

FLORIDA HIGHWAY LANDSCAPE GUIDE

WPI No. 0510694
State Project No. 99700-7105

Prepared for

FLORIDA DEPARTMENT OF TRANSPORTATION
605 Suwannee Street
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April 14, 1995

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Mr. Gary Henry
Florida Department of Transportation
Central Office
Environmental Office, MS 37
605 Suwannee Street
Tallahassee, FL 32399-0450

RE: *Florida Highway Landscape Guide*
WPI No. 0510694
State Project No. 99700-7105

Dear Mr. Henry:

We are pleased to submit the *Florida Highway Landscape Guide*. These guidelines coordinate the established standards of the Florida Department of Transportation with aesthetic considerations of the highway corridor.

Implementation of the guidelines will assure that highway aesthetics are considered throughout the State. It will result in the planning, design, construction and maintenance of safe and aesthetically pleasing highways that emphasize a "view of and from the road".

We appreciate the opportunity to develop these guidelines for the Florida Department of Transportation. The cooperation and assistance provided by you and the landscape task team was extremely important in the development of the landscape guidelines for statewide application.

Respectfully submitted,

TAMPA BAY ENGINEERING, INC.

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Enclosure

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Section 1

INTRODUCTION

Millions of residents and visitors travel Florida's highways annually. The condition, safety and attractiveness of the State's urban, suburban and rural corridors are important issues with residents of the State and travelers along the highways.

The Sunshine State's strong tourist-based economy is dependent upon a well-maintained and aesthetically pleasing highway system. Enhancing the natural image of Florida, with lush foliage along major thoroughfares, conveys the image of a vacation paradise and attracts tourists. Likewise, quality highways reflect community pride and economic vitality, thereby attracting businesses and industries.

In 1987, the Florida Legislature approved Florida Statute 339.24. This statute required the Florida Department of Transportation (FDOT) to plan a statewide beautification program for State transportation facilities. The program was to be implemented with grant funds to local governments as appropriated by the State Legislature.

On August 1, 1992, Secretary of Transportation Ben G. Watts issued a policy statement titled *Environmental Policy for State Transportation Facilities*. (See page 1-3 for this policy statement.) This statement shows the emphasis the FDOT places on preserving and enhancing the existing landscape.

President William J. Clinton signed a memorandum on April 26, 1994 directing Federal Agencies to improve landscape practices on Federal grounds and federally-funded projects. The memorandum directs more environmentally and economically beneficial landscaping wherever Federal dollars are spent. This memorandum would affect all federally-funded highway projects and grants. Agencies are asked to implement the memorandum in the following ways:

- Use regionally native plants in landscaping.
- Design, use or promote construction practices that minimize adverse effects on the natural habitat.

- Seek to prevent pollution by reducing fertilizer and pesticide use, using integrated pest management techniques, recycling green waste and minimizing runoff.
- Implement water-efficient practices, such as use of mulches and efficient irrigation systems.
- Create outdoor demonstrations incorporating native plants, pollution prevention and water conservation techniques.

The Florida Highway Beautification Council ("the Council") was established in accordance with Florida Statute 339.2405. The primary duty of the Council is to provide information to local governments, civic organizations, churches and businesses (hereafter referred to as Agency or Agencies) and local highway beautification groups regarding the State highway grant beautification program. The Council also reviews grant applications from Agencies and establishes a priority list for use of grant funds.

With the increased emphasis on protecting and enhancing the landscape of transportation corridors by the FDOT, the importance placed on highway beautification by the State legislature and the establishment of the Council, there has been an increase of plans for highway landscape improvements. There has been, however, a good deal of variation throughout Florida regarding standard design, implementation and maintenance of the highway landscape. Recognizing a need for standardized regulations and information, the FDOT decided to develop a statewide guide, *The Florida Highway Landscape Guide*. This guide and its accompanying video was prepared as a tool to assist in implementing and maintaining safe highway beautification projects.

POLICY STATEMENT

Section 2

PLANNING PHASE

LOCAL GOVERNMENT COMPREHENSIVE PLAN

The Comprehensive Plan of local governments should include a section on aesthetic treatment of streets and highways. This plan needs to identify the streets and highways that the community wants considered for highway landscape improvements. It should include scenic routes and routes where the community wants special emphasis placed on the highway landscape. Blighted areas, that need highway landscaping to improve the aesthetics of the community, should be identified. The plan should show the location of existing trees and plants that the community wants to preserve.

The District Planning Department will include a highway landscape element for all roadway improvements programmed along a highway identified for aesthetic treatment. If the local government comprehensive plan does not include a section on highway aesthetics, the District Planning Department will coordinate with the local government Planning Department to determine their position on including a highway landscape element within the project. The programming of a highway landscape element, during the initial programming phase, assures that landscaping will be addressed during the development of the project.

Highway landscape improvements may be installed as part of a highway improvement project or as a separate project. When installed as part of a highway project or as a separate project, it is critical that close coordination be maintained between the highway designer and landscape designers. The primary function of the highway is to provide a safe and efficient transportation system for its users; therefore, the design must comply with appropriate design standards. However, the highway is part of the landscape and should be designed to be compatible with the existing landscape and meet the public desire for aesthetically pleasing highways.

PROGRAMMING OF PROJECTS

Projects to improve the landscape of State highways may be accomplished as part of a FDOT roadway project, with a highway beautification grant from the FDOT or by permit from the FDOT. The FDOT standard landscaping design is grass and sod. If the local government Agency

wants to beautify a highway with trees, shrubs and ground covers, they must agree to be responsible for the additional maintenance that will be required. Therefore, the local government or Agency must commit to the maintenance responsibility before the FDOT will include a landscape element in a highway project, approve a highway beautification grant or issue a permit for highway landscape improvements within the right-of-way of a State highway.

Major Highway Projects

Highway landscape is an element that must be considered on all major highway projects. The greatest opportunity to preserve the landscape and implement highway landscaping occurs during the construction of new highways or major expansion of existing highways. The FDOT will work with Agencies to include a landscape element in the plans for all major roadway projects under the condition that the Agencies will agree to maintain certain highway landscaping. The landscaping included on major projects will vary from project to project based on the highway design, local Agencies commitment and public input.

Highway Resurfacing, Restoration and Rehabilitation Projects (3R)

The FDOT will work with Agencies to include landscaping on 3R type projects to the extent practical. These are primarily resurfacing and minor widening projects within the existing right-of-way. Therefore, all landscaping improvements have to be within the existing right-of-way. When access management improvements are included with a 3R project, it enhances the opportunity to improve the landscape.

Highway Beautification Grant Projects

Highway beautification projects sponsored by local governments are eligible for State highway beautification grant funds. These funds are administered by the Council in accordance with FDOT, Rule Chapter 14-92, *Florida Highway Beautification Council*. The plans prepared for highway beautification grant projects must comply with all FDOT design standards.

Permit Beautification Projects

Many highway landscaping projects are installed by Agencies. When these projects are on the State highway system, the Agencies obtain permits from the FDOT. The plans for these projects must comply with all FDOT design standards.

Section 3

PROJECT DEVELOPMENT AND ENVIRONMENTAL PHASE (PD&E)

During this phase, the following shall be accomplished:

- Analysis of highway landscape requirements.
- Develop conceptual landscape plans.
- Develop typical section to accommodate landscape plan.
- Identify plant preservation area.
- Establish plan for shared right-of-way use by utilities and landscaping.
- Obtain public input and hold hearings.

GENERAL CONCEPT OF HIGHWAY LANDSCAPE

The central objective of highway beautification in Florida is to create safe, low maintenance, attractive landscaping within the rights-of-way of the State's transportation corridors. The design concepts and implementation are intended to beautify, enhance and maintain the natural environment; to direct views and screen objectionable views; and to mediate vast areas of paved roadway, thus relieving driving monotony and increasing highway safety.

Planting along roadways improves the highway environment. In addition to absorbing carbon dioxide and releasing oxygen into the atmosphere, trees reduce glare and lower temperatures up to 10 degrees in Florida's hot and humid climate. Plant materials also absorb runoff water and buffer roadway noise.

Along each highway the planting pattern should be relatively consistent to create a spatial quality and rhythm to the design. Pattern is determined by:

- **Planting location** (in the median or along the sides of the road).
- **Spacing** (the distance between trees or large masses of plant materials).
- **Arrangement** (the formal look of "on center" spacing in rows, natural "clustered" spacing, small trees in front of large trees, and so on).

A simple, consistent pattern will reinforce the identity of the highway. A change in this planting pattern may occur at landmark locations along the highway, for example, a major intersection, gateway, significant natural feature, etc. Landmarks may feature heavier landscape treatment with unique, ornamental or flowering plant materials suitable for a high focal area. However, maintenance must be a consideration and the landscape plan designed around the ability to maintain.

Native and adapted plant species should be used in the landscape, particularly those which are drought tolerant, disease and pest resistant. Noxious and invasive exotic plant materials must not be used. Generally, the range of plant types for urban usage will consist of hardwood shade trees, ornamental trees or palms surrounded by turf grass; this is encouraged as a simple, low maintenance landscape treatment. Mass plantings of hardy, vigorous shrubs and ground cover

may be used around stands of trees or palms. A design should contain more than one species, to reduce the risk of disease or pests destroying the entire landscape. However, tree species should be limited to a single theme tree, and one or two secondary species, to achieve a recognizable character for highway planting. Without exception, plant materials must be selected with consideration of mature height and mass in relationship to highway visibility. Thorny or toxic plant materials shall not be used near pedestrian areas, nor shall plants with excessive leaf or fruit drop. Trees should be selected and located to avoid root problems and shedding of debris on the roadway. Color in the landscape should be introduced wherever possible. All plants must be grade Florida Number 1 or better as designated in the most recent publication of *Grades and Standards for Nursery Plants, Part I and II*, published by the Florida Department of Agriculture and Consumer Services. All plants must conform to the *Nursery Stock Standards* by the American Association of Nurserymen (stated in Section 4, *DESIGN PHASE*, "Trees, Shrubs and Ground Cover").

The landscape plan should use native plants and wildflowers to the greatest extent possible. Exotic plants should be considered only to serve a specific limited purpose, such as accent or specimen plantings. A minimum of one-fourth of one percent of the total cost for landscape improvements must be spent on wildflowers when Federal funds are used.

The selection of plants for a landscape project should consider the natural environmental factors associated with the plantings. Such factors would include salt tolerance, sun or shade tolerance, drought tolerance, wind exposure, etc. Only plantings that are compatible with the natural environment should be used. The plant selections should also be based on the anticipated level of maintenance. Plants that will receive minimal maintenance must be hardy, native, site-specific plants. Plants requiring a high level of maintenance should not be specified unless the maintenance plan and agreements address these needs. Plants that are deemed unacceptable by the Florida Department of Agriculture and Consumer Services, Rule Chapter 5B-57, *Introduction or Release of Plant Pests, Noxious Weeds, Arthropods, and Biological Control Agents*, or Florida Department of Environmental Protection, Rule Chapter 16C-52, *Florida Prohibited Aquatic Plants* are not to be utilized in FDOT rights-of-way.

ENGINEERING STANDARDS

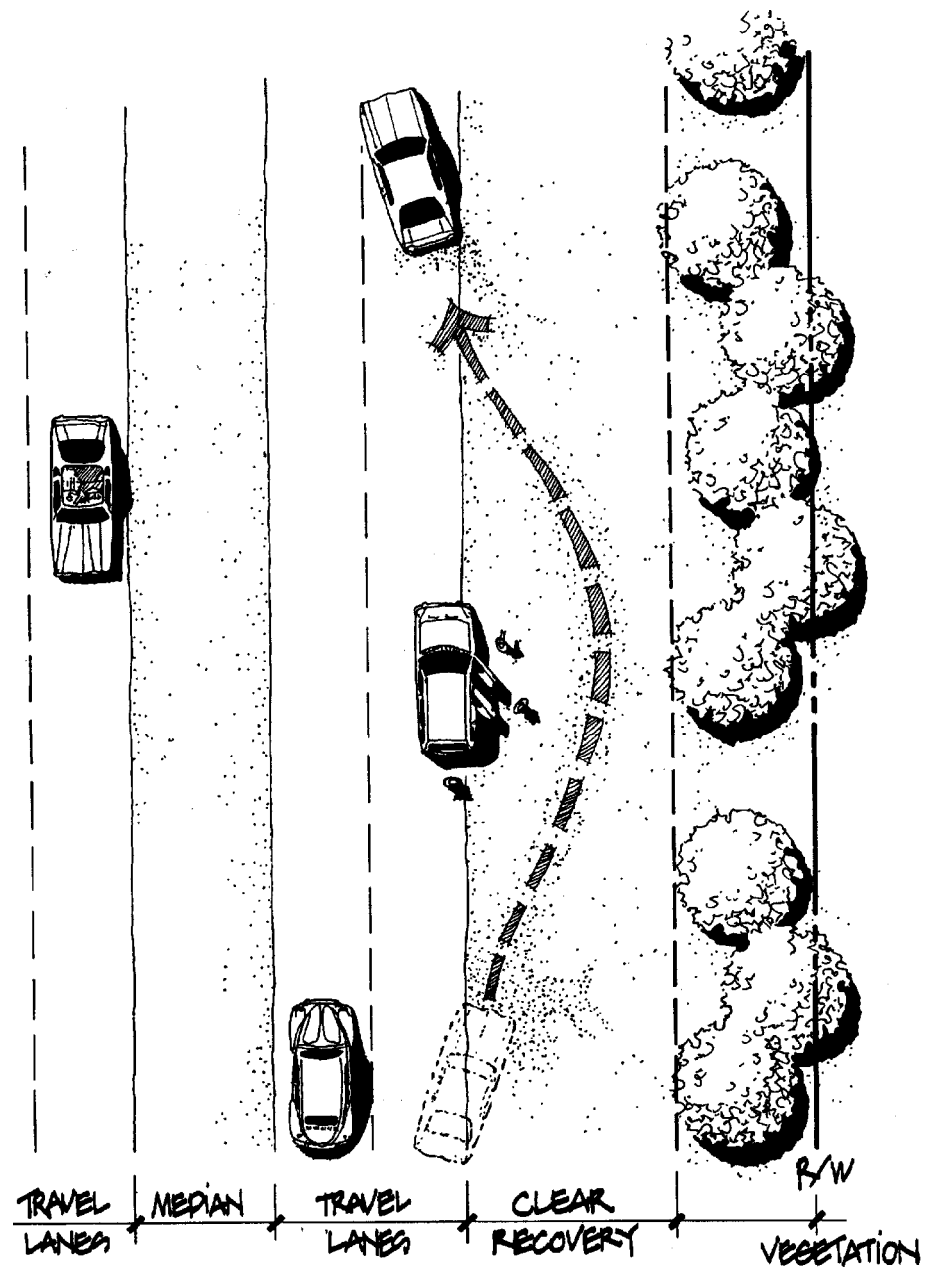
The engineering standards that have the most influence on highway landscape designs are horizontal clearance, sight distance, and access management. The horizontal clearance criteria for trees is they must be located outside the clear zone.

On roadways with shoulders the horizontal clearance is the roadside area, starting at the edge of the travel way, that is available for corrective action by errant vehicles. Horizontal clearance areas are based on the forgiving highway design concept that the highway design should provide the driver who makes a mistake, the opportunity to recover. There can be no fixed objects within the limits of the horizontal clearance area that would prevent the driver from recovering. In highway landscape design, all plantings within the horizontal clearance area must have a trunk diameter of 100 mm or less when measured 150 mm above the ground. The horizontal clearance criteria is based on the type of highway design (rural or urban), the design speed of the highway and the projected 20-year average daily traffic. These criteria are currently shown on FDOT Standard Index No. 700, *Design Elements Related to Highway Safety* (hereinafter referred to as "FDOT Standard Index No. 700") and FDOT *Roadway Plans Preparation Manual*, Volume I, Chapter 2, "Roadside Safety". See Figure 1.

Clear-sight distance is needed at intersections and driveway connections for two reasons. The driver stopped on the crossroad, or driveway, must have sufficient sight distance along the main highway to select a gap between approaching vehicles to safely enter and depart the intersection area. The driver on the main highway must have a view of the crossroad from a sufficient distance to allow him to safely react when a vehicle from the crossroad enters the main highway. The required sight distance for intersections is based on the geometry design of the highway, vehicle operating characteristics, driver behavior and design speed of the highway. These distances are currently shown on FDOT Standard Index No. 546, *Sight Distance for Intersections* (hereinafter referred to as "FDOT Standard Index No. 546"), and are based on current American Association of State Highway and Transportation Officials (AASHTO) criteria and FDOT criteria and standards.

Clear-sight windows are necessary to provide drivers of vehicles on the main roadway and on the crossroad, sufficient clear view of each other to safely react to potential conflicts. The design requirements for the clear-sight windows are shown on FDOT criteria and standards.

Figure 1



CLEAR RECOVERY ZONE
VARIES WITH HIGHWAY SIZE AND SPEED

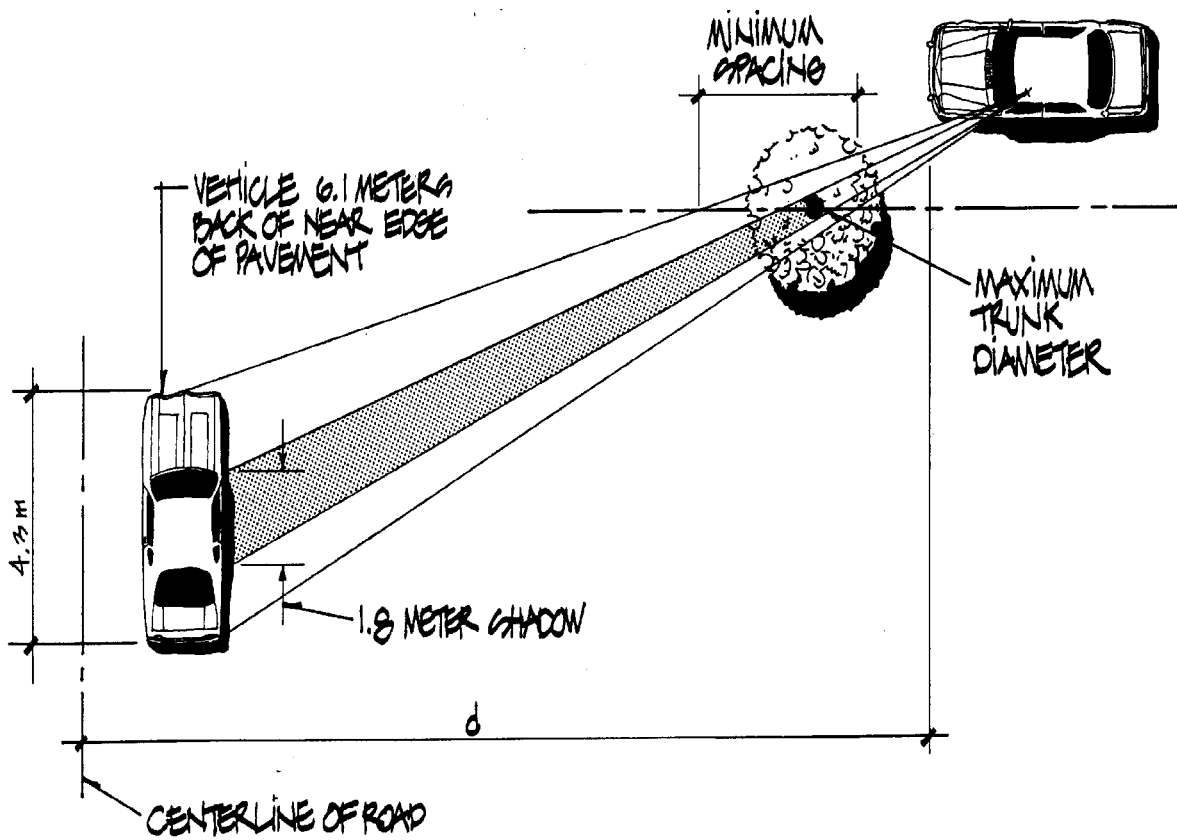
The spacing and size of tree trunks within the clear-sight distance must be controlled. This is necessary to provide adequate clear-sight window width between trees and to limit the amount of sight blockage by the tree trunk. These controls are based on the design of the highway and its design speed. The standards for tree trunk size and spacing between trees and ground cover, within the intersection sight distance, is shown on FDOT Standard Index No. 546. See Figures 2 and 3.

Access management is the management of vehicular access to the highway. This includes ingress to the highway, egress from the highway and median openings on divided highways. A well-designed highway with good access management can be aesthetically pleasing. It provides the landscape architect greater opportunity in the development of practical and efficient landscape plans. When the number of median openings and driveway connections are reduced, a greater area is generally available for landscaping. The reduction of median openings and driveways also reduces the number of locations that must meet clear-sight requirements. This allows greater flexibility in the landscape plan. Therefore, any plan for landscaping a highway should consider access management. The plan for access management should conform with the standards of the adopted access classification for the highway and FDOT, Rule Chapter 14-96, *State Highway System Connection Permits*, and FDOT, Rule Chapter 14-97, *Access Management Classification Systems and Standards*. Access management is addressed on all projects. For major highway projects, the access management plan is developed during the Project Development phase. For 3R projects, permit projects and grant application projects, it is developed during the Design phase. All projects that include highway landscaping should consider the plans for landscaping in the development of access management plans.

TYPICAL SECTIONS FOR LANDSCAPING

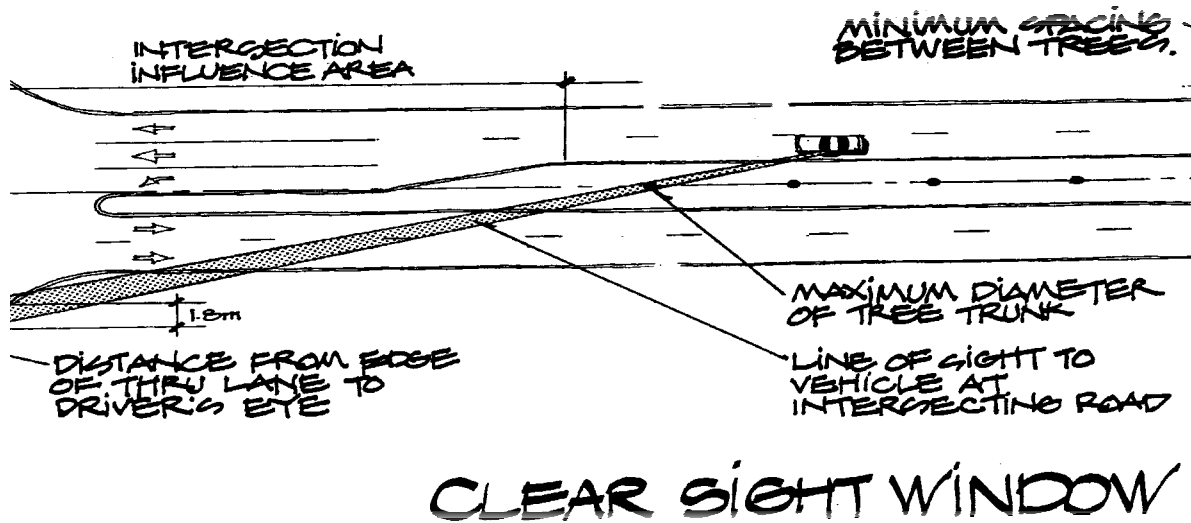
A major element in the design of a highway project is the typical section of the highway from right-of-way line to right-of-way line. If a project is to include landscaping, the typical section design must provide an area for its installation. The two areas in which landscaping can be considered are the median and outer roadside. If trees are included in plans for landscape improvements the typical section has to be designed to provide an area for their installation that meets horizontal clearance criteria.

Figure 2



SITE DISTANCE AT INTERSECTIONS
SHADOW DIAGRAM

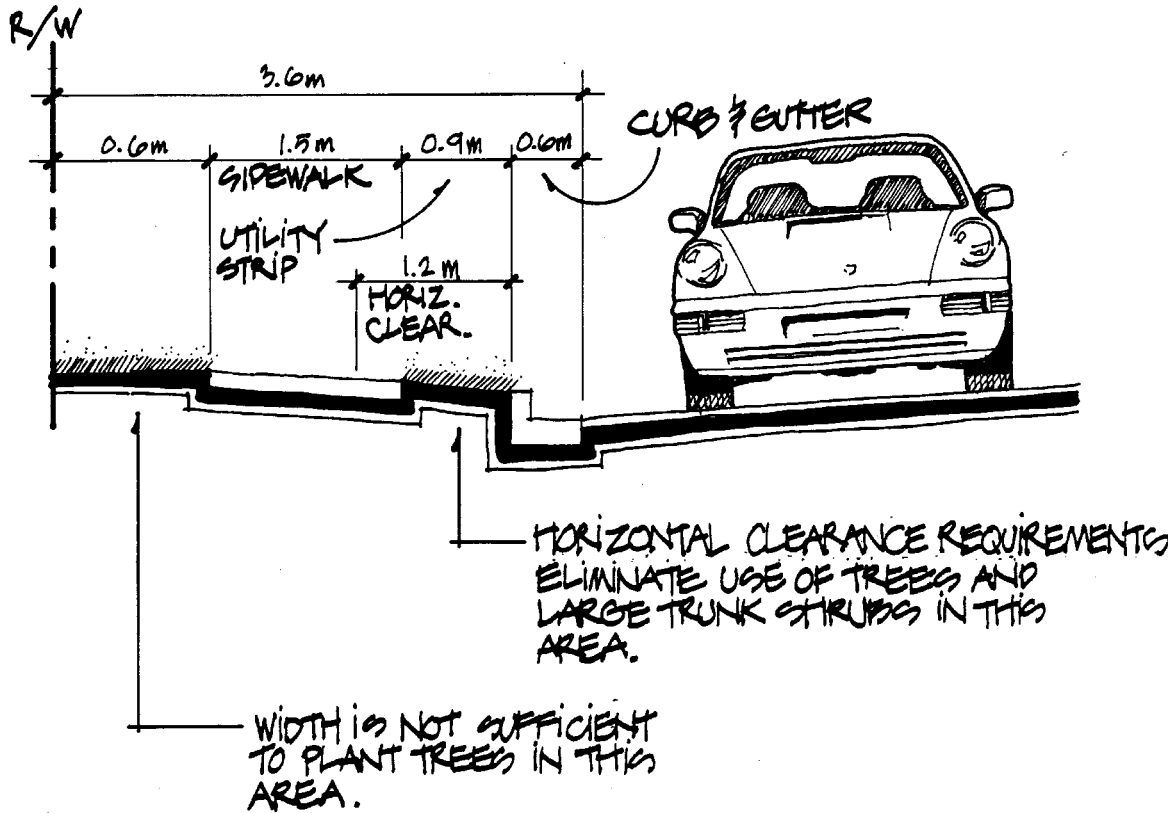
Figure 3



Urban

The standard curb and gutter typical sections for urban highways are not designed to allow the use of trees between the curb and right-of-way line. The width from back of curb to right-of-way line is designed to provide sidewalks and utility strips. Grass can be used in the small buffer strips between the curb and sidewalk, and grass or shrubbery between the sidewalk and right-of-way line. There is not enough width in either of these areas to install trees (see Figure 4). If trees between the curb and right-of-way line are an important part of plans to improve the landscape, the typical section must be designed to provide an area for their location. Trees must satisfy the horizontal clearance requirements of criteria in FDOT's *Roadway Plans Preparation Manual*. The location, size and spacing of trees along the roadside, within the limits of clear-sight at intersections, must meet the criteria of FDOT Standard Index No. 546.

Figure 4



STANDARD ROADSIDE TYPICAL SECTION URBAN HIGHWAY NTS NOT DESIGNED FOR ROADSIDE TREES

The area between the sidewalk and right-of-way is the area least impacted by intersection sight criteria. Therefore, if the typical section is designed to provide an area for trees, it should be between the sidewalk and right-of-way line. See Figures 5 and 6.

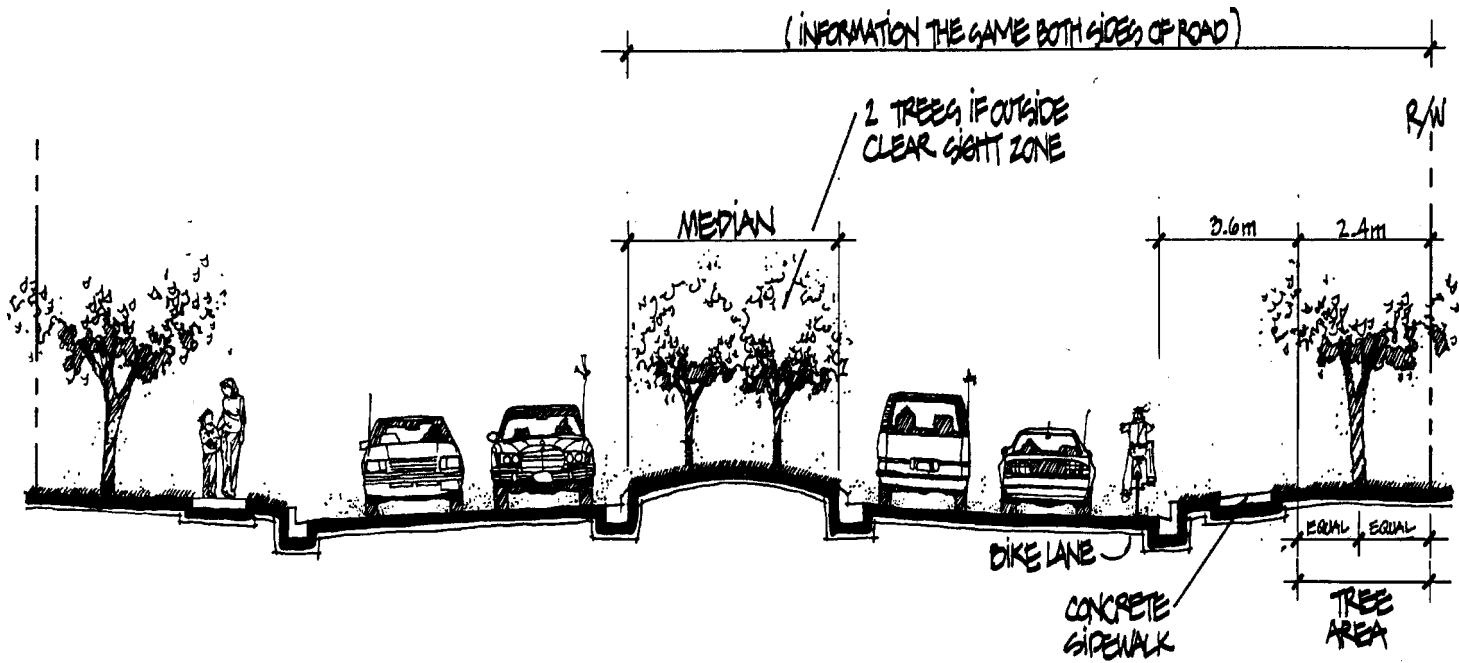


Figure 5

URBAN TYPICAL SECTION 4-LANE DIVIDED DESIGNED FOR ROADSIDE TREES

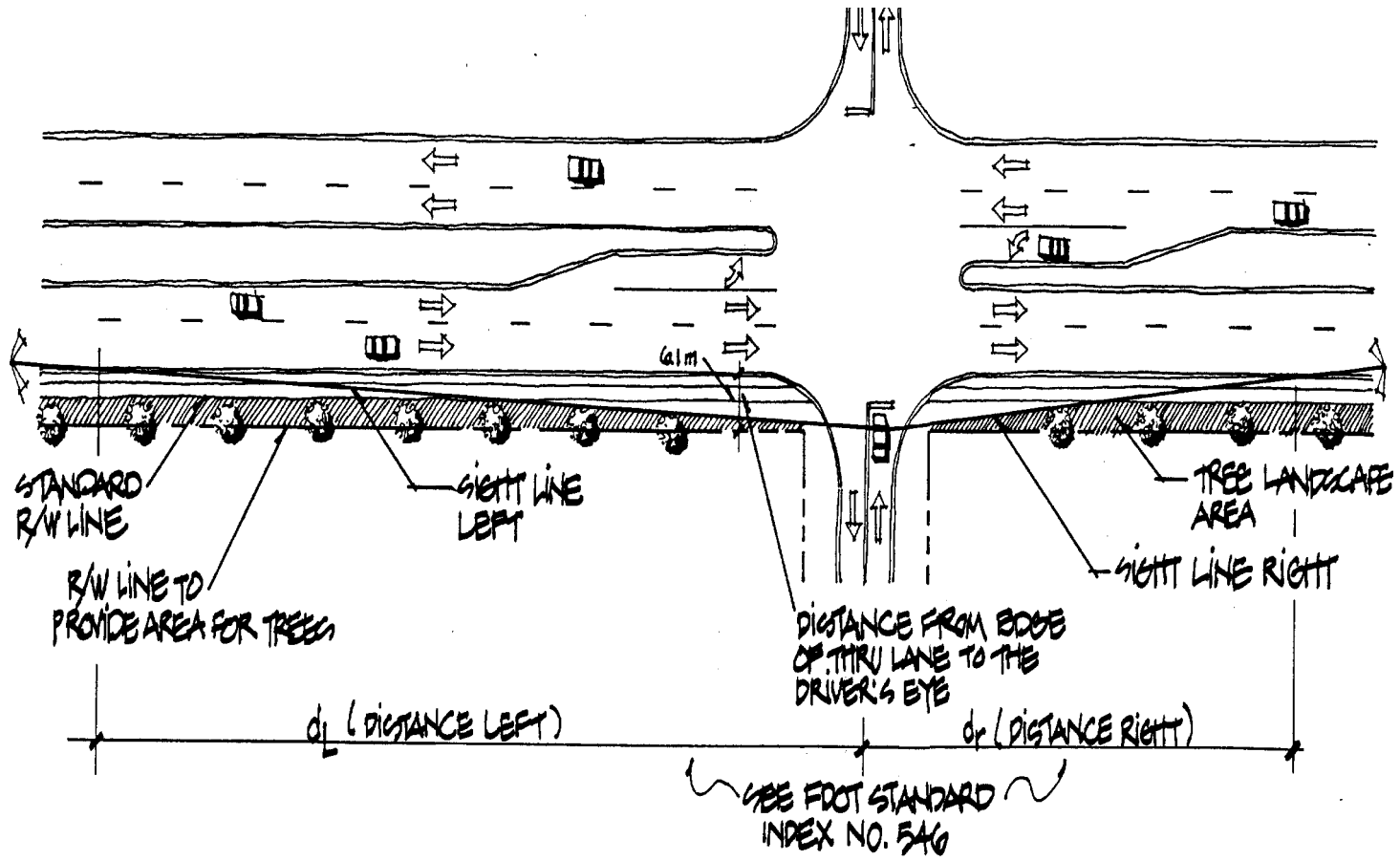


Figure 6

CLEAR SIGHT ZONES FOR R/W LANDSCAPING

The width of urban medians must meet FDOT's *Roadway Plans Preparation Manual*, Chapter 4. Curbed medians are only used on highways with a design speed of 80 km/hr or less. They should have a width of 4.7 m, or greater, from edge of through lane to edge of through lane before trees are placed within the median. The trees must be offset a minimum 1.8 m from the edge of the inside through lane to meet FDOT requirements. With this minimum offset requirement there is a 1.1 m strip available for trees in the center of a 4.7 m wide median for tree landscaping. Trees within the limits of clear-sight must satisfy the requirements of the FDOT.

Rural

Rural highways are designed for high speed traffic; curb and gutter designs are not used. The width of the horizontal clearance area for highways without curb and gutter is based on the design speed of the highway. Therefore, horizontal clearance requirements are wider and have a greater influence in rural areas. The standard typical sections for rural highways are not designed to accommodate trees within the right-of-way. Trees are limited to areas behind the guardrail constructed for other purposes or on the backside of ditch slopes that are greater than 3:1. Existing trees that are located outside the horizontal clearance area may be retained.

Grass should be used from the edge of pavement for the first 3.0 m. This provides an area for emergency use. Shrubs, ground cover, wildflowers and grass may be used for the remainder of the roadside areas. All plants used within the limits of clear-sight must satisfy the requirements of FDOT Standard Index No. 546.

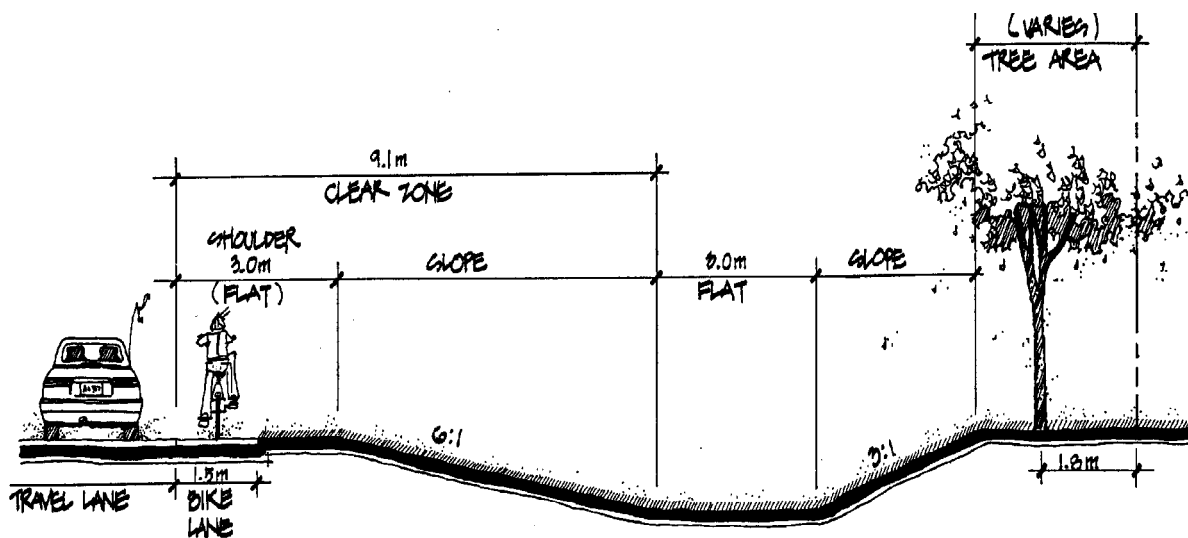
If trees are to be included within the right-of-way of a rural highway, the typical section must be designed to provide an area for them. The 9.1 m horizontal clearance requirements for highways with a design speed of 90 km/h would require a median width greater than 18.2 m to provide an area outside the horizontal clearance. Therefore, it is not normally practical to provide a typical section with sufficient median width to include trees in the landscape plan and satisfy horizontal clearance requirements.

When trees are installed along the outer roadside of rural highways, they must be outside the horizontal clearance area and on top of a raised berm, or natural ground, with 3:1 slopes. The 3:1 slopes will help redirect an errant vehicle that does not recover within the horizontal clearance area. See Figures 7 and 8 for examples of a rural typical section designed to provide an area for trees.

RIGHT-OF-WAY NEEDS

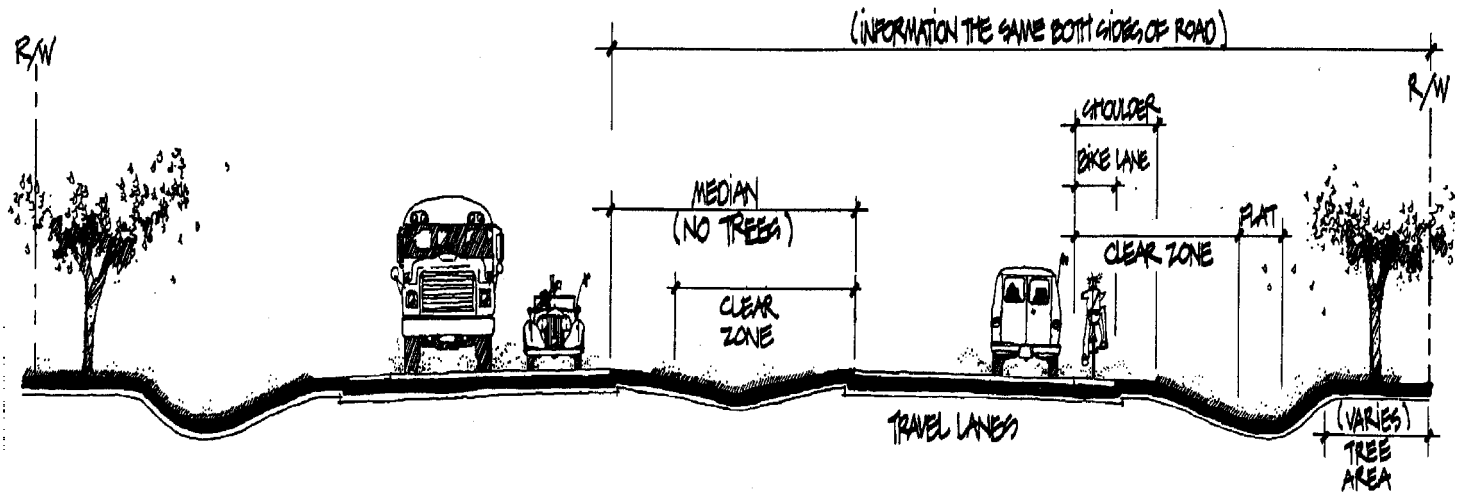
In the design of the typical section, all factors have to be considered. The cost of the right-of-way is a major factor for both developed and developing areas. Increasing the right-of-way needed for a highway, to provide landscaping or save existing landscaping, will increase the project cost substantially. The typical section must be designed for the transportation and safety needs of the highway over its design life. Highway aesthetics should be considered in development of the typical section design. Also, the type of environment that the highway travels through and public support for highway landscaping must be considered. A typical section that is economically feasible, meets both transportation and safety needs, and addresses the public's desire for highway beautification should be designed.

Figure 7



RURAL ROADSIDE SECTION
DESIGNED FOR ROADSIDE TREES

Figure 8



RURAL TYPICAL SECTION
4-LANE DIVIDED
DESIGNED FOR ROADSIDE TREES

ACCESS MANAGEMENT PLANS

The landscape plan for highways is dependent upon access management and highway design controls. In rural areas median openings and driveways are spaced well apart. However, pressure by property owners for median and driveway access has resulted in numerous median openings and driveway connections along most urban highways. When this occurs, it restricts or eliminates the possibility for significant landscape treatments.

As urban-fringe areas develop, the pressure for access continues. The FDOT and Agencies need to support each other to impede this trend. The enactment of FDOT, Rule Chapter 14-96, *State Highway System Connection Permits*, and FDOT, Rule Chapter 14-97, *Access Management Classification Systems and Standards*, is a step in this direction. By implementing the standards in these access management rules, the capacity and safety of Florida highways will be improved. An added benefit is that access management enhances the opportunity for landscaping highways.

All median openings are treated as intersections and the clear-sight requirements of FDOT Standard Index No. 546 must be satisfied at each opening. The intersection influence area is defined as the approach to the intersection from the point that the pavement begins transitioning for the development of turn lanes. There should be no plants with a trunk diameter greater than 100 mm located in the median within the intersection influence area.

The ability to landscape highways is enhanced as the spacing between median opening and between driveway connections increases. Figure 9 is a plan view of a typical urban highway. Figure 10 is a plan view of an urban highway with moderate access control (Class V) and Figure 11 an urban highway with an even greater degree of control (Class III). These figures demonstrate how access management affects the development of plans to improve the highway landscape.

An access management plan is developed for each major project during the PD&E phase. The requirements of FDOT, Rule Chapter 14-96, *State Highway System Connection Permits*, and FDOT, Rule Chapter 14-97, *Access Management Classification Systems and Standards*, are followed in the development of these plans.

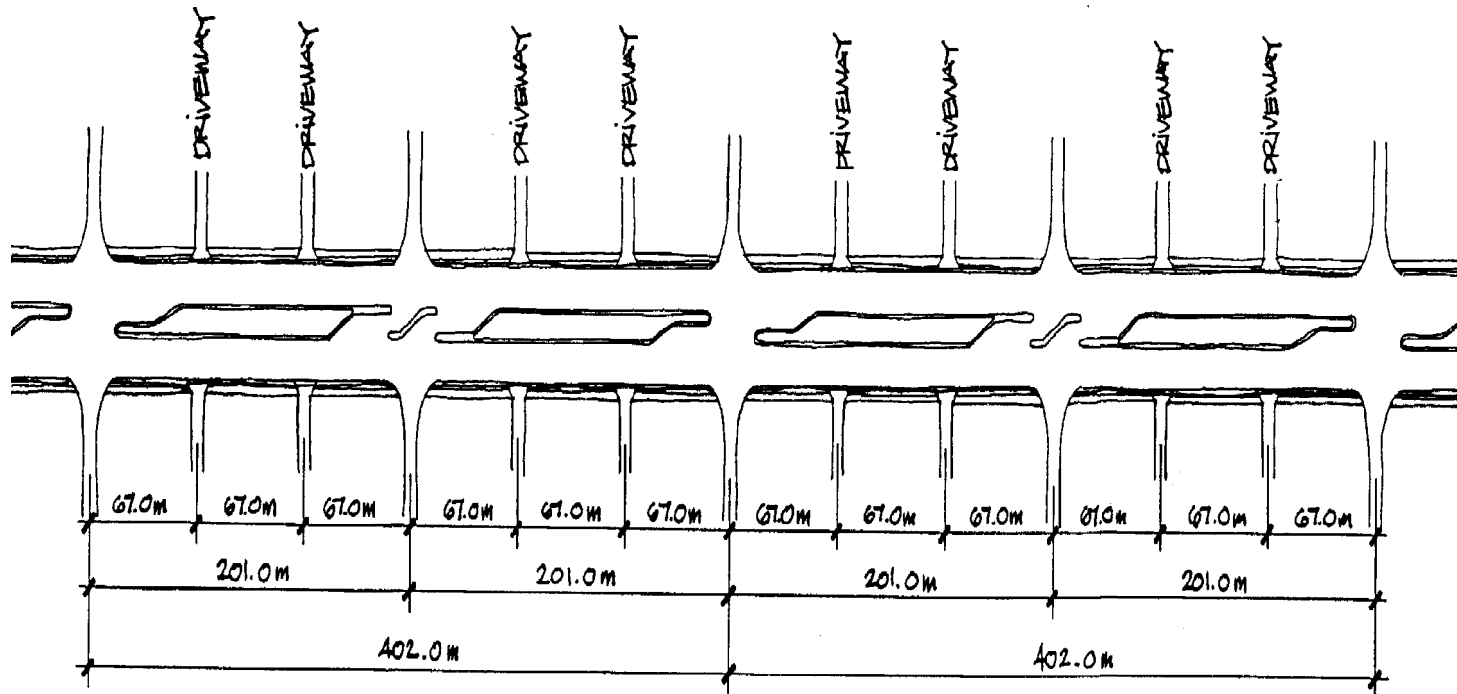
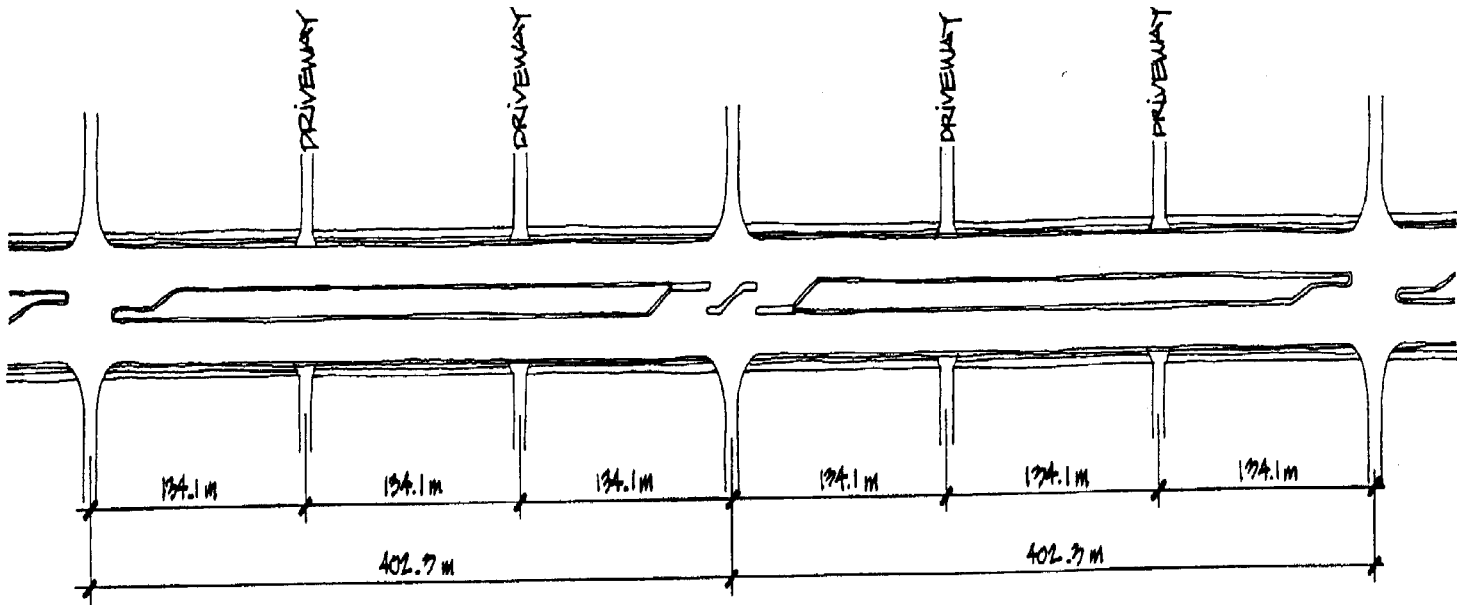


Figure 10

FULL MEDIAN OPENINGS SPACED AT 402.0m
 DIRECTIONAL MEDIAN OPENINGS SPACED AT 201.0m
 CONNECTIONS SPACED AT 67.0m

CLASS V ACCESS MANAGEMENT STANDARD



FULL MEDIAN OPENINGS SPACED AT 804.6 m
 DIRECTIONAL MEDIAN OPENINGS SPACED 402.7 m
 CONNECTIONS SPACED AT 134.1 m

CLASS III ACCESS MANAGEMENT STANDARD

Figure 11

Access management plans are developed for all 3R type projects during the Design phase. When landscaping is part of the project, the access management plan should consider landscape needs. As 3R projects are improvements to the existing highway system, it may not be possible to meet all the requirements of FDOT, Rule Chapter 14-96, *State Highway System Connection Permits* and FDOT, Rule Chapter 14-97, *Access Management Classification Systems and Standards*; however, this should be the goal.

