CITY OF JACKSONVILLE, FLORIDA

Land Development Procedures Manual

VOLUME 2:

Design Guidelines

Effective: January 2025

LAND DEVELOPMENT PROCEDURES MANUAL

VOLUME 2: DESIGN GUIDELINES

CITY OF JACKSONVILLE, FLORIDA

2025

Approved and Adopted in Accordance with
Provisions of Chapter 654, Jacksonville Ordinance Code
(Code of Subdivision Regulations)

Prepared By:

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LAND DEVELOPEMENT PROCEDURE MANUAL REVISIONS

Revision Number	Sections Revised	Effective Date
28	All manual sections reorganized, all of Sections 1, 3, 4 and 7 revised, Appendix 1 Revised, Appendix 3 deleted	07/13/2021
29	Sections 1.7.1 and 7.1.5 revised	03/18/22
30	Reorganization of LDPM into 4 volumes. Updates from CSSC throughout Section 2.0 Roadway Design Criteria and Section 3.0 Traditional Neighborhood Design Section 1.1.11 Traffic Impact Study Requirements added	01/9/2024
31	Replace Volume 2 of the previous LDPM in its entirety with the sections contained herein	01/31/2025

GENERAL STATEMENT OF LAND DEVELOPMENT PROCEDURES AND CRITERIA

The Land Development Procedures Manual (LDPM) has been produced by the Subdivision Standards and Policy Advisory Committee and the Context Sensitive Streets Standards Committee in conjunction with the Department of Planning and Development, the Department of Public Works, JEA, the Office of General Counsel, and the Private Sector in order to assist in the development of land within the City of Jacksonville. In addition, hereto, certain criteria have been incorporated pursuant to various elements of the 2030 Comprehensive Plan, adopted per Chapter 650 of the Jacksonville Ordinance Code and Chapter 163, Part II, Florida Statutes.

The LDPM includes four volumes as outlined below which are adopted and approved as provided in Chapter 654 of the Jacksonville Ordinance Code to be used by the Divisions within the Department of Planning and Development, the Engineering Division of the Department of Public Works, and JEA in review and approval of permit applications and site development plans.

VOLUME 1: Land Development Review and Approval Procedures

VOLUME 2: Design Guidelines

VOLUME 3: Standard Design Details

VOLUME 4: Standard Specifications

The information contained in the LDPM Volumes 1 through 4 will apply to all development and construction projects, both public and private, within the jurisdiction of the Department of Planning and Development of the City of Jacksonville.

LAND DEVELOPMENT PROCEDURE MANUAL

VOLUME 2: Design Guidelines

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SECTION 1.0 Site Plan Design Requirements

This Section provides design guidelines for site plan development including layout, driveway access requirements, wayfinding and signage, and pedestrian access considerations. Where applicable, the relevant portion of the City Ordinance has been referenced to provide additional detail and requirements. Drainage Requirements are included in Section 3.0 and Landscaping Requirements are included in Section 5.0.

1.1 Site Design Standards

1.1.1 Block Design Standards

City of Jacksonville Sec. 654.125, Ordinance Code

The lengths, widths and shapes of blocks shall be determined based on the following considerations:

- Providing adequate building sites suitable to the special needs of the type of use.
- Zoning requirements for lot sizes and dimensions.
- Needs for convenient access, circulation, control and safety of street and pedestrian traffic and fire protection.
- Limitations and opportunities of topography, with special emphasis on drainage of the proposed subdivision and the possible adverse effects of that drainage on properties surrounding the subdivision.

Block lengths shall not exceed 1,500 feet between intersecting streets. On-grade pedestrian crosswalks may be required where deemed essential to provide circulation or access to schools, playgrounds, shopping centers, transportation and other community facilities as detailed in this Section of the LDPM. Wheelchair ramps shall be provided at intersections or crosswalks as required by state law.

1.1.2 Lot Design Standards

City of Jacksonville Sec. 654.126, Ordinance Code

The lot size, width, depth, shape and orientation and the minimum building setback lines shall be appropriate for the zoning and type of development and use contemplated. Lot arrangement and design shall be such that all lots will provide satisfactory and desirable building sites.

Lot dimensions shall conform to the requirements of the Zoning Code and shall meet the following additional requirements:

- Residential lots proposed with individual wells and/or septic tank disposal fields shall conform to the standards of the Neighborhoods Department and the State Department of Health and Comprehensive Plan.
- Depth and width of properties reserved or laid out for commercial and industrial purposes shall be adequate to provide for facilities required by the type of use and development contemplated.
- Corner lots for residential use shall have extra width, greater than a corresponding interior lot, to accommodate the required building setbacks from an orientation to both streets.

- The subdivision shall provide each lot with satisfactory and permanent access to a public street or approved private street.

1.1.3 Open Space and Active Recreation Requirements

In support of the City's goal to establish a comprehensive active/passive park system in the suburban and rural areas of the City, every residential and non-residential development is required to establish open space, some of which is to be used for active recreation. Open space and active recreation are defined below:

Open space is land that is not intensively developed for residential, commercial, industrial, or institutional use. Open space can be publicly or privately owned and can include elements such as parks, recreational sites, trails, forests and woodlands, wetland and stream corridors, important habitat, urban agriculture, or historic properties.

Active recreation area means a recreation area primarily designed with structured improvements that require modification of natural landforms, as well as the provision of recreational facilities, playing fields, or equipment. Examples may include playground equipment, sports fields, surfaced courts, swimming pools, skate parks, and multipurpose centers. Ancillary and subordinate to these highly structured uses, active recreational facilities may include areas for informal recreational uses such as open playing fields and passive recreational activities such as sightseeing, hiking and picnicking. Standalone linear systems, such as formally designed jogging trails and formally designed bikeways, may be included in such areas but the eligible width of such active recreational/linear systems shall be no greater than triple the width of the track or trail. All active recreational facilities must conform to the standards established in the American Disabilities Act and any standards adopted by the City.

The 2045 Comprehensive Plan, Recreation and Open Space Element as well as the City's Code of Ordinances outlines open space requirements.

Non-Residential Open Space Requirements

City of Jacksonville Ordinance Code Section 656.1210

All non-residential land uses, except those in the CCBD District, must provide a minimum of 10 percent of the property as open space. Open space is defined above.

Residential Neighborhood Open Space Requirements

City of Jacksonville Ordinance Code Section 656.420

The following open space and active recreation requirements have been established based on the size of the neighborhood:

For a residential subdivision development of 100 lots or more, provide at least one acre of useable uplands for every 100 lots, or 5 percent of the total useable uplands area to be platted, whichever is less. This area is to be dedicated as common area and set aside for active recreation. There may be up to two areas for each 100 lots, and the areas shall be a minimum of 0.5 acres in size, unless otherwise approved by the Planning and Development Department. Requests for deviation shall follow the procedures outlined in LDPM Volume 1, Section 5.0.

For residential subdivision development of 25 lots to 99 lots, provide at least 435 square feet of useable uplands for each lot. This area is to be dedicated as common area and set aside for active recreation. If sufficient area is not set aside, the development shall pay a recreation and open space fee of $250 dollars per lot. The City shall use recreation and open space fees collected to improve, enhance, expand, or acquire recreation areas within the same Planning District in which the fees are paid.

All multiple-family developments of 100 units or more, provide 150 square feet of active recreation area per dwelling unit. There may be one area for each 100 units, or the areas may be combined, subject to approval by the Planning and Development Department. Requests for deviation shall follow the procedures outlined in LDPM Volume 1, Section 5.0

1.2 Driveway Requirements and Access Control

Pursuant to Resolution 2019-653-A, the City of Jacksonville ("COJ") is committed to applying the guidelines of Complete Streets. Accordingly, the requirements in this section as well as Roadway design in Section 2.0 and Drainage design in Section 3.0 are intended to provide guidance on providing a complete streets design.

It is the intent of the City to grant owners of property abutting City-owned and maintained streets and highways the right of safe and adequate access to such properties while providing sufficient roadway capacity minimizing accident potential, and maintaining safe and comfortable bicycle facilities, sidewalks, and share-use paths across driveways; therefore, the City finds it necessary to limit the number, width, size, type, and location of driveways and to regulate the vehicular movements in and out of driveways in the best interest of the general public. The design of streets and frequency of driveway access shall be related to the context.

1.2.1 Driveway Classification

Driveways shall be classified according to the type of development they serve, the volume of traffic using the driveway, and the speed and classification of the servicing roadway.

CLASS I DRIVEWAYS

Class I driveways primarily serve residential developments with peak hour traffic volumes of 30 vehicles per hour (VPH) or less or average daily traffic volumes of 300 vehicles per day (VPD) or less and are intended for low-speed passenger vehicle use only. The following types of developments will generally require Class I driveways utilizing a flared design rather than a radial return so that the sidewalk maintains a flat surface. See Section 1.4.1 for Walk Zones through Driveway Connection Areas and ADA Requirements.

1. All single-family residential dwellings.
2. Townhomes.
3. Multifamily developments of 30 or fewer units.

CLASS II DRIVEWAYS

Class II driveways serve developments with peak hour traffic volumes of 30 VPH or less or average daily traffic volumes of 300 VPD or less and are intended primarily for passenger vehicle use on roadways where the average speed is less than 40 mph. The following types of developments will generally require Class II driveways.

1. Convenience stores without diesel facilities.
2. Gas stations without diesel facilities.
3. Daycare facilities serving 150 or fewer children.
4. Professional offices with an area of 8000 square feet or less.
5. Retail stores with an area of 8000 square feet or less.
6. Mini warehouses.

CLASS III DRIVEWAYS

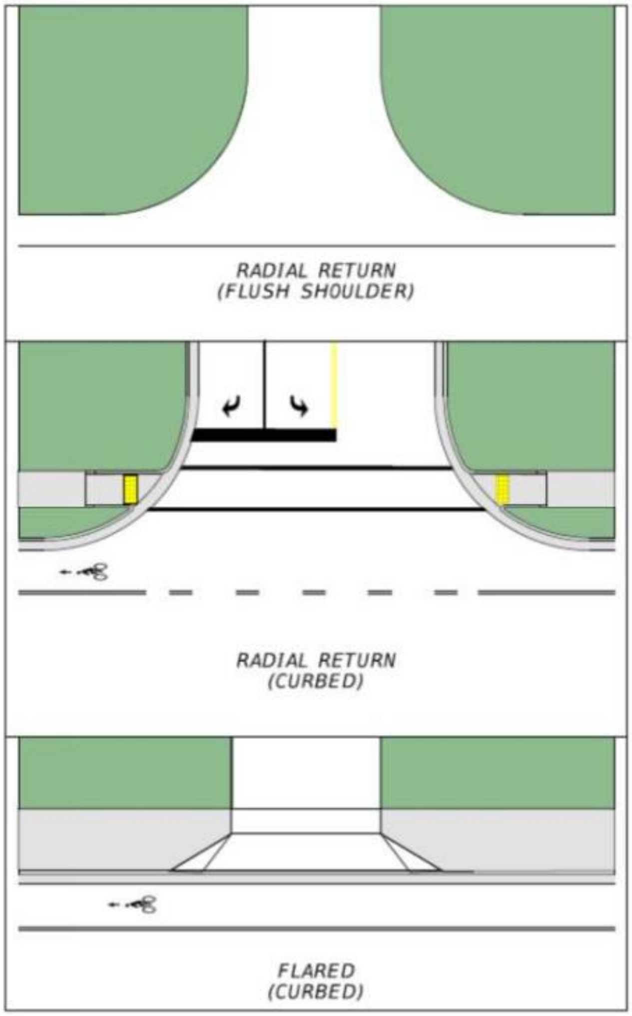
Class III driveways are intended for use when traffic volume exceeds 30 VPH or 300 VPD, the average speed is greater than 40 mph, and are designed to serve all legal vehicle types. The following type of developments will generally require Class III driveways.

1. Multifamily developments greater than 30 units with single family dwellings.
2. Mall entrances.
3. Shopping center main entrances.
4. Schools and churches.
5. Office complexes with an area greater than 8000 square feet.
6. Multi-unit commercial developments.
7. Industrial warehouses.
8. Business parks.
9. Any development with general truck and tractor trailer traffic.
10. Any development with driveways within the limits of a signalized intersection.

1.2.2 Driveway Design and Roadway Types

It is important to design roadways using a context sensitive design to ensure that pedestrians and cyclists can be accommodated while safely providing for motorized users, including large vehicles. Driveways shall be constructed to the same standards as the adjacent roadway except that no stabilization shall be required under driveways. If concrete driveways are constructed, minimum thickness shall be 5 inches for residential driveways (Class I) and 6 inches for industrial and commercial driveways (Class II and Class III). No wire or rebar reinforcement is allowed in driveways installed in the City Right-of-Way. Fiber reinforced concrete is acceptable, but not required.

There are two types of driveway designs: radial return and flared. The design is based on whether the road is curbed or has a flushed shoulder, as well the driveway category, and the posted speed limit. An example of each is shown in **Figure 1.2-1.**



Source: FDOT Design Manual, 2021

Figure 1.2-1 Flared and Radial Return Driveway Examples

These designs impact vehicles entering and exiting sites, with larger radial return type allowing for higher speeds. Other considerations for driveway design are:

1. Context classification.
2. Safety of drivers, pedestrians, and other wheeled units.
3. Design speed of roadway.
4. Driveway traffic volume.
5. Entry and exit movements.
6. Available right-of-way.
7. Design vehicle.

FLARED DRIVEWAYS

Flared driveways are required under the following scenarios:

1. Flared driveways are required on all curbed roadways with a speed limit of 35 mph or less.
2. Flared driveways are required on all roads with a speed limit of 35mph or less in urban contexts whether or not there is a curb.
3. If the speed limit is 40 mph or greater, the designer shall select the driveway type based on FDOT's Access Management Guidebook unless it is Class I. If it is Class I then the driveway shall be flared.
4. The designer may request a specific industrial exception to install radial return driveway for industrial parcels or those with heavy truck traffic. Requests for deviation shall follow the procedures outlined in LDPM Volume 1, Section 5.0.

The advantages of flared driveways are as follows:

- Eliminates the use of curb ramps, providing a higher level of comfort for nonmotorized passage across driveways.
- Encourages lower speeds for vehicles.
- Increases the level-of-comfort for ADA passage across driveways.
- Maintains the elevation of the sidewalk throughout the walk zone.
- May utilize "jogged" sidewalks to maintain grade elevation of existing nonmotorized facilities where sidewalk widths or right-of-way alone is insufficient.
- May maintain the grade elevation and width of existing shared-use paths through the walk zone. See Section 1.4.1 for Walk Zones through Driveway Connection Areas and ADA Requirements.

Requirements for Flared Driveways include the following:

1. Driveways crossing sidewalks shall maintain the same grade and elevation as the adjacent sidewalk through the walk zone. The "walk zone" is the area where the projection of the sidewalk crosses the driveway.
2. The cross slope of the walk zone shall not exceed 2 percent.
3. The ramp portion of the driveway should be located within the furniture zone or utility strip when possible. The "furniture zone" or "utility strip" is the area between the face of the curb and the edge of the sidewalk.
4. The grades of the driveway must meet the grades shown in FDOT Standard Plans 522-003 "Concrete Flared Driveways".
5. In constrained conditions or locations without a utility strip the sidewalk shall be "jogged" to maintain its normal elevation. If there is not enough Public Right-of-Way for the jogged sidewalk, then the developer shall provide an easement to the City.
6. The walk zone may be reduced to 4 feet in constrained conditions unless there is a shared-use path.
7. If a driveway crosses a shared-use path, then the walk zone shall be equal to the full width of the shared-use path.
8. Exceptions to these requirements may be granted in writing by the City Traffic Engineer. Requests for deviation shall follow the procedures outlined in LDPM Volume 1, Section 5.0.

RADIAL RETURN DRIVEWAYS (FLUSH SHOULDER AND CURBED)

Radial return driveways may only be used on roadways with a speed limit of 40mph or higher that have flush shoulders (i.e., non-curbed). Radial return driveways shall not be installed on curbed roadways with a speed limit of 35mph or less unless a waiver has been approved as described in LDPM Volume 1, Section 4.0. For radial return driveways (flush shoulder and curbed), the driveway return radius shall not exceed the curb radius specified in Section 2.2.2 of the LDPM. Radial driveway configurations for Class I-III applications are shown in **Figure 1.2-2.** The disadvantage of radial return driveways is that they may:

- Disrupt continuous sidewalks and shared-use paths across driveways.
- Encourage higher speeds for vehicles.
- Decrease the safety and level-of-comfort for ADA passage across driveways.
- Prioritize vehicle movement over the safety and comfort of vulnerable roadway users.

1.2.3 Driveway and Spacing Requirements

Driveway location and spacing are carefully controlled for the purpose of minimizing conflict and to provide adequate site distance for entering and exiting traffic. Proper spacing helps identify which development and driveway serves and provides adequate spaces for utility poles, traffic signs, and maintenance access.

Driveways shall not be located closer than 10 feet from the point of curve of a roadway radius return or closer than 25 feet from the stop bar of a stop-controlled intersection, or 50 feet from the stop bar at a signalized intersection. In no case shall a driveway or any portion of a driveway be located within a signalized intersection on the signal side of the stop bar unless this driveway is fully controlled by the traffic signal. At high volume intersections or at intersections with high left turn volume, the Traffic Engineer may require driveways to be located as far as 250 feet from the intersection, such that turning movements into and out of the driveway will not take place within the left turn stacking or storage lane.

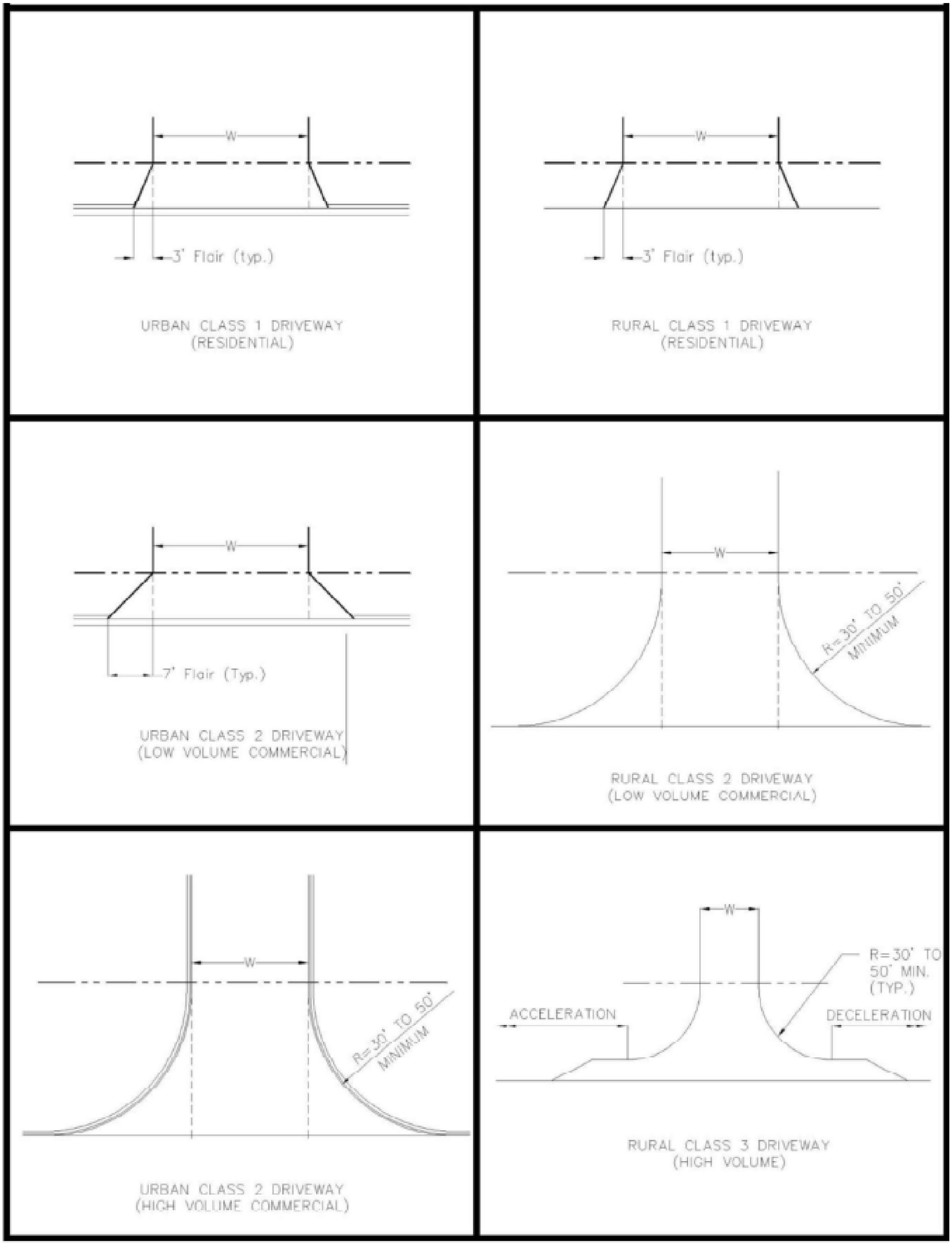


Figure 1.2-2 Radial Driveway Configurations

The minimal spacing between driveways on roadways to be dedicated to the City, is shown in **Table 1.2-1**. Driveway spacing will be measured along the right-of-way line from the edge of the driveway to the edge of the adjacent driveway and shall not include the width of driveway, radius, or flare as shown in **Figure 1.2-3**.

Table 1.2-1 Minimum Driveway Spacing Requirements

Driveway Class		Min Lot Width (feet)	Minimum Spacing (feet)
Class I			
	RLD 120 – RLD 40	≥ 40	5
	RLD-TND & RLD-TNH (includes Cottages)	<40ft	Private Road Only (New Development) Joint Access Driveway with 40ft separation (Infill Development)
	RMD A – RMD D	≥ 40	5
	RH A – RH B	≥ 40	5
Class II			
	Curbed	All	17
	Flush Shoulder	All	75
Class III			
	Curbed	All	75
	Flush Shoulder	All	300

Note: Residential Zoning designation for Class I driveways available on https://maps.coj.net/landdevelopmentreview/# , Land-use – Zoning, Zoning

Minimum driveway separation for Class I driveways has been established, in part, to provide the necessary access for ongoing operations and maintenance activities within the public rights-of-way adjacent to the road for both City and Utility access. Roadways serving land use zoning RLD-TND and RLD-TNH do not provide the minimum driveway separation on one or both sides of the street to allow necessary maintenance. New roadways serving these developments shall not be accepted by the City as a public roadway and will be required to be maintained as a private road by the property owners or homeowner's association, as applicable. Infill RLD-TND and RLD-TNH development on existing City roadways are not able to meet spacing requirements to allow necessary maintenance. For infill development in these zoning categories, the designer must provide joint use driveways with a minimum separation of 40 ft between driveways or joint use parking facilities.

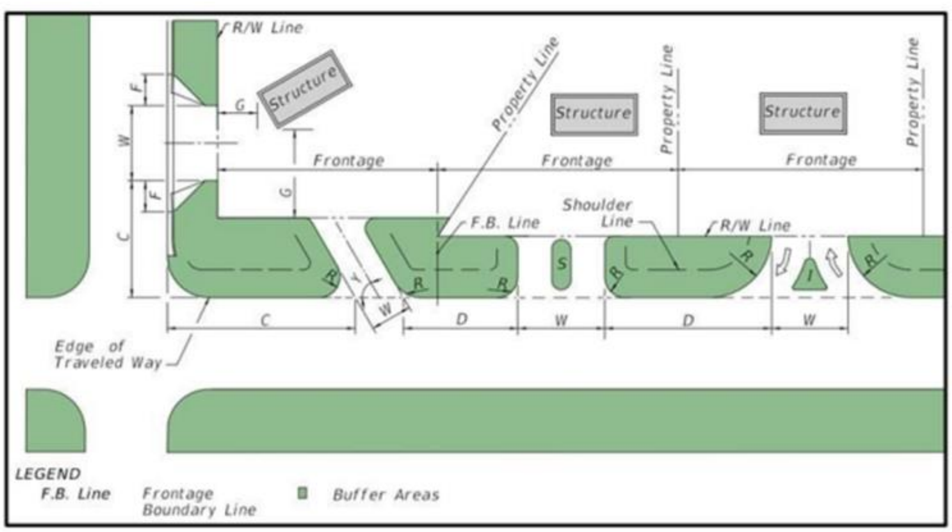


Figure 1.2-3 Driveway Geometry, adapted from FDOT Multimodal Access Management Guidebook (FDOT 2023)

- Radius (R) – The radial dimension of curved driveway entry or exit.
- Flare (F) – The total length of angled approach/exit at the edge of roadway for a flared driveway.
- (W) – Effective width of the driveway, measured between the left edge and the right edge of driveway.
- Driveway Connection Spacing (D) – Spacing between driveways from the projected edge line of each driveway.
- Corner Clearance (C) – Distance from an intersection, measured from the projected closest edge line of the intersecting roadway to a driveway projected edge line.
- (Y) – Angle of the driveway between the driveway centerline and the roadway edge of traveled way.
- Setback (G) – Distance from the ROW line to the closest permanent structure.
- Driveway Traffic Separators (S) – Linear islands or raised medians used to separate traffic movements on the driveway.
- Channelizing Islands (I) – Used to facilitate right turns and discourage left-turn movements on the driveway.

1.2.4 Width and Number of Driveways Per Development

City of Jacksonville Sec. 656.1215(d), Ordinance Code

The width and number of driveways for a parcel or development shall be determined by the type of development and the volume of traffic projected to use the driveway. In general, each parcel or development will be permitted a single driveway or joint-use driveway providing access to a public street. As an exception, any additional driveway(s) may be permitted for large developments when it is shown that the additional driveways are essential to provide adequate access to the development and will not adversely affect the safety or level of service of the existing roadway. Driveways on corner lots shall be designed and located to discourage traffic using the driveway as a bypass to avoid the intersection and/or other obstacles within the public right-of-way.

The width of individual driveways and total width of all driveway connections shall conform to Section 656.1215(d) of the City Ordinance Code as shown in **Table 1.2-2**.

Table 1.2-2 Driveway Width Requirements

<table>
<tr><th></th><th>Street frontage[1]</th><th>Minimum width</th><th>Maximum width of a single driveway[2]</th><th>Maximum combined width of all driveways[2]</th></tr>
<tr><td>Class I</td><td>NA</td><td></td><td>18ft (one way)
24ft (two-way)</td><td>NA</td></tr>
<tr><td>Class II and Class III</td><td>0-100 ft</td><td>24ft</td><td rowspan="2">36ft (no landscape island)
48ft (landscape island)[3]</td><td>48ft</td></tr>
<tr><td>Class II and Class III</td><td>100+ ft</td><td>24ft</td><td>48ft + 1ft for every 4ft of street frontage over 100ft</td></tr>
</table>

1. In no event shall more than 50 percent of any street frontage be paved
2. The width of driveways will be measured perpendicular to the driveway at the right-of-way line and will not include the flares or transitions.

3. Landscaped islands shall measure not less than eight feet in width (from back of curb to back of curb) and not less than 18 feet in length, surrounded by a six-inch continuous raised curb. In such case, each travel way shall be a minimum of 16 feet wide and a maximum of 24 feet wide when measured from the inside edge of the island to the outside edge of the driveway.

Landscaping located within an island shall be approved by the Traffic Engineering Division, Engineering Division, or their designee. Landscaping shall not block sight distance or pose a traffic hazard. Landscaping restrictions also pertain to subdivision and/or commercial signs.

1.2.5 Joint Use Driveways and Internal Cross Easements

City of Jacksonville Sec. 656.1215(e), Ordinance Code

Where a parcel or development does not contain adequate frontage to comply with the minimal spacing specified herein, or when driveway locations may be restricted by the Traffic Engineer, joint use driveways may be required, whereby two or more parcels or developments will be served by the same driveway. The City encourages the use of cross access easements and internal circulation roadways connecting adjacent developments when there are significant productions and attractions between adjacent developments to reduce the total number of trips on the public roadway.

Major developments such as shopping centers and office parks which contain outparcels that are adjacent to existing or proposed compatible developments will require provisions for internal access to such outparcels or internal connections to adjacent developments.

Driveways may be permitted for adjoining lots of compatible use. The maximum number of driveways which may be allowed shall be determined by first calculating the total length of the Vehicular Use Area (VUA) perimeter adjacent to property lines of compatible use, less the portion of the VUA separated from the common property line by a building, and less the portion of the perimeter VUA separated from the compatible use by a jurisdictional wetland or waterbody and then applying the criteria in **Table 1.2-3**.

Table 1.2-3 Maximum Number of Driveways for Adjoining Properties

Net Length of Perimeter VUA	Maximum Number of Driveways
50—149 feet	2
150—299 feet	3
300—599 feet	4
For each additional 500 feet	1 additional driveway

The maximum width of any driveway to an adjacent lot shall be 24 feet. The area of the continuous 5 feet wide perimeter landscape strip normally required where each driveway occurs shall be incorporated into the required perimeter landscape area to each side of the driveway. The developer shall be responsible for all arrangements and agreements with adjacent property owners when joint use driveways or internal cross easements are required by the City.

1.2.6 Cross-Access to Commercial and Office Use Parcels

City of Jacksonville Sec. 654.115(f), Ordinance Code

When providing access to commercial and office use parcels, other than those within the commercial central business district ("CCBD") it is preferred to reduce the number of times a vehicle must use the main collector or arterial roadway to access adjacent parcels that have the same use. To promote use of interconnected, adjacent, compatible use parcels, the following requirements have been established for cross access:

1. The minimum width of a vehicular cross-access shall be 24 feet.
2. If the adjacent site is developed the owner or developer shall design and build the appropriate cross-access to the property line of the adjacent parcel.
3. In rare cases, if the adjacent site is developed, but cross-access is not feasible at this time, the owner or developer shall design and designate on the site plan the location of future cross-access but will not be required to construct the cross-access at the time of initial site development. If vehicular cross-access is not feasible and the building's setback exceeds 50 feet, the owner or developer shall consider opportunities for providing multimodal-only cross-access within the site's internal circulation to improve walkability and multimodal accessibility between adjacent parcels. The owner shall shall record an access and construction easement to facilitate the future construction of the cross-access at such time as the City determines that cross-access is feasible and desirable.
4. If the adjacent site is undeveloped, the owner or developer shall design and build the cross-access to the property line of the adjacent parcel in anticipation of future connection when that site is developed.

Redevelopment of existing commercial or office development sites that do not currently provide cross access shall be brought into compliance under the following conditions:

1. When a new driveway connection permit is required for the existing development; or
2. When substantial enlargements or improvements to the existing development are undertaken.
3. When a 25 percent or greater increase in vehicle trip generation is attributable to the new development, as compared to the existing development.

Parcels zoned CCG -2 shall not be required to connect to parcels within a zoning district other than CCG -2, but they shall be required to interconnect with each other. Similarly, parcels within a zoning district other than CCG -2 are not required to connect to a parcel zoned as CCG-2.

The construction or erection of any barrier or obstacle which would prohibit access to the cross-access drive from a site's major parking area or prohibit sharing access drives for interconnectivity with adjacent properties shall be prohibited. This provision is not to conflict with or exempt a developer from complying with landscape and tree protection regulations.

Specific exemptions for cross access requirements may be granted by the Director of Planning and Development, or his or her designee when one or more of the following conditions occur. Exemptions shall follow the process outlined in LDPM Volume 1, Section 5.0.

1. Physical or regulatory constraints on a currently developed property prohibit the construction of a cross-access drive which meets the City's design and clear zone standards; or
2. The parcel required to provide interconnectivity requests an abatement based upon the use of their property as particularly requiring security or privacy as a mandatory element of their business.
3. The owner or developer can prove to the satisfaction of the Director of Planning and Development that there was a lease, mortgage, or other agreement, related to the real estate parcel in question, in existence prior to April 4, 2018, that prohibits the developer or owner from providing the cross-access. For purposes of this abatement, the abatement ends at the conclusion of such an agreement's full term.
4. The Director of Planning and Development determines that an affected property owner otherwise subject to the provisions of this section would currently be subject to an undue burden if required to provide the interconnectivity. An "undue burden" shall be determined as follows:

- In the opinion of the City's Traffic Engineer, the connection will create undue traffic conflicts.
- In the opinion of the Director, the connection will create undue harm to protected trees.
- In the opinion of the City's Engineer, the elevation change between sites creates an undue engineering burden or creates undue utility conflicts.
- Any other burden expressed in writing by the Director stating the undue burden and the rationale for declaring the burden undue.

1.2.7 Median Crossovers

Driveways which are located on divided roadways shall be aligned with an existing median or shall be offset from the centerline of the median crossing by a distance of 75 feet or more. The Traffic Engineer may require the removal/relocation of existing medians opening or the construction of new median openings to align with proposed driveways when necessary for proper safety and traffic flow. Driveways located at median openings may require construction of adequate left turn lanes. The Traffic Engineering Division shall have the flexibility to make the necessary design changes to accommodate the traffic based on contact, classification, posted speed, safety, projected volumes, and any other unforeseen or unplanned circumstances.

1.2.8 Left Turn Lane

Left-turn storage lanes will be required at all driveways when the volume of left-turn traffic into the driveway and the volume of opposing through traffic is sufficient to affect the safety and capacity of the advancing traffic stream. Left-turn lanes may also be required by the Traffic Engineer when deemed necessary to provide adequate site distance or to align with opposing left-turn lanes.

In general, left-turn storage lanes shall be considered when the volume of left-turn traffic exceeds 30 vehicles per hour, 5 semitrailer truck trips per day, or the through traffic exceeds 200 vehicles per hour in either direction. However, local conditions may require modification of these thresholds depending on the type of development and existing traffic characteristics.

1.2.9 Right Turn Lane

Right-turn storage lanes will be required at all driveways when the volume of right-turn traffic into the driveway is warranted for vehicle deceleration and storage. Right-turn lanes may also be required by the Traffic Engineer when deemed necessary to provide adequate site distance or to align with opposing turn lanes.

In general, right-turn storage lanes shall be considered when the volume of right-turn traffic exceeds 20 vehicles per hour, 5 semitrailer truck trips per day, or the through traffic exceeds 200 vehicles per hour in either direction. However, local conditions may require modification of these thresholds depending on the type of development and existing traffic characteristics.

1.2.10 Restricted Driveways

The City Traffic Engineer may require new restrictions or one-way operation of a driveway when such operation is deemed necessary for safety and/or the present existing levels or service. The owner shall install and maintain all necessary traffic-control devices in a proper manner to assure the intended operation of restricted driveways.

1.2.11 Permits

A permit to work within the public right-of-way will be required for all driveways constructed on City-owned and maintained roadways.

Except for single-family dwelling units, any new or modified driveway access may require civil plan review as outlined in LDPM Volume 1, Section 2.0 before a Right of Way permit is approved. A separate permit from FDOT will be required for all driveways on State roads.

1.3 Signage and Wayfinding

1.3.1 Residential Monument Signs

City of Jacksonville Sec. 320, Sec. 326, Sec 654.123, Sec. 656.1303, Sec. 656.1308, Sec. 656.1312, Ordinance Code

SUBDIVISION IDENTIFICATION SIGNS – OUTSIDE OF CITY RIGHT-OF-WAY

In addition to the provisions of the above sections of the Ordinance Code, all subdivision identification signs, movements, gates, fences, landscape furniture and any other fixed objects located within a City-owned and maintained right-of-way shall be designed and constructed to provide adequate sight distance for pedestrians, bicyclists and vehicular drivers.

SUBDIVISION IDENTIFICATION SIGNS – WITHIN CITY RIGHT-OF-WAY

Application for permit for a development identification sign may be issued only to a licensed sign contractor who has posted the $5,000 bond required by Section 326.106 for sign installation and also the $5000.00 bond required for work in public space, as required by Section 744.110.

Sign installation shall be inspected by representatives of both the Building Inspection Division and the Development Services Division to assure compliance with terms of permit.

Sign shall conform to maximum area or height prescribed by Section 656.1308, except when a variance has been granted by the Planning Commission; For this purpose, area shall mean face area of the entire structure upon which the sign is placed.

Sign shall be constructed of masonry, non-corrodible metal, pressure-treated wood, or other permanent materials. Signs located in street right-of-way or other public space shall not be illuminated, other than subdivision identification signs which may be indirect lighting only, as approved by Traffic Engineer.

Wording of sign shall be as approved by Director of Planning and Development and shall be limited to development identification only with no advertisement, corporate logos, or other information.

Sign shall be removed by owner in not more than 60 days upon notice by the Director of Public Works.

1.3.2 Commercial Monument Signs – Within City Right of Way

City of Jacksonville Sec. 326, Sec. 656 PART 13, Ordinance Code

Application for permit for a development identification sign shall be made to the Chief, Building and Zoning Inspection Division. Permit may be issued only to a licensed sign contractor who has posted the $5,000 bond required by Section 326.106 for sign installation and also the $5000.00 bond required for work in public space, as required by Section 744.110.

Sign shall conform to requirements of Section 656 PART 13 depending on the type of sign, except when a variance has been granted by the Planning Commission.

1.3.3 Street Name Signs

City of Jacksonville Sec. 654.111 and Sec 654.128, Sec 745.107, Ordinance Code

All new street signs, whether for public or private roadways, shall comply with Section 745.107, Street signs for new roadways dedicated to the City will be paid for by the developer and installed by the City, unless unique decorative street signs will be installed and maintained by the developer. Unique street signs on public roads will require a revocable permit and indemnification agreement. For private street signs, quality of the sign, the size of the lettering and the method of mounting shall conform to the standards being used for marking City streets at the time of erection. Private street signs shall clearly show that the street is a private street. Reference LDPM Volume 1, Section 4.1.2 for the procedure to apply for Street Name Signs on roads that will be dedicated to the City.

1.3.4 Traffic Control Signs

Traffic control signs on new roadways shall comply with the MUTCD (latest edition).

1.4 Pedestrian Considerations

All new development and redevelopment projects are required to provide adequate pedestrian access via the construction or reconstruction of sidewalk infrastructure. The goal of this policy is to ensure that all modes of transportation are taken into consideration when designing any new project, whether residential, commercial, industrial or recreational. Furthermore, it is ensuring that a complete sidewalk network is provided throughout the city, while also recognizing that sidewalks may not be feasible in all circumstances due to unforeseen or uncontrollable situations.

1.4.1 Sidewalk Design Requirements

City of Jacksonville Sec. 654.133, Ordinance Code

Sidewalks shall be provided for all developments, including residential or non-residential infill lots, and along all new, reconstructed, and existing streets, to provide for safe pedestrian travel. Sidewalks shall be provided as indicated in Table 2.2-2 and shall be constructed in accordance with these Land Development Procedures Manual, the City Standard Details and the City Standard Specifications:

General Requirements

- Sidewalks shall be constructed of minimum 2500 psi Portland Cement Concrete. Materials and methods of construction shall conform to the City Standard Specifications, latest edition.
- Standard thickness for residential sidewalks shall be 4 inches, except at driveways, where the minimum thickness shall be 5 inches at residential driveways and 6 inches at industrial and commercial driveways.
- No wire or rebar reinforcement is allowed in sidewalks installed in the City Right-of-Way. Fiber reinforced concrete is acceptable, but not required.
- Sidewalk grades; cross slopes; and fencing or railings (where drop off hazards are present), shall be consistent with the current FDOT Design Manual.
- Sidewalks may be required beyond property fronting existing right-of-way in order to provide pedestrian access to schools, parks, churches, shopping centers, and to connect to existing

sidewalks. Off-site sidewalk requirements for residential subdivisions should generally not exceed more than five feet per lot, however, all off-site sidewalk improvements will be reviewed on a case-by-case basis as determined by the City's Transportation Planning Section.

- When the Florida Department of Transportation constructs or reconstructs a roadway, they are required to provide a shared-use path or a sidewalk with a buffered/protected bike lane or separate bike lane, if right-of-way is available. If right-of-way is unavailable, construction or reconstruction will be reviewed on a case-by-case basis as determined by Public Works and the Planning and Development Department.

Sidewalk Width

- Where buildings are located along-side of the right-of-way, minimum sidewalk width specified in Table 2.2-2 shall be increased by 3 feet.

- Permanent obstacles such as utility pole signs, mailboxes, drainage structures, etc., shall not be located within a sidewalk unless a minimum of 4 feet clearance can be obtained within the sidewalk width.

- When the projected volume of pedestrians on a sidewalk is unusually high, the Transportation Planning Section may require an increase in sidewalk width.

Sidewalk Planting Strips and Clear Zones

- To provide proper pedestrian/vehicle separation and adequate space for traffic signs, poles, utilities, etc., planting strips shall be located between the edge of pavement and sidewalk.

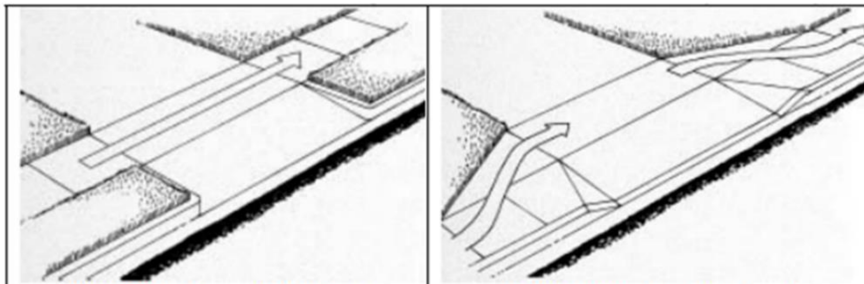
    - For urban, suburban, and rural development areas, the minimum width of a planting strip shall be 5 feet, which measures from the back of the curb to the edge of the sidewalk.

    - When trees will be located within the planting strip, the minimum width shall be increased to 8 feet.

- For sidewalks on roadways without curb and gutter, a minimum clear zone between the edge of pavement and the sidewalk shall be provided in accordance with the clear zone requirements in the FDOT Design Manual, Construction and Maintenance for Streets and Highways.

ADA Access Requirements

- Where sidewalks cross driveway connection areas, provide a through walk zone or jogged sidewalk as shown in **Figure 1.4-1**. Driveway cuts with topography changes that create accessibility issues are not allowed.



DESIRABLE: Through Walk Zone maintained across driveway.

ACCEPTABLE: Jogged sidewalk.

Figure 1.4-1 Walk Zones through Driveway Connection Areas (Source FHWA Accessible Sidewalks and Street Crossings)

Residential Sidewalks

Sidewalks that fall within Categories M, N, O, P, and Q in Table 2.2-2 include the following notes:

1. The number of lots on a cul-de-sac should include only those lots fronting on the cul-de-sac. Corner lots fronting the local street should not be included in the count. Corner lots fronting the cul-de-sac should be included in the count.
2. Where sidewalks are required on one side of the street, they should be placed on the side intersecting the greatest number of side streets unless otherwise justified.
3. Safe and exclusive pedestrian access shall be provided between individual building lots and to all existing bus stops and identified future bus stops.
4. Curb cut ramps are required at all intersections where one or more of the rights-of-way of the intersecting streets contains sidewalks and where roadway lane width do not exceed 12 feet unless authorized by the Director, or his or her designee.
5. Cul-de-sac bulb circumference area shall not require a sidewalk, however a separate ADA Standard curb cut ramp must be provided regardless of available driveway aprons.
6. Cul-de-sacs that lead to parks, mail kiosks, or clubhouses shall have a sidewalk on at least one side of the street regardless of the number of lots.

The subdivision entrance road shall provide a 6 foot wide sidewalk on both sides of the collector or trunk road and the sidewalks shall connect to external sidewalks or public transit if the same exist. If external sidewalks adjacent to the subdivision do not exist, a minimum six-foot wide sidewalk shall be installed at least along the frontage of the subdivision, and perhaps further pursuant to staff review.

Sidewalks may not be required within proposed subdivision right-of-way that directly abuts preserved wetlands and retention ponds unless a pedestrian connection is deemed necessary and if pedestrian movements are accommodated on the other side of the street.

Special Overlay Sidewalk Design Criteria

Sidewalk construction must be consistent with design criteria established for special overlay zones. The following special overlay zones have been established with special sidewalk requirements.

Special Overlay Zone	References
Downtown Overlay Zone	City Ordinance Section 656.361 Downtown Design Guidelines Riverwalk Park Design Criteria
Riverside/Avondale Zoning Overlay	City Ordinance Section 656.399.28-30
Renew Arlington Community Redevelopment Agency Overlay	City Ordinance Section 656.399.62

1.4.2 Curb Ramps

It is important for persons using the sidewalk that the location of the curb ramps be as uniform as possible. Detectable warnings are required at all curb ramps and flush transitions where a sidewalk meets a roadway. Typical curb ramp width shall be a minimum of 4 feet with 1:10 curb transitions on each side when pedestrians must walk across the ramp. Ramp slopes shall not exceed 1:12 and shall have a firm, stable, slip resistant surface texture. Ramp widths equal to crosswalk widths are encouraged. Curb ramps at marked crossings shall be wholly contained within the crosswalk markings, excluding any flared sides.

Typical curb ramps are perpendicular to the curb or street edge at all locations. If diagonal ramps must be used, any returned curbs or other well-defined edges shall be perpendicular to the cross street. The bottom of a diagonal curb ramp shall have a 48-inch minimum clear space within the crosswalk. All details of curb ramps and accessible parking shall conform to the applicable FDOT Standard Plans, latest edition. Any deviation from these Standard Plans will not be allowed without written approval from the City Engineer.

1.4.3 Exemptions From Sidewalk Requirements

Required sidewalk widths shall be provided within existing city or state road rights-of-way for all proposed development and re-development of property fronting along city or state road rights- of-way except as follows:

1. A sidewalk will not be required where a sidewalk already exists as long as it meets ADA Standards and General Sidewalk Requirements. ADA standard curb ramps, curb cuts, and detectable warnings are required at all intersections where one or more of the rights-of-way of the intersecting streets contain sidewalks.
2. Installing sidewalks may not be required when construction of sidewalks by the City or State is funded and provided for in the Capital Improvements Program, Downtown Community Redevelopment Plan, JTA Mobility Works, or Better Jacksonville Plan, and when construction is scheduled to begin within two years. A sidewalk bond shall be posted by the developer in case the sidewalk construction by the City or state is cancelled or delayed. The City's Transportation Planning Section will provide the amount of the bond based on the current fees established.
3. As an alternative to providing sidewalks within the approved right-of-way, a shared use/multi-use path may be provided subject to approval by the Planning and Development Department, based upon the presence of nearby paths, if the location is part of an established plan for shared use/multi-use paths, or if the location is an important link between existing bicycle and pedestrian facilities.
4. In lieu of sidewalks, a construction waiver (i.e. payment to the In-Lieu Sidewalk Program), deferral, or variance may be possible. See LDPM Volume 1, Section 5.0,for qualification requirements and the application processes for these options.

1.4.4 Sidewalks in Urban Development Areas

The FDOT Multimodal Quality/Level of Stress 2023 includes a measurement of the amount of discomfort that people feel when they walk along a road within the right-of-way, which is termed the pedestrian level of traffic stress (LTS). A low LTS indicates a pedestrian facility that is welcoming to all users regardless of age or mobility level. A high LTS indicates a pedestrian facility that is difficult or impassable and most likely to be used by those with limited route choices. **Figure 1.4-2** shows the progression from low LTS to high LTS.

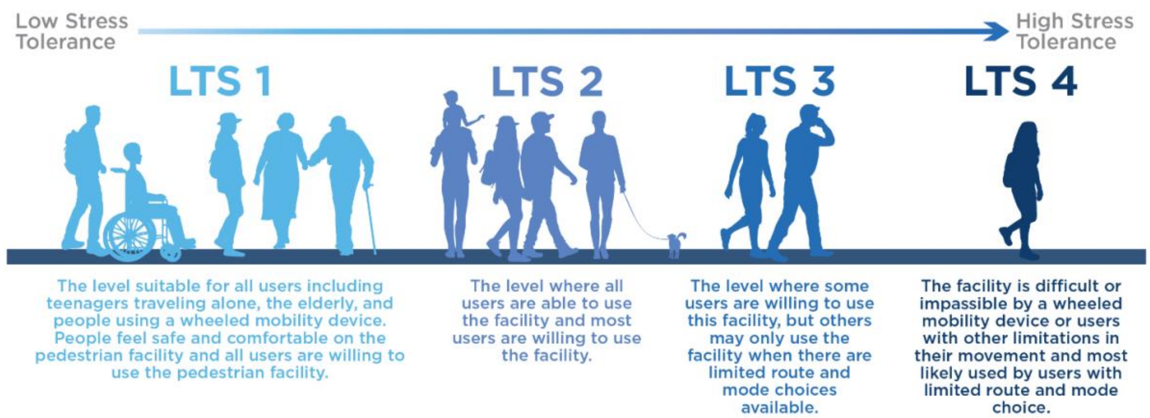


Figure 1.1-2 Pedestrian Level of Stress (Source: FDOT Multimodal Quality/Level of Service Handbook 2023)

The LTS for downtown, urban, and urban priority areas should target achieving a LTS1 or LTS2 by providing continuous sidewalk and providing both horizontal and vertical separation. **Table 1.4-1** provides a decision support tool to assist the designer in determining the LTS achievable.

