JANUARY 1, 2007 UPDATES

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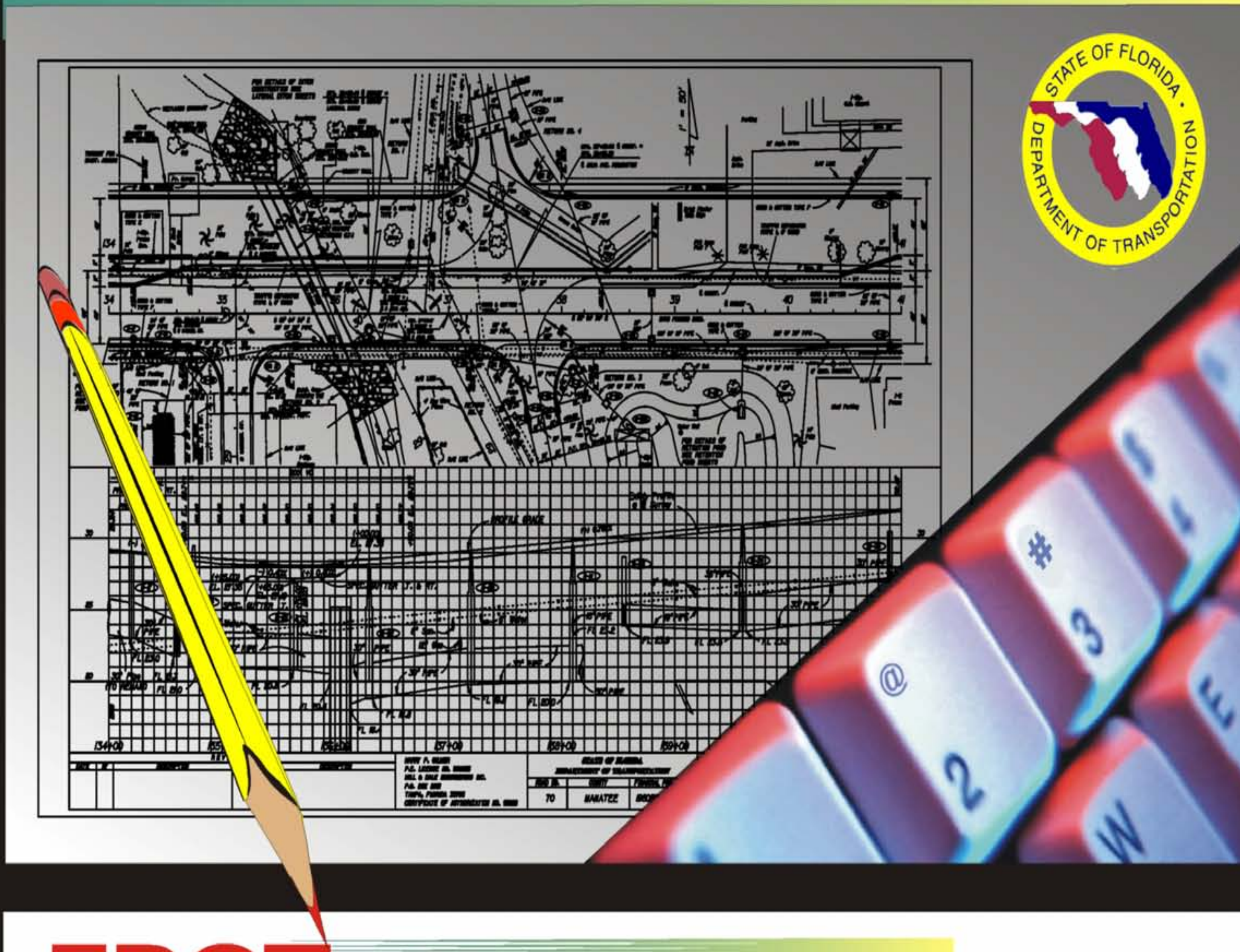
Topic #625-000-007
Plans Preparation Manual

January 2006
Revised – January 1, 2007

DESIGN CRITERIA AND PROCESS



FDOT DESIGN

Volume I

Plans Preparation Manual January 2006 Revised – January 1, 2007

DESIGN CRITERIA AND PROCESS I

Florida Department Of Transportation

PLANS PREPARATION MANUAL

VOLUME I

ROADWAY DESIGN OFFICE

TALLAHASSEE, FLORIDA

JANUARY 1, 2006

SECOND EDITION

REVISED – JANUARY 1, 2007

http://www.dot.state.fl.us/rddesign/PPMManual/PPM.htm

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PLANS PREPARATION MANUAL

REGISTRATION

The Department of Transportation has created a new contact database that will enable the Department to e-mail important information to registered users on topics selected by each user. The database is will allow a user to update their e-mail address, topics of interest and any other information in their profile at any time. The information users provide will not be shared with any other company or agency.

All PPM users (and other Roadway Design manual users) must register their e-mail addresses in this contact database in order to receive future updates, notices, design memos, or other important information concerning the Department's design manuals. **The old database of PPM users is no longer in use, and registrations of current PPM users in the old database were not automatically imported into the new contact database**. PPM users who have not already done so must register in the new contact database at the following link:

http://www2.dot.state.fl.us/contactmanagement/

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Table of Contents

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Introduction

Plans Preparation Manual, Volume I

PURPOSE:

This ***Plans Preparation Manual, Volume 1*** sets forth geometric and other design criteria, as well as procedures, for Florida Department of Transportation (FDOT) projects. The information contained herein applies to the preparation of contract plans for roadways and structures.

AUTHORITY:

Sections 20.23(3)(a) and 334.048(3), Florida Statutes.

SCOPE:

This procedure impacts anyone preparing roadway and structures construction plans for the Department.

GENERAL INFORMATION:

Chapter 334 of the ***Florida Statutes***, as part of the ***Florida Transportation Code,*** establishes the responsibilities of the State, counties, and municipalities for the planning and development of the transportation systems serving the people of Florida, with the objective of assuring development of an integrated, balanced statewide system. The Code's purpose is to protect the safety and general welfare of the people of the State and to preserve and improve all transportation facilities in Florida. Under ***Section 334.048(3)***, the Code sets forth the powers and duties of the Department of Transportation including to adopt rules, procedures and standards for the conduct of its business operations and the implementation of any provisions of law for which the Department is responsible.

PROCEDURE:

The criteria in this manual represent requirements for the State Highway System which must be met for the design of FDOT projects unless approved exceptions or variations are obtained in accordance with procedures outlined in this manual.

Roadway and structures design is primarily a matter of sound application of acceptable engineering criteria and standards. While the criteria contained in this manual provide a basis for uniform design practice for typical roadway design situations, precise standards which would apply to individual situations must rely on good engineering practice and analyses.

Situations will exist where these criteria will not apply. The inappropriate use of and adherence to these criteria does not exempt the engineer from the professional responsibility of developing an appropriate design. The engineer is responsible for identifying those criteria which may not apply to a particular design, and for obtaining the necessary exception or variation to achieve proper design.

1. PLANS PREPARATION MANUAL, VOLUME I - MANUAL ORGANIZATION

   a. Background

      The Florida Department of Transportation ***Plans Preparation Manual (PPM)*** was published in the current format in January 1998. The criteria in the 1998 PPM were given in metric units.

   b. Organization

      The ***Plans Preparation Manual*** is a two-volume manual. ***Volume I*** contains the design criteria and process and ***Volume II*** contains material concerning plans preparation and assembly.

2. DISTRIBUTION

   This document is distributed on CD through **FDOT Maps and Publications Sales**.

   Copies may be obtained from:

   Florida Department of Transportation
   Maps and Publications Sales, Mail Station 12
   605 Suwannee Street
   Tallahassee, FL 32399-0450
   Telephone (850) 414-4050
   FAX Number (850) 414-4915
   http://www.dot.state.fl.us/MapsAndPublications/

   For updates and manual registration information contact:

   Roadway Design Office, Mail Station 32
   Telephone (850) 414-4310
   FAX Number (850) 414-5261
   http://www.dot.state.fl.us/rddesign/

3. REVISIONS AND UPDATES

Plans Preparation Manual holders are encouraged to submit comments and suggestions for changes to the manual to the Roadway Design Office. When ideas or suggestions are received they will be reviewed by appropriate Roadway and/or Structures Design staff in a timely manner and will be coordinated with other offices affected by the proposed change. Items warranting immediate change will be made with the approval of the State Roadway Design Engineer in the form of a Design Bulletin.

Design Bulletins for the ***Plans Preparation Manual*** are numbered and distributed to all official ***Plans Preparation Manual*** holders. Design Bulletins have a maximum life of two hundred seventy (270) days. Within this time period either an official manual revision will be distributed or the Design Bulletin will become void.

Structures design issues, which are subject to modification and revision, will be processed in coordination with the Structures Design Office.

Proposed revisions are distributed in draft form to the District Design Engineers (DDE). The DDE coordinates the review of the proposed revisions with other affected district offices such as Structures Design. The goal is to obtain a majority opinion before revisions are made.

The Roadway Design Office will also coordinate proposed revisions or additions with affected offices within the Central Office. Substantive revisions that result in policy change will be coordinated with the Executive Committee for concurrence.

Revisions are voted on jointly by the District Design Engineers and the State Roadway Design Engineer (for Roadway Design issues) or the State Structures Design Engineer (for Structures Design issues). Each district will have one vote and the central office will have two votes; for a total of ten votes. Requirements mandated by FHWA or State Rules will not be subject to this majority vote.

All revisions and updates will be coordinated with the Forms and Procedures Office prior to distribution to ensure conformance with and incorporation into the Department's Standard Operating System.

The adopted revisions and addenda will be distributed to registered holders of the manual.

TRAINING:

None required.

FORMS ACCESS:

Documents marked as **SAMPLES** provide only a starting point allowing users to change or alter the document as needed to fit specific situations. Samples are not official forms of the Department.

GLOSSARY OF TERMS:

In the application of the criteria in this manual, the following definitions are assigned for consistency of understanding and interpretation.

1. **Arterials:** Divided or undivided, relatively continuous routes that primarily serve through traffic, high traffic volumes, and long average trip lengths. Traffic movement is of primary importance, with abutting land access of secondary importance. Arterials include expressways without full control of access, US numbered routes and principal state routes. May be classified as urban or rural.

2. **Auxiliary Lane:** The designated widths of roadway pavement marked to separate speed change, turning, passing and climbing maneuvers from through traffic. They may also provide short capacity segments.

3. **C-D Roads:** Collector-Distributor Roads are limited access roadways provided within a single interchange, or continuously through two or more interchanges on a freeway segment. They provide access to and from the freeway, and reduce and control the number of ingress and egress points on the through freeway. They are similar to continuous frontage roads except that access to abutting property is not permitted.

4. **Collectors:** Divided or undivided routes which serve to link arterial routes with local roads or major traffic generators. They serve as transition link between mobility needs and land use needs. Collectors include minor state routes, major county roads, and major urban and suburban streets.

5. **Florida Intrastate Highway System (FIHS):** An interconnected statewide system of limited access facilities and controlled access facilities developed and managed by the Department to meet standards and criteria established for the FIHS. It is part of the State Highway System, and is developed for high-speed and high-volume traffic movements. The FIHS also accommodates High-Occupancy Vehicles (HOVs), express bus transit and in some corridors, interregional and high speed intercity passenger rail service. Access to abutting land is subordinate to movement of traffic and such access must be prohibited or highly regulated.

6. **Freeways:** Divided arterial highways, with full control of access. Movement of traffic free of interference and conflicts is of primary importance. Essential elements include medians, grade separations, interchanges, and, in some cases, collector-distributor roads and frontage roads. Freeways include Interstate, toll road and expressway systems. May be classified as urban or rural.

7. **High Speed:** Descriptive term used to summarize all conditions governing the selection of Design Speeds 50 mph and greater.

8. **HOV Lane:** Special designated widths of pavement marked to provide travel lanes for high occupancy vehicles (HOV). They may be directly adjacent to other travel lanes or separated.

9. **Local Roads:** Routes which provide high access to abutting property, low average traffic volumes, short average trip lengths and on which through traffic movements are not of primary importance. Local roads include minor county roads, minor urban and suburban subdivision streets, and graded or unimproved roads.

10. **Low Speed:** Descriptive term used to summarize all conditions governing the selection of Design Speed of less than 50 mph.

11. **Low Volume and High Volume:** Descriptive terms used to describe certain operating characteristics and driver expectancy on highways. Criteria for some elements are selected according to these qualifying controls. Standards for these controls are given in the table following this section.

12. **Ramp:** A turning roadway that connects two or more legs at an interchange. The components of a ramp are a terminal at each leg and a connecting road. The geometry of the connecting road usually involves some curvature and a grade.

13. **Roadway:** The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

14. **Rural Areas:** Places outside the boundaries of concentrated populations that accommodate higher speeds, longer trip lengths and freedom of movement, and are relatively free of street and highway networks. Rural environments are surroundings of similar characteristics.

15. **Strategic Intermodal System (SIS):** A transportation system comprised of facilities and services of statewide and interregional significance, including appropriate components of all modes. The highway component includes all designated SIS Highway Corridors, Emerging SIS Highway Corridors, SIS Intermodal Connectors, and Emerging SIS Highway Intermodal Connectors.

16. **Streets:** The local system which provides direct access to residential neighborhoods and business districts, connects these areas to the higher order road systems and offers the highest access to abutting property; sometimes deliberately discouraging through-traffic movement and high speeds.

    Note: Local roads and streets are not generally a part of the State Highway System and therefore, may not be governed by the FDOT roadway design criteria, but by the ***Manual of Uniform Minimum Standards for Design, Construction and Maintenance for Streets and Highways*** and/or criteria established by the local government.

17. **Traffic Lane/Traveled Way:** The designated widths of roadway pavement, exclusive of shoulders and marked bicycle lanes, marked to separate opposing traffic or vehicles traveling in the same direction. Traffic lanes include through travel lanes, auxiliary lanes, turn lanes, weaving, passing, and climbing lanes. They provide space for passenger cars, trucks, buses, recreational vehicles and, in some cases, bicycles.

18. **Travel Lane:** The designated widths of roadway pavement marked to carry through traffic and to separate it from opposing traffic or traffic occupying other traffic lanes. Generally, travel lanes equate to the basic number of lanes for a facility.

19. **Truck Traffic:** When significant, heavy, substantial, high percent, etc. truck traffic is used as a qualifying control, it shall mean 10% of the AADT or 10% of the daily count (24 hr.)

20. **Urban Areas:** Places within boundaries of concentrated populations, where density of street and highway networks, travel speeds, nature and composition of vehicles and pedestrian traffic dictate street and highway characteristics that promote lower speeds, better circulation movements, more delineation and traffic guidance devices, shorter trip lengths and provisions for pedestrians and bicycles. Urban environments are surroundings of similar characteristics.

21. **Urbanized Areas:** Transitional zones between rural and urban areas, with characteristics approaching or similar to urban areas.

STANDARDS FOR LOW AND HIGH VOLUME HIGHWAYS IN ANNUAL AVERAGE DAILY VOLUMES

HIGHWAY TYPE	LOW VOLUME AADT	HIGH VOLUME AADT
FREEWAY - URBAN		
4-LANE FACILITY	57,000	69,000
6-LANE FACILITY	86,000	103,000
8-LANE FACILITY	114,000	138,000
FREEWAY - RURAL		
4-LANE FACILITY	46,000	56,000
6-LANE FACILITY	69,000	83,000
8-LANE FACILITY	92,000	111,000
ARTERIALS - URBAN		
2-LANE FACILITY	16,000	20,000
4-LANE FACILITY	37,000	43,000
6-LANE FACILITY	55,000	64,000
8-LANE FACILITY	69,000	80,000
ARTERIALS - RURAL		
2-LANE FACILITY	9,000	14,000
4-LANE FACILITY	38,000	47,000
6-LANE FACILITY	58,000	71,000
COLLECTOR - URBAN		
2-LANE FACILITY	11,000	16,000
4-LANE FACILITY	37,000	45,000
COLLECTOR - RURAL		
2-LANE FACILITY	8,000	13,000
4-LANE FACILITY	30,000	38,000

LOW VOLUME FACILITIES ARE HIGHWAY TYPES WITH PROJECTED DESIGN YEARS **AADT** VOLUME EQUAL TO OR LESS THAN THE LOW VOLUME VALUES SHOWN.

HIGH VOLUME FACILITIES ARE HIGHWAY TYPES WITH PROJECTED DESIGN YEAR **AADT** VOLUME EQUAL TO OR GREATER THAN THE HIGH VOLUME VALUES SHOWN.

Chapter 1

Design Controls

Tables

Figures

1.5 RRR Design

Design criteria applicable for the State Highway System facilities are contained in ***Chapter 25*** of this volume, ***Florida's Design Criteria for Resurfacing, Restoration and Rehabilitation (RRR) of Streets and Highways***.

1.6 Design Consistency and Driver Expectancy

Design consistency is achieved when the geometric features of the roadway are consistent with the operational characteristics expected by the driver. Inconsistencies normally relate to:

1. Changes in design speed.
2. Changes in cross section.
3. Incompatibility in geometry and operational requirements.

Changes in design speed may occur on a given stretch of roadway because portions of the highway were built as separate projects over an extended period of time. Inconsistencies may be due to a number of factors: changes in standards or FDOT policy, reclassification of the facility, and lack of necessary funding.

There are two major types of design inconsistencies relative to cross section. These are point inconsistencies and a general incompatibility between cross section and alignment. A point inconsistency may be, for example, the narrowing of lane widths, a narrow bridge, a lane drop, or a change from multilane section to two lanes.

A cross sectional inconsistency is usually the result of upgrading a highway cross section without upgrading the alignment. Sometimes pavements are widened and shoulders added on an older two lane highway. The wider cross section on an old alignment might convey a conflicting message to the driver and lead to an inappropriate expectancy based on the visual aspects of the cross section, because cross section features can be more apparent than the alignment.

Of course, this is not to say that widening creates unsafe conditions. Widening alone can measurably improve the safety characteristics of a road, particularly on very narrow, low-volume roads. Designers should, however, be aware of potential inconsistencies that frequently can be overcome with relatively low cost treatments. In the case of widened roads on old alignments, pavement markings, warning signs, and delineation devices can be very helpful to the driver.

Inconsistencies may also relate to incompatibility in geometric and operational requirements. Occasionally elements of the design appear to have been selected for the purpose of fitting together the geometric components conveniently and economically rather than for the purpose of satisfying operational requirements. An example of an inconsistency resulting from the incompatibility is a direct entry ramp that is intended to

"Streetscaping" techniques in urban areas include an emphasis on pedestrian accommodation, trees and other plantings, access control, careful signing, and zoning restrictions on commercial signs. Parkways and other roads specifically intended for pleasing aesthetics should be designed by a multidisciplined team including landscape architects and planners.

Aesthetics and roadway design considerations and methods are discussed in the ***Project Development and Environment Manual (Topic No. 650-000-001), Volume II, Chapter 15***.

1.8 Access Management

Unregulated access to the State Highway System was determined to be one of the contributing factors to congestion and functional deterioration of the system. Regulation of access was necessary to preserve the functional integrity of the State Highway System and to promote the safe and efficient movement of people and goods within the state. Under ***F.S. 335.18***, the Legislature authorized the Department to develop rules to administer the "State Highway System Access Management Act." These are ***Rule 14-96*** and ***14-97***. In addition, the Department has adopted the ***Median Opening and Access Management Decision Process (Topic No. 625-010-021)***, which further define the principles and processes for the Department to implement the Access Management Statute and Rules.

Each district has established an Access Management Review Committee to guide actions in access management and median decisions through all the Department's processes, and has assigned various offices the responsibility to permit connections and administer other parts of the program. In order to adhere to the program, the designer must be familiar with the statute, the rules, adopted procedures and directives, and the district program. In addition to driveway connections, features such as median openings affect safe and efficient operation. It is critical that the designer know what access classification has been assigned to the highway segment under design and to determine what roadway features and access connection modifications are appropriate to adhere to the program.

During the PD&E phase, a conceptual access management plan is prepared for the preferred alternative. Access management issues are also addressed in the Preliminary Engineering (P.E.) Report. The designer should review these documents and the existing access management classification for information on access management decisions made during the PD&E process.

During the development of construction plans, the designer should evaluate the access connections within the project limits. Driveways and median openings should be considered in the analysis of safety and operational problems. Modifications or closures to access may be the solution in certain cases. ***Rule 14-96.003 (3) & (4)*** and ***14-96.015*** gives the Department the authority to alter, relocate or replace connections in order to meet current Department standards. Furthermore, ***Rule 14-96.011*** allows the FDOT to revoke a permit.... "if the connection causes a safety or operational problem on the State Highway System substantiated by an engineering study…"

1.9 Design Speed

Design speed is a principal design control that regulates the selection of many of the project standards and criteria used to design a roadway project. The selection of an appropriate design speed must consider many factors. The AASHTO publication, ***A Policy on Geometric Design of Highways and Streets***, has a thorough discussion on design speed and these factors.

1.9.1 Design Speed Coordination and Approvals

As a principal design control, design speed must be selected very early in the design process and must be documented in the project design file. The Engineer of Record must coordinate with the District Design Engineer (DDE), the District Traffic Operations Engineer (DTOE), and the responsible PD&E engineer to discuss the anticipated posted speed. Every effort should be made to **use as high a design speed as practical** to attain a desired degree of safety, mobility and efficiency. However, the design speed shall not be less than the project's proposed posted speed (existing posted speed if no change is proposed) or legal speed limit. On new construction and reconstruction projects, designers shall not include in their plans a posted speed higher than the design speed.

The selected design speed shall be jointly approved by the District Design Engineer and the District Traffic Operations Engineer. This includes joint approval that the expected posted speed will not exceed the selected design speed. This is to be documented on the Typical Section Package as described in ***Section 16.2.3***. When agreement between the DDE and DTOE on the Design Speed cannot be reached, the DDE and DTOE will forward the matter to the District Director of Transportation Development and District Director of Transportation Operations for final resolution. Note that in some cases it may be appropriate to select a higher design speed to match an expected posted speed and process Design Exceptions or Variations for those design elements that do not meet the criteria for the higher speed.

The modification of posted speed limits after the construction of a project has been completed is a decision made under the authority of the District Traffic Operations Engineer (***FDOT Procedure No. 750-010-011***). This is based on the 85th percentile speed determined through engineering and traffic investigations described in ***Speed Zoning for Highways, Roads and Streets in Florida, (FDOT Procedure No. 750-010-002)***. The DTOE typically conducts a speed investigation within one year after a new construction or reconstruction project is completed. When it is determined from this speed study that a posted speed higher than the original design speed is warranted, the DTOE working with the DDE must process Design Exceptions or Variations for those design elements that do not meet the criteria for the higher speed. When agreement between the DDE and DTOE cannot be reached, the DDE and DTOE will forward the matter to the District Director of Transportation Development and District Director of Transportation Operations for final resolution. Further explanation on how posted speed limits are developed can also be found on the State Traffic Operations web page:

http://www.dot.state.fl.us/TrafficOperations//FAQs/SpeedLimitFAQ.htm

While the selected design speed will establish minimum geometric requirements (e.g., minimum horizontal curve radius and sight distance), this does not preclude the use of improved geometry (flatter curves or greater sight distances) where such improvements can be provided as a part of economic design. The Engineer of Record is required to document, in a design speed matrix, any design features that were designed to speeds other than the project design speed. Increments of 5 mph should be used when selecting design speeds.

Definitions for high speed and low speed are provided in ***Chapter 2*** of this volume. Curbed sections should not be used on high speed facilities (design speeds ≥ 50 MPH). However, special curbed sections may be used on suburban highways meeting the criteria given in ***Section 2.16*** of this volume.

Table 1.9.1 provides a recommended range of design speeds for new construction and reconstruction projects on the State Highway System except for facilities on the Florida Intrastate Highway System (FIHS)/Strategic Intermodal System (SIS). Design Speed for facilities on the FIHS/SIS (including SIS Highway Corridors, Emerging SIS Highway Corridors, SIS Highway Intermodal Connectors and Emerging SIS Highway Intermodal Connectors) shall meet or exceed the values in ***Table 1.9.2***.

For design speed on RRR projects on the State Highway System, see ***Chapter 25*** of this volume. ***Chapter 25*** may be used for RRR projects on the FIHS/SIS. However, the minimum design speed in ***Table 1.9.2*** should be used when practicable, consistent with proposed improvements defined for the facility in the ***Corridor Management Plan***. See ***Topic Number 525-030-250, Procedure for the Development of the Florida Intrastate Highway System,*** for requirements.

Table 1.9.1 Design Speed
State Highway System - Non-FIHS/SIS Facilities

Facility		Design Speed (mph)
Freeways	Rural	70
	Urban	50 - 70
Arterials	Rural	55 - 70
	Urban	40 - 60
Collectors	Rural	55 - 65
	Urban	35 - 50
TDLC		30 - 40

Table 1.9.2 Minimum Design Speed
FIHS/SIS

Facility		Minimum Design Speed (mph)
Interstate and Freeways	Rural and Urban*	70
	Urbanized*	60
Arterials	Rural*	65
	Urban and Urbanized*	50

Note: For FIHS/SIS facilities (including SIS Highway Corridors, Emerging SIS Highway Corridors, SIS Highway Intermodal Connectors, and Emerging SIS Highway Intermodal Connectors), design speeds less than the above minimums shall be submitted to the Director, Office of Design and approved by the Chief Engineer, following a review by the State Transportation Development Administrator, in accordance with the ***FIHS Procedure (Topic No. 525-030-250)*****.**

*Terms based on definitions contained in ***FIHS Procedure (Topic No. 525-030-250)***.

1.10 Public Involvement

It is the policy ***(Topic No. 000-525-050, Public Involvement Opportunities)*** of the FDOT to promote public involvement opportunities and information exchange activities in all functional areas using various techniques adapted to local area conditions and project requirements.

Typically, when a project reaches the design phase, many of the project commitments and community issues have already been identified. However, this is not always true. Design alternatives still need to be reevaluated to determine their implications in relation to community impacts. Any commitments made in previous phases would be communicated to designers, who will be responsible for carrying them out. If constraints arise that require design changes which affect the Department's ability to meet commitments, then the process would require follow-up with the affected community. In such cases, additional public involvement and community impact assessment may be necessary to address public concerns.

Projects may have potential community impacts that are not identified until the design phase, such as, but not limited to:

1. Impacts on public safety, including people with disabilities
2. School crossings or other areas of high pedestrian activity
3. Aesthetic features such as landscaping or tree replacement
4. Medians or access changes
5. Intersections and driveways
6. Audible signalized intersections
7. Accessibility of corridor businesses and neighborhoods
8. Wider sidewalks or improved bicycle facilities
9. Lighting
10. Transit
11. Transportation Design for Livable Communities
12. Maintenance of Traffic
13. Railroad crossings

Each district has developed Community Awareness Plan (CAP) guidelines to be implemented on all design projects for continued efforts in public involvement depending on the level of impact to the community.

Chapter 2

Design Geometrics and Criteria

Tables

Figures

Chapter 2

Design Geometrics and Criteria

2.0 General

The implementation of design criteria is outlined in the following text.

1. **Design Criteria:** The design criteria presented in this manual are intended as the principal source of criteria for the design of new construction or major reconstruction projects on the Florida State Highway System.

   These criteria are presented by subject for major design elements as fixed values or a range of acceptable values as defined by qualifiers.

   Where design criteria appear in the ***Design Standards***, they will be consistent with the criteria in this manual. In addition, some criteria will remain in the other chapters of this manual. When conflicts are discovered, they should be brought to the attention of the State Roadway Design Engineer or State Structures Design Engineer, as applicable, for resolution.

   On reconstruction projects, existing project features which were constructed to meet minimum metric design criteria, but are mathematically slightly less than equivalent minimum English design criteria, do not require design exceptions or variations to remain.

   Design criteria for Resurfacing, Restoration, and Rehabilitation (RRR) are presented in ***Chapter 25*** of this volume and are applicable only on programmed RRR projects.

   Facilities on the Florida Intrastate Highway System (FIHS) and the Strategic Intermodal System (SIS) are subject to special standards and criteria for number of lanes, design speed, access, level of service, and other requirements. These are identified in ***Topic No. 525-030-250, Procedure for the Development of the Florida Intrastate Highway System.***

   SIS and Emerging SIS Highway Intermodal Connectors on the State Highway System (SHS) shall be designed in accordance with the FIHS/SIS criteria contained in this manual. SIS and Emerging SIS Highway Intermodal Connectors on the local system (non-SHS) should also be designed in accordance with the FIHS/SIS criteria contained in this manual, but the District may allow the use of the ***Manual of Uniform Minimum Standards for Design, Construction and Maintenance for Streets and Highways*** (commonly known as the ***"Florida Greenbook"***), ***Topic No. 625-000-015*** depending on project specifics.

Design Criteria for roads that are not part of the State Highway System should be obtained from the ***Florida Greenbook***.

2. **Design Controls:** Design controls are characteristics and conditions that influence or regulate the selection of the criteria for project standards. It is the designer's responsibility to recognize and apply those controls applicable to the project.

3. **Design Standards:** The specific values selected from the design criteria become the design standards for a design project. These standards will be identified and documented by the designer.

4. **Project Parameters:** The properties or specific conditions with limits which require modification of design standards within these limits. The designer is responsible for establishing and documenting any project parameters and their limits, as part of the justification for deviations from project standards.

Many design standard considerations are related directly to the design speed, including vertical and horizontal geometry and required sight distances. The minimum design values are very closely related to traffic safety and cannot be compromised without an approved design exception or design variation. See ***Chapter 23*** of this volume.

Public facilities constructed or funded by FDOT (parking garages, weigh stations, operation centers, park & ride facilities, etc.) shall comply with the criteria in this manual, ***FDOT Design Standards***, and other applicable Department manuals. Roads not on the State Highway System which are impacted by the construction of these public facilities should also be designed in accordance with Department criteria and standards, but the District may allow the use of the ***Florida Greenbook*** depending on project specifics.

Roadway and bridge typical sections developed for projects must reflect the values and properties outlined in Items 1 - 4 of this section. These typical sections shall include the location and limits of such features as lanes, medians, shoulders, curbs, sidewalks, barriers, railings, etc.. ***Section 16.2.3*** of this volume gives the requirements for approval and concurrence of typical section packages.

Coordination is of primary importance on projects that contain both roadway and bridge typical sections. The Roadway and Structures Offices must address the compatibility of the typical section features mentioned above, and provide for an integrated design and review process for the project.

Example roadway typical sections are included in the exhibits in the back of the manual. Partial bridge sections, ***Figures 2.0.1 - 2.0.4***, provide criteria regarding lanes, medians, and shoulders for various facilities. Subsequent sections of this chapter contain specific information and criteria regarding these and other typical section elements, as well as geometric features of both roadways and bridges.

2.1 Lanes

Florida Department of Transportation (FDOT) criteria for lane widths and pavement slopes are given by highway type and area, through lanes, auxiliary lanes and other special lanes.

2.1.1 Through or Travel Lanes

Standard practice is to provide lane widths as wide as practical, up to 12 feet. See ***Table 2.1.1***.

Table 2.1.1 Lane Widths

LANE WIDTHS (FEET)							
FACILITY		**THROUGH OR TRAVEL**	**AUXILIARY**			
TYPE	**AREA**		**SPEED CHANGE**	**TURNING (LT/RT/MED)**	**PASSING**	**CLIMBING**
FREEWAY	Rural	12	12	----	----	12
	Urban	12	12	----	----	12
ARTERIAL	Rural	12	12	12	12	12
	Urban	12 [1]	12 [1]	12 [1,4]	12 [1]	12
COLLECTOR	Rural	12 [6]	11 [2]	11 [2,4]	11 [2,5]	12
	Urban	11 [3]	11 [3]	11 [3,4]	11 [3]	12

1. 11 ft. permitted on non-FIHS/SIS roads if one of these conditions exist:
    a. R/W and existing conditions are stringent controls
    b. Facility operates on interrupted flow conditions
    c. Design speed 40 mph or less
    d. Intersection capacity not adversely affected
    e. Truck volume 10% or less
2. 12 ft. lanes for all 2-lane rural.
3. 12 ft. lanes in industrial areas when R/W is available.
4. With severe R/W controls, 10 ft. turning lanes may be used where design speeds are 40 mph or less and the intersection is controlled by traffic signals. Median turn lanes shall not exceed 15 ft.
5. 12 ft. when truck volume more than 10%.
6. 11 ft. for low volume AADT.

2.1.2 Other Lane Widths

Collector-distributor lanes and auxiliary lanes for speed change, turning, storage for turning, weaving and other purposes supplementary to through-traffic movement should be of the same width as the through lanes. See ***Table 2.1.2***.

Table 2.1.2 Lane Widths - Special

LANE WIDTHS (FEET)					
FACILITY		**SPECIAL**			
TYPE	**AREA**	**HOV** $_1$	**BICYCLE**	**OFF SYSTEM DETOUR**	**URBAN MULTI-PURPOSE** $_5$
FREEWAY	Rural	12	----	11 $_4$	----
	Urban	12	----	11 $_4$	----
ARTERIAL	Rural	12	5 $_2$	11	----
	Urban	12	4 $_3$	11	8 $_6$
COLLECTOR	Rural	----	5 $_2$	11	----
	Urban	----	4 $_3$	11	8 $_6$

1. Separated or concurrent flow.
2. Designated or undesignated bike lane on shoulder pavement.
3. Designated or undesignated. See ***Section 8.4.1*** of this volume.
4. For Freeway detours, at least one 12 ft. lane must be provided in each direction.
5. Urban multi-purpose lanes are usually used as refuge lanes but may be used for loading zones, bus stops, emergency access and other purposes. Parking that adversely impacts capacity or safety is to be eliminated whenever practical. Standard parking width is measured from lip of gutter, with a minimum width of 8 ft. measured from face of curb.
6. 10 ft. to 12 ft. lanes for commercial and transit vehicles.

2.2 Medians

2.2.1 Median Width for Roadways

Median widths for roadways are given in ***Table 2.2.1***.

Table 2.2.1 Median Widths

MEDIAN WIDTHS (FEET)	
TYPE FACILITY	**WIDTH**
FREEWAYS	
Interstate, Without Barrier	64 [1]
Other Freeways, Without Barrier	---
Design Speed ≥ 60 mph	60
Design Speed < 60 mph	40
All, With Barrier, All Design Speeds	26 [2]
ARTERIAL AND COLLECTORS	
Design Speed > 45 mph	40
Design Speed ≤ 45 mph	22 [3]
Paved And Painted For Left Turns	12 [4]

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

1 88 ft. when future lanes planned.

2. Based on 2 ft. median barrier and 12 ft. shoulder.

3. On reconstruction projects where existing curb locations are fixed due to severe right of way constraints, the minimum width may be reduced to 19.5 ft. for design speeds = 45 mph, and to 15.5 ft. for design speeds ≤ 40 mph.

4. Restricted to 5-lane sections with design speeds ≤ 40 mph. On reconstruction projects where existing curb locations are fixed due to severe right of way constraints, the minimum width may be reduced to 10 ft. These flush medians are to include sections of raised or restrictive median for pedestrian refuge and to conform to ***Section 2.2.2*** of this volume and the Access Management Rules.

2.2.2 Multilane Facility Median Policy

All multilane facilities shall be designed with a raised or restrictive median except four-lane sections with design speeds of 40 mph or less. Facilities having design speeds of 40 mph or less are to include sections of raised or restrictive median for enhancing vehicular and pedestrian safety, improving traffic efficiency, and attainment of the standards of the Access Management Classification of that highway system.

2.2.3 Median Treatments on Bridges

For divided highways, the District will determine the desired distance between structures. ***Figures 2.0.1*** and ***2.0.3*** in this chapter, indicate that a full deck is recommended if the open space between the bridges is 20 ft. or less and required when less than 10 ft. For structures with less than 20 ft. of clearance, consult with District Structures Design and Facilities Maintenance before making a final decision.

Each District Office, in deciding on a single structure deck or twin bridges, must take into account the inspection and maintenance capabilities of its personnel and equipment. If the total width for a single structure exceeds the capacity of district maintenance equipment (approximately 60 ft. reach), twin structures may be specified and the open distance between structures determined by the practical capability of the maintenance and inspection equipment. This is particularly important for girder superstructures because those areas that cannot be reached by topside equipment might require catwalks, ladders or other access features. Such features will add to the cost of superstructures and must be accounted for in the initial selection of alternates.

Table 2.3.1 Shoulder Widths and Slopes - Freeways

HIGHWAY TYPE		WIDTH (FEET)								SLOPES	
		WITHOUT SHOULDER GUTTER				WITH SHOULDER GUTTER					
		FULL WIDTH		PAVED WIDTH		FULL WIDTH		PAVED WIDTH		NORMAL [1]	
		Outside	Median or Left	Outside	Median or Left	Outside	Median or Left	Outside	Median or Left	Outside	Median or Left
FREEWAYS (Lanes One Way)	4-Lane or More	12	12	10	10	15.5	15.5	8	8	0.06	0.06
	3-Lane	12	12	10	10	15.5	15.5	8	8		0.05
	2-Lane	12	8	10	4	15.5	13.5	8	6		
	HOV Lane	N/A [4]	14	N/A [4]	10	N/A [4]	N/A [4]	N/A [4]	N/A [4]	N/A [4]	0.05 [2]
	1-lane Barrier-Separated HOV Lane [5]	6	4 [5]	6	4 [5]	N/A [4]	N/A [4]	N/A [4]	N/A [4]	Same as Lane	Same as Lane [5]
	2-lane Barrier-Separated HOV Lane [5]	10	6 [5]	10	6 [5]	N/A [4]	N/A [4]	N/A [4]	N/A [4]	Same as Lane	Same as Lane [5]
	1-Lane Ramp	6	6	4	2	11.5	11.5	4 [3]	4	0.06	0.05
	2-Lane Ramp Non-Interstate	10	8	8	4	15.5	13.5	8	6		
	2-Lane Ramp Interstate	12	8	10	4	15.5	13.5	8	6		
	C-D Road 1-Lane	6	6	4	2	11.5	11.5	4	4		
	C-D Road 2-Lane	12	8	10	4	15.5	13.5	8	6		
	C-D Road 3-Lane	12	12	10	10	15.5	15.5	8	8		
	C-D Road > 3-Lane	12	12	10	10	15.5	15.5	8	8		0.06
	Auxiliary Lane Climbing & Weaving	12	N/A [4]	10	N/A [4]	15.5	N/A [4]	8	N/A [4]		N/A [4]
	Auxiliary Lane Mainline Terminal: 1-Lane Ramp 2-Lane Ramp	 12 12	 N/A [4] N/A [4]	 10 10	 N/A [4] N/A [4]	 15.5 15.5	 N/A [4] N/A [4]	 8 8	 N/A [4] N/A [4]		 N/A [4] N/A [4]
	Frontage Road	See **COLLECTORS** ***Table 2.3.4***. For local roads and streets see the FDOT ***Manual of Uniform Minimum Standards for Design, Construction and Maintenance for Streets and Highways.***									

1. Shoulders shall extend 4 ft. beyond the back of shoulder gutter and at a 0.06 slope back toward the gutter.
2. 0.06 when 4 lanes or more combined.
3. Shoulder pavement less than 6 ft. in width that adjoins shoulder gutter shall be the same type, depth and slope as the ramp pavement.
4. This does not mean that a shoulder is unnecessary; rather, shoulder is not typically present at this location (i.e., it is not required when adjacent to the through lane).
5. If median side of HOV lane is not barrier-separated, use median shoulder requirements for a standard HOV lane. Refer to AASHTO's ***Guide for High-Occupancy Vehicle Facilities*** for additional information.

Table 2.3.2 Shoulder Widths and Slopes - Arterials Divided

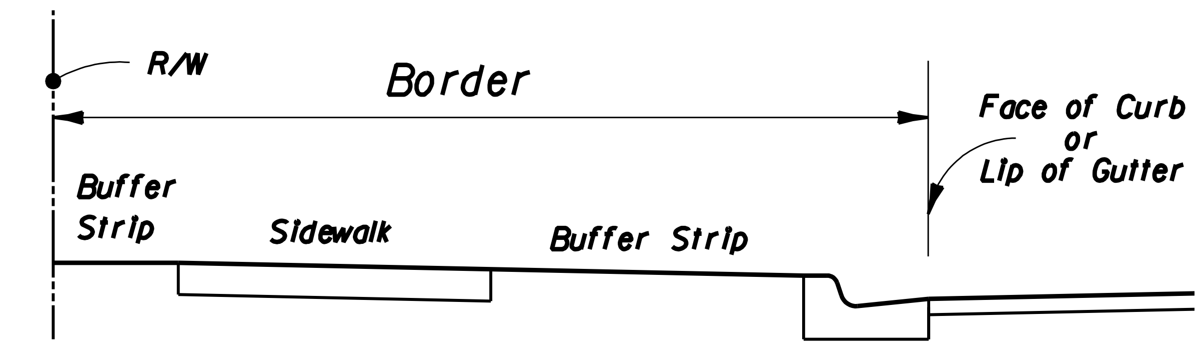
HIGHWAY TYPE		WIDTH (FEET)								SLOPES	
		WITHOUT SHOULDER GUTTER				WITH SHOULDER GUTTER					
		FULL WIDTH		PAVED WIDTH		FULL WIDTH		PAVED WIDTH		NORMAL [1]	
		Outside	Median or Left	Outside [2]	Median or Left	Outside	Median or Left	Outside	Median or Left	Outside	Median or Left
ARTERIALS Divided (Lanes One Way)	4-Lane	12 10 8	12 10 8	5 5 5	4 4 4	15.5 15.5 15.5	15.5 15.5 13.5	8 8 6	8 8 6	0.06	0.06
	3-Lane	12 10 8	12 10 8	5 5 5	0 [4] 0 [4] 0 [4]	15.5 15.5 13.5	15.5 15.5 13.5	8 8 6	8 8 6		0.05
	2-Lane	12 10 8	8 8 6	5 5 5	0 [4] 0 [4] 0 [4]	15.5 15.5 13.5	13.5 13.5 11.5	8 8 6	6 6 4		
	1-Lane Ramp	6	6	5	2	11.5	11.5	4 [3]	4		
	2-Lane Ramp	10	6	5	2	15.5	13.5	8	6		
	C-D Road 1-Lane	6	6	5	2	11.5	11.5	4	4		
	C-D Road 2-Lane	8	6	5	0	13.5	11.5	6	4		
	Auxiliary Lane Climbing & Weaving	Same As Travel Lanes	N/A [5]	Same As Travel Lanes	N/A [5]	Same As Travel Lanes	N/A [5]	Same As Travel Lanes	N/A [5]		N/A [5]
	Auxiliary Lane Mainline Terminal: 1-Lane Ramp 2-Lane Ramp	8 12	N/A [5] N/A [5]	5 10	N/A [5] N/A [5]	11.5 15.5	N/A [5] N/A [5]	4 8	N/A [5] N/A [5]		N/A [5] N/A [5]
	Auxiliary Lane At-Grade Intersection	Same As Travel Lanes	Same As Travel Lanes	5	0	11.5	N/A [5]	4	N/A [5]		0.05 - 0.06
	Frontage Road	See **Collectors *Table 2.3.4***. For local roads and streets see the FDOT ***Manual of Uniform Minimum Standards for Design, Construction and Maintenance for Streets and Highways.***									

1. Shoulders shall extend 4 ft. beyond the back of shoulder gutter and have a 0.06 slope back toward the gutter.
2. Shoulder shall be paved full width through rail-highway at-grade crossings, extending a minimum distance of 50 ft. on each side of the crossing measured from the outside rail. For additional information see the ***Design Standards, Index No. 560 and 17882.***
3. Shoulder pavement less than 6 ft. in width and adjoining shoulder gutter shall be the same type, depth and slope as the ramp pavement.
4. Paved 2 ft. wide where turf is difficult to establish. Paved 4 ft. wide (a) in sag vertical curves, 100 ft. minimum either side of the low point, and (b) on the low side of superelevated traffic lanes extending through the curves and approximately 300 ft. beyond the PC and PT.

   LEGEND FOR VALUES
   X......... High Volume Highways
   X......... Normal Volume Highways
   X......... Low Volume Highways

5. This does not mean that a shoulder is unnecessary; rather, shoulder is not typically present at this location (i.e., it is not required when adjacent to through lane).

Table 2.5.2 Highways with Curb or Curb and Gutter in Urban Areas



** Border width measured from lip of gutter (shown) or from face of curb when there is not a gutter.*

BORDER

TYPE FACILITY	**MINIMUM WIDTH (FEET)**	
	TRAVEL LANES AT CURB OR CURB AND GUTTER	**BIKE LANES OR OTHER AUXILIARY LANES AT CURB OR CURB AND GUTTER**
ARTERIALS COLLECTORS Design Speed = 45 mph	14	12
ARTERIALS COLLECTORS Design Speed ≤ 40 mph	12	10
URBAN COLLECTOR STREETS Design Speed ≤ 30 mph	10	8

2.5.1 Limited Access Facilities

On Limited Access Facilities, the border is measured from the edge of the outside traffic lane to the right of way line. This width may be reduced in the area of a crossroad terminal, as long as the design meets the requirements for clear zone, horizontal clearance, drainage, maintenance access, etc.

Limited access facilities shall be contained by fencing, or in special cases, walls or barriers. These treatments shall be continuous and appropriate for each location. Treatment height and type may vary under special conditions. The treatment is typically placed at or near the limited access right of way line, but location may be adjusted based on site-specific conditions (i.e., ponds, trees, bridges, etc.). Placement information and additional data is included in the ***Design Standards, Indexes 800, 801, and 802***.

Table 2.8.3 Maximum Curvature of Horizontal Curve (Using Limiting Values of "e" and "f")

MAXIMUM CURVATURE (Degrees)			
Design Speed (mph)	RURAL ENVIRONMENT (e max=0.10)	URBAN ENVIRONMENT (e max=0.05)	
		Without Curb And Gutter	With Curb And Gutter
30	24° 45'	20° 00'	20° 00'
35	17° 45'	14° 15'	14° 15'
40	13° 15'	10° 45'	10° 45'
45	10° 15'	8° 15'	8° 15'
50	8° 15'	6° 30'	6° 30'
55	6° 30'	5° 00'	---
60	5° 15'	---	---
65	4° 15'	---	---
70	3° 30'	---	---
Interstate: 3° 00' (Maximum Curvature) (e max=0.10)			

Table 2.8.4 Maximum Horizontal Curvature Using Normal Cross Slopes (-0.02)

MAXIMUM CURVATURE (Degrees)		
Design Speed (mph)	Curvature (e max = 0.10)	Curvature (e max = 0.05)
30	1° 30'	7° 00'
35	1° 30'	5° 00'
40	1° 00'	3° 45'
45	0° 30'	2° 45'
50	0° 30'	2° 00'
55	0° 30'	---
60	0° 15'	---
65	0° 15'	---
70	0° 15'	---

2.8.1.2 Supplemental Alignment Control (Intersections)

For redirection or offset deflection of through lanes through intersections, see the values given in ***Table 2.8.1b***. Curves are not required for these angular breaks. However, short curves may be desirable at each end, especially if pavement markings are used through the intersection to provide positive guidance to the motorist.

2.8.1.3 Roadway Transitions

Transition details have been developed and included in the ***Design Standards***. Transitions on curved alignment will require special design details in the contract plans.

2.10 Vertical Clearance

Minimum vertical clearances, with the exception of structures over water (see ***Section 2.10.1***), are contained in the criteria tables and figures.

Figure 2.10.1 Clearances – Rural and Urban Interstates (Freeways), Arterials and Collectors, with Projected 20-Year ADT of 1500 or Greater

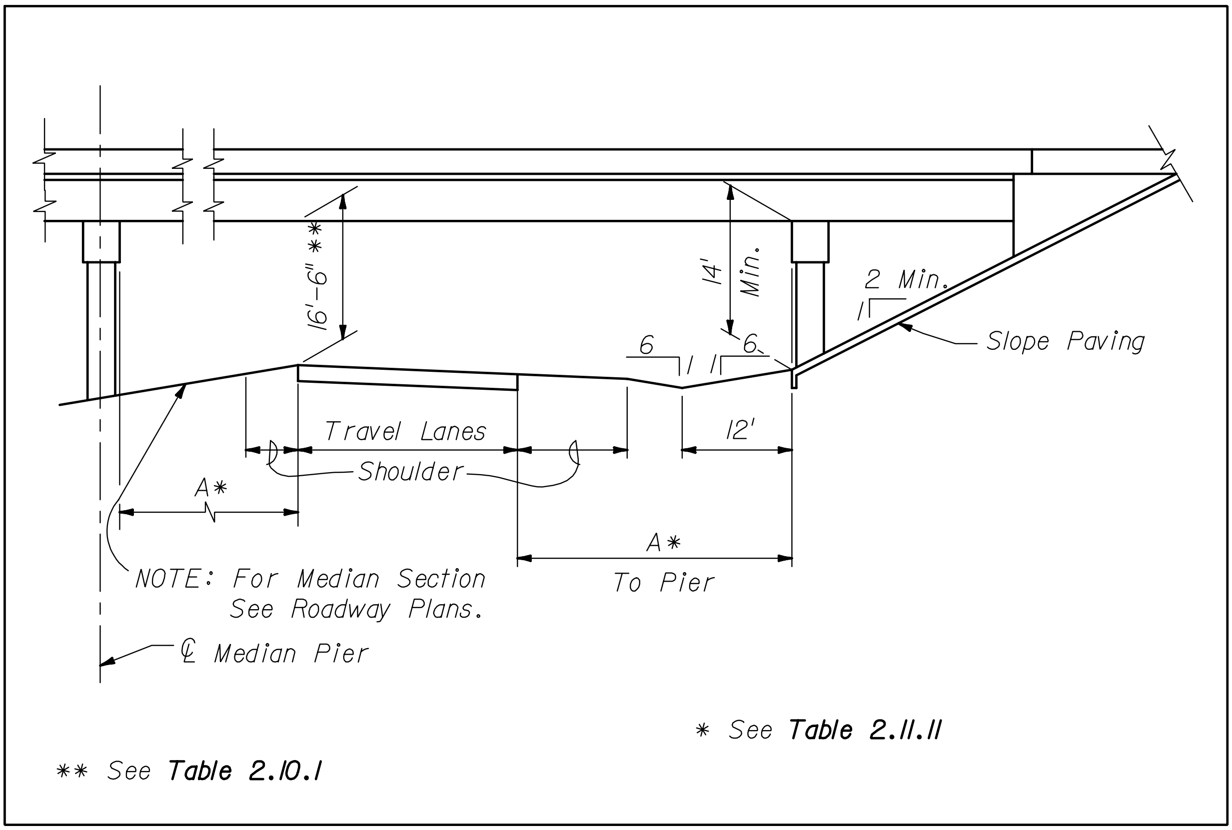


Figure 2.10.2 Clearances – Rural Arterials and Collectors with Projected 20-Year ADT of Less than 1500

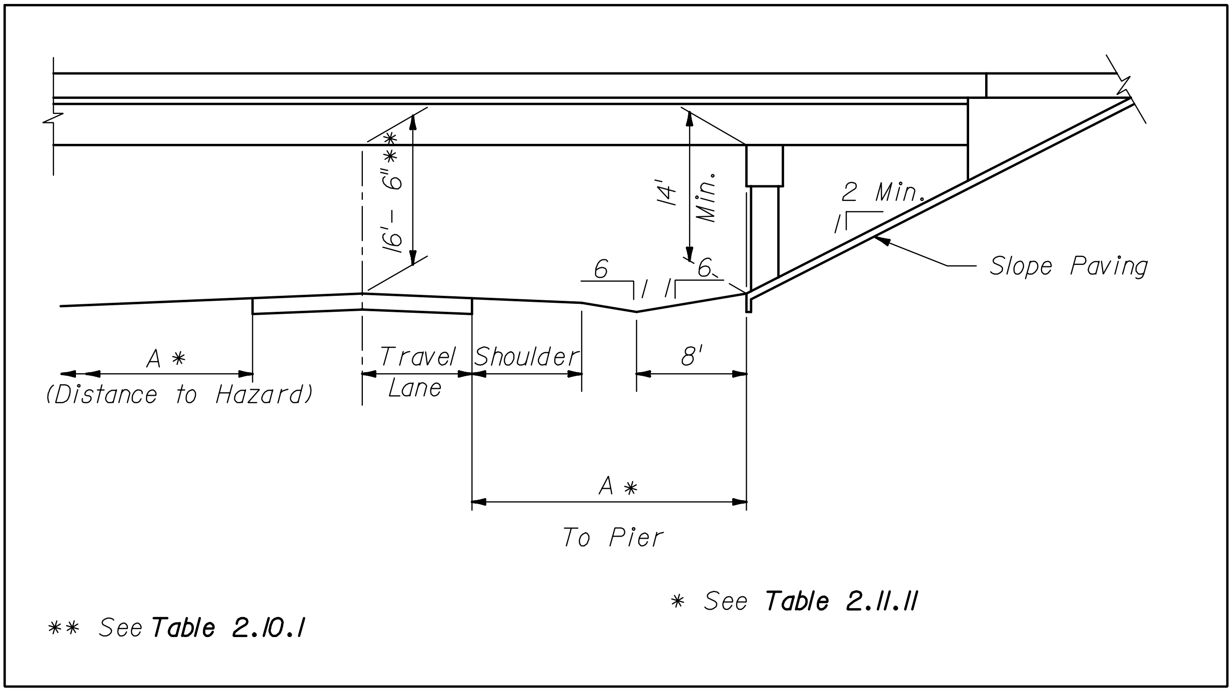


Figure 2.10.3 Clearances – Urban Arterials and Collectors (Without Curb and Gutter)

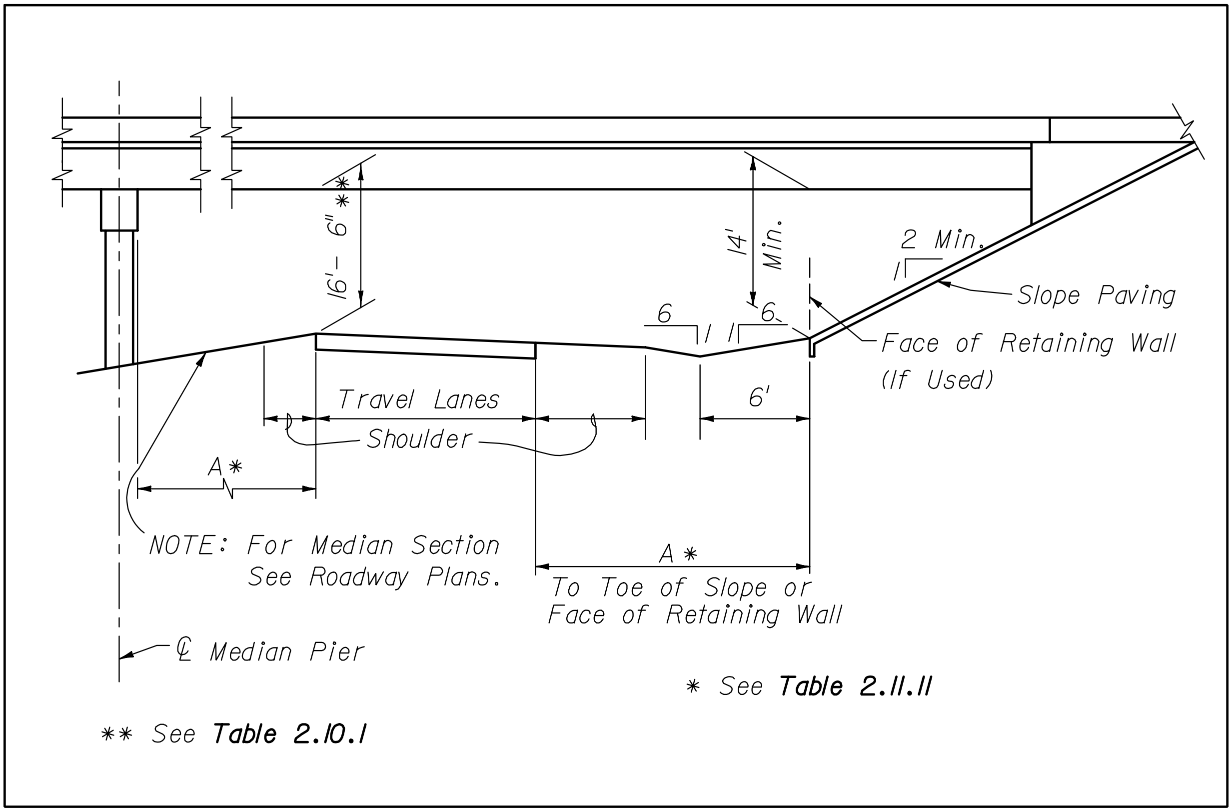
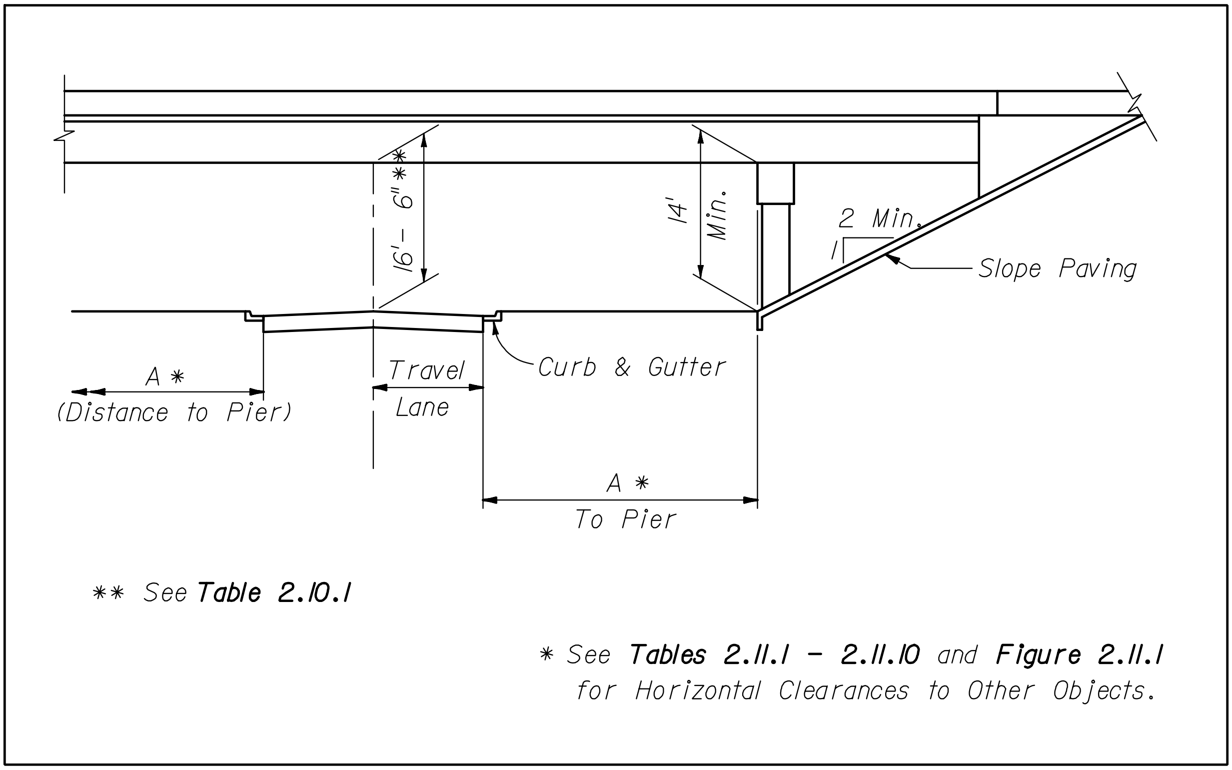


Figure 2.10.4 Clearances – Urban Arterials and Collectors (Curb and Gutter)



2.11 Horizontal Clearance

Horizontal clearance is the lateral distance from a specified point on the roadway such as the edge of travel lane or face of curb, to a roadside feature or object. Horizontal clearance applies to all highways. Horizontal clearance requirements vary depending on design speed, whether rural or urban with curb, traffic volumes, lane type, and the object or feature.

Rural highways with flush shoulders and highways with curb or curb and gutter where right of way is not restricted have roadsides of sufficient widths to provide clear zones; therefore, horizontal clearance requirements for certain features and objects are based on maintaining a clear zone wide enough to provide the recoverable terrain in ***Table 2.11.11***. The procedure for determining required clear zone widths is described in ***Chapter 4*** of this volume.

In urban areas, horizontal clearance based on clear zone requirements for rural highways should be provided wherever practical. However, urban areas are typically characterized with 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. In these areas, curb with closed drainage systems are often used to minimize the amount of right of way needed. Highways 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 highways, 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 no redirectional capabilities except at speeds less than the lowest design speeds used on the State Highway System. Therefore curb should not be considered effective in shielding a hazard. Curb is not to be used to reduce horizontal clearance requirements.

Crashworthy objects shall meet or exceed the offset listed in ***Tables 2.11.1*** through ***2.11.10*** and objects that are not crashworthy are to be as close to the right of way as practical and no closer than the requirements listed in ***Tables 2.11.1*** through ***2.11.10.***

For horizontal clearances where roadways overpass railroads refer to ***Chapter 6*** of this volume.

Table 2.11.1 Horizontal Clearance for Traffic Control Signs

PLACEMENT	Placement shall be in accordance with the ***Design Standards***. Placement within sidewalks shall be such that an unobstructed sidewalk width of 4 ft. or more (not including the width of curb) is provided.
SUPPORTS	Supports, except overhead sign supports, shall be frangible or breakaway. When practicable, sign supports should be located behind barriers that are justified for other reasons. Overhead sign supports shall be located outside the clear zone unless shielded.

Table 2.11.2 Horizontal Clearance for Light Poles

CONVENTIONAL LIGHTING	Not in the median except in conjunction with barriers that are justified for other reasons. Rural and Urban Flush Shoulders: 20 ft. from the travel lane, 14 ft. from auxiliary lane (may be clear zone width when clear zone is less than 20 ft.). Urban Curb or Curb and Gutter: From right of way line to 4 ft. back of face of curb (may be 2.5 ft. back of face of curb when all other alternatives are deemed impractical). Placement within sidewalks shall be such that an unobstructed sidewalk width of 4 ft. or more (not including the width of curb) is provided.
HIGHMAST LIGHTING	Outside of the clear zone unless shielded.

Table 2.11.7 Horizontal Clearance to Railroad Grade Crossing Traffic Control Devices

Placement shall be in accordance with the ***Design Standards***.

Table 2.11.8 Horizontal Clearance to Drop-off and Canal Hazards

Canals: (See also ***Chapter 4*** of this Volume.)

Rural and Urban Flush Shoulders:

Design Speeds ≥ 50 mph: 60 ft. from the travel lane.
Design Speeds < 50 mph: 50 ft. from the travel lane.

Urban Curb or Curb and Gutter:

40 ft. from the edge of the travel lane.

Drop-offs: (See also ***Chapter 4*** of this Volume.)

Rural and Urban Flush Shoulders:

Treat as roadside slopes in accordance with ***Design Standards, Index 700.***

Urban Curb or Curb and Gutter:

22 ft. from traveled way to the point that is 6 ft. below the hinge point.

Table 2.11.9 Horizontal Clearance to Other Roadside Obstacles

Minimum Horizontal Clearance to other roadside obstacles:

Rural and Urban Flush Shoulders:

Outside the clear zone.

Urban Curb or Curb and Gutter:

4 ft. back of face of curb. May be 2.5 ft. back of face of curb when all other alternatives are deemed impractical.

Note:	Horizontal Clearance to mailboxes is specified in the construction details contained in the ***Design Standards, Index No. 532.***
Note:	Transit and school bus shelters shall be placed in accordance with ***Rule Chapter 14-20.003, Florida Administrative Code***. Transit bus benches shall be placed in accordance with ***Rule Chapter 14-20.0032, F.A.C.***.

Table 2.11.10 Horizontal Clearance for ITS Poles and Related Items

POLES AND OTHER ABOVE-GROUND FIXED OBJECTS	Shall not be located in the median except in conjunction with barriers that are justified for other reasons. Rural and Urban Flush Shoulders: Outside the clear zone. Install as close as practical to the right of way without aerial encroachments onto private property. Urban Curb or Curb and Gutter: At the right of way line or as close to the right of way line as practical. Maintain 4 feet of clearance from the face of the curb. Placement within sidewalks is allowed only where an unobstructed sidewalk width of 4 feet or more (not including the curb width) is provided. May be located behind barriers that are justified for other reasons.
EQUIPMENT SHELTERS AND TOWERS	Shall not be located within the limited-access right of way, except as allowed by ***Policy No. 000-625-025, Telecommunications Facilities on Limited Access Rights of Way*****.**
FRANGIBLE AND BREAKAWAY OBJECTS	Rural and Urban Flush Shoulders: Locate as close to the right of way as practical. Urban Curb or Curb and Gutter: Locate no less than 4 feet from the face of the curb (a 2.5-foot setback from the face of the curb is allowed when all other alternatives are deemed impractical).

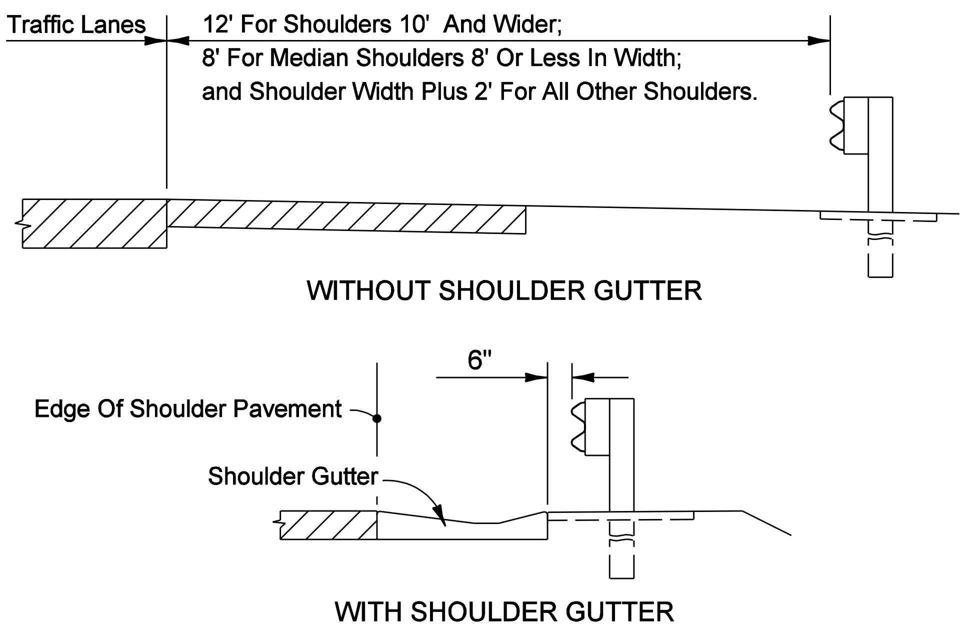
Table 2.11.11 Recoverable Terrain

DESIGN SPEED (mph)	≥ 1500 AADT[1]		< 1500 AADT[1]	
	TRAVEL LANES & MULTILANE RAMPS (feet)	AUXILIARY LANES & SINGLE LANE RAMPS (feet)	TRAVEL LANES & MULTILANE RAMPS (feet)	AUXILIARY LANES & SINGLE LANE RAMPS (feet)
< 45	18	10	16	10
45	24	14	20	14
50	24	14	20	14
55	30	18	24	14
> 55	36	24	30	18

(1) AADT=Mainline 20 years projected annual average daily traffic.

