AGENDA (Draft)

FLORIDA GREENBOOK ADVISORY COMMITTEE MEETING

Friday, March 26, 2021, 9:00 AM – 12:00 PM
Monday, March 29, 2021, 1:00 PM – 4:00 PM
Friday, April 2, 2021, 9:00 AM – 12:00 PM
July 26, 2021, 1:00 – 5:00 PM

Virtual Meeting via Go-To-Webinar
To participate via your computer, tablet, or smart phone, please register at this web link:
https://register.gotowebinar.com/register/4084947796995563792

Friday, March 26, 2021

9:00 – 9:15	Introductions (Michael Shepard)
9:15 – 9:20	General Webinar Communication Tips (Kristin Larsson)
9:20 – 9:40	Sunshine Law, Status of Rulemaking for 2018 Florida Greenbook, Rulemaking Timeline for 2021 Florida Greenbook (Ashley Peacock, Mary Anne Koos)
9:40 – 10:00	FDOT Proposed Changes to post 2021 Florida Greenbook Adoption Process (Michael Shepard)
10:00 – 10:30	FDOT Safety Dashboard (Brenda Young)
10:30 – 10:45	*Break*
10:45 – 10:50	Review and Approval of September 2020 Minutes (Mary Anne Koos)
10:50 – 11:00	Proposed Process for Adoption of Revisions for 2021 Greenbook (Mary Anne Koos)
11:00 – 11:45	Review and Approval of 2021 Florida Greenbook Chapter Revisions (Mary Anne Koos, Chapter Chairs)
11:45 – 11:55	Public Comments. General Discussion (Mary Anne Koos)
12:00	Adjourn (Michael Shepard)

Monday, March 29, 2021

1:00 – 1:15	Public Comments. General Discussion (Mary Anne Koos)
1:15 – 2:30	Review and Approval of 2021 Florida Greenbook Chapter Revisions (Mary Anne Koos, Chapter Chairs)
2:30 – 2:45	*Break*
2:45 – 3:45	Review and Approval of 2021 Florida Greenbook Chapter Revisions (Mary Anne Koos, Chapter Chairs)
3:45 – 4:00	Public Comments. General Discussion (Mary Anne Koos)
4:00	Adjourn (Michael Shepard)

Friday, April 2, 2021

9:00 – 10:00	Review and Approval of 2021 Florida Greenbook Chapter Revisions (Mary Anne Koos, Chapter Chairs)
10:00 – 10:30	Future Greenbook Content and Format (Michael Shepard)
10:30 – 10:45	*Break*
10:45 – 11:45	Proposed Process for Adoption, Format for 202? Greenbook (Mary Anne Koos)
11:45 – 12:00	Public Comments. General Discussion (Mary Anne Koos)
12:00	Adjourn (Michael Shepard)

Monday, July 26, 2021

1:00 – 1:15	Introductions, Membership Changes, Subcommittee Membership
1:15 – 2:45	Review and Approval of 2021 Florida Greenbook Chapter Revisions (Mary Anne Koos, Chapter Chairs)
2:45 – 3:00	*Break*
3:00 – 4:15	Review and Approval of 2021 Florida Greenbook Chapter Revisions (Mary Anne Koos, Chapter Chairs)
4:15 – 4:30	Summary of Quality Assurance Reviews (QAR) on Local Projects (Jeremy Fletcher)
4:30 – 4:45	Addition of Requirements for Safety Countermeasures, Future Meetings, Update on Exempting Greenbook from Rulemaking (Michael Shepard)
4:45 – 5:00	Public Comments. General Discussion (Mary Anne Koos)
5:00	Adjourn (Michael Shepard)

Note – There is no registration fee to attend and no meals are provided.

CHAPTER 8
BICYCLE FACILITIES

TABLES

FIGURES

CHAPTER 8~~9~~

BICYCLE FACILITIES

A INTRODUCTION

Bicycle facilities should be given full consideration in the planning and development of transportation facilities, including the incorporation of such facilities into state, regional, and local transportation plans and programs under the assumption that transportation facilities will be used by cyclists. Bicycle facilities should be established in conjunction with the construction, reconstruction, or other change of any transportation facility and special emphasis should be given to projects in or within 1 mile of an urban area. The provision for bicycle facilities is also desirable for resurfacing, restoration & rehabilitation (RRR) projects.

Bicycle and pedestrian facilities are not required to be established:

1. Where their establishment would be contrary to public safety;
2. When the cost would be excessively disproportionate to the need or probable use; or
3. Where other available means or factors indicate an absence of need.

Appropriately designed and located bicycle facilities play an important role in supporting bicycle travel. Bicyclists should be considered in all phases of transportation planning, design, construction and maintenance activities. ~~Particular~~ Eemphasis should be given to new construction, reconstruction, intersection improvement, and transit projects. Bicycle facilities can include bicycle lanes, paved shoulders, wide curb lanes, shared lanes, shared use paths, and bicycle parking facilities.

In addition to the design criteria provided in this chapter, 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, see Chapter 8 – Pedestrian Facilities. ~~the ***2006 Americans with Disabilities Act Standards for Transportation Facilities*** as required by ***49 C.F.R 37.41*** or ***37.43*** and the ***2017 Florida Accessibility Code for Building Construction*** as required by ***61G20-4.002*** impose additional requirements for the design and construction of facilities such as shared use paths and structures that include provisions for pedestrians.~~

B ON-STREET FACILITIES

Provisions for bicycle traffic should be incorporated in the original roadway design. All roadways, except where bicycle use is prohibited by law, should be designed, constructed and maintained under the assumption they will be used by bicyclists. Roadway conditions should be favorable for bicycling, with smooth pavement and limited changes in elevation along edge lines. Drainage inlets and utility covers that cannot be moved out of the travel way should be designed flush with grade, well seated, and make use of bicycle-compatible grates and covers.

Railroad grade crossings on a diagonal can cause steering difficulties for bicyclists. Crossings for bicycle facilities should be perpendicular to the rail. This can be accomplished with a widened shoulder or bicycle lane, or separate path. Consideration should 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 heavy rail lines to minimize the size of the opening adjacent to the rail.

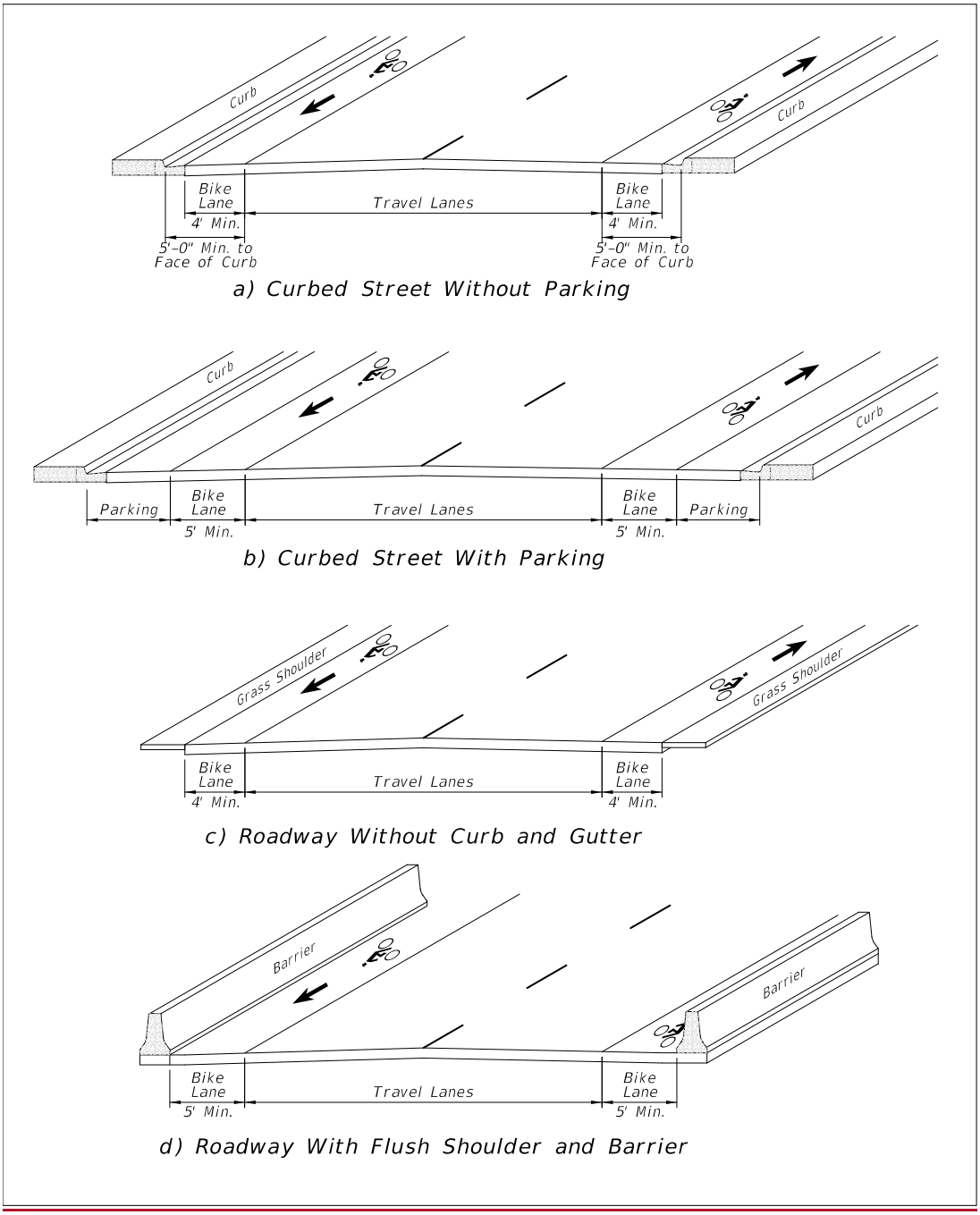
Bicycle lanes, paved shoulders, wide curb lanes, or shared lanes should be included to the fullest extent feasible. The appropriate selection of a bicycle facility depends on many factors, including motor vehicle and bicycle traffic characteristics, adjacent land use and expected growth patterns. All new or reconstructed arterial and collector roadways, in and within one mile of an urban area, should include bicycle lanes.

Rumble strips used in a traffic lane to alert operators 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.

B.1 Bicycle Lanes

Bicycle lanes delineate available roadway space for preferential use by bicyclists, providing more predictable movements by motorists and bicyclists. Bicycle lanes also help increase the total capacity of highways carrying mixed bicycle and motor vehicle traffic. Bicycle lanes shall have a minimum functional width of 4 feet. At least 1 foot additional width is needed when the bicycle lane is adjacent to a curb or other barrier, on-street parking is present, there is substantial truck traffic (>10%), or posted speeds exceed 50 mph. Minimum bicycle lane widths are illustrated in Figure 8~~9~~ – 1 Minimum Widths for Bicycle Lanes. The 4-foot bicycle lane shown in the flush shoulder typical section assumes the grass portion of the shoulder provides emergency maneuvering room.

Figure 8~~9~~ – 1 Minimum Widths for Bicycle Lanes



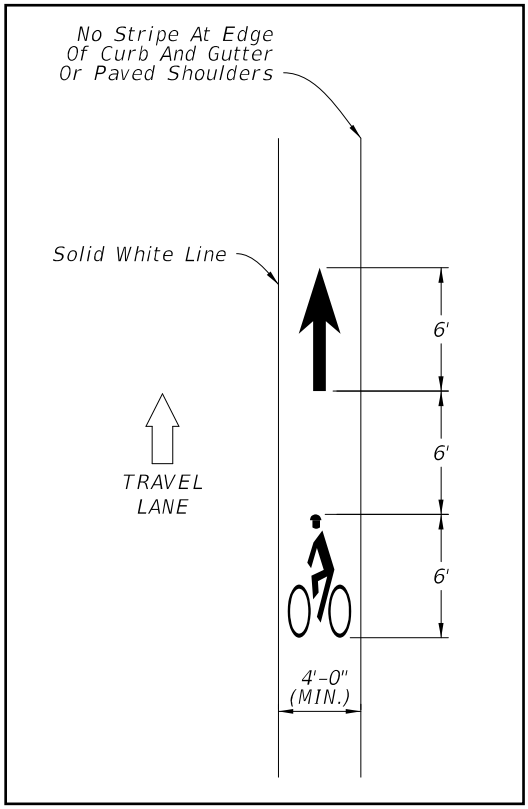
Bicycle lanes are one-way facilities and carry bicycle traffic in the same direction as the adjacent motor vehicle traffic. A bicycle lane should be delineated from the travel lanes with a solid white line and be marked with the bicycle symbol and arrow as shown in Figure 8~~9~~ – 2 Detail of Bicycle Lane Markings. The dimensions for each pavement marking is 72" long, separated by 72".

The recommended placement of bicycle lane markings is:

a) At the beginning of a bicycle lane, on the far side of major intersections, and prior to and within the bicycle lane between a through lane and turn lane.

b) Along the roadway as needed to provide a maximum spacing of 1,320 for posted speeds less than or equal to 45 mph, 2,640 feet for a posted speed of 50 mph or greater.

Figure 8~~9~~ – 2 Detail of Bicycle Lane Markings



If used, bike lane signs and plaques should be placed in advance of the upstream end of the bicycle lane, at the downstream end of the bicycle lane, and at periodic intervals based upon prevailing speed of bicycle and other traffic, block length, and distances from adjacent intersections, and other considerations. They should only be used in conjunction with marked bicycle lanes. Bike lane signs are not required.

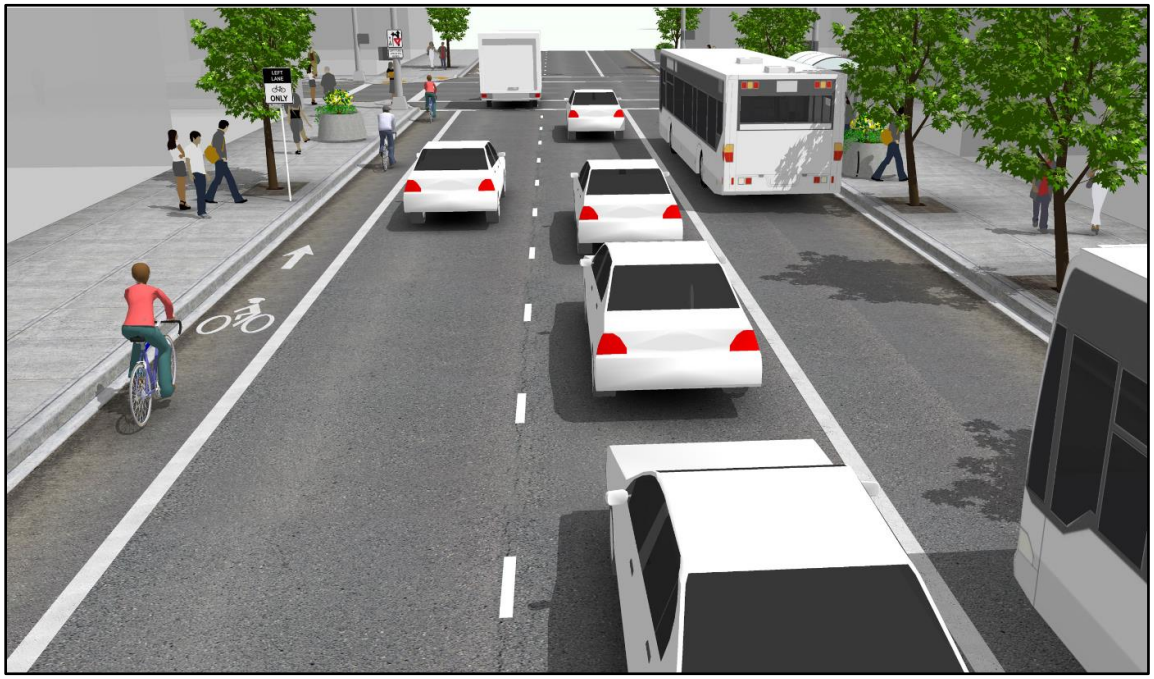
Figure 8~~9~~ – 3 Bicycle Lanes

NACTO Urban Bikeway Design Guide, National Association of City Transportation Officials

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 bicycle lanes are provided between the through lane and right turn lane, bus bay or parking lane they shall be a minimum of 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 to avoid opening vehicle doors.

On one-way streets, bicycle lanes should generally be placed on the right side of the street. A bicycle lane on the left side of the street can be considered when a bicycle lane on the left will substantially decrease the number of conflicts, such as those caused by frequent bus traffic, heavy right turning movements, high-turnover parking lanes, or if there are a significant number of left turning bicyclists. See Figure 8~~9~~ – 4 Left Side Bicycle Lanes for an illustration.

Figure 8~~9~~ – 4 Left Side Bicycle Lanes



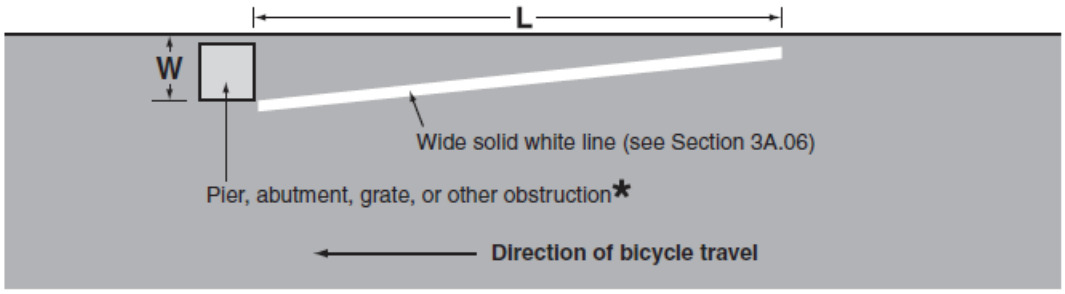
NACTO Urban Bikeway Design Guide, National Association of City Transportation Officials

Bicycle lanes shall not be provided on the circular roadway of a roundabout, and shall be transitioned prior to the roundabout in accordance with the MUTCD.

Existing drainage inlets, grates and utility covers shall be evaluated as to whether they present 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 to be flush with the adjacent pavement surface, utilize a grate recommended for bicycle travel, and may be marked as an obstruction.

Advance 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 FDOT's ~~the Department's *Florida Dept. of Transportation's*~~ ***Drainage Manual, Section 3.7.4 Inlet Placement, (2021)~~*~~January 2018 Edition.~~***

Figure 8~~9~~ – 5 Example of Obstruction Pavement Markings



B - Obstruction at edge of path or roadway

L = WS, where W is the offset in feet and S is bicycle approach speed in mph

* Provide an additional foot of offset for a raised obstruction and use the formula L = (W+1) S for the taper length

Traffic signals should be responsive to bicyclists. Regular maintenance of bicycle lanes should be a priority, since bicyclists are unable to use a lane with potholes, debris or broken glass.

In conjunction with resurfacing projects, the roadway width shall be redistributed when practical to provide for bicycle facilities. The types of bicycle facilities considered for implementation include buffered bicycle lanes, bicycle lanes, wide outside lanes, and shared lanes. Lane widths on urban multilane roadways and two-lane curb and gutter roadways may be reduced as shown in Table 8~~9~~ – 1 Lane Widths to provide for bicycle facilities.

Table 8~~9~~ – 1 Lane Widths
Urban Multilane or Two-Lane with Curb and Gutter

Design Year AADT	Design Speed (mph)	Minimum Thru Lane (ft.)	Minimum Turn Lane (ft.)	Minimum Parking Lane (ft.)
ALL	ALL	10 [1]	9 [2]	7 [3]

1. 11 ft. where either of the following conditions exist:
   a) Trucks are >10% of Design Year Traffic.
   b) Design Speed is 40 mph or greater.
2. 10 ft. for 2 Way Left Turn Lanes.
3. A minimum width of 7 ft. measured from face of curb may be left in place. Otherwise provide 8 ft. minimum, measured from face of curb.

Various configurations of bicycle lanes on curb and gutter and flush shoulder typical sections are illustrated in Figures 8~~9~~ – 6 to 8~~9~~ – 23.

Figure 8~~9~~ – 6 Bicycle Lane Markings

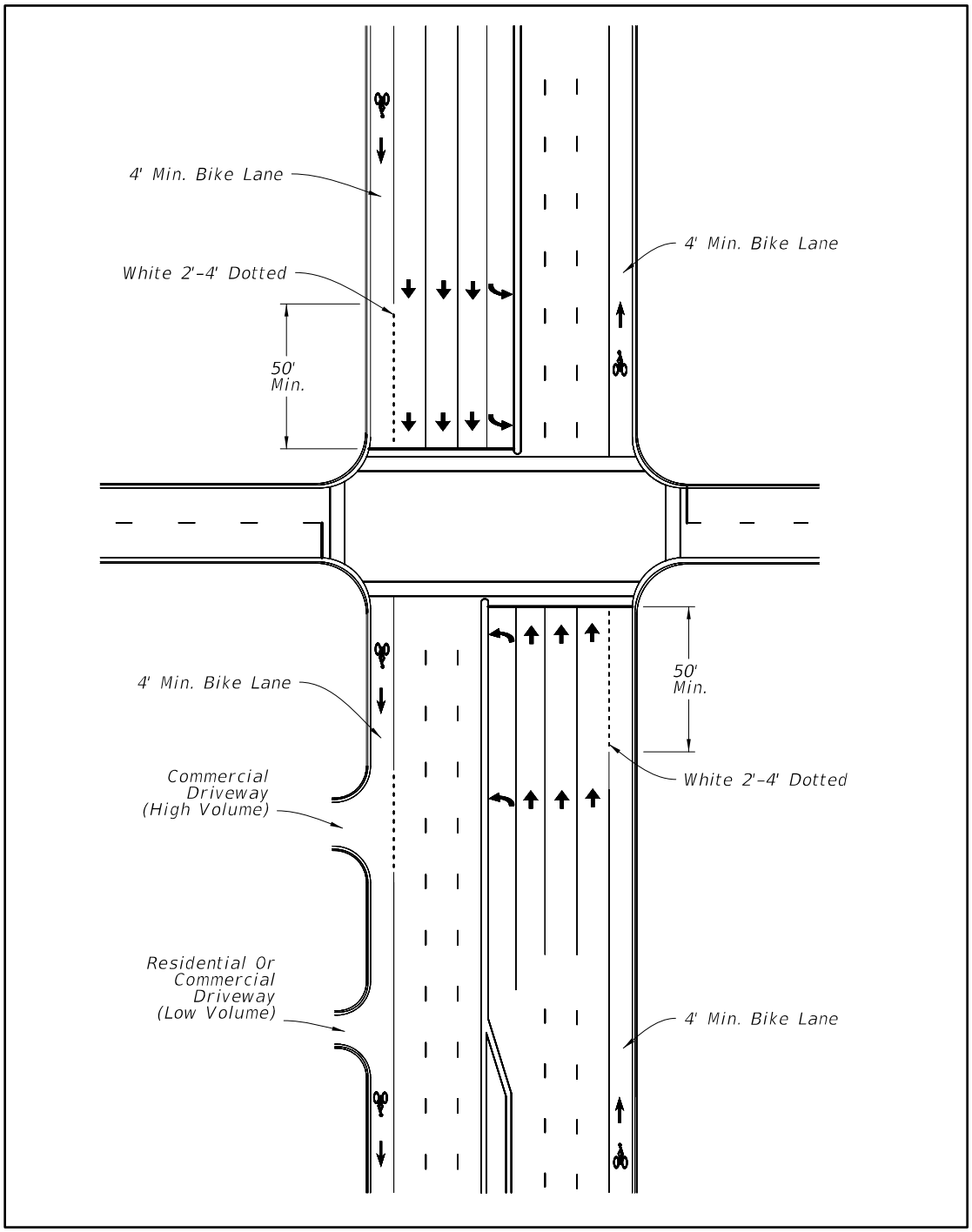


Figure ~~8~~9 – 7 Bicycle Lanes with Separate Right Turn Lane (Curb and Gutter)

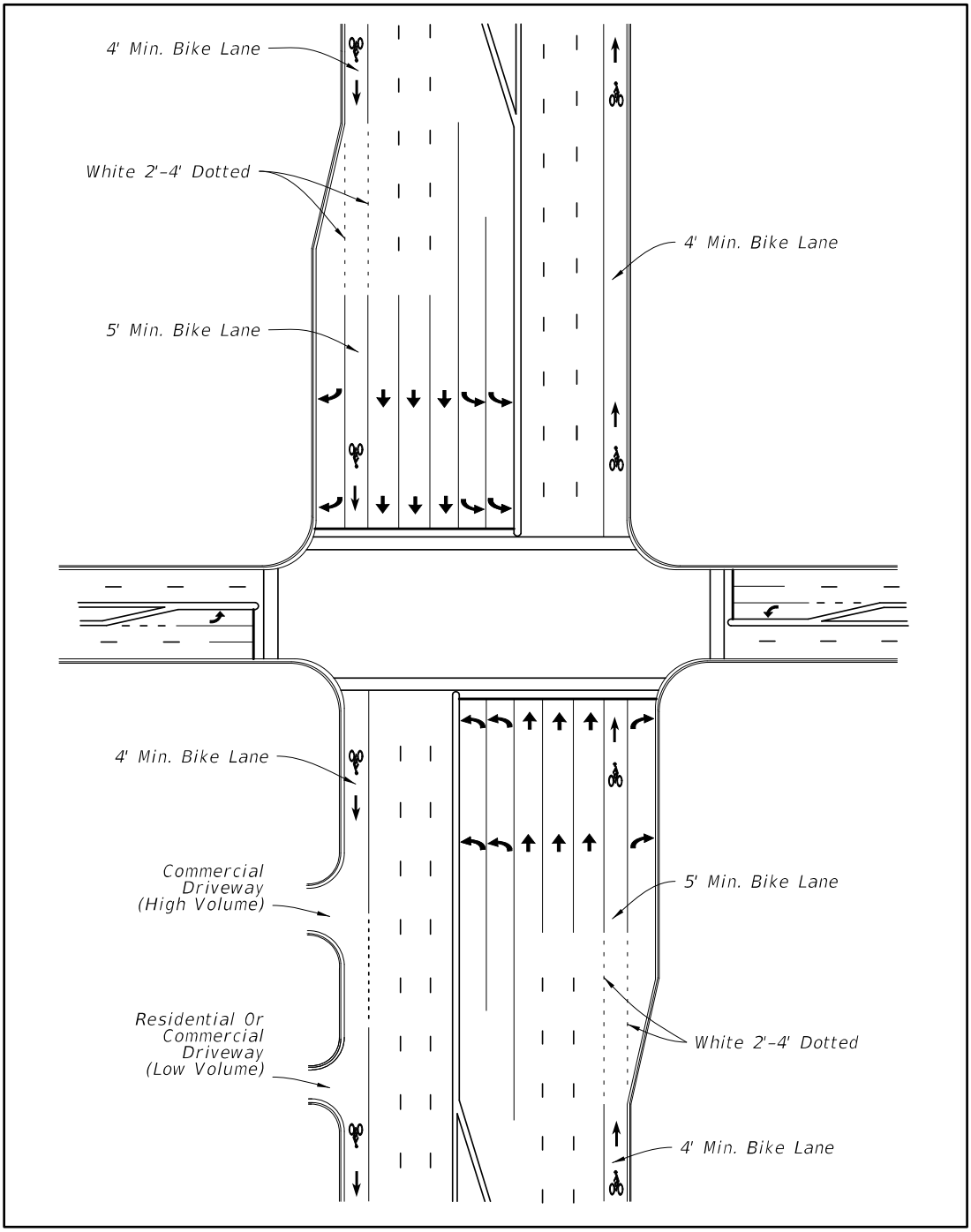


Figure ~~8~~9 – 8 Bicycle Lanes with On Street Parking, No Right Turn Lane (Curb and Gutter)

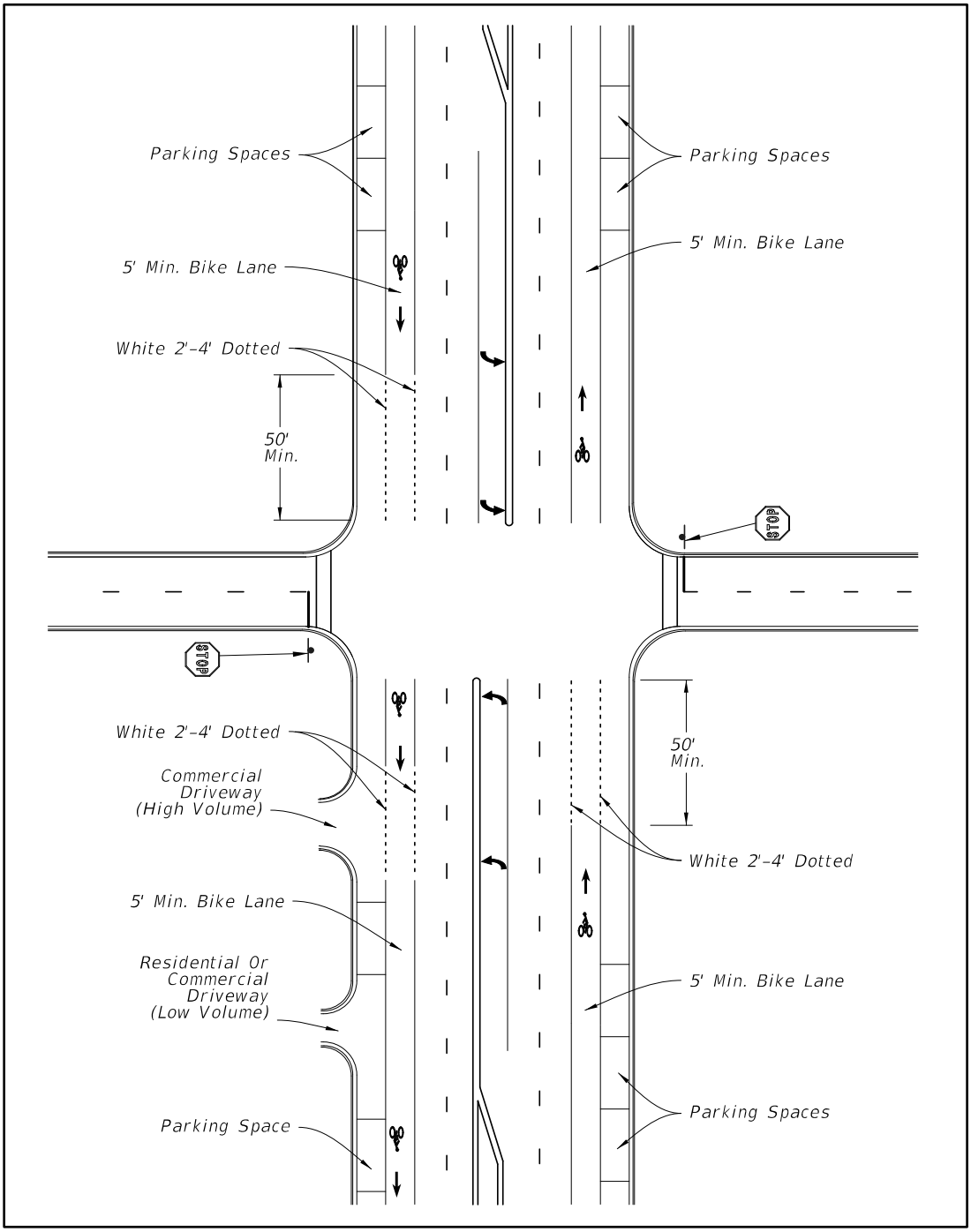


Figure ~~8~~9 – 9 Bicycle Lane with Right Turn Drop Lane (Curb and Gutter)

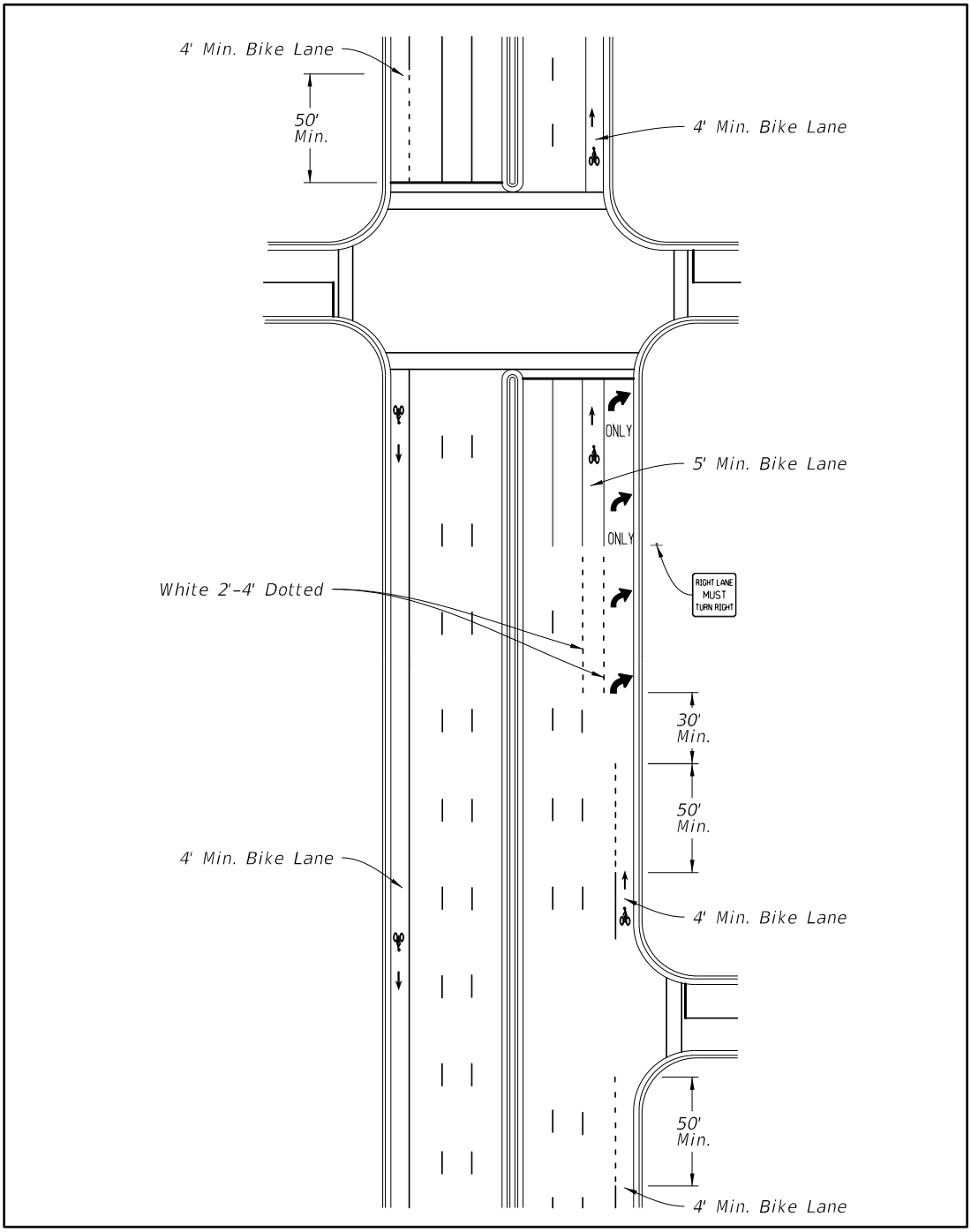


Figure 8~~9~~ – 10 "Tee" Intersection with Bicycle Lane, Separate Right and Left Turn Lanes (Curb and Gutter)

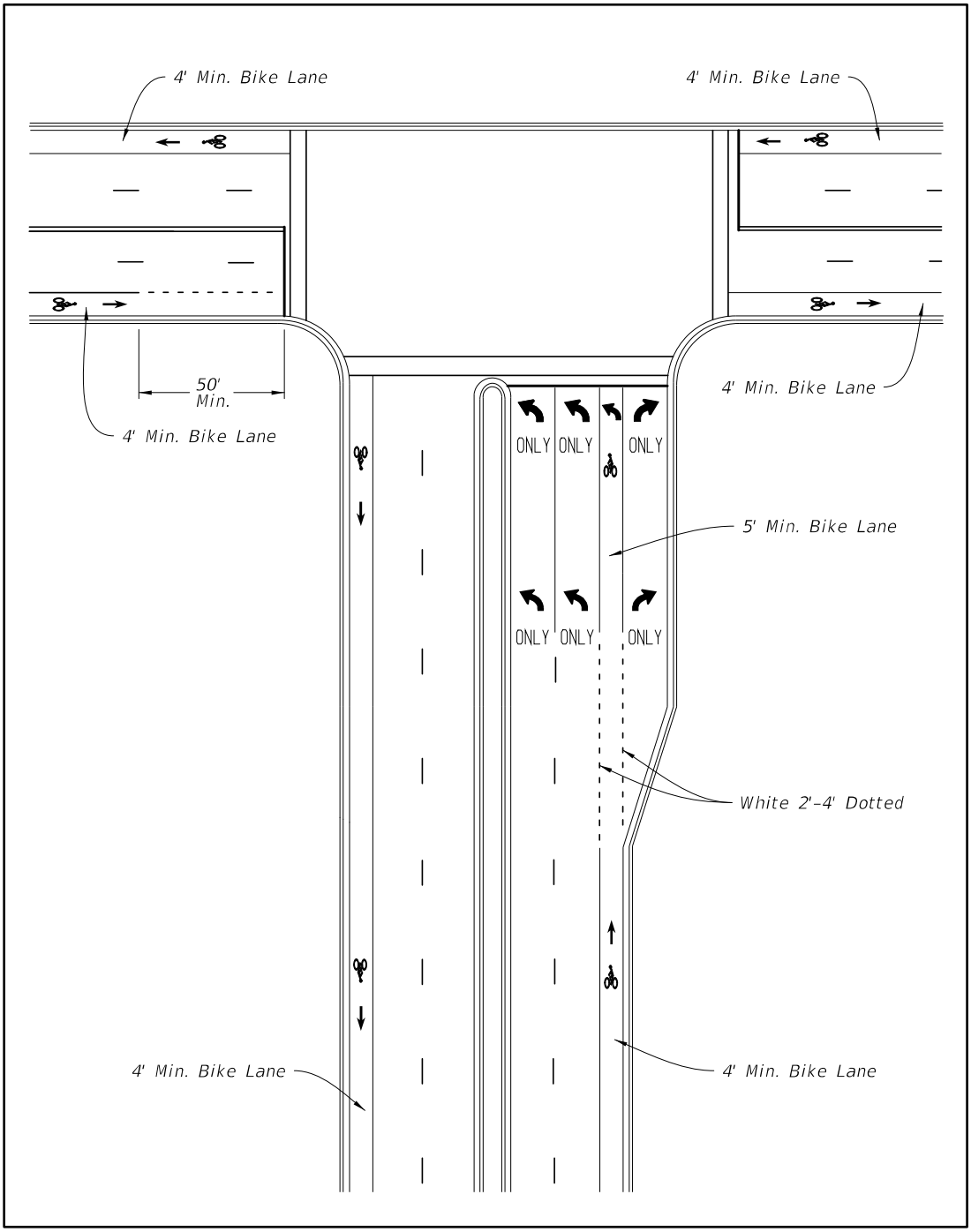


Figure ~~8~~9 – 11 "Tee" Intersection with Bicycle Lanes, Left Turn Lane and Right Turn Drop Lane (Curb and Gutter)

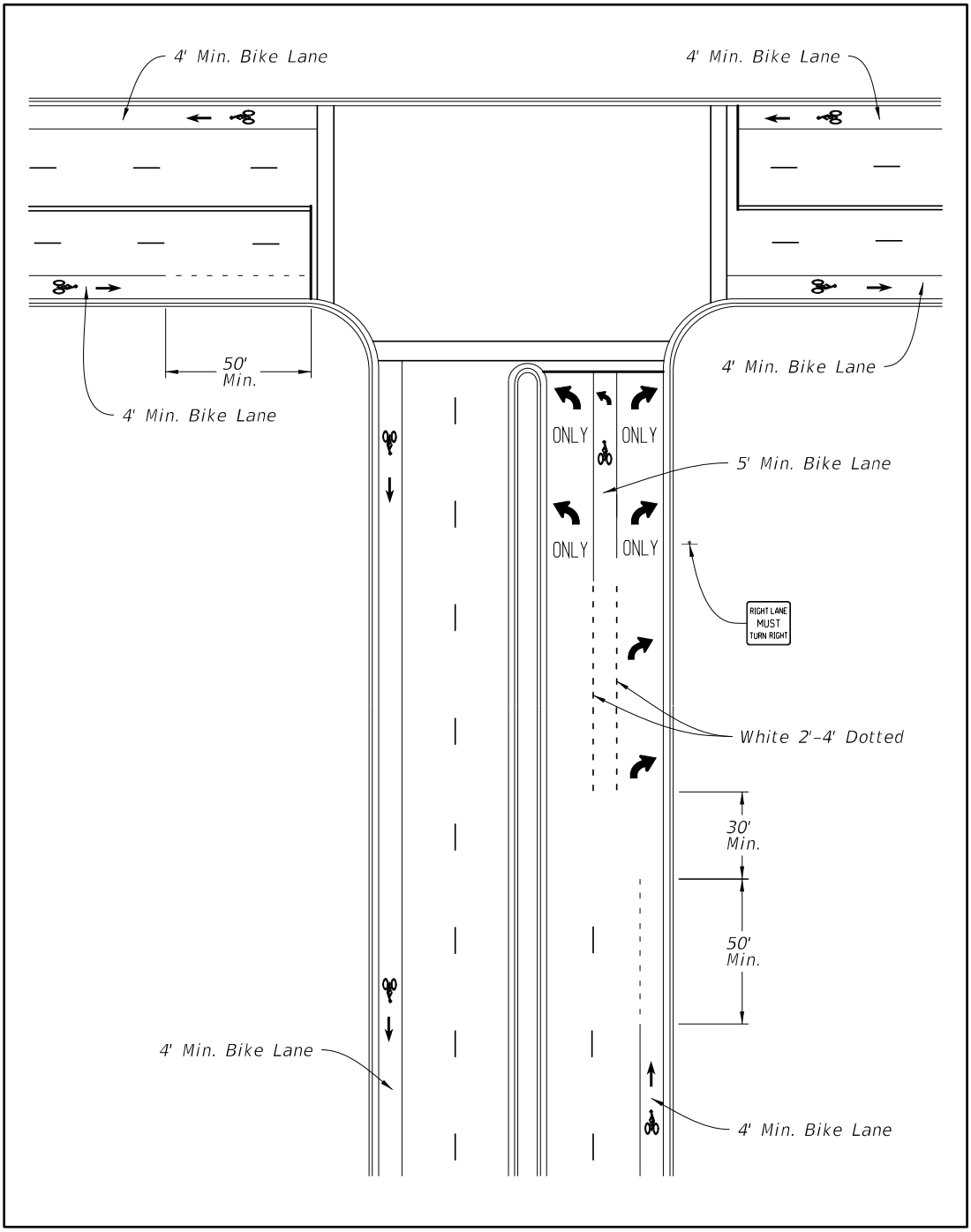


Figure 8~~9~~ – 12 Bicycle Lanes with No Right Turn Lane (Flush Shoulder)