The access management plan should be developed in cooperation with the appropriate local governments. The FDOT will work with Agencies in addressing access management and landscaping on highway projects.

When an Agency is considering a project to landscape a highway, it should review the access management along the highway. Will median access modifications be needed to provide median landscaping? How difficult will it be to sell and implement the modifications? If the modifications cannot be made, is landscaping feasible? These questions need to be answered before pursuing a landscape project on any existing highway. If access modifications are needed, the design should be included with the landscape design.

SPECIAL ATTENTION AREAS

Scenic Views

Chapter 15, Part 2, of the FDOT *Project Development and Environmental Guidelines*, discusses the importance of the visual qualities of roadway design.

The aesthetic quality of a community is composed of visual resources; that is, those physical features that make up the visible landscape including land, water, vegetation and man-made features, i.e., buildings, roadways and structures.

It is the intent of the FDOT to combine, where feasible, aesthetic design, art and architecture in highway and bridge design. The result of this design effort is to provide the road user and community road viewer with a transportation system that is pleasing to the senses, assimilates the qualities of a community's visual resources into its design, and makes the highway system compatible with the community at-large.

This concern over the visual character of the highway system mandates a sensitive review of the existing and proposed landscape features. If the visual environment encompasses significant visual elements or is unique due to the sensitivity of its affected viewers, then a visual analysis of the project is warranted.

Scenic Highways

The FDOT may, after consultation with other State Agencies and local governments, designate scenic highways on the State highway system. State and local highways designated as scenic highways are intended to preserve, maintain and protect a part of Florida's cultural, historical, natural, recreational, archeological and scenic values for vehicular, bicycle and pedestrian travel.

The FDOT may, by Florida Statutes, Chapter 335.093(1),(2), *Scenic Highway Designation*, adopt a rule with appropriate criteria for the designation of scenic highways, and specify appropriate planning and design standards including corridor management plans. The rule defines the process and establishes the criteria that local governments must follow when nominating public roads for scenic highway designation. The categories of scenic highway designations are: Specially Legislated Designated Highways, Locally Designated Scenic Highways, Florida Designated Scenic Highways, National Scenic Byways or All American Roads.

The designation of scenic highways by the FDOT is not intended to limit the commercial or industrial uses of the area adjacent to the highway, or to limit local governments' right to control land development within their jurisdiction.

Blighted Areas

New highway design projects are often routed through areas of least expensive real estate to allow for cost-effective highway construction. Rehabilitation of existing State roadways also often occur in blighted or declining areas. To make the driving experience as pleasant and safe as possible, FDOT encourages attempts to shield, screen or otherwise remove these blighted views from the driver's eye.

Buffering is often achieved with screen walls or berming but these features can, in themselves, be cold and visually unattractive. Another solution which is increasingly utilized, is buffering with

vegetation. For screening purposes, a soft, green edge is far more pleasant to the driver's eye and general highway aesthetics than a concrete wall. There are many opportunities for buffering of objectionable views, but they must be planned early to allow for enough right-of-way to accommodate proper design. Blighted areas should be identified and cataloged in the PD&E phase to best resolve visual problems.

IDENTIFICATION OF PLANT PRESERVATION AREAS

The development of highway beautification projects must include identification and assessment of existing natural elements. Rare and endangered species should be located and cataloged for preservation. Significant, mature hardwood trees and/or wetland species should be preserved wherever possible while accommodating highway design. **Retention of existing natural plant stands is recommended; where this is not possible the re-establishment of similar systems is encouraged.** Provision for protection and relocation of significant plant materials to holding areas may be considered in the preliminary design phase of the project.

Several aggressive plant materials, such as Australian pine, Punk trees and Brazilian pepper, among others, have been introduced to Florida. These species invade native plant communities, alter the visual landscape and disturb ecological communities. These plants also create extensive maintenance problems. Should these species exist on a site, they shall be removed according to proper removal procedure for each species.

Native Plants and Threatened Species

Existing Plant Materials and Natural Systems. Whenever possible, natural systems and natural vegetation should be protected and incorporated into the highway project. Identification of existing vegetation should be included as part of the PD&E phase of project development. Existing vegetation should be identified for all types of projects from beautification projects to new construction and reconstruction.

- Conduct a natural features analysis which will identify significant natural conditions and individual trees.
- On large projects, a natural features analysis may be prepared using black and white or false color-infrared photography. Wetlands, forested areas and other features can be identified and then field checked. Large scale photos may be used

to locate individual or clusters of large trees on smaller projects as well. Other resources such as United States Geological Survey quad sheets, local natural area surveys and records of the Florida Natural Areas Inventory (FNAI) can be useful in conducting a preliminary assessment.

- *The Guide to the Natural Communities of Florida*, published by the Florida Natural Areas Inventory, is useful in identifying and categorizing natural communities.
- Local comprehensive plans and ordinances should be consulted to identify natural features which have been identified as being of local significance. These may include protected natural systems as well as tree types and sizes protected under local ordinances. These features can then be added to the analysis.
- The location of endangered species may have been identified at the local level. The FNAI records the occurrence and location of reported listed species. Biology departments at area universities may also be a source of useful information regarding local natural systems.
- Once natural features have been located, alternative alignments or designs for improvements may be considered. In cases where realignments or redesign are not possible, local regulations may outline procedures by which permits or variances must be obtained.
- The best way to preserve natural features is to avoid impact to them. In some cases, a system may not be impacted by construction activity but may suffer secondary impact as a result of a highway project. Fragmentation of wetlands and other systems, as well as wildlife corridors, should be investigated. Increasing the duration of stormwater input into some wetlands may be detrimental. Increasing sunlight into forested areas or reducing sunlight as a result of a highway project may also impact natural systems. Impact assessment should be undertaken by biologists, aquatic ecologists and other qualified professionals.

Recreating of Wetland and Upland Systems. Recreating wetland and other types of natural systems to compensate for damage done to existing systems is a difficult task. Many of these efforts fail due to poor analysis and lack of proper professional input and monitoring. In some cases, degraded systems may be successfully restored through proper design and management. Such efforts must be reviewed by biologists and other qualified professionals before being considered.

Individual Trees and Vegetation.

- When considering proposed alignments or impacts from highway improvements, a tree and vegetation survey should be conducted. Sometimes a preliminary assessment can be done using large scale aerial photos. Clusters of trees can be identified and then inspected on the site. In other cases, a preliminary ground survey is more efficient and can identify quality trees and vegetation prior to a detailed survey being conducted.
- Large and small trees which may benefit the highway project in the future should be identified and located on a preliminary plan.
- The impact of removing trees and vegetation which enhance neighborhoods and provide buffer vegetation, including canopy trees, exceptional specimens and other significant vegetation, should be noted in the inventory process. Such information may be of value to the landscape architect when designing the highway landscape.
- Include a preliminary assessment of tree conditions as part of a tree survey. Obviously, trees of poor quality and vegetation which includes intrusive exotic species cannot be considered for preservation and should be noted on the preliminary plan.

While existing trees can be relocated, it is preferable to leave existing tree stands in place whenever possible. Most tree relocation techniques are expensive and the loss of trees can be significant. This is especially true of hardwood trees, which are slow growing and more expensive to transplant. Sabal palms can be relocated economically to their final location; however, it is not economically feasible to transplant them to a holding area for final planting later. When sabal palm stands are encountered, it may be more efficient to accommodate them in their natural location within the highway design.

Florida's native wild plants are protected under Florida Statutes, Chapter 581.185, *Plant Protection Law*. Under this law both the preservation and propagation of native species are encouraged. It is against the law to destroy, injure, harvest, collect or remove any plants covered by the law without permission of the landowner. Florida Statutes, Chapter 370.041, *Harvesting of Sea Oats and Sea Grapes Prohibited*, prohibits the digging or removal of sea oats or sea grapes, along coastal systems. Florida Statutes, Chapter 337.405, *Trees or Other Vegetation within Rights-of-way of State Highway System; Removal or Damage; Penalty*, prohibits the damage or

removal of trees and other landscape features within right-of-way of the State-maintained highway system. Penalties can be levied under these laws.

UTILITIES

In the PD&E stage of project development, conflicts between utilities and landscaping should be anticipated to the greatest extent possible. Utility relocation plans especially should be reviewed to identify conflicts which may be created in the course of relocation.

Obtaining easements for relocating utilities behind tree planting areas, guying easements and other easements also needs to be considered in the early stages of PD&E.

Utilities are permitted to use the right-of-way of State highways. The utility facilities occupy the same roadside area of the right-of-way that is used for highway landscaping. It is essential to maintain close coordination with the utility companies when developing the plans.

The best overall plan for highway landscaping would be to locate all utilities underground. However, this is not possible, or economically feasible, along existing highways with established aboveground utilities. In these cases, the landscape plan must be designed around the existing utilities. The landscape plan must provide the utility companies access to their facilities and enable their maintenance. Location and selection of trees that are to be installed within the vicinity of aboveground utilities should be carefully considered. Trees must be maintained to keep limbs and branches clear of utility lines. Therefore, trees should be selected and located where severe trimming is not required to maintain clearance from utility lines.

Planting trees in areas with overhead utilities requires working closely with the utility companies to develop mutually agreeable solutions to tree/utility conflicts. Utilities can zig-zag down the road to avoid conflicts with trees, but close coordination is necessary. Cooperation and mutual understanding is the key to finding solutions to utility-landscape conflicts.

The conceptual plan for the overall aesthetic treatment of a highway improvement project is developed during the PD&E phase. This includes the overall plan for coordination of utilities and landscape design within the typical section. The local government comprehensive plan should be reviewed to determine if it has any specific requirements for the location of utilities along the

corridor. The utility companies along the corridor should be contacted for their input. When aesthetic treatment is considered a major concern, the plan should generally require the utilities be located underground.

PUBLIC INVOLVEMENT

Project Commitment

In the early stages of project development, the Agency should be contacted to determine its interest, support and commitment to highway landscaping. What support will it provide in plan development and implementation cost? Is it willing to maintain the landscaping after installation? These are critical questions and should be answered early in the process. The FDOT, generally, will not include landscaping in a project unless the Agency agrees to maintain it. Therefore, these questions have to be answered before any commitments are made or any work effort expended.

The following factors must be considered and agreed upon when it is decided to enhance a highway aesthetics with landscaping.

- Will the landscaping be included in the FDOT highway project or will it be accomplished with a separate landscaping project?
- If the landscaping is not a part of the highway project, how will the design of the highway and landscaping be coordinated?
- Who will be responsible for preparing the landscape plans?
- Who will be responsible for the construction cost of landscaping?
 - City-State joint participation.
 - 100 percent City.
 - 100 percent State.
 - State and Federal.
 - Approved authorities.
 - Approved established organizations.
 - Approved adjoining development.
 - Others as approved.

The landscaping of a highway is a joint effort between the FDOT and other Agencies. Close coordination and communication are needed throughout the life of a landscape project. This requires a strong commitment by both the FDOT and the Agency.

Agency Coordination

The FDOT and the Agency should reach consensus on the overall concept of a landscape project before initiating the public involvement phase. The public should see the project as a unified effort, and it should be presented as a team design. It is, thus, highly desirable to have representatives of the Agency staff participate in the public involvement phase of the project.

Presentation and Approval

A landscape task team should be formed for each highway landscape project. The team should consist of the landscape architect and representatives from engineering, planning, fire, police and public information departments of the Agencies, and the landscape coordinator, safety engineer and utility coordinator from the FDOT. The task team should review the highway to determine the overall landscape theme, potential problem areas and highway design revisions that will be needed to accommodate the landscape plan. This review should be conducted before starting plan preparations. A resolution from the Agency supporting landscaping of the highway, and agreeing to maintain the landscaping, should also be on file before beginning preparation of the landscape plans.

Workshops

Workshops should be held with groups that have a special interest in the project. Such special interest groups might include businesses along the route, the chamber of commerce, neighborhood groups, garden clubs and environmental groups. (The Agency task team would be an excellent source for establishing these local contacts and should also participate in the workshop sessions.) These sessions would provide a means for the interest groups to have informal input, as well as provide the FDOT and local staff a means for selling their plan prior to the formal public hearings.

Public Hearings

When workshop sessions are completed and general consensus reached on the design, formal public hearing(s) should be held. Again, it is highly desirable to have the Agency participate as a partner with the FDOT at the hearing(s).

CONCEPTUAL LANDSCAPE PLAN

Preparation of a landscape concept should take place in this phase of the planning process. These plans should illustrate preliminary ideas concerning the project's highway landscape development. The landscape concept should contain references to the following project elements:

- General locations of native or endangered plant species.
- Planning options for the retention of desirable existing conditions.
- Depict locations for selective clearing.
- Show general locations of landscape improvements.
- Develop preliminary list of proposed plant species to be incorporated.
- Notation of any potential conflicts between highway design and the proposed landscape.
- Show opportunities for screening of blighted areas and objectionable views.
- Overall access management plan.
- Identify special attention areas such as scenic views or blighted conditions.
- Review of access management opportunities.
- Any special treatment required for mitigation, preservation or relocation of any natural systems or existing conditions.

Section 4
DESIGN PHASE

The following will be accomplished during this phase:

- Prepare highway landscape plans that are in compliance with FDOT standards and criteria.
- Consider needs of other transportation users.
- Prepare landscape design for retention/detention areas.
- Prepare traffic control plans.
- Select plant material for highway landscape plan - trees, shrubs, grass, ground cover and wildflowers.
- Identify noxious plants for removal.
- Prepare irrigation system design (if required).

HIGHWAY DESIGN STANDARDS

The first consideration of any highway improvement plan must be safety. AASHTO has adopted design policies to provide safe and efficient highway designs. These have been adopted by the State of Florida for use on all streets and highways within the State. The FDOT design policies, procedures and guidelines are developed around the AASHTO design policies. These Federal and State design policies, procedures and guidelines must be followed in the development of highway landscape plans. (See Section 7, *REFERENCES*, of this manual for the reference listing.)

The Florida Highway Landscape Guide should be used in the design of highway landscape projects to coordinate the application of approved highway design standards in the development of highway landscape plans. Its goal is the design of safe, aesthetically pleasing highways that emphasize a "view of and from the road". Also, the FDOT *Roadway Plans Preparation Manual* and FDOT, Rule Chapter 14-40, *Highway Landscape Improvements*, must be followed in the development of highway landscape plans.

The services of a Registered (Florida) Landscape Architect shall be required as follows. In conformance with Florida Statutes, Chapter 481.329(7), *Exceptions; Exemptions from Licensure*, "Persons who perform landscape architectural services not for compensation, or in their capacity as employees of municipal or County governments, shall not be required to be licensed pursuant to this part. However, persons who are hired under the title "landscape architect", by any State, County, municipality, or other governmental unit of this State after June 30, 1988 shall be required to be licensed pursuant to this part. Nothing therein shall preclude a County or municipal employee from performing the functions of this part for his governmental employee under a different title".

The FDOT and the government Agency will need to work together in the design phase of the project. The goal is an economical and feasible plan that meets safety guidelines and provides an aesthetically pleasing highway. To achieve this overall goal, each Agency needs to understand the other's specific concerns and objectives. There must be a willingness to discuss and reach consensus on issues.

Horizontal Clearance

The horizontal clearance requirements of FDOT design policies, procedures and standards must be followed in the development of plans for landscape improvements. The standard typical section for new urban highways provides a width of 3.6 m from the edge of the through lane to the right-of-way line. This is not enough width to allow the use of trees. Smaller alternate plants, ground cover and grasses may be used in these areas, or the typical section modified to provide a wider roadside area. Typical sections designed to provide an area for trees along the roadside of urban highways are discussed in Section 3, *PROJECT DEVELOPMENT AND ENVIRONMENTAL PHASE (PD&E)*. The typical curb and gutter urban median has adequate width to include trees in the median landscape plan.

The standard typical section for new divided, rural highways provides a minimum width of 17.0 m from the edge of the through lane to the right-of-way line. The horizontal clearance for high speed rural highways is 9.1 m from the edge of the through lane. This provides 7.9 m outside the horizontal clearance limits. Existing trees that are beyond the 9.1 m horizontal clearance limits may be retained. However, new trees are not normally installed within rural areas that are otherwise clear of fixed objects unless a special design is used to redirect errant vehicles. Therefore, standard typical sections for rural highways are not designed for the installation of new trees.

When the installation of trees and large trunk shrubs is an important part of plans to improve the landscape of rural highways, the typical section should be designed to accommodate them. This is discussed in Section 3, *PROJECT DEVELOPMENT AND ENVIRONMENTAL PHASE (PD&E)*. When the landscape plan includes the installation of trees along the roadside of rural highways, careful attention should be given to areas where there is a high probability of drivers running off the roadway. An example is a horizontal curve at the end of a long tangent section. These areas should be identified, and careful consideration given to them, during the landscape design.

The standard rural typical section provides a minimum median width of 12.0 m. The 9.1 m horizontal clearances for the roadways overlap on most rural medians. Therefore, the landscape plan for rural medians will not normally include landscaping with trees and large trunk shrubs.

When barrier walls or other rigid safety design features are used to redirect errant vehicles, trees and large trunk plants may be planted a minimum distance of 1.2 m behind them. When a guardrail is used, trees and large trunk plants may be planted a minimum distance of 1.5 m behind the face of the guardrail. These distances are measured from the center of the trunk to the safety feature, and not from the tree limbs. These safety design features are used to protect the motorist from other hazards. Barriers are considered a hazard themselves and are only used to protect the motorist from a greater hazard. They should not be used for the primary purpose of allowing trees within the horizontal clearance area. FDOT criteria and standards address back of guardrail landscape applications. See Figure 12.

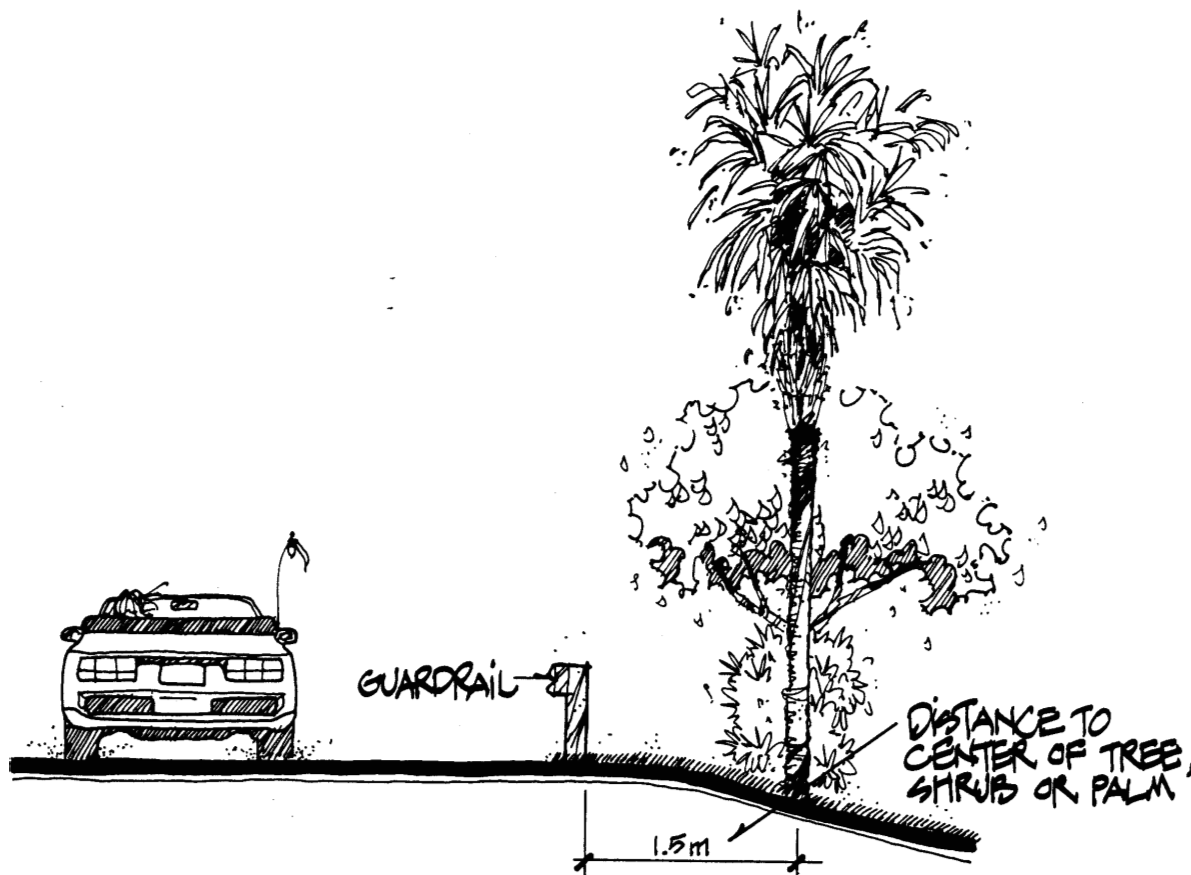
Corner islands at intersections should be kept clear of trees and large trunk shrubs. Planters and other aboveground decorative items that are constructed of rigid materials like bricks, blocks, rocks, wood, etc., shall not be installed within corner islands or medians. These materials may be used at special emphasis points and focal areas along the roadside but must always meet horizontal clearance criteria.

Drainage

The clear zone areas must be traversable in the event an out-of-control vehicle leaves the pavement. Ground levels should not be altered in such a way that the changes will have an impact on the clear-sight windows or constitute a hazard. Standard median and shoulder slopes should be maintained throughout the landscape project. Any changes to existing grades, elevations, or cross-slopes must be shown on the plans and explained in detail. Inward median slopes should be considered for water retention. The District roadway design engineer should be consulted about any proposed design changes.

If the landscape design includes any changes in the highway drainage system, a written drainage assessment report must be prepared. The report should document and explain the changes. The report should show all existing and proposed site conditions and include run-off calculations.

Figure 12



SETBACK FROM GUARDRAIL

Any changes to drainage flow, drainage retention, drainage detention, revisions to cross-section, elevations and curb types must be included in the drainage assessment report. The landscape design must not block or restrict the flow of any drainage structure nor access to the structure. All drainage structures, existing and proposed, within the area of the proposed landscape improvements must be shown on the plans. The District drainage engineer must review and approve the drainage assessment report. If the landscape design does not affect drainage, a statement to this effect can be included in the letter of submittal. In this case, a drainage assessment report is not required.

Intersection Clear-sight

The landscape design must comply with the requirements of FDOT criteria and standards. In the development of landscape plans all intersecting streets must meet the clear-sight requirements of FDOT criteria and standards. On divided highways, all driveway connections at median openings are to be treated as intersections.

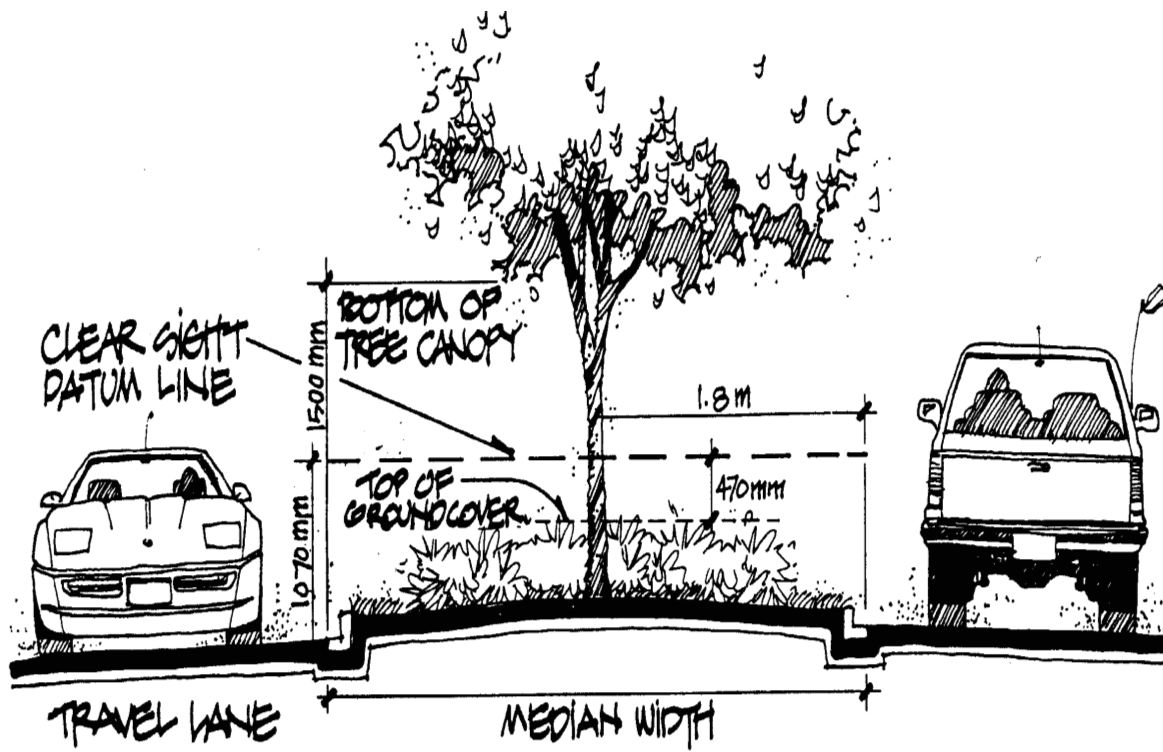
The sight datum line for clear-sight windows is established from the point of the driver's eye on the side street to the point of the driver's eye on the main highway. The design location for the end of the datum line on the side street is 1,070 mm above the pavement at the driver's stop location 6.1 m from the through lane. The design location for the end of the datum line on the main highway is 1,070 mm above the pavement at the point being checked. A clear-sight window must be maintained 1,500 mm above and 470 mm below the sight datum line. The drivers stopped on the side street and the drivers on the main highway approaching the intersection need clear-sight windows to see each other. See Figure 13.

The trunks of trees within the limits of clear-sight on the main highways, and the combination of tree trunks and shrubs, should not block more than 50 percent of a driver's view of a passenger car stopped on the side street. The trees should be spaced to provide the driver on the main highway a view of at least 66.6 percent of a passenger car stopped on the side street.

Vertical curves and grades can have an impact on the clear-sight window. The bottom branches of trees may have to be raised and maximum height of shrubs may have to be lowered when vertical curves or grades are within the clear-sight limits. The clear-sight window of 1,500 mm above and 470 mm below the sight datum line must be maintained. See Figures 14 and 15.

When the roadways of a divided highway are at different elevations, the clear-sight window must be designed to provide a clear-sight window for both roadways.

Figure 13



CLEAR SIGHT WINDOW

Figure 14



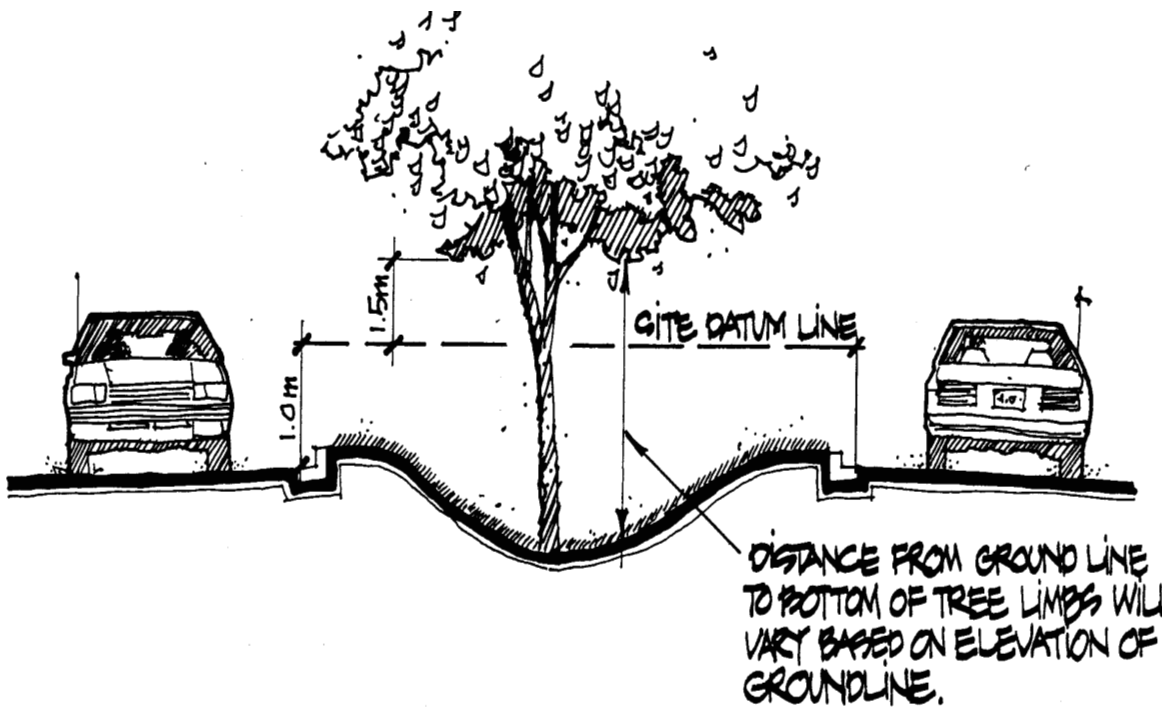
Figure 15



The maximum height of shrubs and minimum height of lower tree branches is based on the sight datum line. All measurements relating to the clear-sight window must be made from the sight datum line. See Figures 16 and 17.

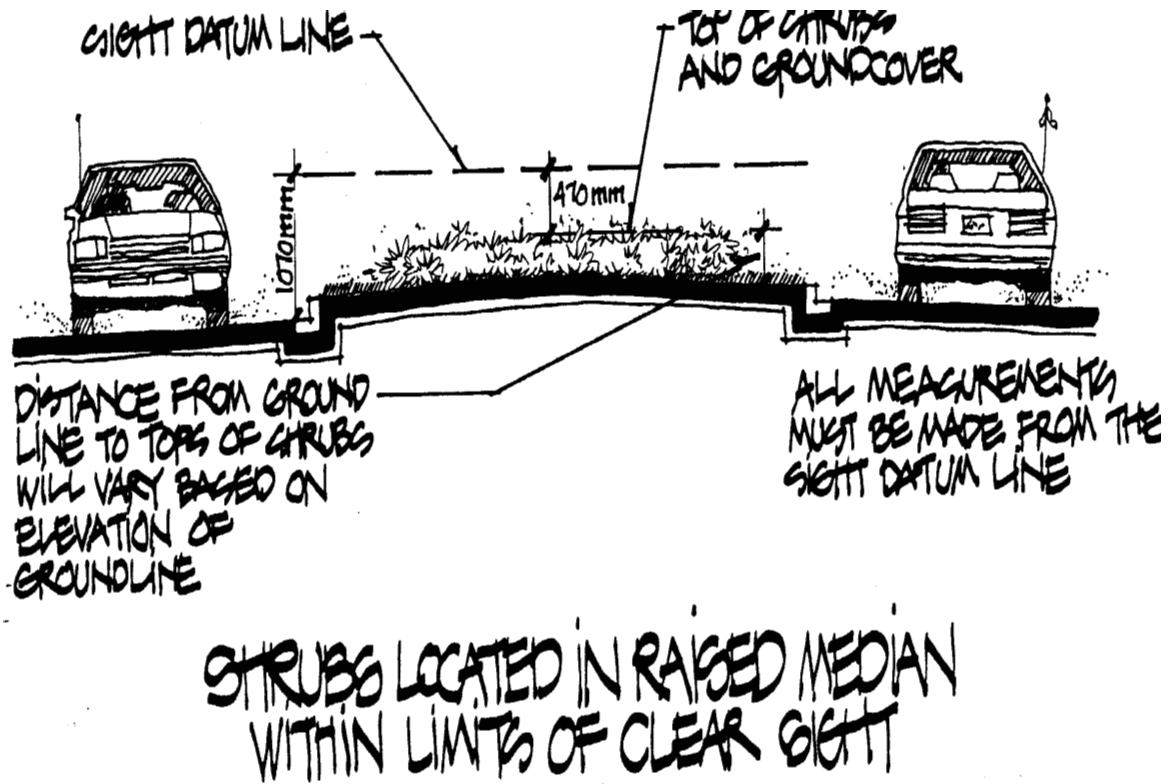
When developing a landscape plan that includes the planting of trees within an urban median, the intersection influence area must be considered. The intersection influence area includes the approaches to the intersection through the limits of its turn lanes and tapers. Trees should not be located in the median within the intersection influence area.

Figure 16



TREE LOCATED IN SWALE MEDIAN
WITHIN LIMITS OF CLEAR SIGHT

Figure 17



The driver on the cross-street will use one of two approaches when crossing a divided highway. When traffic volumes are light, the driver will select a gap between traffic from both approaches on the main highway and cross the highway in one step. However, when the traffic volumes increase, gaps of sufficient length for a safe crossing may not be available between traffic from both approaches. In this case, the driver will select a gap in the traffic approaching from the left, cross to the median, stop, and then select a gap in the traffic approaching from the right to complete the crossing. Therefore, clear-sight windows are needed at the driver's stopped position on the cross-street and at the driver's stopped position within the median.

The design and maintenance of the clear-sight windows within the limits of clear-sight for intersections are important. In selecting plants for installation within the limits of clear-sight for intersections, the designer must consider the manpower requirements to maintain the plants to meet the clear-sight window criteria. If only limited manpower will be available for maintenance of the landscaping, then shrubs and flowers should be restricted to those that will not exceed the maximum height or can be maintained below the maximum height with the projected manpower. Shrubs that are not maintained at or below their maximum height control can result in a continuous sight blockage.

All existing median openings should be reviewed in the development of the landscape plans. The access classification of the highway should be used in this review. The closure of median openings to comply with the highway access classification should be considered. Any median opening that does not presently serve a driveway or street should be a prime candidate for closure. The clear-sight window must be provided for all remaining full-access median openings, even if there are no streets or driveway connections at the openings. This is necessary as median openings are prime locations for future driveway connections. At median openings with directional left turns, the left turn clear-sight window must be provided (FDOT Standard Index No. 546).

Traffic Control Devices

The driver traveling along the highway needs a clear view of highway signs and traffic signals. The placement and visibility of traffic control devices are based on the Federal Highway Administration's *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD). A traffic

engineer, or person responsible for traffic control, should review all highway landscape plans to assure that the visibility of traffic control devices complies with the MUTCD.

At signalized intersections, the traffic signal assigns the right-of-way; however, the need for intersection sight distance remains. A traffic signal may malfunction, protected phases (green arrows) may not be provided for left turns, right turns on red may be allowed or the traffic signal may be operated in a flashing mode during low volume hours. When these conditions exist, intersection sight distances are needed. A variance to the intersection sight distance requirements may be considered when the traffic signal provides protected right-of-way for all movements and right turns on red are prohibited. The report requesting a variance must document that a variance will not endanger public safety and must be signed and sealed by a professional engineer. See the *Roadway Plans Preparation Manual*, Chapter 23, for examples of letters of request for variance approval.

Pedestrians

The safety and comfort of pedestrians must be considered in the development of landscape plans. A safe, comfortable and aesthetically pleasing environment can make walking a more desirable means of transportation. Drivers on the roadway, and pedestrians walking along the sidewalks or crossing the roadway, need a clear view of each other. It is necessary for the driver to be able to see and react to pedestrians entering the roadway and for pedestrians to be able to make a safe crossing. Clear-sight windows must be provided for all pedestrian crossings.

A landscape, with trees along the roadside that shade the sidewalks, provides a comfortable and pleasant walking environment. However, to provide the necessary horizontal clearance and clear-sight areas the trees should be between the sidewalk and right-of-way line. In urban areas, this will normally require additional rights-of-way. See Section 3, *PROJECT DEVELOPMENT AND ENVIRONMENTAL PHASE (PD&E)*, "Typical Sections for Landscaping".

The design should maintain all sidewalks and pedestrian crossing areas free of obstruction. Sidewalks should be maintained free of all growth. The bottom limbs of trees overhanging the sidewalk should be at least 3.0 m above the sidewalk.

Needs of Persons with Disabilities

The needs of persons with disabilities must be considered in the development of landscape plans. Special considerations are required to allow them to safely use the highway facilities. It is critical that clear-sight windows be maintained to allow the drivers to see them enter the roadway. Sight problems, reaction times and crossing speeds of disabled users makes this essential. Accessibility to features like pedestrian push-buttons and handicap ramps must be maintained. There should be no obstruction to prevent persons with disabilities from using the highway facilities. All landscape improvements must comply with the standards of the *Americans with Disabilities Act of 1990*.

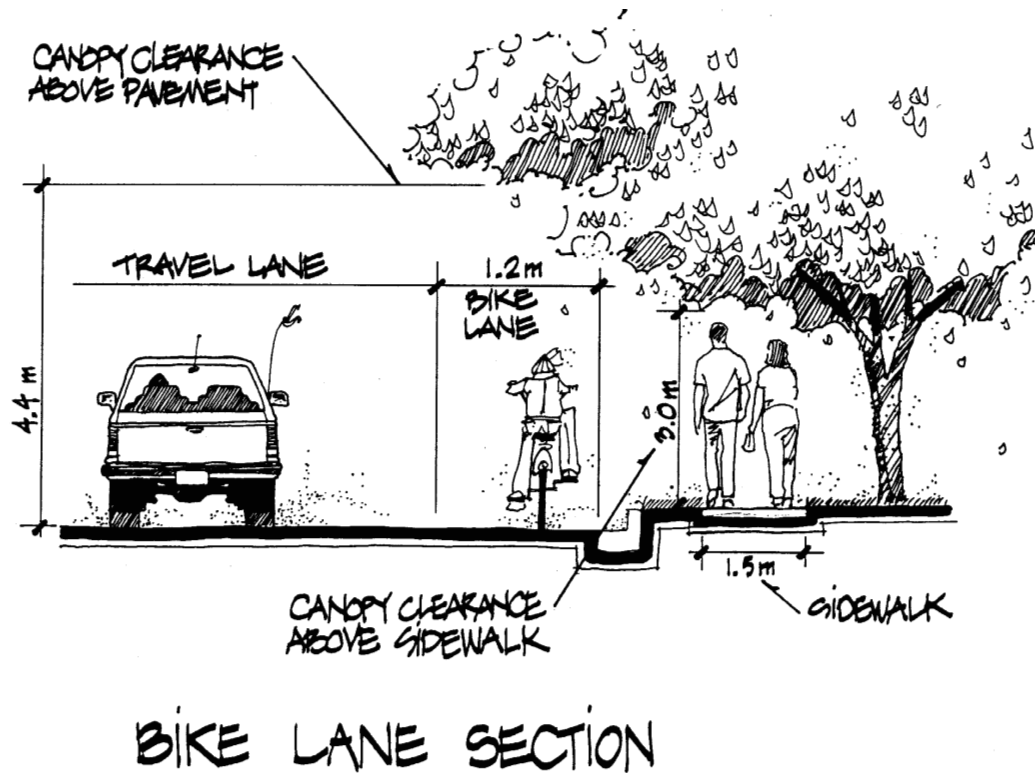
Bicycles

When developing landscape plans, the designer needs to consider the needs of the cyclist. This should include the elderly and younger inexperienced cyclist who use the sidewalks, and the more experienced cyclist who uses the roadway. When the sidewalk and the landscape is properly designed for safe use by all pedestrians, it will provide a safe facility for the older and inexperienced cyclist. Designated and undesignated bike lanes should be maintained free of all growth and debris. Clear-sight windows should be provided for all locations where cyclists cross the roadway. If possible, shaded areas should be provided for bike paths and lanes. When tree limbs extend over separate bike paths, they should be at least 3.0 m above the bike path. When they extend over designated or undesignated bike lanes within the roadway, they must be at least 4.4 m above the pavement. See Figure 18.

Public Transportation

Safe and comfortable bus stops and shelters may increase the use of public transportation. The location of all bus stops and shelters should be identified on landscape plans. The area around the benches and shelters may be landscaped with trees to provide shade. However, the benches and shelters along with the trees must be located outside the horizontal clearance limits. Clear-sight windows should be checked for all locations within the limits of intersection sight distance. If horizontal clearance and/or clear-sight requirements can not be satisfied within the existing right-of-way, management of the transit system should be contacted to see if other arrangements are possible.

Figure 18



Lighting

Highway Lighting. Night visibility should be considered. Highway lighting is designed to provide uniform distribution of lighting. The highway landscape design should be coordinated with the highway lighting design to assure that the landscaping does not interfere with uniform distribution of light.

Landscape Lighting. Opportunities to provide lighting to accentuate roadway and/or median landscaping may present themselves. This type of lighting should be used sparingly and should create a soft, uniform flood light effect. The following issues should be reviewed and resolved prior to installation of any accent lighting within the FDOT right-of-way:

- Provide a layout of where lighting is to be located along with fixture type, wattage, method of switching on/off and electrical source.
- Review existing sources of light for conflicts, glare, hot spots, etc.

- Ensure the lighting is absolutely safe for pedestrians and vehicles.

When landscape accent lighting is used along a highway that has roadway lighting, it should be designed to compliment the roadway lighting. Accent lighting shall not be directed towards the driver and should be designed to avoid bright spots of light in the driver's vision.

Utilities

The specific location of utilities must comply with FDOT's Standard Index No. 700 and the *Utility Accommodation Manual* (Document No. 710-020-001).

Public safety must be the first consideration in any plan for changes to a highway. This includes the location of utilities and their relationship to highway landscaping. Both utilities and highway landscaping must meet the horizontal clearance requirements of the FDOT criteria and standards. The clear-sight window must be maintained within the limits of intersection sight distance. In designing the clear-sight windows, all sight blockage must be considered. This includes utility poles within the limits of intersection sight distance. The spacing of trees in the landscape plan will have to be coordinated with the spacing of utility poles to assure that the clear-sight window is maintained.

The landscape plan must show all existing utilities aboveground and belowground that may be impacted by the landscape project. The landscape improvements cannot interfere with the safe installation, function or maintenance of existing and proposed utilities (aboveground or belowground). The landscape plan must assure that the landscape improvements can be installed safely without harm to persons or existing utilities. The requestor for a landscape permit must notify all utility companies that have utilities within the limits of the landscape project about the project. A notification form should be obtained from the FDOT and used for this purpose. The applicant should obtain letters of no objections from the affected utilities. When highway beautification is an important element of a major highway improvement project, consideration should be given to locating all utilities underground.

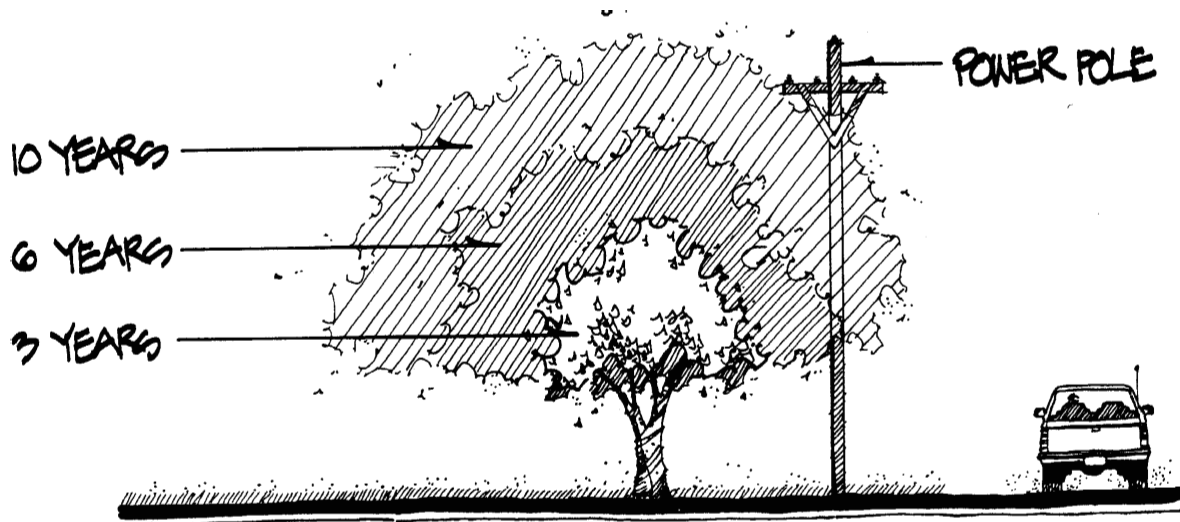
Likewise, the safety of maintenance workers must be considered in the coordination of highway landscape and utility location plans. Trees within the vicinity of overhead utility lines should be located to provide safety for the maintenance of both. Underground utilities must be at least 0.8 m

below the ground level, and trees and shrubs must be located where they can be installed and maintained without endangering the workers or damaging the underground utility.