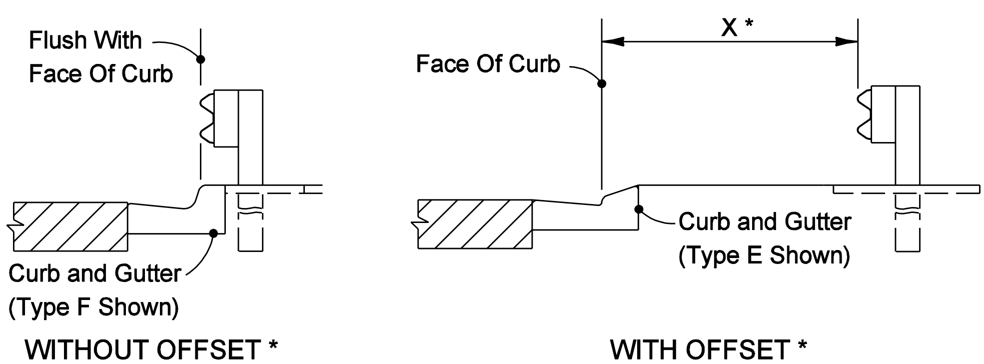
The above values are to be used in the process for determining the clear zone width as described in ***Chapter 4*** of this volume.

Figure 2.11.1 Horizontal Clearance to Guardrail



For additional information see ***Section 2.3*** of this volume.

FLUSH SHOULDERS



* For design speed limitations and minimum offset distances, refer to ***Figure 4.3.1*** of this volume.

CURB AND GUTTER

For additional information see the ***Design Standards, Index No. 400.***

2.14 Interchanges and Median Openings/Crossovers

Design guides and criteria presented heretofore and in the ***Design Standards*** are also applicable to the proper design of interchanges with their inherent ramps, speed change, merging and weaving lanes. Where diamond ramps and partial cloverleaf arrangements intersect the crossroad at grade, an at-grade intersection is formed. In urbanized areas, high speed ramps, weaving areas and acceleration lanes are not appropriate. These ramp terminals should be designed as intersections consistent with the design speed and character of the roadway.

2.14.1 Limited Access Right of Way Limits at Interchanges

The following criteria will be used in establishing limited access limits along crossroads at interchanges:

1. For rural interchanges, limited access will extend along the crossroad to a point 300 ft. minimum beyond the end of the acceleration or deceleration taper. In the event these points are not opposite, the point most remote from the project will be the control and the limited access on both sides will end at that station along the crossroad. Where no taper is used, the limited access will be carried to a point 300 ft. minimum beyond the radius point of the return. In this case also, the radius point most remote from the project will control.
2. For interchanges in urban areas, the criteria given above will apply except that the limited access will end a minimum of 100 ft. beyond the end of taper or the radius point of the return.
3. For unsymmetrical interchanges such as half-diamonds and partial clover leafs, etc., the limited access right of way along the crossroad on that side having no ramp will extend to a point opposite that point controlled by the ramp.
4. Limited access along crossroads overpassing limited access facilities (with no interchange) shall be extended approximately 200 feet, measured from the mainline right of way line, along the crossroad. This distance may be reduced or omitted if the crossroad profile provides for adequate sight distance for existing or proposed driveways. The fence is generally tied into the crossroad structure end bent unless required along the crossroad.
5. Any reduction in the values shown above for limited access limits must be approved by FHWA for interstate projects and by the District Design Engineer for non-interstate limited access facilities.

Access Management Rule 14-97 standards ***(14-97.003(1)j)*** regulate the location of driveway connections and median openings in interchange areas on arterial roads. This standard should be applied in accordance with the District procedures for implementing the Rule, and should not be confused with minimum requirements for limited access right of way.

2.14.2 Median Openings at Interchanges

Median opening locations at interchanges on arterial roads must consider ***Access Management Rule 14-97 (14-97.003(1)(j)2)*** which states "The minimum distance to the first median opening shall be at least 1320 feet as measured from the end of the taper of the egress ramp." This standard is to be applied in accordance with the FDOT median opening decision process. As a minimum, for all crossroad facilities at interchanges in both rural and urban areas, a median opening may be centered no less than 50 ft. beyond the end of limited access except that a minimum distance of 660 ft. to the ramp median opening will be required. In no case should access be permitted between the interchange proper and the median opening as established by these criteria.

2.14.3 Ramp Widths

Ramp widths for interchange ramp terminal design are given in ***Table 2.14.1***.

Table 2.14.1 Ramp Widths - Turning Roadways

RAMP WIDTHS			
RADIUS To Inside of Curve (FEET)	1-LANE 3		2-LANE
	Traveled Way Width 1 **Case I-C 2** One–lane, one-way operation – no provision for passing a stalled vehicle	**Traveled Way Width 1 + Outside Paved Shoulder Width** **Case II-B 2** One-lane, one-way operation – with provision for passing a stalled vehicle	**Traveled Way Width 1** **Case III-A 2** Two-lane operation – either one-way or two-way
	FEET		
50	23	26	29
75	20	23	27
100	18	22	26
150	17	21	24
200	16	20	24
300	15	20	24
400	15	19	24
≥ 500	15	19	24

For widths on the ramp proper, see ***Table 2.1.3***.

For case application, see ***AASHTO*** and the ***Design Standards, Index No. 525.***

1. AASHTO adjustments do not apply.

2. Note: A = Predominantly P vehicles, but some consideration for SU trucks.
   B = Sufficient SU vehicles to govern design, but some consideration for semitrailer combination trucks.
   C = Sufficient bus and combination trucks to govern design.

3. Where accommodation of future resurfacing is a factor, consideration should be given to increasing the minimum width to 24 ft. where practical.

2.14.4 Crossovers on Limited Access Facilities

Permanent crossovers on freeways are sometimes necessary to avoid excessive travel distances for emergency vehicles, law enforcement vehicles, and maintenance vehicles. Median crossings shall be allowed only when there is a clear documented request and need for such a feature; however they shall be limited in number and very carefully located. The location of crossovers used for maintenance purposes should consider the needs of emergency and law enforcement vehicles and vice versa. Permanent crossovers should conform to the recommendations of ***AASHTO's "Geometric Design of Highways and Streets"*** (see Rural Freeway Medians). The location of all crossovers requires approval of the District Design Engineer. Note, this criteria does not apply to contra flow crossovers placed for facilitating hurricane evacuation, nor does it apply to temporary construction crossovers. For temporary construction crossovers, please see ***Design Standards, Index Numbers 630 and 631***.

The following AASHTO crossover recommendations are requirements on FDOT's Limited Access Facilities:

1. Not spaced closer than 3.0 miles apart.
2. Located only in areas with above-minimum stopping sight distance and without superelevated curves.
3. Not located within 1,500 feet to the end of a speed-change taper (of a ramp or facility widening/narrowing) or any structure (bridge, overpassing facility oroverhead sign).
4. Not located where the median width is less than 25 feet.

Crossover locations that do not meet the above criteria require approval by the State Roadway Design Engineer and FHWA (FHWA on Interstate facilities only).

The following additional criteria are also placed on crossovers designed for FDOT's Limited Access Facilities:

1. Not located within 1.5 miles of any interchange.
2. Not located where the median width is less than 40'.
3. Not located in urban areas
4. Where continuous median barrier is present, openings for crossovers should not be greater than 5.0 miles apart between Interchanges.

Crossovers that do not meet these additional criteria require approval by the District Design Engineer.

Typical layouts for the design of median crossovers are provided in ***Figures 2.14.1, 2.14.2 and 2.14.3***. These typical layouts will not cover all situations, but are provided as a guide for developing site-specific designs. Designs should accommodate the types of emergency vehicles expected to use the crossover. Law enforcement vehicles and typical ambulance sized vehicles can usually be easily accommodated. The typical layouts in ***Figures 2.14.1, 2.14.2 and 2.14.3*** will accommodate an SU design vehicle. To the extent practical, designs should accommodate larger emergency response vehicles such as fire trucks. This will require acquiring information from local emergency responders on the size and configuration of vehicles used. Except where median widths are wider than normal, fire trucks and other larger vehicles will likely not be able to make u-turns without encroaching or crossing travel lanes. As a minimum, designs should provide for the necessary minimum radii and width to allow the largest design vehicle to enter the crossover and stop as close to perpendicular to traffic as practical. All designs should be tested by superimposing the turning path of the design vehicle to insure the crossover will operate as expected.

On Interstate facilities, the Federal Highway Administration directs that median shoulders approaching the crossover utilize the standard shoulder width, or existing shoulder width. The FHWA believes the safety benefits derived by making the crossovers appear less conspicuous outweigh the benefits obtained by providing paved shoulders to accommodate acceleration and deceleration lanes for emergency vehicles, law enforcement, or other authorized vehicles.

The profile of the crossover shall conform as close as practical with travel way shoulder slopes and median side slopes so that the crossover is inconspicuous as possible to traffic. The paved width of the crossover should not be any wider than that necessary to provide for the largest design vehicle. Shoulder width for the crossover should be 8' minimum. Side slopes of the crossover (parallel with the mainline travel way) shall be 1V:10H or flatter. However, side slopes may be transitioned to match the slope of a pipe culvert safety end treatment where a culvert crossing underneath the crossover is necessary to provide for proper median drainage.

In locations where a median barrier is present, the length of the barrier opening should be minimized to the extent practical. As shown in ***Figure 2.14.3***, the barrier ends on each side of the opening should be offset to the extent practical. Crashworthy end treatments or crash cushions to shield the barrier ends shall be provided when the ends are within the clear zone and fall within the departure angle used to set length of need. Crashworthy end treatments or crash cushions shall also be provided whenever the angle between barrier ends is less than 30 degrees measured from the direction of mainline travel (see ***Figure 2.14.3***).

Drainage requirements must be determined for each location and appropriate provisions made. The drainage culvert shown in the figures are for example only. Either a mitered end section (1:4) or preferably a u-endwall with grate (1:6) should be used for culverts parallel with the mainline. Note that in some cases existing median ditches are shallow and there will be minimal clearances available for even small size culverts. This requires that site-specific vertical and horizontal geometry be developed for each location rather than use a typical drawing.

A pavement design equivalent to a Limited Access shoulder pavement should be provided (1-1/2" Structural Course, Base Group 1 with a 12" Stabilized Subgrade).

Signing for permanent crossovers shall consist of a "No U-turn" sign (R3-4) with an "Official Use Only" plaque (FTP-66-04). In accordance with ***MUTCD Section 3D.03***, a double yellow delineator should be placed on the left side of the through roadway on the far side of the crossover for each roadway (see figures). To improve nighttime visibility for approaching emergency responders, install yellow RPM's placed outside the yellow edge line in advance of the crossover using the following pattern and spacing: 3 spaced 4" apart @ 1500’, 2 spaced 4" apart @ 1000’, and 1 @ 500' in advance of the crossover.

On reconstruction and RRR projects, the location of existing crossovers shall be evaluated for conformance to the above criteria. Those that do not meet this criterion must be removed as a part of the project unless approved by the State Roadway Design Engineer and FHWA (FHWA approval on Interstate only).

Figure 2.14.1 Crossovers on Limited Access Facilities – 6 or More Lanes

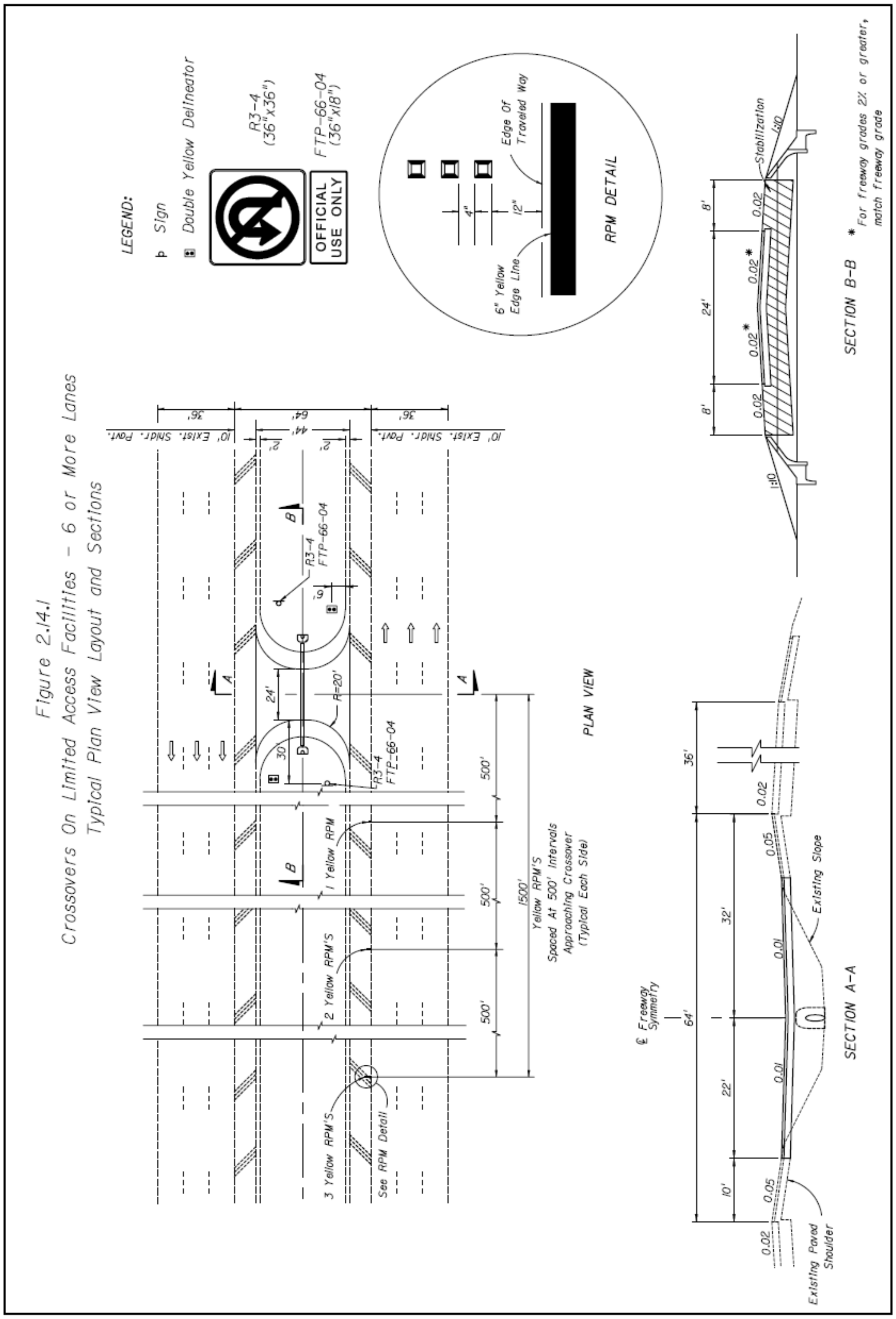


Figure 2.14.2 Crossovers on Limited Access Facilities – 4 Lanes

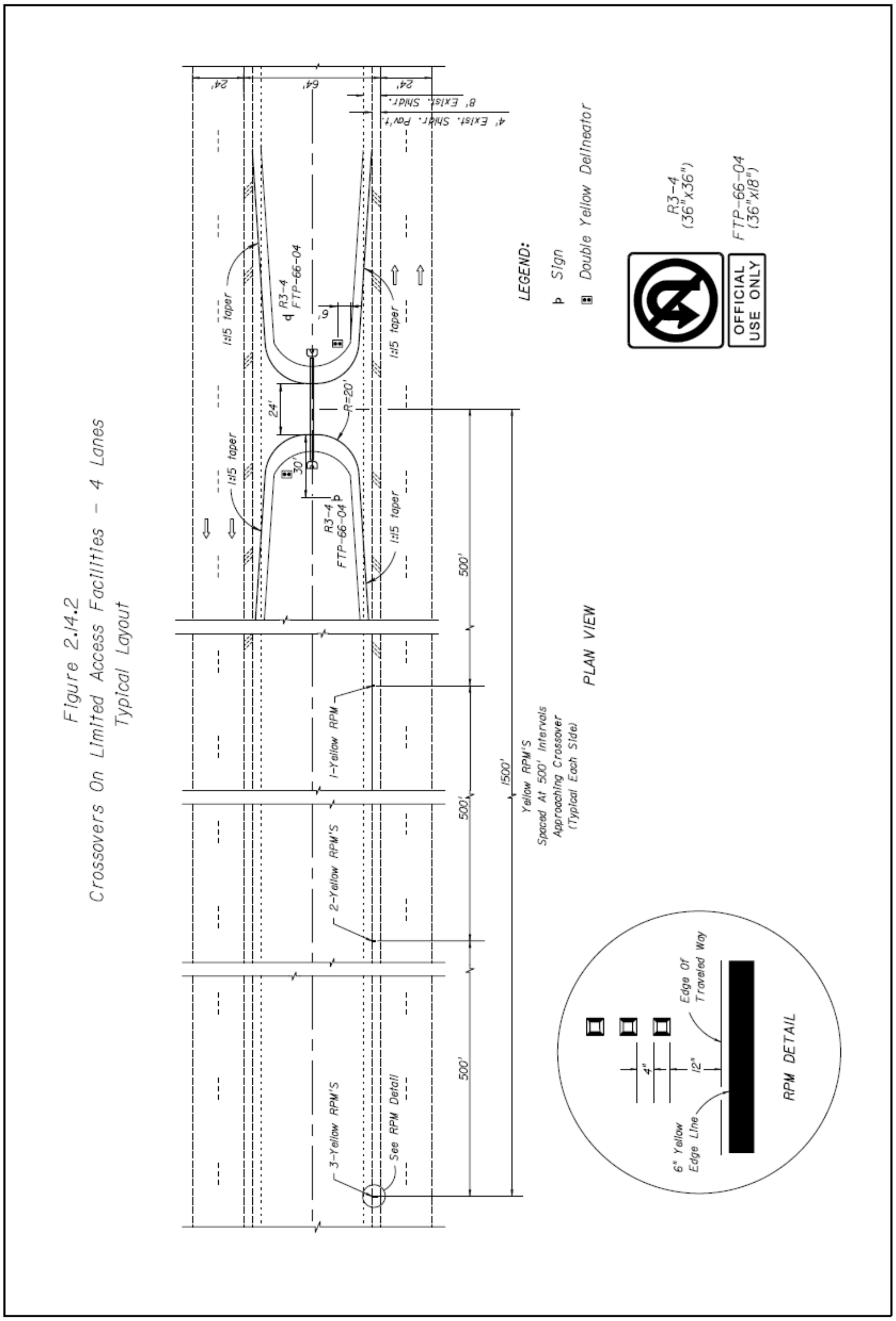
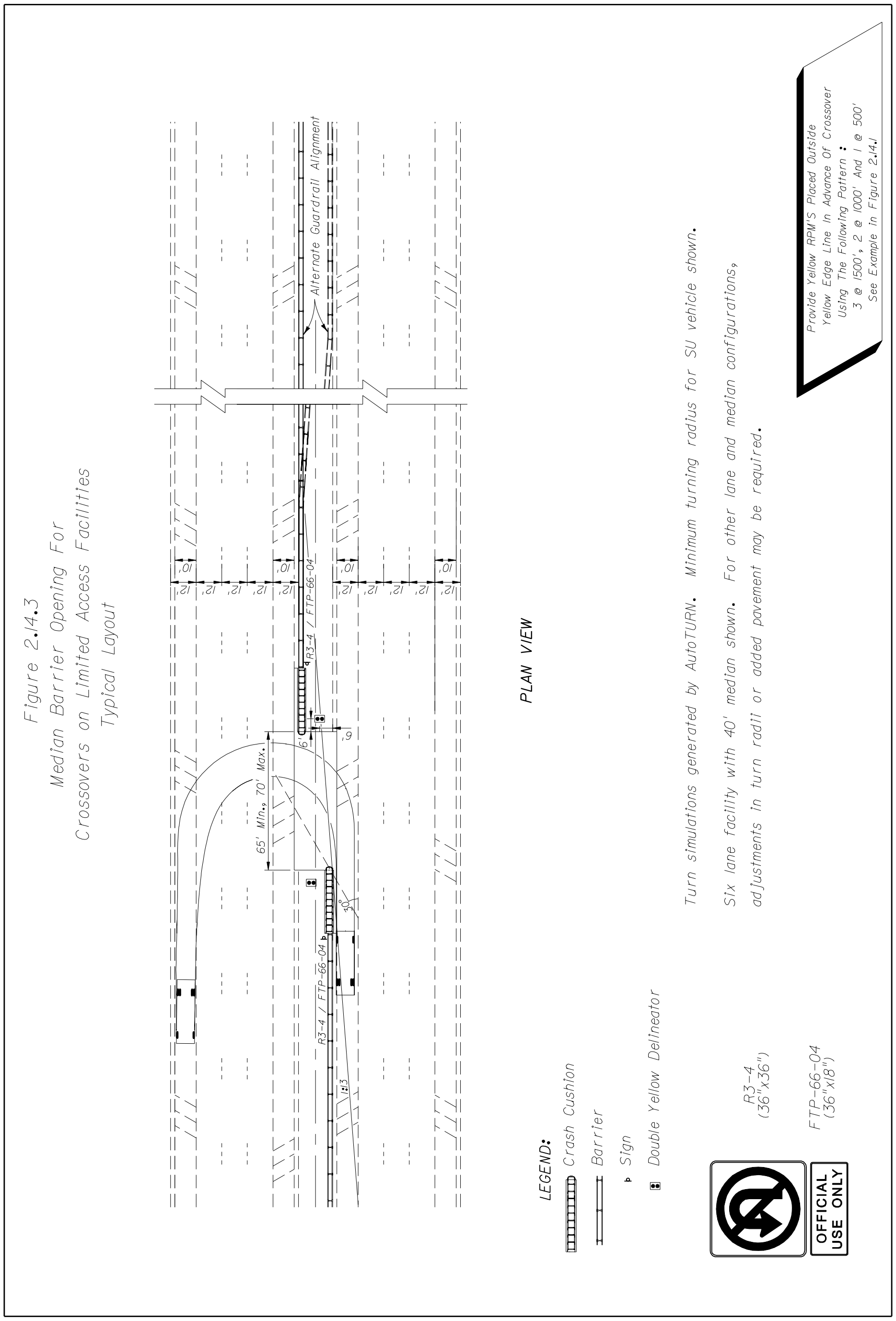


Figure 2.14.3 Median Barrier Opening for Crossovers on Limited Access Facilities



2.15 Lighting Criteria

Lighting Criteria is contained in ***Chapter 7*** of this volume.

2.16 Four-Lane High-Speed Suburban Arterial Highways

The two classifications of rural and urban are generally sufficient for the design of Florida's arterial highways; however, there are some areas that do not lend themselves to these classifications. These are transitional areas where conditions along the highway change from rural to urban or from urban to rural. Also, there are urban arterial highways where the anticipated operating speeds are higher than standard urban design speeds. Because of the undesirable effects of having curb and gutter on high speed highways, four-lane high speed suburban arterial highway typical sections have been developed to insure that these highways are designed consistently and to minimize the need to process design exceptions and variations. These typical sections are found in ***Exhibit TYP-13*** and ***TYP-14*** of ***Chapter 6, Volume II***.

Special design criteria in this section have been developed for these four-lane high-speed suburban arterial highways. For criteria and other guidance not listed below, the designer is to use the values that are commensurate with a four-lane rural arterial highway having the same design speed and traffic volumes. Use of these special criteria is restricted to facilities in developing suburban areas which are initially constructed with 4 lanes and are included in the State Transportation Improvement Program (STIP) for 6 lanes in the future.

The design of the initial 4 lane facility should also take into consideration the ultimate 6 lane section that these roadways will have in the future. Special attention to the ultimate location of drainage structures, sidewalk offset and elevation, superelevation and curve radii can minimize the amount of reconstruction of these elements. To illustrate two possible scenarios, ***Figure 2.16.1*** and ***Figure 2.16.2*** show examples of four-lane high-speed suburban arterial sections with the future six-lane low-speed urban arterial typical section superimposed.

Figure 2.16.1 Curb and Gutter Section

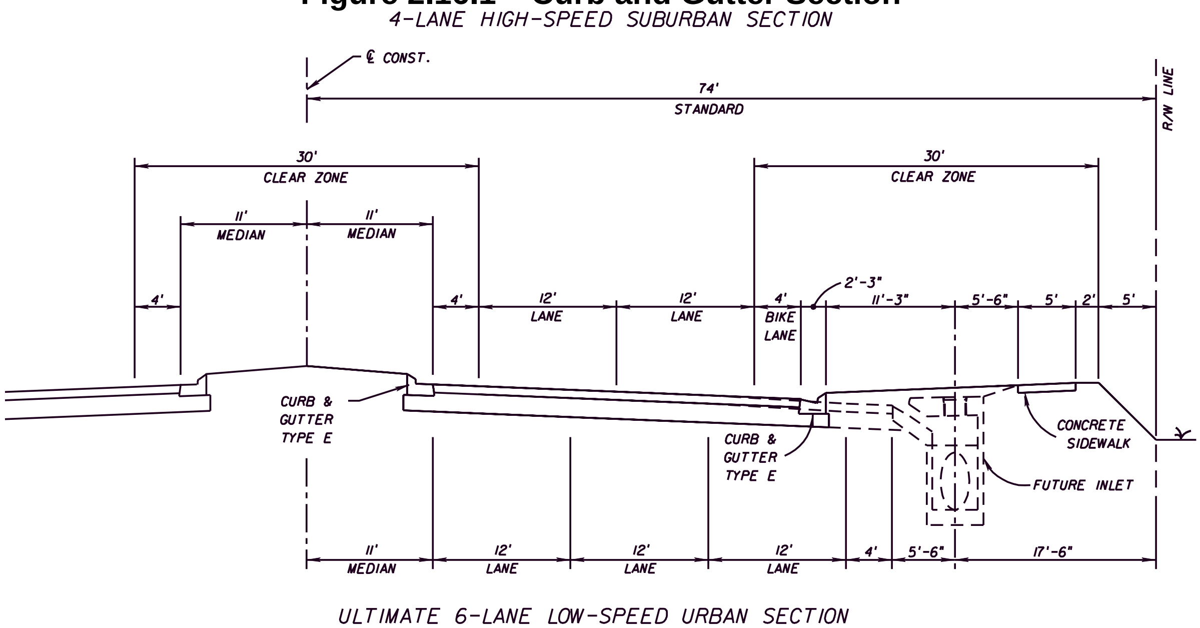
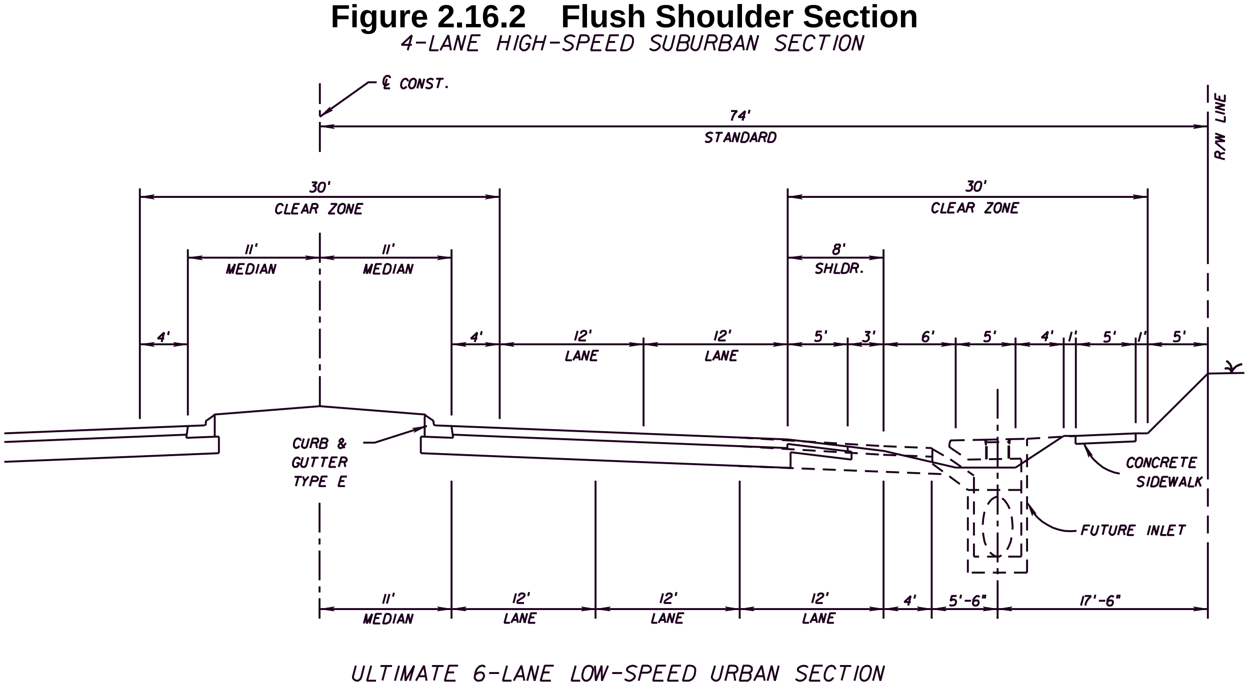


Figure 2.16.2 Flush Shoulder Section



2.16.1 Design Speed

The maximum design speed of four-lane high-speed suburban arterial highways is 55 mph.

2.16.2 Pedestrian and Bicycle Facilities

Four-lane high-speed suburban arterial highways shall have bike lanes and sidewalks.

2.16.3 Medians

The minimum median width for four-lane high-speed suburban arterial highways may be reduced to 30 feet as opposed to 40 feet minimum required in ***Table 2.2.1***. When this is done neither a design exception nor design variation is required.

2.16.4 Friction Course

Because of the higher speeds and the associated risk of hydroplaning, FC-5 friction course is to be provided to reduce surface water. The FC-5 friction course should be placed at the lip of the gutter in accordance with the ***Design Standards, Index 300***.

2.16.5 Border Width

A minimum border width of 35 feet measured from the outside edge of the traveled way to the right of way is to be provided on all four-lane high-speed suburban arterial highways with or without curb and gutter.

2.16.6 Grades

The maximum grade for four-lane high-speed suburban arterial highways is 5%.

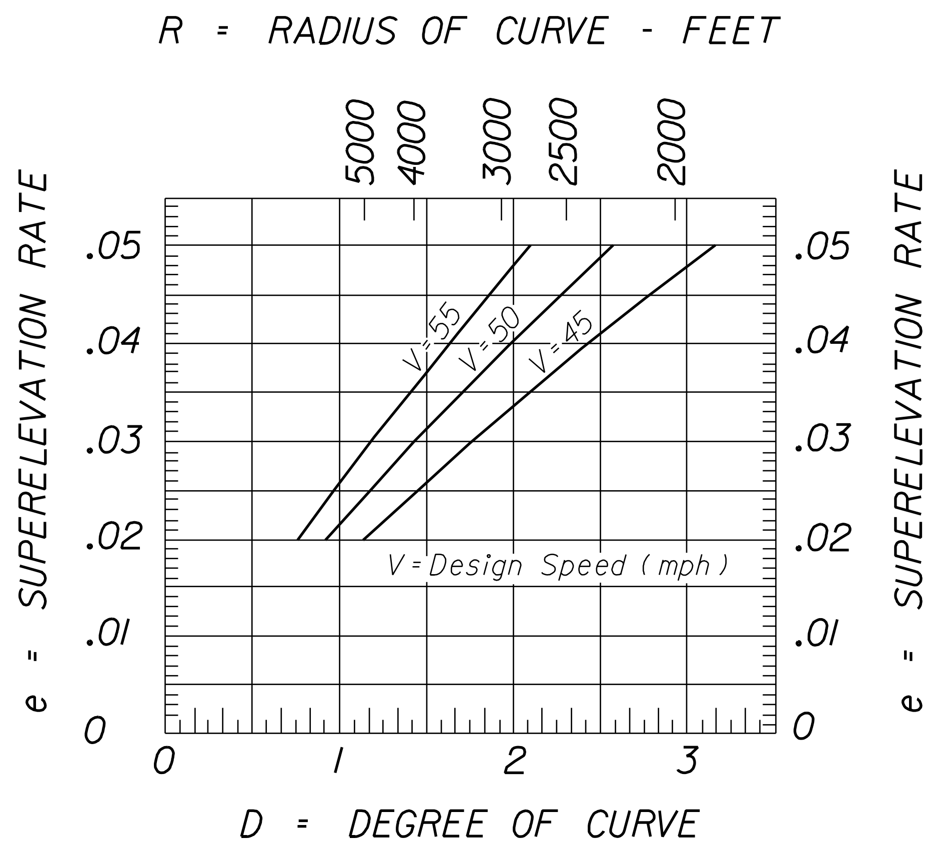
2.16.7 Horizontal Curves

The maximum deflection without horizontal curvature is commensurate with rural new construction and comparable design speeds.

2.16.8 Superelevation

When these suburban typical sections are superelevated, the superelevation rates are based on the e_{max} = 0.10 calculations, however the maximum superelevation rate that may be used is 0.05 (See ***Figure 2.16.3***). Superelevation transition rates are to be commensurate with those for rural highways with 55 mph design speeds.

Figure 2.16.3 Superelevation Rates for High-Speed Urban or Suburban Sections



MAXIMUM DESIGN SUPERELEVATION RATE = 0.05
(BASED ON e_{max} = 0.10)

2.16.9 Horizontal Clearance

Horizontal Clearance requirements are to be commensurate with new construction conditions for flush shoulder highways.

2.16.10 Monitoring

These high-speed suburban arterial highways will require that the county, section, begin milepost and end milepost for these sections be reported to the State Roadway Design Office during the Phase II Design. The District Design Engineer shall report to the State Roadway Design Engineer a speed study containing the speed histograms, the 85th percentile and the 10 mph pace speeds within one year after opening, then again between three to four years after opening. This data along with other data collected will be used to evaluate the overall effectiveness and safety of these high-speed suburban arterial highways.

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2.17 High-Speed Urban Arterial Highways

There are urban arterial highways where the anticipated operating speeds are higher than standard urban design speeds. Because urban curbed roadway sections which typically provide roadside clearances that satisfy only operational needs are not suitable for high speed highways, and because of the right of way demands of rural highways, a high-speed urban arterial highway typical section has been developed. This typical section provides for reduced right of way requirements, yet still provides for horizontal clearances/clear zones commensurate with rural highway design. A six-lane high-speed urban typical section is found in ***Exhibit TYP-16*** of ***Chapter 6, Volume II***. A four-lane high-speed urban typical section differs from the six-lane section in median shoulder width as discussed in ***Section 2.17.5***.

Special design criteria in this section have been developed for these high-speed urban arterial highways. For criteria and other guidance not listed in this section, the designer is to use the values that are commensurate with a rural arterial highway having the same design speed and traffic volumes. Use of these special criteria is restricted to facilities within FHWA Urban or Urbanized boundaries where right of way is constrained.

2.17.1 Design Speed

The design speed for the high-speed urban arterial highway shall be 50 mph. The special criteria listed in this section do not apply to facilities with higher design speeds.

2.17.2 Curbs

To minimize right of way requirements, the high-speed urban arterial highway typical section incorporates the use of curbs and a closed drainage system. The type of curb used within the clear zone on this section is restricted to the FDOT Type E shape (sloping curb not greater than 5” in height above adjacent pavement). This applies to both median and outside shoulder locations.

2.17.3 Pedestrian and Bicycle Facilities

High-speed urban arterial highways shall have shoulders and sidewalks.

2.17.4 Medians

The minimum median width for high-speed urban arterial highways may be reduced to 30 feet (inclusive of median shoulders) as opposed to 40 feet minimum required in ***Table 2.2.1***. A 30 foot median provides sufficient width for a 24 foot clear zone. This median width also allows space at intersections for dual left turn lanes (11’ lanes with 4’ traffic separator), and directional median openings using 4’ traffic separators.

2.17.5 Shoulders

The minimum shoulder width (median and outside) for six-lane high-speed urban arterial highways is 6.5 feet measured to the lip of the gutter. This provides for 8 feet of usable shoulder to the curb face. Under special circumstances (i.e., dual left turn lanes, directional median openings, etc.) it may be necessary to encroach into the median shoulder. In these locations only, the minimum median shoulder width may be reduced to 4 feet (measured to face of curb or separator) while maintaining the same median width. For a four-lane design, the median shoulder may be reduced to 4 feet (measured to the curb face) while maintaining the 30 foot median.

2.17.6 Friction Course

Because of the higher speeds and the associated risk of hydroplaning, FC-5 friction course is to be provided to reduce surface water. The FC-5 friction course should be placed at the lip of the gutter in accordance with the ***Design Standards, Index 300***.

2.17.7 Border Width

A minimum border width of 29 feet measured from the outside edge of the traveled way to the right of way is to be provided on all high-speed urban arterial highways with or without curb and gutter.

2.17.8 Grades

The maximum grade for high-speed urban arterial highways is 6%.

2.17.9 Horizontal Curves

The maximum deflection without horizontal curvature is commensurate with rural new construction and comparable design speeds.

2.17.10 Superelevation

When these high-speed urban typical sections are superelevated, the superelevation rates are based on the e_{max} = 0.10 calculations, however the maximum superelevation rate that may be used is 0.05 (See ***Figure 2.16.3***). Superelevation transition rates are to be commensurate with those for rural highways with 50 mph design speeds.

2.17.11 Horizontal Clearance

Horizontal Clearance requirements are to be commensurate with new construction conditions for flush shoulder highways.

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Chapter 4

Roadside Safety

4.1 Clear Zone

4.1.1 Clear Zone Concept

A roadside that is traversable and unobstructed by fixed objects will allow vehicles that leave the roadway to recover safely. The clear zone is the relatively flat unobstructed area that is to be provided for safe use by errant vehicles. The designer should provide as much clear zone as practical.

If natural or man-made hazards, including slopes steeper than 1:3, occur within the clear zone, the designer should attempt the following treatments, in order of priority:

1. Eliminate the hazard.
    a. Remove the hazard.
    b. Relocate the hazard outside the clear zone.
    c. Make the hazard traversable or crashworthy.
2. Shield the hazard with a longitudinal barrier or crash cushion. This treatment should only be taken if the barrier or crash cushion presents a lesser hazard.
3. Leave the hazard unshielded. This treatment should be taken only if a barrier or crash cushion is more hazardous than the hazard, if the likelihood of striking the hazard is very small or if the expense of treatment outweighs the benefits in terms of crash reduction.

If crash data or safety reports indicate that early treatment of the hazards will result in fewer or less severe crashes, designers should consider directing that those treatments be accomplished as the first order of work, if feasible and practical.

4.1.2 Clear Zone Criteria

The clear zone must be wide enough so that the sum of all the recoverable terrain within is equal to or greater than the recoverable terrain value obtained in the appropriate ***Table 2.11.11, Table 21.5*** or ***Table 25.4.14.1***. The process for determining the clear zone width is to extend the clear zone width as shown in ***Figure 4.1.2.1*** and ***4.1.2.2*** until the recoverable terrain is obtained. If non-recoverable terrain is encountered before obtaining the full amount of recoverable terrain, then the remaining amount must be provided beyond the non-recoverable terrain. Where right of way permits, the portion of recoverable terrain provided beyond the non-recoverable terrain must be a minimum of 10 feet. The clear zone is to be free of hazardous objects, hazardous terrain, and non-traversable terrain. Also, clear zones may be widened based on crash history.

Figure 4.1.2.1 Clear Zone Plan View

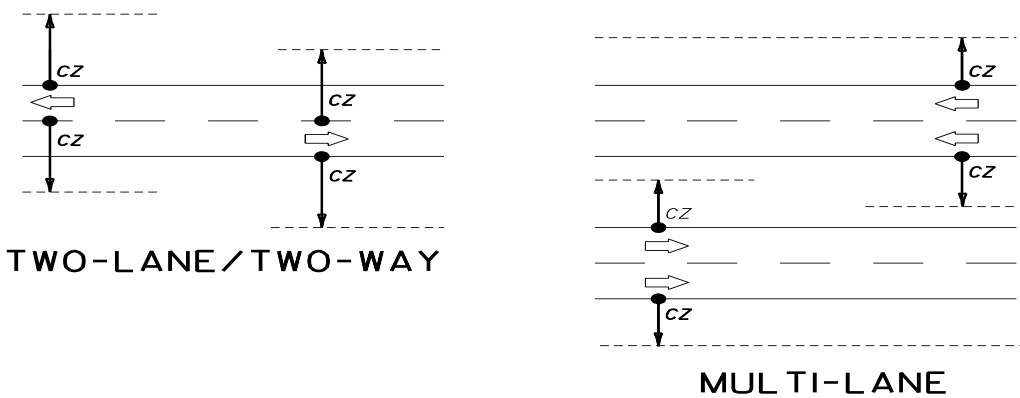
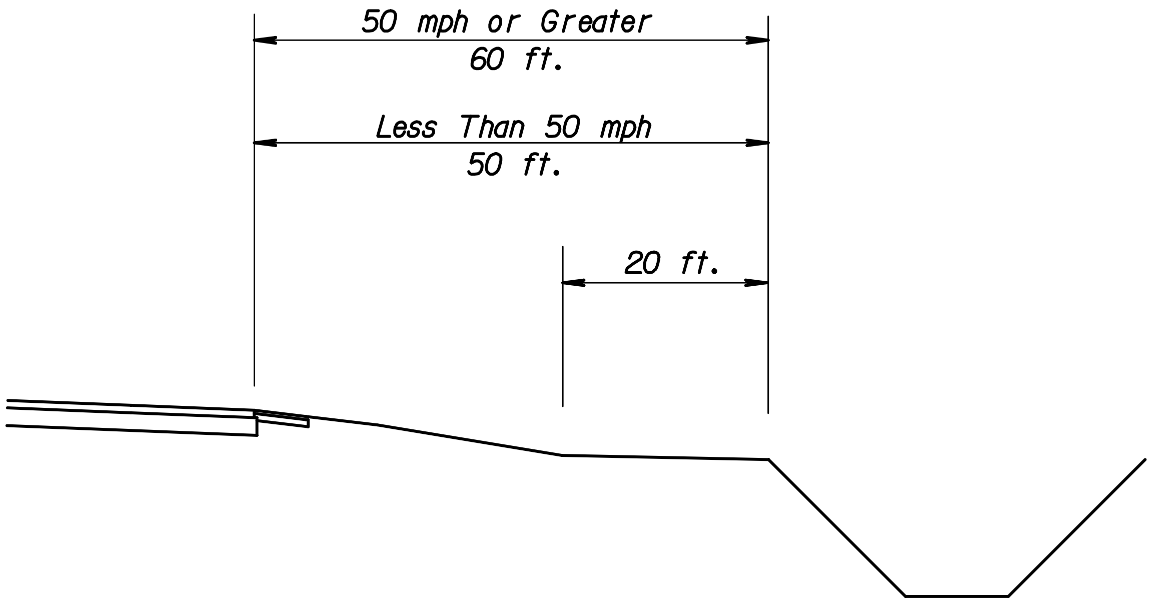


Exhibit 4-A Minimum Standards for Canal Hazards (Rural and Urban Flush Shoulders)



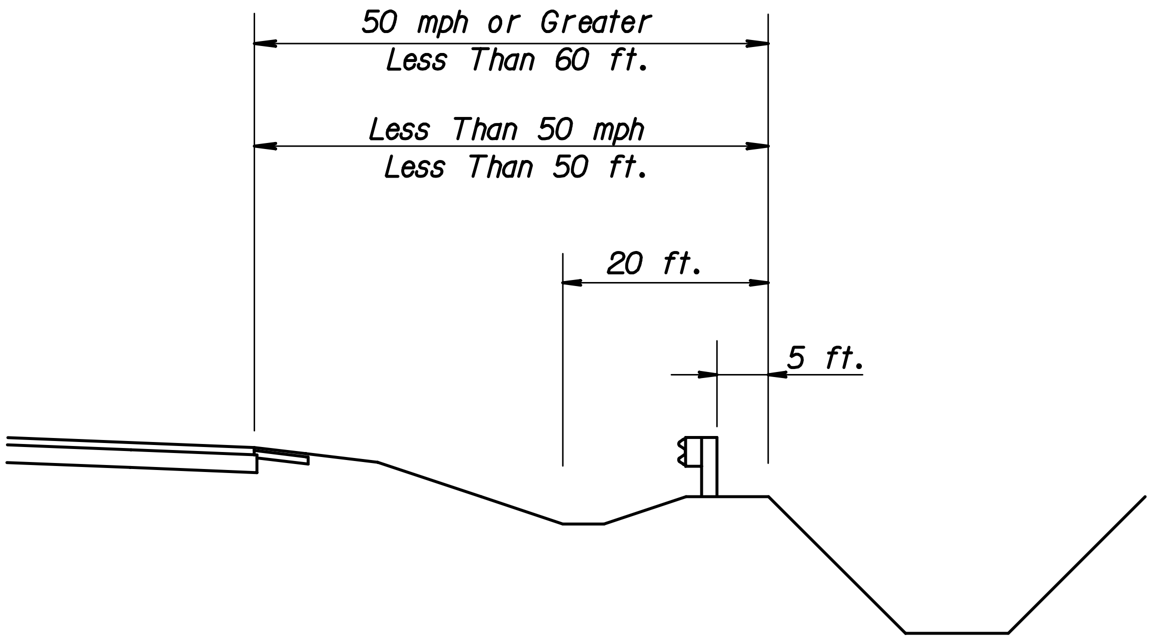
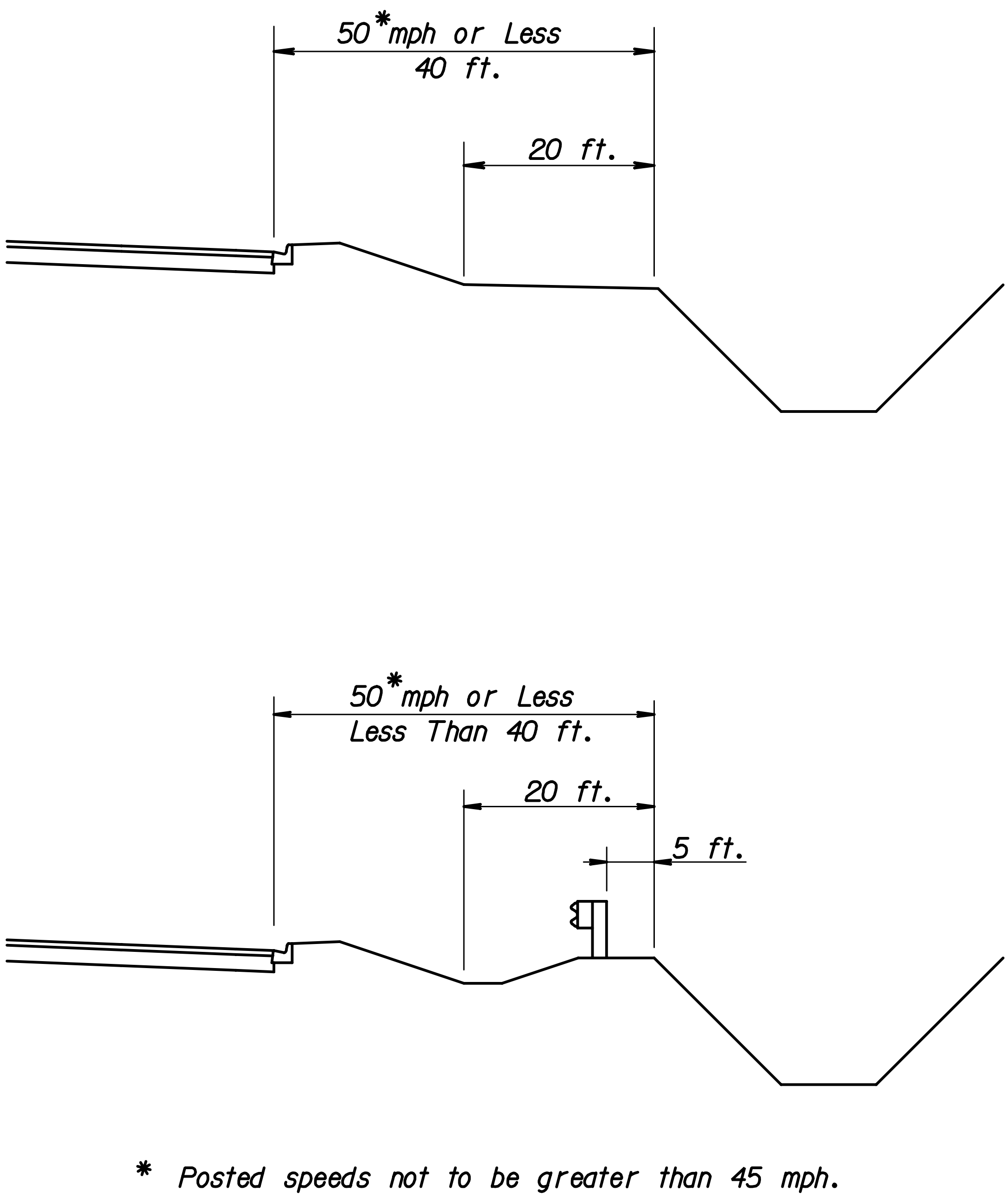


Exhibit 4-B Minimum Standards for Canal Hazards (Urban Curb or Curb and Gutter)



4.3 Roadside Barriers

4.3.1 Warrants

Roadside barriers are warranted when hazards exist within the clear zone, hazards cannot be cost effectively eliminated or corrected, and collisions with the hazards will be more serious than collisions with the barriers.

The length of advancement and length of need necessary to properly shield the hazard must be determined on an installation by installation basis as indicated in the ***Design Standards***.

The following conditions within the clear zone are normally considered more hazardous than a roadside barrier:

1. Fill slopes steeper than 1:3.
2. Bridge piers, abutments and railing ends.
3. Non-traversable culverts, pipes and headwalls.
4. Non-traversable parallel or perpendicular ditches and canals.
5. Bodies of water other than parallel ditches and canals that the engineer determines to be hazardous.
6. Parallel retaining walls with protrusions or other potential snagging features.
7. Retaining walls at an approach angle with the edge of pavement larger than 7 degrees (1:8).
8. Non-breakaway sign or luminaire supports.
9. Trees greater than 4 inches in diameter measured 6 inches above the ground at maturity.
10. Utility poles.
11. Rigid protrusions above the ground in excess of 4 inches in height.

In addition to the above hazards, there may be other situations that warrant barrier consideration, such as nearby pedestrian or bicycle facilities, schools, residences or businesses.

4.3.2 Barrier Selection

Acceptable standard roadside barriers are detailed in the ***Design Standards***. They include:

1. Blocked-out W-beam (strong post).
2. Blocked-out thrie-beam(strong post).
3. Modified thrie-beam (strong post).
4. Concrete barrier wall.

Most guardrail installations will be blocked-out W-beam on wood or steel posts. The thrie-beam guardrail should be considered when additional rail depth is needed because of a potential to under-ride the rail or because additional height may be needed. Other barrier designs may be required by specific site conditions. These must be called for and detailed on a project-by-project basis.

4.3.3 End Treatments

Longitudinal barrier ends which are not crashworthy can present serious hazards if they terminate within the clear zone. The Department's crashworthy end treatments and application criteria are detailed in the ***Design Standards.*** Other end treatments may be required under special circumstances. Special details will be required in the plans, when this is the case.

1. It is very important that the flare with offset be provided exactly as shown in the ***Design Standards***. The end offset should be measured off a projection of the face of guardrail alignment. The maximum allowable cross slope in front of the rail is 1:10, including the area in front of and the upstream approach to the end anchorage assembly.
2. Non-crashworthy end treatments will be used outside the clear zone, and at downstream terminations, which are outside the clear zone of the opposing traffic flow. The Type II end anchorage is non-crashworthy and, therefore, may **NOT** be used as an approach terminal end treatment unless other end shielding is provided.
3. Thrie-beam and concrete barrier wall will be terminated as shown in the ***Design Standards***.

4.3.4 Transitions

Whenever standard W-beam or thrie-beam guardrail transitions into bridge rail or concrete barrier wall, a transition section is necessary. Transitions must include sound structural connections, nested beams and additional posts for increased stiffness, as shown in the ***Design Standards***. Standard flares should be introduced upstream of the transition section. Care must be taken in the details of the junction of the two barrier types to avoid snag points.

4.3.5 Placement

The primary design factors associated with guardrail placement are:

1. Lateral offset from the edge of pavement
2. Terrain effects
3. Flare rate
4. Length of advancement
5. Length of need

The standard offset is the shoulder width plus 2 ft., not to exceed 12 feet. Alternate guardrail offset locations are shown in the ***Design Standards***.

A 2 ft. distance from the back of the barrier posts to the shoulder line or slope break is desirable for post support.

The length of advancement is dependent on the design speed, the offset distance to the face of guardrail and the lesser distance (a) to the back of the hazard or (b) to the clear zone needed. The designer must establish this advancement need for all installations on the project. On all facilities the guardrail needs must consider traffic from both directions.

A barrier should not be located so close to the hazard that it is shielding that the hazard is within the dynamic deflection distance of the barrier. The dynamic deflection of standard barriers is shown in ***Table 4.3.1***.

Table 4.3.1 Minimum Offset of Barriers
(Measured from the face of the barrier)

BARRIER TYPE	OFFSET (ft.)
W-Beam with Post Spacing @ 6'-3"	4.0
W-Beam with Post Spacing @ 3'-1 1/2"	3.0
Thrie-Beam with Post Spacing @ 6'-3"	3.3
Thrie-Beam with Post Spacing @ 3'-1 1/2"	2.6
Barrier Wall	0*
Double W-Beams (Nested) with Post Spacing @ 3'-1 1/2"	2.6
Double W-Beams (Nested) with Post Spacing @ 1'-6 3/4"	2.3

* Except where specifically provided for in the Design Standards, hazards that extend above the top of a barrier wall shall be offset a minimum 1.5' from the face of the top edge of F-shape barrier, and a minimum 2.0' from the face of vertical shape barrier.

NCHRP Report 537 titled "***Recommended Guidelines for Curb and Curb-Barrier Installations***" provides acceptable placement of curb-guardrail combinations as a function of the lateral offset from the guardrail and the operating speed of the roadway. The application of these guidelines for use on FDOT roadways is contained in the design chart shown in ***Figure 4.3.1***.

As shown in the design chart, there is a region between 0 and 8.2 ft behind the face of the curb where guardrail should not be located. For the general case of vehicles leaving the roadway with a broad range of speeds and angles, the bumper is likely to be too high for acceptable guardrail performance in this region. In addition, higher speeds create more suspension system disturbance and; therefore, require more time and distance for the bumper to return to the correct position.

The standard single W-beam guardrail installation (***Design Standards, Index 400***) was tested in this study. Other rails and barrier types (thrie beam, vertical face barrier wall, etc.) were not tested, however may be considered in areas where the W-beam is not considered acceptable.

4.5 Crash Cushions

Crash cushions are attenuating devices that may be non-redirective or redirective.

4.5.1 Warrants

Hazards within the clear zone, that present a more serious collision potential than a crash cushion, warrant the installation of a crash cushion.

4.5.2 Selection

Various types of crash cushions and attenuation devices approved for use on Department projects can be found on the Qualified Products List (QPL). Detailed information about these systems is provided in the ***Design Standards***, approved QPL drawings, and in each manufacturer's publications. Each system has its own unique physical and functional characteristics. The designer shall indicate in the plans either the specific system to be used at each location, or the options that may be used when one or more crash cushion system is suitable at a given location (in accordance with ***Design Standards, Index 430***). The design engineer shall consider the following factors when selecting a system for a particular location:

1. Site characteristics.
2. Structural and safety characteristics of candidate systems.
3. Initial and replacement/repair costs.
4. Expected frequency of collisions.
5. Maintenance characteristics.

Site characteristics and economics dictate the crash cushion selection. Sand barrels are relatively low in initial cost, but usually must be completely replaced when struck, so are more appropriate in locations with a low likelihood of collision. There are a number of other systems that have higher initial costs but can be repaired after collisions relatively quickly and inexpensively, so are more appropriate where frequent collisions are expected. The ability of maintenance forces to perform routine maintenance and to place a crashed system back into service quickly should be a major consideration. Crash cushions that require stocking unusual and expensive parts or that are complex to replace should not be selected.

A pay item has been established for Optional Permanent Crash Cushions, (2)544-75-40, beginning with the January 2006 letting. This pay item is applicable ONLY for crash cushions being used to shield the ends of standard concrete barrier wall, standard W-beam guardrail, or thrie-beam guardrail. Use of this pay item for these locations is not mandatory. The designer may still call for a specific system brand and use the corresponding pay item. However, the reasons for restricting to a specific brand must be documented in the project design file. For crash cushions used to shield hazards other than standard concrete barrier wall, standard W-beam guardrail, or thrie-beam guardrail, designers must continue to identify the specific system to be used and use the corresponding pay item, as has been done in the past.

The Optional Crash Cushion pay item is to be used in conjunction with ***Design Standards, Index 430***. ***Index 430*** includes crash cushion length information for each of the crash cushion systems approved for use under this pay item. Designers should note that certain crash cushion options may have lengths that do not provide the proper length of need, and others may have lengths that exceed the available space at a given location. These should be eliminated from the list of options shown in the plans.

4.5.3 Design

Standard details of systems listed on the QPL for typical installations shielding guardrail ends and barrier wall ends can be found in the ***Design Standards*** and approved QPL drawings. In addition, some of these systems have standard details for shielding wide hazards. For non standard applications, crash cushion suppliers normally provide design assistance for their systems. Special designs should be based on providing performance meeting NCHRP 350 crash test criteria for the established design speed of the facility. For special designed inertial systems where the ***AASHTO Roadside Design Guide*** charts are used, the maximum average deceleration level should not exceed approximately 7 g's.

All terrain within the likely approach of a vehicle should be relatively flat. An impacting vehicle should strike the unit at normal height, with the vehicle's suspension system neither collapsed nor extended. Curbs exceeding 4 inches in height shall not be used in the approach area of a crash cushion.

Care must be taken that the design of a crash cushion system does not create a hazard to opposing traffic.

The nose of all crash cushions shall be delineated with reflective material or standard object markers, as indicated in the ***Design Standards***.

For additional guidance on the selection of crash cushions for temporary use in work zones, see ***Chapter 10***.

4.6 Roadside Appurtenances

4.6.1 Sign Supports

All sign supports, except overhead cantilever, truss type or bridge or barrier wall mounted, shall be either breakaway or frangible as defined in the ***AASHTO Standard Specifications for Structural Supports for Highway Signs*, *Luminaires and Traffic Signals*** and the ***AASHTO Roadside Design Guide***. Sign supports shall be of an acceptable and crashworthy design as described in the ***Design Standards***. Supports not meeting the frangibility or breakaway criteria should not be installed within the clear zone. Sign supports not meeting these requirements, that must be installed within the clear zone, shall be protected by a barrier or crash cushion.

4.6.2 Mailbox Supports

Mailbox supports shall be of an acceptable crashworthy design, as described in the ***Design Standards***.

4.6.3 Other Appurtenances

The ***Design Standards*** contains design criteria for numerous other roadside appurtenances.

4.6.4 Location Criteria

Most breakaway mechanisms are designed to be impacted at bumper height, typically about 20 inches above the ground. If impacted at a significantly higher point, the bending moment in the breakaway base may be sufficient to bind the mechanism, resulting in non-activation of the breakaway device. For this reason, it is important that breakaway supports not be located in ditches or on steep slopes where a vehicle is likely to be partially in sprung suspension at the time of impact.

4.6.5 Bus Benches and Transit Shelters

Refer to ***Table 2.11.9*** for criteria on the placement of shelters and benches.

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Chapter 5

Utilities

5.1 General

The Department has the responsibility to maintain state highways as necessary to preserve the integrity, operational safety and function of the highway facility. Since the manner in which utilities cross or otherwise occupy highway right of way can materially affect the safe operation, maintenance and appearance of the highway, it is necessary that such use of the right of way be authorized and reasonably regulated. By Florida Statutes, utilities, whether public or privately owned, aerial or underground are permitted by the Department to be accommodated within the right of way on the State Highway System. For limited access highways, parallel utilities within the right of way are not allowed except for utilities serving facilities required for operating the transportation system or by approved utility exception (for Limited Access R/W Use). Lateral crossings on limited access facilities are allowed by permit only. (See ***Utility Accommodation Manual, Topic No. 710-020-001****).*

The designer should make every reasonable effort to design a project that will accommodate all existing utilities and new utilities to be constructed concurrently with the project. The selection of typical section features, horizontal alignment and location of storm sewer lines are areas that can sometimes be varied without violating safety standards and design criteria. Design features that reduce or avoid utility conflicts may involve increased cost; however, those costs may be offset by savings in construction time and the total associated cost savings for the FDOT project and the utilities. The use of Subsurface Utility Engineering is promoted to best facilitate utility related cost savings.

Selection of the methods to be employed within the Subsurface Utility Engineering (SUE) discipline should be considered in the scoping process. Relying totally on designating and selectively exposing utility facilities will seldom prevent all utility related delays in construction nor will it prevent the need for redesign. Consulting a state of the art SUE provider early on is the best way to determine the most cost effective approach. Determining the location of utilities when they are great in number or are in intersections is the most problematic and risk prone area within a project. These areas especially lend themselves to being candidates for newer technology locating services because they can reflect changes in shape and alignment not seen with traditional methods. The data gathering process can be less disruptive to the facility user and is non-destructive. A knowledge of potentially limiting environmental conditions is essential to the process. No single method is cost effective when risk versus benefit is measured.

The ***Utility Accommodation Manual (UAM)*** shall be used for all detailed requirements of utility issues. The ***UAM*** is the controlling legal document for criteria and standards to be applied to utilities. The ***UAM*** may not be updated on the same frequency as the ***PPM***. Where differences occur between the ***UAM*** and the ***PPM***, the ***UAM*** controls. New Utility installations shall comply with the latest UAM requirements. When evaluating Utility compliance, the date of the permit establishes which UAM requirements must be met. The Designer/Project Manager should always determine which criteria are appropriate before directing a Utility/Agency Owner (UAO).

5.2 Utility Accommodation Manual

UAOs are required to obtain utility permits for the installation and maintenance of utility facilities within the right of way of any State Highway System. These permits will be issued and approved by FDOT in conformity with the ***Utility Accommodation Manual***. This includes utility work required by FDOT projects. The designer may be involved in the coordination of this process.

The Department's ***Utility Accommodation Manual*** is established to regulate the location, manner, installation and adjustment of utility facilities along, across, under or on right of way under the jurisdiction of the FDOT. This manual also establishes the process for issuing permits for such work which is in the interest of safety, protection, utilization and future development of the highways with due consideration given to public service afforded by adequate and economical utility installations as authorized under ***Section 337.403, Florida Statutes*** and ***Florida Administrative Code Rule 14-46.001***. Adherence shall be required under the circumstances set forth in the ***Utility Accommodation Manual***.

Additional guidance for accommodating utilities within the highway rights of way are given in the AASHTO publications ***A Guide for Accommodating Utilities within Highway Right of Way*** and ***A Policy on Geometric Design of Highways and Streets*** and in the TRB publication ***Policies for Accommodation of Utilities on Highway Rights-of-Way***.

Chapter 6

Railroad Crossing

Tables

Figures

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Chapter 6

Railroad Crossing

6.1 General

A railroad-highway crossing, like any highway-highway intersection, involves either a crossing at-grade or a separation of grades. This chapter provides standard requirements for crossings at other than high-speed railways. Crossing requirements for high-speed railways must be coordinated with the Department's Rail Office on a project-specific basis.

The following three major railroad companies currently operate in the State of Florida:

1. CSX Transportation, Incorporated
2. Florida East Coast Railway Company
3. Norfolk Southern Corporation

Ten shortline railroad companies and three terminal switching companies also operate in the State of Florida.

6.2 At-Grade Crossings

Selection of the warning devices to be used is a function of the geometrics of railroad-highway grade crossing, including the alignment, profile, sight distance and cross section of both the roadway and the railroad. Railroad grade crossing angles should be as near 90 degrees as practical.

Design Criteria and Standards are given in the ***Florida Greenbook*** and the Department's ***Railroad Procedures Manual***. Design considerations are discussed in ***Chapter IX*** of the ***AASHTO Policy on Geometric Design***.

6.2.1 Devices

Traffic control devices for railroad-highway grade crossings consist primarily of signs, pavement markings, flashing light signals and automatic gates. A large number of significant variables must be considered in determining the types of warning device to be installed at a railroad grade crossing. The type of highway, volume of vehicular traffic, volume of railroad traffic, speed of vehicular traffic, volume of pedestrian traffic, accident record, and geometrics of the crossing are some of the factors influencing the choice of warning devices to be provided at the railroad crossing.

Standards and criteria for design, placement, installment and operation of these devices are covered in the ***Manual on Uniform Traffic Control Devices (MUTCD)*** and the Department's ***Railroad Procedure Manual***. The Department's ***Design Standards*** should also be consulted in the design of railroad crossings.

6.2.2 Surfaces

The highway traveled way at a railroad crossing should be constructed for a suitable length with all-weather surfacing. A roadway section equal to the current or proposed cross section of the approach roadway should be carried across the crossing. The crossing surface itself should have a riding quality equivalent to that of the approach roadway. When selecting the type of crossing and the material to be used in its construction, consideration should be given to the character and volume of traffic using the highway. The Department's ***Highway-Railroad Grade Crossing Material Selection Handbook*** should be consulted in selecting the material.

The ***Design Standards***, ***Index 560*** contains details for the construction of crossings.

6.3 Grade Separations

For underpasses, the bridge carries the railway and must be designed and constructed to carry railway loadings in conformance with the **American Railway Engineering and Maintenance Association (AREMA)** ***Manual for Railway Engineering***, latest edition. For overpasses, the bridge carries highway traffic and must be designed and constructed to carry highway loadings. In either case, adequate clearances between the facilities must be provided.

Clearances, geometrics, utilities, provisions for future tracks, and maintenance road requirements for off-track equipment will involve negotiations with the governing railroad company. The railroad's review and approval, including need for and location of crash walls, shall be based on the completed BDR/30% Structures Plans prepared by the SDO, District Structures Design Engineer, or their consultant.

6.3.1 Criteria

The Structures Plans shall be prepared in accordance with the criteria obtained from the governing railroad company, the ***Plans Preparation Manual***, and the ***Structures Detailing Manual***.

