor projects in:
  - Sspringsheds,
  - Ccritical water need~~s~~ areas,
  - Wwater supply hardship areas, and~~or~~
  - Aareas of nutrient impairment. ~~consider the use of a nutrient removal product such as BAM for additional treatment.~~

- Onsite iIrrigation: Consider re-using~~e of~~ the pond treatment volume for nearby irrigation ~~near the project~~ (rather than bleeding downstream).

- Wetland rRe-hydration: Are nearby wetlands underhydrated?

- Compensatory tTreatment: Are there upstream areas ~~that~~ where retrofits ~~treatment~~ and attenuation could be ~~done~~ implemented as compensation?

- ~~-~~Look ~~especially~~ for available land ~~already available~~ and for runoff with high-~~ ~~nutrient loading ~~such as~~ (e.g., agricultural lands).

- Minimum f~~F~~lows and l~~L~~evels: Does the project flow to waterbodies with Minimum Flows and Levels (MFL)?~~.~~

E. Conclude ~~the~~ Step – 2 e(E~~E~~xplore and C~~C~~ollect D~~D~~ata) ~~step~~ with a narrative describing ~~the~~ existing project stormwater conditions, potential partnerships, and innovative stormwater solutions that ~~may~~ can be applied ~~on the project~~.

Outcome: Narrative describing existing project stormwater conditions, potential stormwater management projects, partnerships, and innovative stormwater solutions.

Step 3 – Determine Stormwater Goals and Requirements

Identify and document ~~the~~ project stormwater management goals and requirements ~~for the project~~ based on the information discovered in Step 2. ~~Having~~ It is important to have a general knowledge ~~about~~ of the project scope ~~of the proposed improvements~~ and potential ~~right of - way~~ R/W needs at the ~~start~~ beginning of this step ~~are essential to estimating the stormwater goals and requirements~~.

Outcome: A narrative describing ~~identified~~ project stormwater management goals and requirements ~~for the project~~.

Step 4 – Initial Stakeholders and Regulatory Coordination Meeting

Introduce the project to stakeholders and discuss cooperative ~~or~~ and regional stormwater management opportunities. ~~and understand their priorities. During the initial stakeholders' coordination meeting, present~~ Present the stormwater goals and the opportunities being considered. Understand stakeholder priorities. The presentation should include ~~the following project information~~:

- Project overview.
- Project ~~baseline~~ schedule (including critical milestones).
- Stormwater goals and requirements.
- Potential innovative stormwater solutions that ~~may~~ may be considered ~~on the project~~.
- Preliminary s~~S~~tormwater c~~C~~osts (often based on the preliminary expected cost of traditional ponds), and
- P~~P~~roject f~~F~~unding.

Outcome: List of potential ~~partnership~~ stormwater management partnerships ~~solutions~~ and innovative solutions to be ~~further~~ analyz~~s~~ed further.

Step 5 – Define Potential Stormwater Management Strategies

Discuss the opportunities identified in Step 4 and screen-~~-~~out any non-viable ~~stormwater management~~ solutions. Discuss and a~~A~~gree on the selection criteria. ~~for selection (~~ Includes constraints ~~or~~ and ~~limiting~~ factors that ~~may~~ could prevent implementation, such as:
~~of solutions). These factors may include~~

- S~~s~~tormwater goals and requirements,

- Ccost,
- Permitting challenges in permitting,
-

- M~~m~~aintainability,
- C~~c~~onstructability,
- S~~s~~chedule, and
- E~~e~~nvironmental considerations.

See Table 20 – 2 ~~Evaluation Factors for Screening of Solutions provides more information on~~ for the types of factors to consider in identifying feasible stormwater management strategies.

Additional ~~evaluation~~ factors ~~could~~ may include:

- R~~r~~eliability of partners,
- C~~c~~ompatibility with production schedule, and~~and~~
- B~~b~~enefit/cost.

This step does not overtly compare solutions. ~~, but~~ It only eliminates solutions that are flawed or otherwise do not meet the stormwater management goals and requirements. ~~The screening by the stormwater team includes~~ Screen all potential innovative solutions ~~both~~ (partnership and non-partnership) ~~innovative solutions~~.

Compile a matrix ~~for the comparison of~~ to compare solutions ~~using~~ with the information ~~obtained~~ from Steps 1 through 4. Include the f~~F~~actors used and the scoring method ~~should be included~~ with the matrix to ~~demonstrate the factors and justify~~ support the scoring. ~~An example matrix is provided in~~ See Exhibit 20 – 1 for an example matrix ~~Evaluation Matrix Example~~.

Prepare a work plan for each potential partnership solution ~~strategy that is recommended for detail evaluation~~. Use this plan to facilitate dialogue with the respective stakeholders and secure commitments for ~~all~~ each participant's share of the stormwater management solution.

Outcome: ~~A list of v~~Viable solutions ~~are identified~~ are recommended for additional ~~further~~ detailed evaluation and to be presented at follow-up stakeholder meetings. ~~,~~ D~~d~~ocument~~ed~~ Step 5 in a memorandum.

Table 20 – 2 Evaluation Factors for Screening of Solutions

Factor	Description/Issues to Consider
Project Needs for Water Quality	Will the solution provide all the water quality credits needed for the project?
Schedule Compatibility	Identify if negotiation and implementation of the solution to obtain water quality credits can be completed within the current project production schedule.
Cost / Benefit	The cost of the solution versus. the benefit, (i.e., reduction in maintenance costs, right of way R/Wcosts, construction costs, and mitigation costs, etc).
Partner Reliability	Identify if the partner of a solution can be relied upon to work with the agency for the duration of the solution.
Ease of Permitting	Identify if there have been preliminary discussions with the regulatory agencies. , and d Document the feedback received. Is this solution permittable or will it require extensive negotiations be needed?
Water Quantity/Floodplain Benefit	Identify if the solution will provide water quantity or floodplain benefits. and if so, q Quantify the any benefits to be realized from the project.
Public Perception/Acceptance	Identify if the solution will be generally accepted by the public. Will extensive public involvement be required?
Threatened and Endangered Species and Associated Costs	Identify if there are threatened or endangered species which may may be impacted by the solution. Identify any costs associated with avoiding or mitigating these impacts.
Wetland Credits	Identify if any wetland credits may can be realized by the implementing ation of the solution and the any associated benefit(s) that would be provided to the agency. Identify if the anticipated wetland credits would potentially satisfy project mitigation requirements for the project and if there would be additional credits for future projects.

Seagrass Credits	Identify if any seagrass credits ~~may~~ can be realized by ~~the~~ implementing ~~ation of~~ the solution and ~~the~~ any associated benefit(s) ~~that would be provided~~ to the agency. Identify if the seagrass credits would satisfy project mitigation requirements ~~for the project~~ and if there would be additional credits for future projects.

Table 20 – 2 Evaluation Factors for Screening of Solutions (continued)

Factor	Description/Issues to Consider
Section 4(f) Involvement	Identify the presence of potential Section 4(f) properties which ~~may~~ may have a use under the definition of Section 4(f) or if ~~there~~ the solution would ~~be~~ provide a benefit ~~as a result of the solution~~.
Conservation Lands	Identify the presence of any conservation lands which ~~may~~ may affect ~~the~~ suitability ~~of a solution~~.
Cultural Resources Involvement	Identify the potential presence of cultural resources ~~including~~ (e.g., archaeological and historical resources) which could affect ~~the~~ suitability ~~of a solution~~.
Public Wellfield Issues	Identify the proximity to any public wellfield locations and if the solution could ~~potentially have a direct~~ impact the wellfield.
Contamination – Hazardous Materials	Identify if the area ~~to be utilized for the solution~~ is contaminated. Consider ~~the~~ clean-up costs ~~associated with the clean-up of the area,~~ and if the contamination will limit the area available for stormwater facilities.
Construction	Identify any construction-related impacts ~~of the solution~~ and their potential ~~associated~~ costs ~~, such as~~ (e.g., additional drainage piping ~~to transport stormwater and~~ or access for construction).
Maintenance	Identify the costs ~~and frequencies~~ of regular maintenance ~~needed to maintain the solution~~.
Aesthetics	Identify if there are any associated aesthetic benefits or costs ~~or benefits for aesthetics of the solution, such as~~ (e.g., the cost to install and maintain plantings).

Priority of Regulatory Agencies	Identify if this solution is a priority of the regulatory agencies.
Multiple Benefits/Future Credits/Future Capacity for Other Projects	Identify if the solution will potentially provide for multiple types of credits such as water quality and seagrass. Identify if the project will potentially have credits available for future projects.

