Florida Department of Transportation

Manual of Uniform Minimum Standards for Design, Construction and Maintenance for Streets and Highways

(Commonly known as the Florida Greenbook)

https://www.fdot.gov/roadway

FDOT Office
Office of Design
Topic # 625-000-015

Date of Publication
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USER REGISTRATION

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To: Florida Greenbook Users

The Department of Transportation utilizes a contact database that enables the Department to e-mail important information to registered users on topics selected by each user. The database allows a user to update their physical address, e-mail address, topics of interest, and any other information in their profile at any time.

All Florida Greenbook users must register their e-mail addresses in this contact database in order to receive updates, notices, design memos, or other important information concerning the Department's design manuals. Users must register at the following link:

http://www.fdot.gov/designsupport/ContactDatabase.shtm

New subscribers will need to create a new account. Once the information is registered, new subscribers will need to "Edit Interests." The Florida Greenbook may be found under: Publications → Design → Roadway Design → Florida Greenbook"

TABLE OF CONTENTS

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2018

The Florida Greenbook Advisory Committee is composed of four professional engineers within each of the Department of Transportation's seven district boundaries as described in Section 336.045(2), Florida Statutes (F.S.).

> **Section 336.045, Florida Statutes. Uniform minimum standards for design, construction, and maintenance; advisory committees.**
>
> **(2)** An advisory committee of professional engineers employed by any city or any county in each transportation district to aid in the development of such standards shall be appointed by the head of the department. Such committee shall be composed of: one member representing an urban center within each district; one member representing a rural area within each district; one member within each district who is a professional engineer and who is not employed by any governmental agency; and one member employed by the department for each district.

Contact information for the Florida Greenbook Advisory Committee members can be found on the Florida Greenbook web page:

http://www.fdot.gov/roadway/FloridaGreenbook/FGB.shtm

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15.	Traffic Calming	Billy Hattaway
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17.	Bridges and Other Structures	Keith Bryant
18.	Signing and Marking	Gail Woods
19.	Traditional Neighborhood Development	Rick Hall
20.	Drainage	Andy Tilton

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PURPOSE

The purpose of this Manual is to provide uniform minimum standards and criteria for the design, construction, and maintenance of all transportation facilities off the State Highway System (SHS), roads, highways, bridges, sidewalks, curbs and curb ramps, crosswalks , bicycle facilities, underpasses, and overpasses used by the public for vehicular and pedestrian traffic as directed by ***Sections 20.23(3)(a), 316.0745, 334.044(10)(a),*** and ***336.045, F.S.***

The Florida Greenbook encourages context-based transportation planning and design. Context-based planning and design offers a diverse approach using existing tools in creative ways to improve the transportation system and meet the needs of users of all ages and abilities. This includes pedestrians, bicyclists, transit riders, motorists, and freight handlers. Planning and design of streets and highways must be based on the surrounding development patterns for existing and planned land development patterns. The approach also considers community needs, trade-offs between those needs, and alternatives to achieve multiple objectives. Context-based design principles help to promote safety, quality of life, and economic development.

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

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

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

Section 316.0745, F.S. Uniform signals and devices. –

(1) The Department of Transportation shall adopt a uniform system of traffic control devices for use on the streets and highways of the state. The uniform system shall, insofar as is practicable, conform to the system adopted by the American Association of State Highway Transportation Officials and shall be revised from time to time to include changes necessary to conform to a uniform national system or to meet local and state needs. The Department of Transportation may call upon

representatives of local authorities to assist in the preparation or revision of the uniform system of traffic control devices.

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

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

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

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

(2) An advisory committee of professional engineers employed by any city or any county in each transportation district to aid in the development of such standards shall be appointed by the head of the department. Such committee shall be composed of: one member representing an urban center within each district; one member representing a rural area within each district; one member within each district who is a professional engineer and who is not employed by any governmental agency; and one member employed by the department for each district.

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

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

Standards established by this Manual are intended for use on all transportation facilities off the State Highway System (SHS). Certain projects off the SHS but on the National Highway System (NHS) utilizing federal funds may be required to follow additional design criteria. Please see ***Chapter 19*** of the *Department's* Local Agency Program Manual for further information. Information on roadways included in the NHS is found at the *Department's website:* ***National Highway System Maps***.

Standards are provided for the design of new construction and reconstruction projects as well as maintenance and resurfacing projects. It is understood that existing streets and highways may not conform to all minimum standards applicable to the design of new and reconstruction projects. For existing roads not being replaced or reconstructed, it is intended the requirements provided in ***Chapter 10 – Maintenance and Resurfacing*** are applied. For all projects, there may be practical reasons a certain standard is not met. A process is provided in ***Chapter 14 – Design Exceptions and Variations*** to address those situations.

The Federal Highway Administration's ***Manual on Uniform Traffic Control Devices, 2009 Edition (MUTCD),*** has been adopted by ***Rule 14 – 15.010, F.A.C.***, and establishes a uniform system of traffic control devices. The ***Manual on Uniform Traffic Control Devices (2009 Edition with Revision Numbers 1 and 2, May 2012, MUTCD)*** includes additional requirements.

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

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

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

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

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

POLICIES AND OBJECTIVES

Specific policies governing the activities of planning, design, construction, reconstruction, maintenance, or operation of streets and highways are listed throughout this Manual. This manual uses a context-based design approach that considers the mobility, convenience, accessibility and safety of all road users; and places an emphasis on the most vulnerable users of a given transportation facility. Decisions should be predicated upon meeting the following objectives:

A. Specifies all users - Provide streets and highways with operating characteristics that support users of all ages and abilities.

1' Incorporate appropriate context based design elements when planning and designing the transportation network.

1' Draw on all sources of transportation funding to implement context based design.

1' Seek input from a variety of local stakeholders when designing or revising transportation projects to promote equity and meet the diverse needs of system users.

B. Applies to all projects - Each transportation agency should establish and maintain a program to promote context based design in all activities on streets and highways under its jurisdiction.

1' Planning, design, construction, and maintenance activities are all essential activities for implementing context-based design.

C. Procedure for exceptions and variations – When proposed design elements do not meet the criteria contained in this Manual, sufficient detail and justification of such deviations must be documented.

1' Sufficient detail and explanation must be given to justify approval to those reviewing the request.

1' Consider potential mitigation strategies that may reduce the adverse impacts to highway safety and traffic operations.

D. Creates a network - Design, operate, and maintain a transportation system that provides a highly connected and diverse network of streets that accommodate all intended modes of travel.

- v' Place a priority on connecting communities with economic and employment centers and visitor destinations.
- v' Prioritize non-motorized connectivity improvements to services, schools, parks, civic uses, regional connections, and commercial uses.
- v' Identify routes for freight traffic that provide access to industrial centers, warehouses, distribution centers (rail, freight, intermodal), ports (airports, seaports, and space ports).
- v' Consider the "last mile" needs of freight handlers and transit riders.
- v' Seek opportunities to repurpose or add new rights of way to enhance connectivity for pedestrians, bicyclists, and transit or shift freight traffic to more appropriate corridors.

E. Adoptable by all agencies - A well-connected, diverse transportation system supports Florida's existing and future economic development.