Planting trees in areas with overhead utilities requires working closely with the utility companies to develop mutually agreeable solutions to tree and utility conflicts. Cooperation and mutual understanding is the key to finding solutions to utility-landscape conflicts. Some suggestions for avoiding utility-landscape conflicts include: (see Figure 19)

- In no case should large growing trees be allowed to be planted under utility lines without first consulting the utility. All landscape plans should include overhead utility locations.
- Specify small growing trees, large growing shrubs, or trees which can be easily pruned back without much damage for planting under utility lines. Using small growing trees will help the utility company reduce their maintenance costs and avoid a "butchered" looking landscape. In some areas where aesthetics is a very important element, such as downtowns, historic districts, some residential areas, etc., ask the utility company to prune trees on a more frequent schedule. This allows trees tolerant of pruning, such as chinese elms, to be planted. Sometimes larger trees may be grown around utility lines if pruning is more frequent.
- Develop a partnership with the utility providers. The utility may assist in planting smaller trees and assume maintenance in consideration of not having to contend with large trees. Consider system redesign or relocation. In areas of very high aesthetic value, ask the utility to zig-zag their line from one side of a roadway to the other. This creates "planting pockets" along both sides of the highway where large trees may be planted and not interfere with utilities. This option is best used where overhead lines are small and not visually intrusive. Guying easements may have to be obtained to support poles.
- Changing the configuration of utility lines may also be an option. In some cases, changing from a cross arm configuration to a more compact configuration reduces the area of conflict between trees and utility lines.
- In other cases, simply installing larger poles may allow enough room to plant larger trees under utility lines. The utility company design engineer may have suggestions on other ways of reconfiguring to reduce conflict.

Figure 19



PLANTING NEAR POWER LINES

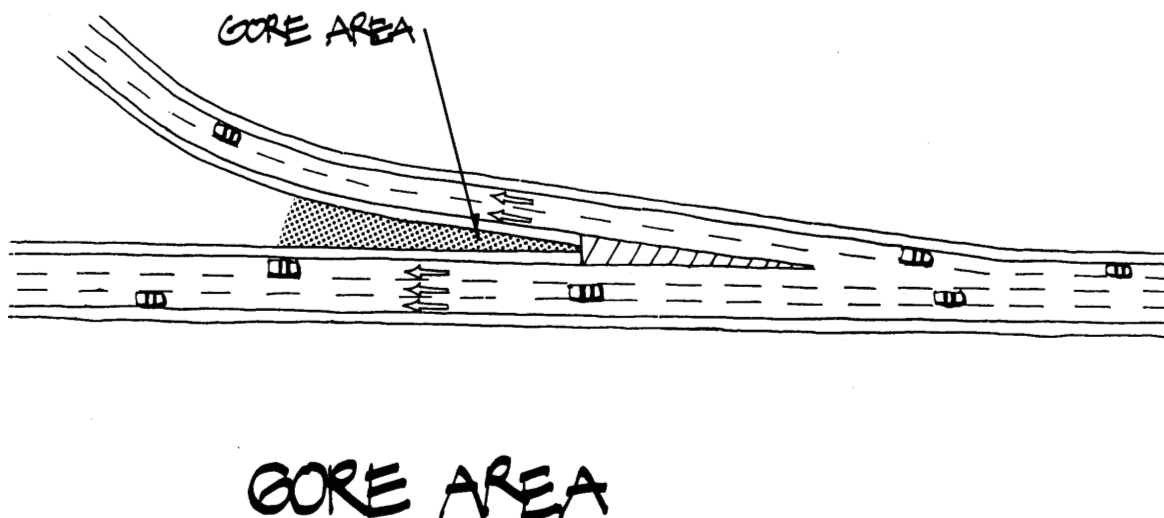
Interchanges

The most common uses for interchanges are along freeways and to provide the necessary capacity at high volume intersections. Safety is a key element in the design of interchanges. Therefore, the design for improving the landscape within the interchange area should follow ideal design standards. "Proposed plantings should be selected with regard to their ultimate growth. Improperly located shrubs or trees may seriously shorten sight distance on curves and seriously interfere with lateral sight distance between adjacent roadways". (AASHTO)

FDOT criteria and standards should be met or exceeded on interchange landscape design. Approval for variances to these standards within an interchange will be rare and require thorough documentation.

Special attention should be given to the design of the landscape within the gore of interchanges. The "gore" is the area immediately beyond the divergence of two roadways, bounded by the edges of those roadways. The term "gore" refers to both the paved triangular area upstream from the approach nose and the graded area a few hundred feet downstream from the approach nose. The term "gore" general refers to the area between a through roadway and an exit ramp (see Figure 20). The term is also used to refer to the similar area between a through roadway and a converging entrance ramp. The gore areas should only have grass and ground cover within the graded area between the ramp and main roadway. This area should be maintained as a recovery zone for errant vehicles. Trees may be installed behind guardrails or other rigid structures used on the bridge approaches. In all other areas of the interchange, trees must satisfy the horizontal clearance requirements of FDOT criteria and standards. All potential conflict points between vehicles travelling on the ramps and approaching roadways must meet clear-sight criteria. Special attention must be given to grades and horizontal curves in establishing the sight datum line for these conflict points. The clear-sight window of FDOT criteria and standards must be maintained throughout the limits of clear-sight at each point of conflict.

Figure 20



Retention/Detention Areas

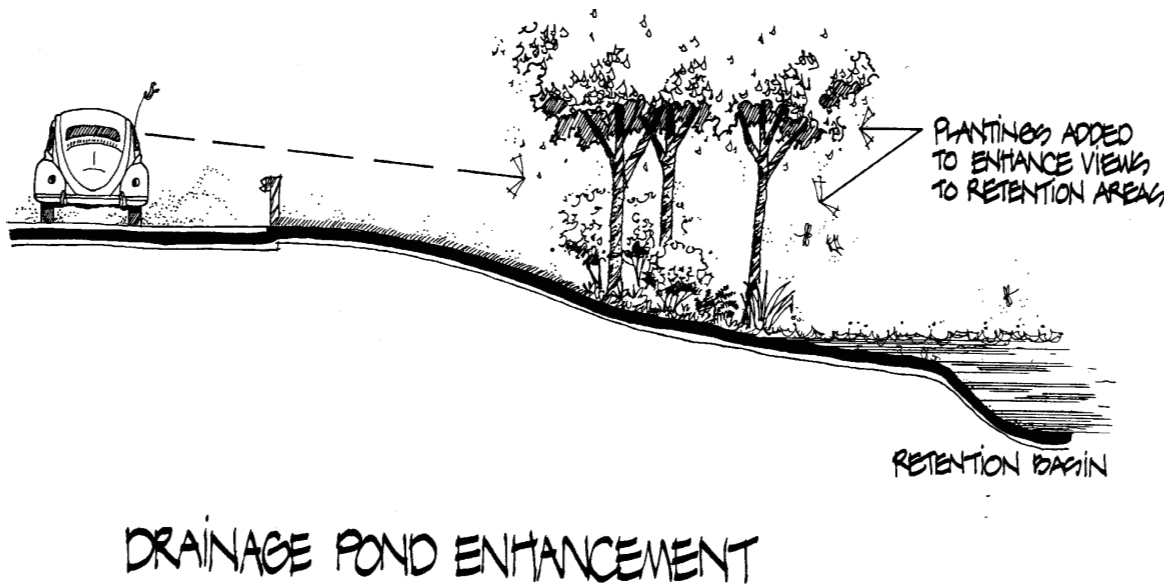
A retention area retains water, holding it for long periods of time. A detention area is designed to detain water, holding it temporarily until it can percolate or be moved elsewhere. These holding methods are employed to filter run-off water and improve water quality.

An increasing number of retention areas are being created for on-site storage of storm water. Retention areas have been viewed in the past primarily as a requirement for site plan approval and as a place to hold water. As a result, many retention areas simply were excavated, graded and sodded with little or no ecological or aesthetic consideration. Such a landscape is essentially barren.

Roadside retention area aesthetics and ecology have been neglected until recent years primarily because they are problematic areas to effectively landscape. The potential exists for these areas to be developed as functioning wetland systems; they then fulfill their design criteria (water storage, filtration, and recharge) and still contribute to the aesthetic quality of the landscape.

Retention areas exhibit many inhospitable environmental conditions including infertile soils, compaction, limerock overflows from paving, high temperature extremes from nearby paved areas, contaminated runoff and the extremes of prolonged inundation during rains followed by desiccation during droughts. While there exists no exact natural system with analogous conditions, there are native species which are rugged and well-adapted to such severe sites. Perhaps the closest natural parallels to retention areas are cypress swamp forests, wetland forests and freshwater marshes. Many of the plant species found in these areas are tolerant of a wider range of conditions than that of their natural communities. Innovative design of retention areas will use the natural wetland systems as models of success. Vegetation for wetland systems should be determined by water depth and will guide design when applied to retention areas. The vegetation of a wetland is typically populated by grasses, sedges and emergent aquatics with the standing water, then woody shrubs and small trees within the low areas and canopy trees along the higher elevation perimeter. Several native palm species occur in wetlands and are well suited for retention area landscapes. By following this layered approach, and selecting plant associations that are adapted to specific regions of the State, the retention pond landscape can meet aesthetic and design criteria. See Figure 21.

Figure 21



Canals and drainage swales are similar to retention ponds and can be subject to extreme fluctuations in water levels. Canal banks and drainage ditches are frequently neglected areas of the landscape site which present unique problems and require a specialized approach. Maintenance of these areas is extremely difficult, nevertheless, they can be effectively landscaped with native and adapted wetland species which will contribute to their function and stability, while not interfering with access.

Detention areas have many of the same characteristics of retention area sites although they remain dry most of the time, filling up only occasionally for a limited period. They should be landscaped to compliment and enhance the balance of the surrounding site; however, the plant materials specified must be able to tolerate periodic standing water as well as drier conditions.

The design of retention/detention areas must be approved by several government Agencies. The design input of these Agencies and the District drainage engineer should be obtained during design. This will make it easier to obtain their approval of the final design.

Outdoor Advertising Signs

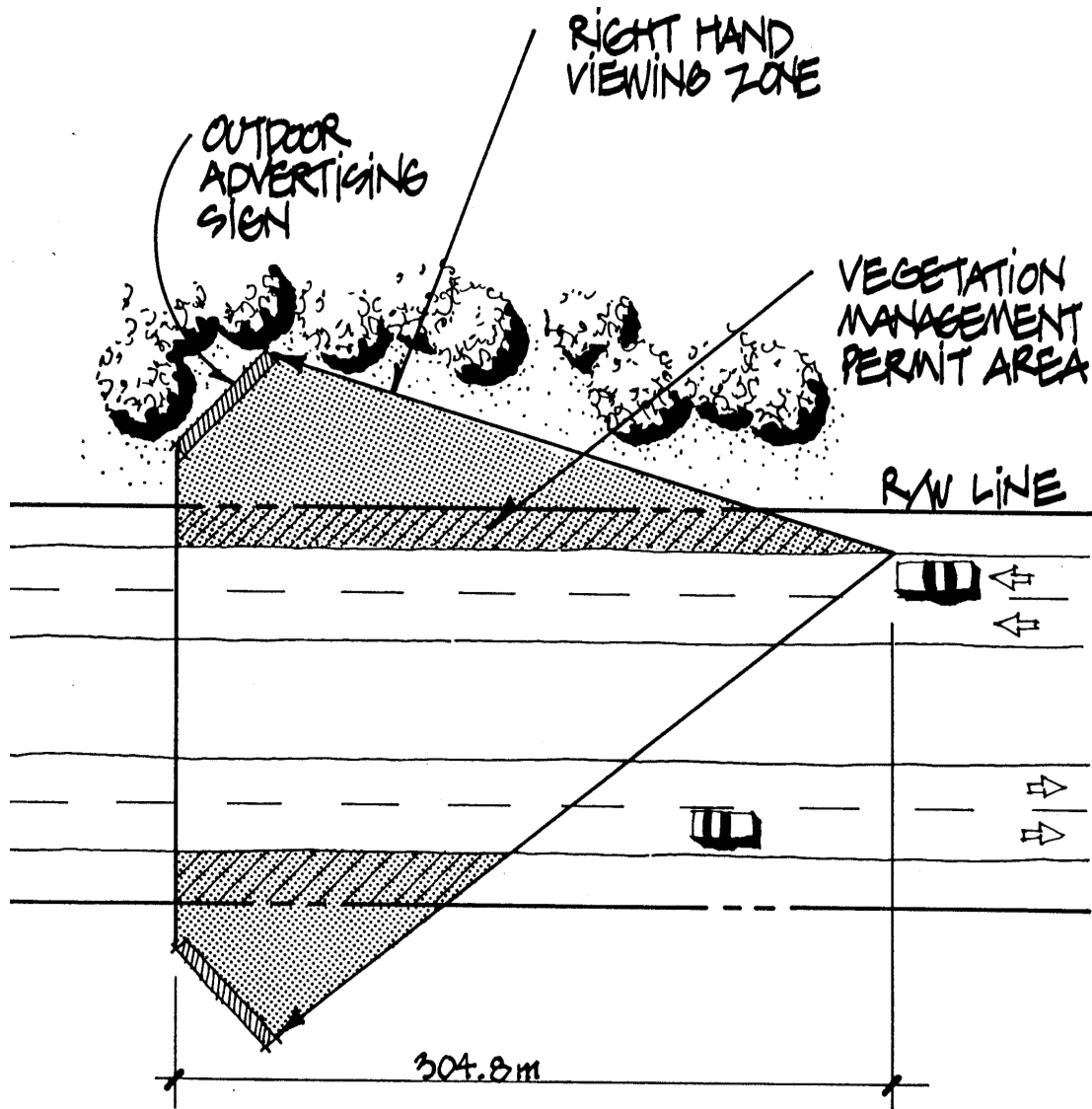
Outdoor advertising signs along State highway corridors have become part of the highway landscape. The methods used by the FDOT to control location and permitting of outdoor advertising signs are covered under Florida Statutes, Chapter 479, *Outdoor Advertising*. The permitting and location of these signs under this law is rigorous and thorough; therefore, those signs which are permitted should be given due consideration when formulating the roadside landscape.

Once permitted and installed, outdoor advertising signs are provided by law with a viewing zone that must be respected in developing the highway landscape plan. FDOT, Rule Chapter 14-13, *Vegetation Control and Outdoor Advertising Signs*, outlines the criteria which must be applied to the placement and maintenance of proposed and existing vegetation. The purpose of this rule is to establish regulations and uniform guidelines covering the permitting of pruning, replacement or removal of selective vegetation on outdoor advertising signs along rights-of-way of the other State highway systems. The "viewing zone" provided under this rule means the area to the left and right of the outdoor display should be maintained for reasonable viewing of the display. This area is called the Vegetation Management Permit Area. See Figure 22 for an example of a right-hand and left-hand Vegetation Management Permit Area.

Other specific regulations for the retention of natural roadside growth and scenery, protection and conservation of native ecosystems, and prohibition of indiscriminate pruning or removal of vegetation are stated in Florida Statutes, Chapters 334.044(25), *Department Powers and Duties*, 335.167, *State Highway Construction and Maintenance*; *Xeriscape Landscaping within Rights-of-way*, 337.405(1), *Trees or Other Vegetation within Rights-of-way of State Highway System; Removal or Damage; Penalty*, and 369.25, *Invasive Non-Native Plants: Prohibition; Study; Removal; Rules*, and relate to the view-shed allowed for outdoor advertisements. In all cases the intent of the permit process was established by the legislature to allow for a minimum disturbance to the native vegetation in establishing the viewing zone.

In no case shall unpermitted signs be considered in the design process.

Figure 22



OUTDOOR ADVERTISING VIEW ZONE

Maintenance of Traffic

Traffic control plans (TCP) must be developed for all highway landscape projects. When the highway landscaping is part of a highway project, the maintenance of traffic for the installation of landscaping will have to be coordinated with the maintenance of traffic for the highway improvements. The maintenance of traffic plan for the project should be one plan that addresses all elements of construction. The TCP must be prepared by a PE "certified" in TCP preparation.

When a project is for landscaping only, a maintenance of traffic plan will also be required. The maintenance of traffic plan must be in accordance with Chapter 10 of the *Roadway Plans Preparation Manual*, Chapter 6 of the *FHWA Manual on Uniform Traffic Control Devices for Streets and Highways* and the *FDOT Standard Index, Series 600, Traffic Control through Work Zones*.

PLANT AND TURF GRASS USAGE

Native and Endangered Species

Native and endangered plant species are important to the State's ecology and have proven to be assets in the roadside landscape. These plant materials require little, if any, fertilizer or maintenance and are generally able to sustain themselves when located in proper growing conditions for the species. As mentioned in Section 3, *PROJECT DEVELOPMENT AND ENVIRONMENTAL PHASE (PD&E)*, these species, when existing, must be identified early to insure that they remain in place whenever possible. Nursery-grown native plant materials should be included in any plant design pallet. Many varieties are attractive, need no supplementary watering and require no pruning. Some varieties are also appropriate for urban median installation within the limits of intersection sight distance.

Native plants used in the right locations can provide additional benefits to the environment by reducing glare, discouraging weed growth and providing wind breaks. Water conservation is a necessity in Florida. Drought resistant native plants can provide an excellent buffer against the use of irrigation for landscape plants. Native plants are not limited to use in their natural habitat. Native plants will generally accept a better site than the one from which they occur naturally, and sometimes will accept a poorer one. Native species can be used in rural and urban highway landscapes.

Availability of native plant material has been a limiting factor to the use of these plant materials, but the large demand for these species has encouraged the formation of many new native plant nurseries. It is still wise to give advance notice to the native nursery industry when large quantities of uniform quality are required.

The use of these materials in the highway landscape must be encouraged throughout the FDOT. Useful species are noted in the "Plant and Turf Grass Selection Guide" of this Section.

Xeriscape™ Principles

Utilization of Xeriscape landscape techniques and methods is encouraged by Florida Statutes, Chapter 335.167, *State Highway Construction & Maintenance; Xeriscape Landscaping within Rights-of-way*, FDOT, Rule Chapter 14-40, *Highway Landscape Improvements* and FDOT, Rule Chapter 14-92, *Florida Highway Beautification Council*.

Water conservation has become vitally important to Florida. As much as possible, landscape improvements along our highways should be designed to survive on natural rainfall. Water trucks may be used to establish newly planted materials or to augment rainfall during times of severe drought; but generally, landscapes must be able to sustain themselves. At the same time it is obvious that roadway medians and shoulders are not natural environments, but are designed to efficiently remove water and keep a roadway dry. Additionally, roadway pavement surfaces are hot and windblown, giving plants an extremely harsh environment in which to survive. Xeriscape principles will assist in developing landscapes that can withstand these conditions.

Xeriscape (pronounced "zer-i-scape") is water conservation through the careful selection, placement and maintenance of landscape materials. It is estimated that water consumption through landscape irrigation can be reduced from 30 percent to 80 percent by employing Xeriscape principles. Xeriscape plant materials are drought-tolerant and do not require special attention in order to flourish. The following Xeriscape principles are a practical and essential consideration in the planning and design of Florida's highway landscapes.

- **Appropriate choice of drought-tolerant native and adapted plant materials for the site.** Plants with the same water requirements should be grouped together in the appropriate locations. Plants that like wet conditions should be planted in wetter

areas; plants that prefer dry soils should be grouped together in drier areas. The use of swales or low points in the topography should be considered for planting areas as they will provide more water.

- **Improve the soil as necessary.** Florida soils are mostly sand which does not absorb or hold moisture well. Clay soils, also found within the State, retain water much better. Analysis and addition of appropriate soil amendments will increase the soil's ability to retain water. Soils with organic matter also provide beneficial nutrients to the plants. When compost is added, it should be free of shredded plastic debris and other extraneous material, and properly tilled into the soil if used as an amendment. Man-made water retentive soil amendments may also be used to supplement the compost or in its place.
- **Efficient irrigation.** Irrigation should be installed only if it is essential for the project. Well-planned irrigation systems, where appropriate, can save water. Sub-surface emitter type systems, required by Florida Statutes, Chapter 335.167, *State Highway Construction and Maintenance*; *Xeriscape Landscaping within Rights-of-way*, are most efficient for trees, shrubs, ground cover and flowers. Turf areas are best watered with low-gallonage, aboveground sprinklers. Water only where and when the plant materials need to be watered. Rain sensor devices are required to be installed to override the irrigation system when adequate rainfall has occurred. Control water runoff by creating basins around plant material to collect water. Under no circumstances shall water be allowed to overspray or seep into roadway. Turf may be drought conditioned by only watering when signs of wilt occur, and then just enough to wet the soil in the root zone. This practice will develop a deep root system that can better withstand drought periods.
- **Practical use of turf grasses.** Drought-tolerant turf grass species should be used for roadway shoulders and large open areas. Grasses requiring more than natural water should only be used in high focal or specially selected areas.
- **Appropriate use of mulches.** Mulch is a porous material, usually organic, such as finely shredded wood chips, solid waste compost, or pine straw and bark. A 75 mm thickness of mulch placed on exposed earth surfaces will help to retain moisture, control temperature and unwanted vegetation, slow erosion, and enhance the uniform appearance of planting beds. Recycled mulch and solid waste compost are recommended where available. Avoid use of cypress bark mulches as the trees have been harvested for bark value only, rather than the bark as a byproduct.
- **Proper maintenance.** Xeriscape landscape installations should not be over-watered or over-fertilized; this decreases their tolerance for drought conditions and increases the risk of plant disease. A balanced nitrogen-potassium fertilizer with a formulation similar to 12-4-12 is recommended to support root growth and can help make turf more drought-tolerant. In addition, letting grass clippings decompose on the lawn adds the equivalent of one application of nitrogen. Turf grasses should be mowed

above 75 mm and with a sharp blade that will not shred the leaves and damage their vitality.

Where periodic flooding is a concern, careful selection of materials that can survive standing water must be considered. The County Agricultural Extension Service in your area can be of assistance in providing additional information.

Plant Life Cycle of Trees vs. Design Year

Unlike inanimate objects, plants are dynamic and move outward and upward after their placement in the landscape. This growth must be considered when designing the roadside landscape. While trees, shrubs and ground cover do grow and change once installed, they have a "design life" at which time the plant should be removed and replaced. This period varies with the plant type and species. An oleander shrub may have a design life of 12 years, while a sabal palm's design life might be 20 years or more.

It has long been a concern of the FDOT that once a tree is placed in the highway landscape it is there forever. The fact is plant materials, like other highway appurtenances, should be periodically evaluated for stability and viability. Generally, FDOT highway projects are revisited every 20 years; the landscape will be included in this review which will be performed by the District landscape architect or vegetation specialist. When maintenance of projects has been relegated to local governments, their qualified personnel must make the initial review and report to the District for any required modifications. As yet, there is no criteria established for the design life of landscape materials used in the highway landscape. There are, however, some guidelines that should be considered in the review process.

- Does the plant demonstrate all of the characteristics for which it was initially selected?
- What is the health of the plant material?
- Are there any structural weaknesses in trees or large shrubs that may be dangerous to vehicular or pedestrian traffic?
- Has the plant become too large for the area? (This characteristic is critical with regard to locations within the limits of intersection sight distance.)

- Have plants become invasive to adjacent areas?
- Have plants grown to conflict with utilities?
- Have plants grown to conflict with safety or maintenance functions?

Should the review process determine that trees, shrubs or ground cover are a potential hazard, or that the materials are in an unhealthy condition, the District landscape architect or vegetation specialist may require the removal and replacement of the plants in question. These findings must be reviewed on a plant-by-plant basis with proper replacement options and funding as part of the decision process.

Location within Highway Cross-section

An important aspect in landscaping Florida's highways is the correct placement of plant materials within the highway cross-section. Highways are constructed with varying topographical characteristics and plants must be selected to meet the final elevation growing conditions. Swales in median strips that will experience periodic flooding will require plant material that will withstand wet conditions. Conversely, a well-drained outer slope requires vegetation that can withstand drought conditions. The elevation of the roadway itself will also affect the selection of tree and shrub species. Planting in a median swale on the crest of a hill may require different plant material than for the base of the hill. One must review closely the grading and drainage of the roadway before selecting the landscape plant material.

Trees, Shrubs and Ground Cover

All landscape plants must meet or exceed the FDOT's *Standard Specifications for Road and Bridge Construction*, Section 580. All plants must be Florida Grade Number 1 quality or better according to the most recent edition of the Florida Department of Agriculture and Consumer Services' *Grades and Standards for Nursery Plants, Part I and II*. Proper horticultural nomenclature must be used according to L. H. Bailey and E. Z. Bailey, *Hortus Third*, 1976, a concise dictionary of plants cultivated in the United States and Canada.

Tree Design Criteria. Because trees are growing, dynamic elements in the landscape, it is important to realize to what degree they will affect the environment in which they are placed. It is critical to select the appropriate shade trees, ornamental trees and/or palms for the project site; the

overall and lasting success of the landscape design depends upon this important step. Trees must also be placed so they will not impair motorists vision or obscure highway signage either when first installed or when they have reached mature size. Factors to be considered in tree/palm selection include determining the mature size and shape of the tree and its root system, cold hardiness, water requirements, adaptability to the site and to the highway environment and maintenance requirements (see the "Plant and Turf Grass Selection Guide" of this Section for plant characteristics).

Long-term maintenance is a major factor in tree selection. Prior to the selection of trees for highway landscaping, questions about the growth characteristics of a proposed species must be answered satisfactorily. How large will this tree get? Is it evergreen or deciduous? What kind of leaf or fruit drop will it create? Are the limbs brittle and subject to breakage in high winds? How often must the tree be fertilized and pruned to maintain a healthy condition? What will the root system do to the surrounding pavement over time?

Trees should be selected according to their use and location in the highway landscape. Low-growing, dense-canopied evergreen trees, such as hollies or wax myrtle, would be a good selection to create a buffer between the highway and a residential area. A weeping willow or red maple would be a good tree to create a focal point at the edge of a retention area. When a splash of color is required at an interchange or overpass, crepe myrtle or red bud would be appropriate. An urban median would be a good spot for many single stemmed palms or tree-form shrubs like oleander.

Tree Planting Locations. When space and safety criteria are met, a high priority for tree planting within urban areas is in roadway medians. Medians provide the highest visibility for tree planting. On urban roadways, median planting helps reduce the perceived mass of pavement, enhances views, breaks driving monotony and cools the roadway. In addition, median planting dramatically increases the community's perception of aesthetic roadway enhancement.

Tree planting opportunities also exist along the shoulders of urban and rural highways. These trees provide an aesthetic compliment to existing vegetation, create shade, add visual interest and buffer traffic sounds, thus increasing pedestrian comfort and providing a greater sense of safety. Where

existing utilities create conflicts, opportunities for planting shade trees outside the right-of-way can be explored with the adjacent property owners.

Tree Size and Spacing. The trunks of trees within the limits of intersection sight distance should never block more than 50 percent of a driver's view of a passenger car. Trees should be spaced to provide the crossroad driver a view of at least 6.0 m of the approaching major roadway between tree trunks. The bottom of the tree limbs should be trimmed to a minimum height of 2.58 m above the highest elevation of pavement on the cross-section, not from where it is planted.

The maximum diameter of tree trunks within the limits of intersection sight distance has to provide visibility of 50 percent of a conflict vehicle as stated in FDOT criteria and standards. When intersections are not spaced far enough apart, intersection sight distances overlap.

The recommended maximum tree spacing on a highway relates to the roadway width and vehicular design speed. When the tree type and spacing is coordinated with highway size and type, trees reduce the perceived amount of paving, provide shade and unify the roadway both visually and spatially. Urban highways with more development generally require more planting to soften and humanize the environment than do rural highways.

The minimum spacing of trees within the limits of intersection sight distance is stated in FDOT criteria and standards. Spacing of trees outside the limits of intersection sight distance varies greatly according to tree type and available growing area. The spacing distance must be determined for each project according to safety standards and aesthetics (see Section 3, *PROJECT DEVELOPMENT AND ENVIRONMENTAL PHASE (PD&E)*, "Engineering Standards", for tree size and spacing criteria). Outside of the limits of intersection sight distance, depending on the site, species and location, shade trees along a highway might be ideally planted 4.5 m to 7.6 m on center to allow for root development. Ornamental trees and palms in the same area might be planted 2.4 m to 3.0 m on center.

When permitted, tree plantings may be clustered to create natural-looking stands of a particular species. It may be practical to install a shrub or ground cover planting bed around clustered trees to

alleviate mowing difficulty. Trees should be placed no further than 6.0 m apart if a continuous ground cover is implemented.

When designing with sabal, washingtonia, queen, royal or other single-stem palms, it is recommended that the same species be grouped with one another in natural-appearing clusters to accent bridge overpasses, toll plaza areas, etc. Palms used in this informal clustering configuration should be of one species at alternating, staggered heights in order to give the appearance of a natural palm stand. Sabal, washingtonia, queen, royal and Canary Island palms with similar clear trunk heights may also be used in a single or double row to formally line overpasses or exit ramps to toll plazas or to enhance medians or boulevards. When palms are planted in formal rows however, the design intent may be lost if one or more of the palms dies, leaving gaps or open spaces in the planting row.

It is important to locate multiple tree groupings with sufficient space between them for the maximum viewer effect. The traveling viewer's eye needs a spacial rest between focal elements to maximize the effect of the focal elements. This open-space factor is normally dependent on the travel lane speed and size of the corridor. Major groupings of several trees located closer than 30.0 m tend to become blurred to the driver's eye at high speed. A suitable scenario would be to leave ample open space, such 30.0 m to 60.0 m between these tree groupings. This will allow the grouping to become a focal point of its own. The best landscape planting scheme creates an intermittent rhythm of mass and open space.

Median Tree Planting. Medians are the primary area for landscaping in urban areas when a community wants to beautify their highways. Because space is limited for plant growth and highway safety indexes are involved, median landscaping must be designed with special considerations.

Many median planting areas are within the horizontal clearance limits and trees must have a caliper (the diameter of the trunk at 150 mm above the ground) of 100 mm or less. Even in areas where no horizontal clearance restrictions apply, median areas are likely to be crossed by vehicles at some time and designers may wish to specify small growing trees as an additional safety measure. The following are some desirable characteristics for median tree material:

- **Malleability.** Malleability is the quality of plant material to easily recover after being damaged by vehicles, vandalism or similar causes. Damaged trees will sprout from roots or stems to quickly restore their ornamental function. Similarly, trees with high malleability can be more easily managed at a 100 mm or smaller caliper. Stems are simply removed and replaced by sprouts which take the place of removed stems. Thus, a tree may be managed at a designated caliper diameter for a much longer time than one which cannot be so easily renewed.
- **Tree Root Systems.** Some trees have aggressive root systems that tend to spread out laterally, rather than grow down, due to the high water table in many areas of Florida. Other trees put out large lateral roots due to shallow, adverse soil conditions. Roots can cause major damage to surrounding hard surface elements by breaking up asphalt, cracking curbs and heaving sidewalks. To deter this from happening, it is recommended that root deflecting methods be introduced in the planting process. There are several products on the market to accomplish the movement of root systems downward instead of outward (see Section 4, *DESIGN PHASE*, "Soils/Amendments/Planting Products").
- **Tree and Palm Quality.** All trees and palms installed along FDOT highways must be guaranteed to be grade Florida Number 1 or better as designated in the most recent publication of *Grades and Standards for Nursery Plants, Part I and II*, published by the Florida Department of Agriculture and Consumer Services. All plants should conform to *Nursery Stock Standards* by the American Association of Nurserymen.

Trees should be container grown, unless specified otherwise, with a minimum two-inch caliper. If not container grown, palms shall be dug with root ball intact and carefully delivered to the site with roots adequately protected prior to transporting. A minimum of fronds shall be removed from the crowns of any palms, with the balance of fronds tied together, to facilitate moving. Sabal palms are an exception to this transportation method as they have been shown to transplant better with all of the fronds removed. No tree or palm shall be installed with a cracked or broken root ball. Trees and palms shall be protected against permanent abrasions to the bark or trunk by chains or other moving equipment (see Section 5, *CONSTRUCTION PHASE*, "Landscape Installation Techniques").

Qualified Personnel. It is recommended that a Florida State licensed landscape architect, certified arborist, qualified nurseryman or forester assist in the selection of trees and palms for highway landscaping. These professionals can be knowledgeable guides in the location and placement of trees and palms, and can provide information on geographical and soil tolerances, aesthetic considerations, potential landscape problems and many other factors in the tree selection process. It is costly and wasteful to install a tree in the wrong location.

Shrub and Ground Cover Design Criteria. Placement of plant material should always be designed to insure that clear-sight windows are provided within the limits of intersection sight distance and highway signage is not obscured when the plants are installed or when they reach mature size. Shrubs and ground cover species should be selected which are well suited for the site, will not grow too large for the area and need minimal maintenance.

Shrubs are utilized in the highway landscape for many reasons. Gateways, landmarks or other focal areas benefit from ornamental shrubs and ground cover. These plant materials also provide a good understory for trees, and introduce color and texture in the landscape. Screening and buffering shrubs can be used to separate sights and sounds from residential areas or to hide objectionable views. Mass planted shrubs can eliminate the necessity of mowing large areas and slopes. Properly placed shrubs can provide an aesthetically pleasing visual experience along roadsides, at interchanges and other key areas. As landscaping interest on Florida's highways increases, more use will be made of low-maintenance shrubs, especially native plants.

Mass planting of shrubs and ground cover is recommended, using plants of one species and flower color in each planting bed. Shrubs and ground cover should be installed so that each species will grow together into one solid mass. This technique is aesthetically pleasing, decreases maintenance and crowds out weeds. Planting design should be simple; intricate landscape patterns require a higher level of maintenance and are not discernable at 45 mph and above.

The harsh highway environment limits the materials that are suitable for planting. Plants must be highly drought tolerant for most highway applications, although wetland or irrigated conditions would allow some variation. Selection of the proper shrub or ground cover species is critical for long term success and safety. In all cases shrubs must be highly durable, suited to the location and conditions and possess low-maintenance characteristics. Important criteria should be satisfied prior to plant selection. How tall does the plant grow naturally without trimming or pruning maintenance? Is the plant suited to the location within the highway? Is the plant suited for the geographical, water, soil make-up and pH, and other conditions at the site? What are the maintenance requirements of the plant species? What is the availability and cost of the species selected? Does the plant fulfill the intended design use? Plants may be selected from the "Plant and Turf Grass Selection Guide" located in this Section. The plant characteristics included in this index will be helpful in selection

of the most attractive and utilitarian plant materials for a variety of geographic locations and conditions.

Placement. The placement of shrubbery must comply with all FDOT safety criteria. The limits of these safety criteria are stated in Section 3, *PROJECT DEVELOPMENT AND ENVIRONMENTAL PHASE (PD&E)*, "Typical Sections for Landscaping". These standards must be referred to prior to selection of any shrub and ground cover.

Plant Quality and Size. Plant selection also involves specifying the best plant quality and assuring that the installation criteria are suitable for roadside landscaping. Shrubs should be of Florida Number 1 quality or better, according to the *Grades and Standards for Nursery Plants, Part I and II*, published by the Florida Department of Agriculture and Consumer Services. Selecting plants of this quality will guarantee healthy, sturdy plant material. It is imperative that shrubbery be of high quality to withstand the rigors of transplantation and allow the plant to survive the establishment period with vitality intact. Shrubs should be containerized, nursery-grown plant material and of adequate size to establish themselves despite harsh highway conditions. Three-gallon containers should be the minimum installed size for medium height shrubs and one-gallon containers for ground cover shrubs. Dune sunflower or urban wildflowers should be in four-inch containers. Plants should be placed so as to achieve a solid plant mass within 18 months. This planting goal will provide a solid shrub or ground cover mass which will assist in choking off weed growth, lowering maintenance and providing an aesthetically-pleasing planting bed.

Turf Grass

Planning for erosion control is an important element of good highway landscape design. All soil areas of a completed highway should be protected with appropriate vegetation. To achieve an effective and harmonious flow between the roadway pavement and the adjoining countryside, it is necessary that vegetation, normally turf grass, be installed to blend with the natural roadside environment and control erosion along the right-of-way shoulders. Grass areas should be designed for ease of mowing. The outside radius of grass planting areas should not be smaller than 1.5 m. The width of grass areas should ideally be in multiples of 1.2 m for the most efficient mowing patterns. The relatively low-growing heights of turf grass allows a clear view of the roadway area,

as well as providing an aesthetically pleasing appearance to the landscape for motorists traveling at highway speeds.

Turf grasses are plants that form a continuous ground cover that persists under regular mowing and foot traffic. Turf includes both the grass itself and the soil in which it is growing. Because turf grasses exist in such close association with their environment, all components of the environment, natural and artificial, affect the hardness and quality of the turf.

Selection of turf grass depends on multiple factors including geographic location, season(s) of use, shade or sun, site usage, quality of turf desired, availability of water and the level of maintenance desired. FDOT uses two types of turf: lawn turf and utility turf.

Lawn Turf. Lawn turf is located primarily in areas of high visibility and pedestrian usage such as rest areas, landmarks, urban medians or areas that are focal points or have substantial foot traffic. It prevents soil erosion and provides an open area for clear visibility. It also serves an aesthetic function as it provides thicker, more attractive coverage for recreation or relaxation.

Utility Turf. Most of the turf along Florida's highways is utility turf. Utility turf is used primarily for soil stabilization along highways. The binding effect of the turf grass roots helps to prevent erosion from wind and water. The aerial shoots or leaf blades provide additional soil stabilization, help retain moisture and reduce soil temperature during periods of extreme heat if cut 150 mm or higher.

Turf Quality. Seven factors contribute to the visual quality of turf: density, texture, uniformity, color, smoothness, growth habit and rooting.

1. **Density** refers to the number of turf grass plants in a given area. Growing density varies with the different species and cultivars of turf grass. Density is also affected by maintenance procedures, for example, proper mowing height results in a denser turf.
2. **Texture** refers to the width of the leaf blades. A fine-textured turf grass such as Bermuda has narrow leaves, while a coarser grass such as St. Augustine has wider leaves.

3. **Uniformity** refers to the evenness of the turf's growth, its composition and the evenness of the surface of the grass. When turf is not uniform, weeds, insects and/or mechanical damage is usually responsible.
4. **Color** is a good indicator of the health of turf grass. A yellow color (chlorosis) may indicate disease or a deficiency of nutrients. An overly dark color may indicate excessive fertilization, wilting or disease.
5. **Smoothness** refers to the appearance of the turf and is directly affected by mowing. Using a mower with sharp blades produces a smooth appearance because the leaves are cut cleanly and evenly. Mowers with dull blades produce ragged and discolored leaf tips. Mowing too close to the ground (scalping) reduces the smoothness of the turf grass and can severely injure it and promote weed growth.
6. **Growth habit** refers to the type of leaf growth and the method by which the turf grass spreads. Turf grasses fall into three categories according to growth habit:
 - a. **Rhizomatous:** These grasses spread primarily through below ground shoots called rhizomes. Bahia is an example of a grass that forms an extensive system of rhizomes (bahia is also stoloniferous).
 - b. **Stoloniferous:** These grasses spread by aboveground, lateral shoots called stolons. St. Augustine and centipede are examples of turf grass spread by stolons.
 - c. **Bunch Type:** These grasses spread exclusively by tillering, the development of new leaves, and thus tend to grow in bunches. Examples of bunch-type grasses are smut grass, rye grass and love grass.
7. **Rooting** is the amount of root growth evident at any one time during the growing season. The rooting of plants is a good indicator of their condition. Healthy, well-maintained turf grasses develop strong root systems.

Wildflowers

History. In 1963, the FDOT initiated the Wildflower Program for the State's roadsides. Aesthetics, lower maintenance costs, and driver safety were the main reasons for the program. Since that time public interest in planting wildflowers has continually grown, with hundreds of inquiries being received by the FDOT each year.

Design Criteria. Flowering plants and wildflower sites may be established and maintained within existing mowing limits if their locations are compatible with routine maintenance operations. If

Federal funds are to be used for landscaping, the use of wildflowers is mandatory (one-fourth of one percent of the total landscape budget shall be allotted for wildflowers).

A wildflower planting project begins with research into climate, soils, drainage, selection of indigenous wildflower annuals and perennials, and optimum planting times and procedures. Each FDOT District Office has developed research on wildflowers adaptable to their geographical area. It may also be helpful to contact your County Agricultural Extension Service, Florida Federation of Garden Clubs, a local botanist or other knowledgeable person regarding selection and installation of species. Locations selected for wildflower plantings should be highly visible from the highway. Start with a small area initially and expand plantings in time using techniques and species that have proven successful in the initial procedure. Select species that provide a blooming period of at least two months and include both annuals and perennials. Generally annuals germinate and flower the first year, while perennials often take two to three years to become established and flower. Wildflowers species selected should have showy foliage or flowers; be relatively free from competitive or noxious plants; should not be poisonous; should be a perennial or an annual that self-seeds and re-establishes itself readily; have a good root system to help stabilize the soil and must associate and compete well with other vegetation. While other species are utilized, the species that the FDOT utilizes the most are:

- Blanket flower (*Gaillardia pulchella*)
- Black-eyed susan (*Rudbeckia hirta*)
- Lance-leaved tickseed (*Coreopsis lanceolata*)
- Tickseed (*Coreopsis tinctoria*)
- Phlox (*Phlox drummondii*)

Native wildflower seed sources are not currently available locally, but should be able to be purchased from local growers sometime in 1998. See Table 1.

Table 1
WILDFLOWER SELECTION GUIDE

BOTANICAL NAME	COMMON NAME	COLOR	SITE PREFERENCE
<i>Aletris farinosa</i>	Colic root	white	T - prairies, savannahs
<i>Aletris lutea</i>	Yellow colic root	yellow	T - pine flatwoods
<i>Anemone berlandieri</i>	Anemone	white	N & C - open rocky woods
<i>Aquilegia canadensis</i>	Columbine	red/yellow	N - woodlands
<i>Aster dumosus</i>	Aster	lavender	T - low pinelands
<i>Baptisia alba</i>	White indigo	white	N - sandy woods
<i>Baptisia lanceolata</i>	Pineland baptista	yellow	N & C - dune, open wood
<i>Cassia nictitans</i>	Sensitive plant	yellow	S - coastal pinelands
<i>Clematis crispa</i>	Leather flower	lavender	T - wet woods, marshes
<i>Coreopsis lanceolata</i> *	Lance-leaf tickseed	yellow	T - moist pinelands
<i>Coreopsis grandiflora</i>	Sea dahlia	yellow	N - roadsides, woods
<i>Coreopsis tinctoria</i> *	Tickseed	yellow	T - moist pinelands
<i>Gaillardia pulchella</i> *	Gaillardia or blanket flower	orange/yellow	T - sandy, open sites
<i>Helianthus debilis</i>	Beach sunflower	yellow	T - dunes, disturbed areas
<i>Hibiscus moscheutos</i>	Swamp mallow	white/red	N - open lowlands, marsh
<i>Ipomopsis rubra</i>	Standing cypress	red	N & C - dunes, waste areas
<i>Kosteletzkya virginica</i>	Salt marsh mallow	white	S - marshes, low sand areas
<i>Liatris tenuifolia</i>	Dense blazing star	lavender	T - dry pinelands, dunes
<i>Lobelia cardinalis</i>	Cardinal flower	red	N & C - moist open meadows
<i>Lupinus perennis</i>	Sundial lupine	blue	N - open woods, dunes
<i>Monarda punctata</i>	Horsemint	ivory/yellow	N & C - open sandy areas
<i>Phlox drummondii</i> *	Roadside phlox	pink/deep pink	N & C - open fields, pinelands
<i>Phlox nivalis</i>	Creeping phlox	pink	N & C - open fields, pinelands
<i>Rhexia alifanua</i>	Tall meadow beauty	pink	N & C - pinelands, savannah

* Species FDOT uses most.

N = North

C = Central

S = South

T = Throughout

Table 1
WILDFLOWER SELECTION GUIDE (continued)

BOTANICAL NAME	COMMON NAME	COLOR	SITE PREFERENCE
<i>Rhexia virginica</i>	Meadow beauty	pink	N - wetlands
<i>Rudbeckia hirta</i> *	Black-eyed susan	yellow	T - fields & roadsides
<i>Rudbeckia triloba</i>	Coneflower	yellow	N - woods & moist soils
<i>Salvia coccinea</i>	Tropical sage	red	T - open areas
<i>Sisyrinchium xerophyllum</i>	Blue-eyed grass	blue	N - pinelands & scrub
<i>Vicia acutifolia</i>	Vetch	purple/white	T - wetlands

* Species FDOT uses most.

N = North

C = Central

S = South

T = Throughout

Installation. Wildflower plantings can be successful, but success is not without effort. Roadsides are altered habitats and can be hostile to plant life, however, wildflowers can adapt to the landscape of the highway right-of-way provided care and consideration in planning, planting and maintenance is necessary. Important considerations are:

1. **Site preparation** must facilitate good seed/soil contact. Seed germinates more readily in loose soils than in hard, compacted ones. Improper site preparation can harm germination and the continued survival of the wildflower species. Sites that have been cleared of vegetation and tilled for seeding could induce the growth of broadleaf weeds and unwanted grasses if tilling is too deep. Preparing wildflower sites should, at a maximum, only involve breaking up the top 25 mm of soil. This can be accomplished by shallow rototilling, mowing with a flail mower or by power raking. For best results, do not till or disturb the soil. The following planting techniques for varying turf cover should be followed:
 - a. Thin turf cover areas: Broadcast the wildflower seed over the area then rake or drag the area to obtain seed-to-soil contact.
 - b. Average turf cover areas: Scalp the turf to 25 mm, remove the clippings, then broadcast seed over the area and replace clippings evenly as a mulch. A mechanized seed drill can be used without removing the clippings.

- c. Heavy turf cover: Spray with herbicide and let the area sit for one month. Scalp to 25 mm, then follow the step above. The establishment of wildflowers is not recommended for areas of heavy turf and areas of excessive weed infestation. The use of a mechanized seed drill designed for planting wildflowers produces the best results.

The majority of the FDOT's maintenance offices herbicide the area, till the soil, and then uses a mechanized seed drill for placing the seed.

2. **Seed quality** is very important to the success of wildflower planting. Several factors can effect seed quality, including germination, purity, or improper seed storage and can turn a good effort into failure. Proper consideration must be given to the germination characteristics of a wildflower species, so that the maximum percentage of seeds sown are likely to germinate without the introduction of weeds or unwanted grass. Seeds should be properly cleaned and free of residue which might impair germination. Finally wildflower seeds should not have been stored for prolonged periods but should be planted at the earliest possible date. It is most advantageous to secure seeds that were collected during the most recent season.
3. **Proper planting procedures** will encourage successful wildflower growth. Seeding of wildflowers is most commonly used for rural application, while four-inch pots of established flowers are used in urban settings (see Section 5, *CONSTRUCTION PHASE*, "Tree Transplanting", for installation of container plants). Seeding is done by three techniques for planting including: drill seeding, hydromulching and broadcasting. Whichever technique is selected should not cause damage to or adversely disturb the existing turf. One of the most common causes of wildflower planting failures is the tendency to plant seeds too deep and in the wrong season. Wildflower species have different soil depth requirements for timely germination; check the proper depth for each species with the seed supplier. Again, the time of planting is also critical for success. Although wildflowers begin to bloom in the spring, nature ripens seeds during the late summer and fall months. Fall plantings offer the advantage of early germination and growth. Many varieties actually germinate and grow throughout the winter months and stay semi-dormant until the first signs of spring. The planting periods recommended for seed installation are:
 - North Florida - November/December
 - Central Florida - December/January
 - South Florida - January

If seed is planted at other times of the year, the percentage of germination will be lowered and the overall effect of the bloom period will be greatly reduced. Determine the appropriate time for wildflower seeding to take place rather than planting wildflower seeds to accommodate a construction schedule.