See ***Figure 6.1*** for dimensions which must be obtained from the railroad company before preparing the BDR/30% Structures Plans.

The District Rail Coordinator is an additional reference source available to the designer.

6.3.2 Bridge Width

For overpasses, the highway bridge width is determined from the approved typical section for the proposed bridge. Details for underpasses will depend on the specific project.

6.3.3 Horizontal Clearances to Face of Structures

Horizontal clearances shall be measured in accordance with ***Figure 6.1***. The governing railroad company occasionally may accept a waiver from normal clearance requirements if justified; i.e., for designs involving widening or replacement of existing overpasses. The FDOT's Rail Office should be consulted if such action is being considered.

The minimum horizontal clearances measured from the centerline of outside track to the face of pier cap, bent cap, or any other adjacent structure are shown in ***Table 6.3.3***, but must be adjusted for certain physical features and obstructions as described hereinafter.

Table 6.3.3 Horizontal Clearances for Railroads

Minimum Clearance Requirements	Normal Section	With 8 ft. Required Clearance for Off-Track Equip.	Temporary Falsework Opening
With Crash Walls	18 ft.	22 ft.	10 ft.
Without Crash Walls	25 ft.	25 ft.	N/A

The additional 8 ft. horizontal clearance for off-track equipment shall be provided only when specifically requested in writing by the railroad. In the event there is any doubt, the FDOT's Rail Office should be consulted.

6.3.3.1 Adjustments for Track Geometry

When the track is on a curve, the minimum horizontal clearance shall be increased at a rate of 1.5 inches for each degree of curvature. When the track is superelevated, clearances on the inside of the curve will be increased by 3.5 inches horizontally per inch of superelevation. For extremely short radius curves, the ***AREMA*** requirements shall be consulted to assure proper clearance.

6.3.3.2 Adjustments for Physical Obstructions

Columns or piles should be kept out of the ditch to prevent obstruction of drainage. Horizontal clearance should be provided to avoid the need for crash walls unless extenuating circumstances dictate otherwise.

Figure 6.1 shows horizontal dimensions from the centerline of track to the points of intersection of a horizontal plane at the rail elevation with the embankment slope. This criteria may be used to establish the preliminary bridge length which normally is also the length of bridge eligible for FHWA participation; however, surrounding topography, hydraulic conditions, and economic or structural considerations may warrant a decrease or an increase of these dimensions. These dimensions must be coordinated with the governing railroad company.

6.3.3.3 Required Foundation Clearances

Edges of footings shall not be closer than 11 ft. from centerline of the track to provide adequate room for sheeting.

6.3.4 Crash Walls

See the ***Structures Design Guidelines*** for crash wall requirements.

6.3.5 Vertical Clearance

Minimum vertical clearances for overpasses are given in ***Table 2.10.1, Chapter 2*** of this manual. Vertical clearance is the least distance between the bottom of the superstructure and the top of the highest rail utilized anywhere within the horizontal clearance zone determined by ***Section 6.3.3*** and ***Table 6.3.3***. If a track is identified as an electrified railroad, the minimum vertical clearance shall be 24 feet 3 inches. This provision is based on the FDOT's ***South Florida Rail Corridor Clearance Policy for 25 KV service (Topic No. 000-725-003***). In addition to existing electrified railroads, this provision applies to tracks identified as candidates for future electrification.

6.3.6 Special Considerations

1. Shoring and Cribbing requirements during construction should be accounted for in the preparation of the preliminary plans to assure compliance with the clearance criteria set forth herein. See ***Figure 6.2***.

   NOTE: Anything (e.g., cofferdams, footings, excavation, etc.) encroaching within 10 ft. of centerline of the track requires approval of the governing railroad.

2. Overpasses for electrified railroads may require protection screens.

3. Sometimes the substructure supports may be located between tracks or an outside track and the off-track equipment road.

4. Drainage from the section of the bridge above railroad right of way shall be drained away from the railroad right of way. When open scuppers are provided on the bridge, none shall be closer than 25 ft. from the centerline of the nearest track.

6.3.7 Widening of Existing Overpasses

The requirements for widening existing overpasses are as follows:

1. If existing horizontal or vertical clearances are less than those required for a new structure, it is required that the new portion of the structure be designed so as not to encroach into the existing clearances.

2. Permanent vertical clearances will have to take into account the track grade and the cross slope of the bridge superstructure. Therefore, it is generally more desirable to widen on the ascending side of the bridge cross slope.

3. Permanent horizontal clearances will have to take into account horizontal curves and substructures that are not presently parallel to the track.

4. Temporary construction clearances are particularly critical where existing clearances are already substandard. If vertical and horizontal clearances less than 22 ft. and 10 ft., respectively, are necessary, they will have to be approved on an individual basis. On high volume main lines, it may not be possible to reduce already restricted vertical clearances.

5. If widening requires construction of new widened approach fills, it is required that the same consideration be given to drainage design as required on new bridges. If new substructures provide less than 25 ft. horizontal clearance from center line of track, they must be designed with crash wall protection except as stated above.

The BDR/30% Structures Plans shall show a cross section at right angles to the centerline of the track where the centerline of bridge intersects the centerline of track. In situations where the substructure is not parallel to the track, or the track is curved, sections perpendicular to the centerline of the tracks shall be furnished at each substructure end.

If the Railroad is in an existing cut section, plan approvals will be considered by the governing railroad on an individual location basis. Factors to be considered will be the length, depth, and type material of the existing cut section, in addition to all of the previously mentioned factors.

Figure 6.1 Track Section

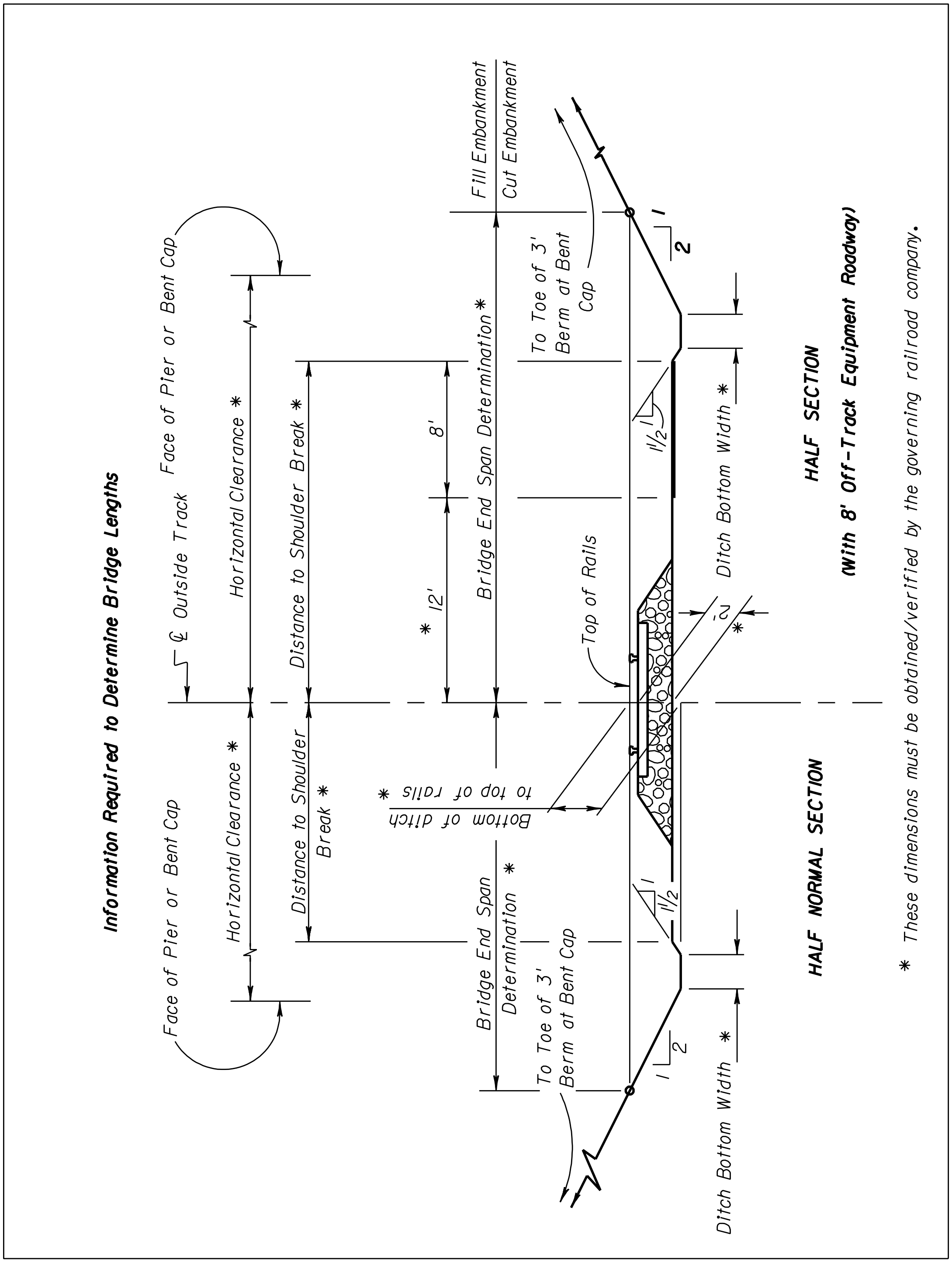
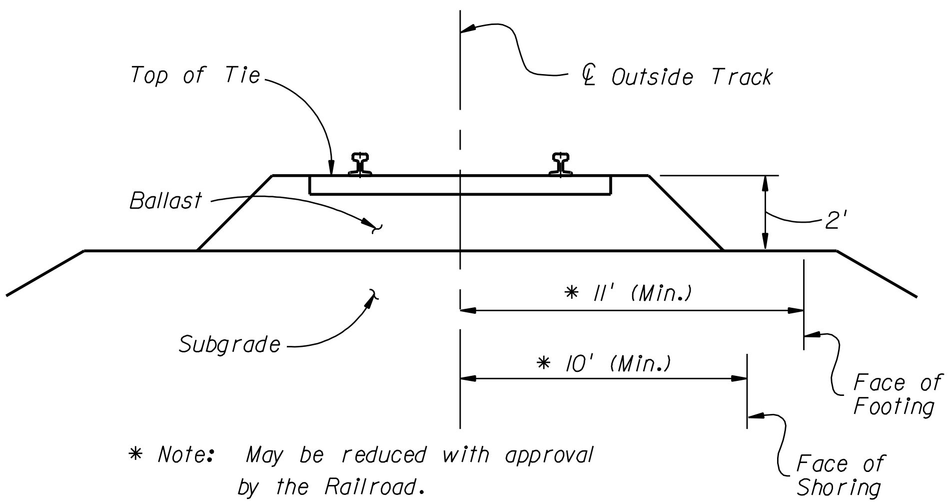


Figure 6.2 Section Thru Tracks



SECTION THRU TRACKS
(Showing Foundation Clearance)

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Chapter 7

Traffic and ITS Design

Tables

Chapter 7

Traffic and ITS Design

7.1 General

Traffic control devices and intelligent transportation system (ITS) deployments are necessary to help ensure highway safety by providing the orderly and predictable movement of all traffic, motorized and nonmotorized, throughout the highway transportation system, and to provide such guidance and warnings as are needed to ensure the safe and informed operation of individual elements of the traffic stream. The design and layout of signs, signals, pavement marking and lighting should complement the basic highway design.

7.2 Signing and/or Pavement Marking

The designer responsible for a signing and/or pavement marking project should be aware that the design must comply with various standards. In addition to Department Standard Specifications, the following standards should be consulted:

Manual on Uniform Traffic Control Devices (MUTCD) - The ***MUTCD*** was adopted by the Department as the uniform system of traffic control for use on the streets and highways of the State. This action was in compliance with ***Chapter 316.0745*** of the ***Florida Statutes***. The ***MUTCD*** is therefore the basic guide for signing and marking. The requirements of the ***MUTCD*** must be met, as a minimum, on all roads in the State.

Standard Highway Signs, FHWA - This manual contains detailed drawings of all standard highway signs. Each sign is identified by a unique designation. Signs not included in this manual or in the ***Design Standards*** must be detailed in the plans.

AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals and ***FDOT*** **Structures Manual** - These documents provide structural design criteria.

Design Standards - These standards are composed of a number of standard drawings or indexes that address specific situations that occur on a large majority of construction projects.

Manual on Uniform Traffic Studies (MUTS) - This is a Department publication containing documentation for several types of traffic studies. This manual provides a systematic data collection procedure for the studies described.

Traffic Engineering Manual - This Department publication provides traffic engineering standards and guidelines to be used on the State Highway System.

7.2.1 Design Criteria

The ***MUTCD*** and the ***Design Standards*** should be consulted for sign location. All signs not bridge or barrier wall mounted and installed within the clear recovery zone, must be frangible or protected by an approved barrier. ***Chapter 4, Roadside Safety*** of this volume, contains detailed instructions on safety design.

Post sizes for single column signs are covered in the ***Design Standards***. The supports for multipost signs are not in that reference and must be included in the plans. The designer must provide post sizes and length for each multipost sign. The Structures Design Office has written a program for personal computers that calculates post sizes and length for multipost signs. This program may be used for these calculations.

The design for all overhead sign structures and foundations shall be included in the plans. Refer to ***Section 7.6***, ***Foundation Design***, and ***Chapter 29*** of this volume for more information.

The type lamp for signs shall be specified in the plans. The following table gives the number of luminaires for various sign widths for 175 watt mercury vapor deluxe white lamps. See the ***Design Standards, Index 17505*** for spacing details and mounting location.

Table 7.2.1 Number of Luminaires for Various Sign Widths

Sign Width (ft.)	To 10	To 21	To 32	To 43
Luminaires	1	2	3	4

7.2.2 Wind Loading Criteria - Signs

The wind loadings given below are based on the ***AASHTO Standard Specification For Structural Supports for Highway Signs, Luminaires and Traffic Signals*** and ***FDOT Structures Manual.*** The Counties are listed by wind loading for the appropriate sign type.

110 mph Alachua, Baker, Bradford, Clay, Columbia, Gadsden, Gilchrist, Hamilton, Hardee, Jackson, Jefferson, Lafayette, Lake, Leon, Madison, Marion, Polk, Putnam, Sumter, Suwannee, and Union

130 mph Bay, Brevard, Calhoun, Charlotte, Citrus, DeSoto, Dixie, Duval, Flagler, Franklin, Glades, Gulf, Hendry, Hernando, Highlands, Hillsborough, Holmes, Lee, Levy, Liberty, Manatee, Nassau, Okaloosa, Okeechobee, Orange, Osceola, Pasco, Pinellas, Sarasota, Seminole, St. Johns, Taylor, Volusia, Wakulla, Walton, and Washington.

150 mph Broward, Collier, Miami-Dade, Escambia, Indian River, Martin, Monroe, Palm Beach, Santa Rosa, and St. Lucie

7.2.3 No-passing Zones

The procedures required by the Department for determining the limits of no-passing zones are contained in the ***Manual on Uniform Traffic Studies, (MUTS).*** The requirements of this manual must be followed.

Limits of pavement markings for no-passing zones shall be established by one of the following methods:

1. On projects where existing roadway conditions (vertical and horizontal alignments) are to remain unaltered by construction, the no-passing zones study shall be accomplished as part of the design phase. This will be either by in-house staff or included in design consultant contracts.

   The limits of the no-passing zones shall be included in the contract documents, and a note to this effect shown on the plans.

2. On projects with new or altered vertical and horizontal alignments, limits for no-passing zones shall be established during construction. The required traffic study and field determination of limits shall be performed through the design consultant as a post design service, or as part of a districtwide consultant contract for such services.

   When this service is included as part of post design services, sufficient time shall be included to accomplish the required field operations without delaying or interfering with the construction process.

7.2.4 Use of Local Street Names on Guide Signs

The normal practice is to use route numbers on guide signs to designate roadways. In some areas, the local names for certain roadways are more familiar than the route number. For this situation, the local street name may be used. However, some roadways are known by more than one name as well as the route number. In many instances, the existing sign panel is not large enough to accommodate the street name and would require a new panel.

For these reasons, the decision to use local names on guide signs must be evaluated on a case-by-case basis. It is recommended that the District Traffic Operations Engineer be contacted for input in these decisions.

7.2.5 Signing and Pavement Marking Project Coordination

Coordination with other offices and other agencies is a very important aspect of project design. The offices discussed in this section are not intended to be an all inclusive list with which the designer should coordinate, but are those that are typically involved in a signing and marking project.

Roadway Design - The designer of a signing and pavement marking project receives the base sheets for design from the roadway designer, who can also provide any required cross sections. If the signing project is not an active roadway design project, base sheets may be obtained from existing plans.

Utilities - The District Utilities Engineer provides the coordination between the designer and the various utilities involved in the project. The Utilities Section can also identify potential conflicts with overhead and underground utilities or verify those which have previously been identified. The District Utilities Engineer should be contacted as early in the design phase as possible.

Structures Design - The Engineer of Record for Structures Design provides the design of the sign structures for overhead cantilever and overhead truss sign assemblies. This includes the design of the foundation for these structures. The Engineer of Record must be contacted early in the design phase to allow adequate time for coordination with the Geotechnical Engineer in obtaining the necessary soils information.

Right of Way – The State Motorist Information Services Administrator must be contacted on any projects that may impact Interstate Logo Signs. See ***Section 13.5.4*** for requirements and additional information.

7.2.6 Foundation Criteria

Refer to ***Section 7.6***, ***Foundation Design***, for geotechnical requirements.

7.2.7 Signing for Bridges with Steel Decks

Slippery When Wet Signs (W8-5) shall be placed in advance of all movable and non-movable bridges with steel decks. Refer to ***Section 2.1*** of the ***Traffic Engineering Manual (Topic No. 750-000-005)***. This also applies to temporary bridges.

7.2.8 Guidance on Use of Various Pavement Marking Materials

The Engineer should consider several factors before selecting the pavement marking materials to be used during the Maintenance of Traffic Operations or in application of the permanent markings.

7.2.8.1 Maintenance of Traffic Applications

The factors which should be considered in a Maintenance of Traffic (MOT) should include:

1. How long do the markings need to last?
2. Will the markings need to be removed or will they be covered by an asphalt course?
3. Cost.
4. Traffic Volumes.

Paint is normally used in MOT operations and is appropriate for short term operations lasting for approximately six months. When a MOT operation lasts between six months to a year under moderate traffic volumes, a high-build paint or hot-spray thermoplastic marking should be considered. If a MOT operation lasts for more than a year under heavy traffic volumes a refurbishment thermoplastic should be considered.

7.2.8.2 Permanent Marking Applications

The factors which should be considered for permanent marking should include:

1. How long do the markings need to last?
2. What are the traffic volumes?
3. Type of Surface.
4. Does the marking need to meet special requirements (audible & vibratory, contrast, etc?)
5. Cost.
6. If it is a refurbishment marking, what is the thickness and condition of the existing markings?

Thermoplastic is Departments primary material to be used for the permanent markings on asphalt surfaces. When used in conjunction with RPM's on centerline application, it provides excellent wet night visibility and long term performance at a reasonable cost. When used in an edge line application, it provides moderate wet night visibility and long term performance at a reasonable cost.

On concrete pavements and bridge decks contrast markings shall be used. Options include thermoplastic, tapes and two-component reactive materials. On concrete surfaces tapes are normally used for only centerline applications and are the preferred alternative. Two-component reactive or thermoplastic materials are normally used for edge line applications in conjunction with tape.

For guidance on contrast, audible & vibratory and other special use marking, contact the State Traffic Standards Engineer.

7.3 Lighting

The designer responsible for a highway lighting project should be aware that the design must comply with various standards. In addition to the Department's Standard Specifications, the following standards should be consulted:

Roadway Lighting Design Guide, AASHTO - This is the basic guide for highway lighting. It includes information on warranting conditions and design criteria.

AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, **and FDOT Structures Manual**- This specification contains the strength requirements of the poles and bracket arms for the various wind loadings in Florida as well as the frangibility requirements. All luminaire supports, poles and bracket arms must be in compliance with these specifications.

Design Standards - These indexes are composed of a number of standard drawings or indexes which address specific situations that occur on a large majority of construction projects.

7.3.1 Design Criteria

The ***AASHTO Roadway Lighting Design Guide*** permits either the illuminance technique or the luminance technique to be used in the design of highway lighting. The luminance technique requires a more complex design process and knowledge of the reflective characteristics of the pavement surface used. These reflective characteristics change as the pavement ages and with variations in weather conditions. The Department has elected to use the illuminance technique for lighting design. The design values for light levels given by the ***AASHTO Roadway Lighting Design Guide*** are maintained values. The light levels given in this criteria have been adjusted and are listed as average initial foot candle. This, in effect, sets the maintenance factor to be used in the calculation process to a value of 1. Lighting criteria is contained in ***Tables 7.3.1 – 7.3.5***. Refer to ***Section 7.2.1*** for Overhead sign lighting criteria.

Mounting height (M.H.) for conventional lighting is the vertical distance from the roadway to the light source, regardless of lateral placement of the pole. Pole setback is the horizontal distance from the edge of the travel lane to the pole.

Refer to ***Chapter 29*** of this volume for more information.

Table 7.3.1 Conventional Lighting - Roadways

ROADWAY CLASSIFICATIONS	ILLUMINATION LEVEL AVERAGE INITIAL HORIZONTAL FOOT CANDLE (H.F.C.)	UNIFORMITY RATIOS	
		AVG./MIN.	MAX./MIN.
INTERSTATE, EXPRESSWAY, FREEWAY & MAJOR ARTERIALS	1.5	4:1 or Less	10:1 or Less
ALL OTHER ROADWAYS	1.0	4:1 or Less	10:1 or Less
* PEDESTRIAN WAYS AND BICYCLE LANES	2.5	4:1 or Less	10:1 or Less

Note: These values should be considered standard, but should be increased if necessary to maintain an acceptable uniformity ratio. The maximum value should be one and one-half values.

* This assumes a separate facility. Facilities adjacent to a vehicular roadway should use the levels for that roadway.

Table 7.3.2 Highmast Lighting - Roadways

ROADWAY CLASSIFICATIONS	ILLUMINATION LEVEL AVERAGE INITIAL (H.F.C.)	UNIFORMITY RATIOS	
		AVG./MIN.	MAX./MIN.
INTERSTATE, EXPRESSWAY, FREEWAY & MAJOR ARTERIALS	0.8 to 1.0	3:1 or Less	10:1 or Less
ALL OTHER ROADWAYS	0.8 to 1.0	3:1 or Less	10:1 or Less

Table 7.3.3 Underdeck Lighting - Roadways

LUMINAIRE TYPE	LIGHT SOURCE	MOUNTING LOCATION
PIER CAP	150 watt to 250 watt HPS	Pier or Pier Cap
PENDANT HUNG	150 watt to 250 watt HPS	Bridge Deck

Note:
1. The light levels for underdeck lighting shall be equal to the adjacent roadway lighting.
2. Underdeck lighting is accomplished by mounting either pier cap or pendant hung fixtures under the bridge structure.
3. Pier cap luminaires should be installed when bridge piers are located less than 15 ft. from edge of travel lane.
4. Pendant hung luminaires shall be mounted to the bottom of the bridge deck and should suspend where 50% of the lamp is below bridge beam.

Table 7.3.4 Rest Area Lighting

AREA ILLUMINATED	ILLUMINATION LEVEL AVERAGE INITIAL (H.F.C.)	UNIFORMITY RATIOS	
		AVG./MIN.	MAX./MIN.
ENTRANCE & EXIT	1.5	4:1 or Less	10:1 or Less
INTERIOR ROADWAYS	1.5	4:1 or Less	10:1 or Less
PARKING AREAS	1.5	4:1 or Less	10:1 or Less

Table 7.3.5 Mounting Height Restrictions

LUMINAIRE WATTAGE	LIGHT SOURCE	MOUNTING HEIGHT (MIN.) (FEET)
150	High Pressure Sodium (HPS)	25
200	High Pressure Sodium (HPS)	30
250	High Pressure Sodium (HPS)	30
400	High Pressure Sodium (HPS)	40
750	High Pressure Sodium (HPS)	50
1000	High Pressure Sodium (HPS)	80

7.3.2 Pole Design Criteria

7.3.2.1 General

Chapter 2 of this volume specifies the minimum horizontal clearances for light poles. High mast lighting poles should not be located in gore areas within the runout length as defined in the ***AASHTO Roadside Design Guide***. Engineering judgment should be used when locating high mast poles adjacent to bridges and high fills. All conventional height poles shall be frangible unless bridge or barrier wall mounted.

Frangible pole installations shall not be used in areas of heavy pedestrian traffic where the hazard of a falling pole is a greater hazard to others than it is to the motorist. See the ***Design Standards*** for frangibility requirements.

The installation of lighting in certain locations (e.g., adjacent to residential areas) may require the luminaires to be shielded. This is especially true for high mast poles.

Poles on bridges over open bodies of water or on causeway sections should be considered for dampers. These poles are subject to sustained winds of a critical velocity that may induce vibrations in the pole.

7.3.2.2 Standard Aluminum Light Poles

The Department has developed an aluminum light pole standard for Conventional Lighting. The standard provides details for 40, 45 and 50 foot luminaire mounting heights on poles mounted either at grade or on fills up to 25 feet in height, all of which accommodate fixture arm lengths of 8, 10, 12 and 15 feet. Standard Aluminum Light Poles have been designed for 110, 130 and 150 mph design wind speeds.

The manufacturer of the Standard Aluminum Light Poles will be pre-approved by the Department and added to the Qualified Products List (QPL). When the standard assemblies are used, neither design details in the plans nor Shop Drawing submittals are required. Special designs, for those locations where the Standard Aluminum Light Poles are not appropriate, will require the pole Fabricator’s complete Shop Drawings and the Specialty Engineer’s sealed calculations, all submitted as Shop Drawings in accordance with ***Section 5*** of the ***Standard Specifications for Road and Bridge Construction***.

7.3.3 Foundations Criteria

Refer to ***Section 7.6***, ***Foundation Design***, for geotechnical requirements and ***Chapter 29*** of this volume for additional design information.

7.3.4 Wind Loading Criteria - Lighting

See ***Chapter 29*** of this volume.

7.3.5 Lighting Project Coordination

Coordination with other offices and other agencies is a very important aspect of project design. The offices discussed in this section are not intended to be an all inclusive list with which the designer should coordinate; instead it includes offices that are normally involved in projects.

Roadway Design - Normally the designer of a lighting project receives the base sheets for lighting design from the roadway designer. The roadway designer can also provide any required cross sections. If the lighting project is not an active roadway design project, base sheets may be obtained from existing plans.

Utilities - The District Utilities Engineer provides the coordination between the designer and the various utilities involved in the project. This usually is limited to agreements with the power company for electrical service. The Utilities Section can also identify potential conflicts with overhead and underground utilities or verify those which have previously been identified.

The Utilities Engineer should be contacted as soon as pole locations are set and the electrical load has been determined. The designer should indicate a preferred location for the electrical service.

Drainage - When the locations of high mast poles are established, they should be checked with the Drainage Section to determine if high water level is a problem. High mast poles are often located in the center of interchange loops. These same areas may be used as drainage retention areas. Coordination with the Drainage Section will alleviate this type problem.

Structures Design - Conventional height poles require the standard base shown in the ***Design Standards*** and ***Standard Specifications***. A foundation design is only required in special cases. High mast poles, on the other hand, require foundation designs for each location. Soil bores are required for this design. The Engineer of Record for Structures Design provides the foundation design for high mast poles. He or she must be contacted early in the design phase to allow adequate time for coordination with the Geotechnical Engineer in obtaining necessary soils information.

Normally the District Traffic Operations Engineer in conjunction with the District Utilities Engineer obtains the required maintenance agreements. The designer should coordinate with these offices to ensure that this activity is either underway or scheduled.

Any lighting project, especially high mast, adjacent to or in the vicinity of an airport, may be a potential problem. Any lighting project within 3 miles of an airport should be discussed with the Office of Public Transportation, Aviation Office to determine if a problem exists.

7.3.6 Voltage Drop Criteria

When determining conductor sizes for lighting circuits, the maximum allowable voltage drop from the service point on any one circuit is 7%.

7.3.7 Maintenance of Existing Lighting During Construction

The maintenance of existing lighting shall be the responsibility of the contractor only if the lighting is affected by the construction. The contractor should not be expected to replace lamps and pole knockdowns or to repair wiring if these problems are not caused by the construction work. As an example, a milling and resurfacing project should have no effect on the roadway lighting and the contractor should not be responsible for the maintenance of the lighting system.

The plans should specify the scope of the contractor's responsibility for the maintenance of existing lighting.

7.3.8 Grounding

The grounding requirements for lighting systems shall be as follows:

1. Install 20’ of ground rod at each conventional height light pole and at each pull box.
2. Install 40’ of ground rod at each electrical service point.
3. At each high mast pole, install an array of 6 ground rods 20’ in length, as shown in the ***Design Standards, Index 17502***.

This information is covered in the ***Design Standards***. The above lengths of ground rod will be installed at each pole, pull box and service point, and the cost will be incidental to the unit or assembly being installed.

7.4 Traffic Signals

The designer responsible for a traffic signal project should be aware that the design must comply with various standards. In addition to the Department's ***Standard Specifications***, the following standards should be consulted:

Manual on Uniform Traffic Control Devices (MUTCD), ***FHWA*** - The ***MUTCD*** was adopted by the Department as the uniform system of traffic control for use on the streets and highways of the State. The action was in compliance with ***Chapter 316.0745*** of the ***Florida Statutes***. The ***MUTCD*** is therefore the basic guide for traffic signals. The requirements of the ***MUTCD*** must be met, as a minimum, on all roads in the State.

AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, FDOT Structures Manual and ***Chapter 29*** of this volume - These documents provide structural design criteria.

Design Standards - These standards are composed of a number of standard drawings or indexes which address specific situations that occur on a large majority of constructions.

Traffic Engineering Manual – This Department publication provides traffic engineering standards and guidelines to be used on the State Highway System.

7.4.1 Design Criteria

The design of traffic signal mast arms and foundations shall be included in the plans. Refer to ***Section 7.6***, ***Foundation Design***, and ***Chapter 29*** of this volume for more information.

The horizontal clearance requirements for signal poles and controller cabinets are given in ***Chapters 2*** and ***25*** of this volume. Final location of these devices should be based on safety of the motorist, visibility of the signal heads, ADA requirements, and access by maintenance. When these clearances cannot be met with standard mast arm designs, alternatives and special designs must be coordinated with the District Design Engineer.

The ***MUTCD***, as noted above, has been adopted as the uniform system of traffic control for use on the streets and highways of the state. The ***MUTCD*** is the basic guide for traffic signal design; therefore, the traffic signal designer should be familiar with this document. The criteria in the following sections supplement the ***MUTCD***.

7.4.2 Certification and Specialty Items

Traffic signal equipment installed in Florida is required to be certified by the Department. The Office of Traffic Engineering in the Central Office is charged with the responsibility of certifying traffic control equipment. The designer of a traffic signal project, if requiring new equipment types or types not normally used, should contact Traffic Engineering in Tallahassee to determine the certification status of the equipment. Noncertified equipment cannot be used.

Standard Specifications have not been developed for all signal equipment. Some items are project dependent and the development of standard specifications is difficult. Specifications for these items must be developed on a project by project basis and included in the contract as a special provision. Some of these specialty items are included on the Department's approved products list. For these items, detailed specifications are not required. The Office of Traffic Engineering should be consulted on these items.

7.4.3 Stop Line Location

A stop line that is not properly located invites violation by the motorist. The ***MUTCD*** specifies the minimum and maximum distances from the signal head to the stop line for adequate visibility. The traffic signal designer must insure that this requirement is met.

Instead of relocating the signal heads, the stop lines at many intersections have been moved from their proper location to comply with these requirements. The tendency for the motorist is not to stop at the new stop line location, but rather to creep beyond the stop line. This could in some cases result in valid calls being dropped, thereby increasing delay and decreasing the overall efficiency of the intersection.

The first step in the design process should be to locate crosswalks and stop lines properly. Then the signal head location should be determined to meet the ***MUTCD*** requirements. This may require changing the mounting configuration. A box span, for example, may be required where a diagonal span would normally be installed.

7.4.4 Controller Assemblies

Controller Timings: The development of controller timings is a basic part of traffic signal design. A recent ruling from the Board of Professional Engineers stated that the development of timings is considered engineering and therefore requires the signature and seal of a professional engineer.

All traffic signal designs prepared for or by the Department shall include initial timings of all controllers. This is also true for signals to be included in local systems. If the timings in the plans are not implemented, it will be the responsibility of the agency providing the timings to insure they were prepared under the supervision of a professional engineer.

Future Intersection Expansion: Any planned intersection improvements, should be considered in the signal design. The controller type, cabinet type and the number of load switches are examples of design features that may be affected by future intersection improvements. It is the responsibility of the signal design engineer to determine if the current design should include capabilities for future improvements.

Upgrade of Existing Controller Assemblies: For projects requiring an upgrade to an existing controller assembly, the assembly may either be expanded or replaced. Minor expansions include the addition of load switches, new controller timings, and/or new controller unit if the cabinet is properly wired. These may be made in the field; therefore, expansion is the logical choice. On the other hand, major expansions include cabinet rewiring or any work requiring the removal of the cabinet back panel. Major expansions shall not be made in the field and replacement of the assembly is required. The designer may wish to contact the District Traffic Operations Engineer before making the decision to expand or replace an existing controller assembly.

7.4.5 Left Turn Treatments

The guidelines given below should be followed when determining signal treatments for left turns.

1. Single Turn Lane

    a. Restrictive/Permissive Phasing - A five-section cluster should be used for this location. The head should be installed over the lane line between the left turn lane and through lane. The five-section cluster can serve as one of the two indications required for the through traffic.

b. Restrictive Phasing - A separate signal head for the left turn lane with red, yellow and green arrow indications should be positioned over the center of the left turn lane.

2. Dual Turn Lanes - Only restrictive phasing should be used. Permissive movements should not be allowed for dual turn lanes. A single three-section head with red, yellow, and green arrow indications should be centered over each turn lane. These heads are in addition to the dual indications required for the thru movement.

3. Separated Turn and Thru Lanes - Turn lanes that are separated from the thru lanes more than 12 ft. by a raised or painted island shall not be operated in the permissive mode.

4. Single Lane Approach on Stem of "T" - Two three-section heads are required as minimum. All indications must be circular in this situation.

5. Two Approach Lanes on Stem of "T"

   Option #1: The approach may display two three-section heads with circular indications on all sections.

   Option #2: The approach may display a five-section cluster in conjunction with a three-section head. If the lanes are exclusive left and right turn lanes, then the five-section cluster should be placed over the center of the lane line and the three-section head over the major movement lane. If one of the lanes is a shared left and right lane, then the five-section cluster should be placed over the center of this lane and the three-section head over the center of the other lane.

   Option #3: The approach may display two three-section heads for the major movement and a single three-section head for the secondary movement.

6. Three Approach lanes on Stem of "T"

   Option #1: The approach may display two three-section heads for the major movement and one for the secondary movement (Exclusive left and right turn lanes).

   Option #2: The approach may display a five-section cluster in conjunction with three-section head (exclusive left and right turn lanes). The five-section cluster should be placed over the center of the lane line separating the left turn lane(s) from the right turn lane(s). The three-section head should be placed over the other lane line to provide dual indication for the major movement.

   Option #3: When the middle lane is a shared left and right turn lane, then a five-section cluster should be placed over the center of this lane and a three-section head placed over each of the other two lanes. Each head must contain green and yellow arrow indications in this situation.

NOTE:

1. For all cases, the approach shall display "dual indications". This means that there must be at least two heads with identical indications on the major approach. For example, if a green arrow is displayed on one head of the major movement or approach then a green arrow must be displayed on the second head.
2. The same signal display option should be used throughout an urban area to provide consistency in display to the motorist.
3. The use of advance and/or overhead lane use signs should be used as a supplement to pavement arrows on stems of signalized "T" intersections.

7.4.6 Signal Preemption

The engineer responsible for the design of a traffic signal project shall, as a matter of routine, check each intersection to determine if the need for signal preemption is present.

Intersections located in accordance with ***Department Procedure 750-030-002*** should be considered for preemption. Department signalization projects may also include preemption or priority systems for emergency vehicles or mass transit vehicles.

Refer to ***Department Procedure 750-030-002, Signalization Preemption Design Standards***, for more information.

7.4.7 Intersection Design - Lane Configuration

The engineer responsible for the traffic signal design may be asked to verify the number and configuration of traffic lanes required for an intersection to function properly when signalized.

The results are dependent upon the traffic volumes used in the analysis. The traffic used for this calculation shall be the design hourly volume based on the 30th highest hour (K factor) and not a peak to daily (P/D) ratio based on a 24-hour count. The K factor volumes account for traffic variations through the year, and, in most cases, are higher than P/D volumes.

The K, D, and T factors convert the two-way AADT volumes to a one-way Design Hourly Volume (DHV). This is appropriate for the total approach movements. The AM and PM peak turning movement counts on each approach should be addressed individually. Current turning movement counts should be taken to determine the percentage of turns for each approach. These percentages should then be applied to the DHV for each approach volume to determine the turning volumes that should be used for the turn lane design calculations. These values should be compared to the movement counts supplied by Planning and the greater of the two values used for the design of turn lanes. The District Planning Office should be contacted to determine if recent counts are available and also if any use changes are planned which would require adjustments to the turn percentages found in the current counts.

Storage lanes for left turns can affect the capacity and safety of intersections. The storage length of a left turn lane is a critical design element. The queue of left turn vehicles in a storage lane of inadequate length may extend into the through lanes. The result is loss of capacity for the through lanes. The queue of through vehicles may also extend beyond the entrance of a short left turn storage lane, blocking access to the storage lane. Either case results in a less efficient operation of the intersection and may cause last minute lane changes, thereby increasing the possibility of conflicts.

Turn lanes should comply with the ***Design Standards***, ***Index 301*** to the extent practical. The available queue length provided should be based on a traffic study.

The important factors that determine the length needed for a left turn storage lane are:

1. The design year volume for the peak hour (see discussion above).
2. An estimate for the number of cycles per hour.

   NOTE: If the cycle length increases, the length of the storage for the same traffic also increases.
3. The signal phasing and timing.

There are several techniques used to determine necessary storage length. The following are suggested guidelines for left turn lanes.

1. Where protected left turn phasing is provided, an exclusive turn lane should be provided.
2. Left turn lanes should be provided when turn volumes exceed 100 vehicles per hour (VPH) and may be considered for lesser volumes if space permits.
3. For signalized intersections, the following formula may be used, assuming an average vehicle length of 25 feet.

$$Q = \frac{(2.0)\ (DHV)\ (25)}{N}$$

   Where:

   Q = design length for left turn storage in ft.
   DHV = left turn volume during design peak hour, in VPH.
   N = number of cycles per hour for peak hour, use N = 30 as default.

   Note: Computer programs, such as ***TRANSYT-7F***, are used to develop signal phasing and timing. One of the outputs of these programs is the queue length. For projects where traffic signal timing is included as a part of the project, the output of these programs should be considered in determining storage length.
4. Where left turn volumes exceed 300 vph, a double left turn should be considered.
5. When right of way has already been purchased, and the designer has to choose between a long wide grass median or a long left turn lane, the storage length for the left turn should be as long as practical without hindering other access.

Right turn lanes are provided for many of the same reasons as left turn lanes. Right turns are, however, generally made more efficiently than left turns. Right turn storage lanes should be considered when right turn volume exceeds 300 vph and the adjacent through volume also exceeds 300 vehicles per hour per lane (vphpl).

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7.4.8 Signal Loops

Traffic signal loops are detailed in the ***Design Standards, Index 17781***. These loops are standard and will be appropriate for most locations.

The traffic signals for each intersection should be individually designed. The requirement for type and placement of loops is a part of this design. The above standard allows for some variation in size and placement of the standard loops. These modifications are intended to be used only when required by the design of a particular location.

7.4.9 Grounding and Electrical Bonding

The grounding requirements for traffic signal components shall be as follows:

1. Install 20' of ground rod at each signal pole, mast arm, pedestrian signal, etc. and at each pull box.
2. Install 40' of ground rod at each electrical service and controller cabinet.

This information is covered in the ***Design Standards*** and specifications. The above lengths of ground rod will be installed at each component, and the cost will be incidental to the unit or assembly being installed.

The designer will not be required to add plan notes or develop quantities for ground rods and the use of the 620 pay item number for grounding electrode will not be required on the plans.

Design Standards, Index 17736 requires a bond wire connecting all poles, controllers, mast arms and pedestrian signal pedestals. This conductor is incidental to the cost of the signal installation.

7.4.10 Wind Loading - Traffic Signals

See ***Chapter 29*** of this volume.

7.4.11 Foundation Criteria

Refer to ***Section 7.6, Foundation Design***, for geotechnical requirements.

7.4.12 Mast Arm Supports

All new signals installed on the State Highway System that meet any of the following criteria (considered the mast arm policy area):

1. along designated coastal evacuation routes;
2. along the Strategic Intermodal System routes; or
3. along corridors within the approximate ten mile coastline boundary defined by the State Traffic Engineering Office Implementation Guidelines

shall be supported by mast arms with the signal head(s) rigidly attached to the mast arm. A span wire assembly may be used within this mast arm policy area only when it is impractical to use a mast arm or overhead rigid structure and a Design Variation has been approved in accordance with ***Chapter 23*** of this volume.

Mast arm signal supports or other types of rigid supports outside the mast arm policy area must be carefully considered before inclusion in a project. The districts have the flexibility to provide the total funding if funding is available. If funding is not sufficient, mast arm signal supports or other types of rigid supports outside the mast arm policy area can be installed by the Department with Maintaining Agency providing the funding for the cost difference between the proposed supports and strain pole supports typically installed by the Department.

In addition, an underground communication cable infrastructure shall be utilized for those signals operating as part of an advanced traffic management system on these designated corridors.

The signal support system used for signals located outside the mast arm policy area shall be selected after consideration of appropriate site conditions, design requirements and cost.

The Structures Design Office has developed a Traffic Signal Mast Arm Standard. The standard includes single arm designs, with and without luminaires and double arm designs without luminaires. The standard designs include both 110, 130 and 150 mph design wind speeds. A foundation and base plate design has been developed for each pole type.

The manufacturer of the standard mast arms will be pre-approved by the Department and added to the Qualified Products List (QPL). When the standard assemblies are used, design details in the plans or shop drawing submittals will not be required. Special designs, for those locations where the standard design is not appropriate, will require complete design details for the pole, arm and foundation to be included in the plans, and will require shop drawings.

Mast arm design will require close coordination between the signal designer and the Structures Office. If standard designs are utilized, the Structures Engineer shall review applicability of structural parts with site conditions. Early coordination is important.

The Signal Designer will provide the Structures Office a copy of the mast arm tabulation sheet that includes the following information:

1. The pole and arm locations
2. Elevations and offsets
3. Signal and sign sizes and locations on the mast arm

The Structures Office will analyze the data and determine the standard pole and arm configuration required, and complete the "Standard Mast Arm Assemblies Data Table" (Structures CADD cell table) for the plans. If a special design is required the Structures Office will provide the complete design details for the special mast arm assembly. A special design will require additional design time for either the Department or Consultant Structures Office. As noted above, the standard includes a foundation design for each pole. These designs were based on assumed soil conditions. The Structures Office will verify the project soil conditions to ensure the standard foundations are adequate. A special design will be developed if required.

The engineer responsible for signal design will seal the mast arm tabulation sheet and the Structures Design Engineer will seal the structures data table and special design details if required for the plans.

Refer to ***Volume II, Chapter 24*** for instructions on the mast arm tabulation sheet.

7.4.13 Traffic Signal Project Coordination

Coordination with other offices and other agencies is a very important aspect of project design. The offices discussed in this section are not intended to be an all inclusive list with which the designer should coordinate, instead it includes offices that are normally involved in projects.

Roadway Design - Normally the designer of a signal project receives the base sheets for design from the roadway designer. The roadway designer can also provide any required cross sections. If the signal project is not an active roadway design project, base sheets may be obtained from existing plans.

Utilities - The District Utilities Engineer provides the coordination between the designer and the various utilities involved in the project. This usually is limited to agreements with the power company for electrical service. The Utilities Section can also identify potential conflicts with overhead and underground utilities or verify those that have previously been identified.

The Utilities Engineer should be contacted early in the design phase. The designer should indicate a preferred location for the electrical service.

Structures Design - The Engineer of Record for Structures Design provides the design of the traffic signal mast arms and strain poles. This includes the design of the foundation for these structures. The Engineer of Record must be contacted early in the design phase to allow adequate time for coordination with the Geotechnical Engineer in obtaining the necessary soils information.

Pedestrian Coordinator - The pedestrian coordinator should be consulted to be sure that all of the pedestrian concerns have been fully addressed.

7.4.14 LED Light Sources

The standard light source for signal indications has been the incandescent lamp. The Department is now adopting the Light Emitting Diode (LED) as the standard for all indications.

7.4.15 Pedestrian Countdown Signal Applications

Countdown pedestrian signal head devices are considered to be the Department's preferred installation on all projects that require pedestrian signal head devices. When these devices are proposed for use, the Department must coordinate with the local maintaining agency prior to installation. The Department's ***Traffic Engineering Manual, Section 3.9***, contains specific criteria for their installation and operation.

7.5 Intelligent Transportation System (ITS) Components

Intelligent transportation system (ITS) designs utilize electronics, communications, or information processing systems singly or in combination to improve the efficiency and safety of a surface transportation system. ITS components are devices and subsystems that provide certain specialized functions within an ITS system. These devices are typically deployed to obtain information (including traffic data, video imagery, weather information, and other information relevant to roadway management) from field sites along Florida's Intrastate Highway System. This information is transmitted to transportation management centers (TMCs) and associated control facilities, where traffic managers use it to assess conditions, respond to incidents, and conduct other activities. ITS components also provide various means of disseminating travel-related information and alerts to motorists concerning traffic or weather conditions they may encounter.

The inclusion of new ITS design guidelines in this chapter will occur as statewide minimum specifications for ITS devices are finalized and adopted by the Department. Because this is an ongoing process, those individuals seeking the latest information on ITS device design requirements and specifications should contact the ITS Section in the Traffic Engineering and Operations Office.

The plans preparation information provided in this section applies to the placement and installation of ITS devices and systems along Florida's limited-access and non-limited-access corridors. ITS device requirements as adopted by the Department are published by the State Specifications Office and available online at the FDOT Web site. The ITS project designer is advised that plans involving ITS devices must also include provisions for grounding and surge suppression in order to protect ITS equipment and ensure human safety.

7.5.1 Design Criteria

ITS design criteria, in general, require that devices and systems be able to gather, analyze, and distribute accurate information to support the overall goal of improving the safety, efficiency, mobility, security, and integration of transportation systems. Designers must consider the strengths and limitations of various technologies for collecting, analyzing, and disseminating information, and select devices that are most appropriate for a specific application. Many ITS devices have specific placement and configuration requirements that must be met for the equipment to perform properly. Designers are strongly encouraged to familiarize themselves with the strengths and limitations of various devices and technologies prior to incorporating them into their designs. Other general considerations for

ITS designs include promoting safety for road users, monitoring traffic and travel conditions, supporting traffic management operations, providing equipment access for maintenance personnel, and disseminating useful information to motorists. Lastly, the designer needs to ensure that the ITS project is consistent with the FDOT regional ITS architecture, and that the project reflects the application of system engineering management principles.

For vehicle detection systems, such as those utilizing video, microwave, magnetic field, or acoustic technologies, the designer should consult with the device manufacturers to ensure that placement and installation plans facilitate proper operation of a particular device type. Be aware of a technology's capabilities and limitations in a given location in order to create a design that is capable of achieving the required levels of detection accuracy.

The clearance requirements for poles, sign structures, field cabinets, and communication hubs for ITS deployments should conform to those provided in ***Chapters 2*** and ***25*** of this volume. Any deviation or alternative or special design must be coordinated with the District Design Engineer.

7.5.2 ITS Device Approval and Compatibility

ITS devices sold or installed in Florida are required to be evaluated by the Traffic Engineering and Operations Office's Traffic Engineering Research Laboratory (TERL) prior to their use on the state's highways. The evaluation of ITS devices by the TERL will occur as statewide minimum specifications for ITS devices are finalized and adopted by the Department. Designers should consult the FDOT Approved Product List (APL) for the device types requiring evaluation and the currently approved devices. If the designer wishes to utilize a new device type or a device not on the APL, they should contact the TERL in Tallahassee to determine the appropriate course of action.

Designs should ensure that ITS devices which share communications networks or provide related functions are compatible with each other and will not interfere with the operation of other devices or systems. In addition, designs should incorporate features and functions that allow interoperability with other ITS deployments throughout the state. Examples of general design characteristics that promote interoperability include:

1. Systems and products based on open architectures and standards.
2. Systems and products that are scalable and nonproprietary.
3. Compatibility with the Department's SunGuide℠ Software System directly or via support of one or more of its related Interface Control Documents (ICDs).

7.5.3 Required Information

The basic information necessary for ITS plans includes device placement and installation requirements (including communication and power interconnect), roadway geometrics, street names, construction stationing or milepost information, right of way lines, location of underground utilities, and presence of other roadside features or existing devices that may impact ITS device locations in the field.

The requirements for a complete set of ITS project plans are found in ***Chapter 29 of Volume 2***.

7.5.4 Motorist Information Systems

7.5.4.1 Dynamic Message Sign (DMS)

The DMS is an electronic sign capable of displaying more than one message, which is changeable manually, by remote control, or by automatic control. The DMS is intended primarily to advise approaching motorists of freeway conditions, such as road construction or a traffic incident ahead, so that they can take appropriate action. In some instances the DMS could be used to display other messages, such as AMBER Alerts or traveler information related to special events, emergencies, and incidents impacting mobility and safety. A DMS generally displays messages that can be selected or modified by electronic means from a TMC or other central command location. As such, system designs utilizing DMS must also include designs for a communication infrastructure that supports this remote control capability.

The DMS should be positioned and illuminated to be readable from the roadway, taking into account the display characteristics of DMS technology (e.g., the vertical and horizontal viewing angles of the LED displays).

The DMS and its support structure must meet the wind load requirements as specified in ***Chapter 29*** of this volume and comply with the ***AASHTO 1994 Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals*** (50-year reoccurrence).

Placement of a DMS should be determined by project-specific needs, as well as the following general design criteria:

1. Ability to communicate a meaningful message that can be read and comprehended by motorists within a brief time period (dictated by the sight distance characteristics of the location and the design features of the sign). This is also dependent upon the posted speed limit of the roadway.
2. Placement prior to freeway interchanges that offer alternate routes.
    a. In advance of 1-mile exit approach signing.
    b. Maintain minimum 800-foot spacing between existing and planned overhead static sign panels and other signs, per the MUTCD. Consider increased spacing when conditions allow.
    c. Maintain minimum of 1450-foot distance from decision points (meets MUTCD/AASHTO Green Book requirements).
3. Placement in advance of high crash locations and traffic bottlenecks.
4. Placement that accommodates access for service and maintenance.
5. Placement in advance of system interchanges.
6. Placement along key commuter or evacuation corridors.

The sign enclosure must be mounted with a minimum vertical clearance height as specified in ***Table 2.10.4***.

7.5.4.2 Highway Advisory Radio

A highway advisory radio (HAR) system design should include all the equipment necessary for the operator to record verbal messages from onsite or remote locations, and to continually broadcast live, prerecorded, or synthesized messages from roadside transmission sites. HAR designs also include highway signs with remotely operated flashing beacons to notify motorists of HAR broadcasts.

The designer should be aware of the Federal Communications Commission (FCC) regulations in ***CFR Title 47, Part 90.242***, pertaining to the operation of travelers' information stations. Additional information on licensing issues, frequency allocation, and other specifics can be obtained by contacting the FDOT ITS Telecommunications Office.

Radio waves are also propagated through the ground and grounding components are used to ensure peak performance. This necessitates a well-designed and well-constructed ground field, a circular space radiating from the antenna location. This design is critical to the successful operation of the HAR site, and may require a significantly sized circle around the antenna mast. An array of wiring emanating from the antenna mast radiates outward; ground assemblies at the end of each wire or cable are drilled into the ground.

Placement of a HAR installation should be determined by project-specific needs, as well as the following general design criteria:

1. Ability to transmit a meaningful message that can be received by motorists traveling through the broadcast zone.
2. Placement prior to freeway interchanges that offer alternate routes.
3. Placement in advance of high crash locations and traffic bottlenecks.
4. Placement that accommodates access for service and maintenance.
5. Placement along key commuter or evacuation corridors.

7.5.5 Video Equipment

7.5.5.1 Closed-circuit Television Cameras

Closed-circuit television (CCTV) systems consist of roadside cameras, communication devices, as well as camera control and video display equipment at one or more remote monitoring locations that allow surveillance of roadway and traffic conditions

CCTV device placement and overall system design should be determined by project-specific needs, as well as the following general design criteria:

1. A camera should be strategically located to obtain a complete view of the freeway (keeping all ramps in mind) and to view the arterial traffic.
2. Camera location should provide the ability to view any nearby DMS for message verification.
3. A camera's location should provide the ability to view crossing features (i.e., streets, rail, bridges), as feasible.
4. Camera structures must be placed in accordance with ***Section 2.11***.
5. Device placement should be such that it accommodates access for service and maintenance with minimal to no impact on traffic. For instance, the use of lowering devices to allow cameras to be lowered from the pole top to ground level for servicing with little or no disruption of traffic.

Designs and plans should consider and illustrate camera mounting height. Mounting height should be selected based upon project specific needs, as well as the following general design criteria:

1. Required viewing distance.
2. Roadway geometry and lane configuration.
3. Roadway classification (i.e., arterial or freeway).
4. Life-cycle cost, including maintenance impacts.
5. Environmental factors, such as glare from the horizon or from headlights.
6. Vertical clearance.

All camera housings, enclosures, lowering devices, and mounts must be designed to withstand sustained wind loads and gust factors according to ***Chapter 29*** of this volume.

CCTV camera poles should also be designed and installed according to the requirements of ***Section 641, Prestressed Concrete Poles***, or ***Section 649, Steel Strain Poles, Steel Mast Arms and Monotube Assemblies***, in the ***FDOT Specifications***, and as depicted in ***Index 17723*** and ***Index 17725*** of the ***Design Standards***.

Designs for support structures and foundations should be based on the ***PPM*** guidelines***,*** the ***Design Standards***, and on the ***AASHTO LTS-4*** standard with current addenda. The wind load requirements as specified in ***Volume 9*** of the ***FDOT Structures Manual*** should also be used as design criteria for CCTV structures and their associated foundations.

7.5.5.2 Video Display Equipment

Video display equipment is utilized in the TMC for viewing CCTV images and other information obtained from field locations. It is important to develop a display system design plan that is based on a detailed, documented analysis of the control center room dimensions, the operator's console desk layout, various distances from the operator's seating position to the video wall display, and the viewing angles to the display wall at the proposed mounting height for the display supporting structure.

The designer should consider any potential limitations introduced or imposed by existing facility construction that may hinder the installation of the video wall display. The video display components should be capable of being brought into the TMC control room and assembled in place without the Contractor having to make modifications to existing doorways, walls, floors, or ceilings.

7.5.6 Network Devices

Network devices utilized in ITS include a variety of Internet Protocol (IP)-addressable electronic equipment used for the collection and dissemination of video, traffic data, and other information.

Due to the critical nature of the network equipment described below, the complexity of the electronics, and harsh environmental conditions at installation locations, designs utilizing network devices should facilitate immediate replacement of defective or damaged units with minimal system downtime.

Consideration should be given to designs that promote open architecture, non-proprietary systems, as well as survivability and reliability. Designers should consider solutions that provide immunity to single-point failure and implement redundant paths for reliability and survivability.

7.5.6.1 Managed Field Ethernet Switch

The managed field Ethernet switch (MFES) is an environmentally hardened field device that provides Ethernet connectivity from the remote ITS device installation location to the ITS network trunk interconnection point. Local connections from nearby Ethernet field devices or other cabinet electronics to the MFES are generally accomplished using CAT5e or CAT6 UTP cables connected to RJ-45 Ethernet ports on the MFES. However, when planning connections of the MFES to other Ethernet devices beyond a distance of 300 feet, fiber optic cabling from optical ports on the MFES is generally the preferred method. The designer should also consider fiber optic connection to devices outside the local cabinet if the design requires additional protection from transients or interference that may be induced on copper-based interconnects.

The design should provide an Ethernet port for the connection of each remote ITS field device. Field devices that typically connect to an MFES include, but are not limited to, CCTV camera systems, HAR field assemblies, vehicle detection systems, DMS, road weather information systems (RWIS), and traffic controllers.

7.5.6.2 Device Server

The device server encapsulates serial data in network packets and transports the packets across IP networks. Designs generally include device servers when remote field devices must connect to an Ethernet network, yet only possess serial communication interfaces.

Equipment that may require the use of device servers includes, but is not limited to, HAR field assemblies, DMS, vehicle detection systems, RWIS stations, and other low-speed data output devices

7.5.6.3 Digital Video Encoder and Decoder

Digital video encoders (DVEs) and digital video decoders (DVDs) are specialized network-based hardware devices and software that allow data signals and analog video to be encoded to digital format and transmitted across IP networks. These networks are designed so that the digitized video and data packets the DVE produces and places on the network can be reconstructed (decoded) by hardware-based and software-based DVDs also attached to the network.

When designing a video and data transmission system incorporating DVE and DVD hardware with existing or planned network infrastructure, ensure that the system can transport video and data from multiple remote field locations simultaneously to multiple monitoring locations. If applicable, the designer should also seek to maintain video, data, and switching interoperability with legacy systems.

7.5.7 Fiber Optic Cable and Interconnect

The following sections describe the various fiber optic facilities that are used for device control and data communications between ITS field devices, TMCs, regional transportation management centers (RTMCs), and other identified stakeholder facilities. Designs that include network facilities should meet project-specific needs, as well as include the following information:

1. Facility diagrams illustrating facility routes.
2. General network topology.

7.5.7.1 Fiber Optic Cable

Fiber optic cable is utilized in the statewide ITS network infrastructure to provide data and device control communications between TMCs, RTMCs, ITS devices, and other identified stakeholder facilities. The designer should refer to Department specifications for material requirements of fiber optic cable and related material.

7.5.7.2 Fiber Optic Conduit

The type of fiber optic cable installation will determine the design for the conduit needed. For example, use polyvinyl chloride (PVC), fiberglass, or high-density polyethylene (HDPE) conduit for fiber optic cable that is exposed or placed underground along the roadway. Use HDPE SDR 11 conduit underground along the interstate. Use a UV-rated, flexible conduit to protect the cable in above-ground installations.

The design of the conduit should depict all required fittings and incidentals necessary to construct a complete installation. The conduit system should allow the fiber optic cable to maintain the minimum bend radius after installation.

7.5.7.3 Fiber Optic Splices and Terminations

Fiber optic splices provide a continuous optical path for transmission of optical pulses from one length of optical fiber to another. Designs and plans should identify splice points and provide splicing diagrams that detail the interconnection of specific fiber strands, their origination and final destination points, and expected link loss. The preferred method of presentation is a graphical format.

Fiber optic terminations connect the optical fibers housed within a cable to a fiber distribution panel (FDP) or a fiber patch panel (FPP). The FDP and FPP help connect the optical fibers to the electronic equipment and devices located throughout the network. Therefore, all fiber optic terminations should include the installation of a FPP or a FDP. Field terminations also include the installation of fiber optic connectors to the optical fibers if factory-installed connectors are not used.

7.5.7.4 Fiber Optic Cable Designating System

The fiber optic cable designating system provides visual notification of the presence of the underground fiber optic conduit/cable system, and provides a mechanism for electronically locating the physical presence of the conduit system below ground. The designating system provides a means to identify, locate, and protect the statewide fiber optic network between RTMCs, TMCs, ITS devices, and other facilities.

The designating system may consist of several components, including electronic markers, above-ground route markers, tone wire access points, buried cable warning tape, underground tracers, and tone wires. Design the designating system to support both high-power, office-based tone generators and portable field tone generators.

The design and construction of the designating system should consist of furnishing and installing the type, size, and quantity of system components as specified by the project, and meeting the following functional requirements based on project needs:

1. Provide visual notification of the presence of the conduit installed on FDOT projects.
2. Inform the public of potential hazards and provide contact information for conduit system marking prior to planned excavation.
3. Provide an end-to-end electrical conductor (tone wire) attached to the conduit system for conductive facility locating.
4. Provide above-ground access to the tone wire.

7.5.7.5 Fiber Optic Access Points

Fiber optic access points consist of splice boxes and pull boxes. They are utilized to provide access to the statewide fiber optic conduit system for the installation, operation, and maintenance of fiber optic cables between RTMCs, TMCs, ITS devices, and other identified stakeholder facilities. More information about pull and junction boxes is provided in ***Section 635*** of the ***FDOT Specifications***.

Access point items should be planned and designed according to the type, size, and quantity necessary for the project. Design the access points to meet the following minimum functional requirements:

1. Provide at-grade access to fiber optic cables housed within conduit systems used for FDOT ITS communications.
2. Provide assist points to aid in fiber optic cable installation.
3. Provide protection for the fiber optic cable.
4. Provide adequate space for storing cable slack/coils and splice enclosures.
5. Make certain that pull boxes and splice boxes provide sidewall entry of the fiber optic cables.

Fiber optic access points should be placed at the following locations unless otherwise directed by the Engineer:

1. All major fiber optic cable and conduit junctions.
2. At all planned or future splice locations.
3. Every 2,500 feet in a continuous straight conduit section if no fiber optic cable splice is required.
4. At a maximum of 1,000 to 1,500 feet in metropolitan areas.
5. On each side of a river or lake crossing and at each end of a tunnel.
6. On each side of an above-ground conduit installation (i.e., attachment to bridge or wall).
7. All 90-degree turns in the conduit system.

Use splice boxes as the preferred access points on fiber optic cable backbone routes. Use pull boxes as the access points when the conduit system extending from the backbone to the ITS field devices requires an access point to house only fiber optic drop cables.

7.5.8 Infrastructure

7.5.8.1 Grounding and Transient Voltage Surge Suppression

Effective grounding and surge suppression is generally achieved through a combination of three primary techniques: proper bonding and installation of grounding rods, use of air terminals, and the application of a transient voltage surge suppressor (TVSS). These three methods work in concert to protect ITS equipment installed in the field and should be incorporated, as applicable, in ITS designs and plans.

Designs and plans should consider existing geological and other physical characteristics at proposed installation locations that may affect the design or layout of grounding systems. Information such as locations of rock formations, buried utilities, gravel deposits, soil types and resistivity, and presence of groundwater should be considered when developing plans that include these systems. Any pertinent survey data gathered during plans development, such as soil resistivity measurements, should be noted on the plans.

Placement and layout of grounding arrays should be planned in such a way that grounding paths from the down cable to the primary electrode are as straight as possible. Where practical, plans should provide detail related to cable routing and other installation details required to maximize the efficiency of Grounding and TVSS.

Grounding and TVSS device placement and overall system design should be determined by project-specific needs, as well as these general design criteria:

1. Follow best practices defined in the NFPA 780 Standard for the Installation of Lightning Protection Systems.
2. Place TVSS equipment so that grounding connections are as short and straight as possible.
3. Cable routing should avoid excessive bending and provide physical separation between low-voltage and high-voltage signal paths.
4. Avoid routing unprotected or grounding wires parallel or adjacent to protected wiring.

7.5.8.2 ITS Pole and Lowering Device

For installations of pole-mounted devices where height precludes easy access using a bucket truck, consider using a lowering device.

If designs call for a lowering device to be attached to an existing pole or similar structure, ensure that the design includes external conduit for housing the cabling, the necessary mounting box hardware at the top of the structure, and any other component details required for installation. Do not create designs that would require an operator to stand directly beneath equipment while it is being lowered.

The designer should consider the placement of all devices on the pole and how they affect the ability to utilize the lowering device.

7.5.8.3 ITS Field Cabinet

ITS field cabinets are designed and furnished to house any combination of several ITS devices installed along the roadway, including managed field Ethernet switches, hub switches, device servers, digital video encoders, vehicle detection system electronics, DMS communication devices, CCTV camera hardware, and power supplies for these items.

Final location of the cabinet should be based on safety of the motorist, visibility of roadside devices, and access by maintenance. ITS field cabinets can be base mounted on a concrete pad, structure mounted, or pole mounted.

The cabinet should be sized appropriately to accommodate the equipment to be installed inside. In addition, the cabinet design should take into account the ease of access to the equipment and the ability to achieve proper ventilation in order to maintain an internal operating environment that does not exceed the operating temperature ranges for the devices housed inside.

7.5.9 Vehicle Detection and Data Collection

The FDOT uses vehicle detectors along roadways to collect traffic information. Data from these detectors are used in the TMCs to initiate traffic control measures. There are various kinds of detectors available, each with its unique attributes and limitations. The four types described here are considered nonintrusive because their operation does not interfere with the flow of traffic, and installation does not require altering the roadway surface.

Prepare a design that details a complete detection assembly, including all other necessary components to be supplied and constructed. Detail in the drawings the exact location and placement of system components, and include installation details for the required cables. Design the cabling installation according to the manufacturer’s recommendations.

7.5.9.1 Microwave Vehicle Detection System

The Microwave Vehicle Detection System (MVDS) is installed above ground on the side of the road (i.e., side-fire) for multilane detection, or over the travel lanes for single lane coverage only. This detection system uses a FCC-certified, but non-site licensed, low-power microwave radar beam to measure vehicle presence, volume, speed and occupancy.

7.5.9.2 Video Vehicle Detection System

The Video Vehicle Detection System (VVDS) measures vehicle presence, volume, occupancy, and speed by analyzing video signals generated by the video camera used to detect traffic.

Besides vehicle detection, the VVDS can also function as a roadway surveillance device. When surveillance capability is desired, dual-use VVDS systems are used. In the surveillance mode, these systems automatically turn off the vehicle detection functions.

The recommended deployment geometry for optimal video detection and surveillance requires that there be an unobstructed view of each travel lane where detection and surveillance are required. Though optimal results can be achieved when the cameras are directly above the travel lane, the cameras are not required to be directly over the roadway.

Cameras can be positioned so they can view either approaching or receding traffic or both in the same field of view. The preferred orientation for optimal detection is the view of approaching vehicles because there are more high-contrast features on vehicles viewed from the front than from the rear. Cameras should be positioned high enough to minimize the effects of occlusion from closely spaced vehicles and to avoid glare from the horizon.

7.5.9.3 Magnetic Traffic Detection System

The Magnetic Traffic Detection System (MTDS) relies on magnetic sensors or probes that are placed in conduits under the road surface. A probe is a transducer that converts changes in the vertical component of the earth’s magnetic field to changes in inductance in a loop. Vehicles on the road surface increase the vertical component of the earth’s magnetic field at the detection point when they move over the sensor. The increased magnetic field changes inductance in a loop connected to the sensor, and the system converts this input into traffic data.