- v' Increase productivity by improving the accessibility of people and businesses to reach jobs, services, goods, and activities.
- v' Increase level of accountability for metropolitan, regional, and local agencies to demonstrate the need, economic impact, and return of transportation investments.
- v' Strengthen local policies, ordinances requiring new development or redevelopment to provide interconnected street networks with small blocks that connect with existing or planned streets on the perimeter.
- v' Support regional land use, economic development goals, and regional vision.

F. Latest and best design criteria - Provide uniformity and consistency in the design and operation of streets and highways.

- v' Strive to design and maintain facilities that are consistent with the local context, through single projects or incremental improvements over time.

v' Document conditions that may preclude achieving full multi-modal design, such as environmental, historical or cultural constraints, limited right of way, or disproportionate cost.

v' Anticipate needs of connected and autonomous vehicles and other emerging technologies.

G. Context-sensitive - Transportation investments should align with land use, and support a community's quality of life. A context-based approach helps communities and regions make sound decisions which support their long-term vision.

v' Harmonize the transportation system with adjacent existing or proposed context such as neighborhoods, business districts, commercial areas, and public services (schools, parks, health, and entertainment centers).

v' Design streets with a strong sense of place; use architecture, landscaping, streetscaping, public art, and signage to reflect the community, neighborhood, history, and natural setting.

v' Highlight natural features such as waterways, trees, scenic views, slopes, and preserved lands and minimize impacts.

H. Establishes performance measures - Develop and maintain a transportation system that provides a safe environment.

v' Understand that children, elderly adults, and persons with disabilities may require appropriate accommodations.

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

v' Use existing street pavement widths as efficiently as possible to accommodate all modes of transportation, recognizing that allocating designated space by mode is preferred, but shared facilities may be the most practical solution in some cases.

I. Includes specific next steps for implementation.

v' Understand the priorities and concerns by reaching out to stakeholders, collect data, synthesize issues and opportunities, and define context classifications.

- v' Define the project's purpose, needs and evaluation measures (i.e., person throughput, network completeness, street connectivity, access to jobs, housing, retail, public facilities).

- v' Define and evaluate alternatives.

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

DEFINITIONS OF TERMS

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

Alley	A narrow right of way to provide access to the side or rear of individual land parcels.
Annual Average Daily Traffic (AADT)	The total volume of traffic on a highway segment for one year, divided by the number of days in the year. This volume is usually estimated by adjusting a short-term traffic count with weekly and monthly factors.
Average Daily Traffic (ADT)	The total traffic volume during a given time period (more than a day, less than a year) divided by the number of days in that time period.
Auxiliary Lane	A designated width of roadway pavement marked to separate speed change, turning, passing, and climbing maneuvers from through traffic.
Average Running Speed	For all traffic, or component thereof, the summation of distances divided by the summation of running times.
Bicycle Lane (Bike Lane)	A portion of a roadway that has been designated for preferential use by bicyclists by pavement markings, and if used, signs. They are one-way facilities that typically carry traffic in the same direction as adjacent motor vehicle traffic.

Boarding And Alighting (B&A) Area — A firm, stable, slip resistant surface that accommodates passenger movement on or off a transit vehicle.

Border Area — The border area provides space for roadside design components (e.g., signing, drainage features, sidewalks, and traffic control devices), a buffer between vehicles and pedestrians, and permitted public utilities. It also provides space for construction and maintenance of the facility.

Bridge — A structure, including supports, erected over a depression or an obstruction, such as water, a highway, or a railway, having a track or passageway for carrying traffic or other moving loads, and having a total span of more than 20 feet between undercopings of abutments.

Clear Zone — The unobstructed, traversable area beyond the edge of the traveled way for the recovery of errant vehicles. The clear zone includes shoulders and bicycle lanes.

Context Classification System — Broadly identifies the built environments in Florida, based upon existing and future land use characteristics, development patterns, network scale, and roadway connectivity of an area.

Corridor — A strip of land between two termini within which traffic, topography, environment, population, access management, and other characteristics are evaluated for transportation purposes.

Cross Slope — The transverse slope and/or superelevation described by the roadway section geometry.

Crosswalk

Portion of the roadway at an intersection included within the connections of lateral lines of the sidewalks on opposite sides of the highway, measured from the curbs or in the absence of curbs from the traversable roadway. Crosswalks may also occur at an intersection or elsewhere distinctly indicated for pedestrian crossing.

Design Hour Volume (DHV)

Traffic volume expected to use a highway segment during the design hour of the design year. The DHV is related to the AADT by the "K" factor. It includes total traffic in both directions of travel.

Directional Design Hour Volume (DDHV)

Traffic volume expected to use a highway segment during the design hour of the design year in the peak direction.

Design Speed

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

Design User

Anticipated users of a roadway (including pedestrians, bicyclists, transit riders, motorists, and freight handlers) that form the basis for each roadway's design.

Design Vehicle

A vehicle, with representative weight, dimensions, and operating characteristics, used to establish highway design controls for accommodating vehicles of designated classes.

Driveway

An access from a public way to adjacent property.

Expressway	A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at major intersections.
Federal Aid Highway	A highway eligible for assistance under the United States Code Title 23 other than a highway classified as a local road or rural minor collector.
Freeway or Limited Access Highway	An expressway with full control of access.
Frontage Road or Street	A street or highway constructed adjacent to a higher classification street or other roadway network serving adjacent property or control access.
Grade Separation	A crossing of two roadways or a roadway and a railroad or pedestrian pathway at different levels.
High Speed	Speeds of 50 mph or greater.
High-Speed Rail	Intercity passenger rail service that is reasonably expected to reach speeds of at least 110 miles per hour.
Highway, Street, or Road	General terms, denoting a public way for purposes of traffic, both vehicular and pedestrian, including the entire area within the right of way. The term street is generally used for urban or suburban areas.
Intersection	The general area where two or more streets or highways join or cross.
Lateral Offset	The lateral distance from the edge of the traveled way or when applicable, face of curb, to a roadside object or feature.

Low Speed	Speeds less than or equal to 45 mph.
May	A permissive condition. Where "may" is used, it is considered to denote permissive usage.
Maintenance	A strategy of treatments to an existing roadway system that preserves it, retards future deterioration, and maintains or improves the functional condition.
New Construction	The construction of any public way (paved or unpaved) where none previously existed, or the act of paving any previously unpaved road, except as provided in Chapter 3, Section A of these standards.
Operating Speed	The rate of travel at which vehicles are observed traveling during free-flow conditions.
Paratransit	Comparable transportation service required by the ADA for individuals with disabilities who are unable to use fixed route transportation systems.
Pedestrian Access Route	A continuous and unobstructed path of travel provided for pedestrians with disabilities within or coinciding with a pedestrian circulation path.
Pedestrian Circulation Path	A prepared exterior or interior surface provided for pedestrian travel in the public right of way.
Preferential Lane	A street or highway lane reserved for the exclusive use of one or more specific types of vehicles or vehicles with at least a specific number of occupants.

Public Way

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

Ramp

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

Reconstruction

Streets and highways that are rebuilt primarily along existing alignment. Reconstruction normally involves full-depth pavement replacement. Other work that would fall into the category of reconstruction would be adding lanes adjacent to an existing alignment, changing the fundamental character of the roadway (e.g., converting a two-lane highway to a multi-lane divided arterial) or reconfiguring intersections and interchanges.

Recovery Area

A clear zone that includes the total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles.