Planting wildflowers in urban areas is best accomplished by installing 100 mm containerized plants. (Planting techniques for containerized plants are shown in Section 5, *CONSTRUCTION PHASE*, "Landscape Installation Techniques".)

4. **Soil conditions** must be considered even though the wildflower species selected is appropriate to the geographical region. Wildflower species do not adapt to all soils. Highly alkaline or acidic soils can be a threat to the success of the project. Test soils for compatibility with the needs of the wildflower species selected for the project.
5. **Adequate moisture** is critical to any effort to establish wildflowers. Moisture is crucial to induce seed germination and plant growth. The success of the planting depends on the availability of moisture at the time of planting and throughout the time leading up to germination. This is true even for species that are classified as drought tolerant; wildflowers must receive adequate water in order to germinate and become established. Once established, they are drought tolerant. Absence of rainfall or supplemental watering during germination will jeopardize the project. Ideally wildflower planting dates should be determined in accordance with the timing of seasonal precipitation.
6. **Maintenance** is important after wildflowers are established and some species require more attention than others. During severe drought, supplemental watering may be needed to insure survival and future germination. To enhance reseeding, the planted areas will require periodic mowing. Very often wildflowers will bloom well for one year and then disappear the next. This is generally caused by the inability of the seeds to germinate; they either do not achieve good soil/seed contact or are choked out by competing weeds. Mowing gives the wildflower reseeding cycle a slight advantage over other threatening conditions. Mowing should only occur during the fall. After the blooming season, wait four to six weeks for the seed to mature before mowing. The absence of timely mowing will contribute to the unsuccessful growth of wildflowers. Wildflowers must be protected from machinery performing regularly-scheduled turf grass mowing during the rest of the year.
7. **Fertilization** is also a factor that can negatively impact the success of wildflower plantings. Once wildflowers have been established, fertilization is more harmful than helpful to their growth since it encourages broadleaf weeds and unwanted grasses. Similarly the improper use of herbicides can have a devastating effect on wildflowers. Spraying areas that have been or will immediately be planted with wildflowers will virtually destroy those areas. There has been a practice of applying herbicides during the first year of growth after annual wildflowers have bloomed to minimize problems with broadleaf weeds. This does not seem to harm the annual wildflower species since they reproduce from seeds. However, the application will result in the destruction of the perennial wildflower species.

PLANT AND TURF GRASS SELECTION GUIDE

Turf Grass Selection Guide

Although all grasses are members of the same family of plants, only a few of these plant species are hardy and tolerant enough of mowing and traffic to be used as turf grasses. The selection of turf grass is based on environmental factors (soil, weather, location) present at the site, and on the purpose for which the turf is to be established (utility turf or lawn turf).

FDOT uses two general categories of grasses: permanent grasses and temporary grasses.

Permanent Grasses. Permanent grasses continue to grow from year to year when properly maintained. All permanent grasses used by the FDOT are warm-season grasses. Their optimum temperature range for growth is 15° C (60° F) to 32° C (90° F).

The primary permanent grasses used by FDOT are bahia and common bermuda grass. Less frequently used permanent grasses include centipede and St. Augustine. Table 2 summarizes the important characteristics of primary permanent grasses.

- **Bahia grass.** Bahia is a low-growing perennial grass that spreads slowly either by seed or by short, belowground runners called "rhizomes". When mowed at its proper height and frequency bahia grass forms a tough, coarse-textured, wear-resistant utility turf especially well suited for use along inland highways. Bahia is a stress-tolerant turf grass and is the species best adapted to most of the soil conditions found throughout the State of Florida. It thrives in sandy, infertile soils and drought conditions. However, bahia grass is susceptible to damage from mole crickets and, during the summer months, it continuously forms tall seedheads. Two varieties of bahia grass used by FDOT are Argentine and Pensacola. **Argentine bahia** has a lower growing height and broader leaves than pensacola bahia and forms a denser turf, while holding its green color longer in the winter. It is most frequently used at high focal medians, landmarks, rest areas or recreational sites. **Pensacola bahia** has a finer leaf texture and a higher growing height than argentine bahia and is more resistant to drought, cold and pests. Pensacola bahia grass is most frequently used as a roadside utility turf.
- **Common bermuda grass** is a warm-season perennial grass that forms a dense, wear-resistant turf. It spreads by both rhizomes and stolons, and may be propagated by seed. Bermuda grass grows well in almost any soil. Because it can grow in sandy soils with a relatively high salt content, bermuda grass is recommended for use in coastal highway areas. It does not do well in wet or shaded areas and because of its

aggressive growth characteristics it may escape into areas where it is not desired; such as, pavement cracks, landscaped areas or adjacent property. Bermuda grass tolerates the use of selective herbicides better than most other turf grasses.

- **Centipede grass** is a medium-textured, slow-growing grass that forms a low, dense turf. It spreads primarily by stolons but may be initially established through seed, sod, sprigs or stolons. Centipede grass grows in a wide range of soil types but, it grows best in the moist clay or organic soils found in the northern and panhandle regions of Florida. The sandy soils of South Florida do not support centipede grass well. Centipede grass is most often used by FDOT as a lawn turf in selected locations such as rest or recreation areas but may be used along urban highways. Centipede grass is easily damaged by nematodes, mole crickets and fungus.
- **St. Augustine grass** is a coarse-textured, aggressively-growing lawn turf that reproduces primarily through stolons. Unlike other turf grasses, St. Augustine can be established only through sodding or sprigging. It is adapted to a wide range of soil conditions but grows best in moist, well-drained, sand, slightly-acidic soils of moderate to high fertility. It requires a good deal of moisture. St. Augustine is the most shade and salt-tolerant of all the permanent grasses utilized by FDOT. It is used at rest and recreational areas, high focal areas and along urban roadside areas adjacent to developed property. St. Augustine grass is susceptible to damage from chinch bugs and brown patch.

Table 2

TURF GRASS CHARACTERISTICS

TYPE OF GRASS	TEXTURE	SOIL RANGE	SALT TOLERANCE	DROUGHT TOLERANCE	SHADE TOLERANCE
Argentine and pensacola bahia	Medium to coarse	Wide range	Fair	Excellent	Poor
Bermuda	Fine	Wide range	Fair to good	Good	Very poor *
Centipede	Medium	Acid soils	Very poor	Poor	Fair to good
St. Augustine	Coarse	Wide range	Excellent	Poor	Excellent **

* Some bermuda hybrids have poor to moderate shade tolerance.

** "Floratine" variety has good shade tolerance while "floritam" has poor tolerance.

Temporary Grasses.

- **Annual ryegrass** is an aggressive, cool-season temporary grass that is normally planted in the fall and winter. It dies out in the heat of spring and summer.
- **Brown-top millet** is used as a warm season, temporary grass in much of the State, although it can be grown as a permanent grass in South Florida. Other species of millet should not be used as temporary grasses because they are too competitive. Do **not** exceed the recommended seeding rates when planting brown-top millet. A too-dense stand of millet can overshadow the growing permanent turf grass seedlings, thus could hinder their growth or cause them to die.

Sodding. Many urban areas as well as roadside slopes are sodded rather than seeded. Although sodding is more expensive than seeding or sprigging, under favorable conditions it forms a completely established turf soon after planting. In North Florida, sod may be planted from early spring (April) through late summer (August). In Central and South Florida, sod may be planted year around. Sod should not, however, be planted during very dry weather or when freezing temperatures are expected.

Sod is preferable when a quickly established turf is desired or necessary. It is preferred for steep slopes, ditch bottoms and other areas subject to erosion, as well as at areas which are highly visible and used by the public such as rest and recreation areas, landmarks and along the right-of-way shoulder in urban areas. Choose a sod variety that suits the environmental conditions at the site and the purpose for which the turf is to be established. In addition, make sure that any sod purchased is weed and nematode free.

Before the sod is placed, the site should be prepared to provide an optimum growing environment. The site should be properly tilled and graded; it should be firmed by rolling and any depressions dressed out with extra soil to provide a smooth, uniform surface upon which to lay the sod. Fertilizer may be added to supply the nutrients necessary for healthy growth. For best rooting, the soil should be moist, but not wet, at the time the sod is placed to avoid placing the roots in contact with excessively dry soil.

Seeding. Seeding is the standard form of rural highway turf grass installation. Seed quality will affect the seeding rate of grasses. Low percentages of purity and germination will reduce the number

of viable seeds in any lot of grass seed and require heavier rates to compensate for the reduction. Seed for permanent turf grasses should be applied to a well-prepared site and distributed uniformly over the site in relatively large quantities. A general guideline is to apply a sufficient number of pure, live seed to develop approximately 1,500 seedlings per square meter. When seeding rates are too high, the resulting seedling stands may be so dense that individual plants fail to develop properly because of competition for available nutrients.

Fairly low seeding rates should be used with temporary grasses such as ryegrass. If the stands of temporary grass are too thick, they may deprive the permanent grass seedlings of light and compete for important soil nutrients. See Table 3.

Research and experience have shown that for best results permanent grass seed must be placed 3 mm to 6 mm below the soil surface with a seed drill, rake or other appropriate implement. If seed is not placed into the soil, it is usually washed away by surface runoff, eaten by birds or rodents. When seed is placed too deep into the soil, the growing seedling's food reserves may be depleted before the seedling reaches the surface or before it can develop enough for photosynthesis (food production within the plant) to begin. (Bahia seed needs a soil temperature of 65 degrees to germinate. Bahia seed should not be fertilized for five weeks after germination.)

After seeding, the planting site should be lightly rolled to ensure firm contact between the seed and soil particles. It may be necessary to use an erosion-control material, such as a topcoat of hay, after seeding to help protect the soil from erosion and ensure seed germination.

Sprigging. Sprigs or runners can also be used as a means of propagating turf grasses. Sprigs with at least two nodes (joints) each are planted in rows with the nodes covered by 25 mm to 50 mm of soil. A portion of each sprig must be left exposed to the sunlight to allow photosynthesis to take place. Site preparation activities for sprigging are the same as those for sodding. After placement, rolling can be used to press the sprigs into the soil.

Table 3
SEED APPLICATION RATES
(KILOGRAMS PER HECTARE)

SEED TYPES		ZONE 1 (NORTH OF INTERSTATE 4)			
		COASTAL		INLAND	
		MARCH TO OCTOBER	NOVEMBER TO MARCH	MARCH TO OCTOBER	NOVEMBER TO MARCH
Permanent Grasses	Unhulled bermuda	6.8 kg	6.8 kg	4.5 kg	6.8 kg
	Argentine/Pensacola bahia	-	-	13.6 kg	13.6 kg
Temporary Grasses	Brown-top millet	9 kg	-	9 kg	-
	Annual ryegrass	-	9 kg	-	9 kg
Note: Bahia 1.814 kg - 3.628 kg per 93 sq m; bermuda 1.814 kg - 3.628 kg per 93 sq m. When seeding centipede grass, use approximately 5 kg of seed per hectare. Centipede may be seeded from April to September throughout Florida.					

SEED TYPES		ZONE 2 (SOUTH OF INTERSTATE 4)			
		COASTAL		INLAND	
		MARCH TO OCTOBER	NOVEMBER TO MARCH	MARCH TO OCTOBER	NOVEMBER TO MARCH
Permanent Grasses	Unhulled bermuda	6.8 kg	6.8 kg	4.5 kg	6.8 kg
	Argentine/Pensacola bahia	-	-	13.6 kg	13.6 kg
Temporary Grasses	Brown-top millet	9 kg	-	9 kg	-
	Annual ryegrass	-	9 kg	-	9 kg
Note: Bahia 1.814 kg - 3.628 kg per 93 sq m; bermuda 1.814 kg - 3.628 kg per 93 sq m. When seeding centipede grass, use approximately 5 kg of seed per hectare. Centipede may be seeded from April to September throughout Florida.					

Plant Species Selection Guide

The guide for plant species selection was developed in table form. The following chart gives the legends used on the recommended selection tables. This is only a listing of possible plant species frequently used in roadway landscape design. There are numerous other plants that can be used. Those usable on State highways is not limited to this list.

Plant Tables Legend:

DROUGHT TOLERANCE INDICATORS			
H = High	M = Moderate	L = Low	N = None
HEIGHT RANGE - GROUND COVERS			
S = Small	150 mm or under		
M = Medium	150 mm - 300 mm		
L = Large	300 mm - 500 mm		
VL = Very large	500 mm or greater		
HEIGHT RANGE - SHRUBS			
S = Small	0.5 m - 1.0 m		
M = Medium	1.0 m - 2.0 m		
L = Large	2.0 m - 4.0 m		
VL = Very large	4.0 m or greater		
HEIGHT RANGE - TREES			
S = Small	8.0 m or under		
M = Medium	8.0 m - 12.0 m		
L = Large	12.0 m - 18.0 m		
VL = Very large	18.0 m or greater		
GROWTH RATE			
F = Fast	M = Moderate	S = Slow	
HARDINESS ZONE			
N = North	C = Central	S = South	
SALT TOLERANCE			
H = High	M = Moderate	L = Low	N = None

Plant Tables Legend (continued):

PLANT TYPE			
D = Deciduous	C = Conifer	E = Evergreen	P = Palm
SD = Semi-deciduous			
FLOWER COLOR/FRUIT			
B = Blue	I = Inconspicuous	P = Pink	Y = Yellow
F = Fruit	L = Lavender	U = Purple	
G = Green	O = Orange	W = White	
STANDING WATER TOLERANCE			
H = High	(tolerates surface water table)		
M = Medium	(tolerates intermittent surface water table)		
L = Low	(low tolerance of surface water table)		
NUTRITIONAL REQUIREMENT			
H = High	M = Moderate	L = Low	
pH TOLERANCE			
AK = Alkaline (high pH preferred)	AC = Acid (low pH preferred)	W = Wide tolerance	
ABILITY TO REGENERATE (after damage or pruning)			
H = High	M = Moderate	L = Low	
LIGHT REQUIREMENT			
H = High	L = Low	W = Wide tolerance	
MAINTENANCE REQUIREMENT			
H = High	M = Moderate	L = Low	
SYMBOL KEY			
+ = Most desirable		* = Native	

Table 4

RECOMMENDED HIGHWAY PLANT MATERIALS - GROUND COVERS

GROUND COVERS

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Asparagus densiflorus 'sprengeri'</i>	Asparagus fern		L	F	CS	M	E	I	M	L	W	H	W	L	Do not shear. Invasive: use in isolated beds.
<i>Canavalia maritima</i>	Beach bean *	H	M	F	S	H	E	U	M	L	W	H	W	L	
<i>Carissa macrocarpa</i>	Dwarf natal plum	H	L	S	S	H	E	W	L	M	W	L	H	M	
<i>Catharanthus roseus</i>	Madagascar periwinkle	H	M	M	CS	H	E	BPRUW	L	L	W	L	H	L	
<i>Chiococca pinnerarum</i>	Pineland snowberry *	H	L	S	S	L	E	I	L	L	AK	L	H	L	
<i>Crossopetalum ilicifolium</i>	Christmas berry *	H	L	S	S	L	E	I	L	L	AK	L	H	L	
<i>Ernandea littoralis</i>	Golden creeper *	H	L	S	S	H	E	I	L	L	W	L	H	L	
<i>Evolvulus glomeratus</i>	Blue daze	M	L	M	S	H	E	B	L	M	W	M	H	L	
<i>Gaillardia pulchella</i>	Blanket flower *	H	L	F	NCS	H	E	RY	L	L	W	L	H	L	Short lived.
<i>Gelsemium sempervirens</i>	Carolina yellow jasmine	H	L	F	NCS	N	E	Y	M	M	W	M	H	M	Aggressive vining plant.
<i>Helianthus debilis</i>	Beach sunflower + *	H	L	F	S	H	E	Y	L	L	W	M	H	L	Looks best if mowed in December.
<i>Hemerocallis spp.</i>	Daylily	H	L	F	NCS	M	D	ORUY	M	L	W	M	H	L	Garden plant/urban areas.
<i>Hymenocallis latifolia</i>	Spider lily *	L	VL	M	CS	H	E	W	H	L	W	M	W	L	
<i>Ilex vomitoria 'shillings'</i>	Dwarf yaupon holly + *	H	VL	S	NCS	H	E	I	H	L	W	L	H	L	
<i>Juniperus conferta</i>	Shore juniper +	H	L	M	NCS	H	C	-	L	L	W	L	H	L	Roadside stress allows frequent Red Spider attacks.

+ = Most Desirable

* = Native

Table 4

RECOMMENDED HIGHWAY PLANT MATERIALS - GROUND COVERS

GROUND COVERS

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Lantana montevidensis</i>	Trailing lantana	H	L	F	CS	H	E	LU	M	L	W	M	H	L	Possible pest.
<i>Lantana ovalifolia</i>	Dwarf lantana *	H	M	S	CS	H	E	Y	M	L	W	L	H	L	Possible pest.
<i>Licania michauxii</i>	Gopher apple *	H	M	M	NCS	H	E	I	M	L	W	L	H	L	
<i>Liriope muscari</i>	Liriope	H	M	M	NCS	H	E	L	M	L	W	M	W	L	
<i>Liriope muscari 'giant'</i>	Giant liriope +	H	VL	F	NCS	M	E	L	M	L	W	M	W	L	
<i>Ophiopogon japonicus</i>	Mondo grass	H	S	S	NCS	H	E	I	M	L	W	L	W	L	
<i>Portulaca grandiflora</i>	Purslane	H	S	M	NCS	M	D	OPRY	L	L	W	M	H	L	Bedding plant/urban use.
<i>Rhoeo spathacea</i>	Oyster plant	H	M	F	S	H	E	I	M	L	W	M	W	L	Invasive: use in isolated beds.
<i>Russelia equisetiformis</i>	Firecracker plant +	H	VL	F	CS	H	E	R	L	L	W	F	H	L	Invasive: use in isolated beds.
<i>Setcreasea pallida</i>	Purple queen	H	M	F	CS	H	E	LP	L	L	W	F	W	L	
<i>Trachyllopernum asiaticum</i>	Asiatic jasmine +	H	S	F	NCS	M	E	-	M	L	W	F	W	L	
<i>Vaccinium myrsinites</i>	Shiny blueberry *	H	L	S	NCS	L	E	I	M	L	AC	S	W	L	
<i>Wedelia trilobata</i>	Wedelia	H	M	F	CS	H	E	Y	H	L	W	F	W	L	Tolerates high mowing. Invasive: use in isolated beds.
<i>Yucca smalliana</i>	Beargrass	M	L	M	NC	M	E	W	L	L	W	M	W	L	Does not produce solid cover.
<i>Zamia floridana</i>	Coontie *	H	VL	S	NCS	H	E	-	M	L	W	F	W	L	

+ = Most Desirable

* = Native

Table 5

RECOMMENDED HIGHWAY PLANT MATERIALS - SHRUBS

SHRUBS

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Abelia x grandiflora</i>	Glossy abelia	H	M	M	NC	M	E	P	M	L	W	M	W	L	
<i>Acalypha wilkesiana</i>	Copperleaf	H	L	F	CS	L	E	I	M	L	W	H	W	L	
<i>Borrchia arborescens</i>	Silver sea oxeye *	H	S	S	S	H	E	Y	L	L	W	M	H	L	
<i>Caesalpinia pulcherrima</i>	Dwarf poinciana	H	L	F	CS	M	D	OY	L	L	W	M	H	L	Short lived.
<i>Callicarpa americana</i>	Beauty berry *	H	M	M	NCS	L	E	F	M	L	W	M	W	L	Ornamental berries.
<i>Capparis cynophallophora</i>	Jamaican caper *	H	L	M	S	H	D	PW	L	L	W	M	W	L	
<i>Casasia clusifolia</i>	Seven-year apple *	H	L	S	S	H	E	W	M	L	W	M	W	L	
<i>Cephalanthus occidentalis</i>	Buttombush *	L	VL	F	CS	N	D	W	H	L	W	H	W	L	
<i>Cleyera japonica</i>	Cleyera	M	L	S	NC	N	E	F	M	L	W	L	W	L	
<i>Coccoloba uvifera</i>	Sea grape + *	H	VL	F	CS	H	E	I	M	L	W	H	W	L	
<i>Codiaeum variegatum</i>	Croton	M	M	M	CS	H	E	I	M	L	W	M	W	L	
<i>Cortaderia selloana</i>	Pampas grass	H	M	F	NCS	H	E	W	M	L	W	H	W	L	
<i>Dracena fragrans 'massangeana'</i>	Corn plant	H	VL	F	S	L	E	I	M	M	W	H	W	L	
<i>Duranta repens</i>	Golden dewdrop +	H	L	F	NCS	L	E	BWF	L	L	W	H	H	L	
<i>Elaeagnus pungens</i>	Silverthorn +	H	L	F	NCS	H	E	I	M	L	W	H	W	L	
<i>Eugenia spp.</i>	Stoppers + *	H	L	M	CS	H	E	I	L	L	W	M	W	L	

+ = Most Desirable

* = Native

Table 5

RECOMMENDED HIGHWAY PLANT MATERIALS - SHRUBS

SHRUBS

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Forestiera segregata</i>	Florida privet *	H	L	S	CS	H	D	I	M	L	W	L	W	L	
<i>Hamelia patens</i>	Scarletbush *	H	L	F	CS	M	E	R	M	L	W	H	W	L	
<i>Ilex cornuta 'burfordii'</i>	Burford holly	H	L	M	NC	M	E	F	M	L	W	M	W	L	
<i>Ilex cornuta 'burfordii nana'</i>	Dwarf burford holly	H	S	M	NCS	M	E	I	M	L	W	M	W	L	
<i>Ilex cornuta 'rotunda'</i>	Dwarf chinese holly	H	S	S	NC	M	E	I	M	L	W	M	W	L	
<i>Ilex crenata</i>	Japanese holly	H	M	M	N	M	E	I	M	L	W	M	W	L	
<i>Ilex vomitoria</i>	Yaupon holly	H	S	M	NCS	H	E	I	M	L	W	M	W	L	
<i>Jacquinia keyensis</i>	Joewood *	H	L	S	S	H	E	YW	M	L	W	L	W	L	
<i>Jasminum humile</i>	Yellow jasmine	M	VL	F	NCS	N	E	Y	M	L	W	H	W	L	
<i>Jasminum mesnyi</i>	Primrose jasmine +	M	L	F	NCS	N	E	Y	M	L	W	H	W	L	
<i>Juniperus chinensis 'blue vase'</i>	Blue vase juniper	H	L	M	NCS	H	C	-	L	L	W	M	H	L	
<i>Juniperus chinensis 'hetzii'</i>	Hetzii juniper	H	L	F	NCS	H	C	-	L	L	W	M	H	L	
<i>Juniperus chinensis 'mini julep'</i>	Mini julep juniper	H	S	M	NCS	H	C	-	L	L	W	M	H	L	
<i>Juniperus parsonii</i>	Parson's juniper +	H	S	M	NCS	H	C	-	L	L	W	M	H	L	
<i>Leucophyllum frutescens</i>	Texas sage	H	M	M	NCS	M	E	L	L	L	W	M	H	L	
<i>Ligustrum japonicum</i>	Japanese privet	M	L	F	NCS	M	E	W	L	L	W	M	W	L	

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Table 5

RECOMMENDED HIGHWAY PLANT MATERIALS - SHRUBS

SHRUBS

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Lycium caroliniana</i>	Christmas berry *	H	M	M	NCS	H	E	I	M	L	W	M	H	L	
<i>Lyonia ferruginea</i>	Rusty lyonia *	H	L	S	NCS	L	E	I	L	L	W	L	H	L	
<i>Mallotonia gnaphalodes</i>	Sea lavender *	H	M	S	S	H	E	I	L	L	W	L	H	L	
<i>Malvaviscus arboreus</i>	Turk's cap +	H	L	F	NCS	M	E	R	M	L	W	H	W	L	
<i>Murraya paniculata</i>	Orange jessamine	H	S	S	S	N	E	W	M	M	W	M	H	L	Invasive: use in isolated beds.
<i>Myrica cerifera</i>	Southern wax myrtle *	H	L	F	NCS	H	E	I	H	L	W	H	H	L	Disease prone; nursery-grown preferred.
<i>Myrsine guianensis</i>	Rapanea *	H	VL	M	NCS	H	E	I	M	L	W	M	W	L	
<i>Nandina domestica</i>	Nandina	H	M	M	NC	L	E	WF	M	L	W	M	W	L	
<i>Nerium oleander</i>	Oleander +	H	L	F	CS	H	E	PRWY	M	L	W	H	H	L	
<i>Nerium oleander</i> (dwarf cultivars)	Dwarf oleander	M	M	M	CS	H	E	PW	M	L	W	M	H	L	Avoid shearing.
<i>Osmanthus americanus</i>	Wild olive *	M	L	S	NC	H	E	I	M	L	W	L	W	L	
<i>Pithecellobium guadelupense</i>	Blackbead *	H	VL	M	CS	H	E	PW	M	L	W	M	W	L	List under trees (HT = S).
<i>Pithecellobium unguis-cati</i>	Cat's claw *	H	VL	M	CS	H	E	I	M	L	W	M	W	L	List under trees (HT = S).
<i>Prunus angustifolia</i>	Chickasaw plum *	H	VL	M	NC	N	D	WF	M	L	W	M	H	L	List under trees (HT = S).
<i>Pyracantha coccinea</i>	Fire thorn	H	L	F	NC	L	E	WF	M	L	W	H	H	L	

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SHRUBS

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Rhus copallinum</i>	Shining sumac *	H	L	F	NCS	L	D	F	M	L	W	M	W	L	
<i>Ruaphiolepis indica</i>	India hawthorn +	H	S	M	NCS	H	E	WP	L	L	W	M	W	L	
<i>Sabal minor</i>	Dwarf palmetto + *	H	M	S	NCS	H	E	W	H	L	W	L	W	L	Fire damaged foliage, regrows quickly.
<i>Savia bahamensis</i>	Maidenbush *	H	L	S	S	H	E	I	M	L	W	L	W	L	
<i>Scaevola taccata</i>	Scaevola *	H	L	F	S	H	E	W	M	L	W	H	H	L	Fire damaged foliage, regrows quickly.
<i>Serenoa repens</i>	Saw palmetto +	H	M	S	NCS	H	P	W	H	L	W	L	W	L	
<i>Severinia buxifolia</i>	Boxthorn +	H	M	M	NCS	H	E	I	M	L	W	M	W	L	
<i>Spartina bakeri</i>	Sand cordgrass *	H	S	M	CS	H	E	I	H	L	W	M	H	L	
<i>Suriana maritima</i>	Bay cedar *	H	L	S	CS	H	E	I	L	L	W	L	H	L	
<i>Tecoma stans</i>	Yellow elder + *	H	L	F	CS	M	E	Y	M	L	W	H	W	L	
<i>Tetrazygia bicolor</i>	Florida tetrazygia *	H	L	M	S	M	E	W	L	L	W	L	W	L	
<i>Vigurnum obovatum</i>	Blackhaw *	M	L	M	NCS	L	E	W	M	L	W	M	W	L	
<i>Yucca aloifolia</i>	Spanish bayonet *	H	L	M	NCS	H	E	W	M	L	W	M	H	L	Spiny - locate with caution.
<i>Yucca gloriosa</i>	Mound-lily yucca	H	M	M	NCS	M	E	W	L	L	W	L	H	L	Spiny leaves - dangerous.
<i>Zamia furfuracea</i>	Cardboard cycad	H	S	S	CS	H	E	-	M	L	W	L	H	L	

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Table 6

RECOMMENDED HIGHWAY PLANT MATERIALS - TREES

TREES

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Acer barbatum</i>	Florida maple *	M	M	M	NC	N	D	I	L	M	W	H	W	L	Excellent under used native.
<i>Acer rubrum</i>	Red maple *	M	M	M	NCS	N	D	R	H	M	W	H	W	L	Form varies among seedlings. Borer. Red/orange fall color.
<i>Acrocomia aculeata</i>	Macaw palm	H	M	S	S	M	P	I	M	M	W	L	H	L	
<i>Beaucarnea recurvata</i>	Ponytail palm	H	S	S	S	M	P	W	M	M	W	L	H	L	
<i>Betula nigra</i>	River birch *	M	M	F	NC	L	D	I	H	M	W	H	W	M	Aphids in early spring. Very upright habit.
<i>Bulnesia arborea</i>	Bulnesia	H	M	M	S	N	E	Y							
<i>Bursera simaruba</i>	Gumbo-limbo *	H	M	F	S	M	SD	I	M	M	W	H	W	L	Good highway tree.
<i>Butia capitata</i>	Pindo palm	H	S	S	NCS	M	P	O	M	M	W	L	H	L	Showy fruits may be problem in pedestrian areas. Good.
<i>Callistemon viminalis</i>	Weeping bottlebrush	M	S	S	NCS	M	E	R	L	M	W	H	H	L	May be damaged by frost in some years.
<i>Canella alba</i>	Wild cinnamon	H	M	S	CS	M	E	W							
<i>Carpinus caroliniana</i>	American hornbeam *	M	S	M	NC	N	D	I	H	M	W	M	W	M	Excellent for utility lines or medians. Interesting bark.
<i>Carya aquatica</i>	Water hickory *	L	VL	S	NCS	N	D	I	H	M	W	M	W	M	Appearance similar to pecan.
<i>Carya glabra</i>	Pignut hickory *	H	L	M	NC	N	D	I	M	M	W	L	W	M	Large hard seeds. Excellent yellow fall color.
<i>Carya illinoensis</i>	Pecan	H	VL	M	N	N	D	I	H	M	W	L	W	M	Hard fruits. Pecan scab. Brittle wood. Interesting bark.

* = Native

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RECOMMENDED HIGHWAY PLANT MATERIALS - TREES

TREES

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Celtis laevigata</i>	Sugarberry *	M	VL	F	NCS	L	D	I	H	M	W	H	W	M	Relatively short lived. Interesting bark. Yellow fall color.
<i>Cercis canadensis</i>	Redbud *	M	S	M	NC	N	D	LPW	L	M	W	H	W	M	Many varieties available in red, pink and white. Spring bloom.
<i>Chamaerops humilis</i>	European fan palm	H	L	S	NCS	L	P	I	M	L	W	L	W	L	
<i>Chionanthus retusus</i>	Chinese fringe tree	H	S	S	NC	N	D	W	M	M	W	L	W	M	White flowers after <i>C. virginicus</i> . Mounding habit. Medians, utility.
<i>Chionanthus virginicus</i>	Fringe tree *	H	S	S	NC	N	D	W	M	M	W	L	W	M	Feathery texture spring flowers. Median or under utilities.
<i>Coccoloba diversifolia</i>	Pigeon plum *	M	M	M	S	M	E	W	M	M	AK	M	W	L	Good median or under utilities. Compact crown.
<i>Coccoloba uvifera</i>	Seagrape *	H	S	M	S	H	E	I	M	M	W	H	H	L	Fruits and flowers. Medians and utility lines.
<i>Coccothrinax argentata</i>	Silver palm *	H	S	S	S	H	P	I	M	M	W	L	H	L	Silvery foliage. Medians.
<i>Cochlospermum vitifolium</i>	Buttercup tree	H	M	F	S	M	D	G	L	M	W	M	H	M	Brittle, may break in strong wind. Median, utility, hedge.
<i>Cocos nucifera</i>	Coconut palm	H	VL	F	S	H	P	I	M	M	W	L	H	L	Heavy fruits.
<i>Conocarpus erectus</i>	Buttonwood *	H	M	M	S	H	E	I	M	M	W	H	H	L	
<i>Conocarpus erectus 'sericeus'</i>	Silver buttonwood *	H	S	M	S	H	E	I	M	M	W	H	H	L	Silvery foliage form of species. Less cold hardy than species.
<i>Cordia sebestena</i>	Geiger tree *	H	S	S	S	H	E	O	M	M	W	H	H	L	Erratic form. High maintenance where uniform growth is needed.

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Table 6

RECOMMENDED HIGHWAY PLANT MATERIALS - TREES

TREES

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Cornus florida</i>	Dogwood *	M	S	M	NC	L	D	W	L	M	W	L	W	M	Borers, anthracnose. Red/orange fall color.
<i>Crataegus spp.</i>	Hawthorn *	M	M	M	NC	N	D	W	L	M	AC	L	H	M	Early spring flowers, fall color varies, some spp. have thorns.
<i>Fagus grandifolia</i>	American beech *	M	L	S	N	N	D	I	L	M	W	L	W	M	Beautiful foliage and bark. Seeds small. Excellent tree.
<i>Frangipani spp.</i>	Frangipani	H	S	M	S	M	D	PWY	M	M	W	M	H	L	Many species available.
<i>Fraxinus pennsylvanica</i>	Green ash *	M	L	F	NC	M	D	I	M	M	W	L	W	L	Non-fruiting varieties are best.
<i>Gordonia lasianthus</i>	Loblolly bay *	L	M	M	NC	N	E	W	H	M	AC	H	H	M	Intolerant of poor environments. Scale insects may be problem.
<i>Guaiacum sanctum</i>	Lignum vitae *	H	S	S	S	M	E	B	M	M	W	L	H	L	Sometimes called "wood of life".
<i>Halesia diptera</i>	Silverbell *	M	S	S	N	N	D	W	M	M	AC	M	W	M	Under used, good urban tree. Interesting flowers in spring.
<i>Harpulia arborea</i>	Tulipwood	H	L	S	S	L	E	F	L	M	W	L	H	L	
<i>Hypelate trifolia</i>	White ironwood	H	M	S	CS	N	E	I							
<i>Ilex cassine</i>	Dahoon holly	L	M	M	NCS	M	E	F							
<i>Ilex opaca</i>	American holly *	H	M	M	NCS	M	E	F	M	M	W	H	W	M	Excellent for medians or under utility lines.
<i>Ilex vomitoria</i>	Yaupon holly *	H	S	F	NCS	H	E	F	M	M	W	H	W	M	Excellent for medians or under utilities. Black berries.

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TREES

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Ilex vomitoria 'pendula'</i>	Weeping holly *	H	S	M	NCS	H	E	F	M	M	W	H	W	M	Interesting weeping habit, very distinctive in medians, other.
<i>Ilex x 'savannah'</i>	Savannah holly	M	M	F	NC	N	E	F	M	M	W	H	W	M	Profuse berries. Scales may be a problem. Median, utility areas.
<i>Juglans nigra</i>	Black walnut *	M	VL	M	N	L	D	I	M	M	W	L	W	M	Large fleshy nut. Feathery texture, dark bark.
<i>Juniperus silicicola</i>	Southern red cedar *	H	M	F	NCS	H	C	I	M	M	W	L	H	M	Some fungal problems. Transplants well. Excellent buffer.
<i>Koelreuteria formosana</i>	Goldenrain tree	H	L	F	NCS	N	D	Y	M	M	W	H	H	M	Frost damage in some years. Fruits showy in fall.
<i>Lagerstroemia indica</i>	Crape myrtle	H	S	F	NCS	L	D	LPW	L	M	W	H	H	M	Excellent for medians or utilities. Nat. Arboretum varieties best.
<i>Lagerstroemia speciosa</i>	Queen's crape myrtle	H	M	F	S	N	D	P							
<i>Latania spp.</i>	Latan palm	H	S	M	S	M	P	I							
<i>Licuala grandis</i>	Licuala palm	L	S	S	S	L	P	I							
<i>Ligustrum japonicum</i>	Japanese privet	H	S	M	NCS	N	E	W	M	M	W	H	W	M	Scales, whitefly, leaf spot may be problem on stressed plants.
<i>Ligustrum lucidum</i>	Tree ligustrum	M	M	F	NCS	N	E	W	M	M	W	H	W	M	Same as above.
<i>Liquidambar styraciflua</i>	Sweetgum *	H	L	F	NCS	N	D	I	H	M	W	H	W	M	Good fall color red to purple. Fruits may be problem.
<i>Liriodendron tulipifera</i>	Tulip poplar *	L	VL	F	NC	N	D	Y	H	M	AC	L	W	M	

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RECOMMENDED HIGHWAY PLANT MATERIALS - TREES

TREES

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Livistona chinensis</i>	Chinese fan palm	H	M	M	CS	M	P	I	M	M	W	L	H	L	
<i>Macadamia integrifolia</i>	Macadamia nut	H	S	S	S	N	E	I	L	M	W	L	H	L	
<i>Magnolia grandiflora</i>	Southern magnolia *	M	L	M	NC	M	E	W	M	M	W	L	W	M	Large leathery leaves may be problem.
<i>Magnolia soulangeana</i>	Saucer magnolia	M	S-M	M	N	L	D	PW	L	M	W	L	H	L	Spectacular early spring flowers. Good for medians, power lines.
<i>Magnolia virginiana</i>	Sweetbay *	M	M	M	NCS	N	SD	W	H	M	AC	H	W	M	Silvery-backed leaves. Smooth bark.
<i>Maringa oleifera</i>	Horsedialh tree	H	S	F	S	N	E	W							
<i>Mastichodendron foetidissima</i>	Mastic tree *	H	L	S	S	M	SD	I							
<i>Milletia ovalifolia</i>	Milletia	H	M	M	S	N	E	P							
<i>Minusops elengi</i>	Spanish cherry *	M	M	M	S	N	E	I							
<i>Mycanthes fragrans</i>	Twiberry	H	S	M	S	H	E	I							
<i>Myrica cerifera</i>	Wax myrtle *	H	S	F	NCS	H	E	I	M	M	W	H	W	M	Wildlife value. Good buffer. Median or utility planting.
<i>Noronia enarginata</i>	Madagascar olive	H	S	S	S	H	E	I	L	M	W	L	H	L	
<i>Nyssa sylvatica</i>	Black tupelo *	M	VL	M	NCS	N	D	I	H	M	W	L	W	M	Tolerates wide range of habitats. Excellent red fall color.
<i>Ochrosia elliptica</i>	Ochrosia	H	S	M	S	H	E	I	M	M	W	L	H	L	Red fruits.

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<i>Ostrya virginiana</i>	American hopbarn beam *	H	M	M	NC	N	D	Y	M	M	W	L	W	M	Interesting leaves, bark, fruits. Excellent under used.
<i>Pandanus utilis</i>	Screw pine	M	S	S	S	H	E	I	M	M	W	H	H	L	
<i>Parkinsonia aculeata</i>	Jerusalem thorn	H	S	F	NCS	M	D	Y	L	M	W	H	H	M	Thorns problem near pedestrian. May freeze back in north.
<i>Persea borbonia</i>	Redbay *	M	S	M	NCS	M	E	I	M	M	W	L	W	M	Under used. Should be tried more often.
<i>Phoenix canariensis</i>	Canary date palm	M	L	S	NCS	M	P	I	M	M	W	L	H	L	Large majestic palm.
<i>Phoenix reclinata</i>	Sengal date palm	M	M	M	CS	M	P	W	M	M	W	L	W	L	
<i>Phoenix rupicola</i>	Cliff date palm	H	M	S	S	M	P	I							
<i>Phoenix sylvestris</i>	Wild date palm	H	M	S	CS	M	P	I							
<i>Photinia glabra</i>	Redleaf photinia	H	S	F	NC	N	E	W							
<i>Photinia serrulata</i>	Chinese photinia	H	S	M	N	N	E	W	M	M	W	H	W	M	Showy clusters of white flowers. Median or utility use. Buffer.
<i>Pinus clausa</i>	Sand pine *	H	L	F	NCS	H	C	I	L	M	AC	L	H	M	May be sheared to thicken.
<i>Pinus elliotii</i>	Slash pine *	H	VL	F	NCS	M	C	I	M	M	AC	L	H	M	Fungal disease may be problem.
<i>Pinus palustris</i>	Longleaf pine *	H	VL	M	NCS	N	C	I	M	M	AC	L	H	M	Excellent native pine.
<i>Pinus taeda</i>	Loblolly pine *	H	VL	M	NC	N	C	I	H	M	AC	L	H	M	Fungal disease may be problem.
<i>Piscidia piscipula</i>	Jamaican dogwood *	H	M	F	S	H	SD	LW	M	M			H	L	

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RECOMMENDED HIGHWAY PLANT MATERIALS - TREES

TREES

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Pittisporum ferrugineum</i>	Rusty pittisporum	H	L	F	CS	N	E	I							
<i>Podocarpus gracilior</i>	Weeping yew	L	M	S	CS	M	E	I	L	M	W	L	W	L	Silvery new growth.
<i>Populus deltoides</i>	Eastern cottonwood *	M	L	F	NC	L	D	I	H	M	W	H	H	L	
<i>Prunus angustifolia</i>	Chickasaw plum *	H	S	F	NC	L	D	W	M	M	W	H	H	L	Small edible fruits and some thorns. Median and utility lines.
<i>Prunus caroliniana</i>	Cherry laurel *	H	S	F	NCS	L	E	W	L	M	W	H	W	L	
<i>Prunus umbellata</i>	Flatwoods plum *	H	S	M	NC	N	D	W	L	M	AC	L	W	M	Needs wider use to evaluate as urban plant.
<i>Pseudophoenix sargentii</i>	Buccaneer palm	H	S	S	S	H	E	I							
<i>Ptychosperma macarthurii</i>	MacArthur palm	M	S	F	S	N	E	I							
<i>Quercus acuta</i>	Japanese oak	H	M	M	NC	L	E	I	L	M	W	L	H	M	Smooth bark, evergreen.
<i>Quercus chapmanii</i>	Chapman oak *	H	M	S	CS	M	D	I							
<i>Quercus hemisphaerica</i>	Laurel oak *	H	L	F	NCS	L	SD	I	M	M	W	H	W	M	Hardy evergreen oak.
<i>Quercus laevis</i>	Turkey oak *	H	M	S	NCS	M	D	I	L	M	AC	L	W	M	Red fall color.
<i>Quercus michauxii</i>	Swamp chestnut oak *	M	VL	M	NC	L	D	I	L	M	W	L	W	L	Large acorns. Interesting bark. Syn: Q. michauxii.
<i>Quercus myrtifolia</i>	Myrtle oak *	H	S	S	NCS	M	E	I							
<i>Quercus nigra</i>	Water oak *	H	VL	F	NC	L	SD	I	M	M	W	L	W	L	Tardily deciduous. Smooth bark. Very small acorns.

* = Native

Table 6

RECOMMENDED HIGHWAY PLANT MATERIALS - TREES

TREES

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Quercus shumardii</i>	Shumard oak *	H	VL	F	NC	N	D	I	L	M	W	L	W	L	Compact round form. Good red fall color. Large acorns.
<i>Quercus virginiana</i>	Live oak *	H	L	M	NCS	M	SD	I	M	M	W	L	W	L	Excellent urban tree.
<i>Sabal palmetto</i>	Cabbage palm *	H	L	S	NCS	H	P	Y	M	M	W	L	H	L	Florida state tree.
<i>Senolobium stans</i>	Yellow elder	H	S	F	S	L	D	Y	M	M	W	H	H	L	
<i>Swietenia mahogani</i>	Mahogany *	H	L	M	S	H	E	I	M	M	AK	L	H	L	Heavy fruits.
<i>Syagrus schizophylla</i>	Arikury palm	H	S	S	S	M	P	I							
<i>Tabebuia rosea</i>	Pink trumpet tree	M	L	M	S	M	SD	PW	L	M	W	L	H	L	Deciduous individuals have more profuse flowers.
<i>Tabebuia spp.</i>	Trumpet tree	H	S	M	CS	M	SD	Y	L	M	W	L	H	L	
<i>Tamarindus indica</i>	Indian tamarind	M	VL	M	S	N	E	I	M	M	W	L	H	L	Wind tolerant.
<i>Taxodium ascendens</i>	Pond cypress *	M	L	M	NCS	M	D	I	H	M	W	H	H	L	May have "knees".
<i>Taxodium distichum</i>	Bald cypress *	M	L	M	NCS	M	D	I	H	M	W	H	H	L	May have "knees" in wet, poorly aerated or shallow soil.
<i>Terminalia catappa</i>	Tropical almond	H	M	M	S	H	D	I	M	M	W	L	H	L	
<i>Thrinax radiata</i>	Thatch palm *	H	M	S	S	H	P	I	M	M	W	L	H	L	Good for medians and under utility lines.
<i>Trachycarpus fortunei</i>	Windmill palm	M	S	S	NCS	M	P	I	L	M	W	L	H	L	Medians and utility lines.

* = Native

Table 6

RECOMMENDED HIGHWAY PLANT MATERIALS - TREES

TREES

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	HEIGHT RANGE	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Ulmus alata</i>	Winged elm *	M	M	M	NC	M	D	I	L	M	W	L	H	L	Interesting winged bark on branches. Good for medians.
<i>Ulmus americana</i> <i>'floridana'</i>	American elm *	H	L	F	NC	L	D	I	H	M	W	L	W	L	Dutch elm disease not in Florida. Typical vase shape.
<i>Ulmus parvifolia</i>	Chinese elm	H	M	F	NC	N	SD	I	M	M	W	L	W	L	Excellent for medians and some utilities. Good urban tree.
<i>Vetelia merrillii</i>	Moutgouery palm	M	M	F	S	M	P	I	M	M	W	L	H	L	
<i>Vetelia winin</i>	Winin palm	H	L	F	S	M	P	I	M	M	W	L	H	L	
<i>Viburnum rufidulum</i>	Rusty blackhaw *	H	S	S	NC	N	D	W	L	M	W	L	W	L	Under used. Prolific flowers in sun. Interesting leaves.
<i>Washingtonia robusta</i>	Washington palm	H	VL	F	NCS	M	P	I	M	M	W	L	W	L	
<i>Ximenia americana</i>	Tallowwood plum *	H	S	M	S	H	P	I	M	M	W	L	W	L	
<i>Zanthoxylum fagara</i>	Wild lime *	H	S	M	CS	H	E	I	M	M	W	L	H	L	Thorns.