7.5.9.4 Acoustic Vehicle Detection System

The Acoustic Vehicle Detection System (AVDS) utilizes a passive acoustic sensor that measures traffic parameters by detecting vehicle-generated acoustic signals. The AVDS can be mounted over the travel lane on a bridge or a mast arm, or on roadside poles or sign structures for a side-fire mounted configuration.

Acoustic detection systems measure traffic flow parameters for five adjacent lanes on a lane-by-lane basis. The system can identify acoustic signals from approaching vehicles with a different signal level and a different wave front angle (i.e., arrival angle) than that of passing vehicles that are leaving the detection area. The system also processes acoustic signals generated by stationary (i.e., idling) vehicles in real time.

The detection system can also be used to emulate a dual-loop speed trap configuration for speed measurement.

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7.6 Foundation Design

For foundations for standard conventional Roadway Lighting Poles, refer to the ***Design Standards, Index 17515***. Refer to the ***Design Standards, Index 17503*** for foundations for non-standard conventional Roadway Lighting Poles. ***Section 715*** of the ***Specifications*** allows the screw type foundation as an alternate. The Geotechnical Engineer shall determine whether the soil characteristics meet the requirements of ***Section 715***. If it is determined that the soil conditions do not allow the use of the screw type foundation as shown in ***Section 715***, a note shall be added to the plans stating: "Use of the screw type foundation is not allowed on this project."

The ***Design Standards, Index Nos. 17743 and 17745*** include foundations for standard Mast Arm Assemblies, and ***Index 17746*** includes foundations for standard Monotube Signal Structure assemblies. Unique site circumstances may require the foundation variables to be modified from the foundations shown. If special designs are required, the Geotechnical Engineer shall provide the soil information to be used by the District Structures Design Engineer during the design phase of the project.

The foundation design and drawings where special foundations are required for locations where standard Mast Arm Assemblies and Standard Monotube Signal Structures are used and for overhead sign structures, high mast light poles, and traffic signal strain poles shall be the responsibility of the Structures Engineer of Record (EOR). The Geotechnical Engineer shall provide the EOR the following soils information (this information may be derived from the borings of other nearby structures or from roadway borings):

1. Soil Type
2. Effective Unit Weight of the Soil
3. Seasonal High Water Table Elevation
4. Effective Friction Angle of the Soil (if applicable)
5. Cohesion Value (if applicable)
6. Allowable Bearing Capacity (if applicable)

The above soils information shall be included in the plans. Additionally, Soil Boring Data Sheets shall be included in the plans, except for strain poles. This will provide the Contractor with the conditions for which the foundations were designed as compared to actual on-site conditions and establish criteria for any future analysis of the foundations.

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Chapter 8

Pedestrian, Bicycle and Public Transit Facilities

Tables

Figures

8.2 References

1. ***Manual on Uniform Traffic Control Devices (MUTCD)***
2. ***Design Standards***
3. ***FDOT Pedestrian Planning and Design Handbook***
4. ***FDOT Bicycle Facilities Planning and Design Handbook***
5. ***FDOT Trail Intersection Design Handbook***
6. ***AASHTO Guide for Bicycle Facilities***
7. ***Highway Capacity Manual***
8. ***Americans With Disabilities Act (ADA)/Florida Accessibility Code for Building Construction (FACBC)***
9. ***Uniform Vehicle Code (UVC)***
10. ***AASHTO LRFD Bridge Design Specifications, Current Edition***
11. ***AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities***
12. ***Transportation Research Board (TRB). Guidelines for the Location and Design of Bus Stops adapted from TCRP Report 19. Washington D.C.: National Academy Press***
13. ***FDOT Accessing Transit: Design Handbook for Florida Bus Passenger Facilities***
14. ***Transit Facilities Guidelines on the Public Transportation Office website: http://www.dot.state.fl.us/transit/***
15. ***FDOT Structures Manual, Current Edition***

8.3 Pedestrian Facilities

All roadways and bridges where pedestrian travel is expected should have separate walking areas such as sidewalks or shared use paths that are outside the vehicle travel lanes. Refer to ***Section 8.6*** for shared use paths.

8.3.1 Sidewalks

Sidewalks are walkways parallel to the roadway and designed for use by pedestrians. Generally, sidewalks should be constructed along both sides of arterial roadways that are not provided with shoulders, even though pedestrian traffic may be light. However, the construction of sidewalks on both sides of the street would not be required in such cases as when the roadway parallels a railroad or drainage canal and pedestrians would not be expected. If sidewalks are constructed on the approaches to bridges, they should be continued across the structure. If continuous sidewalks are constructed on only one side of the street, pedestrians should be provided access to transit facilities located on the opposite side of the street.

The minimum width of a sidewalk shall be 5 ft. when separated from the curb by a buffer strip. The minimum separation for a 5 ft. sidewalk from the back of curb is 2 ft. The buffer strip should be 6 ft. where possible to eliminate the need to narrow or reroute sidewalks around driveways. If the sidewalk is located adjacent to the curb, the minimum width of sidewalk is 6 ft. Grades on sidewalks should not exceed 5% when not adjacent to a travel way. There should be enough sidewalk cross slope to allow for adequate drainage, however the maximum shall be no more than 2% to comply with ADA requirements. Edge drop-offs should be avoided. When drop-offs cannot be avoided, they should be shielded as discussed in ***Section 8.8***.

A 5-foot wide sidewalk that connects a transit stop or facility with an existing sidewalk or shared use path shall be included to comply with ADA accessibility standards.

Particular attention should be given to pedestrian accommodations at the termini of each project. If full accommodations cannot be provided due to the limited scope or an existing sidewalk isn't present at the termini, then temporary measures should be considered such as: Extend sidewalk and project limits to next appropriate pedestrian crossing or access point. If special accommodations are made, it is equally important to address these measures on the adjoining projects. In all cases, the District Pedestrian/Bicycle Coordinator should be contacted to make a determination regarding continuous passage.

On roadways with flush shoulders, the minimum width of sidewalk is 5 feet.

On existing roadways with flush shoulders, sidewalks or pedestrian pathways should be placed as far from the roadway as practical in the following sequence of desirability:

1. Outside of the roadway right of way in a separate, offsite and/or parallel facility.
2. At or near the right of way line.
3. Outside of the clear zone.
4. As far from edge of driving lane as practical.

For new roadway construction with flush shoulders, the sidewalk should be outside of the clear zone.

8.3.2 Disability Considerations

Pedestrian facilities must be designed in accordance with ADA to accommodate the physically and visually challenged citizens whose mobility is dependent on wheelchairs and other devices. In areas with sidewalks, curb ramps shall be incorporated at locations where a marked crosswalk adjoins the sidewalk. ***Index 304*** of the ***Design Standards*** sets forth requirements. Pull boxes, manholes, and other types of existing surface features in the location of a proposed curb ramp should be relocated when feasible. When relocation is not feasible, the feature shall be adjusted to the new ramp to meet the ADA requirements for surfaces (including the provision of a non-slip top surface, and adjustment to be flush with and at the same slope as the curb ramp).

To assist pedestrians who are visually or mobility impaired, curb ramps should be parallel to the crossing. By providing ramps parallel to the crossing, the pedestrian is directed into the crossing. At intersections where more than one road is crossed, each crossing should have a separate curb ramp. Under no circumstance shall a curb ramp be installed allowing a pedestrian to enter a crossing without providing a curb cut (or at grade sidewalk if no curb is present) on the opposite side of the crossing.

8.3.3 Marked Crosswalks at Uncontrolled Locations

There are a number of treatments that may be used to get pedestrians safely across the street, whether crossing at an intersection or midblock. A marked crosswalk is one of these tools, but it is best used in conjunction with other treatments (including signs, flashing beacons, curb extensions, raised crossing islands, and enhanced overhead lighting). Not only are marked crosswalks used to advise pedestrians where to cross, but also to alert motorists to expect pedestrians crossing at those locations. The criteria provided in this section do not apply to school crossings.

Marked crosswalks shall not be installed in an uncontrolled environment (without signals, stop signs, or yield signs) when posted speeds are greater than 40 mph or on multilane roads where traffic volumes exceed 12,000 vpd (without a raised median) or 15,000 vpd (with a raised median).

Roundabouts present a unique challenge for the design of pedestrian crossings. In a roundabout, the crosswalk to the splitter island should be placed with a minimum offset of 20 feet from the yield line of each approach leg.

8.3.3.1 Midblock Crosswalks

Marked crosswalks can be used to supplement the pedestrian crossing needs in an area through the use of midblock crosswalks. This can provide pedestrians with a more direct route to their destination. The use of unsignalized midblock crosswalks should be carefully considered. When used, midblock crosswalks should be illuminated, marked and outfitted with advanced warning signs or warning flashers in accordance with the ***Manual of Uniform Traffic Control Devices (MUTCD)***. Pedestrian-activated, signalized midblock crosswalks may be appropriate at some locations, but the locations must meet the warrants established in the ***MUTCD***.

In addition to the requirements in ***Section 8.3.3***, the following conditions also apply:

1. Midblock crosswalks should not be located where the spacing between adjacent intersections is less than 660 feet
2. Midblock crosswalks should not be located where the distance from the crosswalk to the nearest intersection (or crossing location) is less than 300 feet
3. Midblock crosswalks shall not be provided where the crossing distance exceeds 60 feet (unless a median or a crossing island is provided)
4. Midblock crosswalks shall not be provided where the sight distance for both the pedestrian and motorist is not adequate (stopping sight distance per ***Table 2.7.1***)
5. Midblock crosswalks shall not be provided where the roadway lighting illuminating the proposed crosswalk is inadequate

An engineering study is required before a marked midblock crosswalk is installed at an

Table 8.6.8.2 Minimum Stopping Sight Distances

MINIMUM STOPPING SIGHT DISTANCE (FEET) FOR 20 MPH PATH = 127 FEET, FOR 30 MPH PATH = 230 FEET														
Design Speed	GRADES													
	-9%	-8%	-7%	-6%	-5%	-4%	-3%	3%	4%	5%	6%	7%	8%	9%
20 MPH	Use 30 MPH Values					137	134	121	119	118	116	115	114	113
30 MPH	298	287	277	268	260	Use 20 MPH Values								

8.6.9 Vertical Alignment

The minimum length of vertical curve necessary to provide minimum stopping sight distance at various speeds on crest vertical curves is selected by using the formula listed below:

When $S > L$: $L = 2S - (900 / A)$

When $S < L$: $L = AS^2 / 900$

L = Min. Length of Vertical Curve (ft.)

A = Algebraic Grade Difference (%)

S = Stopping Sight Distance (ft.)

8.6.10 Separation Between Shared Use Path and Roadway

When two-way shared use paths are located adjacent to a roadway, a 5-foot separation should be provided. This demonstrates to both path users and motorists that the shared use path is a separate facility.

On roadways with flush shoulders, this 5 foot separation is measured from the outside edge of shoulder to the inside edge of the path. On roadways with curbs, the 5 foot separation is measured from the outside edge of the traveled way to the inside edge of the path.

8.6.11 Path Railings

Railings or fences shall be provided as indicated in ***Section 8.8***.

8.6.12 Lighting

Lighting for shared use paths is important and should be considered where riding at night is expected, such as paths serving college students or commuters, and at roadway intersections. Lighting should also be considered through underpasses or tunnels. Lighting standards are provided in ***Table 7.3.1*** of this volume.

8.6.13 Signing, Pavement Marking, and Signalization

The ***MUTCD*** shall be consulted for all signage, pavement markings, and signals, especially on path/roadway intersections.

8.7 Bridges, Overpasses, and Underpasses

A bridge, an overpass, or an underpass may be necessary to provide pedestrian/bicycle continuity to sidewalks and shared use paths.

The overpass or bridge design shall be in accordance with the criteria established below:

1. ***FDOT Structures Design Guidelines – Chapter 10***.
2. ***Section 8.2*** of this volume.
3. The minimum clear width for new FDOT pedestrian bridges is:
    a. On a pedestrian structure - 8 feet.
    b. On a shared use path structure - 12 feet.
    c. If the approach sidewalk or path is wider than these minimums, the clear width of the structure should match the approach width. The desirable clear width should include additional 2-foot wide clear area on each side.
4. Vertical clearance criteria shall be as per ***Chapter 2, Table 2.10.1*** of this volume. Horizontal clearances shall take into affect future widening plans of the roadway below.
5. Ramps
    a. Comply with ADA requirements. See the ***Structures Design ADA Website:***

        http://www.dot.state.fl.us/structures/ada/default.htm
    b. Ramps (routes with grades>5%) should be provided at all pedestrian separation structures. When possible, stairways should be provided in addition to ramps.
    c. Design ramps with the least possible grade, but in no case more than 8.33% and with 5 feet long, intermediate level platforms at a maximum 30-inch rise. Provide level platforms 5 feet long at the top of the ramp and 6 feet long at the bottom.
    d. Provide full-length pedestrian ADA grab handrails on both sides of pedestrian ramps.
6. Fencing/Railing
    a. Provide fencing/railing options in accordance with the ***SDG Chapter 10***.
    b. Provide full or partial screening on pedestrian bridges crossing FDOT right of way in order to reduce the likelihood of objects being dropped or thrown onto

the roadway below. See ***Figure 8.1*** for example of full screening.

c. Pedestrian Bridges on FDOT right of way but not crossing FDOT right of way are not required to be screened.

d. Check with local authorities for guidance on screening for FDOT pedestrian bridges crossing local rights of way.

e. The use of chain link fence on ramps of the pedestrian bridges will be determined on a project-by-project basis.

See ***Chapter 26*** for review requirements based on pedestrian bridge structure category.

Pedestrian underpasses are generally undesirable; however, if one is required, the geometrics and lighting requirements should be discussed with the Department Project Manager and the District Pedestrian/Bicycle Coordinator. Local law enforcement personnel may need to be consulted to assure public safety, emergency accessibility and other desirable features.

8.8 Drop-off Hazards for Pedestrians and Bicyclists

Drop-off hazards are defined as steep or abrupt downward slopes that can be perilous to pedestrians and bicyclists. The Engineer should consider shielding any drop-off determined to be a hazard. Generally, pedestrians and bicyclists will be adequately protected from a drop-off hazard if a guardrail or barrier has been installed between the path or sidewalk and the drop-off. However, circumstances do exist that will ultimately dictate when a railing is needed. Railings or fences should be provided for vertical drop-off hazards. The horizontal clearance discussed in ***Section 8.6.5*** should be maintained where practical when railings or fences are used for drop-offs along shared-use paths.

The following guidelines will be useful in standardizing the identification and treatment of drop-off hazards for pedestrians and bicyclists.

There are two cases that require shielding. As shown in ***Figure 8.2 (Case I)***, a drop-off greater than 10" that is closer than 2 feet from the pedestrians' or bicyclists' pathway or edge of sidewalk should be considered a hazard and shielded. Also, as shown in ***Figure 8.2 (Case II)***, a slope steeper than 1:2 that begins closer than 2 feet from the pedestrians' or bicyclists' pathway or edge of sidewalk should be considered a hazard and shielded when the total drop-off is greater than 30". Also, depending on the depth of the drop-off and severity of the conditions below, shielding may be necessary for cases other than described above.

However, in determining if shielding a drop-off hazard would be feasible for protecting pedestrians and bicyclists, the following should be considered:

1. The engineer should ask the Pedestrian/Bicycle Coordinator for information on the number of pedestrians and bicyclists and their routes.
2. Installing fencing or railings are two ways to shield the drop-offs. Fencing is generally intended for rural areas along paths and trails. Standard railing is generally intended for urbanized areas, locations attaching to bridge rail or along concrete walkways. Railings* shown on ***Index 850*** and ***860*** of the ***Design Standards*** are appropriate for all drop-offs. ***Index 870*** of the ***Design Standards*** is appropriate where drop-offs are 30" or less.

   * Note: Care should be taken when using railings or fencing near intersections as they could obstruct the driver's line of sight.
3. Where drop-offs vary from less than 30" to greater than 30", the engineer should consider utilizing the railing type for greater than 30" drop-offs along a continuous section for uniformity.

8.9 Florida Intrastate Highway System/Strategic Intermodal System

Department Procedure No. 525-030-250, ***Development of the Florida Intrastate Highway System (FIHS)***, gives the following guidance relating to the provisions of bicycle and pedestrian facilities on the FIHS:

"Bicycle and pedestrian facilities shall not be provided on FIHS limited access roadways. For FIHS controlled access facilities, the safe movement of bicycles and pedestrians must be carefully considered and accommodated in such a way as to have no adverse impact to safety, capacity or speed. Separate, offsite, and/or parallel facilities, shall be used where practical and feasible. Bicycle facilities shall be consistent with the requirements of the Department's ***Plans Preparation Manuals, (Topic Nos. 625-000-007*** and ***625-000-008)***."

The above guidance will apply to the Strategic Intermodal System (SIS), until such time that a SIS procedure is developed.

8.10 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.

The FDOT ***Accessing Transit: Design Handbook for Florida Bus Passenger Facilities*** provides guidance relating to provisions for curb side and street side facilities. Refer to ***Table 2.11.9*** for criteria on the placement of shelters and benches.

8.10.1. Curb-Side Facilities

Curb-side facilities are the most common, simplest and convenient form of facilities at a bus stop. These include bus stop signs, passenger waiting shelters, bus stop wheelchair access pad, curb ramps, benches, leaning rails, and shelter lighting. ***Chapter 1 of Accessing Transit*** provides additional details for each facility. Coordination with the District Modal Development Office and/or local public transit provider(s) is necessary in developing the plans.

8.10.2 Street-Side Facilities

Bus stop locations can be categorized as far-side, near-side and midblock 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. See ***Figure 8.3*** for typical detail for the bus stop categories. ***Chapter 2 of Accessing Transit*** provides additional details for each facility.

The greater distance placed between waiting passengers and the travel lane increases safety at a stop. Bus bays are encouraged on roadways with high operating speeds, such as roads that are part of the Urban Principal Arterial System. For a particular bus stop, a high frequency of crashes involving buses is a good indicator for the need of a bus bay. Bus bays are classified as closed, open or bulbs. See ***Figure 8.3*** for typical detail for the bus bay categories. Detailed standard drawings for various bus bay configurations are provided in the ***Transit Facilities Guidelines*** on the Public Transportation Office website: http://www.dot.state.fl.us/transit/

At a specific location, a balance must be obtained based on the designer's judgment and input from the applicable transit agencies. In locations where the traffic volumes exceed

1,000 vehicles per hour per lane, it is difficult to maneuver the bus into the bay and back into the travel lane. Incorporating an acceleration distance, signal priority, or a far-side (rather than near-side or midblock) placement, are potential solutions when traffic volumes exceed 1,000 vehicles per hour per lane.

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 when right of way is unlimited and access points are limited.

Chapter 9

Landscaping

9.1 General

"Landscape" or "Landscaping" means any vegetation, mulches, irrigation systems, and any site amenities, such as, street furniture, decorative paving, fences, and lighting (excluding public utility street and area lighting), as defined in ***Rule Chapter 14-40.003, Florida Administrative Code, Highway Beautification and Landscape Management***. Community Identification Structures are also considered landscape site amenities and are discussed in ***Section 9.4***.

Landscape plans should be designed to complement and enhance the natural and man-made environment. This may include irrigation systems and site amenities such as street furniture and decorative pavement, fences, and lights. **To the extent practical**, plans should consider the following elements:

1. Conservation of natural roadside growth (vegetation) and scenery.
2. Relocation of existing vegetation.
3. Selective clearing and thinning.
4. Natural regeneration and succession of native plants.
5. Plants purchased from Florida based nurseries.
6. Large plants (plants equivalent or larger than those grown in 5 gallon containers) with combined value of 50% or more of the estimated value of all plants specified in the plans.
7. Florida native plants.
8. Plant selection and placement that minimizes roadside maintenance requirements.
9. Plant selection and placement that reduces stormwater runoff volume and velocity.
10. Plant selection and placement that promotes water conservation.
11. Reclaimed water for irrigation.
12. Recycled and recyclable materials.
13. Plant selection and placement that minimizes impacts to natural areas.

Landscaping should be arranged to permit sufficiently wide, clear, and safe pedestrian walkways and transit waiting areas. Care should be exercised to ensure that requirements for sight distances and clearance to obstructions are observed, especially at intersections.

On all federally funded projects that have landscaping, 1/4 of 1% of the estimated cost of the landscaping is required to be for wildflowers. For state funded projects that have landscaping, the inclusion of wildflowers is optional.

Landscape plans must be designed, constructed and maintained in conformity with the ***Manual on Uniform Traffic Control Devices***, the ***Standard Specifications for Road and Bridge Construction***, the ***Design Standards***, and this manual. No landscaping shall screen from view a legally permitted outdoor advertising sign. The limits of the screening prohibition are provided in ***Section 479.106(6), Florida Statutes***. Additional information is found in ***Rule Chapter 14-40, Part I, Florida Administrative Code (F.A.C.)***.

When a legally erected and permitted outdoor advertising sign is within the project limits (adjacent to the right of way), and there is no permitted view zone, the landscape architect will notify the sign permittee that a highway landscape project is proposed. An example letter and other useful information is available at www.myfloridabeautiful.com. The sign permittee will have 30 days to establish a view zone by submitting an **Application for Vegetation Management** that proposes a view zone (see ***Rule Chapter 14-40, Part III, F.A.C.***) If an **Application for Vegetation Management at Outdoor Advertising Sign** is submitted within 30 days, a view zone will be established in accordance with the provisions of ***Rule Chapter 14-40*** upon approval of the application by the Department. If the sign owner does not respond to the notice within the 30-day time frame provided, and the specific location of the view zone is not established by permit or agreement, screening will be prohibited as described in ***Section 479.106(6), F.S.***. Contact information for any permitted sign may be obtained by contacting the State Outdoor Advertising Administrator, Florida Department of Transportation, 605 Suwannee Street, MS 22, Tallahassee, Florida 32399-0450.

Additional information regarding landscape plans may be found in:

1. ***Rule Chapter 14-40, Florida Administrative Code, Highway Beautification and Landscape Management***.
2. ***Florida Highway Landscape Guide***.
3. ***Highway Landscape, Beautification, and Plan Review Procedure (Topic No. 650-050-001).***
4. ***Identification & Biology of Non-Native Plants in Florida's Natural Areas*****,**

Langeland and Burks, 1998, University of Florida.

5. ***Waterwise Florida Landscapes*****,** 2001, Florida's Water Management Districts.

6. ***TCRP Report 19 – Guidelines for the Location and Design of Bus Stops*** (for additional guidance in areas where transit is present).

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9.4 Community Identification Structures and Landscapes

Community Identification Structure and Landscapes (CISL) are designed and placed on the highway right of way for the sole purpose of representing, reflecting, or recognizing nearby community cultural and/or natural values and resources, or to enhance the sense of place through which a highway passes. The following criteria do not apply to Place Name Signs. Requirements for Place Name Signs are in ***Rule 14-51 Part IV Place Name Signs***: http://www.dot.state.fl.us/trafficoperations/Operations/Studies/TEM/14-51.htm#PartIV

A proposed CISL located on the Interstate System must be approved by the State Roadway Design Engineer and the Federal Highway Administration (FHWA). A proposed CISL located on the State Highway System but not on the Interstate System can be approved by the District Design Engineer without further approvals if consistent with the established criteria.

For consideration, plans for a proposed CISL must be accompanied by a resolution of the local government legislative body endorsing their financial support of project design, construction, and perpetual project maintenance. If private funding is to be used, local endorsement is also required.

Prior to any construction within the highway right of way, the local government (or private enterprise) must execute a maintenance agreement with the Florida Department of Transportation.

These features are not eligible for regular federal-aid. They would not be eligible for repair or replacement under FHWA's Emergency Relief (ER) program.

Any changes to the FDOT's criteria shall be reviewed and approved by FHWA. Approval by the State Roadway Design Engineer is required when any of the CISL criteria in ***Section 9.4.1*** cannot be met.

9.4.1 Design Criteria

The design of a CISL must meet the following:

1. The structures/features site plan should be laid out so as to strongly discourage drivers from stopping to take pictures, or otherwise create an unsafe situation by stopping on the shoulder.
2. The location must be as far outside the appropriate clear zones as practical. Placement on Interstate routes should be well outside the minimum clear zone, a minimum of 50 feet, 100 feet preferred, from edge of the travel lane or ramp, whether guardrail is present or not. The 50 feet minimum/100 feet preferred lateral placement will help to minimize driver distraction, and reduce the likelihood that vertical structures will become storm debris blown across the roadway.
3. No structures should be placed in the median regardless of median width.
4. The object's highest point must not be greater in elevation than 14 feet above the nearest point of the roadway.
5. The structures must not contain any signs or other traffic control features, auditory devices, flashing lights or moving illumination, and be devoid of advertising per the ***MUTCD*** and ***23CFR 1.23*** which prohibits advertising on or commercial use of the right of way. Commercial advertising on state right of way is prohibited by ***Section 479, Florida Statutes***, including charitable, fraternal, religious, or political signs, symbols, logo's, banners or any other such device. The permit for the CISL shall be immediately revoked by the Department for violation of this provision.
6. Only one structure is allowed per mainline interchange approach; thus, pick one site from amongst the ramp and the mainline, along the outside of a ramp, or the area inside a loop ramp.
7. The structure must meet all applicable building codes and design criteria for similar structures or landscapes placed adjacent to the highway's right of way, including wind loading commensurate with highway signs in the area.
8. The structures/features must meet all environmental regulations.
9. No obstruction of any other signs or interference with any sight triangle.

Chapter 10

Transportation Management Plan

Tables

Exhibits

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Chapter 10

Transportation Management Plan

10.1 General

The need to improve the capacity of, and to rehabilitate Florida's highways, has greatly increased the frequency of highway construction taking place immediately adjacent to or under traffic. The traveling public, as well as construction and inspection personnel, are exposed to conflicts that may become hazardous. In addition to the safety issue, the potential delays to the public, as traffic is interrupted by construction, can be significant. As a result, the Department places a great deal of emphasis upon ensuring that all traffic, including motorists, transit operations, bicyclists and pedestrians can be accommodated through construction zones with minimum delay and exposure to unsafe conditions.

10.2 References

The following references contain the basic criteria and other required information for work zone traffic control in Florida:

1. The ***Manual on Uniform Traffic Control Devices for Streets and Highways, (MUTCD),*** Federal Highway Administration. ***Part VI*** of the ***MUTCD*** deals specifically with work zone traffic control. Other parts of the ***MUTCD*** may also be useful in designing a temporary traffic control plan.
2. ***Policy on Geometric Design of Highways and Streets, AASHTO***.
3. ***Roadside Design Guide, AASHTO, Chapter 9***.
4. ***Design Standards, Indexes 412, 414, 415, 417*** and the ***600 Series***.
5. ***Standard Specifications for Road and Bridge Construction***.
6. ***Basis of Estimates Handbook***.

10.2.1 Design Standards

The ***Design Standards, Index 600 Series,*** contains information specific to the Federal and State guidelines and standards for the preparation of temporary traffic control plans and for the execution of traffic control in work zones, for construction and maintenance operations and utility work on the State Highway System. Certain requirements in the ***Design Standards*** are based on the high volume nature of state highways. For highways, roads and streets off the State Highway System, the local agency (city/county) having jurisdiction, may adopt requirements based on the minimum requirements provided in the ***MUTCD.***

10.3 Transportation Management Plan (TMP)

A Transportation Management Plan (TMP) is a method for minimizing activity-related traffic delay and accidents by the effective application of traditional traffic handling practices and an innovative combination of public and motorist, bicyclist and pedestrian information, demand management, incident management, system management, construction strategies, alternate routes and other strategies.

All TMPs share the common goal of congestion relief during the project period by managing traffic flow and balancing traffic demand with highway capacity through the project area.

TMPs are required for significant projects which are defined as:

1. A project that, alone or in combination with other concurrent projects nearby, is anticipated to cause sustained work zone impacts**.**
2. All Interstate system projects within the boundaries of a designated Transportation Management Area (TMA) that occupy a location for more than three days with either intermittent or continuous lane closures shall be considered as significant projects.

For significant projects, a multi-discipline TMP team may be formed to handle the planning, coordination, implementation, monitoring, and evaluation details of the TMP elements. Depending on the project logistics, the team composition may vary from project to project. The TMP team may include representatives from the entities as follows:

3. PD& E
4. Design
5. Traffic Operations
6. Construction
7. Transit
8. FHWA
9. Local government (county and/or city)
10. Public Information
11. Others as deemed necessary (e.g., State Police, hospitals, etc.).

A TMP consists of strategies to manage the work zone impacts of a project. Its scope, content, and degree of detail may vary based upon the expected work zone impacts of the project. For significant projects a TMP will consist of three components: (1) Temporary Traffic Control (TTC) plan component (2) Transportation Operations (TO) component and (3) Public Information (PI) component. For individual projects that have less than significant work zone impacts, the TMP may consist only of a TTC plan, although it is encouraged to consider TO and PI issues for all projects. When multiple projects are in the same corridor or on corridors within the same traffic area, it may be possible to develop a single corridor or regional TMP.

1. The Temporary Traffic Control plan component describes TTC measures to be used for facilitating road users through a work zone or an incident area. The TTC plan plays a vital role in providing continuity of reasonably safe and efficient road user flow and highway worker safety when a work zone, incident, or other event temporarily disrupts normal road user flow. The scope of the TTC plan is determined by the project characteristics. The TTC plan shall either be a reference to specific Design Standard Index drawing(s) or be designed specifically for the project.
2. The Transportation Operations component of the TMP shall include the identification of strategies that will be used to mitigate impacts of the work zone on the operation and management of the transportation system within the work zone impact area. Typical TO strategies may include, but are not limited to, demand management, corridor/network management, safety management and enforcement, and work zone traffic management. The scope of the TO component should be determined by the project characteristics.
3. The Public Information component of the TMP shall include communications strategies that seek to inform affected road users, the general public, area residences and businesses, and appropriate public entities about the project, the expected work zone impacts, and the changing conditions on the project. This may include traveler information strategies. The PI component may be integrated in the project's Community Awareness Plan (CAP) if the district's CAP guidelines include communications strategies addressed above. The scope of the PI component should be determined by the project characteristics.

Public information should be provided through methods best suited for the project, and may include, but not be limited to, information on the project characteristics, expected impacts, closure details, and commuter alternatives.

Public information campaigns serve two main purposes in TMPs. They inform the public about the overall purpose of the project to generate and maintain public support; and they encourage changes in travel behavior during the project to minimize congestion. Because they give travelers the information they need to make their own travel choices; public information campaigns can be the single most effective of all TMP elements.

TMPs should be developed and implemented in sustained consultation with stakeholders e.g., other transportation agencies, railroad agencies/operators, transit providers, freight movers, utility suppliers, police, fire, emergency medical services, schools, business communities, and regional transportation management centers.

Consideration of TMPs must begin at the Project Development and Environmental (PD&E) study stage. Impacts on traffic, traffic handling options, constructability, and design features and constraints, as they affect traffic and transit operations, are to be evaluated for each alternate alignment studied. The Project Development Summary Report (PDSR) must specifically address the TMP.

As the design progresses, using the TMP material from the PD&E study as the basis, the following should be considered:

> **Design features and constraints**. Length of the project, lane configuration, transit stops, bike lanes, sidewalks and grade differentials between existing and proposed, interchanges and intersections, pavement materials, storm sewers, roadway lighting, utilities and bridge features are some of the design element decisions that might be influenced by work zone traffic control considerations.
>
> **Contract specifications**. Provisions such as time restrictions on construction activities; incentive-disincentive clauses; daily, weekly and seasonal restrictions and special materials may be necessary. Time restrictions could include work stoppages for Manatee (or other endangered/protected species) inhabitation, sporting events, holidays or other special considerations. The designer should coordinate with local agencies as to the dates of local events or other community sensitive issues. Public relations activities such as media releases, television and radio spots, and handbills may be specified.
>
> **Other actions**. Actions may need to be taken by the Department prior to or during construction that may not be a contract requirement. Examples are dealing with the media and local businesses, provisions for mass transit options to commuters, service patrols, improvements to alternate routes, coordination with other projects and maintenance activities, and special inspection requirements.
>
> **Public input**. On very large and complicated projects, it may be necessary to involve the public through informal public meetings to be held early in the design of a project. Close coordination with city and county officials may be necessary. Citizen and business advisory committees may be established as sources of input.

Utility work. If contract utility work is anticipated in conjunction with or during the highway construction, the Temporary Traffic Control plan must account for and adequately protect all work activities. The phasing of construction activities must be compatible with the utility work. Utilities, whose work affects traffic, are required to have a TTC plan by FHWA. This requires early and effective coordination with utilities.

10.3.1 Transportation Management Plan Components

10.3.1.1 Temporary Traffic Control (TTC) Plans

A TTC plan is a set of specific plan sheets, references to standard (typical) layouts, and/or notes on roadway plans describing how traffic will be controlled through a work zone. All projects and work on highways, roads and streets shall have a temporary traffic control plan, as required by Florida Statute and Federal regulations. All work shall be executed under the established plan and Department approved procedures. The TTC plan is the result of considerations and investigations made in the development of a comprehensive plan for accommodating traffic through the construction zone. These considerations include the design itself, contract specifications, and plan sheets.

TTC plan sheets detail the proper delineation of traffic through the work zone during all construction phases. The complexity of the TTC plan varies with the complexity of the traffic problems associated with a project. Many situations can be covered adequately with references to specific sections from the ***Manual on Uniform Traffic Control Devices (MUTCD)***, or the ***Design Standards, Series 600***. Specific TTC plan sheets shall be required in the plans set whenever project conditions are not specifically addressed in a typical layout from the manuals noted above. This is usually the case for complex projects; therefore references to the ***Design Standards***, as well as specific TTC plan sheets, will likely be necessary.

A temporary traffic control plan should address the appropriate following information for the mainline and any affected crossroads, side streets, and ramps:

1. The location of all advance warning signs and lighting units.
2. Temporary pavement markings, (including RPM's).
3. Location of temporary barriers and attenuators.
4. Temporary drainage design.
5. Channelizing devices at special locations.
6. Locations for special devices such as changeable (variable) message signs (CMS), arrow panels, radar speed display units (RSDU), portable regulatory signs (PRS) and temporary signals.
7. CMS messages for each phase.

8. Signal timing for each phase, including temporary actuation, to maintain all existing actuated or traffic responsive mode signal operations for main and side street movements for the duration of the Contract (Check with Traffic Operations Engineer).
9. Location and geometry for transitions, detours, and diversions.
10. Typical sections for each phase of work on all projects, except simple resurfacing projects, in order to show lane widths, offsets, barrier locations and other features influencing traffic control.
11. The proposed regulatory speed(s) for each phase.
12. Reference to appropriate ***Design Standards*** or ***MUTCD*** drawings whenever applicable.
13. Appropriate quantities, pay items and pay item notes.
14. Resolve any conflicts between permanent signing and markings and work zone signing and markings.
15. Key strategies such as service patrol, police, public service announcements, night work, etc..
16. Good plan notes.
17. Address the need for maintaining existing roadway lighting.
18. Work area access plan.
19. Address the need for transit operations to safely stop along the roadway to board and discharge passengers, and to maintain transit stop signage.

Volume II, Chapter 19, explains the required information for specific TTC plan sheets.

Consideration must also be given to adjoining, intersecting or sequential work zones. This can be a particular problem with maintenance operations, bridge or roadway projects under different contracts, and operations of other jurisdictions or utilities. When such work must take place, the operations must be coordinated and taken into account in the TTC plan so that the motorist encounters one, consistently designed, work zone.

TTC plan's for project designs "on the shelf" must be updated prior to contract letting.

10.3.1.1.1 TTC Plan Development

The following step-by-step process should be followed by designers when preparing temporary traffic control plans:

Step #1 Understand the Project

1. Field reviews by designers should be required.
2. Review the scope.
3. Examine the plans early in the plans development process.
4. Look at plan-profiles and cross sections for general understanding.
5. Review PD&E study for any constraints.
6. Consider transit and bicycle/pedestrian needs during construction.
7. For complex projects consider developing a TTC plan study and other possible strategies such as public awareness campaigns, alternate route improvements, service patrols, etc...

Step #2 Develop Project Specific Objectives

What are your objectives? Examples might be:

1. Use barrier wall to separate workers from traffic.
2. Close road if adequate detour exists.
3. Maintaining 2-way traffic at all times.
4. Maintaining existing roadway capacity during peaks.
5. Maintaining business/resident access.
6. Maintaining transit operations.
7. Provide bike/pedestrian access.
8. Minimize wetland impacts.
9. Expedite construction.

Step #3 Brainstorm TTC Plan Alternatives

Develop some rough alternatives considering what could be used to accomplish the work, such as constructing temporary pavement and/or temporary detours, using auxiliary lanes, placing 2-way traffic on one side of divided facility, using detour routes, etc. Also, south side as opposed to north side on an east-west roadway. Don't worry that an alternate doesn't meet all objectives.

Designers should check condition of any proposed detour routes. If off state system, may need a documented agreement with locals. Design should prevent or minimize interruption of local transit operations.

Step #4 Develop a Construction Phasing Concept

1. Examine existing facility versus what is to be built. This is a major task on jobs other than resurfacing.
2. Coordinate with bridge designer.
3. Involve the Construction office as early as practical for input on alternate traffic control plans.
4. Color or mark the plan-profile sheets to show existing roadway versus new construction. Then, check station by station, the plan sheet against cross section sheets. Make notes on plan sheets as to drop-offs or other problems. Use profile grade lines or centerlines for reference points.
5. List out major tasks to be completed, such as:
    a. Construct new WB Roadway
    b. Construct new EB Roadway
    c. Construct frontage roads
    d. Construct bridge/flyover

    Note: The designer may need input from construction personnel or even contractors' representatives in determining construction phases.
6. Make notes on plan sheets or notepad as to "decisions" that you make along the way.

Step #5 Examine/Analyze Alternatives Which Meet Objectives (for each phase)

Next, consider how you could achieve the proposed alternatives and meet the stated objectives.

1. Examine pros and cons of various alternatives.
2. Consider how much work and expense is involved for each alternative.
3. Consider detour/transition locations, signal operations during construction, how to handle buses, bicycles, pedestrians, service vehicles, etc...

Step #6 Develop Detailed TTC Plan

Select the most feasible alternative for each phase. Add details such as:

1. Detour/transition geometrics and locations.

2. If lane closures are needed, use the lane closure technique discussed in ***Section 10.12.7*** to determine time frame for closures.
3. Advanced signing scheme and locations, revisions needed to existing signs - including guide signs, and proposed signs for all work activities - lane closures, detours, etc., on mainline, side roads, crossroads and ramps.
4. Need for portable traffic signals, changeable (variable) message signs, and barriers.
5. How existing operations will be maintained - side streets, businesses, residents, bikes, pedestrians, buses - bus stops, etc...
6. Revisions to signal phasing and/or timing during each TTC plan phase.
7. Regulatory speed desired for each phase.
8. All pay items and quantities needed for TTC plan.
9. How existing auxiliary lanes will be used and any restriction necessary during construction.
10. Typical sections for each phase.
11. Outline key strategies to be used:
    a. Service patrol
    b. Police
    c. Public service announcements
    d. Night work
    e. Motorist Awareness System (MAS)
12. Need for alternate route improvements.

10.3.1.1.2 TTC Plan Phase Submittals

TTC plan phase submittals should include the following:

1. **Phase I** - a typical section for each phase as well as a description of the phasing sequence and work involved.
2. **Phase II** - a majority of the TTC plan completed (75-90%), including the information outlined in ***Section 10.3.1.1*** of this chapter, and a list of the pay items needed.
3. **Phase III** - a final TTC plan, including all notes, pay items and preliminary quantities.

(Note: The construction office estimates the duration for each phase of construction during Phase III review. The designer will finalize the quantities in the plans, comp book, and TRNS*PORT after receiving the estimated durations for construction.)

10.3.1.2 Transportation Operations (TO)

Many work zone impact management strategies can be used to minimize traffic delays, improve mobility, maintain or improve motorist and worker safety, complete road work in a timely manner, and maintain access for businesses and residents. The table below presents various work zone management strategies by category. This set of strategies is not meant to be all-inclusive, but offers a large number to consider, as appropriate, in developing TMPs.

Transportation Operations (TO)			
Demand Management Strategies	Corridor/Network Management Strategies	Work Zone Safety Management Strategies	Traffic /Incident Management and Enforcement Strategies
Transit services improvements	Signal timing/ coordination improvements	Speed limits reduction or variable speed limits	ITS for traffic monitoring and management
Transit incentives	Temp. traffic signals	Temp. traffic signal	Transportation Management Center (TMC)
Shuttle services	Intersection improvements	Temp. barrier	Aerial surveillance
Ridesharing/ carpooling incentives	Bus turnouts	Crash Cushions	Call boxes
Park-and-Ride promotion	Turn restrictions	Automated flagger assistance devices (AFAD)	Mile post markers
HOV lanes	Truck restrictions	On-site safety training	Service patrol
Variable work hours	Dynamic lane close system	TMP inspection team meetings	Local detour routes
Telecommuting	Ramp closures		Contract support for incident management
	Railroad crossing controls		Incident/emergency response plan
			Law enforcement

10.3.1.3 Public Information (PI)

A work zone public information and outreach campaign involves communicating with road users, the general public, area residences and businesses, and appropriate public entities about a road construction project and its implications for safety and mobility. The PI component may be integrated in the project's Community Awareness Plan (CAP) if the district's CAP guidelines include public information communications strategies. Detailed information on Public Information can be found in the ***Project Development and Engineering Manual (PD&E) Chapter 8*** and the ***Public Involvement Handbook***. Both documents are available on the Environmental Management Offices web site at: http://www.dot.state.fl.us/emo/

Developing and implementing a public information and outreach campaign should be started well before road construction begins and will need ongoing monitoring throughout the life of the project. Planning and implementing a public information and outreach campaign involves a set of key steps that ideally will be coordinated and outlined in a public information and outreach plan:

1. **Determine the appropriate size and nature of the public information and outreach campaign.** The size and nature of a public information and outreach effort will be determined by the characteristics of a project, its location, and the anticipated impacts of a road construction project. Aspects to consider include size and duration of the project, the amount of delay anticipated, special traffic and safety conditions such as heavy truck traffic, and disruptions to other modes and key facilities such as airports, stadiums, and hospitals.

2. **Identify resources. In most cases, public information and outreach spending will need to be part of a road construction project budget.** In addition, campaign managers will also need to tap existing resources, an operating 511 system for example, and leverage external resources such as free media coverage.

3. **Identify partners.** Working with a range of partners to design and implement an information and outreach campaign will strengthen the strategies employed and may reduce the costs to the agency. Partners include, among others, State and local agencies, major employers, and business and neighborhood associations.

4. **Identify target audiences.** A key to any communication strategy is to identify the target audience(s). This will help to determine the types of messages that need to be conveyed and the best ways of communicating those messages.

5. **Develop the message(s).** In general, the messages communicated by the campaign should provide project information to maintain safety and minimize

delay, and should indicate that the agency cares about the driving public. More specific messages might include details of the work zone, travel times through the work zone, and alternate routes and modes of transportation.

6. **Determine communication strategies.** How information is communicated will depend on the audiences, the messages to be conveyed, and the campaign budget. The ***Public Involvement Handbook*** discusses a wide range of strategies for communicating information about a project.

7. **Determine communication timing.** Public information and outreach should not be limited to when a work zone is up and running. Before work commences is the best time to begin developing partnerships and informing the public about the project, its anticipated impacts, and how to find out more information. Post-construction it is a good idea to publicize completion and to thank project partners.

10.4 Coordination

Work zone traffic control can be a complex undertaking that requires the coordination of a number of agencies and other interested parties. Planning and coordination must begin early in a project design.

Traffic control is a joint responsibility of design (both roadway and bridge), construction and traffic operations personnel. Coordination is necessary by all three parties in the development of TMPs. Both traffic operations and construction personnel must routinely review TMPs during Phase I and Phase II plans to ensure that the plan is sound and constructible and bid items are complete and quantities reasonable. With subsequent reviews of Phase III plans, designers are also encouraged to contact contractors for ideas on Temporary Traffic Control Plans.

Temporary traffic control plans should also be reviewed with other appropriate entities such as maintenance, FHWA, community awareness teams, general public, transit agencies, businesses, freeway coordinator management teams, and local agencies. **Initial reviews should be made by construction and traffic operations no later than the Phase II plans stage with subsequent reviews of Phase III plans**. Input from local engineering and law enforcement agencies should be obtained early in the process, such as during the PD&E study and the Phase I plans stage.

Adjoining work zones may not have sufficient spacing for standard placement of signs and other traffic control devices within their traffic control zones. These situations can occur when separate contracts adjoin each other (separate bridge and roadway contracts are a typical example), utility work performed separately from roadway work or when maintenance activities are performed adjacent to a construction project. Where such restraints or conflicts occur, or are likely to occur, the designer should try to resolve the conflicts in order to prevent misunderstanding on the part of the traveling public.

10.5 Work Zone Traffic Control Training

10.5.1 Background

Work zone traffic control is an important function affecting the safety of the traveling public, contractor personnel and equipment, and department employees. Every reasonable effort should be made to eliminate or reduce involvement in crashes within work zones. Proper traffic control training is vital to achieving this objective.

The Department's Maintenance of Traffic Committee consists of representatives from Roadway Design, Construction, Maintenance, Traffic Operations and FHWA. Its purpose is to develop, review or revise procedures, standards and specifications regarding work zone traffic control to maximize efficiency and enhance safety of motorists, transit operations, bicyclists, pedestrians, and workers within the work zone.

10.5.2 Training Requirements

The Department's Maintenance of Traffic Committee has prescribed work zone traffic control training requirements outlined in ***Department Procedure*, *Topic No. 625-010-010***.

All Department employees, contractors, consultants, utility company personnel, local maintaining agency, or any other person responsible for work zone traffic control planning, design, implementation, inspection and/or for supervising the selection, placement, or maintenance of traffic control schemes and devices in work zones on the State Highway System, shall satisfactorily complete the training requirements of this procedure in the appropriate category of involvement. The Department may request to see a person’s certificate or wallet size card documenting the successful completion of a Work Zone Traffic Control training course.

District Design, Construction, and Maintenance Engineers shall ensure that employees, including consultant personnel, who are responsible for temporary traffic control plan design, implementation, inspection or supervision of the design, selection, placement, or maintenance of traffic control schemes and devices in work zones have been certified under the provisions of this procedure.

10.6 Traffic Control Devices

Traffic control devices/methods that are available for use include:

1. Signs (warning, regulatory and guide)
2. Lighting units (arrow panels, barricade and sign lights, illumination devices, temporary signals and changeable (variable) message signs)
3. Channelizing devices (cones, tubular markers, plastic drums, vertical panels, and Types I, II and III barricades)
4. Markings (pavement markings, raised pavement markings, delineators, and removal of conflicting markings)
5. Safety appurtenances (portable concrete barriers, guardrail and crash cushions) - See ***AASHTO Roadside Design Guide*** (***Chapter 9***)
6. Flaggers
7. Law Enforcement
8. Motorist Awareness System (MAS)

The ***MUTCD*** contains detailed instructions on the use of traffic control devices. Special design considerations applicable to Florida are discussed in the following sections.

Traffic control devices should not be placed in locations where they will block transit stops, sidewalks or bike lanes.

10.7 Signs

Sign messages for speed limits and distances are to be posted in English units.

10.7.1 Advance Warning Signs

The TTC plan should identify the advance construction warning signs, including legends and location. These include signs such as "Road Work Ahead" and "Road Work One Mile". The TTC plan should provide the advanced warning signs, legends and locations for all proposed operations that require signing. These include diversions, detours, lane closures, and lane shifts, on the mainline as well as crossroads. The sequence for advance signing should be from general to more specific. As an example: Road Work Ahead (general), Left Lane Closed Ahead (more specific), and Merge Right (specific).

10.7.2 Length of Construction Sign

The length of construction sign (G20-1) bearing the legend "Road Work Next X Miles" is required for all projects of more than 2 miles in length. The sign shall be located at begin construction points.

10.7.3 Existing Signs

Existing (regulatory, warning, etc.) signs that conflict with the TTC plan shall be removed or relocated to complement the work zone conditions (i.e., if a stop sign on an existing side road is needed, use the existing sign and show the location that it is to be relocated to). Existing guide signs should be modified as necessary. It is good practice to revise existing guide signs by using black on orange panels to show changes made necessary by the construction operations.

If permanent guide signs are to be removed during construction, provisions should be made for temporary guide signing. The temporary sign should be black on orange with the legend designed in accordance with ***MUTCD*** requirements for permanent guide signing whenever possible.

10.8 Lighting Units

10.8.1 Warning Lights

Warning lights shall be in accordance with the ***Design Standards*, *Index 600.***

1. **Type A Flashing**

   To be mounted on Vertical Panel, Barricade, or Drums to mark an obstruction adjacent to or in the intended travel way. It is to be paid for as part of the device that it is mounted on.

2. **Type B Flashing**

   To be mounted on the first and second advanced warning signs where two or more signs are used, as well as on advanced warning signs of intersecting roads. Type B Warning lights are to be paid for as High Intensity Flashing Lights (Temporary - Type B).

3. **Steady-Burn Type C**

   Steady-Burn lights are to be placed on channelizing devices and barrier wall to delineate the traveled way on lane closures, lane changes, diversion curves and other similar conditions. On channelizing devices (Vertical Panels, Barricades, and Drums), their payment is included as part of the device. For use on Barrier wall, they are to be paid for separately as Lights, Temporary, Barrier Wall Mount (Type C, Steady-Burn). Their spacing on barrier wall is as follows:

   a. Transitions - 50 ft. on center

   b. Curves - 100 ft. on center

   c. Tangents - 200 ft. on center (Note: Curves flat enough to maintain a normal 2% cross slope are to have steady burn lights placed at the same spacing as tangents)

10.8.2 Advance Warning Arrow Panels

Arrow panels shall be used to supplement other devices for all lane closures on high-speed (55 mph or greater) and high-traffic density multilane roadways. The use of arrow panels should be considered for all other multilane closures. These devices are also useful for short-term operations, such as during work zone installation and removal.

Arrow panels should not be used in lane shift situations. Research has shown that motorists tend to change lanes (on multilane facilities) whenever an arrow panel is used to indicate a lane shift. Since this "response" is not desired, the arrow panel should not be used for lane shift situations on multilane roadways. Refer to current ***MUTCD*** for further information.

Arrow panel locations shall be shown on the TTC plan, along with any necessary notes concerning the use of this device.

10.8.3 Changeable (Variable) Message Signs

Changeable (variable) message signs (CMS) may be used to supplement a traffic control zone. As a supplemental device, it cannot be used to replace any required sign or other device. These devices can be useful in providing information to the motorist about construction schedules, alternate routes, expected delays, and detours. Changeable (variable) message signs should be considered for use in complex, high-density work zones. Messages must be simple, with a minimum number of words and lines and should require no more than two displays of no more than three lines each with 8 characters per line. The TTC plan shall include the location and messages to be displayed.

The message displayed should be visible and legible to the motorist at a minimum distance of 900 ft. on approach to the signs. All messages should be cycled so that two message cycles are displayed to a driver while approaching the sign from 900 ft. at 55 mph.

The CMS units may be used:

1. To supplement conventional traffic control devices in construction work areas and should be placed approximately 500 to 800 ft. in advance of potential traffic problems, or
2. 0.5 to 2 miles in advance of complex traffic control schemes that require new and/or unusual traffic patterns for the motorists.

A CMS is required for night time work that takes place within 4 ft. of the traveled way.

Typical Conditions

Consistent with the factors described above, CMS messages should be considered under the following conditions:

1. Road closures
2. Ramp closures
3. Delays one hour or longer created by:
    a. Congestion
    b. Crashes
    c. Lane closures
    d. Two-way traffic on divided highway
    e. Multiple lane closures
    f. Unexpected shifts in alignment

Message Selection

Programmed messages should provide appropriate messages for the conditions likely to be encountered. A worksheet is provided and may be placed in the TTC plan. The following items must be carefully considered in the development of a message:

1. **Message elements - not necessarily in order**
    a. Problem statement (where?)
    b. Effect statement (what?)
    c. Attention statement (who?)
    d. Action statement (do?)
2. **Message format**
    a. Will vary depending on content
    b. "Where" or "what" will generally lead
    c. "Who" and "do" follow in that order
    d. "Who" often understood from "where"
3. **Display format**
    a. Discrete, with entire message displayed at once is most desirable
    b. Sequential is OK, 2 parts maximum
    c. Run-on moving displays prohibited
    d. One abbreviation per panel display desirable, two abbreviations are the maximum. Route designation is considered as one abbreviation and one word. Guidelines for abbreviations are provided on the following pages.

CHANGEABLE (VARIABLE) MESSAGE SIGNS WORKSHEET

Location of board:____

Used: from ______-______-______at ______:______am/pm

to ______-______-______at ______:______am/pm

Message programmed by: ____

MESSAGE 1

MESSAGE 2

Timing:

Message 1 will run ____.____ seconds.

Message 2 will run ____.____ seconds.

STANDARD ABBREVIATIONS FOR USE ON CHANGEABLE (VARIABLE) MESSAGE SIGNS

Standard abbreviations easily understood are:

WORD	ABBREV.	WORD	ABBREV.
Boulevard	BLVD	Normal	NORM
Center	CNTR	Parking	PKING
Emergency	EMER	Road	RD
Entrance, Enter	ENT	Service	SERV
Expressway	EXPWY	Shoulder	SHLDR
Freeway	FRWY, FWY	Slippery	SLIP
Highway	HWY	Speed	SPD
Information	INFO	Traffic	TRAF
Left	LFT	Travelers	TRVLRS
Maintenance	MAINT	Warning	WARN

Other abbreviations are easily understood whenever they appear in conjunction with a particular word commonly associated with it. These words and abbreviations are as follows:

WORD	ABBREV.	PROMPT
Access	ACCS	Road
Ahead	AHD	Fog*
Blocked	BLKD	Lane*
Bridge	BRDG	[Name]*
Chemical	CHEM	Spill
Construction	CONST	Ahead
Exit	EX, EXT	Next*
Express	EXP	Lane
Hazardous	HAZ	Driving
Interstate	I	[Number]
Major	MAJ	Accident
Mile	MI	[Number]*
Minor	MNR	Accident
Minute(s)	MIN	[Number]*
Oversized	OVRSZ	Load
Prepare	PREP	To Stop
Pavement	PVMT	Wet*
Quality	QLTY	Air*
Route	RT	Best*
Turnpike	TRNPK	[Name]*
Vehicle	VEH	Stalled*
Cardinal Directions	N, E, S, W	[Number]
Upper, Lower	UPR, LWR	Level

*** = Prompt word given first**

The following abbreviations are understood with a **prompt** word by about 75% of the drivers. These abbreviations may require some public education prior to usage.

WORD	**ABBREV.**	**PROMPT**
Condition	COND	Traffic*
Congested	CONG	Traffic
Downtown	DWNTN	Traffic
Frontage	FRNTG	Road
Local	LOC	Traffic
Northbound	N-BND	Traffic
Roadwork	RDWK	Ahead [Distance]
Temporary	TEMP	Route
Township	TWNNSHP	Limits

*** = Prompt word given first**

Certain abbreviations are prone to inviting confusion because another word is abbreviated or could be abbreviated in the same way. **DO NOT USE THESE ABBREVIATIONS:**

ABBREV.	**INTENDED WORD**	**WORD ERRONEOUSLY GIVEN**
WRNG	Warning	Wrong
ACC	Accident	Access (Road)
DLY	Delay	Daily
LT	Light (Traffic)	Left
STAD	Stadium	Standard
L	Left	Lane (Merge)
PARK	Parking	Park
RED	Reduce	Red
POLL	Pollution (Index)	Poll
FDR	Feeder	Federal
LOC	Local	Location
TEMP	Temporary	Temperature
CLRS	Clears	Color

10.8.4 Traffic Signals

Frequently portable or temporary traffic signals will be a preferred alternative to a flagger. Also, existing signal operations may need to be revised to accommodate the construction operations. The TTC plan should identify all existing actuated or traffic responsive mode signal operations for main and side street movements that are to be maintained for the duration of the Contract. In addition, the TTC plan should identify the specific alterations (physical location and timing) necessary for existing signals and the location and timing of portable signals. It shall include signal installation plans for each phase of construction. The signal installation plan shall include both the initial signal operation plan and the initial timing adjustments. Traffic control signal requirements or responsibilities shall be included in the Technical Special Provisions. Signal displays and location must meet ***MUTCD*** requirements. If temporary signals are used where a pedestrian crossing is present, either existing or temporary, the pedestrian must be accommodated in the signal timing.

Temporary Signal Plans or modification to existing signals should be reviewed by the appropriate section in the district for structural soundness and signal function.

10.9 Channelizing Devices

10.9.1 Type III Barricades

Two Type III barricades should be used to block off or close a roadway. Whenever two barricades are used together, only one warning light is required on each barricade.

10.9.2 Separation Devices

Placing two-lane two-way operations (traffic) (TLTWO) on one roadway of a normally divided highway should be a last resort (see ***MUTCD***) and should be done with special care.

When traffic control must be maintained on one roadway of a normally divided highway, opposing traffic shall be separated either with portable barrier wall or Temporary Traffic Separators (see the ***Design Standards, Index 600***). The use of striping, raised pavement markers, and complementary signing, either alone or in combination is not considered acceptable for separation purposes.

10.9.3 Channelizing Device Alternates

It is intended that cones, Type I and II barricades, vertical panels, drums and tubular markers be considered as alternative channelizing devices to be used at the contractor's option. The only exceptions to this are that tubular markers are not allowed at night and the use of cones shall comply with the notes shown on ***Design Standards, Index 600***. The designer should not further restrict the options of channelizing devices.

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10.10 Pavement Markings

10.10.1 Removing Pavement Markings

Existing pavement markings that conflict with temporary work zone traffic patterns must be obliterated where operations will exceed one work period. Painting over existing pavement markings is not permitted.

10.10.2 Raised Retro-Reflective Pavement Markers (RPM)

Raised Retro-Reflective Pavement Markers (RPM) are required as a supplement to all lane lines during construction. For further direction on the use of RPMs in the work zone the designer should refer to the ***Design Standards, Index 600***.

10.10.3 Work Zone Markings

Markings for work zones include "Removable" and "Non-Removable" markings. ***Section 102-10*** of the ***Standard Specifications*** describes when each type is required. A separate pay item number is used for each. The designer should be aware of this information and provide appropriate pay items in the plans.

The designer should also consider using an asphalt layer and/or milling with an asphalt layer for covering/removing unneeded markings, especially in areas such as diversions or crossovers. Some construction phase durations may be long enough to require use of interim friction courses. When these type issues arise, the designer should work with the District Pavement Design Engineer, to determine what combination of pavement options best complements the Maintenance of Traffic with the final pavement design.

10.11 Safety Appurtenances for Work Zones

10.11.1 Traffic Barriers

Work zone traffic barriers are designed either as permanent barriers or as temporary barriers that can be easily relocated. They have four specific functions: to protect traffic from entering work areas, such as excavations or material storage sites; to provide positive protection for workers; to separate two-way traffic; and to protect construction such as false work for bridges and other exposed objects. The designer should anticipate when and where barriers will be needed and include this information and the quantities on the plans.

10.11.2 Barrier Walls (Temporary)

Portable concrete safety shape barriers, also known as portable concrete barriers (PCBs), are used in work zones to protect motorists as well as workers. Care must be taken in their design, installation and maintenance. Installation instructions and flare rates are given in the ***Design Standards, Index 415 & 600.***

When a PCB system other than ***Design Standards, Index 414***, Type K Temporary Concrete Barrier is used, the surface that the PCB is placed on shall have a cross slope of 1:10 or flatter carried a minimum of 2 ft. behind the barrier. See ***Design Standards, Index 414*** for specific requirements for the use of Type K Temporary Concrete Barrier. When the designer proposes temporary barrier walls, the cross-slope should be checked and temporary earthwork shown in the plans if necessary for the proper placement of the barrier system. For requirements for PCB's that are used on bridges and retaining wall sections, see the ***Structures Design Guidelines, Section 6.7***. When ***Design Standards, Index 414,*** Type K Temporary Concrete Barrier is used on bridges, see ***Design Standards, Index 415*** for details on transitioning between the Type K Temporary Concrete Barrier on the bridge and the Index 415 Barrier Wall on the adjoining roadway.

Water filled barriers should be used in accordance with the ***Design Standards, Index 416.***

The designer should show or note the location of all temporary barrier walls in the plans. The plans should also include a work area access plan for those projects with median work which is shielded with barrier wall.

10.11.3 End Treatments

The desirable treatments for exposed ends of barriers are:

1. Connecting to an existing barrier (smooth, structural connections are required - Refer to the ***Design Standards, Indexes 410 & 415***) or
2. Attaching a crashworthy terminal (such as a crash cushion) or
3. Flaring away to the edge of the clear zone (For Work Zone Clear zones, see the ***Design Standards*, *Index 600***)

10.11.4 Modifications of Existing Barriers

When 2-way traffic is placed on a facility that is normally one-way, the existing permanent or temporary barriers will be modified as necessary to ensure their proper crashworthiness during the temporary situation. This will include eliminating non-crashworthy end treatments, snag points or other protrusions normally angled away or hidden from approaching vehicles.

10.11.5 Crash Cushions

Crash cushions in work zones may be used in the same manner as at permanent highway installations. Crash cushions are used to protect the motorists from the exposed ends of barriers, fixed objects and other hazards within the clear zone. The designer must determine the need for crash cushions, select the appropriate type, and provide the necessary details and quantities in the plans. Selection of a system should be the result of an analysis of site conditions (i.e., space and need). Two types of stationary crash cushions are commonly used; redirective crash cushions and inertial crash cushions (i.e., sand filled module systems).

Redirective crash cushion systems will shield hazards by redirecting vehicles or absorbing end-on hits and are the principal type systems that should be used for shielding exposed ends of temporary concrete barrier wall on FDOT projects. ***Index 415*** provides details for shielding exposed ends of temporary concrete barrier wall using redirective systems. Temporary redirective crash cushions are paid for using the pay item IMPACT ATTENUATOR - CRASH CUSHION (TEMPORARY) (REDIRECTIVE OPTION). When this pay item is used, the contractor is allowed to use any temporary redirective crash cushion on the ***Qualified Products List***, unless the plans restrict the options to a specific redirective crash cushion system. Restricting the options is normally not necessary and when done, must be justified with the reasons documented.

Inertial systems are gating devices with no redirection capability for side impacts and can only shield a hazard by absorbing end-on hits. Conditions and sites where these type systems are used are limited. ***Index 417*** provides standard arrays that may be used for shielding the ends of temporary concrete barrier wall where site conditions and duration restrictions can be met. Site conditions must provide for a clear runout area behind the array as shown in the index, as well as sufficient lateral space for the 5 degree taper in the alignment of the array with respect to the traffic lane. This taper helps to minimize the potential for side impacts into the heavier modules near the rear of the array as well as side impacts at the corner of the barrier wall end. When these site conditions can be met and the installation does not exceed 30 days in duration, ***Index 417*** may be used. Otherwise, a redirective system must be called for. As stated in ***Index 417*** the contractor does not have the option to use ***Index 417*** unless specifically called for in the plans.

End protection for hazards other than temporary barrier wall ends, must be custom engineered for each independent installation and detailed in the plans. The ***Design Standards*** and the ***AASHTO Roadside Design Guide*** can be consulted for more information.

10.12 Temporary Traffic Control Plan Details

The ***Design Standards**, **Indexes 601*** through ***670***, are layouts of work zone traffic control for typical conditions. These indexes should be referenced only if project conditions are nearly the same as the typical layout. Otherwise, specific plan sheets or details must be prepared. Some conditions that will require specific plan sheets include:

1. Construction work zones near railroad crossings.
2. Work not covered by a typical layout.
3. Nighttime work requiring special lighting, oversized or additional devices.
4. Ramps and intersections that interrupt the standard layout.
5. Sight distance restrictions such as horizontal or vertical curves.
6. Lane or shoulder configurations that do not match the standards.
7. Special considerations during installation, intermediate traffic shifts and removal.
8. Complex projects, including add-lane projects, which involve many phases, traffic shifts, entrances and exits.
9. Special plan and notes detailing bus pullover bay/bus stop configuration.

When designing layouts, the following shall be considered:

10.12.1 Taper Lengths

Minimum taper lengths in the ***Design Standards*** are shown on individual Index sheets when applicable. When an Index sheet is not used, the minimum taper length shall be calculated by the formulas shown below ***Table 10.12.1***.

Table 10.12.1 (taken from ***MUTCD***) gives the criteria for the lengths of the various taper types.

Table 10.12.1 Taper Length Criteria for Work Zones

Type of Taper	Taper Length
UPSTREAM TAPERS	
Merging Taper	L Minimum
Shifting Taper	1/2 L Minimum
Shoulder Taper	1/3 L Minimum
Two-way Traffic Taper	100 ft. Maximum
DOWNSTREAM TAPERS	
	100 ft. per lane (use is optional)

Formulas for L are as follows:

For speed limits of 40 mph or less:

$$L = WS^2/60$$

For speed limits of 45 mph or greater:

$$L = WS$$

"L" is the length of the taper in feet

"W" is the width of lateral transition in feet

"S" is the posted regulatory speed for the work zone.

10.12.2 Intersecting Road Signing and Signals

Signing for the control of traffic entering and leaving work zones by way of intersecting highways, roads and streets shall be adequate to make drivers aware of work zone conditions. Under no condition will intersecting leg signing be less than a "Road Work Ahead" sign. The designer should remember to include these signs in the estimated quantity for Construction warning signs.

Existing traffic signal operations that require modification in order to carry out work zone traffic control shall be as approved by the District Traffic Operations Engineer (DTOE). If lane shifts occur, signal heads may have to be adjusted to maintain proper position. The DTOE should also determine the need for temporary traffic detection for traffic actuated signals. The TTC plan should include all necessary signal adjustments.

10.12.3 Sight Distance to Delineation Devices

Merging (lane closure) tapers should be obvious to drivers. If restricted sight distance is a problem (e.g., a sharp vertical or horizontal curve approaching the closed lane), the taper should begin well in advance of the view obstruction. The beginning of tapers should not be hidden behind curves.

10.12.4 Pedestrians and Bicyclists

10.12.4.1 Pedestrian Considerations

Where an existing pedestrian way is located within a work zone, it must be maintained.

There are three threshold considerations in planning for pedestrian safety in work zones on highways and streets:

1. Pedestrians should not be led into direct conflicts with work site vehicles, equipment or operations.
2. Pedestrians should not be led into direct conflicts with mainline traffic moving through or around the work site.
3. Pedestrians should be provided with a safe, convenient travel path that replicates as nearly as possible the most desirable characteristics of sidewalks or footpaths.

Pedestrian accommodations through work zones must include provisions for the disabled. Temporary traffic control devices for vehicular traffic should not be allowed within the pedestrians' travel path.