Table 1.1-1 Pedestrian Level of Traffic Stress Flow Chart (Source: FDOT Multimodal Quality/Level of Service Handbook 2023, Appendix C)

<table>
<tr><th colspan="6">Is there a continuous sidewalk present?</th></tr>
<tr><td colspan="3">No</td><td colspan="3">Yes</td></tr>
<tr><td colspan="3">LT4</td><td colspan="3">Proceed to next step</td></tr>
<tr><th colspan="6">What is the posted Design Speed?</th></tr>
<tr><td colspan="2">25mph</td><td colspan="2">30-35mph</td><td colspan="2">40mph or more</td></tr>
<tr><th colspan="6">Is there a separation?[1]</th></tr>
<tr><td>Yes</td><td>No</td><td rowspan="2">Yes</td><td>No</td><td rowspan="2">Yes</td><td>No</td></tr>
<tr><td>LTS1</td><td>LTS2</td><td>LTS3</td><td>LTS4</td></tr>
<tr><td colspan="2" rowspan="3"></td><th colspan="4">Does the separation include vertical separation?</th></tr>
<tr><td>Yes</td><td>No</td><td>Yes</td><td>No</td></tr>
<tr><td>LTS1</td><td>LTS2</td><td>LTS2</td><td>LTS3</td></tr>
</table>

Separation is defined by space between the outside vehicular travel lane and sidewalk and can include bicycle lanes, unmarked shoulders, street furniture, vertical separation, landscaping, or utility strips. Vertical separation in the separation includes tubular markers, islands, on-street parking, rigid barriers, and landscaping.

1.5 Roadway Lighting Standards

1.5.1 Roadway Lighting Standards - Intent

To provide for the safety of vehicular and pedestrian traffic, it is the policy of the City of Jacksonville to require adequate street lighting for all new residential and commercial subdivision streets. The purpose of this section is to relate the design criteria and processing requirements to street lighting.

1.5.2 Roadway Lighting Design Criteria

Illumination Criteria

Table 1.5-1 Roadway Illumination Criteria

Functional Highway Classification	Average Maintenance fc	Uniformity Avg/Min	Uniformity Min/Max
Arterial (Major and Minor)	1.0	6:1	10:1
Collector	0.6	8:1	10:1
Local	0.4	10:1	10:1

Layout and Spacing

Streetlights shall be placed at all critical locations, such as intersections, curves of less than 35 mph design speed, pedestrian crossing, high-volume driveways (50 mph or greater) and at all areas of the roadway at which traffic hazards exist or at which lighting is necessary for vehicular, bicycle, or pedestrian safety. In addition to the above locations, streetlights shall be equally spaced between critical locations to obtain the required illumination criteria.

Design Responsibility

Unless indicated otherwise, the Traffic Engineering Division will be responsible for the layout of approved JEA fixtures to accomplish the specified illumination criteria. They will forward this layout to JEA for the electrical design.

However, the developer may elect to design the street lighting plan as a part of the development plans when the location of streetlights is critical to the development. In this case, the street lighting plan shall be submitted as a part of the two-set plan submittal and shall include the necessary calculations demonstrating compliance with the design criteria. Following approval, the Traffic Engineering Division will forward to JEA for electrical design. The street lighting plan and associated calculations shall be prepared by a registered Professional Engineer in the State of Florida with experience in the design of street lighting systems.

JEA Equipment Standards

JEA street and area light options can be viewed at the JEA Street and Area Lights weblink.

Special Street Lighting

In certain locations, the City may accept non-standard or special street lighting within the public right-of- way design; installation and maintenance including all operational cost are the responsibility of the developer/owner. Non-standard and special street lighting shall comply with the design criteria specified above.

1.5.3 Roadway Lighting as Built Requirements

As-builts shall be submitted for review and approval and shall be stamped using **Form LDPM-ABS** as applicable.

SECTION 2.0 Roadway Design Requirements

This section provides guidance on roadway design requirements for the City of Jacksonville. The below sections are to be used in concert with the City's publicly available GIS portal to identify roadway segment designations to establish design guidelines.

2.1 General Roadway Design Designations

The following standards and criteria have been established for a context sensitive approach to the construction of new, reconstructed, and resurfacing of City roadways and intersections. Reference Standards include:

- Portions have been excerpted from The American Association of State Highway and Transportation (AASHTO) guidelines ("A Policy on Geometric Design of Highways and Streets" – Guide for the Development of Bicycle Facilities),
- Florida Department of Transportation (FDOT) Standards (Manual of Uniform Minimum Standards for Design,
- Maintenance and Construction for Streets and Highways FDOT Design Manual),
- Institute of Transportation Engineers (Designing Walkable Urban Thoroughfares: A Context Sensitive Approach), and
- National Association of City Transportation Officials (NACTO) guides.

Where unusual and/or extraordinary conditions are encountered, a variance from the Standards may be granted. See LDPM Volume 1, Section 5.0 for procedures to request a variance. Any approved variance shall be obtained in writing and submitted with the plans for approval.

The design guidelines established in the following sections reflect a context sensitive approach that incorporates transportation, safety, access, as well as the preservation of aesthetic, environmental, and community values. To determine the best context sensitive design criteria, the following factors must be determined at the project outset:

- Roadway Functional Classification categorizes roads based on their function and capacity. It assigns roadways into classes based on the road's role in the roadway network, its traffic flow, and how it provides access to nearby properties.
- Context Sensitive Design Classification considers a roadway's land use context and incorporates all modes of transportation in designing a street or a road.
- Development Area defines the density and transportation characteristics in order to maintain overall goals established by the Comprehensive Plan.
- Truck Route Status identifies preferred truck routes which will need to accommodate larger vehicles which make frequent deliveries.

Determining the applicable designations, which will drive the design requirements, is a two-step process. The design professional can use the LDPM and publicly available GIS information to identify the preliminary design designations, as shown in **Figure 2.1**. The project pre-application meeting, (LDPM Volume 1, Section 2.0) should be used to discuss the preliminary designations identified by the design professional and receive confirmation from the City's Transportation Planning Division that these values should be used for project design.

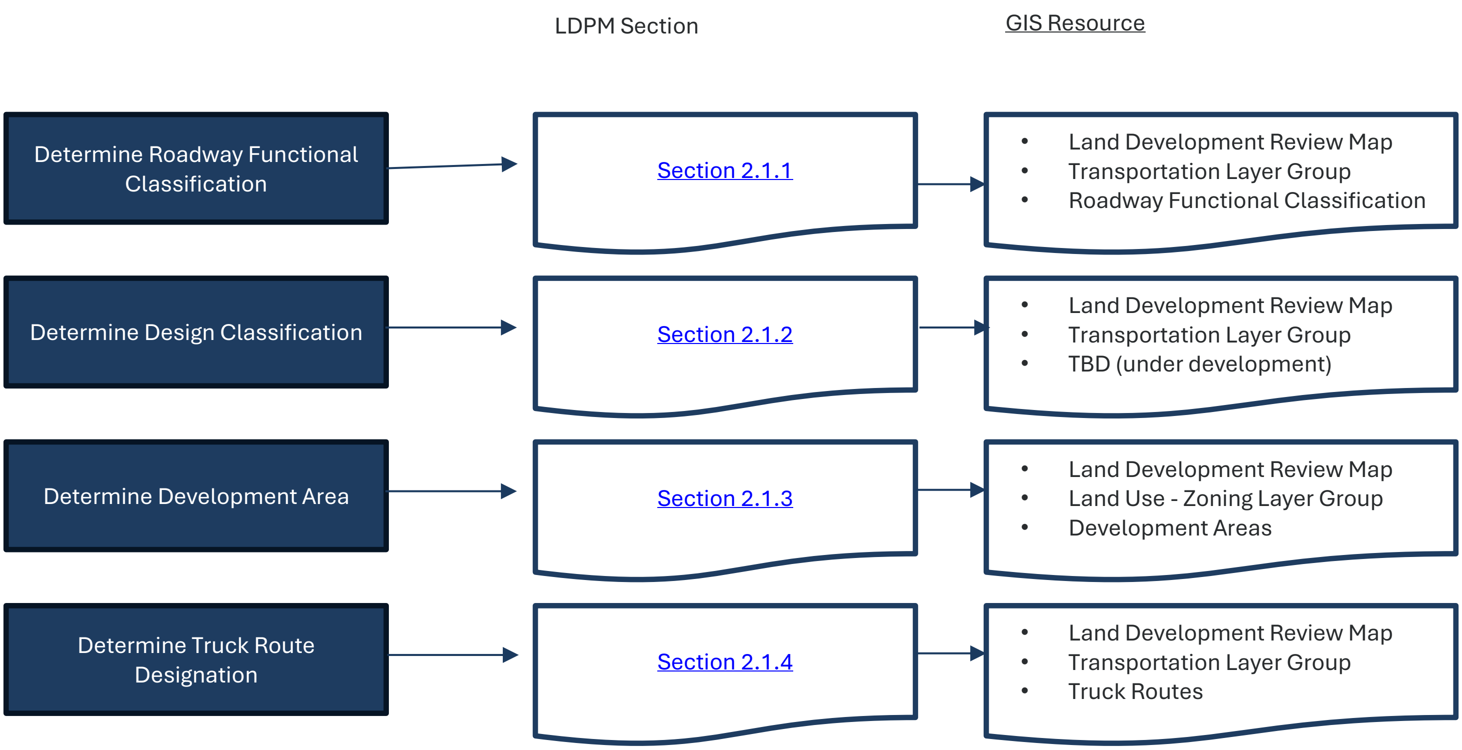


Figure 2.1 Roadway Design Process Flow Chart – Establishing Design Requirements

2.1.1 Roadway Functional Classification

The Roadway Functional Classification is based on the FDOT Urban Boundary and Functional Class Handbook and is documented in the City's Comprehensive Plan. The current roadway functional classifications can be found on the City's Land Development Review Map using the Transportation Layer Group and are defined in **Table 2.1-1**.

Table 2.1-1 Functional Classification Roadway Type and Descriptions

Roadway Functional Classification	Description*
Major Arterial	A highway that serves major through movements of traffic between activity centers and a substantial portion of trips entering and leaving the area. It also connects highways with major traffic generators. Service to abutting land is very subordinate to the function of moving through traffic.
Minor Arterial	A facility that connects and augments the Principal Arterial system. Although its main function is still traffic mobility, it performs at a lower level and places more emphasis on land access than does the Principal Arterial.
Collector	Surface street providing land access and traffic circulation within residential, commercial and industrial areas. Collector streets connect local roadway networks to the larger city-wide arterial road network.
Unclassified Local	Roadway which provides direct access to residential, commercial and industrial properties.

*Pursuant to the 2045 Comp Plan

2.1.2 Context Sensitive Design Classification

All new, reconstructed, and resurfaced roadways will be assigned a context sensitive Design Classification by the Planning and Development Department, Transportation Planning Division. The current design classifications can be found on the City's Land Development Review Map using the Transportation Layer Group and are defined in **Table 2.1-2**. In some situations, segments of the same road or street may be assigned different Design Classifications.

Table 2.1-2 Design Classification Roadway Type and Descriptions

Context Sensitive Design Classification	Description
Thoroughfare P-119	A higher speed multi-lane roadway designed to primarily carry through traffic. May serve as a high-ridership transit corridor.
Boulevard P-120	A medium speed roadway designed to carry both through and local traffic. May be multi-lane or two-lane and serve several transit routes.
Avenue P-122	A low-to-medium speed roadway designed to serve as primary pedestrian and bicycle route and may serve local transit routes.
Limited Avenue P-124	Any Neighborhood Commercial Street, Boulevard, or Avenue with frequent curb cuts and where one travel lane in each direction provides sufficient capacity (typically less than 21,000 vehicles per day).
Industrial P-128	A low speed street designed to serve local industrial traffic and located in an industrial park. These streets are not designated truck routes. The lanes are 12', there is no on-street parking, and they have sidewalks and multiuse paths on one or both sides of the road.
Neighborhood Commercial Street P-125	A low speed street designed to serve commercial and residential as well as a primary pedestrian and bicycle route and may serve local transit routes.
Business Park P-129	A low speed street designed to serve local business park traffic and located in a business park. These streets are not designated truck routes. The lanes are 11', there is no on-street parking, and there are bicycle lanes and sidewalks on both side of the roads.
Neighborhood Residential Street P-126	A low speed street designed to serve as a primary pedestrian and bicycle route and may serve local transit routes.
Residential Local Subdivision Street P-127	A low speed street designed to serve as a primary pedestrian and bicycle route. A cul-de-sac, loop road, or a road that does not connect thoroughfares or serve major traffic generators.
Alley P-130	Alleys are privately owned and maintained accessways to minimize driveway cuts, provide space for utilities and drainage, and provide access for trash collection, residential garages, and service access to commercial buildings.

2.1.3 Development Area

Each roadway exists within a development area, which defines the desirable development characteristics to maintain community growth according to the City's Comprehensive Plan. Development Areas are established by the Planning and Development Department. The development area can be found on the City's Land Development Review Map using the Land Use - Zoning Layer Group, Development Areas and are defined in **Table 2.1-3**.

Table 2.1-3 Development Area Descriptions

Development Areas	Description
Downtown	This area encompasses Jacksonville's downtown urban core. Within this area, the City encourages revitalization and the use of existing infrastructure through redevelopment and infill development at high densities.
Urban Priority Area (UPA)	This area generally includes the historic core of the City and major connecting corridors. Within this area, the City encourages revitalization and the use of existing infrastructure through redevelopment and infill development at high densities. Development is expected to employ urban development characteristics.
Urban Area (UA)	This area generally corresponds with the densely developed portions of the City that have been in residential or employment generating uses since consolidation. It also includes major corridors which connect the other Development Areas. Similar to the UPA, the intent of the UA is to encourage revitalization and the use of existing infrastructure through redevelopment and infill development, but at moderate urban densities which are transit friendly. Also similar to the UPA, the UA is intended to support multimodal transportation and the reduction of per capita greenhouse gas emissions and vehicle miles traveled.
Suburban Area (SA)	This area generally corresponds with the urbanizing portions of the City in areas that have usually been developed after consolidation. Development should generally continue at low densities with medium density development at major corridor intersections and transit stations. Development at these locations should promote a compact and interconnected land development form.
Rural Area (RA)	This area consists of all lands outside of the SA and corresponds with predominantly undeveloped portions of the City with land uses such as Agriculture, Recreation, Conservation, or Public Buildings Facilities. Development should occur at very low densities which create little demand for new infrastructure and community serving supporting uses, unless development occurs under the Multi-Use Category or as a Master Planned Community as defined in this element. Development may occur within the RA provided that it is consistent with Operational Provisions and the Land Use category descriptions. Otherwise, development beyond such boundaries is considered urban sprawl and is to be discouraged.

** ITE *Manual of Transportation Engineering Studies* provides guidance in regard to travel speeds

2.1.4 Truck Route

Different design requirements apply to preferred truck routes which must accommodate longer and heavier design vehicles and longer turning radii. Truck routes were established by Sec. 804.1604, Ordinance Code, City of Jacksonville Regulated Truck Route System Map. The Preferred truck routes can be found on the City's Land Development Review Map using the Transportation Layer Group. If the roadway in question has been designated a Preferred Truck Route, distinct design guidelines are required to accommodate the designated truck traffic as shown in Table 2.2-2.

2.2 Roadway Design Requirements

2.2.1 General Design Requirements

The designations for Roadway Functional Classification, Design Classification, Development Area, and Truck Route determined in Section 2.1 will be used to determine the specific design criteria for the roadway segment as shown in **Figure 2.2-1**.

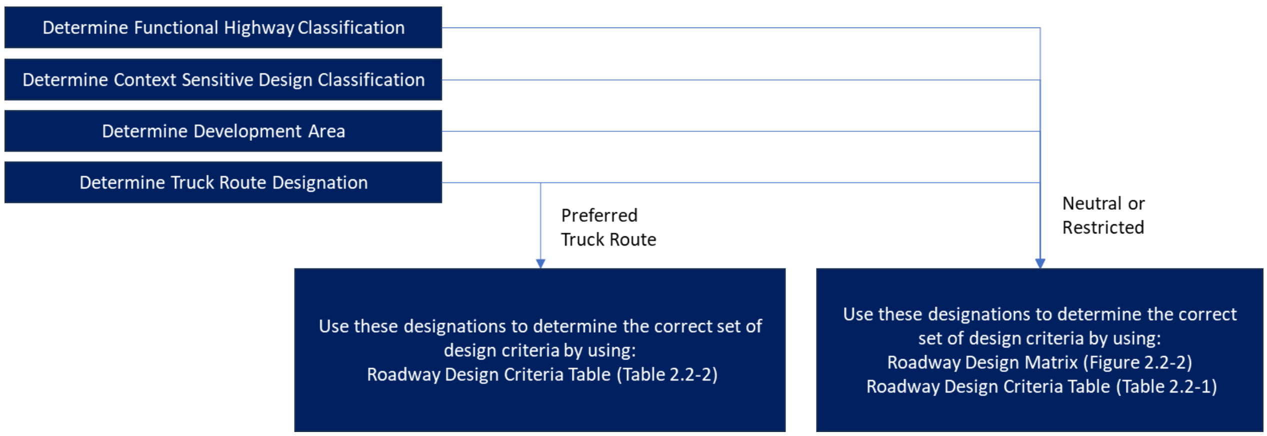


Figure 2.1-1 Determining Roadway Design Requirements Based on Design Designations

First, use **Figure 2.2-2** to determine the portion of the matrix in which the subject roadway falls. For example, a "Minor Arterial" road, which has been classified as an "Avenue", and is located in the "Suburban" development area and is not a "Preferred" truck route would fall under matrix "D".

Now, use **Table 2.2-1** to look up the specific design criteria this roadway should meet. In the previous example, looking-up matrix "D" in the left column would show the below information. The "suburban" design criteria have been highlighted for clarity. These requirements must be met by the provided roadway design. Compliance with these design criteria will be checked through the Site Development Review process (LDPM Volume 1, Section 2.0)

Development Area	Design posted speed	Min R/W Width	Min Lane Width	Typical Cross Section	Design Vehicle	Effective Intersection Radius (ft)
D						
Downtown	≤ 30	120	11	P-122	SU-30	30 See Section 2.2.2
Urban						
Urban Priority	≥ 30					
Suburban	≥ 35					
Rural						

If the roadway being considered is a "Preferred" Truck Route, use Table 2.2-2 to establish the roadway design criteria. Preferred truck routes must accommodate a minimum design vehicle consistent with delivery trucks and implement larger turning radii. In general, the intent is for connectivity, pedestrian facilities, and bicycle safety measures will be maintained based on context sensitive design designation.

Figure 2.2-2 Roadway Design Matrix Based on Design Classification Designations

		Context Sensitive Design Classification[1]									
		Thoroughfare	Boulevard	Avenue	Limited Avenue	Industrial	Neighborhood Commercial Street	Business Park	Neighborhood Residential Street	Residential Local Subdivision Street	Alley
		Development Areas[2]									
		- Downtown - Urban - Urban Priority - Suburban - Rural	- Downtown - Urban - Urban Priority - Suburban - Rural	- Downtown - Urban - Urban Priority - Suburban - Rural	- Downtown - Urban - Urban Priority - Suburban - Rural	- Downtown - Urban - Urban Priority - Suburban - Rural	- Downtown - Urban - Urban Priority - Suburban - Rural	- Downtown - Urban - Urban Priority - Suburban - Rural	- Downtown - Urban - Urban Priority - Suburban - Rural	- Downtown - Urban - Urban Priority - Suburban - Rural	- Downtown - Urban - Urban Priority - Suburban - Rural
Roadway Functional Classification [3,4]	Major Arterial	A	B								
	Minor Arterial		C	D	E	F					
	Collector			G	H	I	J	K	L		
	Local [5]					M	N	O	P	Q	R

Notes:
Context Sensitive Design Classification - COJ GIS, Land Development Review Map Set, Design Classification Layer
Development Area - COJ GIS, Land Development Review Map Set, Land Use - Zoning Group, Development Areas Layer
Roadway Functional Classification - COJ GIS, Land Development Review Map Set, Transportation Group, Roadway Functional Classification Layer
Truck Route - COJ GIS, Land Development Review Map Set, Transportation Group, Truck Routes Layer
Any road not classified is considered a Local Road.

Table 2.2-1 Roadway Design Criteria

See Fig 2.2-1	Design/Posted Speed (mph)	Minimum R/W Width (ft.)[1]	Lane Width (ft.)[2]	Typical Section Detail	Design Vehicle	Effective Intersection Curb Radius (ft.)	Maximum Superelevation Rate (ft/ft)	Sidewalk Width (both sides) (ft)	Bike Lanes	Roadway Lighting
A										
Downtown	≤ 30	150	11	P-119	WB-40	30 See Section 2.2.2	0.05	8	See Section 2.4.1	See Section 1.5
Urban								6		
Urban Priority	≥ 30							8		
Suburban	≥ 35							6		
Rural								5		
B										
Downtown	≤ 30	150	11	P-120	SU-30	30 See Section 2.2.2	0.05	8	See Section 2.4.1	See Section 1.5
Urban					WB-40			6		
Urban Priority	≥ 30							8		
Suburban	≥ 35							6		
Rural								5		
C										
Downtown	≤ 30	120	11	P-120	SU-30	30 See Section 2.2.2	0.05	8	See Section 2.4.1	See Section 1.5
Urban					WB-40			6		
Urban Priority	≥ 30							8		
Suburban	≥ 35							6		
Rural								5		
D										
Downtown	≤ 30	120	11	P-122	SU-30	30 See Section 2.2.2	0.05	8	See Section 2.4.1	See Section 1.5
Urban								6		
Urban Priority	≥ 30							8		
Suburban	≥ 35							6		
Rural								5		
E										
Downtown	≤ 30	120	11	P-124	SU-30	30 See Section 2.2.2	0.05	6	See Section 2.4.1	See Section 1.5
Urban										
Urban Priority	≥ 30									
Suburban	≥ 35									
Rural										

See Fig 2.2-1	Design/Posted Speed (mph)	Minimum R/W Width (ft.)[1]	Lane Width (ft.)[2]	Typical Section Detail	Design Vehicle	Effective Intersection Curb Radius (ft.)	Maximum Superelevation Rate (ft/ft)	Sidewalk Width (both sides) (ft)	Bike Lanes	Roadway Lighting
F										
Downtown	≤ 30	120	12	P-128	WB-40	35 See Section 2.2.2	0.05	6	See Section 2.4.1	See Section 1.5
Urban										
Urban Priority	≥ 30									
Suburban	≥ 35									
Rural										
G										
Downtown	≤ 30	80	11	P-122	SU-30	30 See Section 2.2.2	0.04	8	See Section 2.4.1	See Section 1.5
Urban								6		
Urban Priority	≥ 30							8		
Suburban	≥ 35							6		
Rural		100					0.08	5		
H										
Downtown	≤ 30	80	11	P-124	SU-30	30 See Section 2.2.2	0.04	6	See Section 2.4.1	See Section 1.5
Urban										
Urban Priority	≥ 30									
Suburban	≥ 35									
Rural		100					0.08			
I										
Downtown	≤ 30	80	12	P-128	WB-40	35 See Section 2.2.2	0.04	6	See Section 2.4.1	See Section 1.5
Urban										
Urban Priority	≥ 30									
Suburban	≥ 35									
Rural		100					0.08			
J										
Downtown	≤ 30	100	11	P-125	WB-40	30 See Section 2.2.2	0.04	8	See Section 2.4.1	See Section 1.5
Urban								6		
Urban Priority	≥ 30							8		
Suburban								6		
Rural	≥ 25	120					0.08	5		

See Fig 2.2-1	Design/Posted Speed (mph)	Minimum R/W Width (ft.)[1]	Lane Width (ft.)[2]	Typical Section Detail	Design Vehicle	Effective Intersection Curb Radius (ft.)	Maximum Superelevation Rate (ft/ft)	Sidewalk Width (both sides) (ft)	Bike Lanes	Roadway Lighting
K										
Downtown	≤ 30	80	11	P-129	WB-40	30	0.04	6	See Section 2.4.1	See Section 1.5
Urban										
Urban Priority	≥ 30									
Suburban	< 35									
Rural		100				See Section 2.2.2	0.08			
L										
Downtown	≤ 25	80	11	P-126	DL-23	20	0.04	8	See Section 2.4.1	See Section 1.5
Urban								6		
Urban Priority								8		
Suburban								6		
Rural		100				See Section 2.2.2	0.08	5		
M										
Downtown	≤ 35	60	12	P-128	WB-40	35	0.04	6	See Section 2.4.1	See Section 1.5
Urban										
Urban Priority										
Suburban										
Rural		80				See Section 2.2.2	0.08			
N										
Downtown	≥ 25	80	11	P-125	DL-23	30	0.04	8	See Section 2.4.1	See Section 1.5
Urban								6		
Urban Priority								8		
Suburban								6		
Rural		100				See Section 2.2.2	0.08	5		
O										
Downtown	≤ 35	60	11	P-129	WB-40	30	0.04	6	See Section 2.4.1	See Section 1.5
Urban										
Urban Priority										
Suburban										
Rural		80				See Section 2.2.2	0.08			

See Fig 2.2-1	Design/Posted Speed (mph)	Minimum R/W Width (ft.)[1]	Lane Width (ft.)[2]	Typical Section Detail	Design Vehicle	Effective Intersection Curb Radius (ft.)	Maximum Superelevation Rate (ft/ft)	Sidewalk Width (both sides) (ft)	Bike Lanes	Roadway Lighting
P										
Downtown	≤ 25	60	11	P-126	DL-23	15 See Section 2.2.2	0.04	8	See Section 2.4.1	See Section 1.5
Urban								6		
Urban Priority								8		
Suburban								6		
Rural		80					0.08	5		
Q										
Downtown	≤ 25	50	12	P-127	DL-23	15 See Section 2.2.2	0.04	5	See Section 2.4.1	See Section 1.5
Urban										
Urban Priority										
Suburban										
Rural							0.08			
R										
Downtown	≤ 25	24	Single 12' lane w/ 6' pavers on each side	P-130	P	15 See Section 2.2.2	0.04	Not Applicable	Not Applicable	See Section 1.5
Urban										
Urban Priority										
Suburban										
Rural							0.08			

1. Minimum ROW widths established by Code of Ordinance Section 654.113
2. Minimum lane width may be reduced to 10 feet in specific low-speed situations at the discretion of Traffic Engineering

Table 2.2-2 Preferred Truck Route Design Criteria

See Fig 2.2-1	Design/Posted Speed (mph)	Minimum R/W Width (ft.)[1]	Minimum Lane Width (ft.)[2]	Typical Section Detail	Design Vehicle	Effective Intersection Curb Radius (ft.)[3]	Maximum Superelevation Rate (ft/ft)	Sidewalk Width Both Sides ft	Bike Lanes	Roadway Lighting
Major Arterial										
Downtown	≥ 35	150	11	See Table 2.2-1 based on Context Classification	WB-62	See FDOT Design Manual Section 212	0.05	8	See Section 2.4.1	See Section 1.5
Urban								6		
Urban Priority								8		
Suburban								6		
Rural								5		
Minor Arterial										
Downtown	≥ 35	120	11	See Table 2.2-1 based on Context Classification	WB-62	See FDOT Design Manual Section 212	0.05	8	See Section 2.4.1	See Section 1.5
Urban								6		
Urban Priority								8		
Suburban								6		
Rural								5		
Collector										
Downtown	≥ 35	80	11	See Table 2.2-1 based on Context Classification	WB-62	See FDOT Design Manual Section 212	0.04	See Table 2.2-1 based on Context Classification	See Section 2.4.1	See Section 1.5
Urban										
Urban Priority										
Suburban										
Rural							0.08			
Local										
Downtown	≤ 35	50	11	See Table 2.2-1 based on Context Classification	WB-62	See FDOT Design Manual Section 212	0.04	See Table 2.2-1 based on Context Classification	See Section 2.4.1	See Section 1.5
Urban	≥ 35									
Urban Priority										
Suburban										
Rural							0.08			

1. Minimum ROW widths established by Code of Ordinance Section 654.113
2. Minimum lane width may be reduced to 10 feet in specific low-speed situations at the discretion of Traffic Engineering
3. Consider implementing mountable aprons for intersections in downtown, urban, and urban priority truck routes.

ADDITIONAL DESIGN CONSIDERATIONS

The following are additional design considerations to supplement the values in Table 2.2-1 and 2.2-2.

2.2.2 Curb Radii and Return Radii

Curb and turning radii for streets includes consideration of the design vehicle, control vehicle, and managed vehicle as defined by NACTO:

Design Vehicle: The design vehicle is the largest vehicle that can be accommodated without encroachment onto curbs or adjacent vehicle lanes, bike lanes, or parking lanes The design vehicle may be required to go over a mountable element such as a truck apron.

Control Vehicle: The control vehicle is the largest vehicle that is infrequent. The control vehicle is accommodated by allowing encroachment into opposing lanes, adjacent lanes, bike lanes, and parking lanes. Minor encroachment onto curbs is acceptable if no critical infrastructure is present.

Managed Vehicle: The managed vehicle is the most common vehicle to use the street. It is typically smaller than the design vehicle which means it is capable of higher more dangerous speeds.

Table 2.2-3 outlines each class of vehicle in these categories based on the design classification categories established in Table 2.2-1.

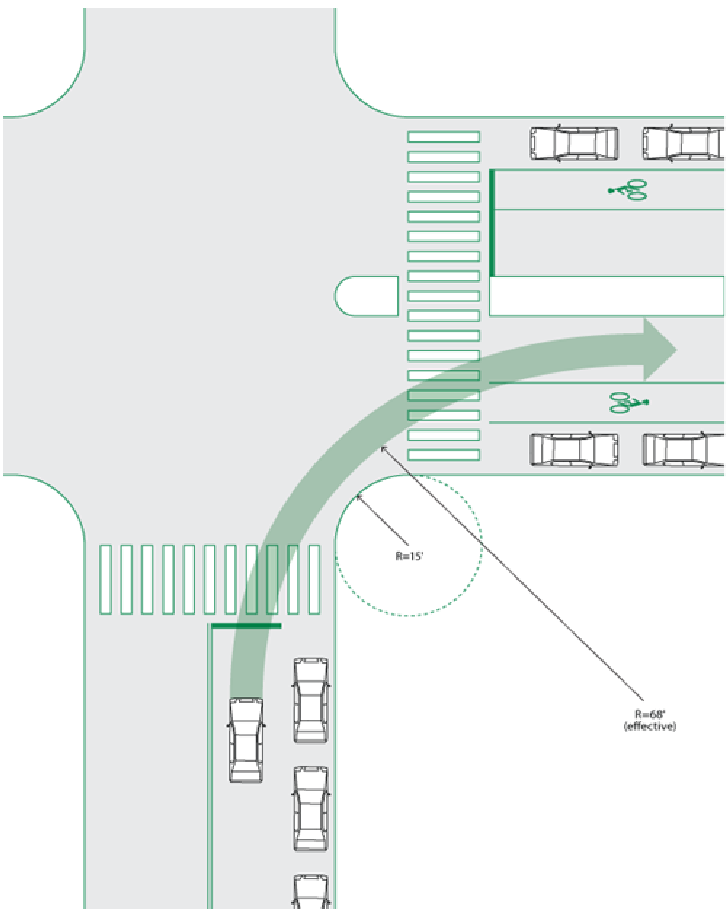


Figure 2.2-3: Physical Curb Radius vs. Effective Turning Radius

The selection of curb radii must take into account both the most vulnerable street user (i.e. bicycles and pedestrians) as well as the t largest vehicle (i.e., emergency vehicles). It is important to understand that the curb and return radii are not designed for the control vehicle; however, the selected radii must be able to accommodate these vehicles by allowing encroachment outside the designated travel lanes. Additionally, consideration must be given to the longevity of infrastructure and replacement requirements if tight turning radii result in frequent mounting of the curb and drainage infrastructure.

Table 2.2-3 outlines the recommended physical curb radius based on a street's design classification, managed vehicle and target speed, as well as the control vehicle. The Intersection Physical Curb Radius (in feet) is the standard. Using a higher number in the range will need approval from the City Engineer. Curb radii lower than the range may also be considered and approved by the City Engineer.

The presence of or planned bicycle facilities and on-street parking, increases the effective turning radius which allows for a decrease in the physical curb radius. For an example of how the presence of on-street parking and bicycle lanes increases the effective turning radius refer to **Figure 2.2-3**. The image does not show buffer between bike lane(s) and parking lane, therefore actual typical section design standard does not change.

Table 2.2-3 Physical Curb Radius vs. Effective Turning Radius

	Managed Vehicle	Target Speed for Managed Vehicle (mph)	Design Vehicle	Control Vehicle	Effective Turning Radius (feet)
A/B/C/H/J/K	P	10-15	WB-40	WB-62FL	30
D/E/G	P	10-15	SU-30	WB-62FL	30
F/I/M	P	10-15	WB-40	WB-62FL	35
L	P	10-15	DL-23	SU-40	20
N/O/P/Q/R	P	10	DL-23	SU-40	15

For all driveways, the recommended return radius shall be consistent with the physical curb radius based on a street's design classification and the associated control vehicle, as specified in Table 2.2-3.

Point of Measurement

5. Guttered Sections - back of curb or gutter (parkway side).
6. Non-guttered Sections - edge of pavement.

2.2.3 Stopping Sight Distance

Stopping-sight distance shall be based on FDOT Florida Greenbook Standard for Design.

2.2.4 Roadway Level of Service

Roadways within the Downtown, Urban Priority, and Urban development areas should be designed for a minimum level of service "E" based on projected 20-year ADT or minimum level of service "E" based on projected 20-year 30 HV, whichever is more critical (restrictive). A traffic study may be required.

Roadways within the Suburban and Rural development areas should be designed for minimum level of service "D" based on projected 20-year ADT or minimum level of service "D" based on projected 20-year 30 HV, whichever is the more critical (restrictive). A traffic study may be required.

2.2.5 Bridges

Bridges shall be constructed of precast concrete, prestressed concrete, or cast-in-place concrete. Bridge design shall conform to the design criteria of the latest edition, AASHTO Standard Specifications for Highway Bridges. The design load shall be HS-20-44 (AASHTO) or the controlling axle configuration of the six legal load limits in the State of Florida, whichever produce the greater stresses. Materials and methods of construction shall conform to the FDOT Standard Specifications for Road and Bridge Construction, latest edition.

All new or reconstructed bridges shall contain pedestrian facilities at a minimum in accordance with 654.133, City Ordinance. A shared-use path may be acceptable per Sec.654.133(d), Ordinance Code. For State and other entity owned roads, coordination will be required with the City of Jacksonville.

2.2.6 Roadway Alignment
All roadway typical sections shall conform to LDPM Volume 3, Standard Details. Any deviations from these Standard Details will not be allowed without the approval of the City Engineer in coordination with the Planning and Development Department, Transportation Division. Procedures for submitting a request for deviation are outlined in LDPM Volume 1, Section 5.0. Such deviations may be requested with written justification.

2.2.7 Roadway Shoulders
Rural truck routes, Major Arterial, Minor Arterial, and Collector roads in rural development areas that do not utilize curb and gutter shall follow the FDOT Florida Greenbook, latest edition, for shoulder dimensions and design requirements. On bridges, the shoulder cross slope shall match the cross slope of the adjacent lane. A minimum transition length of 50 feet should be provided for the shoulder cross slope approaching a bridge. Where bicycle and/or pedestrian traffic is expected within paved shoulders, see the requirements in Section 2.4.1.

2.2.8 Roadway Clear Zones
A Clear Zone is an unobstructed, traversable roadside area that allows a driver to stop safely or regain control of a vehicle that has left the roadway. On rural local streets the clear zone shall be 6 feet, and on rural collectors the clear zone shall be 11 feet. Where hazards are within the clear zone, guardrail or barrier wall shall be provided at least 6 feet off the traveled way.

For urban sections the clear zone is 4 feet from face of curb. On urban local streets the clear zone may be reduced to 2.5 feet under unusual conditions.

2.2.9 Roadway Vertical Alignment
All streets shall have grades less than 8 percent. Streets with curb and gutter shall have grades equal to or greater than 0.3 percent. Design speed and safe stopping distance shall govern the design.

Vertical Curves
Vertical curves will be required at changes in grade with an algebraic difference of 2 percent or more in relation to design speed as established in the Florida Greenbook. No vertical curve will be required for any change in grades with an algebraic difference less than 2 percent. Length of vertical curve shall provide for minimum safe stopping sight distance.

Superelevation
Minimum superelevation rates shall be as shown in Table 2.2-1: Where superelevated curves carry through intersections, the maximum superelevation rate shall be 0.04 foot/foot. In local subdivision-type streets, superelevation should not be used. Instead, curve radii and minimum design speeds should be utilized.

Superelevation Transition
Minimum lengths of superelevation runoff shall be as established by AASHTO. The tangent should include 60 percent to 80 percent of the total transition length. These criteria will also control tangent lengths required between reverse curves.

2.2.10 Horizontal Curves

The minimum centerline radii for local residential subdivision roadways shall be 80 feet. All other roadways, including those that serve as a local residential collector shall meet the requirements contained in Chapter 3: Geometric Design, FDOT Florida Greenbook, latest edition.

2.2.11 Intersections

Crosswalks should be as short as possible for pedestrian safety and comfort. Curb radii at intersections should be no larger than what is needed to accommodate the design vehicle, which is the largest type of vehicle that will frequently turn at each corner. Vehicles that are larger than the design vehicle will occasionally encroach into an opposing travel lane.

It may be advisable, at certain intersections to design curbs that can be safely mounted without causing significant physical damage to accommodate vehicles larger that the design vehicle such as emergency vehicles, maintenance vehicles or delivery trucks. A smaller curb radius may be acceptable at intersections where parking lanes and bike lanes would provide for an effective turning radius that would be greater than the curb radius.

It is assumed that the vehicle will move slowly forward to obtain sight distance (without intruding into the crossing travel lane), stopping a second time as necessary when executing a crossing or turning maneuver after stopping at a stop sign or cross walk. When curb extensions are used, or on-street parking is in place, the vehicle can be assumed to move forward on the second step movement, stopping just shy of the travel lane, increasing the driver's potential to see further than when stopped at the stop bar. The resulting increased sight distance provided by the two-step movement allows parking to be located closer to the intersection, but not less than 20 feet from a crosswalk.

Where bicycle facilities are existing, proposed, or required, the intersection design shall include channelization marking also known as 'bicycle intersection crossing markings' or 'cross-bike markings' through the intersection to indicate the intended path of the bicyclist. Markings provide conspicuity and directional guidance to bikes in the intersection. They are marked with skipped bicycle lane line extensions and may be supplemented with green color or bike symbols between these lines. The use of green color is preferred, where possible, to increase visibility and draw attention to potential conflict zones with vehicles.

All intersections within proposed project limits shall be designed to comply with the latest edition of at least one of the following guidance documents: Improving Intersections for Pedestrians and Bicyclists (FHWA); Don't Give Up at the Intersection (NACTO); Designing Walkable Urban Thoroughfare (ITE); or the FDOT Florida Greenbook and FDOT Florida Design Manual (FDOT).

2.2.12 Travel Lane Widths

Travel lanes are specified in Table 2.2-2 based on roadway classification. In order for drivers to maintain appropriate driving speeds, lane widths should create some level of discomfort when driving too fast. In low-speed urban environments, lane widths are typically measured to the curb face instead of the edge of the gutter pan. Consequently, when curb sections with gutter pans are used, the travel lane and parking lane widths include the width of the gutter pan.

2.2.13 Right Turn, Left turn, Acceleration/Deceleration Lanes

Turn lanes should generally be avoided in local neighborhood streets, as they tend to allow through vehicles to maintain higher speeds through intersections; lengthen crosswalks; and take up roadway space that could be used for wider sidewalks, landscaping, or other placemaking features.

When right turn, left turn and/or acceleration/deceleration lanes are required based on traffic analysis and Sections 1.2.8 and 1.2.9, the entire area which encompasses the existing pavement, from the beginning of the taper to the end of the taper, shall be resurfaced, unless otherwise waived by the City Engineer (LDPM Volume 1, Section 5.0). The intersection shall also be restriped.

2.2.14 Medians

Roadway medians are typically landscaped with raised curbs. Medians used in low-speed urban thoroughfares provide for access management, safety, pedestrian refuge, landscaping, lighting, and utilities. Landscaped medians can enhance the street or help create a gateway entrance into a community as well as provide pedestrian refuge for longer crossings. Medians can be used to create tree canopies over travel lanes for multi-lane roadways, contributing to a sense of enclosure, increasing pedestrian and bicycle comfort, and mitigating heat island effects by cooling down the street environment. Where constructed, they shall be surrounded by a suitable curb. The construction of unpaved medians within roadways requires approval of the City Engineer based on the procedures outlined in LDPM Volume 1, Section 5.0.

Adequate drainage facilities shall be provided within the median to prevent erosion and protect the structural integrity of the adjacent pavement during the five-year design storm. Where landscaping is provided, the design must provide for adequate sight distance. Maintenance of landscaping shall be the responsibility of the Homeowners' Association, abutting property owners, or other designated entity. The minimum median width shall be 12 feet unless otherwise approved by the City Engineer based on the procedures outlined in LDPM Volume 1, Section 5.0.

2.2.15 Curb and Gutter

Curb and gutter and/or green infrastructure drainage features (see Section 4.0) is preferred for roadway cross sections. Local roadways in all development areas (except alleys) are required to provide curb and gutter. Major Arterial, Minor Arterial, and Collector roads in suburban and rural development areas may utilize roadway swales in place of curb and gutter. Roadway sections shall be constructed with curb and gutter or green infrastructure drainage features in accordance with the typical cross sections.

All details of concrete curb and gutter shall conform to the applicable City Standard Details (LDPM Volume 3), latest edition. Any deviation from these Standard Details will not be allowed without written approval from the City Engineer based on the procedures outlined in LDPM Volume 1, Section 5.0. Materials and installation shall conform to the applicable City Standard Specifications, latest edition.

2.2.16 Clearing Roadway Rights-of-Way

All roadway rights-of-way shall be cleared and grubbed in accordance with City Standard Specifications, LDPM Volume 4, latest edition, and the Landscape and Tree Protection Regulations, unless plans for selective clearing and grubbing are submitted and approved by the City Engineer based on the procedures outlined in LDPM Volume 1, Section 5.0.

2.2.17 Grassing and Mulching Requirements

All roadway rights-of-way except those areas with enhanced landscaping, shall be grassed using one of the following methods.

1. One row of sod shall be placed behind the curb.
2. The disturbed areas from the back of the curb to the right-of-way line shall be seeded and/or mulched; or
3. Alternate stabilization measures may be installed subject to the approval of the Director of Public Works.

Final acceptance of roadway rights of way and enhanced landscaping areas are included in LDPM Volume 1, Section 4.0.

2.2.18 On-Street Parking

City of Jacksonville Sec. 656.607, Ordinance Code

On-street parking means parking located within the public right of way. On-street parallel or angle parking provides a buffer for the pedestrians and bicyclists, helps to calm traffic speeds, and is important for the success of those retail businesses that line the street. The appropriateness of on-street parking on a roadway varies based on context. **Table 2.2-4** and **Figures 2.2-4**, **2.2-5** and **2.2-6** below outline the minimum dimensions for on-street parking.

Where a bicycle lane is provided or proposed next to parking and right-of-way allows, locating the bicycle lane on the curbside of on-street parking, also known as a protected bike lane, should be considered. A bicycle buffer zone of a minimum of 3 feet must be provided between the on-street parking and the bike lane. The buffer may include pavement marking, raised medians, concrete barriers, delineators, or other types of special paving. If pavement markings are used, solid white line marking shall be used and diagonal crosshatch markings may be placed in the neutral area for special emphasis.

Table 2.2-4 Minimum dimensions for on-street parking

Parking Angle	Curb Width	Stall Depth	Stall Width	Stall Length	Car Parking Overhang	Step Out Zone
60° (angled – head-in or back-in)	9.8	20.0’	8.5’	22.0’	2.0’ min.	N/A
0° (parallel)	22.0	7.0’ minimum, 8.0’ preferred on functionally classified roadways	7.0’ minimum, 8.0’ preferred on functionally classified roadways	22.0’	N/A	2.0’

<u>**Definitions**</u>

Step Out Zone: A strip of land adjacent to a curb where parallel or angled on-street parking exists. It is designed to create a clear space for pedestrians to exit a vehicle without having to step into a planting strip.

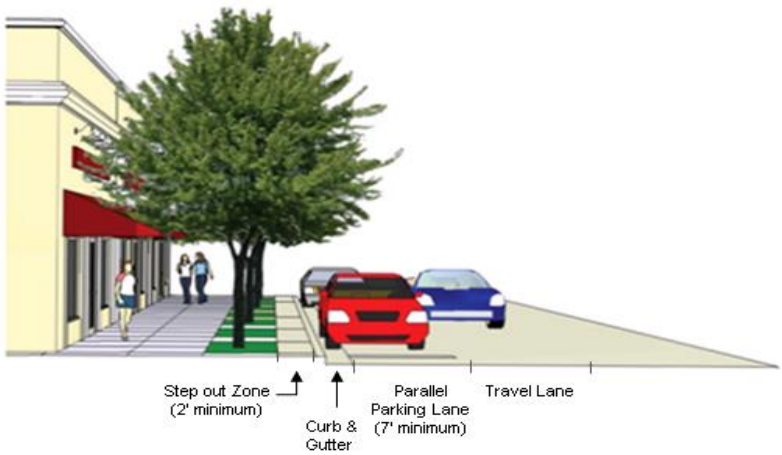
Car Parking Overhang Zone: A strip of land adjacent to a curb where angled on-street parking is exists. It is designed to provide space for the front or rear of a vehicle to hang over the curb. This area should be clear of all obstructions.

Stall Depth: Distance from face of curb to end of parking stall stripe, measured perpendicular to the curb.

Stall Width: Distance between the two stripes of a parking stall, measured perpendicular to the stripes.

Stall Length: Distance from face of curb to end of parking stall stripe, measured parallel to parking stall stripe.

Bicycle Buffer Zone: A minimum 3’ strip of land adjacent to parallel or angled on-street parking and between the on-street parking and the bicycle lane. It is designed to create a clear space for pedestrians to exit the vehicle on the passenger side and to prevent “dooring” of bicyclists.