* = Native

Table 7

RECOMMENDED HIGHWAY PLANT MATERIALS - VINES

VINES

BOTANICAL NAME	COMMON NAME	DROUGHT TOLERANT	GROWTH RATE	HARD ZONE	SALT TOLERANT	PLANT TYPE	FLOWER COLOR	WATER TOLERANT	NUTRITION	pH TOLERANT	REGENERATION	LIGHT	MAINTENANCE	REMARKS
<i>Allamanda cathartica</i>	Yellow allamanda	H	F	CS	M	E	Y	L	M	W	H	W	L	Some micro-nutrient problem.
<i>Antigonon leptopus</i>	Coral vine +	H	F	NCS	M	E	P	M	L	W	H	W	L	Invasive: use in isolated beds.
<i>Bougainvillea spp.</i>	Bougainvillea	H	F	CS	H	E	YLOPRWV	M	L	W	H	H	L	
<i>Campsis radicans</i>	Trumpet creeper +*	H	F	NC	M	D	O	M	L	W	H	W	L	
<i>Ficus pumila</i>	Creeping fig	H	F	NCS	H	E	I	M	L	W	H	W	L	Small leaf - form lost unless sheared.
<i>Gelsemium sempervirens</i>	Carolina jessamine *	H	F	NCS	L	SE	Y	H	L	W	H	W	L	
<i>Lonicera japonica</i>	Japanese honeysuckle +	H	F	NCS	N	E	Y	M	L	W	H	W	L	Invasive: use in isolated beds.
<i>Lonicera sempervirens</i>	Coral honeysuckle *	H	F	NCS	N	E	R	M	L	W	H	W	L	Invasive: use in isolated beds.
<i>Pyrostegia venusta</i>	Flame vine	H	F	CS	L	E	O	M	L	W	H	W	L	
<i>Senecio confusus</i>	Mexican flame +	H	F	CS	L	E	O	M	L	W	H	W	L	
<i>Thunbergia grandiflora</i>	Skyflower	H	F	CS	L	E	BW	M	L	W	H	W	L	
<i>Trachelospermum asiaticum variegated</i>	Variegated asiatic jasmine	H	M	NCS	L	E	J	M	L	W	H	W	L	
<i>Trachelospermum jasminoides</i>	Confederate jasmine +	H	F	NCS	M	E	W	M	L	W	H	W	L	
<i>Trachelospermum jasminoides variegated</i>	Variegated confederate jasmine	H	F	NCS	M	E	W	M	L	W	H	W	L	
<i>Urechites lutea</i>	Yellow mandevilla *	H	F	S	H	E	Y	M	M	W	H	W	L	
<i>Wisteria sinensis</i>	Wisteria	H	F	NC	N	D	L	M	L	W	H	W	L	

+ = Most Desirable

* = Native

NOXIOUS PLANTS

Weed Identification

It is important that the landscape design identify existing noxious plant communities. The FDOT is concerned with the introduction or release of plant pests, noxious weeds, arthropods and biological control agents, and follows the requirements of the Florida Department of Agriculture and Consumer Services, Rule Chapter 5B-57, *Introduction or Release of Plant Pests, Noxious Weeds, Arthropods, and Biological Control Agents*. The purpose of this rule is to control the introduction, movement, or spread within the State of these biological agents. These materials can be destructive to Florida's native habitat and become overpowering in introduced planting areas.

The focus of this Guide is on the landscape of roadway corridors and the materials utilized in accomplishing that purpose. This section will deal with description and identification of unwanted and invasive plant materials, while later chapters will discuss the maintenance methods for controlling them.

- A **Noxious Plant** is a weed specified by law as being especially undesirable, troublesome and difficult to control. These plants can also be invasive, environmental and health hazards, and can cause economic hardship. These plant materials include grasses, vines, trees and shrubs, and are generally perennial growers and include trees such as Brazilian pepper and punk trees. Some of these plant materials are non-cultivated species; while others are cultivated or introduced species that are undesirable for various reasons. None of these plant materials should ever be used within horizontal clearance limits and clear-sight distances, and should not be used in other highway landscape applications without specific approval of the FDOT District Vegetation Specialist (see Table 9 for the list of noxious plant materials).
- A **Weed** is a plant growing where it is not desired. Plants are considered weeds when they interfere with activities of man or his welfare. Any plant that is a hazard, nuisance or causes injury to man, his animals or his desired crops, is considered a weed (see Tables 8 and 10 for common grass, broadleaf and aquatic weeds).

Table 8
COMMON GRASS AND BROADLEAF WEEDS

GRASSES AND GRASSLIKE WEEDS		BROAD-LEAVED WEEDS	
BOTANICAL NAME	COMMON NAME	BOTANICAL NAME	COMMON NAME
<i>Andropogon spp.</i>	Broom Sedge	<i>Ambrosia artemesiifolia</i>	Ragweed
<i>Brachiaria mutica</i>	Paragrass	<i>Bidens alba</i>	Spanish needle
<i>Cenchrus echinatus</i>	Sandbur	<i>Cassia occidentalis</i>	Coffeeweed (Wild senna)
<i>Chloris gayana</i>	Rhodes grass	<i>Chenopodium album</i>	Pigweed
<i>Dactyloctenium aegyptium</i>	Crowfoot grass	<i>Cirsium spp.</i>	Thistle (all species)
<i>Digitaria decumbens</i>	Pangola	<i>Crotalaria spectabilis</i>	Crotalaria
<i>Digitaria spp.</i>	Crab grass	<i>Descurainia pinnata</i>	Tansy mustard
<i>Eleusine indica</i>	Goose grass	<i>Desmodium spp.</i>	Common beggarweed
<i>Imperata cylindrica</i>	Cogon grass	<i>Equisetum hyemale</i>	Horsetail
<i>Panicum maximum</i>	Guinea grass	<i>Eupatorium capillifolium</i>	Dog fennel
<i>Panicum repens</i>	Torpedo grass	<i>Pluchea odorata</i>	Camphorweed
<i>Paspalum dilatatum</i>	Dallis grass	<i>Salidago canadensis</i>	Goldenrod
<i>Paspalum urvillei</i>	Vasey grass	<i>Sesbania emerus or Sesbania exaltata</i>	Sesbania
<i>Pennisetum purpureum</i>	Napier grass	<i>Smilax spp.</i>	Briars
<i>Phragmites australis</i>	Giant reed grass		
<i>Sorghum halepense</i>	Johnson grass		
<i>Sporobolus poiretti</i>	Smut grass		

Table 9
NOXIOUS PLANT MATERIALS

(Plants to avoid using without specific approval from the FDOT District Vegetation Specialist)

BOTANICAL NAME	COMMON NAME	BOTANICAL NAME	COMMON NAME
<i>Abrus precatorius</i>	Rosary pea	<i>Ficus retusa</i>	Indian laurel
<i>Acacia auriculiformis</i>	Earleaf acacia	<i>Ficus species</i>	Ficus
<i>Albizia julibrissin</i>	Mimosa tree	<i>Grevillea robusta</i>	Silk oak tree
<i>Albizia lebeck</i>	Woman's tongue	<i>Hibiscus tiliaceus</i>	Mahoe
<i>Araucaria heterophylla</i>	Norfolk Island pine	<i>Jacaranda acutifolia</i>	Jacaranda
<i>Ardisia solanacea</i>	Shoebutton ardisia	<i>Jasminum dichotomum</i>	Gold coast jasmine
<i>Bauhinia species</i>	Orchid tree	<i>Jasminum fluminense</i>	Tri-foliolate jasmine
<i>Bischofia javanica</i>	Toog	<i>Kalanchoe pinnata</i>	Life plant
<i>Brassaia actinophylla</i>	Schefflera/umbrella	<i>Leucaena leucocephala</i>	Lead tree
<i>Broussonetia papyrifera</i>	Paper mulberry	<i>Manilkara zapota</i>	Sapodilla
<i>Calophyllum species</i>	Calophyllum	<i>Melaleuca quinquenervia</i>	Punk tree
<i>Cannabis species</i>	Cannabis	<i>Melia azedarach</i>	Chinaberry
<i>Casuarina equisetifolia</i>	Australian pine	<i>Metopium toxiferum</i>	Poisonwood
<i>Casuarina species</i>	Casuarina	<i>Mimosa pigra</i>	Catclaw mimosa
<i>Cestrum diurnum</i>	Day jessamine	<i>Morus rubra</i>	American mulberry
<i>Chrysalidocarpus lutescens</i>	Areca palm	<i>Neyraudia reynaudiana</i>	Burma reed
<i>Cinnamomum camphor</i>	Camphor tree	<i>Paederia foetida</i>	Skunk vine
<i>Clerodendrum species</i>	Clerodendrum	<i>Pueraria lobata</i>	Kudzu
<i>Colubrina asiatica</i>	Lather leaf	<i>Rhodomyrtus tomentosa</i>	Downy myrtle
<i>Dioscorea bulbifera</i>	Air potato	<i>Ricinus communis</i>	Castor bean
<i>Enterolobium cyclocarpum</i>	Ear tree	<i>Sanservieria hyacinthoides</i>	African bowstring hemp
<i>Eucalyptus species</i>	Eucalyptus	<i>Sapium sebiferum</i>	Chinese tallow tree
<i>Ficus altissima</i>	Council tree	<i>Schefflera actinophylla</i>	Schefflera
<i>Ficus benghalensis</i>	Banyan tree	<i>Schinus terebinthifolius</i>	Brazilian pepper tree
<i>Ficus benjamina</i>	Benjamin fig	<i>Solanum diphyllum</i>	Amatillo
<i>Ficus elastica</i>	India rubber tree	<i>Syngonium species</i>	Syngonium
<i>Ficus nitida</i>	India laurel fig	<i>Syzygium cumini</i>	Java plum

Table 10
AQUATIC WEEDS

BOTANICAL NAME	COMMON NAME	BOTANICAL NAME	COMMON NAME
<i>Alternanthera philoxeroides</i>	Alligator weed	<i>Monochoria hastata</i>	No common name
<i>Crassula helmsii</i>	Swamp stonecrop	<i>Monochoria vaginalis</i>	No common name
<i>Eichhornia (all spp.)</i>	Water hyacinth	<i>Myriophyllum spicatum</i>	Eurasian watermilfoil
<i>Hygrophila polysperma</i>	Hygro	<i>Nechamandra alternifolia</i>	No common name
<i>Ipomoea aquatica</i>	Water spinach	<i>Pontederia rotundifolia</i>	Tropical pickerelweed
<i>Ipomoea fistulosa</i>	No common name	<i>Salvinia (all spp. except minima)</i>	Salvinia
<i>Lagarosiphon (all spp.)</i>	African elodea	<i>Sparganium erectum</i>	Exotic bur-reed
<i>Limnocharis flava</i>	Flowering rush	<i>Stratiotes aloides</i>	Water soldier (aloe)
<i>Limnophila sessiliflora</i>	Ambulia	<i>Trapa (all spp.)</i>	Water chestnut
<i>Melaleuca quinquenervia</i>	Melaleuca	<i>Vossia cuspidata</i>	Hippo grass
<i>Mimosa pigra</i>	Giant sensitive plant		

Noxious plants, and weeds are plants, growing in such a manner as to crowd out desired plants or disfigure a turf area. These unwanted plants do more than affect the appearance of a planting area, they disrupt the stabilizing capacity and overall function of the plant materials. Noxious plants and weeds also compete with desired plants and turf for valuable nutrients. The primary objective of highway erosion control is to establish a dense and permanent vegetative cover on areas adjacent to and effecting the highway. When this objective has been achieved, soil erosion will be minimal and roadsides will be safer for out-of-control vehicles. Weed growth can be a serious deterrent to the establishment of plant material and highway turf.

Weed Types

Weeds are classified by their life span and plant type. According to life span, weeds may be annual, biennial or perennial. **Annual weeds** grow from seed and complete their life cycles within one year. Goose grass and crab grass are two common annual weeds. **Biennial weeds**, such as wild carrot, complete their life cycles within a two-year period. **Perennial weeds** live for more than two years and can live indefinitely. Johnson grass and cogon grass are examples of perennial weeds.

Within these general classifications, weeds can be further identified by plant type. The three basic plant types are the grasses and grasslike plants, the broad-leaved weeds and the woody plants. **Grasses and grasslike weeds** include smut grass, vasey grass, johnson grass, various sedges and rushes. **Broad-leaved weeds** include ragweed, camphor weed and croton (see Table 8, Common Grass and Broadleaf Weeds).

Aquatic Weeds

Florida has a semi-tropical climate, 1.05 million hectares of interlaced waterways, and a thriving tropical aquarium plant importation and farming industry. These factors, along with a lack of safeguards before 1969, resulted in the introduction of exotic aquatic plants into many of Florida's waterways. Freed from the natural controls of their native countries, these aggressive plants have proliferated in our lakes, rivers, streams and retention ponds. Millions of dollars are spent each year in the control of these noxious weeds.

Florida Department of Environmental Protection, Rule Chapter 16C-52, *Florida Prohibited Aquatic Plants* was adopted in compliance with Florida Statutes, Chapter 369.25, *Invasive Non-Native Plants: Prohibition; Study; Removal; Rules*. This rule prohibits the importation, transportation, cultivation, collection, possession or retail sales of aquatic plants without first obtaining an aquatic plant permit from the Department of Natural Resources. Existing aquatic plants should be identified and removed according to proper removal procedure for each species if they are listed as a Florida Prohibited Aquatic Plant as shown on Table 10.

PRESERVATION OF EXISTING LANDSCAPE

Vegetation or natural areas that have been designated in the planning phase must now be incorporated in the design. Measures must be taken at this phase to insure these preserve areas are adequately considered as design elements and protected from violation.

Detailed Survey

The following steps should be reviewed in the design process:

1. Once a preliminary survey has been conducted and alignment or design decisions further developed, a detailed survey and assessment of existing vegetation should be conducted.

2. Choosing what vegetation is desirable for preservation should be a cooperative effort between the landscape architect and highway designers. In some cases community involvement may be useful in identifying areas of local significance.
3. Natural systems previously identified should be closely reviewed at this time. Intrusive vegetation in need of removal can be identified and removal plans begun. Characteristics of natural vegetation should be noted for use by the designer in integrating these elements with other landscape plantings.
4. Individual trees should be surveyed and located on the preliminary plan. Preserving existing trees reduces planting and maintenance costs and can result in an immediate impact compared to planted trees which take time to grow. Small trees are often more tolerant of construction damage than larger trees and should not be ignored for potential protection and preservation.
5. Large trees which contribute to the aesthetic character of the highway or provide other significant benefit should be preserved if possible. These trees should be in good condition and have a good probability of withstanding construction impact.
6. A hazard assessment should be conducted to identify potential hazard trees. The International Society of Arboriculture publication, *Evaluation of Hazard Trees in Urban Areas*, should be used to determine hazard potential. A forester, arborist or landscape architect familiar with this method can be consulted to determine hazard potential. Trees with significant hazard potential should not be preserved. In special circumstances, hazard potential may be reduced using braces or guys installed in the tree. Such measures should be reserved for high value trees.
7. A condition assessment should also be conducted. Trees showing dieback, profuse lichen growth on branches, epicormic sprouting, or other signs of poor health should be questioned. A detailed analysis by a forester, arborist or other qualified person should be conducted to determine if such trees should be preserved.

Design of Tree Protection

Once trees have been evaluated and a decision made to incorporate them into the project, protection measures should be developed.

- Tree protection should be part of the project contract. A subcontractor may be given responsibility for providing tree protection services, but the general contractor must have the ultimate responsibility for providing tree protection.

- The contractor should designate a person, who can be easily contacted at any time, to supervise tree protection measures. The contact person should have sufficient authority to issue whatever orders may be necessary to avoid damage to protected trees. The contact person's name and phone number should be prominently posted.

Using the Critical Protection Zone as a Planning Tool

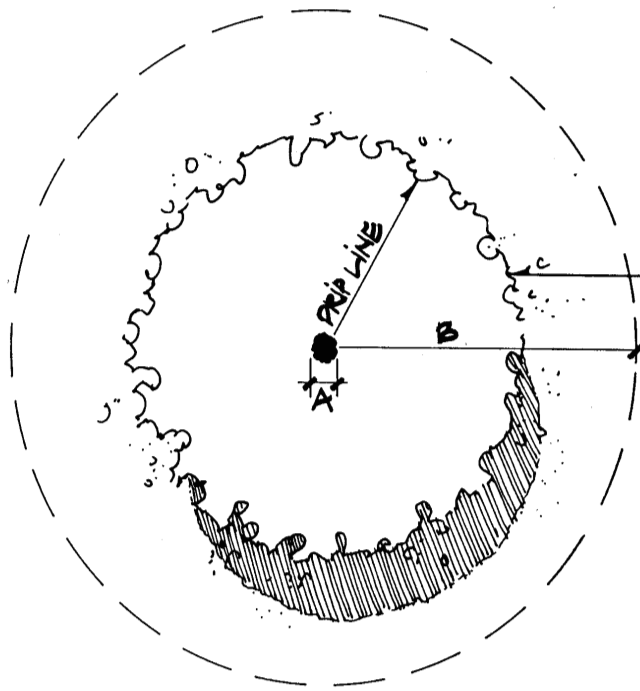
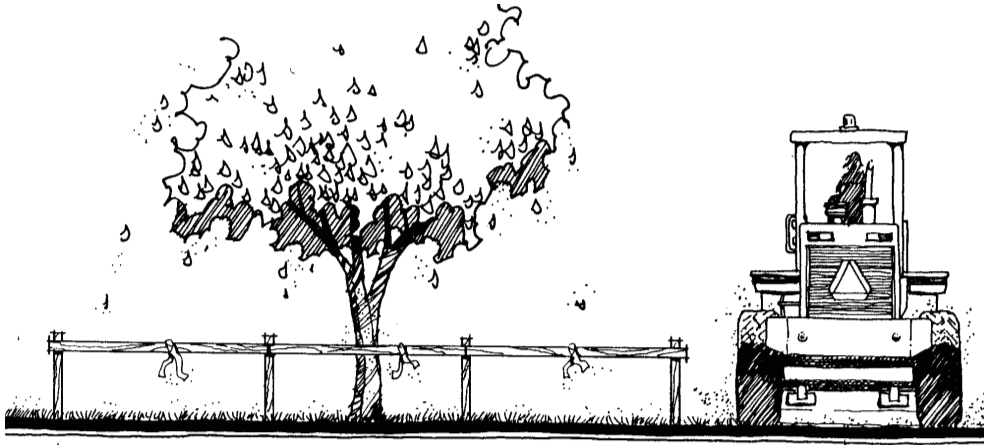
A useful tool to determine potential impact to trees is the Critical Protection Zone (CPZ). The CPZ is a tool used to evaluate potential impact. The CPZ is determined by laying out a circle on the plan sheet which has a radius of 0.3 m for each 2.5 cm of tree DBH (diameter at 1.2 m aboveground level) using the center of the tree as the center of the circle. For example, a tree with a diameter of 25 cm would have a CPZ of 3.0 m. See Figure 23.

Disturbance within the CPZ is considered to have a potential impact on the tree. For planning purposes the impact to a tree may be considered proportional to the degree of impact within the CPZ. Thus, a 50 percent impact to the CPZ would reduce the chance of survival of that tree by 50 percent. In PD&E, the CPZ is used to determine potential critical areas of tree impact. Then, a decision to redesign, remove the tree, or mitigate the impact may be made. Be sure to consider the impact of utility relocation when assessing potential impact.

Mitigating Impact

In some cases potential impact to trees may be avoided or mitigated. Root systems of trees usually inhabit the top 60 cm of soil. This root zone must remain well aerated and drained. The design engineer should consider maintaining soil pore space within the CPZ, maintaining free movement of oxygen within the CPZ, and protecting roots within the CPZ from physical damage. By considering these factors, the engineer can anticipate impact and treatments necessary to mitigate tree damage.

Figure 23



TREE BARRICADE:
2" x 4" WOOD FENCING WITH FLAGGING.
THE BARRICADE SHALL BE PLACED
SO AS TO PROTECT THE CRITICAL
PROTECTION ZONE (CPZ) AREA
AND NEVER WITHIN THREE-FOURTHS
($\frac{3}{4}$) OF THE RADIUS OF THE CPZ
[$.87 \times r = 75\%$ OF CPZ].

EXISTING TREE

A = DIAMETER OF PROTECTED TREE
IN INCHES
B = CRITICAL PROTECTION ZONE (CPZ).
THAT AREA SURROUNDING A TREE
WITHIN A CIRCLE DESCRIBED BY
A RADIUS OF ONE FOOT FOR EACH
INCH OF THE TREE'S DIAMETER
AT BREAST HEIGHT (DBH).

TREE PROTECTION

- If the CPZ analysis applied during PD&E identifies significant impact is likely to occur, design changes or realignments may be possible to reduce impact.
- In other cases the type of impact may be lessened through treatment of the tree or by using alternative techniques.
- Damage from trenching to install a water line, for example, may be mitigated by simply boring under a tree rather than cutting a trench across the root system.
- Soil compaction within the CPZ may be mitigated by covering the area with a 25 cm deep layer of wood chips or similar material.

A Florida Division of Forestry (DOF) urban forester can assist in developing mitigation treatments for specific circumstances. The following are examples of additional mitigation measures:

- Specify coarse textures material for minor fill sections within the CPZ.
- Install an aeration system under extensive fill sections within the CPZ.
- Install wood chip cushions to reduce compaction from equipment.
- Provide supplemental watering during construction especially when surrounding vegetation is to be removed exposing soils within the CPZ to drying sunlight.
- For cut sections within the CPZ, specify that roots are cleanly cut using a trencher or saw prior to excavation with heavy equipment. Cutting roots reduces impact to the residual root system caused by pulling and ripping roots with equipment.
- If cut banks or trenches within the CPZ are to be left exposed for more than 24 hours, cover banks or trenches with plastic to retain soil moisture. Cut banks at the margin of the CPZ should also be covered with plastic to avoid significant loss of soil moisture from exposed soil surfaces.
- Excavate root systems by hand to determine the extent and location of major roots. If piles, posts or similar installations are planned, excavating can locate major roots and installations can be designed to avoid root damage.
- Excavation can uncover major roots and allow installation of small cables and pipes under major roots when boring is not warranted or feasible.

- When driveways or other pavements are to be installed over a portion of the CPZ, use reinforced concrete sections rather than asphalt as paving. Concrete can be installed over noncompacted existing soil rather than compacted base. A shallow sand base may also be used. Sections of concrete may be divided with drainage grates to provide for the movement of water and air.
- Avoid using concrete pavers on soil other than deep sand. Pavers require a base preparation which compacts soil in the tree root zone. Use reinforced concrete, railroad ties or other material which does not require a compact base.
- Protect overhead limbs from impact from backhoes or other equipment requiring high overhead clearance. Protect limbs by wrapping with plywood or lumber wraps. Attach wraps with metal strapping.
- When southern pines are to be impacted in any way within the CPZ, including clearing ground cover vegetation, spray with Dursban or other recommended insecticide to protect from pine beetle attack. A contract should be entered into with a pest control company to respray pines for a period of two years. Spray frequency should be three times per year or as recommended by the Florida Division of Forestry.

Selective Clearing

Highway beautification must include identification and assessment of existing natural elements prior to site development. Rare and endangered species should be located and cataloged for preservation. Significant, mature hardwood trees and/or wetland species should be preserved wherever possible while accommodating highway design. Retention of existing natural plant stands is recommended; where this is not possible, the reestablishment of similar systems is encouraged. It is far more advantageous, both economically and environmentally, to retain existing plant communities rather than replanting.

Several aggressive plant materials, such as Australian pine, punk trees and Brazilian pepper among others, have been introduced to Florida and invade native plant communities, alter the visual landscape and ecological communities (see "Noxious Plants" in this Section). Where these species exist on a site, they should be removed according to proper removal procedure for each species.

Tree Relocation Considerations

Provision for protection and relocation of significant plant materials can be included in the preliminary design phase of the project. The most desirable procedure for moving existing trees is to transplant them to their permanent location. While tree holding areas can be employed for storing trees, if a single transplant is not possible, this method is costly and adds to the risk of losing the tree due to transplanting twice.

Tree Transplanting. Occasionally, existing trees within highway rights-of-way may be transplanted either to a specified landscaped area, to a holding area or a neighborhood willing to assist in transplanting and maintenance. Careful consideration should be given to whether transplanting is preferable to purchasing good quality nursery grown material. When considering transplanting, a landscape architect, District vegetation specialist, the local Florida Division of Forestry urban forester, or licensed arborist should be contacted to review the trees to be relocated to ascertain feasibility, tree selection and method of transplanting. Trees selected to be transplanted should be in very good condition and show no signs of stress, dieback, trunk damage or lichen growth. Transplanting poor quality trees usually results in poor performance and is often more costly in terms of loss than if a quality nursery-grown tree was used.

Transplanting existing trees is a process that needs planning. Identify trees to be transplanted and be ready to move them to another portion of the project as planting areas become available. Transplant trees only once whenever possible. Avoid transplanting trees to a holding area for replanting at a later time. In some cases construction activities may be scheduled to allow transplantable trees to be barricaded to protect them from construction until a planting site is available. Be sure to have a reliable source of water available to immediately begin watering transplanted trees. A key factor to successful transplanting is keeping the tree root ball evenly moist from the time of transplanting to establishment. Without adequate watering, tree transplanting often has limited success.

Canopy and evergreen trees, up to 0.3 m caliper, are transplantable with a tree spade but younger trees typically transplant better than older ones. Tree spades are the most commonly used method for relocating this size tree; and this method produces the highest survival rate. The cost of moving this size tree with an appropriately sized tree spade is normally cost effective. The largest available

spade should be used to gather as many roots as possible and reduce shock. Tree spades are available in most areas of the State and range in size from 1.5 m to 2.1 m in diameter. Contact local nurseries to find the tree spade operators available in the project area.

Larger trees, up to 1.2 m caliper, may be transplanted by wire ball and burlapping, and lifting with a tree strap or by "pinning" the tree with a steel dowel and attaching cable for lifting, but these methods are costly and require a lengthy preparation time. Only the most valuable specimens over 0.3 m should even be considered for transplanting. Many large canopy and ornamental trees may need to be root pruned two months prior to transplantation. In some cases root pruning two to four months prior to transplanting may be beneficial. Research has shown long term effects of root pruning are minimal but there may be some short term benefits during establishment. Consider the value of trees to be transplanted, landscaping budget and logistics when considering root pruning. Care during establishment may be more important to survival and performance than root pruning.

With proper care and handling during and after the transplanting process, most trees can be transplanted throughout the year. The best time to move deciduous trees is in the spring, fall or winter. Pine trees are best transplanted during the winter months.

Transplanting Execution. Planting of transplanted trees requires similar procedures to planting new trees. Prepare a planting hole for a tree spade moved tree by excavating a planting area larger than the diameter of the tree spade. Backfill the planting area with loose native soil and then use the tree spade to excavate a planting hole within the loosened soil area. This method will provide a suitable rooting environment outside of the root ball and assist in plant establishment. An alternative, but not preferable method, is to plant the tree in the tree spade dug hole, then excavate around the root ball to loosen the surrounding soil. Planting trees by methods other than a tree spade require similar planting pit preparation. Loosening of the existing soil in an area three to five times the diameter of the root ball is conducive to a successful transplanting procedure. If trees are planted in holes with compacted sidewall soil, trees will likely perform poorly.

Palm Relocation. Opportunities for transplanting existing palm trees may arise. It is important, however, to evaluate the condition and value of the palms being considered for transplantation.

While some palms are valuable, others are not, and the price to transplant them may be more than the tree is worth.

Most palms are easily transplanted throughout the year, although they establish themselves better if they are transplanted in spring and early summer. Palms do not grow as rapidly during the winter months and some species have shown susceptibility to freeze damage if not properly established. See Table 6, Recommended Highway Plant Materials - Trees.

SOILS/AMENDMENTS/PLANTING PRODUCTS

Soils

Soil structure refers to the way the sand, silt and clay particles group together to form granules. Soil structure influences the speed with which water penetrates the soil; the soil's retention of water and nutrients; and its resistance to erosion and compaction. Soil structure is fragile and can be destroyed by excessive traffic and/or cultivation. The physical characteristics of the soil that are most desirable to sustain plant growth are:

- Reduced compaction tendency of the soil. To have a low bulk density, 1.4 g/cm³ - 1.6 g/cm³ depending on the soil mixture, that is maintained over time.
- Good soil water infiltration and percolation. Water must be able to penetrate and move through the soil; one-inch per hour is considered optimal.
- Good subsurface drainage should be present to a depth of 762 mm - 1,219 mm which is the normal critical rooting zone. There should be no impervious layer/hardpan, or soil interfaces to disrupt the flow of water downward and away from the roots.
- Adequate aeration. Oxygen must be both able to diffuse in from the atmosphere and be able to move readily through the soil profile.
- Desirable soil should have adequate available water holding capabilities. Soil should be able to retain 10 percent to 15 percent of the available water after gravitational water has drained away.

The physical properties of existing or imported soil should be reviewed. Table 11 describes the characteristics of various soils.

Table 11
SOIL CHARACTERISTICS

SOIL TEXTURE	SUSCEPTIBILITY TO COMPACTION	NUTRIENT HOLDING CAPACITY	AVAILABLE WATER	INFILTRATION RATE	DRAINAGE	REAERATION TIME
Sand	None	Limited	6.7 percent	50 mm per hour	0.5 days	2 days
Loamy Sand	Limited	Limited	10.1 percent	32 mm per hour	1 day	2 days
Sandy Loam	Limited to moderate	Moderate	15.6 percent	25 mm per hour	2 days	2 days
Loam	Moderate	Moderate to substantial	15.6 percent	12.5 mm per hour	3 days	3 days
Silt Loam	Substantial	Substantial	19.9 percent	9.5 mm per hour	3 days	3 days
Clay Loam	Substantial	Substantial	12 percent	2.5 mm per hour	3 days	3 days
Clay	Substantial	Substantial	11.5 percent	0.25 mm per hour	5 days	5 days

Review of the above table demonstrates that it is hard to find one soil that has good physical properties in each category. Typically, a sandy loam is considered the best all-around soil.

When soil conditions are not ideal there are four basic methods for physical modification of the soil.

1. **Mechanical.** This method involves mechanically breaking-up of the soil through deep cultivation to 305 mm - 457 mm and regrading.
2. **Drainage.** In this method, water is removed from a site through surface runoff, underground subsurface drainage, evaporation from the soil surface, and plant transpiration.
3. **Amendments.** Adding amendments to improve soil conditions are grouped into two classifications:
 - a. Organic - such as compost, wood chips, peat moss, sewage sludge and manure. Organic amendments enhance soil structure, increase aeration and contribute to improved nutrient and water holding capabilities. Twenty-five percent to 50 percent by volume is required to be effective.

- b. Inorganic or mineral - such as sand, gravel, sintered fly ash, expanded shales and slate and calcined clay. These minerals function to dilute the soil by separating the soil particles, rather than enhancing soil structure. To be effective, 45 percent or more must be added to the soil.
- 4. **Soil Replacement.** In some cases the condition of the base soil is such that it cannot be amended successfully. Completely replacing the soil with a sandy loam may be the ideal solution. This method can be most successful for urban median landscape projects.

Urban soils have characteristics that are distinct from their natural counterparts. They tend to compact, have vertical and spatial variability, display surface crust that tends to repel water, show evidence of contaminants, restrict drainage and aeration, intermix with imported soil stabilization materials, and so forth. Thus, soils within the urban environment must be carefully examined and amended to a suitable growing medium.

Fertility is one of the most important chemical properties of soil. The more natural nutrients in the soil, the more fertile the soil is and the better it will be able to sustain plant growth. Soils containing a large amount of organic matter are usually fertile. Nearly all soils contain some of each of the nutrients essential for plant growth. Unless replaced at appropriate levels, nutrients will decrease over time as they are used by the plants or are leached (washed) from the soil. Natural life cycles of some plant materials can return nutrients without chemical fertilizers. Additionally, the use of compost can increase the organic content and/or increase the nutrient holding capacity. Commercial fertilizers are generally effective and efficient in restoring nutrients to the soil.

Soil pH, or the potential level of hydrogen ions in the soil, is an important chemical property. A low pH rating indicates that the soil is acidic; a high pH rating indicates that the soil is alkaline. Soil pH influences nutrient absorption and plant growth. Each nutrient has a pH level at which it is most available for use by plant materials. Nutrient availability can often be improved by correcting the soil pH. Applications of lime increase soil pH (decrease acidity). Acidifying fertilizers, such as those containing ammonium sulfate, decrease the pH (increase acidity). Applications of sulphur also reduce soil pH levels, however, such applications have been shown to have only short-term effects. Applications of sulphur to existing plant materials or turf grass can also result in chemical burning of the plants.

Contact a landscape architect, horticulturalist or the County Agricultural Extension Service regarding proper plant selection for difficult soil conditions.

Mulches

Florida's soils provide a good growing medium for a wide range of ornamental plant materials; they also provide a haven for a vast number of weeds. Once a planting bed is properly prepared using a topical and pre-emergent herbicide, mulching of the bed assists in deterring weed germination, thus giving the plants an opportunity to flourish. All planting beds should be weed-free prior to mulching. Sterilized soil propagates weeds only if they are either brought in with the plant stock or are blown or dropped into the bed and exposed to sunlight. If the soil is left bare it provides an opportune place for the weed to germinate. Mulched beds (75 mm thick before compaction) provide a dense cover over the soil making it more difficult for weed seed to penetrate. In the North and Central regions of the State mulch also acts as an insulator, helping to ward off freeze damage to roots. In the sandy and dry landscaped areas of Florida's highways mulching greatly assists in retaining moisture in the soil. Additionally, heavy mulches of large particles will last longer, assist in erosion control, add aesthetic enhancement, assist in invasive plant control (especially from seed), and lowers maintenance. Applying mulch too thick, especially some types of organic materials, can inhibit water penetration and may cause shallow rooting of the plant material.

Types. There are many mulches available on the market for use in landscape installations. Mulches are excellent for retaining soil moisture in landscapes, helping to reduce weed problems and providing a pleasing "finished" look to landscape planting beds. Various materials are commonly used as mulch. The following are common types of mulches and recommendations for their use:

- **Hay** is used as a mulch over freshly seeded areas to provide protection from the elements and to hold in moisture while the seeds germinate. This mulch is not recommended for landscaped areas.
- **Cypress Bark** is discouraged for use as mulch since it is produced by chipping growing cypress trees. Cypress mulch is not as long lasting as thought and is usually more expensive than other materials.

- **Wood Chips** are sometimes available free from local tree services, line clearing operations and municipal tree crews. Chips that are very uniform in size may wash away with rain water and should be used in areas where washing is not a problem. Chips which contain a variety of sizes, some long and stringy pieces as well as uniform chips, hold together better than chips of uniform size and may not present as great a wash problem. Wood chips decompose quickly and add organic matter to soils, but may need replacing more often than other materials. Using wood chips helps to reduce municipal solid waste.
- **Rock and Shale.** Some commercially available rock and shale mulches may be appropriate for traffic areas or some urban settings. These materials do not need to be replaced as often as organic materials. CAUTION, avoid using these materials in some urban settings where they may be picked up and thrown. Check with local police crime prevention officers to see if they foresee any problems before using this material.
- **Pine Straw** is an excellent mulch material. Carefully check the source of pine straw mulch and avoid using straw that may be collected from natural areas where environmental damage may result from harvesting. Pine straw usually needs replacing twice each year and may wash with moving water.
- **Melaleuca** mulch is being commercially marketed in Florida. Because of the potential to create a greater market for this material, and encourage removal of this noxious species, use of commercial melaleuca mulch is highly recommended.
- **Compost.** Whenever possible compost should be used for mulching highway landscape projects. Compost is one of the best mulch materials. It is organic and eventually adds organic matter to soils. Compost can be used in combination or in lieu of mulch. Compost made from recycling municipal waste, waste from tree services and landscape maintenance operations, and recycled yard waste is highly recommended for use in highway landscape projects. Using recycled waste materials assists in supporting recycling efforts and should be preferred whenever available. Research is being conducted as to additional uses and effectiveness of compost in roadside landscape and turf planting. Refer to Section 162, "Topsoil", of the *FDOT Standard Specifications for Road and Bridge Construction*.
- **Pine Bark** is a byproduct of pine lumber milling and readily available as a heavy-textured mulch. This product has a tendency to float and should be used in planting beds not affected by flooding or washouts.

- **Shredded Rubber Tires** are not an organic material, but can be useful as a mulch in appropriate applications. As with compost and melaleuca mulches, this product is a recycled material. Prime use of this material is for areas requiring a non-decomposing mulch material.

Mulch Installation. Mulch should be installed around every tree, shrub and ground cover in the landscape project. When individual trees are installed, mulch should be placed around the tree in a dimension at least as wide, and up to three times as wide, as the planting excavation pit. Shade and ornamental trees should be mulched to the distance of the crown spread. Shrubs and ground covers planted 1.5 m on center and less should have the entire planting bed mulched; this will protect the shrubs from mowers and reduce maintenance within the planting bed. Green mulch should not be used in wildflower or annual flower installations. Mulch should be checked annually and replenished as necessary. In urban conditions or curbed median areas, mulch should be kept recessed ± 25 mm below the curb to retain mulch in planter area. Mulches should be applied to a settled depth of not more than about 75 mm (see Section 5, *CONSTRUCTION PHASE*, for more about mulch installation).

Manufactured Soil Amendments

Polymer Additives. Many areas of Florida contain sandy or very well-drained soils which do not retain moisture sufficiently for optimum plant growth. The best solution to this condition is to match the plant material to the soil type, thereby eliminating soil amendments of any kind. If this is not possible or desirable, polymer products are available to be added to the plant pit which are designed to retain moisture and make it available to the plant's root system. Review of the effectiveness of these products has been ongoing with no conclusive results. Consult with your landscape architect, District vegetation specialist or other qualified professionals before utilization of these materials.

Geo-textile Fabric. Geo-textile fabrics are sometimes employed on highway landscape projects for two primary purposes: slope stabilization and weed control. Some soil and slope conditions may require special erosion stabilization. Large planting beds, not properly treated with topical and pre-emergent herbicides, may require a weed barrier fabric. These conditions can be addressed by the use of a variety of geo-textile fabrics and soil stabilization products. Geo-textiles are woven or nonwoven fabrics which allow the passage of water. Quality fabrics contain stabilizers and/or inhibitors to make the filaments resistant to deterioration due to ultra-violet light, heat exposure and

commonly encountered chemicals. Small pre-cut squares are available which can be installed around planted trees for weed control. Using these fabrics around trees may also help in reducing damage from string trimmers. **Plastic barriers for this purpose are not recommended.** Weed fabrics which are constructed of woven fibers may not control weeds as well as those which are constructed as a continuous unwoven sheet. Vigorous weeds, such as nutgrass, can separate and penetrate woven fabrics.

Erosion control is of primary concern in highway landscaping. While FDOT slopes are designed to maintain themselves with turf grass, disturbing this slope for new planting may create erosion problems. Part of the plans preparation process is to determine the soil type and its particle binding properties. Should there be a concern raised from this research, the use of a soil-stabilization product should be employed. A design professional, such as a landscape architect, soils or civil engineer, should be consulted for decisions regarding erosion control products.

Most properly prepared planting beds will not require additional weed control measures other than routine maintenance. There are conditions, however, that call for an additional weed inhibiting treatment. For these conditions a weed barrier fabric can be utilized. These fabrics vary in material composition, permeability and durability. The weed-barrier fabrics are usually installed over the entire planting bed with the plants then installed through the fabric. This process can add to the installation expense but in cases of severe weed growth, the added cost will prove to save effort and expense while allowing for healthy plant development.

Plant and Turf Grass Fertilization

The landscape design should always try to match soil fertility, site conditions and the selection of plant materials. This effort will result in minimizing the need for fertilizer additives. When this is not possible, the need for fertilization may be required.

Fertilization is used to add essential nutrients to the soil to support the growth of landscape plant materials. Improving the vigor and density of plants through a sound, systematic program of fertilization produces an environment least favorable to undesirable vegetation. Proper fertilization is a primary determinant of hardiness and long-term high quality.

Healthy turf grass makes more efficient use of water. A thick turf with dense root system helps slow water movement and keeps it in the root zone. Turf grass which is able to acquire adequate nutrients develops a deep root system which is very important under roadside conditions. Fertilization may be needed to establish or restore turf grass. Fertilization requirements vary per turf grass species. For example, bahia grass in rural areas needs no fertilization after establishment.

Major Nutrients. Thirteen mineral elements found in soil are recognized as essential for plant growth. The three primary nutrients necessary for plant growth found in greatest concentration in fertilizers are nitrogen, phosphorus and potassium. A complete fertilizer contains each of these three main nutrients.

1. **Nitrogen (N).** The most important element for plants and turf grasses is nitrogen. Nitrogen is essential for healthy growth and is the nutrient required in greatest amounts by turf grass. Nitrogen stimulates aboveground growth as well as root development. It is a key component of chlorophyll, amino acids and other substances vital to the internal processes of the plant. Nitrogen is depleted as it is used by the turf grass and as it is leached from the soil. Nitrogen deficiencies may be indicated by chlorosis (yellowing) of the leaves, slow growth and low plant density. Nitrogen used in fertilizers may be soluble, insoluble or a combination of the two.
 - a. **Soluble nitrogen** is also referred to as quick-release nitrogen. The nitrogen carrier dissolves when wet, promptly releasing the nutrient into the soil. Because the nitrogen is quickly released, it is either rapidly used by the plants or leached from the soil before plants can take it in through their root systems. A characteristic of soluble nitrogen is rapid but short-term plant response. Soluble nitrogen also has a high chemical-burn potential and must be used with care to avoid damaging the turf grass. There is also the possibility of environmental contamination from excessive nitrogen levels when soluble nitrogen is used. Examples of commercially available sources of soluble nitrogen include ammonium sulfate, ammonium nitrate, potassium nitrate and urea.
 - b. **Insoluble nitrogen**, or slow-release nitrogen, is made available to the plant gradually over a longer period of time. The rate at which insoluble nitrogen is released depends upon the speed at which moisture or bacterial action within the soil breaks down the nitrogen carrier. Insoluble nitrogen is characterized by slow initial but good long-term response. Because insoluble nitrogen is released into the soil gradually, there is less chance that overly-high nitrogen levels will chemically burn plants or cause environmental contamination.

Insoluble or slow-release nitrogen carriers include milorganite, urea-formaldehyde, IBDU and sulfur-coated urea.

- c. **A combination of soluble and insoluble nitrogen** is frequently used in commercial fertilizers. With a combination of the two types, the initial quick-growth reaction from the soluble nitrogen and the long-term response characteristic of insoluble nitrogen are available.
2. **Phosphorus (P).** Phosphorus is another major nutrient necessary for healthy plant growth. It provides plants with the means for holding and transferring energy for metabolic processes. Applications of phosphorus through fertilization are most important during early plant and turf grass establishment. After establishment, the addition of supplemental phosphorus is usually unnecessary because the phosphorus is conserved by the plant and used repeatedly. In addition, phosphorus is not readily leached from the soil. Other important functions of phosphorus are to maintain the pH in cells and for special roles in germination of seeds and seedling growth, the ripening of seeds and fruits and the development of roots. Phosphorus deficiencies are most evident early in the establishment period. Signs of insufficient phosphorus are reduced plant growth, dark to reddish leaf coloration and narrow leaf blades on turf grass. Many of Florida's soils are naturally high in phosphorus. A soil test should be performed before supplemental phosphorus is incorporated into a fertilization program. Phosphorus can be toxic if applied at too high a rate. Some plants and grasses are especially sensitive to the over-application of phosphorus.
3. **Potassium (K).** Potassium is second only to nitrogen in the amount required for plant and turf grass growth. Potassium is important in the synthesis of numerous plant compounds and in the regulation of many physiological processes. It promotes root growth and development and aids the plant in withstanding stress. Potassium is lost through plant usage and through leaching in sandy soils. Deficiencies in this nutrient result in increased respiration and transpiration, reduced environmental stress tolerances (especially to excessive water), increased incidence of disease and a reduction in growth.

Analysis. Fertilizer analysis or grade is the minimum guaranteed percentage by weight of nitrogen (N), phosphorus (P), and potassium (K)---that is, the proportion or ratio in which each of the nutrients is present. A 45 kg bag of 20-5-10 fertilizer, for example, contains 9 kg of nitrogen, 2.25 kg of phosphorus and 4.5 kg of potassium. Complete fertilizers include some percentage of each of the major nutrients. When a fertilizer is incomplete, zeros are used to indicate the missing nutrients. A fertilizer with a 20-0-0 analysis, for example, contains 20 percent nitrogen, but no phosphorus or potassium. The remaining bulk of the fertilizer is made of inert material such as sand.

Root Guard Products

Some trees have aggressive root systems that tend to spread out laterally, rather than grow down, primarily due to the high water table in many areas of Florida. Other trees put out large lateral roots due to shallow, adverse soil conditions. Roots can cause major damage to surrounding hard surface elements by breaking up asphalt, cracking curbs and heaving sidewalks. The best deterrent to tree root damage is to select the proper tree for the given planting area. When a tree with a more aggressive root system than the area can contain is selected, or if an existing tree with aggressive roots is encountered in a landscape project, root deflecting methods can be introduced in the planting process. There are several products on the market to accomplish the movement of root systems downward instead of outward. These products range from tree rings of extruded polyethylene to herbicide-impregnated geo-textile fabric. These and similar products should be considered as part of the installation process for all trees planted adjacent to sidewalks, near asphalt pavement, in close proximity (1.5 m or less unless it is an extremely aggressive tree) to curbs and within medians. For new plantings, one-piece, rigid plastic planters are available in either square or round forms. These barriers are available in depths up to 0.6 m and can be placed within 75 mm of the root ball. When roots come in contact with the barrier, they are driven downward into the soil. Research has shown that solid root barriers should be installed slightly above grade to deter lateral roots from growing over the barrier.

Soft root barrier systems are available for new tree planting as well, but are more suitable for new pavement around an existing tree where root systems have already spread horizontally and cannot be severely cut to install a vertical hard barrier. This type of system is generally designed with a time-released herbicide impregnated into a fiber fabric which is flexible and can be placed horizontally, if necessary, and to any reasonable length. When the roots come in proximity (25 mm) with this material they take a downward direction to avoid the chemical. This system has a 10 to 15 year chemical life. Root barrier products have become regularly specified by professionals for trees in close proximity to pavement materials. The long-term benefits of employing root deflecting materials will far exceed the initial added cost of installation. See Figure 24.