At transit stops, provisions should be made to ensure passengers have the ability to board and depart from transit vehicles safely.

Signing should be used to direct pedestrians to safe street crossings in advance of an encounter with a work zone. Signs should be placed at intersections so pedestrians, particularly in high-traffic-volume urban and suburban areas, are not confronted with midblock crossings.

10.12.4.2 Bicycle Considerations

When an existing bicycle way is located within a work zone, it must be maintained.

There are several considerations in planning for bicyclists in work zones on highways and streets:

1. Bicyclists should not be led into direct conflicts with mainline traffic, work site vehicles, or equipment moving through or around traffic control zones.
2. Bicyclists should be provided with a travel route that replicates the most desirable characteristics of a wide paved shoulder or bike lane through or around the work zone.
3. If the work zone interrupts the continuity of an existing shared use path or bike route system, signs directing bicyclists through or around the work zone and back to the path or route should be provided.
4. The bicyclist should not be directed onto the same path used by pedestrians.

10.12.5 Superelevation

Horizontal curves constructed in conjunction with temporary work zone diversions, transitions, and crossovers should have the required superelevation. Under conditions where superelevation is not used, the minimum radii that can be applied are listed in the ***Table 10.12.2***. Superelevation must be included with the design whenever the minimum radii cannot be achieved.

Table 10.12.2 Minimum Radii for Normal 0.02 Cross Slopes

SPEED (mph)	MINIMUM RADIUS (feet)
65	3130
60	2400
55	1840
50	1390
45	1080
40	820
35	610
30	430

10.12.6 Lane Widths

Existing lane widths of through roadways should be maintained through work zone travel ways wherever practical. The minimum widths for work zone travel lanes shall be 10 ft. for all roadways other than Interstate. On Interstate highways the minimum width for work zone travel lanes shall be 11 ft. except at least one 12 ft. lane in each direction shall be provided.

10.12.7 Lane Closure Analysis

The lane closure analysis is a process used by designers to calculate the peak hour traffic volume and the restricted capacity for open road and signalized intersections. The analysis will determine if a lane closure should or should not be allowed and the time of day or night a lane closure could occur without excessive travel delay.

For all projects under reconstruction, the existing number of lanes shall remain open to traffic when construction is not active.

For widening or major reconstruction on Limited Access facilities, the Temporary Traffic Control Plan will keep the existing number of traffic lanes open at all times throughout the duration of the construction project.

Closing a traffic lane on Interstate or Limited Access facilities can have a significant operational impact in terms of reduced capacity and delay. There will be no daytime lane closures allowed on Florida's Turnpike unless it is approved in writing by the Deputy Executive Director and Chief Operating Officer. Other districts have adopted similar policy for Interstate daytime lane closures; therefore, it is recommended the Designer verify the District’s lane closure policy at the beginning of the design process.

No lane closures in excess of one work day shall be permitted on Limited Access construction where only two traveled lanes in one direction exist. If it becomes necessary to have a long-term lane closure on a four lane Interstate, sufficient documentation shall be provided to the District Secretary for her/his approval.

Chapter 22 of the ***Highway Capacity Manual 2000***, titled “***Freeway Facilities Methodology***” contains a capacity reduction procedure appropriate for lane closures on Limited Access facilities and other freeways. The Designer may use the ***HCS2000*** method in lieu of the procedure described in this chapter of the ***PPM***. The ***HCS2000***

method considers the intensity of the work activity, the effects of heavy vehicles and presence of ramps. For certain freeway segments it will result in a lower capacity than the lane closure analysis described in the ***PPM***.

Exhibit 10-A includes the lane closure analysis worksheets and two sample analyses. The sample ***Lane Closure Worksheet*** (***Exhibit 10-A**, **Sheet 3 of 11***) has been cross-referenced to the ***Lane Closure Symbols and Definitions*** sheets (***Exhibit 10-A***, ***Sheets 1 & 2 of 11***) with circled numbers. The circled numbers correspond to the numbers of the symbols and definitions. The symbols and definitions sheets show the designer where to find the necessary information to fill out the lane closure worksheet.

Fill out the top part of the lane closure worksheet and complete the formulas to calculate the hourly percentage of traffic at which a lane closure will be permitted (see ***Exhibit 10-A**, **Sheets 6 & 8 of 11***). Transfer these percentages to the graph on the ***Lane Closures 24 Hour Counts*** sheet (***Exhibit 10-A**, **Sheet 5 of 11***). Draw a line across the graph representing the percentage for both open road and signalized intersections (see ***Exhibit 10-A**, **Sheets 7 & 9 of 11***). Plot the hourly percentages (hourly volume divided by total volume) on the graph. Any hourly percentage extending above the restricted capacity percentage lines for open road or signalized intersections indicated lane closure problems. The bottom of the graph gives times for AM and PM. By coordinating the lane closure problem areas to the time of day, a designer knows when to restrict lane closure.

Many of Florida's roadways have directional peak hour traffic volumes, with inbound morning traffic, and outbound afternoon traffic. Doing a composite lane closure analysis would in many cases require night work. However, if a separate lane closure analysis is calculated for inbound and outbound separately, a lane closure may be allowed and the contractor could work in daylight hours, (See ***Exhibit 10-A**, **Sheets 10 & 11 of 11***).

Exhibit 10-A Lane Closures
Sheet 1 of 11

Symbols and Definitions

1. **ATC** = Actual Traffic Counts. Use current traffic counts. Traffic counts can be obtained from the Office of Planning, or you may need to get traffic counts done. The designer needs hourly traffic volumes with a total traffic volume for a 24-hour period (see ***Exhibit 10-A*, *Sheet 7 of 11***).

2. **P/D** = Peak Traffic to Daily Traffic Ratio. Highest hourly volume divided by the total 24-hour volume. Convert the percentage to a decimal on the Lane Closure Worksheet (see ***Exhibit 10-A*, *Sheet 7 of 11***).

3. **D** = Directional Distribution of peak hour traffic on multilane roads. This factor does not apply to a two-lane roadway converted to two-way, one-lane. The directional distribution can be obtained from the Office of Planning.

4. **PSCF** = Peak Season Conversion Factor. Many counties in Florida have a significant variance in seasonal traffic. The designer should use the PSCF for the week in which the actual traffic count was conducted. The Office of Planning has tables showing Peak Season Conversion Factors for every county in Florida. (See sample table of values on ***Exhibit 10-A*, *Sheet 4 of 11***).

5. **RTF** = Remaining Traffic Factor is the percentage of traffic that will not be diverted onto other facilities during a lane closure. Convert the percentage to a decimal on the Lane Closure Worksheet. This is an estimate that the designer must make on his own, or with help from the Office of Planning. Range: 0% for all traffic diverted to 100% for none diverted.

6. **G/C** = Ratio of Green to Cycle Time. This factor is to be applied when lane closure is through or within 600 ft. of a signalized intersection. The Office of Traffic Engineering has timing cycles for all traffic signals.

7. **V** = Peak Hour Traffic Volume. The designer calculates the peak hour traffic volume by multiplying the actual traffic count, times peak to daily traffic ratio, times directional factor, times peak seasonal factor, times remaining traffic factor. This calculation will give the designer the expected traffic volume of a roadway at the anticipated time of a lane closure.

Exhibit 10-A Lane Closures, Sheet 2 of 11

Symbols and Definitions (Continued)

8. **C** = Capacity of a 2L, 4L or 6L roadway with one lane closed, and the remaining lane(s) unrestricted by lateral obstructions. The capacity of a 4L or 6L roadway is based on lane closure in only one direction (see Lane Closure Capacity Table on ***Exhibit 10-A**, **Sheet 3 of 11***).

9. **RC** = Restricting Capacity of the above facilities by site specific limitations detailed in the Temporary Traffic Control plans which apply to travel lane width, lateral clearance and the work zone factor. The work zone factor only applies to two lane roadways (see the tables on ***Exhibit 10-A**, **Sheet 4 of 11*** to obtain the Obstruction Factor and Work Zone Factor).

10. **OF** = Obstruction Factor which reduces the capacity of the remaining travel lane(s) by restricting one or both of the following components: Travel lane width less than 12 ft. and lateral clearance less than 6 ft. (see TTC plan and Obstruction Factor Table in ***Exhibit 10-A**, **Sheet 4 of 11***).

11. **WZF** = Work Zone Factor (WZF) is directly proportional to the work zone length (WZL). The capacity is reduced by restricting traffic movement to a single lane while opposing traffic queues. The WZF and WZL only apply to a two lane roadway converted to two way, one lane (see the Work Zone Factor Table on ***Exhibit 10-A**, **Sheet 4 of 11***).

12. **TLW** = Travel Lane Width is used to determine the obstruction factor (see TTC plan and the Obstruction Factor Table on ***Exhibit 10-A**, **Sheet 4 of 11***).

13. **LC** = Lateral Clearance is the distance from the edge of the travel lane to the obstruction. The lateral clearance is used to determine the obstruction factor (see TTC plans and Obstruction Factor Table on ***Exhibit 10-A**, **Sheet 4 of 11***).

Exhibit 10-A, Lane Closures, Sheet 3 of 11

LANE CLOSURE WORKSHEET

FINANCIAL PROJECT ID:____________________ FAP NO.:____________________

COUNTY:____________________ DESIGNER:____________________

NO. EXISTING LANES:_________ SCOPE OF WORK:____________________

Calculate the peak hour traffic volume (V)

V=ATC_1_ X P/D_2_ X D_3_ X PSCF_4_ X RTF_5_ = _7_

LANE CLOSURE CAPACITY TABLE

Capacity (C) of an Existing 2-Lane – Converted to 2-Way, 1-Lane = 1400 VPH
Capacity (C) of an Existing 4-Lane – Converted to 1-Way, 1-Lane = 1800 VPH
Capacity (C) of an Existing 6-Lane – Converted to 1-Way, 2-Lane = 3600 VPH

Factors restricting Capacity:

TLW _12_ LC_13_ WZL_11_ G/C_6_

Calculate the Restricted Capacity (RC) at the Lane Closure Site by multiplying the appropriate 2L, 4L, or 6L Capacity (C) from the Table above by the Obstruction Factor (OF) and the Work Zone Factor (WZF). If the Lane Closure is through or within 600 ft. of a signalized intersection, multiply the RC by the G/C Ratio.

RC (Open Road) = C_8_ X OF_10_ X WZF_11_ = _9_

RC (Signalized) = RC (Open Road) _9_ X G/C _6_ = _9_

If V ≤ RC, there is no restriction on Lane Closure
If V > RC, calculate the hourly percentage of ADT at which Lane Closure will be permitted

Open Road % = RC (Open Road) _9_ / (ATC _1_ X D _3_ X PSCF _4_ X RTF _5_) = _______%

Signalized % = Open Road % ______ X G/C _6_ = _____ %

Plot 24 hour traffic to determine when Lane Closure permitted. (See ***Exhibit 10-A, Sheet 5 of 11***)

NOTE: For Existing 2-Lane Roadways, D = 1.00.
Work Zone Factor (WZF) applies only to 2-Lane Roadways.

For RTF < 1.00, briefly describe alternate route ______________________________

Exhibit 10-A, Lane Closures, Sheet 4 of 11

Lane Closures – Capacity Adjustment Factors
Peak Season Conversion Factor (PSCF) Sample

1998 Peak Season Factor Category Report for Tropic County

WK	Dates	SF	PSCF	WK	Dates	SF	PSCF
9	02/22 – 02/28/98	1.14	1.48	15	04/05 – 04/11/98	0.86	1.12
10	03/01 – 03/07/98	1.04	1.35	16	04/12 – 04/18/98	0.87	1.13
11	03/08 – 03/14/98	0.94	1.22	17	04/19 – 04/25/98	0.90	1.17
12	03/15 – 03/21/98	0.83	1.08	18	04/26 – 05/02/98	0.93	1.21
13	03/22 – 03/28/98	0.84	1.09	19	05/03 – 05/09/98	0.96	1.25
14	03/29 – 04/04/98	0.85	1.11	20	05/10 – 05/16/98	0.99	1.29

Obstruction Factors (OF)

Lateral Clearance (LC) (feet)	Travel Lane Width (TLW) (feet)			
	12	11	10	9
6	1.00	0.96	0.90	0.80
4	0.98	0.94	0.87	0.77
2	0.94	0.90	0.83	0.72
0.0	0.86	0.82	0.75	0.65

Work Zone Factors (WZF)

WZL (ft.)	WZF	WZL (ft.)	WZF	WZL (ft.)	WZF
200	0.98	2200	0.81	4200	0.64
400	0.97	2400	0.80	4400	0.63
600	0.95	2600	0.78	4600	0.61
800	0.93	2800	0.76	4800	0.59
1000	0.92	3000	0.74	5000	0.57
1200	0.90	3200	0.73	5200	0.56
1400	0.88	3400	0.71	5400	0.54
1600	0.86	3600	0.69	5600	0.53
1800	0.85	3800	0.68	5800	0.51
2000	0.83	4000	0.66	6000	0.50

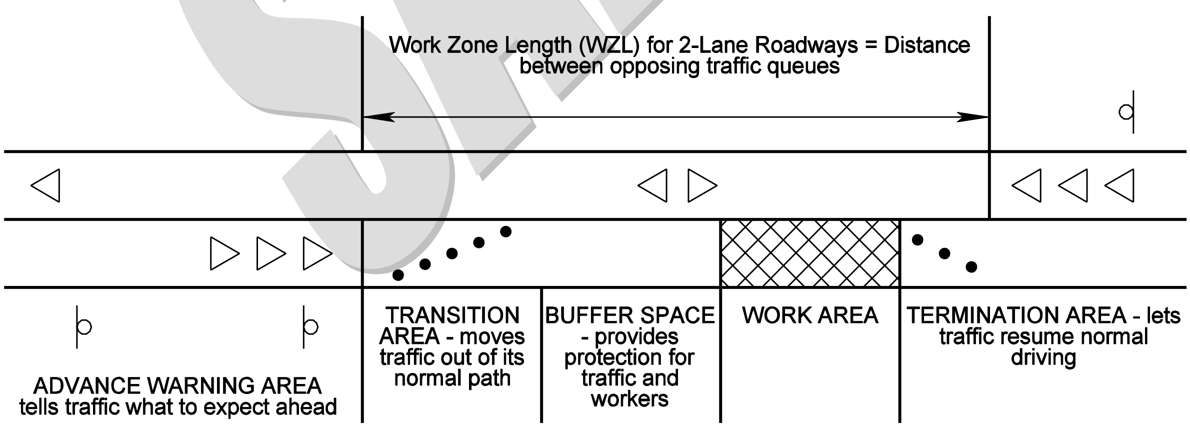


Exhibit 10-A, Lane Closures, Sheet 5 of 11

LANE CLOSURES

24 HOUR COUNTS

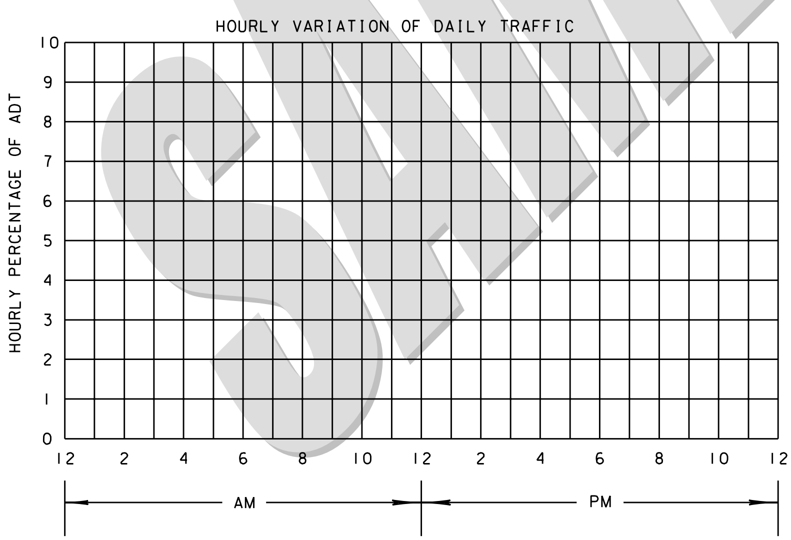
TIME	AM HOURLY VOLUME	ATC %	PM HOURLY VOLUME	ATC %
12 - 1	______	______	______	______
1 - 2	______	______	______	______
2 - 3	______	______	______	______
3 - 4	______	______	______	______
4 - 5	______	______	______	______
5 - 6	______	______	______	______
6 - 7	______	______	______	______
7 - 8	______	______	______	______
8 - 9	______	______	______	______
9 - 10	______	______	______	______
10 - 11	______	______	______	______
11 - 12	______	______	______	______
		TOTAL	______	______

DATE ______________________

DESIGNER ______________________

FINANCIAL PROJECT ID ______________________

LOCATION ______________________



-CONCLUSION-

ROUND TO THE NEAREST 1/2 HOUR CONSERVATIVELY

OPEN ROAD LANE CLOSURE

SIGNALIZED LANE CLOSURE

Exhibit 10-A, Lane Closures, Sheet 6 of 11

LANE CLOSURE WORKSHEET

FINANCIAL PROJECT ID: ***123456-7-89-10*** FAP NO.: ***NA***

COUNTY: ***Tropic*** DESIGNER: ***Yates***

NO. EXISTING LANES: ***2*** SCOPE OF WORK: ***Widen and Resurface***

Calculate the peak hour traffic volume (V)

V=ATC ***15000*** X P/D ***0.083*** X D ***NA*** X PSCF ***1.17*** X RTF ***0.75*** = ***1092***

LANE CLOSURE CAPACITY TABLE

Capacity (C) of an Existing 2-Lane – Converted to 2-way, 1-Lane = 1400VPH
Capacity (C) of an Existing 4-Lane – Converted to 1-way, 1-Lane = 1800VPH
Capacity (C) of an Existing 6-Lane – Converted to 1-way, 2-Lane = 3600VPH

Factors restricting Capacity:

TLW ***10*** LC ***4*** WZL ***2100*** G/C ***0.64***

Calculate the Restricted Capacity (RC) at the Lane Closure Site by multiplying the appropriate 2L, 4L, or 6L Capacity (C) from the table above by the Obstruction Factor (OF) and the Work Zone Factor (WZF). If the Lane Closure is through or within 600 ft. of a signalized intersection, multiply the RC by the G/C Ratio.

RC (Open Road) = C ***1400*** X OF ***0.87*** X WZF ***0.82*** = ***999***

RC (Signalized) = RC (Open Road) ***999*** X G/C ***0.64*** = ***639***

If V ≤ RC, there is no restriction on Lane Closure

If V > RC, calculate the hourly percentage of ADT at which Lane Closure will be permitted

Open Road % = RC (Open Road) ***999*** / (ATC ***15000*** X D ***1.00*** X PSCF ***1.17*** X RTF ***0.75***) = ***7.59*** %

Signalized % = Open Road % ***7.59*** X G/C ***0.64*** = ***4.86*** %

Plot 24 hour traffic to determine when Lane Closure permitted. (See ***Exhibit 10-A, Sheet 7 of 11***)

NOTE: For Existing 2-Lane Roadways, D = 1.00.

Work Zone Factor (WZF) applies only to 2-Lane Roadways.

For RTF < 1.00, briefly describe alternate route: ***25% of existing traffic diverted on Bullard Blvd., north on Newhall Lane, then east on Xanders Expressway.***

Exhibit 10-A, Lane Closures, Sheet 7 of 11

LANE CLOSURES

24 HOUR COUNTS

TIME	AM HOURLY VOLUME	ATC %	PM HOURLY VOLUME	ATC %
12 - 1	160	1.1	960	6.4
1 - 2	90	0.6	830	5.5
2 - 3	30	0.2	810	5.4
3 - 4	25	0.2	1080	7.2
4 - 5	30	0.2	1190	7.9
5 - 6	130	0.9	1240	8.3
6 - 7	525	3.5	930	6.2
7 - 8	1135	7.6	680	4.5
8 - 9	910	6.1	530	3.5
9 - 10	870	5.8	425	2.8
10 - 11	825	5.5	365	2.4
11 - 12	960	6.4	270	1.8
		TOTAL	15,000	100

P/D
=.083

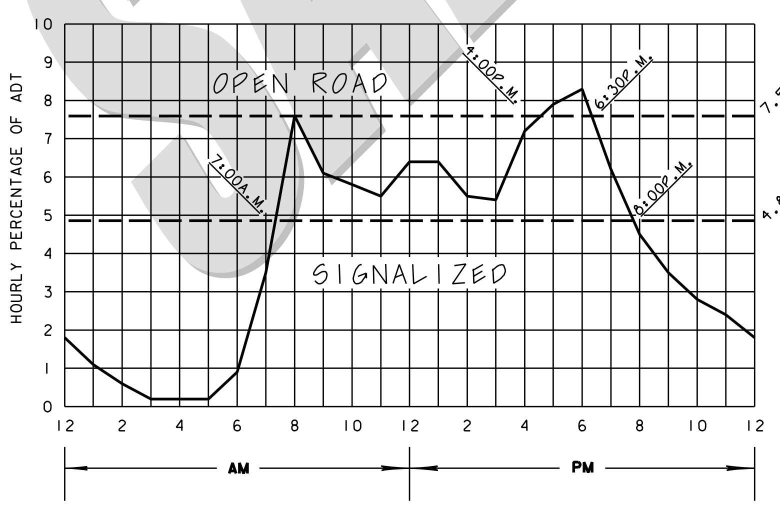
DATE
APR 19, 1998

DESIGNER
YATES

FINANCIAL PROJECT ID
123456-7-89-10

LOCATION
BUCK LAKE RD.

HOURLY VARIATION OF DAILY TRAFFIC



-CONCLUSION-

ROUND TO THE NEAREST 1/2 HOUR CONSERVATIVELY

OPEN ROAD LANE CLOSURE
6:30P.M. - 4:00P.M.

SIGNALIZED LANE CLOSURE
8:00P.M. - 7:00A.M.

Exhibit 10-A, Lane Closures, Sheet 8 of 11

LANE CLOSURE WORKSHEET

FINANCIAL PROJECT ID: ***123456-7-89-10*** FAP NO.: ***NA***

COUNTY: ***Tropic*** DESIGNER: ***Giddens***

NO. EXISTING LANES: ***4*** SCOPE OF WORK: ***Resurface***

Calculate the peak hour traffic volume (V)

V=ATC ***30000*** X P/D ***0.083*** X D ***0.55*** X PSCF ***1.17*** X RTF ***1.00*** = ***1602***

LANE CLOSURE CAPACITY TABLE

Capacity (C) of an Existing 2-Lane – Converted to 2-way, 1-Lane = 1400VPH
Capacity (C) of an Existing 4-Lane – Converted to 1-way, 1-Lane = 1800VPH
Capacity (C) of an Existing 6-Lane – Converted to 1-way, 2-Lane = 3600VPH

Factors restricting Capacity:
TLW ***11*** LC ***6*** WZL ***NA for 4L*** G/C ***0.74***

Calculate the Restricted Capacity (RC) at the Lane Closure Site by multiplying the appropriate 2L, 4L, or 6L Capacity (C) from the table above by the Obstruction Factor (OF) and the Work Zone Factor (WZF). If the Lane Closure is through or within 600 ft. of a signalized intersection, multiply the RC by the G/C Ratio.

RC (Open Road) = C ***1800*** X OF ***0.96*** X WZF ***1.00*** = ***1728***
RC (Signalized) = RC (Open Road) ***1728*** X G/C ***0.74*** = ***1279***

If V ≤ RC, there is no restriction on Lane Closure
If V > RC, calculate the hourly percentage of ADT at which Lane Closure will be permitted

$$\text{Open Road \%} = \frac{\text{RC (Open Road) } \mathbf{1728}}{\text{(ATC } \mathbf{30000} \text{ X D } \mathbf{0.55} \text{ X PSCF } \mathbf{1.17} \text{ X RTF } \mathbf{1.00}\text{)}} = \mathbf{8.95}\ \%$$

Signalized % = Open Road % ***8.95*** X G/C ***0.74*** = ***6.62*** %

Plot 24 hour traffic to determine when Lane Closure permitted. (See ***Exhibit 10-A, Sheet 9 of 11***)
NOTE: For Existing 2-Lane Roadways, D = 1.00.
Work Zone Factor (WZF) applies only to 2-Lane Roadways.

For RTF < 1.00, briefly describe alternate route: ***NA***

Exhibit 10-A, Lane Closures, Sheet 9 of 11

LANE CLOSURES

24 HOUR COUNTS

TIME	AM HOURLY VOLUME	ATC %	PM HOURLY VOLUME	ATC %
12 - 1	320	1.1	1920	6.4
1 - 2	180	0.6	1660	5.5
2 - 3	60	0.2	1620	5.4
3 - 4	50	0.2	2160	7.2
4 - 5	60	0.2	2380	7.9
5 - 6	260	0.9	2480	8.3
6 - 7	1050	3.5	1860	6.2
7 - 8	2270	7.6	1360	4.5
8 - 9	1820	6.1	1060	3.5
9 - 10	1740	5.8	850	2.8
10 - 11	1650	5.5	730	2.4
11 - 12	1920	6.4	540	1.8
		TOTAL	30,000	100

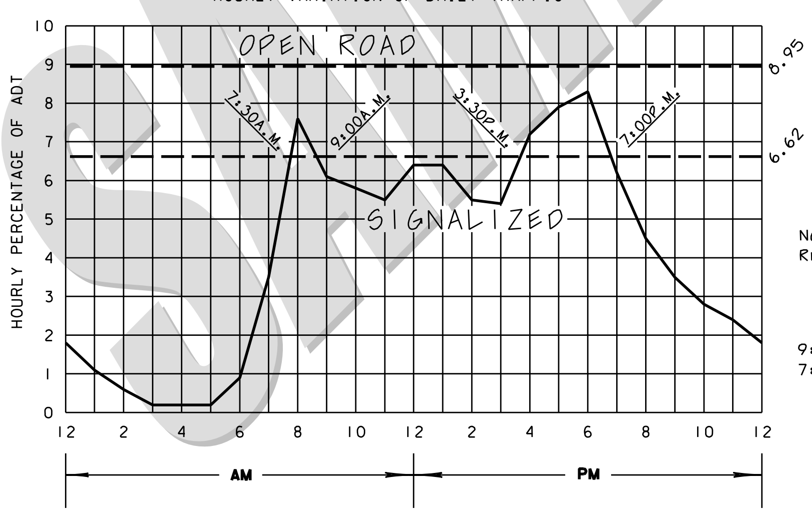
DATE
APR 19, 1998

DESIGNER
GIDDENS

FINANCIAL PROJECT ID
123456-7-89-10

LOCATION
BUCK LAKE RD.

HOURLY VARIATION OF DAILY TRAFFIC



-CONCLUSION-

ROUND TO THE NEAREST 1/2 HOUR CONSERVATIVELY

OPEN ROAD LANE CLOSURE

NO RESTRICTION

SIGNALIZED LANE CLOSURE

9:00A.M. - 3:30P.M.
7:00P.M. - 7:30A.M.

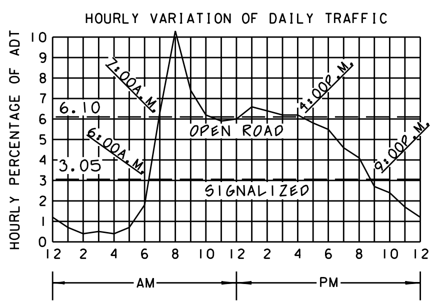
Exhibit 10-A, Lane Closures, Sheet 10 of 11

SAMPLE 4 LANE SITE = SR 60 AT 301 EAST OF TAMPA - HILLSBOROUGH COUNTY

INBOUND LANE CLOSURES

24 HOUR COUNTS

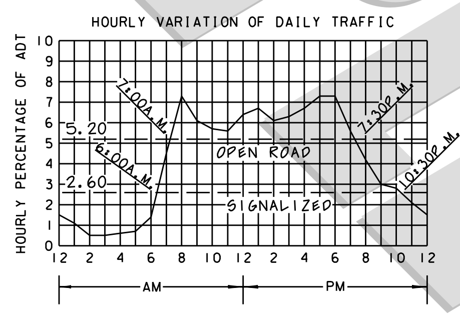
TIME	AM HOURLY VOLUME	ATC %	PM HOURLY VOLUME	ATC %
12 - 1	146	0.7	1437	6.6
1 - 2	88	0.4	1387	6.4
2 - 3	99	0.5	1357	6.2
3 - 4	94	0.4	1358	6.2
4 - 5	158	0.7	1261	5.8
5 - 6	392	1.8	1188	5.5
6 - 7	1377	6.3	998	4.6
7 - 8	2235	10.3	901	4.1
8 - 9	1602	7.4	594	2.7
9 - 10	1339	6.2	518	2.4
10 - 11	1276	5.9	380	1.7
11 - 12	1316	6.0	259	1.2
		TOTAL	21,760	100



COMPOSITE LANE CLOSURES

24 HOUR COUNTS

TIME	AM HOURLY VOLUME	ATC %	PM HOURLY VOLUME	ATC %
12 - 1	444	1.1	2836	6.7
1 - 2	232	0.5	2594	6.1
2 - 3	195	0.5	2644	6.3
3 - 4	245	0.6	2823	6.7
4 - 5	294	0.7	3066	7.3
5 - 6	599	1.4	3080	7.3
6 - 7	1895	4.5	2362	5.6
7 - 8	3070	7.3	1775	4.2
8 - 9	2559	6.1	1291	3.0
9 - 10	2403	5.7	1212	2.8
10 - 11	2367	5.6	890	2.1
11 - 12	2694	6.4	662	1.5
		TOTAL	42,232	100



OUTBOUND LANE CLOSURES

24 HOUR COUNTS

TIME	AM HOURLY VOLUME	ATC %	PM HOURLY VOLUME	ATC %
12 - 1	298	1.5	1399	6.8
1 - 2	144	0.7	1207	5.9
2 - 3	96	0.5	1287	6.3
3 - 4	151	0.7	1465	7.2
4 - 5	136	0.7	1805	8.8
5 - 6	207	1.0	1892	9.2
6 - 7	518	2.5	1364	6.7
7 - 8	835	4.1	874	4.3
8 - 9	957	4.7	697	3.4
9 - 10	1064	5.2	694	3.4
10 - 11	1091	5.3	510	2.5
11 - 12	1378	6.7	403	2.0
		TOTAL	20,472	100

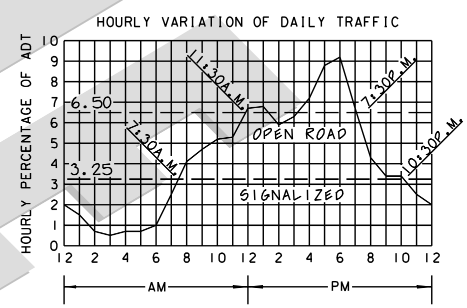


Exhibit 10-A, Lane Closures, Sheet 11 of 11

LANE CLOSURE WORKSHEET SUMMARY
LANE SAMPLE WITH SIGNIFICANT AM-PM PEAKS
SAMPLES = INBOUND (WB), COMPOSITE (EB & WB), OUTBOUND (EB)
SITE = SR 60 @ US 301 EAST OF TAMPA, HILLSBOROUGH CO.

COMPONENT	INBOUND	COMPOSITE	OUTBOUND
ADT	21,760	42,232	20,472
P/D	0.103	0.073	0.092
D	1.00	0.60	1.00
PSCF	1.17	1.17	1.17
RTF	1.00	1.00	1.00
V	2622	2164	2203
TLW	12	12	12
LC	0	0	0
C	1800	1800	1800
OF	0.86	0.86	0.86
RC (OPEN ROAD)	1548	1548	1548
G/C	0.50	0.50	0.50
RC (SIGNAL)	774	774	774
% OPEN ROAD	6.10	5.20	6.50
% SIGNAL	3.05	2.60	3.25
LANE CLOSURE	7:00 AM	7:00 AM	11:30 AM
(OPEN ROAD)	4.00 PM	7:30 PM	7:30 PM
LANE CLOSURE	6:00 AM.	6:00 AM	7:30 AM
(SIGNAL)	9:00 PM.	10:30 PM	10:30 PM

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10.12.8 Pacing Specification (a.k.a. Rolling Roadblock)

A technical specification has been developed to pace traffic for up to twenty (20) minutes maximum to allow work in or above all lanes of traffic for the following purposes:

1. Placing bridge members or other bridge work
2. Placing overhead sign structures
3. Other work items requiring interruption of traffic

The Contractor shall provide a uniformed Traffic Control Officer(s) with marked patrol vehicle and blue flashing light for each lane in the direction of pacing. When ready to start the work activity, the Traffic Control Officer(s) will pull into the travel lane(s) and act as a pilot vehicle(s) slowing the traffic thereby providing a gap (not to exceed 20 minutes) in traffic, allowing the Contractor to perform the work. Any on-ramps between the pace and the work area shall be blocked during pacing of traffic.

Extreme care must be taken to assure that traffic on connecting roads will not be backed up causing excessive delays.

10.12.9 Detours, Diversions, and Lane Shifts

A **detour** is the redirection of traffic onto an alternate route, using state roads, county roads, or city streets, to bypass the work zone. A **diversion** is a special detour onto a temporary roadway adjacent to the existing or permanent roadway. A **lane shift** is the redirection of traffic onto a section of the permanent roadway or shoulder.

Detour signing is usually done under the direction of the traffic engineer who has authority over the roadway to be used. The detour should be signed clearly so drivers can traverse the entire detour and return to the original roadway. When detours are required, the geometry of the detour route should be compared against the type of traffic being routed through the detour. For example, detouring of traffic which includes large trucks and transit vehicles will require certain pavement widths, turning radius, and overhead clearance (including low power lines, span wires, and low hanging tree limbs). The structural capacity of the detour pavement should also be considered.

The designer has two methods of paying for diversions: by (1) using the "special detour" lump sum pay item or (2) using the lump sum Maintenance of Traffic (MOT) pay item.

When the special detour pay item is used, the work and quantities included for pay under the item are to be tabulated and noted in the plans. The special detour pay item is intended to be used in all situations where traffic is shifted one lane width or more onto temporary pavement.

A Diversion, which is to be signed as a lane shift, may be paid for under Special Detour, Pay Item 102-2 (Lump Sum). The ***Basis of Estimates Handbook*** should be referenced to make sure that the appropriate items are included in this lump sum.

TTC plans shall include sufficient detail for diversion geometry. Diversions should be designed with shoulders (2 ft. min.) whenever practical. The radius of curvature and taper lengths shall be shown. Diversions should be designed and operated as close to the normal speed as possible. When speed reductions are necessary, the reduction should be in accordance with the ***Design Standards**, **Index 600***. The recommended minimum radius of curvature (without superelevation) for diversions is shown in ***Table 10.12.2***.

10.12.10 Above Ground Hazards

An above ground hazard is anything that is greater than 4 inches in height and is firm and unyielding or doesn't meet breakaway requirements. For treatment of an above ground hazard, see the ***Design Standards**, **Index 600**.*

10.12.11 Drop-offs in Work Zones

Acceptable warning and barrier devices for traffic control at drop-offs in work areas are detailed in the ***Design Standards**, **Index 600***.

The designer should anticipate drop-offs that are likely to occur during construction and provide the appropriate devices. For those projects where barrier wall would be needed and yet it is not practical, such as highly developed urban areas where numerous driveways exist, the designer should consider adding plan notes that require conditions be returned to acceptable grade by the end of the day's operation.

10.12.12 Narrow Bridges and Roadways

Simultaneously working on both sides of a bridge (bridge widening, etc.) or roadway may be hazardous due to the narrow widths of some bridges and roads. Consideration should be given to specifying that work be done only on one side at a time, particularly on high speed roadways. In some situations, the installation of barrier wall on both shoulders can totally eliminate any shoulder or refuge area. The designer should consider whether or not this restriction of the effective width is acceptable and consistent with the desired operational ability of the facility.

10.12.13 Existing Highway Lighting

If the project has existing highway lighting, the designer shall prepare a specification that completely describes what is to be done with the existing lighting during all phases of construction. Give detailed information on any poles that have to be relocated or any new conduit or conductors that would have to be installed. A field survey should be conducted to establish the condition of the existing system and what responsibility the contractor will have in bringing the existing lighting system back to an acceptable condition.

The designer should use the appropriate pay items and quantities for all work to be done for maintaining existing lighting throughout construction.

10.12.14 Work Area Access

The TTC plan should consider the need for a work area access plan. This is a constructability issue in which the designer addresses the question of how the contractor is to get materials and equipment into the work area safely. This is a particularly critical issue on high speed facilities (such as the Interstate) where barrier wall is used to protect median work areas. Some consideration may be given to the design and construction of temporary acceleration and deceleration lanes for the construction equipment.

10.12.15 Railroads

Railroad crossings that are affected by a construction project must be evaluated to ensure that the Temporary Traffic Control Plan does not cause queuing of traffic across the railroad tracks. Evaluate the Plan's signal timing, tapers, lane closures and distance to intersections as compared to projected peak traffic volumes. The effects of the temporary traffic control plan on interconnected traffic signals and railroad signals must be evaluated to avoid conflicting or ineffective signal controls.

10.12.16 Pay Items and Quantities

The ***Basis of Estimates Handbook*** contains detailed instructions on calculating many of the MOT quantities.

10.13 Speed Zoning

10.13.1 Regulatory Speeds in Work Zones

Regulatory speeds should be established to route vehicles safely through the work zone as close to normal highway speeds as possible. Temporary Traffic Control Plans (TTC plans) for all projects must include specific regulatory speeds for each phase of work. This can either be the posted speed or a reduced speed. The speed shall be noted in the TTC plans: this includes indicating the existing speed if no reduction is made. By virtue of ***Florida Statute 316.187***, all regulatory speeds must be established on the basis of a traffic and engineering investigation. Designers should only reduce speed when the temporary geometry requires it. The justification for establishing work zone regulatory speeds different from normal speed limits must be included in the project file. The TTC plan and the project file will suffice as the traffic and engineering investigation.

When field conditions warrant speed reductions different from those shown in the TTC plan, the contractor may submit to the project engineer for approval by the Department, a signed and sealed study to justify the need for further reducing the posted speed or the engineer may request the District Traffic Operations Engineer (DTOE) to investigate the need. It will not be necessary for the DTOE to issue regulations for regulatory speeds in work zones due to the revised provisions of ***Florida Statute 316.0745(2)(b)***.

Regulatory speed signs in rural areas (Interstate and Non-Interstate) are to be preceded by a "Reduced Speed Ahead" sign positioned as follows:

Interstate (Rural)	-	1000 ft. in advance
Non-Interstate (Rural)	-	500 ft. in advance

Urban areas, ordinarily do not require an advance sign, however, the sign may be included at the designer's option.

The regulatory speed and “Reduced Speed” Ahead signs are to be paid for under the pay item for Construction Work Zone Signs (per each per day).

If the existing regulatory speed is to be used, consideration should be given to supplementing the existing signs when the construction work zone is between existing regulatory speed signs. For projects where the reduced speed conditions exist for greater than 1 mile in rural areas (Non-Interstate) and on Rural or Urban Interstate, additional regulatory speed signs are to be placed at no more than 1 mile intervals.

Engineering judgment should be used in the placement of additional signs. For urban situations (Non-Interstate), additional regulatory speed signs are to be placed at a maximum of 1000 ft. apart.

The regulatory speed should not be reduced more than 10 mph below the posted speed, and never below the minimum statutory speed for the class of facility, without the approval of the District Traffic Operations Engineer and the appropriate District Director (See the ***Design Standards**, **Index 600**).*

To ensure credibility with motorists and enforcement agencies, temporary regulatory speed signs shall be removed or covered as soon as the conditions requiring the reduced speed no longer exist. Once they are removed or covered, the speed existing prior to construction will automatically go back into effect unless new speed limit signing is provided for in the plans. On projects with interspaced work activities (such as interstate resurfacing) speed reductions should be located in proximity to those activities which merit a reduced speed, and not "blanketed" for the entire project.

The TTC plan phase notes shall indicate when to remove the regulatory reduced speed limit signs.

When the regulatory speed is changed in a work zone, the permanent speed limit signs are to be removed or covered during the period when the work zone regulatory speed zones are in effect.

10.14 Law Enforcement Services

Work zones may require law enforcement services to protect both the workers and motorists during construction or maintenance activities. The need for these services should be considered during the development of the Temporary Traffic Control Plans. The service needed could involve a Speed and Law Enforcement Officer for speed and traffic law enforcement, a Traffic Control Officer for traffic control, or a combination of the two.

A contractual agreement between the FDOT and the Florida Department of Highway Safety and Motor Vehicles (DHSMV) was entered into for the use of Speed and Law Enforcement Officer (Central Office Statewide Contract) to exclusively enforce the speed limit in specified work zones. (REF. ***Contract #B-8970***) Each district has also been encouraged to enter into contractual agreements with local law enforcement agencies to provide additional resources for the use of a Speed and Law Enforcement Officer (District Contract).

Traffic Control Officers are to be used for traffic control only as described in ***Specification 102***. The Traffic Control Officer may be acquired from local law enforcement agencies or the Florida Highway Patrol. Such Traffic control law enforcement services shall not include patrolling or speed enforcement. The use of Traffic Control Officers may be called for on a project that also uses Speed and Law Enforcement Officers.

10.14.1 Use of Speed and Law Enforcement Officers

The Department has determined that construction or maintenance activities that divert, restrict, or significantly impair vehicular movement through work zones may require patrolling by a Speed and Law Enforcement Officer specifically for speed and law enforcement to provide a safer environment for both workers and motorists. A Speed and Law Enforcement Officer may also be warranted, for the safety of the motorists, through some work zones during times when construction or maintenance activities are not in progress.

Conditions to consider for the use of Speed and Law Enforcement Officer may include, but not be limited to:

1. A work zone requiring reduced speeds
2. Work zones where barrier wall is used adjacent to through traffic

3. Night time work zones

4. Areas with intense commuter use where peak hour traffic will require speed enforcement

5. A work zone in which workers are exposed to nearby high speed traffic

6. Work zones similar to the ***Design Standards**, **Indexes 608**, **613**, **614**, **and 651***

10.14.2 Use of Traffic Control Officer

There are certain construction activities that impede traffic flows such that supplemental traffic control is desirable. Uniformed law enforcement officers are respected by motorists; therefore, it may be in the best interest of the situation to utilize Traffic Control Officer as a supplement to traffic control devices to assist the motorists and provide a safer work zone.

By specification, conditions for the use of Traffic Control Officer shall be:

1. Traffic control in a signalized intersection when signals are not in use.

2. When ***Index Nos. 607 and 619*** of the ***Design Standards*** is used on Interstate at nighttime and required by the plans.

3. When pacing/rolling blockade is used.

10.14.3 Coordination, Documentation and Payment

On each individual project, the designer and/or the project manager shall coordinate with the district construction office to determine if law enforcement services will be justified. If possible the associated law enforcement commander shall also be included in the coordination.

Once the determination has been made that law enforcement will be used on a project, the designer/project manager and the construction engineer shall develop supporting documentation for each TTC phase including the conditions requiring the law enforcement services, the number of personnel, the man-hours, and any other requirements that may be established. The supporting documentation for Speed and Law Enforcement Officer and Traffic Control Officer will be kept separate.

The documentation for Speed and Law Enforcement Officer will be shown in the Computation Book only and there will be no reference made to these services in the plans except as shown on the Summary of Pay Items Sheet.

Speed and Law Enforcement Officer can be used on non-limited access highways provided that the District Director of Transportation Operations has approved its use.

Speed and Law Enforcement Officer will be paid for under pay item 999-102-xxa - Speed and Law Enforcement Officer (Do Not Bid) HR.

For Traffic Control Officer, the TTC plan shall clearly indicate the intended use of the officer(s) during each phase of construction, the need for the service, the number of officers needed, and the required man-hours. Traffic Control Officer will be paid for under pay item 102- 14 - Traffic Control Officer HR. Complete documentation that complies with the TTC plan shall be included in the Computation Book.

The initial coordination between the designer/project manager and construction shall take place prior to Phase II. The final determination of man-hours and final documentation shall be accomplished at the same time that construction days are set.

10.14.4 Other Uses of Law Enforcement

The contractor may choose to use law enforcement services beyond the details of the TTC plan for situations that assist with mobilization, demobilization, TTC setup, and other instances where he prefers the use of law enforcement.

The contractor is responsible for the coordination of these uses and will be included under the Lump Sum Maintenance of Traffic pay item. These contractor required services are not to be included in the Department's contract pay items for law enforcement services.

10.15 Motorist Awareness System (MAS)

The purpose of a Motorist Awareness System (MAS) is to increase the motorist awareness of the presence of active work and provide emphasis on reduced speed limits in the active work area. A MAS is created by using a combination of several different traffic control devices to draw attention to the legal speed and inform the motorist of his vehicle speed. Descriptions of some MAS devices are provided below. The ***Design Standards**, **Index 670**,* provide details on the most effective combination and placement of MAS traffic control devices.

The Department's goal is to achieve the same respect for Work Zones that School Zones currently receive. The key in achieving this respect is to discontinue blanket speed limit reductions in work zones, increase enforcement, and to remove the MAS when the conditions requiring it no longer exist and restore the speed limit within the limits of the project to the posted speed limit. Specifically, MAS components are to be activated when the lane closure is setup and deactivated when the lane closure is taken down. All MAS components shall be moved outside of the clear zone or to be shielded by a barrier or crash cushion when not in use.

The MAS shall be used if all of the following conditions exist:

1. Multilane facility
2. Posted speed limit is 55 mph or greater
3. Work activity requires a lane closure for more than 5 days (consecutive or not)
4. Workers are present

The following is a list of some of the devices that are used as part of a Motorist Awareness System.

10.15.1 Portable Regulatory Signs (PRS)

The purpose of this device is to highlight the regulatory speed for the work zone. A portable regulatory sign is a portable trailer that has the regulatory speed sign mounted with flashing lights on each side of the sign. The lights are used to draw the driver's attention to the regulatory speed.

10.15.2 Radar Speed Display Unit (RSDU)

The purpose of this device is to display the motorist's work zone speed. A radar speed display unit is a portable trailer that displays the speed of approaching motorists on a LED display panel. The radar mounted on the unit detects the speed. A regulatory sign with the posted speed is mounted above the LED display panel. The unit is fitted with a device, which counts the number of vehicles passing the Radar Speed Display Unit. The counter device is capable of:

1. Digital readout of the number of vehicles passing the radar speed display unit.
2. Digital readout of the number of vehicles exceeding the speed limit shown on the radar speed display unit.

The device can be set that only speeds greater than the work zone speed are displayed.

10.15.3 Speed and Law Enforcement Officer

The use of moving officers on a random basis, in conjunction with the other MAS devices, has proven to be effective. Although the Speed and Law Enforcement Officer is not shown on ***Index 670***, the Designer should include the Speed and Law Enforcement Officer (DO NOT BID) pay item when using this Index. Department personnel are responsible to identify when Speed and Law Enforcement Officers are needed based on actual field conditions, document the manhours used and directly pay the appropriate law enforcement agency. See ***Section 10.14*** for additional information.

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12.2 Procedures for Establishing R/W Requirements

The procedures for addressing R/W requirements require engineering analyses, economic comparisons and professional judgments. Consultation with the District R/W Surveyor and District R/W Manager is required. One excellent method of providing the consultation is the "R/W Partnering" concept with all parties that have a vested interest participating in the decision making process.

12.2.1 Open Cut and Fill Roadway Sections

R/W requirements along the project boundaries are dictated by the actual construction limits plus a reasonable maintenance buffer. The roadway cut and fill slopes, drainage ditch slopes and other construction elements are used to define the construction limits, which are generally shown on the roadway cross sections. R/W requirements are determined by reviewing the plotted cross sections after the roadway and drainage design elements have been established and major revisions are highly unlikely.

The procedures should, at this point, include a joint review of the proposed R/W, including a field review if necessary. The design details and the property information must be reviewed by the designer, personnel from the R/W Office and the R/W Mapping Office. This review should be scheduled during the Phase II design process as defined in this manual and should address such issues as:

1. Will additional R/W be required for project access, maintenance of the facility, or transit facility needs? Check pond sites, high embankment slopes, bridges, outfalls, canals and similar sites.
2. Can acquisitions be avoided or design modified to avoid substantial damages to remainder property or businesses? Examples include designing retaining walls or by adjusting slopes or grades to reduce the difference in elevation between the remainder and the project grade at the R/W line.
3. Can the roadway grades be revised or connections relocated so access to the remainders can be constructed without damaging the use of the remainder, thereby minimizing or avoiding severance and business damages caused by altering the access?
4. Can drainage facilities (outfalls, ponds, ditches, etc.) be maintained without additional R/W space? Can uneconomic remainders be used for stormwater treatment?
5. Has consideration been given to joint use ponds (including golf course ponds) and/or regional treatment facilities?

6. Check the suitability and cost effectiveness of storm water treatment facilities and the status of permit approval.
7. What types of legal instruments are likely to be required to secure the appropriate property rights for the project?
8. Review the status of R/W activities by others in the project area. Avoid multiple acquisitions from the same owner at ramp terminals, intersections and by future FDOT projects.
9. Check for potentials of hazardous materials, "4F" parcels, utility easements, landlocked remainders and parcels, which could be eliminated.
10. Check for acquisitions involving existing treatment systems which could be mitigated within the FDOT system.
11. Discuss the possibility of advance acquisition of any parcel where development is imminent.
12. Check for incidental work which will fall outside of R/W such as trenching, wall forms, or equipment maneuvering space.
13. Check for availability of offsite property owned by FDOT which could be used for mitigation sites.
14. Discuss status of any R/W being claimed by maintenance pursuant to ***Section 95.361, F.S.*** (Maintenance Statute).

12.2.2 Curb and Gutter Roadway Section

Establishing R/W requirements in urban sections will generally follow very similar procedures as the open roadway section projects. The analysis and decision making is complicated by more property owners, generally higher property values, businesses, and more complex access management problems.

The roadway and drainage design must be developed to a point where all major elements of the project (including transit facilities, signalization poles, lighting poles and overhead sign foundations) are firmly fixed. On projects with sidewalks and driveway connections, the design elements can be accurately established ONLY if proper survey data has been obtained for the designer's use. Profile elevations along the proposed R/W line and back of sidewalk and half-sections or profiles at each driveway location should be obtained as a minimum standard practice.

The design engineer must perform the design work required to establish the project profile

Chapter 13

Initial Engineering Design Process

Tables

Exhibits

Exhibit 13-A Major Activities – Initial Engineering Process

Review & Confirm:
... Project objectives/scope
... PD&E study results
... Typical section data accuracy
... Environmental evaluation
... PD&E and Environmental commitments (i.e., Sound barriers, TDLC, pond sites, etc.)
... Budget (WP) & staff-hour estimates
... Schedule & production dates
... Approvals & authorizations

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Prepare, Document & Approve:
1. Typical section standards
2. Design controls - speed, design period, vehicle, traffic volumes, LOS, access class & function, bike & pedestrian LOS, ADA
3. Design project standards & assumptions, Pavement Type Selection

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Compare & Confirm:
... Project design standards vs. R/W
... PD&E study vs. standards
... Design controls vs. standards
... Objectives & scope vs. standards
... Documentation & approval

↓

Field Review and Verify:
... Adequacy of survey data
... Updates required
... Transfer survey data to design files
... Adequacy of R/W survey data

Surveyor signs off on location files

↓

Review, Confirm & Approve:
... Alignment and topo in CADD
... Alignment vs. standards
... New alignments, CL construction
... Exceptions & variations

Initiate utility contact

↓

Review & Establish Needs:
... Environmental issues
... PD&E and Environmental commitments (i.e., Sound barrier locations, TDLC features, etc.)
... Retention/outfalls
... Permits, mitigation, R/W field review

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Develop:
... Preliminary project layout: grades, superelevation rates, transitions, vertical curves, geometry calculations

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Review:
... Grades vs. soil data vs. Base Clearance Water Elevation
... Clearances above and below
... Existing drainage structure size used on existing facility vs. grades

↓

Develop:
... Existing ground cross sections
... Approval of alignment & grades along project, computations
... Soil data on existing ground cross sections
... Utility locations & potential conflicts

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Develop:
... Roadway cross section templates
... Special ditch profiles
... Check impact on utilities
... Drainage outfalls

↓

Develop:
... Geometric layout - intersections, interchanges, transitions & connections
... Verify and confirm access management design
... Confirm bike, pedestrian, transit & ADA needs vs. project standards
… Sound barrier geometry

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Field Review:
... All preliminary engineering activities & decisions
... Approvals documented

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Finalize:
... Alignments, grades, geometry, reports
Begin:
... R/W requirements, Summary of Pay Items

↓

Review & Confirm:
... Preliminary project design report
... Project objectives/scope
... Project design controls/standards
... Environmental issues/permits
... Budget, staff-hour estimate & production dates
... Engineering support data & services

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To Final Engineering Design

Chapter 13

Initial Engineering Design Process

13.1 General

The engineering design process, as discussed in this and following chapters, includes the data gathering, development and contract preparation phase of highway construction projects. It begins with the approval of the Project Location/Design and ends with the construction letting. It also includes the update process when the construction plans and specifications are ready and on hold in the district and require revising to make them contract ready. Throughout this design process, quality control will be exercised by those responsible for the engineering design and plans preparation activities by having a plan-do-check routine for each and every significant task or operation.

The engineering and design activities and the schedules depend on the type of project and the required effort to accomplish the desired objectives. Projects can be designated as three basic types:

1. **New Construction -** A highway or bridge project along a new corridor on new alignments, horizontal and vertical.
2. **Add Lanes and Reconstruct -** A highway project along an existing facility to add lanes, widen or add bridges, improve intersections, and, in general, upgrade and improve the capacity and safety of the facility.
3. **Other Projects -** May include Resurfacing, Restoration and Rehabilitation (RRR), Local Agency Program (LAP), or other projects such as a highway and/or enhancement projects - A highway and/or bridge project undertaken to extend the service life of an existing facility and to enhance the safety of the facility. These projects generally do not require a PD&E phase. The scopes are so varied that it is difficult to define them, except project by project. They can vary in magnitude from installing highway lighting for enhanced safety or resurfacing pavement to extend the service life, to minor lane and shoulder widening, bridge rail modification or intersection improvements. These projects may also include transit facilities, bike paths, sidewalks and landscaping projects.

13.2 Initial Engineering Design (Phase I)

It is important to distinguish the initial engineering design activities from planning and the preliminary engineering done during the Project Development and Environmental (PD&E) phase. If a PD&E phase has been completed, some of the activities discussed here may have been performed to varying levels during that phase. The information contained in the preliminary engineering report should be considered as the starting point for the initial engineering phase. In the case where there was not a PD&E phase, the initial engineering design activities must establish the project scope, controls and standards, data gathering requirements, right of way (R/W) needs, and major design elements necessary to determine that the project is viable and R/W can be cleared.

Generally, the initial engineering process **should** accomplish or complete the following activities:

1. Completely and fully define and document the objectives of the project and the scope of activities to accomplish them. This will almost always require an on-site review.
2. Develop and document a realistic staff-hour estimate and production schedule to accomplish the scope of activities identified.
3. Establish and document the design controls, assumptions, project design standards, exceptions, and variations. Significant changes to previously approved PD&E elements may result in a re-evaluation of the environmental document. Discuss with the District Environmental Management Office.
4. Identify all prior PD&E and environmental commitments such as the need to design and locate sound barriers (with insertion loss calculations), special pond site requirements, landscape or aesthetic considerations, transportation design for livable community issues, pedestrian and bicycle commitments, access commitments, wildlife management commitments, wetland issues, transit issues, etc.
5. Identify and document additional engineering, data gathering, and support services.
6. Determine and document the structural design requirements.
7. Determine and document if R/W is required.
8. Establish and document the review procedure and number of submittals, if different from guidelines provided in this manual.
9. Establish preliminary geometry, grades, and cross sections.
10. Identify and implement needed public involvement activities.
11. Develop Pavement Type Selection Report based on FDOT ***Pavement Type Selection Manual (Topic No. 625-010-005)***.

13.3 Scope, Objectives, Schedule and Budget

The project manager and other FDOT managers are responsible for the development, review and approval of the project objectives, scope of work, and schedule in accordance with the ***Project Management Guidelines.*** They also must verify that required funds are in the work program.

The project objectives and scope are best confirmed and/or completed by:

1. Reviewing the PD&E study recommendations, conclusions and commitments, if they exist.
2. Performing a field review of the project with the project manager and personnel from other FDOT offices, such as Roadway Design, Traffic Operations, Safety, R/W Engineering, Utilities, Survey, Maintenance and Construction, as appropriate.
3. Requesting a review of the draft scope of services activities by FDOT offices, such as Maintenance, Construction, Design, Traffic Operations, Access Management, Public Transportation, Pedestrian and Bicycle, etc.
4. Developing the scope of services sufficient to advertise for professional services. After the scope of services is completed and approved, the schedule and budget may be confirmed and/or updated by the engineer/project manager and approved by the appropriate district manager.
5. After consultant selection or in-house assignment, the designer or consultant should review and confirm the scope by completing steps one through four above.
6. The scope should anticipate and include the most cost effective methods that may be used in Subsurface Utility Engineering (SUE) for locating subsurface anomalies, structures, and utilities. Its use may affect the design process and should be considered in the scoping process. Selecting which methods to be employed should be accomplished by balancing risk versus benefit. Seldom will the use of only one method provide the most value. For example: Using radar tomography may have an initial higher cost but yield significantly more information much earlier in the design process which can facilitate drainage design, shorten the over all project time, reduce contractor risk, minimize redesign, and identify unknown facilities. Conversely, radar tomography has limited depth and resolution issues in a salt or high mineral environment, but other high technology methods exist and are worthy of consideration. The designer must recognize that SUE is a process that has many old and new technologies at its disposal. Consulting a SUE provider who can demonstrate state of the art knowledge will yield the most benefit.

13.4 Project Design Controls and Standards

Among the activities the Engineer of Record (EOR) will accomplish on a project are the identification of the given design controls and the selection of the appropriate design standards. These will be documented in the project file(s).

The design controls as addressed in this manual and AASHTO include such things as rights of way constraints, major utilities, design speed, design vehicle, design period, traffic volume and service level, functional classification of the corridor, the access class, and other factors that control the selection of project standards that will ensure the facility will function safely at the level desired and expected by the motorists.

Establishing the project standards is one of the first requirements of the engineering design process. The decisions, assumptions and calculations for the design are based on these factors. All project standards shall be documented in the project file(s).

The preliminary engineering report (PD&E) or concept report may include some of the controls and standards to be used on the project. These values should be reviewed, confirmed as valid and consistent with the overall corridor or system, and documented. Significant changes to approved PD&E elements of design may require a re-evaluation of the environmental document.

The Engineer of Record must coordinate with the District Design Engineer, the District Traffic Operations Engineer, and the responsible PD&E engineer to discuss the anticipated posted speed and determine the appropriate design speed for the project.

If project standards must be used that do not meet recommended values, these must be documented and receive approval/concurrence by the appropriate FDOT and/or FHWA engineer. These are either exceptions or variations as described in ***Chapter 23*** of this volume and must be maintained in the project file(s).

When all project standards are selected, documented, and agreed upon, the engineer should get the District Design Engineer to concur that the appropriate standards are being used. The Typical Section package will include some of the project standards. Those not included, and all known exception/variation justification shall be documented in the project file(s).

13.5 Support Services

Any information or support services that have been provided must be reviewed by the Engineer of Record to determine the completeness of the information. Conditions and data may have changed drastically if they are not current.

Technical data required for the design of a roadway project can be available from various sources, such as:

1. Surveys - design, topographical, aerial, drainage, right of way location, soil, utilities
2. Traffic Data
3. Pavement Design
4. Environmental Documents (including Noise Study Report)
5. Original Plans
6. Accident Data
7. Access Management Classification

During the design process, the project will require coordination with different sections or departments. When engineering decisions, information, or other support services are required from FDOT functional areas, it is the project manager's responsibility to coordinate and facilitate the request and expedite a timely response. The functional areas include but are not limited to:

1. Planning and Programs
2. Surveying and Mapping
3. Traffic Plans
4. Geotechnical
5. Drainage
6. Maintenance
7. Construction
8. Utilities
9. Estimates and Specifications
10. Right Of Way
11. FHWA
12. Value Engineering
13. Traffic Operations
14. Environmental Mgmt. Office
15. Access Management
16. Structures
17. Safety
18. Plans Review
19. Public Transportation Office
20. District Landscape Architect

13.5.1 Aviation Office Coordination

If it is determined that an airspace obstruction exists (based on the criteria contained in ***Table 2.10.5***), refer to ***Table 13.5.1*** for applicable FAA notification guidelines. For guidelines on airspace obstruction permitting, refer to ***Chapter 333, Florida Statutes, "Airport Zoning",*** and ***Chapter 14-60, Florida Administrative Code, "Airport Licensing and Airspace Protection".***

While the responsibility for filing FAA notifications and permitting applications for FDOT Airspace Obstruction Permits or Variances to the local ordinance rests with the Engineer of Record, the FDOT Aviation Office is available to provide any requested technical assistance on planned projects that may impact the national airspace system in Florida. Please direct your request to the following:

FDOT Aviation Office
Airspace and Land Use Manager
605 Suwannee St., M.S. 46
Tallahassee, FL 32399-0450
Tel: (850) 414-4500
Fax: (850) 414-4508
Internet: http://www.dot.state.fl.us/Aviation/

Table 13.5.1 Construction of Airspace Obstructions - Notification

FAA Notification Federal law, ***Title 14 Code of Federal Regulations (CFR), Federal Aviation Regulations (FAR), Part 77, "Objects Affecting Navigable Airspace"***, requires that prior notification must be given to the Federal Aviation Administration (FAA) regarding any construction or alteration of structures that meet specific criteria (See ***Table 2.10.5***, this volume). If FAA notification is required, ***FAA Form 7460-1, "Notice of Proposed Construction or Alteration"*** is submitted to the FAA Southern Regional Office in Atlanta. This notification must be submitted at least 30 days before the earlier of the following dates: 1. Date proposed construction or alteration is to begin. 2. Date an application for a construction permit is to be filed.
FAA Emergency Notification In the case of an emergency involving essential public services, public health, or public safety, that requires immediate construction or alteration, the 30-day advance notice requirement does not apply. In such a case, the required notification may be sent by telephone or any expeditious means to the nearest FAA Flight Service Station, and within 5 days thereafter, a completed copy of the ***FAA Form 7460-1***, must be submitted to the FAA Southern Regional Office in Atlanta.

13.5.2 Hazardous Materials on Bridges

13.5.2.1 Projects Involving Steel Bridges

For all projects that involve the repair, repainting or replacement of a steel bridge, the Design Project Manager shall contact the State Corrosion Engineer in the State Materials Office to determine if the bridge contains lead or other hazardous elements. The State Corrosion Engineer will furnish a site specific specification for disposition of the lead based paint waste for that particular project.

The Design Project Manager must provide the site specific specification to the Engineer of Record who is preparing the contract plans and specifications. The Engineer of Record must ensure that the project specifications conform to the site specific specifications and that they prohibit the use of lead based paint. A mandatory pre-bid conference is not required unless special conditions exist and the district determines one is needed.

The Design Project Manager shall notify the Contracts office (State or District) that the project requires the contractor to show proof of qualification before receipt of the bid proposal if 51% or more of the project is painting or at the time of award if less than 51% of the project is painting. The Contractor must have a QP2 Category A certification, from the Society for Protective Coatings (SSPC), for painting projects. For structure removal projects, consult with the Construction Office (State or District) to determine if QP2 Category A certification will be required, or a less stringent qualification. The contractor will be required to present proof of qualification prior to beginning any structure removal work and not at award. Qualifications for both painting and structure removal projects must be noted in the advertisement and specification.

13.5.2.2 Projects Involving Bridge Demolition or Renovation

There may be asbestos containing materials used in bridges. For projects involving bridges that are to be either partially or fully demolished or renovated, the Project Manager must follow the Department Procedure on ***Asbestos on Bridges / Inspection, Abatement and Notification (Topic No. 625-020-020)*** which requires coordinating as early in the project as possible with the District Asbestos Coordinator for information on asbestos inspections, abatement and for notification requirements. Some bridge elements potentially containing asbestos include (but are not limited to) the following:

1. Tender House Roof Materials (felts, flashings, mastics, etc)
2. Tender House Floor Materials (tiles, sheet flooring, mastics, etc.)
3. Tender House Wall Materials (drywall muds, joint compounds, etc.)
4. Tender House Window Materials (caulks, gaskets, etc.)
5. Bridge Equipment Materials (gaskets, packings, linings, insulation, etc.)
6. MSE Wall Gaskets
7. Beam/Deck Bearing Pads
8. Asbestos-cement pipes(scuppers, etc.)
9. Bascule Bridge Machinery Brake Pads
10. Trowelled-on or Sprayed-on Decorative Coatings

13.5.3 Projects Involving Bridges Over Navigable Water

For projects involving bridges over navigable water, the Project Manager must provide the District Structures and Facilities Engineer (DSFE) sufficient notification prior to engaging in any action in, on, or around the bridge(s). This includes any field reviews involving persons conducting activities that may be perceived as suspicious (i.e., parking on the bridge, repeated viewing from a boat or other vehicle, carrying cameras and other electronic equipment like a GPS, etc.) This will allow the DSFE to notify the U.S. Coast Guard prior to such activities taking place.

13.5.4 Projects Affecting Interstate Logo Signs

On projects that may impact Interstate Logo Signs through any construction activities, any affected logo signs must be identified so that early coordination can take place and so those signs can be properly addressed in the plans. When the affected logo signs are identified, that information must be coordinated with the State Motorist Information Services Administrator, the District Traffic Operations Office, and Florida Logos, Inc. to determine the degree of impact, and the maintenance of the signs during construction. Through this coordination, the following questions must be answered:

1. Will the logo signs need to be removed during construction?
2. Can the logo signs be reinstalled after construction?
3. Can the logo signs be temporarily relocated out of the work zone during construction so the service will not be interrupted, and then permanently reinstalled after the work is complete?
4. If the logo signs cannot be temporarily relocated during construction, where can they be stored until they are reinstalled?

13.5.5 Buy America Provisions

The Buy America provisions, established in ***CFR 635.410***, requires that on all Federal-aid highway construction projects, if steel or iron materials are to be used, all manufacturing processes for these materials, including application of a coating, must occur in the United States. Buy America requirements are covered in ***FDOT Standard Specification Section 6-12.2***. ***Section 6-12.2*** identifies allowable levels of foreign steel or iron and contractor certification requirements.

While ***Section 6-12.2*** applies to contractors, designers also have a responsibility to insure Buy America provisions are met. When Buy America provisions are not met, the entire project is not eligible for Federal funds. The design engineer of record needs to do sufficient research to determine that any steel or iron called for in the plans is manufactured in the United States. This is necessary when the plans include the following:

1. Non-standard or special grade steel components and shapes.
2. New proprietary products containing steel or iron materials.
3. Sole source products containing steel or iron materials.
4. Special machinery with steel or iron components.
5. Heavy sections of steel sheet pile wall.