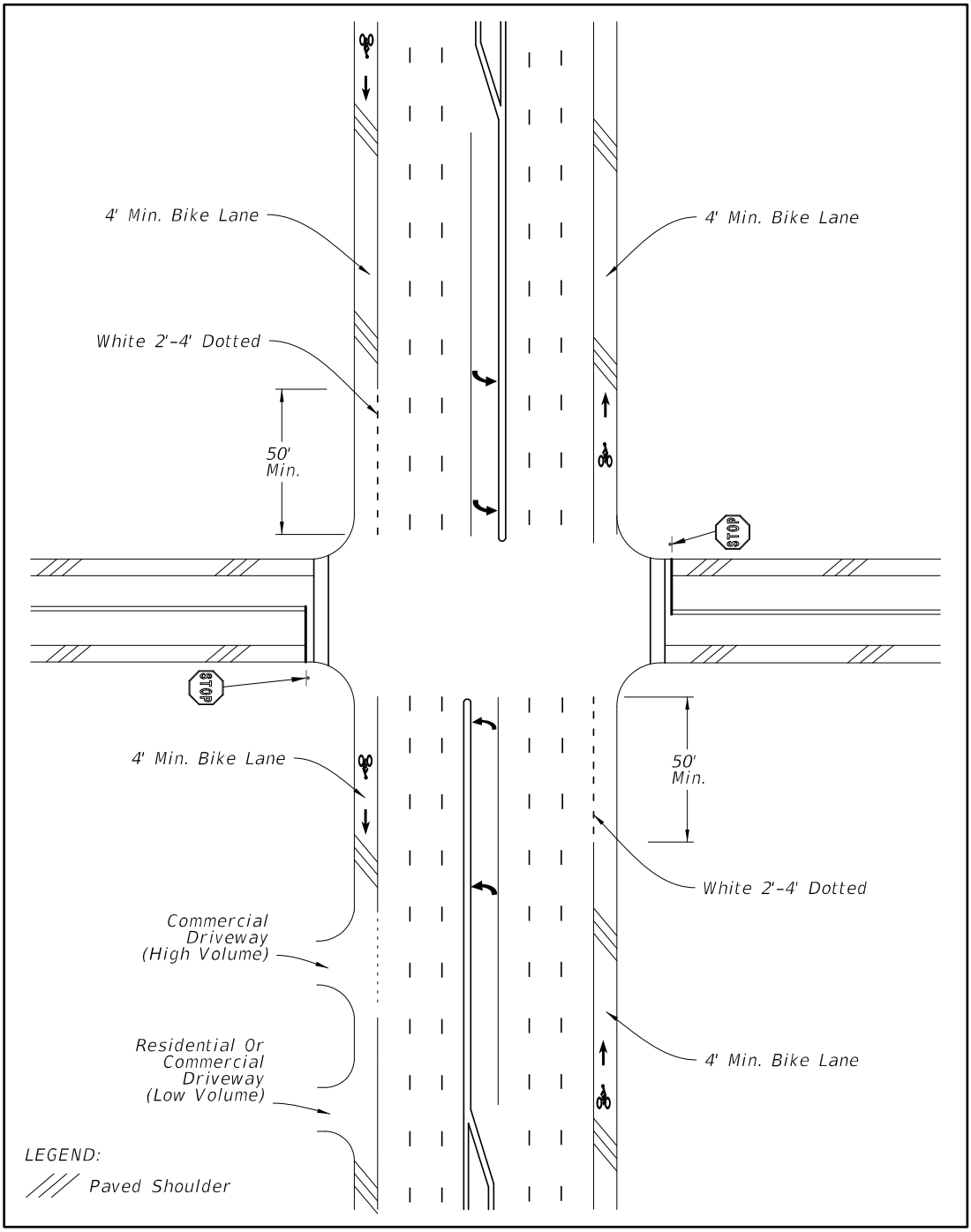


Figure 8~~9~~ – 13 Bicycle Lane with Separate Right Turn Lane (Flush Shoulder)

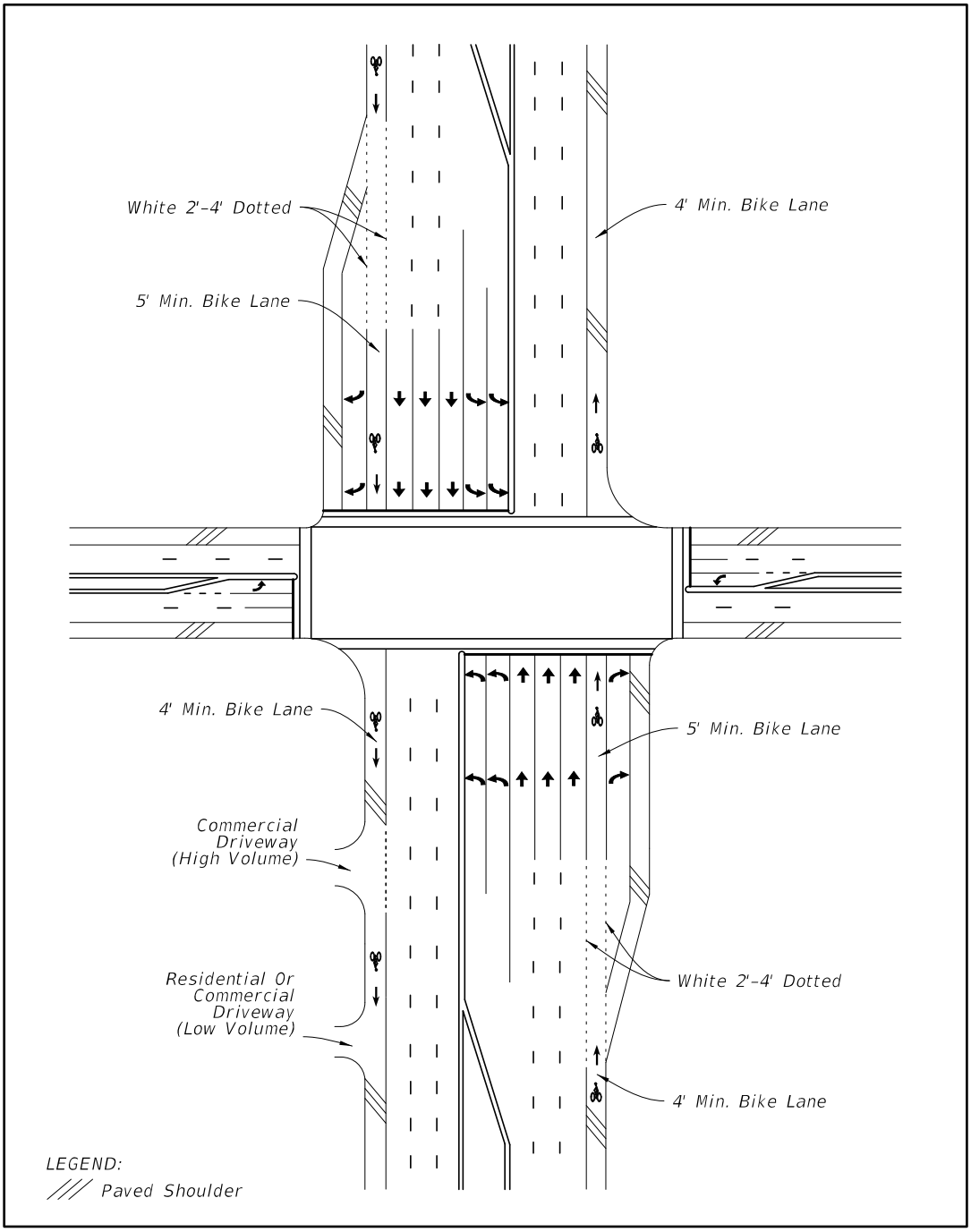


Figure 8~~9~~ – 14 Bicycle Lanes with Bus Bay, No Right Turn Lane (Curb and Gutter)

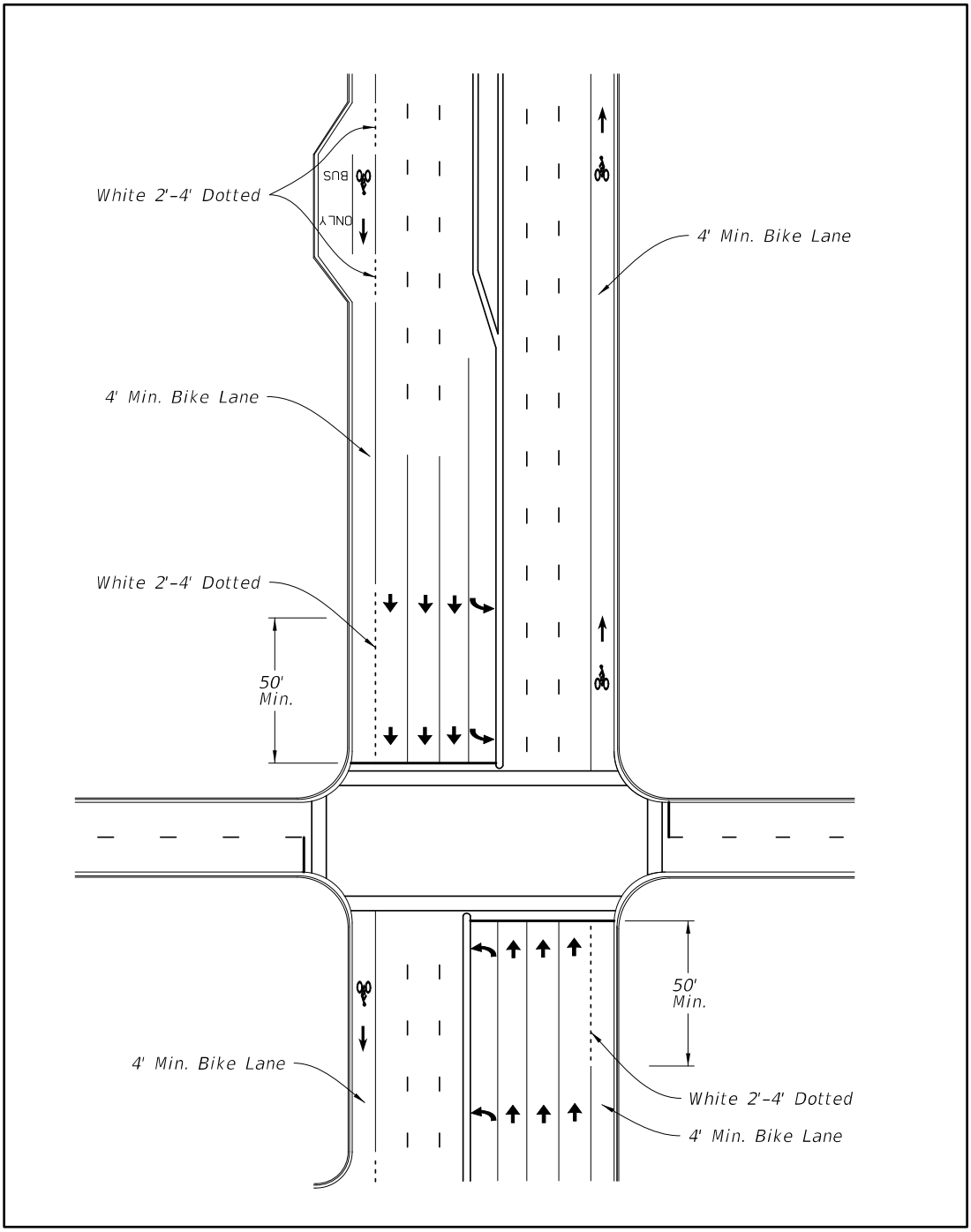
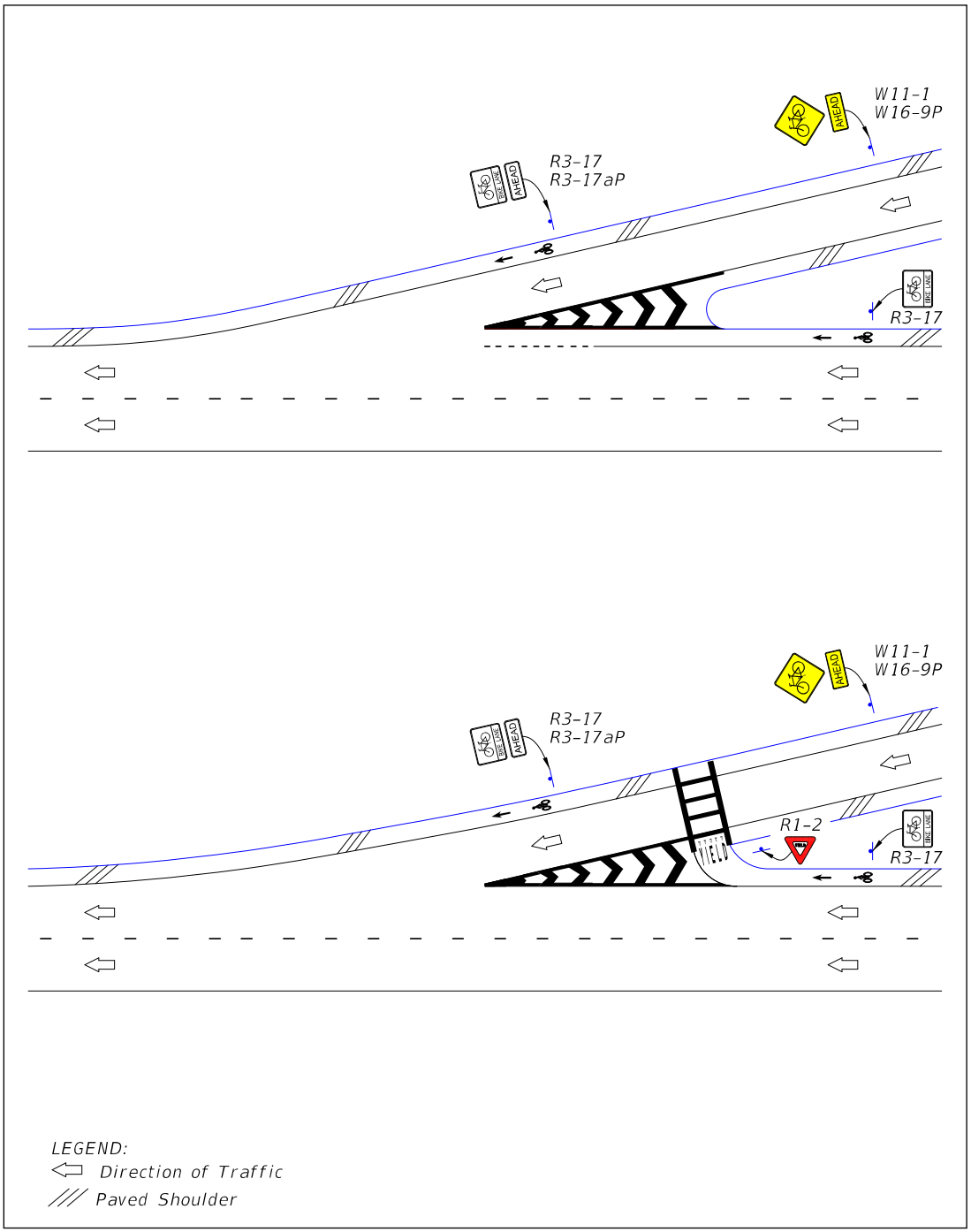


Figure 8~~9~~ – 15 Bicycle Lanes on Interchange Ramps (Flush Shoulder)



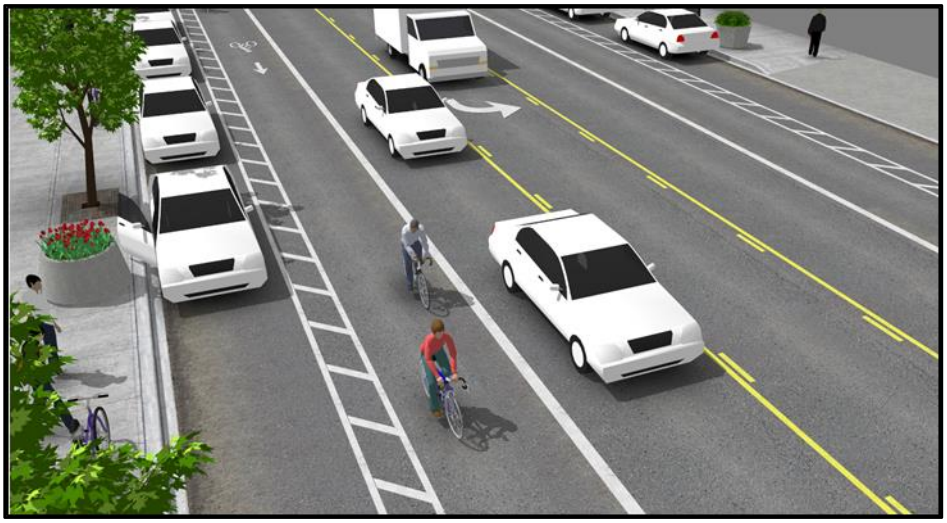
B.2 Buffered Bicycle Lanes

Buffered bicycle lanes are bicycle lanes separated from either the adjacent travel lane or parking lane with a marked buffer area. They provide greater shy distance between motor vehicles and bicyclists and encourage bicyclists to ride outside of the "door zone" of parked cars. Typical applications include streets with high travel speeds, high traffic volumes, high amounts of truck or transit traffic, or where there are underutilized travel lanes or extra pavement width.

The bicycle lane symbol and arrow markings shall be used, along with longitudinal lines to create the buffer. There are several options for marking the buffer area, including a wide solid double line (crossing prohibited), wide solid single line (crossing discouraged) or wide dotted single line (crossing permitted to make right hand turn). Where 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, the buffer striping should transition to a wide dotted stripe using a 2/4 skip pattern. The transition should begin 150 feet in advance of an intersection to provide sufficient distance for an automobile or truck to merge into the bicycle lane before turning right. Figures 8~~9~~ – 16, 17 and 18 provide examples of buffered bicycle lanes. ***Chapter 3D. Markings for Preferential Lanes*** of the ***MUTCD*** provides additional information on the striping of buffered bicycle lanes.

Figure 8~~9~~ – 16 Buffered Bicycle Lane Adjacent to On-Street Parking



NACTO Urban Bikeway Design Guide, National Association of City Transportation Officials

Figure 8~~9~~ – 17 Buffered Bicycle Lane Markings

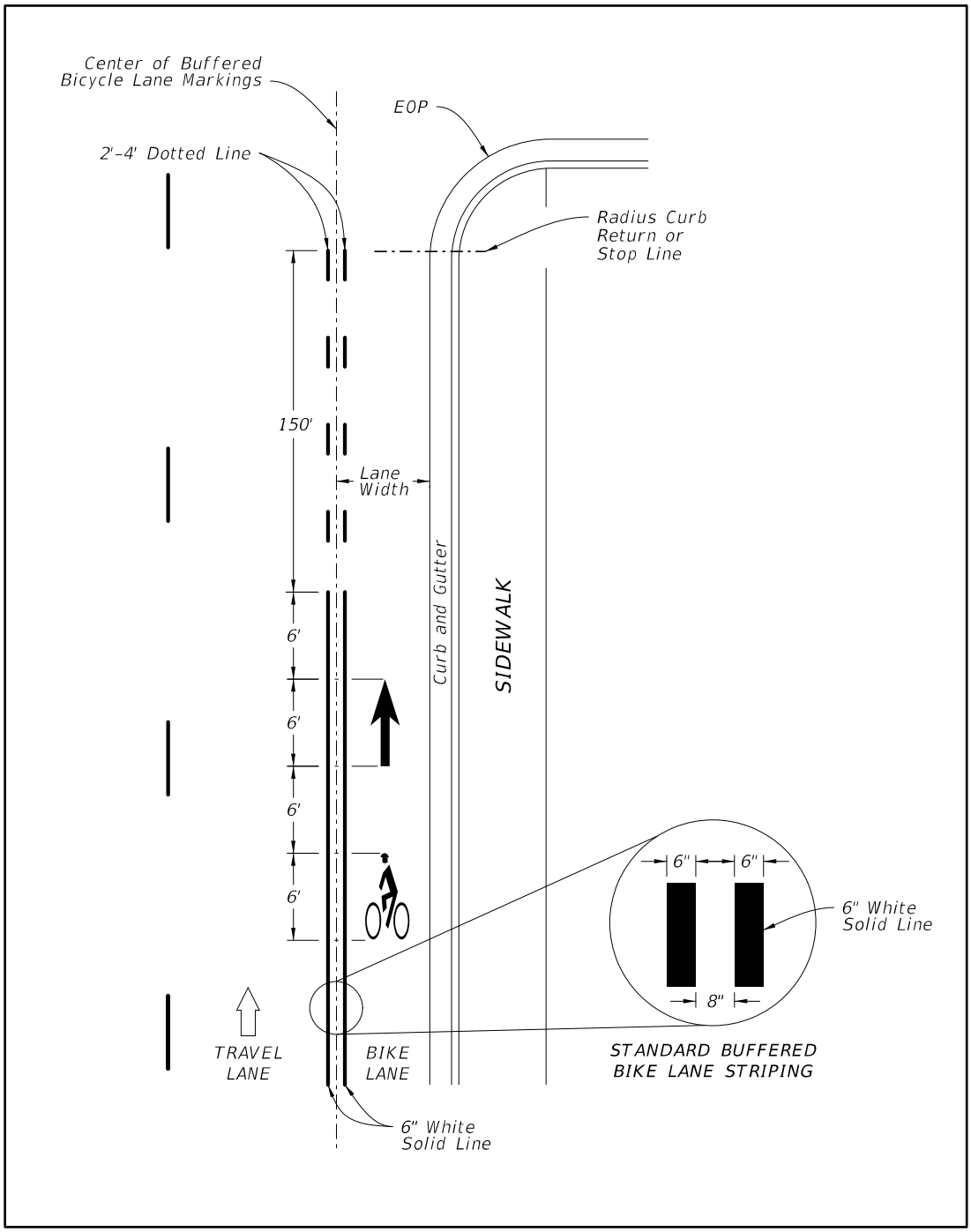
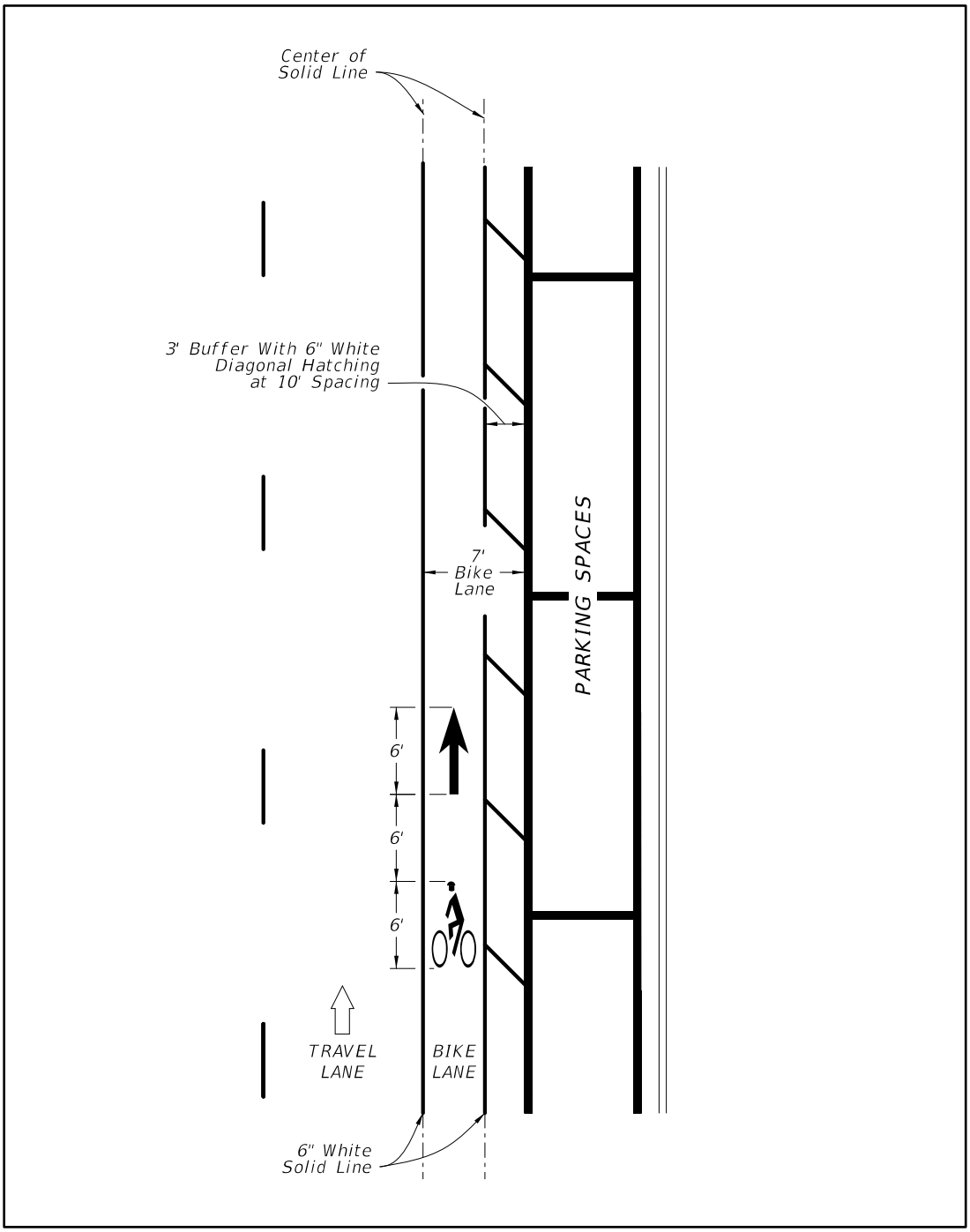


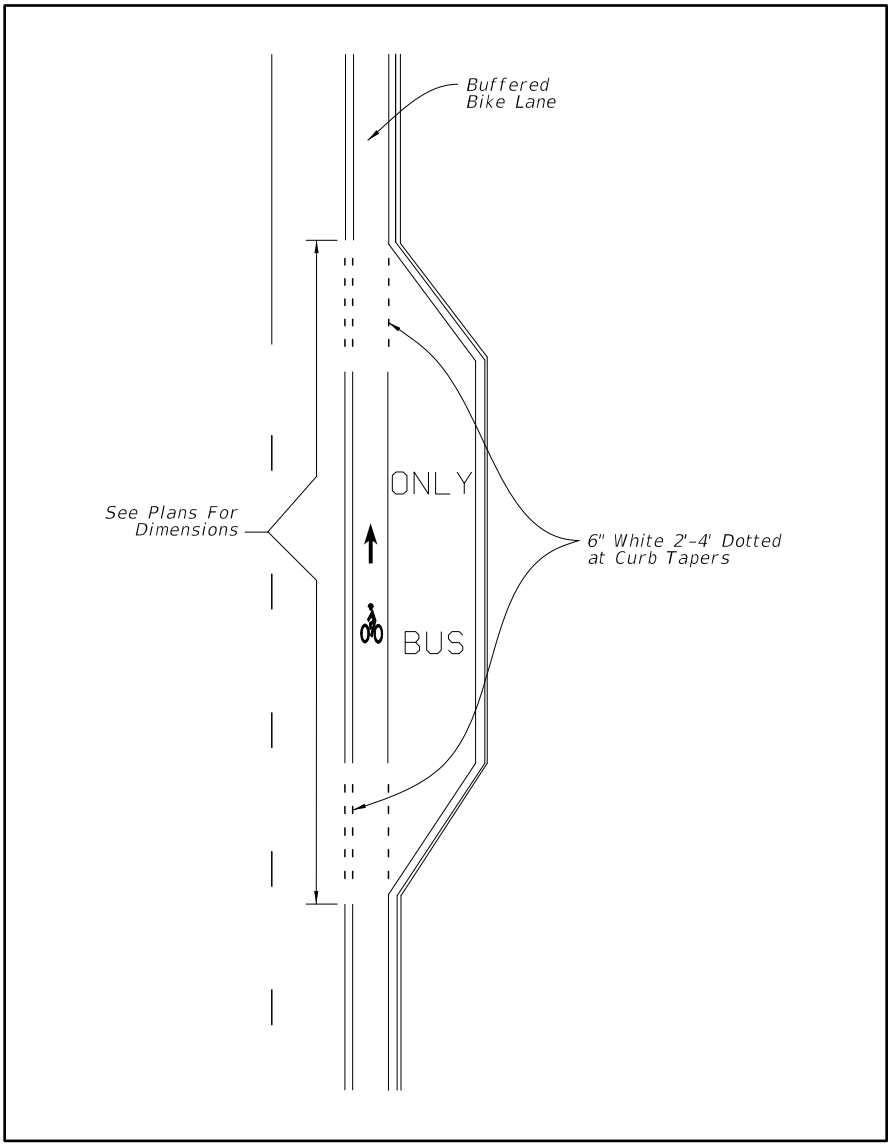
Figure ~~8~~9 – 18 Buffered Bicycle Lane Markings with On-Street Parking



B.3 Bicycle Lane with Bus Bay

When a bus bay is provided on roadways with bicycle lanes, the bicycle lane shall be continued adjacent to the bus bay. Figure 8~~9~~ – 19 Buffered Bicycle Lane with Bus Bay Marking provides an example of a buffered bicycle lane with a bus bay.

Figure 8~~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) and vertical separation (e.g., flex posts, parked cars, medians, traffic separators, or curbs) to separate people bicycling 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 improve the comfort level of bicycling. They may be designed to 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:

- Is a preferential use lane, signed and marked 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. 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 – a 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 see ***FHWA's Separated Bike Lane Planning and Design Guide.***

B.54 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:

- 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~~may be~~ 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 by definition 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 cyclists 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 shall~~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 8~~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 ***FDOT's Product Approval System (PATH) which includes products on both FDOT's Approved Product List (APL),*** ~~for~~ ***Specification 523, Patterned Pavement or FDOT's Innovative Products List (IPL), Dev-714 Green-Colored Pavement Markings.***

Figure 8~~9~~ – 20 Green Bicycle Lane with Separate Right Turn Lane

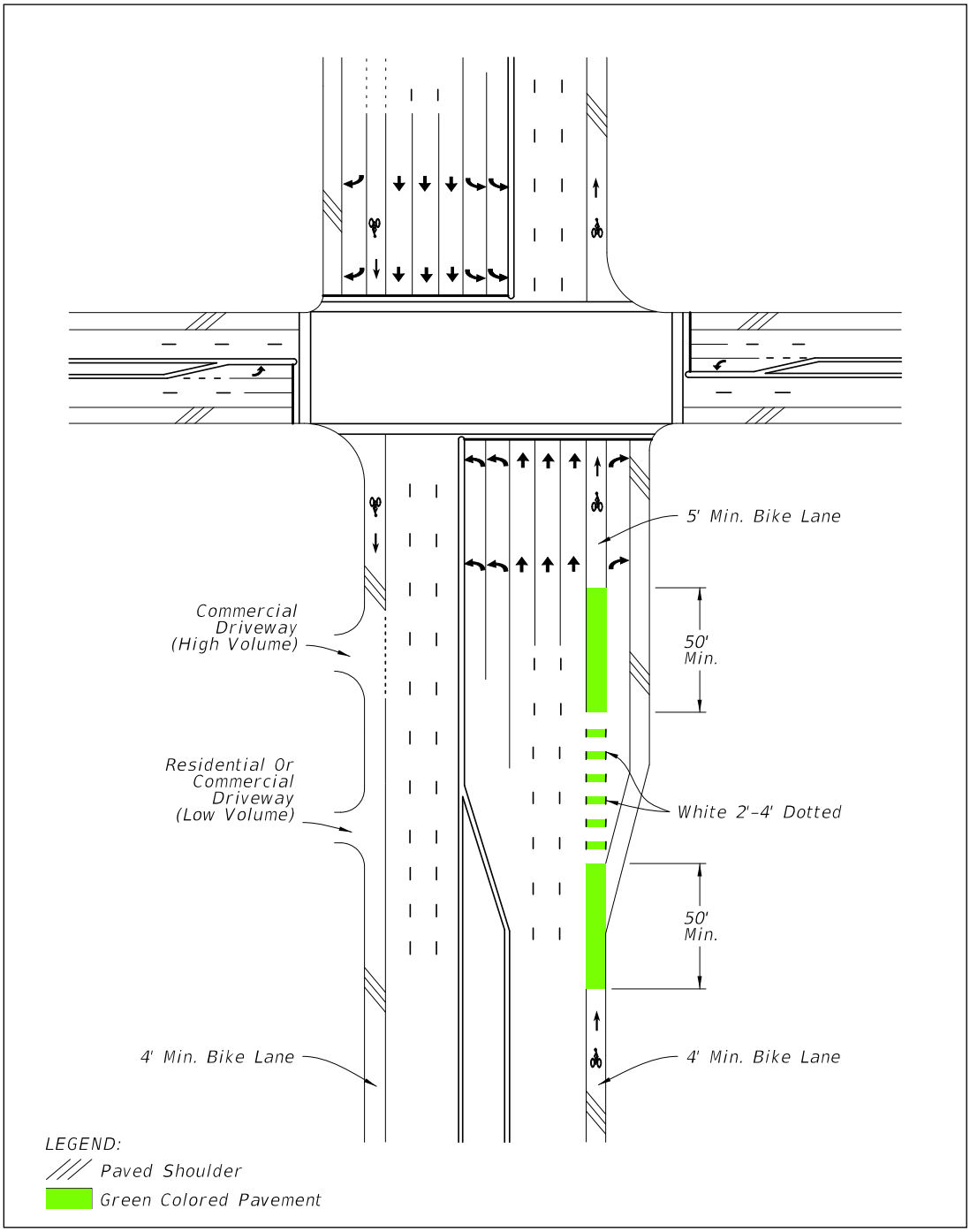


Figure ~~8~~9 – 21 Green Bicycle Lane with Right Turn Drop Lane

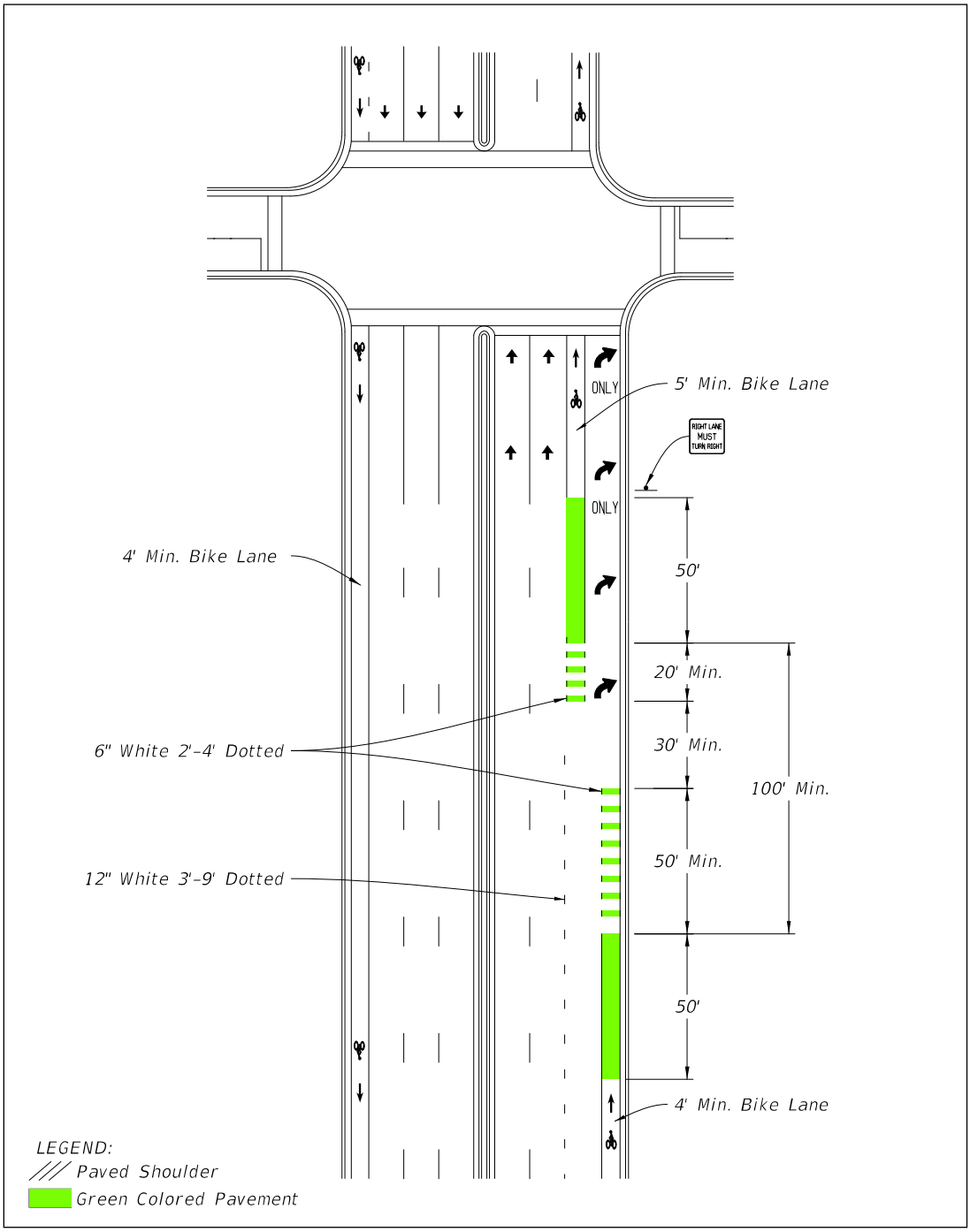


Figure 8~~9~~ – 22 Green Bicycle Lane with Channelized Right Turn Lane

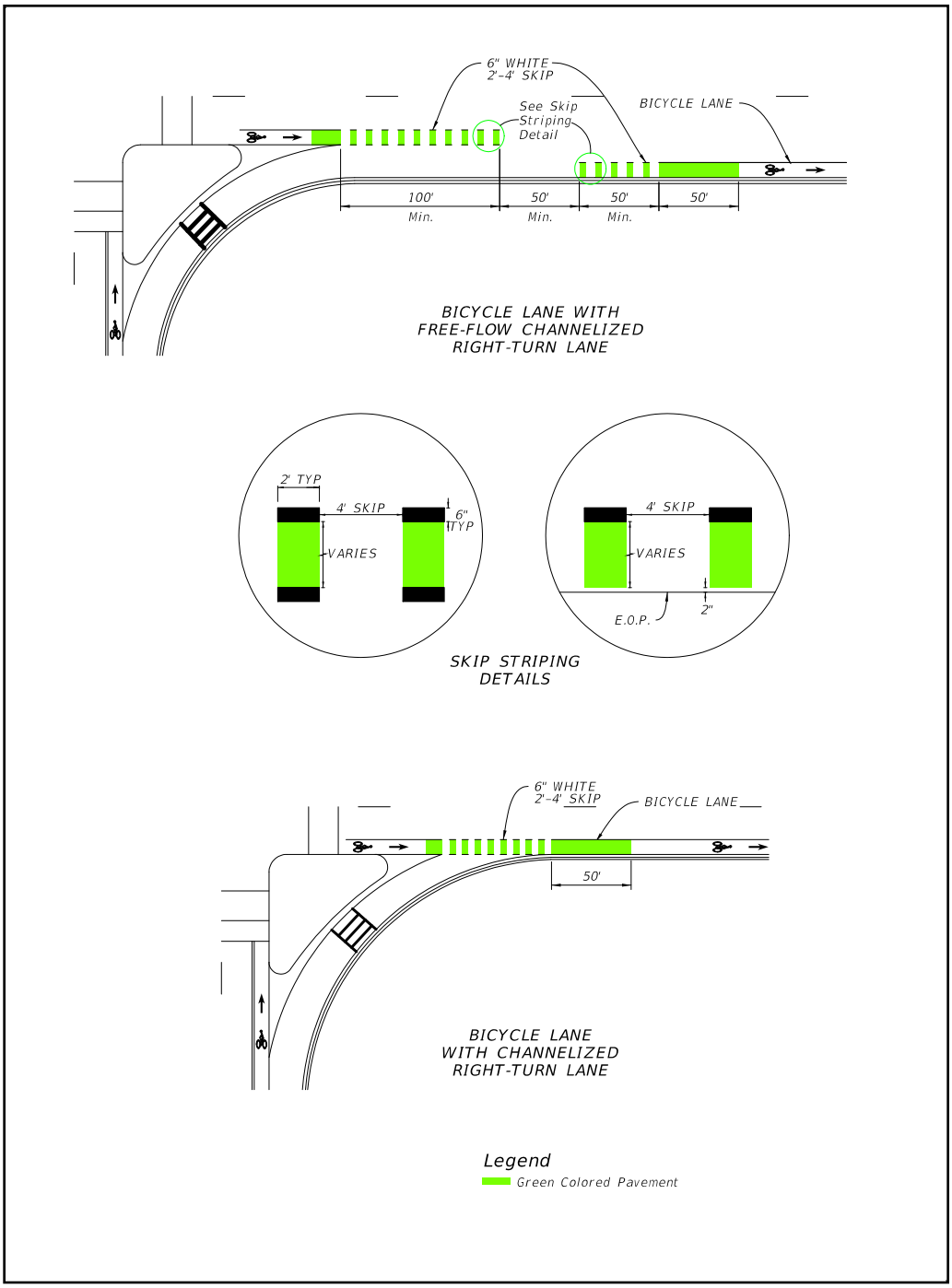
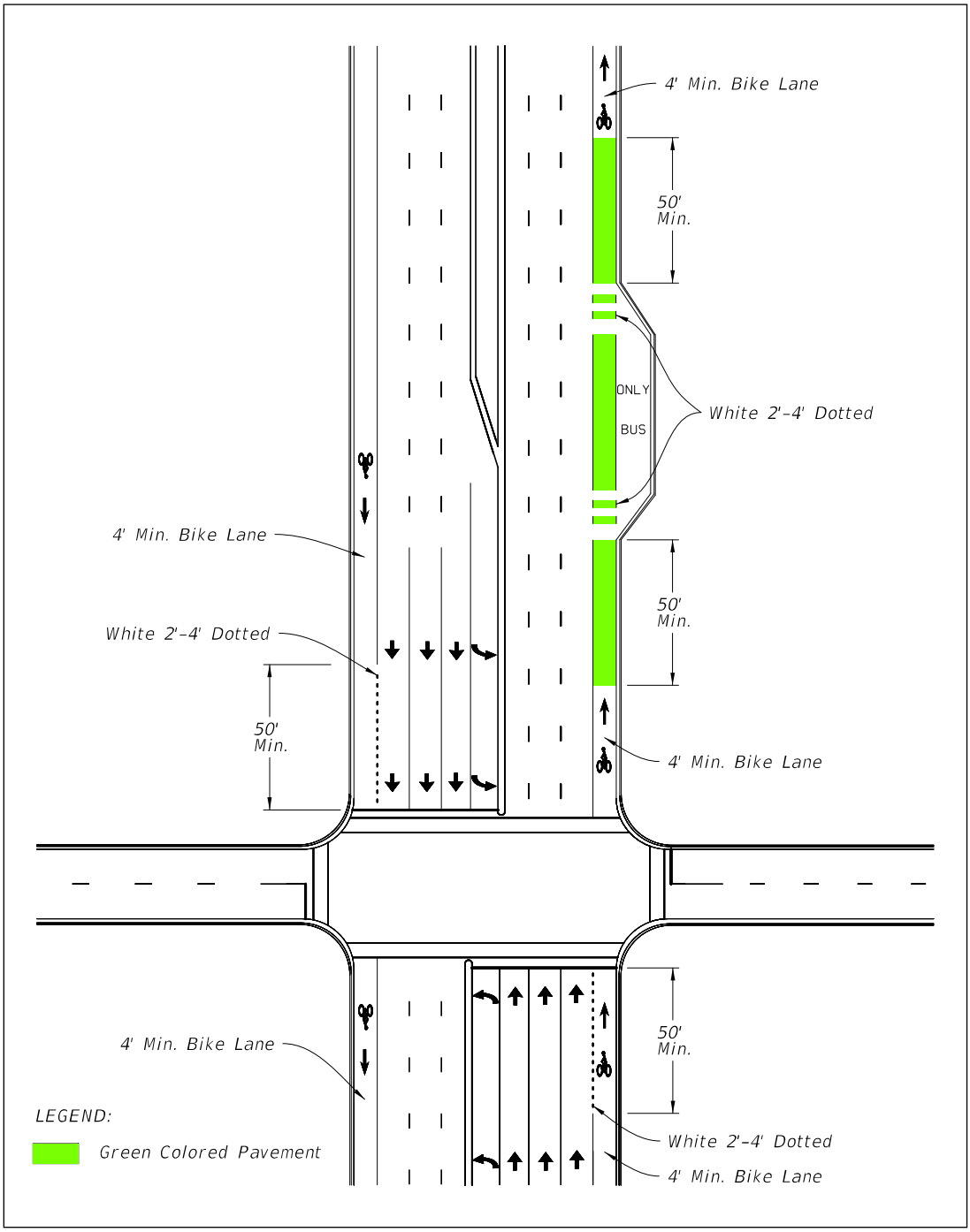


Figure ~~8~~9 – 23 Green Bicycle Lane with Bus Bay



B.6~~5~~ Paved Shoulders

A paved shoulder is a portion of the roadway which has been delineated by edge line striping. Adding, widening or improving paved shoulders often can be an acceptable way to accommodate bicyclists. However, when a shoulder is intended to serve as a bicycle facility and is adjacent to a curb, guardrail or other roadside barrier, a minimum 5-foot clear width between the traveled way and the face of the barrier is required. Additional shoulder width is desirable if the posted speed exceed 50 mph, or the percentage of trucks, buses, or recreational vehicles is high (>10%).