Residential Streets

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

Resurfacing

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

Right of Way

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

Roadway

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

Rural Areas

Those areas outside of urban boundaries. Urban area boundary maps based upon the 2010 Census are located on the ***Department's Urban Area 1-Mile Buffer Maps.***

Shall or Must

A mandatory condition. (When certain requirements are described with the "shall" or "must" stipulation, it is mandatory these requirements be met.)

Shared Roadway

A roadway that is open to both bicycle, motor vehicle, street cars, and rail travel. This may be an existing roadway, street with wide curb lanes, or road with paved shoulders.

Shared Street

Street that includes a shared zone where pedestrians, bicyclists, and motor vehicles mix in the same space. The design supports slower vehicle speeds and lower motor vehicle volumes. It lacks design elements that suggest motor vehicle priority or segregates modes; and includes elements that suggest a pedestrian priority (e.g. gathering areas, seating, lighting, art, special plantings).

Shared Use Path or Multi - Use Trail A facility with a firm, stable, slip-resistant surface physically separated from motorized vehicular traffic by an open space or barrier with minimal cross flow by motor vehicles. Users may include pedestrians, bicyclists, skaters, and others. Special design and approval is needed when travelers use vehicles such as golf carts or other motorized devices.

Should An advisory condition. Where the word "should" is used, it is considered to denote advisable usage, recommended but not mandatory.

Slope The relative steepness of the terrain, expressed as a ratio or percentage. Slopes may be categorized as positive (backslopes) or negative (foreslopes) and as parallel or cross slopes in relation to the direction of traffic. In this manual slope is expressed as a ratio of vertical to horizontal (V:H).

Surface Transportation System Network of highways, streets, and/or roads. Term can be applied to local system or expanded to desired limits of influence.

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

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

Traffic Lane	Includes travel lanes, auxiliary lanes, turn lanes, weaving, passing, and climbing lanes.
Travel Lane	A designated width of roadway pavement marked to carry through traffic and to separate it from opposing traffic or traffic occupying other traffic lanes. Generally, travel lanes equate to the basic number of lanes for a facility.
Traveled Way	The portion of the roadway for the movement of vehicles, exclusive of shoulders and bicycle lanes.
Turning Roadway	A connecting roadway for traffic turning between two intersection legs.
Urban Area	A geographic region comprising, as a minimum, the area inside the United States Bureau of the Census boundary of an urban place with a population of 5,000 or more persons, expanded to include adjacent developed areas as provided for by Federal Highway Administration (FHWA) regulations. Urban area boundary maps based upon the 2010 Census are located on the Department's Urban Area 1-Mile Buffer Maps.
Urbanized Area	A geographic region comprising, as a minimum, the area inside an urban place of 50,000 or more persons, as designated by the United States Bureau of the Census, expanded to include adjacent developed areas as provided for by Federal Highway Administration (FHWA) regulations. Urban areas with a population of fewer than 50,000 persons which are located within the expanded boundary of an urbanized area are not separately recognized.

Vehicle	Every device upon, or by which any person or property is or may be transported or drawn upon a traveled way, excepting devices used exclusively upon stationary rails or tracks. Bicycles are defined as vehicles per Section 316.003, Florida Statutes.
Vertical Clearance	Minimum unobstructed vertical passage space.
Very Low-Volume Road	A road that is functionally classified as a local road and has a design average daily traffic volume of 400 vehicles per day or less.
Wide Outside Lane	Through lanes that provide a minimum of 14 feet in width. This lane should always be the through lane closest to the curb or shoulder of the road when a curb is not provided.

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CHAPTER 1

PLANNING

TABLES

FIGURES

CHAPTER 1

PLANNING

A CONTEXT-BASED PLANNING AND DESIGN

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

The Florida Greenbook's Context-Based Design policy captures three core concepts:

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

This Context-Based approach builds on flexibility and innovation to ensure that all streets and highways are developed based on their context classification, as determined by the local jurisdiction to the maximum extent feasible. With a Context-Based approach, every non-limited access transportation project, including those on the Strategic Intermodal System (SIS), is uniquely planned and designed to serve the context of that roadway and the safety, comfort, and mobility of all users.

In a high-speed rural context, where higher truck traffic is anticipated, and walking and bicycling are infrequent, wider travel lanes with paved shoulders are appropriate. Shared use paths as part of a regional trail system or for access to schools or parks may also be needed. In urban contexts, where high volumes of pedestrians, bicyclists, and transit users are expected or desired, a roadway should include features such as wide sidewalks, bicycle facilities, transit stops, and frequent, pedestrian crossing opportunities.

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

B CLASSIFICATION

Designs for transportation projects are based on established design controls for the various elements of the project such as width, side slopes, horizontal and vertical alignment, drainage, accessibility and intersection considerations.

The design criteria presented in this manual is based on:

- Functional Classification
- Context Classification
- Design Speed

A determination of the functional and context-based design classification of each facility are required prior to the actual design.

B.1 Functional Classification

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

Functional road classifications for Florida are defined in ***Section 334.03 F.S.***. The ***AASHTO*** publication ***A Policy on Geometric Design of Highways and Streets (2011)*** presents an excellent discussion on highway functional classifications.

Table 1 – 1 Functional Classification Types

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

B.2 Context Classification

Projects are uniquely planned and designed to be in harmony with the surrounding land use characteristics and the intended uses of the street or highway. To this end, a context-based classification system comprising eight context classifications has been adopted. Figure 1 – 1 Context Classifications describes the context classifications that will determine key design criteria elements. Criteria for limited access facilities are independent of the adjacent land uses; therefore, context classifications shown in Figure 1 – 1 do not apply to these facilities.

Urban and rural are based on population density gathered from the most recent census and mapped as urban area boundaries. Urban areas are considered to have *dense* development patterns, while rural areas are considered to have *sparse* development patterns. The Department's ***Urban Area 1-Mile Buffer Maps*** identify urban and rural areas based on the census data and regional travel patterns.

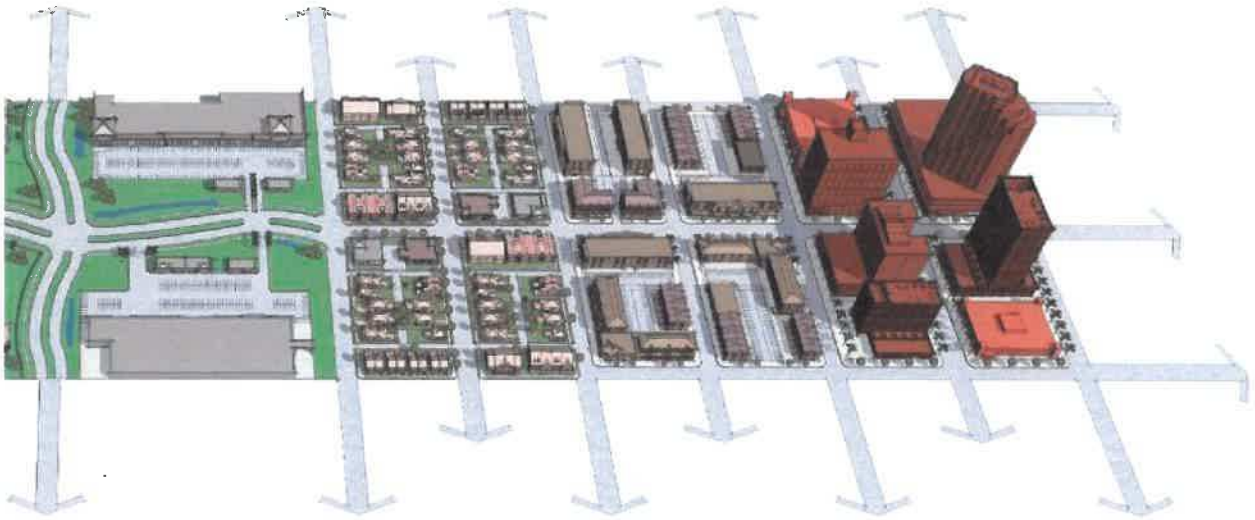
Additional information on context classifications and guidance on the determination of the context classification is provided in the ***FDOT Context Classification Document***.