It is not necessary to conduct such research for the following:

1. Standard domestic steel beams and shapes of standard grades as shown on the National Steel Bridge Alliance (NSBA) website.
2. Standard concrete reinforcing steel sizes and grades.
3. Standard steel drainage pipe sizes and gages.
4. Items covered in the ***Design Standards*** including:
    a. Standard mast arm assemblies.
    b. Standard steel guardrail, posts, and end treatments.
    c. Standard drainage grates.
    d. Standard steel fences.
    e. Standard steel sign supports and structures.

If it is determined that a steel or iron product being proposed is not manufactured in the United States, then the Designer shall determine if the estimated costs of such foreign steel or iron is within the thresholds stated in the specification. If the costs exceed such threshold, the Designer shall explore alternatives that utilize domestic steel or iron, or seek a waiver from FHWA. Generally it is preferred to select a different engineering solution utilizing domestic products.

Should a waiver become necessary, it must be obtained BEFORE the contract letting to insure federal funding is not jeopardized. Buy America waiver requests shall be submitted to the Central Office for concurrence by the Directors of Design and Construction. Requests will then be forwarded to the FHWA Florida Division Office for approval and coordinated with the FHWA headquarters in Washington D.C. for further concurrence. Originals will be returned to the District by the Central Office. These issues must be identified early in the plans preparation process.

13.5.6 Traffic Monitoring Sites

One or more traffic monitoring sites should be considered for addition to each construction project which has a type of work consistent with the construction of such sites. Examples of compatible work types include traffic signals, resurfacing, reconstruction, and other work that involves either pavement surfaces or electrical systems. Inquiries about monitoring sites should be addressed to the Traffic Data Section Manager of the Transportation Statistics Section, Office of Planning.

13.6 Preliminary Geometry, Grades, and Cross Sections

To establish geometry, grades, and cross sections, the following activities should be accomplished or near completion:

1. Supporting data such as surveys, traffic and pavement evaluation data.
2. Typical sections and pavement design.
3. Standards, variations and exceptions.
4. PD&E and environmental commitments addressed and if necessary, re-evaluation.
5. Need for R/W phase addressed.
6. Utility initial contact and survey data.
7. Transit initial contact and facility location.

The initial engineering design activities to establish the preliminary project plans are:

1. Set and calculate the horizontal alignment.
2. Set the proposed profile grade lines.
3. Develop preliminary cross sections at selected intervals or control locations.
4. Develop preliminary layout of roadway, intersections, interchanges, transitions, and connections.
5. Field review all proposed preliminary engineering layout and decisions for conflicts, R/W needs, connections, updates and additional needs.

The initial engineering review (Phase I) is used to obtain confirmation and approval of the objectives, scope, standards, decisions, and assumptions to be used as the basis for the engineering and design. The Engineer now has the decisions and direction necessary to perform final engineering. If this is not the case, the necessary initial engineering activities must be accomplished before continuing to the final design process.

The results of the above activities should be that:

1. Structures can now be given the horizontal and vertical alignment and clearance requirements for bridges.
2. R/W Engineering can be furnished with mainline R/W requirements for the project.
3. Plan-profile sheets can be clipped.
4. Traffic plans development can be initiated.

5. Cross sections, grades and alignments, as required, can be provided to the drainage section.
6. Work sheets, as needed, can be provided to the permits section for initial evaluation.
7. Utility/Agency Owners (UAOs) can be provided plans, profiles and cross sections as required to identify/verify and designate their existing utilities as well as indicate proposed installations.
8. The TRNS*PORT pay item listing can be initiated by identifying the items of work involved at this point.
9. The need for sound barriers has been confirmed and locations established.

13.7 Distribution of Exempt Public Documents

It is the policy of the Department to protect the State Highway System's infrastructure from disclosure under Florida's public records law for documents concerning Department structures. This exemption is created by ***Section 119.07(3)(ee), F.S.*** and covered by Department Procedure "***Distribution of Exempt Public Documents Concerning Department Structures and Security System Plans*** (***Topic No. 050-020-026***)."

Structure is defined in ***Section 334.03(28), F.S.***, as "a bridge, viaduct, tunnel, causeway, approach, ferry slip, culvert, toll plaza, gate, or other similar facility used in connection with a transportation facility." This includes pipes and pipe systems. Therefore, those portions of Department plans that depict pipes, pipe systems, or the internal layout and structural elements of a structure owned or operated by the Department, are exempt from a public records request under ***Section 119.07(3)(ee), F.S.***. This applies to all formats (paper, electronic, etc.), and at any phase of completion (existing, draft, preliminary, phase reviews, or final).

Entities or persons outside the Department requesting or receiving copies of any portion of plans considered Exempt Documents will need to complete a request form (***Form No. 050-020-26***). The form also advises the requestor that the entity or person receiving the information shall maintain the confidential and exempt status of the information.

This procedure applies to both Department internal or contracted staff who produce such Exempt Documents in their Department work or have other methods of access to such Exempt Documents in the distribution to persons or entities outside of the Department. Refer to ***Topic No. 050-020-026*** for further requirements.

Chapter 14

Final Engineering Design Process

14.1 General

The final engineering design process follows the initial engineering design process and review (see ***Chapters 13*** and ***16*** of this volume). The final engineering design phase should be roughly 50% of the total effort. The primary objective of the final engineering design phase is to prepare contract plans and specifications that can be used to bid and construct the project with a minimum of field changes, delays, and cost overruns.

14.2 Final Engineering Design

The Engineer and Project Manager must coordinate all activities to ensure that the quality, accuracy, and appropriate decisions go into the performance of each step. The project quality control should include a plan-do-check routine for each set of activities or operations.

The major design activities include, but are not limited to, the following:

1. Pavement design
2. Drainage design
3. Structural (bridge) design
4. Structural (roadway) design
5. Roadway design including access management, earthwork, geometrics, ADA, etc.
6. Traffic plans design including signing, marking, signals, lighting, etc.
7. Utility adjustment design
8. Permit preparation design including ponds, mitigation, etc.
9. Traffic control plans (work zone) design
10. R/W requirements design
11. Building and site design including landscaping, ADA, transit, etc.
12. Estimates and computation book preparation
13. Specifications and special provisions
14. Landscaping design
15. Sound barrier design

Project stationing information is to be checked and entered into the Work Program Administration (WPA) system during final engineering design. This information is important for tying construction records, such as material coring, sampling and testing to other databases. The information is entered by stations, which are related to roadway mile post for later information retrieval.

The project designer is responsible for finalizing the project stationing. The District Design Engineer should designate an individual to be responsible for coordinating the input of stationing information into the WPA system.

The begin/end stations and station equations are entered into the WP50 computer screen under FM on the FDOT CL/SUPERSESSION Main Menu for each WPA location. After logging onto SUPERSESS, the WP50 designees enter on FM (Financial Management System). On the FM Main Menu, press ENTER: 3 for WPA (Work Program Administration). On WPA Main Menu, press ENTER: 25 for WP50 (Station Definition).

Update access to WP50 screen is granted through the Work Program Development Office in Tallahassee. Listed below are the important edit and browse features:

1. Only enter FM Item_Segment number on the top line.
2. The RDWYLOC sequence number displays on the top line of the screen and on the first line of the header information. It's entered on the top line to retrieve a particular location.
3. The transaction type "00" is entered on the top line to browse all station equation information for that RDWYLOC. The transaction type "02" is entered on the top line to update all station equation information for that RDWYLOC. The transaction type "99" is entered on the top line to erase all station equation information for that RDWYLOC.
4. Press the F8 key will forward from one RDWYLOC to the next RDWYLOC on the same Item_Segment number. Press ENTER key to update or delete data on the screen depending on the transaction type but will not page forward.
5. Press F3 key will take the user to the FM main menu while press F15 key will take the user back to the SUPERSESS main menu.

After entering the station information, it is important to check to see if the milepost limits in WPA are still accurate. This can be accomplished by reviewing the WP50 computer screen.

If the project length has changed, the District Work Program Office should be advised to correct the mileposts.

This information will become increasingly important as Geographic Information Systems increase in use and project locations are automatically mapped based on milepost limits.

Chapter 15

Update Engineering Design Process

15.1 General

The update engineering design process begins when a final contract plans, specification and estimates (PS&E) package has been on the shelf for any significant period (approximately nine months). The update process depends on the type of project, the adequacy and appropriateness of the original design controls and standards, and the original scope and objectives. The extent of the update process should be determined based on both engineering and management input.

15.2 Design Update Review and Decision Process

An engineering review of the PS&E and proposed contract documents must be made to determine the activities required to update the package and get it ready for letting.

1. The original project objectives, scope and standards must be reviewed and compared with current corridor conditions, as well as growth rate and patterns, to determine if the project design is still valid.
2. Original environmental evaluations and commitments must be weighed against current requirements.
3. Permit date and terms must be weighed against current requirements.
4. R/W certifications and agreements must be reviewed and the status of documents confirmed.
5. Contract plans must be reviewed for current requirements, including standard indexes, specifications, pay items and design criteria.
6. Agreements with outside entities such as Utility/Agency Owners (UAOs), maintaining agencies and local agencies must be reviewed.
7. Design Exceptions and Variations must be resubmitted with updated documentation based on current data and conditions.

If the decision is that engineering updates are required, the scope, staff-hour estimate, schedule, cost estimate, and other activities described in ***Chapter 13*** of this volume should be followed to the extent necessary to define the scope and schedule for the update process.

15.3 Updating Engineering Design and Documents

The actual engineering design activities necessary to update the plans package will vary from project to project. They must be fully described in the professional services contract, if one is to be used. If done in-house, a fully defined scope of work must be developed to determine resources and schedule needed for the update.

All reports, calculations, assumptions, and engineering decisions that support the changes to plans, specifications, or other documents must be signed and sealed by the Engineer updating the engineering plans, specifications and documents. All changes to the plans must be approved by the responsible engineer in charge of the work and receive the concurrence of the District Design Engineer, Structures Design Engineer, or Consultant Project Management Engineer, as appropriate for the type of change. Updated documentation of all approvals and concurrences shall be in the project file.

15.4 Revised Contract Plans Package

In addition to the required engineering changes, which may be necessary, the contract transmittal package must be reviewed and updated to current status.

1. All component plans sets are made current and sealed.
2. Specifications and special provisions are made current.
3. The CADD electronic files are revised.
4. The computation book and pay item summaries are made current.
5. The contract file is made current.

c. A crossroad which may affect a structure exists.

d. Major work of significant length is being done on an intersecting roadway.

2. **May** be required if a change in design speed occurs within the project limits.

The proposed typical sections for roadway and bridges are to be submitted by the responsible engineer for concurrence by the District Design Engineer. Coordination with the District Structures Design Engineer is also required on all bridge typical sections. The roadway and bridge typical sections shall be submitted together to ensure compatibility.

The typical section package for both roadway and bridges shall be approved as part of the Project Development & Environmental (PD&E) process. Typical section package preparation, and coordination between the responsible PD&E engineer and the District Design Engineer, must occur during the development of project alternatives prior to preferred alternative selection. The responsible PD&E engineer shall prepare, seal and submit the typical section package for concurrence. Typical section package concurrence by the District Design Engineer shall be obtained after the preferred alternative is selected. A copy of the approved typical section package shall be included as part of the PD&E Final Preliminary Engineering Report.

For projects that do not contain a PD&E phase, the typical section package shall be prepared, sealed and submitted by the responsible engineer for concurrence by the District Design Engineer. The typical section package should be concurred with prior to the final engineering process.

The Engineer of Record must coordinate with the District Design Engineer, the District Traffic Operations Engineer, and the responsible PD&E engineer to discuss the anticipated posted speed. The selected design speed shall be jointly approved by the District Design Engineer and the District Traffic Operations Engineer. This joint approval shall be documented on the Typical Section Data Sheet (see ***Exhibit 16-B, Sheet 1 of 6***)

Exhibit 16-B contains example typical section package sheets. The following is an outline of the information which is required as part of the typical section package submittal. This information is critical for proper evaluation by the District Design Engineer. Missing information may require a resubmittal of the typical section package.

The following information is required on the project controls sheet:

1. Financial Project ID

2. County (and Section)

3. Project Description
4. Functional Classification
5. Highway System
6. Access Classification
7. Traffic Data (AADT, for Current, Opening and Design Year, Design Speed, Posted Speed; K, D, and T Factors)
8. Potential Exceptions and Variations related to the typical section elements
9. List Major Structures Requiring Independent Structures Design (including location and description)
10. List Major Utilities within project corridor
11. List other information pertinent to the design of the project

The following information is required on the project identification/proposed typical section sheet:

Project Identification:

1. Financial Project ID
2. State Project No. (if assigned)
3. Federal Aid Project No. (if assigned)
4. Work Program Item (if assigned)
5. Road Designation
6. County Name (and Section)
7. Limits (In Milepost)
8. Project Description

Proposed Roadway Typical Section Drawing:

1. Design Speed
2. Limits (station limits of the typical section shown if available)
3. Lanes (dimension width, show cross slope of each lane, label bike and HOV lanes)
4. R/W Line (graphically show, label and dimension from centerline const.)
5. Shoulder (dimension width, show cross slope, paved shoulder is dimensioned and labeled separately)

3. 90% Structures Plans
4. 100% Structures Plans

These reviews should be coordinated with the phase reviews of the roadway plans. The latest set of structural plans shall be submitted with the Phase II roadway plans submittal. This joint submittal at Phase II roadway plans review is to ensure that roadway and bridge structures plans are consistent, i.e., widths, superelevation transitions, vertical and horizontal alignment, and work zone traffic control agree. The precise number and type of plans submittals depends on the complexity of the design and/or the sensitivity of the project. Each submittal shall include written responses to the comments received on the previous submittal.

16.3.3 Other Structural Submittals and Reviews

In addition to bridge plans, structures plans may include retaining walls, sheet piling, sound barriers, box or three-sided culverts, pedestrian overpasses, temporary bridges, and special structural appurtenances. Special structural appurtenances that include transit related furnishings and amenities would require review by the local transit agency.

For projects where bridges and other structures plans are involved, preliminary and final plan submittals (usually along with bridge plans) should be handled according to the instructions for structures plans submittals covered in ***Chapters 26*** and ***30*** of this volume.

For projects where retaining walls are required along with roadway plans only (no bridge in the project), the Engineer of Record shall follow the procedure outlined in ***Chapter 30*** of this volume. The submittal of detailed control plans should occur as early in the design process as possible.

Where the District Roadway Office cannot carry out the structural review or verify the review as proper by a consultant, such review may be requested from the District Structures Design Office or the State Structures Design Office.

16.4 Plans Phase Reviews

The number of submittals and phase reviews shall be determined on a project-by-project basis and shall be defined in the scope. Submittals allow functional areas to review the development of the project as contained in the scope.

Formal plans phase review requirements are covered in the District Quality Control Plan. Reviews should include Department personnel that can assist in making timely decisions and confirm that the requirements have been met for their discipline. Ideally, reviews should be driven by the engineering process and should occur when there is a need for input or a decision to complete a critical activity before progressing with the design. Some of these activities are discussed in ***Section 16.2*** of this chapter. Reviews are complete when the comments from all the various offices have been resolved and have been documented as required in ***Chapter 24*** of this volume.

Constructability and biddability reviews by the District Construction Office shall be included at appropriate stages of the phase review process. Procedures for these reviews are provided in the ***Construction Project Administration Manual (Topic No. 700-000-000)***.

Minor projects, such as resurfacing, should typically have two plans phase reviews. The two reviews should consist of a decision-making phase review on the scope and intent of the project and a final plans phase review for constructability/biddability. One of these will be an on-site review.

On complex projects plans phase reviews may be required at the Phase I, II and III stages and a final check at Phase IV. Two on-site reviews will be required. Generally, one of the site reviews is held early in the initial engineering phase.

Section 2.3 of ***Volume II*** outlines, in detail, the sequence for contract plans preparation and assembly required by the several design phase submittals. Also included in the chapter is information required to be presented on various plan sheets included with each submittal.

When the plans are in compliance with all phase review requirements and are considered final, they are to be submitted in accordance with the process described in ***Chapter 20*** of this volume.

Exhibit 16-B Typical Section Package
Sheet 1 of 6

PROJECT IDENTIFICATION

FINANCIAL PROJECT ID ____________ **COUNTY (SECTION)** ____________

PROJECT DESCRIPTION ____________

PROJECT CONTROLS

FUNCTIONAL CLASSIFICATION

( ) RURAL
( ) URBAN

( ) FREEWAY/EXPWY. ( ) MAJOR COLL.
( ) PRINCIPAL ART. ( ) MINOR COLL.
( ) MINOR ART. ( ) LOCAL

HIGHWAY SYSTEM

Yes	No	
( )	( )	NATIONAL HIGHWAY SYSTEM
( )	( )	FLORIDA INTRASTATE HIGHWAY SYSTEM
( )	( )	STRATEGIC INTERMODAL SYSTEM
( )	( )	STATE HIGHWAY SYSTEM
( )	( )	OFF STATE HIGHWAY SYSTEM

ACCESS CLASSIFICATION

( ) 1 - FREEWAY
( ) 2 - RESTRICTIVE w/Service Roads
( ) 3 - RESTRICTIVE w/660 ft. Connection Spacing
( ) 4 - NON-RESTRICTIVE w/2640 ft. Signal Spacing
( ) 5 - RESTRICTIVE w/440 ft. Connection Spacing
( ) 6 - NON-RESTRICTIVE w/1320 ft. Signal Spacing
( ) 7 - BOTH MEDIAN TYPES

TRAFFIC

	YEAR	AADT
CURRENT	______	______
OPENING	______	______
DESIGN	______	______

		DISTRIBUTION	
DESIGN SPEED	______	K	%
POSTED SPEED	______	D	%
		T_{24}	%

DESIGN SPEED APPROVALS

____________ ______
DISTRICT DESIGN ENGINEER DATE

____________ ______
DISTRICT TRAFFIC OPERATIONS ENGINEER DATE

CRITERIA

( ) NEW CONSTRUCTION / RECONSTRUCTION
( ) RRR INTERSTATE / FREEWAY
( ) RRR NON-INTERSTATE / FREEWAY
( ) TDLC / NEW CONSTRUCTION / RECONSTRUCTION
( ) TDLC / RRR
( ) MANUAL OF UNIFORM MINIMUM STANDARDS (FLORIDA GREENBOOK) (OFF-STATE HIGHWAY SYSTEM ONLY)

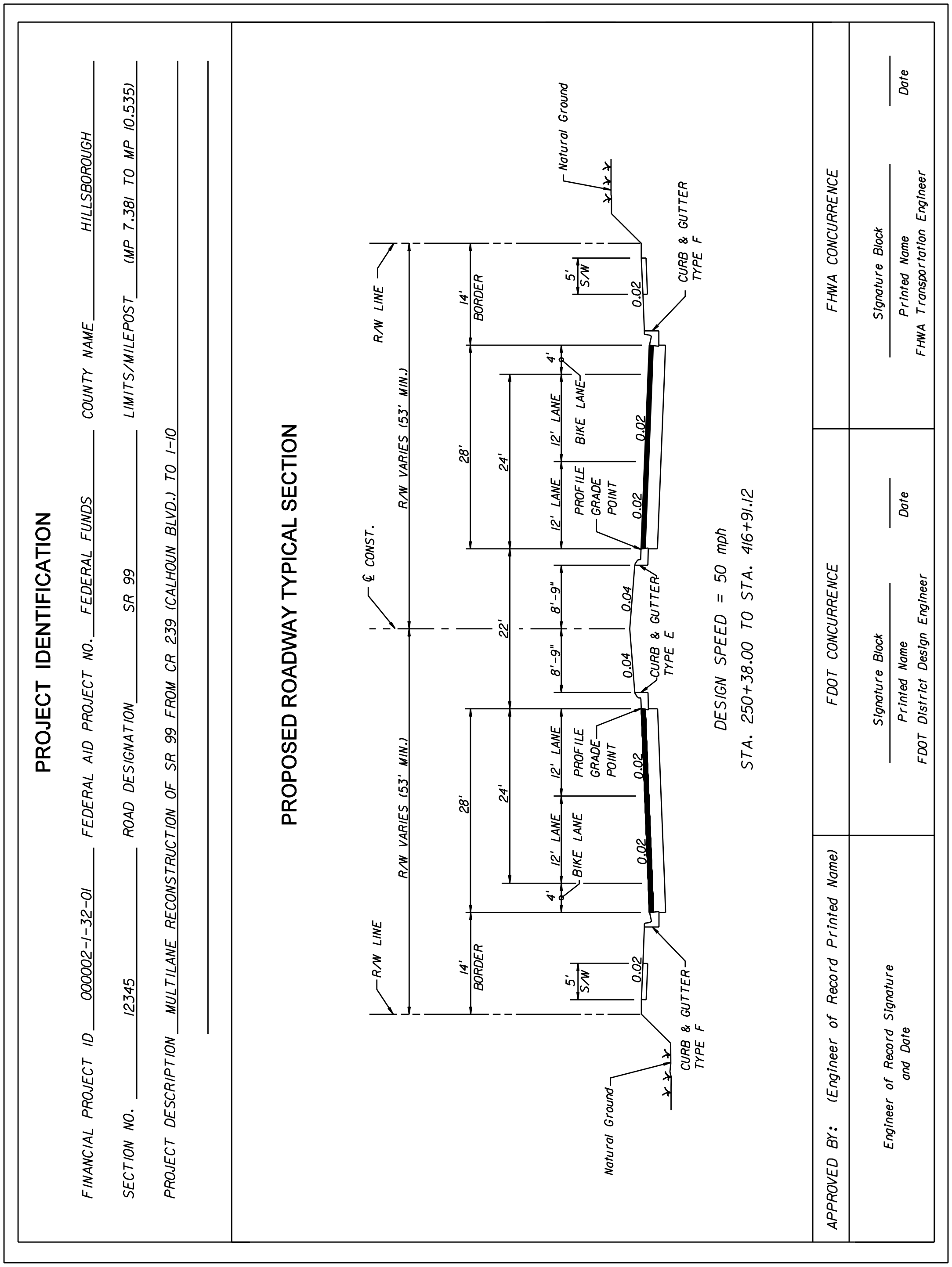
LIST ANY POTENTIAL EXCEPTIONS AND VARIATIONS RELATED TO TYPICAL SECTION ELEMENTS:

LIST MAJOR STRUCTURES LOCATION/DESCRIPTION - REQUIRING INDEPENDENT STRUCTURE DESIGN:

LIST MAJOR UTILITIES WITHIN PROJECT CORRIDOR:

LIST OTHER INFORMATION PERTINENT TO DESIGN OF PROJECT:

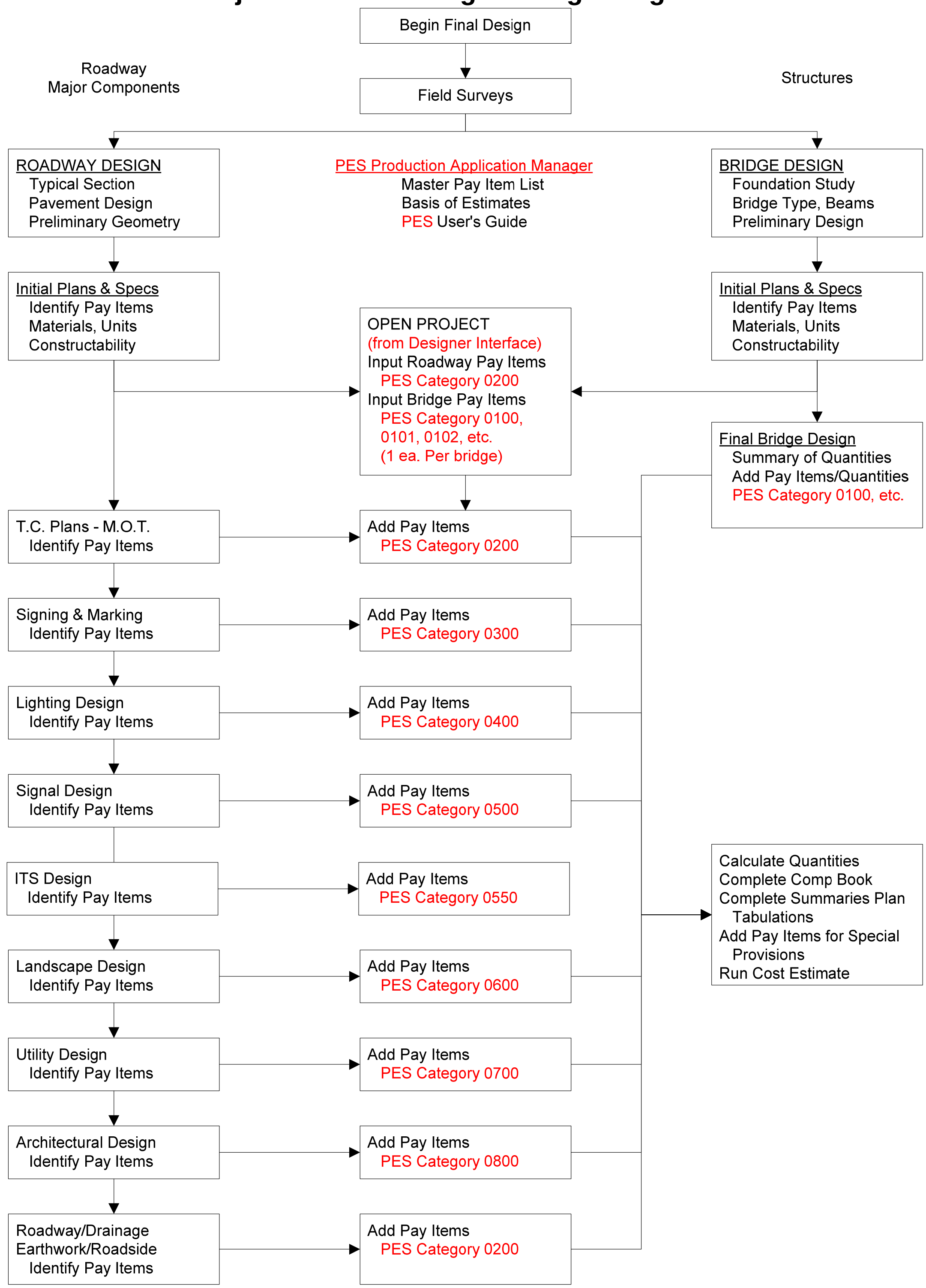
Exhibit 16-B, Sheet 2 of 6



Chapter 17

Engineering Design Estimate Process

Exhibit 17-A Major Activities - Engineering Design Estimate Process



18.3 Quality Control

Quality Control is the process performed to ensure conformance with valid requirements. This process includes quality planning, training, providing clear decisions and directions, constant supervision, immediate review of completed activities for accuracy and completeness, and documenting all decisions, assumptions and recommendations.

Each District shall have a **District Quality Control Plan for Roadway Design** and the other production units, which addresses broad overall quality initiative. The **District Quality Control Plan** shall identify the organization, responsibility, and accountability used to perform and document overall quality control, including the requirement for a Project Quality Control Plan on all projects. All **Project Quality Control Plans** must address any project specific scope of service needs and be approved by the Project Manager or District Design Engineer as appropriate.

In-house and consultant designers and reviewers must recognize quality is the result of several processes. It requires many individuals performing many appropriate activities at the right time during the plans development process. Quality control does not solely consist of a review after a product is completed. Quality requires performing all activities in conformance with valid requirements, no matter how large or small their overall contribution to the design process. Good CADD techniques, attention to details and ensuring the plans are correct and useful to the contractor are also essential to quality.

18.3.1 Authority

Section 20.23(4)(b), Florida Statutes, requires a **Quality Control Process**. It requires that each District shall be accountable for ensuring their District's quality of performance and compliance with all laws, rules, policies, and procedures related to the operation of the department.

18.3.2 Accountability

1. The **District** shall follow established design policies, procedures, standards and guidelines in the review and preparation of all design products; and review Consultant prepared individual engineering and design for compliance and good engineering practice.
2. The **Consultant** is an agent for the District with the primary responsibility for preparation of contract plans. Consultants must ensure quality and adherence to established design policies, procedures, standards and guidelines in the review and preparation of all design products for compliance and good engineering practice as directed by the District Project Quality Control Plan.

18.3.3 Critical Areas to be Monitored

The District shall monitor the Quality Control efforts used by in-house staff and its consultant services units. The District shall assure project scopes include an adequate **Project Quality Control Plan.**

18.3.4 Documentation

The Districts shall maintain a file containing the current District Quality Control Plan and shall furnish Central Office Design with a copy to be used as part of the critical areas to be reviewed. Every project file will contain a Project Quality Control Plan at the beginning of the Initial Engineering Design Process.

18.3.5 Training

The District shall identify and coordinate training needs of in-house and Consultant services through the appropriate Central Office units.

19.2.2 Electronic Sealing

Information stored in electronic files representing plans, specifications, plats, reports, or other documents which must be sealed under the provisions of ***Chapter 471, Florida Statutes***, shall be signed, dated and sealed by the professional engineer in responsible charge.

Electronic files may be sealed by creating a "signature" file that contains the engineer's name and PE number, a brief overall description of the engineering documents, and a list of the electronic files to be sealed. Each file in the list shall be identified by its file name utilizing relative Uniform Resource Locators (URL) syntax described in the ***Internet Architecture Board's Request for Comments (RFC) 1738, December 1994***, which can be obtained from the Internet Website:

ftp://ftp.isi.edu/in-notes/rfc1738.txt

Each file shall have an authentication code defined as an SHA-1 message digest described in ***Federal Information Processing Standard Publication 180-1 "Secure Hash Standard," 1995 April 17***, which can be obtained from the Internet Website:

http://www.itl.nist.gov/fipspubs/fip180-1.htm

A report shall be created that contains the engineer's name and PE number, a brief overall description of the engineering documents in question and the authentication code of the signature file. This report shall be printed and manually sealed by the professional engineer in responsible charge. The signature file is defined as sealed if its authentication code matches the authentication code on the printed, manually signed, dated and sealed report. Each electronic file listed in a sealed signature file is defined as sealed if the listed authentication code matches the file's computed authentication code.

For those sheets that are electronically signed and sealed, the following note shall be placed legibly on the sheet (outside and along the right sheet border line, within 1/8" of the line and beginning within 1" of the bottom sheet border line):

"NOTICE: THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE SIGNED AND SEALED UNDER RULE 61G15-23.003, F.A.C." *

* Note: The Rule number referenced is determined by the discipline of the professional that is signing and sealing (i.e., for Surveyors, this Rule is 61G17-7.0025, F.A.C.; for Geologists, this Rule is 61G16-2.005, F.A.C.; for Landscape Architects, this Rule is 61G10-11.011, F.A.C.; for Architects, this Rule is 61G1-16.005, F.A.C.).

19.3 Sealing Other Engineering Documents

Other engineering documents include related plans, reports, computations, specifications or criteria, as defined in ***Rule 61G15-30.002 (4)***, and used in the development of design plans. Bound engineering documents must be sealed on a signature page or cover letter by the EOR. If a document includes work by more than one EOR, the signature page or cover letter must have an index with sufficient information for the user to be aware of each portion of the document for which each engineer is responsible. To seal a document, the engineer will sign, date immediately under the signature, and seal over the signature and date. With the exception of specifications, any document, report or computations not bound shall have all sheets sealed. Specifications will be sealed in accordance with the ***Specifications Package Preparation Procedure***.

The following engineering documents shall be kept in the district's Project File(s).

1. Specifications and Special Provisions
2. Pavement Design Package
3. Typical Section Package
4. Drainage Computations
5. Hydraulics Reports
6. Bridge Development Report
7. Traffic Engineering Reports and Recommendations
8. Environmental Reports and Recommendations
9. Soil Survey Reports and Geotechnical Report
10. Value Engineering Record
11. Other Engineering Reports
12. Permit Documentation
13. Design Exceptions and Variations
14. Design Exceptions for Utilities prepared by an Engineering Consultant

20.4 Revisions to the Contract Plans Package

Design revisions are modifications to the PS&E Package after it has been accepted by Central Office Plans Processing but prior to bid opening. The Project Manager insures a revision is complete as follows (see ***Figure 20.2***):

1. If the project is FA Oversight, obtain concurrence from FHWA prior to making revisions. Include the name of the FHWA contact who gave concurrence and the concurrence date on the revision memo. FHWA concurrence may not be required on minor changes such as in quantities or to relocate a driveway.
2. Revisions include the modification, deletion, or addition of data on individual sheets, adding new sheets, or the removal of entire sheets.
   a. All plans revisions require sealed revised sheet(s).
   b. For revisions to plans sheets other than a Key Sheet, place a conspicuous unique numbered symbol (e.g., a numbered triangle) beside the revision that corresponds to the Revision Number on the Revision Memo. Begin the revision numbering with “1” and number subsequent revisions of the plans sequentially. Place the revision date, corresponding numbered symbol for the revision, and a brief description of the revision in the Revision Block on each modified sheet. The same applies to adding sheets, however the added sheets may be numbered with alpha characters (e.g., 22a, 22b, 22c). If a sheet is being deleted, the sheet numbers for the following sheets remain unchanged.
   c. The revisions of plans sheets other than a Key Sheet are also noted on the lower left corner of the Key Sheet in the “Revisions” area. (See ***Exhibit KS-1, Chapter 3, Volume II***). If the changes to a Key Sheet only involve notes in the Revisions area, no entry is made in the Key Sheet Revisions Block at the lower right corner. The Key Sheet Revisions Block is only used to record changes other than revisions notes. Revisions to component sets such as the Signalization Plans are noted in the Revision Block of the modified sheet and on the **lead** Key Sheet in the Revisions Area. If a sheet is being deleted, this must be noted in the Revisions Area on the lead Key Sheet, and the Index of Sheets must be revised to show the sheet number(s) of the deleted sheet(s), with a sheet description of “(DELETED)”. This also must be recorded in the Key Sheet Revisions Block as a revision to the Index of Sheets. A newly sealed lead Key Sheet is required when any sheet is revised.
3. Prepare the Revision Memo (***Exhibit 20-C***), provide a Revision Number, and describe modifications. Record the revision date for each revised sheet, using the

date shown in the revision block on the sheet. The District Design Engineer, District Consultant Project Management Engineer or the District Structures Design Engineer, as appropriate, reviews and concurs with the revision.

4. The District Specifications Engineer reviews the revisions for any effect on the specifications and dates and signs the Revision Memo.

5. The number of revision packages submitted should be kept to a minimum. When more than one revision is expected, hold until all revisions are ready and submit as a package. Revision packages should be submitted by the Monday prior to Authorization for Advertisement, whenever practical. Revisions after this date should be coordinated with the District Estimates Engineer, as soon as possible.

6. Revisions Involving Pay Item Changes:

   a. Send the Revision Memo to the District Estimates Staff for review.

   b. The District Estimates Staff or appropriate person for the District is required to fax the Revision Memo to the State Estimates Office.

   c. The State Estimates Office will determine who will make the Changes to the Pay Items (Central Office or District Office) and will pass control as required to the District. Note: Control will be passed to Decentralized Districts for revisions. When control is passed, the Revision must be completed within 24 hours.

   d. The District will complete the Revision and change the Control back to the State Estimates Office (within the 24 hours). The District will also notify the State Estimates Office that the revision is complete via email using the Distribution List FDOT-PRELEST.

7. Ensure that sealed plans sheets are attached to the Revision Memo. The Engineer of Record seals each revised document in accordance with ***Chapter 19, Sealing Design Documents***, of this volume.

8. Mail the signed original Revision Memo with attachments (or scan the signed original and email) to Plans Processing at (Mail Station 75). If a Supplemental Specifications Package is required, submit it as an electronically sealed package accompanying the Revision Memo. Send the revised original computation sheets and one copy to the District Construction Engineer. If the original Revision Memo will be received in Plans Processing between 15 and 6 working days prior to letting, the District Secretary must approve by signing the Revision Memo. Revisions within five work days of letting are not allowed since there is no assurance that all prospective contractors will get these documents on time to consider in their bids. After this date the project must be let as is, or must be withdrawn from letting. Withdrawing the Plans Package after advertisement requires approval by the District Secretary and the State Highway Engineer.

Exhibit 20-A Transmittal of Plans, Specifications, and Estimates Package Sheet 1 of 2

TRANSMITTAL OF PLANS, SPECIFICATIONS, AND ESTIMATES PACKAGE

Date: ____________________

Financial Project ID(s): ____
Proposal/Contract ID: ____________________ **Letting Date:** ____________________
County: ___________________________ **State Road No.:** ______________________
Federal Funds: ☐**No** ☐ **Yes** **Federal Aid No.:** ____________________________
Work Type: ____
____

On ___/___/_____, the District Director of Transportation Development (Production) certified that the Plans, Specifications and Estimates (PS&E) Package is complete, has no known errors or omissions, has been reviewed for constructability and biddability, and is ready to advertise for construction.

The following items transmitted as noted:

SEALED CONTRACT PLANS SET (_____ SHEETS):
☐ Hardcopy ☐ Electronic (If "Electronic", the Electronic Plans Package was reviewed by ______________________________ and posted to the server on ____/____/_____).

SEALED SPECIFICATIONS PACKAGE (_____ PAGES):
The Electronic Specifications Package was reviewed by __________________________ and posted to the server on____/____/____.

ESTIMATES OFFICE INFORMATION:
The Authorization Estimate will be reviewed by __________________________ and will be posted to the server on____/____/____.

FEDERAL AID OFFICE INFORMATION:
Federal Aid Oversight: ☐ No ☐ Yes
FHWA: Approved by ____________________________________ Date: ________________
Print Name of FHWA Engineer

CONTRACTS OFFICE INFORMATION:
Contract Time: _________ Calendar Days
Special Start Time: ☐ No ☐ Yes (If yes, Start Date: ____/____/____)
Flexible Start Time: ☐ No ☐ Yes (If yes, ______ Calendar Days)
Acquisition Time: ☐ Standard ☐ Other (________ days)
Lead-based paint: ☐ No ☐ Yes (If yes, is it greater than 51% of the work? ☐ No ☐ Yes)
Alternative Contracting: ☐ No ☐ Yes
(If yes, Type: ____)
TRNS*PORT Site Record: User Cost Per Day $____________ Maximum Days _________)
(If Lump Sum, Checklist 22-A submitted to District Specs. Office: ☐ No ☐ Yes)
Partnering: ☐ No ☐ Yes **Disputes Review Board:** ☐No ☐ Yes
E-Mail Intent & Scope: ☐ No ☐ Yes
Pre-Bid Conference Mandatory? ☐ No ☐ Yes (Date:____/____/____ Time:_______ A.M./P.M.)
(Contact Person and Phone:____)
(Location of Conference: ____)

SPECIAL NOTES and REQUIREMENTS (List/Explain):
____
____

If any items are missing please contact the Project Manager, SC____________________________.

Exhibit 20-A Transmittal of Plans, Specifications, and Estimates Package
Sheet 2 of 2

REMINDER

1. The sealed Contract Plans Set is from first-generation CADD produced plots or laser prints, size B (11x17), on good quality multipurpose (typewriter/printer) paper.*
2. Punch 2 holes (standard holes are 8 1/2 inches apart on the left edge of the sheet), and bind plans sheets with fasteners such as Chicago Screw Posts (do not staple).*
3. Check that all components of the Contract Plans Set are included as listed on the lead key sheet.
4. Check that all sheets are included according to key sheet index(es).
5. Check that all sheets have the correct Financial Project ID.
6. Check that all sheets are legible and reproducible.
7. On strung projects, check that all Summary of Pay Items sheets from the Proposal/Contract ID go in the lead project and the Financial Project ID of the strung project is shown on the lead key sheet.
8. Check that bridge pay item sheets show bridge numbers and the quantity breakdowns.
9. Organize attachments in the order listed.
10. E-mail the Transmittal and all applicable documents (including the Contract File Index and attachments) to the group “CO-CPKG” and copy the Project Manager. If submitting hardcopy plans, mail to Plans Processing at Mail Station 75.
11. COMPUTATIONS - Send original computation book and 1 copy to the District Construction Engineer.

* Applies to jobs with hardcopy plans.

Exhibit 20-B Contract File Index
Sheet 1 of 2

CONTRACT FILE INDEX

Financial Project ID ____

Proposal/Contract ID ____

ATTACHMENTS (check or expected day of transmittal to Central Office)

______ Calendar Days Recommendation*
______ Preliminary Engineering Certification*
______ Utility Certification
______ Status of Environmental Certification*
______ Permit Transmittal Memo
______ Railroad Clear Letter
______ Special Component Plan Approval**
______ FHWA Cost Estimate Summary Sheet*

☐ No ☐ Yes Federal Authorization Request (FAR) Form has been electronically transmitted*

☐ No ☐ Yes Project exempt from FHWA oversight under agreement dated April 26, 1999*

☐ No ☐ Yes Right of Way Certification was mailed to State R/W Administrator

☐ No ☐ Yes Local Funds Agreement sent to Office of Comptroller

☐ No ☐ Yes Local Funds Sent to Office of Comptroller

☐ No ☐ Yes Project is Federally Funded off the State Highway System, requiring a Maintenance Agreement. If yes, a Maintenance Agreement (Number ________) was executed on ____________________. A copy is available upon request.

---

* Include if federally funded.

** Per Volume 2, Section 2.1.

Name:________________________________ Date:____________________________

Print Name of Project Manager/Other Title

Exhibit 20-B Contract File Index, Sheet 2 of 2

REMINDER

PROCESS:

1. Organize attachments in the order listed.
2. Show the number of Maintenance Agreements (Federal funds – off the State Highway System).
3. Show anticipated date of arrival on any item not included in package.

NOTE: The Contract File Index is an integral part of the Transmittal of Plans, Specifications, and Estimates Package.

Exhibit 20-C Revision Memo
Sheet 1 of 3

DATE: ____________________ 1 of ___
TO: Plans Processing, Mail Station 75

FROM: _________________________, Project Manager

SUBJECT: **Revision Memo** - Letting (mo./yr.) _________

Financial Project ID _________________________ (Lead number only)

Proposal/Contract ID ________________________

Federal Funds: ☐No ☐ Yes Federal Aid No. _____________________

County ________________________ State Road No. __________

Concurred by: _____________________________ Date: ________________
Signature of DDE, DCPME or DSDE

I have reviewed for effects on the Specifications Package and a package revision **is** ___ **is not** ___ required. Approved By: ____________________ Date: ____________
Signature of District Specifications Engineer

If FA Oversight, Authorized By: ________________________ Date: ____________
Print Name of FHWA Engineer

THE DISTRICT SECRETARY MUST APPROVE REVISIONS RECEIVED IN PLANS PROCESSING BETWEEN 15 AND 6 WORK DAYS BEFORE LETTING.

NO REVISIONS ALLOWED WITHIN 5 WORK DAYS BEFORE LETTING.

Approved By: ____ Date:__________
Signature of District Secretary

☐ SUPPLEMENTAL SPECIFICATIONS PACKAGE NUMBER _______ (_____Pages).

☐ PLANS REVISION NUMBER ___ (_____Sheets): ☐ Hardcopy ☐ Electronic

Sheet No(s).	Rev. Date	Description
__________	________	____
__________	________	____
__________	________	____
__________	________	____

Central Office Use:
Processed By: ____

Exhibit 20-C Revision Memo, Sheet 2 of 3

REMINDER

PROCESS:

1. Fill out headings.
2. On oversight projects, get FHWA concurrence. Print name of FHWA Engineer and date.
3. Get concurrence signature from the District Design Engineer, District Consultant Project Management Engineer or the District Structures Design Engineer, as appropriate.
4. Get signature of the District Specifications Engineer.
5. If revisions will be received in Plans Processing between 15 and 6 workdays before the letting date (bid opening), get approval signature from the District Secretary. Notify Plans Processing. No revisions are allowed within 5 workdays before letting.
6. Enter the sheet number and:
    a. Describe new pay item number with quantity, or
    b. deleted pay item number only, or
    c. revised quantities by entering pay item number with old and new quantities.
7. If a revision(s) will impact the utility plans, adjustments and/or schedules, provide a copy of the revision memo and affected plans sheets to the District Utilities Engineer.
8. If adding or deleting a pay item, revise the whole Summary of Pay Items design group to insure any pay item rollover between sheets is properly printed.
9. Fax the Revision Memo to the State Estimates Engineer at (850) 414-4877 to unlock the summary of pay items.
10. Make revisions to the Summary of Pay Items with an Addendum within 24 hours after changing of Control Group.
11. Mail Revision Memo with attachments to Plans Processing (Mail Station 75). If transmitting the revisions electronically, scan the signed Revision Memo and e-mail it (with attachments) to Plans Processing.

ATTACHMENTS:

1. Revised sealed plans sheets including Summary of Pay Items.
2. Revised District Cost Estimate if federally funded.
3. Electronically sealed Supplemental Specifications Package.

COMPUTATIONS:

Show Financial Project ID on revised computation book sheets, and mail originals and one copy to the District Construction Engineer.

Exhibit 20-C Revision Memo, Sheet 3 of 3

DATE: ____________ ____of___

Financial Project ID __________________________________

Proposal/Contract ID __________________________________

PLANS REVISION NUMBER _____

Sheet No(s).	Rev. Date	Description
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Exhibit 20-D Status of Environmental Certification

STATUS OF ENVIRONMENTAL CERTIFICATION

Financial Project ID ________________________

Proposal/Contract ID ________________________

Federal Aid No. ________________________

Project Description ______________________________________

This project is a Categorical Exclusion under 23 C.F.R. 771.117:

_____ This project is a Type 1 Categorical Exclusion under (23 CFR 771.117(c)) effective November 27, 1987 as determined on _____________, and the determination remains valid.

_____ This project is a Programmatic Categorical Exclusion per FHWA, FTA, and FDOT Agency Operating Agreement executed on January 15, 2003 as determined on_____________________, and the determination remains valid.

The environmental document for this project was a (check one):

_____ A Type 2 Categorical Exclusion under 23 C.F.R. 771.117(d) approved on ______________________,

_____ A Finding of No Significant Impact under 23 C.F.R. 771.121 approved on ______________________, or

_____ A Final Environmental Impact Statement under 23 C.F.R. 771.125 approved on ___________________.

A reevaluation in accordance with 23 C.F.R. 771.129 was (check one):

_____ Approved on ___________________.

_____ Not required.

Signature: __________________________________ Date: _______________

Environmental Administrator

Table 21.4 Horizontal Clearance to Drop-off and Canal Hazards

Canals: (See also ***Chapter 4*** of this Volume.)

Rural and Urban Flush Shoulders:

Design Speeds ≧ 50 mph: 60 ft. from the travel lane.
Design Speeds < 50 mph: 50 ft. from the travel lane.

Urban Curb or Curb and Gutter:

40 ft. from the edge of the travel lane.

Drop-offs: (See also ***Chapter 4*** of this Volume.)

Rural and Urban Flush Shoulders:

Treat as roadside slopes in accordance with ***Design Standard 700***.

Urban Curb or Curb and Gutter:

22 ft. from traveled way to the point that is 6 ft. below the hinge point.

Table 21.5 Horizontal Clearance to Other Roadside Obstacles

Minimum horizontal clearance to other roadside obstacles:

Rural and Urban Flush Shoulders:

Outside the clear zone.

Urban Curb or Curb and Gutter:

1.5 ft. from the face of curb.

Note: Horizontal clearance to mailboxes is specified in the construction details contained in the ***Design Standards, Index 532***.

Note: Transit and school bus shelters shall be placed in accordance with ***Rule Chapter 14-20.003, Florida Administrative Code***. Transit bus benches shall be placed in accordance with ***Rule Chapter 14-20.0032, F.A.C.***.

Table 21.6 TDLC Recoverable Terrain

Design Speed (mph)	(feet)
≤ 30	12
35	14
40	16

21.5.7 Intersections

Intersection designs must adequately meet the needs of motorists, transit riders, bicyclists and pedestrians. Large return radii increases the crossing distance for pedestrians while small return radii decreases a vehicle's ability to negotiate the turn. Return radii must balance the needs of the pedestrian and the design vehicle. See ***Figure 21.1***.

21.5.8 Lighting

Lighting requirements are discussed in ***Chapters 2*** and ***7*** of this volume.

21.5.9 Traffic Control

Where traffic volumes are high enough to require traffic signals, they should be placed to allow good progression of traffic from signal to signal. Optimal spacing of signals depends on vehicle operating speeds and signal cycle lengths. At speeds of 35 mph and standard cycle lengths, signals must be at least a fourth of a mile apart. Such spacing is consistent with FDOT's requirements for state highways, and with its recommended minimums for local arterials and collectors.

Where traffic volumes are not high enough to warrant traffic signals, 4-way stop signs and roundabouts should be considered. Four-way stops are considered to have a traffic calming effect and cause minimal delays under light traffic conditions. Roundabouts allow traffic from different directions to share space in the intersection, while signals require traffic to take turns.

Where traffic volumes are high enough to warrant traffic signals but does not require them, roundabouts should also be considered.

If Roundabouts are being considered in a TDLC project, refer to ***Florida Roundabout Guide*** for requirements.

Exhibit 21-A General Techniques

TECHNIQUE	FIHS/SIS		SHS URBAN	SHS RURAL	NON-SHS
	LIMITED ACCESS	CONTROLLED ACCESS			
Improved location, oversized or redundant directional signs	A	A	A	M	M
Use of route markings/ signing for historical and cultural resources	M	A	A	A	A
Increased use of variable message signing	A	A	A	M	M
Landscaping	M	M	M	M	M
Sidewalks or wider sidewalks	N	M	A	M	M
Street furniture	N	M	M	N	M
Bicycle lanes	N	M	M	M	M
Independent Shared Use Paths	N	M	M	M	M
Conversion to one-way street pairs	N	M	M	N	M
Alternative paving materials	N	N	M	N	M
Pedestrian signals, midblock crossings, median refuge areas	N	M	A	M	M
Parking modifications or restoration	N	N	M	N	M
Safety and personal security amenities	M	M	M	M	M
Street mall	N	N	N	N	M

A Appropriate for the system or facility indicated.

M May be appropriate for the system or facility indicated.

N Not appropriate for the system or facility indicated.

Exhibit 21-B Techniques To Reduce Speed Or Traffic Volume

TECHNIQUE	FIHS/SIS		SHS URBAN	SHS RURAL	NON-SHS
	LIMITED ACCESS	CONTROLLED ACCESS			
Lower speed limits	N	N	N	N	N
Increase use of stop or multiway stop signs	N	N	N	N	N
Speed humps	N	N	N	N	M
On-street parking to serve as buffer between travel and pedestrian areas	N	N	M	N	M
Curb bulb-outs at ends of blocks	N	N	M	N	M
Traffic “chokers” oriented to slowing traffic	N	N	N	N	M
“Compact” intersections	N	A	A	A	A
Traffic roundabouts to facilitate intersection movement	N	M	M	M	M
Curvilinear alignment (with redesign, chicanes, winding paths, etc.)	N	N	M	N	M
Street closing or route relocation	N	N	M	N	M

A Appropriate for the system or facility indicated.

M May be appropriate for the system or facility indicated.

N Not appropriate for the system or facility indicated.

Exhibit 21-C Techniques To Support Shifts Between Modes

TECHNIQUE	FIHS/SIS		SHS URBAN	SHS RURAL	NON-SHS
	LIMITED ACCESS	CONTROLLED ACCESS			
Sidewalks	N	M	A	M	M
“Pedestrian friendly” crosswalk design	N	M	A	M	M
Midblock pedestrian signals	N	M	M	M	M
Illuminated pedestrian crossings	N	M	M	M	M
Bicycle lanes/paved shoulders	N	M	A	A	M
Independent Shared Use Path	N	M	M	M	M
“Bicycle friendly” design	N	M	A	A	A
Transit system amenities	N	M	A	M	M
Transit user amenities	N	M	A	M	M
HOV/Exclusive lanes	A	A	A	M	M
Linking modal facilities	A	A	A	A	A
Lower speed limits	N	N	N	N	N
Removal of street parking	N	N	M	M	M

A Appropriate for the system or facility indicated.

M May be appropriate for the system or facility indicated.

N Not appropriate for the system or facility indicated.

Exhibit 21-D Area-Wide Techniques

TECHNIQUE	FIHS/SIS		SHS URBAN	SHS RURAL	NON-SHS
	LIMITED ACCESS	CONTROLLED ACCESS			
Design the street network with multiple connections and relatively direct routes	N	N	N	N	M
Space through-streets no more than a half mile apart.	N	N	N	N	M
Use traffic calming measures	N	M	M	N	M
Limit local speed to 20 mph	N	N	N	N	M
Limit lanes	M	M	M	M	M
Align streets to give buildings “energy-efficient” orientations	N	N	M	N	M
Avoid using traffic signals wherever possible. Space them for good traffic progression	N	A	A	A	A
Incorporate pedestrian and bicyclist design features	N	A	A	A	A
Incorporate “transit-oriented” design	A	A	A	A	A
Use car pooling, flex-time and telecommuting	A	A	A	A	A
Design attractive “greenway” corridors	A	A	A	A	A
Design attractive storm water facilities	A	A	A	A	A

A Appropriate for the system or facility indicated.

M May be appropriate for the system or facility indicated.

N Not appropriate for the system or facility indicated.

Exhibit 22-A Items of Work

DATE: ________________________

TO: ___________________________, District Specifications

FROM: ________________________, Project Manager

COPIES TO:

SUBJECT: ITEMS OF WORK

Financial Project ID: _____________________ (GOES WITH ____________________)

County Section: ________________________

Description: ___________________________

The plans package for the above referenced project has the following items of work to be performed:

_________	Milling & Resurfacing	_________	Highway Signing
_________	Base Work	_________	Guardrail
_________	Shoulder Treatment	_________	Landscaping
_________	Drainage Improvements	_________	Box or Three-sided Culverts
_________	Curb & Gutters	_________	Bridges
_________	Traffic Signals	_________	MSE Walls
_________	Lighting	_________	Sidewalks/Bicycle Path

_________ Other (Please Specify) ______________________________________

____

____

____

____

Please include these items of work in the *Intent and Scope* so they may be added to the advertisement description.

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Chapter 23

Exceptions and Variations

Tables

Exhibits

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Chapter 23

Exceptions and Variations

23.1 General

The Department's roadway design criteria and standards are contained in this volume and are usually within the desirable ranges established by AASHTO. The values given in this volume have been accepted by FHWA and govern the design process. When it becomes necessary to deviate from the Department's criteria, early documentation and approval are required. There are three approval processes: Design Exceptions, Utility Exceptions and Design Variations. When the Department's criteria are met, no Design Exception, Utility Exception or Design Variation is required. However, when the Department's criteria are not met, a Design Exception, Utility Exception or Design Variation is required. This requirement applies to all entities affecting planning, design, construction, maintenance and utilities.

For projects using safety funds and developed to improve specific safety problems, only the elements identified under the scope of work for the safety improvement project are subject to these approval processes. The existing features, within the limits of the safety improvement project that do not meet design criteria do not require approval to remain.

23.2 Identification

To allow time to research alternatives and begin the analysis and documentation activities, it is important proper approval process be identified as early in the Planning and Design as possible. This is preferably done during the PD&E process for major projects and the scope development process for minor projects. It is required that approval be obtained no later than the initial engineering phase.

Design Exceptions are required when the proposed design elements (other than utility elements) are below both the Department's governing criteria and AASHTO's new construction criteria for the 13 Controlling Design Elements.

The 13 Controlling Design Elements are:

1. Design Speed
2. Lane Widths
3. Shoulder Widths
4. Bridge Widths
5. Structural Capacity
6. Vertical Clearance
7. Grades
8. Cross Slope
9. Superelevation
10. Horizontal Alignment
11. Vertical Alignment
12. Stopping Sight Distance
13. Horizontal Clearance

Section 23.9 provides AASHTO's minimum requirements for the above elements.

Utility Exception requirements are found in ***Chapter 13 of the Utility Accommodation Manual (UAM)***.

Design Variations are required when proposed design elements are below the Department's criteria and where a Design Exceptions or Utility Exception is not required.

23.3 Approval

All required approvals shall be obtained as described in this section.

Approval is required from the District Design Engineer or Turnpike Design Engineer for the following:

- Design Exceptions.
- Utility Exceptions.
- Design Variations.

Approval is required from the State Roadway Design Engineer for the following:

- Design Exceptions.
- Utility Exceptions.
- Design Variations involving modifications to or elimination of required rumble strips.

Approval is required from the State Chief Engineer for the following:

- Design Exceptions for Design Speed on FIHS/SIS facilities (following review by the State Transportation Planner).
- Utility Exceptions for limited access R/W use.
- Design Variations for Design Speed on FIHS/SIS facilities (following review by the State Transportation Planner).

Approval is required from the District or Turnpike Structures Design Engineer for the following:

- Utility Exceptions impacting a Category 1 structure, with none of the 13 Controlling Design Elements below AASHTO's Criteria.
- Design Variations for Category 1 Structures.

Approval is required from the State Structures Design Engineer for the following:

- Design Exceptions impacting Catagory 1 and 2 structures.
- Utility Exceptions impacting Category 2 structures, or impacting Catagory 1 structures with controlling elements below AASHTO's criteria.

- Design Variations impacting Category 2 structures.

Approval is required from the FHWA Division Administrator for the following:

- Design Exceptions on Interstate projects.
- Design Exceptions on full FHWA oversight projects.
- Utility Exceptions involving any controlling element below AASHTO's Criteria.
- Design Exceptions, Utility Exceptions and Design Variations for vertical clearance over an interstate roadway less than 16 feet.

23.4 Justification for Central Office Approval

Sufficient detail and explanation must be given in order to build a strong case to those reviewing the request. The 13 Controlling Design Elements are considered safety related and the strongest case must be made to lower these requirements. At some point, this justification may be used to defend the Department's and/or the designer's design decisions. All deviations must be uniquely identified, located, and justified; no blanket approvals are given.

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 usually compared are:

- Operational Impacts.
- Impacts on Adjacent Section.
- Level of Service.
- Safety Impacts.
- Long term effects.
- Costs.
- Cumulative Effects.

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

- The Department can save money.
- The Department can save time.
- The proposed design is similar to other designs.

23.5 Documentation for Central Office Approval

During the justification process supporting documentation will be generated which needs to accompany each submittal. This documentation includes, but is not limited to the following:

Utility Exception documentation requirements are found in ***Chapter 13 of the Utility Accommodation Manual (UAM)***.

All Design Variations needing Central Office approvals and all Design Exceptions should include the following documentation:

a) Project description (general project information, typical section, begin/end milepost, county section number).

b) Description of the Design Exception (specific project conditions related to Design Exception, Controlling Design Element, acceptable AASHTO and Department value and proposed value for project).

c) Amount and character of traffic using the facility.

d) A plan view or aerial photo of the exception location, showing right of way lines, and property lines of adjacent property.

e) A photo of the area.

f) Typical section or cross-section of exception location.

g) The milepost and station location of the exception.

h) Any related work programmed or in future work plans.

i) The Project Schedule Management (PSM) Project Schedule Activities maintained by the Finance Management Office.

j) All mitigating efforts.

k) Comments on of the most recent 5-year crash history including all pertinent crash reports.

For the specified conditions the following additional documentation is required:

l) For design speed on FIHS/SIS, provide typical sections at mid blocks and at intersections.

m) For lane width, provide locations of alternative routes that meet criteria and a proposal for handling drainage, the proposed signing and pavement markings.

n) For shoulder width, provide a proposal for handling stalled vehicles and a proposal for handling drainage.

o) For bridge width, provide a plan view of the approaching roadways and existing bridge plans (these may be submitted electronically).

p) For structural capacity, provide the calculation of the affected structure capacity and load rating.

q) For vertical clearance, provide locations of alternative routes that meet criteria.

r) For cross-slope, provide a proposal for handling drainage and details on how the cross slope impacts intersections.

s) For conditions that may adversely affect the roadway's capacity, provide the comments on compatibility of the design and operation with the adjacent sections. Effects on capacity (proposed criteria vs. AASHTO) using an acceptable capacity analysis procedure and calculate reduction for design year, level of service).

t) For superelevation, provide the side friction factors for the curve for each lane of different cross-slope at the PC of the curve, the point of maximum cross-slope, and the PT of the curve using the following equation.

$$f = \frac{V^2 - 15Re}{V^2e + 15R}$$

where

f = Side Friction Factor
V = Design Speed (mph)
R = Radius (feet)
e = Superelevation (ft/ft) at the station evaluated

u) For areas with crash histories or when a benefit to cost analysis is requested, provide a time value analysis between the benefit to society quantified in dollars and the costs to society quantified in dollars over the life of the exception.

In general practice the benefit to society is quantified by the reduction in crash cost foreseeable because of the proposed design and the cost due to the implementation of that change such as construction and maintenance costs over the life of the project. This analysis may be performed by using either the Roadside Safety Analysis Program (RSAP), available through AASHTO's publications, or the Historical Crash Method (HCM) depending on their applicability. The RSAP is applicable to crashes into roadside objects and the HCM is applicable to sites with a crash history. Use a 5% time value of money for both the RSAP and HCM methods.

The Historical Crash Method (HCM) uses the below ***Highway Safety Improvement Program Guideline (HSIPG)*** cost per crash by facility type to estimate benefit to society while the cost to society is estimated by the cost of right of way, construction, and maintenance.

HSIPG COST/CRASH BY FACILITY TYPE				
FACILITY TYPE	DIVIDED		UNDIVIDED	
	URBAN	RURAL	URBAN	RURAL
<3 Lanes	$68,800	$152,200	$78,000	$218,900
3 Lanes	$47,100	$152,200	$52,000	$218,900
4 Lanes	$74,500	$181,200	$53,500	$76,400
5 Lanes	$52,400	$181,200	$53,500	$76,400
6 Lanes	$63,300	$181,200	$53,500	$76,400
Interstate	$83,600	$195,700	$83,600	$195,700
Turnpike	$99,700	$228,800	$99,700	$228,800

All State Roads Average Cost/Crash: $83,070
*The above values were derived from 1994, 1995, and 1996 traffic crash and injury severity data for crashes on state roads in Florida, using the formulation described in ***FHWA Technical Advisory "Motor Vehicle Accident Costs", T 7570.1, dated June 30, 1988*** and updated injury costs provided in the companion ***FHWA Technical Advisory, T 7570.2, dated October 31, 1994***.

23.6 Central Office Submittal and Approval

The report justifying and documenting a request is to be sealed by the Responsible Engineer in accordance with ***Chapter 19*** of this volume. The Responsible Engineer then attaches a Submittal/Approval Letter (***Exhibit 23–A***) to the Sealed Report and submits them to the District or Turnpike Design Engineer. The District or Turnpike Design Engineer then approves or denies the request and notifies the Responsible Engineer. When further approvals are required the District or Turnpike Design Engineer will forward the Submittal/Approval Letter and Sealed Report to the State Roadway Design Office.

The State Roadway Design Office will assign reference numbers to each request. The request will be reviewed then forwarded for approval to the Chief Engineer, the State Roadway Design Engineer, the State Structures Design Engineer, the Planning Office and/or FHWA as appropriate.

Each request will be reviewed on a case by case basis and approved on its merits. When approval is obtained the Roadway Design Office will e-mail the District or Turnpike Design Engineer the Central Office's disposition and return the signed Submittal/Approval Letter and Sealed Report. The Roadway Design Office will keep a copy filed under the assigned reference number. Additional copies will be provided upon request.

23.7 Central Office Denial and Resubmittal

When a request is denied, the State Roadway Design Office will notify the District or Turnpike Design Engineer of the Central Office's disposition.

Denied requests can be resubmitted when all deficiencies, noted in the denial notification, have been addressed. This may require only a new Submittal/Approval Letter if the Sealed Report does not need to be amended. However, if the Sealed Report requires revision, a new Sealed Report and attached Submittal/Approval Letter must be submitted.

The State Roadway Design Office will assign the resubmittal a tracking reference number. The resubmittal will be reviewed for completeness and forwarded for approval to the Chief Engineer, the State Roadway Design Engineer, the Structures Design Engineer, the Planning Office and/or FHWA as appropriate.

23.8 Design Variations Needing District Approval Only

Design Variations requiring Central Office approval from the State Chief Engineer. State Roadway Design Engineer, and/or the State Structures Design Engineer (see ***Section 23.3***) follow the processes in ***Section 23.4-7***. For those needing district approval only,

It is critical that Design Variations be identified early in the process in order to allow time to research alternatives and begin the analysis and documentation activities. This is preferably done during the PD&E process for major projects and the scope development process for minor projects. It is required that approval be obtained no later than the initial engineering phase.

The following is the minimum justification and documentation required. However, on a case by case basis the District approvers may require more or may opt for the design variation to follow ***Sections 23.4-7***:

A Design Variation request must address the following items:

1. Design criteria versus proposed criteria.
2. Reason the design criteria are not appropriate.
3. Justification for the proposed criteria.
4. Any background information which documents or justifies the request.

The Responsible Engineer submits the documentation with Submittal/Approval Letter (***Exhibit 23–A***) as the cover letter and seals the submittal in accordance with ***Chapter 19*** of this volume The District or Turnpike Design Engineer then approves or denies the request and notifies the Responsible Engineer.

23.9 AASHTO Criteria for Controlling Design Elements

As an aid to the designer, the following tables may be used as a reference for determining when a Design Exception is required based on AASHTO criteria, but are in no way intended to replace Department design criteria. The page numbers referenced are to AASHTO's ***A Policy on Geometric Design of Highways and Streets 2004*** (unless otherwise noted) and are a starting point for researching project criteria.