Ground-in rumble strips should not be included in paved shoulders if a minimum clear width of 4 feet outside of the rumble strip cannot be provided.

B.7~~6~~ Wide Outside Lanes

Wide outside lanes on curbed roadways are through lanes that provide a minimum of 14 feet in width, which allows most motor vehicles to pass cyclists 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 may be the only practical option for a bicycle facility.

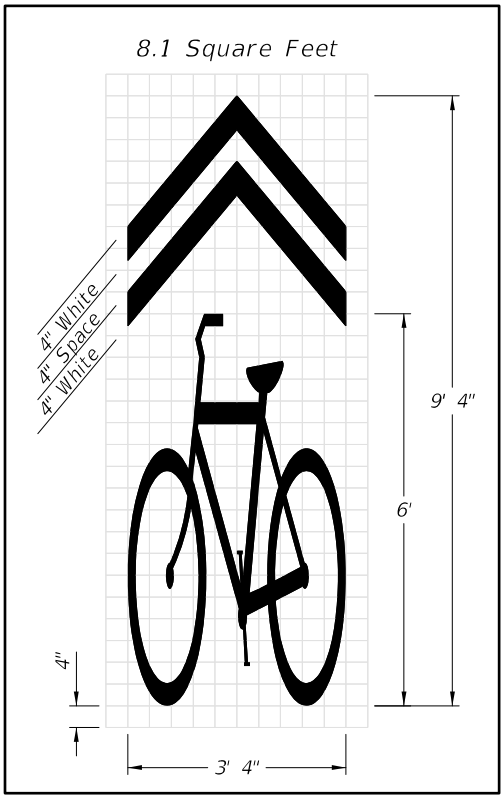
B.8~~7~~ Shared Lane Markings

The shared lane marking is an optional pavement marking for roadways where bicyclists and motor vehicles are intended to share the lane 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 cyclists 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 be used to identify an alternate route as part of an approved temporary traffic control plan. Figure 8~~9~~ – 24 provides the dimensions for shared lane markings.

Shared lane markings should be placed as follows:

Figure 8~~9~~ – 24 Shared Lane Marking



- If used on a roadway without on-street parking that has an outside travel lane that is 14 feet wide or less, the Shared Lane Markings should be centered in the travel lane (Figure 8~~9~~ – 25).
- If used on a roadway with on-street parking, the Shared Lane Markings should be centered in the travel lane (Figure 8~~9~~ – 26).
- Shared Lane Markings should be placed immediately after an intersection and spaced at intervals not greater than 250 feet thereafter.

Figure 8~~9~~ – 25 Shared Lane Marking Placement
(No Designated Parking, Lane Width ≤ 14 Feet)

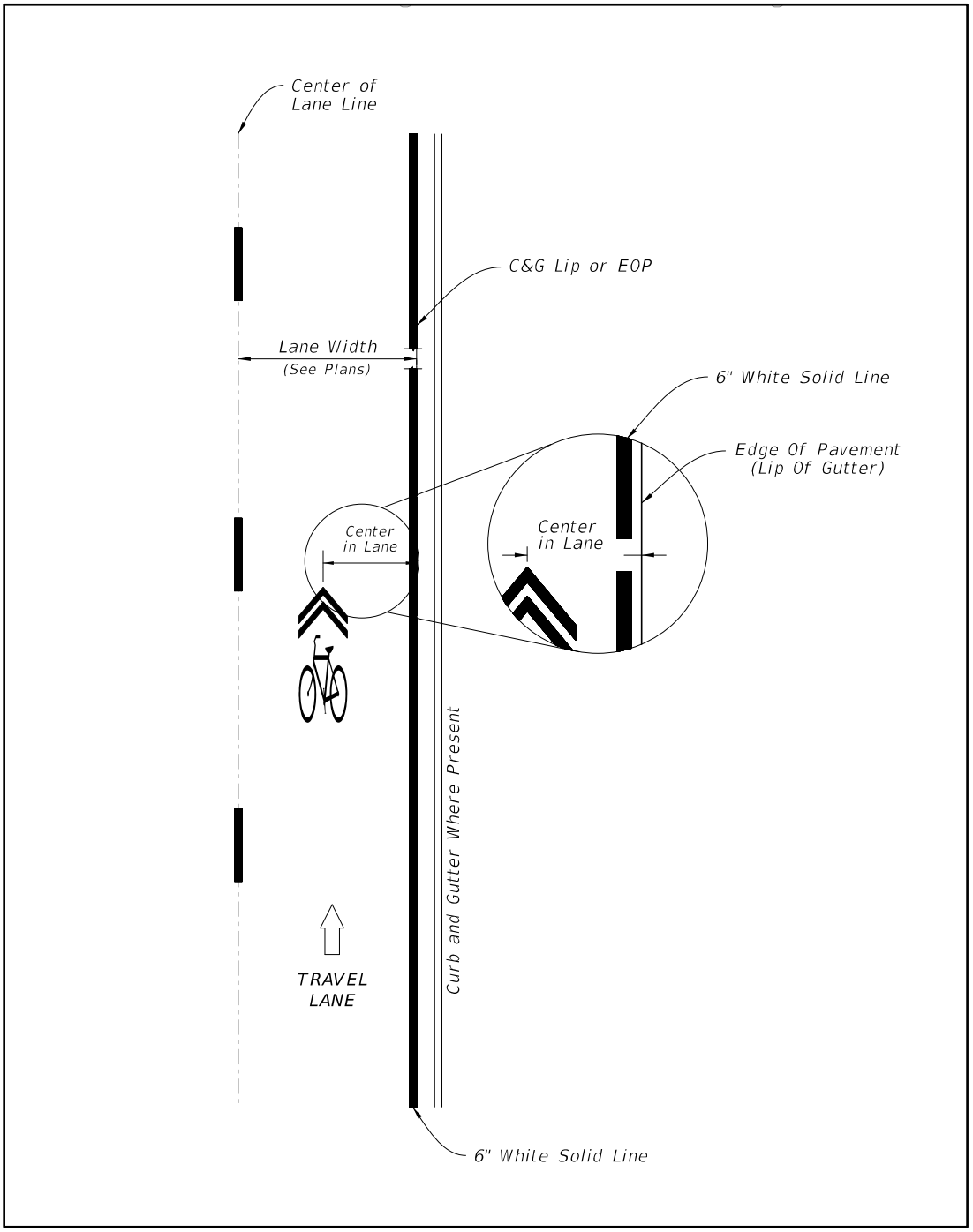
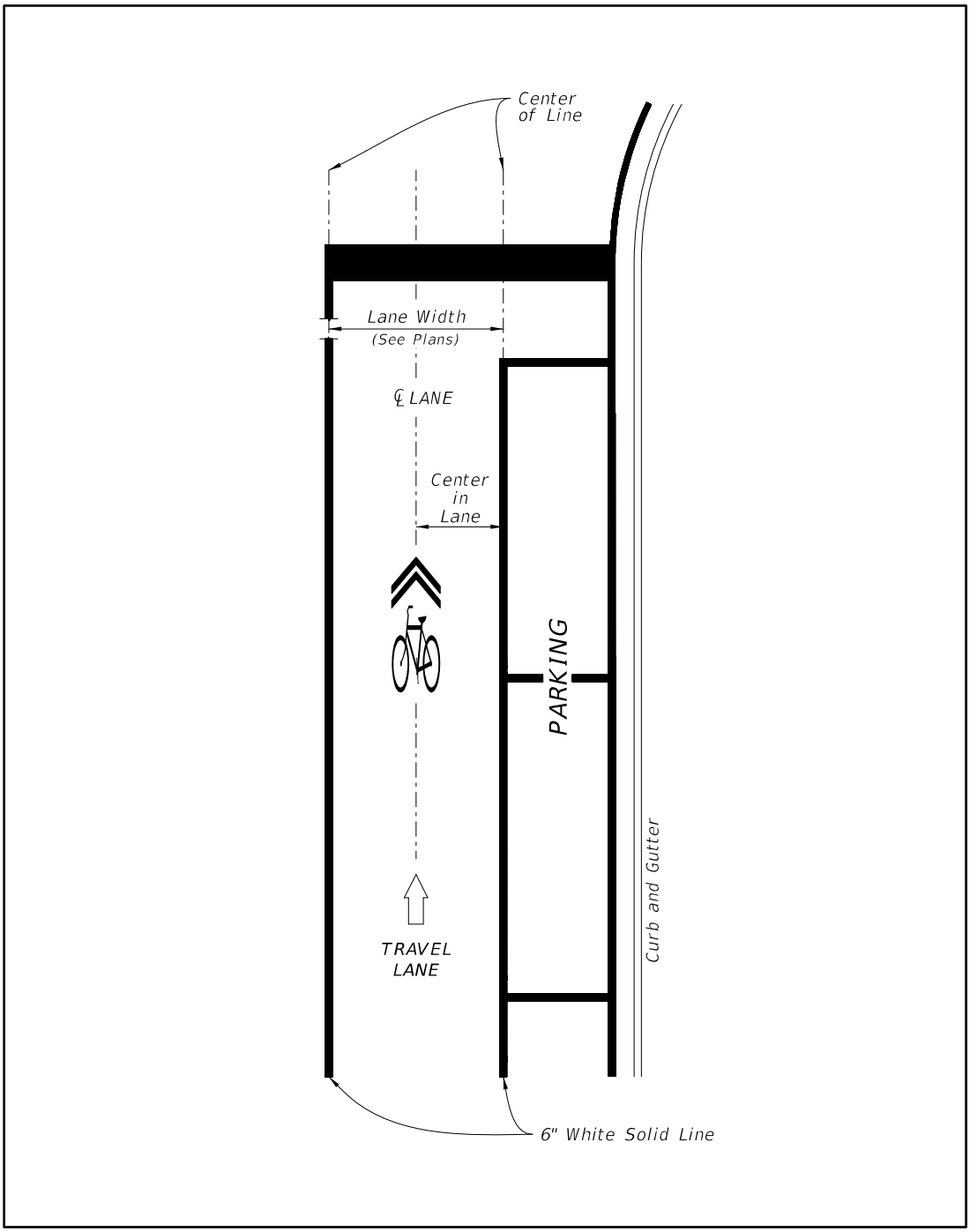


Figure ~~8~~9 – 26 Shared Lane Marking Placement (With On-Street Parking)



B.9~~8~~ 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 travel lanes are less than 14' wide. The ***MUTCD*** provides additional information on the use of the sign.

C SHARED USE PATHS

Shared use paths are paved facilities physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right of way or an independent right of way, with minimal cross flow by motor vehicles. They are used by bicyclists, pedestrians, runners, skaters, and in some cases equestrians. The bicycle's operating characteristics will govern the design of shared use paths. The ***2006 Americans with Disabilities Act – Standards for Transportation Facilities*** and the ***2012 Florida Accessibility Code*** impose additional requirements for the design and construction of shared use paths since they serve as pedestrian facilities.

Shared use paths serve a variety of purposes. They can provide a school age child, a recreational cyclist, or a person with a disability an alternative to busy roadways. Shared use paths can be located along former rail corridors, the banks of rivers or canals, and through parks and forests. Shared use paths can also provide access to areas otherwise served only by limited access highways. For transportation purposes, they should be thought of as an extension of the roadway network for non-motorized users. The inclusion of a shared use path 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 the ***AASHTO Guide for the Development of Bicycle Facilities (2012, 4th Edition).***

C.1 Width and Clearance

The useable width and horizontal clearance for a shared use path are primary design considerations. The minimum paved width for a two-way path is 10 feet. Typically, widths range from 10 to 14 feet, with the wider values applicable to areas with high use or a wider variety of users, on steep grades, through curves, or used by larger maintenance vehicles.

In very rare circumstances, a reduced width of 8 feet may be used where the following conditions prevail:

- Bicycle traffic is expected to be low, even on peak days or during peak hours.
- Pedestrian use of the facility is not expected to be more than occasional.
- Horizontal and vertical alignments provide frequent, well-designed passing and resting opportunities.

- The path will not be regularly subjected to maintenance vehicle loading conditions that would cause pavement edge damage.

In addition, a path width of 8 feet may be used for a short distance due to a physical constraint such as an environmental feature, bridge abutment, utility structure, or fence.

A minimum 2 foot wide graded area with a maximum 1:6 slope should be maintained adjacent to both sides of the path; however, 3 feet or more is desirable to provide clearance from trees, poles, walls, fences, guardrails or other lateral obstructions. See Chapter 8, Section D Barrier Separation and Chapter 3~~4~~ – Roadside Design, Figure 3~~4~~ – 8 Location of Guardrail for information on when and how longitudinal barriers should be utilized,

Where the path is adjacent to canals, ditches, or slopes steeper than 1:3, a wider separation should be considered. A minimum 5 foot separation from the edge of the path pavement to the top of the slope is desirable. Depending on the height of embankment and condition at the bottom, a physical barrier, such as a railing or chain link fence may need to be provided.

Where a recovery area is less than 5 feet, physical barriers or rails are recommended in the following situations:

- Slopes 1:3 or steeper, with a drop of 6 feet or greater;
- Slopes 1:3 or steeper, adjacent to a parallel body of water or other substantial obstacle
- Slopes 1:2 or steeper, with a drop of 4 feet or greater; and
- Slopes 1:1 or steeper, with a drop of 1 foot or greater.

The ***AASHTO Guide for the Development of Bicycle Facilities (2012, 4th Edition)*** provides additional information on the design of barriers or railings.

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, vertical clearance greater than 10 feet may be needed to permit passage of maintenance and emergency vehicles.

C.2 Separation Between Shared Use Paths and Roadways

When shared use paths are located adjacent to a roadway, a separation shall be provided. This demonstrates to both path users and motorists that the shared use path is a separate facility.

The minimum distance between a path and the face of curb or edge of traveled way (where there is no curb) should be 5 feet. On roadways with flush shoulders, this separation is measured from the outside edge of the shoulder to the inside edge of the path. Where the separation is less than 5 feet, a physical barrier or railing should be provided between the path and the roadway.

A barrier or railing between the path and adjacent highway should not impair sight distance 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 to redirect errant motorists toward the roadway, unless other conditions indicate the need for a crashworthy barrier.

Barriers or railings at the outside of a structure or steep fill embankment that not only define the edge of the path but also prevent bicyclists from falling over the rail to a substantially lower elevation should be a minimum of 42" high. Barriers 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 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

For paths in relatively flat areas (grades 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 the ***AASHTO Guide for the Development of Bicycle Facilities (2012, 4th Edition)*** for further guidance,

C.4 Horizontal Alignment

The typical adult bicyclist is the design user for horizontal alignment. Please refer to the ***AASHTO Guide for the Development of Bicycle Facilities (2012, 4th Edition)*** for further information on determining the minimum radius of curves on shared use paths.

Shared use paths should be transitioned as necessary towards the roadway at intersections to provide a more functional crossing location that also meets driver expectation.

C.5 Accessibility

Since nearly all shared use paths are intended to be used by pedestrians, they fall under the accessibility requirements of the Americans with Disabilities Act.

Pull boxes, manholes (and other utility covers), and other types of existing surface features in the location of a proposed curb ramp or detectable warning should be relocated when feasible. When relocation is not feasible, the feature shall be adjusted to meet the ADA requirements for surfaces (including the provision of a nonslip top surface, and adjustment to be flush with and at the same slope as the adjacent surface).

The detectable warning systems are designed to work with concrete surfaces. In areas where the path has an asphalt surface, the engineer must specify an appropriate detectable warning system. In these cases, consider including a short section of concrete that will accommodate any system.

If curb ramps are included in the path design, they should be parallel to and the full width of the approaching path width. Shared use path crossings shall meet the same grade and cross slope requirements as sidewalks 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 existing driveways to determine if it is feasible to upgrade nonconforming driveway turnouts to meet maximum cross slope criteria. Nonconforming driveways are not required to be upgraded if it is not feasible within the scope of the project.

Chapter 78 – Pedestrian Facilities provides additional information regarding accessible design of shared use paths.

C.6 Structures

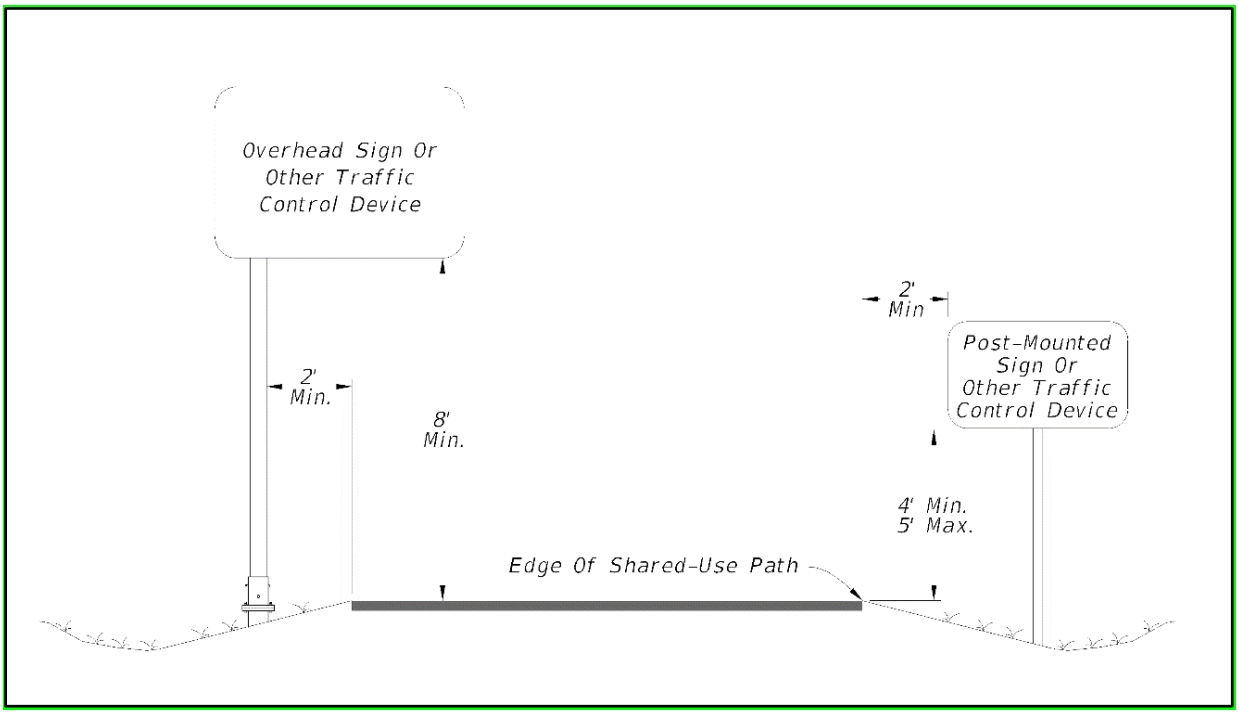
The minimum clear width on structures should be the same as the approach shared use path, plus the minimum 2 foot wide clear areas. Access by emergency, patrol and maintenance vehicles should be considered in establishing the design clearances of structures on shared use paths. Where practical, a path vertical clearance of 10 feet (on the structure) is desirable for adequate vertical shy distance.

Ramps on new structures that are part of a shared use path and serve as the accessible route shall have a running slope not steeper than 1:12 and cross slope not steeper than 1:48. Landings are required at the top and the bottom of each ramp run.

C.7 Pavement Markings and Signage

The MUTCD regulates the design and use of all traffic control devices on shared use paths. Figure 89 – 27 Sign Placement on Shared Use Paths provides the minimum criteria for the placement of signs along or over a shared use path. The maximum height from 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 ***Table 9B-1 Bicycle Sign and Plaque Sizes, MUTCD***. Guidance on the placement of stop or yield lines and crosswalks on roadways intersecting with shared use paths is provided in the ***MUTCD, Part 3***.

Figure 8~~9~~ – 27 Sign Placement on Shared Use Paths



D RAILROAD CROSSINGS

Railroad-highway grade crossings should ideally be at a right angle to the rails. This can be accomplished either as a separate path or a widened shoulder. 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, an additional paved shoulder of sufficient width should be provided to permit the bicyclist to cross the track at a safer angle, preferable 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 the roadway approach be at the same elevation as the rails. For more information, see Figure 4 – 28 Correction for Skewed Railroad Grade Crossing – Separate Pathway in the ***AASHTO Guide for the Development of Bicycle Facilities***.

E STRUCTURES

All 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.***

All 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. The 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)
  http://www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-ada-standards/ada-standards
- AASHTO – Guide for the Development of Bicycle Facilities, 2012, 4th Edition
  https://bookstore.transportation.org/
- NACTO Urban Streets Design Guide
  http://nacto.org/usdg
- FHWA Policy Memo for Flexibility in Pedestrian and Bicycle Facility Design
  http://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design_guidance/design_flexibility.cfm
- Storm Drain Handbook, Florida Department of Transportation, October 2014
  http://www.dot.state.fl.us/rddesign/Drainage/files/StormDrainHB.pdf
- Manual on Uniform Traffic Control Devices, May 2012
  http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 11

WORK ZONE SAFETY AND MOBILITY

TABLES

FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 11

WORK ZONE SAFETY AND MOBILITY[KM1]

A INTRODUCTION

Construction, maintenance, and utility work, along with traffic incident management, are roadwork operations that may create highway safety and mobility challenges. 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 is required to minimize the risks and effects of these roadwork operations. These comprehensive plans are known as transportation management plans. Any activity within a street, the highway or shared use path corridorright of way shall followbe subjected to the requirements of this chapterwork zone safety.

The general objective of a transportation management plan is to protect workers, traffic incident responders, pedestrians, bicyclists, and motorists during work zone operations. This may be achieved by meeting the following[KM2]:

- Provide adequate advance warning and information about upcoming work zones
- Promote the use of the appropriate traffic control and protection devices
- Provide pedestrians, bicyclists and motorists clear information to understand how to navigate through or around the work zone
- Provide accessible and continuous routes for pedestrians through, in, and/or around construction or maintenance work zones at least to the same level of accessibility that existed prior to the project
- Reduce the consequences of an out-of-control vehicle
- Provide safe access and storage for equipment and material
- Promote the speedy completion of projects (including thorough cleanup of the site)

B REGULATORY REQUIREMENTS

Each agency with responsibilities for construction, maintenance, utility, or traffic incident[KM3] management, or any roadwork operations on streets and highways shall develop and maintain a program of work zone safety, as set forth 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 ***Title 23 Code of Federal Regulations (CFR) 630 Subpart J***, more commonly known as the ***Work Zone Safety and Mobility Rule*** and ***Temporary Traffic Control Devices Rule (Subpart K)***.s financed in whole or in part with federal-aid highway funds.

When an existing pedestrian facility is in place, aAn Provide accessible and continuous routes for pedestrians through, in, and/or around construction 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.*** *The* ***2017 Florida Accessibility Code*** also includes requirements that apply to work zones, as required by ***F.A.C 61G20-4.002.***

C TRANSPORTATION MANAGEMENT PLAN

A Transportation Management Plan (TMP) lays out a set of strategies for managing work zone impacts of a project. The TMP helps to expand mitigation of work zone impacts beyond traffic safety and control to also address mobility for all users. The scope and content of the TMP required for a project are based on the work zone policies, expected work zone impacts of the project, and whether a project is determined to be significant. For all projects, the TMP will contain a Temporary Traffic Control Plan (TTCP) that addresses traffic safety and control through the work zone and is consistent with the provisions under Part 6 of the ***MUTCD.***

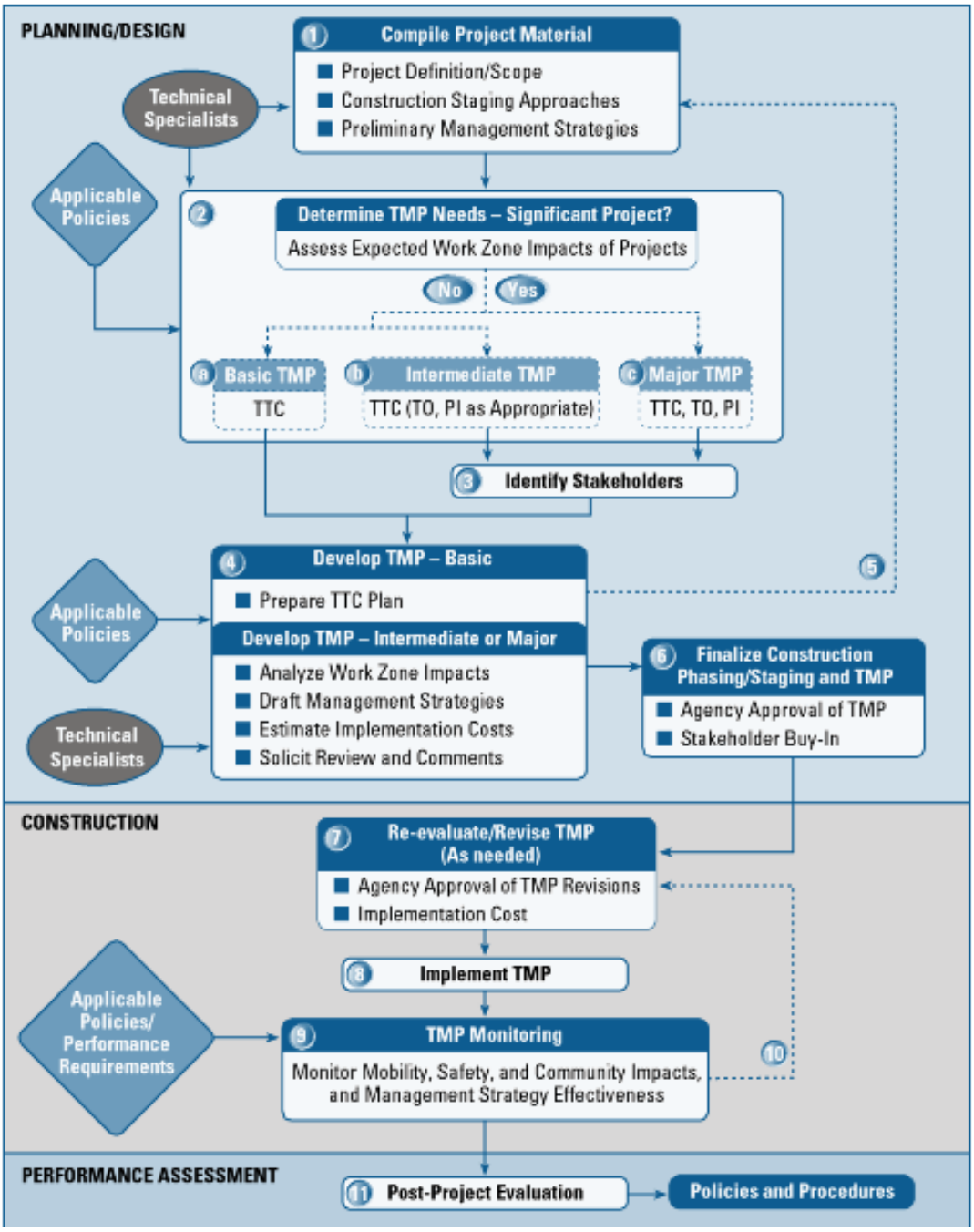
If a project is expected to be significant, the TMP for that project must also contain both transportation operations and public information components. The Transportation Operations Plan (TOP) addresses operations and management of the transportation system in the work zone impact area. Examples of TOP strategies include travel demand management, signal retiming, use of Intelligent Transportation Systems (ITS), speed enforcement, and traffic incident management.

The Public Information Plan (PIP) addresses communication with the public and concerned stakeholders, both before and during the project, about the project, what to expect in and around the work zone, and available travel alternatives. Examples of PIP strategies include using brochures, web sites, radio, and/or variable 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.

Figure 11 – 1 TMP Development provides an overview of the steps taken in developing a Transportation Management Plan. Further information on developing TMPs for projects can be found on ***FHWA's Work Zone Management*** web page.

Figure 11 – 1 TMP Development[KM4]



Source: FHWA Figure 6.1 Transportation Management Plans

B BACKGROUND

Section 316.0745, Florida Statutes, mandates the Department of Transportation compile and publish a manual of traffic control devices for use on the streets and highways of the state. To comply with this statute, the ***Federal Highway Administration's (FHWA) Manual on Uniform Traffic Control Devices (MUTCD)*** has been adopted for use in ***Rule 14-15.010, Florida Administrative Code (F.A.C.)***.

The intent of this chapter is to require conformance to the ***MUTCD, Part 6***.

C OBJECTIVES

Managing through traffic and maintaining access during construction, maintenance and emergency response roadwork operations is necessary. The goal is to complete roadwork or resolve traffic incidents in a timely manner while minimizing traffic delays, maintaining access to travelers, and most importantly maintaining an acceptable level of safety. The general objective of a program of work zone safety is to protect workers, traffic incident responders, pedestrians, bicyclists, and motorists during roadwork operations. This general objective may be achieved by meeting the following specific objectives:

- Provide adequate advance warning and information about upcoming work zones
- Provide the pedestrians, bicyclists and motorists clear information to understand how to navigate through or around the work zone
- Reduce the consequences of an out-of-control vehicle
- Provide safe access and storage for equipment and material
- Promote the speedy completion of projects (including thorough cleanup of the site)
- Promote the use of the appropriate traffic control and protection devices
- Provide safe passageways for pedestrians through, in, and/or around construction or maintenance work zones

D POLICY

Each agency with responsibilities for construction, maintenance, utility, or traffic incident management, or any roadwork operations on streets and highways shall develop and maintain a program of work zone safety, as set forth in the ***MUTCD, (Chapter 6A)***. Additional requirements related to all highway construction projects financed in whole or

in part with federal-aid highway funds are provided in ***Title 23 Code of Federal Regulations (CFR) 630 Subpart J***, more commonly known as the ***Work Zone Safety and Mobility Rule*** impose additional requirements for the design and construction of projects financed in whole or in part with federal-aid highway funds.

DE TEMPORARY TRAFFIC CONTROL PLAN (TTCP) PLANNING OF ROADWORK OPERATIONS

The achievement of work zone safety requires careful and complete planning prior to the initiation of any roadwork. The planning objective is to develop a comprehensive Temporary Traffic Control Plan (TTCP) that includes the following considerations:

- Type of Operation
- Nature of Work Zone
- Work Zone ImpactsTTCP Details
- Work Scheduling
- Coordination

DE.1 Type of OperationProject Requirements

DE.1.a Type of Operation

Roadwork The type of operations may be further classified as routine, unplanned, or planned operations.

DE.1.a.1 Routine Operations

Routine operations would involve projects such as mowing, street cleaning, and preventive maintenance operations conducted on a regularly scheduled basis.

DE.1.a.2 Unplanned Operations

Unplanned operations require prompt, efficient action to restore the facilityroadway to a safe condition. These include traffic incident management such as clearing vehicle crash or storm debris, addressing hazardous materials spills, repairing or replacing damaged highway safety components and restoring inoperative traffic

control devices.

DE.1.a.3 Planned Operations

Planned operations are scheduled roadwork projects, neither routine nor time-sensitive in nature, that are occasionally required to maintain or upgrade a street, or highway, sidewalk or path.

DE.21.b Nature of the Work ZoneRoadwork

The development of the TTCPtemporary traffic control plan for work zone safety should include consideration of the following factors:

- Length of the project
- Duration and complexity of the work
- Hazards that may be created (e.g., long term drop-offs)
- Time span required
- Requirements for continuous operation or occupation of the work zone
- Capability of clearing the site during cessation of work activity
- The various construction methods, equipment, and procedures that may be utilized. Evaluation of alternate methods should be undertaken to determine the safest and most efficient procedures
- The Nnecessity for storing equipment or material in the facilityhighway right of way
- Traffic characteristics and patterns
- Effects on nearby businesses and residences, especially when detouring
- Site conditions that may be confusing or distracting
- Limitations on sight distance
- Decreased visibility associated with nighttime operations
- Reasonableness of detour length and complexity
-

- Roadwork Ooperations that may expose workers to hazards from through traffic

- Hazards to pedestrians, bicyclists or out of control motoristsvehicles such as excavations or unguarded structures or equipment

- Equipment inspection and preventive maintenance program

DE.31.c Nature of the Work Zone Impacts

The nature of the work zone and the prevailing traffic conditions should, to a large degree, influence the procedures incorporated into the TTCP plan for work zone safety. The development of the TTCPtemporary traffic control plan should include consideration of the following factors:

- Location of the work zone in relation to the proximity to side streets, driveways, transitbus stops, schools, parks, places of worship, etc.

- Determination of the type of traffic affected, design vehicle, normal vehicle travelling speed, and existing traffic volumes.

- Distribution of traffic with respect to peak traffic periods (seasonal, day of week, time of day, etc.)

- Truck percentage, frequency of transit vehicles, unique characteristics of pedestrians and bicyclists who commonly travel the corridor (e.g. school children), and direction of traffic is also important for establishing traffic control procedures.

- Presence of Intelligent Transportation Systems (ITS) such as dynamic message boards.

- Site conditions that may be confusing or distracting to the motorist, pedestrian, or bicyclist.

- Limitations on sight distance.

- Decreased visibility associated with nighttime roadwork operations.
- Impacts of detours and diversions to businesses, and residential communities, schools, parks, community services.
- Pedestrian and bicycle accommodations.
- Reasonableness of detour length and complexity.

D.3 TTCP Details

Plans should include protection at work zones when work is in progress and when operations have been halted (such as during the night, special events or restrictions, holidays). The TTCP should include provisions for the following[MK5]:

- Work zone traffic signs
- Channelizing devices
- Temporary barriers (see ***Chapter 4 – Roadside Design***)
- The usage of 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[KM6])
- 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
- Night safety (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.3.1 Short Term Transverse Rumble Strips

In locations with existing raised rumble strip sets (e.g., intersections, approaches to horizontal curves, toll plazas), maintain or replace the 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. Short-term raised rumble strip sets must be installed prior to opening the road to traffic; therefore, quantities may include multiple applications due to construction phasing. ***FDOT's Standard Plans, Index 546-001*** and ***Standard Specifications, Section 546*** provide additional information on short term raised rumble strips.

D.3.2 Temporary Raised Rumble Strip Sets

Temporary raised rumble strip sets are used to warn vehicular traffic of the upcoming work zone. They may be used to supplement the required signs, channelizing devices, and flagging operations in the work zone. They are most often used when both of the following conditions occur:

- Lane closure on a two-lane, two-way roadway
- Existing posted speed prior to construction is 55 mph or greater

D~~E~~.4~~2~~ Work Scheduling

Proper work scheduling and sequencing of ~~roadwork~~ operations will ~~not only~~ promote efficiency, but also improve the safety aspects. Where feasible, routine operations and special projects should be conducted during periods of low traffic volume to reduce conflicts. Projects that may be carried out concurrently at the same site should be scheduled simultaneously to eliminate successive disruptions of traffic.

Major projects that impede or restrict traffic flow should be coordinated and sequenced with similar projects in adjacent areas, to produce a minimum of disruption to orderly traffic flow in the overall ~~highway~~ network. The scheduling of work at a given location should include consideration of traffic generation (including special events), as well as traffic restrictions by work activities on the surrounding ~~highway~~ network.

~~DE.53 Traffic Control and Protection~~

Plans for traffic control around or through work zones should be developed with safety receiving a high priority. Plans should include protection at work zones when work is in progress and when operations have been halted (such as during the night). Provisions for the protection of work crews, traffic control personnel, bicyclists, pedestrians, (in areas of high pedestrian use, construction of temporary facilities should be considered), and motorists shall be included in the operation plans. The plan for traffic control and protection should consider provisions for the following:

Clear view of work zone

- Advance warning devices

Work zone traffic signs

Channelizing devices

- Clear view of work zone

Roadway, sidewalk and shared use path delineation and channeling devices

Transit Stops – including passenger access

- Clear zone (***Chapter 4 – Roadside Design***[KM7])
- Regulatory information
- High visibility safety apparel for workers
- Traffic control officers and law enforcement
- Hazard warning
- Barriers
- Pedestrian and bicyclist safety

- Access for pedestrians, bicyclists, and motor vehicles
- Access to adjacent properties by the public during construction
- Location of construction vehicles and equipment, including access into and out of the work zone
- Night safety (***Chapter 6 – Lighting***)
- Personnel training

Traffic control and protective devices – including transverse rumble strips (***Chapter 18 – Signing and Marking***[KM8])

- Transit Stops – including passenger access
- Abrupt changes in geometry (lane narrowing, lane drop, transitions)
- Turning restrictions
- Temporary traffic signals

DE.564 Coordination with Others

To ensure safe and efficient roadwork operations, the temporary traffic control planTTCP should be developed and executed in cooperation with interested individuals and agencies, which may include the following:

- Transportation Highway agencies
- Police and sheriff's departmentsagencies
- Emergency respondersagencies
- Contractors
- Utilities
- Building departments
- Mass transit providersagencies

- Traffic generators
- Local Rresidents and businesses
- Neighboring jurisdictions
- School Boards
- Postal Services
- Media
- Trash and recycling pick ups

D.6 Number and Width of Travel Lanes, Bike Lanes, Sidewalks, and Shared Use Paths

The number and width of travel lanes, sidewalks, shared use paths, and bike lanes should be maintained through work zones. The minimum widths for work zone travel lanes, sidewalks, shared use paths, and bike lanes shall be as follows:

- Freeways – 11 feet
- Arterials – 10 feet except on transit 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
- Bike Lanes – 4 feet plus 1'offset from barrier or curb

Do not allow traffic control and warning devices to encroach on travel lanes, bike lanes, paved shoulders, sidewalks and shared use paths open for travel.