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

Figure 1 – 1 Context Classifications

C1 – Natural	C2 – Rural	C2T – Rural Town	C3R – Suburban Residential
Lands preserved in a natural or wilderness condition, including lands unsuitable for settlement due to natural conditions.	Sparsely settled lands; may include agricultural land, grassland, woodland, and wetlands.	Small concentrations of developed areas immediately surrounded by rural and natural areas; includes many historic towns.	Mostly residential uses within large blocks and a disconnected or sparse roadway network.

Figure 1 – 1 Context Classifications (continued)



C3C – Suburban Commerical

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

C4 – Urban General

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

C5 – Urban Center

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

C6 – Urban Core

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

B.3 Design Speed

See Chapter 3, Section C.1 Design Speed for information on establishing appropriate design speeds.Road classifications are defined in ***Section 334.03 F.S.*** Functional classification is the assignment of roads into systems according to the character of service they provide in relation to the total road network.

C CONSIDERATIONS FOR DESIGN

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

C.1 Safety

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

C.2 Economic Constraints

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

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

C.3 Access Requirements

Degree and type of access permitted on a given facility is dependent upon its intended function and context and should conform to the guidelines in ***Chapter 3 – Geometric Design***. Reasonable access control must be exercised to allow a

street or highway to fulfill its function. The proper layout of the highway network and the utilization of effective land use controls (***Chapter 2 – Land Development***) can provide the basis for regulating access.The proper layout of the highway network and the utilization of effective land use controls (***Chapter 2 – Land Development***) can provide the basis for regulating access.

C.4 Measures of Level of Service

Level of service (LOS) is essentially a measure of the quality of the operating characteristics of a street or highway for each travel mode. Factors involved in determining the level of service include speed and safety, as well as travel time; traffic conflicts and interruptions; freedom to maneuver; convenience and comfort; and operating costs. Level of service is also dependent upon actual traffic volume and composition of traffic (motor vehicles, trucks, transit, bicyclists, and pedestrians).

The ***Highway Capacity Manual, 6th Edition*** provides further information on assessing the traffic and environmental effects of highway projects.

C.5 Maintenance Capabilities

Planning and design of streets and highways should include provisions for the performance of required maintenance. The planning of the expected maintenance program should be coordinated with the initial highway design to ensure maintenance activities may be conducted without excessive traffic conflicts or hazards.

C.6 Utility and Transit Operations

Utility accommodation within rights of way is generally considered to be in the public's best interest, since rights of way frequently offer the most practical engineering, construction, and maintenance solutions for utility service to businesses and residences. Utility and transit facility locations should be carefully chosen to optimize operations and safety of the transportation facility. Additional information on the design of transit facilities can be found in ***Chapter 13 – Transit***.

C.7 Emergency Response

Development of an effective emergency response program is dependent upon the nature of the highway network and the effectiveness of the operation of the system. Provisions for emergency access and communication should be considered in the initial planning and design of all streets and highways. Local emergency response personnel should be included in primary activities.

C.8 Environmental Impact

Construction and operation of streets and highways frequently produces an adverse effect upon the environment. Early consideration and resolution of environmental issues can avoid costly delays and modifications that may compromise the quality and efficiency of operation. Specific topics often encountered include the following:

- Air Quality
- Coastal Zone Resources
- Farmland
- Floodplains
- Hazardous Waste and Brownfields
- Noise
- Roadside vegetation
- Safe Drinking Water Act
- Water Quality
- Watersheds Management
- Wetlands
- Wild and Scenic Rivers and Wilderness Areas
- Wildlife and Threatened and Endangered Species
- Wildlife, Habitat and Ecosystems

C.9 Community and Social Impact

Quality and value of a community is directly influenced by the layout and design of streets and highways. Quality of the network determines the freedom and efficiency of movement. Inadequate design of the network and poor land use practices can lead to undesirable community separation and deterioration. Specific design of streets and highways has a large effect upon the overall aesthetic value which is important to the motorist and resident. When using federal funds for transportation projects, the following considerations should be addressed:

- Corridor Preservation
- Historical and Archaeological Preservation
- Scenic Byways
- ***Section 4 (f)*** (parks, refuges and historic sites)
- ***Section 6 (f)*** properties
- Visual Impacts

D OPERATION

The concept of operating the existing street and highway network as a system is essential to promote safety, efficiency, mobility, and economy. This requires comprehensive planning and coordination of all activities on each street and highway. These activities would include maintenance, construction, utility operations, public transit operations, traffic control, and emergency response operations. The behavior of travelers should be considered as an integral part of the operation of streets and highways. Coordination of the planning and supervision of each activity on each facility is necessary to achieve safety and efficient operation of the total system.

D.1 Policy

Each transportation agency with general responsibility for existing streets and highways should establish and maintain an operations department. Each existing street or highway should be assigned to the jurisdiction of the operations department. The operations department shall be responsible for planning, supervising, and coordinating all activities affecting the operating characteristics of the system under its jurisdiction.

D.2 Objectives

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

D.3 Activities

The achievement of these objectives requires the performance of a variety of coordinated activities by the operations department. The following activities should be considered as minimal for promoting the safe and efficient operation of a system.

D.3.a Maintenance and Reconstruction

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

All maintenance work should be conducted in accordance with the requirements of ***Chapter 10 – Maintenance and Resurfacing***. The priorities and procedures utilized should be directed toward improvement of the existing system. The standards set forth in this Manual should be used as guidelines for establishing maintenance and reconstruction objectives. All maintenance and reconstruction projects should be planned to minimize traffic control conflicts and hazards.

D.3.b Work Zone Safety

An important responsibility of the operations department is the promotion of work zone safety on the existing system. The planning and execution of maintenance, construction, and other activities shall include provisions for the safety of motorists, bicyclists, pedestrians, and workers. All work shall be conducted in accordance with the requirements presented in ***Chapter 11 – Work Zone Safety***.

D.3.c Traffic Control

Traffic engineering is a vital component of highway operations. The planning and design of traffic control devices should be carried out in conjunction with the overall design of the street or highway and highway user. The devices and procedures utilized for traffic control should be predicated upon developing uniformity throughout the system and compatibility with adjacent jurisdictions.

A primary objective to be followed in establishing traffic control procedures is the promotion of safe, orderly traffic flow. The cooperation of police agencies and coordination with local transit providers is essential for the achievement of this objective. Traffic control during maintenance,

construction, utility, or emergency response operations should receive special consideration.

D.3.d Emergency Response

The emergency response activities (i.e., emergency maintenance and traffic control) of the operations department should be closely coordinated with the work of police, fire, ambulance, medical, and other emergency response agencies. The provisions for emergency access and communications should be included in the initial planning for these activities.