Exhibit 20 – 1 Evaluation Matrix Example

Weight of Factor	Factor	Score	W Score	Score	W Score	Score	W Score	Score	W Score
1-10		1-10		1-10		1-10		1-10	
	Alternative Number	A		B		C		D	
	Brief Description of Alternative	Vacant land near school		Home		Developed		Vacant land	
	Parcel Number	101		105		160		170	
	Parcel Size (Acres)	5		4		3.2		6.5	
2	Project Needs for Water Quality	5	10	6	12	5	10	6	12
7	Schedule Compatibility	3	21	8	56	3	21	1	7
10	Cost / Benefit	2	20	8	80	2	20	7	70
10	Partner Reliability	6	60	8	80	6	60	4	40
2	Ease of Permitting	1	2	3	6	1	2	5	10
10	Water Quantity/Floodplain Benefit	7	70	2	20	7	70	3	30
6	Public Perception/Acceptance	4	24	1	6	4	24	2	12
6	Threatened and Endangered Species	10	60	1	6	5	30	6	36
5	Wetland/Seagrass Credits	10	50	10	50	3	15	1	5
6	Section 4(f) Involvement	2	12	6	36	2	12	7	42
6	Conservation Lands	6	36	5	30	6	36	6	36
6	Cultural Resources Involvement	10	60	1	6	1	6	10	60
6	Public Wellfield Issues	10	60	1	6	7	42	10	60
8	Contamination – Hazardous Materials	6	48	3	24	4	32	6	48
9	Construction/Maintenance	5	45	2	18	10	90	5	45
2	Aesthetics	3	6	1	2	10	20	3	6
8	Priority of Regulatory Agencies	10	80	6	48	2	16	10	80
0	Multiple Benefits/Future Credits/Future Capacity for Other Projects	0	0	0	0	0	0	0	0
	Score	664		486		506		599	
	Ranking	4		1		2		3	

Note: “W Score” = Weighted Score

Step 6 – Present Potential Stormwater Strategies at Stakeholders Meeting

Present ~~to the stakeholders~~ viable partnership solutions to the stakeholders and provide the stakeholders and regulators with an opportunity to provide input. Inform the group ~~about~~ of any potential innovative stormwater solutions ~~which are~~ being pursued. This is also an opportunity to learn about any other projects that ~~may~~ may be worth considering.

Outcome: Meeting notes and a memorandum that documents the findings ~~of the Planning phase~~.

Step 7 – Further Coordination, Data Gathering, and Analysis

Continue coordinating ~~on~~ with prospective partners ~~continues during this step~~. Initiate preliminary geotechnical and survey investigations for each of the potential solutions. ~~addition to technical investigations, i.e., preliminary soil borings or survey, specific to the solutions being proposed with potential partners,~~ Discuss the topics listed under Partnership Solutions in Step 5 ~~should be discussed~~ with potential partners. Share the results of the investigations with the water management districts (and other partners) to determine:

- Which solutions are permittable, and ~~ascertain the ability to permit the alternative solutions and determine~~
- W~~w~~hat additional information is needed to resolve any uncertainties ~~the level of alternatives' certainty~~.

~~Where corridors cross several basins, a~~ A combination of solutions ~~may~~ can be needed where projects cross different drainage basins ~~to address project stormwater requirements~~. Consider using traditional retention or detention ponds w~~W~~hen a single innovative approach does not fully~~-~~ satisfy project stormwater ~~regulatory~~ requirements ~~on the project, different solutions may be applied, including traditional stormwater retention or detention ponds~~.

Outcome: Documentation of satisfaction of stormwater regulatory requirements.

Step 8 – Negotiate and Execute Agreement with Partners

Formal partnership agreements ~~involving partnership solutions~~ are developed by agency legal staff and executed between the agency and its partner(s). The type of legal agreement ~~will~~ depends on the partnering entity. ~~For example, with state or federal regulatory agencies, a~~ A Memorandum of Agreement (MOA) or a Memorandum of Understanding (MOU) ~~may~~ can be used with state and federal agencies. ~~, but l~~ Local governments typically ~~execute~~ use a Joint Project Agreement (JPA) or easements.

Outcome: MOU/MOA/JPA

Step 9 – Traditional Pond Siting

The pond siting process can begin~~Once~~ when it has been determined ~~by the Stormwater Team~~ that:

- P~~p~~onds ~~may~~ may be needed to meet regulatory requirements, and ~~that~~
- T~~t~~he acquisition of pond R/W is ~~right of way will be~~ required. ~~to accommodate these proposed ponds, a Pond Siting Process may commence~~. ~~An explanation of the Pond Siting Process is in~~ See ***Section D.2*** ***~~Pond Siting Process~~*** of this c~~C~~hapter for additional information.

Outcome: Stormwater Management Report.

Step 10 – WMD Coordination and ERP Permit (as needed)

With innovative solutions selected and agreements in place, the stormwater component of the ERP ~~may~~ may now be ready ~~for at least~~ to apply for a ~~conceptual~~ WMD permit. ~~Different permitting scenarios can be employed, depending on the types of stormwater management solutions selected, as shown in~~ See Table 20 – 3 ~~Project Permitting Scenarios Involving Full and Partial Solutions.~~ for some permitting scenarios for different types of stormwater management solutions.

Obtain a construction ERP i~~I~~f the Design Phase is concurrent with the Preliminary Engineering Phase. ~~a Construction ERP permit can be obtained.~~

Table 20 – 3 Project Permitting Scenarios Involving Full and Partial Solutions

Innovative Solutions -Full	Innovative Solutions -Partial	Pond Siting Process Complete	Resource Requirements Satisfied and Roadway Plans Sufficiently Developed	Conceptual Permit	Construction Permit
ü	-	-	ü		ü
ü	-	-	X*	ü	
-	ü	ü	ü		ü
-	ü	ü	X*	ü	

* Conceptual plans ~~will be~~ are needed for ~~the~~ a Conceptual Permit application.

Outcome: Appropriate WMD permit.

Step 11 – Document: Stormwater Management Report

The Stormwater Management Report:

- S~~s~~ummarizes the memoranda prepared ~~in~~ during planning,~~;~~
- D~~d~~iscusses ~~the~~ all stormwater solutions analyzed, ~~, and solutions considered but eliminated;~~ and
- D~~d~~ocuments the ~~stormwater management~~ solutions which ~~will~~ satisfy the water quality and attenuation needs of the project.

This report ~~will~~ includes all agreements with stakeholders and a summary of all meetings. ~~If traditional pond siting was pursued the report will contain~~ A traditional pond siting analysis includes the preliminary drainage design ~~of the project and, as needed,~~ and describes all traditional pond sites analyzed ~~for design~~. Include t~~T~~he memoranda prepared ~~in~~ in planning, any agreements with stakeholders, and meeting minutes ~~should be included~~ as attachments to this report.

Outcome: Stormwater Management Report.

Step 12 – Final Design, Final Permits, Construction, and Maintenance

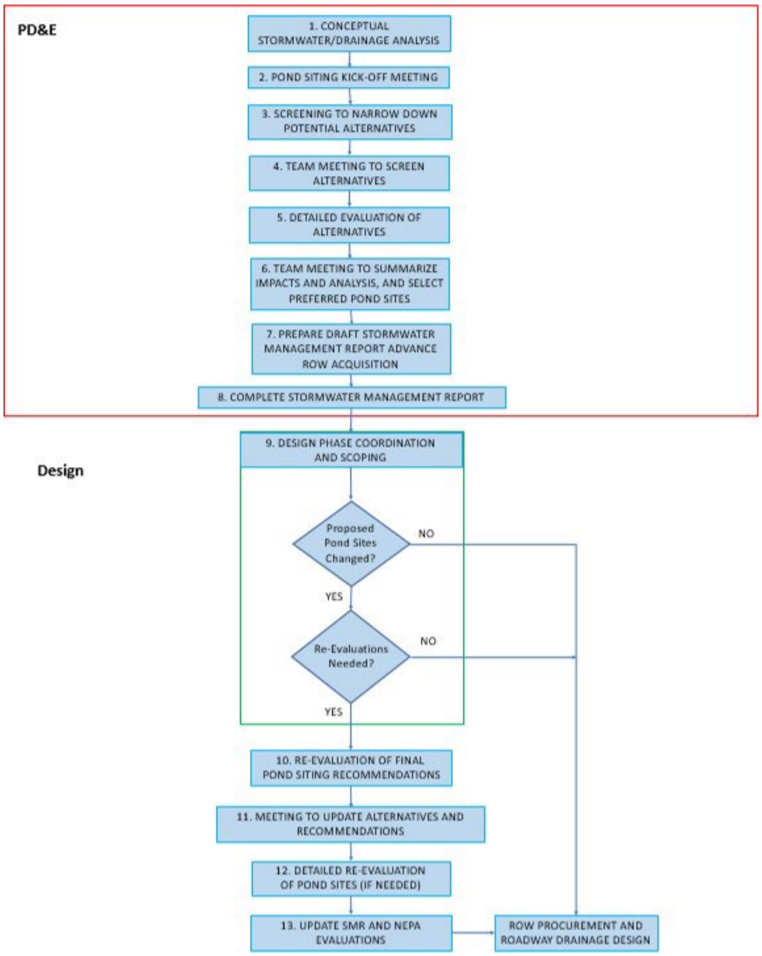
Finalize all stormwater d~~D~~esign and ~~stormwater~~ plans production ~~are finalized~~. Obtain c~~C~~onstruction permits ~~are obtained for the project as required~~. The champion continues communicating with s~~S~~takeholder(s) ~~coordination and communication should be continued by the Champion during this time, including the~~ and transfers ~~of~~ maintenance responsibility (if applicable) ~~to partners, if agreed upon as part of the partnership~~.

Outcome: Completed project including transfer of maintenance responsibility ~~to partners,~~ (if applicable).

D.2 Pond Siting Process

The ~~following~~ pond siting process below provides guidance for identifying, evaluating, and selecting locations for stormwater management ponds when those ponds require ~~right of way (ROW)~~ acquisition of R/W. The need for ponds ~~may~~ may be driven by regulatory water quality, attenuation, and/or floodplain mitigation requirements. ~~An overview is provided in~~ See Figure 20 – 2 ~~Pond Siting Process Flowchart~~ for an overview.