[MK9]D.7 Clear Zones, Above-Ground Hazards, ~~Drop-Offs~~Drop-Offs, and Temporary Barriers[KM10]

When 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.~~are required~~. See ***Chapter 4 – Roadside Design*** for requirements.

~~A drop-off is defined as a drop in elevation, parallel to the adjacent travel lanes, greater than 3" with slope (A:B) greater than 1:4. In superelevated sections, the algebraic difference in slopes should not exceed 0.25. See Figure 11 – 21xx Drop-off Condition Detail, Table 11 – 1 Drop-off Protection Requirements and Table 11 – 2 Clear Zone Widths for Work Zones for further requirements. A setback distance appropriate for the type of barrier selected shall be provided. For further iInformation on setback requirements for various types of barriers, see can be found in ***FDOT's Standard Plans, Index 102-100***.~~

For Conditions 1 and 3 provided in Table 11 – 1xx Drop-off Protection Requirements, 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, unless existing permanent curb heights are ≥ 6". For curb heights < 6", see Table 11 – 1 Drop-off Protection Requirements[KM11].

Drop-offs may be mitigated by placing slopes of optional base material. See the ***FDOTDepartmen'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.

Protect any drop-off adjacent to a pedestrian facility with pedestrian longitudinal channelizing devices, temporary barrier wall, or approved handrail. Adjacent to pedestrian facilities, a drop-off is defined as:

- a drop in elevation greater than 10" that is closer than 2 feet from the edge of the sidewalk or shared use path, or

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 drop-off is greater than 60".

Figure 11 – 21xx Drop-Off Detail[MK12]

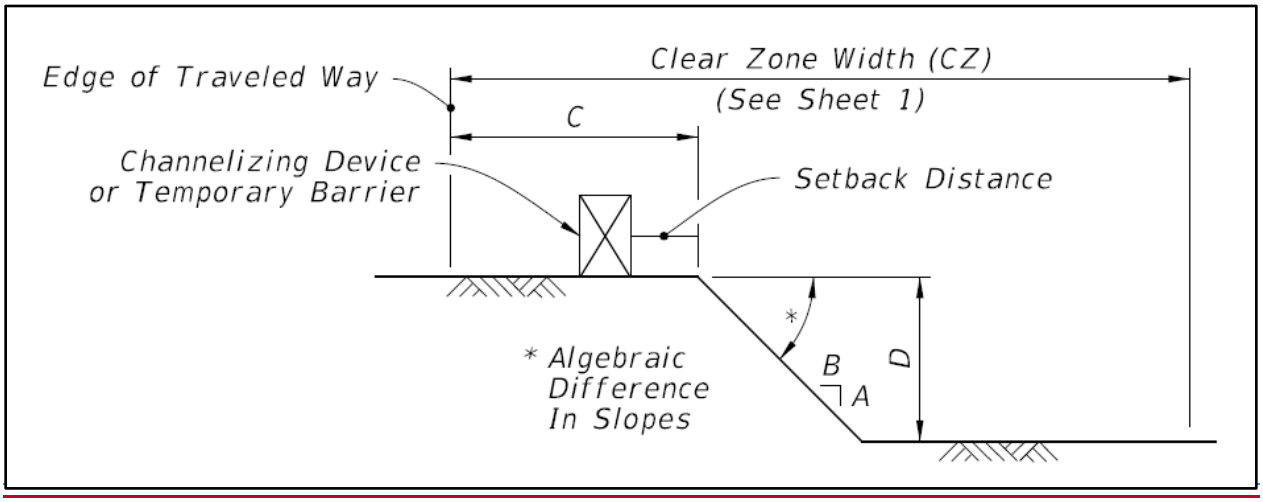


Table 11 – 1x Drop-off Protection Requirements

Condition	D (inches)	C (feet)	Device Required
1	> 3	2 – 12	Temporary Barrier
2	> 3 to ≤ 5	12 – CZ	Channelizing Device
3	> 5	2 – CZ	Temporary Barrier
4	Removal of Bridge or Retaining Wall Barrier		Temporary Barrier
5	Removal of Portions of Bridge Deck		Temporary Barrier

Notes:

- Do not allow any drop-off conditions greater than 3 inches within two feet of the edge of traveled way.
- See Table 114 – 21 Clear Zone Widths for Work Zones Minimum Width of Clear Zone in Chapter 4 – Roadside Design for Clear Zone (CZ) values.

The table below gives clear zone widths in work zones for 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 Chapter 4 – Roadside Design[MK13].

Table 11 – 2x Clear Zone (CZ) Widths for Work Zones[MK14][MK15][KM16][KM17]

Work Zone Speed (mph)	Travel Lanes & Multilane Ramps (feet)	AuxiliaryAuxiliary Lanes & Single Lane Ramps (feet)
< 30		
30 - ≤ 40	14	10
45 – 50	18	10
55	24	14
60 – 70	30	18
All Speeds Curbed Roadways (All Speeds)	4’ Behind Face of Curb	4’ Behind Face of Curb

D.8 Work Affecting Pedestrian and Bicycle Facilities[KM18]

D.8.1 Pedestrian Facilities

When an accessible sidewalk or shared use path is temporarily closed to pedestrians by construction, alterations, maintenance operations, or other conditions, an alternate pedestrian access route complying with Sections 6D.01, 6D.02, and 6G.05 of the ***MUTCD*** shall be provided. Where provided, pedestrian barricades and channelizing devices shall comply with sections 6F.63, 6F.68, and 6F.71 of the ***MUTCD***. The temporary sidewalk or shared use paths shall maintain the same level of accessibility as the existing facility or greater. Minimize diversions and detour lengths[KM19].

For a temporary sidewalk, provide a minimum width of 5 feet. In constrained conditions, a minimum sidewalk width of 4 feet may be provided, with a 5' x 5' passing section at least every 200 feet. For a temporary shared use path, provide a minimum width of 8 feet. Both sidewalks and shared use paths 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, ensure that all curb ramps or blended transitions meet ADA requirements. Detectable warnings shall be provided at intersections with all streets and signalized or stop sign ~~traffic~~ 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 further information. Additional information on designing accessible sidewalks and shared use paths can be found on the ***United States Access Board's*** web page ~~for ***Streets and Sidewalks***~~, including the ***(Proposed) Public Rights-of-Way~~Supplemental Notice of Proposed Rulemaking, Accessibility Guidelines (PROWAG)***. ~~for Pedestrian Facilities in the Public Rights of Way; Shared Use Paths.~~

D.8.2 Bicycle Facilities

The continuity of a ~~pedestrianor~~bicycle facility should[KM20] be maintained through the work zone. Continuity through the work zone is particularly important where

pedestrians or bicyclists have been traveling on a shoulder, bike lane, or shared-use path prior to the work zone and adjacent to a lane having a posted speed limit ≥ 35 miles per hour. If a bicycle lane, paved shouldershoulder, or shared use path on a roadway having a speed limit of 35 mph or higher is closed a separate bicycle facility or detour route should be provided[KM21]. In order to maintain room for bicycle lanes, paved shoulders or a shared use path 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 typical applications for general traffic will usually be adequate for bicyclists as well.

If a bicycle facility detour is unavoidable, it should be as short and direct as practical, using roadways where conditions are appropriate for bicycling. On-road bicyclists should not be directed onto a sidewalk or shared use path intended for pedestrian use except where such a path or sidewalk is a shared-use path, or where unless no practical alternative is available (such as might be the case on a bridge in the course of a rehabilitation project or roadway with environmental or right of way constraints). If directing cyclists onto a sidewalk; sidewalks should be widened to be at least 6 feet, 7 feet when back of curb.

If a portion of a bicycle facility is to be closed due to construction activities and the detoured facility follows a complex path not in the original corridor, then a full detour plan should be developed and implemented. The TTCP for the detour of the bicycle facility should include all necessary advance warning (W21 series) signs, detour (W4-9 series) signs, and any other TTCP devices necessary to guide bicyclists along the detour route.

If an on-street bicycle facility had a wide outside through travel lane [KM22](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.

Additional requirements for providing for and managing bicycle travel in work zones is found in ***Part 6*** of the ***MUTCD***. The minimum TTC 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 minimum TTC sign and plaque sizes for on-street bicycle facilities shall conform to ***Chapter 6F*** of the ***MUTCD***.

D.9 Typical Application Examples

The following figures provide examples of typical applications. Typical applications should be used to develop a site-specific TTCP. Examples are provided for the following scenarios:

Figure 11 – 2 Two-Lane Roadway Lane (Closure Using Flaggers)

Figure 11 – 3 Multi-Lane Roadway 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 Without Detour

Figure 11 – 7 Bicycle Lane Closure With 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

The recommended spacing 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; for work zone sign spacing see ***Table 6H-3***; for taper length see ***Table 6H-4***, and for buffer length, see ***Table 6C-2.*** Provide pavement markings in accordance with ***Section 6F-78*** of the ***MUTCD***. ~~The~~ ***FDOT~~Department~~'s Standard Plans~~, 102 Series~~*** provides additional information and modifications of typical applications found in the ***MUTCD***. ~~Most work zones will require further development of the typical applications to address project-specific conditions. For work zone sign spacing, see Table 6H-3; for taper length see Table 6H-4, and for buffer length, see Table 6C-2 of the ***MUTCD***. Provide 6" white lines in accordance with Section 6F-78 of the ***MUTCD***.~~

Table 11 – 1 Work Zone Sign Spacing "X"

Road Type	Min. 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 Roadways	1,500

Table 11 – 2 Taper Length "L"

Work Zone Speed (mph)	Min. 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 Buffer Length "U" cannot be attained due to geometric constraints, use the greatest length possible, but not less than 155 feet.	

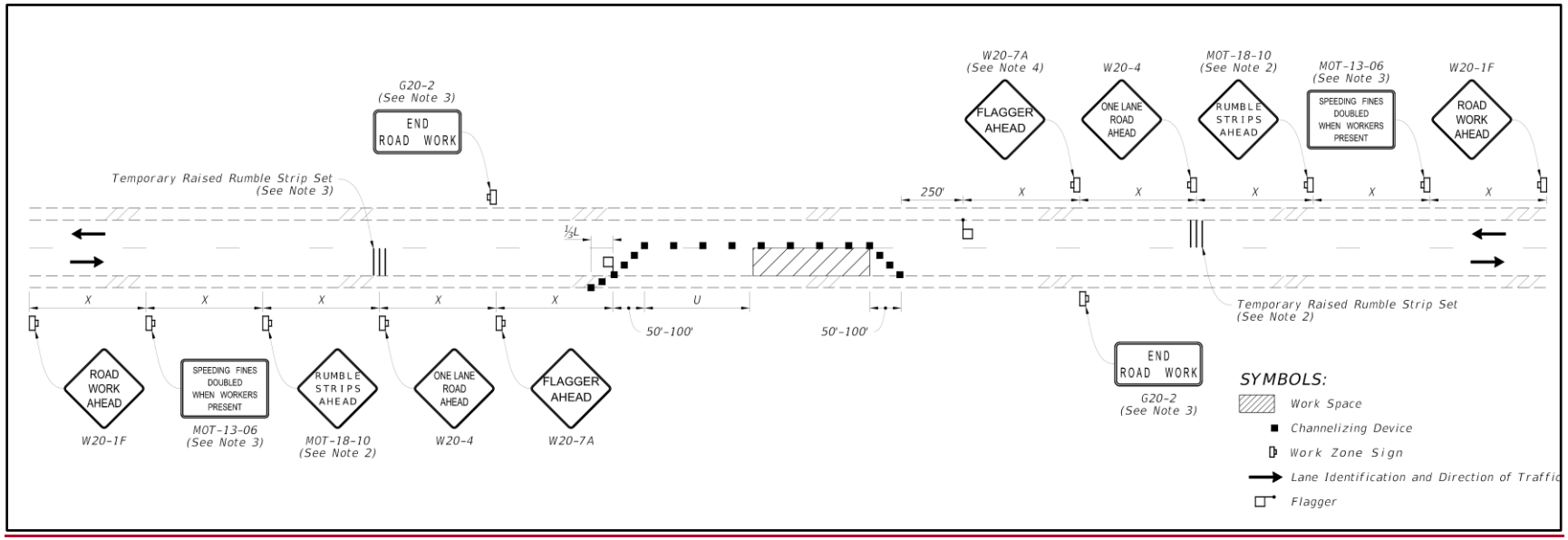
Table 11 – 4 Channelizing Device Spacing

Speed (mph)	Max. 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

For a temporary sidewalk, provide a minimum width of 5 feet. In constrained conditions, a minimum sidewalk width of 4 feet may be provided, with a 5' x 5' passing section at least every 200 feet. For a temporary shared use path, provide a minimum width of 8 feet. Both sidewalks and shared use paths 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, ensure that all curb ramps or blended transitions meet ADA requirements. Detectable warnings shall be provided at intersections with all streets and signalized or stop sign traffic controlled driveways. Detectable warnings are not required for curb ramps or blended transitions diverting pedestrian traffic into a closed lane. Additional information on designing accessible sidewalks and shared use paths can be found on the ***United States Access Board's*** web page for ***Streets and Sidewalks***, including the Supplemental Notice of Proposed Rulemaking, Accessibility Guidelines for Pedestrian Facilities in the Public Rights of Way; Shared Use Paths.

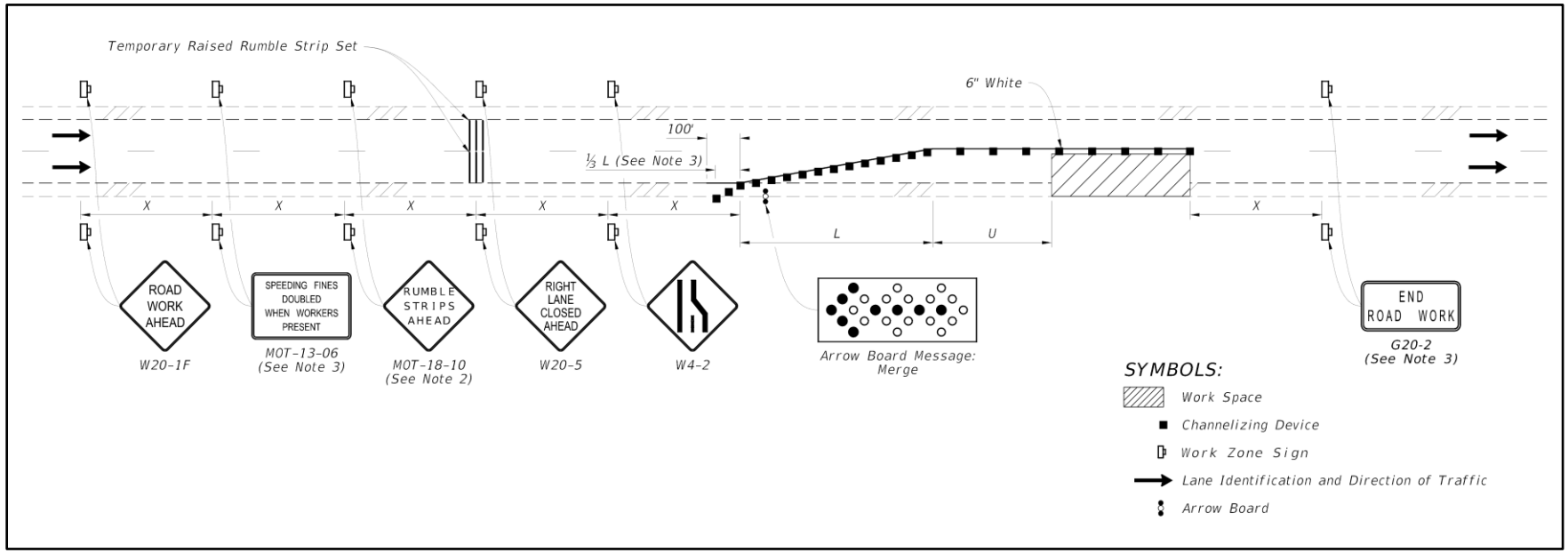
Figure 11 – 2 Two-Lane Roadway, Single Lane Closure Using Flaggers[KM23]



Notes:

1. X = Work Zone Sign Spacing, L = Taper Length, U = Buffer Length[KM24], see Table 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 be used,
5. "End Road Work" signs may be included when the work zone is in place for greater than 24 hours.
6. Temporary Pavement Markings are required for work zones 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.

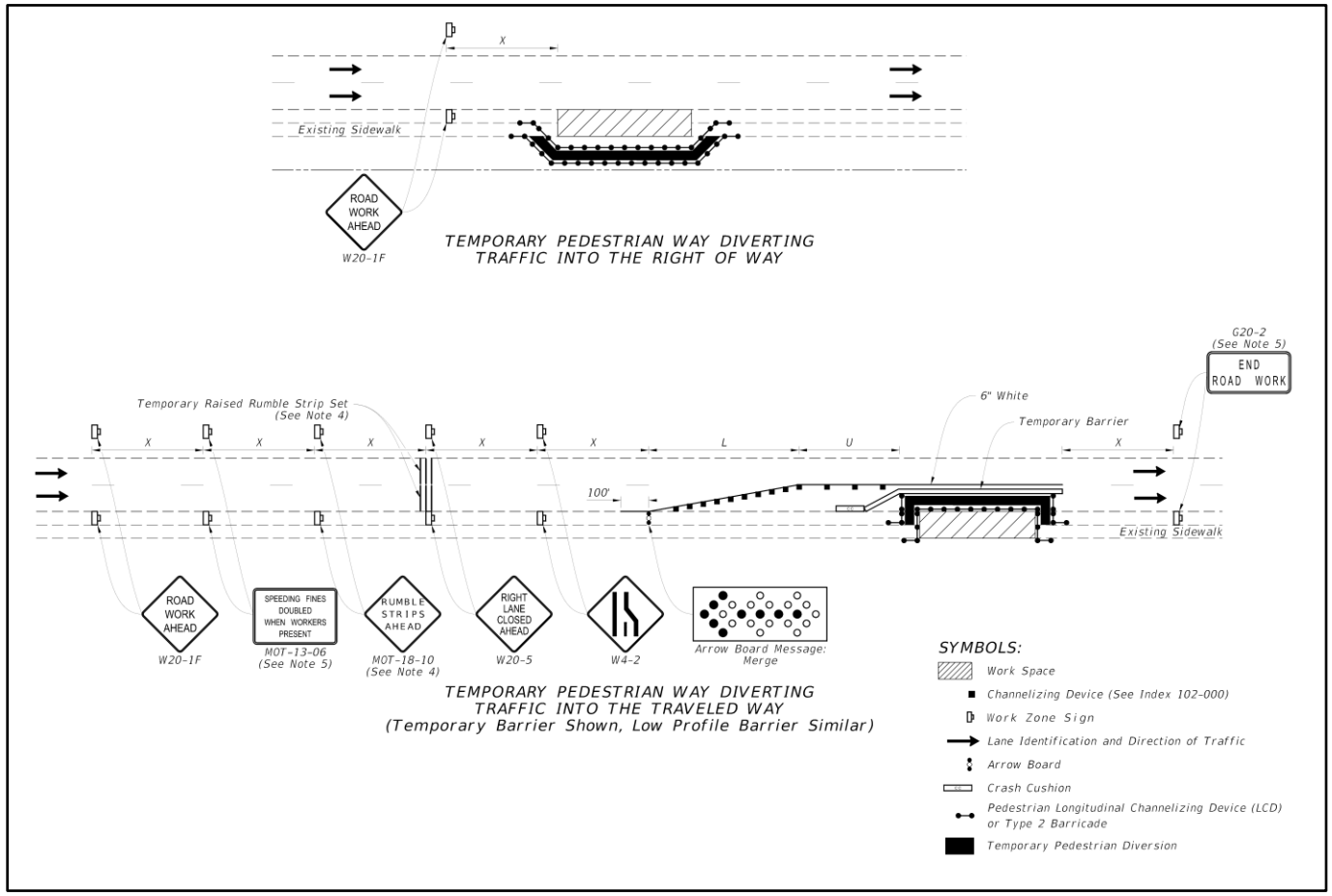
Figure 11 – 3 Multi-Lane Roadway, Single Lane Closure



Notes:

1. 1X = Work Zone Sign Spacing, L = Taper Length, U = Buffer Length[KM25], see Table 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 be used.
5. “End Road Work” signs may be included when the work zone is in place for greater than 24 hours
6. Temporary Pavement Markings are required for work zones 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[KM26])



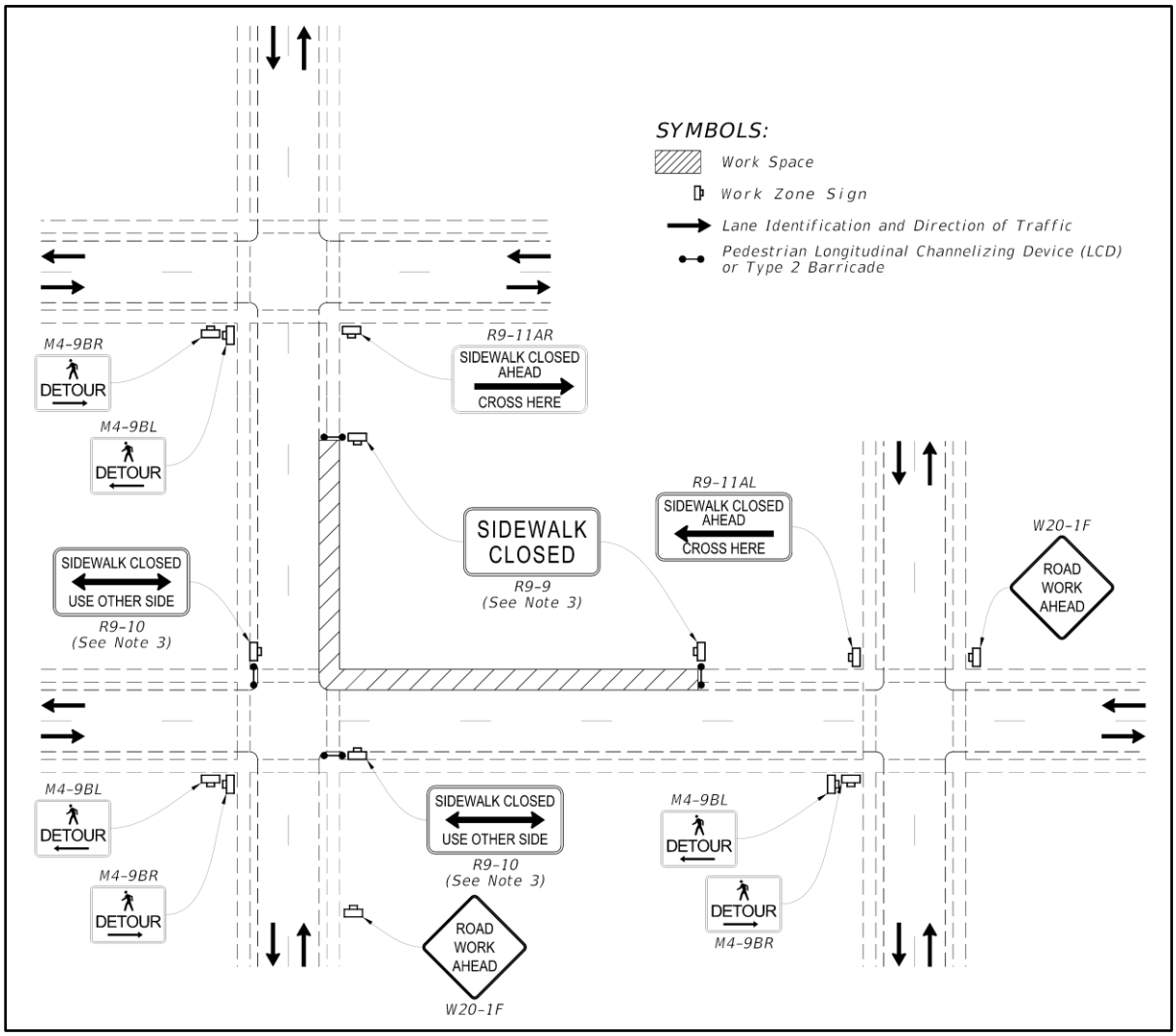
Notes: See following page.

1. X = Work Zone Sign Spacing, L = Taper Length, U = Buffer Length, see Table 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 have a maximum cross-slope of .02. Provide curb ramps or blended transitions with detectable warnings. Detectable warnings are not required for curb ramps and blended transitions diverting pedestrian traffic into a closed lane. See Chapter 8 – Pedestrian Facilities and Chapter 9 – Bicycle Facilities for further information.

1. When a temporary 5' wide sidewalk cannot be provided due to space restrictions, provide a sidewalk ≥ 4' wide, with a 5' x 5' passing space at intervals not to exceed 200'.

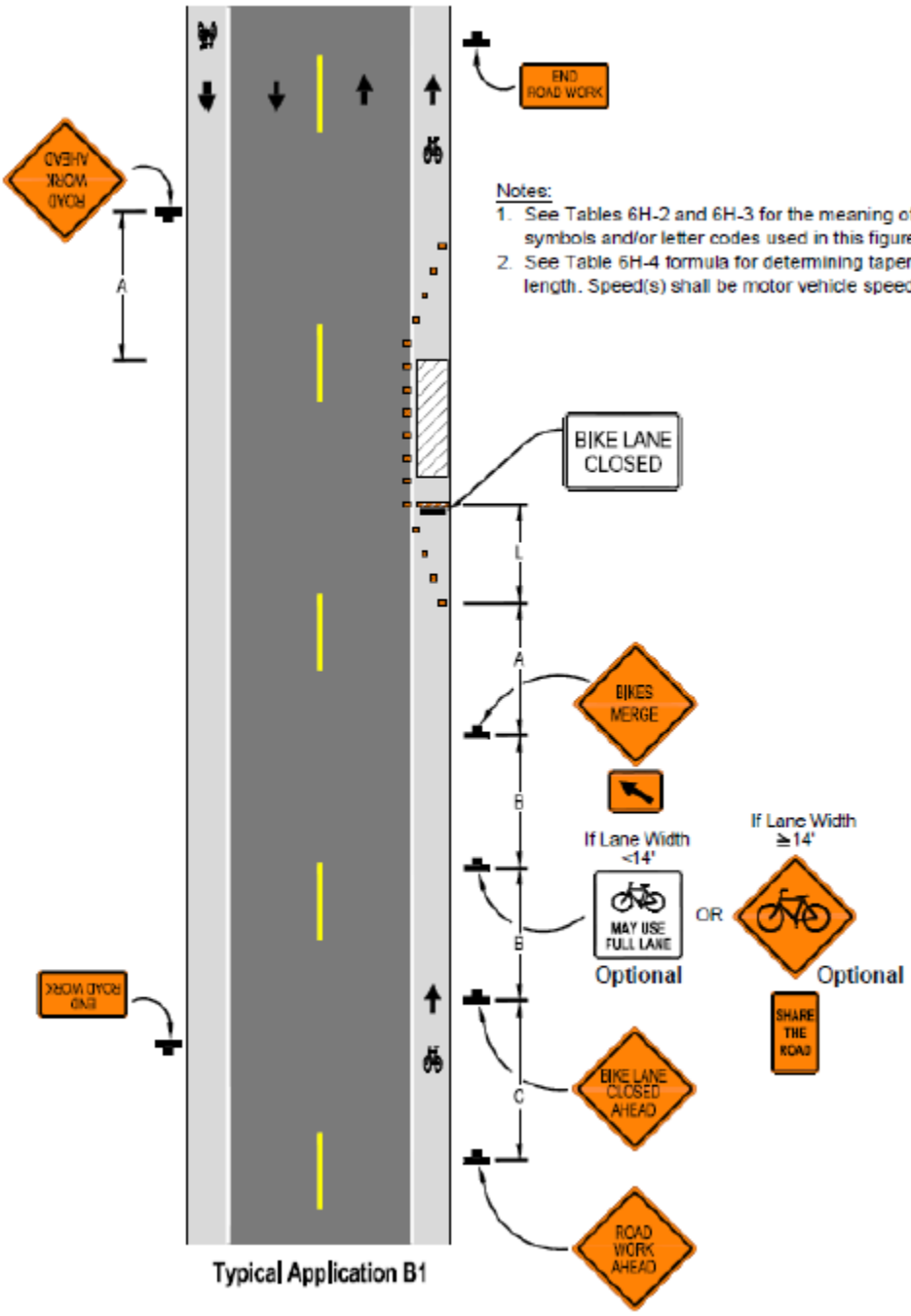
4. If temporary rumble strips are used, include "Rumble Strips Ahead" signs and associated sign spacing distance.
5. "Speeding Fines Doubled When Workers Present" signs may be used.
6. "End Road Work" signs may be included when the work zone is in place for greater than 24 hours.
7. Temporary Pavement Markings are required for work zones 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[KM27])



Notes:
1. Cover or deactivate pedestrian traffic signal display(s) 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 be mounted on pedestrian LCDs in accordance with the manufacturer's instructions.

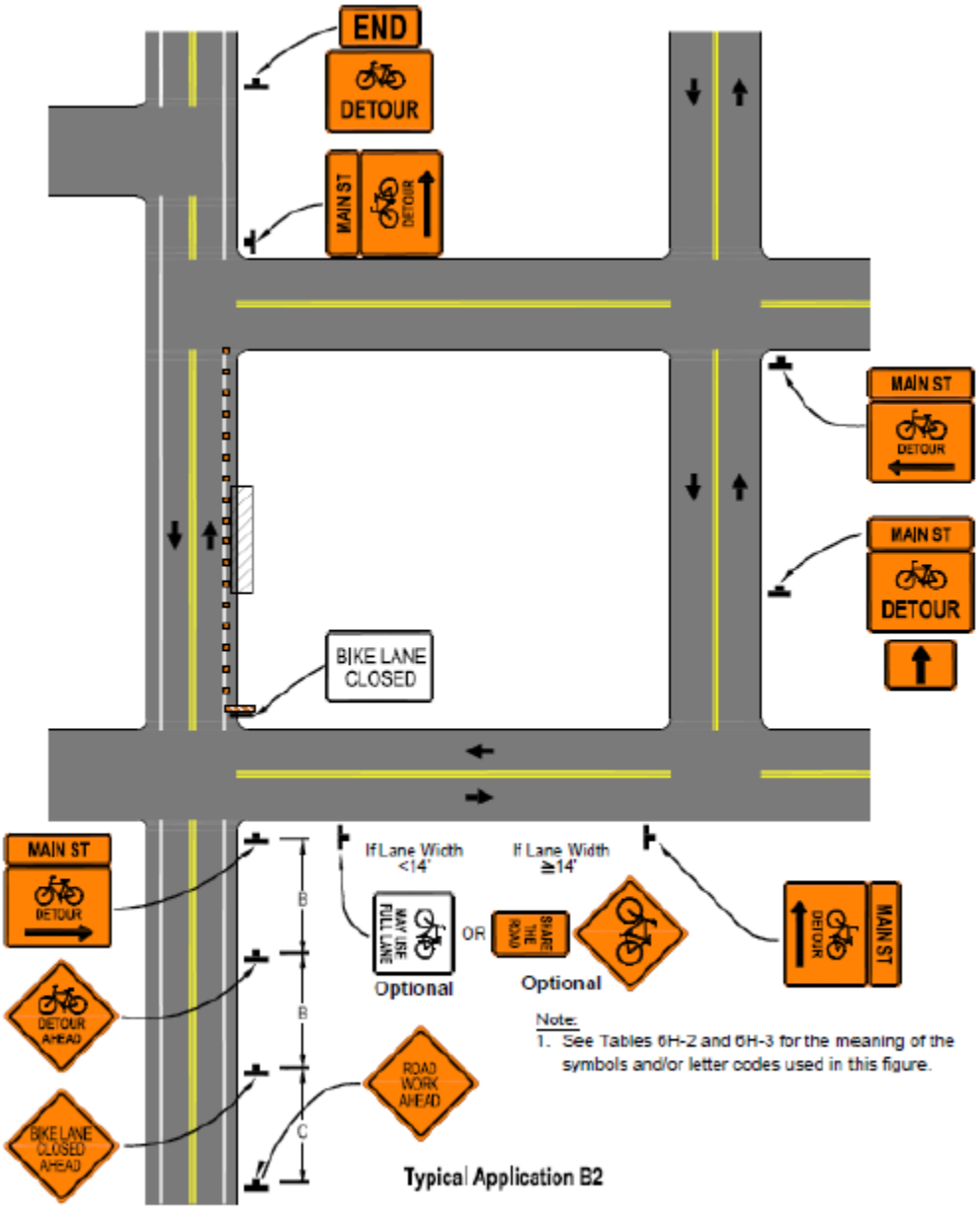
Figure 11 – 6Bicycle Lane Closure Without Detour[KM28]



Notes: See following 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 for Determining Taper Length for the distance L. Speeds shall be posted speeds.
3. If the posted speed limit is ≤ 35 mph, and the outside through travel lane is < 14 feet wide, then Bicycles May Use Full Lane (R4-11) signs should be used[KM29].
4. 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[KM30].

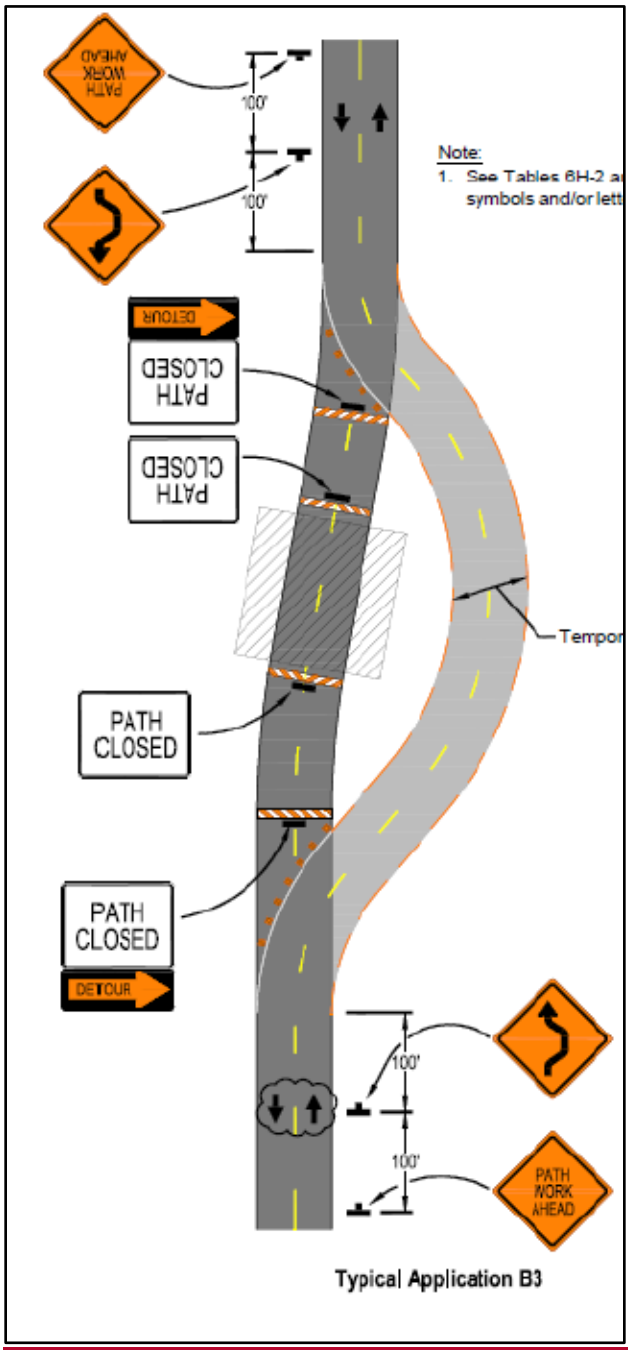
Figure 11 – 7 Bicycle Lane Closure With On-Road Detour[KM31]



Notes: See following page.

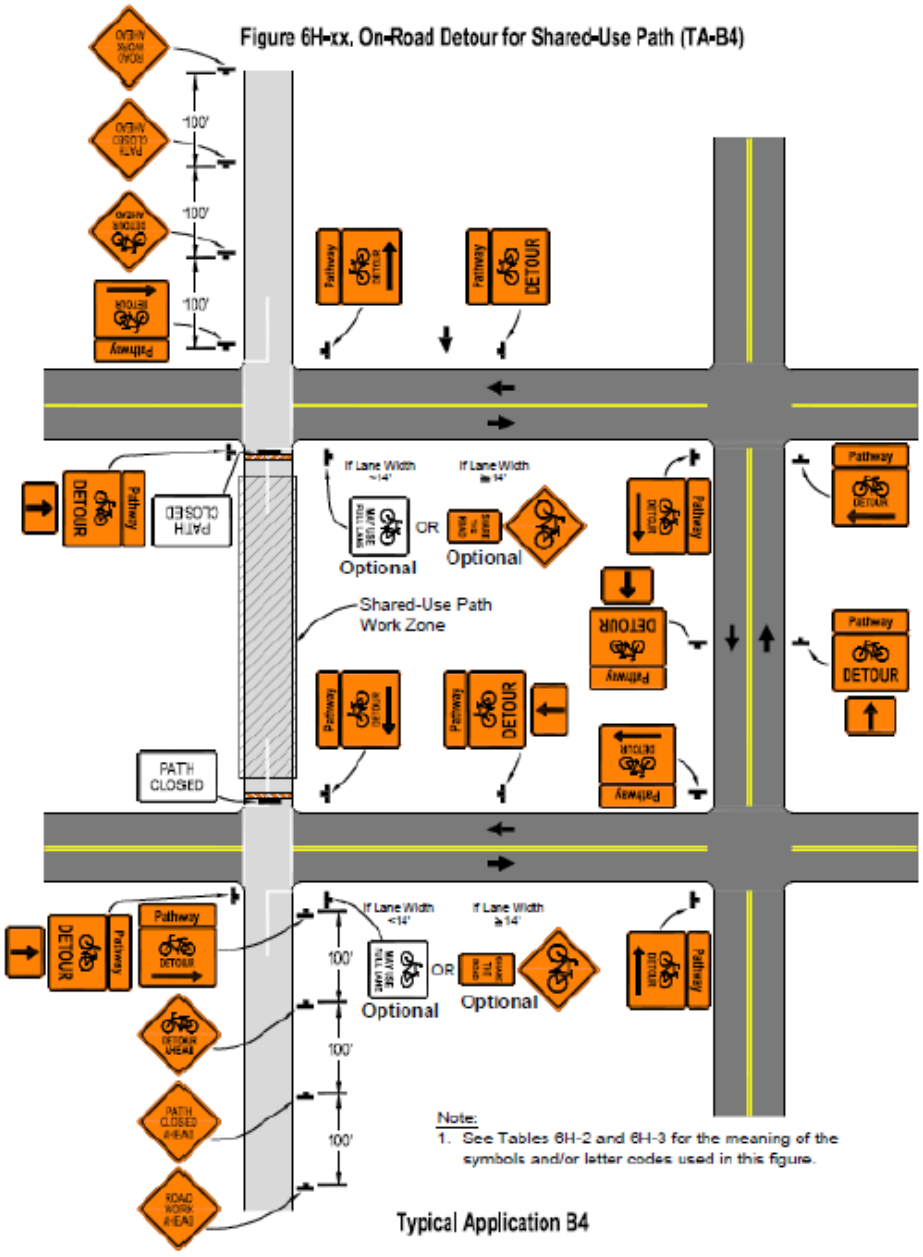
1. See Table 6H-3 Meaning of Letter Codes of the MUTCD for the distances A, B and C between signs.
2. If the posted speed limit is ≤ 40 mph, and the outside through travel lane is < 14 feet wide, then Bicycles May Use Full Lane (R4-11) signs should be used.
3. If the posted speed limit is ≤ 40 mph, and 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.
4. 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 be placed above the Bike Detour sign. The Street Name sign or Bike Route Name sign may be either white on green or black on orange.

Figure 11 – 8 Shared Use Path Closure with a Diversion[KM32]



Notes:
1. See MUTCD Table 6H-2 Meaning of Symbols on Typical Application Diagrams.