D.3.e Coordination and Supervision

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

- Supervision and/or coordination of all activities of the operations department and other agencies to promote safe and efficient operation
- Coordination of all activities to provide consistency within a given jurisdiction
- Coordination with adjacent jurisdictions to develop compatible highway systems
- Coordination with other transportation modes to promote overall transportation efficiency

D.3.f Inspection and Evaluation

The actual operation of streets and highways provides valuable experience and information regarding the effectiveness of various activities. Each operations department should maintain a complete inventory of its system and continuously inspect and evaluate the priorities, procedures, and techniques utilized in all activities on the existing system under its jurisdiction. Activities by other agencies, as well as any agency, should be subjected to this supervision.

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

Results of this inspection and evaluation program should be utilized to make the modification necessary to promote safe and efficient operation. Feedback for modifying design criteria should be generated by this program. Experience and data obtained from operating the system should be utilized as a basis for recommending regulatory changes. Cooperation of legislative, law enforcement, and regulatory agencies is essential to develop the regulation of vehicles, driver behavior, utility, emergency response activities, and the access land use practices necessary for the safe and efficient operation of the highway system.

E REFERENCES

Design criteria are established for transportation projects to ensure that they provide safe, economical, and fully functional multimodal transportation facilities. Various Department publications contain information on procedures, criteria, and standards for guiding and controlling design and construction activities. There are many local, state, and federal laws and rules that may impact the design of a project. These laws and rules are referenced in the publications when the Department is aware of them.

For situations where specific design standards or criteria cannot be found in the Department publications, current approved technical publications such as ***AASHTO's Policy on Geometric Design of Highways and Streets (2011)*** should be used as design guidelines. Local agencies must ensure that project designs meet or exceed the referenced design criteria and that the standards developed from acceptable guidelines are appropriate for the proposed facility.

The following publications provide further information and guidance for Roadway and Bridge/Structure designs:

- FDOT Design Manual, (Topic No. 625-000-002)
  http://www.fdot.gov/roadway/FDM/
- Standard Plans for Road and Bridge Construction(Topic No. 625-010-003) http://www.fdot.gov/design/standardplans/
- FDOT Standard Specifications for Road and Bridge Construction
  https://www.fdot.gov/programmanagement/Specs.shtm
- Project Development and Environment Manual Part 1 and Part 2 (Topic No. 650-000-001)
  http://www.fdot.gov/environment/pubs/pdeman/pdeman1.shtm
- AASHTO Highway Safety Manual, 1st Edition (AASHTO Bookstore HSM-1)
  https://bookstore.transportation.org/
- Standard Highway Signs (FHWA)
  http://mutcd.fhwa.dot.gov/ser-shs_millennium.htm

- Highway Functional Classification: Concepts, Criteria and Procedures, 2013 Edition (FHWA)
  http://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/section00.cfm
- Quality/Level of Service Handbook (FDOT, 2013)
  http://www.fdot.gov/planning/systems/programs/sm/los/default.shtm
- Manual on Uniform Traffic Studies (Topic No. 750-020-007)
  http://www.dot.state.fl.us/trafficoperations/Operations/Studies/MUTS/muts.shtm
- Surveying Procedure (Topic No. 550-030-101)
  http://www.dot.state.fl.us/surveyingandmapping/doc_pubs.shtm
- Right of Way Mapping Procedure (Topic No. 550-030-015)
  http://www.dot.state.fl.us/surveyingandmapping/doc_pubs.shtm

CHAPTER 2
LAND DEVELOPMENT

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CHAPTER 2

LAND DEVELOPMENT

A INTRODUCTION

A major portion of street and highway construction and reconstruction is a result of land development for residential, commercial, industrial, and public uses. The general land use layout influences, and is controlled by, connections to adjacent road networks with different transportation modes. Techniques, principles, and general layout used for any development also dictate the resulting internal road network. The arrangement and space allocations for this network may determine whether safe, efficient, and economical streets and highways are constructed or reconstructed.

Land development practices should promote high quality street networks that provide interconnectivity and access control. The street network shall be designed for the safety of all road users – pedestrians, bicyclists, transit, and motor vehicle operators and passengers.

The design of the street network and features should be consistent with the desired context and meet the criteria in this Manual. Context based street design incorporates the following elements:

- Streets are sized and detailed to equitably serve the needs of the intended road users.
- Building size and character spatially define streets and squares.
- Compact form reduces requirements for energy, infrastructure, and automobile use.
- Public transit is supported through a high level of connectivity and attractive facilities (stops, shelters, hubs).

Some development patterns, such as conventional suburban, do not promote the creation of a high quality, accessible street network. To promote the creation of context-sensitive high quality interconnected streets:

- Design for desired/target speeds.
- Design desirable geometry to achieve sufficient sight distance and appropriate cross section (not too wide or too narrow for the context).
- Provide sufficient right of way and space allocations for stormwater, utilities, pedestrian features, and lighting, etc.
- Provide reasonable control of access.

Two of the more recent alternatives to the conventional suburban development patterns include Traditional Neighborhood Development (TND) and Transit Oriented Development (TOD). For more information, refer to ***21st Century Land Development Code***.

Development controls are needed to aid in the establishment of safe streets and highways that will retain their efficiency and economic worth. Provisions for adequate alignment, right of way, setbacks, expansion, and access control are essential.

There may be legal, social, and economic challenges in land use controls. Proper coordination among the public, various governmental bodies, and public transit and highway agencies can provide solutions to many of these challenges. Implementation of responsible land use and development regulations along with intergovernmental respect for the goals and objectives of each, will promote a high-quality long term transportation network.

B OBJECTIVES

Provisions for vehicular and pedestrian safety are important objectives to be considered in land development. Other land development objectives, related to surface transportation, should include the promotion of smooth traffic flow, efficiency, economy, aesthetics, and environmental compatibility of the transportation network.

General objectives for land development that should be followed to promote good highway design include the following:

- Ensure the function of each street and highway meets its intended purpose and context
- Provide for logical and energy efficient interconnected street network and flow patterns
- Reduce trip lengths
- Encourage the appropriate vehicular speed
- Reduce traffic conflicts to a minimum and eliminate confusion
- Apply safe geometric design principles
- Promote bicycle and pedestrian use through connectivity and access
- Provide for future modifications and expansion
- Provide for aesthetic and environmental compatibility
- Develop economic design, construction, and maintenance strategies
- Provide for public transit facilities
- Provide accessibility for persons with disabilities

C PRINCIPLES AND GUIDELINES

There are many variables involved in land development; therefore, specific standards and requirements for land use and road network layouts cannot always be applied. Use of sound principles and guidelines can, however, aid in meeting the objectives of a better road network. Proper planning and design of the development layout are necessary to provide a satisfactory road network and to allow for the construction of safe roadways. The following principles and guidelines should be utilized in the design of the road network, in the control of access, and in the land use controls and space allocation that would affect vehicular and pedestrian use.

C.1 Development Types and Area Types

C.1.a Conventional Suburban Design

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

C.1.b Traditional Neighborhood Design (TND)

This development type is a development alternative that promotes a strong integration of land use and transportation. For further information on TND, refer to Chapter 19 of this Manual.

C.1.c Transit–Oriented Design (TOD)

This development type is defined as a compact, mixed use area within one half mile of a transit stop or station that is designed to maximize walking trips and access to transit. They also are characterized by streetscapes and an urban form oriented to pedestrians to promote walking trips to stations and varied other uses within station areas. Further information on TOD can be found on the Department's website: http://www.fltod.com/.