IRRIGATION USE AND DESIGN

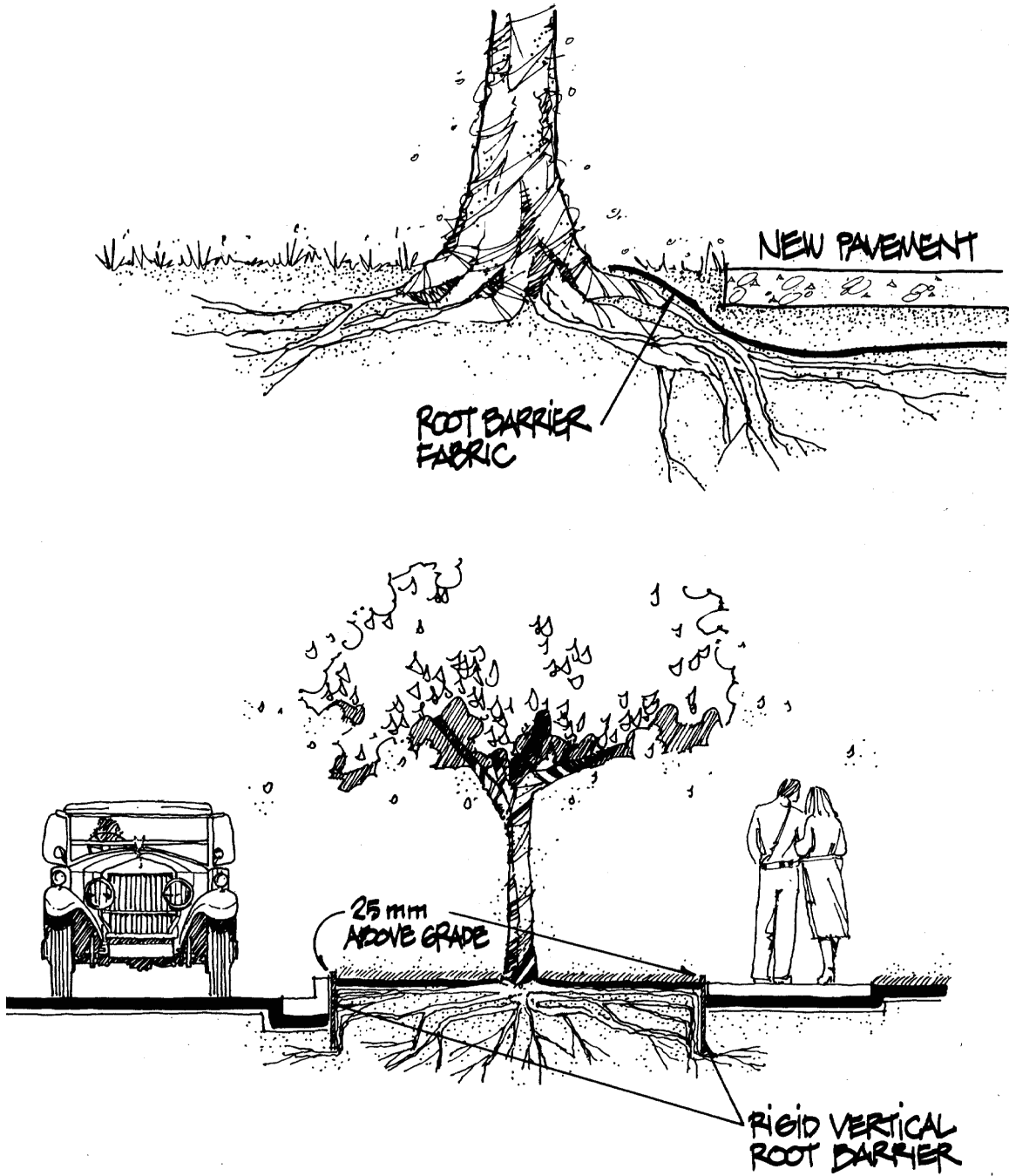
Irrigation

Irrigation of highway landscaping is not recommended for rural highways and should be used minimally for urban highways. The use of native and adapted species of landscape materials and Xeriscape planting principles should minimize the need for supplemental watering, after the establishment period, beyond what nature will provide. However, in select areas of community significance it may be desirable to have high-focal and/or seasonal plantings which might require additional water to maintain ideal health and appearance.

Types of Irrigation Systems

Where irrigation is required, it will be necessary to review the options available prior to design and installation, including access to an effluent or recycled water supply. The irrigation system should be designed for low volume use. A conventional system incorporates underground main and lateral lines with "pop-up" spray or rotor heads. This type of irrigation is not recommended for highway use because of the danger of excessive over-spray into the drive lanes; wasted water through evaporation and run-off; vandalism of aboveground equipment; and general high maintenance of spray heads and nozzles. Recent irrigation technology has developed low-trajectory, water-saving nozzles, timers and other equipment that can assist in the efficiency of the conventional irrigation system, however, these new techniques do not solve all of the problems associated with aboveground watering. Aboveground spray irrigation should be used only when low volume systems are not practical, such as large sodded areas. It must be outside the horizontal clearance area and designed to prevent overspray on the roadway, sidewalk or other paved surfaces. Under no circumstances shall water from irrigation systems be allowed to overspray or seep onto the roadway.

Figure 24



EXAMPLES OF ROOT BARRIER SYSTEMS

The need for water conservation throughout the United States has encouraged irrigation manufacturers to develop better ideas for irrigating plant materials. Totally sub-surface irrigation systems are now available which provide an alternative to conventional watering systems. These systems are recommended for use wherever possible. They irrigate the plant root zone directly, eliminating waste through evaporation and overspray. This type of system requires less water and pressure for its operation, is low-maintenance, vandal-proof and eliminates the hazard of overspray onto the roadway driving lanes. Sub-surface irrigation is good for trees and shrubs but its method of water disbursement is not recommended for turf grass areas.

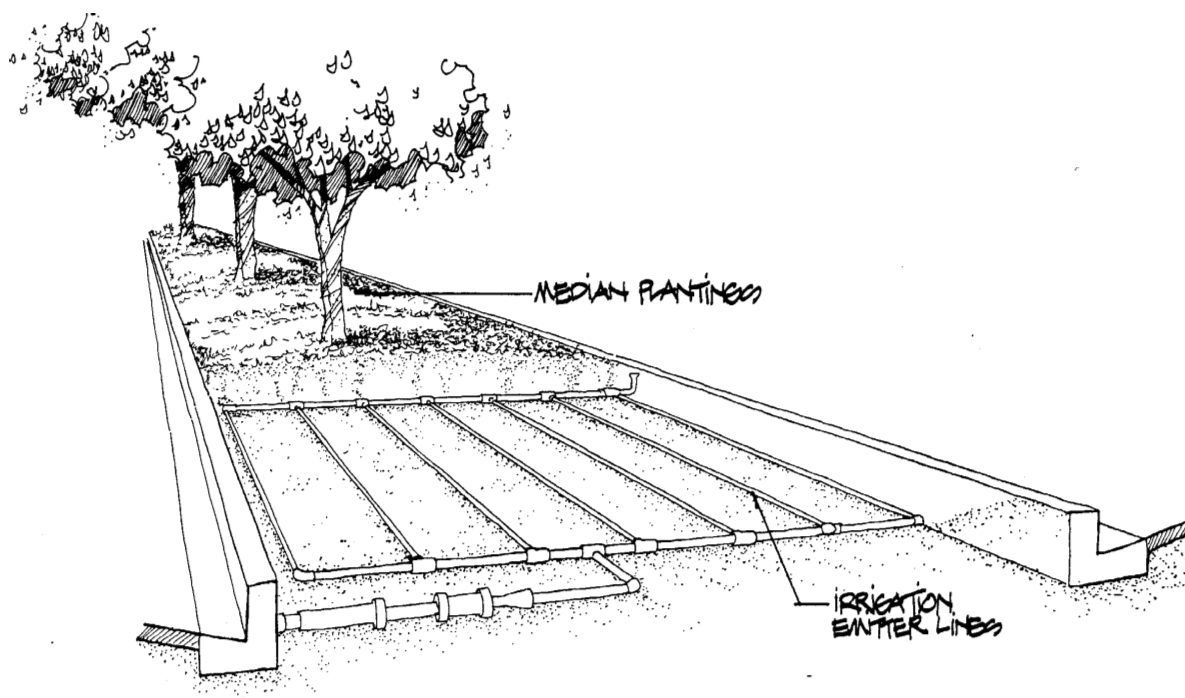
Median Irrigation

The current trend toward water conservation and Xeriscape may encourage median plantings designed without irrigation. Highway medians can be one of the most stressful environments for plant growth. During summer months, pavement temperatures surrounding medians may exceed 100 degrees for some time after sundown. Irrigation or access to supplemental watering is essential to proper plant establishment and may be necessary to help established plant material survive periods of infrequent rain. Plantings in narrow medians are particularly susceptible to drought stress and damage. Plans to use water tanks or trucks to water plantings should be carefully reviewed to assure that such plans consider the availability of staff and equipment to provide watering and the need to provide traffic control. A temporary drip type irrigation system, which can be used during establishment and can be available during severe drought stress, can be a low cost and water saving alternative to conventional irrigation. Proper preparation reduces water needs. See Figure 25.

Water Conservation Measures

The source of water is a critical element of irrigation design. All options must be considered; effluent or recycled water is recommended where available. Deep wells are another water source option. Potable water as a source for irrigation should be used only when no other source is available. The use of potable water is expensive, depletes the drinking water supply and must be used sparingly.

Figure 25



SUB-SURFACE DRIP IRRIGATION SYSTEM

The design of all irrigation systems installed within FDOT rights-of-way must include a manual shut-off valve for use when sensors or automatic timers do not operate properly. If the irrigation system is automatic and operated by timers, it must have a rain sensor device or switch which will override the timed cycle when adequate rainfall has occurred.

Moisture Requirements. Grasses, trees and shrubs require varying and different water requirements.

- **Grasses:** The grasses specified for use by FDOT, such as Pensacola bahia, Argentine bahia and Bermuda grass, are those which withstand dry periods extremely well and still rejuvenate when natural rains continue. These grasses should need no

supplemental watering after the establishment period. When high focal turf areas are desired, St. Augustine strains of turf grass may be specified. This grass will require supplemental watering either by a watering truck or an underground irrigation system for maximum viability.

- **Trees:** Installation of trees must be appropriate for the locale in which they are installed, with the primary adaptability factor being their ability to survive in relation to the water availability and/or restrictions of the area. Some tree species can thrive with little water, while others require a great deal of water to survive. Watering saucers should be constructed around each new or transplanted tree and palm to collect water and direct it into the soil and root area. One must match the tree to the location and available water; remembering that all trees need **some** water to survive. The trees recommended in the "Plant and Turf Grass Selection Guide" of this Section have water requirements listed.
- **Shrubs:** There are very few shrubs that will withstand the rigors of a non-irrigated rural highway. These species are generally those that are native to the area or have been climatized to act as a native plant. The use of native and/or adapted plants will make most landscape designs successful simply because these plants might survive where others might perish. Shrubs, like trees, will vary in their water requirements. It is essential that the correct shrub be selected for the appropriate availability of water. Slopes and swales must be identified prior to shrub selections, in order to determine the exact conditions in which these materials will be living.

Watering Methods

Xeriscape and drought-tolerant plant materials will survive in the harsh highway landscape if given a good start when they are planted. It is important to provide enough water to adequately establish the plant material. Supplemental watering is recommended for 90 days following installation to help plants establish themselves. This period will vary depending on the locale, time of year, rainfall and other planting conditions. If possible plant installations should coincide with the rainy season. A 75 mm covering of uncompacted mulch in all planting beds will help to retain moisture and create better growing conditions.

Section 5
CONSTRUCTION PHASE

The following will be accomplished during this phase:

- Develop systems for the protection of existing vegetation and controls for mitigation of construction impacts.
- Establish appropriate methods for relocation of existing vegetation.
- Select plant materials installation and establishment techniques.
- Provide criteria for the proper installation of irrigation systems.
- Provisions for construction inspection and staffing.

PROTECTION OF EXISTING VEGETATION

Protective measures must be taken to insure the viability of existing vegetation and other natural conditions that are intended to be retained in the project. Plant materials can be damaged by construction equipment, backfilling and improper temporary drainage. Damage to existing vegetation can be minimized by the use of proper protective methods and devices.

Prior to any construction, a staging area should be established. This area should be located away from existing vegetation that is to remain. Storage of materials and equipment or employee parking should be kept away from existing trees and vegetation.

Tree Protection During Construction

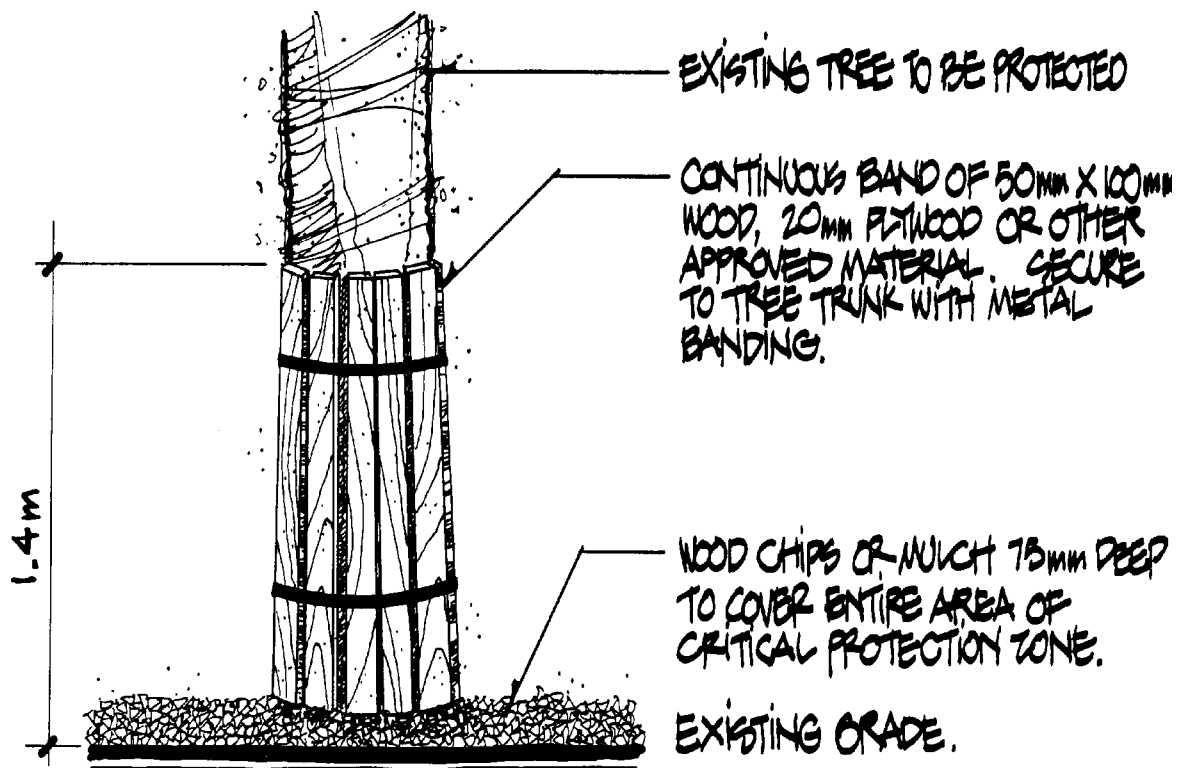
The most effective way to protect trees is with the use of tree barricades. Barricades should be made of substantial material such as 100 mm x 100 mm wooden posts connected by 50 mm x 100 mm wooden stringers. Barricades should be able to withstand inadvertent bumps by heavy equipment and trucks. Barricades should be maintained in good condition. When barricades are allowed to deteriorate, they are more likely to be ignored and violated (see Figure 26). The following items should be reviewed when installing and maintaining protective tree barricades:

- Prior to commencement of any construction work, protective devices for existing trees must be in place. Barricades are to be placed around every tree, or tree grouping, which is to be protected.
- Install barricades at, or outside, the limits of the CPZ for all protected trees. (See Section 4, *DESIGN PHASE*, "Using the Critical Protection Zone as a Planning Tool", for an explanation of CPZ.)
- Barricades should be scheduled for installation prior to right-of-way clearing. Clearing within barricades should be carefully undertaken with the guidance of the project landscape architect or urban forester.
- Remove understory at the end of the project rather than at the beginning. Not clearing under-protected trees can preserve protective understory vegetation.
- There may be instances where infrequent, minor operations must be conducted within the CPZ, sometimes using heavy equipment. In such cases a trunk wrap should be used to protect the tree from incidental damage by equipment. The tree is wrapped with lumber or plywood secured with metal strapping. The wrap should extend from ground level high enough on the trunk to protect from damage

by whatever equipment is being used. Wraps should flare at the bottom to protect protruding surface roots whenever necessary. Use a wood chip cushion to avoid soil compaction.

- Inspectors should pay attention to the condition of barricades and take barricades seriously in the context of the overall project. When inspectors begin to ignore the condition and proper use of barricades, they commonly become a useless expense.
- Install signs at regular intervals along tree barricades. Use signs such as:

Figure 26



PROTECTION OF EXISTING TREES

TREE PROTECTION AREA
KEEP OUT
DO NOT USE EQUIPMENT INSIDE BARRICADE
DO NOT STORE OR PILE MATERIALS OR TRASH

Other Vegetation to be Protected

Other existing vegetation and natural conditions noted on the landscape plan to remain shall be protected by the use of similar wooden barricades, safety fence or other acceptable means.

CONTROL OF CONSTRUCTION IMPACTS

Highway construction is an unnatural event in the environment. As such it has various, and sometimes enormous, impacts on the natural landscape. It is the role of the landscape documents to minimize these impacts wherever possible within the project limits. Existing vegetation preservation areas should be noted and "designed around" in the plans preparation phase. It is the responsibility of the District construction engineer (for FDOT construction projects) or the District maintenance engineer (for permit or grant projects) in conjunction with the design professional to provide direction during construction to see that the design intent is carried out correctly.

The following items must be noted and action taken to minimize construction impacts upon the natural environment:

- **Existing Desirable Vegetation** must be protected at all times during the construction process with periodic inspection of protective barricades, protective fencing and other protection devices. Should any of these devices be damaged during construction, work should be interrupted for complete repairs prior to continuing the project.
- **Erosion Control** must be maintained throughout construction to insure against undermining, slippage of constructed work or creation of unstable conditions to the site construction area. This is particularly important when tree and shrub operations are underway. Digging of plant pits and establishment watering can cause serious erosion conditions, as well as safety hazards.

- **Water Quality** must be maintained to levels required by permitting Agencies or the highest levels possible. Conditions that would cause contamination of adjacent water bodies or soils must be monitored at all times during construction. Methods, such as turbidity screens, temporary drainage facilities and other control devices, should be maintained in prime condition continually until project completion and acceptance.
- **Existing Conditions to Remain** are those elements, such as sidewalks, monuments, landscaping, urban design structures and other facilities, that are intended to remain as part of the highway design concept. These structures and facilities should be protected by barricading or similar devices to keep them from harm during construction.

TREE TRANSPLANTING

Tree Transplanting Methods

Transplanting existing trees is a process that needs planning. Trees that can be relocated should be identified in the early phase of design. (Selection criteria for transplanted trees is discussed in Section 4, *DESIGN PHASE*, "Tree Relocation Considerations".) Mark trees to be transplanted; and, be ready to move trees to another portion of the project as planting areas become available. Transplant trees only once, whenever possible, and avoid moving trees to a holding area for replanting at a later time. In some cases construction activities may be scheduled to allow transplantable trees to be barricaded to protect them from construction until a planting site is available. Be sure to have a reliable source of water available to immediately begin watering transplanted trees. A key factor to successful transplanting is keeping the tree root ball evenly moist from the time of transplanting to establishment. Without adequate watering tree transplanting is, usually, only marginally successful.

There are two generally recommended methods for transplanting trees:

1. Canopy and evergreen trees, up to 0.3 m caliper, are transplantable with a tree spade but younger trees typically transplant better than older ones. Tree spades are the most commonly used method for relocating this size tree and this method produces the highest survival rate. The cost of moving this size tree with an appropriately sized tree spade is normally cost effective. The largest available spade should be used to gather as many roots as possible and reduce shock. Tree spades are available in most areas of the State and range in size from 1.5 m to 2.1 m in diameter. Contact local nurseries to find out what tree spade operators are available in the project area.

2. Larger trees, up to 1.2 m caliper, may be transplanted by wire ball and burlapping, lifting with a tree strap or by "pinning" the tree with a steel dowel and attaching cable for lifting. These methods are costly and can require a lengthy preparation time. Only the most valuable specimens over 0.3 m should even be considered for transplanting.

Many large canopy and ornamental trees may need to be root pruned two months prior to transplantation. In some cases root pruning two to four months prior to transplanting may be beneficial. Research has shown long term effects of root pruning are minimal but there may be some short term benefits during establishment. Consider the value of trees to be transplanted, landscaping budget and logistics when contemplating root pruning. Care during establishment may be more important to survival and performance than root pruning.

With proper care and handling during and after the transplanting process, most trees can be transplanted throughout the year. The best time to move deciduous trees is in the spring, fall or winter. Pine trees are best transplanted during the winter months.

Transplanting Execution

Planting of transplanted trees requires similar procedures to planting new trees. Prepare a planting hole for tree-spade-moved tree by excavating a planting area larger than the diameter of the tree spade. Backfill the planting area with loose native soil, then use the tree spade to excavate a planting hole within the loosened soil area. This method will provide a suitable rooting environment outside of the root ball and assist in plant establishment. An alternative, but not preferable method, is to plant the tree in the tree-spade-dug hole, then excavate around the root ball to loosen the surrounding soil. Planting trees by methods other than a tree spade require similar planting pit preparation. Loosening of the existing soil in an area three to five times the diameter of the root ball is conducive to a successful transplanting procedure. If trees are planted in holes with compacted sidewall soil, trees will likely perform poorly (see "Tree Planting Detail" in this section).

LANDSCAPE INSTALLATION TECHNIQUES

To properly install landscape material, several steps must be taken prior to and during planting operations. This section focuses on the proper landscape installation techniques and includes:

- Methods, materials and equipment necessary to prepare and install plantings and turf grass.
- Initial maintenance of landscape materials.

Site Preparation for Tree Planting

Trees can grow along rural and urban highways. With proper planning trees can not only survive but thrive, in rural and urban roadside planting conditions. Many species can survive air pollution, temperature extremes and desiccating winds. In order to do so, their roots must have a suitable environment for active growth and absorption of water and nutrients.

In planting trees, three basic needs of the roots must be met:

1. Tree roots need oxygen, so aeration of the soil must be provided.
2. They need an adequate, but not excessive, supply of water. The rate of water drainage away from the roots should be controlled.
3. Trees need a balanced supply of nutrients. If these nutrients are not present in the soil, they should be supplemented.

Urban Tree Planting Preparation

Roadway medians and borders can be the most stressful planting environments. Soils in medians are often severely compacted from construction activity and are fully exposed to hot, drying sun. Trash, rubble, waste concrete, roadway sub-base and asphalt is commonly piled into medians and planter strips adjacent to travel lanes prior to final grading. The result is a compacted and irregular "soil" environment in which trees must try to establish roots. In some cases soils are so compacted that hand planting is impossible. Remember, proper preparation can be as important as plant selection in terms of plant performance.

Several factors should be considered when preparing to plant trees in urban areas:

- When designing sites for trees in urban areas, every effort should be made to provide the trees with a root environment similar to that found in a natural environment. Many trees are amazingly tenacious and will often live in seemingly impossible urban conditions. When a tree fails, the problem usually begins beneath the soil surface. The needs of tree roots are relatively simple and straightforward,

a balance of oxygen and water and ample nutrition. By providing planting sites which allow for adequate aeration, moisture with adequate drainage and ample nutrients, great strides can be taken in increasing tree survivability in urban areas.

- **New Construction:** Prohibit dumping of trash in medians and require that a suitable planting environment be present prior to planting. Soils in medians should be a well-drained sandy loam texture to a depth of at least 450 mm. Avoid covering compacted soils with a thin veneer of "top soil" as a planting medium. Such treatments usually result in a shallow rooting area and poorly performing plant material.
- **Existing Construction:** Medians in existing roadways can be expected to have hard, compacted soil sometimes containing rubble and other construction trash. A backhoe, subsoil plow or tree spade may be used to prepare planting areas for trees. In some cases the median soil may have to be completely replaced with a suitable sandy loam to a depth of at least 450 mm.

Tree Installation

The distance between the curb and the tree should be as stated in FDOT criteria and standards. Sufficient clearance is required to prevent out-of-control vehicles from impacting the tree before getting the vehicle back under control. Protection of the tree is also of concern. Damage caused by man and/or vehicles is often a major cause of decline and death of trees along a highway. The following procedures should be followed in tree installation:

1. Trees should be brought to the site and installed in a timely manner, preferably the same day, using approved Florida nurserymen standards and appropriate equipment for the installation.
2. If possible, prepare the site before the tree is delivered.
3. Keep the root ball well watered and maintain trees in a shady place while awaiting installation.
4. Measure the height and diameter of the root ball. This will establish the size of the planting hole required for proper installation.
5. All synthetic or non-degradable material, such as nylon rope or treated burlap should be removed from the root ball prior to planting. All material including biodegradable material should be removed from the upper one-third (or 100 mm minimum) of a tree root ball. Precautions should be taken to prevent remaining pieces of material from extending above the soil where they can act as wicks, drying the soil. Tree wrap, tape or string should be removed from trunks just prior

to planting. Tree wrap is only required for protection of trunks during off-site transport.

6. Locate trees as shown on the landscape plan. Site factors which influence long-term survivability should be considered, such as, overhead and underground utilities, sidewalks, signage conflicts, traffic visibility, light poles, right-of-way improvements, etc. Slight modifications in layout of tree placement may have to be made to accommodate these conditions.
7. With a rototiller or shovel, loosen the soil in an area three to five times the diameter of the root ball and at the same depth of the root ball or about 300 mm deep. Never dig the planting pit too deep. At a minimum, the width of tree pits shall be dug to twice the size of the root ball.
8. Position the tree in the center of the planting hole with the top of the root ball even with the surrounding soil surface. The plant pit should be excavated to the depth of the tree root ball. Plants should be set straight or plumb in the planting pit and normal relationship of crown of plant with ground surface established.
9. If trees are planted with wire baskets around the root ball, it is recommended that the top two tiers of wire be cut and removed after the root ball is set in planting the hole. Balled and burlapped plants are to be set with native soil carefully tamped in around the base of the ball to prevent voids. Ropes and wires are to be removed. Lay open burlap around the top one-third of the root ball (100 mm minimum), but do not remove it, or in any way, disturb the root ball.
10. Roots of bare rooted plants are to be properly spread out within the planting pit.
11. If a tree is container-grown, cut and remove the container. Prune away dead or crushed roots. Straighten or clean-cut circular roots.
12. With the trees placed in the planting hole, backfill one-half of the pit lightly with native soil if not contaminated. It is not recommended that large amounts of organic matter be incorporated into the backfill. All large rocks should be removed.
13. Do not amend soil unless planting in construction rubble, very poor or severely disturbed soils. If fertilizer is required, use only a slow-release fertilizer at time of installation prior to completion of pit backfilling.
14. When the hole is half full, slowly water to saturate the soil and remove air pockets, then continue to fill the hole with soil. Water in slowly and thoroughly without flooding to remove air pockets and to secure the soil around the roots before bringing backfill to proper grade.

15. Rake the soil evenly around the entire planting area. Some conditions, such as berm slopes, will require the establishment of a water basin around the tree. This basin should be constructed at the same diameter as the planting pit, or at least twice the size of the root ball. The height of this basin should be a minimum of 100 mm.
16. Stake only the trees that require more solid positioning for safety or stability.
17. After installation of trees and large trunked plants, place weed barrier fabric, if applicable, in locations indicated per manufacturer's specifications. After fabric is firmly in place, plant shrubs and ground cover. See Figure 27 for tree planting details.
18. Remove staking and guying at the end of the establishment period.

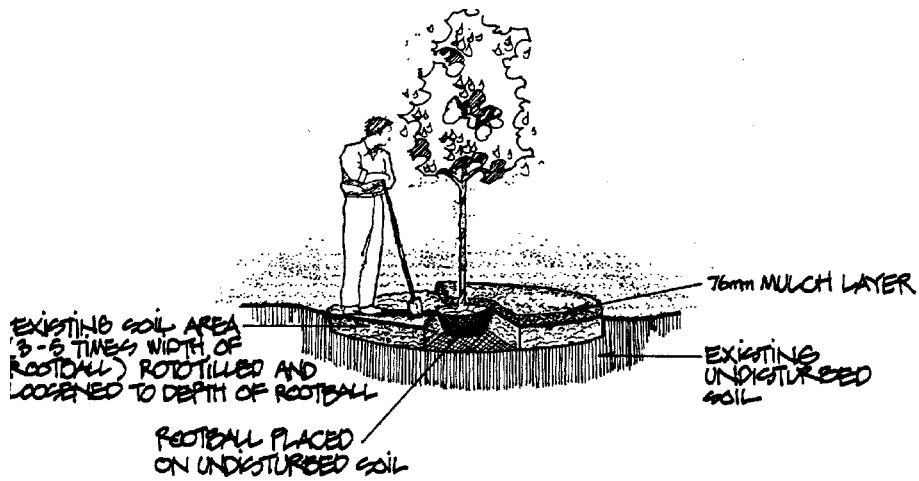
Palm Installation

Planting procedures for palms are the same as for trees with a few distinctions (see the "Palm Planting Details" in this Section). Palms shall have roots adequately wrapped before transporting (except when container-grown), and palm roots and fronds shall be carefully protected from wind and exposure during transportation and until planting. Burlapping will not be required if the palm is carefully dug from marl or heavy soil that adheres to the roots and retains its shape without crumbling and handling. See Figures 28, 29 and 30 for palm planting details.

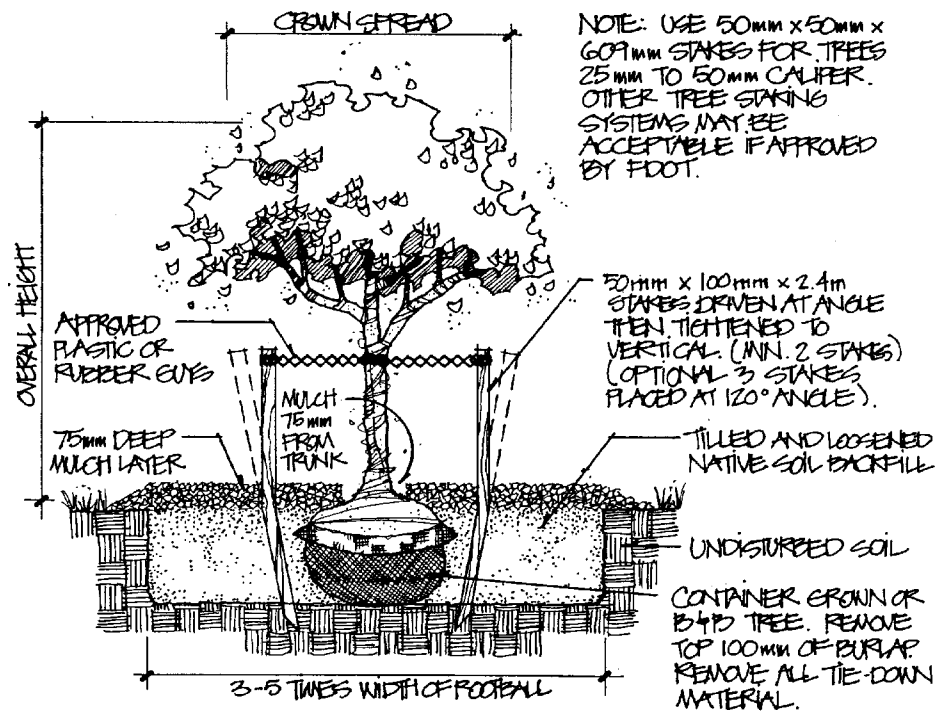
Mulching

Mulch an area at least three times the diameter of the root ball, or to the crown spread of the tree, to a depth of 75 mm (before compaction) with wood chips, recycled mulch, shredded mulch, leaves, compost or pine needles, within two days after planting. Do not use shredded cypress bark mulch, as young cypress trees have been harvested for their mulch value. Therefore, the use of cypress mulch is not recommended for environmental reasons. Leave 75 mm diameter area free from mulch at the base of the tree.

Figure 27

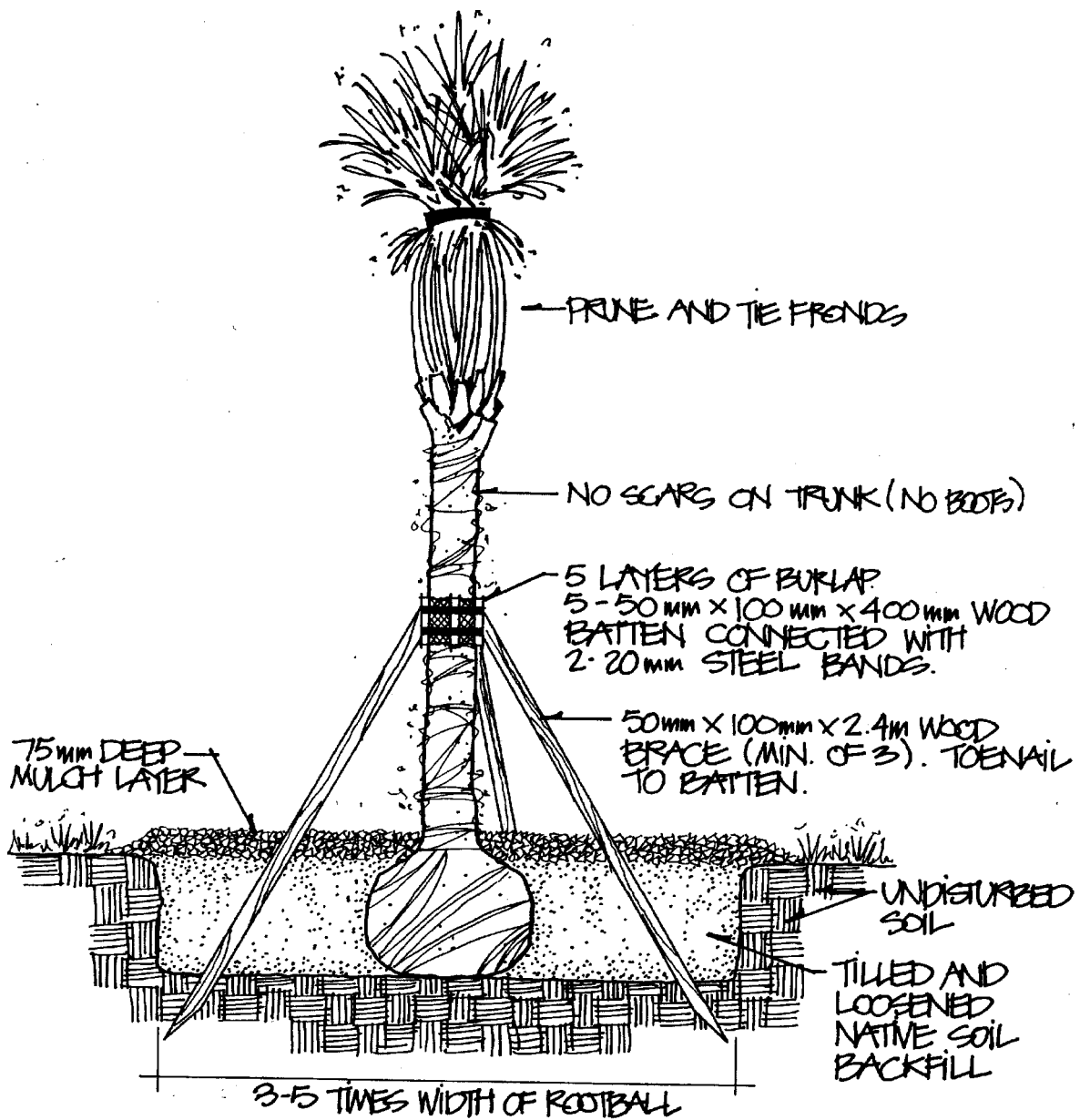


THE BASICS OF GOOD TREE PLANTING



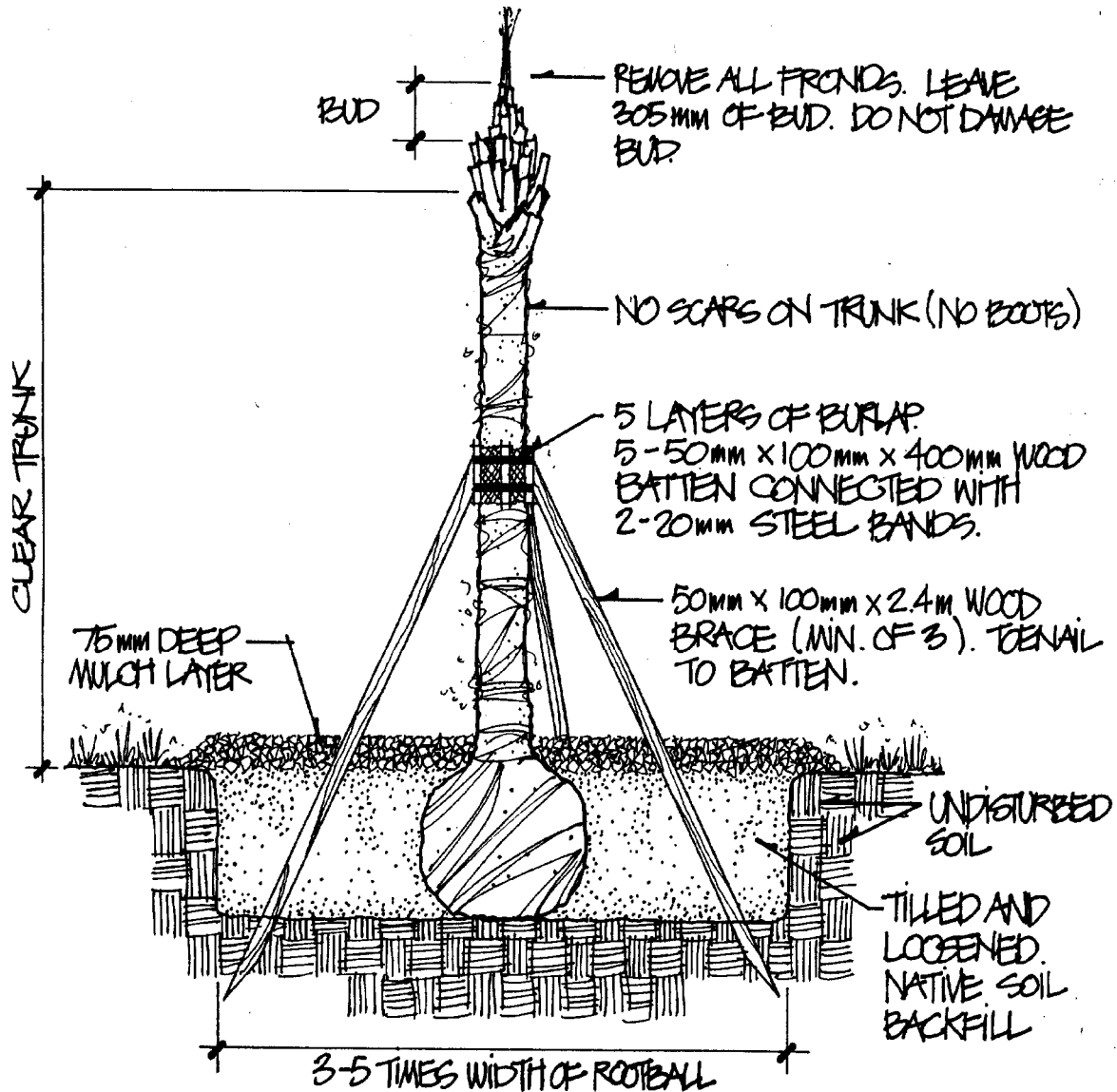
TREE PLANTING DETAIL

Figure 28



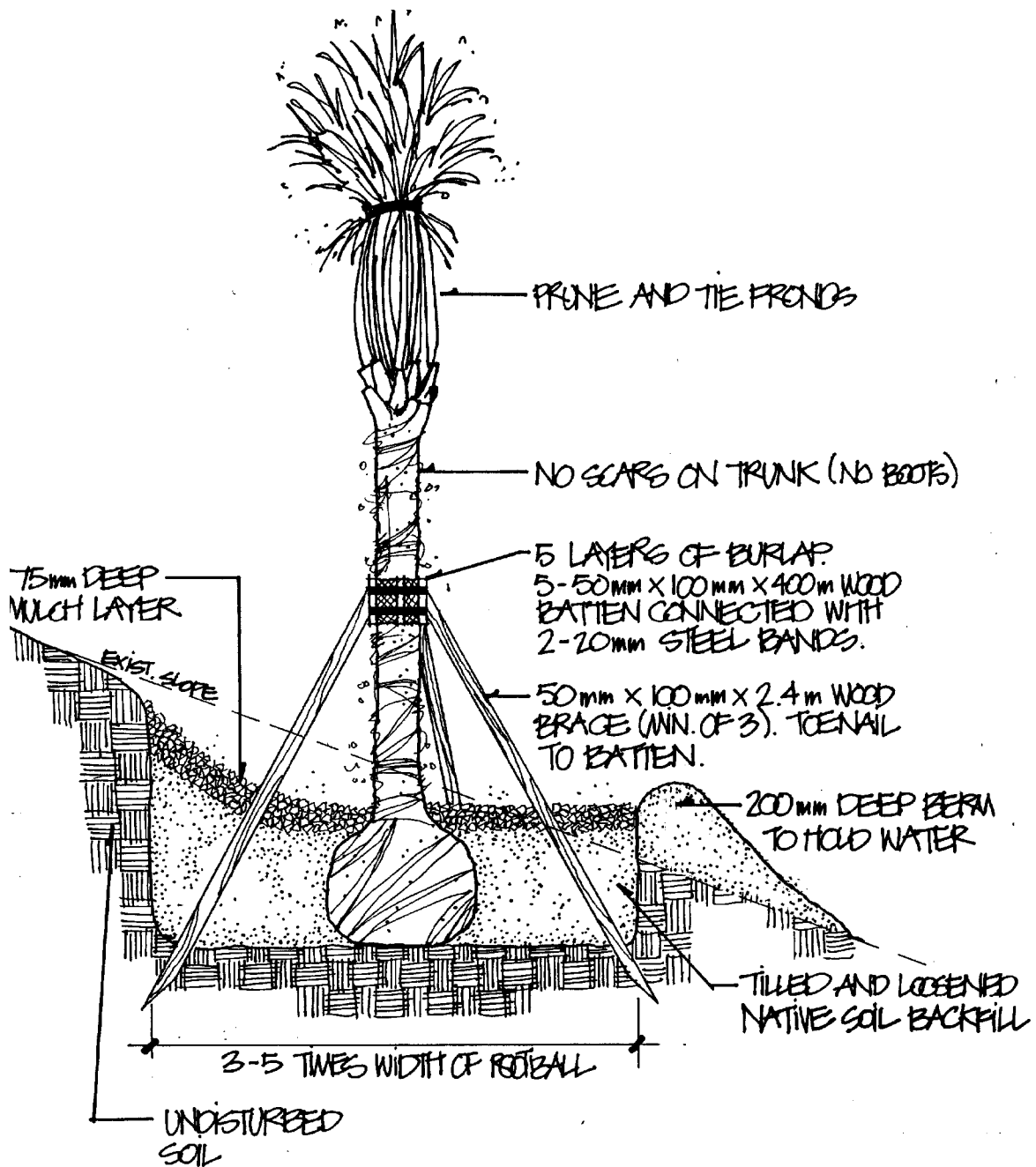
PALM PLANTING DETAIL (EXCEPT FOR SABAL PALMS)

Figure 29



SABAL PALM PLANTING DETAIL

Figure 30



SLOPE PLANTING DETAIL

Staking

Stake trees only if necessary. For example, if the tree will not stand on its own, or to prevent wind damage, hazard or vandalism. Use wide plastic, rubber or other flexible strapping materials to support the tree to stakes or ground anchors that will give as the tree increases diameter. The tree must also be allowed to sway. Do not use rope or wire through a hose; biodegradable material is recommended (see Figure 27, Tree Planting Detail).

Stakes and ties should remain until the tree has become established, but no longer than one year after planting to avoid girdling the tree. Remove debris from the site. (See Figures 28, 29 and 30 for staking methods.)

Protective Spraying

All broadleaf evergreen trees and large shrubs planted should be sprayed with an anti-desiccant. Spraying should be done in accordance with spray manufacturer's instructions.

Pruning

All pruning and trimming operations will be done in accordance with Section M580, "Tree Trimming and Removal", of the FDOT *Standard Specifications for Road and Bridge Construction*, and as follows:

- At the time of planting only dead, damaged, rubbing or cross branches should be removed. Do not paint wounds.
- Remove sucker sprouts from the base of the tree after planting.
- Do not remove more than one-third of the live crown at any time. Be careful to not prune away growing tips or buds, as this may slow root regeneration.
- Desired pruning can begin one year after planting.

(See Section 6, *MAINTENANCE*, "Maintenance Techniques", for additional information on pruning and trimming of established plant material.)

Watering

Establish a regular watering schedule and adhere to it. Slow deep watering is recommended. (See "Establishment Period Criteria" in this Section for complete establishment watering directions.)

Various species of trees and/or soil types may require varied degrees of watering. Soil moisture and tree health should be monitored and supplementary irrigation adjusted accordingly. Non-irrigated sites need to be monitored more closely.

Fertilizing at Time of Planting

Fertilizing is typically not recommended within the first year of planting. Slow-release fertilizers may be incorporated with newly planted material. If micronutrient deficiencies are suspected, have a soil test completed and supplement the fertilizer program accordingly. Fertilize lightly after the first year using a balanced fertilizer. The rates used should be based on the amount of tree crown.

For further information or assistance, contact your local County or urban forester, or your County extension agent.

Shrub and Ground Cover Installation

All plant materials shall be properly prepared and shipped to prevent wilting, damage and contamination and should be watered as necessary until planted. The following steps should be taken in the preparation and planting of shrubs and ground covers:

1. Where bedding plants or large planting beds for ground cover are to be planted, the area should be treated with the appropriate herbicide per manufacturer's specifications.
2. Soil around the shrub planting area should be rototilled to three times the width of the plant root ball and no deeper than the depth of the root ball.
3. If weed barrier fabric is to be used, install as indicated per manufacturer's specifications and after trees and large trunk plants have been installed. After fabric is firmly in place, plant shrubs and ground cover.

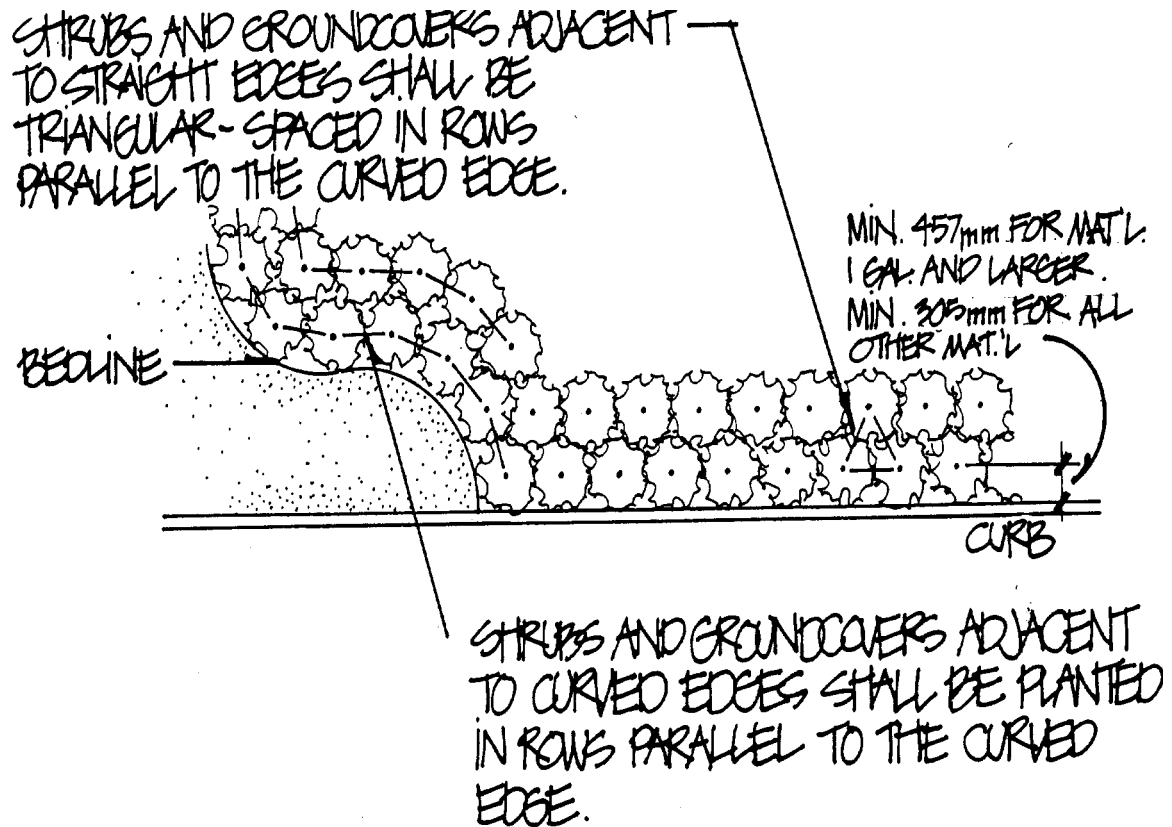
4. Do not remove container-grown stock from any containers until time for planting. All containers should be cut and opened fully in a manner that will not damage the root system. Plants which have become pot bound should not be planted.
5. Plants should be centered in the plant pit and set straight or plumb, and at a level to provide a natural relationship of the crown of the plant with the ground surface after settlement.
6. Burlap, rope and wires should be removed from the sides and tops of the balls and trunks, but no burlap should be pulled from underneath.
7. Roots of bare plants should be properly spread out, and native soil carefully worked in among them. All broken and frayed roots should be cut off cleanly.
8. When plants are set, the loosened native soil should be carefully tamped under and around the base of the balls to prevent voids.
9. All soil used in backfilling plant pits should be native, unamended soil unless conditions require additional soil amenders.
10. When the hole is nearly filled, add water slowly, but thoroughly allow it to soak away. Fill the hole to finish grade allowing for mulch.
11. Drainage of final installation is to be considered during planting operations. Xeriscape principles suggest median final grade and mulch elevations remain below adjacent curb levels to retain moisture and mulch within the planting area. Because a large area around each plant has been rototilled, there is no need for earthen plant wells to be installed.