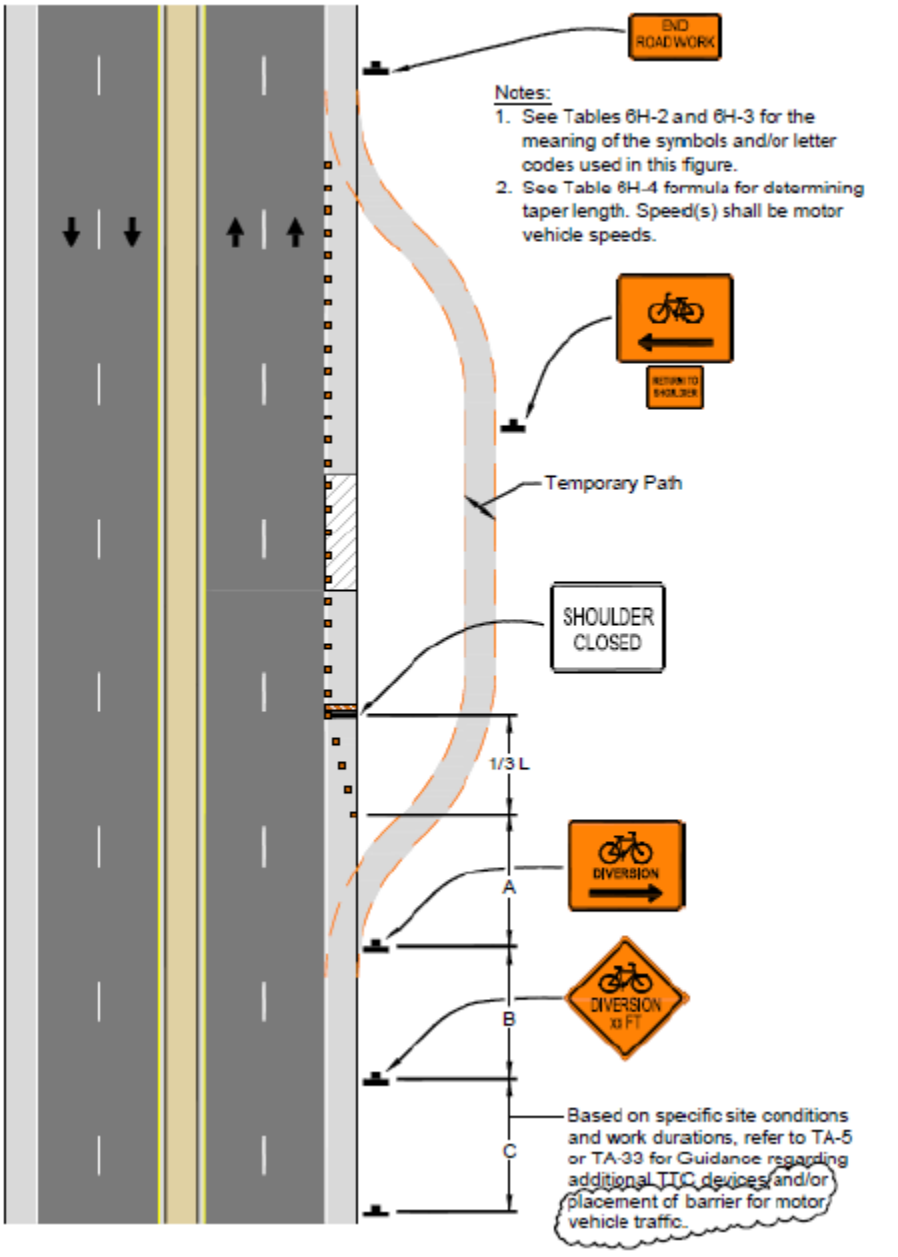
Figure 11 – 9 On-Road Detour for Shared Use Path[KM33]



Notes:

1. See MUTCD Table 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[KM34]



EF TRANSPORTATION OPERATIONS PLAN WORK ZONE MANAGEMENT[KM35][KM36]

The Transportation Operations Plan (TOP) addresses operations and management of the transportation system in the work zone impact area. RoadworkManagement of construction, maintenance and emergency response operations shall supportfollow thean appropriate TTCPtemporary traffic control plan.

F.1 Public Information

All reasonable effort should be made to inform the public of the location, duration, and nature of impending roadwork operations. Transit agencies should be given advanced notice of planned operations so they can be responsible for notifying their passengers.

EF.12 Contracts and Permits

For construction and reconstruction projects, tThe[KM37] general work zone layout; planned detours, traffic control and protection procedures; occupational safety and health requirements; and specific traffic control devices required should be incorporated in the contract plans and specifications.

E.1.a Utilities

New utility installations in public rights of way are prohibited unless a permit by the appropriate highway agency with jurisdiction over the facility is issued. Permits for routine maintenance (e.g., deteriorated pole/equipment replacement), minor alterations (e.g., changes in cable, wire, or transformer size), service drops, or emergency work will be determined by the agency with jurisdiction over the facilityshould generally not be required. ***Occupational Safety and Health Administration (OSHA)*** regulations for work zone safety should be reviewed prior to any construction by utility companies involving encroachment intoof the transportation facility highway right of way by workers, equipmentequipment, or material.

E.1.b Wildlife Sensitive Lighting

If lighting is provided in a work zone along coastal roadways where sea turtles may be affected, incorporate the following for temporary lighting of work zone operations[KM38]:

- Direct all work zone lighting away from the beach to avoid illumination of or direct visibility from the beach.

- Shield luminaires to avoid lighting areas outside of the immediate construction area

2nd Option:

If lighting is provided in a work zone along coastal roadways where sea turtles may be affected, see ***Section J*** of ***Chapter 6* – Lighting** for requirements and further information. In addition to the resources in ***Chapter 6***, coordinate with the local agencies for additional guidance with providing lighting in work zones.incorporate the following for temporary lighting of work zone operations[KM39][KM40]:

EF.23 Inspection and Supervision

A regular program of inspection and supervision of all construction and maintenance projects shall be established and executed.

F PUBLIC INFORMATION PLAN[KM41]

During construction, the Public Involvement Plan (PIP) serves a public information role, informing people about work zone limits, sidewalk, shared use path or travel lane closures, median changes, detours, business access impacts, work hours, and grand openings. A major function is to provide up-to-date information and solicit concerns in order to minimize the disruption to residents, businesses and the traveling public during the construction phase.

Some agencies may hold pre-construction open houses, which can either be formal meetings held in enclosed spaces or informal activities conducted within the project corridor.

Below is a summary of activities which could be included in a PIP:

- Determine need for a project specific public information officer (prior to scope for construction engineering and inspection)
- Handoff meeting from design to construction (after letting)
- Mass mailing of project information flyer/brochure (two to four weeks prior to construction)
- Project information meeting/open house (two to four weeks prior to construction)
- Presentations to other local governments, community groups, or general public as needed
- Construction notices included in weekly traffic report (one week prior and throughout construction)

In addition to traditional public information meetings, some projects may benefit from other methods such as one-on-one meetings, an up-to-date project website, and social media. Variable message signs (VMS) are routinely used to communicate lane closures and changes in access.

All reasonable effort should be made to inform the public of the location, duration, and nature of impending work. Transit agencies should be given advance notice of planned operations so they can make adjustments in service or routes if needed, and coordinate with passengers.

G EVALUATION OF PROGRAM

The entire program for work zone safety should be periodically evaluated and revised to provide the safest practicable environment for workers, pedestrians, bicyclists and motorists during roadwork operations.

H REFERENCES

CHAPTER 12

CONSTRUCTION

CHAPTER 12

CONSTRUCTION[KM1][KM2][KM3]

A INTRODUCTION

The purpose of this chapter is to establish guidelines for field procedures, as they pertain to control of construction projects, supervision, and contract administration. All construction projects require an inspection process to administer the contract, to certify the project has been constructed within reasonable conformance with the plans/specifications, and the 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 a Professional Engineer registered in the State of Florida that develops the criteria and concept for the project, performs the analysis, and is responsible for the preparation of the Plans and Specifications. The Maintaining Authority's Engineer of Record may be in-house staff or a consultant.

The Construction Engineer (CE) is a Professional Engineer registered in the State of Florida that supervises the construction of the project. The Maintaining Authority's Construction Engineer or Designee may assign in-house staff or a consultant to act on their behalf.

B OBJECTIVES

Construction of street and highway facilities is the result of the effort~~,~~ of the engineer~~(s)~~, the contractor, and the owner. Minimum construction standards shall be followed to provide for proper implementation of the design. The following general objectives for roadway construction should be followed to ensure proper construction:

- All construction performed and all materials utilized shall be in reasonably close conformity with the construction plans and contract documents.

- The responsibilities and obligations of the owner, engineer~~(s)~~, and contractor should be clearly defined.
- A safe working environment shall be provided in accordance with ***Chapter 11 – Work Zone Safety***.
- Adequate 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

The Contractor will be furnished an appropriate number of copies of the plans and special provisions as required for the particular project. The Contractor shall have available at the work site, 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 show, in general, alignment, profile grades, typical cross sections, and general cross sections as necessary. Structure plans, in general, will show in detail all dimensions of the work contemplated.

C.1.b Alterations in Plans

No changes shall be made on any plan or drawing after it is approved by the ~~Engineer of Record (~~EOR~~)~~, except as authorized in writing by the[KM4][KM5] ~~(~~EOR~~)ngineer~~.

All authorized alterations affecting the requirements and information given on the approved plans shall be in writing.

C.1.c Working Drawings (for Structures)

C.1.c.1 General

The Contractor shall furnish such working, shop, and erection drawings, as may be required, to complete the structure in compliance with the design shown on the plans.

C.1.c.2 Submission of Working, Shop, and Erection Drawings

All 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 submission to the EOR~~Engineer of Record~~ for review. The Contractor's signed approval of drawings submitted shall confirm he/she has verified the work requirements, field measurements, construction criteria, sequence of assembly and erection, access and clearances, catalog numbers, and other similar data. Each series of drawings shall indicate the specification section and page or drawing number of the contract plans to which the submission applies. The Contractor shall indicate on the working, shop, and erections drawings all deviations from the contract drawings and shall itemize all deviations in his letter of transmittal.

C.1.c.3 Responsibility for Accuracy of Working Drawings

It is understood that approval by the EOR~~Engineer~~ of the Contractor's working drawings does not relieve the Contractor of any responsibility for accuracy of dimensions and details, or for conformity of dimensions and details. The Contractor shall be responsible for agreement and conformity of his working drawings with the approved plans and specifications.

C.2 Coordination of Plans, Specifications, and Special Provisions

The specifications, plans, special provisions, and all supplemental documents are integral parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are to be complementary and to describe and provide for a complete work.

In cases of discrepancy, the governing order of the documents shall be as follows:

- Special Provisions
- Plans
- Standard Drawings
- Specifications

C.3 Conformity of Work with Plans

All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions, and material requirements, including tolerances, shown on the plans or indicated in the specifications.

In the event the CE ~~Construction Engineer~~ [KM6]~~)~~ 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, the CE~~Engineer~~ will document the basis of acceptance by contract modification which will provide for 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~~Engineer~~ finds the materials, or the finished product in which the materials are used, or the work performed, are not in reasonably close conformity with the plans and specifications and have resulted in an inferior or unsatisfactory product, 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 be accomplished in accordance with special conditions of the regulatory permits.

C.5 Authority of the Construction Engineer[KM7]

All work shall be performed to the satisfaction of the CE~~Engineer~~.

C.6 Engineering and Layout

C.6.a Control Points Furnished

Horizontal and vertical control points are required at appropriate intervals along the line of the project to facilitate the proper layout of the work. The Contractor shall preserve all control points furnished.

C.6.b Layout of Work

Utilizing the control points furnished, all horizontal and vertical controls shall be established as necessary to construct the work in conformance with the plans and specifications. The work shall include performing all calculations required and setting all stakes needed, such as grade stakes, offset stakes, reference point stakes, slope stakes, and other reference marks or 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 Contractor shall employ only competent personnel and utilize only suitable equipment in performing layout work.

Adequate field notes and records shall be kept as layout work is accomplished. These field notes and records shall be available for review by the CE~~Engineer~~ as the work progresses and copies shall be furnished to the CE~~Engineer~~ at the time of completion of the project. Any inspection or checking of the Contractor's field notes or layout work by the CE~~Engineer~~, and the acceptance of all or any part thereof, shall not relieve the Contractor of his responsibility to achieve the lines, grades, and dimensions shown in the plans and specifications.

C.7 Contractor's Supervision

C.7.a Prosecution of Work

The Contractor shall give the work the constant attention necessary to assure the scheduled progress and shall cooperate fully with the CE~~Engineer~~ and with other contractors at work in the vicinity.

C.7.b Contractor's Superintendent

The Contractor shall at all times have on the work site, as his/her agent, a competent superintendent capable of thoroughly interpreting the plans and specifications and thoroughly experienced in the type of work being performed, and who shall receive the instructions from the CE~~Engineer~~ or his/her authorized representatives. The superintendent shall have full

authority to execute the orders or directions of the CE~~Engineer~~ and to supply promptly any materials, tools, equipment, labor, and incidentals which may be required. Such superintendence shall be furnished regardless of the amount of work sublet.

C.7.c Supervision for Emergencies

The Contractor shall have a responsible person available at or reasonably near the work site on a twenty-four hour basis, seven days a week, in order that he/she may be contacted in emergencies and in cases where immediate action must be taken to maintain traffic or to handle any other problems that might arise. The Contractor shall be responsible for initiating, installing, and maintaining all traffic control devices as described in ***Chapter 11 – Work Zone Safety*** and in the plans.

C.8 General Inspection Requirements

C.8.a Cooperation by Contractor

No work shall be done nor materials used without suitable supervision or inspection by the CE~~Engineer~~. The Contractor shall furnish the CE~~Engineer~~ with every reasonable facility for ascertaining whether the work performed and materials used are in accordance 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~~Engineer~~ should fail to reject defective work or materials, whether from lack of discovery of such defect or for any reason, such initial failure to reject shall in no way prevent his/her later rejection when such defect is discovered.

C.8.c Qualifications of the Construction Engineer for State Funded Projects

For projects administered by a local government that are wholly or partially funded by the Florida Dept. of Transportation, there are limitations on who may perform design and construction engineering and inspection services.

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 Contractor shall maintain all work in first-class condition until it has been completed as a whole and has been accepted by the CE~~Engineer~~. When all materials have been furnished, all work has been performed, and the construction contemplated by the contract has been satisfactorily completed, the CE~~Engineer~~ will make the final inspection.

D CONTROL OF MATERIALS

D.1 Source of Supply and Quality Requirements

D.1.a Only Approved Materials to be Used

Only materials conforming to the requirements of the specifications and approved by the Engineer shall be used in the work. Any materials proposed for use may be inspected or tested at any time during their preparation and use. No material which, after approval, has in any way become unfit for use, shall be used in the work.

D.2 Inspection and Tests at Source of Supply

D.2.a General

The CE~~Engineer~~ may undertake the inspection of materials at the source of supply.

D.2.b Cooperation by Contractor

The Contractor shall assure the CE~~Engineer~~ has free entry at all times to such parts of the plant as concern the manufacture or production of the materials ordered, and shall bear all costs incurred in providing all reasonable facilities to assist in determining whether the material furnished complies with the requirements of the specifications.

D.3 Control by Samples and Tests

D.3.a Materials to be Tested, Samples

The CE~~Engineer~~ may require any or all materials to be subjected to tests by means of samples or otherwise, at production points, after delivery, or both, as he/she may determine.

D.3.b Applicable Standards

Methods of sampling and testing materials shall conform to the CE~~Engineer~~'s requirements and should be in accordance with ***Florida Sampling and Testing Methods (FSTM)*** so far as covered therein. Otherwise, they should be in accordance with Standards of AASHTO, ASTM, or other criteria as specifically designated by the CE~~Engineer~~. Where an AASHTO, ASTM, or other non-Florida Method is designated, but a Florida Method which is similar exists, sampling and testing should be in accordance with the Florida Method.

Whenever in these Specifications, FSTM, AASHTO, ASTM, or 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 Contractor shall furnish and maintain a quality control system that will provide reasonable assurance that all materials and products submitted for acceptance conform to the contract requirements, whether manufactured or processed by the Contractor or procured from suppliers or subcontractors. The Contractor shall perform or have performed the inspection and tests required to substantiate product conformance to contract requirements and shall also perform or have performed all inspections and tests otherwise required by the contract.

D.4.b Documentation

The Contractor shall maintain adequate records of all inspections and tests. The records shall indicate the nature and number of tests made, the number and type of deficiencies found, the quantities approved and rejected, and the nature of corrective action taken, as appropriate.

D.4.c Corrective Actions

The Contractor shall 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 conform to the requirements of the specifications.

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 13

PUBLIC TRANSIT

FIGURES

CHAPTER 13

PUBLIC TRANSIT

A INTRODUCTION

All modes of transportation (autos, trucks, transit vehicles, rails, aircraft, water craft, bicyclists, and pedestrians) should be considered when planning, designing, and constructing the surface transportation system. Where there is a demand for highways to serve vehicles, there could also be a demand for public transit or public transportation. Public transit should be considered in all phases of a project, including planning, preliminary design and engineering, design, construction, and maintenance. Coordination with the appropriate public transit provider(s) will help determine the need for transit related infrastructure on a project-by-project basis. The integration of public transit street side facilities along with pedestrian and bicycle facilities furthers the implementation of this goal.

Planning and designing for 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 includes bus, light rail, street cars, bus rapid transit and paratransit.

With rising levels of congestion resulting in the use of new strategies to effectively and efficiently manage mobility, 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 Transportation Demand Management (TDM). TSM is the use of low cost capital improvements to increase the efficiency of roadways and transit services such as~~,~~ retiming traffic signals or predestinating traffic flow. TDM focuses on people reducing the number of personal vehicle trips, especially during peak periods. TDM includes the promotion of alternatives to the single occupant vehicle, including public transportation, carpooling, vanpooling, bicycling, walking, and telecommuting, as well as other methods for reducing peak hour travel.

Federal and State legislation provide the stimulus for planning, designing, and constructing a fully integrated transportation system benefiting the traveling public and

the environment. Examples of legislation include ~~the~~ ***Fixing America's Surface Transportation Act (FAST Act)***, ~~The~~ ***Americans with Disabilities Act of 1990 (ADA)***, and ~~The~~ ***Clean Air Act Amendment of 1990 (CAAA)***. In response to this legislation, the surface transportation system should provide for concurrent use by automobiles, public transit and rail, bicycles and pedestrians.

B OBJECTIVE

There are a number of methods to efficiently develop a coordinated surface transportation system. Coordination among agencies is necessary during the planning and design stages to:

- incorporate transit needs and during the construction phase for re-routing bus (and complementary pedestrian) movements, and
- for actual transit agency specific requirements (e.g., bus stop sign replacement, shelter installations, etc.).

For planning purposes, the state and local Transportation Improvement Program (TIP) should be referenced. Additionally, individual transit authorities have ten-year Transit Development Plans (TDPs) that are updated annually. The TDP can be used as a guide for planned transit needs along existing and new transportation corridors so transit consideration and transit enhancements can be incorporated where appropriate.

C TRANSIT COMPONENTS

C.1 Boarding and Alighting (B&A) Areas ~~Stops and Station Areas~~

Boarding and Alighting (B&A) areas help to create an accessible bus stop by providing a raised platform that is compatible with a bus that kneels or extends a ramp. A B&A area has a firm, stable and slip-resistant surface with a minimum clear length of 8.0 feet (measured perpendicular to the curb or roadway edge), and a minimum clear width of 5.0 feet (measured parallel to the roadway). Firm, stable, and slip resistant B&A areas are required if amenities such as benches or shelters are added to a bus stop. B&A areas are not required at bus stops on 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 parallel to the roadway shall to the extent practicable, be the same as the roadway. For water drainage, a maximum slope of 1:50 (2%) perpendicular to the roadway is allowed. Benches and other site amenities shall not be placed on the B&A area. The B&A area can be located either within or outside the shelter, and shall be connected to streets, sidewalks, or pedestrian circulation paths by an accessible route.

On flush shoulder roadways, a B&A area may be constructed at the shoulder point (or edge of shoulder pavement on roadways with a design speed of 45 mph or less) as shown in Figures 13 – 1 and 13 – 2 Boarding and Alighting Area for Flush Shoulder Roadways. A Type “E” curb (5” curb height) should be used.

A sidewalk and/or ramp provided with the B&A area shall be a minimum of 5 feet in width, and the ramp shall not exceed a slope of 1:12. A detectable warning is required where a sidewalk associated with a B&A area connects to the roadway at grade. Except for the area adjacent to the 5” curb, the areas surrounding the B&A area shall be flush with the adjacent shoulder and side slopes and designed to be traversable by errant vehicles. On the upstream side of the platform, a maximum slope of 1:12 should be provided, and may be grass or a hardened surface. The B&A area (and ramp and level landing if needed) should be constructed with 6” thick concrete.

Figure 13 – 1 Boarding and Alighting Area for Flush Shoulder Roadways with Connection to the Roadway

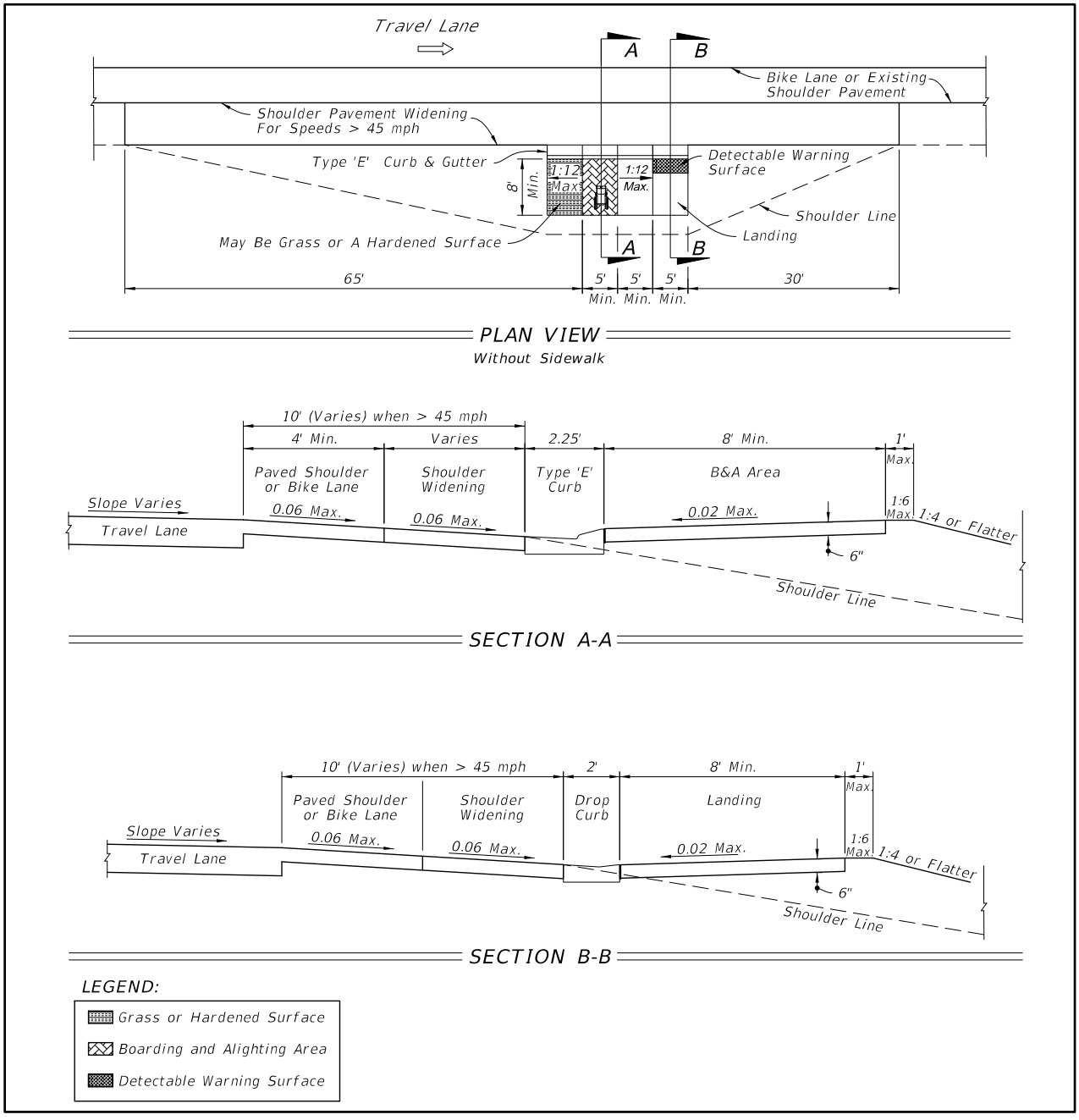
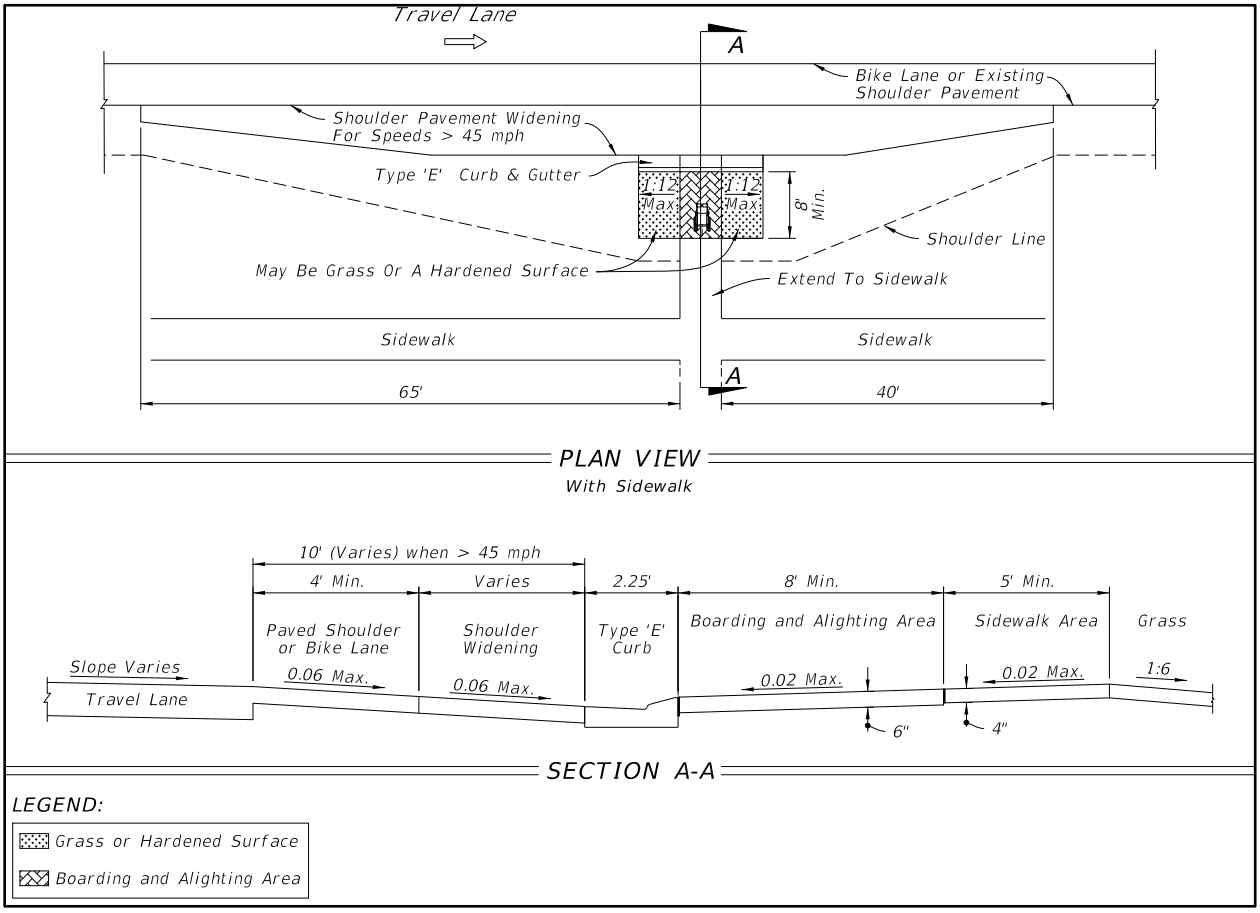


Figure 13 – 2 Boarding and Alighting Area for Flush Shoulder Roadways with Connection to the Sidewalk

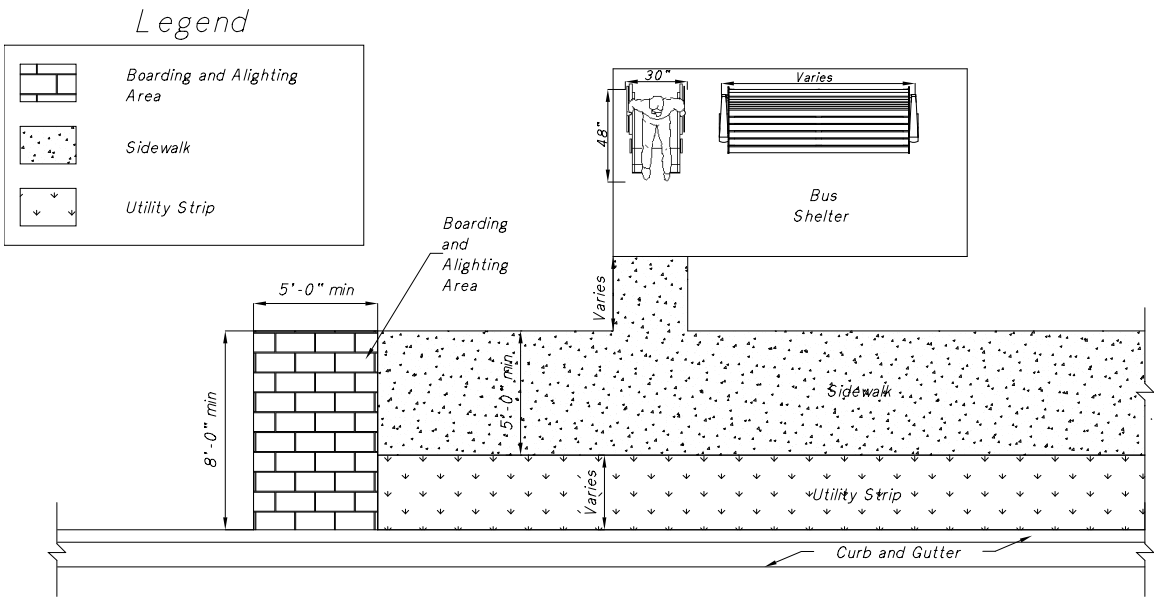


C.2 Shelters

Every public transit system has different needs with regards to shelters and corresponding amenities (e.g., benches, information kiosks, leaning posts, trash receptacles, etc.). Shelter foundation and associated pad size vary from stop to stop based on right of way availability, line of sight, and facility usage. New 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 a minimum clear floor area of 30 inches by 48 inches, entirely within the perimeter of the shelter.

Shelters shall be connected by an accessible route to a B&A area. Coordinate with the appropriate public transit provider(s). Where feasible, shelters should provide a location for a bicycle rack. Shelters should be installed at locations where demand warrants installation and in accordance with clear zone criteria in ***Chapter 3 – Geometric Design, Section C.10.e*** Bus Benches and Transit Shelters and Chapter 4 – Roadside Design, Table 4~~3~~ – 1~~5~~ Minimum Width of Clear Zone of this Manual.

Figure 13 – 3 Bus Shelter Location



C.3 Benches

If a bench is provided, it should be on an accessible route, out of the path of travel on a sidewalk. Benches shall have an adjacent firm, stable and slip-resistant surface at least 30 inches wide and 48 inches deep to allow a user of a wheelchair to sit next to the bench, permitting the user shoulder-to-shoulder seating with a companion. Connection between the bench, sidewalk and/or bus B&A area shall be provided. Coordinate with the local public transit provider(s).

C.4 Stops and Station Areas

Transit stops should be located so that there is a level and stable surface for boarding vehicles. Locating transit stops at signalized intersections increases the usability for pedestrians with disabilities.

C.5 Bus Bays (Pullout or Turnout Bays)

Bus bays for transit vehicles may be necessary (e.g., extended dwell time, layover needs, safety reasons, high volumes or speed of traffic.). Bus bays can be designed for one or more buses. Coordinate with the local public transit provider(s) to determine the need for bus bays. When possible, bus bays should be located on the far side of a signalized intersection. The traffic signal will create the critical gap needed for bus re-entry into traffic. There are several publications available which provide additional design information for transit system applications. The Department District Public Transportation Office(s) maintains a library of these publications.

D PUBLIC TRANSIT FACILITIES

When a project includes a public transit route, curb-side and street-side transit facilities for bus stops should be considered in the roadway design process. Transit facilities shall comply with ***Chapter 14-20, Florida Administrative Code***.

~~Following is a link to the code~~https://www.flrules.org/gateway/ChapterHome.asp?Chapter=14-20

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. These include bus stop signs, shelters, bus stop B&A areas, benches, bike racks, leaning rails, and shelter lighting. "Accessing Transit" provides additional details and guidelines for each type of transit facility. Coordinate with the appropriate public transit provider(s) to determine the appropriate type and placement of amenities.

D.2 Street-Side Facilities

Bus stop locations can be categorized as far side, near side and mid-block stops. Bus stops may be designed with a bus bay or pullout to allow buses to pick up and discharge passengers in an area outside of the travel lane. This design feature allows traffic to flow freely without the obstruction of stopped buses. Far side bus stops and bays are preferred. See ***Accessing Transit, Version 3 (2013)*** and ***Accessing Transit Updates (2017)*** for a more detailed discussion of the location of the bus stop or bay.

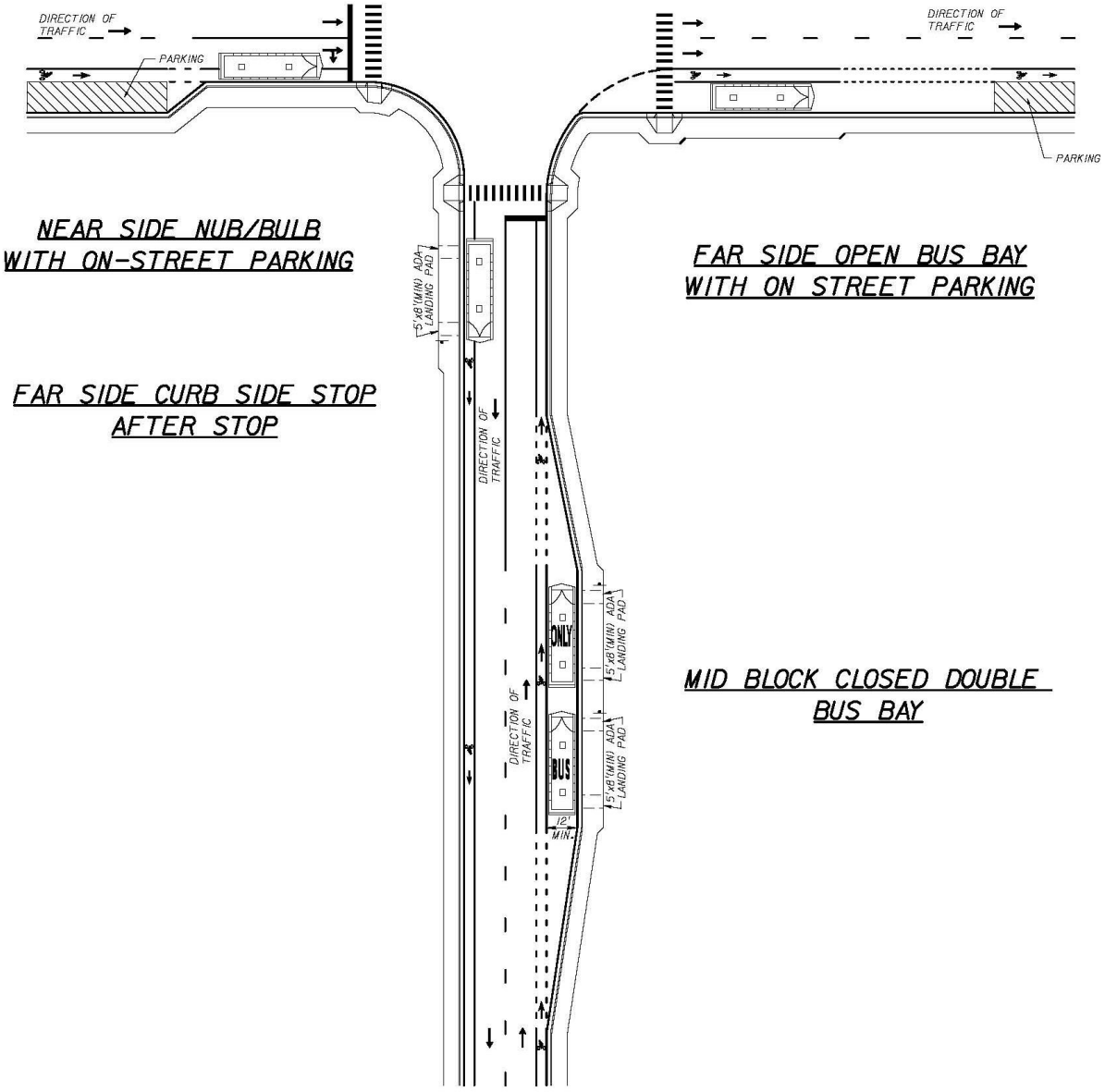
Bus bays can be closed-ended, open-ended, or nubs/bulbs, and can be positioned near-side, far-side, or mid-block in relation to an intersection, as illustrated in Figure 13 – 3 Bus Shelter Location. The total length of the bus bay should allow room for an entrance taper, a stopping area, and an exit taper as a minimum. However, in some cases it may be appropriate to consider providing acceleration and deceleration lanes depending on the volume and speed of the through traffic. This decision should be based upon site specific conditions. "Accessing Transit"

provides detailed bus bay dimensions for consideration with various right of way and access conditions.

D.3 Bus Stop Lighting

Lighting design for bus stops should meet the same criteria for minimum illumination levels, uniformity ratios and max-to-min ratios that are being applied to the adjoining roadway based on ***Chapter 6 – Lighting*** of this Manual. If lighting is not provided for the adjoining roadway, coordinate with the transit agency to determine if 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 the bus bay pavement area. The use of solar panel lighting for bus stops is another option that should be considered.

Figure 13 – 4 Bus Stop Locations



E REFERENCES FOR INFORMATIONAL PURPOSES~~FOR INFORMATIONAL PURPOSES~~

The following is a list of publications that may be referenced for further guidance:

- FDOT's ~~2013~~ Accessing Transit, Design Handbook for Florida Bus Passenger Facilities, Version III, 2013
  http://www.fdot.gov/transit/

  ~~http://www.dot.state.fl.us/transit/Pages/NewTransitFacilitiesDesign.shtm~~

- 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
  http://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

THIS PAGE INTENTIONALLY LEFT BLANK

- ~~"Transit Vehicles and Facilities on Streets and Highways", from Transit Cooperative Research Program (TCRP) of the Transportation Research Board of the National Research Council January 2007~~

CHAPTER 14

DESIGN EXCEPTIONS AND VARIATIONS

EXHIBITS

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 14

DESIGN EXCEPTIONS AND VARIATIONS

A GENERAL

Uniform minimum standards for design, construction, and maintenance ~~of~~ for streets and highways are contained in this Manual and meet or exceed the minimum values established by AASHTO. Consequently, the values given govern the design process. When it becomes necessary to deviate from the Manual's criteria, early documentation and approval are required.

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.

The 10 Controlling Design Elements for high speed (Design Speed ≥ 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 (Design Speed < 50 mph) roadways are:

- Design Speed
- Design Loading Structural Capacity

~~Documentation in the form of a Design Exception is required whenever any of the following 10 Controlling Elements, as identified by FHWA, cannot be met:~~

~~1. Design Speed (DS)~~

~~2. Lane Width (LW)~~

~~3. Shoulder Width (SW)~~

~~4. Horizontal Curve Radius (HCR)~~

~~5. Superelevation Rate (SR)~~

~~6. Stopping Sight Distance (SSD)~~

~~7. Maximum Grades (MG)~~

~~8. Cross Slope (CS)~~

~~Vertical Clearance (VC)~~

~~Design Loading Structural Capacityy (DLSC)~~

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.

~~Design Exceptions are required when any of the Manual's criteria for the 13 controlling Design Elements listed in Section B cannot be met.~~ This chapter provides the process for documentation and approval of Design Exceptions and Variations. ~~When the Manual's criteria are met, no Design Exception is required.~~ ~~To expedite the approval of these deviations, it is important that to follow the correct approval process be followed. The design project file should~~The approved Design Exception or Variation submittal should be included in the project file to clearly document the action taken and the approval given.

~~When proposed design elements other than the 13 controlling Design Elements do not meet the criteria contained in this Manual, sufficient detail and justification of such deviations shall be documented by the and provided to the maintaining agency. The level of detail included in the documentation is at the discretion of the maintaining agency.~~

~~B DESIGN EXCEPTIONS~~

~~Design Exceptions are required when any of the Manual's criteria for the 13 controlling Design Elements listed below cannot be met.~~

~~9. Design Speed~~

~~10. Lane Widths~~

~~11. Shoulder Widths~~

~~12. Bridge Widths~~

~~13. Structural Capacity~~

~~14. Vertical Clearance~~

~~15. Grades~~

~~16. Cross Slopes~~

~~17. Superelevation~~

~~18. Horizontal Alignment~~

~~19. Vertical Alignment~~

~~20. Stopping Sight Distance~~

~~21. Horizontal Clearance~~

~~13. Lateral Offset~~

~~Projects that comply with~~ If the county or municipality has adopted by ordinance design criteria for local subdivision roads and/or residential streets ~~adopted by ordinance do not require a compliance with those regulations is an approved~~ Ddesign Eexception or Variation.