Source: Jacksonville Design Guidelines and Best Practices Handbook (Section 1: Commercial Development)

Figure 2.2-4 Parallel parking diagram

Source: Jacksonville Design Guidelines and Best Practices Handbook (Section 1: Commercial Development)

Figure 2.2-5 Angled parking diagram

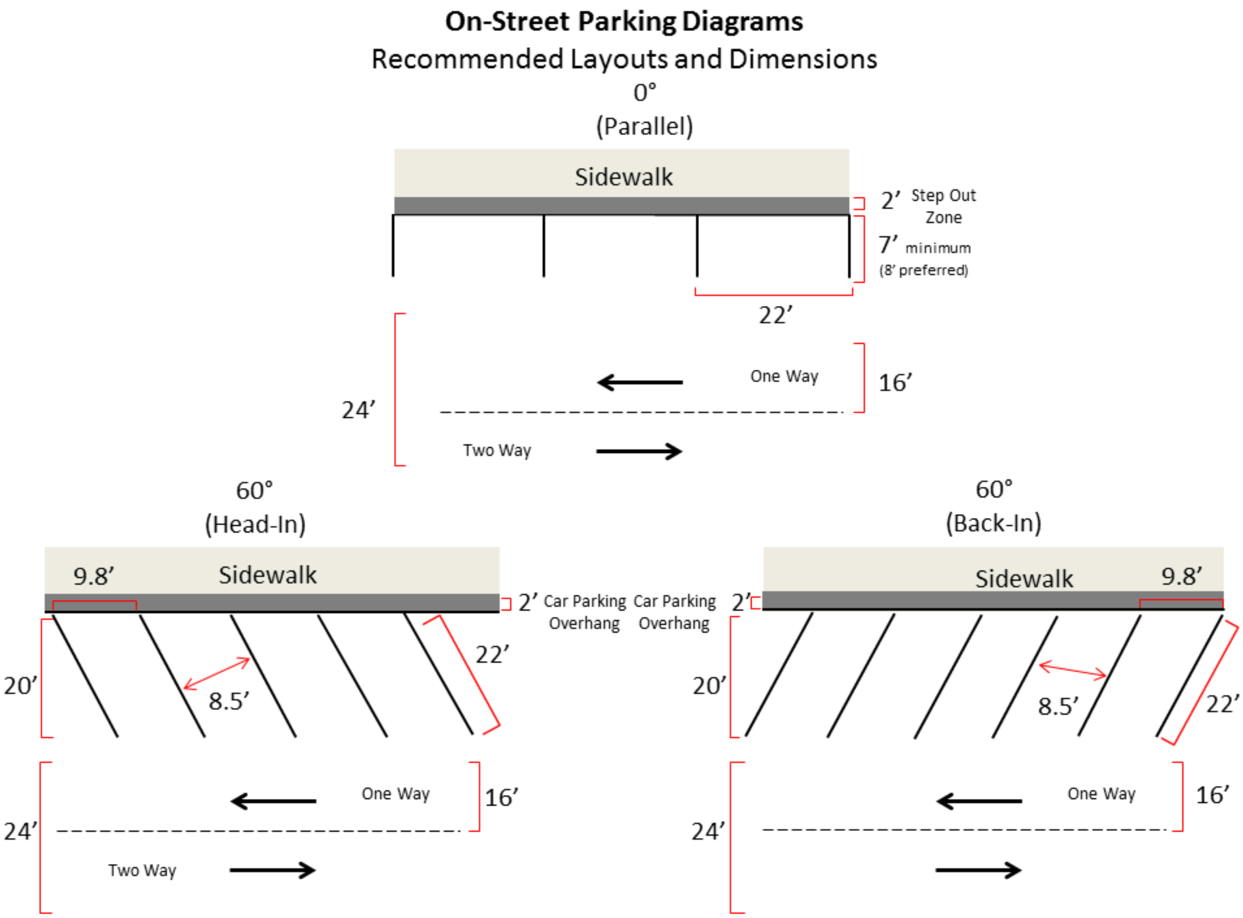


Figure 2.2-6 On-street parking diagrams

2.3 Pavement Design

2.3.1 General

The criteria presented in this section are considered the minimum acceptable standards and may not apply to all situations. The City Engineer may require greater pavement thickness when the existing conditions and/or future traffic demands warrant. When, in the judgment of the City Engineer, conditions warrant additional testing to assure compliance with the specifications, the developer's registered professional will be advised in writing that additional tests will be required and the extent of such additional tests.

In general, Pavement Design shall follow procedures established in the FDOT Flexible Pavement Design Manual, latest edition, for new construction, reconstruction, and pavement rehabilitation projects, unless otherwise notified by the City Engineer. Pavement widening projects do not require thickness design calculations. The widened pavement section will be designed and constructed to match the existing pavement. The total structural number of the widened section must equal or exceed the existing roadway's structural number.

2.3.2 Required Pavement Design Data

The following data shall be obtained to prepare the pavement design for Classifications A through O (as identified in Figure 2.2-1):

1. Design Resilient Modulus (M_R) of the existing soil (Geotechnical Investigation)
2. Average Annual Daily Traffic (AADT) (Traffic Engineering Counts)
3. Percent Truck Traffic to calculate the 18-kip Equivalent Single Axle Load (ESAL) (Traffic Engineering Counts)

   Note: if the roadway in question does not have truck traffic counts available through FDOT or COJ Traffic Planning division, the design professional will be responsible for collecting the necessary data.

   Note: FDOT ESAL calculation spreadsheet may be used by the design professional to perform these calculations.
4. Estimated Seasonal High Groundwater Table (SHGWT) (Geotechnical Investigation)
5. For Pavement rehabilitation/resurfacing projects: Existing pavement cores with a determination of the condition of the existing pavement (Geotechnical Investigation)

For pavement design calculations (Classification A through O), utilize a minimum of 8 inch base course as described in Section 2.3.6 and a minimum of 12 inch Stabilized Subgrade as detailed in Section 2.3.5.

2.3.3 Pavement Design Life and Reliability Values

"Reliability" is the probability that the pavement will resist the loads applied to it throughout its design life. Unless otherwise approved by the City Engineer, the minimum Design Life for New Construction and Rehabilitation/Resurfacing projects shall be 20 Years. **Table 2.3-1** provides the Reliability for different Roadway Classifications.

Table 2.3-1 Reliability Percentage to be used for Pavement Design

Figure 2.2-1 Classification	New Construction	Pavement Rehabilitation/Resurfacing
A, B, C, D, E, F, G, H, I & M	90%	95%
J, K, L, N & O	80%	90%

2.3.4 Pavement Design Threshold and Minimum Pavement Thickness Requirements

Roadway Classifications P through R (as identified in Figure 2.2-1) and roadways with less and 300,000 ESAL's over a 20-year period do not require a pavement design if they meet minimum pavement requirements for the roadway classification. The Pavement Design for those Roadways are as defined in **Table 2.3-2**.

Table 2.3-2 Minimum Pavement Thickness Design Requirements

Figure 2.2.1 Classification	Base Course	Structural Course
P, Q, & R	6" Limerock or Equivalent	1.5" asphalt

2.3.5 Stabilized Subgrade Requirements

The stabilized subgrade for all roadways shall have a minimum depth of 12 inches and a minimum limerock bearing ratio in accordance with City Standard Specifications, LDPM Volume 4.

Where the design plans call for existing soils to be used in the roadway subgrade because they have the required bearing value, no additional stabilizing material need be added; but the native material shall be mixed and compacted to 98 percent of maximum density as determined by the FM-1 T-180 compaction test.

2.3.6 Base Course Requirements

The minimum base course thickness shown in **Table 2.3-3** are applicable for Asphaltic Concrete pavement. Roadway pavement base course materials and construction shall be limerock, bituminous or crushed concrete material and shall conform to City Standard Specifications, LDPM Volume 4. All bases shall be primed and provided with a tack coat that conforms to City Standard Specifications, LDPM Volume 4.

Table 2.3-3 Roadway Pavement Base Course Requirements

Figure 2.2-1 Classification	Minimum Thickness	Minimum Density
A through O	8 inches	98% Mod Proctor FM-1 T-180
P, Q, & R	6 inches	98% Mod Proctor FM-1 T-180

2.3.7 Surface/Structural Asphalt Course Requirements

Flexible Pavement Requirements

Asphaltic concrete courses for flexible pavements shall be Type SP and shall meet the minimum thickness requirements in **Table 2.3-4**.

Table 2.3-4 Flexible Pavement Surface/Structural Asphalt Course Thickness

Figure 2.2-1 Classification	Type [1, 3]	Minimum (per lift)	Maximum (per lift)
A through L	SP-12.5 [2]	1.5"	3.0"
M through R	SP-9.5	1.0" [4]	1.5"

1. Asphaltic Concrete Type SP-19.0 may not be used as a surface course.
2. Polymer (PG 76-22) shall be added to Industrial Roads (F, I & M) and any designated preferred truck route to provide greater protection from rutting due to a high volume of heavy trucks.
3. All Type SP asphalt shall be Traffic Level C, unless $ESAL_D$ are greater than 10 million where Traffic Level E is required.
4. New development roadways in classification M-Q must follow the two-lift pavement system requirements outlined below, i.e. two lifts at minimum 1" SP9.5 each lift.

Two-Lift Pavement System Requirements

A two-lift asphalt course is required for all ***new*** roadways (M through Q). The two-lift requirement shall include a first asphalt course (first lift) and a final asphalt surface (second lift) applied in thicknesses based on Table 2.3-4. A tack coat shall be required between each lift of asphalt. The City of Jacksonville does not require FDOT Friction Course as the final surface layer for asphaltic concrete roadways. Asphaltic Concrete Type SP, including prime and tack coats, shall conform to City Standard Specifications, LDPM Volume 4, for materials and method of construction.

The final asphalt surface course application, on local streets, shall be delayed in each phase of single and multi-family residential developments until either:

- 80 percent of the units in that phase have received a certificate of occupancy; or
- 24 months have passed since the first certificate of occupancy was issued in that phase.

Rigid Pavement Requirements

Rigid pavement (plain concrete) shall be designed and constructed using the FDOT Rigid Pavement Design Manual, latest edition. Minimum pavement thickness requirements are shown in **Table 2.3-5**. Rigid Jointed Plain Concrete pavement, including joints and base shall conform to City Standard Specifications, LDPM Volume 4.

Table 2.3-5 Cement Concrete Pavement Minimum Thickness

Figure 2.2-1 Classification	Minimum Thickness
A through O	8”
P,Q,R	6”

2.4 Bicycle Considerations

2.4.1 Bicycle Facilities Standards

Bicycle facilities are required on all new or reconstructed streets. Streets to be resurfaced will be assigned a Functional Use Classification prior to resurfacing and shall include bicycle facilities in accordance with Functional Use Classification when existing pavement width is sufficient. If the pavement width is insufficient, the City of Jacksonville’s Planning and Development Department, Transportation Division with the Public Works Department will determine the feasibility of a road diet or widening or reconstruction of the frontage zone to create space for bicycle facilities and/or a shared-use path. The below **Tables 2.4-1 and 2.4-2** outline the required bicycle facilities in order of preference.

Figure 2.4-1 Bike Facility Safety

Table 2.4-1 for Roadways within Non-Rural Development Areas (Downtown, Urban Priority, Urban, Suburban)

Local and Collector (AADT 0-2,999)		
≤25MPH	30MPH	≥35MPH
• Shared-use path • Side path • Two-way cycle track, raised bike lane, or protected/separated bike lane • Min 5' bike lanes • Bicycle boulevard with (r4-11) MUTCD signage. • None (if Min 6' sidewalk)	• Shared-use path • Side path • Two-way cycle track, raised bike lane, or protected/separated bike lane • Min 5' bike lanes with 2' buffer	• Shared-use path • Side path • Two-way cycle track, raised bike lane, or protected/separated bike lane

Minor Arterial (AADT 3,000-6,499)	
≤30MPH	≥35MPH
• Shared-use path • Side path • Two-way cycle track, raised bike lane, or protected/separated bike lane • Min 5' bike lanes • None (if min 5' sidewalks)	• Shared-use path • Side path • Two-way cycle track, raised bike lane, or protected/separated bike lane

Major Arterial (AADT > 6,500)
All Speeds
• Shared-use path • Side path • Two-way cycle track with buffer and vertical delineators • Min 5' bike lanes with 3' buffer and vertical delineators

Based on FHA Bikeway Selection Guide 2019 and FDOT Multimodal Quality/Level of Service Handbook 2023

In some instances, the available roadway width may require a bicycle facility other than what is recommended by its Functional Classification. **Consult with the City of Jacksonville Traffic Engineering or Bike-Ped Coordinator prior to Final Design.**

Table 2.4-2 for Roadways within Rural Development Areas

Local and Collector (AADT 0-999)	
≤30MPH	≥35MPH
• Shared-use path • Side path • Two-way cycle track, raised bike lane, or protected/separated bike lane • Min 5' bike lanes • Min 5' paved shoulder • Sharrows with/or bicycles may use full lane (r4-11) MUTCD signage.	• Shared-use path • Side path • Two-way cycle track, raised bike lane, or protected/separated bike lane • Min 5' bike lanes • Min 5' paved shoulder • None (if min 5' sidewalks present)
Collector (AADT 1,000-1,999)	
≤30MPH	≥35MPH
• Shared-use path • Side path • Two-way cycle track, raised bike lane, or protected/separated bike lane • Min 5' bike lanes • Min 5' paved shoulder • None (if min 5' sidewalks present)	• Shared-use path • Side path • Two-way cycle track, raised bike lane, or protected/separated bike lane • Min 5' bike lanes with 2' buffer and vertical delineators • Min 7' paved shoulder • None (if min 5' sidewalks present)
Minor Arterial (AADT 2,000-9,999)	
≤25MPH	≥30MPH
• Shared-use path • Side path • Two-way cycle track with buffer and vertical delineators • Min 5' bike lanes with 2' buffer • Min 7' paved shoulder • None (if min 5' sidewalks Present or limited Access state route).	• Shared-use path • Side path • Two-way cycle track with buffer and vertical delineators • Min 5' bike lanes with 3' buffer and vertical delineators • Min 8' paved shoulder • None (if min 5' sidewalks Present or limited Access state route).
Major Arterial (AADT > 10,000)	
≤ 35MPH	≥ 40MPH
• Shared-use path • Side path • Two-way cycle track with buffer and vertical delineators • Min 5' bike lanes with 3' buffer and vertical delineators or Min 8' paved shoulder • None (if min 5' sidewalks Present or limited Access state route).	• Shared-use path • Side path • Two-way cycle track with buffer and vertical delineators • Min 7' bike lanes with 3' buffer and vertical delineators or Min 10' paved shoulder • None (if min 5' sidewalks Present or limited Access state route).

Based on FHA Bikeway Selection Guide 2019 and FDOT Multimodal Quality/Level of Service Handbook 2023

In some instances, the available roadway width may require a bicycle facility other than what is recommended by its Functional Classification. **Consult with the City of Jacksonville Traffic Engineering or Bike-Ped Coordinator prior to Final Design.**

A general description of each bicycle facility is provided in **Figure 2.4-2**. A detailed description of the bicycle facilities is included below for informational purposes:

Shared Use Path

A shared use path, sometimes referred to as a multiuse path or trail, is a continuous, paved surface facility, located outside of the roadway, separated from all vehicle traffic by curbing, landscaping, or another vertical delineator, with a preferred 12 ft to 14 ft width, and a minimal 10 ft width. Where right-of-way is constrained, short 8ft wide sections may be allowed. Shared use paths are the preferred bicycle facilities in all cases, when right-of-way is available. A shared use path on one side of a roadway may be substituted for in-street bicycle lanes on both sides of a roadway when all the following conditions are met:

1. Separation can be maintained between bicycle and motorized traffic through intersections [and]
2. Conflict points are minimal and mitigated.

The preferred setback from back of curb for shared use paths is a minimum of 5 feet. In some cases, it may be possible to fit a shared-use path into the same space required for a sidewalk and buffered bicycle lane (See Sidepath definition). In other cases, additional width may be required.

Shared use path design criteria shall be provided based on FDOT Design Manual: 224 Shared-use path, latest edition. If a shared-used path is substituted for a bike lane, other safety design features shall be used such as, but not limited to, green paint, wayfinding route signage, and detectable warning pads. Consideration for specific traffic signalization for shared-use path shall be based on guidance in Section 2.4.2. Depending on the context of the road and land use, both a shared-use path and bicycle lane may be required. ADA detectable curb ramps and detectable warnings shall be located at all pedestrians, shared-use path, and trail crossings.

Sidepath

A sidepath meets all the requirements for shared use paths but is constructed within the 5 foot setback from back of curb. Sidepaths are commonly immediately adjacent and parallel to the roadway and are shared by both people walking and those on bicycles.

Bicycle Boulevard

Bicycle boulevards are streets with low motorized traffic volumes and speeds, designed to give bicycle travel priority. Bicycle Boulevards use signs, pavement markings, and speed to discourage through trips by motor vehicles and create safe, convenient bicycle crossings of busy arterial streets.

There are three applications for signing and markings on bicycle boulevards (NACTO Urban Bikeway Design Guide):

1. Modified street signs identify and brand the route without introducing a new sign. A bicycle symbol can be placed on a standard road sign, along with the coloration associated with the bicycle boulevard network. These are commonly used in tandem with pavement markings.
2. Pavement markings identify the route as a bicycle boulevard and can guide users through jogs. Bicycle Boulevard markings shall comply with MUTCD-approved shared lane.
3. Wayfinding signs also guide users through jogs, help brand the network, and include information about the route by identifying intersecting bikeways and providing distance/time information to nearby or popular destinations.

Two-Way Cycle Track

The lane widths for separated bicycle facilities are as follows: 12 feet preferred; 10 foot minimum. Use wider lanes where higher volumes are expected.

Figure 2.4-2 Summary of Pedestrian and Bicycle Facilities.

Raised Bike Lane

Raised bike lanes are pedestrian restricted, vertically separated from motor vehicle traffic, and many are paired with a furnished zone between the cycle track and motor vehicle travel lane and/or pedestrian area. A raised bike lane may allow for one-way or two-way travel by bicyclists and may be at the level of the adjacent sidewalk or set at an intermediate level between the roadway and sidewalk to segregate the bike lane from the pedestrian area.

Separated/Protected Bike Lanes

Separated bike lanes, also known as protected bike lanes, are bike lanes with some form of both horizontal and vertical separation from motor vehicle traffic. They are separated from pedestrian spaces and can be for one-way or two-way travel. Vertical separation in separated/protected bicycle lanes may include but is not limited to curbs, bollards, planters, landscaping, on-street parking, and raised bumps, to separate the bike lane from the motor vehicle traffic. Separated/Protected bike lanes are 7 feet preferred; 6 feet minimum. Where right-of-way is constrained, a reduced width may be provided only upon written approval from the Bicycle/Pedestrian Coordinator.

Buffered Bike Lane

Buffered bike lanes are standard designated bicycle lanes with an additional painted buffer area that does not include vertical delineators of any type, to separate or “buffer” the bicycle lanes from adjacent motor vehicle travel lane(s) and/or parking. The painted buffers are comprised of painted pavement striping and are typically 3 to 6 feet wide.

Bike Lanes

When roadway pavement is continuous to the face of guardrail or barrier, the minimum bicycle lane width is 5 feet. When a bicycle lane is placed between a through lane and the adjacent right turn lane, bus bay, or parking lane please refer to the FDOT Design Manual: 223 Bicycle Facilities, latest edition, unless otherwise defined in this manual.

Five-foot bicycle lanes are the minimum, but 4-foot bike lanes may be allowed on streets with a speed limit of 25 mph or less and in constrained conditions, with approval from the Bicycle/Pedestrian Coordinator. Depending on the context of the street and land use, a bicycle boulevard with additional traffic calming features may be a better option.

Shared Roadway and Lane Markings

Shared Roadways exist in all contexts where a person bicycling can legally operate, such as local neighborhood streets, urban streets and suburban and rural highways. Shared roadways provide people bicycling little to no physical separation from motor vehicles and are most appropriate on low volume, low speed roads. Shared roadways are the foundation for many bicycle boulevards but serve as a bicycle facility only when they are designed to favor bicycles over motor vehicle traffic. The requirements for shared lane markings as referenced in typical standards shall be consistent with the FDOT Design Manual, Section 223.3, latest edition.

Colored Pavement Markings

Intersection bicycle box and two-stage bicycle turn box, will be used in accordance with the current FDOT Design Manual, Section 223 Bicycle Facilities, latest edition, and FHWA Interim Approval IA-20 Two-Stage Bicycle Turn Boxes and IA-18 Bicycle Boxes. NACTO may be used as a guide as long as it meets federal approval. In addition, all bike lanes, including cycle tracks, shall be considered for the application of green paint conforming to FHWA Interim Approval 1A-14.

Colored pavement markings will be considered and implemented in accordance with FHWA guidelines through the City of Jacksonville resurfacing program for bike lanes. High bicycle traffic volumes and crash data should support the design. Section 2.2.11 provides guidance on intersection markings for bicycle facilities and incorporation on colored pavement through intersections.

Active Warning Devices

Active Warning Devices may include Rectangular Rapid Flashing Beacons (RRFB), Pedestrian Hybrid Beacon (PHB), and should be provided at pedestrian crossings, shared-use path crossings, trail crossing, and bike crossings based on minimum levels of demand as determined by the City Traffic Engineer.

2.4.2 Bicycle Signal Standards

Bicycle signalization on shared use paths will allow pedestrians and bicycles to safely execute controlled movements through intersections that are shared with motorized vehicles to minimize conflicts with motor vehicle movements. The standards outlined in this section are in agreement with the MUTCD recommendations for bicycle signals. Bicycle signalization shall be provided for separate control of bicycle signal movement for the following situations: (MUTCD Section 4H.01.01)

- To reduce bicycle delay and increase bicyclist compliance. When advanced detection is used the signal shall be timed so that the bicyclist does not need to stop.
- To reduce vehicular delay.
- To create a green band (wave) for bicyclists so that they do not need to stop at each signalized intersection.

Bicycle Signal Warrants

Bicycle signals shall be used when a shared use path crosses a roadway carrying a volume of more than 10,000 Average Annual Daily Traffic (AADT) or has a posted speed limit equal to or greater than 40 mph.

When a shared use path crosses a multi-lane roadway carrying a volume of less than 10,000 AADT or a posted speed limit of less than 40mph, the need for a bicycle signal should be determined through engineering judgement in consultation with the City Traffic Engineering Division. (MUTCD Section 4H.01.04)

Signal Face

A 12-inch bicycle signal indication shall only be used when the primary bicycle signal face is located more than 120 feet beyond the stop line. Otherwise, an 8-inch signal indication shall be used. (MUTCD Section 4H.07.01)

Bicycle signal faces should be placed such that visibility is maximized for bicyclists and minimized for adjacent or conflicting vehicles movements not controlled by the bicycle signal face. The bicycle signal indication shall be visible at all times within a 50-feet stopping sight distance. (MUTCD Section 4H.08.04)

Where determined as feasible by engineering judgement, bicycle signals shall be mounted on existing infrastructure to prevent visual clutter and ensure cost efficiency.

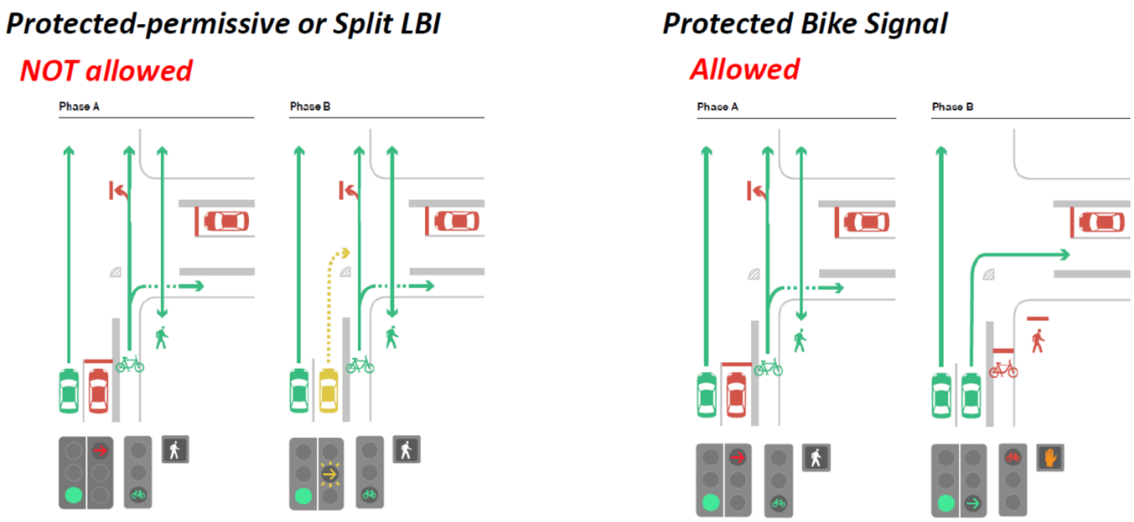
Mounting Height

The bottom of the bicycle signal face housing (including brackets) that is not located over a roadway or shoulder shall be a minimum of 7 feet above the sidewalk or ground and shall be placed at the lowest feasible height determined by engineering judgement.

When a bicycle and pedestrian signal indication are mounted on the same pole on a signalized multi-use path/trail, the bicycle signal face shall be placed above the pedestrian signal face and the bicycle signal sign shall be placed above the bicycle signal face at the lowest feasible height determined by engineering judgement. (MUTCD Section 4H.09.01)

Conflicts with Motor Vehicle Movement

The bicycle signal indication shall never be in conflict with a simultaneous motor vehicle movement i.e. right (or left) turns on red for motor vehicles shall not be allowed during the GREEN BICYCLE OR YELLOW BICYCLE signal indication. Conflicting bicycle and motor vehicle movements shall be controlled by their respective signals as separate movements as shown in **Figure 2.4-3**. (MUTCD Section 4H.01.09)



Source: NACTO Don't Give Up at the Intersection

Figure 2.4-3 Bicycle Signalization for Conflicts with Vehicle Movements

Advanced Detection

Where determined as feasible by engineering judgement and in consultation with the city traffic engineering department, advanced detection shall be used. Advanced detection is used to call a phase or to prolong the phase to allow a bicyclist to clear an intersection without stopping. There are three methods that can be used for advanced detection: 1) induction loops 2) infrared, and 3) video surveillance. The method used should be determined through engineering judgement in consultation with the City Traffic Engineering Division.

Green Band (Wave)

Intersections are pivotal conflict points for both safety, operations, and travel convenience for people bicycling. To decrease the conflict between bicycles and vehicles, a passive transit signal progression, or green band (wave) shall be used when there is more than one signalized intersection within 600 ft. Prevailing bike speeds of 7 mph should be used to set transit progression speeds.

Advanced Stop Lines

Advanced Stop Lines must be placed at least 5 feet ahead of stop vehicle lines in the same direction of travel.

Maximum Wait Times for Bicycles on Shared Use Paths

The wait time for bicyclists at signalized intersections on a multi-use path/trail shall be minimized to the greatest extent possible. The maximum wait time shall be less than 30 seconds in Downtown and Urban Priority Areas and less than 60 seconds in suburban areas when doing so maintains at least an overall Level of Service E for the intersection. Maximum wait times shall be optimized based on the time of the day. Peak hour AM or PM timing shall not be used for all 24 hours. The wait time for bicyclists shall never be longer than the signal cycle length of the intersection.

Bicycle Leading Interval

Bicycle and pedestrian leading intervals shall be implemented on shared use paths in the city.

Bicycle Clearance Interval

To determine bicycle clearance intervals the following formula shall be used and shall assume a bicyclist speed of 7mph:

Clearance Interval = 3 + (Width of the Intersection/Bicyclist Speed)

Additional Guidance

- Multi-use paths/trails at signalized intersections should incorporate leaning rail for bicyclist queuing.
- Where the bicycle signal indication is separate from the pedestrian signal indication a countdown indicator may be used on the bicycle signal pole to alert the cyclist of how much time remains before the green bicycle symbol.

2.4.3 Short Term Bicycle Parking Standards

Bicycle parking is required for all new developments and redevelopments, including in-parcel structure additions, expansions, and renovations, based on intended usage and requirement calculations. A new or reconstructed parking garage is required to provide bicycle parking facilities for 5 percent of the number of vehicular parking spaces provided. Short-term bicycle parking is intended to offer readily visible and intuitive (self-explanatory) off-street bicycle parking for users visiting businesses and other destinations for short periods of time (generally 0-3 hours). Provided bicycle parking must be convenient to users, secure from theft, in a safe location for all modes (pedestrians, drivers, etc.), intuitively designed, and accommodating to a variety of bicycle types. The following standards describe the location, design, placement, and installation of short-term bicycle parking that will ensure these requirements are met consistently throughout the City of Jacksonville. These standards cover most short-term and long-term parking solutions; however, some developers may want to consider more long-term bicycle parking that offers the highest protection from theft, inclement weather, and vandalism in developments such as new office buildings, projects near transit stops, mixed-use projects, and residential buildings. Guidance for more long-term facilities, such as bicycle lockers, secure cages, and bicycle storage rooms, possibly in tandem with shower facilities, are detailed in Section 2.4.4.

Location

Bicycle parking must be located as close, or closer, to the entrance of the building it serves than the nearest car parking space. In general, multiple buildings should not be served by a large, distant bicycle parking area (corral), but instead by smaller parking areas near active entrances. Locate bicycle parking within 50 feet of major destinations and transit stations. Bicycle parking areas should be well lit and visible from the sidewalk so that users can find them, to deter theft, and to ensure bicyclists' safety while locking/unlocking their bicycles. A clear zone should be provided around the bicycle parking area to avoid moving vehicles, parked car doors, transit vehicle boarding areas, and pedestrian right-of-way, and to allow for bicycle maneuverability between the parking area and any nearby landscaping, buildings, or street furniture. Bicycle parking should not impede pedestrian flow on the sidewalk and should not be placed directly in front of doors or disabled parking spaces.

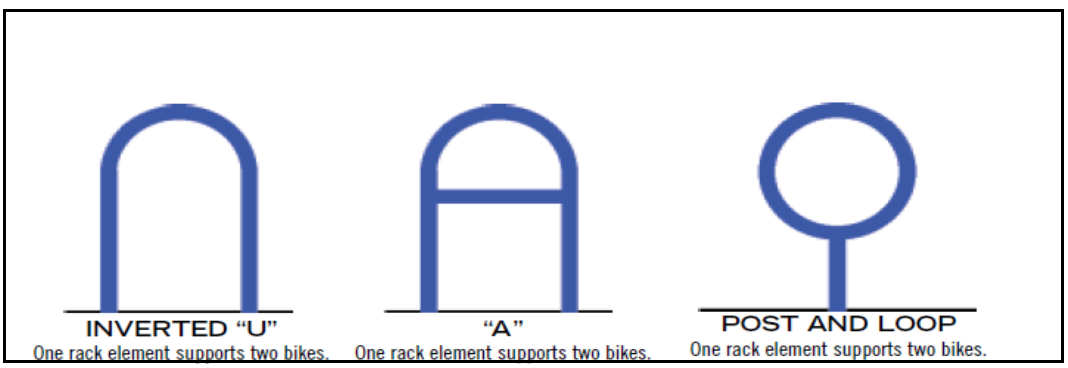
Design

There are a variety of styles of bicycle racks available; however, some designs do not provide the security from theft, ease of use, and prevention of bicycle damage as well as others. A bicycle rack should:

- Support the bicycle upright by its frame in two places.
- Prevent the wheel of the bicycle from tipping over.
- Enable the frame and one or both wheels to be secured by a lock.
- Support different styles of bicycles.
- Allow front-in and back-in parking: A U-lock (**Figure 2.4-4**) should be able to lock the frame and either the front or rear wheel to the rack.
- Not require the user to lift the bicycle onto the rack.
- Be located so that bicycles can reasonably be safeguarded from damage.
- Resist being cut or detached using common hand tools.
- Have a finish that requires minimal maintenance (e.g., galvanized steel)
- Include no sharp edges or moving parts.
- Adhere to the Americans with Disabilities Act standard as follows: if the protruding edge of the rack is between 27 inches and 80 inches above the sidewalk surface, it may overhang a maximum of 4 inches. (This applies only to relatively tall racks designed to protrude horizontally from the base).

Figure 2.4-4 U-lock

The three bicycle rack designs shown in **Figure 2.4-5**, inverted-“U”, A-style, and post-and-loops, meet the design criteria listed above and are approved by the City of Jacksonville for implementation within both the public and private right-of-way. “Artistic” variations of the three approved bicycle rack that meet the designs criteria listed in Section 2.5.3 may be allowed, subject to meeting the guidelines specified in Section 656.609 of the Zoning Code and subject to approval by the City of Jacksonville’s Bicycle and Pedestrian Coordinator.



Source: APBP Bicycle Parking Guidelines, 1st edition, www.apbp.org, used with permission form the copyright holder

Figure 2.4-5 Bicycle rack designs approved by the Association of Pedestrian and Bicycle Professionals

Placement

Each rack should be placed so that no objects obstruct users from entering/exiting the parking area, locking/unlocking their bike, and unloading/loading any cargo. There are multiple options for bicycle parking shown in **Table 2.4-3** from on-street bicycle corrals to the furniture zone, to designated off-street areas.

Table 2.4-3 Design Requirements for Bicycle Parking Facilities

Location	Orientation	Dimensions	Figure
Off Street, inside furniture zone	Parallel to curb	• Minimum 3 feet of space between the curb and the rack (4 ft when next to on street parking) • Multiple racks should have at 6 feet in between them (8 feet preferred), as measured from the center of each rack. • There should be at least 5 feet of clearance between any bicycle rack and a driveway or curb cut. • Sidewalk should be at least 9 feet wide, leaving at least 5 feet width of sidewalk clear of obstructions.	Figure 2.4-6
	Perpendicular to curb	• Minimum 5 feet of space between the curb and the center of the rack. • Multiple racks should have at least 4 feet in between them (5 feet preferred). • There should be at least 5 feet of clearance between any bicycle rack and a driveway or curb cut. • Sidewalk should be at least 9 feet wide, leaving at least 5 feet width of sidewalk clear of obstructions.	Figure 2.4-7
	Angled	• Minimum 3 feet of space (4 feet preferred) between the curb and the edge of the rack. • Multiple racks should have at least 30 inches between them by the nearest edges. • Angle for the rack to a perpendicular line from the curb should be between 45 and 60 degrees. • There should be at least 5 feet of clearance between any bicycle rack and a driveway or curb cut. • Sidewalk should be at least 9 feet wide, leaving at least 5 feet width of sidewalk clear of obstructions.	Figure 2.4-8
Off-street, outside furniture zone	Parallel	• Racks should be placed at least 2 feet from any objects (3 feet preferred). • Multiple racks installed in this way should follow the spacing for end-to-end or side-by-side arrangements.	Figure 2.4-9
In-street, parallel parking spaces	Perpendicular to curb	• Minimum recommended spacing between racks is 36 inches. • Provide flexible delineators and wheel stops at the end where vehicle may back into the adjacent spot	Figure 2.4-10
In-street, angled parking spaces	Perpendicular to curb		Figure 2.4-11

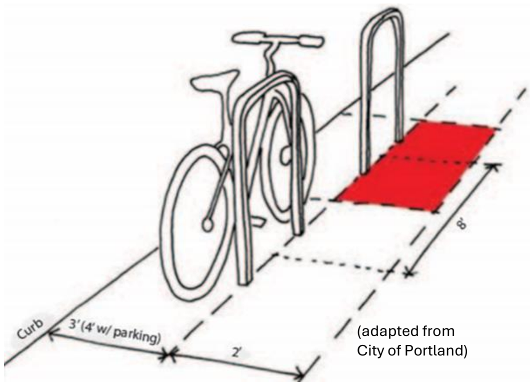


Figure 2.4-6 Bicycle rack spacing when installed in furniture zone parallel to curb.

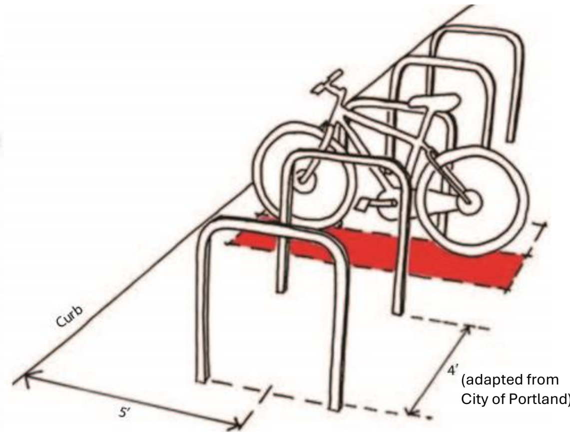


Figure 2.4-7 Bicycle rack spacing when installed in furniture zone perpendicular to curb.

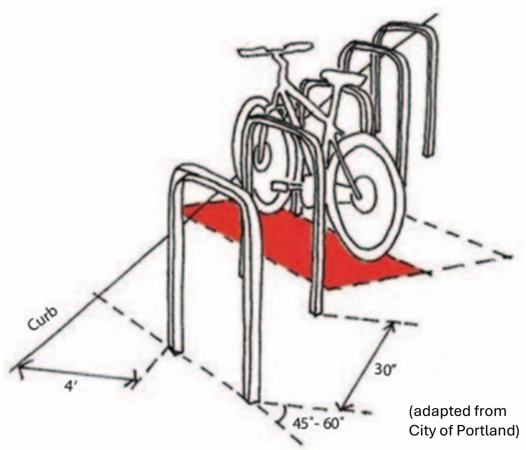


Figure 2.4-8 Bicycle rack spacing when installed in furniture zone at an angle to the curb.

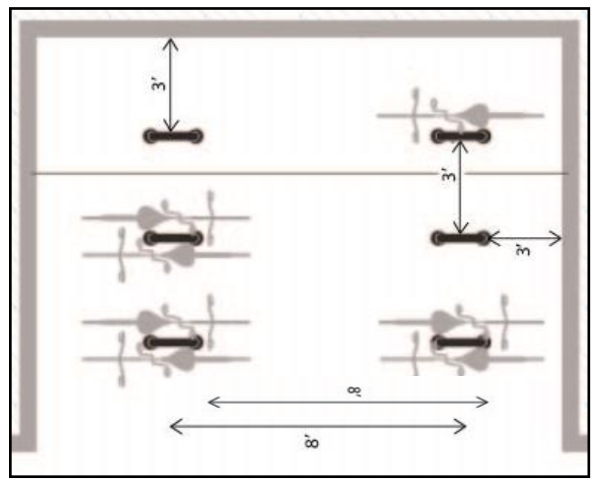


Figure 2.4-9 Bicycle rack spacing outside of furniture zone.

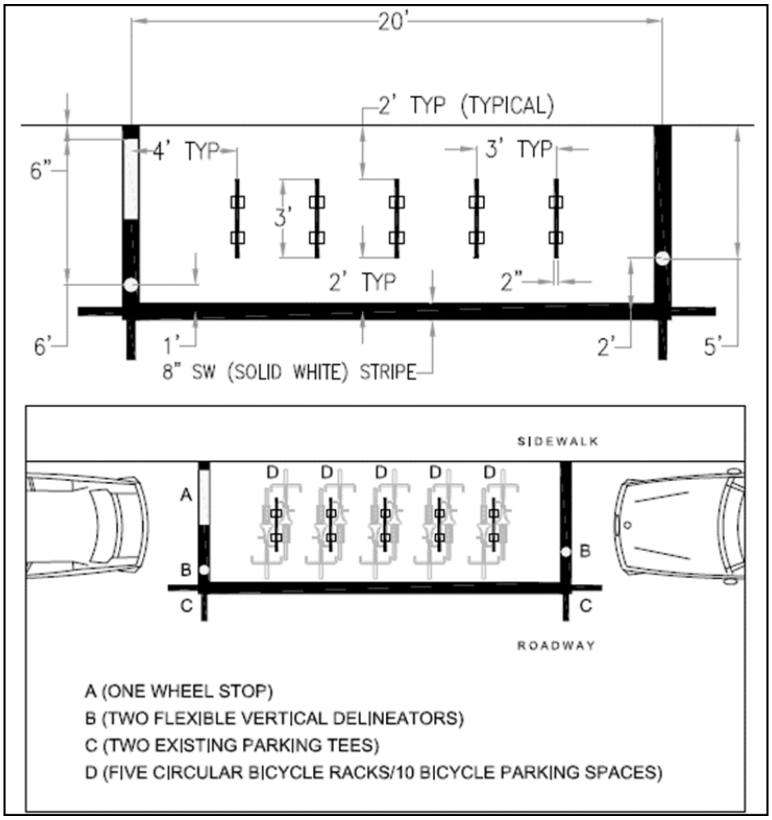
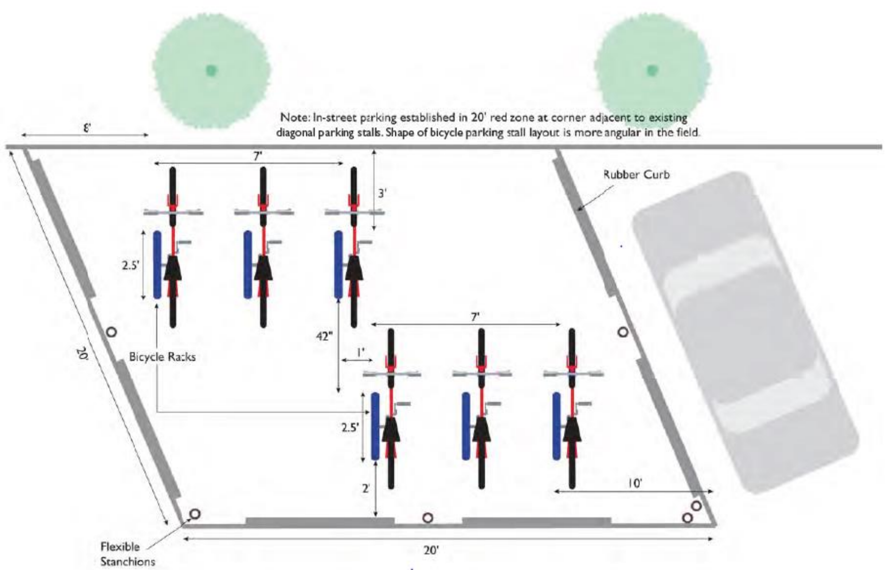


Figure 2.4-10 Bicycle corral diagram (from SFMTA Bicycle Parking Guidelines)

Figure 2.4-11 Bicycle corral diagram, angled parking layout



Source: APBP Bicycle Parking Guidelines, 2nd Edition page 52, www.apbp.org, used with permission from the copyright holder

Installation

For security, bicycle racks should be installed in concrete. Asphalt is acceptable for bicycle corrals. There are two primary types of bicycle rack installation: surface mount and cast in place. Either is acceptable, but some rack models only allow for one type of installation.

Surface mount is used when racks are being installed onto an existing concrete slab. Anti-tampering bolts and other hardware should be used to prevent theft of the whole rack. Some locations where theft may be an issue can benefit from security fasteners such as concrete spikes or tamper-resistant nuts on wedge anchors, which are shown in **Figure 2.4-12**. Drill any holes at least three inches from concrete edges or joints. If an asphalt substrate is all that is available in the rack location, concrete footings should be poured before surface mounting if possible. If concrete footings cannot be poured, use anchor techniques specific to asphalt.

Cast-in-place is the best option for security purposes but may be impossible if the rack installation location already has a slab poured or if the chosen rack type does not provide a cast-in-place option. Cast-in-place installation is appropriate for either asphalt or concrete.

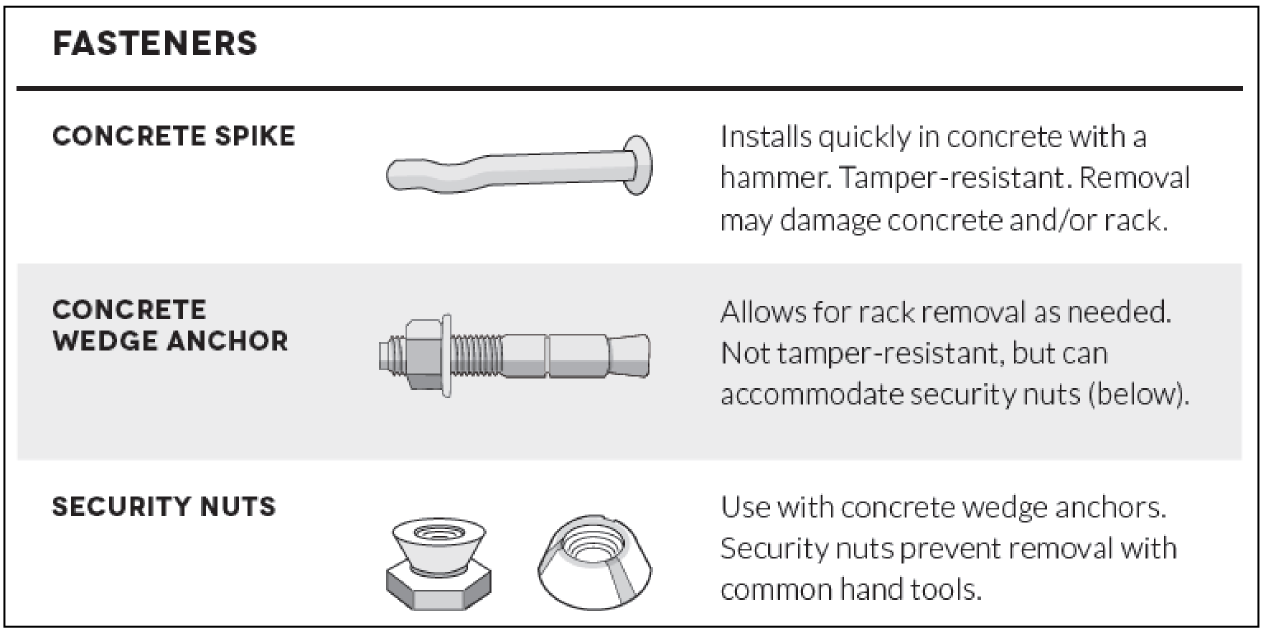


Figure 2.4-12 Examples of concrete fasteners (from APBP Essentials of Bike Parking, page 8, www.apbp.org, used with permission from the copyright holder)

2.4.4 Long Term Bicycle Parking Considerations and Shower and Locker Facilities

Long-term bicycle parking. Long-term bicycle parking consists of individual bicycle lockers, or a corral of racks contained in a locked room (such as a private room accessible from the sidewalk or within an apartment complex) that is meant for individuals (i.e. employees at a business or residents) expecting to park for more than a few hours.

Bicycle Lockers

A bicycle locker is a fully enclosed space for one bicycle, accessible only to the owner of the bicycle. A bicycle locker must be equipped with an internally mounted key-actuated or electronic locking mechanism, and not lockable with a user-provided lock. Groups of internal-lock bicycle lockers may share a common electronic access mechanism provided that each locker is accessible only to its assigned user. Bicycle lockers shall be constructed of molded plastic/fiberglass, solid metal or perforated metal and be at least 2 feet by 6 feet. Lockers shall be maintained by owner.

Restricted Access Bicycle Enclosure

A restricted-access bicycle enclosure is a covered or indoor locked area containing within it one bicycle rack space for each bicycle to be accommodated and accessible only to the owners of the bicycles parked within it. Long-term bicycle parking facilities for tenant and occupant use shall be conveniently accessibly by pedestrians from the street and shall be at least as convenient and close to building entrances as the nearest non-disabled automobile parking space. Tenant and occupants shall not be charged for bicycle parking.

Shower Facilities

Showers are considered end-of-trip facilities that provide enormous benefits for bicycle riders and those that commute by walking. Showers and locker/changing rooms support employee retention, may reduce absenteeism, reduce individual monthly budgets for students and workers that would normally drive vehicles, and incentivize healthier communities. Shower facilities should be conveniently located close to bicycle parking and major building entrances. Separate, individual shower facilities are preferred for males and females. Facilities should have non-slip surfaces, hooks and/or benches to keep belongings off the floor, adequate lighting and ventilation and are included in regular cleaning and maintenance programs. Facilities must be lockable and not easily accessed by persons who do not work or attend school in the building.

Locker Facilities

Where possible, lockers are best located within changing rooms. As a general rule, there should be one locker available per each individual bike parking space provided, with additional lockers available for an estimated number of commuters that walk or jog. The design of the lockers should ensure secure storage for personal belongings. Lockers must have adequate ventilation and space to secure clothes and belongings safely for short periods of time. As with shower facilities, locker facilities must be included in regular cleaning and maintenance programs.

SECTION 3.0 Drainage Design Guidelines

3.1 General

3.1.1 Developers Responsibility

All storm runoff in the development must ultimately be disposed of in a manner which will not cause damage to upstream or downstream property owners. The developer shall respect the rights of adjacent property owners with regard to overloading the stream or creating an excessive rise in water level in the receiving body of water. The development will be under pre/post development discharge restriction unless an analysis (which may include existing studies, master plans or permitting rules criteria) of the existing receiving system is performed to prove no adverse impact.

Once a project begins (issuance of site permit or notification from the developer) a formal 6-month inspection report will be required to be submitted to the city. Formal inspection reports will be required to be submitted every 6-months until construction is complete.

All new developments shall provide for stormwater treatment. Treatment volume shall be based on current St. Johns River Water Management District (SJRWMD) rules or the Master Stormwater Management Plan (MSWMP) special basin criteria to achieve pollution loading targets. In those areas where no special basin criteria are adopted, the City reserves its right to participate in all SJRWMD permitting, administrative and judicial appellate procedures; however, a SJRWMD issued permit, which is administratively and judicially final, will be accepted as demonstrating compliance with SJRWMD rules.

Additional requirements apply to drainage basins with known ongoing drainage problems (Restricted Drainage Basins). Boundary maps of these basins can be found in City's Civil Planning Map using the Flood Plains Layer Group, ResBasin Layer. The requirements for restricted basins are outlined in Section 3.7.3 Detention Basin Design Criteria

3.1.2 Dependence on Future Development

When development is accomplished in phases, each individual unit constructed must provide the drainage improvements necessary for that unit. All runoff from each individual unit must be handled to a point of positive outfall. No design of an individual unit shall be dependent upon the ultimate installation of a future unit. When circumstances dictate, the developer must agree to accept the public water and provide temporary easements.

