EXHIBIT A Bridge Load Rating Summary Table

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

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., Interior/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	Performed by:.	Date:
Rating Type, *Analysis*	enter Rating Type	Checked by:	Date:
Distribution Method	enter Distribution Method	Sealed By:	Date:
Impact Factor	enter IM (axle loading)	FL P.E. No.:	
FL120 Gov. Span Length	enter Gov Length (feet)	Cert. Auth. No.:	
Recommended Posting	enter Posting (70)	Phone & email:	
Rec. SU Posting	enter SU posting (tons)	Company:	
Rec. C Posting	enter C posting (tons)	Address:	
Rec. ST5 Posting	enter ST5 posting(tons)	P.E. Seal	
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.			

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 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 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.
- 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 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.
- 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

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 Florida Accessibility Code for Building Construction
  https://codes.iccsafe.org/public/document/FAC2017

CHAPTER 18

SIGNING AND MARKING

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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 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, Florida Administrative Code (F.A.C.):*

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

The *Manual on Speed Zoning for Highways, Roads, and Streets in Florida (2017),* is adopted for use by the State of Florida under *Rule 14-15.012, F.A.C.* This manual is prepared by 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 the Department's *Standard Plans, Index 700-050.*. 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 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.*

C.6 Design Details for Signs

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

Shared use path sign sizing for traffic control shall follow the "Shared-Use Path" sizing and height shown in the MUTCD. See ***Chapter 9 – Bicycle Facilities*** for additional requirements on the signing of shared use paths.

D PAVEMENT MARKINGS

D.1 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

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 lane, it is recommended that treatments be installed system-wide or in corridors, Their use should be determined on the suitability of the cross-section and appropriateness in the surrounding land use context.

Considerations that may limit the acceptability and effectiveness include low speeds, noise for adjacent residences, and pavement width. 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.***

E.2 Transverse Rumble Strips

Transverse rumble strips may be used to alert the driver to upcoming stop conditions or abrupt changes in alignment. 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*** provides further information on the use of transverse rumble strips.

CHAPTER 19

TRADITIONAL NEIGHBORHOOD DEVELOPMENT

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TRADITIONAL NEIGHBORHOOD DEVELOPMENT

A INTRODUCTION

Florida is a national leader in planning, design and construction of Traditional Neighborhood Development (TND) communities, and in the renovation of downtown neighborhoods and business districts. TND refers to the development or redevelopment of a neighborhood or town using traditional town planning principles. Projects should include a range of housing types and commercial establishments, a network of well-connected streets and blocks, civic buildings and public spaces, and include other uses such as stores, schools, and worship within walking distances of residences.

They represent patterns of development aligned with the state's growth management, smart growth and sprawl containment goals. This approach, with its greater focus on pedestrian, bicycle and transit mobility; is distinct from Conventional Suburban Development (CSD). CSDs are comprised largely of subdivision and commercial strip development.

TND communities rely on a strong integration of land use and transportation. A TND has clearly defined characteristics and design features that are necessary to achieve the goals for compact and livable development patterns reinforced by a context-sensitive transportation network. The treatment of land use, development patterns and transportation networks necessary for successful TND communities is a major departure from those same elements currently utilized in other Greenbook chapters.

To provide a design that accomplishes the goals set out in this chapter, designers will be guided by the context of the built environment, established or desired, for a portion of the communities because TND communities rely on a stronger integration of land use and transportation than CSD communities. This chapter provides criteria that may be used for the design of streets within a TND when such features are desired, appropriate and feasible. This involves providing a balance between mobility and livability. This chapter may be used in planning and designing new construction, urban infill, and redevelopment projects.

Section B of this chapter discusses the primary objectives of TND in more detail to aid the designer in the selection of proper criteria. Section C sets forth specific design criteria for the transportation system within TND.

The Department's ***Traditional Neighborhood Development Handbook (2011)*** provides designers guidance in the successful application of this Chapter.