Figure 20 – 2 Pond Siting Process Flowchart



Step 1: Conceptual Stormwater/Drainage Analysis

Use the process below for conceptual analysis ~~Once it has been determined that~~ of traditional pond sites ~~are needed to~~ for meeting water quality and/or quantity requirements~~ or dual evaluation will be needed, the following process can be used for conceptual analysis~~.

1. Establish the drainage design criteria (~~may~~ may include a pre-permit application meeting with agencies). Criteria should include~~ the following~~:
   - Permitting criteria (water quality and quantity ~~as well as~~ and discharge limitations).
   - Rainfall intensities ~~y~~ for ~~critical duration~~ design storm events ~~(identify design storm events)~~.
   - Curve numbers or runoff coefficients.
   - Times of concentration.
   - Tailwater criteria (discharge condition and stages).
2. Conduct a review of drainage permits ~~files~~ for the corridor and adjacent developments.
3. Determine drainage basin boundaries and general outfall locations using aerial contour maps, old construction plans, and available surveys~~ to identify the primary basins and general outfall locations~~.
   - Identify profile high points ~~on the profile to~~ which separate the primary basins.
   - Conduct field visits ~~for~~ to confirm this determination.
4. Determine major off-site contributing areas.
5. Establish floodplain elevations and potential ~~for~~ encroachments.
6. Identify outfall locations and verify if closed basin criteria apply.
7. Develop ~~generic~~ basic soils information (obtain from County Soil Conservation Survey or from earlier geotechnical studies nearby ~~conducted in the area~~).
8. Establish the seasonal high ground~~-~~water table (SHGWT) elevation(s).
9. ~~Develop design e~~Estimate~~s~~ ~~for~~ water quality and water quantity requirements.
10. Develop an initial system model using a routing program.

11. Identify alternative pond designs ~~options~~ based on project site conditions and ~~available~~ project funding. A general rule of thumb ~~for placement of ponds~~ in ~~relatively~~ flat terrain is ~~to target~~ one pond per mile of corridor. ~~In hilly areas, p~~Ponds ~~locations~~ are typically ~~typically much~~ more frequent in hilly areas ~~, as driven by the roadway profile~~.

12. Identify ~~alternative~~ stormwater management alternatives ~~options (consider available~~ based on project funding~~)~~:

    - Existing stormwater management facilities – are these adequate to ~~handle~~ accommodate the proposed improvements (with or without modifications)?
    - Potential exfiltration trench options.
    - Dry detention / retention systems.
    - Wet detention / retention systems.

13. Coordinate with the R/~~O~~W Office on some ~~initial~~ potential sites to discuss at the kick-off meeting.

14. Discuss the area's stormwater management with the other agencies involved and estimate the impacts of the potential pond sites and feasibility of ~~being~~ incorporation ~~ed~~ into the area plan.

Outcome: Conceptual drainage design ~~, including identified~~ (including pond types and sizes) ~~of ponds and their approximate capacity~~.

Approximate Timeline: 2 months

Step 2: Pond Siting Kick-off Meeting

~~Before the meeting, c~~Coordinate with ~~the~~ R/W ~~right of way~~ and legal staff before the meeting to identify ~~some initial~~ potential pond sites ~~to discuss at the kick-off meeting~~. Address these issues d~~D~~uring the meeting ~~, the following issues should be addressed~~:

1. Verification of pond design guidelines and criteria (includ~~es~~ing District preferences).

2. Identify potential detention / retention pond sites.

3. Assign property ID number to each property ~~to~~ being considered. The R/~~O~~W Office ~~will~~ provides these ID numbers.

4. Identify potential joint-use pond sites (public / private).

5. ~~Task team members with an assignment to c~~Conduct an impact analysis~~.~~ (aAssign ~~impact analysis~~ to team members).

Outcome: A developed framework for future pond siting ~~e~~ evaluations.

Approximate Timeline: 2 weeks

Step 3: Screening to Narrow Down Potential Alternatives

~~This evaluation consists of~~ Conduct a general review to narrow down potential alternatives. This effort ~~may~~ may include:

- S~~s~~ite specific geotechnical testing,
- S~~s~~urvey, and
- C~~c~~onstructability reviews~~, etc~~.

~~Issues to c~~Consider these strategies in ~~when~~ evaluating R/W ~~right of way include~~:

~~1.~~2. Use existing R/~~O~~W whenever possible.

~~2.~~3. Minimize the number of parcels required ~~for pond construction along the corridor~~.

~~3.~~4. Review aerials for potentially available vacant land. Use vacant land whenever possible and economical.

- ~~Establish~~ Determine why ~~a~~ the property is vacant. ~~, and if~~ Does the property owner ha~~s~~ve development plans? ~~for development. Land may~~ The property may be vacant because the owner is having difficulty in permitting proposed improvements.

- Consider the property's development potential~~ of a property~~.

5. Look at how each pond location is situated on the site.
    - Consider the impacts to the remainder of the parcel and its viability for development.
    - How will it function for its current or future use?
    - Weigh the impacts of a partial~~ ROW~~ acquisition versus a whole acquisition ~~of the property~~.

~~4.~~6. Avoid these ~~following~~ types of properties if possible:

- Residential and commercial properties~~relocations~~.
- Public and historic facilities.
- ~~Pond sites directly~~ Properties ~~located~~ along major streets and highways.
- ~~Pond sites~~ Properties on or adjacent to contaminated sites.

~~5.~~7. Look at access management ~~issues~~ and how the remainder of the site will operate.

- Avoid landlocking the remaining property.
- Consider how maintenance staff will access the ~~pond~~ site.

~~6.~~8. Avoid or minimize impacts to existing wetland systems and wildlife habitat. ~~When placing ponds near wetlands,~~ C~~c~~heck the potential drawdown effects ~~on the wetlands.~~ when locating ponds near wetlands.

~~7.~~9. Avoid floodplain impacts.

10. Minimize utility relocations. ~~and~~

~~8.~~11. ~~r~~Review requirements for utility access for maintenance purposes.

12. Identify if proposed pond sites are candidates for advanced acquisition.

- Coordinate advanced acquisitions with R/W staff.
- ~~If so, the ROW staff must have an increased role and the advanced ROW process identified in the project schedule.~~

Outcome: Initial evaluation of potential pond sites.

Approximate Timeline: 4 weeks.

Step 4: Team Meeting to Screen Alternatives

~~For the evaluation of stormwater management ponds~~ See Table 20 – 4 for ~~s~~several standard ~~ized~~ factors ~~should be~~ to consider~~ed~~ in evaluating stormwater management ponds ~~, as shown in Table 20 – 4 Evaluation Factors for Pond Siting Alternatives~~. ~~The project's stormwater team has the option of c~~Customize ~~ing~~ these factors ~~within the matrix~~ within the matrix to address project-specific requirements ~~satisfy the particularities of their project~~. See Exhibit 20 -1 for a~~A~~n example of ~~a~~ an evaluation matrix ~~format is shown in Exhibit 20 – 1 Evaluation Matrix Example~~.

~~For consistency,~~ T~~t~~he stormwater team should agree upon ~~use~~ a ranking scale for each factor ~~that is agreed upon by the entire group.~~

Outcome: Reduce p~~P~~ond site alternatives ~~are reduced~~ to 3 sites per basin. ~~, with (1) team member assignments allocated for further,~~ Conduct a more detailed evaluation. ~~; and (2) needed~~ Obtain field survey ~~requested~~ for ~~the alternative~~ sites still being ~~under~~ considered ~~ation~~.

Approximate Timeline: 2 - 3 weeks.

Table 20 – 4 Evaluation Factors for Pond Siting Alternatives

Factor	Description/Issues to Consider	Cost $	Weighted Value
Brief Description of Alternative	Provide a detailed description of the pond site.	N/A	N/A
Parcel Number	~~Identify~~ Obtain the Parcel Number ~~with~~ from the R/W ~~ight of Way o~~Office.	N/A	N/A
Estimated Parcel Size (Acres)	Provide the total area ~~for~~ of the required R/~~O~~W acquisition. The total area ~~is to~~ includes the area to meet the water quality / quantity storage requirements, ~~as well as~~ maintenance berms ~~width~~, slopes, perimeter drainage/conveyance ditches, ~~area~~ and access ~~to pond sites~~ for maintenance.	N/A	N/A
Right of Way (Zoning)	Describe the status of the parcel ~~in question~~. ~~For example, the parcel~~ It could be ~~currently under a proposed plan~~ planned for improvement (Rezoning ~~Request~~) or ~~the site may~~ it may ~~currently~~ be ~~located~~ on a commercial site with an active business. Consider ~~ation should also be given to~~ existing and proposed zoning.	N/A	~~If there are no zoning issues with the site a~~Add 5 points per acre if there are no zoning issues. ~~If there are potential zoning issues, add zero points.~~
Land Use	Identify the current and/or proposed land use~~, which~~ (could affect ~~the~~ acquisition costs) ~~of the parcel~~. ~~For example, a~~ A partial ~~ROW~~ acquisition ~~of a property~~	N/A	Add these c~~C~~osts ~~will need to be added~~ to the overall site costs. ~~and~~ Apply a weighted value ~~applied~~ accordingly.

	could ~~have a~~ significantly impact ~~on the use of~~ the remaining parcel.		
R/W ~~Right of Way~~ Costs	Identify ~~Right of Way~~the associated R/W c~~C~~osts ~~associated with the acquisition of the parcel~~.	$	Add these c~~C~~osts ~~will need to be added~~ to the overall site costs. ~~and~~ Apply a weighted value ~~applied~~ accordingly.
Drainage Considerations	Include a description of the proposed drainage system and ~~corresponding~~ outfall location and parameters. Consider pond location ~~such as in~~ relative to the center of the basin, ~~in~~ the low area ~~within~~ of the basin, adjacent to the outfall ~~location~~, and piping needs / costs, etc. ~~Also c~~Consider site elevations and the ~~corresponding~~ need to elevate (build-up) the perimeter berm.	$	Meets the FDOT's needs – points TBD by Team. Meets most needs – points TBD by Team. Other issues between sites ~~will~~ depend on the construction costs ~~of a facility at~~ of each particular site.
FEMA Flood Zone	Identify the f~~F~~lood z~~Z~~one and associated impacts / benefits ~~of a pond~~ within the flood zone. The perimeter berm ~~will affect~~ reduces floodplain ~~zone~~ storage, while the pond ~~will~~ increases ~~enhance~~ storage. When R/W~~right of way~~ is acquired ~~with~~in a low-lying area, ~~the construction of~~ the roadway template ~~may~~ may affect adjacent properties' ~~ability to~~ use of that area for storage.	N/A	Meets the FDOT's needs – points TBD by Team. Meets most needs – points TBD by Team. Other issues ~~will~~ depend on the benefit to the floodplain at each particular site.