3.2 Drainage Information Required for Site Plan Approval

3.2.1 Master Drainage Map

The registered professional shall include in the site development plans a Master Drainage Map showing all existing and proposed features. The map is to be prepared on a 24-inch by 36-inch sheet on a scale not to exceed 1 inch = 200 feet unless otherwise approved by the City Engineer. Listed below are the features that are to be included on the drainage map:

1. Drainage Area
    a. All areas draining to or through the proposed development.
    b. All areas tributary to existing structures.
2. All areas tributary to proposed structures.

3. Cross-sections depicting the project site as well as adjacent properties.
4. High water data on existing structures upstream and downstream from the development.
5. Notes indicating sources of high-water data.
6. Notes pertaining to existing standing water, areas of heavy seepage, or springs.
7. Vicinity and location map.
8. Limits of construction.
9. Existing ground contours drawn to a 1-foot interval or elevations based on NAVD datum (1988). Greater contour intervals may be approved where steeper slope dictates.
10. Existing drainage channels and structures with their size, elevations, and slopes.
11. Proposed drainage channels and structures with their size, elevations, and slopes.
12. Time of concentration paths.
13. Land use with the appropriate soil type and CN's or runoff coefficients.
14. Site topography shall extend a minimum of 100 feet beyond the boundaries of the development to the greatest extent possible. Existing City topographic contour maps, or other reliable sources, may be utilized to provide necessary topographic mapping to establish the entire drainage basin beyond 100 feet.
15. Location and size of existing and proposed easement and right-of-way.
16. Show the 100-year flood plain or flood-prone areas (current FIRM map).

3.2.2 Lot Grading Plan

The registered professional shall include in the site development plans a Lot Grading Plan including the following:

1. Elevation of each lot corner proposed, and minimum proposed floor elevation based on NAVD datum (1988). Also, show proposed centerline pavement elevations (nearest 0.1 feet) in front of approximately every other lot corner and centerline intersections and center of cul-de-sacs.
   - In cases where natural ground slopes equal or exceed 0.8 percent (*) and where filling or cutting is not required, specific rear lot corner elevations may be waived, and directional flow arrows be used instead.
   - In cases where drainage divides occur between the front and rear of lots, minimum typical standard swale slopes may be used to maintain integrity of drainage divides in lieu of specific elevations.
   - All residential subdivision lots to have a minimum continuous slope of 0.5 percent, and be compliant with the Florida Building Code.

     (*) May be reduced to a lesser value in Ortega and Kershaw Sands.
2. Proposed sidewalk location in accordance with Section 1.4.1 Sidewalk Design Requirements, the City Standard Details, the City Standard Specifications and consistent with the current FDOT Design Manual

3. Indicate lot filling and tie-ins with adjacent properties using one of the cases outlined below.

	Adjacent Property Ownership	When to Use	Example Figure
CASE A	Adjacent property not owned by Developer	When filling occurs and the adjacent property drains away from the site	Figure 3.2.1
CASE B	Adjacent property not owned by Developer	When filling 0-4 feet occurs and the adjacent property drains to site	Figure 3.2.2
CASE C	Adjacent property owned by Developer or temporary construction easement	When filling occurs and the adjacent property drains away from the site	Figure 3.2.3
CASE D	Adjacent property owned by Developer	When filling occurs and adjacent property includes wetlands	Figure 3.2.4

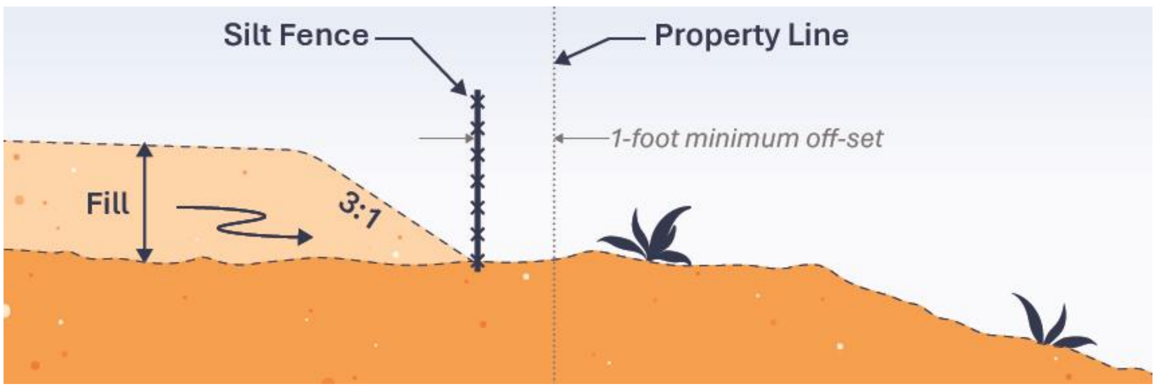


Figure 3.2-1 Case A Lot Filling (Adjacent Property Not Owned by Developer)

Notes:

1. the minimum setback from the property line shall be 1 foot.
2. This is one acceptable means to handle this condition, however other engineering options can be considered.

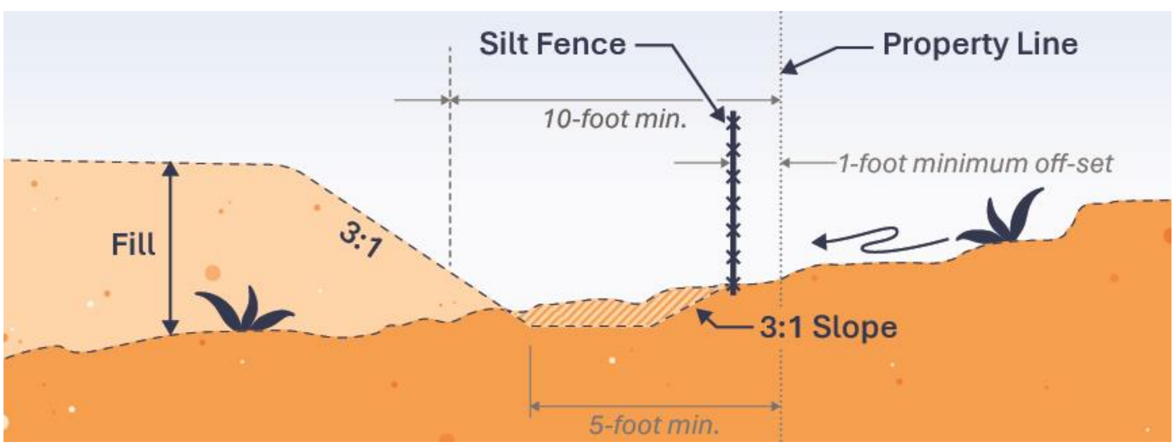


Figure 3.2-2 Case B Lot Filling (Adjacent Property Not Owned by Developer)

Notes:

1. The minimum setback from the property line shall be 1 foot.
2. A swale/yard drain system shall be constructed with a minimum swale slope of 0.3 percent and one drainage inlet placed every 3rd lot line unless approved otherwise.
3. Min. 10 foot private easement for shallow swales/piped and yard drain system.

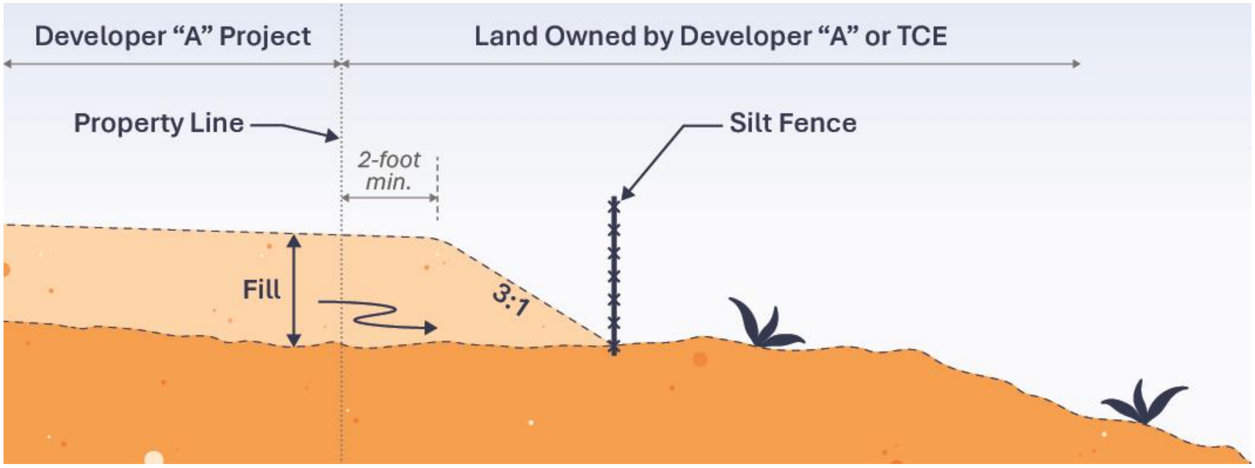


Figure 3.2-3 Case C Lot Filling (Adjacent Property Owned by Developer or Temporary Construction Easement)

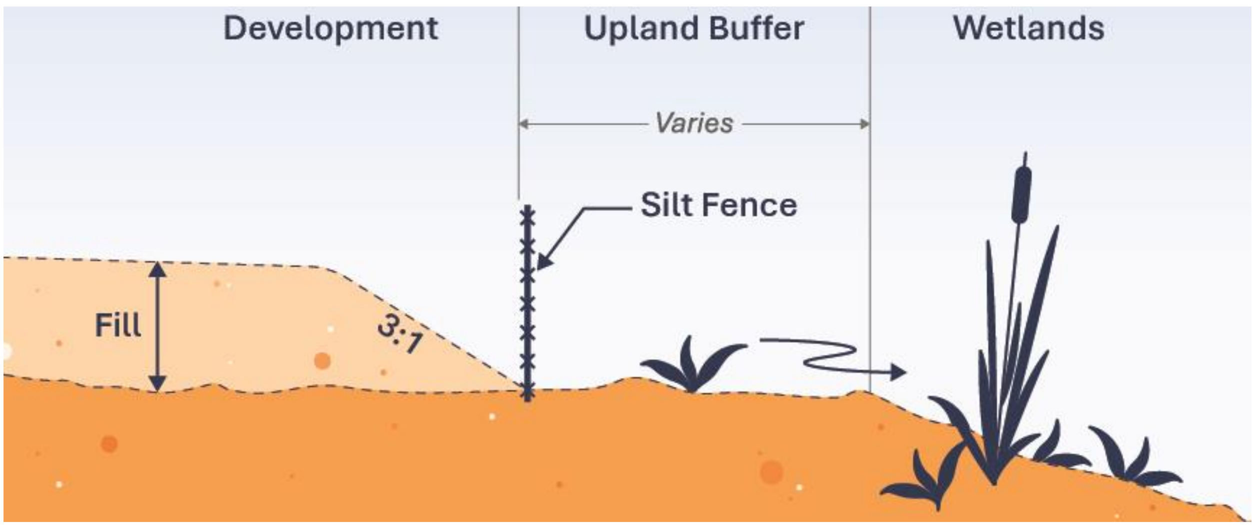


Figure 3.2-4 Case D Filling (Adjacent Property Owned by Developer)

3.2.3 Soil Investigation Report

A soil investigation report shall be submitted with the site development plans and shall include:

1. Test borings to a depth (min. 4 feet below proposed edge of pavement) and spacing (max. 500 feet along centerline) showing existing water table and estimated water table during periods of normal rainfall and without drainage improvements that may lower the groundwater.
2. In special cases additional borings to determine the soil classifications predominant to the area may be required by the City Engineer.
3. Soil borings for pond designs shall be in accordance with Section 3.7.3 Detention Basis Design Criteria paragraph 10.

3.2.4 Maintenance of Drainage Plan

If a maintenance of drainage plan is determined to be necessary during the pre-application meeting, it shall be submitted with the site development plan and shall include:

1. Demonstrate that there is no obstruction to existing drainage unless approved by the City Engineer. This includes flow in streams or ditches, overland flow, underground flow, flow in pipes, or flow in flood plains.
2. Identify the site-specific method to maintain stormwater drainage patterns during the construction phase of a project.

A Plan Reviewer will examine all commercial and residential projects for compliance with the Maintenance of Drainage requirements. In addition, staff from the Development Services Division will also routinely inspect construction sites for compliance. Again, the city will not prescribe specific methods to achieve this objective and the individual method to achieve and maintain full compliance will be the responsibility of the owner or person in charge of the project.

3.2.5 Flood Zone and Flood Prone Areas

If any portion of the proposed project or development is located within the special flood hazard area (SFHA), the design professional shall provide the following information at a minimum:

1. A map showing the current Flood Insurance Rate Map (FIRM) showing:
   - FIRM Panel Number
   - SFHA
   - LiMWA
   - Regulatory Floodway plus 25 ft setback
   - Determination of riverine/coastal boundary
   - Base Flood Elevation (BFE)
   - Project boundary
2. Indicate where filling of the SFHA is planned. Indicate where storage is provided to hold the same quantity of water that the flood area did prior to filling (i.e., “cup for cup”). Floodplain compensation is not allowed within proposed stormwater facilities.
3. For compensatory storage, the area of floodplain fill and compensatory storage must be shown on the plans and the volume of floodplain fill and compensatory storage must be listed in the plans and/or drainage report.
   a. A cross-section of the compensatory storage area showing proposed slopes, existing grade, proposed grade, and normal water level/groundwater level shall be provided. The top of bank of the compensatory storage area must not be above existing grade, and the engineer must demonstrate that the compensatory storage area is hydraulically connected to the existing floodplain under flood conditions.
   b. If the compensatory storage area is dug deep enough to create a wet pond, then the same slope requirements apply to the compensatory storage as to regular stormwater ponds, but there is no maximum depth. However, the top of bank must not be above adjacent grade, and only the volume above the NWL counts towards the compensatory storage volume.
   c. In cases where the bottom of the compensatory storage is above the SHWL, the top of bank must still not be above adjacent grade, and the entire excavated volume counts towards the compensatory storage volume.
4. Approval from any local, State of Florida, or U. S. government agency for proposed activities within the SFHA – this could include CLOMR, LOMR, LONMR-F, etc.

5. Demonstrate that finished floor elevations for buildings and structures meet the freeboard requirements outlined in Section 3.3.5.
    a. Flood Zones
    b. Any site (including residential lots) adjacent to a stream or river must be evaluated to assure that no blockage occurs in the flood plain.
    c. In the event a 100-year flood zone, as shown on current FIRM MAPS or delineated by the best available data, is to be filled,
6. Flood-Prone Areas
    a. Adequate drainage must be provided to accommodate storm water if flood-prone areas are filled. This could be in the form of alternate water storage areas, improvements, or combination of these or other basin changes.
    b. All design must be in conformance with Chapter 652 of the Ordinance Code, Floodplain Management.

3.2.6 Drainage Calculations

The plan submittal shall contain FDOT storm sewer tabulations.

3.2.7 Hydrologic and Hydraulic Study for Downstream Improvements

The Public Works Department shall require that drainage systems downstream of a proposed development have the capacity or hydraulic gradient to accept the proposed developments discharge, or that the proposed development must improve the downstream drainage system. Accordingly, the City Engineer may require the developer to perform a hydrologic and hydraulic study to analyze the downstream drainage system. Based on this analysis and easement requirements, the following criteria may apply.

1. There is no peak discharge requirement for direct discharges to the St. Johns River or Intracoastal Waterway. If there are no known flooding problems, approval of off-site stormwater discharge shall be based on:
    - Downstream off-site easements will not be required if the development provides a demonstration of no downstream flooding by maintaining existing peak discharge(s) and stage-discharge relationship(s) immediately downstream of the site discharge location(s) and demonstrate no upstream flooding by considering upstream inflow(s); or
    - Maintenance of existing peak discharge(s) at the site discharge location(s) and route the design storms (5, 25, and 100-year, 24-hour) through a recorded easement or man-made channel obtained into publicly maintained rights-of-way or receiving waters defined as the following:
        - FEMA FIS extent of coverage, including flood profiles and/or FIRMS (least squares regression for interpolation);
        - The 25-year, 24-hour storm flood stage for wetlands; or
        - Natural streams (as identified on "Drainage Basins in Duval County, Florida," Stone and Largen, WRI 82-4069 USGS, 1983), or agreed to by the City Engineer.

2. If there are known flooding problems, approval of off-site stormwater discharge shall be based on:
   - Maintaining existing peak discharge(s) and stage-discharge relationship(s) at the site discharge location(s) as well as the timing, duration, and volume of existing off-site discharge(s) in volumetrically sensitive basin as defined by SJRWMD, or the City.
   - A demonstration that peaks discharge(s) and volume release(s) from the site will not increase flood stages or velocities off-site; or
   - Providing improvements along entire discharge path (in recorded easements, unless approved otherwise by the City Engineer) to the receiving waters.

Known flooding problems are those which pose an imminent threat to public safety and/or property including loss of human life, blockage of evacuation and/or emergency vehicle routes, and/or flooding of homes, buildings, or roadways as evaluated by the following criteria:

- Home/building flooding for any storm.
- Roads being overtopped by flood stages based on the appropriate design event and over topping of the roadway of greater than one foot based on the 100 year, 24-hour event; or
- Greater than one foot per 50 feet of head loss across a stormwater conveyance structure for the appropriate design events. i.e., 5 years for local roadways draining less than 40 acres; 25 years for local roadway draining 40 acres or more; 50 years for box culvert crossings; and 100 year for bridges and evacuation routes.

3.2.8 Demonstration of Off-site Drainage

The following information is required to be provided:

Drainage at Property Entrances

1. All driveway entrances and exits to private property must be graded to prevent water entering from public streets.
2. Show all existing and proposed entrances and exits.
3. Show existing and proposed parking layouts.

Downstream Owner

Increased concentrated storm water runoff shall not be directed onto adjacent property without the written consent of that property owner. If any drainage structure is to be placed off-site, a description of the required easement and any restriction(s) imposed by the agreement must also be submitted. Note: If proposed runoff is to be drained into state roads or railroad property, a letter from that agency indicating approval of such must be submitted prior to drainage approval.

Sheet drainage: Sheet drainage into public right-of-way is normally not acceptable. Increased sheet drainage onto adjacent private property is not acceptable without the owner’s permission.

Upland Owner

All water must be accepted from all upland owners. Such water must be accepted according to land conditions present before the proposed project. When the development constructs a drainage system to accept the private off- site upstream drainage, unless accepted by the City as part of a master plan, the property owner, the Homeowners Association or other acceptable entities as approved by the City Engineer, shall maintain the system.

3.3 Design Methods and Equations

3.3.1 Design Methods

The registered professional may use SCS method for determining runoff for any site with no acreage restriction. The rational method may be used only for sites that are 10 acres or less.

3.3.2 Design Storm Frequency

1. For rivers, the 100-year frequency storm shall be used.
2. Major outfalls - For canals, waterways, natural drainage streams and culverts of major outfalls, the 25-year frequency storm shall be used.
3. Stormwater Management Facilities (SMF) – 25 years
4. Subdivisions - For suburban, subdivision, or medium density areas, the 5-year frequency storm with a minimum time of concentration of 20 minutes shall be used.
5. Urban Areas - When utilizing the rational method for urban areas, the 5-year frequency storm with a minimum time of concentration of 10 minutes shall be used.

Note: The times of concentrations above apply only to hydrology (stormwater management facility design), not to hydraulics (pipe and ditch design) (FDOT Storm Tabs). In hydraulic calculations, a minimum time of concentration of 10 minutes shall be used.

3.3.3 Coefficient of Runoff

Coefficient of runoff used in the design of drainage facilities shall be in accordance with sound engineering practices. The following is a list of typical rational coefficients for various types of developments:

Table 3.3-1 Runoff Coefficients by Landuse

Type of Development	% Runoff
Swamps	10%
Low Hammocks	15%
Natural Ground	20%
Grassed Recreation Areas	30%
Subdivisions	40%
Gravel	50%
Apartments	60-70%
Industrial/Commercial Area	80-100%

3.3.4 Rainfall Intensity

Table 3.3-2 provides the rainfall intensities for the 24-hour design storms for drainage design. All the design storms use the 24-hour SJRWMD temporal distribution where 40 percent of the total rainfall volume occurs during the peak 1-hour.

Table 3.3-2 Rainfall Intensity Based on Storm Frequency (24-hr design storm)

Storm Frequency	24-hr Design Storm (inches/24-hrs)[1]
5-yr	7.7
10-yr	8.2
25-yr	10.4
50-yr	12.6
100-yr	15.0

1. Based on City of Jacksonville Master Stormwater Management Plan (MSMP) 2070 design storms

3.3.5 Freeboard Requirements

City of Jacksonville Ordinance Code, Section 652.1005 (Elevation Requirements), Section 652.1006 (Accessory Structures), Section 652.502 (Flood Hazard Areas Without Base Flood Elevations)

Where base flood elevations have been established, buildings and structures (other than accessory structures specified in Chapter 652.1006, Ordinance Code) shall be elevated to or above the base flood elevation plus two feet.

Where base flood elevations have not been established (Section 652.502), construction shall be elevated to the depth number specified on the FIRM plus two feet prior to the placement of fill. If no depth number is specified, the lowest floor including the basement, shall be elevated, at least three feet above the highest adjacent natural grade prior to the placement of fill.

Where the Special Flood Hazard Area is immediately adjacent to a “floodway” a more stringent base flood elevation is shown in the Flood Insurance Study. Where flood studies have produced floodways that provide a flood elevation based upon the floodway encroachment, these elevations are listed in the “With Floodway” column in the Floodway Data Table in the community’s flood insurance study. These higher elevations shall be used as the BFE for that area, and then the freeboard requirement stated above shall be applied.

NOTE: In non-coastal SFHAs (i.e. A, AE, AO, and AH Zones), the lowest floor is measured from the top of the finished floor. In V Zones and in areas within the limits of moderate wave action (LiMWA), the elevation requirement is measured from the bottom of the lowest horizontal structural member (e.g. the bottom of the floor joist).

3.3.6 Pipe and Open Channel Equations

Design of pipe and open channels shall be calculated by application of the Manning Formula and the Continuity Equation.

$$V = \left(\frac{1.486}{n}\right) * R^{\frac{2}{3}} * S^{\frac{1}{2}}$$

$$Q = A * V$$

V = Velocity of flow in feet per second (fps)

A = Cross-section area of flow (square foot)

R = Hydraulic radius; area of flow divided by wetted perimeter in feet (a/WP)

S = Slope of hydraulic grade line (feet per foot)

Q = Rate of runoff in cubic feet per second cfs

n = Manning's coefficient of flow

3.3.7 Manning Coefficients

Table 3.4-1 Manning Coefficient for common conveyance

Type Culvert	"n"
15" to 30" RCP & Concrete Lined Pipe	0.012
36" to 48" RCP & Concrete Lined Pipe	0.012
54" and larger RCP (including concrete box culverts)	0.012
HDPE,PVC, and PP Pipe (all sizes)	0.012
CMP Asphalt Coated - 15" diameter	0.013
CMP Asphalt Coated - 18" diameter	0.014
CMP Asphalt Coated - 21" diameter	0.015
CMP Asphalt Coated - 24" diameter	0.016
CMP Asphalt Coated - 30" diameter	0.017
CMP Asphalt Coated - 36" diameter	0.019
CMP Asphalt Coated - 42" diameter	0.020
CMP Asphalt Coated - 48" diameter	0.020
CMP Asphalt Coated - 54" diameter	0.021
CMP Asphalt Coated - 60" diameter	0.022
CMP Asphalt Coated - 66" diameter	0.024
CMP Asphalt Coated - 72" diameter	0.026
CMP Asphalt Coated - 78" diameter and larger	0.027
Concrete Paved Open Channels	0.013
Earth Lined Open Channels-Good Condition	0.030
Earth Lined Open Channels-Average Condition (Design)	0.040
Earth Lined Open Channels-Poor Condition	0.045

3.4 Closed Conveyance Drainage Design Criteria

3.4.1 Pipe Velocity Design Criteria

The minimum acceptable pipe velocity is 2.5 fps flowing full. If this is a physical impossibility, an absolute minimum hydraulic velocity of 2.0 feet per second for full flow should be obtained. The maximum velocity shall be kept below 8 fps. The maximum allowable velocity at the point of discharge is 4 fps unless energy dissipation is provided. If the outfall discharges into a still body of water, submergence of the outfall by at least two thirds of the outfall diameter may be considered as energy dissipation.

3.4.2 Storm Sewer Alignment

All storm sewer layouts shall avoid abrupt changes in directions or slope and shall maintain reasonable consistencies in flow velocity. Where abrupt changes in direction or slope are necessary, provisions shall be made to handle the resulting head loss and erosion.

The maximum vertical distance between inflow invert and outlet invert shall be 8 feet. The maximum deflection angle between inflow pipe and outlet pipe shall be 90 degrees. If conditions arise which make the above criteria impractical to utilize, the City Engineer may waive the standard, provided the registered professional submits a special structural design for the drainage structure.

3.4.3 Storm Sewer Materials

Storm sewer may be provided as reinforced concrete pipe, corrugated steel pipe, corrugated aluminum pipe, Polyvinyl Chloride (PVC) pipe, or smooth interior corrugated polypropylene. Specifications for each of these pipe materials are included in LDPM Volume 4, Standard Specifications.

The FDOT Culvert Service Life Estimator should be used to select the appropriate pipe material based on the site-specific environmental and structural conditions associated with the project. The design professional will be responsible for collecting the pertinent environmental data (e.g. soil pH resistivity, chlorides, etc.) to use the culvert service life estimator. Design life for the culvert service life estimator should be 100 years for all pipe materials.

3.4.4 Minimum Storm Sewer Pipe Size

The minimum pipe size shall be 15 inches round or 15 inches elliptical equivalent.

3.4.5 Maximum Storm Sewer Pipe Lengths

The maximum length of pipe to be used without an access structure shall be:

Table 3.4-2 Maximum allowable pipe distance between structures

PIPE SIZE	MAXIMUM LENGTH (FT)
15" pipe	250
18”	300
24” THRU 36”	400
42” and larger pipe (including all box culverts)	500

3.4.6 Storm Sewer Maximum Hydraulic Slope

The maximum hydraulic gradient shall be that slope which produces a velocity of 8 fps. When hydraulic calculations do not consider minor energy losses, the elevation of the hydraulic gradient for the design storm condition should be at least 1 foot below the gutter or ground elevation. As a general rule, minor losses should be considered when the hydraulic gradient velocity exceeds 6 fps or lower on critical systems. If all minor losses are calculated, it is usually acceptable for the hydraulic gradient to reach the gutter elevation.

For major drainage crossings, a maximum 1-foot rise in the hydraulic gradient shall be allowed at the entrance to the structure provided there are no adverse impacts to adjacent property. A maximum 0.1-foot rise shall be allowed 500 feet upstream of the structure.

3.4.7 Minimum Physical Slope

The minimum slope for all culverts shall be that which will produce a minimum velocity of 2.5 fps when the culvert is flowing full. Short (150 feet or less) equalizer pipes may be proposed flat.

3.4.8 Pipe Cover

The minimum and maximum cover on a culvert shall utilize the FDOT Current Drainage Manual Appendix C, Cover Height Tables, latest edition, based on the pipe material, shape, and cover conditions (i.e., flexible pavement, rigid pavement, or no pavement). In no case shall the provided cover be less than 12 inches without approval of the City Engineer. Beneath a vehicular travel way, the distance shall be measured from the outside bell of the culvert to the top of the base at any point. It is the responsibility of the Engineer of Record to make sure the pipe has the minimum design cover to prevent floatation.

3.4.9 Storm Sewer Inlets

Storm Inlet Capacity and Protective Treatment: The capacity of City standard curb inlets shall be designed to satisfy hydraulic capacity, structural capacity, vehicular, pedestrian, cyclist or ADA safety and durability. Curb inlets capacity shall be 4.0 cfs per throat unless otherwise approved by the City Engineer.

In areas that are subject to high salinity or are located within a half mile of brackish water containing chlorides greater than 2,000 ppm, FDOT Alternate G hot dipped galvanized grates and frames shall be required.

Storm Inlet Spacing:

- The maximum distance surface water will be allowed to run in the gutter prior to discharge into an inlet shall be 500 feet.

Storm Inlet Locations:

- Where inlets are located on returns, a return profile may be included in the site development plans.
- Other than at intersections, inlets should be located as near as possible to common lot lines.
- Inlets shall be recessed from the roadway as shown on LDPM Volume 3, City Standard Details, Plate D-202.

Storm Drainage Structures:

- General - All structures shall be in accordance with LDPM Volume 3, CityStandard Details.
- Conflict Manholes - Where it is necessary to allow a sanitary line or other utility to pass through a manhole, inlet or junction box because of no reasonable alternative, the utility shall be cast iron, steel, or other suitable material and maintained in the upper half of the storm sewer opening.
- The use of valley gutters is generally unacceptable. However, they will be acceptable across cul-de-sacs of no more than 150 feet in length or as approved by the City Engineer.

3.4.10 Drainage Easements

Easement width for pipe shall be 20-foot minimum for 4 feet of cut or less and 2 feet additional width for each additional foot of cut below 4 feet. The pipe shall be located in the center part of any easement. The City may require unobstructed easements or rights of way along rear or side lot lines where necessitated by maintenance requirements. This criterion does not apply for private easements for shallow rear yard swales and/or yard drains with small/shallow pipes.

3.5 Roadside Ditches and Swales

3.5.1 Roadside Swale Design Guidelines

Roadside swales shall not be provided on new local roadways. For new swales on major arterial, minor arterial, and collector roads or reconstruction of swales on existing roadways, the following guidance shall be applicable. LID and Green Infrastructure bioretention shall follow the design guidelines in Section 4.0.

- Roadside ditches are to be no more than 3 feet in depth or 10 feet in top width, unless the roadside shoulder is increased to a minimum of 10 feet.
- Swales shall have a maximum front and back slope of 1(V):3(H).
- The maximum allowable velocity shall be 2.5 feet per second. All ditches or swales shall be grassed and mulched in accordance with the latest City Specifications.

3.5.2 Roadside Ditch Driveway Crossings

Driveway crossing pipe shall be placed in the ditch line of the proposed roadway ditch with an invert elevation equal to the proposed ditchgrade. A schedule showing the size and type crossing needed to gain entrance to each site shall appear in the site development plans. This may be accomplished by a note as to type and size needed appearing in the profile portion of the plan and profile sheet. A driveway culvert that is 60 feet or more in length will require drainage design (sizing) calculations that have been signed and sealed by a registered professional and require installation by a licensed underground utility contractor. Sizing calculations shall utilize the 5-year, 24-hour design storm. A check is to be made to ensure that the proposed ditch section has adequate depth to insure minimum cover.

3.6 Drainage Outfall Ditches and Canals

The following design guidelines are applicable to outfalls to surface waters and canals. Outfalls are those drainage ditches that exceed 3 feet in depth or 10 feet in top width.

3.6.1 Drainage Rights of Way Widths

To determine the required right-of-way or easement width over an outfall ditch; determine the width of the top of the ditch, add 5 feet to one side and 20 feet to the other side for equipment access and consider extra radius or extra width at sharp turns to allow equipment turning. The total equals the minimum width required. When the top width of a ditch exceeds 100 feet, 35 feet should be added to each side.

3.6.2 Drainage Ditch Sizes

All ditches shall be sized using accepted engineering practices. In all cases sufficient engineering data giving drainage area, velocity, and depth of flow is to be included in the drainage analysis.

3.6.3 Drainage Ditch Velocities

Unless unstable or highly erosive soil conditions indicate a lower design velocity, the maximum allowable velocity shall be 2 feet per second. Erosion protection may be required when the velocity exceeds 2 feet per second, or the ditch slope exceeds 2 percent.

3.6.4 Drainage Ditch Slope

The minimum required to provide for design flow.

3.6.5 Analysis of Existing Outfalls

Where an existing outfall is being utilized and the capacity to handle any additional runoff is in question, data to support the design shall be included in the drainage analysis.

3.6.6 Cross Section Design Criteria

Grading Adjacent to Cross Section

Areas adjacent to outfall ditches and canals shall be graded in such a manner as to preclude the entrance of excessive runoff except at locations where erosion protection is provided. Such locations shall be piped.

Cross Section Maximum Side Slopes

The maximum side slope allowed shall be 1(V):2(H) or as soil conditions allow with the top ditch bank rounded off.

3.6.7 Ditch Protection

Ditch Alignment Changes

Appropriate erosion protection shall be provided at changes in either or both horizontal or vertical alignment.

Grassing and Mulching or Sod

All ditches and earth embankments are to be grassed and mulched per LDPM Volume 4, City Standard Specifications. Sod is required for slopes exceeding 1(H):3(V). The Contractor is responsible for grass until a good stand has been rooted. An asphalt membrane to hold grass and mulch material will be acceptable. Topsoil or a mulch blanket may be required.

3.6.8 Utility Crossings

Where it is necessary for a utility to cross a drainage right-of-way, the following minimum requirements shall be adhered to:

1. Aerial crossing - minimum of 1.0-foot clearance above design high water.
2. Underground - minimum of a 2.5-foot clearance below the design invert of the canal.
3. Utilities shall be adequately permanently marked to protect against accidental damage during maintenance operation.
4. No supports for aerial crossings shall be allowed in the confines of the canal cut unless authorized by the City Engineer.
5. Conduit material for crossing shall be submitted for approval by the City Engineer.

3.7 Detention/Retention Basis (Stormwater Management Facilities)

3.7.1 Stormwater Management Facility General Requirements

Detention/retention basins may be incorporated into a drainage system for the following reasons:

1. The outfall system is inadequate to handle post-development flows and revisions to the outfall are not practical.
2. Peak flow attenuation as required by state agencies.
3. Stormwater water quality treatment facilities.
4. Amenity to the proposed development.

3.7.2 Stormwater Management Facilities – Total Retention

All detention/retention facilities must have a positive discharge except as approved by the City Engineer, according to the procedures outlined in LDPM Volume 1, Section 5.0. If total retention is allowed, the basin must recover to its design low water stage within 72 hours. To provide the City with assurances, a double ring infiltrometer test must be performed at the same elevation as the bottom of the basin and a safety factor of 4 shall be applied to thedesign.

3.7.3 Stormwater Management Facilities Design Criteria

General Design Methodologies

The registered professional may use SCS method for determining runoff for any site with no acreage restriction. Rational method may be used only for sites that are 10 acres or less.

Detention Basis Design Criteria

The site development plans must be accompanied by a complete detention analysis showing:

1. Overall drainage layout including all drainage areas contributing to the detention basin.
2. Calculations showing inflow, discharge, storage capacity, minimum and maximum design water depth and detention time, capacity of the receiving system, tailwater conditions at the outlet structure.
3. The drainage basin lag time shall be incorporated into the inflow hydrograph for drainage basins in excess of 40 acres.
4. The outflow hydrograph shall reflect the varying pond discharge from design low water to design high water.
5. Inflow shall be determined based on the design storms stated in Table 3.7-1.

Table 3.7-1 Design storms for wet detention design

METHODOLOGY USED	DESIGN STORM (Developed Conditions)
Rational Method	
- Inflow	100-year storm
- Contributing pipe system	5-year storm
SCS Method	
- Inflow	25-year storm
- Contributing pipe system	3-year

6. Outflow
   - The maximum allowable outflow rate shall be based on the runoff rate for existing conditions using the 100-year rational or 25-year SCS design storm.

     AND

   - The outflow rate shall not exceed the capacity of the downstream drainage system based on the appropriate inflow-outflow design storm for that system as defined herein.
     - For a Subdivision - 5-year Rational or 3-year SCS design storm. The outflow rate shall not exceed the capacity of the downstream system based on a 5-year design storm inflow into the detention pond.
     - For Major Outfalls - 25-year Storm. The outflow rate shall not exceed the capacity of the downstream system based on a 25-year design storm inflow into the detention pond.
7. Storage Required

The storage required shall be that volume necessary to store the difference between the 100-year rational or 25-year SCS storm developed-condition runoff and the 100-year rational or 25-year SCS storm existing-condition runoff.

Volumetric Pre-Post Basins. In the following restricted drainage basins, development discharge volumes must not exceed the pre-development discharge volumes between hours 10 and 17 of the 24-hour design storm:

- Sandalwood Canal/Hogpen Creek

- Cedar River/Wills Branch
- Pablo Creek

Half CFS Basins. In the following restricted drainage basins, development discharge id limited to 0.5 cfs per acre:

- Atlantic Boulevard at Girvin Road (northeast quadrant)
- Christopher Creek
- Doctors Branch
- Orange Pickers Road and Mandarin Road
- Moncrief Creek

8. Exceptions

When downstream conditions will not accept runoff from the appropriate storm-existing conditions or other special instances, the development will be required to provide a drainage system which will not increase flooding downstream.

9. Design storms for detention basin design:

Design storms shall be based on the 24-hour design storms stated in Section 3.3.4 using the Type II Florida Modified Distributions.

10. Soil Investigation

- Soil borings shall be made to a depth which equal to the design low water, seasonal high water table, or the pond bottom if dry.
- Soil types estimated seasonal high water table elevation to be included and illustrated as a part of the detailed storm water management facility construction plans.
- No less than 1 boring per acre or fraction thereof of storm water management facility water surface at design low water elevation, or as specified by the City Engineer.
- If the analysis of the basin utilizes infiltration to achieve either peak flow attenuation or recovery time, a double ring infiltrometer test shall be performed at the bottom of the proposed basin. A safety factor of 2 shall be used for design calculations.

11. Flooding of a private commercial site to satisfy attenuation requirements is allowed with the property owner's permission. The limits of flooding shall be shown in the plans along with the following statement signed by the Owner:

> *I (type or print owner's name) hereby acknowledge that the property to be developed is subject to flooding during the following design storm(s), to the limits shown shaded on these plans, and to the following elevations:*
>
> *5 year (or 3 yr., as designed) elevation _____*
>
> *100 year (or 25 yr., as designed) elevation _____*
>
> *(Owner's Signature)*

12. For small projects proposing less than 4,000 sq. ft. of vehicular use paving and less than 9,000 sq. ft. of impervious area total (which do not exceed any of the thresholds of Chapter 62-330.020(2) (a through j), F.A.C.), and not within a Restricted Drainage Basin, the following design criteria shall apply if the site discharges to a City right of way in the pre-development condition:

- Post development discharge must be to a City right-of-way or Water of the State.
- Attenuation (pre vs. post) requirement may be limited to the 3-year SCS or 5-year Rational method.
- There shall be no minimum freeboard required within the stormwater management facility.
- Innovative methods for attenuation shall be considered.
- The permeability rate in the Soils Survey of City of Jacksonville, Duval County, Florida, may be used to determine recovery time — the minimum rate must be used.

13. Previously Developed Sites Within Half cfs Restricted Basins
    - No credit for existing impervious surfaces shall be given for sites constructed within a drainage basin that is restricted to 0.5 cfs per acre discharge.
14. Maintenance Access Requirements. A minimum 15-foot drivable access easement must be provided along the entire top of bank of the stormwater management facility. The area within the access easement shall have a maximum slope of 1(H):15(V). Alternative access to provide for long-term maintenance access may be proposed using the process set out in LDPM Volume 1, Section 5.0.

Stormwater Water Quality Treatment Design Criteria

When basins are designed to provide stormwater water quality treatment only, the design criteria shall be the same as a detention basin design with the following exceptions:

1. If the basin is constructed below adjacent land, a 5-year rational storm or a 3-year SCS storm may be used for the analysis.
2. If the basin is constructed above the adjacent land, then a 100-year rational or 25-year SCS storm shall be used.

Offline Detention of Treatment Basin

If an offline basin is used to provide peak flow attenuation or stormwater water quality treatment, the basin may be analyzed on the same design storm as the contributing system provided the basin is constructed below adjacent land and the project is less than 40 acres.

Rear Lot Treatment Facilities

When a swale is constructed to provide stormwater water quality treatment at the rear property line, no analysis is required provided the top of berm is 2 feet wide and is set at an elevation 0.5 foot higher than the treatment volume. The maximum side slope for these swales shall be 1(H):3(V).

Stormwater Facility Basin Geometry

It is intended the stormwater basin has a minimum V-shaped cross-section (minimum design low water depth of 8 feet) aligned along the line of flow from the point of entry to the storm water management facility to the point of exit. Larger storm water management facilities may require flat bottoms where appropriate transitions at the points of entrance and exit shall be designed.

Where the guidance produces a larger-than-required basin, individual design will be necessary. In all cases, the basin shall be located in such a manner as to cause the least amount of damage if the design storm is exceeded.

1. Sides Slope - Side slopes shall not be steeper than 1(H):4(V) and shall be used on all man-made basins. Where natural basins are existing, the criteria will be set on an individual basis. Side slopes steeper than 1(H):4(V) may be approved by the City Engineer provided permanent bank stabilization and fencing is constructed.

2. Protection - All exposed or disturbed soil is to be mulched and grassed to achieve a good stand of grass in accordance with current LDPM Volume 3, City Standard Specifications.
3. Depth - Basins which will not drain dry within 72 hours after the design storm shall have a minimum depth below the design low water stage of 8 feet. Side slopes of 4:1 or flatter shall be used between the design low water and the basin bottom.
4. Illustrative Example Sketch - A cross-sectional drawing to a scale of each and all storm water management facilities included in the overall drainage layout are to be part of the site development plans.

Water Elevation and Overflow

1. Water elevation must be controlled by an appropriate concrete drainage structure.
2. The minimum difference in elevation between the design low water of the basin and the lowest contributing roadway inlet grate shall be 2.5 feet unless approved by the City Engineer. If a wet treatment system is utilized for water quality, the water elevation at 60 hours shall be utilized.
3. A 1-foot minimum basin freeboard is required at all points around a storm water management facility for all storm events, except for the 100-year rational or 25-year SCS storm events. However, if the basin is constructed higher than the adjacent land, the 1 foot minimum freeboard is required for all design storms.
4. All basins shall have an emergency overflow which will direct the water to a suitable drainage system.
5. The aerial extent of the basin shall be shown and labeled on all plans as top of basin. Where applicable, this shall include the area within the 1 foot of basin freeboard.
6. Pumps used in stormwater basins shall not be allowed except as authorized by the City Engineer or his/her designee. Requests to provide pumping facilities shall be submitted per the process established in LDPM Volume 1, Section 5.0. In cases where public waters are involved, the pumps shall be maintained by the property owner or Homeowners' Association.
7. The basin shall be designed to return to its low water elevation in accordance with criteria as set forth by the St. Johns River Water Management District.

Ownership of Stormwater Management Facilities

1. All stormwater management facilities are to be owned and maintained by either:
   - The surrounding property ownersor,
   - Another group as approved by the City.
2. Rights-of-way or easements must continue through all storm water management facilities. Littoral zones and wetland mitigation areas shall not be located within City easements. Such rights-of-way or easements shall include a hold harmless agreement.
3. Annual reports in compliance with the SJRWMD stormwater permits, are required from the maintenance entity of all stormwater treatment facilities.
4. All rear-lot drainage systems shall be included as a part of the ongoing development's stormwater management certification requirements. An access easement shall be dedicated to the City of Jacksonville and the appropriate State Agency for access to rear-lot drainage systems for inspection by the City of Jacksonville or such State Agency.

3.8 Subsurface Drainage

In accordance with the test boring data obtained for the soil investigation and considering anticipated groundwater changes due to drainage improvements, underdrain shall be installed in accordance with City Standard Details in all cases where the groundwater table is closer than 20 inches below the lowest finished gutter or edge of pavement of any roadway. The "iron-oxide" lens in the soil may be used as an indicator of the usual high predevelopment groundwater elevation.

Should underdrain quantities be adjusted in the field during construction, as concurred therein by the City's on-site representative, the registered professional shall revise the site development plans accordingly and submit revised signed and sealed plans to the City Engineer for the record, with note on plans showing date of site meeting and the City's representative in attendance.

The size of the underdrain required shall be determined using accepted engineering practices. The minimum size acceptable is 6 inches in diameter. The minimum slope shall be 0.002 ft/ft. Only Type I underdrain shall be used. Type II and Type III (partial wrap and no wrap) shall not be permitted. Underdrain fabric shall be a minimum of 6 ounces.

3.9 Erosion and Sediment Control

3.9.1 Erosion and Sediment Control – General (C/CM-2.3.2)

The United States Environmental Protection Agency (EPA) lists sediment as the most common pollutant in surface waters, such as rivers, streams, and lakes. Erosion during and immediately after construction is a major contributor of sediment impacts to wetlands, waterbodies, and stormwater systems. Turbid water discharges are a major factor in the degradation of surface water quality.

To minimize the impacts of erosion and sediment transport, an effective erosion and sediment control plan for all land-disturbing activities must be submitted for initial approval. All erosion and sediment control plans to be submitted must be signed and approved prior to submittal by a person trained and certified in the State of Florida Erosion and Sediment Control Designer and Reviewer Manual as well as the Florida Stormwater, Erosion and Sedimentation Control Inspector’s Manual (Tier I and Tier II).

Soil erosion and sediment control measures shall conform to the State of Florida Erosion and Sediment Control Designer and Reviewer Manual as well as the Florida Stormwater, Erosion and Sedimentation Control Inspector’s Manual (Tier I and Tier II), which are hereby adopted and incorporated by reference, as well as the standards herein described, whichever is more stringent. The application of measures shall apply to all land-disturbing activities under the City’s jurisdiction, except single-family residential building permits. These activities shall include, but not be limited to, roadway and drainage construction, utility installation, site dewatering, and other temporary or permanent improvements.

To be successful, an erosion and sediment control plan must be a dynamic plan that can be implemented in stages and can be modified to suit different construction practices and site conditions. The initially approved erosion and sediment control plan shall be submitted with the permit application and should be used by the contractor as the initial plan. However, these plans are performance based and should be modified throughout the life of the construction project to ensure that no off-site impacts occur. Changes to the erosion and sediment control plan should be properly documented in the Stormwater Pollution Prevention Plan on site.

3.9.2 Erosion and Sediment Control - Principles

1. The plan of development should fit the particular topography, soils, drainage patterns, and natural vegetation of the site.
2. Minimize the extent of the area exposed at one time and the duration of exposure.
3. Apply effective erosion and sediment control measures to prevent off-site damage.

4. Apply perimeter control practices to protect the disturbed area from off-site runoff and to prevent sedimentation damage to areas below the development site.
5. Woven silt fence is not effective in the control of turbidity. Therefore, consideration should be made for additional or alternative best practices in erosion and sediment control adjacent to wetlands, stormwater systems, and surface waters.
6. Runoff velocities should be kept low and should be detained on the site.
7. Stabilize disturbed areas immediately after final grade has been obtained.
8. Implement a thorough maintenance and compliance program.
9. The municipal storm sewer system (MS4) is comprised of any City or FDOT conveyance or system of conveyances designed or used for collecting or conveying stormwater. The MS4 includes ponds, roads with drainage systems, streets, catch basins, curbs, gutters, ditches, man-made channels, pipes, head walls, manholes and storm drains. Erosion and sediment controls must ensure that construction activities do not cause any erosion, sediment, or turbid water impacts, or any other types of illicit discharges, including, but not limited to, track-out or debris from the site to any component of the MS4.

3.9.3 Erosion and Sediment control - Practices

To comply with the principles set forth above, the erosion and sediment control plan should utilize those practices set forth in the State of Florida Erosion and Sediment Control Designer and Reviewer Manual as well as the Florida Stormwater, Erosion and Sedimentation Control Inspector's Manual (Tier I and Tier II) or the most effective combination of the following, whichever is more stringent:

1. Inspections by site personnel are required, at a minimum, once every 7 calendar days and within 24 hours of a 0.5-inch or greater storm event. Deficiencies noted during the inspection should be corrected as quickly as possible and the reason for any delay in addressing any deficiency must be documented.
2. Construction site activities can often result in alteration of the initial installations of erosion and sediment controls. Regulations require that all erosion and sediment controls must, likewise, be maintained, at a minimum, once every 7 calendar days and within 24 hours of a 0.5-inch or greater storm event.
3. Synthetic bale barrier: Synthetic bale barriers can be used below disturbed areas subject to sheet and rill erosion with the following limitations:
   - Where the maximum slope behind the barrier is 33 percent.
   - In minor swales or ditch lines where the maximum contributing drainage area is no greater than 2 acres.
   - Where effectiveness is required for less than 3 months.
   - Every effort should be made to limit the use of bale barriers constructed in live streams or in swales where there is the possibility of a washout. If necessary, measures shall be taken to properly anchor bales to insure againstwashout.
4. Filter fabric barrier: Filter fabric barriers can be used below disturbed areas subject to sheet and rill erosion with the following limitations:
   - Where the maximum slope behind the barrier is 33 percent.
   - In minor swales or ditch lines where the maximum contributing drainage area is no greater than 2 acres.
5. Brush barrier with filter fabric: Brush barrier maybe used below disturbed areas subject to sheet and rill erosion where enough residue material is available on site.