Criteria Tables Cross Reference

Table 23.9.1 AASHTO Design Speed (Minimum)

Type Facility	Other Factors	Design Speed (mph)	AASHTO
Freeways	Urban Rural	50 70	pg. 503
Urban Arterials	Major Other	30 30	pg. 72
Rural Arterials	Rolling terrain Level terrain	50 60	pg. 444
Urban Collectors		30	pg. 430
Rural Collectors	Level ADT < 400 ADT 400 - 2000 ADT > 2000 Rolling ADT < 400 ADT 400 - 2000 ADT > 2000	40 50 60 30 40 50	pg. 422, Exh. 6-2
CBD	Major or Minor	30	pg. 430
Ramps	Highway Design Speeds (mph) 30 35 40 45 50 55 60 65 70	 15 18 20 23 25 28 30 30 35	pg. 826
Loop Ramps	150 ft. radius	25	pg. 825
Connections	Direct Semi-Direct	40 30	pg. 825

Table 23.9.2 AASHTO Lane Widths (Minimum)

Type Facility	Lane Width (feet)	AASHTO
Freeways	12	pg. 504
Rural Arterials	11	pg. 448, Exh. 7-3
Urban Arterials	10	pg. 472
Urban Collectors	10	pg. 433
Rural Collectors	10	pg. 425, Exh. 6-5
Low Speed	10	pg. 312
Residential	9	pg. 312
Auxiliary	10	pp. 312, 433
Continuous TWLTL	10	pg. 312

Table 23.9.3 AASHTO Shoulder Widths (Minimum)

Type Facility	Other Factors	Right (feet)	Median (feet)	AASHTO
Freeways	4 lanes	10	4	pg. 505
	≥ 6 lanes	10	10	pg. 505
Rural Arterial	ADT > 2000	8		pg. 448, Exh. 7-3
	ADT 400-2000	6		
	ADT < 400	4		
	Divided highway 4 lanes	8	4 paved	pg. 455
	Divided highway 6 lanes	8	8	pg. 456
Urban Arterial	Low Type	2		pg. 314
	High Type	10		pg. 314
Heavily Traveled	High Speed (≥ 50 mph)	10		pg. 314
Rural & Urban Collectors	ADT > 2000	8		pg. 425, Exh. 6-5
	ADT 1500-2000	6		
	ADT 400-1500	5		
	ADT < 400	2		

Table 23.9.4 AASHTO Bridge Widths (Minimum)

Type Facility	Other Factors	Bridge Widths	AASHTO
Freeways	New Bridges	Approach Roadway Width	pg. 506
Rural Arterials	New Bridges (Short)	Approach Roadway Width	pg. 447
	New Long Bridges (> 200 ft.)	Travel Lanes + 4 ft. each side	pg. 447
	Remain in Place	Travel Lanes + 2 ft. each side	pg. 447
Urban Arterials	Long (> 200 ft.), where shoulders or parking lanes are provided on the arterial	Travel Lanes + 4 ft. each side	pg. 481
	All new bridges	Curb to curb width of street	pg. 481

		Bridge Widths		
Type Facility	Other Factors	New or Reconstruction	To Remain	AASHTO
Rural and Urban Collectors	Under 400 ADT	Traveled Way + 2 ft. each side [(1)]	22 ft. [(2)]	pp. 426, 427
	ADT 400-1500	Traveled Way + 3 ft. each side [(1)]	22 ft. [(2)]	pp. 426, 427
	ADT 1500-2000	Traveled Way + 4 ft. each side[(1),(3)]	24 ft. [(2)]	pp. 426, 427
	ADT > 2000	Approach Roadway Width [(1),(3)]	28 ft. [(2)]	pp. 426, 427

1. If the approach roadway has paved shoulders, then the surfaced width shall be carried across the bridge.
2. Bridges longer than 100 ft. are to be analyzed individually.
3. For bridges > 100 ft. in length, the minimum bridge width of traveled way plus 3 ft. on each side is acceptable.

Table 23.9.5 AASHTO Structural Capacity (Minimum Loadings)

Type Facility	Other Factors	Loading	AASHTO
Freeways	---	HS-20	pg. 506
Rural Arterials	---	HS-20	pg. 447
Urban Arterials	---	HS-20	pg. 447
Local Roads	New & Reconstruction Bridges	HS-20	pg. 386, Exh. 5-6
	Existing Bridges	H 15	pg. 386, Exh. 5-7
Collectors	New & Reconstruction Bridges	HS-20	pg. 426, Exh. 6-6
	Existing Bridges	H 15	pg. 427, Exh. 6-7

Table 23.9.6 AASHTO Vertical Clearance (Minimum)

Type Facility	Vertical Clearance (feet)	AASHTO
Freeways	16 (1),(2)	pp. 506, 507, 763, 764
Arterials: Rural Urban	16 (1),(2) 16 (1),(2)	pp. 447, 763, 764 472, 763, 764
Other Highways	14 (2)	pp. 385, 507
Sign Trusses	17 (2)	pg. 507
Pedestrian Overpass	17 (2)	pg. 507
Tunnels: Freeways Other Highways	16 (2) 14 (2)	pg. 355 pg. 355
Railroads	23 (2)	pg. 522

1. 14 feet allowed in highly developed urban areas if alternate route has 16 feet.
2. Minimum value that can be used without a Design Exception. An allowance of 6 inches should be added to vertical clearance to accommodate future resurfacing.

Table 23.9.7 AASHTO Grades (Minimum and Maximum)

Maximum Grades

Type Facility	Type Terrain	Grades (%) For Design Speed (mph)									AASHTO
		30	35	40	45	50	55	60	65	70	
Freeway [1]	Level Rolling	--- ---	--- ---	--- ---	--- ---	4 5	4 5	3 4	3 4	3 4	pg. 506, Exh. 8-1
Rural Arterial	Level Rolling	--- ---	--- ---	5 6	5 6	4 5	4 5	3 4	3 4	3 4	pg. 446, Exh. 7-2
Urban Arterial:	Level Rolling	8 9	7 8	7 8	6 7	6 7	5 6	5 6	--- ---	--- ---	pg. 472, Exh. 7-10
Rural Collector[2]	Level Rolling	7 9	7 9	7 8	7 8	6 7	6 7	5 6	--- ---	--- ---	pg. 423, Exh. 6-4
Urban Collector[2]	Level Rolling	9 11	9 10	9 10	8 9	7 8	7 8	6 7	--- ---	--- ---	pg. 432, Exh. 6-8

1. Grades one percent steeper than the values shown may be used for extreme cases in urban areas where development precludes the use of flatter grades and for one-way downgrades.
2. Short lengths of grade in rural and urban areas, such as grades less than 500 ft. in length, one-way downgrades, and grades on low-volume rural and urban collectors may be up to 2 percent steeper than the grades shown above.

Minimum Grades for Urban Curb & Gutter

Type Facility	Minimum %	AASHTO
Arterials	as required for adequate drainage	pg. 471
Collector Roads & Streets	0.30	pg. 431
Local Roads & Streets	0.20	pg. 391

Table 23.9.8 AASHTO Cross Slope (Minimum and Maximum)

Type Facility	Other Factors	Minimum	Maximum	AASHTO
Freeways	---	0.015	0.025 [1]	pg. 504
Arterials	Rural Urban	0.015 0.015	0.02 [1] 0.03	pg. 446 pg. 472
Divided Highways	---	0.015	0.02 [1]	pg. 455
Collectors	Rural Urban	0.015 0.015	0.02 [1] 0.03	pg. 421 pg. 431
Shoulders	Paved Gravel Turf	0.02 0.04 0.06[2]	0.06 0.06 0.08[2]	pg. 316 pg. 316 pg. 316

1. Values given are for up to two lanes in one direction. Additional outside lanes may have cross slopes of 0.03.
2. Shoulder cross slopes which meet FDOT criteria do not require a Design Exception.

Table 23.9.9 AASHTO Superelevation (Maximum)

Type Facility	Superelevation Rate	AASHTO
Highways (Rural)	0.12	pg. 144
Urban	0.06	pg. 145
Low Speed Urban w/severe constraints	None	pg. 145
Ramps and Turning Roadways at Intersections	0.10	pg. 639

Table 23.9.10 AASHTO Horizontal Alignment

Minimum Radius (feet) with Superelevation (page 147, Exh. 3-15)

Type Facility	Super-elevation e-max	Minimum Curve Radius (feet) for Design Speed (mph)											
		15	20	25	30	35	40	45	50	55	60	65	70
Rural Highways and High Speed Urban Streets	0.04	42	86	154	250	371	533	711	926	1190	1500	---	---
	0.06	39	81	144	231	340	485	643	833	1060	1330	1660	2040
	0.08	38	76	134	214	314	444	587	758	960	1200	1480	1810
	0.10	36	72	126	200	292	410	540	694	877	1090	1340	1630
	0.12	34	68	119	188	272	381	500	641	807	1000	1220	1480

Minimum Radius (feet) for Section with Normal Cross Slope (***2001 AASHTO***, page 168, Exh. 3-26)

Type Facility	Minimum Curve Radius (feet) for Design Speed (mph)											
	15	20	25	30	35	40	45	50	55	60	65	70
All	960	1700	2460	3350	4390	5570	6880	8350	9960	11720	13180	14730

Minimum Radius (feet) for Intersection Curves (***2001 AASHTO***, page 201, Exh. 3-43)

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

Minimum Passing Sight Distance (feet) (page 124, Exh. 3-7)

Design Speed (mph)	20	25	30	35	40	45	50	55	60	65	70
Passing Sight Distance	710	900	1090	1280	1470	1625	1835	1985	2135	2285	2480

Table 23.9.11 AASHTO Vertical Alignment

(Taken from page 272 Exh. 3-72, page 277 Exh. 3-75, and page 422 Exh. 6-2)

Design Speed (mph)	K Value (1) for Vertical Curves Rounded for Design Crest	Sag
15	3	10
20	7	17
25	12	26
30	19	37
35	29	49
40	44	64
45	61	79
50	84	96
55	114	115
60	151	136
65	193	157
70	247	181

1. Rate of vertical curvature, K, is the length of curve per percent algebraic difference in the intersecting grades.

Table 23.9.12 AASHTO Stopping Sight Distance

(Taken from page 112, Exh. 3-1**)**

Design Speed (mph)	Stopping Sight Distance (feet) Computed for Design
15	80
20	115
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730

Table 23.9.13 AASHTO Horizontal Clearance (Minimum)

Feature	Clearance			AASHTO
Bridges			See ***Table 23.4.4***	---
Tunnels			2.5 ft. from edge of traffic lane	pg. 354, Exh. 4-17
Underpasses	2-lane: (1)		Normal shoulder width (to edge of barrier)	pg. 762, Exh. 10-6
	Divided Roadway:		Normal shoulder (outside or median) width (to edge of barrier) (1)	
Barrier Wall & Guardrail			Normal shoulder width	pg. 762, Exh. 10-6
Light Poles (2)	Rural:		Outside clear zone (if non-breakaway)	pg. 291
	Urban:		1.5 ft. from face of curb	pg. 319
Trees greater than 4 inches in diameter measured 6 inches above the ground	Rural	Arterials:	Outside clear zone	pg. 399, 481
		Collectors ≤ 45 mph:	10 ft. from traveled way	pg. 427
		Collectors > 45 mph:	Outside clear zone	pg. 427
	Urban:		1.5 ft. from face of curb	pg. 399, 437, 481
	Freeways (Rural and Urban):		Outside clear zone	pg. 507
Sign supports			Outside clear zone (if non-breakaway)	pg. 294
Utility Poles (2)	Rural:		Outside clear zone	pg. 294
	Urban:		1.5 ft. from face of curb	pp. 293, 319
Building Line			15 feet from elevated roadway (wall)	pg. 522
Signal Pole and Controller Cabinets	Rural:		As far from the roadway as practicable	pg. 4-13 (3)
	Urban:		1.5 ft. from face of curb	pg. 319

1. For metal guardrail, add deflection distance.
2. Exceptions for utility poles are to be in accordance with the current ***Utility Accommodation Manual*** exceptions procedure for horizontal clearance for utility poles.
3. ***2002 AASHTO Roadside Design Guide***.

Exhibit 23-A Submittal/Approval Letter

To: ______________________________ Date: ____________________
District or Turnpike Design Engineer

Financial Project ID: _________________ New Const. ( ) RRR ( )
Federal Aid Number:_________________
Project Name: ____
State Road Number: _________________ Co./Sec./Sub. ________________
Begin Project MP: _________________ End Project MP: ________________
Full Federal Oversight: Yes ( ) No ( )
Request for Design Exception ( ), Design Variation ( )
(For Design Exception or Variations Requiring Central Office Approval)
Re-submittal: Yes ( ) No ( ) Original Ref# ________ - ____ - _____

Requested for the following element(s):

( ) Design Speed	( ) Lane Widths	( ) Shoulder Widths	( ) Bridge Widths
( ) Structural Capacity	( ) Vertical Clearance	( ) Grades	( ) Cross Slope
( ) Superelevation	( ) Horizontal Alignment	( ) Vertical Alignment	( ) Stopping Sight Distance
( ) Horizontal Clearance	( ) Other ______________		

1. **Include a brief statement here concerning the project and the exception or varaiation requested.**
2. **Attach additional pages if necessary.**
3. **Attach the Sealed Report.**

Recommended by:

______________________________Date _____________
Responsible Professional Engineer

Approvals:

______________________________Date _____________
District or Turnpike Design Engineer

______________________________Date _____________
District Structures Design Engineer

______________________________Date _____________
State Roadway Design Engineer

______________________________Date _____________
State Structures Design Engineer

______________________________Date _____________
State Chief Engineer

______________________________Date _____________
FHWA Division Administrator

Chapter 25

Florida's Design Criteria for Resurfacing, Restoration and Rehabilitation (RRR) of Streets and Highways

Tables

Exhibits

Chapter 25

Florida's Design Criteria for Resurfacing, Restoration and Rehabilitation (RRR) of Streets and Highways

25.1 Introduction

25.1.1 General

Resurfacing, restoration and rehabilitation (RRR) work is defined as work undertaken to extend the service life of an existing highway and/or enhance highway safety. This includes the placement of additional surface materials and/or other work necessary to return an existing roadway to a condition of structural and functional adequacy. Many of the RRR Standards used by the Department are derived from the ***National Academy of Sciences "Special Report 214"***. This publication contains many of the methods necessary to make the safety and cost effective evaluations required by this chapter.

RRR projects must be designed and constructed in a manner that will comply with the accessibility standards and requirements set forth in the ***Americans with Disabilities Act of 1990 (ADA).***

25.1.2 Application

The criteria included in this chapter are for all RRR projects except Interstate highways, freeways, and Florida Intrastate Highway System (FIHS)/Strategic Intermodal System (SIS) facilities, and are not intended to apply to new construction or major modifications of existing facilities.

The RRR design criteria applicable for Interstate Highways and Freeways are new construction criteria, with the following exceptions:

1. The standards used for horizontal alignment, vertical alignment, and widths of median, traveled way and shoulders may be the AASHTO interstate standards that were in effect at the time of original construction or inclusion into the interstate system.
2. Mainline bridges may remain in place if they have minimum cross sections

consisting of 12 ft. lanes, 10 ft. shoulder on the right and 3 ft. shoulder on the left. For mainline bridges (over 200 ft.), the offset to the face of parapet or bridge rail on both the left and right is 3 ft. (minimum) measured from the edge of the nearest traveled lane. Bridge railing shall meet or be upgraded in accordance with the requirements of ***Section 25.4.25.3 Bridge Railing*** of this volume.

3. Existing bridges can remain in place if the operating rating capacity can safely service the system for an additional 20-year service life.

4. Roadside Safety Hardware shall meet the requirements of ***Section 25.4.26 Roadside Safety Hardware*** of this volume.

5. Pier protection and design shall comply with the requirements provided in ***Structures Design Guidelines, Section 2.6***.

Existing median crossovers on Interstate highways and freeways shall be evaluated for conformance to the criteria in ***Section 2.14.4, Crossovers on Limited Access Facilities***. Crossovers that do not meet those criteria must be removed as a part of the project unless approved by the State Roadway Design Engineer and FHWA (FHWA approval on Interstate only).

Projects on FIHS/SIS facilities are designed using new construction criteria. However, RRR criteria may be applied on controlled access FIHS/SIS facilities to the extent permitted by the FIHS/SIS Corridor Plan and consistent with the schedule for phased improvements to bring the facility up to new construction criteria.

The RRR criteria may be used for establishing the minimum requirements for intersection improvement projects with the understanding that when right of way is adequate, new construction criteria will be used to the maximum extent feasible.

25.2 Planning and Programming RRR Projects

RRR projects must balance a number of competing objectives, the principal ones being the preservation of highways, improved service levels and enhancement of safety. The success in meeting these objectives depends on the quality of individual project designs and project programming decisions.

The majority of RRR projects are identified and programmed as a result of deficient pavement condition. These projects are funded under the Department's Pavement Resurfacing program. Districts are provided specific lane mile targets that must be met annually. Program funds are allocated to each District based on a fixed amount per lane mile to be resurfaced. The amount allocated includes funds necessary to resurface/rehabilitate the pavement plus a limited amount which can be used for other improvements and upgrades. Improvements and upgrades which cost more than the allocated amount result in reduced funds for such improvements on other roadways being resurfaced and/or must come from other Department funding programs. For additional information on the Department's Pavement Resurfacing program requirements and restrictions, see the Department's ***Work Program Instructions***.

25.2.1 Projects Requiring Right of Way

RRR projects do not typically involve Right of Way acquisition. However, in all cases, facilities programmed for RRR projects should be given a review of the existing right of way, roadway, transit stops, access management, drainage design elements and other improvements to identify locations that require additional right of way. For such locations, the design should be expedited to determine actual right of way requirements. The designer must coordinate the requirements with the Right of Way Office so that necessary areas will be cleared before the project is ready for letting.

25.2.2 Projects With Bridges Within Project Limits

Bridges must be reviewed in sufficient detail to clearly establish the cost effective and appropriate changes to be included in the project design effort. Pavement resurfacing funds can only be used for minor bridge improvements such as rail retrofits and ADA improvements. Bridges that require major improvement or replacement must be programmed with the appropriate bridge program funds.

25.2.3 Project Features Requiring Design Exceptions and Design Variations

Projects may have features below criteria values which have not been programmed and/or which are determined not to be appropriate to accomplish under the design project. These usually require design exception or design variation approval, as appropriate. See ***Sections 25.3.6*** and ***25.5***.

25.2.4 Ride Rehabilitation Projects

Projects that are deficient only due to Ride Rating (<5.5) as rated by the Pavement Condition Survey, and have a posted speed limit less than 50 mph, can be programmed as Ride Rehabilitation Projects.

If the pavement is in good structural condition, the scope of the work can be limited to meeting ADA requirements and doing what is necessary and practical to improve the smoothness of the pavement to meet standards. This can often just be adjustments to manholes and valves or the correcting of utility cut patches through short milling and paver-laid friction course.

These projects meeting the specific criteria above do not have to comply with ***Sections 25.3.6 and 25.5***. They can be funded with Resurfacing Funds and will receive lane mile target resurfacing credit.

25.4 RRR Design Criteria

Design values and decisions for roadway features should reflect the anticipated service life of the project. The designer has the responsibility to choose the specific design value to be used, taking into consideration its cost-effectiveness, which can range from the minimum RRR Criteria presented herein, to new construction criteria. Design values in the following sub-sections apply to RRR projects only. When specific values are not provided, the standards used in the original construction or subsequent enhancements may be retained except when an upgrade is identified in the project scope.

Designers are encouraged to make a deliberate selection of design values by explicitly addressing issues of safety cost-effectiveness, overall highway consistency in geometric design, design of adjoining segments and expected trends in traffic growth and truck use before specifying design values. The design values indicated in this chapter usually reflect a cost-effective basis for evaluating existing roadway characteristics to determine which features require upgrading.

The design values presented herein are the minimum to be used for a RRR project on the State Highway System without obtaining an exception or variation. See ***Section 25.5*** of this volume. Existing project features which were constructed to meet minimum metric design criteria, but are mathematically slightly less than equivalent minimum English design criteria, do not require design exceptions or variations to remain.

25.4.1 Design Period

Improvements should be evaluated using a design period which is consistent with the design period selected for the pavement rehabilitation. The design period (service life) for RRR projects should be from 8 - 20 years for projects without milling and 12 - 20 years for projects with milling. See the ***Flexible Pavement Design Manual, Topic No. 625-010-002*** for specific design periods. For skid hazard projects, where other improvements are not made, the design year is the expected year of construction.

25.4.2 Project Traffic Volume

The design year for traffic volume is the same design year as the year established for service life. Traffic data to be used for design:

AADT and DHV for mainline (current, post construction and design year),

1. K, D and T factors,
2. Peak turning movements at signalized and problem intersections and major traffic generators,
3. Movements for future traffic generators that are scheduled during the service life should be considered.

25.4.3 Pavement Design

The pavement design procedures are found in the ***Flexible Pavement Design Manual (Topic No. 625-010-002)***, the ***Rigid Pavement Design Manual (Topic No. 625-010-006)***, and the ***Pavement Type Selection Manual (Topic No. 625-010-005).***

Alternative paving treatments such as patterned/textured pavement may be used to accent the roadway in accordance with the ***Standard Specifications***. Architectural pavers, however, shall not be used on the traveled way of the State Highway System. See ***Section 2.1.6.1*** for additional requirements.

25.4.4 Design Speed

Most highway features are based on design speed. Design speed is a principal design control that regulates the selection of many of the project standards and criteria used to design a roadway project. Selection of the design speed must be logical for the type, location and operational conditions of the highway, and the design speed used should be consistent with comparable adjacent projects. Design speed must not be dictated by an isolated geometric feature.

Design speed should generally not be less than the legal posted speed. The design speed used in the original design of the highway should be used for RRR projects. However, there may be situations where the existing posted speed on the highway is different than that used in the original design of the highway. The decision to modify the posted speed limit after the construction of the original project was completed would have been made under the authority of the District Traffic Operations Engineer (DTOE). In this case, the selected design speed shall be jointly approved by the District Design Engineer and the DTOE. This is to be documented on the Typical Section Package as described in ***Section 16.2.3***. New project features and the correction of features having a significant crash history shall be designed using a design speed equal to or greater than the posted speed and process Design Exceptions or Variations for those new design elements that do not meet the criteria for the higher speed. See ***Table 25.4.4.1*** for further guidance.

Table 25.4.4.1 RRR Design Speed vs. Posted Speed

Condition	Establishing the Proposed Project Design Speed (DS_p)
CASE 1	Use the design speed used in the original design of the highway. $\mathbf{DS_p = DS_o}$
CASE 2	Use the design speed used in the original design of the highway unless a reduced design speed (not less than posted speed) is approved by the DDE and the DTOE. $\mathbf{DS_p = DS_o}$
CASE 3	Use the design speed used in the original design of the highway unless there is a significant crash history associated with a specific highway feature. If so, then the design speed used in correcting the feature shall be equal to or greater than the posted speed. The posted speed shall also be used as the design speed for any other new highway features (not replacements). Special attention should be given to curb and gutter sections. $\mathbf{DS_p = DS_o}$ and $\mathbf{DS_p = PS}$ (for design of features that are new or have a significant crash history)

CASE 1: The existing posted speed falls **within** an acceptable range of the original design speed. (i.e., $\mathbf{PS \leq DS_o \leq (PS + 10\ mph)}$ Example: $\mathbf{DS_o = 65mph}$ **and PS = 55mph**).

CASE 2: The existing posted speed falls **below** an acceptable range of the original design speed. In a case like this, the posted speed was reduced, and the operational conditions have changed. (i.e., $\mathbf{DS_o > (PS + 10\ mph)}$ Example: $\mathbf{DS_o = 65mph}$ **and PS = 35mph**).

CASE 3: The existing posted speed falls **above** an acceptable range of the original design speed. In a case like this, the posted speed was increased, and the operational conditions have changed. (i.e., $\mathbf{PS > DS_o}$ Example: $\mathbf{DS_o = 50mph}$ **and PS = 60mph**).

<u>LEGEND</u>
DS_o = Design speed used in the original project
DS_p = Proposed design speed for project
PS = Existing (or proposed if different) posted speed

Regardless of the original design speed or posted speed, the following are the minimum design speeds:

1. Rural Facilities: 55 mph
2. Urban Facilities: 30 mph

Note: Values for design speeds less than these minimums have been provided in the tables in this chapter in the event that lower design speeds can be justified. If reconstruction is indicated, the criteria used for design should be selected from ***Chapter 2*** of this volume.

25.4.5 Lane and Shoulder Widths

The minimum lane and shoulder widths allowed are provided in ***Tables 25.4.5.1***, ***25.4.5.2***, ***25.4.5.3***, and ***25.4.5.4***. Except as discussed in ***Section 25.4.19***, the minimum widths shown in these tables are to allow existing lanes and shoulders to remain at these widths, not to be reduced to these widths.

On resurfacing projects, when the original construction was in metric units, hard convert typical section dimensions where existing conditions permit. Exception: Use direct mathematical (soft) conversion for existing pavement widths in curbed sections, existing right of way widths, and existing median widths.

For interchange ramps, where accommodation of future resurfacing is a factor, consideration should be given to increasing the minimum combined width (traveled way + outside paved shoulder) to 24 ft. where practical.

Table 25.4.5.1 Lane and Shoulder Widths - Rural Multilane

Design Year AADT	Design Speed (mph)	Minimum Lane Width (ft.)	Minimum Shoulder Width (ft.)
ALL	ALL	12	6

Table 25.4.5.2 Lane and Shoulder Widths
Two-Lane Rural and Urban, Without Curb and Gutter

Design Year AADT	Design Speed (mph)	Minimum Lane Width (ft.)	Minimum Shoulder Width (ft.)
1 - 750	ALL	10 [1]	6
751 - 2000	< 50	11 [2]	6
	≥ 50	12 [2]	6
> 2000	ALL	12 [2]	6

1. For rural and urban projects without curb and gutter (regardless of traffic volume), when widening is required, a minimum lane width of 11 ft. is required.
2. May be reduced by 1 ft. if trucks ≤ 10% of design year traffic.

Table 25.4.5.3 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. if Trucks are >10% of Design Year Traffic.
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.

Table 25.4.5.4 Lane and Shoulder Widths
Urban Multilane Without Curb and Gutter

Design Year AADT	Design Speed (mph)	Minimum Thru Lane (ft.)	Minimum Turn Lane (ft.)	Minimum Shoulder Width (ft.)
ALL	ALL	10_1	9_2	6

1. 11 ft. if Trucks are >10% of Design Year Traffic.
2. 10 ft. for 2-Way Left Turn Lanes.

25.4.6 Roadway Cross Slopes

The existing pavement and shoulder cross slopes shall be reviewed for compliance with criteria. Existing pavement and shoulder cross slopes shall be field verified by the design location survey. If cross slopes are out of tolerance, additional cross sections may be requested by the designer to estimate cross slope correction material quantity. Whenever practical, pavement and shoulder cross slopes shall be constructed to new construction criteria. When meeting new construction cross slope criteria is not practical, documentation in the design file is required and the normal non-superelevated cross slope used shall be consistent with the values in ***Table 25.4.6***. Superelevation requirements are covered in ***Section 25.4.7*** of this volume.

When cross slope correction is necessary, the designer must work closely with the Pavement Design Engineer and the District Bituminous Engineer to determine the appropriate method of correction and ensure constructability. Special milling and layering details showing the method of correction shall be shown in the plans. For projects with superelevated sections, details shall address how the transition from normal cross slope to superelevation is to be achieved. Since this type work will often involve variable depth milling and/or asphalt layers, special care in estimating quantities for milling, overbuild, and structural courses will be necessary.

Table 25.4.6 Roadway Cross Slopes

Feature	Standard	Range
Travel Lanes	0.02	0.02 - 0.04 [1]
Shoulders	0.06	0.03 - 0.08 [2]
Parking Lanes	0.05	0.03 - 0.05

1. Existing multilane curb and gutter sections originally constructed with a parabolic crown section may be resurfaced using a series of tangents with a cross slope range from 0.015 to 0.05.
2. When existing shoulders are to remain, the algebraic difference between the shoulder slope and adjoining roadway pavement slope shall be ≤ 0.07.

25.4.7 Superelevation

Roadway and shoulder superelevation shall be provided in accordance with the ***Design Standards, Index 510*** for rural curves and ***Index 511*** for urban curves, consistent with ***Section 25.4.11.1, Number 2, Superelevation***.

25.4.8 Shoulder Treatment

On projects with rural type (without curb) construction, shoulder treatment, erosion control, turf and sod shall be provided consistent with the criteria for new construction. Paved shoulders shall be provided in accordance with new construction criteria with the following exceptions:

1. The widening of existing 4 ft. paved shoulders is optional.
2. When a bike lane is provided between the through lane and the right turn lane in accordance with ***Section 25.4.19***, a paved shoulder should be provided for the right turn lane, but is optional. When a paved shoulder is provided for the right turn lane, it should be 5 feet wide (2 feet minimum) to address off-tracking vehicles and to provide drainage benefits.

For RRR projects using ***Index 105*** of the ***Design Standards***, the shoulder treatment option must be identified in the plans. Treatment 1 can only be used if the shoulder is established with good soil and turf, and there is no significant shoulder erosion. If a project meets the overlay thickness requirements for Treatment 1, but there is significant shoulder erosion, Treatment 2 must be used in the plans.

For new construction paved shoulder criteria, refer to ***Chapter 2*** of this volume. Shoulder cross slope is addressed in ***Section 25.4.6***.

Table 25.4.11.1 Safe Criteria for State Highway System With Maximum Superelevation

DESIGN SPEED (mph)	$e_{max.} = 0.10$				$e_{max.} = 0.05$			
	SHS		RRR		SHS		RRR	
	D_{max}	$R_{min.}$ (ft.)	D_{max}	$R_{min.}$ (ft.)	D_{max}	$R_{min.}$ (ft.)	D_{max}	$R_{min.}$ (ft.)
30	24° 45'	231	30° 30'	188	20° 00'	286	25° 45'	223
35	17° 45'	323	20° 45'	276	14° 15'	402	17° 15'	332
40	13° 15'	432	14° 45'	388	10° 45'	533	12° 15'	468
45	10° 15'	559	11° 00'	521	8° 15'	694	9° 00'	637
50	8° 15'	694	8° 30'	674	6° 30'	881	6° 45'	849
55	6° 30'	881	6° 45'	849	N/A		N/A	
60	5° 15'	1091	5° 30'	1042	N/A		N/A	
65	4° 15'	1348	4° 30'	1273	N/A		N/A	
70	3° 30'	1637	3° 45'	1528	N/A		N/A	

25.4.12 Stopping Sight Distance

Stopping sight distance requirements are provided in ***Table 25.4.12***.

Table 25.4.12 Stopping Sight Distance

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

25.4.13 Vertical Clearance

The following clearances apply to highway bridges (to remain or be modified only) and other roadway features over the entire roadway. Entire roadway includes lanes and shoulders. Replacement structures shall be to new construction standards.

Underpass Clearance - For roadways passing under existing bridges, vertical clearance shall be at least 14 ft. over the entire roadway. Signing and warning features shall be provided whenever vertical clearance is less than 14 ft. 6 inches. The existing vertical clearance shall not be reduced by the RRR project if the existing clearance is 16 ft. or less.

Low Member Clearance - Existing bridges with sway bracing members over the bridge deck shall have at least 14 ft. clearance over the entire roadway.

Signs and Traffic Control Devices - Clearances shall be provided consistent with new construction standards.

25.4.14 Horizontal Clearance

Horizontal clearance is the lateral distance from a specified point on the roadway such as the edge of the travel lane or face of curb, to a roadside feature or object. Horizontal clearance applies to all highways. Horizontal clearance requirements vary depending on the design speed, whether rural or urban with curb, traffic volumes, lane type, the object or feature, and whether the object is or is not within a control zone as described in the following ***Sections 25.4.14.1*** and ***25.4.14.2***.

Table 25.4.14.5 Horizontal Clearance to Signal Poles and Controller Cabinets for Signals

Shall not be located in medians. Rural and Urban Flush Shoulders: Outside the clear zone. Urban Curb or Curb and Gutter: 4' from face of outside curbs and outside the sidewalk. However, when necessary the Signal Poles may be located within sidewalks such that an unobstructed sidewalk width of 4' or more (not including the width of curb) is provided. Also, when site conditions make the 4' clearance impractical, clearance may be reduced to 1.5'.

Table 25.4.14.6 Horizontal Clearance to Trees

Minimum Horizontal Clearance for new plantings shall meet new construction criteria. Minimum Horizontal Clearance to existing trees where the diameter is or is expected to be greater than 4" measured 6" above the ground shall be: Rural and Urban Flush Shoulders: Outside the clear zone. Urban Curb or Curb and Gutter: 1.5' from face of outside curbs. 3.5' from edge of inside traffic lane.

Table 25.4.14.7 Horizontal Clearance to Bridge Piers and Abutments

Minimum Horizontal Clearance to Bridge Piers and Abutments: Rural and Urban Flush Shoulders: Outside the clear zone. Urban Curb or Curb and Gutter: 16' from the edge of the travel lane.

Table 25.4.14.8 Horizontal Clearance to Railroad Grade Crossing Traffic Control Devices

Placement shall be in accordance with the ***Design Standards***.

Table 25.4.14.9 Horizontal Clearance to Other Roadside Obstacles

Minimum Horizontal Clearance to other roadside obstacles: Rural and Urban Flush Shoulders: Outside the clear zone. Urban Curb or Curb and Gutter: 4' back of face of curb. May be 1.5' back of face of curb when all other alternatives are deemed impractical.
Note: Horizontal Clearance to mailboxes is specified in the construction details contained in the ***Design Standards**, **Index No. 532***.
Note: Transit and school bus shelters shall be placed in accordance with ***Rule Chapter 14-20.003, Florida Administrative Code***. Transit bus benches shall be placed in accordance with ***Rule Chapter 14-20.0032, F.A.C.***.

Table 25.4.14.10 Horizontal Clearance to Drop-off and Canal Hazards

Canals: (See also ***Chapter 4*** of this Volume.) Rural and Urban Flush Shoulders: Design Speeds ≥ 50 mph: 60 ft. from the traveled way. Design Speeds < 50 mph: 50 ft. from the traveled way. Urban Curb or Curb and Gutter: 40 ft. from the edge of the travel lane. Drop-offs: (See also ***Chapter 4*** of this Volume.) Rural and Urban Flush Shoulders: Treat as roadside slopes in accordance with ***Design Standard 700***. Urban Curb or Curb and Gutter: 22 ft. from traveled way to the point that is 6 ft. below the hinge point.

25.4.24 Highway Traffic Control Devices

Traffic control devices such as signals, signing, and pavement markings shall be updated as required to comply with the ***Manual on Uniform Traffic Control Devices,*** the ***Manual on Uniform Traffic Studies,*** the Department's ***Design Standards,*** and the ADA design guidelines issued by the Secretary of the U.S. Department of Transportation. The District Traffic Operations Engineer (or staff) shall determine any new or additional devices required.

25.4.25 Bridges

On each project, a determination must be made as to whether an existing bridge should remain as is, be rehabilitated or be replaced. This determination should be made as early as practical due to the potential impact to the work program. Pavement resurfacing funds can only be used for minor bridge improvements such as rail retrofits and ADA improvements. Bridges that require major improvement or replacement must be programmed with the appropriate bridge program funds.

The determination of bridge improvement needs must be supported by an engineering analysis/report and be based on an assessment of the bridge's structural and functional adequacy. The engineering report must include the project description, an operational impact evaluation, safety impacts, and a benefit/cost analysis. The safety impacts must include a detailed review of crash history, severity, contributing factors, etc. If the engineering analysis determines it is not feasible to bring the bridge in full compliance with minimum criteria, a design exception or variation addressing the feature(s) not meeting criteria must be processed in accordance with ***Chapter 23*** of this volume. The engineering analysis/report should be used to support the exception or variation.

If a bridge is found to be functionally obsolete but structurally sound, complete replacement is usually not warranted. For these type structures a full range of possible improvements must be considered, including improvements that enhance safety but do not necessarily bring the bridge into full compliance with minimum criteria. Improvements such as upgrading of connecting guardrail systems, approach roadway or shoulder widening, "Narrow Bridge Ahead" signing, or other appropriate feature modifications should be considered as appropriate. Widening of the structure itself, or rail retrofit, are also options that should be addressed. The designer should always review the Department's work program to see if a structure is scheduled for replacement in the near future, before determining short term improvements.

If the structure is on the Florida Intrastate Highway System (FIHS)/Strategic Intermodal System (SIS), the designer should also consider any improvements based on future alignment and possible lane additions required for an FIHS/SIS corridor. For example: if a bridge is to be replaced, the corridor is on the FIHS/SIS, and the project will be multilaned in the future, the new bridge should be aligned to fit future typical sections.

25.4.25.1 Bridge Loading

Bridges shall have an Inventory Load Rating equal to or greater than the load requirements shown in the following table:

Table 25.4.25.1 Bridge Loading

Type	Load Requirement
Collector Facilities	HS-15
Arterial Facilities	HS-20

25.4.25.2 Bridge Width

Bridges shall meet or exceed the following clear width criteria. If lane widening is planned as part of the RRR project, the minimum useable bridge width shall be determined using the width of approach lanes after widening.

Table 25.4.25.2 Clear Width Criteria for Bridges

Design Year ADT		Minimum Usable Bridge Width (ft.)
UNDIVIDED	0 - 750	Total width of approach lanes + 4
	751 +	Total width of approach lanes + 8
DIVIDED	ALL	Total width of approach lanes + 5.5 (median separator) * Total width of approach lanes + 6.5 (median barrier wall)**
ONE WAY BRIDGES	ALL	Total width of approach lanes + 6.5 (2.5 Lt. and 4.0 Rt.)

* 1.5 ft. median and 4 ft. outside shoulder

** 2.5 ft. median and 4 ft. outside shoulder

If widening is required, it shall be in accordance with the ***Structures Design Guidelines*** and meet the geometric requirements for new construction.

25.4.25.3 Bridge Railing

Florida bridge railing must meet or exceed design strength specified in the ***AASHTO "LRFD Bridge Design Specifications"***. In addition, FDOT is moving towards full implementation of ***NCHRP Report 350*** crash test criteria for bridge traffic railing, and FDOT policy is to bring all bridge traffic railing to current standards on bridges that are being widened or rehabilitated. Bridge traffic railings are required to be evaluated for conformance to current standards whenever any improvements are made to any bridge or its approach roadway. An existing obsolete bridge traffic railing within a RRR project must be brought up to current standards, or else a design exception must be obtained for the project, providing that railing replacement or retrofit, or entire bridge replacement, is scheduled within a reasonable time. Structures Design Office staff are available to advise Districts on options.

The Thrie Beam Guardrail Retrofit and Vertical Face Retrofit ***Design Standards***, ***Index 470 and 480 Series*** respectively, are suitable for retrofitting specific types of obsolete bridge traffic railings. These retrofits provide a more economical solution for upgrading obsolete traffic railings when compared with replacing the obsolete traffic railings and portions of the bridge decks that support them. As these retrofits do not provide for any increase in clear width of bridge deck, and in a few cases actually decrease clear width slightly, they should only be considered for use on existing bridges where adequate lane and shoulder widths are present. Detailed guidance and instructions on the use of these retrofits is included in the ***Structures Manual, Volume 3***.

All superseded FDOT Standard Traffic Railings conforming to the designs shown on ***the Existing FDOT Traffic Railing Details in Volume 3 of the Structures Manual*** are both structurally and functionally adequate. Refer to ***the Existing FDOT Traffic Railing Details in Volume 3 of the Structures Manual*** for information on existing "New Jersey Shape" and "F Shape" Traffic Railings.

Existing bridge traffic railing retrofits constructed in accordance with ***1987 through 2000 Roadway and Traffic Design Standards, Index 401, Scheme 16, "Guardrail Continuous Across Bridge"*** may be left in place provided the following four criteria are met:

1. The retrofit railing is in good condition.
2. There is not a history of severe crashes at the site.
3. The bridge is not on an Interstate or a high-speed-limited-access facility.
4. The dimension from the center of the W-beam guardrail to the roadway surface is at least 1'-9" (1" tolerance acceptable).

Existing bridge traffic railing retrofits constructed in accordance with ***1987 through 2000 Roadway and Traffic Design Standards, Index 401, Schemes 1 and 19 "Concrete Safety Barrier"*** may be left in place provided the height of the railing is at least 2'-5" measured from the roadway surface.

All other former FDOT bridge traffic railings not listed above and any other traffic railings that are not based on crash tested designs are inadequate and shall be replaced, retrofitted or excepted, as appropriate, using the criteria included in the ***Structures Design Guidelines***.

For guardrail to bridge rail transition requirements, see ***Section 25.4.26.2.***

25.4.25.4 Vertical Clearance

For vertical clearance requirements for bridges, refer to ***Section 25.4.13***.

25.4.25.5 Considerations

When evaluating bridge replacement or widening, the following should be considered:

1. Cost of replacing the existing bridge with a wider bridge designed to new bridge criteria.
2. Cost of widening the existing bridge (if widening is practical), including life cycle costs of maintaining a widened bridge.
3. The number of crashes that would be eliminated by replacement or widening.
4. The hydraulic sufficiency and the risk of failure due to scour and/or ship impact as well as the consequences of failure.

25.4.25.6 Pier Protection and Design

Pier protection and design shall comply with the requirements provided in ***Structures Design Guidelines, Section 2.6***.

25.4.26 Roadside Safety Hardware

Roadside conditions must be reviewed to determine the need for roadside safety hardware. This review must include a review of existing roadside safety hardware for need and adequacy and whether upgrading or replacement is necessary. See ***Chapter 4*** of this volume for guidance on conducting reviews. All roadside safety hardware on RRR projects must comply with the following requirements.

25.4.26.1 Longitudinal Barriers, Guardrails, Median Barriers

Existing longitudinal guardrail sections must be upgraded or replaced unless they conform to the current ***Design Standards**, **Index 400***. As an exception, existing guardrail constructed with steel offset blocks, but otherwise conforming to the current ***Design Standards***, are not required to be upgraded or replaced.

Existing concrete barriers conforming to the current ***Design Standards**, **Index 410***, New Jersey shape barriers, and approved vertical faced concrete barriers may remain in place. Other concrete barrier shapes must be replaced.

All replacements and new installations shall conform to the current ***Design Standards***.

The above applies to barriers used for shielding roadside hazards not involving pier protection. See ***Structures Design Guidelines, Section 2.6***, for barrier requirements for pier protection

See ***Section 25.4.25.3*** for bridge rail requirements.

25.4.26.2 Guardrail to Bridge Rail Transitions

Existing guardrail to bridge traffic railing approach and trailing end transitions must be upgraded or replaced unless they conform to one of the following systems.

1. For approach ends of existing standard New Jersey Shape and F Shape bridge traffic railings:
   a. The nested thrie beam approach transition shown as ***Detail J*** in the current ***Design Standards, Index 400.***
   b. For retrofitted installations, the appropriate nested thrie beam transition shown in the current ***Design Standards, Index 402.***

c. The nested W-beam approach transition shown as ***Detail J*** in the 1998 edition of the ***Roadway and Traffic Design Standards, Index 400,*** Sheet 7 of 21. This detail is also shown in the 2000 edition of the ***Roadway and Traffic Design Standards, Index 401,*** Sheet 1 of 9.

All guardrail replacements and new installations connecting to standard New Jersey Shape and F Shape bridge traffic railings shall conform to the current ***Design Standards, Index 400***. For guardrail retrofits connecting to existing bridge traffic railings, see ***Design Standards, Index 402*** and the ***Structures Manual, Volume 3***.

2. For approach ends of existing bridge traffic railing retrofits constructed in accordance with the ***1987 through 2000 Roadway and Traffic Design Standards, Index 401, Scheme 16, "Guardrail Continuous Across Bridge"***:

   a. The W-beam approach transition shown as ***Detail J*** in the 1987 edition of the ***Roadway and Traffic Design Standards, Index 400,*** Sheet 9 of 13, upgraded as shown in ***Interim Design Standards, Index 403*** by the installation of a nested section of W-beam guardrail, additional guardrail posts and offset blocks and a transition block if a curb is not present beyond the bridge end.

   b. The nested W-beam approach transition shown as ***Detail J*** in the 1998 edition of the ***Roadway and Traffic Design Standards, Index 400,*** Sheet 7 of 21, upgraded as shown in ***Interim Design Standards, Index 403*** by the installation of a transition block if a curb is not present beyond the bridge end. A transition block is not required if a curb is present.

3. For trailing ends of existing bridge traffic railing retrofits constructed in accordance with the ***1987 through 2000 Roadway and Traffic Design Standards, Index 401, Scheme 16, "Guardrail Continuous Across Bridge"***:

   a. In the absence of continuing guardrail, two panels of W-beam guardrail and a Type II End Anchorage as shown in ***Design Standards, Index 400*** or another approved end anchorage.

   b. A continuous W-beam guardrail system.

4. For approach ends of existing bridge traffic railing retrofits constructed in accordance with the ***1987 through 2000 Roadway and Traffic Design Standards, Index 401, Schemes 1 and 19, "Concrete Safety Barrier"***:

   a. The appropriate nested thrie beam transition shown in ***Design Standards, Index 402***.

Chapter 26

Bridge Project Development

26.1 General

All structural designs for new construction for the Florida Department of Transportation (FDOT) are developed under the direction of the Structures Design Office (SDO) and/or the District Structures Design Offices (DSDO). All designs are to be developed in accordance with the ***Structures Manual*** which includes the ***Structures Design Guidelines (Topic No. 625-020-150)***, the ***Structures Detailing Manual (Topic No. 625-020-200)***, this Manual, the ***Design Standards (Topic No. 625-010-003)***, and the ***AASHTO Standard Specifications for Highway Bridges*** or the ***AASHTO-LRFD Bridge Design Specifications*** as referenced in the Structures Manual, applicable FHWA Directives, and other criteria as specified by the Department.

Designs for repair or rehabilitation of bridges are generally developed under the direction of the District Structures and Facilities Engineer (DSFE) and may not include all the submittal types discussed in this chapter.

Structures for other agencies or authorities such as the Jacksonville Transportation Authority, various Expressway Authorities, etc. may be designed to meet the Department's criteria or additional criteria as specified by the authority.

For projects involving bridges over navigable water, the Project Manager must provide the District Structures and Facilities Engineer (DSFE) sufficient notification prior to engaging in any action in, on, or around the bridge. Refer to ***Section 13.5.3*** of this volume for further information.

26.2 Organization

The Structures Design Office (SDO) is a subdivision of the Office of Design under the direction of the State Highway Engineer and the Assistant Secretary for Transportation Policy. The SDO is under the direction of the State Structures Design Engineer (SSDE). Each District, including the Turnpike, has a staff of structural design engineers that comprise the District Structures Design Office (DSDO), and which is under the direction of the District Structures Design Engineer (DSDE).

26.3 Definitions

All structures have been grouped into the following two categories based upon design difficulty and complexity:

26.3.1 Category 1 Structures

Category 1 Structures consist of box or three-sided culverts, short span bridges (continuous reinforced slabs and prestressed slabs), simple span bridges with spans less than 150 feet, continuous straight steel plate girder bridges with spans less than 150 feet, bridge widenings for these structure types, retaining walls, roadway signing, signalization and lighting supports, sound barriers, and overhead sign structures.

26.3.2 Category 2 Structures

A structure will be classified as a Category 2 Structure when any of the following are present: steel box girders, curved steel plate girders, span lengths equal to or greater than 150 feet, cast-in-place concrete box girder bridges, concrete segmental bridges, continuous post-tensioned concrete bridges with or without pretensioning, steel truss bridges, cable stayed bridges, movable bridges, depressed roadways, tunnels, , non-redundant foundations, straddle piers, integral caps, bridges designed for vessel collision, or any design concepts, components, details or construction techniques with a history of less than five (5) years of use in Florida.

26.4 Abbreviations Used in Structures Design

Terminology used in the area of Structures Design for the Florida Department of Transportation often is written or spoken in the form of abbreviations and/or acronyms. Following is a list of those terms frequently encountered in this manual and in other references used in structures design and include those commonly used for offices, organizations, materials, systems, features, equipment, conditions, and expertise:

AASHTO	***American Association of State Highway and Transportation Officials***
ACI	***American Concrete Institute***
ACIA	***Assigned Commercial Inspection Agency***
ADA	***Americans with Disabilities Act***
AISC	***American Institute of Steel Construction***
ANSI	***American National Standards Institute***
AREMA	***American Railway Engineering and Maintenance Association***
ASTM	***American Society for Testing and Materials***
AWS	***American Welding Society***
BBS	***Bulletin Board System***
BDR	***Bridge Development Report***
BHR	***Bridge Hydraulics Report***
BHRS	***Bridge Hydraulics Recommendation Sheet***
CADD	***Computer Aided Design and Drafting***
CEI	***Construction Engineering and Inspection***
C.I.P. (C-I-P)	***Cast-in-Place (Concrete)***
CPAM	***Construction Project Administration Manual***
CVN	***Charpy V-Notch (Impact Testing)***
DSDE	***District Structures Design Engineer***
DSDO	***District Structures Design Office***
DSFE	***District Structures and Facilities Engineer***
EMO	***Environmental Management Office***
EOR	***Engineer of Record***
FDOT	***Florida Department of Transportation***
FHWA	***Federal Highway Administration***
LRS	***Low-relaxation Strands***
LRFD	***Load and Resistance Factor Design***
MHW	***Mean High Water***
MSE	***Mechanically Stabilized Earth (Walls)***
MUTCD	***Manual on Uniform Traffic Control Devices***
NHS	***National Highway System***
NHW	***Normal High Water***

NOAA	***National Oceanic and Atmospheric Administration***
OIS	***Office of Information Systems***
OSHA	***Occupational Safety and Health Administration***
PDA	***Pile Driving Analyzer***
PD&E	***Project Development and Environment***
PPD	***Plans Production Date***
PPM	***Plans Preparation Manual***
QPL	***Qualified Products List***
RDR	***Required Driving Resistance***
SDO	***Structures Design Office***
SIP (S-I-P)	***Stay-in-Place (Forms)***
SRS	***Stress-relieved Strands***
SSDE	***State Structures Design Engineer***
TAG	***Technical Advisory Group (SDO and DSDEs)***
TFE (PTFE)	***Polytetrafluorethylene (Teflon)***
TRB	***Transportation Research Board***
UBC	***Ultimate Bearing Capacity***
UV	***Ultraviolet***
VECP	***Value Engineering Change Proposal***

Chapter 29

Structural Supports for Signs, Luminaires, and Traffic Signals

Figures

Chapter 29

Structural Supports for Signs, Luminaires, and Traffic Signals

29.1 General

The design criteria for the structural design of all sign, signal, and lighting structures shall be in accordance with AASHTO's ***2001 Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals***, with current addenda and the ***FDOT Structures Manual Volume 9***.

Use standard sign structures unless site conditions or other considerations require a custom design.

For overhead sign structures, mast arm signal structures and steel strain poles; indicate in the Plans whether a grout pad is or is not to be installed.

29.2 Sign Structures

29.2.1 General

FDOT assigns identification numbers to overhead sign structures. See the ***Structures Detailing Manual, Chapter 2***, for instructions.

29.2.2 Standard Single Column Ground Signs

Refer to ***Design Standards, Index Nos. 11860 thru 11865***.

29.2.3 Standard Multipost Ground Signs

Refer to ***Design Standards, Index No. 11200*** and ***FDOT Multi-Post Sign Program***.

29.2.4 Standard Span Overhead Sign Structures

The EOR is responsible for the design of all overhead sign structures whether ground mounted or supported on a structure (including bridge structures), unless otherwise directed by the Department. This responsibility is for the entire sign structure, including the supports and foundations, as well as all details necessary to fabricate and erect the sign structures. The EOR is also responsible for the shop drawing review in accordance with ***Chapter 28*** when sign structure shop drawings are required by the Contract Documents.

In general, however, the designer may refer to the ***Design Standards, Index Nos. 11310 and 11320***.

29.2.5 Standard Cantilever Overhead Sign Structures

The EOR is responsible for the design of all cantilevered overhead sign structures whether ground mounted or supported on a structure (including bridge structures), unless otherwise directed by the Department. This responsibility is for the entire sign structure, including the supports and foundations, as well as all details necessary to fabricate and erect the sign structures. The EOR is also responsible for the shop drawing review in accordance with ***Chapter 28*** when sign structure shop drawings are required by the Contract Documents.

In general, however, the designer may refer to the ***Design Standards, Index Nos. 11310 and 11320***.

29.2.6 Custom Designs

The Structures Engineer of Record is responsible for the design of the attachment system for signs mounted on bridge structures.

If custom design is required, during the design process include with the 30% submittal, a brief written justification.

For signing or lighting structures mounted on bridge structures, include their plans in the structures plans. Otherwise, include design details in the signing or lighting plans.

29.3 Luminaire Structures

29.3.1 General

Luminaire Structures may be Standard Aluminum Light Poles, Standard High-Mast Lighting or Custom Designs.

29.3.2 Standard Aluminum Light Poles

Standard, QPL listed, aluminum light poles must comply with the detail requirements shown on ***Index No. 17515*** of the ***Design Standards***.

For additional design information, see ***Chapter 7*** of this volume.

Selection Procedure

1. Use an Importance Factor (I_r) = 0.80 (25-year recurrence interval.)
2. Determine the height difference between the top of foundation and the top of roadway used to set the fixture mounting height, round as necessary.
   a. Determine the design mounting height (40, 45, or 50 feet) and fixture arm length (8, 10, 12, or 15 feet) required.
   b. The wind height at fixture equals the design mounting height for poles not on fill. For poles on fill, determine the height of the roadway above the surrounding terrain. The wind height at fixture will equal the design mounting height plus the fill height, rounded up to the next highest 5-foot increment.
   c. Determine the pole design variables for each light pole.

Limitations

1. Fixture Arm Length of 8-feet, 10-feet, 12-feet or 15-feet. Single arm only.
   a. Design Mounting Height of 40-feet, 45-feet or 50-feet. (May differ from Fixture Mounting Height, see Selection Procedure item 2).
   b. 25-feet maximum height above adjoining ground surface.
   c. Design weight of luminaire assumed to be 51 lbs.
   d. Equivalent projected area of luminaire for design is 1.5 square feet.
2. No bridge or wall mounting permitted.
3. Maximum fill slope at the pole of one vertical to four horizontal. Steeper slopes can be accommodated provided the face of the slope on a horizontal projection from the

foundation base is no closer than it would be if a 1:4 slope were projected from the top of the foundation.

4. Unique site circumstances where poorer soil conditions are encountered than shown on ***Index No. 17515*** may require the foundation variables to be modified from those shown. If special designs are required, the Geotechnical Engineer will provide the soil information to be used by the District Structures Design Engineer during the design phase of the project.

For additional design information, see ***Chapter 7*** of this volume.

29.3.3 Standard High-Mast Lighting

Refer to ***Design Standards, No. 17520***.

29.3.4 Custom Designs

When special aluminum light poles are required, or otherwise specifically designated in the contract documents, the Contractor's Specialty Engineer is responsible for the structural design of the roadway light poles and foundations and the EOR is responsible for the review of the Shop Drawings.

29.4 Traffic Signal Structures

29.4.1 General

Mast Arm Assemblies may be Standard Mast Arm Signal Structures, Standard Mast Arms for Site-Specific Loadings, or Custom Designs.

29.4.2 Standard Mast Arm Signal Structures

Design the arm to pole connections on mast arm structures as “through-bolted” (tapped connections are not permitted).

Regardless of the design wind speed for the pole and arm, base the torsional resistance of foundations for all mast arm Assemblies on a service wind speed of 85 mph with a safety factor of 1.0.

For signals, design all mast arm assemblies with backplates unless the Maintaining Agency for a County has a written policy that prohibits the use of backplates in that County. The prohibiting policy must be on file with the Department's District Office in which the County is located, and the policy must be included in the Scope of Services of both the Signal and Structures Design Engineers.

Design and detail mast arm assemblies using one of the following three methodologies:

1. Standard Mast Arm Assemblies: Mast arms that utilize all pre-approved components listed on the Department's Qualified Products List (QPL) and that have been pre-designed for the selected Load Trees shown in ***Figure 29.2***.
2. Standard Mast Arm Assemblies for Site-Specific Loadings: Mast arms for unique loadings but which utilize all pre-approved QPL components.
3. Custom Designs: Special Mast arms for unique loadings and/or geometric constraints that contain any component (arm or pole) that is outside the range of those listed on the QPL.
4. For additional design information, see ***Chapter 7*** of this volume.

The standard mast arm assemblies must comply with all the requirements and design criteria shown on ***Index Nos. 17743*** and ***17745*** of the ***Design Standards***, and the “Standard Mast Arm Assemblies Data Table”.

Standard Mast Arm assemblies are limited to 110,130 or 150 mph design wind speeds with one of the load tree configurations shown in ***Figure 29.2***, and either single arm, single arm with luminaire, or double arms with arm orientations of 90° or 270° only.

Foundations and base plates for standard mast arm assemblies are pre-designed based on the following conservative soil criteria:

Classification:	Cohesionless (Fine Sand)
Friction Angle:	30 Degrees
Unit Weight:	50 lbs./cubic foot (assumed saturated)

When the designer considers soil types at the specific site location to be of lesser strength properties than shown above, an analysis is required. Auger borings, SPT borings, or CPT soundings may be used as needed to verify the assumed soil properties, and at uniform sites, a single boring or sounding may cover several foundations. Borings in the area that were performed for other purposes may be used to confirm the assumed soil properties. Unique site circumstances may require the foundation variables to be modified from those shown on ***Index 17743***. Accomplish this by completing the “Special Drilled Shaft Data” in the “Standard Mast Arm Assemblies Data Table”. The Geotechnical Engineer must justify the differing foundation criteria to the District Structures Design Engineer during the design phase of the project.

To use standard mast arm assemblies:

1. Confirm that the information furnished by the signal designer in the "Mast Arm Tabulation Sheet" meets the geometric and load tree limitations shown in ***Figure 29.2***.
2. Follow the procedure described in the design examples in ***Volume 2, Chapter 24,*** complete the necessary information required in the "Standard Mast Arm Assemblies Data Table" and include in the Traffic Plans.

29.4.3 Standard Mast Arms for Site-Specific Loadings

The Department's mast arm computer program will select component parts from those shown on ***Index No. 17743*** for site specific load configurations differing from those shown in ***Figure 29.2***.

In order to be eligible for utilization of QPL component parts, the mast arm assemblies must utilize only arms and poles from the components listed in the tables on ***Index No. 17743***.

As for standard mast arm assemblies, the foundation design is included with the pole selection and needs no further information.

Design and detail standard mast arm assemblies utilizing QPL component parts in the plans in the same manner as for standard mast arm assemblies by use of the "Standard Mast Arm Assemblies Data Table". Similarly, because all QPL component parts are used, shop drawings are not required.

29.4.4 Custom Designs

The Department's mast arm Computer Program will provide the necessary variables to be shown in the “Special Mast Arm Assemblies Data Table”.

Show special mast arm assemblies and foundations in the plans. Refer to ***Index No. 17745***. Require shop drawings for all special mast arm assemblies.

29.4.5 Anchor Bolt Installation on Existing Foundations

Ensure that anchors used in the installation of a traffic signal mast arm on an existing foundation conform to ***Structures Design Guidelines 1.6 – Adhesive Anchor Systems*** and ***Sections 416 & 937*** of the ***Standard Specifications***.

Verify that the foundation and strength of the anchors are adequate for mast arm applied loads.

Verify the existing condition of the drilled shaft.

Anchors may be offset from center but all anchors must be within the foundation reinforcing cage. Note the desired offset in the plans.

Figure 29.1 Flowchart for Designing and Detailing Mast Arm Assemblies

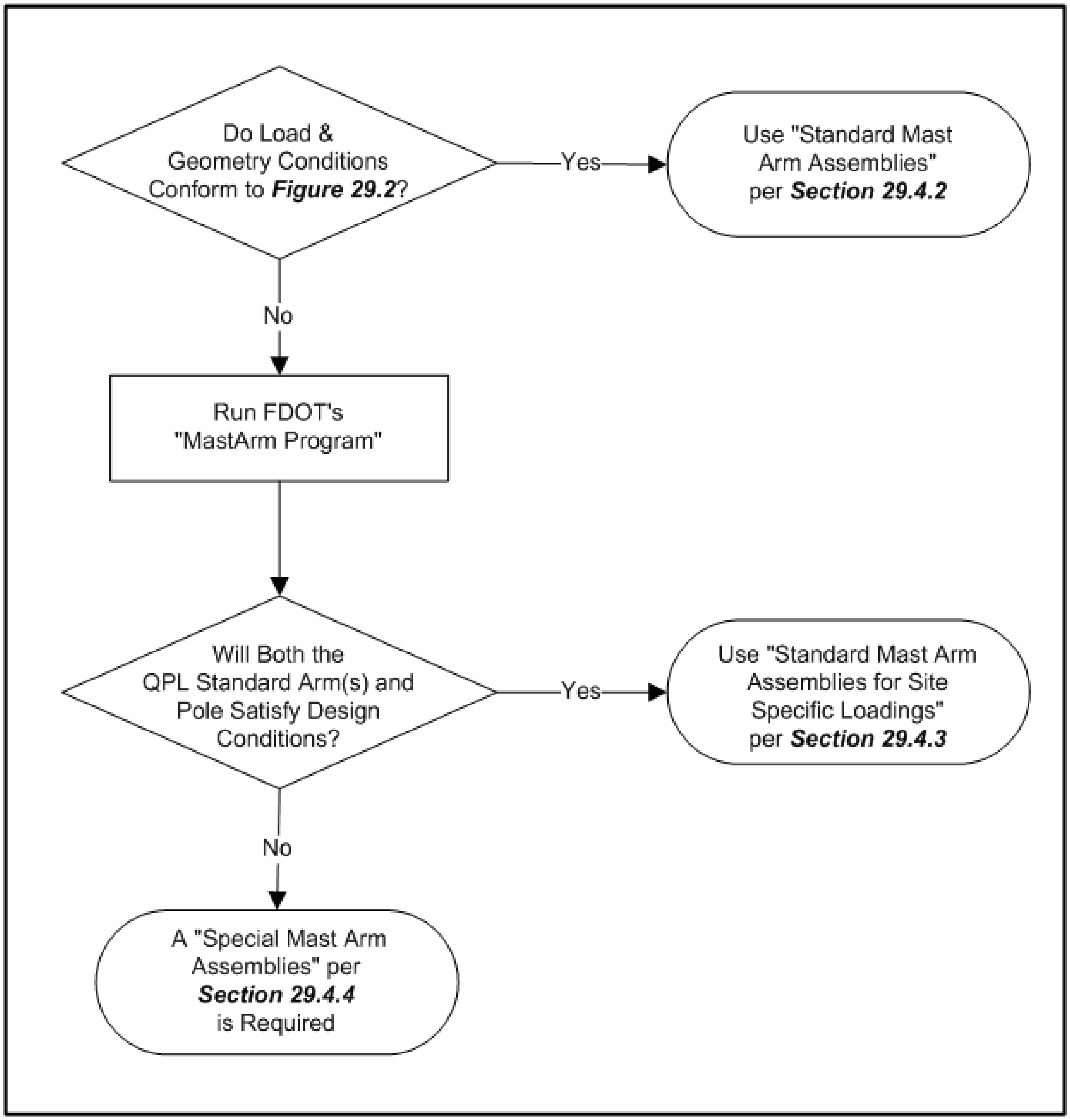
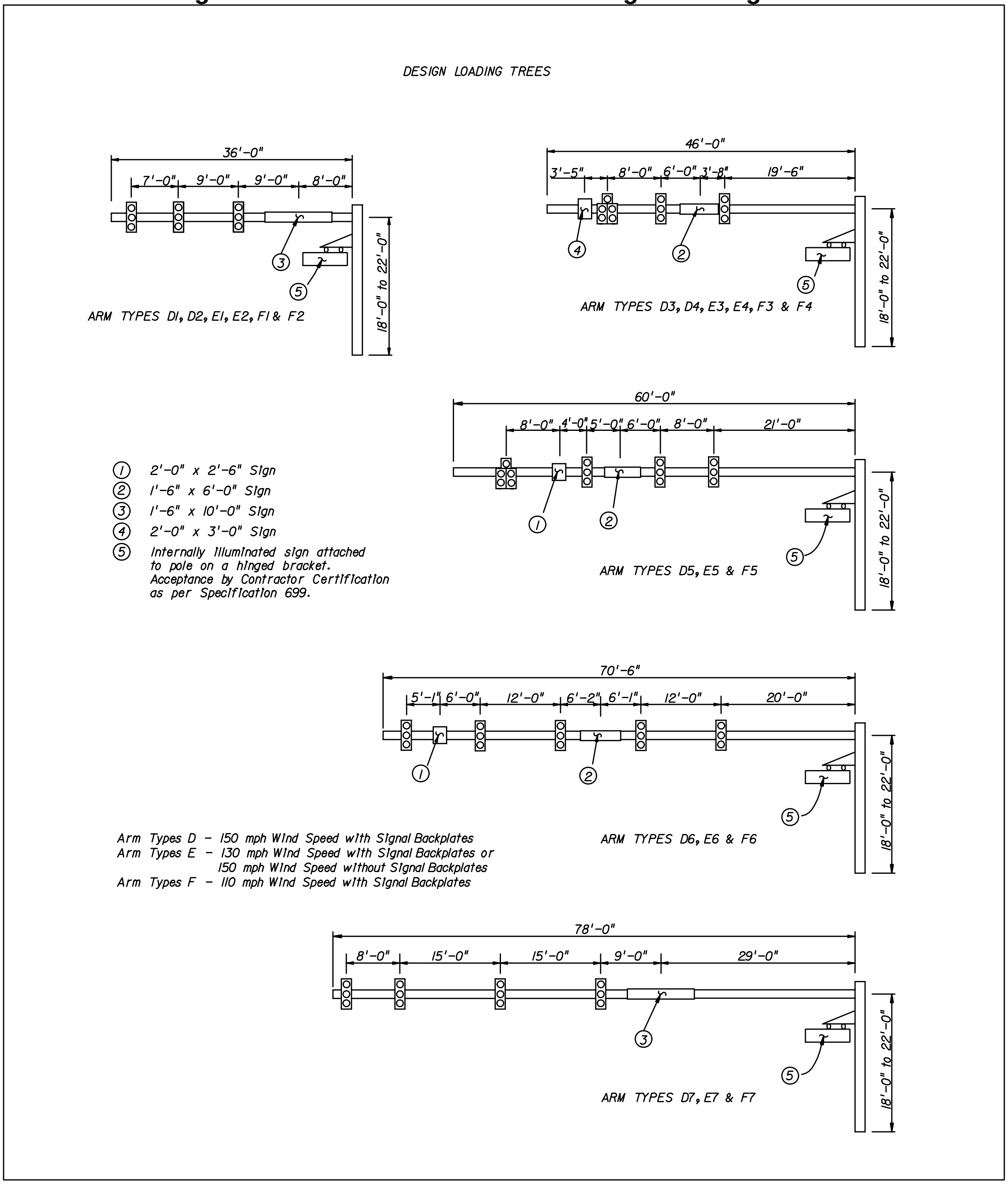


Figure 29.2 Standard Mast Arm Design Loading Trees



29.4.6 Standard Span Wire with Concrete Strain Poles

Refer to Design Standards, Index No. 17725.

29.4.7 Standard Span Wire with Steel Strain Poles

Refer to Design Standards, Index No. 17723.

Chapter 30

Retaining Walls

Exhibits

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Chapter 30

Retaining Walls

30.1 Purpose

The purpose of this chapter is to give the designer an understanding of the procedure to develop retaining wall plans. A step-by-step method to develop and organize the retaining wall plans is presented. An example of retaining wall plans is included. This chapter should be used in conjunction with the ***Structures Design Guidelines (SDG)***.

If the difference in height between the ground levels to be supported is 5 ft. or less, a gravity retaining wall is generally the most efficient structure to be used. For details of gravity retaining walls see the ***Design Standards, Index No. 520***.

When the difference in height between the ground levels to be supported exceeds 5 ft., then either a reinforced cast-in-place (C.I.P.) concrete cantilever retaining wall or a proprietary retaining wall is required.