B APPLICATION

A project or community plan may be considered a TND when at least the first seven of the following principles are included:

1. Has a compact, pedestrian-oriented scale that can be traversed in a five to ten-minute walk from center to edge.
2. Is designed with low speed, low volume, interconnected streets with short block lengths, 150 to 500 feet, and cul-de-sacs only where no alternatives exist. Cul-de-sacs, if necessary, should have walkway and bicycle connections to other sidewalks and streets to provide connectivity within and to adjacent neighborhoods.
3. Orients buildings at the back of sidewalk, or close to the street with off-street parking located to the side or back of buildings, as not to interfere with pedestrian activity.
4. Has building designs that emphasize higher intensities, narrow street frontages, connectivity of sidewalks and paths, and transit stops to promote pedestrian activity and accessibility.
5. Incorporates a continuous bike and pedestrian network with wider sidewalks in commercial, civic, and core areas, but at a minimum has sidewalks at least five feet wide on both sides of the street. Accommodates pedestrians with short street crossings, which may include mid-block crossings, bulb-outs, raised crosswalks, specialty pavers, or pavement markings.
6. Uses on-street parking adjacent to the sidewalk to calm traffic, and offers diverse parking options, but planned so that it does not obstruct access to transit stops.
7. Varies residential densities, lot sizes, and housing types, while maintaining an average net density of at least eight dwelling units per acre, and higher density in the center.
8. Integrates at least ten percent of the developed area for nonresidential and civic uses, as well as open spaces.
9. Has only the minimum right of way necessary for the street, median, planting strips, sidewalks, utilities, and maintenance that are appropriate to the adjacent land uses and building types.
10. Locates arterial highways, major collector roads, and other high-volume corridors at the edge of the TND and not through the TND.

The design criteria in this chapter shall only be applicable within the area defined as TND.

C PLANNING CRITERIA

Planning for TND communities occurs at several levels, including the region, the city/town, the community, the block, and, finally, the street and building. Planning should be holistic, looking carefully at the relationship between land use, buildings, and transportation in an integrated fashion. This approach, and the use of form based codes, can create development patterns that balance pedestrian, bicycling, and transit with motor vehicle transportation.

C.1 LAND USE

In addition to its importance in calculating trip generation, the Institute of Transportation Engineers (ITE) recognizes land use as fundamental to establishing context, design criteria, cross-section elements, and right of way allocation. The pedestrian travel that is generated by the land uses is also important to the design process for various facilities.

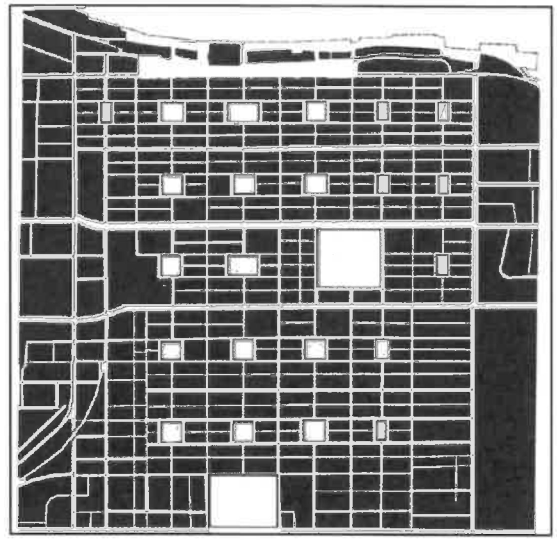
A well-integrated, or "fine grained", land use mix within buildings and blocks is essential. These buildings and blocks aggregate into neighborhoods, which should be designed with a mix of uses to form a comprehensive planning unit that aggregates into larger villages, towns, and regions. Except at the regional scale, each of these requires land uses to be designed at a pedestrian scale and to be served by "complete streets" that safely and attractively accommodate many modes of travel.

The proposed land uses, residential densities, building size and placement, proposed parking (on-street and off-street) and circulation, the location and use of open space, and the development phasing are all considerations in facility design for TNDs. ITE recommends a high level of connectivity, short blocks that provide many choices of routes to destinations, and a fine-grained urban land use and lot pattern. Higher residential density and nonresidential intensity, as measured by floor area ratios of building area to site area, are required for well-designed TNDs.

C.2 NETWORKS

Urban networks are frequently characterized as either traditional or conventional. Traditional networks are typically characterized by a relatively non-hierarchical pattern of short blocks and straight streets with a high density of intersections that support all modes of travel in a balanced fashion.