6. Temporary diversion dike: Temporary diversion dikes may be used to divert runoff through a sediment-trapping facility.
7. Temporary sediment trap: A sediment trap is usually installed in a drainageway at a storm drain inlet or at other points of discharge from a disturbed area with the following limitations:
8. The sediment trap may be constructed either independently or in conjunction with a temporary diversion dike.
9. Outlet protection: Applicable to the outlets of all pipes and paved channel sections where the velocity of flow at design capacity of the outlet will exceed the permissible velocity of the receiving channel or area.
10. Level spreader: A level spreader may be used where sediment-free storm runoff is intercepted and diverted away from the graded areas onto undisturbed stabilized areas. This practice applies only in those situations where the spreader can be constructed on undisturbed soil and the area below the level lip is stabilized. The water should not be allowed to reconcentrate after release.
11. Surface Roughening: Surface roughening may be used to reduce erosion and provide sediment trapping for the following conditions:
12. For slopes steeper than 3:1, surface roughening will consist of either stair-step grading, grooving, furrowing or tracking if they are to be stabilized with vegetation.
13. Areas with grades less steep than 3:1 should have the soil surface lightly roughened and loose to a depth of 2 to 4 inches.
14. Areas which have been graded and will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place.
15. Stockpiling Material: No excavated material, fill, construction materials, waste piles, or trash containers shall be stockpiled or managed in such a manner as to allow runoff, sediment, or debris from the project site into any adjacent waterbody, wetlands, or stormwater system.
16. Exposed Area Limitation: The surface area of open, raw, erodible soil exposed by clearing and grubbing operations or excavation and filling operations shall not exceed 10 acres. This requirement may be waived for large projects with an erosion and sedimentation control plan which demonstrates that opening of additional areas will not significantly affect off-site deposit of sediments.
17. Inlet Protection: Inlets and catch basins which discharge directly off-site shall be protected from sediment-laden storm runoff until the completion of all construction operations that may contribute sediment to the inlet.
18. Temporary Seeding: Areas opened by construction operations and that are not anticipated to be re-excavated or dressed and receive final grassing treatment within 30 days shall be seeded with a quick-growing grass species which will provide an early cover during the season in which it is planted and will not later compete with the permanent grassing.
19. Temporary Seeding and Mulching: Slopes steeper than 6:1 that fall within the category established in Paragraph 12 above shall additionally receive mulching of approximately 2 inches loose measure of mulch material cut into the soil of the seeded area adequate to prevent movement of seed and mulch.
20. Temporary Grassing: The seeded or seeded and mulched area(s) shall be rolled and watered or hydro-mulched or other suitable methods if required to assure optimum growing conditions for the establishment of a good grass cover.
21. Temporary Re-grassing: If, after 14 days from seeding, the temporary grassed areas have not attained a minimum of 75 percent good grass cover, the area will be reworked, and additional seed applied sufficient to establish the desired vegetative cover.

22. Maintenance: All features of the project designed and constructed to prevent erosion and sediment shall be maintained during the life of the construction so as to function as they were originally designed and constructed.
23. Permanent Erosion and Sedimentation Control: The erosion and sedimentation control facilities of the project should be designed to minimize the impact on the off-site facilities. All stormwater discharge from the project limits shall be designed in accordance with Section 3 of the Land Development Procedures.
24. Permanent Seeding: All areas which have been disturbed by construction will, as a minimum, be seeded. The seeding mix must provide both long-term vegetation and rapid growth seasonal vegetation. Slopes steeper than 4:1 shall be seeded and mulched or sodded.

3.9.4 Contractor Certification and Attestation

1. Where required by Chapter 489 of the Florida Statutes, contractors shall be licensed as underground utility contractors.
2. All contractors conducting land-disturbing activities shall be certified with the Florida Stormwater, Erosion and Sedimentation Control Inspector's Manual (Tier I and Tier II).
3. The contractor shall be able to attest to the adherence with the State of Florida Erosion and Sediment Control Designer and Reviewer Manual throughout the construction project until final stabilization.

3.9.5 Drainage Swale Construction

Drainage swales across more than 1 lot and shown on the approved site development plans shall be constructed as a part of the subdivision improvements. The swales shall be inspected and approved prior to acceptance of the public improvements.

3.9.6 Notice of Intent

Coverage under a Florida Department of Environmental Protection Construction Generic Permit (CGP) is required for discharges from construction activities that:

- Disturb at least one or more acres of land or disturb less than one acre of land but are part of a common plan of development or sale (CGP Section 8.3).
- Discharge stormwater to surface waters of the state or to surface waters of the state through a MS4.
- FDEP regulations require that if your project discharges stormwater to any MS4, you must send a copy of your "Notice of Intent to Use Generic Permit for Stormwater Discharge from Large and Small Construction Activities, DEP Form 62-621.300(4)(b)," (NOI) or the FDEP acknowledgement letter within 7 calendar days of receipt to the operator of the MS4.

The owner or contractor shall contact the City of Jacksonville Environmental Quality Division Erosion and Sedimentation Control Section (ESC) by email to esc@coj.net in order to:

- Provide verification that all applicable stormwater permits have been obtained prior to commencement of any clearing, grading, or excavation.
- Schedule a pre-construction ESC site inspection to verify that all erosion and sediment control measures detailed in the site Erosion and Sediment Control Plan are in place prior to land disturbance.
- Submit the NOI 48 hours prior to beginning construction.
- Seek erosion and sedimentation control compliance assistance.

SECTION 4.0 Green Infrastructure Design Guidelines

The following design guidelines are provided from the City of Jacksonville Low Impact Design Manual (COJ 2013). This design guidance can be used for private development or projects that will become public rights of way.

4.1 Overview

4.1.1 Purpose

This section provides technical guidance and design specifications on Low-Impact Development (LID) stormwater management practices to apply to projects in Duval County, Florida. This section is not to be used in place of but rather as a supplement to the stormwater and surface water management guidance documents of the City of Jacksonville, St. Johns River Water Management District (SJRWMD), and other municipalities within Duval County with regard to local design criteria and LID applicability. The guidance provided in the section is designed to be flexible, with performance criteria provided where possible.

This section is limited to detailed design information for three practices that were selected as being the most applicable for right-of-way in Duval County but may also be used in other stormwater management scenarios. Additional practices will be added to the section as the need arises. Depending on the magnitude of specific or cumulative impacts, other methods of meeting the overall water resources objectives of the City of Jacksonville and SJRWMD may be considered. For all projects, check with local officials and other agencies to determine additional restrictions and/or surface water or watershed requirements that may apply.

LID stormwater management practices are not mandatory in Duval County. However, Duval County encourages the use of LID practices where possible to help meet its water resource objectives.

4.1.2 Background

LID is a stormwater management strategy that uses a suite of structural and non-structural hydrologic controls distributed throughout the site and integrated as a "treatment train" (i.e., in series to replicate the natural hydrologic functioning of the landscape). Unlike conventional systems that typically control and treat runoff using a single engineered stormwater pond at the "bottom of the hill" or the lowest point of an area, LID systems are designed to promote volume attenuation and treatment at or near the source of stormwater runoff via distributed retention, detention, infiltration, treatment, and harvesting mechanisms. The fundamental goal of applying LID concepts, designs, and practices is to improve the overall effectiveness and efficiency of stormwater management relative to conventional systems and thus reducing total and peak runoff volumes and improving the quality of waters discharged from the site.

1. A site-specific suite of LID-integrated management practices can be applied to most if not all development scenarios in Duval County. Regardless of the project context, LID requires the following core site- planning and design objectives to be considered:
2. Preserve or conserve existing site features and assets that facilitate natural hydrologic function.
3. Minimize runoff generated from impervious surfaces (i.e., use peak and total volume controls) and contamination (i.e., use load controls) as close to the source as possible.
4. Promote the distribution of retention, detention, treatment, and infiltration of runoff.
5. Harvest stormwater on site.
6. Minimize site disturbance and soil compaction through low impact clearing, grading, and construction measures.

The toolbox of LID-integrated management practices, including structural and non-structural designs, is most effective when applied in a treatment train, or a series of complementary stormwater management practices and techniques. Typically, LID practices will not completely replace other more conventional "bottom-of-the-hill" stormwater management practices but can be used to complement these practices and to ensure that the entire stormwater management system meets water resources objectives.

In addition, stormwater management that includes LID is most effective when sites are evaluated for LID compatibility as early as possible in the planning process and site conditions are considered carefully in the design and construction of each LID practice. This section supports the goal of applying the LID concept and design where feasible to enhance existing stormwater management measures and reduce the adverse impacts of land development projects on natural resources.

4.1.3 Intended Users

This green infrastructure guidance is intended to be used primarily by professionals engaged in planning, designing, constructing, operating, and maintaining building and development projects in Duval County. These potential users include but are not limited to stormwater design engineers, stormwater utility staff, natural resource managers, planning officials and administrators, building officials, architects, landscape architects, site design specialists, and landscape operations and maintenance professionals.

4.1.4 Demonstrating LID Effectiveness

Demonstrating the effectiveness of a green infrastructure treatment system will be a critical step in permitting a development in Duval County. This guidance provides guidelines for demonstrating the effectiveness of LID practices for meeting the appropriate water quantity and water quality requirements and standards.

Water Quality

The water quality effectiveness of a green infrastructure treatment system must be quantified based on the reduction in the average annual pollutant load. This section provides details such as design curves that can be used to calculate the average annual load reduction of some LID practices in Duval County. The effectiveness of the entire stormwater treatment system must be calculated by first calculating the effectiveness of each practice and then determining the effectiveness of the entire system. **Figure 4.1-1** shows an example of how this effectiveness can be demonstrated for Total Nitrogen (TN). The same approach can be used for other constituents.

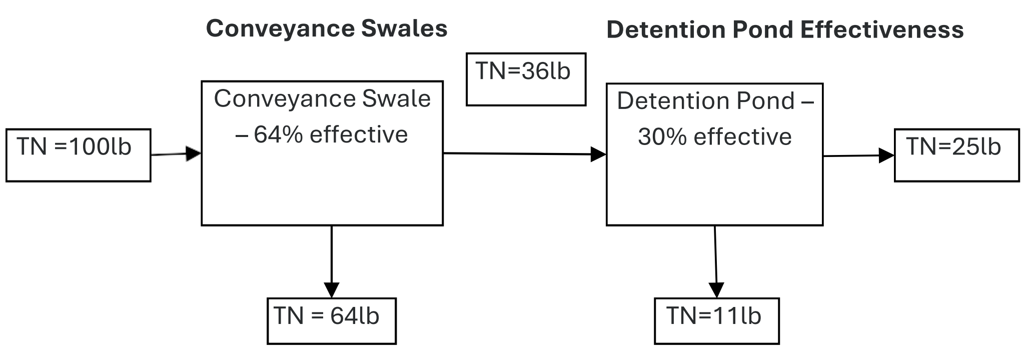


Figure 4.1-1 Treatment Train Effectiveness for a Dry Treatment System Followed by a Wet Treatment System

Water Quantity

Most LID practices will provide some attenuation of peak flows and/or reduction in runoff volume during flood events. The effectiveness of some LID practice in reducing peak runoff rate and/or runoff volume can be demonstrated by modifying the Natural Resource Conservation Service (NRCS) Curve Number (CN) used to represent the LID practice and/or the area contributing to the practice. in Sections 4.3, 4.4, and 4.5 provide details on how the CN should be modified. In some instances, the hydraulic functioning of the LID practice may be explicitly modeled.

4.1.5 Local Context

Duval County's Hydrology

LID applications should be designed to mimic the natural hydrologic functioning of a site. Five hydrologic soil groups, as classified by NRCS, are found in Duval County.

- A - well-drained
- B/D - moderately well- drained when dry; not well-drained when wet
- C - somewhat poorly drained
- C/D - somewhat poorly drained when dry; not well-drained when wet
- D - poorly drained

Figure 4.1-2 maps these hydrologic soil groups in Duval County. Most soils in Duval County are classified in the B/D hydrologic soil group due to a shallow seasonal high water level (SHWL), so the performance of infiltration-dependent LID applications will be constrained under wet conditions in areas with these soil types.

Land use varies widely throughout the County, with most development having occurred near the St. Johns River. Pine flatwoods dominate the west half of Duval County, while saltmarsh dominates the north portion.

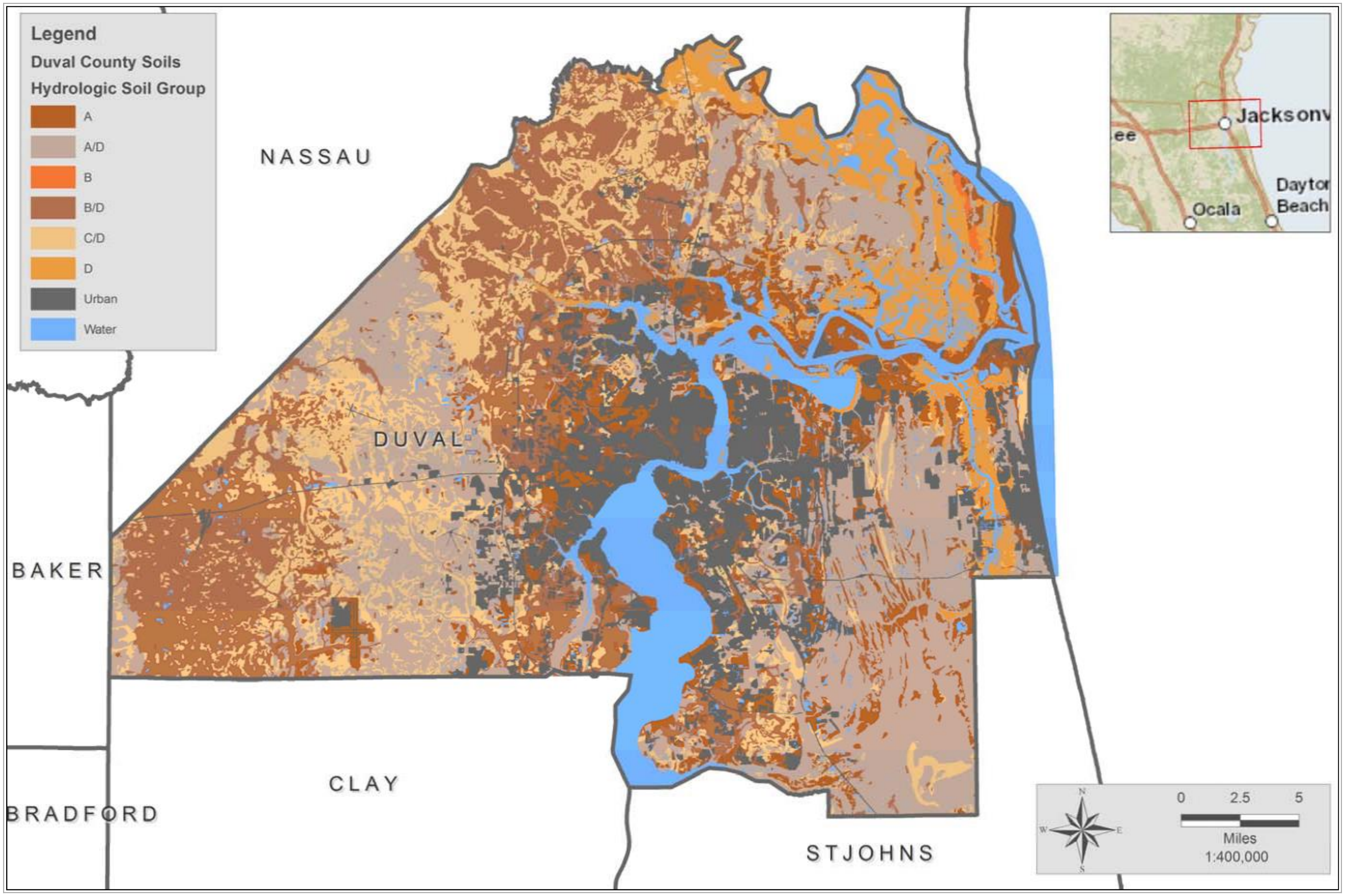


Figure 4.1-2 Hydrologic Soil Groups

Urbanization and Water Quality Standards

Florida's stormwater rules established goals to control and treat runoff from urban development. Structural engineering criteria for stormwater ponds were designed to (1) minimize flooding and subsequent damage to property and life by providing adequate drainage and flood control and (2) achieve at least 85 percent average annual reductions in post-development pollutant loading.

While these stormwater rules and design criteria have been effective in addressing flood control and have facilitated an efficient process for managing stormwater runoff, research indicates that they have fallen short of achieving established water quality goals (Harper and Baker, 2007). Over 200 of Florida's water bodies have been listed as impaired, meaning that they fail to achieve water quality standards established to maintain their designated use (e.g., potable water, shellfish propagation, recreation); nutrients in stormwater runoff – particularly nitrogen and phosphorus – have been identified as the cause of impairment in a majority of these water bodies (Florida Department of Environmental Protection, 2006b).

Standards Supporting LID

Although they may not use the term "Low-Impact Development" explicitly, many City of Jacksonville's ordinances, resolutions, and policies and SJRWMD's rules support the application of LID principles and design. City of Jacksonville documents that should be referenced with this manual to provide guidance on LID projects and to ensure compliance with requirements include but are not limited to the Comprehensive Plan, Ordinance Code, and Zoning Regulations.

4.1.6 Terminology

This section defines terminology used throughout this manual.

- *Average Annual Load Reduction:* An estimate of the long-term average reduction in annual pollutant loading provided by a stormwater management practice. This is typically expressed as a percentage.
- *Average Annual Rainfall:* The long-term average rainfall that occurs annually.
- *Bioretention:* The use of shallow landscaped depressions with soils, mulch, and planted vegetation intended to prevent the discharge of a given volume of stormwater runoff into surface waters by providing complete on-site storage.
- *Cistern*: A closed reservoir or tank used for storing stormwater for stormwater harvesting.
- *Density:* The number of residential dwelling units permitted per gross acre of land as determined by the City of Jacksonville's 2030 Comprehensive Plan: Future Land Use Element.
- *Detention:* The collection and temporary storage of stormwater with subsequent gradual release of the stormwater.
- *Detention with Biofiltration:* A landscaped depression area with a separate inlet and outlet (underdrain). Depressions are often linear and may be connected in series. Storage volume recovery of the depression is through an underdrain system. Other terms often applied to similar practices include *biodetention, bioswales*, and

vegetated swale.

- *Development:* Any proposed material change in the use or character of the land, including but not limited to land-clearing associated with new construction, the placement of any structure or site improvement on the land, or expansion of existing buildings (Jacksonville Ordinance Code, Zoning Section, Chapter 656-Zoning Code, Part 12—Landscape and Tree Protection Regulations).
- *Diameter at Breast Height (DBH):* The diameter of a plant's trunk or main stem 4.5 feet above the ground.
- *Directly Connected Impervious Area (DCIA):* The area covered by a building, impermeable pavement, and/or other impervious surfaces that drains directly into the conveyance without first flowing across sufficient permeable vegetated land area to allow for runoff infiltration.
- *Equivalent Impervious Area (EIA):* The area of a completely impervious watershed that would produce the same volume of runoff as the actual watershed.
- *Floodplain:* Land area subject to inundation by flood waters from a river, watercourse, or lake. Floodplains are delineated according to their estimated frequency of flooding.
- *Low-Impact Development*: A stormwater management approach that uses a suite of structural and non-structural hydrologic controls distributed throughout the site and integrated as a treatment train (i.e., in series) to replicate the natural hydrologic functioning of the landscape.
- *Native:* A species whose natural range included Florida at the time of European contact (1500 AD).
- *Nutrient-Sorption Layer:* A layer included in pervious pavement systems that absorbs nutrients, thereby reducing the nutrient loading from the system.
- *Pervious Pavement:* A pavement system that allows stormwater to infiltrate the parent soil.
- *Predevelopment:* The natural vegetative community type of the project area.
- *Pretreatment:* Stormwater volume and/or water quality controls applied upstream from or before capture, storage, treatment, infiltration, and/or harvesting by a subsequent stormwater management practice in a treatment train.
- *Protected Tree*: includes all of the following:
  - *Private protected tree* means any tree with a DBH of 6 inches or more located on any lot within 20 feet of a street right-of-way (including an approved private street or other access easement) or a tree with a DBH of 8 inches or more located within 10 feet of any other property line, or a tree with a DBH of 11.5 inches or more located elsewhere on the lot.
  - *Public protected tree* means any tree located on lands owned by the City of Jacksonville or other governmental agencies or authorities, or any land upon

which easements are imposed for the benefit of the City of Jacksonville or other governmental agencies or authorities, or upon which other ownership control may be exerted by the City of Jacksonville or other governmental agencies or authorities, including rights-of-way, parks, public areas, and easements for drainage, sewer, water, and other public utilities, with:

- A DBH of 6 inches or more located within a County, City, or other governmental right-of-way, or
- A DBH of 6 inches or more and located on any lot within 20 feet of a street right-of-way, or
- A DBH of 8 inches or more located on any lot within 10 feet of any other property line, or
- A DBH of 11.5 inches or more located elsewhere on the lot.

- *Exceptional specimen tree* means any hardwood tree with a DBH of 24 inches or greater.

  (Jacksonville Ordinance Code, Zoning Section, Chapter 656-Zoning Code, Part 12—Landscape and Tree Protection Regulations)

- *Rain Barrel:* A rainwater storage vessel with a capacity less than or equal to 80 gallons that captures runoff from a roof. Systems using rain barrels for storage, including systems that link several barrels together in series, do not constitute an acceptable BMP for the ERP program administered by SJRWMD.
- *Rainwater:* Runoff from a roof that is collected before it contacts the ground.
- *Reclaimed Water:* Water that has received at least secondary treatment and is reused after flowing out of a wastewater treatment facility (Rule 62-600.200, Florida Administrative Code[FAC]).
- *Redevelopment:* The construction of a stormwater treatment system on sites having existing commercial, industrial, institutional, or multi-family land uses where the existing impervious surface will be removed as part of the proposed activity.
- *Retention:* A system designed to prevent the discharge of a given volume of stormwater runoff into surface waters in the state by providing complete on-site storage. Examples are systems such as excavated or natural depression storage areas, pervious pavement with subgrade, or above-ground storage areas.
- *Seasonal High Water Level (SHWL):* The elevation to which the ground and surface water can be expected to rise due to a normal wet season.
- *Site Plan:* A scaled graphic and informational representation of a specific design solution for a development phase or the entirety on which is shown an area location map; existing and proposed topography, streams, rights-of-way, easements, structures, wooded areas, and water bodies; provisions for ingress and egress; off-street parking, loading, refuse, and service areas; necessary facilities and utilities; required yards, open spaces, and recreational uses and facilities; proposed landscaping, fencing, screening, and buffering and provision for trees protected or required by City regulations; proposed signs and lighting; and any other information that may be necessary or reasonably required.

- *Soils:* As defined in the current United States Department of Agriculture Soil Survey of Duval County.
- *Stormwater Harvesting:* Capturing stormwater for irrigation or other beneficial use.
- *Stormwater Management System:* A system that is designed and constructed or implemented to control discharges that are necessitated by rainfall events, incorporating methods to collect, convey, store, absorb, inhibit, treat, use, or reuse water to prevent or reduce flooding, over drainage, environmental degradation, and water pollution or otherwise affect the quantity and quality of discharges from the system. [Sections 373.403(10) and 403.031(16), FS]
- *Survey:* A survey as defined in the Minimum Technical Standards for Surveying, Rule 5J-17, FAC.
- *Total Maximum Daily Load (TMDL):* The sum of the individual wasteload allocations for pointsources and the load allocations for nonpoint sources and natural background for an impaired waterbody or waterbody segment. Prior to determining individual wasteload allocations and load allocations, the maximum amount of a pollutant that a waterbody or water segment can assimilate from all sources without exceeding water quality standards must first be calculated. A TMDL shall include either an implicit or explicit margin of safety or a consideration of seasonal variations. (Chapter 62-302.200, F.A.C.)
- *Treatment Train:* An integrated series of stormwater management practices, each of which provides incremental stormwater attenuation and/or treatment benefits.
- *Turf Grass:* Continuous plant coverage consisting of grass species suited to growth in Duval County (Jacksonville Ordinance Code, Zoning Section, Chapter 656-Zoning Code, Part 12— Landscape and Tree Protection Regulations).
- *Water or Waters in the State:* Any and all water on or beneath the ground surface or in the atmosphere, including natural or artificial watercourses, lakes, ponds, or diffused surface waterand water percolating, standing, or flowing beneath the ground surface, as well as all coastal waters within the jurisdiction of the state. [Section 373.019(20), FS]
- *Water Quality Standards:* Standards set forth in Chapters 62-4, 62-302, 62-520, and 62-550, FAC, including the antidegradation provisions of Paragraphs 62-4.242(1)(a) and (b), FAC, Subsections 62- 4.242(2) and (3), FAC, and Rule 62-302.300, FAC, and any special standards for Outstanding Florida Waters and Outstanding National Resource Waters set forth in Subsections 62-4.242(2) and (3), FAC.

4.1.7 References

City of Jacksonville Land Development Procedures Manual (March 2012).

Ordinance Code of the City of Jacksonville (November 2012).

Florida Department of Environmental Protection. 2006a. Water Resource Implementation Rule, Chapter 62-40, FAC. May 7, 2006.

Florida Department of Environmental Protection. 2006b. Integrated Water Quality Assessment for Florida: 2006 305(b) Report and 303(d) List Update. May 2, 2006.

Florida Department of Environmental Protection. Environmental Resource Permitting and Sovereign Submerged Lands Rules. Accessed July 12, 2008: http://www.dep.state.fl.us/water/wetlands/erp/rules/stormwater.index.htm.

Harper, H. H. and D. M. Baker. Evaluation of Current Stormwater Design Criteria within the State of Florida: Final Report. Prepared for Florida Department of Environmental Protection. June 2007.

4.2 Site Evaluation

4.2.1 Overview

Site choice is the first decision affecting the success of applying LID to any project. When the project location is not predetermined, planners are encouraged to consider compatibility with LID principles and practices in their site selection, an approach that complements and/or satisfies the City of Jacksonville's development standards and stormwater management requirements.

LID principles aim to reduce total and peak volumes of stormwater runoff, thereby reducing pollutant loading to receiving waters; applying them to a development project – from site selection to long-term operations and maintenance – can help ensure that City land-development standards are achieved.

Rather than focusing solely on treating stormwater runoff once it has been generated on a site, LID relies primarily on source controls and spatially distributed practices and systems that complement centralized, structured stormwater controls. Preserving the hydrologic signature of a site to promote the management of stormwater runoff volumes and quality at the source, integrated with a series of on-site treatment practices, reduces the demand on centralized stormwater treatment systems. This is typically referred to as a treatment-train approach to stormwater management. While conventional stormwater design typically involves constructing a single retention or detention pond to meet volume storage and pollutant-control requirements for each basin, treatment-train design involves constructing multiple practices in series in which each individual practice provides incremental benefits that collectively achieve storage and pollution-control requirements. Design professionals are encouraged to evaluate and design sites with a holistic perspective and in a fashion that is consistent with the treatment-train approach.

Fundamental LID principles such as those listed below should be considered in the development planning and design process:

- Preserve or conserve site features and assets that facilitate natural hydrologic function.
- Minimize runoff generated from impervious surfaces (i.e., use peak and total volume controls).
- Minimize runoff contamination (i.e., use load controls) as close to the source as possible.
- Promote distributed retention, detention, treatment, and infiltration of runoff.
- Capture and harvest stormwater on site.
- Minimize site disturbance and soil compaction through low impact clearing, grading, and construction measures.
- Coordinate the construction schedule to minimize the area disturbed at any one time and plan construction phases to reduce the erosion potential of the site.

This section's overview of the site-assessment and planning processes provides examples of specific LID practices supporting these principles. Design standards and methods for calculating the effectiveness of certain practices are provided in Sections 4.3, 4.4, and 4.5.

4.2.2 Site Assessment

In most development projects, stormwater systems are designed to attenuate and treat altered hydrologic conditions that result from implementing a master development plan. Plans for new developments typically require the following:

- Clearing on-site vegetation.
- Disturbing and compacting native or parent soils.
- Importing and grading fill material to establish the construction base and drainage contours.
- Constructing infrastructure to facilitate drainage away from the site.
- Introducing new landscapes that require nutrient and water inputs greater than natural conditions to thrive.

Rather than fitting the stormwater system into the predetermined site plan, LID encourages an alternative design approach that integrates existing site features that facilitate natural hydrologic functions into the master plan. LID systems are designed to use and enhance predevelopment hydrologic, soil, and landscape conditions that promote on-site interception, capture, storage, treatment, and infiltration of stormwater. Site assessment, the first step in implementing this type of LID approach to stormwater management, involves carefully considering the project's intent and thoroughly evaluating, documenting, and analyzing predevelopment site conditions.

Definition Project Intent

The type of development being planned, and the expected uses and users of a site all have implications for effectively integrating LID features into the site, so these factors should be identified and documented early in a project. The designer should consider the following questions regarding the project's fundamental intent:

- Is the project a new or greenfield development, redevelopment or infill, or retrofit of an existing site?
- Is the property planned (and zoned) for residential, commercial, industrial, or public use?
- What local standards and/or programs offer incentives for and/or discourage implementing certain LID practices?
- Who are the expected users of the site (primary and secondary), and what are the project planners' expectations of how they will use the site?

An approach that includes LID is compatible with all types of development; however, the suite of LID practices most appropriate for the project can vary significantly from one site to the next depending on the answers to the questions above. The list of practices that can be applied to new development of a relatively undisturbed site is usually extensive, ranging from opportunities to preserve tree canopy and natural depressions in the landscape to flexibility in sizing and locating stormwater ponds to allow stormwater to be efficiently captured and harvested. The number of potential practices for retrofit applications, on the other hand, might be limited because of existing site constraints yet can be extensive in terms of the potential design scenarios for practices that are appropriate. Zoning requirements for different land-use categories may support the construction of certain LID practices and limit or prohibit others.

Those who will be using the site and the manner in which they will be using it can also influence the appropriateness and effectiveness of LID systems. For example, stormwater systems in residential applications are typically exposed and can often be physically accessed by homeowners, so LID applications should not only function as stormwater quantity and quality measures but also should be perceived as functional community amenities rather than nuisances or hazards.

Evaluating Predevelopment Conditions

When evaluating a site for the feasibility of integrating LID practices, the design professional must conduct a thorough analysis of predevelopment conditions. For this section, predevelopment conditions are site features – including assets and constraints – as they currently exist on the site. For new development projects, this predevelopment might closely resemble a natural or native landscape, whereas for redevelopment it is likely to be altered significantly from natural or native conditions. In this phase, the design professional should identify, understand, and document site conditions that facilitate rainfall interception, capture, storage, evaporation, transpiration, infiltration, treatment, and harvesting; note site features that restrict these natural hydrologic processes; and consider options for mitigating degraded conditions.

One way to begin this evaluation is to conceptually trace the path of rainfall as it moves within and through the site, considering for example the following types of questions:

- What natural features (e.g., tree canopy, vegetation) intercept and/or capture rain as it falls on the site and return portions of it to the atmosphere via evaporation and/or transpiration?
- What is the site topography, and does it promote stormwater drainage away from the site or capture and infiltrate stormwater on site?
- What are the hydrologic soil groups (as classified by the most current NRCS Soil Survey for Duval County, available at: http://websoilsurvey.nrcs.usda.gov/app/) and distributions on site and to what extent do they promote rainfall infiltration (i.e., what are their infiltration rates)? More than 60 percent of soils in Duval County are classified in the B/D, C/D, or A/D hydrologic soil group (not well-drained when wet) due to a shallow seasonal high water level (SHWL).
- Where and to what extent have soils been disturbed and/or compacted, reducing infiltration rates and promoting runoff generation?
- What is the elevation of the SHWL throughout the site?
- Do critical and sensitive areas (e.g., wetlands, riparian areas) that capture, uptake, and filter pollutants exist on site and have they been protected or disturbed?
- What physical structures (e.g., buildings, parking lots) intercept rainfall and convey it as stormwater to other areas of the site and/or away from the site?
- What pervious surfaces (natural and structural) allow stormwater to infiltrate parent soils?
- What impervious surfaces (natural and structural) prevent infiltration of stormwater and promote runoff?
- What engineered stormwater treatment systems exist on site and could they be enhanced or retrofitted to improve performance?

The collective opportunities and constraints posed by predevelopment site conditions will directly influence the final suite of LID practices most appropriate for a site.

Design professionals should assemble any available data and analyses that improve their understanding of predevelopment conditions and hire the appropriate Florida-registered and -licensed professionals to conduct additional surveys and/or inventories to fill important information gaps. Recommended datasets and analyses for the site and surrounding areas include but are not limited to the following:

- Historical and current land-use maps.

- Aerial photographs.
- Road and utility surveys.
- Topographic and drainage maps.
- Floodplain and wetland maps.
- Riparian zone/stream buffer maps.
- Most current NRCS Soil Survey data for Duval County (available at http://websoilsurvey.nrcs.usda.gov/app/) or other historical soil information.
- Tree and vegetation surveys.
- Rainfall data.
- Hydrologic analyses.
- Verifiable oral accounts of the natural hydrologic functioning of the site.
- Archaeological data.

With these, design professionals can identify key site opportunities for and constraints to LID, including those that affect the ability of the LID systems to control stormwater quantity and quality at the source, infiltrate stormwater on site, function effectively as a treatment train, and capture and store stormwater for harvesting.

4.2.3 Site Planning and Design

Site planning for LID stormwater management is similar to planning for conventional stormwater management in that it applies structural-engineered designs to meet stormwater quantity and quality criteria. LID site planning differs, however, by extending well beyond structural stormwater controls to include guidance on the fundamental design of a development; methods for protecting water quality and minimizing runoff generation at the source; practices that use physical, biological, and geochemical processes for stormwater treatment; and innovative stormwater harvesting options. Most if not all LID practices provide multiple stormwater, environmental, and aesthetic benefits, but the entire suite of practices that might be applied in terms of their relationship to the seven fundamental LID principles discussed in this section should be considered:

1. Preserve existing site assets.
2. Minimize and control runoff generation at the source.
3. Promote infiltration.
4. Promote stormwater harvesting.
5. Minimize site disturbance.
6. Preserve on-site SHWL.
7. Improve water quality.

Preserving Site Assets

Planning for projects that include LID requires design that capitalizes on the beneficial features, or assets, of a site. A thorough inventory and composite analysis of site features helps the project planner identify design options for conserving, preserving, protecting, and enhancing areas that promote LID function. These beneficial features include the following:

- Tree canopy and protected tree survey.
- Native species of vegetation.

- Natural landscape depressions distributed throughout the site.
- Native soils that have not been compacted or disturbed.
- Stream buffers or riparian zones.

Carefully managing these assets not only protects critical water resources but can also reduce or eliminate certain costs of site development, including those for vegetation clearing, site grading, erosion control, and post-development maintenance.

Minimizing and Controlling Runoff Generation at the Source

Conventional development practices modify natural site drainage pathways by introducing a network of impervious surfaces (e.g., rooftops, driveways, sidewalks, roads, gutters) that route stormwater away from the site or to stormwater treatment basins. While this process is very efficient at controlling runoff, it significantly alters the hydrologic signature of the site and increases runoff volumes and rates while conveying pollutants away from the site. Alternatively, LID emphasizes minimizing and controlling runoff and pollutant generation at the source. LID facilitates on-site infiltration by applying practices that preserve pervious surfaces, limit the total area of impervious surfaces introduced, and disconnect impervious surfaces.

Source-control design strategies, whether applied to new residential, commercial, or industrial development, are valuable not only for achieving stormwater quantity and quality targets but also for reducing site preparation and infrastructure costs. The following are among the key LID site-design practices that promote volume control and water quality protection at the source (subject to zoning code requirements or restrictions):

- Preserving mature tree canopy, protected trees, and understory vegetation.
- Clustering homes, buildings, and other structures on smaller lots
- Constructing green roof stormwater treatment systems.
- Minimizing impervious areas.
- Minimizing directly connected impervious areas (DCIA).
- Using natural topographic lows and natural drainage paths as a part of the drainage system design.
- Using shared driveways in residential applications.
- Using narrower roads with a pervious shoulder and/or right-of-way.
- Using a road layout that minimizes linear impervious area.
- Using alternative parking lot designs that minimize total impervious area.
- Designing landscapes that minimize turf or landscape plants with high nutrient and water requirements.
- Designing landscapes that maximize preservation of existing native vegetation and introduce new vegetation that is appropriate for site conditions (e.g., Florida-friendly landscaping).
- Irrigating for vegetation establishment only or using smart water-application technologies, such as soil-moisture sensors, that maximize irrigation efficiency.

Promoting Infiltration

Many LID strategies that reduce stormwater generation at the source do so by preserving and promoting opportunities for infiltration on site. While potential stormwater infiltration capacity and rates are constrained by predevelopment conditions such as SHWL and soil types, infiltration-dependent LID practices can be designed to perform effectively as part of a treatment train under most site conditions in Duval County. Design professionals should identify optimal areas for locating infiltration-dependent stormwater practices (i.e., those with the highest infiltration rates) during the site-assessment phase of development. Specific LID practices that preserve or enhance infiltration function throughout the catchment basin include the following:

- Retaining pervious surface areas.
- Using bioretention.
- Using pervious pavements (Section 4.5) for parking lots and residential parking areas, driveways, walking and bike paths, sidewalks, and emergency vehicle access lanes.
- Using grassed conveyance swales to convey stormwater.
- Using vegetated swales with check dams to promote retention on a site.
- Engineering or amending soils to improve infiltration properties.
- Ecologically and biologically enhancing stormwater treatment ponds

Promoting Stormwater Harvesting

Design professionals should consider stormwater an asset that can be used to reduce the impact of development projects on Duval County water resources. Rather than designing systems that allow stormwater to leave the site, often exacerbating downstream flooding and surface water degradation, LID promotes treating and harvesting stormwater on site. Stormwater harvesting can offset potable water demands significantly, particularly when used for outdoor irrigation, which accounts for approximately 50 percent of residential households' water use in Florida (Purdum, 2002). Specific stormwater-harvesting practices such as the following should be considered in site planning:

- Cisterns or rain barrels for collecting, storing, and using rainwater, air- conditioning condensate, and graywater for irrigating lawns and landscape beds, irrigating green roofs, washing vehicles, cooling tower make-up water, and toilet flushing as approved by Duval County health codes.
- Stormwater harvesting ponds, typically used for irrigating lawns and landscape beds.
- Distribution pipes for non-potable water (i.e., stormwater harvesting or reclaimed water)

Minimizing Site Disturbance

Mechanisms to reduce site disturbance before, during, and after construction are some of the most critical elements of an integrated and effective approach to LID stormwater planning. Opportunities to preserve and promote natural hydrologic functioning of a site are often lost as a result of conventional development practices such as non-selective site clearing, exporting native soils, importing fill, mass grading, and using heavy machinery for construction in sensitive areas. Compacting soils reduces the pore space available for stormwater storage and infiltration. Some 80 percent of compaction occurs in the first pass of a vehicle across the soil, and compaction occurs to deeper depths in wetter soils. Clearing, grading, and construction measures that minimize site disturbance and promote LID function include:

- Minimizing the clearing area.
- Clearing selectively.
- Using smaller and lighter construction equipment where possible.
- Keeping heavy equipment outside the drip line of preserved trees.
- Minimizing grading and importing of fill (e.g., through use of stemwall construction).
- Keeping heavy equipment off soils where infiltration-dependent stormwater practices will be used.
- Designating laydown areas for construction equipment and materials.

- Sequencing construction to minimize the disturbed area and reduce the potential for erosion on the site.

City of Jacksonville stormwater regulations provide maximum allowable compaction values when constructing certain LID practices, such as pervious pavements (see Section 4.5).

4.2.4 Performance Monitoring and Feedback Mechanisms

Design professionals should provide a plan for performance monitoring and feedback mechanisms to ensure that LID systems are operating as designed or alternatively to alert stormwater managers when individual practices or entire systems are not achieving performance goals. This plan should allow monitoring and feedback to occur through all project phases: before, during, and after construction. Specific monitoring and feedback requirements are defined for each practice in this section; however, these requirements should be confirmed with the City and SJRWMD staff during the pre-application meetings. The performance requirements and recertification requirements for stormwater systems may differ between the City and SJRWMD.

4.2.5 Project Guidance for Design Professionals

LID techniques offer a wide diversity of applications for both new and redevelopment projects that can be implemented in virtually any project situation encountered within Duval County. In planning any LID project, design professionals should note that LID techniques complement traditional stormwater treatment BMPs. They do not necessarily provide the full water quality treatment or stormwater attenuation requirements of City of Jacksonville or SJRWMD. LID practices may often require a combination of treatment strategies to achieve the treatment goal. In this regard, the design professional is encouraged to consider various LID techniques in this section to use in a treatment-train arrangement to optimize the effectiveness of LID and to achieve the traditional water quality benefits recognized through City of Jacksonville permitting and the SJRWMD ERP review process.

The traditional approach to stormwater management design is based on storage of a specified volume of stormwater. The City of Jacksonville recognizes that LID practices offer additional treatment benefits through detention and natural treatment processes. These additional processes are environmentally beneficial and offer advantages for the design professional to meet new proposed treatment goals. The design professional may be required to provide supporting technical documentation to demonstrate reasonable assurance to meet State water quality criteria for LID practices to successfully secure a permit. To achieve a successfully permitted project, the design professional must understand how environmental variables will affect the feasibility and placement of treatment features.

4.2.6 References

Purdum, E. D. (2002). Florida Waters: A Water Resources Section from Florida's Water Management Districts. Available: http://www.sjrwmd.com/floridawaters/index.html (Accessed 05/29/2009).

4.3 Grassed Conveyance Swales

Key Considerations	Practice Intent: ▪ Retain, infiltrate, and treat stormwater from small events close to source. ▪ Convey stormwater from larger events to the next practice in the treatment train. Design Criteria: ▪ Top width-to-depth ratio equal to or greater than 6:1. ▪ Recommended bottom width of 2 to 8 feet. ▪ Longitudinal slope between 0.5 percent and 3 percent. ▪ Landscape with turf grass suitable for soil stabilization, maintainability, stormwater treatment and conveyance, and nutrient uptake. Advantage/Benefits: ▪ Good retrofit capability. ▪ Can be planned as an aesthetic feature. ▪ Low construction cost. ▪ Low maintenance cost. ▪ Combines treatment and conveyance. Disadvantages/Limitations: ▪ More frequent maintenance than a curb-and-gutter system. ▪ Cannot be used on steep slopes. Maintenance Requirements: ▪ Maintain grass heights of 4 to 6 inches. ▪ Remove trash, litter, and sediment. Monitoring/Record Keeping: ▪ None. Recovery: ▪ Standing water must be recovered within 72 hours.
Pollutant-Removal Potential	H Total Suspended Solids. M Nutrients—Total Phosphorus/Total Nitrogen. L Metals—Cadmium, Copper, Lead, and Zinc. L Pathogens—Coliform, Streptococci, and E.Coli.
Stormwater Management Suitability	☒ Water Quality ☐ Flood Attenuation
Implementation Considerations	Residential Subdivision Use: Well suited High-Density/Urban: Less frequent Drainage Area: To receive pollutant-load-reduction credits, point discharges to a swale should be from areas of 1 acre or less. This area threshold does not apply to inflows along the swale length. Shallow Water Table: To receive pollutant-load-reduction credits, the SHWL should be at least 6 inches below the bottom of the grassed conveyance swale. Soils: Water quality benefits are reduced by low soil permeability.
Other Considerations	Use of drought-tolerant turf grass is recommended

L—Low, **M**—Moderate, **H**—High

4.3.1 General

A swale is defined by the State of Florida as a manmade trench that meets the following criteria:

- Has a top width-to-depth ratio of the cross section equal to or greater than 6 (H):1(V) or side slopes equal to or greater than 3(H):1(V).
- Contains contiguous areas of standing or flowing water only after rainfall.
- Is planted with or has stabilized vegetation suitable for soil stabilization, stormwater treatment, and nutrient uptake.
- Is designed to account for soil erodibility, soil percolation, slope, slope length, and drainage area to prevent erosion and reduce pollutant concentration of any discharge.

Grassed conveyance swales are used to move stormwater away from critical infrastructure, such as a road. However, these systems are also able to provide water quality improvement through processes such as infiltration, settling, and filtration. Grassed conveyance swales are included because they provide both a conveyance and treatment function and meet the distributed stormwater treatment goals of LID. Figure 4.3-1 shows features of a grassed swale system.

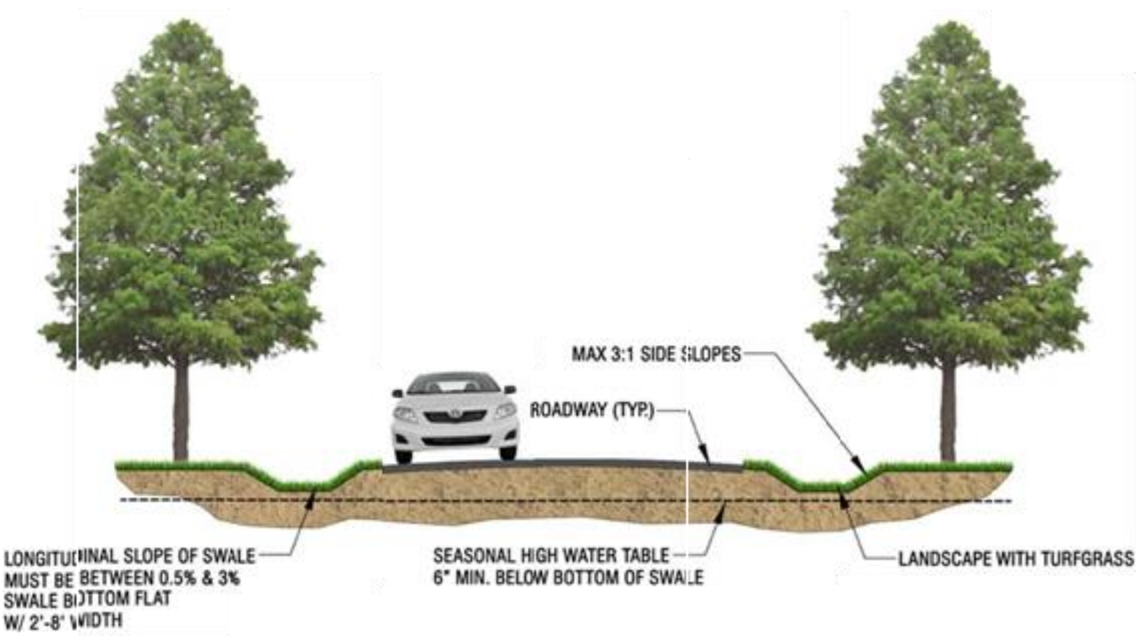


Figure 4.3-1 Cross-Section View of a Grassed Swale System

Grassed conveyance swales provide infiltration capacity that can capture and infiltrate stormwater close to the source of the runoff. When the storm event is too large to be infiltrated, the swale is used to convey the excess runoff to another stormwater management practice, such as a wet detention pond. Grass in the swale helps filter pollutants, increase particulates settling, stabilize soils, and minimize erosion. Swales can be an important component in a stormwater treatment train as they provide water quality improvements and conveyance. Grassed conveyance swales are open conveyance systems and do not include any physical barriers such as swale blocks or raised driveway culverts. Watershed models such as EPA-SWMM5 include components that can be used to model the hydraulics and water quality benefit of grassed conveyance swales. Research published by authors such as Barrett et al. (1998), Deletic & Fletcher (2006), Yousef et al. (1987), and PBS&J (2010) have demonstrated how effective conveyance swales can be at reducing pollutant loading through both infiltration and pollutant- concentration reductions.

The current SJRWMD presumptive criteria for permitting grassed conveyance swales as a stormwater- quality BMP require that a swale percolate either 80 percent or 100 percent of the 3-year/1-hour storm depending on the receiving water body. This section provides a methodology for accounting for the water quality improvement of grassed conveyance swales that are not able to infiltrate a sufficient volume to meet the SJRWMD presumptive criteria.

For stormwater quality permitting, a swale that includes a ditch block would be permitted as a linear retention basin. The permitting methodology for these types of systems is not covered in this section as it is already established by SJRWMD and published in the SJRWMD Applicant's Handbook: Regulation of Stormwater Management Systems (SJRWMD, 2010, page 11-1).

Water Quality Control

Grassed conveyance swales will provide some attenuation of peak discharge volumes. However, they will most likely not provide sufficient attenuation to meet SJRWMD water quantity control criteria or the City of Jacksonville Master Stormwater Management Plan special basin criteria.