B RECOMMENDATIONS FOR ~~AND~~ APPROVAL ~~OF DESIGN EXCEPTIONS~~

Design Exceptions and Variations are recommended by the Professional Engineer responsible for the project design element~~s~~ (Responsible Professional Engineer). ~~A public or private utility may submit to the maintaining authority a completed exception package for work designed by the utility's forces. However, if the design is by others, the Design Exception package must be submitted, signed and sealed by a Professional Engineer licensed in the State of Florida.~~ All Design Exceptions and Variations require approval from the M~~m~~aintaining A~~a~~uthority's ~~(county or municipality) designated~~ Professional Engineer or Designee.~~representative with project oversight or general compliance responsibilities.~~

For additional information on the process to be followed for a D~~Any D~~esign E~~E~~xception or V~~v~~ariation that involves a state facility or located on ~~on~~ the National Highway System (NHS) ~~federal facility~~, please see FDOT~~must be processed through the Department's local district that has jurisdiction over the facility. The District Design Engineer who will then follow the Department's process~~es as specified in Chapter 23 of the Department's ***Design Manual, Chapter 122 Design Exceptions and Design Variations*** ~~*Plans Preparation Manual*~~. This process also includes the requirements for concurrence and approval by FHWA, when needed~~if necessary.

~~A public or private utility may submit to the municipal or county engineer a completed exception package for work designed by the utility's forces. However, if the design is by others, the Design Exception package must be submitted, signed and sealed by a Professional Engineer licensed in the State of Florida. The Department's ***Utility Accommodation Manual*** provides guidance on exceptions with respect to utilities located on state highway rights of way.~~

C COORDINATION ~~OF DESIGN EXCEPTIONS~~

In order to allow time to research alternatives and begin ~~the~~ 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 ~~in the~~during initial design ~~efforts~~.

When the need for a Design Exception or Variation has been determined, the Responsible Professional Engineer must coordinate with the M~~m~~aintaining A~~a~~uthority's Professional Engineer or Designee and FDOT~~the Department~~ (if applicable), to obtain conceptual concurrence ~~providing~~ and provide any ~~required~~ requested documentation. ~~requested.~~

FDOT ~~The Department~~ will be involved only if the proposed design on the local (Non-State Highway System (SHS)) roadway is part of a FDOT~~Department~~ project. For example, a FDOT~~Department~~ project for a roadway on the SHS includes work on the adjacent local roads, or a FDOT~~Department~~ project is exclusively on a local (Non-SHS) roadway. In these cases, the FDOT District Design Engineer will be listed for "concurrence" in the Design Exception or Variation request letter ~~for "concurrence".~~

D JUSTIFICATION FOR APPROVAL~~AND DOCUMENTATION OF DESIGN EXCEPTIONS~~

Sufficient detail and explanation must be given in order for the Maintaining Authority's Professional Engineer or Designee to approve the request for a Design Exception or Variation~~to justify approval to those reviewing the request~~. The 10 Controlling Design Elements are considered to have significant effects on safety ~~related~~ and the strongest case possible must be made if the designer is not able to meet ~~made to lower~~ these requirements. All deviations below ~~from~~ the minimum criteria and standards in this Manual must be uniquely identified, located, and justified.

A strong case can be made if it can be 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 environmental or community needs prohibit meeting criteria.

Most often a case is made by showing the required criteria are impractical and the proposed design wisely balances all design impacts. The impacts required for documentation are:

- Safety and Operational performance
- Level of Service
- Right of Way impacts
- Community impacts
- Environmental impacts
- Costs
- Usability by all modes of transportation
- Long term and cumulative effects on adjacent sections of roadway

A case should not be made based solely on the basis that:

- Money can be saved~~The Department can save money.~~
- Time can be saved~~The Department can save time.~~
- The proposed design is similar to other designs.

E DOCUMENTATION FOR APPROVAL OF DESIGN EXCEPTIONS

Supporting documentation that is generated during the approval process is to accompany each submittal. Design Exceptions should include the following documentation:

1. Submittal/Approval Letter (Example shown in Exhibit 14-A)

2. Project Description:

   a) General project information, location map, existing roadway characteristics, project limits (mileposts), county section number, work mix, objectives, and obstacles.

   b) Associated or future limitations that exist as a result of public or legal commitments.

3. Project Schedule and Lifespan:

   a) Letting date 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) Specific design criteria that will not be met (AASHTO, Florida Greenbook) and a detailed explanation of why the criteria or standard cannot be complied with or is not applicable.

   b) Proposed value for the project or location and why it is appropriate.

   c) Plan view, plan sheet, or aerial photo of the location, showing right of way lines and parcel lines of adjacent property.

   d) Photo of the area of the deficiency.

   e) Typical section or cross-section.

   f) Milepost or station location.

5. Alternative Designs Considered:

   a) Meeting AASHTO or Florida Greenbook criteria, partial correction, and the no-build (existing) condition.

6. Impacts of the Exception:

a) Safety Performance:

• Anticipated impact on safety, long and short term effects and of any anticipated cumulative effects.

• Summary of the most recent 5-year crash history including any pertinent crash reports.

b) Operational Performance:

• Description of the anticipated impact on operations (long and short term effects) and any anticipated cumulative effects.

• Summary of the amount and character of traffic using the facility.

• Compatibility of the design with adjacent sections of roadway.

• Effects on capacity and Level of Service (proposed criteria vs. AASHTO)

c) Right-of-way

d) Community

e) Environment

f) Usability by all modes of transportation

7. Anticipated Costs:

a) Description of the anticipated costs (design, 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

~~The objective of the justification of A Design Exception's justification is to demonstrates that the impacts on the operation and safety of the facility are acceptable as compared to the impacts and added benefits of meeting the criteria. All Design Exception requests shall include documentation sufficient to justify the request and independently evaluate the operational and safety impacts.~~

When preparing a Design Exception, the Responsible Professional Engineer should consider potential mitigation strategies that may reduce the adverse impacts to highway safety and traffic operations. Please refer to t~~T~~he ***FHWA Mitigation Strategies for Design Exceptions (July 2007)*** for ~~provides the following~~ examples of mitigation strategies.~~:~~ The ***Highway Safety Manual (HSM)*** and ***Highway Capacity Manual*** provide information on quantifying and evaluating highway safety performance.

~~Provide advance notice to the driver of the condition.~~

~~Enhance the design of another geometric element to compensate for a potentially adverse action.~~

~~Implement features designed to lessen the severity of an incident or action.~~

~~Any request for a Design Exception request for a controlling design element should address the following issues applicable to the element in question:~~

~~Description:~~

~~a) Project description (general information, typical section, etc.)~~

~~b) Description of Design Exception (specific project conditions related to the Design Exception, controlling design element, acceptable Manual valuedesign criteria, and proposed value for project)~~

~~c) The cCompatibility of the design and operation with the adjacent sections~~

~~Operational Impacts:~~

~~a) Amount and character of traffic using facility~~

~~b) Effect on capacity of the deviation (proposed criteria vs. Manual design criteria using an acceptable capacity analysis procedure and calculatete determine the reduction for design year, level of service)~~

~~Safety Impacts:~~

~~a) Crash history and analysis from most recent 5 years (location, type, severity, relation possibly attributable to the Design Exception element)~~

~~b) Impacts associated with proposed criteria (annualized value of expected economic loss associated with crashes)~~

Benefit/Cost Analysis:

Calculate a benefit/cost analysis which estimates the cost effectiveness of correcting or mitigating a substandard design ~~feature~~element. The "benefit" is the expected reduction in future crash costs and the "cost" is the direct construction and maintenance costs associated with the design. These costs are calculated and annualized so that direct comparison of alternate designs can be made.

A benefit/cost ratio equal to or greater than 1.0 indicates it may be cost effective to implement a particular design; however, the final decision is a management decision which considers all factors and applies sound engineering judgement. K~~T~~he ~~k~~ey factors in the analysis are:

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 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

~~g) Period of time over which the benefits will be realized~~

NOTE: ~~Chapter 2 of the AASHTO Roadside Design Guide and the FHWA Technical Advisory titled "Motor Vehicle Accident Costs" dated October 31, 1994. Volume 1, Chapter 23 of~~ The FDOT~~Department's~~ ***Design Manual, Chapter 122 Design Exceptions and Design Variations*** ~~Plans Preparation Manual~~ provides guidance for the benefit/cost analysis, and may be used~~considered~~. FDOT~~The Department~~ provides a useful tool, called ***Benefit Cost Analysis Spreadsheet Tool*** (BCAnalysis.xlsm), to aid in determining the benefit/cost ratio ~~that is available at the following website: http://www.dot.state.fl.us/rddesign/QA/Tools.shtm~~.

Conclusion and Recommendation:

a) The cumulative effect of other deviations from design criteria

b) Safety mitigating measures considered and provided

c) Summarize specific course of action

F DOCUMENTATION FOR APPROVAL OF DESIGN VARIATIONS

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. The documentation, submittal and approval requirements for Design Variations are similar to that for Design Exceptions described in this chapter.

Design Variations 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 or justifies the request.

G FINAL PROCESSING OF DESIGN EXCEPTIONS AND VARIATIONS

After receiving conceptual approval ~~has been obtained~~ from the designated Professional Engineer representative of the municipality or county,~~maintaining authority's designee~~ and the documentation justifying the Design Exception or Variation shall be ~~is~~ signed and sealed by the Responsible Professional Engineer and delivered to the municipality or county.~~ and forwarded the submittal as per the sample request letter.~~ ***Exhibit****~~EXHIBIT~~* ***14 -~~ A~~ Sample Request Letter for Design Exception or Variation*** provides an example of an appropriate format and should be included with the signed and sealed supporting documents.~~ to the maintaining authority's designated Professional Engineer.~~ The Design Exception or Variation will be reviewed for completeness and adherence to the requirements of ~~Sections D and E of~~ this Chapter.

If the Design Exception satisfies all requirements, the acknowledgment of receipt ~~approval~~ will be signed by the M~~m~~aintaining A~~a~~uthority's designated Professional~~Professional~~ Engineer or Designee,~~.~~ and, if applicable, forwarded to FDOT's~~the Department's~~ District Design Engineer for concurrence.

When all signatures are obtained, the Design Exception or Variation will be returned to the Responsible Professional Engineer. The original ~~A copy~~ will be retained by the municipality or County~~maintaining agency~~ and a copy kept by FDOT~~the Department~~, if applicable.

Exhibit 14-A Sample Request Letter for Design Exception or Variation

TO: _____ DATE:_____

SUBJECT: ☐ **DESIGN EXCEPTION** or ☐ **DESIGN VARIATION**

Local road number or street name:_____
Project description (limits): _____
Type construction (new, rehabilitation, adding lanes, resurfacing, etc.)_____
Design Speed _____
State and/or Federal road number (if applicable): _____
FDOT Financial Project ID No. (if applicable): _____

DESIGN EXCEPTION OR VARIATION FOR THE FOLLOWING ELEMENT:

( ) Design Sspeed ( ) Stopping Sight Distance~~Lane widths~~ ( ) ~~Shoulder widths~~Other (explain):
( ) ~~Bridge widths~~
( ) Lane Width~~Structural capacity~~ ( ) Maximum Grade~~Vertical clearance~~ _____ (—) ~~Grades~~
( ) ~~Cross slope~~
( ) Shoulder Width~~Superelevation~~ ( ) Cross Slope ~~Horizontal alignment~~ _____ (—) ~~Vertical alignment~~
( ) Horizontal Curve Radius ~~Stopping sight distance~~ ( ) Vertical Clearance~~Horizontal clearance~~~~Lateral Offset~~
( ) Superelevation Rate ( ) Design Loading Structural Capacity

Include a brief statement concerning the project and items of concern.

Attach all supporting documentation to this exhibit in accordance with Chapter 14~~SECTION 14 – ED.~~.

_____

Recommended by:_____
(Responsible Professional Engineer)

Approval:_____
(Maintaining Aauthority's designated Professional Engineer or Designee)

Concurrence:_____
FDOT~~/~~FHWA (if applicable)

~~Concurrence:~~
FHWA (if applicable)

CHAPTER 15

TRAFFIC CALMING

TABLES

FIGURES

CHAPTER 15

TRAFFIC CALMING

A INTRODUCTION

As Florida continues to grow, more and more of the major highways in its communities are becoming congested. This has caused many drivers to seek less crowded local residential streets as alternatives to get to their destinations. In many cases, this has meant the use of local residential streets as bypasses. The increase in traffic intrusion, volume, and speeds on residential streets has degraded the livability standards of various neighborhoods in Florida and as a result many residents complain about their environment (noise, air pollution), livability (quality of life, traffic intrusion, excessive volume, and speed of traffic), safety (as well as safety of their children, pets, and property) and physical characteristics (absence of sidewalks, etc~~.~~). This chapter provides some guidance to Florida roadway planners, designers, and traffic engineers on how to address concerns about maintaining or enhancing the quality of life in residential neighborhoods by balancing the need for safety for all roadway users and adjacent property owners of the street network and maintaining the integrity of the highways networks as a whole.

B PLANNING CRITERIA

Traffic calming is the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior, and improve conditions for non-motorized street users.

Communities undertaking a traffic calming program shall have a procedure for planning which neighborhoods and roadways qualify for participation in the program. Specifics of these methods shall be developed by the local jurisdictions. The methods will likely vary from locality to locality. However, some issues should be addressed in all communities:

- Through the public involvement process, adjacent residents and road users who are impacted by the situation should be included in identifying the concern(s).
- The need for traffic-calming measures should be confirmed by appropriate studies (license plate survey, speed, volume, crash analyses) studied.
- Once the concerns are clearly identified and confirmed by traffic studies, and documented, it will provide the focus for possible solution, prioritizing, and development of appropriate traffic calming measures. It will also help determine the best approach to address the 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 not be the appropriate method in all cases to address vehicle speeds, volumes, and safety. Alternative solutions or educational tools may be considered, as well as coordinated effort with law enforcement.

The application of traffic calming measures should consider possible network and access issues. A system impact analysis should be performed as part of the development process. Vehicular and pedestrian counts, speed data, and crash history of the streets under evaluation should be reviewed. Storm water and environmental impacts also need to be addressed, as well as facility type, urban and rural design factors, and driveway densities.

Design details for each traffic calming measure may vary depending on local conditions. Factors to be considered include both horizontal and vertical deflection, ease of use, emergency vehicle accessibility, ease of maintenance, and facility type. Operational considerations and geometrics are critical factors to consider as well. A list of references and resources to consider in providing more detailed design factors and information can be found at the end of this section. It may be desirable to begin with less restrictive measures and progress to more restrictive ones in stages.

Listed below are some "Do's" and "Don'ts" of the planning process 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 features on site prior to permanent installation will relieve resident anxiety about the impact on their own driving patterns and driving behaviors will adjust to the new route circumstances.
- Have an organized program including public involvement. Plans and policies should be approved and supported by the local government. Emphasize the selected treatments(s) will be initially in a "test" mode, with permanency pending the outcome measurement. Be able to describe what is being done to keep traffic off residential streets.
- Channel public resources by prioritizing traffic calming request according to documentable criteria, setting thresholds of volume, speed, etc., to merit treatment.
- Involve the local service agencies, including fire, police, and emergency medical services personnel, from the start.
- Consult with fire department and EMS personnel to develop the preferred design, particularly with speed humps and traffic circles. Set up traffic circles with cones and have fire trucks and other emergency vehicles drive around them; this will help determine what radius is best for the vehicles used in a given area. The same process can be used in the design of speed humps.
- Review traffic patterns in the neighborhood as a whole. Avoid solving the problem on one neighborhood street by just shifting the traffic to another neighborhood street.
- Consider appropriate landscape treatments as part of the traffic calming design and implementation.

- Make certain that all signing, pavement markings, and channelization is in accordance 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 vehicles, pedestrians, and bicyclists. Sight distance should be consistent with the dimensions shown in ***Chapter 3 – Geometric Design or Chapter 16 – Residential Street Design.***
- Become familiar with the traffic calming features used in other communities and assemble references so that residents can be directed where to see them.
- Decide 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 distance?
- Review the 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 the channelization during the day and night. Is it a clear approach from all directions? Can it be seen at night? Watch the traffic: Is the driving public confused by the signing and channelization? Make adjustments as needed.
- Review the site for utility conflicts. Is there a fire hydrant? Does it need to be moved? Are there existing utilities in the way?
- Check the storm water drainage. Will the storm drain system need to be moved or revised? Can the runoff flow through or around the device?
- Review on-street parking. Will parked cars block the access of emergency vehicles through or around the proposed neighborhood traffic control devices? Add additional no parking zones where needed. Additional enforcement of parking restrictions may be required to keep the traveled path clear.
- Include weekends in traffic counts, as residential streets may have unique travel patterns and high use periods.

Don't do the following:

- Install neighborhood traffic calming features without a well-engineered program supported by the local government and public.
- Install neighborhood traffic calming features on arterial streets (See Section 1.C.2 for a discussion of roadway classifications). Typically, physical devices are not installed on streets with volumes greater than 3,000 vehicles per day, or with posted or operating speeds of greater than 30 MPH.
- 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 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

Unwarranted stop signs should not be used for traffic calming for the following reasons:

- Increase midblock speeds along the street because of drivers trying to make up for lost time
- Increase noise because of quick accelerations and decelerations
- Increase pollution
- Reduce drivers' expectation of a uniform flow
- Relocate the problem
- Cause disrespect for stop signs by drivers and bicyclists

Stop signs shall be used only when warranted per the ***MUTCD***.

C.2 Speed Bumps

Speed bumps shall not be used on public streets. Speed bumps are severe treatments 3 to 6 inches high and 1 to 2 feet long that slow drivers to speeds of less than 10 mph. Due to their abrupt rise and required low speed they can be a hazard to motorists and bicyclists. Speed *humps*, as described in Section D under vertical deflection, should not be confused with speed *bumps*.

C.3 Other Inappropriate Treatments

There are some other treatments that have been shown to be ineffective at reducing the speed and volume of traffic on local roadways. While a temporary improvement 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 may make an infrequent roadway user aware of a specific local population, most regular users of the roadway are unaffected by the signs.

- Odd speed limit - NEIGHBORHOOD SPEED LIMIT 23 MPH and other 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' speeds and should not be used by themselves as traffic calming treatments.
- Bicycle lanes – Standard bicycle lanes are not traffic calming treatments. They can be used to provide space for bicyclists between the sidewalk and travel lanes but 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 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 have high maintenance requirements and can cause severe noise problems. Also, they can be an obstacle to bicyclists.

D APPROPRIATE TRAFFIC CALMING TREATMENTS

The following sections describe some of the available traffic calming strategies. This list is not exhaustive, nor do the treatments necessarily fall exclusively into only one category.

In a typical traffic calming plan various types of treatments will be used. These plans will be based upon neighborhood preferences combined with engineering judgment.

Design details for traffic calming treatments will vary with application. Specific designs will need to be determined based upon the objective of the installations.

D.1 Vertical Treatments

Vertical treatments are those that depend upon a change in vertical alignment to cause drivers to slow down. When properly used, these treatments can be effective in reducing speeds and crashes. However, consideration should be given to impacts on emergency responders, buses, and, to some extent, bicyclists and motorcyclists.

Traffic calming features that alter the vertical alignment should not be installed near fire hydrants or mailboxes.

Information on 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 street.	Slows vehicles entering intersection and improves pedestrian safety.	Increases 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 makes pedestrians more visible.	May 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 to 14 feet long. Comfortable speeds limited to 15 to 20 mph. See Figure 15 - 2.	Reduces speed.	May cause delays for emergency vehicles and impact patient comfort. May 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 cause delays for emergency vehicles and impact patient comfort.	Low
Speed Cushions/ Pillows	Signed speed humps as described above.	Reduces speed.	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

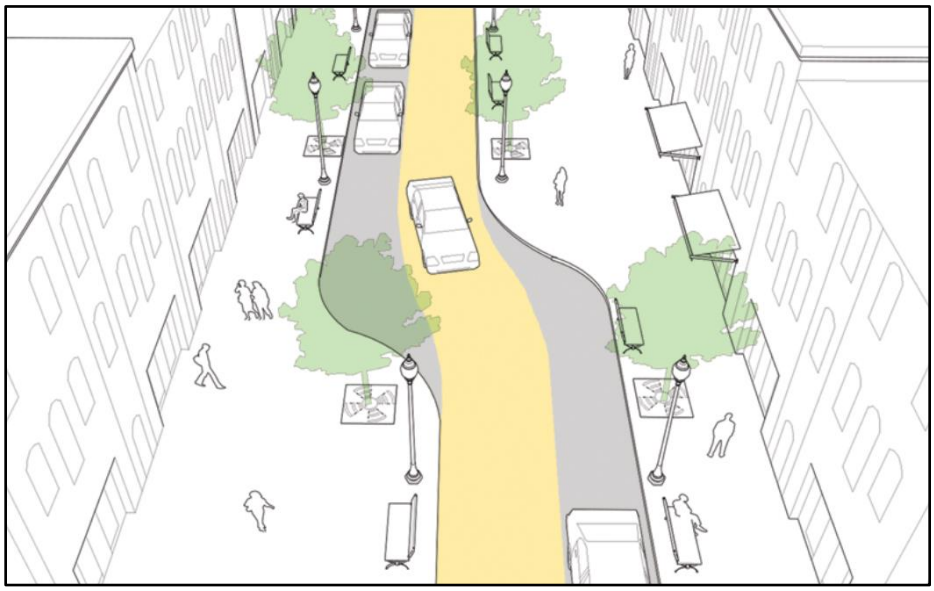
Horizontal deflection treatments are often more expensive than vertical deflection treatments. However, they have less of an impact on emergency responders and large vehicles with multiple axles. They generally do not create problems for bicyclists and motorcyclists. Because pavement area is usually reduced, additional landscaping may be possible, making horizontal deflection treatments useful as part of neighborhood beautification projects.

Information on striping and signing roundabouts can be found in the ***MUTCD***.

Table 15 – 2 Horizontal Treatments

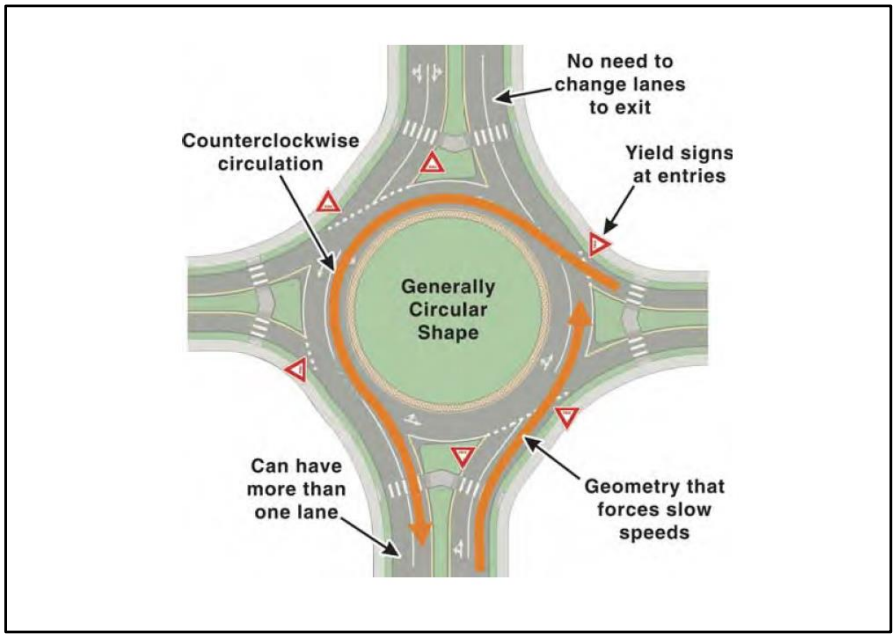
Treatment	Description	Effect	Concerns	Cost
Angled Slow Point	Angled deviation to deter the path of travel so that the street is not a straight line	Reduces speed and pedestrian crossing distance.	Landscaping must be controlled to maintain visibility. Conflicts may occur with opposing drivers.	Medium 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 warrant additional signing and striping to ensure that drivers are aware of a slight bend in the roadway. Increases the area possible 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 have mountable truck apron to accommodate large vehicles.	Reduces speed and both the number and severity of crashes.	May restrict larger vehicles. May cause some confusion when not signed properly. Some communities have documented increased crashes when mini-circles replaced 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 be appropriate at locations as an alternative to a traffic signal. See Figure 15 - 4.	Reduces vehicle speeds and reinforces a change in the driving environment in transition areas.	May require more space at the intersection itself than other intersection treatments. While Roundabouts have 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 be used in conjunction with neighborhood beautification or enhancement projects and residential area identification.

Table 15 – 3 Neighborhood Entry Control

Treatment	Description	Effect	Concerns	Cost
Chokers	Midblock 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 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 impact sight distance, parking, and drainage.	Medium to High
Midblock Median, Slow Point	An island or barrier in the center of a street that separate traffic.	Provides refuge for pedestrians and cyclists.	Landscaping may impede sight distance.	Varies
Lane Narrowing	Street physically narrowed to expand sidewalks and landscaping areas. Could include median, on street parking etc.	Improved pedestrian safety.	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, bike lanes, or on street parking.	Increase maintenance. 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 an island or curbed closure, which prevents certain movements at intersections, and reduces speeds and volumes. By diverting motorists within a neighborhood they can significantly reduce cut through traffic.

Diverters must be planned with care because they will impact the people who live in the neighborhood more than anyone else. Trip lengths increase, creating inconvenience to residents. Emergency responders must also be considered when diverting traffic.

Bicyclists and pedestrians 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 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 vehicles 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 increase volumes on other streets in the area. Access restriction may cause concerns for emergency responders. Additional right of way for proper turnaround at dead ends 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, 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 features, and should be used as supplements.

Table 15 – 5 Other Treatments

Treatment	Description	Effect	Concerns	Cost
Pavement Markings	Highlighting various area of road to increase driver's awareness of certain conditions such as bike lanes or crosswalks. See Figure 15 - 6.	Inexpensive and may reduce speed.	May not be as effective as a structure such as curb.	Low
Traversable Barriers	A barrier placed across any portion of a street that is traversable by pedestrians, bicycles, and emergency vehicles but not motor vehicles.	Eliminates cut-through traffic.	Inconvenience to some residents.	Medium
Colored Bike Lanes or Shoulders	A bike 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 reduce speeds.	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 topics presented in this chapter. Search the Internet Web for up-to-date resources using "traffic+calming" as key words.

- Manual on Uniform Traffic Control Devices, with Revisions 1 and 2, May 2012 (MUTCD). US Department of Transportation, Federal Highway Administration http://mutcd.fhwa.dot.gov/kno_2009r1r2.htm

- 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

- ~~Code of Practice for the Installation of Traffic Control Devices in South Australia, July 2013. Traffic and Operational Standards Section, Department Transportation, P.O. Box. 1, Walkerville, South Australia, 5081. (updated in 2013)~~

- 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

- ~~The Florida Intersection Design Guide. Florida Department of Transportation, http://www.dot.state.fl.us/officeofdesign/publicationslist.shtm~~

- Traffic Calming Measures - Speed Hump, Institute of Transportation Engineers, http://www.ite.org/traffic/

- New York State Supplement (2001) to the Manual of Uniform Traffic Control Devices, 2009. Transportation Planning, Highway Safety, and Traffic Engineering Division, New York State Department of Transportation, 1220 Washington Avenue, Albany, NY 12232-0204. https://www.dot.ny.gov/divisions/operating/oom/transportation-systems/repository/B-2011Supplement-adopted.pdf

- ~~New York State Vehicle & Traffic Law, (latest edition). New York State Department of Motor Vehicles, Swan Street Building, Empire State Plaza, Albany, NY, 12228.~~

- Roundabout Design Guidelines, Supplement to the NCHRP 672 (October 2012). Maryland Department of Transportation, State Highway Administration http://sha.md.gov/OHD2/MDSHA_Roundabout_Guidelines.pdf

- Traffic Control Systems Handbook, Revised Edition, 2005, Federal Highway Administration, DC 20590. (Updated in 2013) http://ops.fhwa.dot.gov/publications/fhwahop06006/

F. REFERENCES FOR INFORMATIONAL PURPOSES

The following is a list of the publications that were used in the preparation of this chapter.

1. *A Guidebook for Residential Traffic Management* WA\RD 368.1, Final Report, December 1994, Savage, J.P. Jr., R.D. MacDonal, J. Ewell. Washington State Department of Transportation, Engineering Publications Room SD3, PO Box 47300, Olympia, WA 98504-7300.

2. *Highway Design Manual*. Plan Sales Unit, Support Services Bureau, New York State Department of Transportation, 1220 Washington Avenue, Albany, NY, 12232-0204. (updated in 2014)

3. ITE Traffic Calming Definition, Lockwood, I.M. In *ITE Journal*, Volume 67, Number 7, July 1997. Institute of Transportation Engineers, 525 School Street, SW, Suite 410, Washington, DC, 20024-2729.

4. *Neighborhood Traffic Management and Calming Program*, City of San Buenaventura, Department of Community Services, Engineering Division, 501 Poli Street, Ventura, C.A, 93001.

5. Supplementary Pedestrian Crossing channelization Devices. TC Werner memo to Regional Traffic Engineers, July 15, 1997, Transportation Planning, Highway Safety and Traffic Engineering Division, NYS Department of Transportation, 1220 Washington Avenue, Albany, N.Y, 12232.

6. *Traffic Calming*, July 1995, Hoyle, C.L., Planning Advisory Service Report Number 456 American Planning Association, Publications Office, 122 S. Michigan Avenue, Suite 1600, Chicago, IL, 60603.

7. *Traffic Calming Guidelines*, 1992, Devon County Council, Engineering and Planning Department, Devon County, Great Britain.

8. *The Traffic Calming Program: Simplification and Enhancement of the Neighborhood Traffic Management and Arterial Traffic Calming Programs* September 30, 1994. City of Portland, Office of Transportation, Bureau of Traffic Management, Neighborhood Traffic Management, 1120 SW. 5th Avenue, Room 730, Portland, OR, 97204-1914.

9. ~~*Traffic Calming: State of Practice*, 1999. FHWA-RD-99-135. R. Ewing. Institute of Transportation Engineers, Washington, D.C.~~

10. ~~*Boulder, Colorado, Neighborhood Traffic Mitigation Program.* Transportation Division. https://bouldercolorado.gov/transportation/transportation-safety~~

~~11. Neighborhood Traffic Management Dade County, Florida's street closure experience, Anthony J. Castellone and Muhammed M. Hasan, I.T.E. Journal, Volume 68, Number 1.~~

~~12. Traffic Flow Modification / Street Closure Procedure, Miami-Dade County Public Works Department and Metropolitan Planning Organization, Florida.~~

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 16

RESIDENTIAL STREET DESIGN

TABLES

CHAPTER 16

RESIDENTIAL STREET DESIGN

A INTRODUCTION

The street is a public way designed for the purposes of serving motor vehicles, bicycles, pedestrians, and transit vehicles. The primary function of residential streets is to provide access to homes that front those streets. The primary consideration, therefore, of residential street design should be to foster a safe and pleasant environment for the residents that live along the street, and safe traveling conditions for motorists, bicyclists and pedestrians. The convenience of motorists is a secondary consideration.

The street design should create an environment that cautions drivers that they are in a residential area where they must safely share the traveling space with pedestrians and bicyclists, both child and adult. Visual cues such as meandering streets, sidewalks, landscaping, signage, narrowed streets, changes in pavement texture (such as brick, stamped, or textured surfaces), and raised 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 the need for traffic calming retrofits.

Section B of this chapter discusses the primary objectives of Residential Street Design in more detail, to aid the designer in the selection of proper criteria. ***Section C*** sets forth specific design criteria for residential streets.

B OBJECTIVES

The basic principles of residential street design are based on four factors:

1. Safety
2. Efficiency of Service
3. Livability and Amenities
4. Economy of Land Use, Construction, and Maintenance

The following 17 principles incorporate these factors. These principles are not intended as absolute criteria, since instances may occur where certain principles conflict. The principles should therefore be used as concepts for layout of proper street systems.

1. Adequate vehicular and pedestrian access should be provided to all parcels.
2. Local street systems should be designed to minimize through traffic movements unless it is specifically desired by the County or municipality to connect residential developments.
3. Street patterns should minimize excessive vehicular travel 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 in the local circulation system should not have to rely on extensive traffic regulations and enforcement in order to function efficiently and safety.
7. Traffic generators within residential areas should be considered in the local circulation pattern.
8. The planning and construction of residential streets should clearly indicate their local function. The street's residential nature should be obvious to those driving on them.
9. The street system should be designed for a relatively uniform low volume of traffic.
10. Local streets should be designed to discourage excessive speeds.

11. Pedestrian-vehicular conflict points should be minimized.

12. The amount of space in the land development devoted to motor vehicle uses should be minimized.

13. Smaller block sizes may be used to encourage walking or bicycling. See ***Chapter 19 – Traditional Neighborhood Development*** for more information.

14. The arrangement of local streets should permit economical and practical patterns, shapes, and sizes of development parcels and provide interconnectivity without using arterials or collectors.

15. Local streets should consider and utilize topography from the standpoint of both economics and amenities.

16. Appropriate provisions for transit service within residential areas should be included.

17. Street design should consider horizontal and vertical compatibility and connectivity with sidewalks, bicycle lanes, and pedestrian walkways.

C DESIGN ELEMENTS

C.1 Design Speed

For local residential streets, design speeds of 15 to 30 mph are appropriate, depending on the adjacent development, terrain, available right of way, and other area controls. Alleys and narrow roadways intended to function as shared spaces (that is, could be used to access driveways, for garbage pickup, and travel by walking or bicycling) may have design speeds as low as 10 mph. Design speeds greater than 30 mph in residential areas require increased sight distances and radii which are contrary to the function of a local residential street.

C.2 Sight Distance

C.2.a Stopping Sight Distance

The minimum stopping sight distance 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

Passing 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 street shall be designed under the design criteria established in ***Chapter 3 – Geometric Design***.

C.2.c Intersection Sight Distance

Intersections shall be designed with adequate corner sight distance as set forth in Table 16 – 2 Minimum Corner Intersection Sight Distance for Residential Streets. Intersection design should take into consideration growth of landscaping and other amenities. Where a local residential street intersects a higher-order street, the design criteria of the higher-order street shall control within the 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 height of eye at 3.5 feet on the minor road to a height of object at 3.5 feet on the major road.

Where stop or yield control is not used, the corner sight distance should be a minimum of 300 feet. If restrictions are unavoidable, a minimum of 200 feet is allowed with proper warning signage found 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 on height of

embankments, locations of buildings, and screening fences 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 pavements. Tree overhangs should be trimmed to at least 8 feet above the level of the intersections.

Intersecting streets should meet at approximately right angles. Angles of less than 60 degrees should be avoided.

C.3 Horizontal Alignment

C.3.a Minimum Centerline Radius

The minimum radii for horizontal curves are given in Table 16 – 3 Minimum Centerline Radii for Residential Streets. Typically, superelevation should not be utilized on local residential streets. Where superelevation is appropriate or required, the street shall be designed under the design criteria established in ***Chapter 3 – 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, 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 minimum radius of 25 feet is desirable to accommodate turning movements of service vehicles.

C.4 Vertical Alignment

C.4.a Vertical Curves

Vertical curves shall be designed for a minimum stopping sight distance using the design criteria of 30 mph established in ***Chapter 3 – Geometric Design.***

C.5 Cross Section Elements

C.5.a Width of Roadway

The minimum width of a two-way residential roadway should be 20 feet from edge-of-pavement to edge-of-pavement (excluding curbs and gutters). Travel lanes should be a minimum of 10 feet wide, and wider where practicable. Under constrained conditions or in some very rural areas, lanes 9 feet or narrower may be used. Refer to ***Chapter 4*** of the ***AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400)***. Lanes narrower than 9 feet are prohibited in the absence of a Design Exception as provided for in ***Chapter 14 – Design Exceptions***.

When parking lanes are provided on one or both sides of the roadway, they shall be at least 7 feet wide including the gutter section where applicable.

Where curb and gutter sections are used, the roadway may be narrowed to the travel lane width (plus bike lane if present) at intersections. This will prevent parking close to the intersection, reduce crossing distances for pedestrians, provide space for curb ramps, and reduce turning speeds. By providing intersection curb extensions, the visual width of the roadway can be reduced.

C.5.b Medians

When used in residential areas, medians or traffic separators 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 100 feet long and open at one end only shall have a special turning area at the closed end. This turning area should be circular and have a radius appropriate to the types of vehicle expected. The minimum outside radius of a cul-de-sac shall be 30 feet. In constrained circumstances, other turning configurations such as a “hammerhead” may be considered. Cul-de-sacs can detract from connectivity if used excessively or inappropriately.

C.7 Pedestrian Considerations

C.7.a Sidewalks

In residential areas, sidewalks should be provided on both sides of the street. The sidewalks should be located as far as practicable from the travel lanes and usually close to the right of way line. In certain circumstances, such as where lots are very large or there are environmental limitations, sidewalk on only one side may be considered. Along collector roadways shared use paths may be provided in lieu of sidewalks. Connectivity to and between existing public sidewalk or shared use path facilities is desired.

Pedestrian access should be provided to schools, day care facilities, parks, churches, shopping areas, and transit stops within or adjacent to the residential development. Pedestrian access to these destinations and throughout the neighborhood shall be designed for safe and convenient pedestrian circulation. Sidewalks or shared use paths between houses or to connect cul-de-sacs may be used where necessary to provide direct access.

Sidewalks, crosswalks and mid-block crossings shall be constructed under the criteria set forth in ***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 specific bicycle facilities are desired they should connect to existing facilities and be designed in accordance with ***Chapter 3 – Geometric Design*** and ***Chapter 9 – Bicycle Facilities***. For bike lane transitions, see ***Chapter 9***.

C.9 Shared Use Paths

Shared use paths may be provided in lieu of sidewalks along collector roads in accordance with ***Section C.7.a***. When shared use paths are desired, they should connect to other pedestrian and bicycle facilities within or adjacent to the residential area, and connect to schools, day care facilities, parks, churches, shopping areas, and transit stops. Shared use paths shall be designed in accordance with ***Section C*** of ***Chapter 9 – Bicycle Facilities***. Shared use paths may be used by golf carts in certain areas, under certain circumstances in accordance with ***Sections 316.212, 316.2125 and 316.2126, F.S.***

C.10 Clear Zone

Clear zone requirements for residential streets shall be based on ***Chapter 3 – Geometric Design***, Table 3 – 15 Minimum Width of Clear Zone.

D REFERENCES FOR INFORMATIONAL PURPOSES ~~FOR INFORMATIONAL PURPOSES~~

The following is a list of publications that may be referenced for further guidance:

- AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400):
  https://bookstore.transportation.org/

- Manual on Uniform Traffic Control Devices (MUTCD)
  http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm

CHAPTER 17

BRIDGES AND OTHER STRUCTURES

EXHIBITS

CHAPTER 17

BRIDGES AND OTHER STRUCTURES

A INTRODUCTION

Bridges provide safe passage for multimodal traffic over various obstacles along a road or path. This chapter presents guidelines and standards for designing, constructing, inspecting, and maintaining bridges as well as other structures such as walls and supports for signs, lights, and traffic signals. These standards and criteria are necessary due to 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 other structures such as walls and supports for signs, lights, and traffic signals. The geometry of structures shall follow the standards and criteria set forth in ***Chapters 3, 8, 9***, and ***13***. Exceptions to these standards and criteria must be processed in accordance with the procedures described in ***Chapter 14***.

In addition to the design criteria provided in this chapter, the ***United States Department of Transportation ADA Standards for Transportation Facilities (2006), United States Department of Justice ADA Standards (2010)***, ~~***2006 Americans with Disabilities Act Standards for Transportation Facilities***~~ as required by ***49 C.F.R 37.41*** or ***37.43*** and the ***2020~~17~~2 Florida ~~Accessibility Code for~~ Building Code – Accessibility, 76th Edition ~~Construction~~*** as required by ***61G20-4.002*** impose additional requirements for the design and construction of pedestrian facilities on bridges or 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 grades that exceed 5%. The ***Public Rights-of-Way Accessibility Guidelines (PROWAG)*** provide additional information for the design of pedestrian facilities.

Note: This chapter applies to all bridges under local control, ~~with the exception of~~except for bridges constructed on or over FDOT's~~the Department's~~ system. For bridges constructed on and over FDOT's~~the Department's~~ system, as well as all bridges that will be maintained by FDOT~~the Department~~, FDOT~~the Department's~~ policies, procedures, standards and specifications will apply.

B OBJECTIVES

The objectives of this chapter are as follows:

- To prescribe uniform criteria with respect to bridge and miscellaneous structures design and geometric layout.
- To alert owners to the various federal and state requirements to be included in the design, construction, maintenance, and inspection of their bridges and other structures.
- To provide practical suggestions specific to Florida on prudent structural engineering based on past experience with statutes, standards, and criteria.

C DESIGN

The design of bridges and other structures shall be led by a licensed professional engineer who shall assume responsible charge of the work. The standards and criteria included here are directed only toward specific considerations that shall be followed. Other considerations are necessary to create a comprehensive bridge design allowing owners and their engineer's flexibility in design. All bridges and other structures shall be designed in accordance with 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 shall be designed in accordance with specifications (including guide specifications) published by the American Association of State Highway and Transportation Officials (AASHTO). At a minimum, the ***AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, 9~~87~~th Edition (2020~~174~~)*** ~~with *Interim Revisions (2015 and 2016)*~~ shall be used. Any bridge reconstruction (i.e., lengthening, widening, and/or major component replacement) shall be designed as specified in this section. Record of such reconstruction shall be maintained as specified in Section D of this chapter. The remaining design life should be considered in the design.

C.2 Bridge Live Loads

In addition to the notional (HL - 93) design load specified in ***LRFD***, bridges shall also require a FL 120 permit load rating greater than 1 as defined in FDOT's ~~the Department's~~FDOT ***Structures Manual, Volume 1 – Structures Design Guidelines, 2021~~187~~ (SDG)***. This vehicle allows for a more consistent load rating comparison considering the current bridge inventory.