Figure 19 – 1 Traditional Network



New York, NY **Savannah, GA** (Source: VHB)

The typical conventional street network, in contrast, often includes a framework of widely-spaced arterial roads with limited connectivity provided by a system of large blocks, curving streets and a branching hierarchical pattern, often terminating in cul-de-sacs.

Figure 19 – 2 Conventional Network

Walnut Creek, CA
(Source: VHB)

Traditional and conventional networks differ in three easily measurable respects: (1) block size, (2) degree of connectivity and (3) degree of curvature. While the last does not significantly impact network performance, block size and connectivity create very different performance characteristics.

Advantages of traditional networks include:

1. Distribution of traffic over a network of streets, reducing the need to widen roads;
2. A highly interconnected network providing a choice of multiple routes of travel for all modes, including emergency services;
3. More direct routes between origin and destination points, which generate fewer vehicle miles of travel (VMT) than conventional suburban networks;
4. Smaller block sizes in a network that is highly supportive to pedestrian, bicycle, and transit modes of travel;
5. A block structure that provides greater flexibility for land use to evolve over time.

It is important in TND networks to have a highly interconnected network of streets with smaller block sizes than in conventional networks. There are several ways to ensure that these goals are achieved.

One method is based upon the physical dimensions used to layout streets and blocks. The following list identifies those parameters:

1. Limit block size to an average perimeter of approximately 1,320 feet.
2. Encourage an average intersection spacing for local streets of 300-400 feet.
3. Limit maximum intersection spacing for local streets to approximately 600 feet.
4. Limit maximum spacing between pedestrian/bicycle connections to approximately 300 feet (that is, it creates mid-block paths and pedestrian shortcuts).

D OBJECTIVES

The basic objectives of a Traditional Neighborhood Development are:

1. Safety
2. Mobility of all users (vehicles, pedestrians, bicyclists and transit)
3. Compact and livable development patterns
4. Context-sensitive transportation network

TND features are based upon the consideration of the following concepts. These concepts are not intended as absolute criteria since certain concepts may conflict. The concepts should therefore be used for the layout of proper street systems.

1. Strong integration of land use and transportation.
2. Very supportive of pedestrian, bicycle, and transit modes.
3. Smaller block sizes to improve walkability, and to create a fine network of streets accommodating bicyclists and pedestrians, and providing a variety of routes for all users.
4. On-street parking is favored over surface parking lots.
5. Limited use of one way streets.
6. Speeds for motor vehicles are ideally kept in the range of 20-35 mph through the design of the street, curb extensions, use of on-street parking, the creation of enclosure through building and tree placement.
7. Street geometry (narrow streets and compact intersections), adjacent land use, and other elements within a TND must support a high level of transit, pedestrian and bicycle activity.
8. Provide access to emergency services, transit, waste management, and delivery trucks.
9. Provide access to property.

This approach to street design requires close attention to the operational needs of transit, fire and rescue, waste collection, and delivery trucks. For this reason, early coordination with transit, fire and rescue, waste collection, and other stakeholder groups is essential. For fire and rescue, determination of the importance of that corridor for community access should be determined, e.g. primary or secondary access.

More regular encroachment of turning vehicles into opposing lanes will occur at intersections. Therefore, frequency of transit service, traffic volumes, and the speeds at those intersections must be considered when designing intersections.

When designing features and streets for TND communities, creativity and careful attention to safety for pedestrians and bicyclists must be balanced with the operational needs of motor vehicles.

Finally, it is very important when designing in TND communities to ensure that a continuous network is created for pedestrians, bicyclists, and transit throughout the community to create higher levels of mobility that are less dependent on automobile travel.

E DESIGN ELEMENTS

The criteria provided in this chapter shall require the approval of the maintaining authority's designated Professional Engineer representative with project oversight or general compliance responsibilities. Approval may be given based upon a roadway segment or specific area.

The criteria provided in this chapter are generally in agreement with AASHTO guidelines with a special emphasis on urban, low-speed environments. Design elements within TND projects not meeting the requirements of this chapter are subject to the requirements for Design Exceptions found in ***Chapter 14*** of this manual.