A grassed conveyance swale is usually able to provide a significant reduction in total loads of suspended solids, phosphorus, nitrogen, and metals through runoff-volume reduction and pollutant-concentration reduction. Grassed conveyance swales may not always provide sufficient water quality improvements to meet all SJRWMD water quality requirements. However, despite this limitation they can be a valuable component of the treatment train because they provide both a conveyance and treatment function.

General Feasibility

A grassed conveyance swale is typically used in place of a conventional curb-and-gutter stormwater system and is most widely used within the right-of-way alongside a road shoulder or within a median. Grassed conveyance swales can also be used to convey site runoff within other settings such as residential, commercial, or institutional developments.

Physical Constraints

When evaluating the appropriateness of a swale system, a design professional should consider some of the physical constraints associated with this type of treatment system including:

- SHWL – Must be at least 6 inches below the bottom of the swale.
- Slope – Low- to-moderately sloped sites.
- Right-of-way – Sufficient width in the right-of-way to include a swale.

4.3.2 Design Considerations and Requirements

The following criteria are considered minimum standards for designing a grassed conveyance swale. Consult with SJRWMD to determine whether any variations must be made to these criteria or if additional standards must be followed.

General

A grassed conveyance swale should be designed to convey at least the 5-year/24-hour design storm without erosion, scouring, or localized flooding. The average annual pollutant-load reduction for a grassed conveyance swale that is unable to infiltrate the 3-year/1-hour storm can then be calculated using the methods described in this section.

Location and Planning

Grassed conveyance swales are generally located within the right-of-way. However, they can also be used as a conveyance feature in other settings such as residential, commercial, or institutional. Grassed conveyance swales are designed for intermittent flow and should not be used on sites with a continuous flow from groundwater, sump pumps, or other sources.

Sizing Requirements

- For maintenance reasons, the swale should have an approximately trapezoidal shape with a bottom width of at least 2 feet to allow mowing.
- The bottom width should be less than 8 feet to avoid forming erosion channels. If the bottom width is greater than 8 feet, a level spreader must be constructed at least every 150 feet along the swale to prevent erosion.
- The side slope should be 3:1 or flatter.
- The longitudinal slope must be between 0.5 percent and 3 percent. The slope should allow the swale to drain but not erode.
- The maximum velocity in the swale for the design storms must not exceed the maximum permissible velocities provided in **Table 4.3-1**.

Table 4.3-1 Maximum Permissible Velocity for Grassed Conveyance Swales (Source Livingston et al 1988)

Channel	Lining	Permissible Velocity (ft/sec)
0 – 5%	Bermuda Grass Bahia Bluestem (broomsedges) Grass-Legume Mixture Sericea Lespedeza Annual Lespedeza Small Grains (temporary)	6.0 5.0 5.0 4.0 2.5 2.5 2.5
5 – 10%	Bermuda Grass Bahia Bluestem (broomsedges) Grass-Legume Mixture	5.0 4.0 4.0 4.0

- All culverts within the swale system should be sized to ensure that the maximum velocity within the culverts does not exceed the maximum permissible velocity for the swale for the design storms because this can result in erosion at the culvert outlet. The appropriate erosion-protection measures should be provided in cases where this maximum permissible velocity is exceeded within a culvert.
- The designer should determine Manning's n considering roughness, flow depth, velocity, and channel geometry. Use Figure 4.3-1 to determine the Manning's n coefficient.

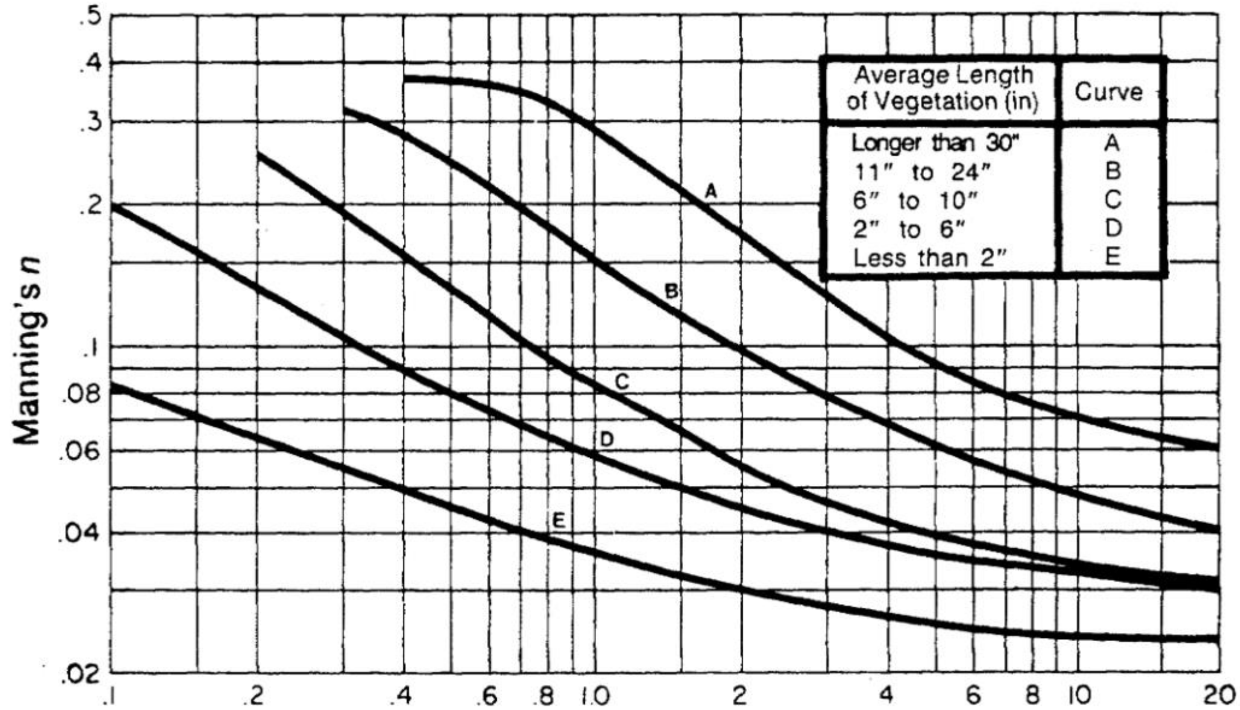


Figure 4.3-1 Manning's "n" Related to Velocity, Hydraulic Radius, and Vegetal Retardance (Source "E&S Control Planning and Design Manual," DEHNR, May 1994 Revised)

- Design infiltration rate should be no more than half the field-measured infiltration rate. The infiltration rate should be field-measured at the depth of the swale bottom using a double-ring infiltrometer and should follow the methodology provided in ASTM D3385-09.
- Swales must be designed to maintain the appropriate flooding level of service.
- Off-street parking that can cause rutting or compaction should be prohibited within 3 feet of the top of bank of the swale.
- Swales must not be constructed within 50 feet of a public or private potable water supply well.
- Discharges into the swales should be as distributed along the length of the swale. The maximum contributing area to a point discharge into the swale is 1 acre.

Discharge Requirements

Grassed conveyance swales are commonly used as a component of the treatment train and may not have a specific flow-attenuation requirement. However, the complete stormwater treatment system for the site must meet SJRWMD and City of Jacksonville water-quantity discharge requirements.

Recovery Requirements

All standing water must be recovered through surface discharge or percolation in less than 72 hours under SHWL conditions with average antecedent soil moisture conditions in the soil profile. An appropriate Florida-registered and -licensed professional must analyze discharge from the swale including percolation and surface flow. Site-specific geotechnical data must be used to determine percolation. For guidance on the number of borings, refer to SJ93-SP10 (SJRWMD, 1993).

Water Quantity Credits

Swale systems may provide some attenuation of peak discharge. This attenuation can be demonstrated using a hydrologic or hydraulic model that has been accepted by SJRWMD.

Water Quality Treatment Requirements/Credits

For permitting as a stormwater BMP, SJRWMD requires that a grassed conveyance swale discharging to a Class I watershed, a Class II watershed, or an Outstanding Florida Water or a Class III watershed restricted for shellfish harvesting be designed to percolate all runoff from the 3-year/1-hour storm and that swales discharging to a Class-III-receiving water body be designed to percolate 80 percent of the runoff from the 3-year/1-hour storm. However, most swale systems are intended to be part of a treatment train in which each practice in the train provides incremental water quality benefits. The level of treatment that can be expected from these systems is based on the average annual volume of water captured and percolated in the swale system and the pollutant-concentration reductions that occur within the grassed conveyance swale.

For those systems that cannot percolate the required volume of the 3-year/1-hour storm, the percentage of the average annual runoff volume percolated in the swale system can be estimated using one of the following methods:

- Continuous simulation – A continuous simulation of the percolation that occurs in the system using a hydrologic and hydraulic model accepted by SJRWMD and a long-term rainfall record (at least 30 years) for Duval County.
- BMPTRAINS model – The Stormwater BMP Treatment Trains model (http://www.stormwater.ucf.edu) may be used to determine the percentage of the average annual volume of water percolated or retained by the grassed conveyance swale. This model requires that the drainage area, swale dimensions, swale length, and infiltration rate are known. Reduction factors for high water table conditions must be used where applicable and are discussed below.
- Other Accepted Methodology – Any methodology accepted by SJRWMD for calculating the long-term average-annual performance of grass conveyance swales.
- The BMPTRAINS model assumes that the SHWL is at least 24 inches below the bottom of the swale. In situations where the SHWL is between 24 and 6 inches below the bottom of the swale, a reduced average-annual performance must be calculated by multiplying the BMPTRAINS-determined average-annual performance by the appropriate reduction factor in **Table 4.3-2**. This table provides a range of performance-reduction factors that are applied based on the design soil infiltration rate.

Table 4.3-2 Performance Reduction Factors for Average Annual Percolation Volume for Grassed Conveyance Swales in Duval County for SHWL between 24-inch and 6-inch of the Swale Bottom

Design Soil Infiltration Rate[1]	Average Annual Performance Reduction Factors[2]
< 1 inch/hour	0.95
1 to 5 inches/hour	0.75
> 5 inches/hour	0.60

1. Field determined using double ring infiltrometer.
2. Developed for this section from multiple 30-year continuous simulations of a swale in Duval County under various high water table conditions in EPA-SWMM5. It was found that percolation performance under high water table conditions was sensitive to soil hydraulic conductivity.

In addition to reducing the volume of runoff from a site, swales can reduce pollutant concentrations. Accounting for this reduction should be discussed with SJRWMD regulatory staff at a pre-application meeting. The reduced pollutant concentration of stormwater from a swale may also have an effect on the performance of downstream BMPs such as detention ponds.

An additional pollutant-load reduction to account for reduced concentrations should only be considered for grassed conveyance swales with a contributing-area-to-length ratio less than or equal to 0.5 acre/100 feet. This pollutant-concentration reduction can be determined from **Table 4.3-3**, or another reference accepted by SJRWMD and City of Jacksonville and can only be considered after the load reduction through percolation has been accounted for. Future monitoring of swale nutrient-removal efficiencies by the City of Jacksonville will be used to refine Table 4.3-3.

Table 4.3-3 Average Annual Concentration Reduction in a Grassed Conveyance Swale

Pollutant	Average Annual Concentration Reduction
TN	30%[1]
TP	16%[1]
TSS	78%[1]

1. 1st Quartile of published average concentration reductions from Barret et al. (1998), Deletic & Fletcher (2006), Yousef et al. (1987), and PBS&J (2010).

The average annual removal efficiency of the swale is assumed to be equivalent to the fraction of the average annual runoff retained and percolated by the swale system and the fraction of the average annual load reduction due to decreased pollutant concentrations. Equation 4.3-1 calculates the average annual effectiveness of the swale.

$$E_{tot} = E_{perc} + (1 - E_{perc})E_{conc} \qquad (4.3\text{-}1)$$

Where: E_{tot} = Total average annual removal efficiency of the swale (decimal fraction)

E_{perc} = Average annual runoff retained and percolated by the swale (decimal fraction)

E_{conc} = Average annual concentration reductions (decimal fraction

Maintenance Access

Access to the swale area must be provided at all times for inspection, maintenance, and landscaping upkeep, and sufficient space must exist around the swale system to allow accumulated surface sediments to be removed if the system fails inspection.

Safety Features

Grassed conveyance swales must meet all Florida Department of Transportation and City of Jacksonville safety requirements.

Landscaping

Vegetation enhances the performance and function of grassed conveyance swales. Turf grass in the swale should be quickly established and be weed-resistant and tolerant of short-term ponding and periods of low soil moisture. The unpaved contributing area must be well-vegetated to minimize erosion and sediment inputs to the swale system.

4.3.3 Design Procedure

Design Steps

- Step 1 – Determine if the development site and conditions are appropriate for a grassed conveyance swale. Consider the Application and Site Feasibility Criteria including Physical Constraints and Location and Planning.
- Step 2 – Follow the SJRWMD design criteria and guidelines for swale systems to determine if the swale is able to percolate the required volume during the 3-year/1-hour storm.

- Step 3 – If the swale does not meet the SJRWMD requirements in Step 2, use the BMPTRAINS model (http://www.stormwater.ucf.edu/) for grassed conveyance swales to determine the average- annual pollutant load reduction:
  - Step 3a – Determine the drainage area and its runoff response characteristics such as DCIA and Non-DCIA CN values.
  - Step 3b – Determine swale dimensions. Size bottom width, depth, length, and slope necessary to convey the design storm.
    1. The maximum velocity should be determined from Table 4.3-1.
    2. If possible, the bottom width should be between 2 and 8 feet.
    3. Side slopes should be 3:1 or flatter.
    4. Manning's n should be determined considering swale geometry, roughness, flow depth, and flow velocity.
  - Step 3c – Find the average annual treatment efficiency from BMPTRAINS model or other accepted methodology. This efficiency is the average annual pollutant-load reduction due to percolation for each constituent.
  - Step 3d – Calculate the total average annual pollutant-load reduction using Table 4.3-2 if required and Table 4.3-3.
- Step 4 – If necessary, determine the effectiveness of the entire "treatment train" by accounting for the effectiveness of all stormwater BMPs on a site. Additional stormwater treatment capacity may need to be designed to ensure that the system meets the water quality and quantity requirements for the site.

Design Example

The following example is intended to guide a design professional through designing a grassed conveyance swale.

Assume a residential project in Jacksonville is discharging to the St. Johns River between Julington Creek and the mouth of the river, which is classified as an OFW, with the following site characteristics:

- Drainage area = 10 acres.
- Post-development runoff coefficient (Cp) = 0.4.
- Tc = 20 minutes; S = 3 percent.
- Fillable Porosity (f) = 0.3.
- Field infiltration rate determined by double-ring infiltrometer tests at the depth of the swale bottom and divided by 2 to account for air entrapment (Kvs) = 36 in/hr.
- Factor of Safety (FS) = 2.0.
- Height of swale bottom above seasonal high groundwater table (hb) = 4 feet.
- Rectangular project site with dimensions of length = 660 ft and width = 660 feet.
- Three streets each 600 feet long with swales on both sides.

The objective is to design a swale system to percolate all or part of the required treatment volume that meets the capacity and velocity requirements for swales.

Design Calculations

- Step 1 – Review the development site and conditions–Physical Constraints and Location and Planning – and determine if appropriate for a grassed conveyance swale.
- Step 2a – Determine the Sustained Peak Runoff Rate (Q_P) and Volume of Runoff (V_R).
- For swales discharging to an OFW, SJRWMD rules requires that if a swale will be used as the only stormwater practice on site, the swale must be able to percolate 100 percent of the runoff from the 3-year, 1-hour storm. In Duval County, grassed conveyance swales that do not percolate all the required treatment volume can be used for partial treatment of stormwater. For this example, the 3-year, 1-hour storm is 2.4 in/hr.

  Q_p is expressed as:

  $$Q_P = C_p I_D A \quad (4.3.2)$$

  Where: Q_P= Peak runoff rate from the 3-year, 1-hour rainfall intensity (*cfs*)

  I_D = Average rainfall intensity for a 1-hour duration (*in/hr*)

  A = Drainage area (*acres*)

  Q_P = (0.4) 2.4 *in/hr* (10 *ac*) = 9.6 *cfs*

  The volume of runoff (V_R) is found by using Equation 3.1-3:

  $$V_R = Q_P D \quad (4.3.3)$$

  Where: V_R= Volume of runoff (ft^3)

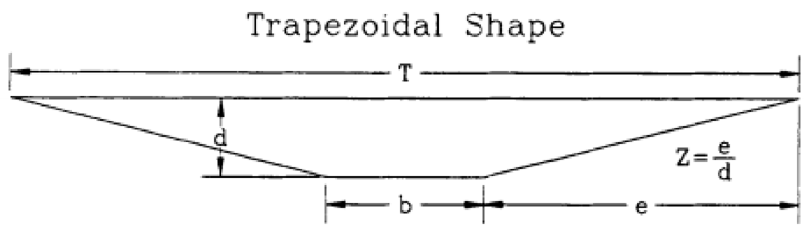
  D = Rainfall duration (*min*)

  V_R = (9.6 *cfs*) (60 *min*) (60 *sec/min*) = 34,560 ft^3

  Since each swale serves approximately an equal drainage area and project land use, the peak runoff rate (Q_P) per swale represents a more realistic flow for the design of the treatment function for the swale. The peak runoff flow rate (Q_P) per swale is:

  Q_P *per swale = 9.6 cfs / (3 streets)(2 swales/street)= 1.6 cfs*

- Step 2b – Select swale dimensions and determine flow depth and percolation area. Assume a trapezoidal shaped swale with side slopes of 4:1 and a bottom width (b) of 2 feet. From **Figure 4.3-2**



Cross-Sectional Area (A) = $Zd^2 + bd$
Top Width (T) = $b + 2dZ$
Hydraulic Radius = $\frac{Zd^2 + bd}{b + 2d\sqrt{Z^2 + 1}}$
Wetted Perimeter (P) = $b + 2d\sqrt{Z^2 + 1}$

Figure 4.3-2 Typical Waterway Shapes and Mathematical Expressions for Calculating Cross-sectional Area, Top Width, Hydraulic Radius, and Wetted Perimeter (Source Livingston et al 1988)

$Z = e/d = 4$

Cross-sectional area (A_{cs}) = $Z d^2 + bd = 4d^2 + 2d$

Hydraulic Radius (R) = $(Z d^2 + bd) / (b + 2d (Z^2+1)^{1/2}) = (4d^2+2d) / (6+6d)$

Where: d = Normal depth of flow in the channel (ft)

Use Figure 4.3-1 to determine Manning's roughness coefficient (n) based on the hydraulic radius of the swale. For Bahia grass, assume the grass is a good stand and mowed. Therefore, the retardance class = Class D and n = 0.04 for design of the swale treatment capacity. A more overgrown condition (retardance class = B and n = 0.077) should be considered for conveyance and level of service flood protection design.

To solve for the normal depth (d), first rearrange the equation for the flow capacity of an open swale:

$Q = (1.49/n)(R^{2/3})(S^{1/2})(A_{cs})$

to give:

$R^{2/3} A_{cs} = Q n / (1.49 S^{1/2})$

Substituting the above values of Q, n, and S:

$R^{2/3} A_{cs} = 1.6 (0.04)/(1.49 (0.03)^{1/2}) = 0.25$

Trial #1: Assume d = 0.5 ft. Acs is:

$A_{cs} = 4 (0.50\ ft)^2 = 1.0\ ft^2$
$R = (4(0.5)^2+2(0.5))/(6+6(0.5)) = 0.327\ ft$
$R^{2/3} A_{cs} = (0.327)^{2/3} 1.0 = 0.47$

Since 0.47 ≠ 0.25, try another value for *d*.

Trial #2: Assume d = 0.40 ft

$A_{cs} = 4\,(0.40\ ft)^2 = 0.64\ ft^2$

$R = (4(0.40)^2+2(0.40))/(6+6(0.40)) = 0.27\ ft$

$R^{2/3}\,A_{cs} = (0.27)^{2/3}\ 0.64 = 0.27$

Since 0.27 ≈ 0.25, the value of d = 0.40 ft is acceptable.

Also, from Figure 4.3-2, the wetted perimeter (*P*) is:

$P = 2d(1+Z^2)^{1/2} = 2\,(0.40)(1+4^2)^{1/2} = 1.79\ ft$

The total length of swales, L = (3 *streets*) (2 *swales / street*) (600 *ft / swale*) = 3,600 *ft*

The total percolation area (A_b) can be determined:

$A_b = L\,P = (3600\ ft)\ 1.79\ ft = 6440\ ft^2$

The percolation area (A_b) per swale is:

A_b per swale = (600 *ft*) 1.79 *ft* = 1073 ft^2 per swale

- *Step 2c* – Check for lateral saturated infiltration (see SJRWMD Handbook Section 26 for a complete description of infiltration processes).

Volume percolated under vertical unsaturated flow (V_u) is determined from Equation 4.3.4:

$$V_u = A_b f\,h_b = 6{,}440\ ft^2\,(0.3)\ 4\ ft = 7{,}728\ ft^3 \qquad (4.3.4)$$

Where: V_u= Volume of water required to saturate the soil below the swale

h_b = Height of swale bottom above the ground water table

f = Fillable porosity (generally 0.2 to 0.3)

Since $V_u < V_R$ percolation will not occur entirely under vertical unsaturated flow conditions, an analysis of lateral saturated infiltration and/or an open channel routing analysis using a SJRWMD-accepted groundwater mounding analysis or hydraulic routing model will be required to demonstrate that the swale can recover the treatment volume (through percolation or surface discharge) within 72 hours.

For this design example, we assumed that we were able to use PONDS to demonstrate that the swale was able to recover the treatment volume within 72 hours.

- *Step 2d* – Calculate the peak infiltration flow rate (Q_{iP}):

The unsaturated vertical hydraulic conductivity (K_{vu}) is found by the following:

$$K_{vu} = \frac{2\ (36\ in/hr)}{3} = 24\ in/hr$$

The design infiltration rate (I_d) is:

$$I_d = \frac{24\ in/hr}{2} = 12\ in/hr$$

Where 2 is a factor of safety recommended by the SJRWMD.

The peak infiltration rate (Qi_P) per swale is determined with the infiltration area (A_b) per swale = 1,073 ft^2:

Qi_P per swale = 12 *in/hr* (1,073 ft^2 per swale) (1 ft/12 in) (1 hr/60 min)

Qi_P per swale = 17.9 ft^3/min = 0.30 ft^3/sec per swale

- Step 2e – Calculate the volume of water infiltrated (VI) per swale and compare to the required infiltration volume.

Using V1 = QiP (D + Tc - (Tc*QiP)/Qp)) (3.1-5)

Where: *Tc* = 20 min; *D* = 60 min; Qi_P = 17.9 ft^3/min; and Q_P = 1.6 ft^3/sec:

V_1 per swale = 17.9 ft^3/min (60 min + 20 min - (20 min(17.9 ft^3/min)/((1.6 ft^3/sec)(60 sec/min))

V_I per swale = 1,365 ft^3 per swale

Total V_I = 1,365 ft^3 per swale x 6 swales = 8,191 ft^3

Required percolation volume for discharges to OFW receiving waters is 100 percent of the 3-year/1-hour runoff volume (V_R):

The required infiltration volume = V_R = 34,560 ft^3

Since the swale can only infiltrate 23.7 percent (V_I) of the runoff (V_R) from the 3-year/1-hour storm, the design is inadequate as the only stormwater quality practice on the site.

- Step 3 – Use the BMPTRAINS model for grassed conveyance swales to determine the average-annual pollutant-load reduction.
  - Duval County is in Meteorological Zone 4.
  - The drainage area is 10 acres with 3.3 acres draining to each street.
  - Assume that the site has a non-DCIA CN of 65 and with 45 percent DCIA.
  - The swale length is 600 feet.
  - Highway length is 600 feet.
  - Highway width—including parking and shoulders—contributing to each swale is 34 feet.
  - The average width of the pervious area draining to the swale is 46 feet.
  - Swale slope is 0.03 foot/foot.
  - Swale top width for flood conditions is 12 feet.
  - Manning's n is 0.04.
  - Soil infiltration is 12 inches/hour.
  - Swale side slope 4:1.
  - No ditch blocks are proposed for the swale since it is primarily for conveyance.

The BMPTRAINS model shows that 84 percent of the average annual runoff volume is percolated by the swale. Since the SHWL is more than 2 feet below the bottom of the swale, the efficiency of the swale does not need to be adjusted.

In the design example, the ratio of the contributing area to the swale length is 0.28 acre/100 feet, which is less than 0.5 acre/100 feet noted in Section 3.1.2.7. Therefore, additional pollutant removal through concentration reductions (Table 3.1-2) can be considered. Using Equation 3.1-1 would result in the following average annual swale effectiveness:

- TN = 0.84 + ((1 – 0.84) x 0.30) = 0.89
- TP = 0.84 + ((1 – 0.84) x 0.16) = 0.87
- TSS = 0.84 + ((1 – 0.84) x 0.78) = 0.96

If the SHWL had been between 24 and 6 inches from the bottom of the swale, the percolation effectiveness (Eperc) of the system would have been adjusted using Table 3.1-1. Since the soil infiltration rate is 12 inches/hour, the reduction factor is 0.6 and the swale effectiveness would be calculated as follows:

- Eperc = 0.84 x 0.6 = 0.50

Considering the additional pollutant removal through concentration reductions (Equation 3.1-1) would result in the following average annual effectiveness if the SHWL had been between 24 and 6 inches from the bottom of the swale:

- TN = 0.50 + ((1 – 0.50) x 0.30) = 0.65
- TP = 0.50 + ((1 – 0.50) x 0.16) = 0.58
- TSS = 0.50 + ((1 – 0.50) x 0.78) = 0.89

- Step 4 – If we assume that due to land use changes the overall stormwater system needs to provide a 93 percent reduction in the annual load of TN, TP, and TSS to meet the “net improvement” required for discharging to an impaired waterbody, then a downstream stormwater BMP will be required to further reduce the TN and TP load.
- The following calculations demonstrate how a downstream stormwater management system could be sized to meet water quality standards given the swale with SHWL more than 2 feet below the bottom on the swale.

Assuming that a wet detention system is the most appropriate downstream stormwater management system to provide flood control and additional water quality improvements, then the overall stormwater system effectiveness can be calculated using the following equation.

$$E_{tot} = E_{swale} + (1 - E_{swale})E_{det}$$

Where: E_{tot} = Annual removal efficiency of the swale and detention pond combination (decimal fraction).

E_{swale} = Annual removal efficiency of the swale that was calculated in Step 3 (decimal fraction).

E_{det} = Annual removal efficiency of the detention pond (decimal fraction).

See Figure 1.1 for a graphical representation of the above calculations.

Therefore:

Edet = (Etot - Eswale) / (1 - Eswale)

TN: E_{det} = (0.93 - 0.89) / (1 - 0.89) = 0.36

TP: Edet = (0.93 - 0.87) / (1 - 0.87) = 0.46

Therefore:

The wet detention system will need to provide at least a 36 percent reduction in annual TN loading and a 46 percent reduction in annual TP loading.

The Florida Department of Environmental Protection and Water Management Districts' Environmental Resource Permit Stormwater Quality Applicant's Handbook (March 2010 – Draft) provides the following equations for calculating removal efficiency of TP and TN in a wet detention pond given a residence time (t_d):

$$TP = 44.53 + 6.146*\ln(t_d) + 0.145*(\ln(t_d))^2$$

$$TN = (43.75*t_d) / (4.38 + t_d)$$

Solving for t_d to get a TP removal efficiency of 46 percent gives t_d = 1.2 days

Solving for t_d to get a TN removal efficiency of 43 percent gives t_d = 20.3 days.

Therefore, the wet detention system should be sized to provide a residence time greater than 20.3 days.

- The size of the wet detention system can then be calculated using the following: Treatment Volume

  1-inch runoff: TV = (10 ac x 1 inch) / 12 = 0.83 acre-feet

  2.5 inch over impervious area: TV = (4.5 acres x 2.5 inches) / 12 = 0.94 acre-feet Therefore, the required treatment volume is 0.94 acre-feet.

  Permanent Pool Volume:

  PPV = (DA x C x R x RT) / (WS x 12)

  Where: DA = Drainage area to pond (acre).

  C = Runoff coefficient.

  R = Wet-season rainfall depth (inches) (Rao et al., 1990).

  RT = Residence Time (days).

  WS = Length of wet season (153 days).

  FR = Average Flow Rate (acre-feet/day).

  PPV = Permanent Pool Volume (acre-feet).

  The results of the BMPTRAINS model in Step 3 show that 84 percent of the average annual runoff into the swales is percolated. Therefore, the effective runoff coefficient for the pond can be estimated to be 0.16.

  PPV = (10 x 0.16 x 30 x 20.3) / (153 x 12) = 0.53 acre-foot

  Therefore, the required permanent pool to achieve a 20.3 day residence time is 0.53 acre-foot.

  It should be noted that the 93 percent load reduction achieved by this treatment train could not have been achieved by a wet detention system alone. The combination of a grassed conveyance swale and wet detention was crucial in meeting the net improvement requirement.

4.3.4 Construction

The following construction procedures are required to avoid degrading the swale's infiltration capacity:

- Verify the location and dimensions of the swale system on site before its construction. All design requirements including swale dimensions and distances to foundations, septic systems, and wells need to be verified.
- Clearly mark the locations of swales at the site to prevent unnecessary vehicular traffic across the area causing soil compaction.

- Excavate using by lightweight equipment to minimize soil compaction. Tracked, cleated equipment does less soil compaction than equipment with tires.
- Ensure that lateral and longitudinal slopes meet permitted design requirements and will not erode due to channelized flow or excessive flow rates.
- Do not conduct final grading and planting of the swale until the adjoining areas draining into the swale are stabilized. Any accumulation of sediments that occurs must be removed during the final stages of grading. The bottom should be tilled to produce a highly porous surface.
- Ensure that measures are in place to divert runoff while vegetation is being established on the side slopes and bottom of the swale. If runoff cannot be diverted, vegetation must be established by staked sodding or by erosion control blankets or other appropriate methods.
- Ensure that the vegetation used in the swale is consistent with values used for Manning's n in the design calculations.

A design professional may propose alternative construction procedures to ensure that the design infiltration rate of the constructed and stabilized swale system is met provided it is accepted by the City and SJRWMD.

4.3.5 Operation and Maintenance

Inspection

The operation and maintenance entity is required to have the total surface water management system inspected by the appropriate Florida-registered and -licensed professional to ensure that the system is properly operated and maintained. The inspections must be consistent with ERP requirements regarding inspection of the stormwater system. If applicable, the City of Jacksonville MS4 NPDES permit inspection and maintenance schedule for grass treatment swales (dry) should also be followed. Inspection must be documented, and the documentation must be retained by the inspecting party for reference if necessary. At a minimum the following should be inspected

- Inflow/outflow points for any clogging.
- Swales for standing water, erosion, or gullying.
- Swales for any obstructions that may have been constructed in the swale such as raised driveway culverts or fences.
- Swales for mosquito-breeding areas such as where standing water occurs more than 72 hours after rainfall or where cattails or other invasive vegetation becomes established.

Maintenance

System maintenance should include:

- Maintaining healthy vegetative cover to prevent erosion of the swale bottom or side slopes.
- Maintaining grass height of 4 to 6 inches and removing grass clippings from the swale.
- Replacing soil and vegetation where needed when erosion is evident.
- Removing trash and debris as needed.
- Aerating, tilling, or replacing topsoil as needed to restore the percolation capability of the soil. Reestablishing vegetation within 60 days of disturbance. Protecting soil surface from erosion until vegetation is reestablished.
- Removing sediment from inflow and outflow systems as needed.
- Stabilizing any upstream erosion as needed.

- Removing and replacing any dead or severely damaged vegetation.
- Eliminating mosquito-breeding habitats.

Additional Maintenance Considerations and Requirements

Regular inspection and maintenance are critical to the effective operation of a grassed conveyance swale. Maintenance responsibility for swales must be vested in a responsible authority by a legally binding and enforceable maintenance agreement executed as a condition of plan approval.

4.3.6 References

Barrett M.E., P.M. Walsh, J.F. Malina Jr., R.J. Charbeneau. 1998. Performance of Vegetative Controls for Treating Highway Runoff. Journal of Environmental Engineering 124 (11), 1121-1128.

Deletic A. and T.D. Fletcher, 2006. Performance of grass filters used for stormwater treatment, a field and modeling study. Journal of Hydrology 317, 261-275.

Florida Department of Environmental Protection and Water Management Districts. 2010. Draft Environmental Resource Permit Stormwater Quality Applicant's Handbook.

PBS&J. 2010. EMC Monitoring in Support of Pollutant Load Modeling. Prepared for Sarasota County and Southwest Florida Water Management District.

Rao D. V., S. A. Jenab, and D. A. Clap. 1990. Rainfall Analysis for Northeast Florida Part V: Frequency Analysis of Wet Season and Dry Season Rainfall. Technical Publication SJ 90-3. St. Johns River Water Management District, Palatka, Florida.

St. Johns River Water Management District (SJRWMD). 2010. Applicant's Handbook: Regulation of Stormwater Management Systems Chapter 40C-42, FAC.

St. Johns River Water Management District (SJRWMD). 1983. Special Publication: SJ93-SP10: Full- Scale Hydrologic Monitoring of Stormwater Retention Ponds and Recommended Hydro- Geotechnical Design Methodologies. Pg. 162. sjr.state.fl.us/technicalreports/pdfs/SP/SJ93- SP10.pdf

Yousef Y.A., T. Hvitved-Jacobsen, M.P. Wanielista, and H.H. Harper. 1987. Removal of Contaminants in Highway Runoff Flowing Through Swales. The Science of the Total Environment 59, 391-399.

4.4 Shallow Bioretention

Key Considerations	Practice Intent: ▪ Capture stormwater runoff and promote evapotranspiration and infiltration of the captured runoff close to source. Design Criteria: ▪ Typically, the tributary area is 2 acres or less. Treatment area consists of grass filter, surface ponding area, top dispersion layer (mulch or similar), planting media layer with vegetation, and optional nutrient-sorption layer. Advantage/Benefits: ▪ Applicable to small tributary areas. ▪ Good retrofit capability. ▪ Can be an aesthetic feature. Disadvantages/Limitations: ▪ Requires landscaping. ▪ High water table can reduce effectiveness. Maintenance Requirements: ▪ Inspect and repair/replace treatment area components. ▪ Remove trash, litter, and sediment. Monitoring/Record Keeping: ▪ Avoid fertilizer applications but if used maintain a record of fertilizer application. ▪ Conduct embedded ring infiltration tests every 5 years. Recovery: ▪ Surface ponding area must be recovered within 72 hours.
Pollutant-Removal Potential	H/M Total Suspended Solids H/M Nutrients—Total Phosphorus/Total Nitrogen H/M Metals—Cadmium, Copper, Lead, and Zinc H/M Pathogens—Coliform, Streptococci, E.Coli
Stormwater Management Suitability	☒ Water Quality ☐ Flood Attenuation
Implementation Considerations	Residential Subdivision Use: Well suited High-Density/Ultra-Urban: Well suited Tributary Area: Typically 2 acres or less to be consistent with the goal of treating runoff as close to the source as possible. Shallow Water Table: SHWL should be a minimum of 6 inches below the bottom of the planting media or nutrient- sorption layer. Soils and Media: Planting and sorption media must meet specified criteria; well-drained native soil is preferable.
Other Considerations:	Use of native plants is highly recommended

L—Low, **M**—Moderate, **H**—High

4.4.1 General

Bioretention areas are shallow depressions used as structural stormwater controls to capture stormwater runoff that promote evapotranspiration and infiltration. Within the bioretention area, soils, mulch, planted vegetation, and optional nutrient-sorption media facilitate treatment and remove pollutants from the runoff. Multiple bioretention areas are often distributed throughout a larger catchment, providing numerous treatment and water storage areas. Although any one treatment area may be small, the cumulative effect can be significant. This distributed approach also better mimics predevelopment hydrologic conditions by promoting stormwater infiltration and evaporation, thereby reducing runoff and recharging groundwater. **Figure 4.4.1** shows features of a bioretention system.

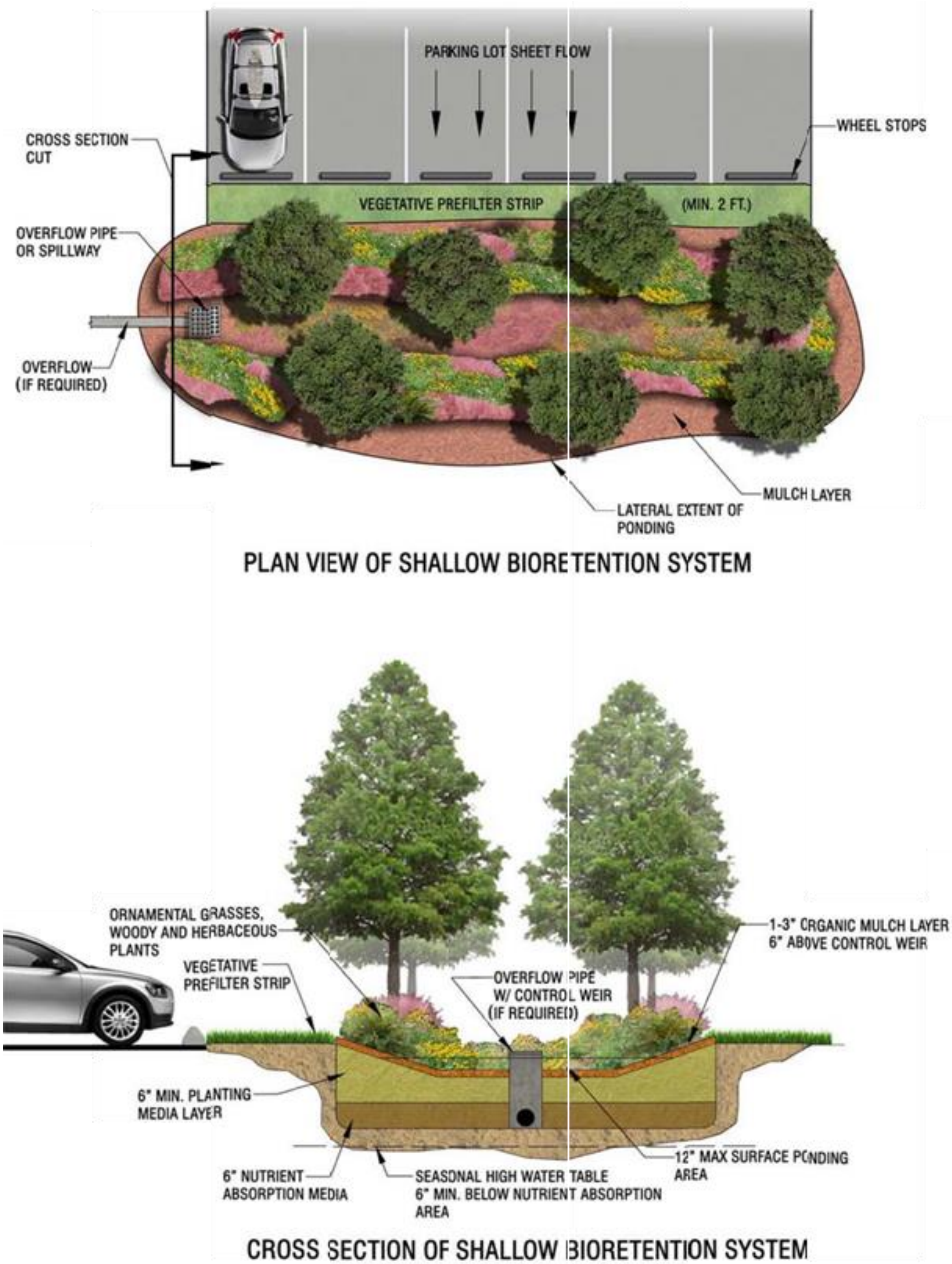


Figure 4.4-1 Plan and Cross-Section Views Illustrating a Shallow Bioretention System

Water Quantity Control

Bioretention systems are designed primarily to address stormwater quality. Bioretention systems provide limited attenuation of peak flows and most likely will not provide sufficient storage capacity to meet City of Jacksonville and SJRWMD water quantity control criteria. Bioretention provides a retention volume related to average annual volume capture efficiency. The retention volume is typically not large enough to account for the required total average annual capture volume, but when used with other BMPs the bioretention may provide a cost-effective solution.

Water Quality Control

Bioretention systems can be more effective for reducing the concentration of pollutants in the water than conventional retention systems. The removal is due to the increased interaction of stormwater runoff with select sorption soil, frequently called media, microbes, and vegetation, thus enhancing biogeochemical processes. Bioretention areas improve the water quality of water being discharged from the bioretention area. The discharge is to the groundwater for retention systems.

General Feasibility

Bioretention systems are suitable for many types of development – from single-family residential to high-density commercial projects. Because the shape and sizing of systems are relatively flexible, the systems can be incorporated into many landscaped designs. These systems are an ideal structural stormwater control to use near impervious areas such as roadway medians, parking lot islands, and swales.

Bioretention systems are also well suited for treating runoff from some pervious areas, such as recreational fields or landscaped areas, where the soil is stabilized and sediment wash off is relatively low. Bioretention systems may also be used to treat roof runoff. However, bioretention systems are generally not suitable for regional stormwater control because of the increased volume of water in regional systems.

Physical Constraints

When evaluating the appropriateness of a bioretention system, a design professional should consider some of the physical constraints associated with this type of treatment system including:

- Drainage Area – Recommended drainage area that is typically 2 acres or less to be consistent with the goal of treating runoff as close to the source as possible.
- SHWL – Must be at least 0.5 foot below the bottom of the surface ponding area.
- Soils – Relatively high hydraulic conductivity in the native soils results in more effective stormwater runoff capture.

4.4.2 Design Considerations and Requirements

The following criteria should be considered minimum standards for the design of a shallow bioretention system in the City of Jacksonville. Consult with SJRWMD to determine whether any variations must be made to these criteria or if additional standards must be followed.

General

A shallow bioretention should address the following (see Figure 4.4-1).

- Prefilter Strip – Where feasible, a prefilter or grass channel strip between the contributing tributary area and the surface ponding area to capture coarse sediments and reduce sediment loading to the ponding area. The design professional may provide other measures, such as a stilling area within the bioretention facility, to minimize the sediment loading in lieu of a prefilter strip. Bioretention systems that do not include a prefilter strip or other measures will be subject to additional testing criteria.

- Surface Ponding Area – An area that provides temporary surface storage (to a maximum depth of 12 inches) for captured runoff before infiltration into the planting media and evapotranspiration.
- Dispersion Material Such as Mulch or Rock Layer – A 1-to-3-inch layer between surface ponding and planting media, with benefits including attenuation of heavy metals, reduced weed establishment, regulation of soil temperature and moisture, and addition of organic matter to the soil. Pre-emergent herbicides may be applied sparingly as needed to further minimize weed establishment.
- Planting Media Layer – A layer that provides at least 6 inches of planting media for vegetation within the basin as well as a sorption site for pollutants and a matrix for soil microbes.
- Nutrient-Sorption Media – A 6-inch layer below the planting media or incorporated within the plant media to a depth of 12 inches, which promotes pollutant removal through sorption and denitrification. Details are discussed in Section 3.2.2.3. This layer is currently not required.
- Woody Plants, Ornamental Grasses, and Herbaceous Plants – Florida-friendly plants that provide a carbon source for the bioretention system, help facilitate microbial activity, and improve infiltration rates.
- Energy-Dissipation Mechanism – For concentrated flow, a structure that reduces runoff velocities, distributes flow, and reduces disturbance of the mulch layer.
- Overflow Pipe or Spillway – If needed, an outlet structure for runoff in excess of the surface storage capacity to bypass the system. The discharge invert should be set no higher than 12 inches above the bottom of the surface ponding area. Conveyance of the excess runoff should include downstream erosion-control measures if necessary.

Location and Planning

Bioretention systems are designed for intermittent flow and should not be used on sites with a continuous flow from groundwater, sump pumps, or other sources.

Locations of bioretention systems should be integrated into the site-planning process, and aesthetics should be taken into account in their siting and design. All control elevations must be specified to ensure that runoff entering the facility does not exceed the design depth.

Sizing Requirements

Prefilter Strip

- The prefilter strip design will depend on topography, flow velocities, volume entering the buffer, and site constraints. Incorporating a filter strip into a retrofit design may be more difficult than new development. The filter strip must have a minimum length of 2 feet in the direction of flow.
- Flow rates entering the bioretention system should be less than 1 foot per second to minimize erosion.

Surface Ponding Area

- The maximum ponding depth must be less than 12 inches below the overflow structure or top of bioretention cell.
- The recovery time must be less than 72 hours under SHWL conditions.

Dispersion Layer

- The surface dispersion or mulch layer must be 1 to 3 inches deep and cover the surface of the basin to above the expected high water line.
- For continuing maintenance, the depth must never exceed 4 inches so that soil aeration is not reduced.

- Organic mulch is preferred due to its favorable pH, improved microbial activity, and slower decomposition rate. Examples of acceptable mulches are those made from melaleuca or eucalyptus trees. Inorganic mulches such as rocks or recycled rubber may also be used.
- Partially composted mulch is acceptable, especially in the lower parts of the depression as this will reduce the tendency of the mulch to float.

Planting Media Layer

- The planting media layer must be at least 6 inches thick.
- The media density should be no greater than 70 pounds/cubic foot dry and contain at most 10 percent organics.
- Clay content should be between 3 and 5 percent.
- Planting media pH should reflect an optimum range for the plants.
- Planting media organic matter content must be between 3 percent and 10 percent by volume.
- The planting media must be uniform and free of stones, stumps, roots, or other similar material greater than 2 inches in size.

Nutrient-Sorption Layer

Although currently not required, a nutrient-sorption layer should typically meet the following requirements:

- The nutrient-sorption layer should be at least 6 inches thick or mixed within the plant media mix.
- The unit weight of layer media should be more than 80 pounds per cubic foot when dry.
- Less than 20 percent of the particles in the layer media should pass the #200 sieve.
- The material should not contain shale.
- The media water-holding capacity should be at least 30 percent as measured by porosity.
- At the specified unit weight noted above, the vertical permeability must be at least 0.08 inch per hour but less than 0.25 inch per hour.
- The media must have an organic content of at least 5 percent by volume. The organic content must be evenly distributed throughout the layer.
- The media pH should be between 6.5 and 8.0.
- The concentration of soluble salts should be less than 3.5 g (KCL)/L.
- The sorption capacity of the sand should exceed 0.005 mg OP/mg media.
- The residual moisture content should exceed 50 percent of the porosity.

Discharge Requirements

The bioretention system is primarily a water quality treatment system and does not normally need to meet any specific discharge requirements. However, for online systems an overflow structure and non-erosive overflow channel should be provided to safely pass flows that exceed the storage capacity of the bioretention system to a stabilized downstream area or watercourse. The complete stormwater treatment system for the site must meet SJRWMD and City of Jacksonville water quantity discharge requirements.

Recovery Requirements

The surface ponding volume must be recovered in less than 72 hours under SHWL conditions.

An appropriate Florida-registered and -licensed professional must perform a recovery analysis using site-specific geotechnical data to determine storage recovery. For guidance on the number of borings, refer to SJ93-SP10 (SJRWMD, 1993).

The assumed hydraulic conductivity for the planting soil must be stated clearly in the ERP application, as this will be used when testing bioretention systems,

Water Quantity Credits

Bioretention systems are typically used for water quality treatment and not for flow attenuation. However, the effectiveness of a bioretention system at attenuating peak flows can be calculated using one of the following procedures:

- Calculate the CN for the bioretention area and include this in the area-weighted CN for the entire site.
- Explicitly model the hydraulic functioning of the bioretention system and its overflow control structure.