(See Figure 31 for shrub and ground cover layout details and Figure 32 for shrub and ground cover planting details.)

Wildflower Installation

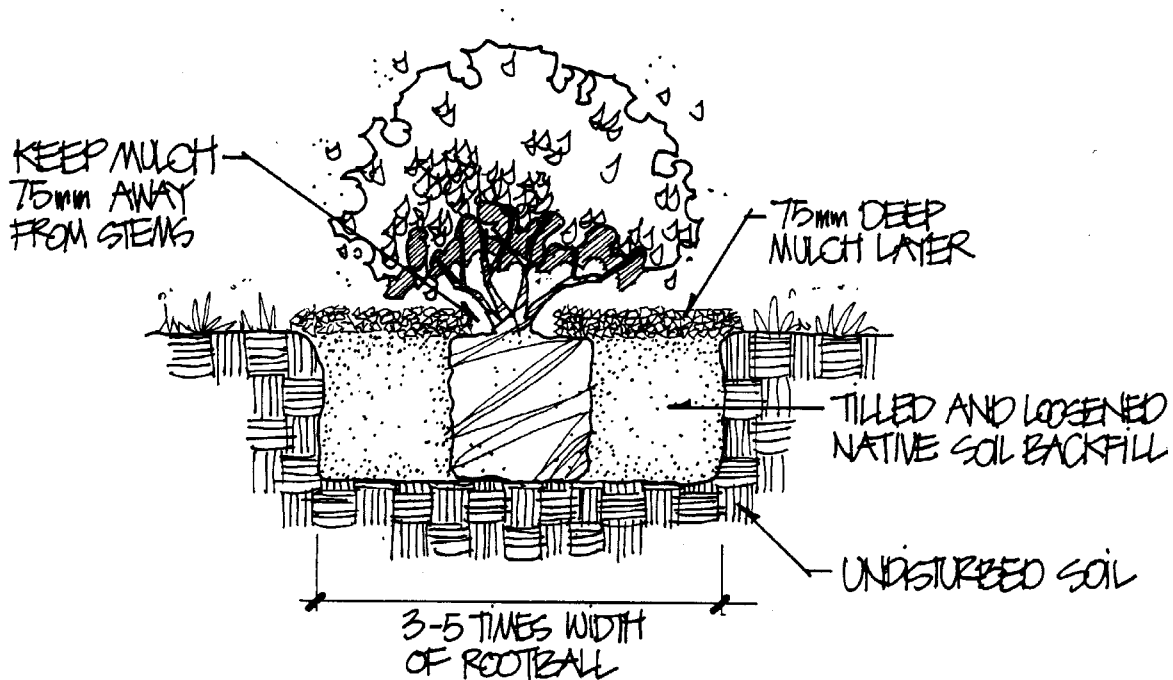
Wildflower plantings can be successful, but success is not without effort. Cleared and grubbed roadsides are altered habitats and can be hostile to plant life. However, wildflowers can adapt to the environment of the highway right-of-way provided care is used in planning, planting and maintenance. Important considerations are:

Figure 31



SHRUB AND GROUNDCOVER LAYOUT DETAIL

Figure 32



SHRUB AND GROUNDCOVER PLANTING DETAIL

- **Site Preparation** must facilitate good seed/soil contact. Seed germinates more readily in loose soils than in hard, compacted ones. Improper site preparation can harm germination and the continued survival of the wildflower species. Sites that have been cleared of vegetation and tilled for seeding could induce the growth of broadleaf weeds and unwanted grasses if tilling is too deep. Preparing wildflower sites should, at a maximum, only involve breaking up the top 25 mm of soil. This can be accomplished by shallow rototilling, mowing with a flail mower or by power raking. For best results, do not till or disturb the soil. The following planting techniques for varying turf cover should be followed:
 1. Thin turf cover areas: Broadcast the wildflower seed over the area, then rake or drag the area to obtain seed-to-soil contact.

2. Average turf cover areas: Scalp the turf to 25 mm, remove the clippings, then broadcast seed over the area and replace clippings evenly as a mulch. A mechanized seed drill can be used without removing the clippings.
 3. Heavy turf cover: Herbicide and let the area sit for one month. Scalp to 25 mm, then follow step number 2. The establishment of wildflowers is not recommended for areas of heavy turf and areas of excessive weed infestation. The use of a mechanized seed drill designed for planting wildflowers produces the best results. (The majority of FDOT's maintenance offices herbicide the area, till the soil, and then use a mechanized seed drill for placing the seed.)
- **Seed Quality** is very important to the success of wildflower planting. Several factors can effect seed quality, including germination, purity or improper seed storage, and can turn a good effort into failure. Proper consideration must be given to the germination characteristics of a wildflower species, so that the maximum percentage of seeds sown are likely to germinate without the introduction of weeds or unwanted grass. Seeds should be properly cleaned and free of residue which might impair germination. Finally, wildflower seeds that have been stored for prolonged periods should not be used. It is most advantageous to secure seeds that were collected during the most recent season and plant them during the recommended planting period.
 - **Proper Planting Procedures** will encourage successful wildflower growth. Seeding of wildflowers is most commonly used for rural application, while four-inch pots of established flowers are used in urban settings (see this Section for installation of container plants). Seeding is done by three techniques for planting including drill seeding, hydro-mulching and broadcasting. Whichever technique is selected should not cause damage to, or adversely disturb, the existing turf. Two of the most common causes of wildflower planting failures are the tendency to plant seeds too deep and in the wrong season. Wildflower species have different soil depth requirements for timely germination; check the proper depth for each species with the seed supplier. Again, the time of planting is also critical for success. Although wildflowers begin to bloom in the spring, nature ripens seeds during the late summer and fall months. Fall plantings offer the advantage of early germination and growth. Many varieties actually germinate and grow throughout the winter months and stay semi-dormant until the first signs of spring. The planting periods recommended for seed installation are:

North Florida - November/December
 Central Florida - December/January
 South Florida - January

If seed is planted at other times of the year, the percentage of germination will be lowered and the overall effect of the bloom period will be greatly reduced. Determine the appropriate time for wildflower seeding to take place rather than planting wildflower seeds to accommodate a construction schedule.

- **Soil Conditions** must be considered even though the wildflower species selected is appropriate to the geographical region. Wildflower species do not adapt to all soils. Highly alkaline or acidic soils can be a threat to the success of the project. Test soils for compatibility with the needs of the wildflower species selected for the project.
- **Adequate Moisture** is critical to any effort to establish wildflowers. Moisture is crucial to induce seed germination and plant growth. The success of the planting depends on the availability of moisture at the time of planting and throughout the time leading up to germination. This is true even for species that are classified as drought tolerant; wildflowers must receive adequate water in order to germinate and become established. Once established, they are drought tolerant. Absence of rainfall or supplemental watering during germination will jeopardize the project.

Bedding Plant Installation

For bedding plant areas consider those flowers and ground covers that can be installed in liners (two-inch pots) or rooted cuttings. This type of plant material should only be used at high-focal areas where traffic is generally slow and maintenance can be provided regularly.

When installing bedding plants:

- Cultivate the entire area to provide a loose friable mixture to a depth of at least 200 mm.
- Fertilizer, if required, shall then be applied uniformly at a rate of 1.35 kg for each 8.4 m² of the plant bed area.
- The bed shall be dressed to a uniform surface, at an elevation approximately matching the adjacent ground level. When individual plants to be placed within the prepared bed have a root system which necessitates excavation below the 200 mm cultivated depth, the additional depth of excavation should be treated as other planting procedures for trees, shrubs and ground cover.

Sodding and Seeding

Install sod and seed per the FDOT *Standard Specifications for Road and Bridge Construction*. (Additional information regarding sod and seed is found in Section 4, *DESIGN PHASE*, "Plant and Turf Grass Selection Guide").

ESTABLISHMENT PERIOD CRITERIA

Establishment Watering Period

When no irrigation system is installed, proper plant establishment requires supplemental watering on a regular basis for an appropriate period of time. This period may vary from six months to one year depending on area yearly rainfall amounts, soils and other geographic and topographic factors. During the establishment period, soil in the tree root zone must be kept near field capacity. Trees are usually established when shoot growth has begun over a majority of the crown. Water applied per plant during this period shall be provided per the following table:

GROUND COVER	=	4.0 L / 1.0 m ² /WATERING
1 GALLON PLANTS	=	8.0 L / WATERING
3 GALLON PLANTS	=	19.0 L / WATERING
7 GALLON PLANTS	=	30.0 L / WATERING
10 GALLON PLANTS	=	38.0 L / WATERING
PALM TREES	=	76.0 L / WATERING
30 GALLON / B&B TREES	=	76.0 L / WATERING
50 GALLON / B&B TREES	=	95.0 L / WATERING

Establishment Period Watering Schedule: (this schedule is provided as a minimum; individual projects may require more frequent waterings).

1ST 4 WEEKS	-	3 WATERINGS / WEEK
2ND 4 WEEKS	-	2 WATERINGS / WEEK
UNTIL ESTABLISHMENT -	-	1 WATERING / WEEK

Additional watering criteria are as follows:

- All watering operations shall comply with FDOT Standard Index, Series 600, *Traffic Control through Work Zones*.
- Watering should be applied so that force from a water truck would not damage plants or destroy the mulch bed around each plant.

IRRIGATION INSTALLATION TECHNIQUES

Complete information for the installation of underground irrigation systems will be found in the supplementary specifications of the individual project. The following is additional information that will be helpful in properly installing irrigation systems:

- Preparation must be made with the area maintenance engineer for all required reviews and permitting of any subsurface piping within the right-of-way. This process is required to avoid any conflicts with other scheduled road work, existing and proposed utilities, and establish location and method of all highway crossings.
- Any obstructions discovered during drilling or excavation procedures should be recorded and reported to the area maintenance engineer, landscape architect or the local governing Agency immediately upon discovery.
- The plans and specifications are to be studied by the installing contractor so as to have a thorough understanding of the system design and installation procedures. The spacing of heads and underground emitters is important to the operation of the watering system and must be rigidly adhered to.
- Protection and safety of all personnel shall be in accordance with an appropriate Maintenance of Traffic criteria and standards.
- Comply with all requirements of the *Uniform Plumbing Code* and the *FDOT Utility Accommodation Manual*.
- Layout the system as stated on the plans and specifications, or as required by the manufacturer's standards, and stake layout all major components such as, pipe crossings, control valves, mainline locations, etc.
- Emitter pipe locations should be as specified or as required by the manufacturer's specifications. The location of pipe may require minor adjustments as necessary to avoid plantings and other obstructions and to obtain coverage.
- Trenches should be dug straight with trench bottoms at a gradient providing support to pipe through its entire length. Remove rocks, clods, debris and sharp-edged objects. The minimum depth of lines should be measured to top of pipe. Unless otherwise indicated on plans, pipe depths should be:
 1. Main lines and quick coupler lines shall be 450 mm to 600 mm below finish grade.
 2. Emitter supply lines shall be a maximum of 150 mm below finish grade.
 3. Provide minimum cover of 300 mm for all control wiring.

4. Emitter feeder lines shall be 150 mm to 200 mm below finish grade.

- Install pipe on a solid sub-base, uniformly sloped without humps or depressions. Changes in grade should not exceed 150 mm per watering zone for horizontal emitter system installations. Do not install emitter lines under pavement, cement, driveways or walks. PVC pipe should be installed in dry weather when temperature is above 40 degrees Fahrenheit and in strict accordance with manufacturer's instructions. Allow joints to cure at least 24 hours at a temperature above 40 degrees Fahrenheit before testing, unless otherwise recommended by manufacturer. Welded joints shall be given at least 15 minutes set-up curing time before moving or handling.
- Plastic pipe should be cut with an appropriate tool in a manner to insure square ends. Burrs at cut ends should be removed prior to installation to obtain a smooth unobstructed flow. All plastic-to-plastic joints shall be solvent-weld joints. Only the solvent recommended by the pipe manufacturer shall be used and applied by industry methods.
- Other types of pipe and pipe related components that may be required for installation are galvanized steel pipe and fittings and thrust blocks. These materials should be installed by trained tradesmen using tools and equipment recommended by the manufacturers of the pipe, fittings or equipment.
- Emitter piping should be installed in a horizontal position at intervals not to exceed the maximum spacing shown on the plans or as specified by the manufacturer for project conditions. Pipes shall be installed 200 mm minimum from the inside edge of the pavement, curb or walk.
- Backfill should be placed when the installed irrigation system has been thoroughly inspected and tested. Backfill material should be the existing soil but free from large rocks, debris or sharp objects. Backfilling should be done when the pipe is not in an expanded or contracted condition due to temperature extremes. Backfill should follow excavation with the least possible delay. Open trenches shall be adequately protected at all times to cause the least possible hazard to vehicles and pedestrians. Place the backfill material over the pipe and lightly compact. Repeat this operation until the finished grade of backfilled trenches matches that of adjacent soil.
- For valves and other operational devices, installation shall be as provided in the plans and specifications; but wherever possible, locate these components in plant bed areas for best concealment and accessibility.
- Solar or electric controllers (time clocks) should be located at grade level, or as close to grade level as possible, if installed in clear zone areas.

- Install rain sensor devices at appropriate locations if an automatic system is installed.
- Completely flush system to remove all dirt and debris that may have entered the line during installation.
- Connect the irrigation system to the available water source. In some cases this will be accomplished by the local governing Agency.
- Adjust all control valves to provide the proper flow rate required for each sprinkler circuit.
- A thorough system check should be made of each operating zone. This procedure includes pressure testing and operational testing. See Figure 25 in Section 4, *DESIGN PHASE*, for subsurface drip irrigation system.

CONSTRUCTION INSPECTION AND STAFFING

Highway landscape projects are more prevalent today than ever and promise to be more frequent components of highway construction. To this end, FDOT has responded with appropriate personnel and training to afford proper construction inspection for landscape projects.

Each District shall have a person, or person's representative, responsible for the timely inspection and construction management of landscape projects. This person might be the District maintenance engineer, the District vegetation specialist, a landscape architect, or other qualified and adequately trained persons. Responsibilities of this person include:

- Assistance in review of landscape plans and specifications.
- Assistance in Memorandum of Maintenance Agreement (when required).
- Review of site conditions.
- Approval of construction submittals required by the plans and specifications.
- Approval of plant material and sod.
- Inspections of installation quality and methods.
- Approval of installed work.
- Review of work and materials compliant with all related FDOT requirements.

- Review of Highway Beautification Grant funds' applications and prepare District recommendations.
- Final acceptance of work.
- Periodic post-construction inspections for establishment period, warranty, and plant replacement.
- Long-term periodic inspections to verify project quality, development and maintenance (when appropriate).

Section 6
MAINTENANCE PHASE

The following will be accomplished during this phase:

- Determine maintenance objectives and responsibility.
- Construct maintenance agreement when being provided by local governing Agency.
- Develop a maintenance management plan.
- Select appropriate maintenance techniques.
- Provide criteria for the proper maintenance of irrigation systems.

Maintenance is one of the most important considerations when planning a highway landscape project. The initial questions to be answered are: who is going to maintain the project, how will maintenance be funded and how will it be monitored? The availability of maintenance resources should be considered in the design of a highway landscape project and the design should be based on realistic maintenance capabilities.

MAINTENANCE OBJECTIVES

The maintenance goals of a landscape project should be the same for both the local governing Agency and FDOT. Both entities want an attractive landscape with the least amount of effort and cost required for upkeep. To meet these objectives, maintenance considerations should be reviewed as part of the design process. By providing the framework for maintenance procedures, standards and responsibilities early in the project, mutual understanding of the maintenance management goals will be achieved. Having a clear consensus of the maintenance strategy and requirements will reduce maintenance cost.

Maintenance personnel should be made aware of the design goals intended in the landscape plans, and be directed toward achieving and continuing these objectives. It is the area maintenance engineer's responsibility to see that all landscaping on the State highway system is maintained to comply with the design intent for safety and aesthetics. All scheduled and routine maintenance inspection should include an inspection of the highway landscape features.

The following checklist of issues should be resolved prior to proceeding with a landscape project whether maintained by FDOT or a local government Agency. Addressing these issues early in the design process will avoid unnecessary conflicts:

- Identify the maintenance needs with regard to sufficient staff, funding and equipment resources.
- Analyze the level of maintenance required to monitor and prune clear zones and clear-sight zones to meet safety standards.
- Determine what action and funding resource will be used, should landscape material become a safety hazard.

MAINTENANCE RESPONSIBILITY AND AGREEMENTS

The FDOT provides routine turf and landscape maintenance under the FDOT *A Guide to Roadside Mowing* and FDOT *Maintenance Management Systems* (325-010-001). This level of maintenance involves scheduled mowing, and periodic or required trimming of trees and landscaping that pose a safety hazard within the right-of-way. This routine maintenance does not, nor is it intended, to provide the necessary regular maintenance for landscape projects.

The Maintenance Department of the FDOT is staffed to maintain turf and natural landscaping within the right-of-way. It does not have the staff to maintain highway landscape projects. Therefore, when a local government or Agency wants to have a greater degree of landscaping within FDOT rights-of-way, they must agree to be responsible for the landscape maintenance. The construction of a locally initiated highway landscape project cannot begin on a State highway without a properly drafted "Highway Landscape Maintenance Memorandum of Agreement" (Maintenance Agreement) executed by FDOT and the local government or Agency. This agreement details the responsibilities for maintenance of areas to be landscaped or improved by the proposed project. FDOT will not permit a landscape project on the right-of-way of a State highway without the Maintenance Agreement in place.

Permission to install landscaping on the FDOT right-of-way may be obtained if the local government Agency agrees to be responsible for maintenance of the landscaping. The permittee should contact the area maintenance engineer to apply for a permit to install landscaping on a State road right-of-way. A letter from the government Agency stating its willingness to maintain the landscaping should be included with the permit request.

The FDOT may agree to provide funds to a government Agency to maintain landscaped areas under a special contract. The amount of funds shall not exceed the cost of routine maintenance of an equivalent area not having additional landscaping. These agreements are negotiated on a year-to-year basis and are provided for in FDOT, Rule Chapter 14-40, *Highway Landscape Improvements*. The local government Agency should contact the area maintenance engineer for further information.

The FDOT may accept donations of maintenance for projects on the State highway system. In addition to other requirements, all such maintenance activities must be performed under the

supervision of FDOT personnel and in conformity with all applicable safety criteria (refer to FDOT, Rule Chapter 14-40, *Highway Landscape Improvements*).

All landscape installation or maintenance activities performed by others on State highway rights-of-way are subject to inspection and supervision by FDOT personnel. The control of traffic during work within the right-of-way must be in conformity with the FDOT Standard Indexes, Series 600, *Traffic Control through Work Zones*. Chapter Six of the MUTCD "Traffic Controls for Street and Highway Construction, Maintenance, Utility and Emergency Operations" should be referred to for conditions not addressed by the standard indexes.

The Maintenance Agreement

The Maintenance Agreement outlines the responsibilities of both the FDOT and the local government Agency. This agreement states the scope, term, compensation, other services and terms of the contract.

The following elements are recommended for inclusion in a Maintenance Agreement between the City, County or legal entity undertaking the project maintenance and FDOT. Each agreement must be legally drafted and customized to the individual site areas, conditions and project requirements.

- **Scope of Work:** This section shall include a description of the work to be performed including routine mowing of grassed or vegetated roadside areas with conventional high-production style mowing equipment, and hand labor or special mowing. It should also include tree, palm and/or shrub pruning, fertilization, disease and pest control. Litter control may also be included in the scope of work.

This section shall also stipulate that the supervision and personnel shall be trained and competent for the particular type work undertaken. Furthermore, the legal entity shall be fully responsible for the performance of its organization and completion of all work under the Maintenance Agreement.

The scope of work must include schedules established by the legal entity, in conjunction with FDOT, for completing the work. Mowing cycles shall be scheduled in accordance with FDOT criteria and seasonal growing conditions. The schedule shall include provisions for accomplishing the work in the event of inclement weather conditions which interrupt the schedule. The schedule shall be submitted to FDOT for approval and will be used in determining compliance or delinquency in performing the work.

- **Areas of Operation:** The FDOT's *A Guide to Roadside Mowing* will be utilized and areas to be mowed clearly stated. Landscape maintenance areas shall be identified with the type of work to be done specifically stated in the agreement. The agreement must state that clear zones and clear-sight windows will be maintained. All work under this agreement must comply with FDOT, Rule Chapter 14-40, *Highway Landscape Improvements*.
- **Equipment:** This section shall give the terms and requirements for all maintenance equipment to be used, including safety precautions, legal responsibility for equipment and work, maintenance of equipment, and inspection and approval of equipment by FDOT. For information on mowing equipment and safety appurtenances, refer to the FDOT's *A Guide to Roadside Mowing*.
- **Method of Operations:** The work shall be regularly undertaken in accordance with the schedule approved by FDOT. It shall be performed as specified in the Maintenance Agreement.

The method of operations shall be clearly stated in the Maintenance Agreement so that both the legal entity and FDOT understand the methods and conditions of the performance of work. This section of the Maintenance Agreement will include items such as: mowing patterns, turf grass height, trimming and pruning of trees, palms and shrubs, fertilization, use of pesticides and herbicides, safety precautions and litter control. Safety provisions shall be stated in accordance with the FHWA *Manual on Uniform Traffic Control Devices for Streets and Highways*, as well as other regulations and directives approved by the FDOT. It shall provide for the safe transport of machinery to, and during, the maintenance operations, as well as temporary storage of equipment during operations.

This section shall also provide for FDOT inspection and tentative approval of work quality being accomplished. In the event of unsatisfactory work, the Maintenance Agreement shall state that the areas in question be redone and completed in a satisfactory manner within a specified time.

- **Limitation of Operations:** This section should provide for the limitation of maintenance operations.
- **Reimbursement:** This section should describe the amount and terms of any reimbursement negotiated and agreed upon between the contract entities.
- **Hold Harmless Clause:** A statement indemnifying FDOT from liability for accidents occurring during maintenance operations.
- **Termination Clause:** A statement allowing for the dissolution of the agreement by either party under certain conditions.

MAINTENANCE MANAGEMENT PLAN

The landscape plans package must include a maintenance management plan. This plan must assure that the plants will be maintained in compliance with all safety indexes. The minimum level of maintenance shall be no less than the standards set forth in the FDOT's *Maintenance Management Systems* (325-010-001). The latest version of the FDOT's *A Guide to Roadside Mowing* shall be followed for a mowing activities. The responsibility for maintenance will include all landscaped and/or turf areas on the FDOT right-of-way within the limits of the project.

The local governing Agency, as stated in the Maintenance Agreement, takes responsibility for maintenance of all landscape areas within the scope of the agreement. To properly execute highway landscape maintenance and set the parameters of the Maintenance Agreement, it is critical to develop a landscape maintenance management plan. Elements which should be included in such a plan are:

- **Safety Standards During Maintenance.** All maintenance operations such as trimming, pruning, weeding, plant replacement, etc., shall be performed by trained personnel, familiar with landscape maintenance activities and FDOT procedures. Safety shall be paramount in the execution of all landscape maintenance activities. Training for traffic control during maintenance activities is available at FDOT District offices.
- **Maintaining Healthy Vegetation.** Primary to the landscape maintenance program is the health and vitality of the plant material under the care of the management program. The management plan should outline criteria for the inspection of materials and conditions, identification of problems and remedial action required to insure the health of the landscape vegetation.
- **Outdoor Advertising Maintenance.** All plant material must be maintained in accordance with FDOT, Rule Chapter 14-13, *Vegetation Control and Outdoor Advertising Signs*. The landscape management plan should contain criteria for the continual maintenance of that landscape vegetation impacting outdoor advertising displays.
- **Maintaining Aesthetics.** The design intent of the installed landscape design should be maintained at all times. To facilitate accurate interpretation of the intended appearance of the plant materials, a walk-through should be undertaken by maintenance personnel with the designer (or a person who completely understands the intent of the design). Where there is a conflict between aesthetics and compliance to safety rules, the regard for safety will always take precedence. There are opportunities to maintain the landscape aesthetic qualities without

compromising safety. When these opportunities present themselves, it is critical to have a well-trained maintenance crew that can address the safety issues while preserving the aesthetic quality of the landscape. Proper shaping of plant materials, persistence with weed control and continued mulching help to accomplish this goal.

- **Ecosystem Management.** Florida's ecology is based on a balance of natural systems. Part of the responsibility of any landscape management program is to insure that these systems are monitored for continued function and equilibrium. As part of the management plan, it is important to have regular inspections and review of the quality and function of project wetlands, retention areas, preservation areas, native plant communities, drainage systems, wildlife concerns and other environmental elements affected by the landscape installation. Once in charge, the maintenance management entity becomes the steward of the environment for which it is responsible. All issues concerning environmental matters not covered by FDOT Rules or procedures should be directed to the proper governing authority.

Developing the Maintenance Management Plan

Once the design and implementation are complete, maintenance, a key element of the success of the project, must begin. A maintenance strategy should be in place before any maintenance begins. Maintenance management should be planned early in the project's development to insure comprehensive maintenance procedures. The following are topics that should be included in the development of a landscape maintenance management plan:

- **Project Analysis.** Site/project quantities and limits, prior planting and maintenance history, utility impacts, adjacent land uses, site soils tests, tree survey and analysis, assessment of natural features and preservation areas, maintenance manpower and equipment requirements, hazardous working areas, future construction, irrigation water requirements and sources, and annual maintenance cost analysis.
- **Turf Grass Maintenance.** Mowing, edging, trimming, fertilization, pest control and thatch control.
- **Tree, Shrub and Ground Cover Maintenance.** Fertilization, pest control, pruning and mulching.
- **Miscellaneous Maintenance.** Shrub and turf replacement, annual flower planting, irrigation systems, thatch removal/scalping, aquatic sites, preservation areas, roadside pedestrian service facilities, historic sites, surface drainage facilities, etc.

Through the maintenance management plan the goals of increased safety, economic benefit, improved environment and aesthetic enhancement can be achieved. When a plan is developed properly, many disciplines are focused on the same objectives. A complete maintenance strategy is achieved through the input and expertise of appropriate regulatory Agencies, State and local governing bodies, foresters, naturalists, wildlife biologists and botanists, landscape architects and highway users working together to develop a comprehensive approach to maintain the highway environment.

MAINTENANCE TECHNIQUES

FDOT's *A Guide to Roadside Mowing*, *Maintenance Management Systems* (325-010-001) and Rule Chapter 14-40, *Highway Landscape Improvements*, are to be used as the rules for implementation of maintenance activity on Florida's highways. This guide provides supplementary or instructional information to assist in the objectives of a comprehensive highway maintenance program.

Mowing

Areas to be mowed are illustrated in the FDOT's *A Guide to Roadside Mowing*. Roadside mowing includes normal mowing and slope mowing. Normal roadside mowing is accomplished with conventional mowing equipment and includes the relatively flat areas of the roadside with slopes of 3:1 or less. Slope mowing, which is not encouraged, involves mowing roadside slopes of 3:1 or greater. In these instances special mowing equipment must be used because the areas are inaccessible by conventional equipment. All mowing must conform to established mowing limits and be performed in a simultaneous roadside mowing operation. Mowing frequency and height for an individual project area may vary depending upon the site and any local Maintenance Agreements in place.

Surveys by the FHWA and the Transportation Research Board have shown that the public is concerned with turf having a uniform appearance and height, although the actual height is not important. Bahia is a low maintenance aggressive turf which will produce foliage to about 355 mm and seed heads to 609 mm height. The seed head will appear approximately 10 days after mowing. Bahia in a rural location should be mowed at a 152 mm height, two to more times per year. The first mowing should occur in July or when appropriate for the climatic conditions of the District. In no case should mowing begin before early blooming wildflowers have gone to

seed. Stands of wildflowers over a meter square in size should be avoided during the mowing task. The last mowing should occur in November. Because mowing is an expensive, high energy effort, the goal should be toward mowing the least number of times possible to maintain a uniform appearance. Highway grass should be mowed before it reaches 558 mm. Mowing is undertaken not only to control the height of the grass, but also to eliminate weeds and trees.

In urban areas the mowing of bahia grass may need to be more frequent in order to maintain the height at a lower level of uniformity. Bahia grass should not be mowed below a 102 mm height because lower levels stress the overall health of the grass. Cutting grass too closely (scalping) should be avoided. If this occurs frequently, the bahia will weaken and weeds and other grasses will establish themselves. If this is the aim, the municipality should look at utilizing an alternate grass within their urban area. The following table shows the mowing heights (including seedheads) which should be ideally maintained for each turf grass:

Table 12
TURF GRASS MOWING HEIGHTS

TURF GRASS	MOWING HEIGHT IN MILLIMETERS
Bahia - rural Bahia - urban	152 to 254 100 to 152
Bermuda	50 to 76
Centipede	50 to 100
St. Augustine	64 to 100

Mowing shall be undertaken in cycles. The number and timing of cycles will be dependent upon grass growth during the growing season. The initial mowing cycle and mowing patterns must be authorized by FDOT. Designated limits of mowing should be accomplished within established work periods. Each mowing cycle must be completed before beginning another cycle. When the mowing cycle is interrupted because of weather, standing water, etc., modified mowing procedures must be approved by FDOT.

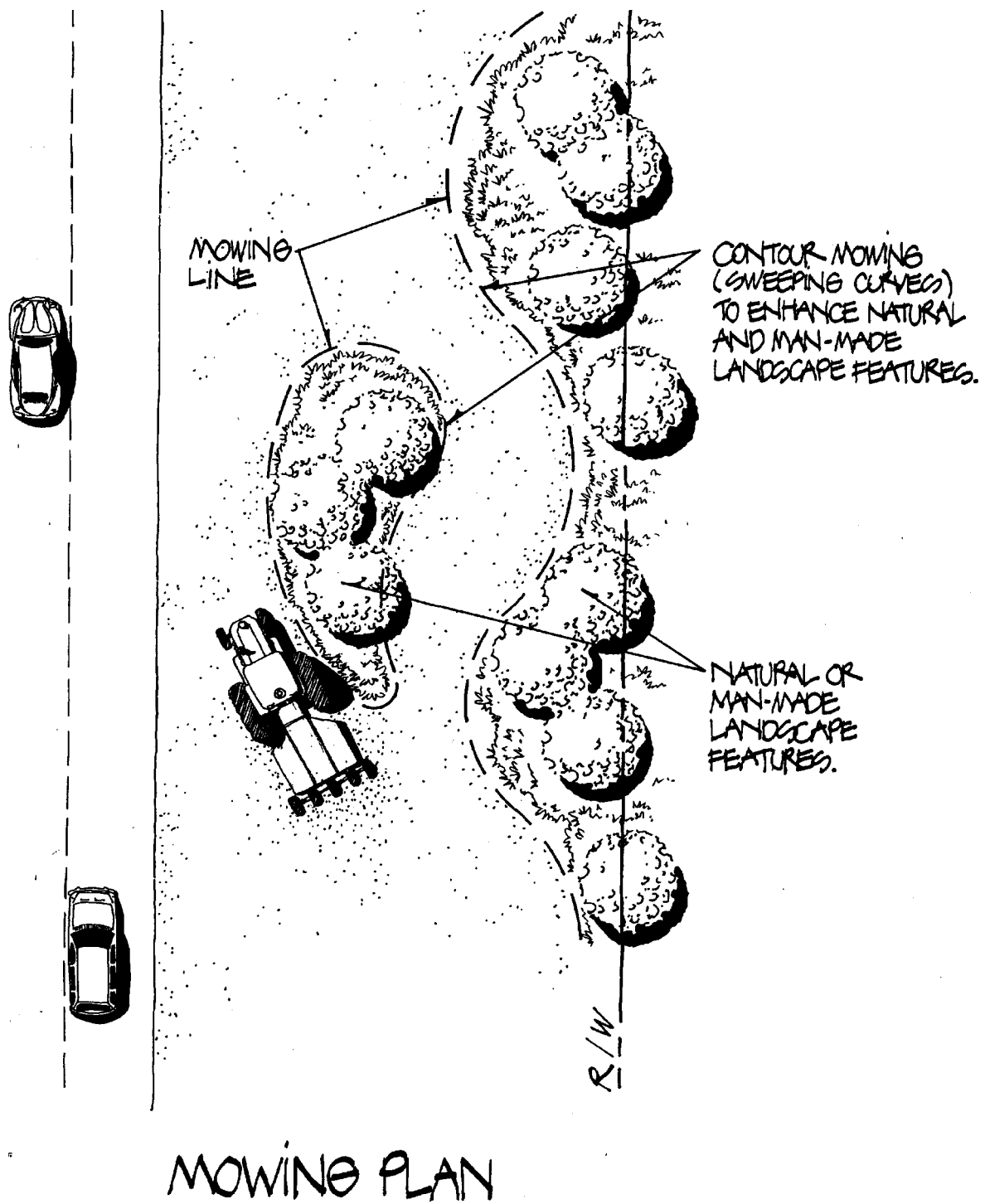
Mowing areas of different widths must be connected with smooth flowing transitions. All cutting must be performed to provide a uniform height with no streaks or scalping. Where landscaping has been established or natural landscaping preserved, the mowing must conform to the established landscaping contours (see Figure 33). No accumulation or piling up of grass cuttings will be allowed as a result of cleaning the mowing equipment. Where mowing equipment damages turf or other landscape elements, repairs must be made to prevent further damage.

Care must be taken when mowing to avoid obstructions such as trees, shrubs, utility boxes, signage, buildings, etc. Optimum mowing conditions are when the grass is dry. Grass clippings should be left on the grass except in high focal areas where it may be desirable to remove them to prevent matting or thatch buildup. The final appearance after mowing must present a neat appearance.

Mowing Equipment

All mowing equipment must be approved by FDOT and have all safety devices required in FDOT's *A Guide to Roadside Mowing* before it is placed in service. The equipment must be properly maintained and in accordance with FDOT or other agreed upon directives. Mower blades shall produce a clean, sharp cut and uniform distribution of the cuttings at all times. When the FDOT determines the equipment is deficient in safety devices, it must be removed from service immediately and not reinstated until the deficiency is corrected. All mowing equipment must be painted a uniform color of high visibility. Equipment shall have amber flashing lights that must be used in the course of the work. Inspection and approval of mowing

Figure 33



equipment by FDOT shall not relieve the responsible County or municipality of responsibility or liability for injury to persons, or damage to property caused by the operation of the equipment. Equipment operations resulting in damages to curbs, pavement or turf will not be allowed.

Trash Removal

Before mowing operations begin, all visible trash should be removed. This includes the pickup, removal and disposal from the right-of-way of any obstacle such as wood, tires, cans, etc., that cannot be traversed by the mowing equipment. Items such as bags of trash, newspapers, magazines, boxes, etc., that would be torn, ripped, scattered or further subdivided by the mower and result in an objectionable appearance should be removed. The mower operator must exercise caution to avoid creation of litter during the mowing operation. All highway light poles, guardrails, signage and other appurtenances shall be mowed, trimmed or spot sprayed with herbicide completely around their bases during each mowing cycle.

Inspections

During periods of mowing operations, FDOT may make periodic inspections of the quality of work being accomplished. If the mowing operation is deemed unsatisfactory by FDOT, according to the Maintenance Agreement, the local government Agency shall re-do the work at their own expense.

Mowing Safety Procedures

When mowing within 3.0 m of the roadway, the equipment shall be operated in the direction of the traffic flow, unless the work site is protected by flagmen and warning signs. When boom-type slope mowers are operated on the shoulder, it may be necessary to station a flagman to warn traffic and assist in the operation. Warning signs shall be placed at least 300.0 m in advance to warn traffic. When these mowers are crossing the roadway, flag protection shall be provided.

When necessary for mowing machines to cross bridges with full width shoulders on the right, the crossing should be made on the shoulder. All bridges should be crossed with extreme care and operations planned to reduce such crossings to a minimum. When necessary for mowing machines to cross the travel way, a location shall be selected that provides an unobstructed sight distance

of 150 m. The operation shall stop before crossing the travel way and permit closely approaching vehicles to pass before crossing. Operations should be planned to minimize crossings.

Any equipment left overnight on the right-of-way must be parked as close to the right-of-way line as possible. No equipment should be parked in the median regardless of the width of the median. All service and supply operations must be conducted between the travel way and the right-of-way line and at least 10.0 m from the travel way, right-of-way permitting. No supply vehicles should enter the median for any purpose. Service vehicles should enter the median only when necessary to repair or remove inoperable equipment.

Property Damage

Damages to turf, curbs, pavement, sign structures or other appurtenances must be replaced or repaired to the satisfaction of FDOT. Appurtenances include sign posts and bases, delineator posts, fences, guardrail or barrier walls, end walls, pipes, drainage structures, poles, guy wires, landscaped areas, etc. Deep ruts caused by mowers on soft sandy soils, wet soils and steep slopes cause severe damage and erosion throughout the highway system.

Edging

Trees, bushes and ornamental plants located in mowing areas should not be trimmed any closer than 225 mm around the base. For high-focal areas, such as rest stops, toll plazas, monuments, etc., edging, using mechanical edgers or line trimmers, shall be performed at the same frequency as mowing and include walks, drives, curbs, planting bed perimeters, trees and tree wells. Edging around the bases of trees should be performed with equipment utilizing a tree protection guard. Grass abutting buildings, light poles, signage, guardrails, benches, etc., that cannot be cut by normal mowing procedures, must be regularly trimmed around their entire bases using a line trimmer to eliminate uneven edges. Grass adjacent to all sprinkler heads, valve boxes and quick couplers should be trimmed as needed to maintain a clean appearance and good irrigation coverage. Chemical defoliant or herbicides may be used for spot spraying difficult to reach areas.

Other Turf Maintenance

Routine inspections of the turf will be made to insure prompt attention to any diseases or pests. Specific diagnosis of lawn diseases and/or pests shall be made, and approved insecticides or biological controls prescribed and applied, by Florida licensed applicators. The application must comply with the manufacturer's recommendations and the *Federal Insecticide, Fungicide and Rodenticide Act*. Every chemical substance used must be on the list of chemical substances, or have been submitted for inclusion on such list, as compiled by the Environmental Protection Agency pursuant to the *Toxic Substances Control Act*. In high focal areas, an effort should be made to abate all gophers, mole crickets and other lawn/vegetation damaging rodents in a timely manner to minimize damage. Fire ants, as well as any other damaging pest, will be treated promptly so as not to present a hazard.

Tree and Palm Maintenance

Equipment. Only equipment designed for tree trimming and pruning will be acceptable for trimming and pruning operations. The equipment used must be in good repair and operating condition, and meet all safety requirements for this type of work. Climbers, gaffs or other tree climbing tools that can injure the bark or create an unsightly appearance will not be permitted. All ascents and descents must be made by mechanical means, ladders and/or ropes.

Trees. Trees within the right-of-way must be trimmed to discourage encroachment over roadways, shoulders, clear zones and sidewalks. The FDOT criteria and standards, and the FDOT's *Florida's Design Standards for Resurfacing, Restoration and Rehabilitation (3R) of Streets and Highways* define the minimum horizontal limits of clear zone by facility type. Trimming of trees, tree limbs or brush should take place when encroachment is lower than 4.4 m over travel ways or clear zones, or lower than 3.0 m over a sidewalk. If there is dead or dying vegetation, next to or over the travel way or clear zone, that could fall or otherwise present a hazard to pedestrian or vehicular traffic, then trimming and removal operations must be undertaken. When these conditions occur from trees outside the right-of-way, permission must be gained from the property owner, unless disposition of tree limbs are a critically serious hazard or there is an emergency involved. The following items should be reviewed for tree trimming operations:

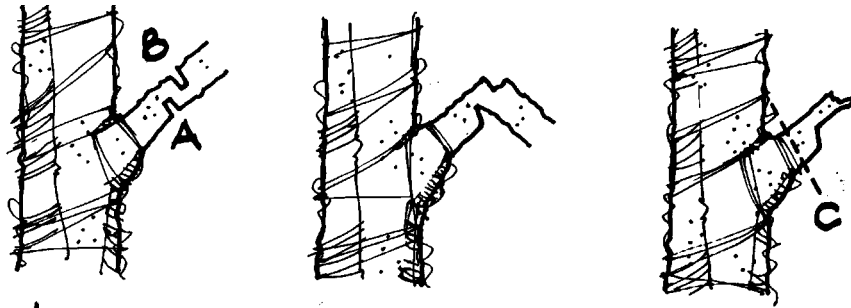
- Trees shall be left to grow naturally, but should be pruned as necessary to remove dead or overgrown branches that pose a hazard to highway safety.

- Trees in high focal areas should be trimmed and shaped as needed to encourage intended growth, maintain a pleasing natural appearance and prevent obstruction of curbs, sidewalks, parking areas, roadways, street lights and signs. Trees should not be trimmed into balled forms unless specifically required by the landscape design. Good pruning techniques, such as heading back and thinning out, should be used where appropriate to maintain proper balance of foliage.
- All pruning cuts must be made with sharp instruments and leave a 25 mm to 50 mm collar. Trees shall not be poled or the leader removed. See Figure 34.
- Trimmings must be removed from the site on the same day that the work is performed, or chipped up with appropriate equipment and used as mulch at an approved location.
- Caution should be exercised during pruning to ensure that branches or trimmings do not endanger traffic or cause damage to property. When storm damage occurs, all felled trees and broken branches that create a potential safety hazard must be removed immediately.
- Trimming and pruning must be done by employees skilled in this type of work.
- The trimming limits should be held continuous throughout work limits to give a uniform appearance. See Figure 35.

Tree trimming involves the removal of one-third or less of the existing tree foliage. Tree pruning involves the removal of greater than one-third of the crown area or foliage profile. In both cases, the work may involve the removal of foliage from the vertical and/or horizontal face or perimeter of the tree.

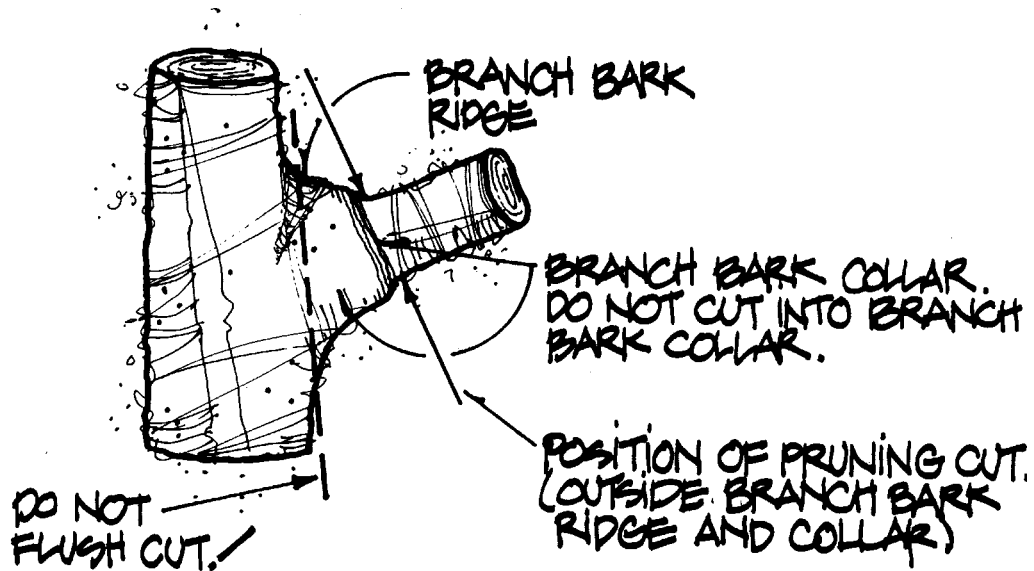
A licensed arborist should be used to treat tree cavities caused by disease, damage or deterioration.

Figure 34



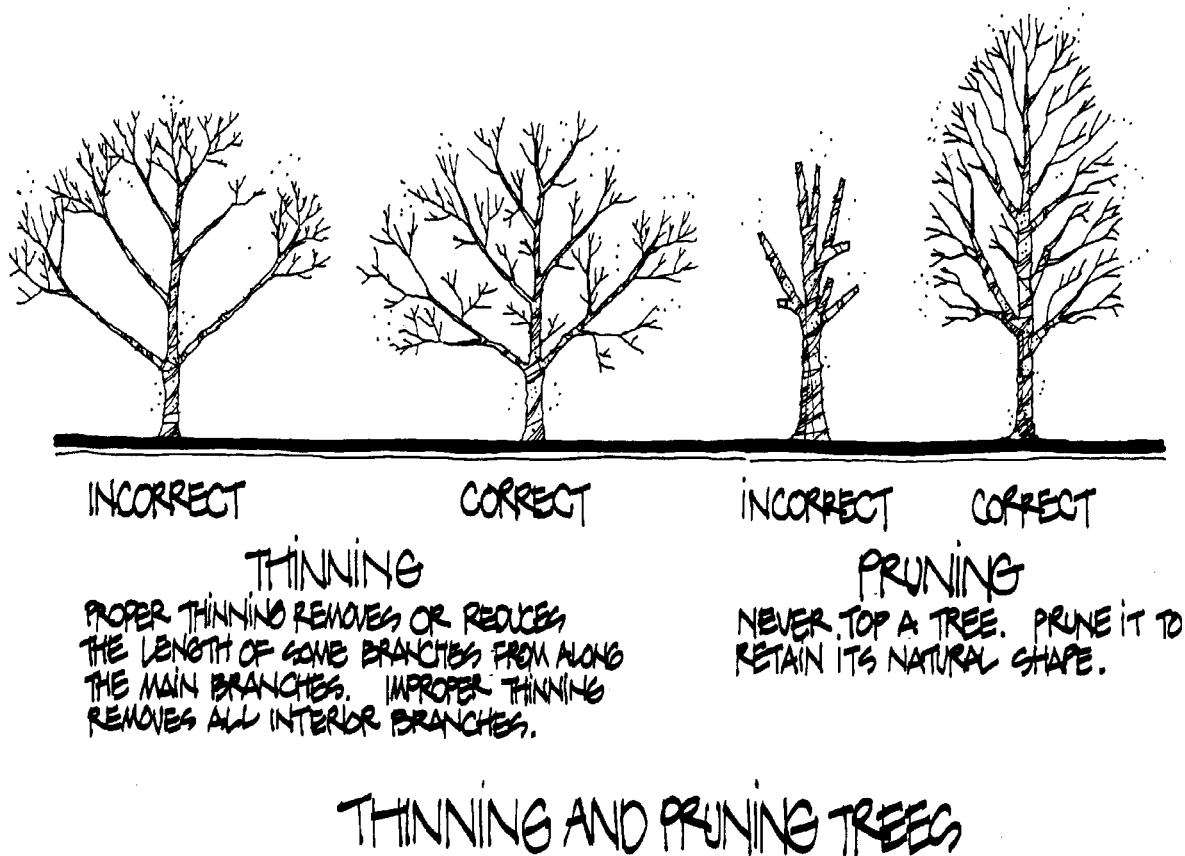
FIRST CUT AT "A" UNTIL SAW BINDS, THEN CUT AT "B" 50mm TO 100mm BEYOND "A" UNTIL THE BRANCH FALLS, THEN CUT AT "C", OUTSIDE OF THE BRANCH COLLAR.