Transit-supportive planning and development rethinks land-use and development patterns so that communities may be effectively served by a balanced transportation system. Transit-supportive development enables citizens to use a variety of transportation modes for at least one or more of their daily trips between home, work, shopping, school, or services. These concepts are often called new urbanism to distinguish that form of urban design practice.

For more information on Conventional Suburban, TND and TOD, refer to the ***21st Century Land Development Code*** and ***Traditional Neighborhood Development Handbook.***

C.2 Network Design

The general layout of the road network establishes the traffic flow patterns and conflicts, thereby determining the basic safety and efficiency criteria. The design of the road network should be based on the following principles:

- The layout of street and highway systems should be logical and easily understood by the user.
- The design and layout of all streets and highways should clearly indicate their function.
- Local circulation patterns should be compatible with adjacent areas.
- Flow patterns should be designed to interconnect neighborhoods while discouraging through motorized traffic on local street networks.
- Elements in the local circulation should be adequate to avoid the need for extensive traffic controls.
- Typically, some streets are designed to accommodate a higher speed than the posted speed, which may cause enforcement problems and can have a negative safety impact on the circulation within an urban or residential network. In other situations, controlling speed levels is important in areas of concentrated pedestrian activities, areas with narrow right of way, areas with numerous access points, and on-street parking. Local authorities may elect to use traffic calming design features which are presented in ***Chapter 15 – Traffic Calming***.
- The internal circulation should be sufficient to provide reasonable travel distance for local trips.

- The road network should be compatible with other transportation modes such as mass transit and pedestrian and bicycle facilities. Conflicts between different modes (particularly with pedestrian and bicycle traffic) should be kept to a minimum.
- The road network layout should be designed to reduce internal traffic and pedestrian conflicts and to design effective transition elements to eliminate substantial speed differentials and hazardous turning and crossing maneuvers. The following principles should be utilized for conflict reduction:
- Generally the number of intersections should meet user needs, support development patterns, and traffic flow and connectivity requirements.
- Roundabouts should be evaluated for installation at new intersections. Consideration should be given to redesigning existing intersections as roundabouts. For further information on roundabouts, refer to the ***National Cooperative Highway Research Project (NCHRP)*** 672 and 674.
- One-way streets are an option to consider where feasible.
- Streets should be designed to limit vehicle speeds (length, width, alignment, and intersections).
- The network should be designed to reduce the number of crossings and left turn maneuvers that are required.

C.3 Access Control

The standards and requirements presented in ***Chapter 3 – Geometric Design***, are necessary to maintain safe and efficient streets and highways. Failure to provide adequate control of access has seriously damaged many existing roadways. Unrestricted access to major collectors and arterials has dramatically reduced their capacity and general economic value. The safety characteristics of these facilities have similarly been diminished by significantly increasing the number of vehicular, pedestrian, and bicycle traffic conflicts.

The utilization of proper control over access is one of the most effective and economical means for maintaining the safety and utility of streets and highways. The procedures and controls used for land development significantly affect access control. The following principles should be utilized in the formation of land use controls for limiting access:

- The standards presented in ***Chapter 3 - Geometric Design, C.8 Access Control***, should provide the basis for establishing land development criteria for control of access.
- The use of an arterial or major collector as an integral part of the internal circulation pattern on private property should be prohibited.
- The intersection of private roads and driveways with arterials or major collectors should be strictly controlled.
- Access to sites which generate major traffic (vehicular, pedestrian, and bicycle), should be located to provide the minimum conflict with other traffic. These generators include schools, shopping centers, business establishments, industrial areas, entertainment facilities, etc.
- Commercial strip development, with the associated proliferation of driveways, should be eliminated. Vehicular and pedestrian interconnections should be encouraged.
- The function of all streets and highways should be preserved by the application of the appropriate access controls.
- The spacing and location of access points should be predicated upon reducing the total traffic and pedestrian conflict.
- Hazardous maneuvers should be restricted by access controls. For example, crossing and left turn maneuvers may be controlled by continuous median separation. Pedestrian access should be allowed at appropriate intervals. Medians with waiting space for pedestrians crossing the street are often necessary.

C.4 Land Use Controls and Space Allocation

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

- Adequate corridors and space should be considered for utilities. Utility locations should be carefully chosen to minimize interference with the operation of the streets, highways, and sidewalks.
- Adequate space for drainage facilities should be provided. Open drainage facilities should be located well clear of the traveled way.

- Design for pedestrian and bicycle facilities should comply with ***Chapter 8 – Pedestrian Facilities*** and ***Chapter 9 – Bicycle Facilities***.
- Adequate space should be provided for off-street and side-street parking. This is essential in commercial and industrial areas.
- Right of way and setback requirements should be adequate to provide ample sight distance at all intersections.
- Sufficient space should be allocated for the development of adequate intersections, including accessibility for disabled individuals.
- Space allocation for street lighting (existing or planned) should be incorporated into the initial plan. Supports for this lighting should be located outside of the required clear zone unless they are clearly of breakaway type, or are guarded by adequate protective devices. Lighting plans should provide for well-lit, safe waiting and walking areas and shall conform with the provisions of ***Chapter 6 – Lighting***.
- Sufficient right of way should be provided for future widening, modification, or expansion of the highway network.
- Adequate corridors for future freeways, High Occupancy Vehicle (HOV) lanes, arterials, or major collectors should be provided.
- Adequate space for desired or required greenways should be provided.
- Adequate space for appropriate public transit facilities should be provided.

D COORDINATION

There are many demands that can conflict with the development of safe and efficient streets and highways. Meeting the demand for access can negatively impact the capacity of a roadway. Pressure to limit the amount of land dedicated for streets and highways inhibits the construction of an adequate road system. Coordination between highway agencies and other governmental bodies can assist in improving the procedures used in land development. Proper coordination should be solicited from legislative bodies, courts, planning and zoning departments, and transit and other governmental agencies to aid in developing a well-designed highway network. Coordination with transit planners, developers, engineers, architects, contractors, and other private individuals should be a continuous process.

The ***Florida Metropolitan Planning Organization Advisory Council (MPOAC)*** is a statewide transportation planning and policy organization created by the Florida Legislature pursuant to ***Section 339.175(11), Florida Statutes***, to augment the role of individual MPOs in the cooperative transportation planning process. The MPOAC assists MPOs in carrying out the urbanized area transportation planning process by serving as the principal forum for collective policy discussion. Further information on the MPOAC, including links to MPOs, can be found at http://www.mpoac.org/.

E CONTROL TECHNIQUES

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

E.1 Right of Way Acquisition

The acquisition of sufficient right of way is essential to allow for the construction of adequate streets and highways as specified in CHAPTER 3 - GEOMETRIC DESIGN and CHAPTER 4 - ROADSIDE DESIGN. The provision of adequate space for clear roadside, sight distance, drainage facilities, buffer zones, intersections, transit, sidewalks, frontage roads, and future expansion is also necessary to develop and maintain safe streets and highways.

E.2 Regulatory Authority

The regulatory authority of state and local highway agencies (and other related agencies) should be sufficient to implement the necessary land use controls. The following general regulatory requirements and specific areas of control should be considered as minimum:

E.2.a General Regulatory Requirements

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

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

- A safety check of proposed streets and highways should be a required step in the review and acceptance of all development plans.