Contamination – Hazardous Materials	Identify if the parcel is contaminated ~~; this will limit the ability to use the site~~. ~~Consideration of this parcel must i~~I Include ~~the~~ clean-up costs for contaminated parcels ~~associated with the clean-up of the site~~.	N/A	Additional costs are ~~will need to be~~ added to the overall site costs and a weighted value applied accordingly.
Utilities	Identify existing and proposed utilities within or ~~adjacent to~~ near the parcel. ~~The cost of relocating~~ Include any potential utility relocation costs ~~ies must be included in the consideration of a parcel~~.	$	Additional costs are ~~will need to be~~ added to the overall site costs, and weighted value applied accordingly.
Threatened & Endangered Species (TES) and associated Mitigation Costs	Identify species as Threatened, Endangered, or Significant. Identify ~~the~~any ~~anticipated~~ potential mitigation costs.	N/A	Additional costs are ~~will need to be~~ added to the overall site costs, and a weighted value applied accordingly.
Noise	Identify noise impacts and ~~corresponding~~ potential noise abatement~~,~~ (which ~~may~~ may impact the pond location) ~~and placement of pond sites~~.	N/A	Additional costs are ~~will need to be~~ added to the overall site costs, and a weighted value applied accordingly.
Wetlands / Protected Uplands and associated Mitigation Costs	High values indicate known habitat or historic presence such as Rookery Area. Medium values ~~may be~~ indicate ~~ive of~~ relatively undisturbed, natural, or stable habitat types. Low values ~~may~~ indicate disturbed habitats. Include ~~dentify~~ the cost of mitigating ~~for~~ these impacts.	$	Additional costs are ~~will need to be~~ added to the overall site costs, and a weighted value applied accordingly.

Cultural Resource~~s~~ Impacts ~~nvolvement~~ and associated Costs	Identify ~~the presence of~~ existing cultural resources ~~including~~ (archaeological and historical) ~~resources~~ which ~~could~~ can affect ~~the~~ site suitability ~~of the site in question~~ and ~~associated~~ costs.	N/A	Additional costs are~~will need to be~~ added to the overall site costs, and a weighted value applied accordingly.
Section 4(f)	Identify the presence of Section 4(F) properties which ~~could~~ can affect ~~the~~ site suitability ~~of the site in question~~ and ~~associated~~ costs.	N/A	Additional costs are~~will need to be added~~ to the overall site costs, and a weighted value applied accordingly.
Public Wellfield	~~The p~~Proximity to a wellfield ~~site will~~ has ~~ve~~ a direct impact on the type of drainage facility which can be ~~placed~~ constructed on the ~~corresponding~~ parcel.	N/A	N/A
Construction	Identify access for construction and associated impacts which ~~may~~ may affect construction costs ~~,~~ ~~such as~~ (e.g., the amount of drainage piping ~~required~~ to reach the pond).	N/A	No set weighted value is applicable for this item; however, requirements for items identified ~~may~~ can have a direct impact on the construction cost. Consider this and add to the overall costs associated with utilizing this site.
Maintenance	Identify the costs of maintaining ~~a~~ the facility at this location and the potential for maintenance agreements with others. Consider the cost of access ~~costs~~ to the pond site.	$	Working with District Maintenance, staff needs to establish yearly maintenance costs per acre of pond area. This could be a yearly cost, say over a twenty-year period, and brought to

Maintenance (continued)			present value for inclusion in the overall cost item below. Establish a cost for: • Wet Detention Maint. Cost per Acre $____ • Dry Pond Maint. Cost per Acre • Dry Linear Swale Cost per Acre • Offsite Pond Maintenance by others At the beginning of the Preliminary Engineering Study, the Project Manager should consult with the Maintenance Office for current maintenance costs.
Aesthetics	Identify the need for landscape buffers, fencing, variable pond shapes, etc.	N/A	No set weighted value is applicable for this item; however, requirements for fencing, landscaping, littoral shelves, etc. which have a direct impact on the area required to physically set the pond needs to be considered. Costs associated with plants, fencing etc. ~~will~~ need to be added

			to the overall costs of using the site.
Public Opinion / Adjacent Residentt~~cy~~ Concerns	Identify possible impacts to current or proposed land use (i.e., schools ~~may~~ may dictate a dry pond versus a wet pond).	N/A	N/A; however, this factor ~~may~~ can affect the type of system selected for a site.
Other	Joint u~~U~~se potential.	N/A	If the ability to use joint use ponds is available, assume a weighted value of 10 per acre-ft of available storage. Otherwise use zero for this value.
Total ~~Applicable~~ Costs	Identify the total cost of the parcel (including the costs ~~identified from~~ of all issues above).	$	Costs vary significantly between rural and urban locations. This value should be used when comparing final costs between alternative pond locations. Engineering judgment ~~will~~ is needed ~~to be considered~~ and an acceptable cost modifier applied as agreed to by the team members. Use 1 point per 5% differential in cost

			between alternative sites.
Comments, Advantages, Disadvantages, etc.	Include a detailed description of the parcel's aAdvantages and dDisadvantages associated with the parcel in question.	N/A	N/A

Step 5: Detailed Evaluation of Alternatives

Conduct a field review(s) and obtain survey as ~~deemed~~ necessary. ~~The extent of t~~The field review should include the verification of impacts to assess the viability of a potential pond site.

Outcome: Alternatives are fully evaluated in preparation for selecting a preferred pond site in each basin.

Approximate Timeline: 4 weeks.

Step 6: Team Meeting to Summarize Impacts and Analysis, and Select Preferred Pond Sites

~~During the public involvement process,~~ Make every reasonable effort~~s must be made~~ throughout to inform the public/affected property owners of the potential impacts of the proposed improvements to the community/properties ~~of the proposed improvements~~. ~~As such,~~ Present properties identified for potential pond acquisition ~~for retention/detention ponds should be presented~~ to the public in the same manner as acquisition for roadway improvements ~~geometric requirements~~. ~~Although the proposed right of way acquisition is displayed,~~ Clearly inform t~~t~~he public ~~should be clearly informed~~ that all proposals are preliminary~~,~~ and subject to change~~,~~ as the project develops.

Outcome: Selection of preferred pond sites.

Approximate Timeline: 1 week.

Step 7: Prepare Draft Stormwater Management Report/Advanced R/~~O~~W Acquisition

The Stormwater Management Report ~~should~~ has~~ve~~ been developed incrementally ~~prepared as~~ during the pond siting process ~~was unfolding and reviewed by the team~~. Present t~~T~~he draft Stormwater Management Report ~~will be presented~~ at the p~~P~~ublic m~~M~~eeting.

Outcome: Make t~~T~~he Draft Stormwater Management Report ~~should be made~~ available for the p~~P~~ublic m~~M~~eeting.

Approximate Timeline: 1 month.

Step 8: Hold Public Meeting/Workshop

Advertise and host a public meeting/workshop to inform the public about the project and the pond locations being considered. Ensure notice of the meeting is provided in a timely manner. ~~Gather public input and document comments for further consideration in design~~. Present c~~C~~onceptual project plans, aerial photos, and geotechnical information ~~can be provided~~ to help ~~improve~~ the public~~'s~~ understand~~ing of~~ the project's impacts. Gather public input for additional consideration ~~Ensure notice of meeting is provided in a timely manner.~~

Outcome: Obtain public input.

Approximate Timeline: 6 weeks.

Step 9: Complete Stormwater Management Report

Finalize the Stormwater Management Report and recommendations based on the stormwater team's evaluation. See Exhibit 20 – 2~~, below, is~~ for a sample t~~T~~able of c~~C~~ontents for a Stormwater Management Report~~s~~.

1. Discuss and address input and comments from the p~~P~~ublic m~~M~~eeting.

2. Re-rank ~~recommended and alternative~~ all pond sites, (if necessary).

Outcome: The Final Stormwater Management Report is completed.

Approximate Timeline: 1 week

Exhibit 20 – 2 Sample Table of Contents for a Stormwater Management Reports

TABLE OF CONTENTS FOR POND SITING REPORTS

APPENDICES

Step 10: Reevaluation of Final Pond Siting Recommendations

The team should reevaluate the pond siting recommendations i~~I~~f any pond sites selected in the Stormwater Management Report have materially changed from their recent condition~~s at the time of the completion, the team should reevaluate the pond siting recommendations~~.