REMOVING A BRANCH OVER 40mm DIAMETER



TREE BRANCH PRUNING

Figure 35



Trees should be routinely checked for abnormal conditions such as insects, borers, milky spore disease, web worms, red spiders, Japanese beetles, etc. Any diseased conditions must be treated by a Florida licensed applicator. All chemicals used should be on the list of chemical substances, or submitted for inclusion, compiled by the Environmental Protection Agency pursuant to the *Toxic Substances Control Act* and in compliance with all Federal, State and local pesticide laws. Anyone applying pesticides must hold a current restricted pesticide applicators license with the Florida Department of Agriculture and Consumer Services.

Palms. Palms are the signature tree of Florida and the sabal palm (cabbage palm) is the State tree. Palms play an important role in Florida's landscape and, as such, should be maintained to provide a safe and aesthetic appearance. Most palms need little maintenance, but falling fronds or seed pods can present a hazard in some conditions.

Palms are divided into two general plant types:

1. **Palmate**-shaped leaves are fan-shaped. It is not necessary to remove dead fronds from palmate-leaved palms, such as sabal and washingtonia. This leaf mass is not unattractive on the palm and nature will remove them in time. If fronds become a safety hazard, they should be removed.
2. **Pinnate**-leaved palms have feather-shaped fronds. These palms, such as the queen, royal and Canary Island, should be trimmed at least once a year to remove dead or unsightly fronds and seed pods. These pinnate-leaf palms should not be severely trimmed; the objective is to retain the arching form of the fronds. Care shall be taken not to cause trauma or damage to the bud of the palm during trimming. Spikes or sharp objects that would penetrate the trunks of the palms during trimming of fronds should not be used. Ladders or "cherry picker" type vehicles must be used to accomplish this task. All dead and/or trimmed fronds, seeds, seed pods and suckers should be removed from the site the same day.

Periodically check palms for signs of distress or disease in the trunks or in the fronds. Should spraying or treatment be required, Florida licensed applicators must apply any and all pesticides or fungicides. Every chemical substance used must be on the list of chemical substances, or submitted for inclusion, compiled by the Environmental Protection Agency pursuant to the *Toxic Substances Control Act*.

Tree Removal. The removal of trees must be accomplished by removing and lowering to the ground suitable sized sections of limbs or trunk starting at the top and working progressively downward to the ground. The main trunk shall be sawed, at or near the ground surface, to enable passage of mowers or other equipment into the area.

Before making any cuts, suitable ropes, slings, guide lines and block and tackle must be securely fastened to the section to be removed in a manner that will prevent free, rapid, uncontrolled descent of that section. No limb or section of a tree shall be left in place after the first cut has been made for its removal.

Stumps that are allowed to remain should be treated with materials designed to eliminate future growth. Sterile soils or residual-type materials will not be permitted. Materials utilized must be approved by the District vegetation specialist, the project landscape architect/engineer or a licensed arborist.

Stump Removal. When specified for removal, tree stumps and major roots projecting through or appearing on the surface of the ground shall be removed to a depth of 25 mm below the existing soil surface. Removal shall be accomplished by means of chipping equipment designed for this purpose, or by hand. Blasting or pushing the stumps out with bulldozers, or equipment that disturbs the surrounding ground, will not be permitted unless in conjunction with clearing and grubbing operations. Holes or voids created by the removal of stumps must be filled, graded and compacted with acceptable fill material.

Shrubs and Ground Cover Maintenance

In the same way that tree vegetation may become hazardous, interrupt vision zones and impact highway facilities, shrubs and ground cover must be included in routine maintenance observation and operations. All safety indexes apply to shrubs and ground cover.

The growth characteristics of some plant species require pruning; others require trimming to look their best.

- Pruning is the selective elimination of branches to maintain or improve the size or shape of a plant.
- Trimming, as defined for shrubs and ground cover, is cutting of the overall tips of a plant to give a smooth, squared, hedge-like, or otherwise formed appearance.

Shrubs are generally defined as woody plants that have a growth height range of 0.6 m to 3.0 m.

Shrub maintenance requires attention to the following conditions:

- Shrubs and ground covers should be pruned or trimmed, as needed, to maintain the suitable size and character of the material. This should be carried out as frequently as needed, but no less than once annually, on plants requiring pruning and trimming.

- Maintained heights of shrubs shall at no time impair the clear-sight distances on the highway and become a safety hazard.
- Plants that have a naturally "unpruned" form should be pruned little except for removal of dead or damaged branches and leaves, or to maintain a certain height required by safety indexes or the plant material's usage. Examples of these types of plants are parson's juniper, bird-of-paradise, crinum lily, cardboard palm, king sago, primrose jasmine, split-leaf philodendron, fountain grass and plumbago.
- Plants used as hedges or borders should be trimmed squarely with the top of hedge slightly narrower than the bottom to facilitate exposure to sun and prevent heavy shading of lower foliage. Avoid trimming into rounded forms except when the hedge forms the bordering edge of a serpentine bed design, in which case round only vertical faces of the border. As new foliage fills-in remove excessively long branches to encourage fullness and good shape. Examples of these types of plants are pittosporum, podocarpus, boxthorn, viburnum and India hawthorn. Do not prune shrubs into individual shapes or balls. Allow shrubs to form a dense mass of plants (see Figure 36).

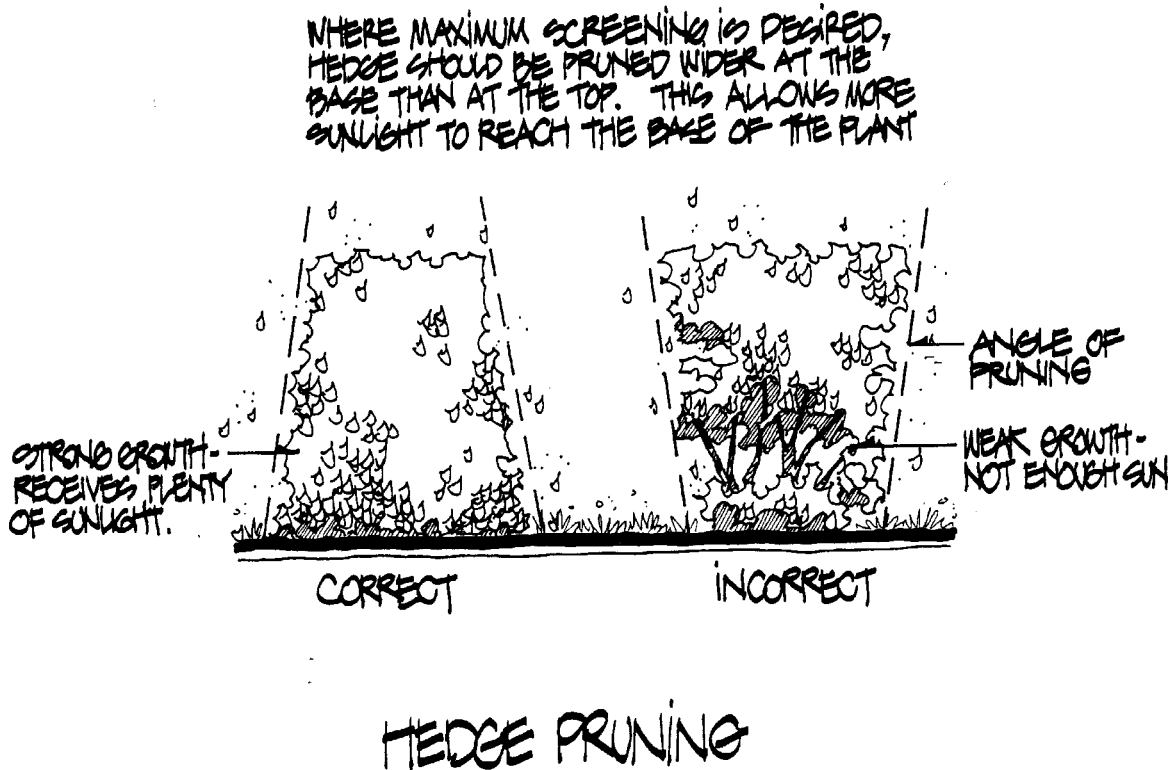
Ground covers are plants generally defined as vining, grassy, herbaceous or woody shrubs having growth ranges from 0.15 m to 0.6 m. Ground covers should be confined within the perimeter of the planting area with little pruning required other than to cut long branches growing outside of the planting bed. Additional maintenance required on some species of ground cover could be an annual or semi-annual "mowing" of the entire planting bed to assist in plant regeneration and density. Examples of these types of plants are confederate jasmine, liriope, aztec grass, ivy and mondo grass. Wedelia and dune sunflower are two species that should be mowed to approximately 100 mm in the spring.

All shrubs and ground covers should be routinely checked during maintenance for signs of disease and pests, and promptly treated as required.

Wildflower Maintenance

Little maintenance, except for possible supplementary watering and a scheduled mowing, should be required for wildflower care.

Figure 36



- In urban areas, wildflowers are recommended to be planted from four-inch pots rather than seeds. This method has proven effective in urban plant establishment, where seeded plants are sometimes lost to mowing and other maintenance operations. Some additional water may be necessary after planting of container plants or seeds if rainfall is inadequate to insure plant establishment and seed germination. This is true even for species that are classified as drought tolerant; plants become drought tolerant once established. Absence of adequate water during the early planting stages will threaten the success of the wildflower project. After establishment, supplemental watering may be needed during severe drought to insure survival and future germination.
- Mowing is essential to enhance reseeding, but the timing of the mowing is critical to its success. Care should be taken throughout the year to protect wildflower stands from machinery performing regularly scheduled mowing of turf grasses. It is advisable to set-up definite site identification for mowing control. Mowing of wildflowers should occur only in the late fall, to eight weeks after the blooming

season ends so that seeds will have time to mature. Some wildflowers like blackeyed susan, coriopsis, gallardia, wedelia and dune sunflower can be mowed at a 150 mm height in mid-season without harm but should not be mowed more frequently.

- Fertilization and the use of herbicides can do more harm than good to wildflower stands. Once wildflowers have been established, fertilization will encourage the growth of weeds and unwanted grasses which compete with the wildflowers for soil nutrients and ground space. Herbicides should be avoided in areas that are, or will soon be, planted with perennial wildflowers since it will destroy the plants and damage the planting area for some time. There has been a practice of applying herbicides during the first year of growth after annual wildflowers have bloomed to minimize problems with broadleaf weeds. However, since annual wildflowers are generally planted alongside perennial wildflowers, herbicide usage is discouraged.

Plant Material Replacement

Replacement of dead or diseased plant materials shall be executed as needed using the original landscape plan and specifications for the new installation. The same species, size and quality of plant material should be installed. The overall quantity of plant materials in a given area must remain consistent with the landscape plan and specifications. Should the plant material requiring replacement be of an undesirable species for whatever reason, the original specifier should be contacted for a suitable replacement. If this individual is not available, the District vegetation specialist should make this determination.

All dead and damaged material should be removed with care to avoid damaging the surrounding healthy foliage. Plant materials removed must be taken away from the site on the same day, as well as any debris created through the planting process.

Procedures for installation of replacement plant material shall be as stated in Section 5, *CONSTRUCTION PHASE*, "Landscape Installation Techniques".

Mulching

Mulch is used in landscape planting to maintain moisture in the soil, reduce erosion, cut off sunlight for weed germination and provide aesthetic appeal. Mulching of landscape areas (except wildflower or annual beds) is required at time of installation. Mulch needs to be replenished over

time to maintain its intended purpose. The following elements should be considered in any mulch maintenance program:

- Mulch in all planting beds should be maintained at a depth of 75 mm before compaction.
- All planting beds should be weed-free prior to mulching.
- Compost, wood chips, pine bark and needles or recycled mulches, such as melaleuca mulch, are recommended. The use of cypress mulch is not recommended for environmental reasons.
- Mulch should be checked as a regularly scheduled maintenance item and be replenished as required.
- Mulch should be maintained below the curb, where applicable, to keep it in place.

Fertilization

Fertilizer is used to add essential nutrients to the soil to support the growth of plant materials. Excessive or improper fertilization can be detrimental to plant growth and create run-off pollutants. Improving the vigor and density of plants and turf grass through a sound, systematic program of fertilization produces an environment least favorable to undesirable vegetation.

- Healthy grass makes more efficient use of water. A thick turf with a dense root system helps slow water movement and keeps it in the root zone. Grass which receives the proper nutrients develops a deep root system which is very important under roadside conditions. Some species of turf grass, such as St. Augustine grass, require a regular fertilization program, while others, such as bahia grass, should have little or no fertilization.
- The application of fertilizer to areas of established turf should be based on an evaluation of the turf quality and should take place only when a need has been identified. The optimum conditions for the release of nitrogen are the same as those for plant growth. Generally, lawn turfs, such as St. Augustine grass or Bermuda grass, should be fertilized more frequently than utility turf areas, up to four times per year. Most utility turfs should be fertilized at least once per year, or twice per year in urban areas receiving higher standards of maintenance. Generally, bahia grass and centipede grass do not require regular fertilization.
- The first consideration in a turf grass fertilization program is to determine if fertilization is needed. Not all turf grasses need regular fertilization and the use of fertilizer can substantially increase mowing maintenance. When the program is for

one fertilization a year, the best time to fertilize is late spring. If fertilizer is applied twice a year, the second application should be in the fall with fertilizer containing insoluble nitrogen. For high-focal urban areas, established bahia grass turf can be made greener with a complete fertilizer having a 12-4-12 ratio of nitrogen, phosphorus and potassium with once a year applications. If other applications are scheduled during the year, a fertilizer with a 4:1:2 ratio should be used for the initial fertilization. Subsequent applications may contain nitrogen only. On occasion, supplemental potassium may also be required. A thick turf and dense root system helps allow water movement and keeps it in the root zone. Grass receiving adequate nutrients develops a deep root system which is very important under roadside conditions.

- Proper fertilization of plants is a primary determinant of hardiness and long-term high quality. It is also one of the least time-consuming and least costly components of a complete landscape maintenance program and should be scheduled as needed for the individual species. Fertilization of plants for highway landscaped areas should be as stated in the maintenance management plan developed prior to, and specifically for, the landscape project.
- Trees, properly specified and once established, rarely need regular fertilization. (See Section 4, *DESIGN PHASE*, "Soils/Amendments/Planting Products", and Section 5, *CONSTRUCTION PHASE*, "Landscape Installation Techniques", for additional information on fertilization.)

Turf Grass Application Rates. The maximum amount of fertilizer that may safely be applied at any one site depends on the type of nitrogen carrier (see Table 13). As a general rule, do not apply more than 0.5 kg of soluble or quick release nitrogen per 100 m² per year. Higher rates may burn the turf grass or cause excessive leaf growth at the expense of root and lateral-shoot growth.

Nitrogen-application rates higher than 0.5 kg per 100 m² may be used with fertilizer containing a combination of soluble and insoluble nitrogen. However, exceeding 1.5 kg per 100 m² may damage the turf.

Table 13
FERTILIZER APPLICATION RATES

ANALYSIS N-P-K	NITROGEN SOURCE	APPLICATION RATE			
		Kg/Hectare		Kg/100 sq m	
		Minimum	Maximum	Minimum	Maximum
24-6-8	Soluble and Insoluble	200 kg	300 kg	1.9 kg	2.9 kg
20-5-10	Soluble and Insoluble	250 kg	370 kg	2.5 kg	3.6 kg
18-4-6	Soluble	N/A	275 kg	N/A	2.7 kg
12-3-4	Soluble and Insoluble	400 kg	600 kg	3.9 kg	5.8 kg
Note: The rates shown above are based on a maximum of 0.5 kg nitrogen per 100 m ² .					

Plant Material Fertilization Rates

- Excess fertilizer applications on turf and landscape plants can increase water requirements by stimulating growth, especially if fertilizers with high nitrogen are used. Fertilizer must be adjusted for xeriscape areas of the landscape, minimized or discontinued altogether for some established species, and only applied as-needed to others. Fertilizer shall be properly and thoroughly watered after application. Fertilizer shall not be applied during windy weather conditions. Fertilizer shall be applied with an approved commercial spreader. Fertilizer in public walk areas shall be swept from all paved surfaces following application. It may be necessary to obtain soil samples, to be analyzed by an approved laboratory, in order to evaluate soil conditions. Results shall include analysis of test results, and the amount and type of materials required to accomplish recommended curative program.
- Shrubs and ground cover should be fertilized at least once a year in early spring or late summer. It shall be applied each time at the rate of 0.6 k per 10 m². Fertilizer shall be commercial grade, mixed granules of which not less than 25 percent of the total nitrogen is slowly soluble.
- All flowering plants except wildflowers should be fertilized with a special bloom producing product with a ratio such as 6-10-10. The product must be 25 percent organic to insure slow release. Apply according to manufacturer's directions.

Wildflowers should not be fertilized since this application would encourage weed growth which will compete with the plants. All fertilizer is to be evenly distributed with no fertilizer left on leaves or branches of plant material. All shrubs and ground cover must be thoroughly watered following fertilization.

Aeration of Soil

To remain healthy and able to absorb water from the soil, plant roots must have oxygen. The amount of oxygen which soil water can contain is limited and will not supply plant roots very long unless it is renewed by a process called aeration. In areas where the soil has become severely compacted from heavy traffic, topsoil erosion or continued close mowing, aeration may be necessary to restore a healthy roadside condition. Aeration is the process of mechanically loosening or breaking up the compacted soil to allow air, water and nutrients to penetrate and thus improve growing conditions. It is often performed through coring, slicing or spiking of the soil. Benefits from aeration include improved wetting of dry soils, increased root growth, increased shoot growth and improved response to fertilizers. Poor soil conditions, severe compaction caused by vehicular traffic and the functional value of roadside turf are improved by including this operation in the maintenance program.

Aeration should be performed during periods of vigorous turf grass growth. Because it temporarily increases plant susceptibility to desiccation and disease, aeration should not take place during periods of atmospheric stress such as drought or cold. Care should be taken not to overly disturb the soil surface or to destroy existing turf grass.

Herbicides

There are two basic methods of weed control: cultural and chemical. Cultural methods should first be employed; and only when they fail, should chemical methods be employed. Herbicides are chemicals used to control weeds. They work by destroying the plants or disrupting their growth processes.

It is important that all personnel involved in a herbicide program receive proper training and follow the operating guidelines provided by the FDOT's *Guide to Chemical Weed and Grass Control*. Contact the local County Agricultural Extension Service for additional information regarding herbicides. Repeat applications as necessary. Under no circumstances should annual wildflowers receive herbicide treatment, as herbicides will destroy them.

Weed Control. The primary objective of highway erosion control program is to establish a dense and permanent vegetative cover on areas adjacent to and effecting the highway. When this objective has been achieved, soil erosion will be minimal and roadsides will be safer for out-of-control vehicles. Weed growth can be a serious deterrent to the establishment of plant material and highway turf.

A weed is an unwanted, uncultivated plant growing in such a manner as to crowd out a desired plant specimen or disfigure a turf area. Weeds do more than affect the appearance of a planting area; they disrupt the stabilizing capacity and overall function of the plant materials. Weeds also compete with desired plants and turf for valuable nutrients. Weed-infested planting areas or turf can be an indication of unfavorable environmental conditions or an inadequate maintenance program. Successful management is dependent upon proper mowing, fertilization and herbicide application to sustain the plant materials and avoid weed infestation (see Section 4, *DESIGN PHASE*, "Noxious Plants", for more information on weeds.)

- Herbicides can be classified by formulation, vegetation affected, application period, mode of action and the persistence or lasting ability of the herbicide. Each factor must be considered when choosing the appropriate herbicide for use.
- Plants and grasses vary in their tolerance to herbicide use. With each plant or grass type, certain herbicides are better than others for use in controlling disease or undesired vegetation. Consult the manufacturer's instructions before applying herbicides.

Herbicide Formulation. Formulation refers to the physical makeup of the herbicide. Each formulation has advantageous characteristics relating to ease of handling, available application equipment or the type of weed to be controlled.

- Dry formulations are soluble powders, wettable powders, dry flowables and granular herbicides.
- Liquid formulations are emulsified concentrates, solutions and flowables.

Type of Vegetation Affected. Herbicides may be either selective or nonselective in the vegetation they affect.

- Selective herbicides, when applied in accordance with the manufacturer's instructions, control targeted weeds without harming the desired plant materials.
- Nonselective herbicides kill or injure vegetation with little regard to species. Nonselective herbicides should be applied directly to the target weed with a direct spray to minimize damage to the plants or turf.

Application Period. Herbicides are applied at various periods during weed growth.

- Pre-emergent herbicides are applied to the soil and absorbed by the roots of germinating seeds before the plant emerges from the ground. As a general rule, pre-emergent herbicides should be applied before February 1st in South Florida, before February 15th in Central Florida, and before March 1st in North Florida.
- Post-emergent herbicides are applied after the weed plant has emerged from the ground. Some of these herbicides act only through the foliage of the plant and can be applied only after the weed has emerged. Some of the herbicides that are used for pre-emergent weed control are also effective if applied after the weed has emerged.

Mode of Action. A herbicide may also be classified according to the mode of action by which it controls a plant: contact, foliar systemic or root systemic.

- Contact herbicides affect only the parts of the plant that are covered by the application. Contact herbicides are nonselective and post-emergence. Repeat applications of contact herbicides may be necessary for continuing weed control.
- Foliar systemic herbicides are applied to the foliage of the vegetation and are then moved through the plant's system. Foliar systemic herbicides may be selective or nonselective and are applied after plants emerge. The effectiveness of foliar systemic herbicides depends upon weather conditions and plant growth. They perform best when plants are growing. It may take several days for the herbicide to move within the plant. No mowing or cutting should take place on any vegetation sprayed with a foliar systemic herbicide until damage symptoms become evident.
- Root systemic herbicides are applied to the soil and enter plants through their root systems. Root systemic herbicides may be selective or nonselective; and they may be applied either before or after plant emergence. As with foliar systemic herbicides, root systemic herbicides perform best when plants are growing and their effectiveness is influenced by the weather.

Persistence. Persistence refers to the residual effect of the herbicide; that is, the length of time that it remains active in the soil.

- Residual herbicides are normally nonselective and root systemic. They may be applied either before or after emergence. Most residual herbicides require moisture for activation and are slowly released into the soil. They remain active for a period of time and, depending on the rate at which they break down, make the soil nonproductive for plant growth.
- Nonresidual herbicides are contact or foliar systemic herbicides that are applied after emergence. They may be either selective or nonselective. After application, nonresidual herbicides break down rapidly and completely with no long-term effects on the soil's productivity.

Ecosystem Management

Natural systems require observation, inspection and periodic maintenance to preserve the natural qualities of the system. Ecosystems may become contaminated by stormwater run-off or invasive, noxious vegetation. These conditions must be identified and should be remedied in a timely manner by the proper means and personnel.

- FDOT has periodic programs for invasive plant removal, but generally this is not an ordinary routine maintenance item.
- Maintenance of retention ponds, wetlands and drainage facilities is a part of routine maintenance at the level required by the permitting Agency agreement. If additional landscaping is installed by a local governing Agency, a Maintenance Agreement must be executed for maintenance of those items.
- Animal habitat is discouraged within rights-of-way for safety reasons. When large animal habitat is encountered within the right-of-way, proper authorities should be contacted for trapping and relocation of the animal.

IRRIGATION MAINTENANCE

All systems must be checked regularly (monthly recommended) to monitor efficiency and check for problems. The following are elements that should be checked during inspections:

- Check filters for trash and other solids; a primary and secondary filter may be required depending on the system water quality.

- Controllers and electric valves should be checked for operational acceptability. Duration and frequency can be adjusted to meet changing water needs throughout the year.
- Pressure control valves and pressure gauges control rate of flow emitted through system. They should be checked visually when checking the filters, timers and valves. The pressure control valve should be exercised periodically to clean the ball. Different watering zones may operate at different pressures to accomplish a different application rate.
- Inspect ground area for broken lines and check for pressure drop in lines while system is operational.
- Periodically inspect the areas under irrigation for adequate coverage. If lack of moisture is suspected, the lines can be checked with a moisture meter while operational.

Section 7

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Section 8

GLOSSARY

3R - Resurfacing, restoration and rehabilitation of a roadway.

AASHTO - American Association of State Highway and Transportation Officials.

Access Management - The management of vehicular access to a highway. This includes ingress to the highway, egress from the highway and median cross-overs on divided highways.

ADT - Average daily traffic.

Aeration - Methods by which compacted soil is penetrated to provide for more oxygen to plant roots which encourages deeper, healthier root growth.

Aesthetics - Visual impact of the highway environment on drivers and other vehicle occupants.

Agency - A municipality, County or special District as defined in Florida Statutes, Chapter 165.031, *Formation of Local Governments*, or other organizations that obtain permits and enter into maintenance agreements with the Florida Department of Transportation for highway landscape projects.

Annual Weeds - A weed which germinates, grows, flowers, fruits and dies within a single year.

Aquatic Weeds - Weeds which grow submerged, floating or along the edge of a body of water including marshes, meadows, swamps and bogs. They proliferate in new environments and are prohibited in the State of Florida by Department of Natural Resources, Rule Chapter 16C-52, *Florida Prohibited Aquatic Plants*.

Area Maintenance Engineer - The individual who works under the direct supervision of the District maintenance engineer and is responsible for the maintenance of a geographical area of the District. Permits for landscape improvements are processed through the office of the area maintenance engineer.

B&B (WB&B) - Balled and burlaped (wire balled and burlaped) in accordance with horticultural standards of the American Association of Nurserymen.

Biennial Weed - A weed which requires two growing seasons for the completion of its life cycle, dying after they have set seed.

Bunch Type Grass - Grass type that spreads exclusively by tillering, the development of new leaves, and thus, tend to grow in bunches.

Caliper - Caliper is the outside diameter of a tree trunk. The measurements are made as described below:

- Nursery-grown trees up to 100 mm diameter are measured 150 mm above the ground line.
- Nursery-grown trees greater than 100 mm diameter are measured at 300 mm above the ground line.
- Existing on-site trees are measured 1.2 m above the ground line.

Clear Zone - The roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope and/or a clear run-out area.

Clear-Sight Window - An area designed to provide the drivers on the main highway and the drivers on the side street, a view of at least 50 percent of each other's vehicle when they are within the limits of clear-sight for an intersection.

Clear-Sight Zone - The zone on the approaches to and at grade intersection where unobstructed clear-sight windows must be provided. The length of the zone is based on the design speed of the highway.

Compost - A mixture that consists largely of decayed organic matter and is used for fertilizing and conditioning land.

Conifer - A tree or shrub, as an evergreen, that bears cones.

Contact Herbicides - Herbicides which affect only the parts of the plant which are covered by the application.

Contract - The written agreement between the FDOT, or government Agency, and the contractor setting forth the obligations of the parties thereto, including, but not limited to, the performance of all work, the furnishing of labor and materials and the basis of payment. The contract shall include the advertisement, proposal, plans, specifications, special provisions, contract form and contract bond, and notice to proceed; also, any supplemental agreements required to complete the construction of the project in an acceptable manner.

Contractor - The individual, firm or company, contracting with the FDOT, or government Agency, for performance of work or furnishing of materials.

Critical Protection Zone - An area around a tree in which construction activity has the potential of impacting the tree. The diameter of the circle area is measured from the center of the tree trunk. The diameter is 0.3 m for each 2.5 cm of tree trunk measured 1.2 m above ground line.

DBH - Diameter of plant or tree as measured at breast height (1.2 m above grade).

Deciduous - A plant that drops its leaves each year.

Density - For buffer areas of the landscape, it is the intensity of plant massing. For plants, it is the intensity of the foliage. For turf grass, it is the number of plants in a given area.

Design Speed - The maximum safe speed that can be maintained over a specific section of highway when conditions are so favorable that the design features of the highway govern.

DIA - Diameter.

District Drainage Engineer - The individual responsible for review and approval of all drainage designs and/or improvements that impact the drainage system within the geographic District boundaries. Each District has a drainage engineer responsible for review and approval of all drainage designs or modifications within the right-of-way of a State highway.

District Maintenance Engineer - The individual responsible for the permitting processes of the FDOT within the geographic District boundaries. Each District has a District maintenance engineer responsible for the review, approval and issuance of permits to perform work on right-of-way of the FDOT.

District Secretary - The senior manager over all operations within a FDOT District.

Emitter Pipe - A pipe used in low-volume or sub-surface irrigation systems. The pipe can be rigid or flexible plastic adapted with orifices to provide water directly to a plant or within a limited planting area.

Exotic Plant - A non-native plant or one introduced or imported into a particular region or environment.

FDOT - Florida Department of Transportation.

FHWA - Federal Highway Administration.

Fixed Object - An object considered to be non-yielding when struck by a passenger car. Trees with a trunk diameter greater than 100 mm when measured 150 mm above the ground line are considered fixed objects.

Foliar Systemic Herbicide - Application of herbicide is made to the foliage of the vegetation, and is then taken up by the plant and moved through the vascular system.

Ground Cover - Prostrate, spreading shrubs and vines (other than lawn grasses) which, at maturity, cover the given planting area.

Growth Habit - The general appearance, shape or form of a plant; for example, upright, spreading, conical, round, columnar.

Herbicide Formulation - The physical makeup of the herbicide; for example, dry formulations - refer to powders and granular forms, and liquids - refer to concentrates and solutions.

Highway - A primary public road and its right-of-way.

Horizontal Clearance - The roadside area of a highway that must be free of fixed objects.

Intersection Influence Area - An intersection and its approaches starting at the beginning of tapers for separate turn lanes.

Landscape Architect/Engineer - This person is the responsible representative of the government Agency who produces the landscape and/or irrigation plans and specifications and who interprets the intent thereof.

Landscape Improvement - Any positive change to an ecosystem effecting visual, aesthetic, biological, habitat or environmental quality.

Local Government - A municipality, County or special District as defined in Florida Statutes, Chapter 165.031, *Formation of Local Governments*.

Malleability - A plant's ability to recover from stress or to be shaped, molded, changed or adapted.

Median - The area between the travel ways of a divided highway.

Mulch - A porous material, usually organic, such as shredded bark, solid waste compost, or pine straw, placed on exposed earth surfaces to retain moisture, control temperature and unwanted vegetation, and to enhance the uniform appearance of planting beds.

MUTCD - *Manual on Uniform Traffic Control Devices*.

Native Plant - An original specie of plant (as opposed to an introduced or exotic specie) living naturally in a particular region or environment.

Noxious Plant - Invasive or aggressive plants which are undesirable, troublesome, difficult to control, and a hazard to the environment and health of livestock and humans. Any plant listed in the Florida Department of Agriculture and Consumer Services, Rule 5B-57, *Introduction or Release of Plant Pests, Noxious Weeds, Arthropods, and Biological Control Agents*.

NTS - Not to scale.

Perennial Weeds - Weeds which reseed themselves and last indefinitely.

Permanent Grasses - Grasses which do not die off seasonally.

Plans - The approved plans, including reproductions thereof, showing the location, character, dimensions and details of the work to be done.

PVC - Shall denote the abbreviation for polyvinyl chloride material used in the manufacture of pipe and fittings.

Rhizomatous - Plants or turf grass having an underground stem, distinguished from a true root by the presence of nodes, buds or scale-like leaves.

Right-of-way - The land area existing or acquired by permanent easement for highway usage.

Roadside - That portion of the right-of-way adjacent to the roadway shoulders and extending to the highway right-of-way line; also, the non-paved area of medians on multi-lane highways.

Roadway - That portion of the right-of-way that includes the road and its shoulders.

Rooting - The process by which a plant establishes its root system in a new planting environment.

Secretary of Transportation - The secretary of the Florida Department of Transportation pursuant to Florida Statutes, Chapter 20.23, *Department of Transportation*.

Sight Datum Line - A reference line used for measurements of clear-sight windows. One end point of the line is the eye level of the driver stopped on the side street; the other end point is the eye level of the driver on the main highway. The design location for the driver's eye level is 1,070 mm above the pavement.

Sight Distance - The viewing range required for a motorist to safely react upon seeing a vehicle, pedestrian or traffic control device as required by the highway design.

Soil Amendment - Any FDOT-approved material blended with soil to increase its nutrient value, its water holding capacity or both; such as pulverized peat, sterilized manure, acceptable artificially prepared planting compost material and solid waste compost.

Solid Waste Compost - Solid waste which is prepared from yard waste according to Florida Department of Environmental Protection, Rule Chapter 17-709, *Criteria for the Production and Use of Compost made from Solid Waste*, and has undergone biological decomposition of organic matter and has been disinfected using composting or similar technologies, and has been stabilized to a degree which is potentially beneficial to plant growth. Solid waste compost used on FDOT rights-of-way must fully comply with Department of Environmental Protection, Florida Administrative Code, Rule Chapter 17-709, *Criteria for the Production and Use of Compost made from Solid Waste*.

Specifications - The directions, provisions and requirements of the FDOT *Standard Specifications for Road and Bridge Construction*, together with all stipulations contained in the plans or in the contract documents, setting out or relating to the method and manner of performing the work, or to the quantities and qualities of materials and labor to be furnished under the contract.

Standard Index - A standard drawing shown in the FDOT *Roadway and Traffic Design Standards*, TOPICS No. 625-010-003.

Stoloniferous - Having a horizontal stem, at or just below, the surface of the ground that produces a new plant at the tip.

Temporary Grasses - Generally, seeded grasses, such as rye or millet, which germinate quickly but only lasts one season.

Tenacious - Not easily pulled apart; holding together.

Texture - The width of turf grass leaf blades or plant leaves. Narrow leaves produce finer texture; broad leaves produce coarse texture.

Traversable - Crash-worthy roadside conditions that would allow an errant vehicle to regain control without serious damage.

Typical Sections - Shows the design elements for the cross-section of a proposed roadway.

Understory - A group of plants which has adapted to a habitat protected by an overhead canopy of other plants. Plants are adapted to full or partial shade.

Viewing Zone - The area to the left and right of a permitted outdoor advertising sign where vegetation growth must be maintained for reasonable viewing of the sign.

Xeriscape™ - The landscape method identified in Florida Statutes, Chapter 335.167, *State Highway Construction and Maintenance; Xeriscape Landscaping within Rights-of-way*, which maximizes the conservation of water by the use of site-appropriate plants and an efficient watering system. The principles of Xeriscape include planning and design, appropriate choice of plants, soil analysis which may include the use of solid waste compost, efficient irrigation, practical use of turf, appropriate use of mulches, and proper maintenance.

Section 9

DISTRICT DIRECTORY

DISTRICT ONE

District One is located in Southwest Florida. The counties within the District are Charlotte, Collier, Desoto, Glades, Hardee, Hendry, Highlands, Lee, Manatee, Okeechobee, Polk and Sarasota. The District office is in the City of Bartow, Polk County.

Bartow District Office Florida Department of Transportation Post Office Box 1249 Bartow, FL 33830-1249 Phone No. 813-533-8161 Fax No. 813-534-7045
Street address: 801 North Broadway, Bartow, FL 33830

The three area maintenance yards in District One are Bartow, Ft. Myers and Sarasota.

The Bartow Maintenance Yard serves Polk, Highlands and Okeechobee counties. It has sub-yards in Highlands and Okeechobee counties.

Bartow Maintenance 2740 Highway 60 West Bartow, FL 33830 Phone No. 813-534-7030 Fax No. 813-534-7067	
SUB-YARDS	
Okeechobee Sub-Yard 500 NW 9th Street (one mile west of US 441) Okeechobee, FL 34972 Phone No. 813-763-2010 Fax No. 813-763-5088	Sebring Sub-Yard 4722 Kenilworth Boulevard Sebring, FL 33870 Phone No. 813-386-6104 Fax No. 813-386-6105

The Ft. Myers Maintenance Yard serves Collier, Charlotte, Glades, Hendry and Lee counties. It has sub-yards in Labelle, Naples and Port Charlotte.

Ft. Myers Maintenance Post Office Box 810 Ft. Myers, FL 33902 Phone No. 813-995-5403 Fax No. 813-338-2305		
Street address: 2981 NE Pine Island Road, Cape Coral, FL 33909		
SUB-YARDS		
Labelle Sub-Yard 880 West Devils Garden Drive Labelle, FL 33935 Phone No. 813-674-4027 Fax No. 813-674-4030	Naples Sub-Yard 4800 Davis Boulevard Naples, FL 33942 Phone No. 813-774-2650 Fax No. 813-434-5033	Port Charlotte Sub-Yard 23016 Harbor View Road Port Charlotte, FL 33980 Phone No. 813-743-6005

The Sarasota Maintenance Yard serves Desoto, Hardee, Manatee and Sarasota counties. The maintenance yard is located in Sarasota County off US 301 just south of the Manatee/ Sarasota county line.

Sarasota Maintenance 1840 61st Street Sarasota, FL 34243 Phone No. 813-359-5666 Fax No. 813-359-5646
SUB-YARD
Arcadia Sub-Yard Post Office Drawer 511 Arcadia, FL 33821 Phone No. 813-993-4634 Fax No. 813-993-4637
Street address: SR 70 West and Parker Street, Arcadia, FL 33821

DISTRICT TWO

District Two is located in North Florida. The counties within District Two are Alachua, Baker, Bradford, Clay, Columbia, Dixie, Duval, Gilchrist, Hamilton, Lafayette, Levy, Madison, Nassau, Putnam, St. Johns, Suwannee, Taylor and Union. The District office is located in Lake City, Columbia County.

Lake City District Office Florida Department of Transportation Post Office Box 1089 Lake City, FL 32056-1089 Phone No. 904-758-3700 Fax No. 904-758-0617
Street address: 1901 South Marion Street, Lake City, FL 32055

The six maintenance yards in District Two are at Lake City, Jacksonville, Gainesville, St. Augustine, Chiefland and Perry.

The Lake City Maintenance Yard serves Baker, Union, Hamilton and Suwannee counties.

Lake City Maintenance Post Office Box 1415, MS 2103 Lake City, FL 32056-1415 Phone No. 904-758-0485 Fax No. 904-758-0463
Street address: 1650 Lake Jeffry Road, Lake City, FL 32055

The Jacksonville Maintenance Yard serves Nassau, Duval and Clay counties.

Jacksonville Maintenance Post Office Box 6884 Jacksonville, FL 32236 Phone No. 904-695-4000 Fax No. 904-695-4154
Street address: 838 Ellis Road, MS 2801, Jacksonville, FL 32205

The Gainesville Maintenance Yard serves Bradford and Alachua counties.

Gainesville Maintenance 5301 NE 39th Avenue Gainesville, FL 32609 Phone No. 904-955-2240 Fax No. 904-955-2239

The St. Augustine Maintenance Yard serves St. Johns and Putnam counties.

St. Augustine Maintenance Post Office Drawer 9024 St. Augustine, FL 32085 Phone No. 904-825-5036 Fax No. 904-825-5030
Location: One mile north of SR 16 and one-half mile east of SR S16A

The Chiefland Maintenance Yard serves Gilcrest, Dixie and Levy counties.

Chiefland Maintenance Post Office Box 842 Chiefland, FL 32626 Phone No. 904-493-2026 Fax No. 904-493-6091
Street address: 1820 South Boulevard, Chiefland, FL 32626

The Perry Maintenance Yard serves Lafayette, Taylor and Madison counties.

Perry Maintenance Post Office Box 5 Perry, FL 32347 Phone No. 904-584-4940 Fax No. 904-584-8461

Street address: 657 Plantation Road, Perry, FL 32347

DISTRICT THREE

District Three is located in Northwest Florida. The counties within District Three are Bay, Calhoun, Escambia, Franklin, Gadsden, Gulf, Holmes, Jackson, Jefferson, Leon, Liberty, Okaloosa, Santa Rosa, Wakulla, Walton and Washington. The District office is located in Chipley, Washington County.

Chipley District Office Florida Department of Transportation Post Office Box 607 Chipley, FL 32428-9990 Phone No. 904-638-0250 Fax No. 904-638-6159
Street address: US Highway 90, Chipley, FL 32428

The five area maintenance offices in District Three are Pensacola, Defuniak Springs, Panama City, Marianna and Tallahassee.

The Pensacola Maintenance Office serves Escambia and Santa Rosa counties.

Pensacola Maintenance 1651 West Nine Mile Road Pensacola, FL 32502 Phone No. 904-484-5055 Fax No. 904-484-5074

The Defuniak Maintenance Office serves Okaloosa and Walton counties.

Defuniak Maintenance No. 1 Park Street Defuniak Springs, FL 32433 Phone No. 904-892-8004 Fax No. 904-892-8012
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The Panama City Maintenance Office serves Bay, Calhoun and Gulf counties.

Panama City Maintenance
3633 Highway 390
Panama City, FL 32405

Phone No. 904-872-4484
Fax No. 904-872-7713

The Marianna Maintenance Office serves Jackson, Holmes and Washington counties.

Marianna Maintenance
2956 Correctional Road
Marianna, FL 32446

Phone No. 904-482-9546
Fax No. 904-482-9161

The Tallahassee Maintenance Office serves Gadsden, Leon, Liberty, Franklin, Wakulla and Jefferson counties.

Tallahassee Maintenance
2612 Springhill Road
Tallahassee, FL 32304

Phone No. 904-922-5626
Fax No. 904-922-9320

DISTRICT FOUR

District Four is located in Southwest Florida. The counties within the District are Broward, Palm Beach, Martin, St. Lucie and Indian River. The District office is in the City of Ft. Lauderdale, Broward County.

Ft. Lauderdale District Office
Florida Department of Transportation
3400 West Commercial Boulevard
Ft. Lauderdale, FL 33309

Phone No. 305-486-1400
Fax No. 904-777-4223

The three area maintenance offices in District Four are Ft. Lauderdale, West Palm Beach and Ft. Pierce.

The Ft. Lauderdale Maintenance Office serves Broward County.

Ft. Lauderdale Maintenance
5548 NW 9th Avenue
Ft. Lauderdale, FL 33309

Phone No. 305-776-4300
Fax No. 305-771-8678

The West Palm Beach Maintenance Office serves Palm Beach County.

West Palm Beach Maintenance
Post Office Box 15061
West Palm Beach, FL 33406

Phone No. 407-683-4646
Fax No. 407-640-5962

The Ft. Pierce Maintenance Office serves Martin, St. Lucie and Indian River counties.

Ft. Pierce Maintenance
3601 Oleander Avenue
Ft. Pierce, FL 34982

Phone No. 407-468-3995
Fax No. 407-468-3909

DISTRICT FIVE

District Five is located in Central Florida. The counties within District Five are Orange, Osceola, Lake, Sumter, Volusia, Flagler, Brevard and Seminole.

The District office is located in Deland, Volusia County.

Deland District Office
Florida Department of Transportation
710 South Woodland Boulevard
Deland, FL 32720

Phone No. 904-943-5000
Fax No. 904-736-5379
Maintenance Fax No. 904-736-5098

The six area maintenance offices in District Five are located in Orlando, Leesburg, Ocala, Deland, Cocoa and Oviedo.

The Orlando Maintenance Office serves Orange and Osceola counties.

Orlando Maintenance
420 Landstreet Road
Orlando, FL 32824

Phone No. 407-855-1831
Fax No. 407-858-6128

The Leesburg Maintenance Office serves Lake and Sumter counties.

Leesburg Maintenance
550 South 14th Street
Leesburg, FL 32748-5603

Phone No. 904-360-6552
Fax No. 904-360-6556

The Ocala Maintenance Office serves Marion and Citrus counties.

Ocala Maintenance
627 NW 30th Avenue
Ocala, FL 34475

Phone No. 904-732-1338
Fax No. 904-732-1458

The Deland Maintenance Office serves Volusia and Flagler counties.

Deland Maintenance
1655 North Kepler Road
Deland, FL 32724

Phone No. 904-736-5270
Fax No. 904-736-5292

The Cocoa Maintenance Office serves Brevard County.

Cocoa Maintenance
555 Camp Road
Cocoa, FL 32927

Phone No. 407-690-3250
Fax No. 407-690-3229

The Oviedo Maintenance Office serves Seminole County.

Oviedo Maintenance
2400 Camp Road
Oviedo, FL 32765-9417

Phone No. 407-365-5679
Fax No. 407-365-7896

Location: 4.3 miles south of Oviedo on SR 426

DISTRICT SIX

District Six is located in South Florida. The counties within the District are Dade and Monroe. The District office is located in Miami, Dade County.

Miami District Office
Florida Department of Transportation
1000 NW 111th Avenue
Miami, FL 33172

Phone No. 305-470-5100
Fax No. 305-470-5699

The three area maintenance offices in District Six are North Dade, South Dade and Marathon.

The North Dade Maintenance Office serves North Dade County.

North Dade Maintenance
1655 NE 205 Terrace
North Miami Beach, FL 33179

Phone No. 305-654-7163
Fax No. 305-654-7182

The South Dade Maintenance Office serves South Dade County.

South Dade Maintenance
14655 SW 122 Avenue
Miami, FL 33186

Phone No. 305-256-6330
Fax No. 305-256-6304

The Marathon Maintenance Office serves Monroe County.

Marathon Maintenance
3490 Overseas Highway
Marathon, FL 33050

Phone No. 305-289-2350
Fax No. 305-289-2356

DISTRICT SEVEN

District Seven is located in West Central Florida. The counties within District Seven are Citrus, Hernando, Hillsborough, Pasco and Pinellas. The District office is in Tampa, Hillsborough County.

Tampa District Office
Florida Department of Transportation
11201 North Malcolm McKinley Drive
Tampa, FL 33612

Phone No. 813-975-6000
Fax No. 813-975-6278

The three area maintenance offices in District Seven are located in Dade City, Pinellas County and Tampa.

The Dade City Maintenance Office serves Citrus, Hernando and Pasco counties.

Dade City Maintenance
36339 SR 52
Dade City, FL 33525-8324

Phone No. 904-521-1444
Fax No. 904-521-1315

The Pinellas Maintenance Office serves Pinellas County.

Pinellas Maintenance
5211 Ulmerton Road (SR 688)
Route 1
Clearwater, FL 34620

Phone No. 813-570-5101
Fax No. 813-570-3050

The Tampa Maintenance Office serves Hillsborough County.

Tampa Maintenance
2820 Leslie Road
Tampa, FL 33619

Phone No. 813-744-6038
Fax No. 813-744-6057

FLORIDA TURNPIKE

Florida Turnpike Maintenance
Post Office Box 17870
Plantation, FL 33318

Phone No. 305-583-3111
Fax No. 305-321-5539

Street address: 5101 West Sunrise Boulevard, Ft. Lauderdale, FL 33313