C.3 Bridge Superstructure

The superstructure of a bridge is that portion of the structure that spans between its supports or piers. Considerations that shall be incorporated into the design of all superstructures will include the following:

C.3.a Girder Transportation

The Engineer of Record (EOR) is responsible for investigating the feasibility of transportation for heavy, long and/or deep girder field sections. In general, the EOR should consider the following 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 ft or weighing more than 160,000 pounds requires coordination through FDOT's~~the Department's~~ Permit Office during the design phase of the project. Shorter and/or lighter field sections may be required if access to the bridge site is limited by roadway(s) with sharp horizontal curvature or weight restrictions.
- On steel superstructures, where field splice locations required by design result in lengths greater than 130 feet, design and detail "Optional Field Splices" in the plans.
- For curved steel box girders, prefabricated trusses, and integral pier cap elements, size field pieces such that the total hauling width does not exceed 16 feet.

C.3.b Vertical Clearance

All 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 9, Section C.6***.

All new bridges over water shall be designed to meet the following vertical clearance standards:

- To allow debris to pass without causing damage, the clearance between the design flood stage and the low member of bridges shall be a minimum of two feet. This standard does not apply to culverts and bridge-culverts.

- For crossings subject to boat traffic, the minimum vertical navigation clearance 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 control elevation

* For locations subject to tidal salt / brackish water splashing, a 12-foot vertical clearance above Mean High Water should be considered for bridge durability reasons.

Higher clearances apply for crossings over legislated channels under the control of the U.S. Coast Guard (USCG). Designers should also consider future navigation demands and future shared use path demands in setting the vertical clearance of a bridge.

C.3.c Railings

All traffic, pedestrian, and bicycle railings shall comply with the requirements in ***Section 13*** of ***LRFD***. Traffic railings shall meet the crash requirements of at least Test Level 3 (TL-3) for bridges with design speeds greater than 45 mph and at least TL-2 for design speeds less than or equal to 45 mph.

For pedestrian/bicycle railings, two-pipe guiderails and details similar to thosee in FDOT's~~Department's~~ ***Standard Plans*** ~~, Indexes 515-070 and 515-080 Design Standards, Indexes 870 or 880~~ may be mounted on walls or other structures where drop-off hazards are 5 feet or less. Concrete, aluminum or steel railing and details similar in strength and geometry to those in FDOT's~~the Department's~~ ***Standard Plans***~~, Indexes 515-021 thru 515-090 and 521-820 thru 521-825 Design Standards, Indexes 820 thru 862~~ shall be used (or modified to suit environmental runoff concerns) where drop-off hazards are greater than 5 feet. See ~~appropriate Instructions for~~ ***Standard Plans Instructions*** ~~Design Standards (IDS)~~ for more information.

C.3.d Expansion Joints

The number of joints should be minimized to reduce the inspection and maintenance needs of the bridge.

C.3.e Drainage

All bridge designs shall include a drainage design that is specific to its site. Conveyance of drainage off the bridge roadway should be designed to meet spread standards contained in FDOT's~~the most recent version of the Department's~~ ***Drainage Manual, Chapter 3 (2021~~18~~)*** and may include open systems (i.e., scuppers) or closed systems (i.e., inlets and pipes) based on environmental permitting restrictions. Drainage from the bridge should not drop onto traffic below. Longitudinal conveyance piping attached to bridges is expensive and maintenance-intensive, and should be avoided whenever possible.

Conveyance of drainage off pedestrian facilities shall be designed to provide an accessible route for pedestrians. 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

Requirements for end treatments of structures are given in ***Chapter 4 – Roadside Design***. Bridge barriers shall be designed to accommodate connection of a guardrail transition or energy absorbing system.

C.4 Bridge Substructure

The substructure of a bridge consists of all elements below the superstructure including its bearings, piers, and foundations. For guidance on bridges vulnerable to coastal storms, see ***SDG, Section 2.5***. Considerations that shall be incorporated into the design of all substructures include the following:

C.4.a Scour

A hydrologic/hydraulic analysis shall be performed to quantify expected stages and flows at the bridge site. Anticipated substructure scour shall be developed for the 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 standards above hydrologic/hydraulic and scour analysis requirements shall be approved in writing by FDOT's~~the Department's~~ local District Drainage Engineer. Methodology for computing bridge hydrology/hydraulics and bridge scour should follow the guidelines set forth in FDOT's ~~the most recent version of the~~ Department's ***Drainage Manual (2021~~18~~).*** Further guidance and training may be obtained through ***FHWA Hydraulic Engineering Circulars (HEC) "HEC-18"*** and ***"HEC-20"*** and FDOT's~~the Department's~~ training courses on these topics. Additionally, for larger bridges (>120,000 sq. ft.), hydraulic designers may wish to consult with FDOT's~~the~~ local ~~Department~~ District Drainage Engineer for case-specific guidance. The ***SDG, Section 2.11*** and ***2.12*** and FDOT's~~the Department's~~ ***Drainage Manual, (2021~~8~~)*** provide guidance on scour load combinations with other loads.

C.4.b Navigation Aids and Vessel Collision

All bridges over USCG designated navigable waterways shall include bridge fender systems and consideration for potential vessel collision.~~—. Such collisions generally occur from barges or oceangoing ships. The engineer shall conduct a vessel risk analysis to determine the most economical method for protecting the bridge. This shall include either designing the bridge to withstand the vessel collision, or protecting it with dolphin cells. Fender systems should only be used to designate the channel width and not for pier protection. The above risk analysis may be conducted utilizing the Department's computer program "Vessel Impact Risk Analysis." For load combinations, use Load Combination "Extreme Event II" as follows:~~

~~(Permanent Dead Loads) + WA+FR+CV~~

~~With all load factors equal to 1.0 where WA are water loads, FR are friction forces and CV are the vessel collision loads. Nonlinear structural effects must be included and can be significant. It is anticipated that the entire substructure (including piles) may have to be replaced and the superstructure repaired if a bridge is subjected to this design impact load; however, the superstructure must not collapse.~~

~~Note: Further refinement or complication of this load case is unwarranted.~~

For ~~Further~~ guidance on navigation aids and bridge fender system design, see ***SDG Section 314***. For guidance on vessel collision design see ~~may be obtained from the~~ ***SDG, Section 2.11*** and ***LRFD, Section 3.14*****.**

~~For guidance on bridge fender system design, see , and FDOT Design Standard Indexes 21900 and 21930.~~

C.4.c Pier Locations

All bridges over roadways shall have substructures supports set back from vehicular traffic lanes in accordance with ***Chapter 3, Section C.7.j.4.(a)***.

All bridges over water shall have substructure supports located with horizontal clearance requirements as listed below. In this case, horizontal clearance is defined as the clear distance between piers, fender systems, culvert walls, etc., projected by the bridge normal to the flow.

- For crossings subject to boat traffic a minimum horizontal clearance of 10 feet shall be provided.
- Where no boat traffic is anticipated, horizontal clearance shall be provided consistent with debris conveyance needs and structure economy.

C.5 Retaining and Noise Walls

The design of conventional, anchored, mechanically stabilized, and prefabricated modular retaining wall structures shall meet the requirements of ***LRFD Section 11***. Local agencies should consider using only wall types approved by FDOT~~the Department~~. These are described in ***Section 3.12*** of the ***SDG***. Local agencies should also follow the design criteria for retaining walls found in ***Section 3.13*** of the ***SDG***.

The design of noise walls should meet the requirements of the ***SDG, Section 3.16***. For noise walls within the clear zone, their design and/or protection should~~all~~ comply with the following:

- For noise walls attached to the top of traffic railings only use crash tested systems consistent with the design speed of the facility. FDOT~~The Department~~ has standards for TL-4 systems that meet the requirements of ***NCHRP Report 350 or the Manual for Assessing Safety Hardware (MASH)***.
- Non-crash tested noise walls may be attached to structures if located behind an approved traffic railing and mounted at least five feet from the face of the traffic railing at deck level.

Potential existing off-site stormwater inflows through the proposed wall location should be verified in the field and considered in the wall design. For 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 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 Interims Revisions*** ~~***(2015)*** with ***2017 Interims***~~,~~ and the FDOT~~Department's~~ ***Structures Manual Volume 3 - FDOT Modifications to LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (LRFDLTS-1)***.

C.7 Pedestrian Bridges

For guidance on pedestrian bridges, see ***SDG Chapter 10***.

D CONSTRUCTION

During 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. Provisions for protecting the public during construction shall be in accordance with the ***MUTCD (2009 Edition with Revision Number 1 and 2, May 2012)*** work zone traffic control procedures and the standards and criteria described in ***Chapter 11 – Work Zone Safety***. Worker safety is the responsibility of the contractor. Temporary barriers shall be installed on all bridges being widened or whose new construction is phased. Spread of stormwater on the bridge deck should be considered in planning temporary traffic routing.

During the construction of a bridge or any structure, records to be kept and maintained throughout its life shall include foundation construction records (pile driving records, shaft tip elevations, borings) and as-built plans. These records provide critical information necessary for future inspection, maintenance, emergency management, enhancement, reconstruction, and/or demolition of these structures. These records shall be delivered to FDOT'sthe Department's local District Structures Maintenance Engineers.

Any proposed changes to the construction details or specifications shall be signed, sealed, and dated by a professional engineer 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 qualifications for personnel. Each state is permitted to modify its bridge inspection standards to deviate from the NBIS standards but only following approval from the FHWA.

Section 335.074, F.S., mandates safety inspection of bridges. ~~as follows:~~

~~*"At regular intervals not to exceed 2 years, each bridge on a public transportation facility shall be inspected for structural soundness and safety for the passage of traffic on such bridge. The thoroughness with which bridges are to be inspected shall depend on such factors as age, traffic characteristics, state of maintenance, and known deficiencies. The governmental entity having maintenance responsibility for any such bridge shall be responsible for having inspections performed and reports prepared in accordance with the provisions contained herein."*~~

~~This statute also defines the minimum dimensions of bridge structures that must be inspected as follows:~~

~~*"Those bridges having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches or extreme ends of openings for multiple boxes and those bridges consisting of multiple pipes where the clear distance between openings is less than half of the smaller contiguous opening..."*~~

Bridge inspectors shall be certified in accordance with ***Chapter 14-48, F.A.C***. Safety inspection of bridges shall be conducted in accordance with ***Chapter 14-48, F.A.C***.

FDOT~~The Department~~ inspects all bridges in Florida, both on-system and off-system and~~.~~ ~~The Department~~ provides each local government with copies of its inspection reports. Each local government should maintain these reports to be responsive to Metropolitan Planning Organization requests for bridge rehabilitation, replacement, or enhancement designations. Please see the following for further information: ***Bridge and Other Structures Reporting Manual 850-010-030***

All on-system and off-system bridges are assigned a Bridge Number by FDOT~~the Department~~. For new bridges, local agencies shall contact the FDOT's~~Department's~~ local District Structures Maintenance Engineers to have a number assigned.

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 consider age, traffic characteristics, state of maintenance, and known deficiencies of the bridge. The governmental entity having maintenance responsibility for any such bridge shall be responsible for having inspections performed and reports prepared.

As required by ***Section 335.074, F.S***., each inspection shall be reported to FDOT~~the Department~~, using the Bridge Load Rating Summary Table form shown in ~~Exhibit A~~the ***FDOT Bridge Load Rating Manual***. Further information for preparing a bridge load rating summary and fillable form may be found on FDOT's~~the Department's~~ ***Office of Maintenance, Bridge Load Rating*** ~~Information~~ web site~~, at the following location:~~

~~http://www.dot.state.fl.us/statemaintenanceoffice/LoadRating.shtm~~

Upon receipt of an inspection report that recommends reducing the weight limit on a bridge, the governmental entity having maintenance responsibility for the bridge shall load post the bridge within 30 days in accordance FS 335.074(5). Further 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 appropriate signage shall be promptly installed in accordance with the ***MUTCD***.

For new construction or reconstruction projects, the bridge owner is responsible for providing FDOT~~the Department~~ with a load rating and completed Bridge Load Rating Summary Table ~~(see Exhibit A – Bridge Load Rating Summary Table)~~ within 90 days of opening for on-system bridges or 180 days for off-system bridges. The bridge owner should consider requiring the engineer of record to perform the load rating.

~~EXHIBIT A Bridge Load Rating Summary Table~~

Bridge No.		**Analysis Method:**	**LRFR-LRFD**
Bridge Name			**FDOT Bridge Load Rating Summary Form (Page 1 of 1)**
Description			

Rating Type	Rating Type	Gross Axle Weight (tons)	Moment/Shear/Service		Dead Load Factor	Live Load Factor	Live Load Distrib. Factor (axles)	Rating Factor	Span No. - Girder No., Interrior/Exterior, %Span·L	Pontis RF·Weight (tons)
Level	**Vehicle**	**Weight**	**Member Type**	**Limit**	**DC**	**LL**	**LLDF**	**RF**	**Governing Location**	**RATING**
Inventory	HL93	36	Member Type	Limit Test	NA	NA				
Operating	HL93	36	Member Type	Limit Test	NA	NA				
Permit	FL120	60	Member Type	Limit Test	NA	NA				
Max Span	FL120	60	Member Type	Limit Test	NA	NA				
Legal	SU2	17	Member Type	Limit Test	NA	NA				
	SU3	33	Member Type	Limit Test	NA	NA				
	SU4	35	Member Type	Limit Test	NA	NA				
	C3	28	Member Type	Limit Test	NA	NA				
	C4	36.7	Member Type	Limit Test	NA	NA				
	C5	40	Member Type	Limit Test	NA	NA				
	ST5	40	Member Type	Limit Test	NA	NA				

Original Design Load	enter Original Design Load		
Rating Type, *Analysis*	enter Rating Type		
Distribution Method	enter Distribution Method		
Impact Factor	enter IM	(axle loading)	
FL120 Gov. Span Length	enter Gov Length	(feet)	
Recommended Posting	enter Posting (70)		
Rec. SU Posting	enter SU posting	(tons)	
Rec. C Posting	enter C posting	(tons)	
Rec. ST5 Posting	enter ST5 posting	(tons)	
Floor Beam Present?	FLOOR BEAM PRESENT?		
Segmental Bridge?	SEGMENTAL BRIDGE?		
Project No. & Reason	FIN No.	Update	
Status	Status		
Software Name, Version	Enter Software Name & Version		

COMMENTS BY THE ENGINEER

Page 1/XX. Contents: summary, narrative, plans, calcs, check.

Performed by:		Date:	
Checked by:		Date:	
Sealed By:		Date:	
FL P.E. No.:			
Cert. Auth. No.:			
Phone & email:			
Company:			
Address:			

P.E. Seal

This 04-24-2015 table is based on requirements within the 2015 FDOT Bridge Load Rating Manual, and the BMS Coding Guide; see http://www.dot.state.fl.us/statemaintenanceoffice/LoadRating.shtm

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.).*
- Resist the temptation to enhance the aesthetics of a bridge with non-structural appurtenances and features that are novel and therefore may have safety challenges (otherwise, consult with FDOT~~the Department~~ on these safety issues).
- Consider the potential for future expansion of a bridge's capacity (vehicular transit and pedestrian) in its layout and bridge-type selection.
- Use FDOT's~~the Department's~~ objective construction unit prices (contained in the Structures Design Guidelines, Sections 9.2 and 9.3) to select bridge type(s) to consider for final design.
- Consider the use of alternative designs (i.e., steel superstructures vs. concrete superstructures) to increase bidding competition on very large bridge construction projects.
- ~~Consider factors other than economics in decisions on a bridge's basic design and its discretionary features.~~
- Invest in a comprehensive subsurface investigation of the site before any significant design of the bridge occurs (which will also help avoid unforeseen conditions during construction).
- Consult with other local officials on experiences relating to construction of other bridges in the area.
- Consider using FDOT's~~the Department's~~ Standard Specifications for Road and Bridge Construction with notes on the plans referencing the Owner as the local governmental agency and the Engineer as the owner's engineer.
- Consider the constructability, inspectability, and maintainability of all bridge components before they are incorporated into the project's final design.
- Include drainage pass-throughs in wall designs.
- ~~Preclude contractors without company or individual bridge experience from bidding on a bridge construction project.~~
- Provide qualified construction inspection personnel for all phases of bridge construction.
- Maintain all design and construction records in a safe, protected, and secure location throughout the life of the bridge.

H REFERENCES FOR INFORMATIONAL PURPOSES FOR INFORMATIONAL PURPOSES

The publications referenced in this chapter can be obtained from the following websites.

- FDOT Structures Design Guidelines (SDG)
  http://www.fdot.gov/structures/
- FDOT Bridge Load Rating Manual
  http://www.fdot.gov/maintenance/LoadRating.shtm
- All other FDOT Publications may be found at:
  http://www.fdot.gov/publications/
- AASHTO, all publications may be ordered from:
  bookstore.transportation.org
- FHWA “HEC-18” and “HEC-20” may be found at:
  http://www.fhwa.dot.gov/engineering/hydraulics/library_listing.cfm
- 2006 Americans with Disabilities Act Standards for Transportation Facilities
  http://www.access-board.gov/guidelines-and-standards/transportation/facilities/ada-standards-for-transportation-facilities
- 2017 2 Florida Accessibility Code for Building Construction
  https://codes.iccsafe.org/public/document/FAC2017
- https://www.flrules.org/gateway/ruleno.asp?id=61G20-4.002

CHAPTER 18

SIGNING AND MARKING

TABLES

FIGURES

CHAPTER 18

SIGNING AND MARKING

A INTRODUCTION

Signing and pavement markings help improve highway safety by providing guidance information to road users. Both signs and pavement markings should provide sufficient 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 the capabilities and needs of seniors, and consider appropriate measures to better meet their needs and capabilities.

Sections C and D of this chapter specifically discuss traffic control devices for both signing and pavement marking that accommodate not only the needs of all types of road users, but also the special needs of seniors.

B BACKGROUND

Section 316.0745, F.S., requires FDOT~~the Department~~ compile and publish a manual of uniform traffic control devices for use on the streets and highways of the state. To comply with this statute, the Federal Highway Administration's (FHWA) ***Manual on Uniform Traffic Control Devices (MUTCD)*** has been adopted for use in ***Rule 14-15.010, F.A.C.***:

~~https://www.flrules.org/gateway/ruleNo.asp?ID=14-15.010~~

All references in this chapter are in conformance with the ***MUTCD***:

~~http://mutcd.fhwa.dot.gov/~~

The ***Manual on Speed Zoning for Highways, Roads, and Streets in Florida (January 2019)***, is adopted for use by the State of Florida under ***Rule 14-15.012, F.A.C.*** This manual is prepared by FDOT~~the Department~~ in compliance with ***Chapter 316, of the Florida Statutes***, to promote uniformity in the establishment of state, municipal, and county speed and school zones throughout the State.

C SIGNS

C.1 Advance Street Name Signs

The use of advance street name signs provides advance notification to road users to assist them in making safe roadway decisions. Signs should be used for signalized or non-signalized intersections that are classified as a minor arterial or higher, or a cross street that provides access to a traffic generator or possesses other comparable physical or traffic characteristics deemed to be critical or significant.

C.1.a Standards

The words Street, Boulevard, Avenue, etc., may be abbreviated, deleted or reduced in size to conserve sign panel length. However, if confusion would result due to similar street names in the area, the deletion should not be made.

Use of the local name is preferred on advance street name signs. When a cross street has a different name on each side of the intersection, both names shall be shown with an arrow beside each name to designate direction. Additional legend such as NEXT SIGNAL or XX FEET may be added.

C.1.b Installation

Advance street name signs should be installed in advance of the intersection in accordance with the distances shown in “Condition A” of ***Table 2C-4. Guidelines for Advance Placement of Warning Signs of the MUTCD***. These distances are 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. The degree of traffic congestion and the potential number of lane change maneuvers that may be required should also be considered when determining the advance placement distance.

C.1.c Sign Design

Advance street name signs shall be designed in accordance with ***Part 2 Signs*** of the ***MUTCD***. The lettering for the signs shall 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 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	Next Signal or Intersection
	Letter Size (inches) Series E Modified (EM) Upper/Lower Case Letters	Letter Size (inches) Series D (D) Upper Case Letters
35 mph or less	8 EM	6 D
40 mph or greater	10.67 EM	8 D

Figure 18 – 1
Examples of Advance Street Name Signs

C.2 Advance Traffic Control Signs

Advance Traffic Control signs, i.e., Stop Ahead (W3-1), Yield Ahead (W3-2), and Signal Ahead (W3-3) signs, shall be installed on an approach to a primary traffic control device that is not visible for a sufficient distance to permit the driver to respond to the device. The visibility criteria for traffic signals shall be based on having a continuous view of at least two signal faces for the distance specified in ***Table 4D-2. Minimum Sight Distance for Signal Visibility*** of the ***MUTCD***.

An Advance Traffic Control sign may be used for additional emphasis of the primary traffic control device, even when the visibility distance to the device is satisfactory.

C.3 Overhead Street Name Signs

Overhead street name signs with mixed-case lettering should be used at major intersections (with multi-lane approaches) as a supplement to post mounted street name signs.

C.3.a Standards

Overhead street name signs shall only be used to identify cross streets, not destinations such as cities or facilities. To avoid the need for lighting of overhead signs, they should have a minimum maintained retroreflectivity value as shown in ***Table 2A-3. Minimum Maintained Retroreflectivity Levels, MUTCD***. Roadway geometry and forward sight distance will also influence the need for overhead sign lighting.

The words Street, Boulevard, Avenue, etc., may be abbreviated, deleted or reduced in size to conserve sign panel length. The 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 local name is preferred.

When a cross street has a different name on each side of the intersection, two options are permitted:

- When two sign panels are used, install one sign panel on the left and the other sign panel on the right side of the signal heads; or
- When one sign panel is used, the left name should be displayed over the right name. Arrows should be provided to indicate which side of the

intersection the street name applies.

C.3.b Installation

Due to the possibility of hurricane strength winds, overhead street name signs should not be installed on span wire but should be mounted to the strain pole or mast arm.

The location of the overhead street name sign on a signal strain pole and/or mast arm may vary. However, it shall not interfere with the motorist's view of the signal heads. The preferred location is shown in FDOT's~~the Department's~~ ***Standard Plans***~~, Index 700-050~~ ~~Design Standards, Index No. 17748~~. In the case of separate street names on each side of the street, where separate signs are used, one sign should be placed 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 sign panel should be at least 24 inches in height with the length determined by text. At a minimum, use 8-inch upper case and 6-inch lower case lettering for the street name. If block numbering text is included, use 6-inch all upper case lettering on the second line. The preferred font is Series E-Modified; however, Series E may be used to accommodate the amount of legend so as not to exceed the 96-inch maximum length.

Where structurally possible, overhead street name signs should be designed in compliance with the FHWA recommendations for older drivers using a minimum lettering size of 10-inch upper case with 9-inch lower case.

C.3.d Internally Illuminated Overhead Street Name Signs

An internally illuminated overhead street name sign may be used to improve night-time visibility. Internally illuminated overhead street name signs should have a standardized height of 24-inches and a length not to exceed 108-inches (nine feet).

A Series E Modified or Series E font, which may vary to accommodate the amount of text on the panel should be used.

The sign design shall be in accordance with the ***MUTCD***. When possible, the text should utilize the following text attributes in descending order to limit the maximum 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 be on FDOT's~~the Department's~~ ***Approved Products List (APL)***.

C.4 Community Wayfinding Guidance

Community wayfinding guide signs should be developed and approved through local resolution with criteria for the destinations shown on the community wayfinding guide sign system plan. Any wayfinding guide sign should be used in accordance with ***Rule 14-51.030, F.A.C.*** The intent is to provide guidance and navigation information to local cultural, historical, recreational, and tourist activities. No destination should be displayed for the purpose of advertising.

C.5 DMS Overview

The main purpose of dynamic message signs (DMS) is to convey timely and important en-route and roadside information to motorists and travelers. Further information on how DMS signs may be used can be found in FDOT's policy on ***Displaying Messages on Dynamic Message Signs Permanently Mounted on the State Highway System***.

~~*http://www2.dot.state.fl.us/proceduraldocuments/procedures/bin/000750015.pdf*~~

C.6 Design Details for Signs

The ***MUTCD*** shall govern all ~~the~~ sign details ~~for all signs~~. At a minimum, the "Conventional Road" size shall~~ould~~ be used on signs intended for motor vehicle operators.

Shared use path sign sizing for traffic control ~~Signs intended for shared-use path users~~ shall~~ould~~ follow the~~use the reduced~~ "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 6-inch Pavement Markings

6-inch pavement markings should be used for all pavement center line, lane separation line and edge line markings.

D.2 Reflective Pavement Markers

To provide greater emphasis and increase visibility, reflective (raised) pavement markers (RPM) may be placed at 40-foot spacings along the centerline markings of roadways.

E AUDIBLE AND VIBRATORY TREATMENTS

E.1 Longitudinal Audible Vibratory Treatments Pavement Markings

Longitudinal audible and vibratory treatments are a countermeasure to reduce the severity and frequency of roadway departure crashes. They include cylindrical ground-in rumble strips, sinusoidal ground-in rumble strips and profiled thermoplastic. They are most effective on high speed roadways with flush shoulders. They should not be placed within the limits of intersections or crosswalks.

Audible vibratory treatments are designed to improve the opportunity for a safe recovery for distracted, drowsy, or otherwise inattentive drivers who may unintentionally drift over the edge or center line. Due to the difficulty in determining where a driver will depart the lanebecome distracted or drowsy, it is recommended that treatments be installed system-wide or in corridors,prioritized by the frequency of the specific crash types targeted by the treatment. Their use should be determined on the suitability meritof the cross-section and appropriateness in the surrounding land use context.

Considerations that may limit the acceptability and effectiveness usefulness or application include low speeds, noise for adjacent residences, and pavement width. andsignificantturning movements or other conflicts for road users. More information on these types of treatments are shown in the Department's ***Standard Plans, Index 546-010*** and ***Design Manual, Chapter 210 Arterials and***

Collectors.

~~For high speed roadways, audible, vibratory markings should be considered.~~

E.2 Transverse Rumble Strips

Transverse rumble strips may be used to alert the driver to upcoming stop conditions or abrupt changes in alignment.~~attract the driver's attention to unexpected changes in alignment or conditions requiring a stop through noise and vibration.~~ Factors influencing their use include crash history, roadway geometry and surrounding land use (noise pollution). They should not be placed in crosswalks or bicycle facilities. If placed on roadways open to bicycle travel, a minimum clear path of 4 feet on the outside edge should be provided. ***Sections 3J.02 Transverse Rumble Strip Markings*** and ***6F.87 Rumble Strips, MUTCD*** provide further information on the use of transverse rumble strips.

CHAPTER 20

DRAINAGE

TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 20

DRAINAGE

A INTRODUCTION

This chapter recognizes that Florida is regularly affected by adverse weather conditions. As such, the proper design of a roadway's drainage system is critical to its function and to the safety of the motoring public as well as pedestrians, bicyclists and other users of these facilities. Standing water on a roadway can not only create a hazard but could also impede the flow of traffic.

This chapter represents the minimum standards that should be used when designing roadway drainage. As is the case for all elements in a facility's design, the designer must consider site specific conditions and determine the proper level of service the facility's drainage system should provide. The design of drainage facilities should not only consider the system's ability to handle the design 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 the travel lanes in order provide a safer environment for users of a facility during adverse weather conditions.
- Design drainage systems by taking into consideration the future maintenance of said system in order to avoid creating hazardous conditions to drivers and maintenance staff during routine servicing.

FDOT's Drainage Design Guide (DDG) is a reference for designers, providing guidelines and examples of how these objectives can be accomplished. The DDG provides information on the following areas of drainage design:

- Hydrology
- Open Channel
- Culvert
- Bridge Hydraulics
- Storm Drains
- Exfiltration Systems
- Optional Pipe Material
- Stormwater Management Facility
- Temporary Drainage Design

C~~F~~ REGULATORY REQUIREMENTS

C~~STORMWATER MANAGEMENT~~

F.1 Regulatory Requirements

C~~F.1.a~~ Chapter 62-330~~25~~, Florida Administrative Code

Chapter 62-330~~25~~. F.A.C., rules of the Florida Department of Environmental ~~Protection~~ Protection, implements the comprehensive, statewide environmental resource permit (ERP) program under ***Section 373.4131, F.S.*** The ERP program governs the following: 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.***)~~specifies minimum water quality treatment standards for new development.~~. ***Chapter 62-25 F.A.C.*** has been repealed.

C~~F~~.21~~.b~~ Chapter 62-40, Florida Administrative Code

Chapter 62-40, F.A.C., rules of the Florida Department of Environmental Protection outlines basic goals and requirements for surface water protection and management to be implemented and enforced by the Florida Department of Environmental Protection and Water Management Districts.

C~~F~~.31~~.c~~ National Pollutant Discharge Elimination System

The ***National Pollutant Discharge Elimination System*** (***NPDES***) permit program is administered by the U. S. Environmental Protection Agency and delegated to the Florida 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 within the definition of 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. The 12 steps detailing the WATERRS process is shown in Figure 20 – 1 WATERSS Process Flow Chart.

The WATERSS process identifies potential cost savings or additional environmental benefits for implementing feasible, non-traditional stormwater management solutions. Innovative practices include regional ponds, joint-use ponds, stormwater harvesting, land use modifications, upstream compensatory treatment, basin or resource improvements, well injection, and bio-sorption activated media (BAM). These practices along with examples of opportunities that can be leveraged by this process are found in Table 20 – 1 Matrix of Typical Innovative Stormwater Management Practices.

Collaboration with external partners is essential for the discovery of stormwater management partnership opportunities. This may involve more time and effort than traditional stormwater pond design, which focuses on isolated activities and design of individual ponds. However, collaborative stormwater management solutions have proven to result in substantial environmental and investment benefits across a watershed or region. ~~Following are steps detailing the WATERRS process~~.

Figure 20 – 1 WATERSS Process Flowchart

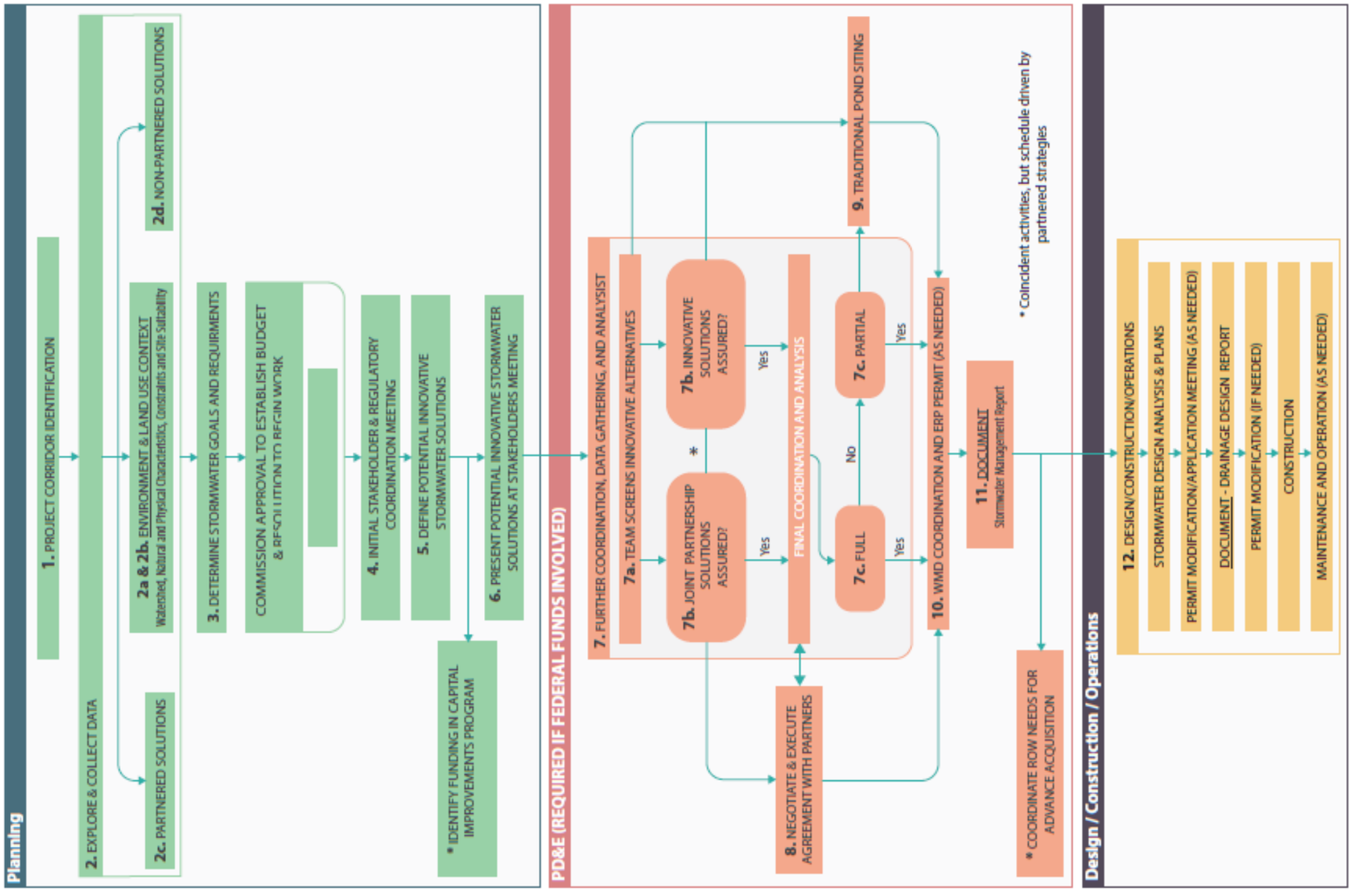


Table 20 – 1 Matrix of Typical Innovative Stormwater Management Practices

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 ROW costs are high or land for ponds is unavailable.	Reduce long term pond costs and improve downstream water quality.	Highly effective in that land beyond the onsite project is treated and attenuated.	Pros: improved water quality and attenuation, reduced long term costs. Cons: (1) 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 ROW costs are recouped by giving away maintenance to local municipalities.	Longer production schedule may be needed to accommodate negotiations with local municipalities and overcoming permitting hurdles.	Sometimes pre-treatment is required onsite, perhaps 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 FDOT to store runoff in downstream golf courses; and (3) sometimes adjacent developments are required to take FDOT runoff as a condition of county approvals.	Reduce pond ROW acquisition and long-term maintenance costs.	Standard ERP water quality rules are satisfied.	Pros: combining ponds into a single pond reduces costs due to economy of scale; typically, maintenance is assumed by the party other than 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 FDOT's right to maintain pond (or hold another public agency as surety) if the developer defaults on his responsibilities.	Combining ponds into a single pond reduces ROW costs due to economy of scale; maintenance is often assumed by the offsite party.	Longer production schedule may be needed to accommodate negotiations with the cooperating party.	The overflow from the combined pond must be able to adequately drain both upstream properties.

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 need to design storage facility, but could assume the pond and pumping/ infrastructure costs are borne by the water consumer.	Longer production schedule may be needed to discover and negotiate with the water consumer.	(1) No privately-owned pumping/piping infrastructure within L/A ROW; (2) re-use with potential human contact must provide filtration; and (3) avoid the need for a 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 ROW 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 ROW adjacent to the highway.	Additional production time may be needed to negotiate with land owners – no ROW condemnation authority.	None.
Upstream Compensatory Treatment	Treating upstream offsite runoff in lieu of onsite runoff.	Desirable when pond ROW 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 be needed to find and design a suitable upstream treatment alternative.	Requires design of offsite treatment BMP.

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 ROW 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 ROW acquisition.	Longer production schedule may be needed to accommodate discussions with the permitting agencies and/or municipality.	Specialty design services may 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 need to include a special BAM design within the discharge well.	UIC permitting rules to allow this option are very restrictive. May 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.

BMP	Specific Characteristics	Applicability	Goals	Effectiveness in Meeting Stormwater Quality and Quantity Goals	Pros and Cons	Permitting Hurdles	Costs	Schedule	Design Constraints
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 ROW for ponds by using BAM within roadside ditches.	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 into Manuals and Specs.	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 ROW; when used to remove phosphorus, the design life of the media is predicted to be about 20 years and may then need replacement.	Longer production schedule may be needed to coordinate design with UCF.	Required residence time within BAM layer may require additional storage in ditches or retention ponds.

Step 1 – Project Corridor Identification

Identify the overall project characteristics including project location, environment and land use context (urban vs. rural project), facility type, alternatives being considered, and potential 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 of potential partnerships and innovative stormwater solutions available. Potential partnerships and initiatives are explored by using Geographic Information System (GIS) support tools, and by querying the National Pollutant Discharge Elimination System (NPDES) Coordinator regarding ongoing Total Maximum Daily Load (TMDL) and Basin Management Action Plan (BMAP) activities. The 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 & land owner information (can be provided as part of public involvement research).
- Existing row maps.
- Copies of any previous stormwater studies or watershed masterplans.
- Available copies of permits for projects within the vicinity.

- Existing 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 water storage/recharge opportunities.
- BMAPs's.
- TMDLs with allocations.
- Identified public lands.
- Floodplain.
- 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 affect suitability of potential stormwater management solutions. The following list is provided as guidance:

- What are the characteristics of the watershed? Is the watershed 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 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 area?
- Are there threated or endangered species or designated habitat which may cause certain types or locations of treatment to be not suitable for stormwater management?

- Are there contamination concerns which will cause a site to be not suitable 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 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 and Biscayne Aquifers.

C. Identify potential innovative stormwater solutions and partners. If the project is in an impaired basin, contact the NPDES Coordinator 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. Examples are listed below:

- Regional Pond: If sub-basins are draining to the same outfall or future development is expected in the watershed.
- Additional offsite inflows: If new or additional offsite inflows of stormwater or wastewater are being proposed.
- Stormwater re-use: In urban or suburban areas, contact local governments or golf courses regarding their interest in stormwater as a raw water supply or for irrigation.
- Joint-use Ponds: Determine if there are 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 PFA then additional scrutiny will be given from regulators on groundwater discharges (dry retention ponds) as opposed to surface water discharges where denitrification can occur. Is the groundwater beneath the project contaminated with nitrates or are there sources of nitrogen adjacent to the project? If so, the nitrogen-

laden water may be pumped directly into the underground BAM layer to achieve large removals

- Tidal or Lake Circulation Improvements: If 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. Examples are listed below:

- Regional Pond: If a substantial portion of the project drains to a single water body a regional pond would allow reduction of typical on-site po~~u~~nds. Would a location downstream have equal or fewer community impacts or other benefits over on-site ponds? Consider if increased project runoff would create or worsen flooding or erosion issues 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: For projects in springsheds, critical water needs area, water supply hardship areas, or areas of nutrient impairment consider the use of a nutrient removal product such as BAM for additional treatment.
- Onsite Irrigation: Consider re-use of the pond treatment volume for irrigation near the project rather than bleeding downstream.
- Wetland Re-hydration: Are nearby wetlands underhydrated?
- Compensatory Treatment: Are there upstream areas that retrofit treatment and attenuation could be done as compensation? Look especially for land already available and runoff with high nutrient loading such as agricultural lands.
- Minimum Flows and Levels: Does the project flow to waterbodies with Minimum Flows and Levels (MFL).

E. Conclude the Explore and Collect Data step with a narrative describing the existing project stormwater conditions, potential partnerships, and innovative stormwater solutions that may 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 stormwater management goals and requirements for the project based on the information discovered in Step 2. Having a general knowledge about the scope of the proposed improvements and potential right of -way needs at the start of this step are essential to estimating the stormwater goals and requirements.

Outcome: A narrative describing identified 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 regional stormwater management opportunities and understand their priorities. During the initial stakeholders' coordination meeting, present the stormwater goals and opportunities being considered. 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 be considered on the project.
- Preliminary Stormwater Costs (often based on the preliminary expected cost of traditional ponds) and Project Funding.

Outcome: List of potential partnership stormwater management solutions and innovative solutions to be further analysed.

Step 5 – Define Potential Stormwater Management Strategies

Discuss opportunities identified in Step 4 and screen out non-viable stormwater management solutions. Agree on the criteria for selection (includes constraints or limiting factors that may prevent implementation of solutions). These factors may include stormwater goals and requirements, cost, challenges in permitting,

maintainability, constructability, schedule and environmental considerations. Table 20 – 2 Evaluation Factors for Screening of Solutions provides more information on the types of factors to consider in identifying feasible stormwater management strategies.

Additional evaluation factors could include reliability of partners, compatibility with production schedule, and benefit/cost. This step does not overtly compare solutions, but only eliminates solutions that are flawed or otherwise do not meet the stormwater management goals and requirements. The screening by the stormwater team includes both partnership and non-partnership innovative solutions.

Compile a matrix for the comparison of solutions using the information obtained from Steps 1 through 4. Factors used and the scoring method should be included with the matrix to demonstrate the factors and justify the scoring. An example matrix is provided in Exhibit 20 – 1 Evaluation Matrix Example.

Prepare a work plan for each partnership strategy that is recommended for detail evaluation. Use this plan to facilitate dialogue with the respective stakeholders and secure commitments for all participant's share of the stormwater management solution.