Outcome: Team members ~~have~~ review~~ed~~ changed pond sites and identify any needs for additional engineering data ~~is identified for pursuit~~. Refine p~~P~~ond site layouts ~~are refined~~.

Approximate Timeline: 1 week.

Step 11: Detailed Re-Evaluation of Pond Sites (If Needed)

Re-evaluate ~~remaining~~ all viable sites ~~recommended sites and identified alternate sites~~ and conduct field reviews as necessary. Finalize pond site layouts ~~layout with site geometrics~~ for ~~the~~ all viable ~~recommended~~ sites ~~and identified alternatives~~.

Outcome: **Evaluate** c~~C~~hanges ~~to previous pond sites are evaluated in~~ to prepare ~~ation~~ for team discussion and updating ~~of~~ documents.

Approximate Timeline: 3 weeks.

Step 12: Update Stormwater Management Report

- Review the findings from the previous step,
- U~~u~~pdate the matrix ~~as necessary~~,
- R~~r~~ecommend final pond sites ~~for project~~,
- U~~u~~pdate the Stormwater Management Report based on the team's evaluations, and
- F~~f~~inalize the information.
- ~~-~~Send the preferred pond sites to the R/W ~~right of way~~ M~~m~~apping Office~~the preferred pond sites as specified in the revised Stormwater Management Report~~.
- Send the ~~right of way~~ R/W requirements to the ~~right of way~~ R/W staff for procurement.

Outcome: Update the Stormwater Management Report. ~~is updated,~~ Initiate R/~~O~~W acquisition ~~begins~~.

Approximate Timeline: 4 weeks.

E OPEN CHANNEL

This section ~~presents~~ provides minimum standards for ~~the~~ designing ~~of~~ natural and~~or~~ manmade open channels, including:

- R~~r~~oadside ditches,
- S~~s~~wales,
- M~~m~~edian ditches,
- I~~i~~nterceptor ditches,
- O~~o~~utfalls, and
- C~~c~~anals.

E.1 Design Frequency

Design o~~O~~pen channels ~~shall be designed~~ to convey and to confine storm~~-~~water within the channel. Table 20 – 5 provides s~~S~~tandard design frequencies for stormwater flow ~~are shown in Table 20 – 5 Stormwater Flow Design Frequencies~~.

Table 20 – 5 Stormwater Flow Design Frequencies

Facility Types	Frequency
Major roadway	10 ~~-~~year
All other road types	5 ~~-~~year

Site-specific factors ~~may~~ may warrant ~~the~~ using ~~e of~~ an atypical design frequency. Any proposed increase over pre-development stages ~~shall~~ cannot significantly ~~change~~ alter land use ~~values~~ (unless flood rights are acquired).

E.2 Hydrologic Analysis

~~For the design of open channels,~~ U~~u~~se one of these ~~followin~~g methods for designing open channels (as appropriate for the site):

1. Use a~~A~~ frequency analysis of observed (gage) data ~~shall be used~~ when available. ~~If insufficient or no observed data is available,~~ Otherwise, use one

of the procedures below shall be used (as appropriate). However, the procedures below shall be cCalibrated these procedures (to the extent practical) with available observed data for the drainage basin, (or similar nearby similar drainage basins).

a) Regional or local regression equation developed by the United States Geological Survey (USGS).

b) Rational eEquation for drainage areas up to 600 acres.

c) For outfalls from stormwater management facilities, TThe method used for the designing of the stormwater management facility may can also be used for outfalls from the facility.

2. For regulated or controlled canals, Obtain hydrologic data for regulated and controlled canals shall be requested from the controlling agency entity. Prior to use for design, t Verify such his data shall be verified to the extent practical before using for design.

3. Stormwater modeling software, approved by the maintaining controlling agency or local government jurisdiction.

E.3 Hydraulic Analysis

Use tThe Manning's Equation shall be used for the to design of open channels.

E.3.a Manning's "n" Values

See FDOT ***Drainage Manual (2022)***, Tables 2.2 and 2.3 for rRecommended Manning's "n" values for channels with:

- Bbare soil,
- Vvegetated ive linings, and
- Rrigid linings. are presented in the FDOT's ***Drainage Manual (2022)***, Table 2.2 Manning's "n" Values for Artificial Channels with Bare Soil and Vegetative Linings and Table 2.3 Manning's 'n" Values for Artificial Channels with Rigid Linings.

The FDOT ***Drainage Mmanual (2022)*** is incorporated herein by reference in ***Rule 14-86.003, F.A.C., Permit, Assurance Requirements, and Exceptions***.

The probable condition of the channel Use the channel condition that will likely exist when the design event is anticipated shall be considered when a in selecting the Manning's "n" value is selected.

E.3.b Slope

Design rRoadside channels should be designed to have promote self-cleaning velocities, (where possible). and Channels should also be designed to avoid to prevent standing water in the roadway R/Wright of way.

E.3.c Channel Linings and Velocity

~~The design of open channels shall c~~ Consider the need for channel linings. ~~When design flow velocities do not exceed the maximum permissible for bare earth,~~ Grassing and mulching are the standard treatment ~~the standard treatment of ditches may consist of grassing and mulching~~ except where design flow velocities exceed the maximum permissible for bare earth. ~~For higher design velocities,~~ Provide s~~s~~odding, ditch paving, or another form of lining ~~shall be provided~~ for higher velocities. See FDOT ***Drainage Manual (2022),*** Tables 2.4 and 2.5 ~~Tables~~ for maximum velocities for bare earth and

~~the various forms of~~ other channel linings ~~can be found in the FDOT's *Drainage Manual (2022)*, Tables 2.4 Maximum Shear Stress Values and Allowable Velocities for Different Soils and Table 2.5 Maximum Velocities for Various Lining Types~~.

E.3.d Limitations on Use of Linings

Do not use g~~G~~rassing or sodding ~~should not be used~~ under these ~~following~~ conditions:

1. Continuous standing or flowing water,
2. ~~Areas that do not receive the regular~~ Not maintained ~~enance necessary~~ regularly to prevent overgrowth by taller vegetation,
3. Lack of nutrients,
4. Excessive soil drainage,
5. ~~Areas e~~Excessive~~ly~~ shade~~d~~.

~~To prevent cracking or failure,~~ Install ~~c~~concrete linings ~~must be placed~~ on a firm, well-~~-~~drained foundation to prevent cracking and failure. Concrete linings are not recommended where expansive clays are present.

Consider the potential for concrete lining buoyancy ~~When concrete linings are to be used~~ where soils ~~may~~ can become saturated~~, the potential for buoyancy shall be considered~~. ~~Acceptable~~ Buoyancy countermeasures ~~may~~ include:

1. Increase~~ing~~ the thickness of the concrete lining ~~to add~~ for additional weight.
2. ~~For sub-critical flow conditions, specifying~~ Install weep holes at appropriate intervals ~~in the channel bottom~~ to relieve ~~the~~ upward pressure for sub-critical flows ~~on the channel~~.
3. ~~For super-critical flow conditions, using~~ Install subdrains (in lieu of weep holes) for super-critical flows.

E.4 Construction and Maintenance Considerations

Consider t~~T~~he type and frequency of maintenance ~~that may be~~ required over ~~during~~ the life of the ~~drainage~~ channel. ~~s should be considered during their design, and~~ Make allowances ~~should be made~~ for ~~the~~ access ~~of~~ by maintenance equipment.

E.5 Safety

The design and location of open channels ~~shall~~ must comply with roadside safety and clear zone requirements. See ***Chapter 3*** ~~***– Geometric Design***~~ for clear zone requirements ~~, including special~~ (including increased clearances ~~criteria~~ for canals).

E.6 Documentation

~~For new construction, design documentation for open channels shall i~~ Provide these analyses for open channel flow for new construction: ~~nclude the~~

- H~~h~~ydrologic analysis, ~~and the~~
- H~~h~~ydraulic analyses, ~~including~~ and
- A~~a~~nalysis of channel lining requirements.

F STORM DRAIN HYDROLOGY AND HYDRAULICS

This section ~~presents~~ provides minimum standards for ~~the~~ designing ~~of~~ storm drain systems.

F.1 Pipe Materials

See Section H for pipe material requirements.

F.2 Design Frequency

The minimum design storm frequency for ~~the design of~~ storm drain systems ~~shall be~~ is 3 years.

Site-specific factors ~~may~~ may warrant ~~the~~ using ~~e of~~ an atypical design frequency. Any proposed increase over pre-development stages ~~shall~~ cannot significantly ~~change~~ alter land use ~~values~~ (unless flood rights are acquired).

F.3 Design Tailwater

~~For most design applications where the flow is subcritical, t~~ The design tailwater ~~will~~ (for subcritical flows) is either ~~be~~ above the crown of the outlet or ~~can be considered to be~~ between the crown and critical depth. To ~~determine~~ estimate the energy grade line (EGL): ~~,~~

- B~~b~~egin with either the tailwater elevation or (dc + D)/2~~,~~ (whichever is higher),
- A~~a~~dd the velocity head for full flow, ~~and~~
- P~~p~~roceed upstream,
- A~~a~~dding appropriate losses (e.g., exit, friction, junction, bend, entrance).