E.1 Design Controls

E.1.a Design Speed

The application of design speed for TND communities is philosophically different than for conventional transportation and CSD communities. Traditionally, the approach for setting design speed was to use as high a design speed as practical.

In contrast to this approach, the goal for TND communities is to establish a design speed that creates a safer and more comfortable environment for pedestrians and bicyclists, and is appropriate for the surrounding context.

Design speeds of 20 to 35 mph are desirable for TND streets. Alleys and narrow roadways intended to function as shared spaces may have design speeds as low as 10 mph.

E.1.b Movement Types

Movement types are used to describe the expected driver experience on a given thoroughfare, and the design speed for pedestrian safety and mobility established for each of these movement types. They are also used to establish the components and criteria for design of streets in TND communities.

Yield: Has a design speed of less than 20 mph. Drivers must proceed slowly with extreme care, and must yield to pass a parked car or approaching vehicle. This is the functional equivalent of traffic calming. This type should accommodate bicycle routes through the use of shared lanes.

Slow: Has a design speed of 20-25 mph. Drivers can proceed carefully, with an occasional stop to allow a pedestrian to cross or another car to park. Drivers should feel uncomfortable exceeding design speed due to the presence of parked cars, enclosure, tight turn radii, and other design elements. This type should accommodate bicycle routes through the use of shared lanes.

Low: Has a design speed of 30-35 mph. Drivers can expect to travel generally without delay at the design speed, and street design supports safe pedestrian movement at the higher design speed. This type is appropriate for thoroughfares designed to traverse longer distances, or that connect to higher intensity locations. This type should accommodate bicycle routes through the use of bike lanes.

Design speeds higher than 35 mph should not normally be used in TND communities due to the concerns for pedestrian and bicyclist safety and comfort. There may be locations where planned TND communities border, or are divided by, existing corridors with posted/design speeds higher than 35 mph. In those locations, coordination with the regulating agency should occur with a goal to re-design the corridor and reduce the speed to 35 mph or less. The increase in motorist travel time due to the speed reduction is usually insignificant because TND communities are generally compact.

When the speed reduction cannot be achieved, measures to improve pedestrian safety for those crossing the corridor should be evaluated and installed when appropriate.

E.1.c Design Vehicles

There is a need to understand that street design with narrow streets and compact intersections requires designers to pay close attention to the operational needs of transit, fire and rescue, waste collection, and delivery trucks. For this reason, early coordination with transit, fire and rescue, waste collection, and other stakeholder groups is essential.

Regular encroachment of turning vehicles into opposing lanes will occur at intersections. Therefore, frequency of transit service, traffic volumes, and the speeds at those intersections must be considered when designing intersections. For fire and rescue, determination of the importance of the street for community access should be determined, e.g. primary or secondary access.

The designer should evaluate intersections using turning templates or turning movement analysis software to ensure that adequate operation of vehicles can occur. Treatment of on-street parking around intersections should be evaluated during this analysis to identify potential conflicts between turning vehicles and on-street parking.

E.2 Sight Distance

See ***Chapter 3 – Geometric Design, C.3 Sight Distance.***

E.2.a Stopping Sight Distance

See ***Chapter 3 – Geometric Design, C.3.a Stopping Sight Distance***.

E.2.b Passing Sight Distance

Due to the importance of low speeds and concerns for pedestrian comfort and safety, passing should be discouraged or prohibited.

E.2.c Intersection Sight Distance

Sight distance should be calculated in accordance with ***Chapter 3, Section C.9.b***, using the appropriate design speeds for the street being evaluated. When executing a crossing or turning maneuver after stopping at a stop sign, stop bar, or crosswalk, as required in ***Section 316.123, F.S.***, it is assumed that the vehicle will move slowly forward to obtain sight distance (without intruding into the crossing travel lane) stopping a second time as necessary.

Therefore, when curb extensions are used, or on-street parking is in place, the vehicle can be assumed to move forward on the second step movement, stopping just shy of the travel lane, increasing the driver's potential to see further than when stopped at the stop bar. The resulting increased sight distance provided by the two step movement allows parking to be located closer to the intersection.