E.2.b Specific Control

Specific areas of control necessary to develop adequate and efficient roadways include the following:

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

E.3 Contracts and Agreements

Where land purchase or regulatory authority is not available or appropriate, the use of contractual arrangements or agreements with individuals can be beneficial. Negotiations with developers, builders, and private individuals should be used, where appropriate, to aid in the implementation of the necessary controls.

E.4 Education

Education of the public, developers, and governmental bodies can be beneficial in promoting proper land development controls. The need for future planning, access control, and design standards should be clearly and continuously emphasized. Successful solidification of the cooperation of the public and other governmental bodies depends upon clear presentation of the necessity for reasonable land development controls.

F REFERENCES

- 21st Century Land Development Code
  https://www.planning.org/publications/book/9026709/
- Florida Transportation Plan
  http://floridatransportationplan.com/
- Florida Growth Management and Comprehensive Planning Laws (DOE)
  http://www.floridajobs.org/community-planning-and-development
- 1000 Friends of Florida
  http://www.1000fof.org/
- Florida Metropolitan Planning Organization Advisory Council (MPOAC) http://www.mpoac.org/
- Understanding Sprawl, A Citizen's Guide
  http://www.davidsuzuki.org/publications/resources/2003/understanding-sprawl-a-citizens-guide/
- Traditional Neighborhood Development Handbook
  http://www.fdot.gov/roadway/FloridaGreenbook/TND-Handbook.pdf

GEO CHAPTER 3
METRIC DESIGN

TABLES

FIGURES

CHAPTER 3

GEOMETRIC DESIGN

A INTRODUCTION

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

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

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

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

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

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

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

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

The selection of the type and exact design details of a particular street or highway requires considerable study and thought. When specific criteria are not provided in this Manual and reference is made to guidelines and design details given by current American Association of State Highway and Transportation Officials (AASHTO) publications, these guidelines and standards should generally be considered as minimum criteria. For the design of recreational roads, local service roads, and alleys, see ***A Policy on Geometric Design of Highways and Streets (AASHTO, 2011)***, also known as the ***AASHTO Greenbook (2011)*** and other publications.

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

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

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

B OBJECTIVES

The major objective in geometric design is to establish a vehicle path and environment providing a reasonable margin of safety for the motorist, transit, bicyclist, and pedestrian under the expected operating conditions and speed. It is recognized that Florida's design driver is aging, and tourism is our major industry. This gives even more emphasis on simplicity and easily understood geometry. The design of street or highway features should consider the following:

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

C DESIGN ELEMENTS

C.1 Design Speed

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

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

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

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

Minimum and maximum values for design speed are given in Table 3 – 1 Minimum and Maximum Design Speed.

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

The ***AASHTO Greenbook (2011)*** provides additional information on design speed.

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

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

Footnotes:

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

C.2 Design Vehicles

A "design vehicle" is a vehicle with representative weight, dimensions, and operating characteristics, used to establish street and highway design controls for accommodating vehicles of designated classes. For the purpose of geometric design, the design vehicle should be one with dimensions and minimum turning radii larger than those of almost all vehicles in its class. Design vehicles are listed in Table 3 – 2 Design Vehicles. One or more of these vehicles should be used as a control in the selection of geometric design elements. In certain industrial (or other) areas, special service vehicles may have to be considered in the design. Fire equipment and emergency vehicles should have reasonable access to all areas. Additional information on the maximum width, height and length of vehicles in Florida can be found in ***Section 316.515, F.S. Motor Vehicles; Maximum width, height, length.***

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

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

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

Table 3 – 2 Design Vehicles

Design Vehicle		Dimensions (feet)					
Type	Symbol	Wheelbase	Overhang		Overall Length	Overall Width	Height
			Front	Rear			
Passenger Car	P	11	3	5	19	7	4.3
Single Unit Truck	SU-30	20	4	6	30	8	11-13.5
Single Unit Truck – 3 Axle	SU-40	25	4	10.5	39.5	8	11-13.5
City Transit Bus	CITY-BUS	25	7	8	40	8.5	10.5
Conventional School Bus (65 passenger)	S-BUS 36	21.3	2.5	12.0	35.8	8.0	10.5
Articulated Bus	A-BUS	22+19.4=41.4	8.6	10	60	8.5	11
Motor Home	MH	20	4	6	30	8	12
Car & Camper Trailer	P/T	11+5+17.7=33.7**	3	12	48.7	8	10
Car & Boat Trailer	P/B	11+5+15=31**	3	8	42	8	---
Intermediate Semitrailer	WB-40	12.5+25.5=38	3	4.5	45.5	8	13.5
Intermediate Semitrailer	WB-50	14.6+35.4=50	3	2	55	8.5	13.5
Interstate Semitrailer***	WB-62	19.5+41=60.5	4	4.5	69	8.5	13.5
Florida Interstate Semitrailer***	WB-62FL	19.5+41=60.5	4	9	73.5	8.5	13.5
Interstate Semitrailer***	WB-67	21.6+45.4=67	4	2.5	73.5	8.5	13.5
"Double-Bottom"-Semitrailer/Trailer Combination	WB-67D	11+23+10*+22.5= 66.5	2.3	3.0	72.3	8.5	13.5

Source: 2011 AASHTO Greenbook, Design Controls and Criteria, Table 2-1b.

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

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

*** The term "Interstate" does not imply the vehicle is restricted to interstate and limited access highways only.

The minimum turning radii of design vehicles is presented in Table 3 – 3 Minimum Turning Radii of Design Vehicles. The principal dimensions affecting design are the minimum centerline turning radius, the out-to-out track width, the wheelbase, and the path of the inner rear tire. The speed of the turning vehicle is assumed to be less than 10 mph.

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

Figures illustrating the minimum turning radii for a variety of vehicles along with additional information can be found in the ***AASHTO Greenbook (2011), Chapter 2 – Design Controls and Geometrics.***

Table 3 – 3 Minimum Turning Radii of Design Vehicles

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

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

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

C.3 Sight Distance

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

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

C.3.a Stopping Sight Distance

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

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

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

The determination of available stopping sight distance shall be based on a height of the driver's eye equal to 3.50 feet and a height of obstruction to be avoided equal to 2.0 feet. It would, of course, be desirable to use a height of obstruction equal to zero (coincident with the roadway surface) to provide the driver with a more positive sight condition. Where horizontal sight distance may be obstructed on curves, the driver's eye and the obstruction shall be assumed to be located at the centerline of the traffic lane on the inside of the curve.

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

Table 3 – 4 Minimum Stopping Sight Distance

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

Source: 2011 AASHTO Greenbook, Table 3-1 Stopping Sight Distance on Level Roadways and Table 32 Stopping Sight Distance on Grades.

C.3.b Decision Sight Distance

Decision sight distance is the distance needed for a driver to detect an unexpected or otherwise difficult to perceive information source or condition in a roadway environment that may be visually cluttered. It allows the driver to recognize the condition or its potential threat, select an appropriate speed and path, and initiate and complete complex maneuvers. Minimum stopping distance does not provide sufficient space or time for the driver to make decisions regarding complex situations requiring more than simple perception-reaction process

Examples of critical locations where additional sight distance is needed include interchange and intersections locations, where unusual or unexpected maneuvers are needed, changes in typical sections such as toll plazas or lane drops, and areas of concentrated demand where there is visual noise from competing sources of information, such as roadway elements, traffic, traffic control devices and advertising signs.