~~An exception to the above procedure is~~ A~~a~~n outfall with low tailwater is an exception to this procedure: ~~.~~ ~~In this case,~~

- Calculate ~~a~~ the water surface profile ~~calculation would be appropriate~~ to determine ~~the location~~ where the water surface ~~will either~~ intersects the top or end of the barrel and full-~~-~~flow calculations can begin. ~~In this case,~~
- T~~t~~he downstream water surface elevation is ~~would be based on~~ the critical depth or the tailwater~~,~~ (whichever is higher).

F.4 Hydrologic Analysis

The Rational Method is ~~the~~ preferred ~~method in use~~ for ~~the~~ designing ~~of~~ storm drains ~~when the momentary peak flow rate is desired~~. Other methods ~~may~~ can be used~~,~~ with permission from ~~by~~ the ~~maintaining agency or~~ local government agency ~~jurisdiction~~.

F.4.a Time of Concentration

The m~~M~~inimum time of concentration ~~shall be~~ is 10 minutes.

F.5 Hydraulic Analysis

Base storm drain h~~H~~ydraulic calculations ~~for determining storm drain conduit sizes shall be based~~ on open channel ~~and~~ or pressure flow (as appropriate). Use t~~T~~he Manning's equation ~~shall be used~~.

F.5.a Pipe Slopes

~~The~~ Provide a minimum physical storm drain slope ~~should be that which will~~ that produces a velocity of
2.5 feet per second (fps) when ~~the storm drain is~~ flowing full. ~~Where not practical or possible in flat terrain,~~ Where impractical due to flat terrain, i~~i~~nclude design features to ~~limit~~ prevent soils from entering the storm drain system ~~pipes~~.

F.5.b Hydraulic Gradient

~~If The~~t Design the storm drain system such that the hydraulic grade line (HGL) ~~does not rise above~~ remains below the top of ~~any~~ the manholes ~~or above an~~ and inlets ~~entrance, the storm drainage system is satisfactory. Standard practice is to ensure that the HGL is below the top of the inlet for the design discharge~~ (some ~~local~~ agencies ~~may add an additional~~ require a safety factor ~~which can be~~ up to 12 inches). Use bolted lids for m~~M~~anholes ~~with bolted lids may be used in locations~~ where the top is below the HGL.

F.5.c Outlet Velocity

~~When discharge exceeds 4 fps,~~ C~~c~~onsider special channel lining or energy dissipation where discharges exceed 4 feet per second. ~~For computation of outlet velocity,~~ Use t~~t~~he lowest anticipated tailwater condition for the given storm event ~~shall be assumed~~ in computing the outlet velocity.

F.5.d Manning's Roughness Coefficients

See FDOT ***Drainage Manual (2022) Section 3.6.4*** for s~~S~~tandard~~s~~ Manning's r~~R~~oughness c~~C~~oefficients ~~can be found in the FDOT's~~

~~***Drainage Manual (2022) Section 3.6.4.***~~

F.6 Hydraulic Openings

~~If the hydraulic grade line does~~ The HGL should not rise above the top of any manhole or ~~above an~~ inlet ~~entrance, the storm drainage system is satisfactory. Standard practice is to ensure that the HGL is below the top of the inlet for~~ during the design discharge.

~~The design stage for a ditch bottom inlet may be allowed to~~ The HGL can exceed the top of an inlet ~~top~~ when the ditch or swale can accommodate the overtopping ~~capacity~~. Examine where ~~the~~ overtopping ~~elevation~~ could occur to ~~ensure there are no~~ ensure there are no on-site or off-site adverse flooding impacts ~~to the roadway or offsite property~~.

F.6.a Entrance Location and Spacing

Design and locate d~~D~~rainage inlets and other hydraulic openings ~~are sized and located~~ to accommodate: ~~satisfy~~

- H~~h~~ydraulic capacity,
- S~~s~~tructural capacity,
- S~~s~~afety (pedestrians, bicyclists, and motor vehicles), and
- D~~d~~urability requirements.

Locate ditch bottom inlets and~~Grate~~ curb inlets ~~and the depression of curb opening inlets should be located~~ outside ~~the~~ all ~~through~~ travel~~ffic~~ lanes ~~to minimize the shifting of vehicles attempting to avoid them~~. ~~All grate~~ Ditch bottom inlet grates ~~s shall~~ must be bicycle safe along roadways that allow bicycles ~~where used on roadways that allow bicycle travel~~.

See ~~The~~ FDOT~~'s~~ ***Drainage Manual (2022), Section 3.7*** ~~provides~~ for guidance on hydraulic openings and protective treatments~~.~~ (Tables 3.3, 3.4, and 3.5 ~~Curb and Inlet Application Guidelines, Table 3.4 Ditch Bottom Inlet Application Guidelines and Table 3-5 Drainage End Treatment – Lateral Offset Criteria in the~~ ~~***Drainage Manual***~~ provide guidance ~~for~~ on inlet selection).

Inlet spacing ~~shall~~ must consider ~~the following~~:

- Regardless of the hydraulic analysis, inlets on a grade should be spaced at no more than 300 feet.

Regardless of the results of the hydraulic analysis, inlets on grade should be spaced at a maximum of 300 feet for 48 inches or smaller pipes.

Inlets on grade should be spaced at a maximum of 600 feet for pipes larger than 48 inches.

- ~~Inlets should be placed on the upstream side of bridge approaches.~~ Locate inlets:
    - At all low points.
    - Upstream of:
        - Bridge approaches.
        - Intersecting roadways (to capture flows beforehand).
        - Driveways,
        - Curb-cut ramps,
        - Pedestrian crosswalks.
        - Median openings.
    - Flanking the low points of sag vertical curves.
    - To prevent water from sheeting across a roadway:
        - Locate inlets before a superelevation transition begins.
    - Outside of pedestrian walkways.
- ~~Inlets should be placed at all low points in the gutter grade.~~
- ~~Inlets should be placed upstream of intersecting streets.~~

- ~~Inlets should be placed on the upstream side of a driveway entrance, curb-cut ramp, or pedestrian crosswalk even if the hydraulic analysis places the inlet further down grade or within the feature.~~
- ~~Inlets should be placed upstream of median breaks.~~
- ~~Inlets should be placed to capture flow from intersecting streets before it reaches the major highway.~~

~~Flanking inlets in sag vertical curves are standard practice.~~

- ~~Inlets should be placed to prevent water from sheeting across the highway (i.e., place the inlet before the superelevation transition begins).~~
- ~~Inlets should not be located in the path where pedestrians walk.~~

F.6.b Grades

F.6.b.1 Longitudinal Gutter Grade

The minimum longitudinal gutter grade ~~shall be~~ is 0.3% (use a rolling profile in flat terrain). ~~Minimum grades can be maintained in very flat terrain by use of a rolling profile.~~

F.7 Spread Standards

Limit t~~T~~he stormwater spread~~,~~ (~~in~~ for both temporary and permanent conditions)~~,~~ resulting from a rainfall intensity of 4.0 inches per hour ~~shall be limited~~ as provided~~shown~~ in Table 20 – 6 ~~Spread Criteria~~.

Table 20 – 6 Spread Criteria

Design Speed (mph) ~~(mph)~~	**Spread Criteria***
Design Speed ≤ 30	Crown of Road
30 < Design speed ≤ 45	Keep ½ of lane clear
45 mph < Design Speed ≤ 55	Keep 8 feet~~'~~ of lane clear
Design Speed > 55	No encroachment

* ~~The criteria in this column~~ A~~a~~ppl~~y~~ies to travel, turn, ~~or~~ and auxiliary lanes adjacent to barrier wall or curb~~,~~ (in normal ~~or~~ and super~~-~~elevated sections).

~~In addition to the above standards, for sections with a shoulder gutter, the spread~~ Limit the outward stormwater spread resulting from a 10-year frequency storm ~~shall~~ for sections with shoulder gutter ~~not exceed 1' 3"~~ to 1.25 feet outside the gutter, ~~in the direction toward the front slope. This distance limits the spread to~~ (e.g., the face of any guardrail posts).

F.8 Construction and Maintenance Considerations

~~Proper design shall also c~~Consider long-term maintenance needs during design, including ~~concerns of~~ adequate physical access for cleaning and repairs.

F.8.a Pipe Size and Length

~~Consider using a~~ The minimum pipe ~~size of 18"~~ size (diameter) for trunk lines, ~~and~~ laterals, and exfiltration trench (French Drain) is 18 inches~~.~~ (15-inch~~"~~ hubcaps ~~commonly~~ can block smaller pipes) ~~resulting in roadway flooding. The minimum pipe diameter for all proposed exfiltration trench pipes (French drain systems) within a drainage system is 18"~~.

The longest pipe runs ~~maximum pipe lengths~~ without a drainage ~~maintenance~~ access structure~~s~~ are ~~as follows~~:

Pipes without f~~F~~rench d~~D~~rains:

18" to~~-~~ 42" pipe	300 feet
48" and larger pipe and all box culverts	600 feet

French d~~D~~rains that have access ~~through~~ from only one end:

18" to 30" pipe	150 feet
36" and larger pipe	200 feet

French d~~D~~rains that have access ~~through~~ from both ends:

24" to 30" pipe	300 feet
36" and larger pipe	400 feet

F.8.b Minimum Clearances

~~A minimum~~ Provide at least 1 foot of cover ~~of 1 ft should be provided~~ between the top of pipe and the top of subgrade. ~~A minimum~~ Provide at least 1 foot of clearance ~~of 1 ft should be provided~~ between storm drain~~age~~ pipes and other underground facilities (e.g., sanitary sewers). Check with local utility owners ~~companies, as~~ as their minimum clearance requirement~~s~~ ~~may~~ may exceed 1 foot ~~vary from the 1' minimum~~.