The ***MUTCD*** requires that on-street parking be located at least 20 feet from crosswalks. The minimum stopping sight distance is 60 feet for low volume (< 400 ADT) streets. Even on slow speed, low volume urban streets, the combination of curb return, crosswalk width and 20-foot setback to the first parking space may not meet the minimum stopping distance. Justification for locating parking spaces 20 feet from crosswalks may be achieved based on community history with existing installations.

E.3 Horizontal Alignment

E.3.a Minimum Centerline Radius

See ***Chapter 3 – Geometric Design, C.4 Horizontal Alignment*** and Table 3 – 12 Minimum Radii (feet) for Design Superelevation Rates Low Speed Local Roads ((e_{max} = 0.05) .

E.3.b Minimum Curb Return Radius

Curb return radii should be kept small to keep intersections compact. The use of on-street parking and/or bike lanes increases the effective size of the curb radii, further improving the ability of design vehicles to negotiate turns without running over the curb return.

Table 19 – 1 Curb Return Radii

Movement Type	Design Speed	Curb Radius w/Parallel Parking*
Yield	Less than 20 mph	5-10 feet
Slow	20-25 mph	10-15 feet
Low	30-35 mph	15-20 feet

* Dimensions with parking on each leg of the intersection. Both tangent sections adjacent to the curb return must provide for on-street parking or else curb radii must **be evaluated using "design vehicle" and** either software or turning templates.

E.4 Vertical Alignment

See ***Chapter 3 – Geometric Design, C.5 Vertical Alignment***.

E.5 Cross Section Elements

E.5.a Introduction

As discussed earlier in this chapter, TND street design places importance on how the streets are treated since they are part of the public realm. The street portion of the public realm is shaped by the features and cross section elements used in creating the street. For this reason, it is necessary the designer pay more attention to what features are included, where they are placed, and how the cross section elements are assembled.

E.5.b Lane Width

Travel lane widths should be based on the context and desired speed for the area where the street is located. Table 19-2 shows travel lane widths and associated appropriate speeds. It is important to note that in low speed urban environments, lane widths are typically measured to the curb face instead of the edge of the gutter pan. Consequently, when curb sections with gutter pans are used, the motor vehicle and parking lanes include the width of the gutter pan.

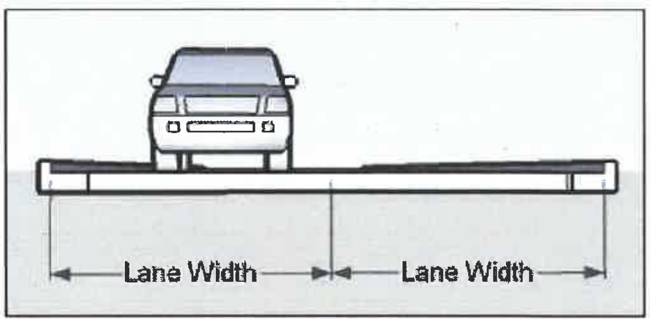
Table 19 – 2 Minimum Lane Width

Movement Type	Design Speed	Travel Lane Width
Yield*	Less than 20 mph	N/A
Slow	20-25 mph	9-10 feet
Low	30-35 mph	10-11 feet

* Yield streets are typically residential two-way streets with parking on one or both sides. When the street is parked both sides, the remaining space between parked vehicles (10 feet minimum) is adequate for one vehicle to pass through. Minimum width for a yield street with parking on both sides should be 24 feet curb face to curb face. Minimum width for a yield street with parking on one side should be 20 feet curb face to curb face, allowing for two 10-foot lanes when the street is not parked.

Figure 19 – 3 Lane Widths shows a typical measurement.

Figure 19 – 3 Lane Width



(Source: VHB)

In order for drivers to understand the appropriate driving speeds, lane widths should create some level of discomfort when driving too fast. The presence of on-street parking is important in achieving the speeds shown in Table 19 – 2 Minimum Lane Widths. When bicycle lanes or multi-lane configurations are used, there is more room for vehicles, such as buses, to operate. However car drivers may feel more comfortable driving faster than desired.

Alleys and narrow roadways that act as shared spaces can have design speeds as low as 10 mph, as noted in ***Chapter 16 – Residential Street Design***.