Water Quality Treatment Requirements/Credits

A specific treatment effectiveness can be calculated for a storage volume within a bioretention system. These systems are typically part of a treatment train, where each practice in the train provides incremental water quality benefits. The level of treatment that can be expected from these systems is based on the average annual volume of water captured and infiltrated by the bioretention system. The percentage of the average annual runoff volume captured by the bioretention system must be estimated using one of the following methods:

- *Continuous simulation* – A continuous simulation of the bioretention system using an applicable long- term rainfall record (at least 30 years).
- *BMPTRAINS* – The Stormwater BMP Treatment Trains BMP model (http://www.stormwater.ucf.edu/) can be used to evaluate runoff capture based on the principles of the Draft Statewide Stormwater Rule. Results using BMPTRAINS should be equivalent to results taken from Appendix D, which relates mean annual mass removal to retention storage for the development site The BMPTRAINS model is used when the SHWL is at least 24 inches below the bottom of the bioretention surface storage.
- *Design Curve* – **Figure 4.4-2** may be used to determine the percentage of the average annual stormwater runoff captured by the bioretention system when the SHWL is between 6 and 24 inches below the bottom of the bioretention surface storage. When using Figure 4.4-2, the depth of the SHWL below the bottom of the swales should be rounded down to the nearest 6 inches. The figure requires that the equivalent impervious area (EIA) and storage volume are known. The EIA is equal to the mean annual runoff coefficient (C_{ma}) [SJRWMD ERP Applicant's Handbook, Appendix N (page 183)] of the tributary area multiplied by the tributary area. C_{ma} is the mean annual runoff coefficient that can be used to estimate the fraction of rainfall that becomes runoff from the tributary on an annual basis. When SJRWMD ERP Applicant's Handbook, Appendix N (page 183), is used, a DCIA should be treated as 100 percent impervious rather than having a CN of 98. Figure 4.4-2 was developed using long- term continuous simulations for various combinations of bioretention areas collecting discharges from adjacent impervious surfaces. The simulations used the bioretention LID features in EPA SWMM5 to simulate the functioning of the bioretention system.
- In Figure 4.4-2, capture effectiveness is presented for various depths to the predevelopment SHWL. The SWMM5 LID feature does not account for water table elevation when considering the percolation rate from the planting media and nutrient-sorption layer to the underlying native soil. The model output was post-processed so that percolation was not allowed when the water table reached the bottom of the nutrient-sorption layer.

- The average annual runoff load reduction is assumed to be equivalent to average annual percentage of runoff captured by the bioretention system.

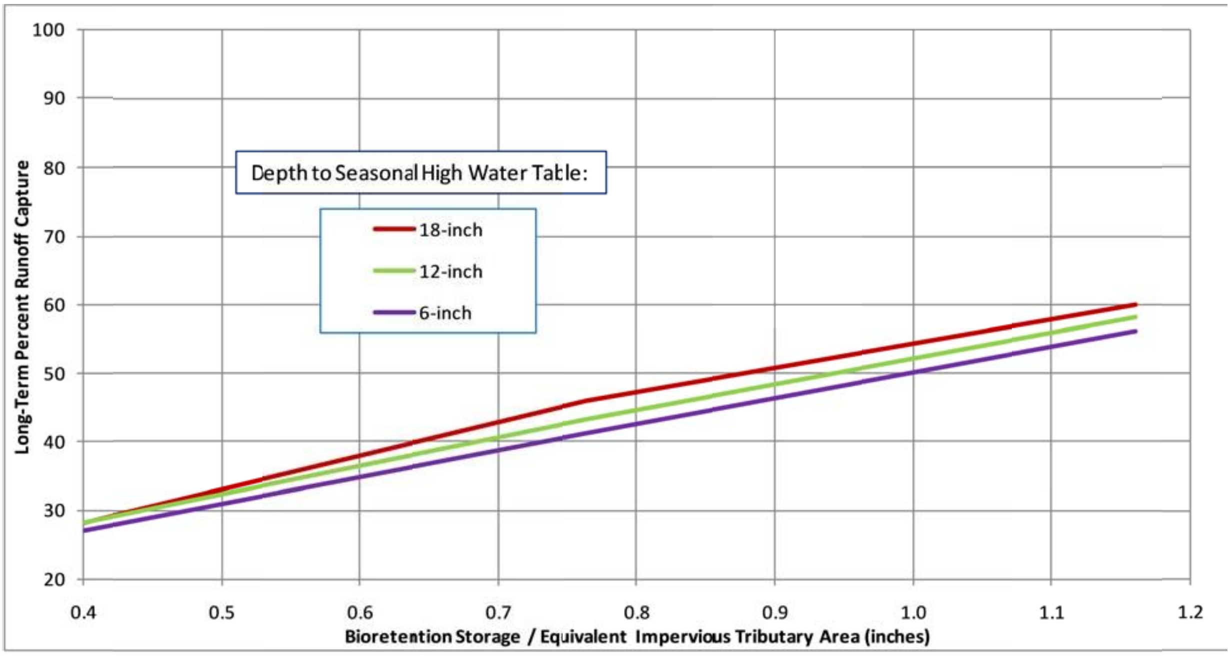


Figure 4.4-2 Average Annual Runoff Capture Efficiency for a Bioretention System in City of Jacksonville

For the design curve, the bioretention storage is the surface ponding volume plus available storage in the planting media. The planting media available storage can be estimated as 15 percent of the planting media volume. Values shown in Figure 4.4-2 assume that the surface ponding layer depth is maximized, subject to the SHWL and the minimum depth of the planting media. In the figure, depth to SHWL represents the distance from the bottom of the facility (i.e., bottom of planting media or optional nutrient- sorption layer) to the SHWL.

Maintenance Access

Access to the bioretention area must be provided at all times for inspection, maintenance, and landscaping upkeep. Sufficient space must exist around the bioretention system to allow accumulated surface sediments to be removed if the system fails infiltration tests or inspection.

Safety Features

Shallow bioretention systems generally do not require any special safety features. However, all Florida Department of Transportation and City of Jacksonville safety requirements must be met where applicable. Fencing these facilities is not generally desirable. Railings or a grate can be used to address safety concerns if the area is designed with vertical walls. Roadway curbs and curb cuts may be considered as part of the design and should be consistent with the most recent FDOT Standard Specifications for Road and Bridge Construction.

Landscaping

Landscaping enhances the performance and function of bioretention systems. Selecting plant material based on hydrologic conditions in the basin and aesthetics will improve plant survival, public acceptance, and overall treatment efficiency. Native or Florida-friendly plants should be selected. Section 656.1210 (Landscaping requirements related to Comprehensive Plan policies) of the Ordinance Code of the City of Jacksonville requires that, if landscape planting is used to meet the preservation of native habitat vegetation requirement, at least 50 percent of these plantings shall consist of native vegetation that is suitable to the site. The following landscaping recommendations should be considered before storm flows are conveyed to the bioretention system:

- The pervious contributing area must be well vegetated to minimize erosion and sediment inputs to the bioretention system.
- Where feasible, a prefilter strip should be installed.
- If used, trees should be spaced appropriately depending on the type.
- If woody vegetation is used, it should be placed along the banks and edges of the bioretention system and not in the direct flow path.
- Only species well adapted to the regional climate must be used.
- Species planted in well-drained media with periodic surface ponding must be tolerant of short-term ponding as well as periods of low soil moisture.
- Vegetation must conform to regulations regarding line of sight.

4.4.3 Design Procedure

The following procedures are intended to guide a design professional through the design of a shallow bioretention system.

Design Steps

- Step 1 – Determine if the development site and conditions are appropriate for the use of a shallow bioretention system. Consider the Application and Site Feasibility Criteria in Sections Physical Constraints and Location and Planning.
- Step 2 – Determine the EIA for the tributary and the depth of storage over the EIA (inches). Mean annual runoff coefficients (C_{ma}), which are available in SJRWMD ERP Applicant's Handbook, Appendix N (page 183), can be used to estimate the EIA for the average annual removal efficiency [EIA = C_{ma} x Drainage Area].
- Step 3 – Compute the maximum retention volume that will be retained in the surface storage of the shallow bioretention system (less than 12 inches).
- Step 4 – Set design elevations and dimensions of facility. See Sizing Requirements.
- Step 5 – Design a pretreatment system if practicable, such as a prefilter strip.
- Step 6 – Design the system to meet the recovery requirements.
- Step 7 – Design the emergency overflow. An overflow must be provided to bypass and/or convey larger flows to the downstream drainage system or stabilized watercourse. Non-erosive velocities need to be ensured at the outlet point.
- Step 8 – Determine the average annual pollutant-load reduction. This average annual pollutant-load reduction for each constituent must be calculated using the retention volume determined in Step 3 and the EIA determined in Step 2.
- Step 9 – Calculate the peak attenuation credit if applicable.
- Step 10 – Prepare the vegetation and landscaping plan. A landscaping plan for the retention area should be prepared to indicate how the area will be established with vegetation. The plan should include irrigation details, particularly until the root system of the new vegetation has had time to be fully established.

Design Example

Assume that a stormwater BMP is needed to help meet the water quality objectives of a site and that sufficient peak-flow attenuation is provided downstream of the site. The site includes 1 acre of paving that is not suitable for pervious pavement and 1 acre of landscaped area with a CN of 78. The SHWL is 36 inches below the surface. The following are sample calculations for evaluating the effectiveness of a proposed bioretention system.

- Step 1 – Assume that the design professional has determined that the site meets the criteria specified in General Feasibility and Physical Constraints and therefore a shallow bioretention system is an appropriate choice for a BMP on this site.
- Step 2 – Determine the EIA for the tributary. Given that the contributing area is a 1-acre paved surface and 1-acre pervious surface with a CN of 78. The 1-acre paved surface can be considered DCIA. Therefore, based on SJRWMD ERP Applicant's Handbook, Appendix N (page 183) using 50 percent DCIA and a non-DCIA (NDCIA) CN of 78, the mean annual runoff coefficient (CMA) can be estimated to be 0.466. The EIA for 2 acres with C_{ma} of 0.466 acre is 0.932 acre [0.466 * 2]. Calculating EIA using the average annual runoff coefficient is specific to the bioretention practices as the annual effectives of bioretention systems was calculated based on an annual runoff coefficient.
- Step 3 – Compute the maximum retention volume that will be retained in the surface storage of the shallow bioretention system. Given the site constraints, the area available for the shallow bioretention system is limited to approximately 80 feet by 30 feet (therefore, the area at top of storage = 80 * 30 = 2,400 sf). Applying the maximum surface ponding depth of 1 foot and assuming a side slope of 3:1 (area and bottom of storage = 74 * 24 = 1,776 sf), the maximum detention volume on the surface of the biofiltration area is calculated to be 2,088 cu ft [((2400 sf + 1776 sf)/2) * 1 foot)]. Assuming 12 inches of planting media and a vertical footprint of 1,776 sf, the storage in the planting media is estimated as 0.15 * 1,776 sf * 1 foot = 266 cubic feet. Total available storage is 2,088 + 266 = 2,354 cf, or 0.649 acre-inches.
- Step 4 – Set the design elevations to meet the criteria specified in Sizing Requirements.
- Step 5 – Assume that the design professional has found that sufficient space is available for a prefilter strip.
- Step 6 – Run the appropriate recovery analysis under SHWL conditions and determines that the system can recover in 72 hours. This meets the criteria detailed in Recovery Requirements.
- Step 7 – If needed, design an emergency overflow and the appropriate erosion controls to meet the discharge from the 100-year/24-hour design storm event in the City of Jacksonville.
- Step 8 – Calculate the average annual pollutant-removal efficiency. With a 12-inch ponding depth and 12-inch planting media, the bottom of the planting media is 24 inches from the ground surface, compared to the SHWL depth of 36 inches from the surface. Therefore, the depth to SHWL is 12 inches and using Figure 3.2-2 is appropriate.
    - Dividing the retention volume of 0.649 acre-in by the EIA of 0.932 acre results in a retention volume of 0.7 inch over the EIA. Figure 4.4-2 shows that a facility with depth to SHWL of 12 inches and volume/EIA value of 0.7 inches is expected to capture 40 percent of the average annual runoff, which would be retained and infiltrated by the shallow bioretention system.
    - For comparison, if the depth to SHWL was 24 inches or greater, BMPTRAINS could have been applied to generate the runoff capture. In that case, the inches of retention over the 2-acre site would have been equal to 0.325 inch (0.649 acre-in divided by 2-ac site) and the runoff capture calculated by BMPTRAINS is 43 percent.
- Step 9 – If needed, calculate the peak attenuation provided by the bioretention system. Two options are described in Water Quantity Credits.

4.4.4 Operation and Maintenance

Inspection

The operation and maintenance entity is required to have the total surface water management system inspected by the appropriate Florida-registered and -licensed professional to ensure that the system is properly operated and maintained. The inspections must be consistent with ERP requirements regarding inspection of the stormwater system. If applicable the City of Jacksonville MS4 NPDES permit inspection and maintenance schedule for dry retention systems should also be followed. Inspection must be documented, and the documentation must be retained by the inspecting party for reference if necessary. At a minimum the following should be inspected.

- Inflow/outflow points for any clogging.
- Prefilter strip/grass channel and bioretention area for erosion or gullying.
- Trees and shrubs to evaluate their health.

Maintenance

System maintenance should include:

- Pruning, weeding and applying pre-emergent herbicide sparingly (if necessary) to keep any structures clear.
- Maintaining/mowing the prefilter or swale at least twice during the growing season and removing clippings from the flow path.
- Replacing mulch where needed when erosion is evident.
- Removing trash and debris as needed.
- If needed, replenishing mulch over the entire area every 2 to 3 years.
- Removing sediment from inflow system and outflow system as needed.
- Stabilizing any upstream erosion as needed.
- Removing and replacing any dead or severely damaged vegetation.

Testing

Testing must be conducted by the appropriate Florida-registered and -licensed professional to provide reasonable assurance that the shallow bioretention system is functioning as intended. Failures and remedial actions should be reported to SJRWMD and City of Jacksonville. Formatting requirements and details on how reports should be submitted must be discussed and agreed to during the permitting process. For sites that include a large number of bioretention systems, a testing schedule in which a representative sample of bioretention systems is tested at the appropriate interval may be agreed to at the pre-application meeting or during the permitting process. Testing must include the following:

- The planting soils pH must be tested initially to establish that the soil pH is between 5.5 and 6.5. Testing should be done again if the vegetation is showing signs of stress. If soil pH is below 5.5, lime must be applied to raise the pH to 6.5.
- Bioretention systems require that a double-ring infiltration test be performed if the observed performance of the facility suggests diminished capacity for infiltration (e.g., ponded water is noted in the facility after more than 72 hours after rain). In that case, a double-ring infiltration test must be performed at three locations in the bottom of the basin to confirm design infiltration rates. If two out of three tests OR the average rate of the three tests are below the Recovery Requirements, the infiltration rate of the mulch layer and surficial planting media layer must be restored. Core aeration or cultivating of non-vegetated areas may be sufficient to restore the infiltration.

Additional Maintenance Considerations and Requirements

Regular inspection and maintenance are critical to the effective operation of a shallow bioretention system. Maintenance responsibility for all LID and stormwater facilities must be vested in a responsible authority by a legally binding and enforceable maintenance agreement executed as a condition of plan approval.

4.4.5 References

St. Johns River Water Management District (SJRWMD). 1983. Special Publication: SJ93-SP10: Full- Scale Hydrologic Monitoring of Stormwater Retention Ponds and Recommended Hydro- Geotechnical Design Methodologies. Pg. 162. sjr.state.fl.us/technical reports/pdfs/SP/SJ93- SP10.pdf

4.5 Pervious Pavements

Key Considerations	Practice Intent: ▪ Promote rainfall infiltration/reduce stormwater runoff production while supporting traffic loading. Design Criteria: ▪ Must use an appropriately certified installer. ▪ Must use on a flat or minimal-slope area. ▪ Must incorporate a perimeter-edge restraint. ▪ Must use in-situ infiltration measurements. ▪ Typically includes a surface pavement overlaying a stone reservoir. Advantage/Benefits: ▪ Has potential to reduce the size of or eliminate stormwater structures from impervious areas. ▪ Increases usable/developable space or decreases developed footprint. ▪ May increase aesthetic value. Disadvantages/Limitations: ▪ May have increased maintenance requirements and costs. ▪ Not suitable for all site soil conditions. Maintenance Requirements: ▪ Vacuum the surface layer as needed when infiltration measurements are lower than 1.5 inches per hour for the pervious pavement layer.
Pollutant-Removal Potential	M/H Total Suspended Solids M/H Nutrients—Total Phosphorus/Total Nitrogen removal M/H Metals—Cadmium, Copper, Lead, and Zinc removal M/H Pathogens—Coliform, Streptococci, E.Coli removal
Stormwater Management Suitability	☒ Water Quality ☒ Flood Attenuation
Implementation Considerations	Residential Subdivision Use: Well suited
	High-Density/Ultra-Urban: Well suited
	Typically for light duty and low-frequency traffic.
	Shallow Water Table: Precautions needed.
	Soils: Well-drained soils.
Other Considerations:	ADA and Florida Building Code Compliance

L—Low, **M**—Moderate, **H**—High

4.5.1 General

Overview and Intent

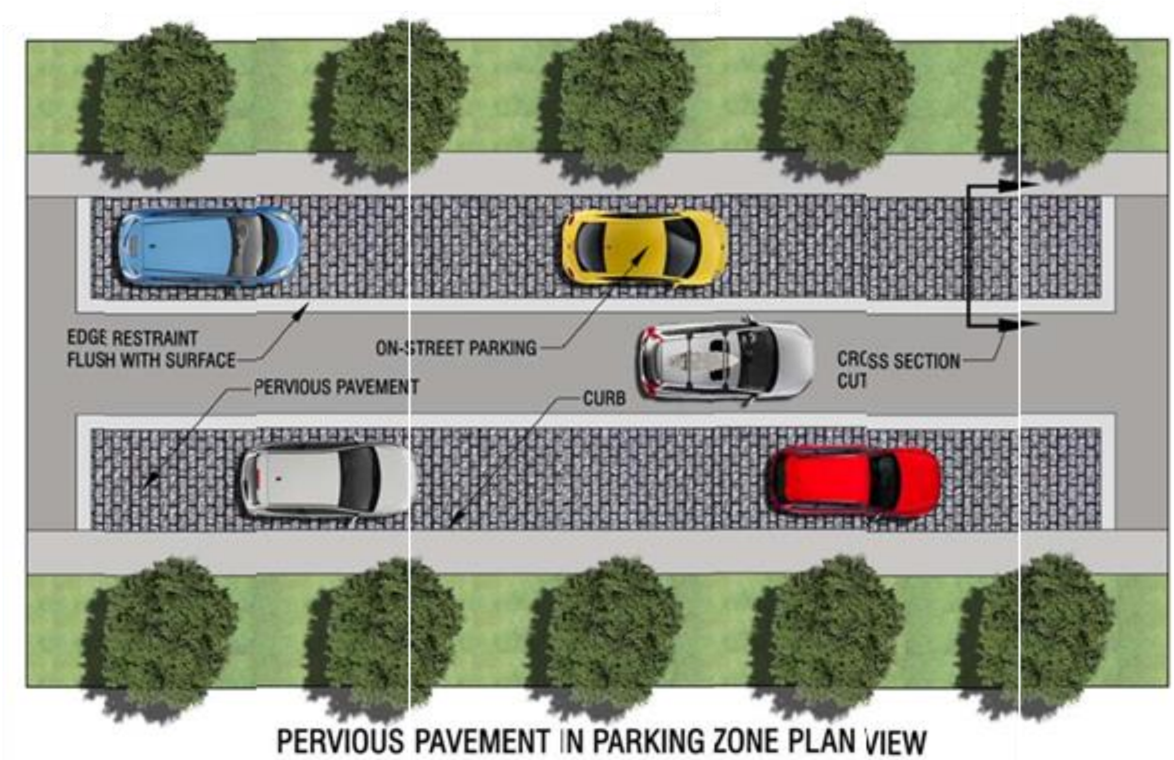
Pervious pavement (also commonly referred to as permeable pavement and porous pavement) systems are pavement systems that infiltrate and temporarily store part or all of the water quality volume. Pervious pavement systems infiltrate and capture rainfall that falls on the surface at rates up to the surface infiltration rate, unlike impervious pavements where almost all direct rainfall becomes runoff. Pervious pavement systems infiltrate water below the surface where water is typically allowed to exfiltrate into the surrounding parent soil. Under these circumstances, pervious pavement systems function as retention systems. Pervious pavement systems may be considered part of a treatment train, with credit based on available storage volume and the ability of the system to readily recover the storage volume.

Many pervious pavement surface materials are available for different aesthetic considerations. Pervious pavements surface materials can be divided into two groups: modular pavers and cast-in-place pavements. **Figure 4.5-1** shows common pervious pavement surface materials. Profiles of modular block pervious pavements systems typically include three layers: surface layer, filter layer, and reservoir layer. Cast-in-place systems can be incorporated into the three-layer design or a two-layer design (eliminating the filter layer) or designed as a single continuous layer of the surface material directly over the parent soil without a separate reservoir layer.

(a) (b) (c)

Figure 4.5-1 Common Pervious Pavement Materials: a) Permeable Interlocking Concrete Pavers, (b) Porous Concrete, (c) Flexi-pave™.

Figure 4.5-2 illustrates a typical single-layer profile system in which water is stored below the surface pavement within the aggregate material's pore space and then exfiltrates out of the profile into the native soil. A multi-layer profile including an upper filter layer and lower aggregate layer may also be used. Filter layers often consist of coarse sand or small aggregate (e.g., pea gravel), which helps stabilize the pavement surface.



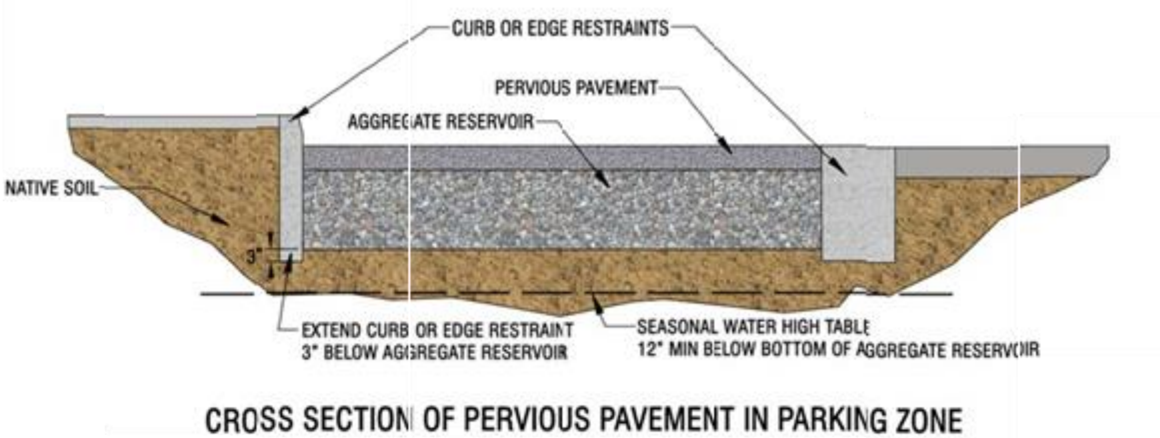


Figure 4.5-2 Typical Pervious Pavement System

Applicability

Typically, pervious pavements are used for low-traffic loading (less than 100 vehicles per day) and low-turning areas such as parking spaces; residential street parking; cart, bicycle, and pedestrian paths; driveways; and emergency-vehicle-access lanes (**Figure 4.5-3**).

(a) (b) (c)

Figure 4.5.3 Examples of Pervious Pavement (a: Driveway, b: Walking Path, c: Parking Lane)

Pervious pavements (such as modular pavers) can be designed to support heavier traffic loads. However, certain pervious pavement materials are susceptible to structural failure due to shear stress on the surface. Caution should be used when designing pervious pavement in areas subjected to high volumes of vehicular traffic, frequent braking, or frequent turning. To address this concern, pervious pavements can be incorporated with traditional impervious pavements to provide a more durable surface in certain areas while runoff is infiltrated in other areas. For example, drive paths and turning areas in a parking lot could be impervious, while the parking spaces, the parking lot perimeter, and areas in front of parking stops could be pervious.

4.5.2 Design Considerations and Requirements

Structural Considerations and Requirements

This section only provides requirements pertaining to the hydraulic functioning of pervious pavements. Therefore, the design professional should determine if the pervious pavement system is appropriate for the design's structural capability.

Hydraulic Considerations and Requirements

For a pervious pavement area to be permitted as part of the stormwater treatment system, an appropriate Florida-registered and -licensed professional must demonstrate that the pervious pavement meets all the following hydraulic requirements:

Infiltration and Storage Requirements

- The surface must be maintained to prevent significant clogging and improve infiltration rates. A pervious pavement system infiltration rate of at least 1.5 inches per hour is required in addition to exfiltration to the parent soil providing adequate drawdown shown in the recovery analysis. Tests must be conducted at least every 2 years and certified by an appropriate Florida-registered and -licensed professional.
- At least two (maximum of 10 for a site) infiltration testing locations per acre must be installed into the pervious pavement system to measure the surface infiltration rates of the pervious pavement system.
- An example of a device that has been shown to be effective is the Embedded Ring Infiltrometer Kits (ERIKs) (Wanielista & Chopra, 2007).

- Sloping pervious pavement surfaces must be minimized. Parking lots and vehicular traffic areas with pervious pavement are recommended – but not mandated – to be flat and not to exceed a slope of 0.5 percent. Sidewalks, walking, cycling, and cart paths are permitted to have slopes not exceeding 5 percent. No volume above the lowest elevation of a sloped pervious pavement surface must be included in the pervious pavement system storage volume. The design professional must also consult other appropriate regulations governing pavement surface slopes.
- Parking lots and other vehicular traffic areas (excluding road rights-of-way, pedestrian walks, and bicycle paths) must be constructed to produce 2 inches of nuisance ponding over a portion of pavement near the infiltration testing site. Nuisance ponding is non-hazardous ponding designed to provide a visible warning that the pervious pavement system has failed, and that remediation is required.
- The infiltration rate of the parent soil is essential to the function of the pervious pavement system. If the parent soil has a low infiltration rate and the compaction of the predevelopment soil exceeds 95 percent Modified Proctor Density, the soil must be scarified to a minimum depth of 16 inches, re-graded, and proof-rolled to a maximum of 95 percent Modified Proctor Density.

Discharge Requirements

- For flood control, the pervious pavement system storage available after a 72-hour drawdown time can be used in the flood control calculation.
- Appropriate downstream flood attenuation must be provided if a pervious pavement system cannot provide sufficient runoff rate or volume reductions to meet its flood control requirements.
- Appropriate downstream erosion controls must be provided for potential pavement discharge.
- The complete stormwater treatment system for the site must meet SJRWMD and City of Jacksonville water-quantity discharge requirements.

Recovery Requirements

- The SHWL must be at least 12 inches below the bottom of the pervious pavement system profile.
- The storage volume used to estimate the average annual load reduction must be recovered within 72 hours under SHWL conditions.
- The storage volume used to determine the CN or Rational C calculation (for flood-control credit) must be recovered within 72 hours under SHWL conditions.
- An appropriate Florida-registered and -licensed professional must perform a recovery analysis of the parent soil using site-specific geotechnical data to determine storage recovery. For guidance on the number of borings, refer to SJ93-SP10 (SJRWMD 1993).
- A safety factor of 2.0 or more must be applied to the recovery analysis to allow for geological uncertainties.

Water Quality Treatment Requirements/Credits

- Designs will be assumed to achieve annual mass removal efficiency consistent with the dry retention depths found in the SJRWMD ERP Applicant's Handbook, Appendix N (pages 214-221) if the pervious pavement system infiltration rate is greater than or equal to 1.5 inches per hour and that the area of the pervious pavement system is assumed to have a CN = 98.
- Alternatively, continuous simulation or a design curve (see **Figure 4.5-4**) can be used to evaluate the percent runoff capture. Figure 4.5-4 was developed using EPA SWMM5 based on long-term continuous simulations for various combinations of pervious pavement system storage that also is collecting discharges from adjacent traditional impervious areas, such as impervious pavement or roof tops, using the pervious pavement LID feature in SWMM5. Values are plotted based on the ratio of pervious pavement system storage (pavement plus aggregate) to the EIA for the contributing area.

Thus, the EIA of the total watershed adding runoff to the pavement (including the pervious pavement area) must be calculated.

- In Figure 4.5-4, capture effectiveness is presented for depths to predevelopment SHWL that are less than 24 inches from the bottom of the pervious pavement system. The SWMM5 LID feature does not account for water table elevation when considering the percolation rate from the pervious pavement system to the underlying native soil. The model output was post-processed so that percolation was not allowed when the water table reached the bottom of the stone reservoir below the pervious pavement.

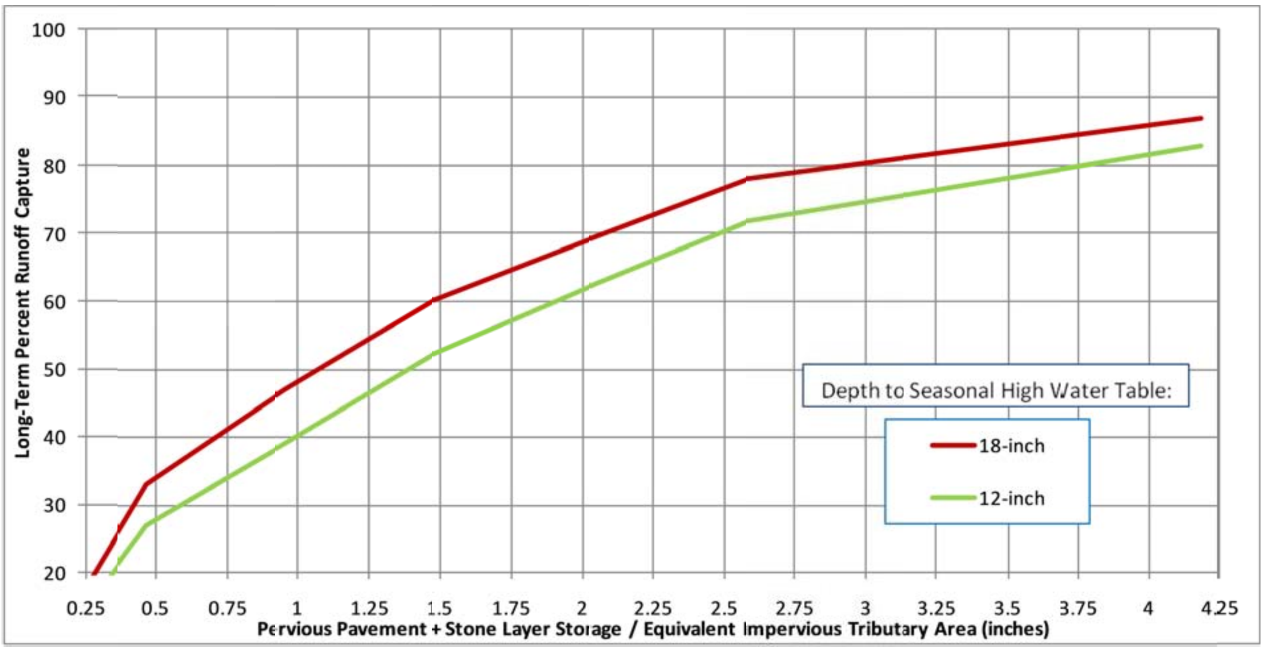


Figure 4.5-4 Long-Term Runoff Capture Based on Depth to Pre-Development Seasonal High Water Level and Pervious Pavement System Storage

Maintenance Requirements

- The surface of the pervious pavements can become clogged with fine particles and material that must be removed to optimize surface infiltration rates. Improper design or construction can also result in premature failure of the pavement surface (i.e., fractures, settling, shifting, etc.).
- If the pervious pavement system infiltration rates measured using the installed testing device are less than 1.5 inches per hour, maintenance must be performed to recover the surface infiltration rates. Maintenance typically involves using a vacuum truck to remove clogging material. However, less- accessible systems such as driveways or walking, cycling, or cart paths may use alternative means (excluding any form of pressure washing) such as industrial-type vacuums or sweepers to recover surface infiltration rates.

Safety Considerations

- Restrictions prohibiting excessive traffic weight, use of abrasives, and resurfacing should be clearly posted.
- Certain pervious pavement surfaces may be difficult to traverse for individuals who have physical disabilities. Void spaces filled with filter material can cause the pavement surface to be uneven and especially difficult for those using crutches, walkers, or high-heeled shoes.

Additional Design Considerations

- Edge restraints must be installed around pervious pavement areas to prevent failure along surface edges and to impede horizontal movement of water below the pavement surface. The edge restraints must extend 3 inches below the bottom of the reservoir material.
- Runoff from adjacent landscaped areas must not be directed onto the pervious pavement system.
- Runoff from nearby roofs or adjacent impervious areas may be routed onto the pervious pavement. However, this may require more frequent testing of the infiltration capacity of the pervious pavement system due to the increased risk of overloading the pervious pavement with sediment.

4.5.3 Example Pervious Pavement Design Procedure

Pervious pavement design has two main components: structural design and hydraulic design. The pavement system must be able to support the traffic loading while also – and equally important – functioning properly hydraulically. This section does not discuss structural designs of pervious pavement systems. Design professionals should consult pavement design standards to ensure that pervious pavements will be structurally stable. The criteria in this section are minimum standards for designing a pervious pavement system in the City of Jacksonville. Design professionals should consult with appropriate City and State agencies for any variations or additions to these criteria.

Hydraulic Design

- Step 1 – Decide on the required/desired removal efficiency.

  Pervious pavement system design has a number of design-dependent variables; therefore, the design professional must first determine which design variables are defined by the specific site restraints. Usually, the system will be designed to meet either a desired annual pollutant load removal to be consistent with the “net improvements standards” of impaired waters or the removal efficiency of a design will need to be calculated.

  If the annual pollutant load removal is the desired approach, the designer must know the meteorological zone, the mean annual rainfall, the predeveloped and post developed land use, and the typical site hydrologic characteristics. This information is used to determine the annual mass loading for nitrogen and phosphorus for both the predeveloped and post developed conditions. The required treatment efficiency may be calculated to meet the “net improvement” criteria. The event mean concentration (EMC) for general land use categories in SJRWMD ERP Applicant’s Handbook, Volume 1, Table 9.2 (page 92). Load reductions should be calculated using SJRWMD-accepted data for EMCs and load reductions.

  If the site is not located in an impaired water body, the required water quality annual pollutant load removal efficiency is 80 percent.

- Step 2 – Determine which variables are fixed by site restraints.

  The variables that depend on the design and are needed to calculate the efficiency of the pervious pavement system are the post-developed DCIA, the post-developed Non-DCIA (NDCIA) CN, the area of pervious pavement, and the storage in the pavement system. To optimize the system and meet the required removal efficiency determined in Step 1, the designer may need to complete a number of iterations. The required number of iterations will be reduced by determining as many of these variables from site-specific characteristics. Some of the items that could be considered are:

  - What is the maximum area available where pervious pavement could be used on the site?
  - What is the minimum pervious pavement section that can be used to accommodate the proposed loads?

    - What is the maximum pervious pavement section that can be used to maintain an adequate separation from the SHWL?

- Step 3 – Calculate the remaining variables.

  The pervious pavement system is assumed to have similar annual mass removal efficiencies as a dry retention area. Therefore, the remaining variable(s) can be determined from the information in SJRWMD ERP Applicant's Handbook, Appendix N (pages 214-221).

- Step 4 – Verify storage recovery time.

  A recovery analysis is needed to demonstrate that the pervious pavement system meets the Recovery Requirements. The design may have to be revaluated if the storage recovery time is not met.

- Step 5 – Determine the flood protection benefit of the pervious pavement system.

  The pervious pavement system storage that is available after 72 hours of recovery can be accounted for in the flood protection/attenuation calculations. This storage volume can be evaluated by one of two methods:

    - The available pervious pavement storage can be evaluated as "soil storage" when calculating the weighted CN for the site.
    - The pervious pavement area can be included in the DCIA calculations, and the storage can be evaluated as "pond storage.

Design Emergency Overflow

A pervious pavement system may overflow during extreme rainfall or if a pervious pavement fails. An adequately sized emergency overflow must be sized to convey runoff from the previous pavement system that could occur from the design storm.

- Driveways, walking, cycling, and cart paths are generally not required to have an overflow structure.

Example Design Problem

The following design problem is intended to illustrate how design professional could demonstrate the effectiveness of the pervious pavement as part of a stormwater treatment system. In most applications the pervious pavement would only be a part of the stormwater treatment system, and the ability of the entire system to meet the applicable stormwater criteria would have to be demonstrated. The design problem can also be solved using the BMPTRAINS model (http://www.stormwater.ucf.edu/). However, the user is encouraged to understand the input data and the process for solving for the capture volume (average annual efficiency).

Problem Statement

The example includes 2 acres of roadway and parking lane that will be a combination of pervious pavement and traditional pavement. By design, the traditional pavement runoff is routed to the pervious pavement. The site was previously Upland Scrubby Flatwoods on soils corresponding with the Hydrologic Soil Group B/D. The SHWL in this location is approximately 24 inches below the surface. The site is in the Meteorological Zone 4 and has a mean annual rainfall of 52 inches. The predeveloped curve number for the pervious area (CN) is 78

- Step 1 – Determine the required/desired removal efficiency.

  We assumed that the site is located in an impaired water body; therefore, the design intent will be to demonstrate a "net improvement." Using BMPTRAINS, the mean TN and TP (mg/L) concentrations can be determined for the site predevelopment and post development land uses:

    - Pre: Upland Mixed – Total N = 1.023 mg/L and Total P = 0.027 mg/L

- Post: Highway – Total N = 1.64 mg/L and Total P = 0.22 mg/L

- Step 2 – Determine which variables are fixed by site restraints.

  We assumed that 50 percent of the site will be pervious pavement and that the site requires minimal fill; therefore, the bottom of the proposed pavement will be assumed to be at the existing grade. Since the SHWL is 24 inches below the existing grade and a 12-inch separation must be maintained between the SHWL and the bottom of the pervious pavement system, 12 inches are available to be used for the pervious pavement reservoir. Given a 4-inch-thick pervious concrete (void space 25 percent) and a 12-inch-thick No. 57 stone pavement reservoir (sustainable void space 21 percent), the inches of pavement storage (S) can be calculated.

  S = (4" * 0.25) + (12" * 0.21) = 3.5"

  The predeveloped annual runoff coefficient, annual runoff, and annual mass load can also be calculated.

  The predeveloped annual runoff coefficient (C) interpolated from SJRWMD ERP Applicant's Handbook, Volume 1, Table 9.2 (page 92) (or calculated in BMPTRAINS) given a CN of 78 and a DCIA of 0 percent. C = 0.116

  The annual runoff (AR in ac-ft/year) = annual rainfall (in/yr) * area (ac) * C * (1 ft/12 in)

  AR = 52 * 2 * 0.116 / 12 = 1.01 ac-ft/yr

  The annual mass load (AML in kg/year) = AR * 43,560 ft^2/ac * 7.48 gal/ft^3 * 3.785 l/gal * concentration (mg/L) * (1 kg/ 106 mg).

  $AML_{N\text{-}pre}$ = 1.01 * 43560 * 7.48 * 3.785 * 1.023 / 10^6 = 1.27 kg/year

  $AML_{P\text{-}pre}$ = 1.01 * 43560 * 7.48 * 3.785 * 0.027 / 10^6 = 0.04 kg/year

- Step 3 – Continuing defining the inputs and performing the calculations.

  The impervious pavement and pervious pavement that make up the 2-acre roadway and parking lane system should be treated as DCIA to determine how much runoff enters the pervious pavement system.

  From SJRWMD ERP Applicant's Handbook, Volume 1, Table 9.2 (page 92)– the post C, given DCIA of 100 percent = 0.823 The post AR = 52 * 2 * 0.823 / 12 = 7.13 ac. ft / year

  $AML_{N\text{-}post}$ = 7.13 * 43560 * 7.48 * 3.785 * 1.64 / 10^6 = 14.42 kg/year

  $AML_{P\text{-}post}$ = 7.13 * 43560 * 7.48 * 3.785 * 0.22 / 10^6 = 1.93 kg/year

  The required removal efficiency to meet the net improvement is determined from the AMLs calculated for nitrogen in this example.

  Required efficiency (E percent) = (1 – (AML_{pre} / AML_{post})) * 100 E percent = (1 – (1.27/ 14.42)) * 100 = 91.2 percent

  The required retention depth can then be determined using Appendix D given CN = 98 and DCIA = 100 percent.

  Based on SJRWMD ERP Applicant's Handbook, Appendix N (pages 214-221), the mass removal efficiency is 92.3 percent for a retention depth of 2.75 inches. The corresponding required treatment storage = area * retention depth * 43,560 / 12 = 19,965cf.

  The provided pervious pavement storage = pervious pavement area * inches of pavement storage S * 43,560/12

  Since 50 percent was used for the impervious area, the system of roadway and parking lane is 50 percent pervious pavement, and the pervious pavement area is 2 ac * .5 = 1.0 ac.

Provided storage = 1.0 acre * 3.5 inches * 43,560 /12 = 12,705 cf

The provided storage is less than the required storage, and the system would not meet the net improvement requirement.

The calculations in BMPTRAINS are based on the presumption of a 24-inch separation between the bottom of the stone reservoir and the SHWL. In this case, the separation was only 12 inches, and therefore the curves in Figure 3.3-4 should be used. The EIA for the site is the total site area (2 acres) times the calculated post development runoff coefficient C of 0.823, or 1.646 acres. The storage of the pervious pavement system is the area of pavement (1 acre) times the depth of storage (3.5 inches), or 3.5 acre-inches. The ratio is therefore 3.5/1.646 = 2.13 inches. Based on the ratio of 2.13 and the 12-inch depth to the predevelopment SHWL, the expected runoff capture is 63 percent, which is less than the required 93 percent storage. Refinement of the design and/or additional water quality treatment will be required.

- Step 4 – Verify storage recovery time.

  A recovery analysis would be needed to demonstrate that the pervious pavement system meets the Recovery Requirements. The design may have to be revaluated if the storage recovery time is not met.

- Step 5 – Determine the flood protection benefit of the pervious pavement system.

  The pervious pavement system storage that is available after 72 hours of recovery can be accounted for in the flood protection/attenuation calculations. This storage volume can be evaluated by one of two methods:

  The available pervious pavement storage can be evaluated as “soil storage” when calculating the weighted CN for the site.

  The pervious pavement area can be included in the DCIA calculations, and the storage can be evaluated as “pond storage.”

The design calculations indicate that the design would meet the net improvement goal if the depth to SHWL is 24 inches or more. However, because the depth to SHWL is only 12 inches, the design will not fully meet the requirement but will provide substantial benefit. The remaining water quality treatment may be provided by a downstream BMP (e.g., detention facility designed to meet peak-shaving requirements for extreme storms).

4.5.4 Construction

Soil Excavation

- Compacting the parent soil will reduce the exfiltration rate from the storage layer and therefore should be avoided. To reduce the risk of compaction, heavy equipment should not be allowed on the parent soil. The maximum allowable soils compaction is 95 percent Modified Proctor Density (ASTM D1557) to a minimum depth of 24 inches.
- If compaction of the predevelopment soil exceeds 95 percent Modified Proctor Density, the soil must be scarified to a minimum depth of 16 inches, re-graded, and proof-rolled to a maximum of 95 percent Modified Proctor Density.

Aggregate Installation

- Aggregate for the reservoir layer must be washed rock such as No. 4 or No. 57 size material, with inert chemical properties. Quartz can be used in areas where available. If the aggregate contains fine particles, the interface between the reservoir layer and parent soil can become clogged. Aggregate must be installed in layers to achieve the required strength. Crushed shell and limestone must not be used in or below the pervious pavement system.

- If used, the filter-layer material must trap fine material but to still allow rapid drainage. Examples of this filter-layer material include washed pea gravel or coarse sand.

Pavement Installation

The pervious pavement must be installed by a contractor certified by the pervious pavement product manufacturer or association to install the pervious pavement specified. For example, pervious concrete systems must be installed by a contractor that is certified by the National Ready Mixed Concrete

Association as being a pervious concrete craftsman. Certification should be verified on either the manufactures or association's website.

Modular pavers can be installed sectionally or mechanically. Modular pavers are laid over the filter layer, and the void spaces are then backfilled with filter material.

4.5.5 Operation and Maintenance

Inspection

The operation and maintenance entity is required to have the total surface water management system inspected by an appropriate Florida-registered and -licensed professional to ensure that the system is properly operated and maintained. The inspections shall be performed 1 year after operation is authorized by both the City and SJRWMD and every 2 years thereafter. Inspection must be documented, and the documentation must be retained by the inspecting party for reference if necessary. At a minimum the following should be inspected.

- The surface for any compromised sections of the pavement. Compromised sections should be repaired as needed, whether fractured, shifted, or otherwise damaged.
- The surface for the accumulation of sediments and other clogging material.
- Voids for missing aggregate. Missing aggregate should be added to the pavement surface as needed.

Testing

The rate of clogging material accumulating will vary based on location and traffic. Surface infiltration rates must be tested at least every 2 years to ensure that rates are not limiting the performance of the system. The frequency of the required testing may be increased in instances where runoff from adjacent impervious areas is directed onto the pervious pavement. If the pervious pavement system infiltration rates are less than 1.5 inches per hour, maintenance must be performed for the respective areas. Maintenance such as vacuuming should typically be carried out over the entire pervious pavement and should not be limited to the areas where the infiltration rate has failed.

Maintenance

Excessive direct rainfall and discharge from adjacent tributary areas can overwhelm a pervious pavement system by intensity (limited by surface infiltration rate) or depth (limited by storage volume). Ponding due to rainfall and intensity of flows onto the pavement exceeding the surface infiltration rate should begin to be alleviated once the combined flows fall below the surface infiltration rate. However, reduced surface infiltration rates may prolong the ponding duration, indicating that maintenance is needed. Frequent ponding may indicate that the storage volume is not recovering in the required time to be able to store water from subsequent events. This could be due to loss of porosity in the pervious pavement profile, reduced exfiltration rates into the parent soil, or other failures in the pervious pavement system that without nuisance ponding may be easily overlooked. The duration and date of occurrence of any nuisance ponding must be documented in the maintenance records.

Pervious pavement systems must be maintained by removing clogging material from the surface to maintain optimum surface infiltration rates. Vacuuming systems on vehicles are often used for large pervious pavement areas where the vehicles' movement is not limited. The surface must not be pressure-washed to remove clogging material since pressure-washing can force clogging material deeper into the pervious pavement system where it is difficult to extract, thus permanently reducing infiltration rates. Alternative methods (e.g., industrial vacuum cleaners) for removing clogging material from less-accessible installations, such as walking, cycling, and cart paths or driveways, may be permissible as long as the pervious pavement system infiltration rates are improved and are greater than the threshold 1.5 inches per hour. Follow-up infiltration rate measurements to ensure that the infiltration rate exceeds 1.5 inches per hour in the pervious pavement system are required. Any surface shifting or cracking should be promptly repaired. Filter material removed during vacuum sweeping for modular systems should be replenished with material that meets the specifications of the original filter material.

4.5.5.4 Additional Maintenance Considerations and Requirements

Regular inspection and maintenance are critical to the effective operation of pervious pavement systems. Maintenance responsibility for all LID and stormwater facilities must be vested in a responsible authority by a legally binding and enforceable maintenance agreement executed as a condition of plan approval.

4.5.6 References

Natural Resource Conservation Service (NRCS). 1986. Urban Hydrology for Small Watersheds: TR-55 (TR-55). http://www.wsi.nrcs.usda.gov/products/w2q/H&H/docs/other/TR55_documentation.pdf

St. Johns River Water Management District (SJRWMD). 1983. Special Publication: SJ93-SP10: Full- Scale Hydrologic Monitoring of Stormwater Retention Ponds and Recommended Hydro- Geotechnical Design Methodologies. Pg. 162. sjr.state.fl.us/technical reports/pdfs/SP/SJ93- SP10.pdf

Wanielista, M. and M. Chopra. 2007. Performance Assessment of Portland Cement Pervious Pavement: Report 1 of 4: Performance Assessment of Pervious Concrete Pavements for Stormwater Management Credit. http://www.stormwater.ucf.edu/research/Final Report 1 of 4 Performance Assessment and Credit Feb.doc

SECTION 5.0 Landscape Design Guidelines

This Section provides design guidelines for landscaping, irrigation, and lighting requirements. Where applicable, the relevant portion of the Jacksonville Ordinance Code has been referenced to provide additional detail and requirements. Site Planning requirements like sidewalks, signage, and access are covered in Section 1.0. Green infrastructure requirements for grassed swales, shallow bioretention, and pervious pavement are covered in Section 4.0.

5.1 Permitting

5.1.1 Site Clearing

Code of Ordinance, Section 656.1206 (a)

A site clearing permit is required before any land clearing and grubbing or site development, including disturbance of the root system of protected trees. A permit is also required for any trimming, cutting, pruning, or removal of trees from the public rights or way or public easement. Site clearing applications shall include a site plan, tree survey of protected trees, preserve areas, and a statement explaining why the protected tree is proposed for removal.