Outcome: A list of viable solutions are identified for further detailed evaluation and to be presented at follow up stakeholder meetings, documented 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 solution vs. the benefit, i.e. reduction in maintenance costs, right-of-way costs, construction costs, 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 document the feedback received. Is this solution permittable or will extensive negotiations be needed?
Water Quantity/Floodplain Benefit	Identify if the solution will provide water quantity or floodplain benefits and if so, quantify the 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 be impacted by the solution. Identify any costs associated with avoiding or mitigating these impacts.
Wetland Credits	Identify if any wetland credits may be realized by the implementation of the solution and the associated benefit(s) that would be provided to the agency. Identify if the anticipated wetland credits would potentially satisfy mitigation requirements for the project and if there would be additional credits for future projects.
Seagrass Credits	Identify if any seagrass credits may be realized by the implementation of the solution and the associated benefit(s) that would be provided to the agency. Identify if the seagrass credits would satisfy 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 have a use under the definition of Section 4(f) or if there would be a benefit as a result of the solution.
Conservation Lands	Identify the presence of any conservation lands which may affect the suitability of a solution.
Cultural Resources Involvement	Identify the potential presence of cultural resources including 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.
Contamination – Hazardous Materials	Identify if the area to be utilized for the solution is contaminated. Consider the 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 associated costs, such as additional drainage piping to transport stormwater and access for construction.
Maintenance	Identify the costs and frequencies of maintenance needed to maintain the solution.
Aesthetics	Identify if there are any associated costs or benefits for aesthetics of the solution, such as 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

Prepare a work plan for each partnership strategy that is recommended for detail evaluation. Use this plan to facilitate dialogue with the respective stakeholders and secure commitments for all participant's share of the stormwater management solution.

Outcome: A list of viable solutions are identified for further detailed evaluation and to be presented at follow up stakeholder meetings, documented in a memorandum.

Step 6 – Present Potential Stormwater Strategies at Stakeholders Meeting

Present to the stakeholders viable partnership solutions and provide the stakeholders and regulators with an opportunity to provide input. Inform the group about any potential innovative stormwater solutions which are being pursued. This is also an opportunity to learn about any other projects that may be worth considering.

Outcome: Meeting notes and a memorandum that document the findings of the Planning phase.

Step 7 – Further Coordination, Data Gathering, and Analysis

Coordination with prospective partners continues during this step. In addition to technical investigations, i.e. preliminary soil borings or survey, specific to the solutions being proposed with potential partners, the topics listed under Partnership Solutions in Step 5 should be discussed with potential partners. Share the results of the investigations with water management districts (and other partners) to ascertain the ability to permit the alternative solutions and determine what additional information is needed to resolve the level of alternatives' certainty.

Where corridors cross several basins, a combination of solutions may be needed to address project stormwater requirements. When a single innovative approach does not fully satisfy 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 agreements involving partnership solutions are developed by agency legal staff and executed between the agency and its partners. The type of legal agreement will depend on the partnering entity. For example, with state or federal regulatory agencies, a Memorandum of Agreement (MOA) or a Memorandum of Understanding (MOU) may be used, but local governments typically execute a Joint Project Agreement (JPA) or easements.

Outcome: MOU/MOA/JPA

Step 9 – Traditional Pond Siting

Once it has been determined by the Stormwater Team that ponds may be needed to meet regulatory requirements, and that the acquisition of 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 ***Section D.2 Pond Siting Process*** of this Chapter..

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 now be ready for at least a conceptual WMD permit. Different permitting scenarios can be employed, depending on the types of stormwater management solutions selected, as shown in Table 20 – 3 Project Permitting Scenarios Involving Full and Partial Solutions.

If 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
✓	-	-	✓		✓
✓	-	-	X*	✓	
-	✓	✓	✓		✓
-	✓	✓	X*	✓	

* Conceptual plans will be needed for the Conceptual Permit application.

Outcome: Appropriate WMD permit.

Step 11 – Document: Stormwater Management Report

The Stormwater Management Report summarizes the memoranda prepared in planning; discusses the stormwater solutions ~~analysed~~analyzed, and solutions considered but eliminated; and documents the stormwater management solutions which will satisfy the water quality and attenuation needs of the project. This report will include all agreements with stakeholders and a summary of all meetings. If traditional pond siting was pursued the report will contain the preliminary drainage design of the project and, as needed, all traditional pond sites ~~analysed~~analyzed for design. The memoranda prepared 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

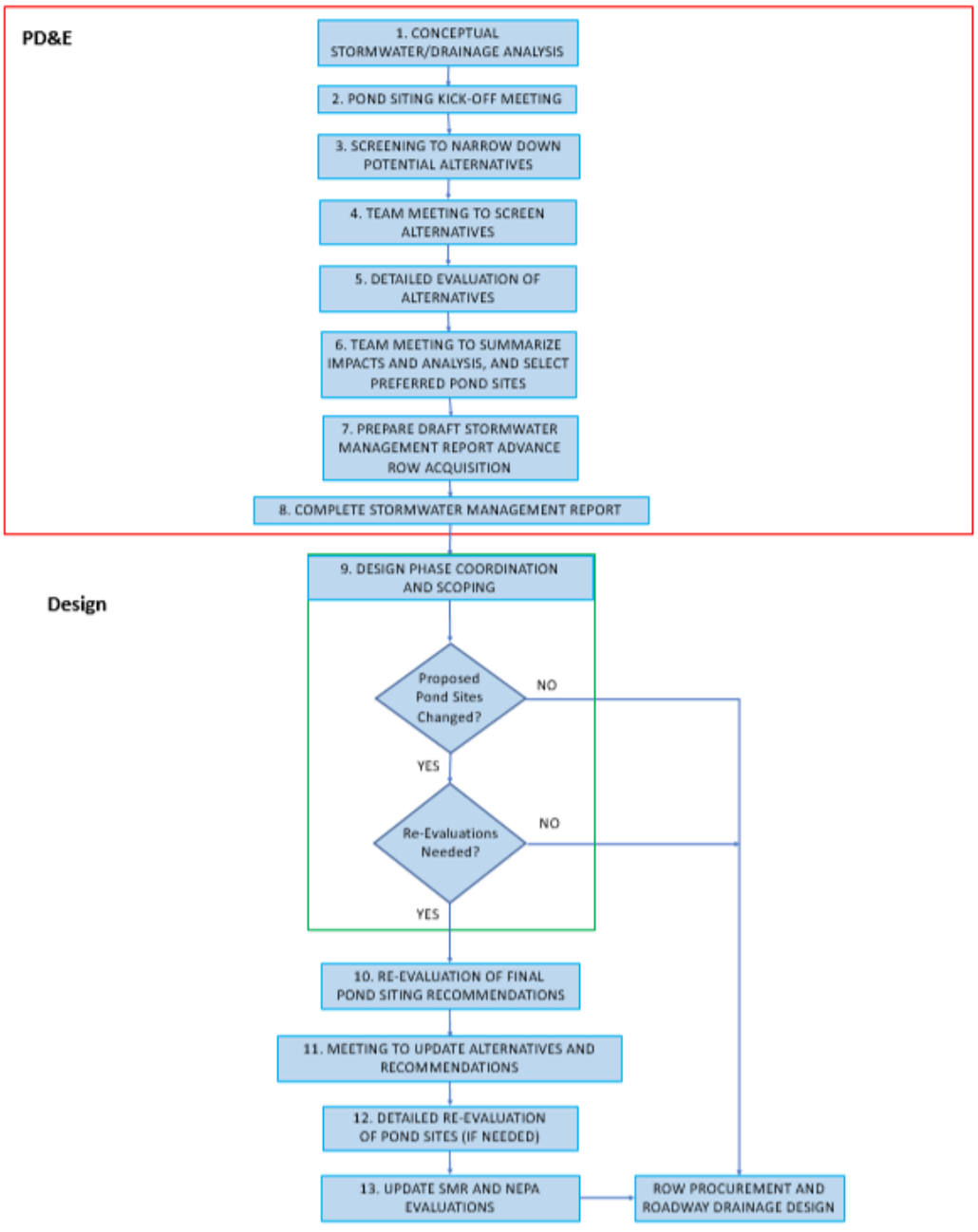
Design and stormwater plans production are finalized. Construction permits are obtained for the project as required. Stakeholder coordination and communication should be continued by the Champion during this time, including the transfer of maintenance responsibility to partners, if agreed upon as part of the partnership.

Outcome: Completed project including transfer of maintenance to partners, if applicable.

D.2 Pond Siting Process

The following pond siting process provides guidance for identifying, evaluating, and selecting locations for stormwater management ponds when those ponds require right of way (ROW) acquisition. The need for ponds may be driven by regulatory water quality, attenuation, and/or floodplain mitigation requirements. An overview is provided in Figure 20 – 2 ~~—~~Pond Siting Process Flowchart.

Figure 20 – 2 Pond Siting Process Flowchart



Step 1: Conceptual Stormwater/Drainage Analysis

Once it has been determined that traditional pond sites are needed to meet water quality or quantity requirements or dual evaluation will be needed, the following process can be used for conceptual analysis.

1. Establish drainage design criteria (may include a pre-permit application meeting with agencies). Criteria should include the following:
   - Permitting criteria (water quality and quantity as well as discharge limitations).
   - Rainfall intensity for critical duration 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 permit files for the corridor and adjacent developments.
3. Determine drainage basin boundaries using aerial contour maps, old construction plans, and available surveys to identify the primary basins and general outfall locations.
   - Identify high points on the profile to separate the primary basins.
   - Conduct field visits for this determination.
4. Determine major off-site contributing areas.
5. Establish floodplain elevations and potential for encroachment.
6. Identify outfall locations and verify if closed basin criteria apply.
7. Develop generic soils information (obtain from County Soil Conservation Survey or from earlier geotechnical studies conducted in the area).
8. Establish seasonal high ground water table (SHGWT) elevations.
9. Develop design estimates for water quality and water quantity requirements.

10. Develop an initial system model using a routing program.

11. Identify alternative pond design options based on project site conditions and available 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, pond locations are typically much more frequent, as driven by the roadway profile.

12. Identify alternative stormwater management options (consider available funding):

- Existing stormwater management facilities – are these adequate to handle the proposed improvements (with or without modifications)?
- Potential exfiltration trench options.
- Dry detention / retention systems.
- Wet detention / retention systems.

13. Coordinate with the ROW Office on some initial 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 incorporated into the area plan.

Outcome: Conceptual drainage design, including identified types of ponds and their approximate capacity.

Approximate Timeline: 2 months

Step 2: Pond Siting Kick-off Meeting

Before the meeting, coordinate with the right of way and legal staff to identify some initial pond sites to discuss at the kick-off meeting. During the meeting, the following issues should be addressed:

1. Verification of pond design guidelines and criteria (includes District preferences).
2. Identify potential detention / retention pond sites.
3. Assign property ID number to each property to be considered. The ROW Office will provide these numbers.
4. Identify potential joint-use pond sites (public / private).
5. Task team members with an assignment to conduct an impact analysis. Assign impact analysis to team members.

Outcome: A developed framework for future pond site evaluations.

Approximate Timeline: 2 weeks

Step 3: Screening to Narrow Down Potential Alternatives

This evaluation consists of a general review to narrow down potential alternatives. This effort may include site specific geotechnical testing, survey, constructability reviews, etc. Issues to consider when evaluating right-of-way include:

1. Use existing ROW whenever possible.
2. Minimize the number of parcels required for pond construction along the corridor.
3. Review aerials for potentially available vacant land. Use vacant land whenever possible and economical.
    - Establish why a property is vacant, and if the property owner has plans for development. Land may be vacant because the owner is having difficulty in permitting proposed improvements.

- Consider the development potential of a property.

4. 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.

5. Avoid the following types of properties if possible:

   - Residential and commercial relocations.
   - Public and historic facilities.
   - Pond sites directly located on major streets and highways.
   - Pond sites on or adjacent to contaminated sites.

6. Look at access management issues and how the remainder of the site will operate.

   - Avoid landlocking the remaining property.
   - Consider how maintenance will access the pond site.

7. Avoid or minimize impacts to existing wetland systems and wildlife habitat. When placing ponds near wetlands, check the potential drawdown effects on the wetlands.

8. Avoid floodplain impacts.

9. Minimize utility relocations and review requirements for utility access for maintenance purposes.

10. Identify if proposed pond sites are candidates for advanced acquisition. 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 several standardized factors should be considered, as shown in Table 20 – 4 Evaluation Factors for Pond Siting Alternatives. The project's stormwater team has the option of customizing the factors within the matrix to satisfy the particularities of their project. An example of a matrix format is shown in Exhibit 20 – 1 Evaluation Matrix Example.

For consistency, the team should use a ranking for each factor that is agreed upon by the entire group.

Outcome: Pond site alternatives are reduced to 3 sites per basin, with (1) team member assignments allocated for further, more detailed evaluation; and (2) needed survey requested for the alternative sites still under consideration.

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 the Parcel Number with the Right-of-Way office.	N/A	N/A
Estimated Parcel Size (Acres)	Provide the total area for the required ROW acquisition. The total area is to include the area to meet the water quality / quantity storage requirements as well as maintenance berm width, slopes, perimeter drainage/conveyance ditch 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 could be currently under a proposed plan for improvement (Rezoning Request) or the site may currently be located on a commercial site with an active business. Consideration should also be given to existing and proposed zoning.	N/A	If there are no zoning issues with the site add 5 points per acre. 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 partial ROW acquisition of a property could have a significant impact on the use of the remaining parcel.	N/A	Costs will need to be added to the overall site costs and a weighted value applied accordingly.

Factor	Description/Issues to Consider	Cost $	Weighted Value
Right-of-Way Costs	Identify Right-of-Way Costs associated with the acquisition of the parcel.	$	Costs will need to be added to the overall site costs and a weighted value applied accordingly.
Drainage Considerations	Include a description of the system and corresponding outfall location and parameters. Consider pond location such as in the center of the basin, in the low area within the basin, adjacent to the outfall location, and piping needs / costs, etc. Also consider site elevations and the corresponding need to elevate (build-up) the perimeter berm.	$	Meets FDOT's needs – points TBD by Team. Meets most needs – points TBD by Team. Other issues between sites will be depend on construction costs of a facility at each particular site.
FEMA Flood Zone	Identify the Flood Zone and associated impacts / benefits of a pond within the flood zone. The perimeter berm will affect flood zone storage, while the pond will enhance storage. When right-of-way is acquired within a low-lying area, the construction of the roadway template may affect adjacent properties' ability to use that area for storage.	N/A	Meets 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 include the costs associated with the clean-up of the site.	N/A	Additional costs will need to be added to the overall site costs and a weighted value applied accordingly.

Factor	Description/Issues to Consider	Cost $	Weighted Value
Utilities	Identify existing and proposed utilities within or adjacent to the parcel. The cost of relocating utilities must be included in the consideration of a parcel.	$	Additional costs 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 anticipated mitigation costs.	N/A	Additional costs will need to be added to the overall site costs, and a weighted value applied accordingly.
Noise	Identify noise impacts and corresponding noise abatement, which may impact the location and placement of pond sites.	N/A	Additional costs 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 indicative of relatively undisturbed, natural, or stable habitat types. Low values may indicate disturbed habitats. Identify the cost of mitigating for these impacts.	$	Additional costs will need to be added to the overall site costs, and a weighted value applied accordingly.
Cultural Resources Involvement and associated Costs	Identify the presence of cultural resources including archaeological and historical resources which could affect the suitability of the site in question and associated costs.	N/A	Additional costs will need to be added to the overall site costs, and a weighted value applied accordingly.

Factor	Description/Issues to Consider	Cost $	Weighted Value
Section 4(f)	Identify the presence of Section 4(F) properties which could affect the suitability of the site in question and associated costs.	N/A	Additional costs will need to be added to the overall site costs, and a weighted value applied accordingly.
Public Wellfield	The proximity to a wellfield site will have a direct impact on the type of drainage facility which can be placed on the corresponding parcel.	N/A	N/A
Construction	Identify access for construction and associated impacts which may affect construction costs, such as amount of drainage piping required to reach pond.	N/A	No set weighted value is applicable for this item; however, requirements for items identified may 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 facility at this location and the potential for maintenance agreements with others. Consider 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 present value for inclusion in the overall cost item below. Establish a cost for: • Wet Detention Maint. Cost per Acre $____

Factor	Description/Issues to Consider	Cost $	Weighted Value
			• 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 Residency Concerns	Identify possible impacts to current or proposed land use (i.e., schools may dictate a dry pond versus a wet pond).	N/A	N/A; however, this factor may affect the type of system selected for a site.

Factor	Description/Issues to Consider	Cost $	Weighted Value
Other	Joint Use 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 cost identified from 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 need 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 Advantages and Disadvantages 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 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, reasonable efforts must be made to inform the public/affected property owners of the potential impacts to the community/properties of the proposed improvements. As such, properties identified for potential acquisition for retention/detention ponds should be presented to the public in the same manner as acquisition for geometric requirements. Although the proposed right of way acquisition is displayed, the 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 ROW Acquisition

The Stormwater Management Report should have been incrementally prepared as the pond siting process was unfolding and reviewed by the team. The draft Stormwater Management Report will be presented at the Public Meeting.

Outcome: The Draft Stormwater Management Report should be made available for the Public Meeting.

Approximate Timeline: 1 month.

Step 8: Hold Public Meeting/Workshop

Advertise and host public meeting/workshop to inform the public about the project and pond locations being considered. Gather public input and document comments for further consideration in design. Conceptual project plans, aerial photos, geotechnical information can be provided to improve the public's understanding of project impacts. 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 Stormwater Management Report and recommendations based on team's evaluation. Exhibit 20 – 2, below, is a sample Table of Contents for Stormwater Management Reports.

1. Discuss and address comments from the Public Meeting.

2. Re-rank recommended and alternative pond sites, if necessary.

Outcome: Final Stormwater Management Report is completed.

Approximate Timeline: 1 week

Exhibit 20 – 2 Sample Table of Contents for Stormwater Management Reports

TABLE OF CONTENTS FOR POND SITING REPORTS

Exhibit F- Pond H Site Plan
Exhibit G- Pond Siting Matrix

APPENDICES

Appendix A- Pond Siting Plan
Appendix B- Geotechnical Data

a. Excerpts from Draft Preliminary Report of Geotechnical Exploration; S.R. 50 from Hancock Road to Orange County Line, Lake County, Florida by Law Engineering and Environmental Services, Inc. October 2003.

b. Excerpts from Draft Preliminary Report of Geotechnical Exploration; S.R. 50 from Lake County Line to East Turnpike Ramps, Orange County, Florida by Law Engineering and Environmental Services, Inc. October 2003.

c. Excerpts from the PD&E Geotechnical Investigation

d. Excerpts from Soil Survey of Lake County, Florida

e. Excerpts from Soil Survey of Orange County, Florida

Appendix C- Rainfall
Appendix D- Floodplain Data
Appendix E- Pond Siting Calculations

a. Water Quality and Attenuation
b. Pond Area Requirements (Proposed Locations)
c. Pond Area Requirements (Alternative Locations)
d. Recovery Time (Preliminary Evaluation)
e. ICPR Pre-Development Model Input & Results
f. ICPR Post-Development Model Input & Results

Step 10: Reevaluation of Final Pond Siting Recommendations

If pond sites selected in the Stormwater Management Report have materially changed from their conditions at the time of the completion, the team should reevaluate the pond siting recommendations.

Outcome: Team members have reviewed changed pond sites and additional engineering data is identified for pursuit. Pond site layouts are refined.

Approximate Timeline: 1 week.

Step 11: Detailed Re-Evaluation of Pond Sites (If Needed)

Re-evaluate remaining viable recommended sites and identified alternate sites and conduct field reviews as necessary. Finalize pond site layout with site geometrics for the viable recommended sites and identified alternatives.

Outcome: Changes to previous pond sites are evaluated in preparation for team discussion and updating of documents.

Approximate Timeline: 3 weeks.

Step 12: Update Stormwater Management Report

Review the findings from the previous step, update the matrix as necessary, recommend final pond sites for project, update the Stormwater Management Report based on team evaluations, and finalize the information. Send to right of way mapping the preferred pond sites as specified in the revised Stormwater Management Report. Send right of way requirements to the right of way staff for procurement.

Outcome: Stormwater Management Report is updated, ROW acquisition begins.

Approximate Timeline: 4 weeks.

E~~C~~ OPEN CHANNEL

This section presents minimum standards for the design of natural or manmade open channels, including roadside ditches, swales, median ditches, interceptor ditches, outfalls, and canals.

E~~C~~.1 Design Frequency

Open channels shall be designed to convey and to confine storm water within the ~~ditch~~channel. Standard design frequencies for stormwater flow are shown in Table 20 – 5~~1~~ Stormwater Flow Design Frequencies.

Table 20 – 5~~1~~ Stormwater Flow Design Frequencies

Facility Types	Frequency
Major roadway	10-year
All other road types	5-year

Site-specific factors may warrant the use of an atypical design frequency. Any increase over pre-development stages shall not significantly change land use values, unless flood rights are acquired.

E~~C~~.2 Hydrologic Analysis

For the design of open channels, use one of the following methods as appropriate for the site: ~~Hydrologic data used for the design of open channels shall be based on one of the following methods as appropriate for the particular site:~~

1. A frequency analysis of observed (gage) data shall be used when available. If insufficient or no observed data is available, one of the procedures below shall be used as appropriate. However, the procedures below shall be calibrated to the extent practical with available observed data for the drainage basin, or nearby similar drainage basins.

~~1.~~a) Regional or local regression equation developed by the United States Geological Survey (USGS).

~~2.~~b) Rational Equation for drainage areas up to 600 acres.

~~3.~~c) For outfalls from stormwater management facilities, the method used for the design of the stormwater management facility may be used.

2. For regulated or controlled canals, hydrologic data shall be requested from the controlling entity. Prior to use for design, this data shall be verified to the extent practical.

~~2.~~3. Stormwater modeling software, approved by the maintaining agency or local government jurisdiction.

E~~C~~.3 Hydraulic Analysis

The Manning's Equation shall be used for the design of open channels.

E~~C~~.3.a Manning's "n" Values

Recommended Manning's n values for channels with bare soil, vegetative linings, and rigid linings are presented in FDOT's~~the Department's Drainage Manual (2008), Table 2.1 and 2.2~~ ***Drainage Manual (2021)***, Table 2.2~~1~~ 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 manual is incorporated by reference in ***Rule***~~Section~~ ***14-86.003, F.A.C., Permit, Assurance Requirements, and Exceptions***.

~~http://www.dot.state.fl.us/officeofdesign/publicationslist.shtm~~

The probable condition of the channel when the design event is anticipated shall be considered when a Manning's n value is selected.

E~~C~~.3.b Slope

Roadside channels should be designed to have self-cleaning velocities, where possible. Channels should also be designed to avoid standing water in the roadway right-of-way.

E~~C~~.3.c Channel Linings and Velocity

The design of open channels shall consider the need for channel linings. When design flow velocities do not exceed the maximum permissible for bare earth, the standard treatment of ditches may consist of grassing and mulching. For higher design velocities, sodding, ditch paving, or other form of lining shall be provided. Tables for maximum velocities for bare earth and the various forms of channel lining can be found in FDOT's~~the Department's~~ ***Drainage Manual (2021~~18~~),*** Tables 2.4~~3~~ Maximum Shear Stress Values and Allowable Velocities for Different Soils and Table 2.5~~4~~ Maximum Velocities for Various Lining Types.

~~http://www.dot.state.fl.us/officeofdesign/publicationslist.shtm~~

E~~C~~.3.d Limitations on Use of Linings

Grassing or sodding should not be used under the following conditions:

1. Continuous standing or flowing water
2. Areas that do not receive the regular maintenance necessary to prevent overgrowth by taller vegetation
3. Lack of nutrients
4. Excessive soil drainage
5. Areas excessively shaded

To prevent cracking or failure, concrete lining must be placed on a firm, well-drained foundation. Concrete linings are not recommended where expansive clays are present.

When concrete linings are to be used where soils may become saturated, the potential for buoyancy shall be considered. Acceptable counter-measures may include:

1. Increasing the thickness of the lining to add additional weight.

2. For sub-critical flow conditions, specifying weep holes at appropriate intervals in the channel bottom to relieve the upward pressure on the channel.

3. For super-critical flow conditions, using subdrains in lieu of weep holes.

E~~C~~.4 Construction and Maintenance Considerations

The type and frequency of maintenance that may be required during the life of drainage channels should be considered during their design, and allowances should be made for the access of maintenance equipment.

E~~C~~.5 Safety

The design and location of open channels shall comply with roadside safety and clear zone requirements. See ***Chapter 3 – Geometric Design*** for clear zone requirements, including special clearance criteria for canals.

E~~C~~.6 Documentation

For new construction, design documentation for open channels shall include the hydrologic and the hydraulic analyses, including analysis of channel lining requirements

.

F~~D~~ STORM DRAIN HYDROLOGY AND HYDRAULICS

This section presents minimum standards for the design of storm drain systems.

F~~D~~.1 Pipe Materials

See Section H~~G~~ for pipe material requirements.

F~~D~~.2 Design Frequency

The minimum design storm frequency for the design of storm drain systems shall be 3 years.

Site-specific factors may warrant the use of an atypical design frequency. Any increase over pre-development stages shall not significantly change land use values, unless flood rights are acquired.

F~~D~~.3 Design Tailwater

For most design applications where the flow is subcritical, the tailwater will either be above the crown of the outlet or can be considered to be between the crown and critical depth. To determine the energy grade line (EGL), begin with either the tailwater elevation or $(d_c + D)/2$, whichever is higher, add the velocity head for full flow and proceed upstream, adding appropriate losses (e.g., exit, friction, junction, bend, entrance).

An exception to the above procedure is an outfall with low tailwater. In this case, a water surface profile calculation would be appropriate to determine the location where the water surface will either intersect the top or end of the barrel and full-flow calculations can begin. In this case, the downstream water surface elevation would be based on critical depth or the tailwater, whichever is higher.

F~~D~~.4 Hydrologic Analysis

The Rational Method is the preferred~~most common~~ method in use for the design of storm drains when the momentary peak-flow rate is desired. Other methods may be used, with permission by the maintaining agency or local government jurisdiction.

F~~D~~.4.a Time of Concentration

Minimum time of concentration shall be 10 minutes.

F~~D~~.5 Hydraulic Analysis

Hydraulic calculations for determining storm drain conduit sizes shall be based on open channel and pressure flow as appropriate. The Manning's equation shall be used.

F~~D~~.5.a Pipe Slopes

The minimum physical slope should be that which will produce a velocity of 2.5 feet per second (fps) when the storm drain is flowing full. Where not practical or possible in flat terrain, include design features to limit soils from entering the pipes.

F~~D~~.5.b Hydraulic Gradient

If the hydraulic grade line (HGL) does 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 the design discharge (some local agencies may add an additional safety factor which can be up to 12 inches). Manholes with bolted lids may be used in locations where the top is below the HGL.

F~~D~~.5.c Outlet Velocity

When discharge exceeds 4 fps, consider special channel lining or energy dissipation. For computation of outlet velocity the lowest anticipated tailwater condition for the given storm event shall be assumed.

F~~D~~.5.d Manning's Roughness Coefficients

Standards Manning's Roughness Coefficients can be found in FDOT's~~the Department's~~ ***Drainage Manual (2021~~018~~) Section 3.6.4***.

~~http://www.dot.state.fl.us/officeofdesign/publicationslist.shtm~~

F~~D~~.6 Hydraulic Openings

If the hydraulic grade line does 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 the design discharge.

The design stage for a ditch bottom inlet may be allowed to exceed the inlet top, when the ditch or swale can accommodate the capacity. Examine where the overtopping elevation could occur to ensure there are no adverse flooding impacts to the roadway or offsite property.

F~~D~~.6.a Entrance Location and Spacing

Drainage inlets and other hydraulic openings are sized and located to satisfy hydraulic capacity, structural capacity, safety (pedestrians, cyclists and motor vehicles), and durability requirements.~~limit the spread of water on the roadway to allowable widths for the design storm.~~

Grate inlets and the depression of curb opening inlets should be located outside the through traffic lanes to minimize the shifting of vehicles attempting to avoid them. All grate inlets shall be bicycle safe where used on roadways that allow bicycle travel.

FDOT's~~The Department's~~ ***Drainage Manual (2021~~18~~), Section 3.7*** ~~*Storm Drain Handbook*~~ provides guidance on hydraulic openings and protective treatments. Table 3.3 Curb and Inlet Application Guidelines, Table 3.4 Ditch Bottom Inlet Application Guidelines and ~~i~~Table 3-5 Drainage End Treatment – Lateral Offset Criteria in the ***Drainage Manual*** provide~~s available as a~~ guidance for inlet selection.

~~http://www.dot.state.fl.us/officeofdesign/publicationslist.shtm~~

Inlet spacing shall consider the following:

- 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.
- 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~~D~~.6.b Grades

F~~D~~.6.b.1 Longitudinal Gutter Grade

The minimum longitudinal gutter grade shall be 0.3%. Minimum grades can be maintained in very flat terrain by use of a rolling profile.

F~~D~~.7 Spread Standards

The spread, in both temporary and permanent conditions, resulting from a rainfall intensity of 4.0 inches per hour shall be limited as shown in Table 20 – 6~~2~~ Spread Criteria.

Table 20 – 6~~2~~ Spread Criteria

Design Speed (mph)	Spread Criteria*
Design Speed ≤ 30	Crown of Road
30 < Design speed ≤ 45	Keep ½ of lane clear
45 < Design Speed ≤ 55	Keep 8’ of lane clear
Design Speed > 55	No encroachment

* The criteria in this column apply to travel, turn, or auxiliary lanes adjacent to barrier wall or curb, in normal or super elevated sections.

In addition to the above standards, for sections with a shoulder gutter, the spread resulting from a 10-year frequency storm shall not exceed 1’ 3” outside the gutter in the direction toward the front slope. This distance limits the spread to the face of guardrail posts.

F~~D~~.8 Construction and Maintenance Considerations

Proper design shall also consider maintenance concerns of adequate physical access for cleaning and repair.

F~~D~~.8.a Pipe Size and Length

Consider using a minimum pipe size of 18” for trunk lines and laterals. 15” hubcaps commonly block smaller pipes resulting in roadway flooding. The minimum pipe diameter for all proposed exfiltration trench pipes (F~~f~~rench drain systems) within a drainage system is 18”.

The maximum pipe lengths without maintenance access structures are as follows:

Pipes without French Drains:

18” - 42” pipe	300 feet
48” and larger and all box culverts	600 feet

French Drains that have access through only one end:

18” to 30” pipe	150 feet
36” and larger pipe	200 feet

French Drains that have access through both ends:

24” to 30” pipe	300 feet
36” and larger pipe	400 feet

F~~D~~.8.b Minimum Clearances

A minimum cover of 1 ft should be provided between the top of pipe and the top of subgrade. A minimum clearance of 1 ft should be provided between storm drainage pipes and other underground facilities (e.g., sanitary sewers). Check with local utility companies, as their clearance requirements may vary from the 1’ minimum.

F.9 Green Stormwater Elements for Context Based Design

Drainage systems are often determined by opportunity, feasibility and topography, rather than context. However, understanding both the existing and future land use and transportation goals can help determine drainage specific options for the proposed design. Future land use and transportation needs can alter the context and change the drainage opportunities available.

The introduction of green streets is one component of a larger drainage design approach to improving the region’s stormwater management, and requires a broader based alliance for its planning, funding, maintenance and monitoring. Green stormwater elements also serve as a visible component of “green Infrastructure” that is incorporated into the aesthetics of the community

The following is a list of drainage considerations that support context based design and minimize the amount of water that leaves 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 be applied in more limited rights of way.

- Bioretention Swale – are shallow, vegetated, landscaped depressions with sloped sides.
- Hybrid Bioretention Cell – combines elements of both swales and planters, featuring a walled side opposite a graded side slope to increase vegetated space and infiltrating area, while providing a softer streetscape treatment for people walking.
- Pervious Strips – are long, linear landscaped areas or linear areas of pervious pavement that can capture and slow runoff.
- Street Trees – can contribute significantly to green stormwater management, with large capacity to transpire water, intercept rainfall, and treat water quality; as well as temperature mitigation and air quality improvement.
- Pervious Pavers/Permeable Pavement – allows water to infiltrate through streets, parking bays and sidewalks, reducing runoff. Maintencae of the pavement will affect long term durability.

Green stormwater infrastructure performance can improve over time if facilities are properly maintained. As vegetation establishes, roots can capture and retain more stormwater. Healthy vegetation and soil increases transpiration, reduces urban heat island effects, supports groundwater recharge, and restores natural ecological cycles and resources.

Robust and iterative operations and maintenance plans are critical to fully capitalizing on the potential of green infrastructure. Include maintenance staff in the project planning process to reduce oversights in the design and ensure that green stormwater infrastructure can achieve its full potential. Although all drainage systems require maintenance, green streets will require special attention to long term mainatence requirements and techniques. Maintenance practices and frequency of maintenance need to be established and personnel trained.

Traffic calming features such as curb extensions can be designed as bioretention areas to intercept stormwater and work with existing roadways and pedestrian features by including ADA compliant grate covered channels or inlets. These and other traffic calming features such as speed tables and raised crosswalks should be evaluated for impacts to pavement hydraulics to ensure runoff is managed without violating spread criteria.

The ***National Association of City Transportation*** Officials' ***(NACTO) Urban Street Stormwater Guide*** provides additional information on the stormwater elements of green streets. FDOT's Standard Plans and FDOT's 2020 Drainage Manual provide further information on the design and placement of trench drains, French 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.***

FD.10~~9~~ Protective Treatment

Drainage designs shall be reviewed to determine if some form ~~–~~of protective treatment will be required to prevent unauthorized entry to long or submerged storm drain systems, steep ditches, or water control facilities. If other modifications, such as landscaping or providing flat slopes, can eliminate the potential hazard and thus the need for protective treatment, they should be considered first. Areas provided for retention and detention, for example, can often be effectively integrated into parks or other green spaces.

Vehicular and 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 evaluation should be made of the relative risks and dangers involved to provide the design that gives the 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.

The three basic types of protective treatment are shown in Table 20 – 7~~3~~ Protective Treatments.

Table 20 – 7~~3~~ Protective Treatments

Feature	Typical Use
Grates	To prevent persons from being swept into long or submerged drainage systems.
Guards	To prevent entry into long sewer systems under no-storm conditions, to prevent persons from being trapped.
Fences	To prevent entry into areas of unexpected deep standing water or high velocity water flow, or in areas where grates or guards are warranted but are unsuitable for other reasons.

When determining the type and extent of protective treatment, the following considerations should be reviewed:

- The nature and frequency of the presence of children in the area, e.g., proximity to schools, school routes, and parks, should be established.
- Highway access status should be determined. Protective treatment is usually not warranted within a limited access highway; however, drainage facilities located outside the limited access area or adjacent to a limited access highway should be considered unlimited access facilities.
- Adequate debris and access control would be required on all inlet points if guards or grates are used at outlet ends.
- Hydraulic determinations such as depth and velocity should be based on a 25-year rainfall event.
- The hydraulic function of the drainage facility should be checked and adjusted so the protective treatment will not cause a reduction in its effectiveness.
- Use of a grate may cause debris or persons to be trapped against the hydraulic opening. Grates for major structures should be designed in a manner that allows items to be carried up by increasing flood stages.

- Use of a guard may result in a person being pinned against it. A guard is usually used on outlet ends.
- A fence may capture excessive amounts of debris, which could possibly result in its destruction and subsequent obstruction of the culvert. The location and construction of a fence shall reflect the effect of debris-induced force.

FD.110 Documentation

For new construction, supporting calculations for storm sewer system design shall be documented and provided to facility owner.

G~~E~~ CROSS DRAIN HYDRAULICS

This section presents standards and procedures for the hydraulic design of cross drains including culverts, bridge-culverts[1], and bridges.

G~~E~~.1 Design Frequency

The recommended minimum design flood frequency for culverts is shown in Table 20 – 8~~4~~ Recommended Minimum Design Flood Frequency. The minimum flood frequency used to design the culvert can be adjusted based on:

- An analysis to justify the flood frequencies greater or lesser than the minimum flood frequencies listed below; and
- The culvert being located in a National Flood Insurance Program mapped floodplain.

Table 20 – 8~~4~~ 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~~E~~.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 a bridge if it meets the requirements of Item 112 in the Department's FDOT "***Bridge Management System (BMS) Coding Guide.***"

- Have a level of inundation that is tolerable to upstream property and roadway for the design discharge.~~;~~
- Consider a duration or inundation that is tolerable to the upstream vegetation to avoid crop damage; and
- Be lower than the upstream shoulder edge elevation at the lowest point of the roadway within the drainage basin.

If the allowable headwater depth to culvert height ratio (HW/D) is established to be greater than 1.5, the inlet of the culvert will be submerged. Under this condition, the hydraulics designer should provide an end treatment to mitigate buoyancy.

G~~E~~.3 Tailwater

For the sizing of cross drains and the determination of 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~~E~~.4 Clearances

To permit the passage of debris, a minimum clearance of 2 ft should be provided between the design approach water surface elevation and the low chord of the bridge where practical. Where this is not practicable, the clearance should be established by the hydraulics engineer based on the type of stream and level of protection desired. Additional vertical clearance information can be found in ***Chapter 3 – Geometric Design***.

G~~E~~.5 Bridges and Other Structures

It is important for the hydraulic engineer to accurately represent the hydraulic condition. The modeling approach should be selected based primarily on its advantages and limitations, though also considering the importance of the structure, potential project impacts, cost, and schedule.

One-dimensional models are best suited for in-channel flows and when floodplain flows are minor. They are also frequently applicable to small streams. For extreme flood conditions, one-dimensional models generally provide accurate results for

narrow to moderate floodplain widths. In general, where lateral velocities are small, one-dimensional models provide reasonable results.

Two-dimensional models should be used when flow patterns are complex and one-dimensional model assumptions are significantly violated. 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.

The National Cooperative Highway Research Program published a report entitled ***"Criteria for Selecting Hydraulic Models" (NCHRP 2006)*** that provides a procedure for selecting the most appropriate model for a particular application incorporating site conditions, design elements, available resources and project constraints.

The following Table 20 – 9 Bridge Hydraulic Modelling Selection may be used to determine the appropriate modeling approach.

Table 20 – 9 Bridge Hydraulic Modeling Selection

Bridge Hydraulic Condition	Hydraulic Analysis Method	
	One-Dimensional	Two-Dimensional
Small Streams	●	□
In-Channel Flows	●	□
Narrow to Moderate-width Floodplains	●	□
Wide Floodplains	□	●
Minor Floodplain Constriction	●	□
Highly Variable Floodplain Roughness	□	●
Highly Sinuous Channels	□	●
Multiple Embankment Openings	□/×	●
Unmatched Multiple Openings in Series	□/×	●
Low Skew Roadway Alignment (<20’)	●	□
Moderately Skewed Roadway Alignment (>20’ and <30’)	□	●
Highly Skewed Roadway Alignment (>30’)	×	●
Detailed Analysis of Bends, Confluences and Angle of Attack	×	●
Multiple Channels	□	●
Small Tidal Streams and Rivers	●	□
Large Tidal Waterways and Wind-influenced Conditions	×	●
Detailed Flow Distribution at Bridges	□	●

Table 20 – 9 Bridge Hydraulic Modeling Selection (continued)

Significant Roadway Overtopping	□	●
Upstream Controls	×	●
Countermeasure Design	□	●

● well suited or primary use

□ possible application or secondary use

× unsuitable or rarely used

□/× possibly unsuitable depending on application

See also Chapter 17 – Structures, Section C.3.e for additional information on Drainage Criteria for structures.

F STORMWATER MANAGEMENT

F.1 Regulatory Requirements

F.1.a Chapter 62-25, Florida Administrative Code

Chapter 62-25. F.A.C., rules of the Florida Department of Environmental Protection specifies minimum water quality treatment standards for new development.

F.1.b Chapter 62-40, Florida Administrative Code

Chapter 62-40, F.A.C., rules of the Florida Department of Environmental Protection outlines basic goals and requirements for surface water protection and management to be implemented and enforced by the Florida Department of Environmental Protection and Water Management Districts.

F.1.c National Pollutant Discharge Elimination System

The ***National Pollutant Discharge Elimination System*** (***NPDES***) permit program is administered by the U. S. Environmental Protection Agency and delegated to the Florida 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 within the definition of an industrial activity.

H~~G~~ CULVERT MATERIALS

The evaluation of culvert materials shall consider functionally equivalent performance in three areas: durability, structural capacity, and hydraulic capacity.

H~~G~~.1 Durability

Culverts shall be designed for a design service life (DSL) appropriate for the culvert function and highway type. The 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 projected future demands on the facility.

In estimating the projected service life of a material, consideration shall be given to actual performance of the material in nearby similar environmental conditions, its theoretical corrosion rate, potential for abrasion, and other appropriate site factors. Theoretical corrosion rates shall be based on the environmental conditions of both the soil and water. At a minimum, the following corrosion indicators shall be considered:

1. pH
2. Resistivity
3. Sulfates
4. Chlorides

FDOT ~~The Department of Transportation~~ provides a ~~free~~ program called ***Culvert Service Life Estimator*** for estimating the service life of culverts~~service life determination~~ based on the above criteria. ~~The program is available for download at:~~ The Culvert Service Life Estimator is based upon the soils the pipe is placed in, and not type of water the pipe carries.

~~http://www.dot.state.fl.us/officeofdesign/publicationslist.shtm~~

To avoid unnecessary site specific testing, generalized soil maps may be used to delete unsuitable materials from consideration. The potential for future land use changes which may change soil and water corrosion indicators shall also be considered to the extent practical.

H~~G~~.2 Structural Design~~Capacity~~

The structural design of all culverts, storm drain pipes and drainage structures shall be in accordance with specifications (including guide specifications) published by the American Association of State Highway and Transportation Officials (AASHTO). At a minimum, the ***AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, 9th Edition (2020)*** shall be used.

~~AASHTO design guidelines and industry recommendations should be considered in pipe material selection.~~

H~~G~~.3 Hydraulic Capacity

The hydraulic evaluation shall establish the hydraulic size for the particular culvert application. For storm drains and cross drains, the design shall use the Manning's roughness coefficient associated with the pipe material selected.

THIS PAGE INTENTIONALLY LEFT BLANK