Alleys can be designed as either one way or two way. Right of way width should be a minimum of 20 feet with no permanent structures within the right of way that would interfere with vehicle access to garages or parking spaces, access for trash collection, and other operational needs. Pavement width should be a minimum of 12 feet. Coordination with local municipalities on operational requirements is essential to ensure that trash collection and fire protection services can be completed.

E.5.c Medians

Medians used in low-speed urban thoroughfares provide for access management, turning traffic, safety, pedestrian refuge, landscaping, lighting, and utilities. These medians are usually raised with raised curb.

Landscaped medians can enhance the street or help create a gateway entrance into a community. Medians can be used to create tree canopies over travel lanes for multi-lane roadways contributing to a sense of enclosure.

Medians vary in width depending on available right of way and function. Because medians require a wider right of way, the designer must weigh the benefits of a median with the issues of pedestrian crossing distance, speed, context, and available roadside width.

Table 19 – 3 Recommended Median Width

Median Type	Minimum Width	Recommended Width
Median for access control	4 feet	6 feet
Median for pedestrian refuge	6 feet	8 feet
Median for trees and lighting	6 feet [1]	10 feet [2]
Median for single left turn lane	10 feet [3]	14 feet [4]

Table Notes:

[1] Six feet measured curb face to curb face is generally considered the minimum width for the proper growth of small caliper trees (less than 4 inches),

[2] Wider medians provide room for larger caliper trees and more extensive landscaping,

[3] A ten foot lane provides for a turn lane without a concrete traffic separator,

[4] Fourteen feet provides for a turn lane with a concrete traffic separator.

E.5.d Turn Lanes

The need for turn lanes for vehicle mobility should be balanced with the need to manage vehicle speeds and the potential impact on the border width, such as sidewalk width. Turn lanes tend to allow through vehicles to maintain higher speeds through intersections, since turning vehicles can move over and slow in the turn lane.

Left turn lanes are considered to be acceptable in an urban environment since there are negative impacts to roadway capacity when left turns block the through movement of vehicles. The installation of a left turn lane can be beneficial when used to perform a road diet such as reducing a four lane section to three lanes with the center lane providing for turning movements. In urban areas, no more than one left turn lane should be provided.

Right turns from through lanes do not block through movements, but do create a reduction in speed due to the slowing of turning vehicles. Right turn lanes are used to maintain speed through intersections, and to reduce the potential for rear end crashes. However, the installation of right turn lanes increases the crossing distance for pedestrians and the speed of vehicles, therefore the use of exclusive right turn lanes are rarely used except at "T" intersections.

E.5.e Parking

On-street parking is important in the urban environment for the success of those retail businesses that line the street, to provide a buffer for the pedestrian, and to help calm traffic speeds. When angle parking is proposed for on-street parking, designers should consider the use of back in angle parking in lieu of front in angle parking.

Table 19 – 4 Parking Lane Width

Movement Type	Design Speed	Parking Lane Width
Slow	20-25 mph	(Angle) 17-18 feet
Slow	20-25 mph	(Parallel) 7 feet
Low	30-35 mph	(Parallel) 7-8 feet

E.6 Cul-de-sacs and Turnarounds

Cul-de-sacs should only be used where no other alternatives exist. Cul-de-sacs should have walkway or bicycle connections to other sidewalks and streets to provide connectivity within and to adjacent neighborhoods.

E.6.a Turning Area

A residential street open at one end only should have a special turning area at the closed end. A residential street more than 100 feet long and open at one end only shall 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.

E.7 Pedestrian Considerations

In urban environments, the "border," or area between the face of a building or right of way line and the curb face, serves as the pedestrian realm because it is the place for which pedestrian activity is provided, including space to walk, socialize, places for street furniture, landscaping, and outdoor cafes. In an urban environment, the border consists of the furniture, walking and shy zones.

Figure 19 – 4 Border

(Source: VHB)

E.7.a Furniture Zone

The furniture zone can be located adjacent to the building face, but more commonly is adjacent to the curb face. The furniture zone contains parking meters, lighting, tree planters, benches, trash receptacles, magazine and newspaper racks, and other street furniture. The furniture zone is separate from the walking/pedestrian and shy zones to keep the walking area clear for pedestrians, including proper access to transit stops.