The decision sight distances in Table 3 – 5 Decision Sight Distance may be used (1) to provide values for sight distances that may be appropriate at critical locations, and (2) serve as criteria for evaluating the suitability of the available sight distances at these locations. If it is not practical to provide decision sight distance because of horizontal or vertical curvature or if relocation of decision points is not practical, special attention should be given to using appropriate traffic control devices providing advance warning of the conditions that are likely to be encountered.

Table 3 – 5 Decision Sight Distance

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

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

Notes: 1. Avoidance Maneuver A: Stop on rural road – t = 3.0 s

2. Avoidance Maneuver B: Stop on urban road – t = 9.1 s

3. Avoidance Maneuver C: Speed/path/direction change on rural road – t varies between 10.2 and 11.2 s

4. Avoidance Maneuver D: Speed/path/direction change on suburban road – t varies between 12.1 and 12.9 s

5. Avoidance Maneuver E: Speed/path/direction change on urban road – t varies between 14.0 and 14.5 s

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

C.3.c Passing Sight Distance

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

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

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

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

Table 3 – 6 Minimum Passing Sight Distance

(For application of passing sight distance, use an eye height of 3.50 feet and an object height of 3.50 feet above the road surface)											
Design Speed (mph)	20	25	30	35	40	45	50	55	60	65	70
Minimum Passing Sight Distance (feet)	400	450	500	550	600	700	800	900	1000	1100	1200

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

C.3.d Intersection Sight Distance

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

C.4 Horizontal Alignment

C.4.a General Criteria

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

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

Maximum curvature should not be used in the following locations:

- High fills or elevated structures. The lack of surrounding objects reduces the driver's perception of the roadway alignment.
- At or near a crest in grade.
- At or near a low point in a sag or grade.
- At the end of long tangents.

- At or near intersections, transit stops, or points of ingress or egress.
- At or near other decision points.

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

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

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

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

C.4.b Maximum Deflections in Alignment without Curves

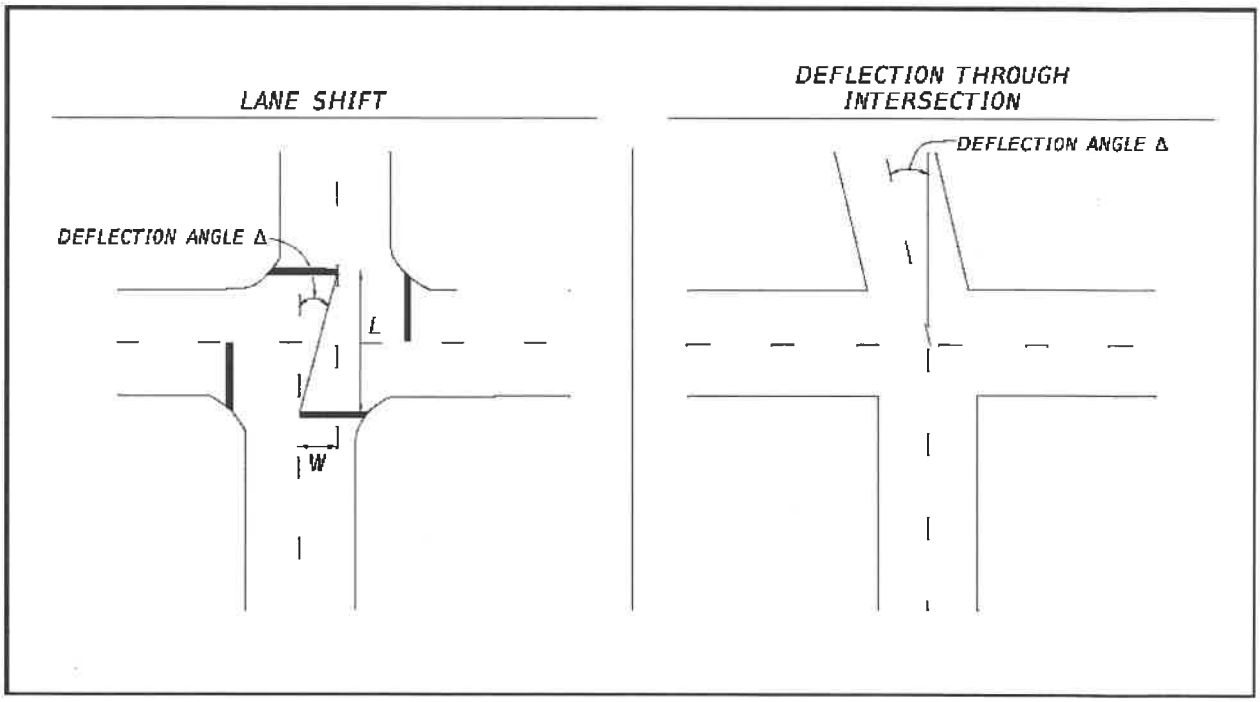
The point where tangents intersect is known as the point of intersection (PI). Although the use of a PI with no horizontal curve is discouraged, there may be conditions where it is necessary. The maximum deflection without a horizontal curve are as follows:

- Flush shoulder and curbed roadways with design speed 40 mph and less is 2° 00' 00".
- Flush shoulder roadways with design speed 45 mph and greater is 0° 45' 00".
- Curbed roadways with design speed 45 mph and greater is 1° 00' 00".
- High speed curbed roadways with design speed 50 mph and greater is 0° 45' 00".

Although deflections thru intersections are discouraged, there may be conditions where it is necessary. The maximum deflection angles at intersections to be used in establishing the horizontal alignment are given in Table 3 – 7 Maximum Deflection Angle Through Intersection.

Table 3 – 7 Maximum Deflection Angle Through Intersection

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



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

Curves on main roadways should be sufficiently long to avoid the appearance of a kink. Gently flowing alignment is generally more pleasing in appearance, as well as, superior from a safety standpoint. Flatter curvature with shorter tangents is preferable to sharp curves connected by

long tangents; i.e., avoid using minimum horizontal curve lengths. Table 38 Minimum Lengths of Horizontal Curves provides minimum horizontal curve lengths that should be used in establishing the horizontal alignment.

Table 3 – 8 Minimum Lengths of Horizontal Curves

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

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

Notes:

1. Horizontal curve length should be the greater of the lengths based on design speed and length based on deflection angle.
2. If the curve lengths for arterials and collectors cannot be attained, provide the greatest attainable length possible, but not less than 400 feet.
3. If the curve lengths for mainline freeways cannot be attained, provide the greatest attainable length possible, but not less than the lengths used for arterials and collectors.
4. Curve length shall provide for full superelevation within the curve of not less than 200 ft. (Rural) or 100 ft. (Urban).

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

Table 3 – 9 Length of Compound Curves on Turning Roadways

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

C.4.c Superelevation

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

The terms Rural and Urban used in this section reflect the location of the project. In addition to the criteria provided below, additional information regarding superelevation given in the Department's FDOT Design Manual, and *A Policy on Geometric Design of Highways and Streets (AASHTO, 2011)*, may be considered.

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

The superelevation rates for high speed (50 mph or greater) roadways are provided in Table 3 – 10 Superelevation Rates for Rural Highways, Urban Freeways and High Speed Urban Highways