F.9 Green Stormwater Elements for Context-~~-~~Based Design

Drainage systems are ~~often determined~~ typically laid-out ~~by~~ based on economics ~~opportunity, feasibility,~~ and topography; ~~, rather than context. However,~~ but understanding ~~both the existing and~~ current and future land use and transportation goals can sometimes allow innovative site-specific solutions ~~can help determine drainage specific options for the proposed design~~. Future land use and transportation needs ~~can~~ may alter the context and change the drainage opportunities~~ available~~.

~~The introduction of~~ G~~g~~reen streets are ~~is one~~ a component of a ~~larger~~ broader drainage design approach to improving ~~the~~ a region's stormwater management.~~,~~ ~~and~~ Green streets require~~s~~ a broad~~er~~-based alliance for their ~~its~~:

- P~~p~~lanning,
- F~~f~~unding,
- M~~m~~aintenance, and
- M~~m~~onitoring.

Green stormwater elements ~~also~~ serve as a visible component of "green i~~I~~nfrastructure", ~~that is incorporated into the~~ which enhances community aesthetics. ~~of the community~~

These innovative drainage solutions ~~following is a list of drainage considerations that~~ can support context-~~-~~based design and ~~minimize~~ reduce the amount of stormwater ~~that leaves~~ leaving the corridor:

- Bioretention/Biofiltration Planter – are stormwater infiltration cells constructed with walled vertical sides, a flat bottom ~~area~~, and a large surface capacity to capture, treat and manage stormwater runoff ~~from the street~~. They provide water quality treatment and reduce runoff volumes~~,~~ and ~~may~~ can be ~~applied~~ used in ~~more~~ limited R/W~~rights of way~~.
- Bioretention Swale – are shallow, vegetated, landscaped swales/depressions with sloped sides.

- Hybrid Bioretention Cell – combines elements of both swales and planters, ~~featuring~~ with a walled side opposite a graded side slope to increase vegetated space and infiltrating area, while providing a softer streetscape ~~treatment~~ for pedestrians~~ople walking~~.
- Pervious Strips – are long, linear landscaped areas or linear areas of pervious pavement that ~~can~~ capture and reduce ~~slow~~ runoff.

- Street Trees – can contribute significantly to green stormwater management, with large capacity to:
  - T~~t~~ranspire water,
  - I~~i~~ntercept rainfall, ~~and~~
  - T~~t~~reat water quality,~~ as well as~~
  - Mitigate temperature, ~~mitigation~~ and
  - Improve air quality~~ improvement~~.
- Pervious Pavers/Permeable Pavement – reduces runoff by allowing~~s~~ water to infiltrate through streets, parking bays and sidewalks~~, reducing runoff~~. Proper m~~M~~aintenance ~~of the pavement will~~ promotes ~~affect~~ long-term durability.

Green stormwater infrastructure performance can improve over time if ~~facilities are~~ properly maintained. ~~As vegetation establishes,~~ R~~r~~oots ~~can~~ capture and retain more stormwater as vegetation matures. Healthy vegetation and soil can:

- I~~i~~ncrease~~s~~ transpiration,
- R~~r~~educe~~s~~ urban heat island effects,
- S~~s~~upport ~~ts~~ groundwater recharge, and
- R~~r~~estore~~s~~ natural ecological cycles and resources.

Robust ~~and~~ regular ~~iterative operations and~~ maintenance ~~plans are~~ is critical ~~to fully~~ in capitalizing on the potential of green infrastructure. Include maintenance staff in the project planning process to ~~reduce~~ discuss best practices and avoid design oversights ~~in the design and ensure that green stormwater infrastructure can achieve its full potential~~. ~~Although all drainage systems require maintenance, g~~ Green streets ~~will~~ require special attention to long-term maintenance ~~requirements and techniques~~. Establish site-specific m~~M~~aintenance practices and frequencies and train all maintenance staff accordingly ~~y of maintenance need to be established and personnel trained~~.

~~Traffic calming features such as c~~Curb extensions can be designed as stormwater bioretention areas ~~to intercept stormwater and work with existing roadways and pedestrian features by including~~ and can feature ADA-compliant inlet grates ~~covered channels or inlets~~. ~~These and other traffic calming features such as~~ Evaluate potential impacts to pavement hydraulics and stormwater spread when using traffic calming features (e.g., curb extensions, s~~S~~peed tables and raised crosswalks) ~~should be evaluated for impacts to pavement hydraulics to ensure runoff is managed without violating spread criteria~~.

See t~~T~~he National Association of City Transportation Officials' (NACTO) ***Urban Street Stormwater Guide*** ~~provides additional information on the~~ for green streets stormwater elements of green streets. See tThe FDOT's ***Standard Plans*** and the FDOT's ***Drainage Manual*** provide further information on the design and placement of for designing trench drains, fFrench drains, and underdrains.

The Transportation Research Board's (TRB) data base (TRID) includes several research projects on how pervious pavements perform in Florida titled ***Pervious Pavements – Installation, Operations, and Strength, Parts 1, 2, 3 and 4***.

Figure 20 – 3 Green Street Elements

F.10 Protective Treatment

Review d~~D~~rainage designs ~~shall be reviewed~~ to determine if ~~some form of~~ some form of protective treatment ~~will be~~ is required to prevent unauthorized ~~entry~~ access to:

- L~~l~~ong or submerged storm drain systems,
- S~~s~~teep ditches, ~~or~~ and
- W~~w~~ater management ~~control~~ facilities. ~~If other modifications, such as~~

Consider providing l~~l~~andscaping ~~or providing~~ and flat slopes to eliminate hazards ~~, can eliminate the potential hazard and thus~~ and avoid the need for protective treatment~~, they should be considered first~~. ~~Areas provided for~~ R~~r~~etention and detention areas ~~, for example,~~ can ~~often~~ be effectively integrated into parks ~~or~~ and other green spaces.

Balance the need for v~~V~~ehicular safety ~~and~~ with need for pedestrian safety. ~~are attained by differing protective treatments, often requiring the designer to make a compromise in which one type of protection is more completely realized than the other~~. ~~In such cases, an e~~E~~valuat~~e ~~ion~~ all potential risks and dangers ~~should be made of the relative risks and dangers involved to provide the design that gives the~~ to achieve the best ~~best~~ balance. ~~It must be remembered that the function of the drainage feature will be essentially in conflict with total safety, and that only a reduction rather than elimination of all risk is possible.~~

See Table 20 – 7 for ~~The t~~ the three basic types of protective treatment ~~are shown in Table 20 – 7 Protective Treatments~~.

Table 20 – 7 Protective Treatments

Feature	**Typical Use** ~~The three basic types of protective treatment are shown in Table 20 – 7 Protective Treatments.~~
Grates	To prevent persons from being swept into long or submerged drainage systems.
Guards	To prevent ~~entry into~~ access to long sewer systems, including ~~-~~under no-storm conditions, to prevent persons from being trapped.

Fences	To prevent access ~~entry in~~to areas of ~~unexpected~~ potentially deep standing water or high velocity ~~water~~ flow, or ~~in areas~~ where grates or guards are warranted but are unsuitable for other reasons.

Consider these factors w~~W~~hen deciding on ~~termining~~ the type and extent of protective treatment~~, the following considerations should be reviewed~~:

- Establish t~~T~~he nature and frequency of the presence of children~~ in the area,~~ (e.g., proximity to schools, school routes, and parks~~, should be established~~).
- Review h~~H~~ighway access ~~status should be determined~~. Protective treatments ~~is~~ are usually not warranted within a limited access (LA) facility. ~~highway; however, d~~ Consider drainage facilities located outside or adjacent to ~~the limited access~~ an LA ~~area~~ facility ~~or adjacent to a limited access highway should be considered~~ as unlimited access ~~facilities~~.
- Provide ~~Adequate~~ debris and access control ~~would be required on~~ at all inlet ends where ~~points if~~ guards or grates are used at outlet ends.
- Base h~~H~~ydraulic calculations ~~determinations such as~~ for depths and velocities ~~y should be based~~ on a 25-~~-~~year rainfall event.
- ~~The hydraulic function of the drainage facility should be checked and adjusted so~~ T~~t~~he protective treatment ~~will~~ cannot cause a reduction in hydraulic capacity ~~its effectiveness~~.
- ~~Use of a~~ G~~g~~rates ~~may~~ can cause debris ~~or~~ and persons to be trapped against ~~the~~ a hydraulic opening. Design g~~G~~rates for major structures ~~should be designed in a manner that~~ to allow~~s~~ items to be ~~carried up~~ lifted by ~~increasing~~ rising flood stages.
- ~~Use of a~~ G~~g~~uards can ~~may result in~~ cause a person to be~~ing~~ pinned against it. Use ~~A~~ guards ~~is usually used~~ only on outlet ends.
- A fence ~~may~~ can ~~capture~~ trap excessive amounts of debris, which ~~could~~ can undermine the fence and obstruct ~~possibly result in its destruction and subsequent obstruction of~~ the culvert. Locate fencing to accommodate ~~The location and construction of a fence shall reflect the effect of~~ debris-induced forces.

F.11 Documentation

~~For new construction, supporting~~ Provide storm drain design calculations ~~for storm sewer system design shall be documented and provided~~ to the facility owner.

G CROSS DRAIN HYDRAULICS

This section ~~presents~~ provides standards ~~and procedures for the hydraulic~~ for designing ~~of~~ cross drains including:

- C~~c~~ulverts,
- B~~b~~ridge-culverts[1], and
- B~~b~~ridges.