Roadside barriers are generally required to shield vertical drop-offs created by retaining walls in fill sections. See ***Chapter 4*** of this volume for guidance on roadside barrier requirements.

Handrails or fences for bicyclists and pedestrians are also generally required when retaining walls are located within the right of way. This requirement must be addressed for retaining walls in fill sections as well as at the top of retaining walls in cut sections. In cut sections, the character and use of the adjoining property shall be considered when selecting the type of protection required. See ***Chapter 8*** of this volume for pedestrian and bicycle rail requirements.

In general, proprietary retaining walls should be utilized for projects when the exposed surface area of the walls exceed 1000 square ft. and sufficient room for the earth reinforcement system is available; however, site specific conditions must always be considered when determining the type(s) of wall to be designed. Proprietary precast walls other than MSE walls should be used as an alternate to C.I.P. walls when sufficient room for soil reinforcement is not available.

The following sections refer to the structures submittal procedure. For projects where there are no bridges, the roadway designer shall adjust the procedure as required for the roadway project.

30.2 Conventional (C.I.P.) Retaining Walls and Proprietary Retaining Walls (Permanent Walls)

The Department's policy is to provide either a set of conventional retaining wall plans or the "preapproved standard details" for all the proprietary walls that are technically appropriate for the site for all projects where walls are not supported on piles. Projects where walls are supported on piles only require a conventional pile supported wall design or a pile supported proprietary wall design. Omission of conventional retaining walls is possible if adequate justification is provided.

Proprietary retaining wall design plans are not required in the contract plans for normal uncomplicated wall projects. If the proprietary walls are experimental, exceed 40 ft. in height, are subject to unusual geometric or topographic features or, by the geotechnical report, will be subjected to excessive settlement, or environmental conditions, they may be required to have fully detailed design plans in the contract set.

The success of this method of producing and letting wall plans is highly dependent on complete, accurate and informative Control Plans. The importance of the Geotechnical Engineer's role in this scheme cannot be emphasized enough and shall include the following responsibilities:

1. Borings.
2. Soils Report.
3. Wall Type recommendation.
4. For Proprietary Walls: external stability analysis, minimum soil reinforcement length vs. wall height for external stability, maximum bearing pressure for each wall height and soil reinforcement length for each different wall height (1.5 ft. increments).
5. Review of internal stability design as provided by the wall companies.
6. Establishment of allowable bearing pressures.

The normal failure modes to be investigated are shown in ***SDG, Figure 3-1***.

Step-by-step procedures for developing retaining wall plans follow.

30.2.1 Retaining Walls (Conventional Design)

1. Bridge Development Report (BDR) / 30% Plans

   The BDR shall discuss and justify the use/non-use of conventional retaining walls. If the use of conventional retaining walls is applicable to the site and economically justified, it may be the only design required or it may be an alternate to a proprietary design. The 30% Plans submittal shall contain a location plan, plan and elevation of walls showing vertical and horizontal alignment, cross sections and details. The plans shall denote location of drainage inlets, utilities, sign structures, lights and barrier joints. Specifically the submittal package shall include:

   a. Plan:

      A plan view of the wall and footings which indicate pertinent dimensions, boring locations and horizontal alignment.

   b. Elevation:

      A front view of the wall which indicates pertinent dimensions and elevations, sign and lighting structures locations, drainage structure locations and flow line elevations, location of section views and vertical alignment.

   c. Sections:

      Sections taken through the wall to better indicate dimensions and elevations.

   d. General Notes including:

      1) Design Toe Pressure

      2) Environmental Classification

      3) Concrete - (Strength and Class)

      4) Reinforcing Steel - (Grade)

      5) Design Method

      6) Soil Design Parameters for both the in situ and backfill materials

      7) Load and Resistance Factors

2. 30% Plans:

   The 30% Plans shall be submitted for approval and development of the plans continued towards the 90% Plans submittal.

3. 90% Plans:

   The 90% Plans submittal shall be further developed to include, in addition to the information required for the 30% Plans, the following:

a. Plan:

A plan view of the wall and footings which indicates pertinent dimensions; reinforcing steel locations, cover and spacing in footings; and boring locations, back of wall drainage details and horizontal alignment.

b. Elevation:

A front view of the wall which indicates pertinent dimensions and elevations; location of section views; reinforcing steel location, cover and spacing; back of wall drainage and flow lines; vertical alignment; and locations of construction and expansion joints.

c. Sections:

Sections taken through the wall to better indicate dimensions, reinforcing steel locations, concrete cover for rebars and elevations.

d. Estimated Quantities:

Estimated quantities for items incorporated in the wall, reinforcing bar list and standard bar bending sheet.

The Structures Design Office has prepared ***Index No. 5100*** of the ***Design Standards*** for use in conventional cantilever retaining wall designs. This Design Standard is to be used in conjunction with the Retaining Wall computer program available on the Structures Design Office web site. Design assumptions used in the development of ***Index No. 5100*** are in the "Retaining Wall Notes" in the program.

30.2.2 Retaining Walls (Proprietary Design) (Design Required in Contract Plans)

The following procedure for plans preparation should be followed if the walls are required to be fully detailed in the contract plans.

1. BDR/30% Plans

   The BDR shall discuss and justify the use of proprietary retaining walls. The 30% Plans shall contain preliminary Control Plans. It will not be necessary for these Plans to contain pay items and standard drawings; however, they shall include, but not be limited to, the following information:

   a. Key Sheet

   b. General Notes Sheet

      1) General notes

      2) In situ soil characteristics

      3) Design parameters

      4) Applicable wall systems

   c. Plan and Elevation Sheet:

      1) Horizontal and vertical alignment

      2) Limits of wall

      3) Utility locations

      4) Plan view of wall

      5) Elevation view of wall (showing existing and proposed ground lines, elevations at 30 ft. intervals at top of wall, wall embedment (maximum elevation at top of leveling pad) and beginning and end of wall stations)

      6) Boring locations

      7) Quantity (pay area of walls)

      8) Table showing soil reinforcement length vs. wall height (for external stability)

      9) Design parameters - Load and Resistance Factors

      10) Sections thru wall showing offset control point, pay area, ditches, sidewalks, superelevation and other unusual features

11) Ranges of wall systems applicable to the portion of the project defined by the plan and elevation sheet.

d. Soil Profile Sheet

e. General Details showing:

1) Wall/end bent cap interface

2) Barrier and coping to wall interface

3) Pile, inlets and pipe conflicts with soil reinforcement and slip joint details

f. Preapproved Standard Drawings:

Note: Through the June 2006 letting, standard drawings for each of the alternate companies will be included in the ***Design Standards***. As of the July 2006 letting, only general notes and common details for the proprietary retaining wall systems will be included in the Design Standards. Vendor drawings with wall specific details for each approved wall company will be relocated on the State Specifications Office QPL website.

2. Control Plans/Invitation Package

The Control Plans shall be reviewed by the Department and, upon approval, sent to all the appropriate wall companies. The companies shall be provided with a set of control plans, roadway plans and foundation report. The Control Plans shall be sent to the wall companies as soon as they are approved. This action shall be accomplished as soon as possible but not later than the 60% Plans. A copy of the transmittals to the wall companies shall be sent to the DSDO or SDO as appropriate. The proprietary companies shall acknowledge receipt of the invitation package. If they choose to participate they shall provide design plans for the retaining walls and submit the plans for review as prescribed in the invitation letter.

3. 90% Plans

Upon receipt of the proprietary design plans, the designer shall review the design and incorporate the wall plans into the contract set. The plans from the wall companies, control plans and wall company standard drawings shall constitute the 100% Plans.

30.2.3 Retaining Walls (Proprietary Design - Control Plans only; Full Design not Required in Contract Plans)

Use the following procedure in preparing plans for wall projects.

1. BDR/30% Plans

   Discuss and justify the use of proprietary retaining walls and FDOT Wall Types (see ***Index 5300***) in the BDR. Provide documentation of all the site-specific geotechnical information and wall system considerations in the Retaining Wall Justification portion of the BDR. Include the Preliminary Control Plans and the information previously shown in this Section.

2. 90% Plans

   Include the Control Plans into the 90% Plans submittal.

   General notes, common details, and the Table of FDOT Wall Types are shown in the ***2006 Design Standards***. Approved proprietary retaining wall system drawings and details are listed, with FDOT Wall Type, on the State Specifications Office QPL website.

   The site-specific wall design details are submitted as shop drawings for each project.

30.2.4 Wall System Selection

Using the site-specific geotechnical information, the Engineer of Record (EOR), in cooperation with the geotechnical engineer, will determine all wall system requirements. Design considerations include short term and/or long term settlement, differential settlement (both longitudinal and from front of wall to end of concrete stems or soil reinforcement (rotation)), and global stability. Use the Flow Chart ***Exhibit 30-A*** for Permanent Retaining Wall Design to determine:

1. Plan requirements
2. Concrete Class, Concrete Cover, and FDOT Wall Type

For all walls, place notes on the General Notes sheet of the Control Plans in accordance with the Plan Requirements listed in the Flow Chart ***Exhibit 30-A***.

During construction on projects with a FDOT Wall Type listed in the plans, the contractor will submit, for approval by the engineer, a QPL approved wall system allowed in accordance with FDOT Wall Type Table. The July 2006 ***FDOT Standard Specifications Section 548, Retaining Wall Systems*** will state: Unless otherwise detailed and/or shown in the plans, choose a wall system from the Qualified Products List (QPL) in accordance with the FDOT Wall Type listed in the plans.

On projects with non-QPL Walls (non-proprietary walls, complex walls, two phase walls, total settlement > 6 inches, differential settlement > 0.5%, etc), the complete wall design and details are included in the plans.

30.3 Critical Temporary Walls

A critical temporary wall is one that is necessary to maintain the safety of the traveling public or structural integrity of nearby structures and utilities for the duration of the construction contract.

Critical temporary walls shall be designed in accordance with this chapter, AASHTO LRFD Specifications, and the ***Structures Design Guidelines*** and shall include the soil reinforcement lengths, sizes, and stress level requirements for permanent walls.

The allowable reinforcement tension for temporary MSE walls using geogrid soil reinforcement shall be in accordance with the ***Structures Design Guidelines***.

The design details of critical proprietary temporary walls shall be submitted in the shop drawings. The generic design details of critical temporary walls shall be included in the contract set of plans. The plans format shall be in accordance with ***Section 30.2.2*** and ***30.2.3***.

30.4 Experimental Wall Projects

Proprietary wall companies must comply with the Department's ***Guidelines for Selection and Approval of Proprietary Retaining Wall Systems, Topic No. 625-A20-118*** (available in Central Office Structures Design) and prepare standards to be approved and adopted by the FDOT. One of the requirements is to build a wall that may, at the discretion of the Department, be instrumented and monitored. Special instruction for design and plans preparation shall be obtained from the State Structures Design Office.

30.5 Shop Drawing Review

Conventional C.I.P. retaining walls do not require shop drawings; however, proprietary retaining walls require shop drawings in accordance with ***Chapter 28***.

The shop drawing reviewer (EOR) shall be experienced in the requirements, design and detailing of proprietary wall plans. The EOR shall review but not be limited to the following items:

1. Verify vertical and horizontal geometry with contract plans.
2. Verify details with MSE wall suppliers standard details in contract plans.
3. Soil reinforcement placement in acute corners shall be detailed.
4. Slip joints shall be at all bin wall and standard MSE wall interface locations.
5. Soil reinforcement shall be detailed at all obstructions. Cutting or kinking of soil reinforcement shall not be allowed. Connection of soil reinforcement to piles or bearing against piles shall not be allowed.
6. Corner panels shall be used at all locations where walls are deflected horizontally 5 degrees or more.
7. Compare proposed reinforced fill characteristics with design fill characteristics. In-place moist density of backfill may vary by $\pm$ 5 pcf, and the internal friction angle may be 1° less than the design values (as shown in control plans) before a check of the wall design is required. If the internal friction angle is greater than the design value then a redesign is not required.
8. Review proprietary wall internal stability design calculations.
9. Verify soil reinforcement lengths for conformance to the ***Structures Design Guidelines***, the external stability table on the plans, and the internal stability design calculations.
10. Confirm wall embedment.
11. Verify panel types and thickness are consistent with contract plans.
12. Soil reinforcement lengths shall be the same from top to bottom of wall at any section. The diameters of the longitudinal and transverse bars of any given mesh reinforcement shall be equal. The cross section of any soil reinforcement shall not vary along its length (i.e., "2Wll" reinforcement shall not be spliced to "4Wll").
13. Check stress level in soil reinforcement and connections.

30.6 Bidding Procedure

The conventional C.I.P. walls shall be bid as Concrete (Retaining Wall) and Reinforcing Steel (Retaining Wall). Conventional walls may be bid as an alternate to proprietary walls if the site conditions justify conventional walls.

Proprietary Walls shall be bid with Pay Item numbers;

548-___ Retaining Wall System (Permanent)

548-___ Retaining Wall System (Temporary)

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Exhibit 30-A Permanent Retaining Wall Design

Flowchart for Retaining Wall Design*

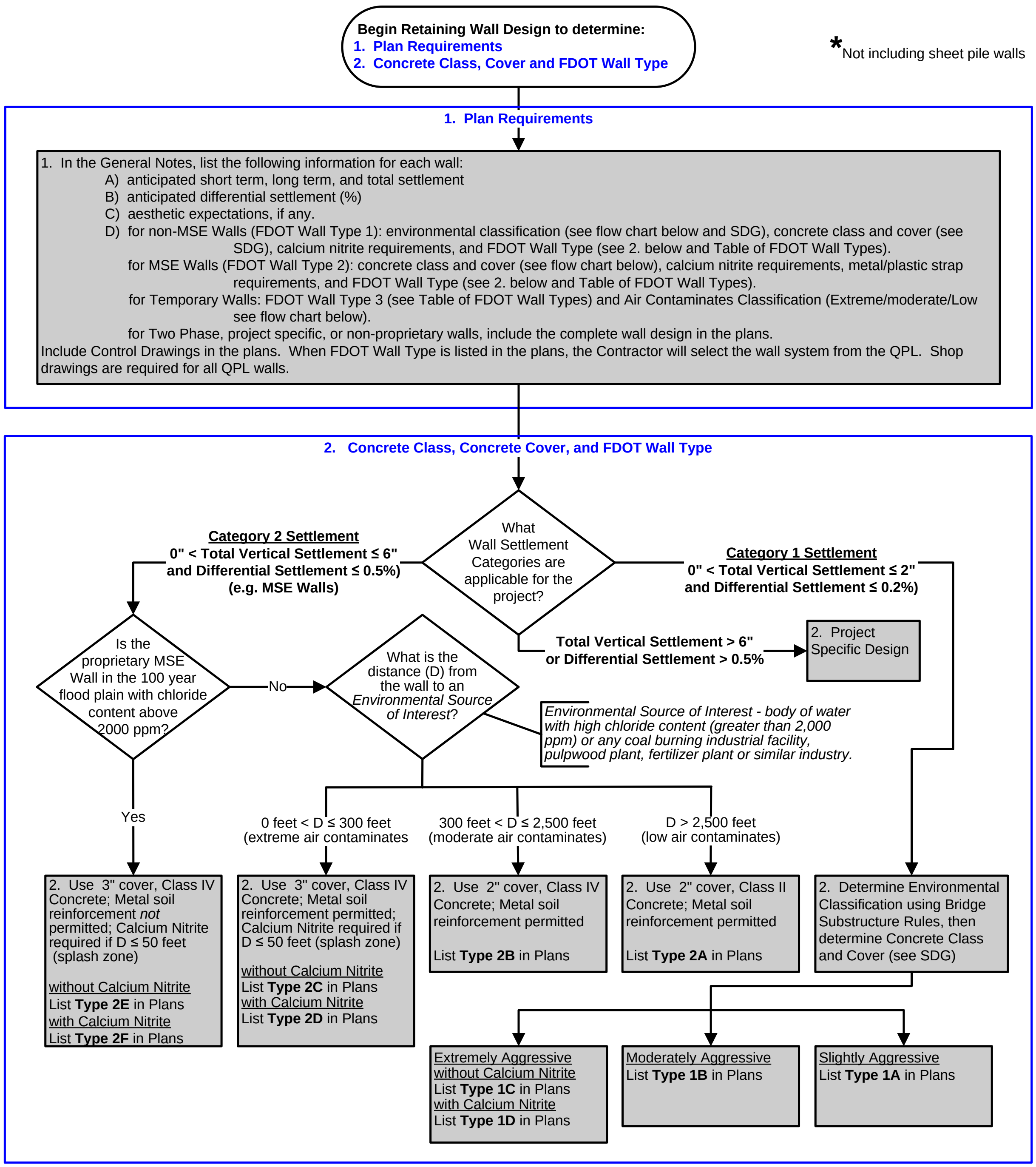

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Exhibit 30-A Permanent Retaining Wall Design (Continued)

Table of FDOT Wall Types

Wall Type[1]	Proprietary QPL Item	Settlement Category	Design Settlement Limitations: Total Settlement[2]		Differential Settlement[3]	Typical Wall Construction	Durability Category	Durability Factors: Concrete Cover	Concrete Class	Calcium Nitrate	Soil Strap Type	Other Allowable Wall Types[7]: 1A	1B	1C	1D	2A	2B	2C	2D	2E	2F
Type 1	No	1	≤ 2"	and	≤ 0.2%	Cantilever, Gravity, and Counterfort Walls	Project Specific					Project Specific									
Type 1A	Yes						A	2"	II	No	n/a		✓	✓	✓	✓	✓	✓	✓	✓	✓
Type 1B							B	2"	IV	No				✓	✓		✓	✓	✓	✓	✓
Type 1C							C	3"	IV	No					✓		✓	✓	✓	✓	✓
Type 1D [4]							D	3"	IV	Yes											✓
Type 2	No	2	≤ 6"	and	≤ 0.5%	MSE Walls	Project Specific					Project Specific									
Type 2A	Yes						A	2"	II [5]	No	metal						✓	✓	✓	✓	✓
Type 2B							B	2"	IV [5]	No								✓	✓	✓	✓
Type 2C							C	3"	IV [5]	No									✓	✓	✓
Type 2D							D	3"	IV [6]	Yes											✓
Type 2E							E	3"	IV [6]	No	plastic										✓
Type 2F [4]							F	3"	IV [6]	Yes											
Type 3	Yes	3	n/a		≤ 2.0%	Temporary Walls	n/a				metal/plastic	n/a									

1 - Listed in the Plans; Wall Type combines both Settlement Limitations and Durability Factors.
2 - Amount of wall settlements that the will occur in its design life and includes both short and long term settlements. Short term settlements occur during wall construction and may contain elastic deformation and densification settlement. Long term settlements continue after the completion of the wall and may include consolidation and secondary consolidation/creep settlements.
3 - Settlements along the alignment of and perpendicular to the wall face; usually are not uniform. Expansion joints for the cast-in-place walls and slip joints for MSE walls are provided to control wall and wall panel cracks, respectively.
4 - Includes all underground walls and walls submerged in water.
5 - For concrete requirements, see Specification Section 346 using slightly aggressive environment.
6 - For concrete requirements, see Specification Section 346 using extremely aggressive environment.
7 - "Other Allowable Wall Types" listed with an "✓", have Settlement Limitations and Durability Factors greater than those required by the "Wall Type" (Column 1).

Chapter 32

Sound Barriers

Tables

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Chapter 32

Sound Barriers

32.1 General Requirements

Chapter 23 of the Code of Federal Regulations Part 772 (23 CFR 772) entitled "Procedures for Abatement of Highway Traffic Noise and Construction Noise" contains the federal regulations for the assessment of traffic noise impacts and abatement on federal aid projects. ***Chapter 335.17 of the Florida Statutes*** requires the use of ***23 CFR 772*** for traffic noise impact assessment on highway projects, regardless of funding. ***Policy No. 000-360-005, Noise Abatement*** contains the policy for abatement of traffic noise on Department projects. The requirements for assessing the noise impacts and abatement commitments are detailed in ***Part 2, Chapter 17 of the Project Development and Environmental Manual (PD&E Manual) (Topic No. 650-000-001)***. The initial evaluation of noise impacts is made during the Project Development and Environmental (PD&E) phase of a project. Any preliminary commitments to provide reasonable and feasible noise abatement measures on a project are included in the Noise Study Report (NSR) and summarized in the environmental document. The environmental documents and any subsequent re-evaluations shall be reviewed to identify all preliminary noise abatement commitments.

Preliminary noise abatement commitments made during the PD&E phase are subject to change due to refinements during final design. Designers must consider final roadway grades and horizontal alignments, land use changes, as well as ground elevation at sound barrier locations. Noise abatement identified as reasonable and feasible during the PD&E phase need to be reassessed against the final roadway features. The typical PD&E phase assumptions are appropriate for reasonableness and feasibility decisions but the final design must utilize location specific data that reflects proposed vertical and horizontal locations of the travel lanes and sound barriers. The noise specialist shall provide the top of wall elevation for both minimum and desirable insertion reductions as described below. The designer shall coordinate with the noise specialist in the District Environmental Management Office to ensure proper analysis and public involvement occurs during final design.

If no noise abatement is identified in the environmental document or any subsequent environmental re-evaluations, no further effort is required during final design. However, it may still be necessary to evaluate construction noise and vibration impacts and develop any special provisions to be included in the plans.

Upon review of the environmental documents the designer and the noise specialist should identify the noise receptors considered during the noise impact assessment performed in PD&E. Noise receptors resulting from development completed after the approval date of the environmental documents should not be considered as the Department is not responsible for providing noise abatement at these sites. A detailed design reassessment of the preliminary noise abatement commitments should be conducted for the following:

1. Locations of preliminary noise abatement commitments

2. Receptor sites where roadway geometric refinements are likely to change noise impacts

An addendum to the NSR prepared by the District Environmental Management Office during Final Design will document the final noise abatement commitments.

32.2 Noise Study Report Addendum

The primary effort related to the reassessment of preliminary noise abatement commitments during design is the preparation of an addendum to the NSR. The reassessment shall be based on the final roadway geometry and the proposed noise abatement design, including sound barrier type, location, dimensions and estimated costs. For consistency, the Final Design reassessment should be conducted using the latest version of the FHWA's Traffic Noise Model (TNM).

Noise abatement measures are considered when noise levels at a receptor(s) approach or exceed the noise abatement criteria or substantially exceed existing noise levels. The noise abatement criteria is listed in ***Table 32.1***. Approaching the criteria means within 1 dBA of the noise abatement criteria. A predicted increase of 15 dBA or more is considered substantial. Noise abatement is generally only considered for Activity Categories 'A' and 'B'. Preliminary noise abatement commitments are documented in the original NSR.

32.3 Noise Abatement Criteria

The insertion loss is the level of noise reduction as a result of abatement. The desirable insertion loss is 10 dBA or more; however, the minimum insertion loss should be 5 dBA for an impacted receiver for abatement to be considered reasonable. If a sound barrier can meet the desired insertion loss for a cost of $42,000 or less per benefited receiver site, the barrier is considered cost reasonable. The statewide average unit cost (per square foot) and the upper limit of the cost per benefited receiver to be used in determining cost reasonableness is established by the Environmental Management Office. As of the printing of this update the statewide average unit cost of sound barriers to be used in the calculation of the cost/benefited receiver is $30.00/ft^2. The PD&E manual should be referenced for the latest unit cost update. Additional costs such as required additional right of way, special drainage features, special bridge support and special foundations associated with the installation of a sound barrier should be added to the unit cost if appropriate. If these special features increase the cost per benefited receiver above $42,000, the decision whether or not to provide a barrier must be made in consultation with the District Environmental Management Office and FHWA. Any decision to eliminate a sound barrier from consideration based on the additional cost of special features will require clear demonstration that the need for such special features are associated only with the sound barrier and cannot be mitigated by other considerations.

If a minimum of 5 dBA insertion loss cannot be achieved at a receiver, that receiver is not benefited; therefore, it cannot be considered in the cost effective calculation to determine the reasonableness of that barrier. The noise specialist should thoroughly investigate the scenarios required to meet the desirable insertion loss of 10 dBA at $42,000 or less per benefited receiver particularly where design changes or the consideration of special features require cost or abatement level reanalysis.

Section 32.6, Structural Design, provides structural design criteria and procedures, and horizontal clearance requirements. Under normal conditions sound barriers shall not exceed the following heights:

1. For sound barriers at the right of way line or outside the clear zone use a maximum height of 22 feet.

2. For sound barriers on bridge and wall structures use a maximum height of 8 feet.

3. For sound barriers at the shoulder point, mounted on embankments only, use a maximum height of 14 feet.

Use of barrier heights greater than these shall require a Design Variation. Justification for a variation should include, as a minimum, a description of site conditions requiring the increased height and a comparison to the standard height of both insertion loss and cost per benefited receiver.

The designer should provide analytical results to the Department project manager evaluating barrier heights necessary to achieve minimum, desired and optimum insertion loss. The optimum barrier height should be most cost effective in consideration of noise reduction benefits per unit cost of the barrier. An evaluation matrix is suited to this type of comparative analysis. The evaluation matrix should consider an appropriate range of sound barrier configurations (height, length and roadway offset) that provide the desirable insertion loss (10 dBA) per impacted receiver and the minimum insertion loss (5 dBA) per impacted receiver. The number of benefited receivers should be identified and the cost per benefited receiver calculated for each configuration evaluated. If a sound barrier configuration can provide the desirable insertion loss (10 dBA) at a reasonable cost (less than $42,000 per benefited receiver), then it should be provided. If this is not achievable, the designer should select a sound barrier configuration that optimizes insertion loss per impacted receiver and cost per benefited receiver. The designer should always provide a recommendation with the evaluation. The designer should also coordinate with the District Structures Design Office to ensure that the sound barrier design meets appropriate structural design standards and that construction is feasible and achievable.

The height of the sound barrier is measured from the ground elevation to the top of the barrier. Tall sound barriers are seldom necessary at the top of roadway embankments or berms since the elevation of the embankment contributes to the effective height of the barrier. In addition, changes in the vertical grade of the top of the barrier should be gradual and abrupt changes in barrier heights should be avoided. Often natural ground elevations at the base of the barrier fluctuate, even in flat terrain. Therefore, the designer should provide plan details that make clear to the contractor the final barrier top elevations, foundation step locations and post spacing.

When an otherwise continuous barrier is broken resulting in a horizontal separation between the barriers, it is often necessary to overlap the barriers to reduce insertion loss degradation. Applications of this occur when the mainline barrier is located at the right of way line, but must be moved to the shoulder point at a bridge location. This may also occur at interchanges when transitioning from the mainline to a ramp. The overlap distance of sound barriers is generally equal to four times the separation; however, an analysis by the noise specialist is necessary to determine the optimum overlap. The need or effectiveness of a sound barrier in the infield area of an interchange should be reviewed as well during final design. The attenuation of ramp traffic may provide adequate insertion loss when considering the intersecting roadway's noise contribution. Maintenance access and clear zone must be considered when selecting barrier termini details.

Other noise abatement techniques that may be considered to supplement or replace sound barrier walls are:

1. Traffic management measures (e.g., traffic control devices and signing for prohibition of certain type vehicles, time use restrictions for certain type vehicles, modified speed limits, and exclusive lane designations);

2. Alteration of horizontal and vertical alignments;

3. Acquisition of property rights for construction of sound barriers by donation, purchase or condemnation;

4. Acquisition of the balance of a noise-sensitive property from which there is a taking, if acquisition is less expensive than other methods;

5. Acquisition of right of way for landscaping adjacent to sound barriers and for buffer zones.

Table 32.1 Noise Abatement Criteria

[Hourly A-Weighted Sound Level-decibels (dBA)]

Activity Category	Abatement Level (in L_{Aeq})		Description of Activity Category
	FHWA	FDOT	
A	57	56 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67	66 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, RV parks, day care centers and hospitals.
C	72	71 (Exterior)	Developed lands, properties, or activities not included in Categories A and B above.
D			Undeveloped lands.
E	52	51 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

32.4 Public Involvement

The identification and design of noise abatement measures during the project design phase will require additional public involvement efforts and will be especially important in the establishment of sound barrier design features such as barrier texture. Public coordination is often necessary to finalize barrier locations, heights and aesthetic features, especially if there are substantial changes to prior commitments. These changes may be the result of any of the considerations noted in ***Section 17-4.6.1*** of the ***PD&E Manual***. Coordination with the District Public Involvement or Community Liaison Coordinator in obtaining additional input during the final design of the sound barrier is required.

When a barrier is warranted, a written survey shall be conducted to establish whether a numerical majority of the benefited receivers are in favor of the construction of the barrier. If they are not in favor, the Department may choose not to build it. If agreement cannot be reached by a neighborhood on the use of sound barriers, the decision to provide them or not will rest solely with the Department. This survey will usually be conducted during the design phase although it is possible that a survey could be conducted during the PD&E phase. Survey issues should be coordinated with the District Environmental Management Office.

Sound barriers located on arterial roadways can potentially impact access. The ability to construct an effective sound barrier(s) can depend on an individual property owner's willingness to sign a right of way indenture allowing access to be cut off or modified. For these type projects it is general practice to obtain a written statement from each affected property owner demonstrating support for the sound barrier. If an adjacent property owner(s) declines to sign the indenture the noise specialist shall re-evaluate the effectiveness of noise abatement on the project segment considering alternate sound barrier layouts. If insertion loss criteria cannot be met, the noise specialist shall document in the NSR Addendum that the barrier is not feasible.

F.S. 479.25 (as amended by ***HB 273***) "Outdoor Advertising", allows permitted, conforming, lawfully erected outdoor advertising signs to be increased in height if visibility is blocked due to construction of "noise attenuation" barriers. In addition, the amended statute requires the Department to notify a local government or local jurisdiction before erecting a sound barrier that will block a lawfully permitted sign. The local government or local jurisdiction is then required to notify the Department if increasing the height of an outdoor advertising sign will violate any local ordinance or land development regulation of the local government. When the notice has been received from the local government or local jurisdiction and prior to erection of the sound barrier, the Department shall:

a.) Inform all the benefited receivers, as part of the written survey, that:

1. Erection of a specific sound barrier may block the visibility of an existing outdoor advertising sign;

2. The local government or local jurisdiction may restrict or prohibit increasing the height of the existing outdoor advertising sign to make it visible over the barrier;

3. If a majority of the benefited receivers vote for construction of the sound barrier, the local government or local jurisdiction will be required to:

    a. Allow an increase in the height of the sign in violation of a local ordinance or land development regulation;

    b. Allow the sign to be relocated or reconstructed at another location if the sign owner agrees; or

    c. Pay the fair market value of the sign and its associated interest in the real property.

The amended statute also requires the Department to hold a public hearing within the boundaries of the affected local government or local jurisdiction to receive input on proposed sound barriers that may conflict with the local ordinances or land development regulations and to suggest or consider alternatives or modifications to the proposed sound barrier to alleviate or minimize the conflict with the local ordinances or land development regulations or minimize any costs associated with relocating, reconstructing, or paying for the affected outdoor advertising sign. Alternatives or modifications to barriers that will reduce the insertion loss below the minimum of 5 dBA will not be considered unless the results of the survey indicate that a numerical majority of the benefited receivers do not favor construction of the sound barrier.

The written survey materials shall inform the affected property owners of the location, date, and time of the public hearing. The public hearing may be held concurrently with other public hearings scheduled for the project. A general notice of the public hearing shall also be published in a newspaper in accordance with the notice provisions of ***F.S. 335.02(1)*** and containing the same information provided in the written survey materials. The notice shall not be placed in that portion of a newspaper in which legal notices or classified advertisements appear. Please refer to ***Part 1, Chapter 11 Public Involvement, of the PD&E Manual*** for additional details about meeting notification requirements.

The Department shall not construct a sound barrier that screens or blocks the visibility of an outdoor advertising sign until after the public hearing is held and the numerical majority of the benefited receivers has approved the construction of the barrier. If the construction of the sound barrier is approved the department shall notify the local governments or local jurisdictions. The local governments or local jurisdictions shall then exercise one of the options in paragraph 3 above.

32.5 Final Noise Abatement Commitments

During the final design phase, the noise abatement locations, sound barrier types, lengths and heights will be determined. The final noise abatement commitments must be documented in the environmental reevaluation and the noise study report addendum prior to construction advertisement. The required data collection, analysis and documentation detailed in ***Part 2, Chapter 17 of the Project Development and Environmental Manual*** will be documented in the NSR addendum. It should also contain a description of the methodology for selecting final sound barrier dimensions including any evaluation matrix(s) used.

A copy of the NSR addendum, a summary of proposed sound barrier and a summary of the public involvement regarding noise abatement that took place during the design effort will be provided to the District Environmental Management Office. The environmental management staff will ensure that the final noise abatement commitments are reflected in the reevaluation of the environmental document and will obtain concurrence from FHWA.

32.6 Structural Design

Designers shall specify the Department's Design Standard for Sound Barriers and any applicable sound barrier panels or systems listed on the QPL (see ***Section 32.8***).

Except as specified below, ***AASHTO's Guide Specifications for Structural Design of Sound Barriers*** shall be used for the structural design; however, the designer shall also refer to the ***Department Specifications, Section 534***, the ***5200 Series*** of the ***Design Standards***, and the Structures Design Office's ***Structures Manual, Volume 6, Chapter 2, Sound Barrier Evaluation Criteria*** for specifications and general design requirements, the ***Structures Manual, Volume 3*** for guidance in the preparation of the drawings and the ***Structures Detailing Manual*** for conformance in detailing.

All sound barrier in the State of Florida shall be designed for a minimum wind velocity of 110 mph. If the sound barriers are not located on other structures, the wind pressures shown in ***Table 1-2.1.2.C (Exposure B2)*** of the referenced ***AASHTO Guide Specifications*** shall be used. If the noise barriers are located on bridge structures, retaining walls, or traffic barriers, the wind pressures shown in ***Table 1-2.1.2.D (Exposure C)*** of the referenced ***AASHTO Guide Specifications*** shall be used. For sound barriers located on embankments and structures, the height zone shall be determined by using the elevation of adjoining ground as being the approximate elevation of the original ground surface prior to embankment construction.

For panels, the maximum deflection due to service wind load shall not exceed the lesser of $1/180^{th}$ of the post spacing or 1½ inch (deflection measured relative to posts). For posts or top of barrier, the maximum deflection due to service wind load shall not exceed the lesser of $1/50^{th}$ of the barrier height or 5 inches for sound barriers on deep foundations or 3 inches for sound barriers founded on shallow foundations, and measured from the following:

1. Sound barriers on deep foundations: the deflection shall be measured relative to the point of fixity in the soil. The lateral displacement at the base of the barrier shall not exceed 1 inch.

2. Sound barriers on shallow foundations: the deflection shall be measured relative to the base of the barrier system.

More restrictive panel and barrier deflection limits may be required based on the specific barrier system utilized. Design auger cast piles in accordance with ***Appendix B, Soils and Foundations Handbook***.

Unless approved by the Department, the maximum post spacing for sound barrier panels shall not exceed 20'-0".

On flush shoulder roadways, sound barriers shall be located outside the clear zone unless shielded, and as close as practical to the right of way line. On urban curbed roadways, sound barriers shall be a minimum of 4 feet back of the face of curb. However, additional setbacks may be required to meet minimum sidewalk requirements. Sound barriers may be combined with traffic railings on a common foundation if the combination meets the crash test requirements of NCHRP 350 Test Level 4 criteria.

Besides the structural integrity of the sound barrier, the structural engineer should also be concerned with aesthetics, maintainability, constructability, cost and durability.

Sound barriers should not be located on bridge structures where feasible alternative locations exist. Sound barriers on bridge structures cause an unproportionate increase in bridge cost because of strengthening of the deck overhang and exterior girder. In addition, sound barriers on bridges interfere with normal maintenance inspection access and detract from the aesthetic quality of the structure. Where feasible alternative locations do not exist and sound barriers must be located on bridges or retaining walls, they shall not be taller than 8 ft. unless specifically approved in writing by the State Structures Design Engineer. See ***Design Standards, Index Nos. 5210 and 5212*** for acceptable crash tested 8 ft. bridge and retaining wall mounted sound barriers.

On bridges or on the top of retaining walls, where the sound barrier does not meet crash test requirements of NCHRP 350, Test Level 4, sound barriers shall be placed a minimum of 5 feet beyond the gutter line of a FDOT approved standard bridge railing, and the sound barrier shall be limited to 8 feet in height unless authorized by the State Structures Design Engineer due to reasons stated in the previous paragraph. Sound barriers may be combined with the traffic railing as long as the structural system meets the crash test requirements of NCHRP 350, Test Level 4 criteria.

32.7 Geotechnical Investigation

Once the barrier location, alignments, height and minimum thickness are determined, the soil exploration should be undertaken. The geotechnical engineer should follow the Department's ***Soils and Foundations Handbook*** for exploration.

32.8 Preparation of Control Drawings

The initial set of drawings to be prepared by the EOR is referred to as Control Drawings. By preparation of these drawings, the EOR shall provide all control parameters such as alignments, limits, notes, etc., and shall provide all the information which is common to all wall types including but not necessarily limited to:

1. Barrier alignments (horizontal and vertical)

2. Barrier limits (beginning and ending)

3. Location of all existing utilities (overhead and/or underground in the vicinity of the proposed barrier)

4. Location of fire-access openings

5. Location of drainage openings

6. Sound barrier graphics details

7. General Notes

8. "Report of Core Borings" (Soil Information Data)

9. Quantities (barrier area as described below for payment purposes only; the itemized quantities such as concrete volume, etc., shall be provided in the specific drawings)

10. All other information that may be construed to be of general nature

11. NOTE: The barrier area for bidding purposes shall be the area bounded by the barrier limits (beginning and ending), the top of the barrier, and the bottom of the lowest panel between posts. This is the vertical surface area that can be seen on an elevation view plus the portion of the lowest panel which is buried.

32.9 Detail Drawings

The EOR shall prepare Detail Drawings showing the specific details required for the implementation of the selected Design Standard barrier type. All barrier components such as: foundations, posts, panels, etc. shall be fully detailed for construction. All sound barriers shall include the FDOT Design Standard (non-proprietary) design. The FDOT Structures Sitemenu CADD cell tables shall be included in the plans depicting which QPL proprietary barrier designs are compliant with project specific requirements. These drawings shall provide the specific information as shown in the applicable drawings (see the ***Design Standards***).

Manufacturers of proprietary sound barrier products may have their products evaluated by the Department in accordance with the FDOT Sound Barrier Acceptance Criteria. Approved products will be listed on the Qualified Products List (QPL). The designer or project manager shall establish the project requirements for sound barriers and include commitments made during the PD&E phase or during the design phase public involvement. Project requirements may include color, textures, graphics, post spacing (10 feet or 20 feet), absorptive vs. reflective surface, flush vs. recessed panels, etc. The project requirements shall be listed in the plans.

The designer should refer to options outlined in the ***Structures Detailing Manual, Chapter 15***.

In addition to the Department's Design Standard for concrete sound barriers, the plans shall list proprietary sound barrier products that meet the project requirements and are listed in the QPL. Characteristics and details of each approved proprietary sound barrier product included in the QPL are listed in the Specification Office's web page.

Chapter 33

Reinforced Concrete Box and Three-Sided Culverts

Tables

Chapter 33

Reinforced Concrete Box and Three-Sided Culverts

33.1 General

This chapter presents the minimum requirements for selection and designing reinforced concrete culverts. The Department recognizes two types of reinforced concrete culverts other than reinforced concrete pipe. These are concrete box culverts (four-sided) and three-sided concrete culverts. Both of these culvert types are classified as Category 1 structures in accordance with ***Chapter 26***. It is not possible to provide prescriptive requirements for all conditions so guidance provided in this chapter is for typical designs. Each location will usually have some unique character (floods, scour, surroundings, salt water, historic character, etc.). Unique environments need to be thoroughly evaluated and all environmental requirements satisfied.

Structures with a span greater than or equal to 20 feet are technically not culverts, however, for simplicity all structures in this chapter are referred to as culverts. The procedures for designing culverts and bridges maybe different due to the differing risks associated with the size of the structure. Safety and economic issues and technical complexity can vary significantly with differing site conditions which will dictate the size and type of the most appropriate structural solution. Bridge-size culverts (≥ 20 feet span) warrant more complex hydraulic and foundation treatments, which require the expertise of a bridge engineer. Simpler, less complex and smaller culvert-size structures (≤ 12 feet span) may be designed with minimal oversight of a bridge engineer. Any questions on who should design a specific-size structure should be discussed with the District Structures Engineer.

The procedure for the hydraulic analysis of culverts differs based on whether the culvert is located at a riverine or tidal crossing. Refer to ***Chapter 4*** of the ***Drainage Manual*** for the appropriate hydraulic analysis and documentation requirements.

Definitions of terms used in this chapter include the following:

Bridge-size culverts are defined as any structure, whether of single-span or multiple-span construction, with an interior width greater than or equal to 20 feet when measured horizontally along the centerline of the roadway from face-to-face (inside) of the extreme abutments or sidewalls.

Culverts are defined as any structure, whether of single-span or multiple-span construction, with an interior width less than 20 feet when measured horizontally along the centerline of the roadway from face-to-face (inside) of the extreme abutments or sidewalls.

Concrete box culverts (four-sided) typically have rectangular cross sections. An arch or arch-topped culvert is considered a box culvert if the "sidewalls" are built monolithic with the bottom (invert) slab. Two-piece (four-sided) box culverts are permitted with a simply supported top slab, which is keyed into a monolithic three-sided bottom section. Concrete box culverts are typically used where the streambed is earth or granular soil and rock is not close enough to the streambed to directly support the structure.

Three-sided concrete culverts may be rectangular in shape or a frame with varying wall and/or slab thickness or an arched or arch-topped structure. These structures have separate foundations with spread footings supported by earth, rock or piles. The largest culverts are typically not boxes; rather they are frames or arches. Use of three-sided concrete culverts where rock is not at or near the streambed requires pile support for the footings or some other form of positive scour protection. Three-sided concrete culverts on spread footings may be used for railroads, wildlife crossings, bicycle/pedestrian/ equestrian/golf cart paths, and other uses that do not convey water or have scour vulnerability.

Clear span is the perpendicular distance between the inside face of the sidewalls. The maximum clear span recommended for a concrete box culvert is 24 feet.

Design span for non-skewed culverts is the perpendicular distance between the centerline of the sidewalls. For culvert units with skewed ends, the design span of end sections is the distance between the centerlines of the sidewalls measured parallel to the skewed end.

33.2 Structure Type Selection

The designer must determine the most appropriate type of short-span structure. The basic choices are a corrugated metal structure, concrete box culvert, concrete frame or arch, and a short-span bridge. While the site conditions are the primary deciding factor for structure selection, aesthetics, constructability and economics are also very important.

Proper selection of the feasible structure alternatives is based on site and project-specific parameters, including but not limited to:

1. Vertical and horizontal clearance requirements.
2. Available “beam” (top slab) depth.
3. Maintenance and protection of traffic requirements (e.g., phase construction).
4. Construction constraints (e.g., water diversion requirements).
5. Foundation requirements.
6. Environmental concerns (e.g., natural streambed).
7. Desired aesthetic treatments (e.g., arch appearance).
8. Geometric limitations (e.g., skew angle, R.O.W. restrictions, utilities, etc.).

Concrete culverts are usually more expensive in initial cost than corrugated metal structures. However, concrete culverts are the preferred alternative when considering suitability to the site and life-cycle cost estimates. The advantages of concrete culverts are superior durability for most environmental conditions, greater resistance to corrosion and damage due to debris, greater hydraulic efficiency, and typically longer service life (i.e., potentially lower life-cycle costs).

At sites with limited headroom, concrete culverts are generally the least expensive option. Smaller corrugated metal structures typically require a minimum height of soil cover of 2 feet and for some structures the soil cover increases to 4 feet or more depending on size and shape. Concrete culverts, frames, and arches can have the least amount of cover by placing a minimum of 3 inches of asphalt pavement directly on the top slab. Corrugated metal structures will also typically require taller structures than concrete box culverts, to provide adequate waterway area below design high water due to their arched shapes. If a corrugated metal structure is a viable option, an engineering evaluation and cost analysis should be performed in consultation with the District Drainage Engineer.

Single-cell and multi-cell concrete box culverts with barrel spans less than 15 feet, are often the most cost effective structural solution where debris collection and aesthetics are not a major concern. Three-sided culverts may be appropriate for single spans exceeding 20 feet where scour is not a concern.

Before a final determination is made to use a large concrete culvert, the use of a short-span bridge should be investigated. Possible advantages of a bridge may be minimized work in the stream, speed of erection, minimized interference with the existing structure foundation, and easier phased construction. For procedural steps on planning short-span bridges, see ***Chapter 26***.

Information on corrugated metal structures (steel and aluminum) is available in the ***Drainage Manual***. When corrugated metal structures are more cost efficient and they may be considered for off-system routes where there will be no major risk of corrosion or by utilizing concrete pedestal walls to ensure there is infrequent water contact with the metal portion of the structure.

33.2.1 Precast Concrete Culverts

Precasting permits efficient mass production of concrete units. The advantages often offset the cost of handling and transporting the units to the site. Precast units are often limited to certain sizes and skews due to forms, transportation and handling concerns. Skewed units may need more reinforcement and thicker slabs and/or sidewalls. The use of skewed units will increase the cost of the culvert due to increased fabrication costs.

Skewed precast culvert units should be avoided, if practical. Precast concrete culverts should have square ends, whenever possible. Skewed end units are sometimes required to satisfy right of way constraints and/or phased construction requirements for skewed alignments. In the event they are necessary, skewed precast culvert units shall be designed for the skewed-end design span. Large skews may lead to units that require additional reinforcement and/or greater wall and slab thickness than typical square units with the same clear opening. Manufacturers should be contacted for information on maximum skews available when only precast culverts are shown in the contract plans.

Precast culverts may occasionally need to be placed on moderate or steep grades. No maximum slope is recommended for box culverts because of the need to match the slope of the streambed. Three-sided box culverts and the frames and arches should be limited to a maximum slope of 2%. If matching a steeper slope is necessary, the ends of the precast units should be beveled to create vertical joints and the footings may be stepped and/or the length of the sidewall varied. Precast manufacturers should be contacted for the maximum grade that can be fabricated if the designer is proposing a grade larger than 2%.

When two or more single-cell, precast concrete culverts are placed side-by-side, it is usually not possible to place the walls of adjacent cells tightly together. The standard detail is to provide a 2 to 4 inch gap between the walls of adjacent cells. This gap should be filled with Class I (non-structural) concrete, non-excavatable flowable fill or non-shrink grout.

All manufacturers must have approved precast drainage product facilities in accordance with ***Section 6.3*** the ***Materials Manual***.

33.2.2 Concrete Box Culverts

When a concrete box culvert is selected as the appropriate structure for the site, a cast-in-place culvert must be designed and detailed in the contract plans. A precast concrete box culvert alternative is usually permitted during construction unless specifically excluded in the contract plans. Speed of erection, maintenance of traffic, stream diversion problems, and site constraints can be minimized when the Contractor utilizes precast culverts.

33.2.3 Three-Sided Concrete Culverts

There are various types of proprietary, precast concrete frames, arch topped units, and arches available. These units are typically used when larger culverts (spans ≥ 20 feet) are required. They can be considered when scour protection can be adequately provided and/or aesthetics are a consideration. They may be placed on spread footings with an invert slab, footings on rock, or pile-supported footings. The advantages of the precast concrete arches and frames are the same as for the precast concrete box culverts, except that longer spans (up to 48 feet) are possible.

When a three-sided concrete culvert is selected as the appropriate structure for the site a precast culvert should be the preferred option. A cast-in-place reinforced concrete foundation and the channel lining must be designed and detailed in the contract plans. The final design of the precast three-sided culvert structure and any necessary foundation modifications should be completed by the Contractor’s Engineer of Record (usually the manufacturer).

Sizes of precast units that are common to more than one manufacturer should be selected. Dimensions of the sidewalls and top slab, reinforcement size and spacing should not be shown on the plans, unless necessary. If sidewall or top slab dimensions are dictated by site conditions, show only the affected dimensions and indicate if they are minimums, maximums, or specifically required dimensions. The assumed top slab dimension used to determine fill limits should be shown in the contract plans.

A note in the contract plans shall require the Contractor to provide all design details not included in the contract plans. This method should result in the most economical culvert design.

33.2.3.1 Precast Arch and Arch-Topped Units

The following guidelines should be considered when selecting a precast arch or arch-topped culvert:

9. Aesthetics concerns may make the use of arch-shaped units desirable. The use of arch-shaped facade panels is not recommended, especially for hydraulic openings due to snagging of debris.
10. The amount of skew that can be fabricated varies. Some manufacturers prefer to produce only 0° skew units. The maximum skew at which a precast unit should be fabricated is 45°. The culvert orientation to the centerline of the highway may be at a skew greater than 45°.
11. An arch unit is preferable for a grade separation for highway vehicles or railroads, when a dry conveyance environment is necessary. The arch shape eliminates any ponding problems above the culvert without special fabrication or field adjustments that would be required for flat-topped culverts.
12. Arch units are preferred in cases where fills above the precast units exceed 20 feet.
13. Precast arch-topped units are currently available in spans up to 48 feet.
14. Arched units have been used as liners for old masonry or concrete arches in other States. After the construction of a pedestal wall at the base, the units are slid into place. The void between the existing arch and the liner is filled with grout installed through fittings cast into the liner units.
15. Large arch units may be shipped in two pieces and assembled on site. Three-piece units are not permitted.

33.2.3.2 Precast Frame Units

The following guidelines should be considered when selecting a precast frame (rectangular) culvert:

1. Many of precast frame-type units can be fabricated with skew angles up to 45°. This characteristic is useful when phased construction is proposed. When used for phased construction with shallow highway pavements, no temporary shoring is needed at the phase construction joint to support the fill or pavement.
2. Frame units provide a simpler traffic railing/headwall connection than arch-topped units.
3. Frame units provide a hydraulic opening greater than arches of equivalent clear span when flowing full.
4. Precast frame units can be fabricated by some manufacturers with any increment of span length up to 40 feet, although typical span length increments are 2 feet.
5. Maximum rise of the units is normally limited to 10 feet due to shipping and handling considerations. If a larger rise is necessary, the designer should investigate the need for a pedestal wall.

33.3 Foundation Design

All structures discussed in this chapter, regardless of span and height of fill, are considered buried structures in regard to foundation design. Thus, there is no requirement for seismic analysis. This may change in the future as more research is completed.

For culverts with spans greater than or equal to 20 feet, foundation recommendations are provided to the designer in the Bridge Geotechnical Report (Phase I) and included in the Bridge Development Report (BDR). Foundation design parameters for culverts with spans less than 20 feet are provided by the District Geotechnical Engineer or the Department's Geotechnical Engineering consultant.

The District Geotechnical Engineer or the District Structures Design Office should be consulted to determine the proper foundation treatment.

33.3.1 Rock Foundations

In the unusual case where sound rock is at or near the surface of a streambed, an invert slab is not required and a three-sided culvert would generally be the appropriate structure selected. Concrete footings are either keyed or doweled into rock based on consultation with an Engineering Geologist and the District Geotechnical Engineer.

If the elevation of the rock surface varies by 2 feet or less, the wall height should be constant and the footing height varied. If the variation in rock surface elevation exceeds 2 feet, the height of the culvert wall may be varied at a construction joint or at a precast segment joint. In some cases, it may be necessary to use walls of unequal heights in the same segment, but this should generally be avoided.

33.3.2 Earth or Granular Soil Foundations

In most cases a concrete culvert will not be founded on rock, so a box culvert (four-sided) with an integral invert slab should be the preferred foundation treatment. However, in areas of compact soil and low stream velocities, three-sided concrete culverts may be used if they have positive scour protection such as piles or channel lining with concrete-filled mattresses, gabions or riprap rubble, and spread footings founded below the calculated scour depth. Three-sided concrete culverts located in stream beds, with spans equal to or exceeding 20 feet, must have pile supported footings when the structure is not founded on sound rock.

To avoid differential settlement, concrete box culverts should never be founded partially on rock and partially on earth. If rock is encountered in a limited area, it should be removed to a minimum depth of 12 inches below the bottom of the bottom slab and backfilled with either select granular material or crushed stone. Concrete culverts are rigid frames and do not perform well when subjected to significant differential settlement due to a redistribution of moments. All concrete box culverts located in streambeds should have a designed undercut and backfill. The standard undercut and backfill by ***Section 125*** of the ***Specifications for Road and Bridge Construction*** is 4 feet. The District Geotechnical Engineer should be consulted to determine the depth of the undercut and type of backfill material required for sites not located in streambeds or where significant settlement is anticipated.

A concrete box culvert can be considered if settlement is expected and the foundation material is fairly uniform. However, the culvert should be designed to accommodate additional dead load due to subsequent wearing surface(s) which may be needed to accommodate the settlement of the box. Precast culverts may require mechanical connections between units when significant differential settlement is anticipated. ***Design Standards Index No. 291*** provides criteria for cast-in-place bond beams to satisfy this requirement when joint openings are expected to exceed 1/8 inch. A Geotechnical Engineer should provide the anticipated differential settlement, which should be included in the contract plans.

If the foundation material is extremely poor and it is desirable to limit settlement, the problem should be referred to the District Geotechnical Engineer to determine the best course of action. A typical remedy might be removal of unsuitable or unstable material and replacement with suitable material.

33.3.3 Three-sided Culvert Foundation Design

When a three-sided structure is selected for a site, a cast-in-place footing design must be included in the contract plans. There are several types of culverts that may meet the project specifications. The designer must decide which specific type of unit would best fit that particular application and use those vertical and horizontal reactions for design of the foundations. The designer may contact known fabricators for design reactions. If no specific type of unit is determined as most appropriate, a conservative estimate of the design reactions for all types should be used and the reactions included in the contract plans.

33.4 Wingwalls

A wingwall is a retaining wall placed adjacent to a culvert to retain fill and to a lesser extent direct water. Wingwalls are preferably cast-in-place, but precast wingwalls may be considered on a project by project basis. Wingwalls are generally designed as cantilevered retaining walls however precast counterfort and binwalls may also be considered. Cast-in-place wingwall designs are provided by the Department's standard box culvert computer programs.

Wingwall alignment is highly dependent on site conditions and should be evaluated on a case-by-case basis. The angle(s) of the wall(s) on the upstream end should direct the water into the culvert. It is also desirable to have the top of the wall elevation above the design high water elevation to prevent overtopping of the wall.

When precast wingwalls are permitted the designer should be aware of potential conflicts with ROW limits and utilities. The footprint of the footing and excavation, especially for bin type walls, can be extensive. Notes should be placed on the plans alerting the Contractor to these requirements when they exist. Due to skew and/or grade differences between the cast-in-place or precast culvert units and precast wingwalls it is necessary to provide a cast-in-place closure pour between the culvert end unit and precast wingwalls. A closure pour is not required if cast-in-place wingwalls are used.

When precast wingwalls are permitted the, cost shall be included in the cost of the culvert barrel. No separate item is required but the estimated concrete and reinforcing steel quantities for a cast-in-place design should be included in the contract plans.

33.5 Headwalls/Edge Beams

Headwalls are normally used on all culverts. In deep fills a headwall helps retain the embankment. In shallow fills the headwall may retain the subbase and/or highway pavement and provide the anchorage area for the railing system.

Headwalls should be cast-in-place and attached to precast culvert end segments in accordance with ***Design Standards Index No. 291***. Headwalls one foot or less in height with no railing attachment for single barrel precast culverts may be precast. If a curb must be placed on a culvert without a sidewalk, the headwall must be cast-in-place to allow for the tie-in of the curb's anchor bar, unless the curb is also cast at the precast facility.

The typical maximum height of headwalls is 3 feet. Greater heights are attainable but are only used in special cases. Headwall heights greater than 2 feet above the top slab require an independent transverse analysis, which is not provided by the FDOT box culvert programs.

Concrete culverts with skewed ends may require additional stiffening of the top and bottom slabs by what is most commonly called an "edge beam". An edge beam is similar to a headwall or cutoff wall. The headwall may be used to anchor guardrail posts and traffic railings or retain earth fill, as well as stiffening the top slab of culverts that lose their rigid frame action as a result of having a skewed end.

When additional strength is required in the concrete edge beam, the following criteria shall be used:

16. If there is a 1-on-2 slope to the edge beam, it will be more economical to increase the depth of the edge beam in order to meet the required design.
17. When the edge beam is at shoulder elevation (anchoring guard rail and traffic railing), the edge beam height should be maintained and the width of the edge beam should be increased.

33.6 Cutoff Walls

A cutoff wall is required in all culverts with invert slabs to prevent water from undermining the culvert. The cutoff wall should be a minimum 24 inches below the bottom of the invert slab or to the top of sound rock if the rock is closer. For culverts founded on highly permeable soils or with significant hydraulic gradients, the designer should investigate the need for deeper cutoff walls. The cutoff wall may also act to stiffen the bottom slab for skewed box culverts.

Cutoff walls shall always be specified at each end of the barrel. When a concrete apron is provided, an additional cutoff wall shall also be shown at the end of the apron. For three-sided culverts, where the apron is made continuous with the barrel invert slab, the cutoff wall is only required at the end of the apron. The wingwall footings should have toe walls extending close to the bottom of the cutoff wall to prevent scour around the edges of the cutoff wall.

When a precast culvert is specified, the cutoff wall must cast-in-place and the cost should be included in the cost of the culvert barrel. No separate item is required but the estimated concrete and reinforcing steel quantities should be included in the contract plans.

33.7 Aprons

Box culverts can significantly increase the stream flow velocity because the concrete has a roughness coefficient significantly lower (i.e., smoother) than the streambed and banks. To dissipate this increase in energy and to prevent scour, a riprap rubble or other type of revetment apron may be required at the ends of some culverts. The District Drainage Engineer should be consulted to determine the appropriate apron requirements.

When a precast culvert is specified with a concrete apron, the apron must be cast-in-place and the cost should be included in the cost of the culvert barrel. No separate item is required but the estimated concrete and reinforcing steel quantities should be included in the contract plans.

33.8 Subbase Drainage

Draining surface and ground water away from the culvert through the subbase is almost as important as the conveyance of water through the culvert. All flat-topped or nonarched culverts should have a minimum longitudinal slope of approximately 1%, if possible, to drain the water that permeates through the pavement and subbase, away from the top of the culvert.

In situations where there is low fill (< 12 inches below the base coarse) ***Design Standards Index No. 280*** and ***Index No.289*** requires additional friable base or coarse aggregate material above the top and along the sides of the culvert to eliminate maintenance problems.

For deeper culverts, if a longitudinal slope is not possible, a 1% slope (wash), perpendicular to the centerline of the culvert, can be used. The wash can be from the centerline to each side or all in one direction. The wash can be formed into a cast-in-place culvert but is difficult to form on precast culverts. On precast culverts, the wash can be added after the culvert is in place by placing a shim course of asphalt or concrete.

An alternate solution in low fill conditions is to place a concrete pavement on top of the culvert. The minimum depth of concrete required is 6 inches. The concrete pavement is less susceptible to potholes than asphalt but is more costly and should have a longer service life. Contact the District Structures Design Engineer for guidance when considering the use of a concrete pavement section. Exclude precast units in the contract plans if there is concern about movement of units cracking the concrete pavement. Post-tensioning to connect precast units is not recommended.

33.9 Joint Waterproofing

Culverts will occasionally be used to allow the passage of things other than water, including but not limited to pedestrians, bicycles, trains, golf carts, wildlife, or farm animals. In cases where it is desirable to have a dry environment, a waterproof joint wrap should be used to cover the joints between precast culvert units or to cover the construction joints in cast-in-place culverts.

Even though a joint sealer is always placed between individual precast concrete culvert units and the units are pulled tightly together, water may seep through the joint. The minimum requirement for waterproofing these joints is to provide an external sealing band in accordance with ***ASTM C 877***, centered on the joints, covering the top slab, and then extending down the sidewalls to the footing. The purpose of the waterproofing membrane is to restrict seepage of water or migration of backfill material through the joints in the culverts and it is not intended to protect the concrete.

The external sealing band is mandatory for precast three-sided culverts under ***Section 407*** of the ***Specifications for Road and Bridge Construction*** but will need to be included as a note in the contract plans when required for box culverts.

33.10 Traffic Railings

The Department has set policy that requires highway rail to meet NCHRP 350 Test Level-3 (TL-3) and requires bridge traffic railings to meet AASHTO LRFD TL-4 in most situations. See ***Chapter 6*** of the ***Structures Design Guidelines*** for more information. Concrete culverts may be highway-size or bridge-size by definition, and therefore, the guardrail requirements can theoretically vary by the span of the structure.

Any roadside protection placed at a culvert should be provided as highway guardrail or as bridge traffic railing. Highway guardrail should be used whenever it meets applicable safety standards since it is the most cost-efficient barrier type.

The anchorage/support of the guardrail or traffic railing is determined by the amount of fill over the top of the culvert. If there is more than a minimum of 4 feet of fill, a zero offset or greater (from the face of guardrail to shoulder break) and a 1:2 or flatter slope, use highway guardrail with standard length posts. When the embankment slopes exceed 1:2 for zero offset or there is less than 4 feet of fill, the preferred option for guard rail depends upon the amount of fill and the size of the culvert as described below:

18. Culverts with less than 5 feet outside widths (railing length) and less than 4 feet of fill should have the posts straddle the outside of the culvert. This assumes the use of standard post spacing of 6.25 feet and W-beam guard rail posts.
19. Culverts between 5 feet and 20 feet outside width (railing length) and less than 4 feet of fill may have posts attached to the top of the box or posts shortened. See ***Design Standards Index No. 400*** for guidance on the appropriate option.
20. Culverts with more than 20 feet outside widths (railing length) and less than 4 feet of fill should have guardrail anchored into the headwall or individual concrete pedestals. When the guardrail is anchored to a headwall or pedestal, either thrie-beam or a concrete traffic railing shall be used.

Concrete traffic railing is generally not recommended due to the short length of culverts unless it is being connected to barrier along the highway. The transition of the thrie-beam guardrail onto the traffic railing face will use up most of the length of traffic railing on the culvert. For example, 32” F-Shape traffic railing has a 16 feet transition from the end of traffic railing to the end of the thrie-beam terminal connector.

Designers should note that the location of the first and last posts is critical on culverts.

Headwalls under guardrail should be a minimum of 18 inches wide and the base plate must be located so that it is located at least 12 inches away from any construction joint or free end of the concrete headwall. Placement of base plates and bolts in the top slab should be avoided due to anchor embedment length problems and potential damage to the top of the culvert barrel.

33.11 Design Requirements for Concrete Culverts

Refer to the ***Chapter 3*** of the ***Structures Design Guidelines*** for design and analysis requirements.

33.12 Design Details

When a box concrete culvert is proposed for a site, the designer is required to provide a complete cast-in-place design for the contract plans. Standard details for concrete box culverts are provided in the ***Design Standards Index No. 289*** (LRFD) or ***Index No. 290*** (LFD). The contractor is usually permitted to substitute precast concrete box culverts for cast-in-place box culverts in accordance with ***Section 410*** of the ***Specifications for Road and Bridge Construction***. The contractor may select a standard precast box culvert design in accordance with ***Design Standards Index No. 292*** or provide a custom design. Design and fabrication details for precast box culverts, including calculations for custom designs, must also comply with the requirements of ***Design Standards Index No. 291*** and be submitted to the Engineer of Record for approval.

When a three-sided concrete culvert is proposed for a site, the designer is required to provide either a complete cast-in-place design or a conceptual precast barrel design with a complete foundation and wingwall design, for the contract plans. The contractor is permitted to substitute precast three-sided culverts for cast-in-place three-sided culverts in accordance with ***Section 407*** of the ***Specifications for Road and Bridge Construction***. Design and fabrication details for precast three-sided culverts, including calculations, must be submitted to the Engineer of Record for approval.

The bar designations in ***Table 33.1*** should be used for box culvert reinforcement:

Table 33.1 Bar Identification Schedule

BAR IDENTIFICATION SCHEDULE			
C.I.P (LFD) Index No. 290	**C.I.P (LRFD) Index No. 289**	**Precast (LRFD) Index No. 292**	**Description / Bar Location**
A1	105	As1	Top Corner Bars
A2	106	As1	Bottom Corner Bars
A100	102	As2	Top Slab, inside face transverse bars
A200	103	As3	Bottom Slab, inside face transverse bars
A300	101	As1/As7	Top Slab, outside face transverse bars
A400	104	As1/As8	Bottom Slab, outside face transverse bars
B1	108	As4	Exterior wall, inside face vertical bars
B2	105/106	As1	Exterior wall, outside face vertical bars
B3	107	-	Interior wall, vertical bars both faces
C1	110/111	As9	Top Slab longitudinal bars (temperature reinf.)
C1	109/112	As9	Bottom Slab longitudinal bars (temperature reinf.)
C1	113/114		Exterior wall longitudinal bars (temperature reinf.)
C1	115/ 116…		Interior wall longitudinal bars (temperature reinf.)
C1	109	As6	Bottom Slab inside face longitudinal bars (design distribution reinforcement)
C2	111	As5	Top Slab inside face longitudinal bars (design distribution reinforcement)

Additional reinforcing bars and designations should be added as required. No standardize bar designations are provided for three-sided culverts.

33.13 Computer Design and Analysis Programs

For LRFD designs the Department's ***LRFD Box Culvert Program*** (Mathcad) is available from the Structures Design Office website. This program analyses monolithic single of multi-barrel box culverts with prismatic members and integral bottom slabs only. The program requires input by the designer for all member thicknesses, material properties and reinforcing area utilizing a trial and error design methodology.

For LFD designs the Department's "Reinforced Concrete Box Culvert & Wingwall Design and Analysis Computer Program" (***PSTDN55***), is available from the Structures Design Office website. This program will design and/or analyze a one-, two-, three-, or four-cell reinforced concrete box culverts with prismatic members (cast-in-place), with or without bottom slabs. All cells are assumed to be the same size for any one culvert and the clear opening dimensions remain constant. Using the span, rise, and fill height, the program will design the box culvert by either Service Load Design or Load Factor Design. The program will design wall and slab thicknesses and the required reinforcement.

Other computer programs are available for design of reinforced concrete culverts such as BOXCAR and CANDE. Generally these other computer programs should only be used for preliminary designs or independent quality assurance checks. Designers should consult with the State Structures Design Office before using one of these other programs in lieu of the FDOT box culvert programs.

33.14 Design and Shop Drawing Approvals

The Engineer of Record for the contract plans has design and shop drawing approval authority for precast concrete box and three-sided culverts. All calculations and shop drawings require a quality assurance review for general compliance of contract requirements and for suitability of the design for the given design conditions.

Standard precast concrete box culvert designs are available in ***Design Standards Index No. 292*** for a limited number of box culvert sizes. Modification of FDOT standard box culverts or design of special size box or three-sided culverts is delegated to Contractor's Engineer of Record in accordance with the ***Section 407*** and ***Section 410*** of the ***Specifications for Road and Bridge Construction***. The Contractor shall be responsible for providing all design computations and details for these units.

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