E.7.b Walking/Pedestrian Zone

Chapter 8 addresses considerations for pedestrians. In a properly designed urban environment, where buildings are at the back of the sidewalk and vehicle speeds are low, the separation from traffic is normally provided by on-street parking, which also helps to calm traffic. The width of the walking/pedestrian zone should be at least four feet and should be increased based on expected pedestrian activity.

E.7.c Shy Zone

The shy zone is the area adjacent to buildings and fences that pedestrians generally "shy" away from. A minimum of one foot is provided as part of the sidewalk width. This space should not be included in the normal walking zone of the sidewalk.

E.7.d Mid-Block Crossings

Properly designed TND communities will not normally require mid-block crossings due to the use of shorter block size. When mid-block crossings are necessary, the use of curb extensions or bulbouts should be considered to reduce the crossing distance for pedestrians.

E.7.e Curb Extensions

Curb extensions are helpful tools for reducing the crossing distance for pedestrians, providing a location for transit stops, managing the location of parking, providing unobstructed access to fire and rescue, and increasing space for landscaping and street furniture.

Designers should coordinate with public works staff to ensure that street cleaning can be achieved with their equipment, and adequate drainage can be provided to avoid ponding at curb extensions.

E.8 Bicyclist Considerations

E.8.a Bicycle Facilities

Chapter 9 contains information on bicycle facilities. This section is directed to designing bike facilities in TND communities. Designing for bicycles on thoroughfares in TND communities should be as follows: bicycles and motor vehicles should share lanes on thoroughfares with design speeds of twenty five mph or less. It is important to recognize that the addition of bike lanes does increase roadway widths and can increase the tendency for drivers to speed.

When bicycle lanes are used in TND communities, they should be a minimum of 5 feet wide and designated as bike lanes. On curb and gutter roadways, a minimum 4-foot width measured from the lip of the gutter is required. The gutter width should not be considered part of the rideable surface area, but this width provides useable clearance to the curb face. Drainage inlets, grates, and utility covers are potential problems for bicyclists. When a roadway is designed, all such grates and covers should be kept out of the bicyclists' expected path. If drainage inlets are located in the expected path of bicyclists, they should be flush with the pavement, well seated, and have bicycle compatible grates.

Where parking is present, the bicycle lane should be placed between the parking lane and the travel lane, and have a minimum width of 5 feet. Designers should consider increasing the bicycle lane to 6 feet in lieu of increasing parallel parking width from 7 to 8 feet. This helps encourage vehicles to park closer to the curb, and provides more room for door swing, potentially reducing conflict with bicyclists.

Shared lane markings, or "sharrows," can be used instead of bicycle lanes adjacent to on-street parking. The sharrow allows the bicyclist to occupy the lane and therefore avoids placing bicyclists in the "door zone", and does not require an increase in lane width or ROW width for the thoroughfare. Guidance for use of the shared lane marking is included in ***Chapter 9 – Bicycle Facilities*** and the *MUTCD*. See Figure 9 –24 – Shared Lane Marking in ***Chapter 9*** for a detailed drawing of a shared lane marking.

E.8.b Shared Use Paths

Greenways, waterfront walks, and other civic spaces should include shared use paths, and provide for bicycle storage or parking. Bicycle storage or parking should also be included in areas near transit facilities to maximize connectivity between the modes.

E.9 Transit

See *Accessing Transit, Design Handbook for Florida Bus Passenger Facilities, Version III, 2013* for information.

E.10 Clear Zone

In urban areas, horizontal clearances, based on clear zone requirements for rural highways, are not practical because urban areas are characterized by lower speed, more dense abutting development, closer spaced intersections and accesses to property, higher traffic volumes, more bicyclists and pedestrians, and restricted right of way. The minimum horizontal clearance shall be 1.5 feet measured from the face of curb.

Streets with curb, or curb and gutter, in urban areas where right of way is restricted do not have roadsides of sufficient widths to provide clear zones; therefore, while there are specific horizontal clearance requirements for these streets, they are based on clearances for normal operation and not based on maintaining a clear roadside for errant vehicles. It should be noted that curb has essentially no redirectional capability; therefore, curb should not be considered effective in shielding a hazard.