G.1 Design Frequency

See Table 20 – 8 for t~~T~~he recommended minimum design flood frequencies~~y~~ for cross drains ~~culverts is shown in Table 20 – 8 Recommended Minimum Design Flood Frequency~~. The minimum design flood frequency ~~used to design the culvert~~ can be adjusted based on:

An analysis that ~~o~~ justifies ~~y the~~ using different minimum design flood frequencies ~~greater or lesser than the minimum flood frequencies listed below~~; ~~and~~or

The culvert being located in a National Flood Insurance Program mapped floodplain.

Table 20 – 8 Recommended Minimum Design Flood Frequency

Roadway Classification	Exceedance Probability (%)	Return Period (Year)
Local Roads and Streets ADT > 3,000 VPD	4%	25
Local Roads and Streets ADT ≤ 3,000 VPD*	20 - 10%	5 – 10

*At the discretion of the local agency

G.2 Backwater

Allowable headwater is the depth of water that can be ponded at the upstream end of the culvert during the design flood. The allowable headwater for the design frequency should:

[1] A culvert ~~qualifies as~~ is considered a bridge if it meets the requirements of Item 112 in the FDOT~~'s~~ "***Bridge Management System (BMS) Coding Guide.***"

- Have a tolerable level of inundation~~ that is tolerable~~ to upstream properties ~~y~~ and roadways ~~for~~ during the design discharge,
- Consider a tolerable duration of~~r~~ inundation ~~that is tolerable~~ to the upstream vegetation (to avoid crop and forest damages),~~;~~ and
- Be lower than the upstream shoulder ~~edge~~ elevation at the lowest point of the roadway within the drainage basin.

The inlet of the culvert is submerged i~~I~~f the allowable headwater depth to culvert height ratio (HW/D) is ~~established to be greater than~~ over 1.5. ~~, the inlet of the culvert will be submerged~~. ~~Under this condition, the hydraulics designer should~~ P~~p~~rovide an end treatment to mitigate buoyancy under this condition.

G.3 Tailwater

Use the highest tailwater elevation which can be reasonably expected to occur coincident with the design storm event f~~F~~or ~~the~~ sizing ~~of~~ cross drains and~~ the determination of~~ calculating headwater and backwater elevations~~, the highest tailwater elevation which can be reasonably expected to occur coincident with the design storm event shall be used~~.

G.4 Clearances

~~To permit the passage of debris, a minimum clearance of 2 ft should be~~ P~~p~~rovide~~d~~ at least 2 feet of clearance between the design approach water surface ~~elevation~~ and the low chord of the bridge (where practical) to allow debris to pass. Where ~~this is~~ not practicable, establish the minimum clearance ~~should be established by the hydraulics engineer~~ based on the type of stream and level of protection desired. See ***Chapter 3*** for a~~A~~dditional information on vertical clearance~~ information can be found in **_Chapter 3 – Geometric Design_**~~.

G.5 Bridges and Other Structures

~~It is important for the hydraulic engineer to accurately represent the hydraulic condition. The modeling approach should be s~~ Select ~~ed~~ the appropriate modeling approach based ~~primarily~~ on:

- I~~i~~ts advantages and limitations, ~~though also considering~~
- T~~t~~he importance of the structure, and
- ~~p~~Potential project impacts, cost, and schedule.

One-dimensional models are best-~~ ~~suited for in-channel flows and whre~~n~~ floodplain flows are minor. They are also ~~frequently~~ applicable to small streams. ~~For extreme flood conditions,~~ O~~o~~ne-dimensional models generally provide accurate results for narrow to moderate floodplain widths under extreme flood conditions. ~~In general, where lateral velocities are small,~~ O~~o~~ne-dimensional models generally provide reasonable results where lateral velocities are low.

Two-dimensional models should be used when:

- F~~f~~low patterns are complex,~~ and~~
- O~~o~~ne-~~ ~~dimensional model assumptions are ~~significantly ~~violated, and ~~. If the hydraulic engineer has great difficulty in visualizing the flow patterns and setting up a one-dimensional model that realistically represents the flow field, then two-dimensional modeling should be used~~
- One-dimensional models do not properly represent the flow field.

See t~~T~~he National Cooperative Highway Research Program ~~published a ~~report ~~en~~titled ***"Criteria for Selecting Hydraulic Models" (NCHRP 2006)*** ~~that provides a procedure~~ for selecting the most appropriate model for a particular application based on~~incorporating~~:

- S~~s~~ite conditions,
- D~~d~~esign elements,
- A~~a~~vailable resources, and
- P~~p~~roject constraints.

~~The following ~~See Table 20 – 9 ~~Bridge Hydraulic Modelling Selection may be used to determine ~~for selecting the appropriate modeling approach.

Table 20 – 9 Bridge Hydraulic Modeling Selection

Bridge Hydraulic Condition	Hydraulic Analysis Method	
	One-Dimensional	Two-Dimensional
Small Streams	●	ʘ
In-Channel Flows	●	ʘ
Narrow to Moderate-width Floodplains	●	ʘ
Wide Floodplains	ʘ	●
Minor Floodplain Constriction	●	ʘ
Highly Variable Floodplain Roughness	ʘ	●
Highly Sinuous Channels	ʘ	●
Multiple Embankment Openings	ʘ/×	●
Unmatched Multiple Openings in Series	ʘ/×	●
Low-Skew Roadway Alignment (<20’)	●	ʘ
Moderately-Skewed Roadway Alignment (>20’ and <30’)	ʘ	●
Highly-Skewed Roadway Alignment (>30’)	×	●
Detailed Analysis of Bends, Confluences and Angle ~~of Attack~~	×	●
Multiple Channels	ʘ	●
Small Tidal Streams and Rivers	●	ʘ
Large Tidal Waterways and Wind-influenced Conditions	×	●
Detailed Flow Distribution at Bridges	ʘ	●
Significant Roadway Overtopping	ʘ	●
Upstream Controls	×	●
Countermeasure Design	ʘ	●

● Well-suited or primary use
ʘ possible application or secondary use
× unsuitable or rarely used
ʘ/× possibly unsuitable depending on application

See ~~also~~ Chapter 17, ~~– Structures,~~ Section C.3.e ~~for additional information on~~ for structures d~~D~~rainage c~~C~~riteria ~~for structures~~.

Commented [KK1]: Are these supposed to be degrees?

H CULVERT MATERIALS

~~The evaluation of culvert materials shall c~~Consider the functionally equivalent performance of different culvert materials in~~ three areas~~:

- D~~d~~urability,
- S~~s~~tructural capacity, and
- H~~h~~ydraulic capacity.

H.1 Durability

Design c~~C~~ulverts ~~shall be designed~~ for a design service life (DSL) appropriate for the culvert function and highway type. The DSL ~~design service life~~ should be based on~~ factors such as~~:

- Projected service life of the facility,
- Importance of the facility,
- Economics,
- Potential inconvenience ~~and difficulties~~ associated with repair or replacement, and
- P~~p~~rojected future demands on the facility.

~~In estimating the projected service life of a material, consideration shall be given to~~ Consider these factors in estimating the DSL of a material:

- A~~a~~ctual performance ~~of the material~~ in nearby similar environmental conditions,
- I~~i~~ts theoretical corrosion rate,
- P~~p~~otential for abrasion, and
- O~~o~~ther appropriate site-specifc factors.

Base t~~T~~heoretical corrosion rates ~~shall be based~~ on the environmental condition~~s~~ of ~~both~~ the soil and the groundwater. ~~In tannic water, the designer will also need to~~ Cconsider the effect of microbially-induced concrete pipe corrosion in tannic waters ~~of concrete pipes,~~ (especially in industrial ~~or~~ and sewer systems).

~~At a minimum,~~ Consider the following corrosion indicators at a minimum ~~shall be considered~~:

- pH,
- Resistivity,
- Sulfates,
- Chlorides.

The FDOT ~~provides a program called~~ ***Culvert Service Life Estimator*** program ~~for~~ estimates DSL ~~ing the service life of culverts~~ based on these ~~above~~ criteria. ~~. The Culvert Service Life Estimator is based~~ The program is based on standard measurement of soil and water parameters. The program does not consider tannic water environments properly ~~-~~(thereby over-predicting the DSL). ~~can provide an environment for organisms to grow on~~

~~the material surface that is not taken into consideration by this tool, which will over-predict the facility life~~.

Site-specific testing is unnecessary. ~~To avoid unnecessary site-specific testing,~~ Use generalized soil maps ~~may be used~~ to ~~delete~~ remove unsuitable culvert materials from consideration. ~~The~~ Consider potential ~~for~~ future land use changes ~~which may change~~ to soil and water corrosion indicators ~~shall also be considered~~ to the extent practical.

H.2 Structural Design

The structural design of ~~all~~ culverts, storm drain pipes and drainage structures ~~shall~~ must comply with ~~be in accordance with~~ the specifications (including guide specifications) published by the American Association of State Highway and Transportation Officials (AASHTO). ~~At a minimum,~~ Use t~~t~~he ***AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, 9th Edition (2020)*** ~~shall be used~~ at a minimum.

H.3 Hydraulic Capacity

The hydraulic evaluation ~~shall~~ must establish the hydraulic size for the specific ~~particular~~ culvert material ~~application~~. ~~For storm drains and cross drains, the design shall~~ U~~u~~se the Manning's roughness coefficient associated with the pipe material selected for storm drains and cross drains.