F REFERENCES FOR INFORMATIONAL PURPOSES

The following publications were either used in the preparation of this chapter, or may be helpful in designing TND Communities and understanding the flexibility in AASHTO design criteria:

- Designing Walkable Urban Thoroughfares: A Context Sensitive Approach: An ITE Recommended Practice, 2010
- http://www.ite.org/css/
- SmartCode 9.2
  http://www.smartcodecentral.org/
- A Guide for Achieving Flexibility in Highway Design, AASHTO, May, 2004
  https://bookstore.transportation.org/
- Accessing Transit, Design Handbook for Florida Bus Passenger Facilities, 2008, FDOT Public Transit Office :
  http://www.dot.state.fl.us/transit/NewTransitPlanning.shtm
- Safe Routes to Schools Program, FDOT Safety Office:
  http://www.dot.state.fl.us/safety/2A-Programs/Programs.shtm

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CHAPTER 20

DRAINAGE

TABLES

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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.

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.

C.1 Design Frequency

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

Table 20 – 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.

C.2 Hydrologic Analysis

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

2. Rational Equation for drainage areas up to 600 acres.

3. 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.

C.3 Hydraulic Analysis

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

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 the ***Department's Drainage Manual (2018)***, Table 2.2 Manning's "n" Values for Artificial Channels with Bare Soil and Vegetative Linings and Table 2.3 Manning's 'n" Values for Artificial Channels and Rigid Linings. The manual is incorporated by reference in ***Section 14-86.003, F.A.C., Permit, Assurance Requirements, and Exceptions***.

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

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.

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 the Department's Drainage Manual (2018), Tables 2.4 Maximum Shear Stress Values and Allowable Velocities for Different Soils and Table 2.5 Maximum Velocities for Various Lining Types.

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 countermeasures 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.

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.

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.

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

D STORM DRAIN HYDROLOGY AND HYDRAULICS

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

D.1 Pipe Materials

See Section G for pipe material requirements.

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.

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.

D.4 Hydrologic Analysis

The Rational Method is the most common method in use for the design of storm drains when the momentary peak-flow rate is desired.

D.4.a Time of Concentration

Minimum time of concentration shall be 10 minutes.

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.

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.

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).

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.

D.5.d Manning's Roughness Coefficients

Standards Manning's Roughness Coefficients can be found in the Department's ***Drainage Manual (2018) Section 3.6.4***.

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.

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.

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.

The Department's *Drainage Manual (2018), Section 3.7* 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 Table 3-5 Drainage End Treatment – Lateral Offset Criteria in the ***Drainage Manual*** provide guidance for inlet selection.

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 ft for 48 inches or smaller pipes.
- Inlets on grade should be spaced at a maximum of 600 ft 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.

D.6.b Grades

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.

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 – 2 Spread Criteria.

Table 20 – 2 Spread Criteria

Design Speed (mph)	Spread Criteria*
Design Speed ≤ 30	Crown of Road
30 < Design speed ≤ 45	Keep 1/2 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.

D.8 Construction and Maintenance Considerations

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

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 (french drain systems) within a drainage system is 18".

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

<u>Pipes without French Drains:</u>

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

<u>French Drains that have access through only one end:</u>

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

<u>French Drains that have access through both ends:</u>

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

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.

D.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 – 3 Protective Treatments.

Table 20 – 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.

D.10 Documentation

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

E CROSS DRAIN HYDRAULICS

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

E.1 Design Frequency

The recommended minimum design flood frequency for culverts is shown in Table 20 – 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 – 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

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:

- Have a level of inundation that is tolerable to upstream property and roadway for the design discharge;

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.*"

- 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.

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.

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***.

E.5 Bridges and Other Structures

See ***Chapter 17, Section C.3.e*** for Drainage Criteria.

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.

G CULVERT MATERIALS

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

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

The Department provides a program called ***Culvert Service Life Estimator*** for estimating the service life of culverts based on the above criteria

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.

G.2 Structural Capacity

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

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.

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