5.1.2 Tree Removal or Relocation

Code of Ordinance, Section 656.1206 (b)

5.1.3 Tree Pruning Permit

Code of Ordinance, Section 656.1206 (c)

5.1.4 Maintenance Permit

Code of Ordinance, Section 656.1206 (d)

5.2 Tree Protection

Protected trees can occur on either private property or within public spaces. Protected trees are defined in the Code of Ordinance, Section 656.1203 (bb). Exceptions for the removal of protected tress are outlined in Section 656.1205. Site clearing or other activities that disturb existing trees may require action to replace the trees being disturbed. The following actions are available to the developer and are presented in order of preference.

5.2.1 Preservation

Code of Ordinance, Section 656.1207

Where possible, it is desirable to work within the constraints of the site to preserve protected trees to the extent practicable. All trees protected for preservation and tree credit shall be protected according to the procedures in Section 656.1207 and as shown in **Figure 5.1-1**.

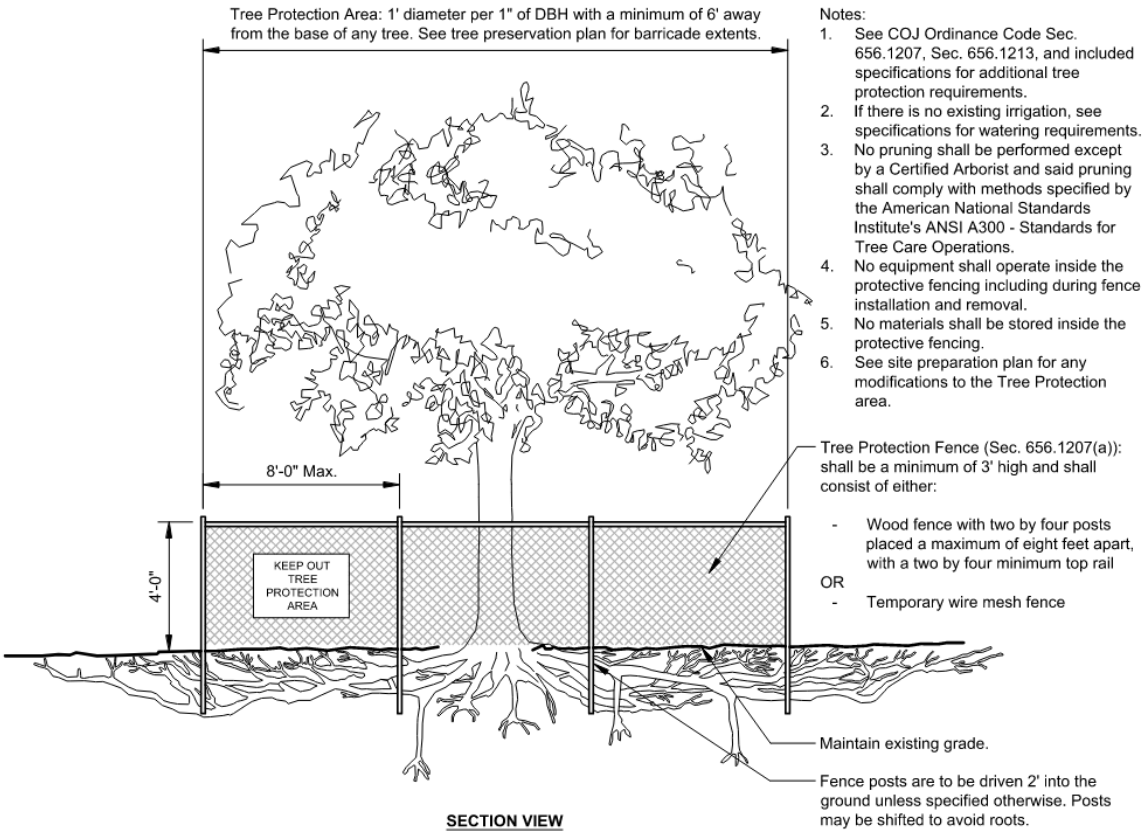


Figure 5.1-1 Tree Protection Procedures for Preservation of Trees

5.2.2 Relocation

Code of Ordinance, Section 656.1206 (f)

Relocation of trees shall be performed in accordance with ANSI A300 guidelines for transplanting and accepted industry practices, including watering to insure survival of transplanted stock.

5.2.3 Replacement

Code of Ordinance, Section 656.1206 (g)

When protected trees must be removed, they must be replaced based on the total caliper inches of the of protected trees removed. Code of Ordinance, Section 656.1206 (g) includes specific guidance on calculation of replacement inches dependent on protected tree type. In some instances, relocation of protected trees may be eligible to offset the inches of replacement trees required.

5.2.4 Mitigation

Code of Ordinance, Section 656.1206 (g) (14), (15), and (16)

In cases where the site cannot accommodate the number of required replacement trees based on insufficient planting area, a monetary contribution to the Tree Protection and Related Expense Fund will be required. Code of Ordinance, Section 656.1206 (g) (14) details the fee calculation for Tree Protection Fund.

As an alternative to providing a monetary contribution to the Tree Protection and Related Expenses Trust Fund, an applicant may, under the conditions outlined in Section 656.1206 (g) (15), provide mitigation in certain off-site locations, the "alternative site", which is not a residential lot.

As a further alternative to providing a monetary contribution to the Tree Protection and Related Expenses Trust Fund, an applicant may, in limited circumstances and under the conditions set forth in Section 656.1206 (g) (16), provide mitigation of the required mitigation amount through conveyance of certain lands to the City of Jacksonville.

5.3 Plant Materials Guidelines

Code or Ordinance, Section 656.121(e), Section 656.1211

In accordance with the Jacksonville Comprehensive Plan, all new developments shall provide for the conservation and preservation of environmentally sensitive lands, native plant communities and wildlife habitat to maintain the natural ecological types and sustainable populations of wildlife native to the City consistent with the provisions of Objective 3.3, Policy 2.3.7 and associated policies of the Conservation/Coastal Management Element of the Comprehensive Plan.

The preservation of native habitat vegetation during land development activities is required, either through maintenance of natural vegetation on the project site, or through the planting of native vegetation. If through planting, at least 50 percent of all plantings incorporated in an approved landscape plan for any project site shall consist of native vegetation suitable to that site, and at least 60 percent of all post-development vegetation shall be indigenous to the City.

5.3.1 Plant Selection Guidance

The University of Florida, Florida Friendly Landscaping ™ Plant Guide can be used to select appropriate plantings according to plant type, plant shape, color, environmental factors, and Florida native status.

5.3.2 Pond Low Maintenance Zone

Areas surrounding stormwater ponds shall include a six-foot low maintenance zone of landscape planting or ground cover that does not require intensive fertilizer, watering and mowing as shown in **Figure 5.3-1**. This low maintenance zone may include the plantings outlined in **Table 5.3-1**.

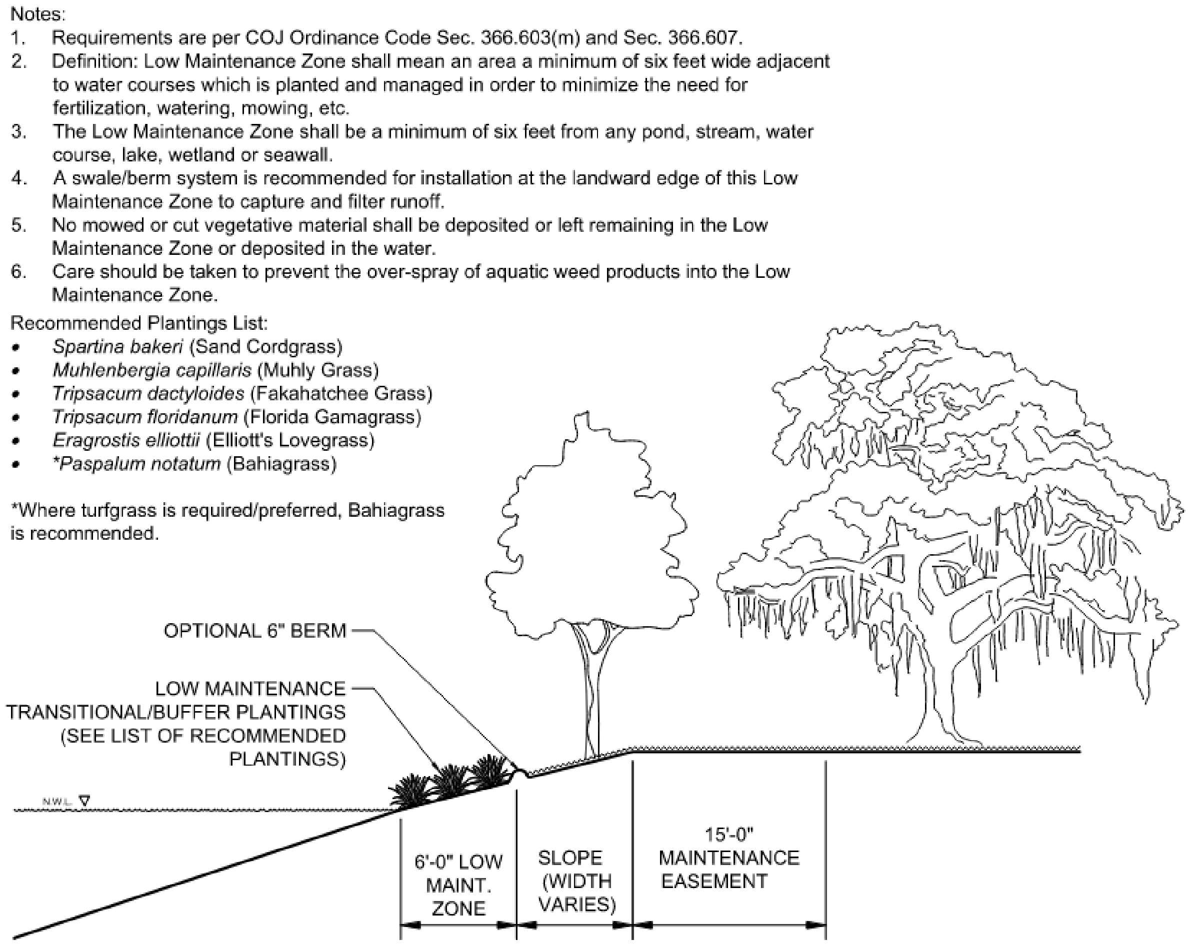


Figure 5.3-1 Pond Low Maintenance Zone

Table 5.3-1 Pond Low Maintenance Zone Plant Selections

Botanical Name	Common Name
Spartina bakerii	Sand Cord Grass
Tripsacum dactyloides	Fakahatchee Grass
Tripsacum floridanum	Florida Gamagrass
Muhlenbergia capillaris	Muhly Grass
Eragrostis elliottii	Elliott's Lovegrass

5.3.3 Tree Types

The City of Jacksonville Tree Commission has approved the list of trees detailed in Table 5.3-2 for city parks and right of ways in their Level 2 Tree Planting Program. This same list serves as an excellent guide for tree selection for commercial and private development. The approved tree planting list is presented below, but it is updated frequently, so reference the City Tree Commission website for the most recent approved list. The approved tree planting list is updated frequently, so reference the City Tree Commission website for the most recent approved list.

Table 5.3-2 Tree Commission Level 2 Tree Planting Approved List

Tree	ROW	Parks	DCPS[14]	Height/ Spread	Plan Canopy Diameter[1]	Foilage[2]	Light Required[3]	Soil Drainage[4]	Drought Tolerance[5]	Growth Rate[6]	Soil Tolerance (pH)	IFAS FL Friendly[13]
SMALL TREES												
American Hornbeam *Carpinus caroliniana*	Y	Y		30-35'/ 25-30'	20'	DECID	FS/PS	WD	HIGH	SLOW	(4.2-7.6)	Y
Ashe Magnolia *Magnolia macrophylla ssp. ashei*		Y		20'	20'	DECID	PSH, SH	OW	MOD	MOD	(4.8-7.5)	
Eastern Redbud *Cercis canadensis*	Y	Y		15-30'/ 15-25'	20'	DECID	FS, PSH	WD	HIGH	RAPID	(4.2-7.6)	Y
Flatwoods Plum *Prunus umbellata*	Y	Y		12 – 20'	20'	DECID	FS, PSH	WD	MOD	MOD	(4.8-7.5)	Y
Crape Myrtle *Lagestroemia indica var. Natchez, Muskogee, or Tuskegee), Standard or Multi- trunk*	Y	Y	Y	15-20'/ 15-25'	18'	DECID	FS	WD	HIGH	MOD	(5.0-7.5)	Y
Hawthorn *Crataegus spp.*		Y	Y	25'	25'	DECID	FS, PSH	WD	HIGH	MOD	(4.8-7.5)	Y
Fringe Tree *Chionanthus virginicus*	Y	Y		12-20'/ 10-15'	10'	DECID	FS, PSH, SH	WD	MOD	SLOW	(6.0-6.5)	Y
Little Gem Magnolia *Magnolia grandiflora 'Little Gem'*	Y	Y		25-35'/ 8-10'	15'	E'GRN	FS, PSH, SH	AW, WD	MOD	SLOW	(4.5-5.0) tolerant to 7.5	Y
Yaupon Holly *Ilex vomitoria*	Y	Y	Y	15-25'/ 15-20'	15'	E'GRN	FS, PSH, SH	AW, WD	HIGH	SLOW	(4.5- 8.2)	Y
Wax-Leaf Ligustrum *Ligustrum japonicum*	Y	Y	Y	8-12'/ 15-25'	12'	E'GRN	FS, PSH	WD	MOD	MOD	(5.5-7.5)	Y
Wax Myrtle[9] *Myrica cerifiera*	Y	Y	Y	15-25'/ 20-25'	20'	E'GRN	FS, PSH, SH	W, WD	HIGH	RAPID	(5.5 -7.0) tolerant to 8.2	
Walters Viburnum *Viburnum obovatum*	Y	Y		8-25'/ 6-12'	10'	SEMI-E'GRN	FS, SH	W, OW	HIGH	MOD	(5.0-7.5)	Y

Tree	ROW	Parks	DCPS[14]	Height/ Spread	Plan Canopy Diameter[1]	Foilage[2]	Light Required[3]	Soil Drainage[4]	Drought Tolerance[5]	Growth Rate[6]	Soil Tolerance (pH)	IFAS FL Friendly[13]
MEDIUM TREES												
Athena Elm *Ulmus parvifolia 'Emer l'*	Y	Y		45'/ 50'	30'	DECID	FS	OW, WD	MOD	MOD	(4.8-7.5)	
Bosque Elm *Ulmus parvifolia 'Bosque'*	Y	Y		45'/ 50'	30'	DECID	FS	OW, WD	MOD	MOD	(4.8-7.5)	
Drake Elm[12] *Ulmus parvifolia 'Drake'*	Y	Y		35-40'/ 35-50'	30'	DECID	FS, PSH	OW, WD	MOD	MOD	(4.8-7.5)	
Dahoon Holly *Ilex cassine*	Y	Y	Y	20-30'/ 8-12'	15'	E/GRN	FS, PSH	W, OW	MOD	SLOW	(3.5-6.5)	Y
Eagleston Holly *Ilex attenuata 'Eagleston'*	Y	Y	Y	30-45'/ 15-25'	20'	E'GRN	FS, PSH	WD	MOD	MOD	(4.0-6.0) tolerant to 7.5	
Japanese Blueberry Tree *Elaeocarpus decipiens*	Y	Y		40'/ 40'	20'	E'GRN	FS, PSH	WD	MOD	MOD	(4.0-6.0) tolerant to 7.5	Y
Loquat *Eriobotrya japonica*		Y		20 - 30'	30'	DECID	FS, PSH	WD	MOD	SLOW	(4.8-7.5)	Y
East Palatka Holly *Ilex attenuata 'East Palatka'*	Y	Y	Y	30-45'/ 15-25'	20'	E'GRN	FS, PSH	WD	MOD	MOD	(4.0-6.0) tolerant to 7.5	Y
Sand Pine Pinus clausa		Y		25 – 40'	15 – 25'	E'GRN	FS, PSH	WD	HIGH	SLOW	(4.8-7.5)	Y
Sweetbay Magnolia *Magnolia virginiana*	Y	Y		40 - 50'	40'	DECID	FS,PSH	OW, WD	MOD	MOD	(4.8-7.5)	Y
Southern Red Cedar Juniperus silocilois	Y	Y		30-40'/ 20-30'	20'	E'GRN	FS, PSH	WD	HIGH	SLOW	(5.5-7.5) tolerant to 8.0	Y
American Hophornbeam Ostrya virginiana	Y	Y		30 – 40'	25 – 30'	DECID	FS, PSH, SH	WD	MOD	MOD	(3.5-6.5)	Y
River Birch[8] Betula nigra	Y	Y	Y	40-50'/ 25-35'	20'	DECID	FS, PSH	W, OW	LOW	RAPID	(4.0-6.5) tolerant <4.0	Y
Winged Elm Ulmus alata	Y	Y		40-50'/ 30-40'	30'	DECID	FS, PSH	OW, WD	LOW	MOD	(5.0-7.0) tolerant to 8.0	Y

Tree	ROW	Parks	DCPS[14]	Height/ Spread	Plan Canopy Diameter[1]	Foilage[2]	Light Required[3]	Soil Drainage[4]	Drought Tolerance[5]	Growth Rate[6]	Soil Tolerance (pH)	IFAS FL Friendly[13]
LARGE TREES[10]												
Allee Elm Ulmus parvifolia 'Emer II'	Y	Y		75'/ 60'	30'	DECID	FS	OW, WD	MOD	MOD	(4.8-7.5)	
Bald Cypress Taxodium distichum	Y	Y	Y	60-80'/ 25-30'	25'	DECID	FS, PSH	W, OW, WD	MOD	RAPID	(4.0 to 6.0), tolerant to 7.5	Y
Hickory Carya sp.		Y		50 - 60'	35'	DECID	FS, PSH	WD	MOD	SLOW	(4.8-7.5)	Y
Blackgum Nyssa sylvatica	Y	Y		75'/ 25-30'	30'	DECID	FS, PSH, SH	W, OW, WD	HIGH	SLOW	(6.0-7.0)	Y
Catalpa Catalpa bignonoides		Y	Y	60'/ 40-60'	35'	DECID	FS, PSH	W, OW, WD	MOD	RAPID	(4.5-6.0)	
Live Oak[7] Quercus virginiana	Y	Y	Y	60-80'/ 60-120'	50'	E'GRN	FS, PSH	OW, WD	HIGH	MOD	(4.5-6.5) tolerant to 8.0	Y
Swamp Chestnut Oak Quercus michauxii	Y	Y	Y	60-70/ 30-50'	35'	DECID	FS, PSH	W, OW, WD	LOW	MOD	(4.5-6.0)	Y
Overcup Oak Quercus lyrata	Y	Y	Y	35-50'/ 30-50'	35'	DECID	FS, PSH	W, OW, WD	LOW	MOD	(4.5-6.0)	Y
Laurel Oak Quercus laurifolia	Y	Y	Y	60'/ 40-60'	35'	DECID	FS, PSH	W, OW, WD	MOD	RAPID	(4.5-6.0)	
Nuttall Oak Quercus nuttallii	Y	Y	Y	60-80'/ 35-50'	35'	DECID	FS	OW, WD	LOW	MOD	(4.5-5.5)	Y
Shumard Oak Quercus shumardii	Y	Y	Y	80'/ 50-60'	35'	DECID	FS, PSH	W, OW, WD	HIGH	RAPID	(4.5-5.5)	Y
Persimmon Diospyros virginiana		Y		30 - 60'	30'	DECID	FS, PSH	WD	MOD	SLOW	(3.5-6.5)	
Red Maple[8] Acer rubrum	Y	Y	Y	60-75'/ 25-35'	30'	DECID	PSH	W, OW	LOW	MOD	(5.4-7.1)	Y
Loblolly Bay Gordonia lasianthus		Y		70'	20'	E'GRN	FS,PSH	W, OW, WD	MOD	MOD	(4.8-7.5)	Y
Leyland cypress Curpressocyparis leylandii	Y	Y		30-40'/ 20-30'	20'	E'GRN	FS, PSH	WD	HIGH	SLOW	(5.5-7.5) tolerant to 8.0	Y

Tree	ROW	Parks	DCPS[14]	Height/ Spread	Plan Canopy Diameter[1]	Foilage[2]	Light Required[3]	Soil Drainage[4]	Drought Tolerance[5]	Growth Rate[6]	Soil Tolerance (pH)	IFAS FL Friendly[13]
Slash Pine Pinus elliottii		Y		60-80'/ 30-40'	20’	E’GRN	FS, PSH	OW, WD	HIGH	RAPID	(4.5-7.0)	Y
Long Leaf Pine Pinus palustris	Y	Y		60-80'/ 30-40'	20’	E’GRN	FS	WD	HIGH	MOD	(4.5-7.0)	Y
Southern Magnolia Magnolia grandiflora	Y	Y		30-100’/ 20-40’	30’	E’GRN	FS, PSH	OW, WD	MOD	MOD	(5.5-6.5) tolerant to 7.5	Y
Sweetgum Liqudambar straciflua	Y	Y	Y	60-75’/ 35-50'	30’	DECID	FS, PSH	W, OW	LOW	MOD	(4.5-7.0) tolerant to 7.5	Y
Sycamore Platanus occidentalis	Y	Y		75-90'/ 50-70'	30’	DECID	FS	W, OW, WD	MOD	RAPID	(4.9-6.5),tolerant up to 8.0	Y
Tulip Poplar Liriodendron tulipifera	Y	Y		80-100'/ 30-50'	30’	DECID	FS,PSH	OW, WD	MOD	RAPID	(4.5-6.5) tolerant up to 7.5	Y
8 Weeping Willow Salix babylonica or alba		Y		45-70’/4 5-70’	30;	DECID	FS,PSH	OW, WD	MOD	RAPID	(4.5-7.5)	
PALMS												
Washington Palm Washingtonia robusta	Y	Y		60-100'/ 10-15'	12’	E’GRN	FS, PSH	OW, WD	HIGH	RAPID	(5.5-7.5) tolerant up to 8.0	Y
Cabbage Palm Sabal palmetto	Y	Y	Y	40-50'/ 10-12'	10’	E’GRN	FS	OW, WD	HIGH	MOD	(6.0-6.8) tolerant up to 8.0	Y
Ribbon Palm Livistona decipiens	Y	Y		30-50’/ 18-25'	15’	E’GRN	FS	WD	HIGH	MOD	(5.5-7.5)	

LEGEND

1 Draw each tree symbol on the landscape plan to the diameter shown above to match the normal mature (20 year) canopy of each tree species. Do not overlap tree canopies of different species (ie,do not show the canopy circle of a sun loving crape myrtle overlapping the mature canopy circle of a live oak). However, tree canopy circles of the same species can overlap to create tree clusters or to create a solid, closely spaced row of trees. Also, new understory trees can be shown under existing shade trees if existing trees have high branching.

2 Foilage: DECID = Deciduous, E'GRN = Evergreen

3 Light Requirement: FS = Full Sun, PSH = Partial Shade (2-5 hrs. of sun or filtered sun), SH = Full Shade (<2 hrs. sun)

4 Soil Drainage: W=Always Wet (soil saturated for more than several days during growing season), OW=occasionally Wet (Soil saturated for several days during several days of growing season), WD=Well Drained

5 Drought Tolerance: HIGH=High (no watering required once well established), MOD= Moderate (occasional watering required during dry periods in growing season), LOW= Low (frequent watering required during dry periods of growing season)

6 Growth Rate: SLOW=Slow (<1ft/ yr.), MOD=Moderate (1-2 ft/ yr.), FAST=Fast (>2ft/ yr.)

7 Use Live Oak cultivars (Q. v. 'SDLN' ('Cathedral' Live Oak) or Q. v. 'QVTIA ('Highrise' Live Oak)) in medians when a single row of oaks with uniform spacing is desired. Use 'Highrise' Oak where oaks are near overhead power lines. Use common live oak for informal groupings.

8 Limit use of River Birch, Red Maple, and Weeping Willow to clusters around retention ponds and in areas of R.O.W. undisturbed by construction. Do not use in medians or within 20' of pavement. These trees don't do well in alkaline conditions generally found near pavement. Because River Birch and Willows have a short life span, use these tree sparingly. Generally, cluster with longer lived tree types.

9 Use Wax Myrtle only in mass planting for visual screening and transition into natural areas.

10 Provide 6'-8' minimum between Large Trees and pavement, curbs and other structures.

11 Trees not on the above approved list may be considered for approval by the Tree Commission. (www.coj.net/departments/public-works/tree-commission)

12 Because of weeping nature of Drake Elm, limit use to medians 30' wide or greater, measured from the edge of travel lane (i.e. two 1.5' curb & gutter & 27' grassed median) and where the tree can be set back 15' from the travel lane, if planted on the side of the street.

13 The definition of Florida-Friendly Landscaping™ in Florida Statutes section 373.185 (adopted in 2009 in Senate Bill 2080) addresses "quality landscapes that conserve water, protect the environment, are adaptable to local conditions, and are drought tolerant. The principles of such landscaping include planting the right plant in the right place, efficient watering, appropriate fertilization, mulching, attraction of wildlife, responsible management of yard pests, recycling yard waste, reduction of stormwater runoff, and waterfront protection. Additional components include practices such as landscape planning and design, soil analysis, the appropriate use of solid waste compost, minimizing the use of irrigation, and proper maintenance."

14 DCPS=Duval County Public Schools. When landscaping on Public Educational Facilities in Florida (including colleges and universities), please refer to State Requirements for Educational Facilities manual for a comprehensive description of planting standards at www.flrules.org.

5.4 Streetside Landscaping

5.4.1 Streetside Landscaping Definition

Streetside landscaping shall include the installation of any tree, bush, shrubbery, groundcover (except sod or grass), irrigation system or any fixed object such as rocks, boulders, planters, fountains or soil mounds which are installed or planted in a median strip, utility strip or landscape island within the right-of-way of a city-owned and maintained roadway. This section shall not apply to existing natural vegetation within existing rights-of-way or to any protected trees or other items covered by the Landscape Ordinance in Part 12 of the Charter of the City of Jacksonville.

5.4.2 Streetside Landscaping Maintenance and Permits

Except under special arrangements or in certain designated districts, the City does not maintain streetside landscaping. Maintenance shall be the responsibility of the developer, property owner, Homeowners' Association or others as indicated in the permit. Prior to installing or planting any streetside landscaping, a plan shall be submitted for approval and permitting showing the location, size, and type of plants, as well as any other landscaping features.

5.4.3 Streetside Landscaping Design Criteria

All streetside landscaping shall be designed to provide adequate site distance for pedestrians, bicyclists, and vehicular drivers entering, exiting, or traveling within the right-of-way.

Trees or other landscaping shall be no closer than 4 feet from the face of the curb, or outside the critical root zone of the tree , whichever is further. For roadways containing no curb and gutter, landscaping shall not be placed within the recovery zone as specified in the FDOT Florida Greenbook Standard for Design.

All shrubbery, bushes, groundcover and landscape berms located within a median or landscape island shall not be higher than 2 feet from the pavement surface. Landscaping items located within the utility strip or adjacent to the outside edge of pavement shall not be greater than 2.5 feet in height when located within the line of sight required to maintain adequate sight distance at all intersections, horizontal curves, driveways and pedestrian crossings.

All trees used in streetside landscaping shall have a minimum trunk diameter of 4 inches and shall have an unobstructed clear height of 7 feet from the sidewalk or roadway surface to the bottom of the branches. Trees that have a drip line which protrudes over the roadway surface shall have an unobstructed clear height of 18 feet from the roadway surface to the bottom of the branches.

5.4.4 Guidelines For Planting Trees in City of Jacksonville ROW

PREPARING A STREET TREE PLAN

As part of the Site Engineering Plan Preliminary Submittal Package (LDPM Volume 1, Section 2.0), submit a tree planting plan drawn to scale that clearly shows the proposed locations of new trees and any existing structures such as sidewalks, light poles, driveways and existing trees found in the right-of-way grass strip. Before a plan is developed, the particular site conditions must be known to choose a proper tree species and to select a suitable location for the street trees.

HOW TO CHOOSE THE RIGHT TREE FOR THE RIGHT LOCATION

- Trees must be located to avoid damage to shallow underground utilities when holes are dug for new trees.

- Choose tree size based upon width of planting strip between the street and the sidewalk and height of overhead power lines:

Table 5.4-1 Tree Minimum Planting Widths

Tree Size	Minimum Planting Width
Small	4-6 ft.
Medium	6-8 ft.
Large	8+ ft.

Use upright growing tree.

- Where the entire strip between the street and the property line is sidewalk, tree planting areas can be created by the removal of section of sidewalk to the following dimensions.

Table 5.4-2 Tree minimum Planter Size

Tree Size	Minimum Planter Size
Small	5 x 5 ft
Medium	5 x 5 ft
Large	5 x 7 ft

- If the street is currently lined with trees all of the same type or of one dominate type, select a new tree of the same type to maintain the existing harmonious street canopy.
- Keep trees away from power poles, street lights, street warning signs, water meters, driveways, and street intersections the following distances to minimize conflicts with existing physical improvements in the right of way and to insure that safe traffic visibility is maintained:

Table 5.4-3 Minimum Distance Between Trees (and/or Structures)

Structure	Minimum Distance Between Trees (and/or Structures) (ft)		
	SMALL TREE	MEDIUM TREE	LARGE TREE
Power Pole	10	15	25
Street Light	10	15	25
Water Meter	5	10	15
Driveways, House Entry Walks	10	15	20
Street Intersections (measured to curb edge)	30	30	3

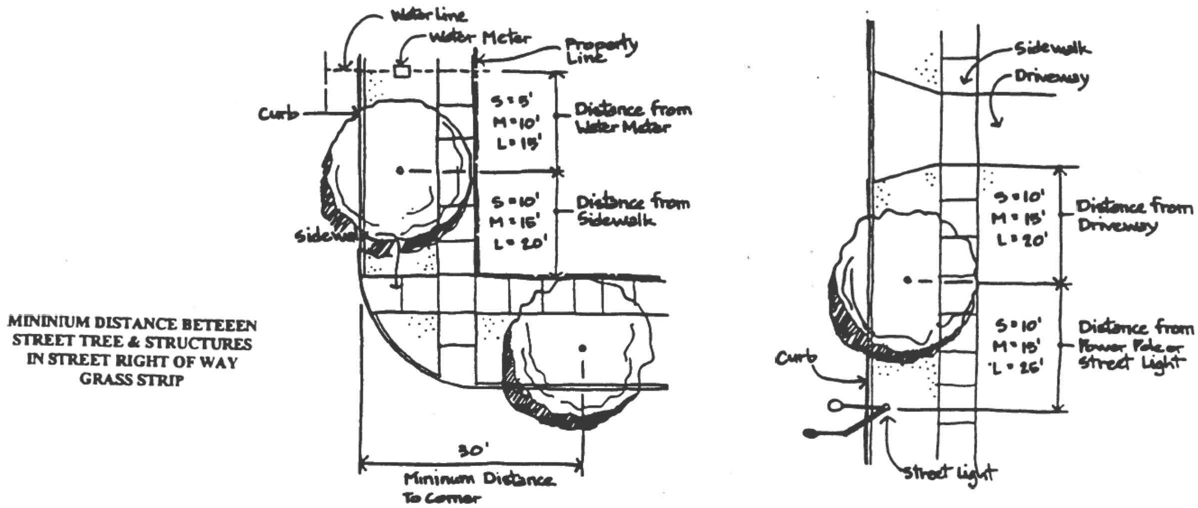


Figure 5.4-1 Minimum distance between street trees and structures in street ROW grass strip

- Check the soil. There are generally two broad soil conditions in Jacksonville. Very sandy, well drained soils occur on broad sand ridges; sandy loam, poorly drained soils occur in the flat lands. The remaining native vegetation is a good indication of the soil conditions. If you see numerous scrub oaks, pines, laurel oaks and live oaks in the area, the soil is well drained; if you see red maples, sweet gums and wax myrtles, the soil is poorly drained. Choose a tree that can handle the soil type. See the following table of recommended tree species that are suitable for your soil conditions.
- When incorporating trees along roadways with significant bicycle and pedestrian traffic or shared use paths, consider the use of trees that will provide shade for facility users.

USE RECOMMENDED TREE SPECIES:

Use the tree planting guide listed in Section 5.3.3 to select recommended trees for planting within the street right-of ways in Jacksonville.

- The following trees are attractive street side accents, but because of their irregular growth habits, lower limbs, and short life they should be planted in the front yards near the right-of-way line.

Table 5.4-4 Recommended Front Yard Trees

Tree Name	Height/ Spread	Plant Type	Soil Type	Location	Notes
Golden Rain Tree	30-40ft/ 20-30ft	D	Varied, not wet	Sun	Yellow fall flowers followed by pink fruit. Poor shape when young
Redbud	20-30ft/ 15-20ft	D	Varied	Sun, PS	Early pink flowers, short live
Fringe Tree	10-20ft/ 0-15ft	D	Organic	Sun, PS	Avoid hot dry sites
Chickasaw Plumb	15-25ft/ 15-25ft	D	Varied	Sun	Native, white spring flowers, drought tolerant

- Trees to avoid using as street trees:

Table 5.4-5 Trees to Avoid Using as Street Trees

Tree Name	Remarks
Weening Willow	Weak wood, invasive roots, weening low branches
Mimosa	Weak wood, sucker growth
Paper mulberry	Weak wood, suckers
Pecan	Weak wood, fruit drop
Chinaberry	Weak wood, sucker growth
Silver Maple	Weal wood, short lived, shallow roots
Southern Magnolia	Dense surface roots, messy leaves and fruit

- Tree Spacing will vary according to the street tree height class and generally should be the following:

Table 5.4-6 Tree Spacing Guidelines

Tree Size	Minimum Planter Size
Small	20-30 ft
Medium	30-40 ft
Large	40-60 ft

5.4.5 Grassing and Mulching Requirements

All roadway rights-of-way within the development, except those listed below, shall be grassed prior to final acceptance using one of the following methods.

1. One row of sod shall be placed behind the curb.
2. The disturbed areas from the back of the curb to the right-of-way line shall be seeded and/or mulched; or
3. Alternate stabilization measures may be installed subject to the approval of the Director of Public Works. Requests for deviation shall follow the procedures outlined in LDPM Volume 1, Section 5.0.

All areas disturbed by the Developer along the roadway rights-of-way outside of the development, except those listed below, shall be sodded, seeded and/or mulched prior to final acceptance.

Medians, landscape areas around entrance features and all other areas for which enhanced landscaping is proposed are not required to be grassed prior to final acceptance. In lieu thereof, such areas shall be delineated and included in the Developer's Warranty, Section I. GRASS AND SOD AGREEMENT (**Form LDPM-DWI**).

The owner of a lot (Developer, Builder or Homeowner) shall be responsible for maintaining stabilization on all lots/property owned by that party after final acceptance so as to ensure that the curb and streets remain free of silt and erosion.

5.4 Landscaping Standards for Residential Development

5.4.1 Buffer Standards

Code or Ordinance, Section 656.1222

A buffer area is required between all perimeters of residential development adjacent to public rights-of way in accordance with Section 656.1222.

The following figures are provided to illustrate landscaping requirements for specific conditions encountered in residential developments. Relevant references to the City's Code of Ordinances are provided.

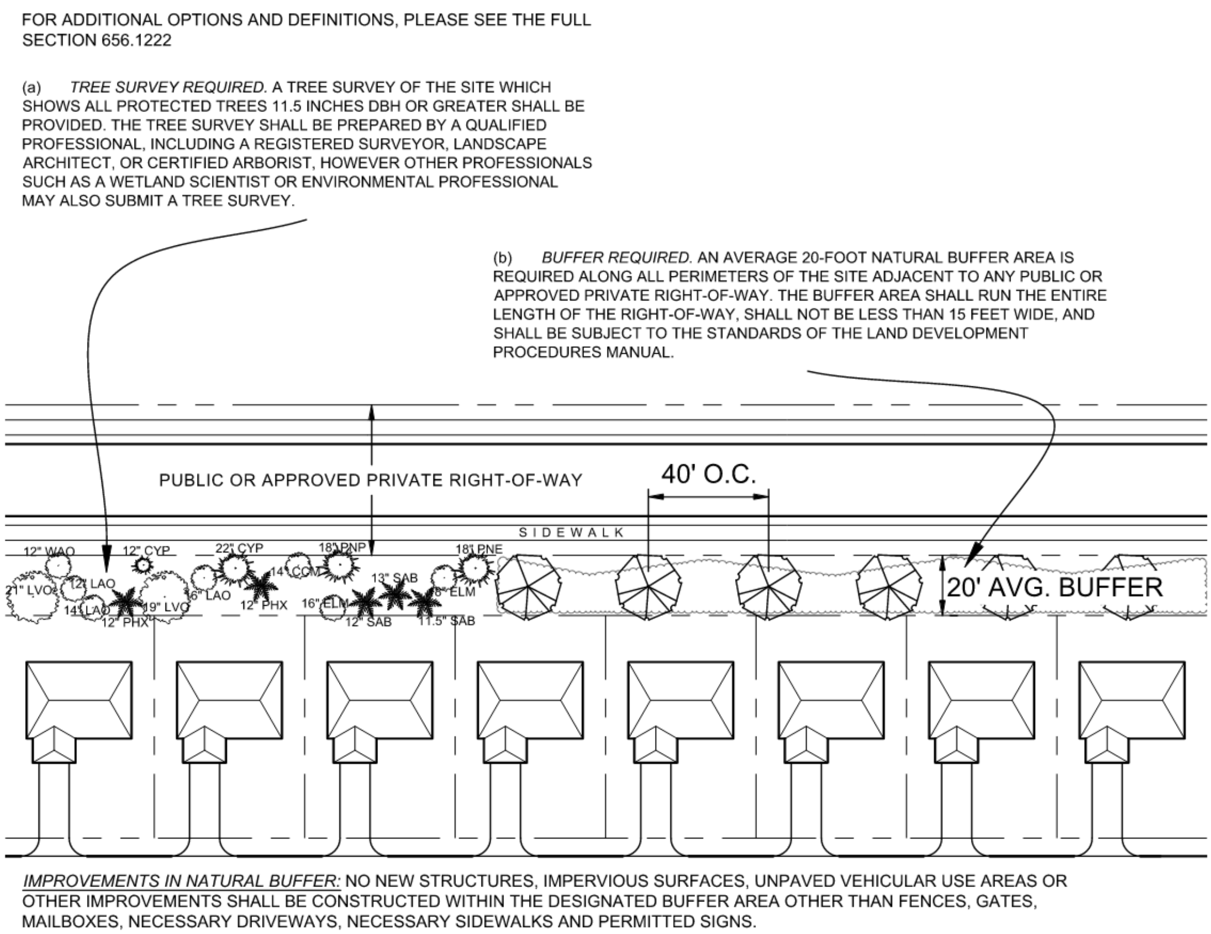


Figure 5.4-1 Buffer Requirements for Residential Subdivisions (Public or Approved Private ROW) (not to scale)

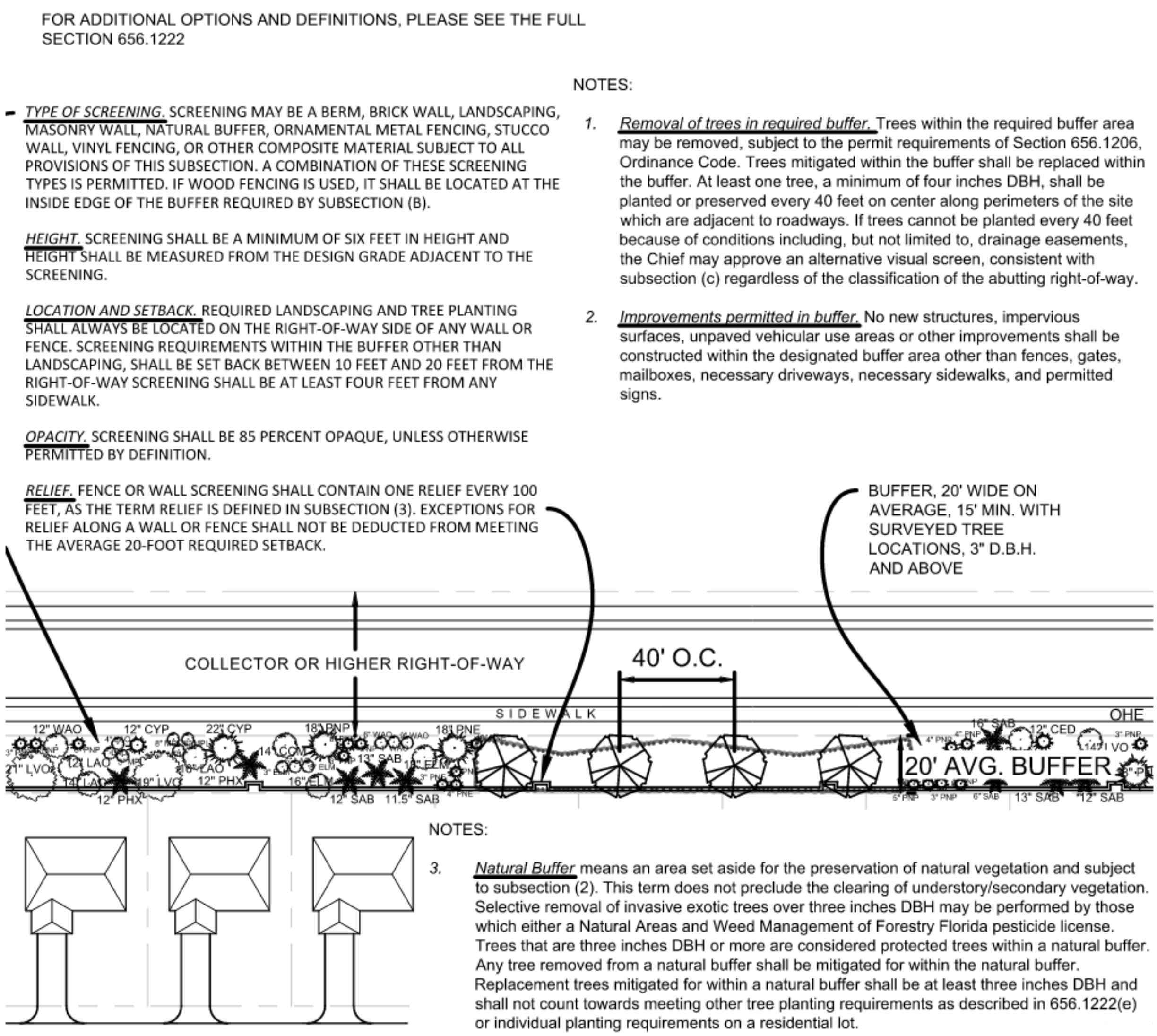


Figure 5.4-2 Buffer Requirements for Residential Subdivisions (Collector or Higher ROW) (not to scale)

5.4.2 Landscaping Around Utilities

This section provides information on buffer landscaping and required clear spaces around JEA utilities including pump stations and above-ground transformers. Please reference JEA planting standards for Lift Stations, Pad Mounted Transformers, and Cell Towers.

5.5 Landscaping Standards for Commercial Development

5.5.1 Perimeter Landscaping

Code of City Ordinance, Section 656.1215

The following figures are provided to illustrate landscaping requirements for specific conditions encountered in commercial and multi-family development. Relevant references to the City's Code of Ordinances are provided. The figures below are illustrative in nature, the requirements of the Code of Ordinance prevail in all cases.

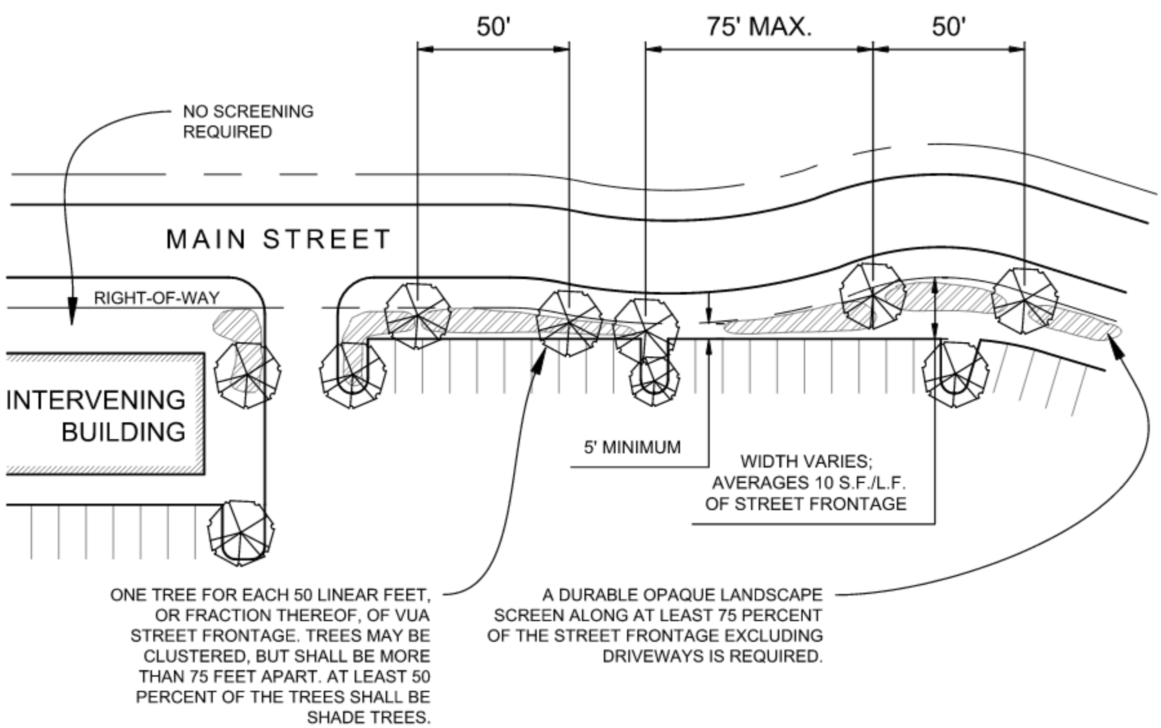


Figure 5.5-1 Design Standards for Perimeter Landscaping Along a Roadway (not to scale)

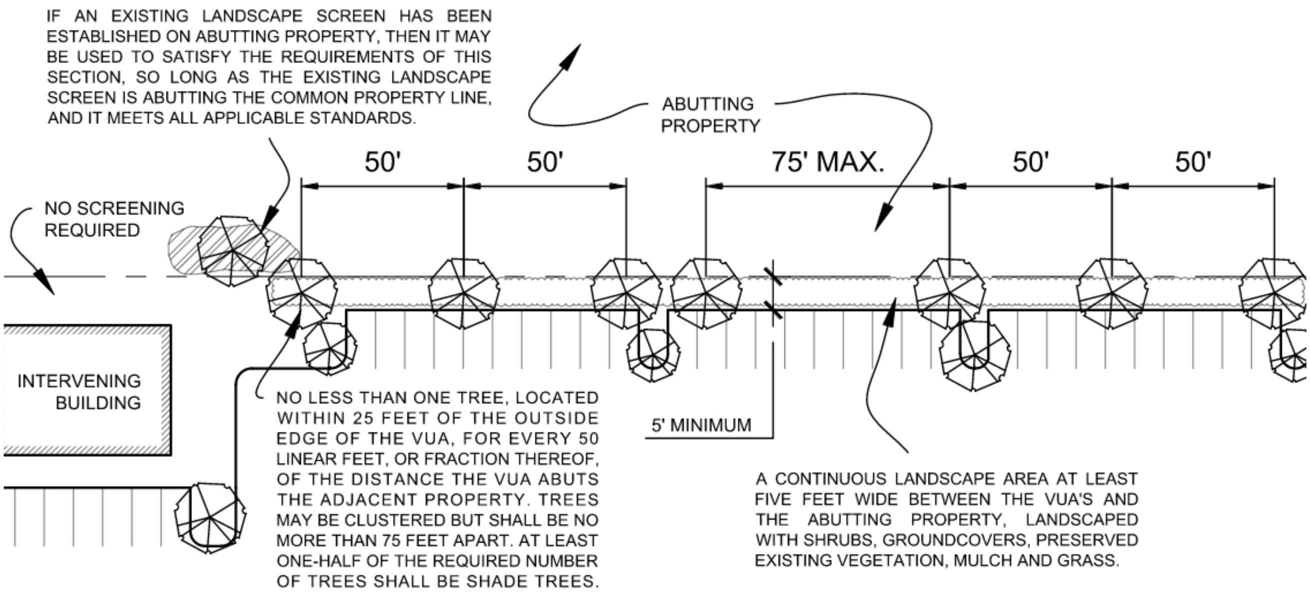


Figure 5.5-2 Design Standards for Perimeter Landscaping Along Abutting Property (not to scale)

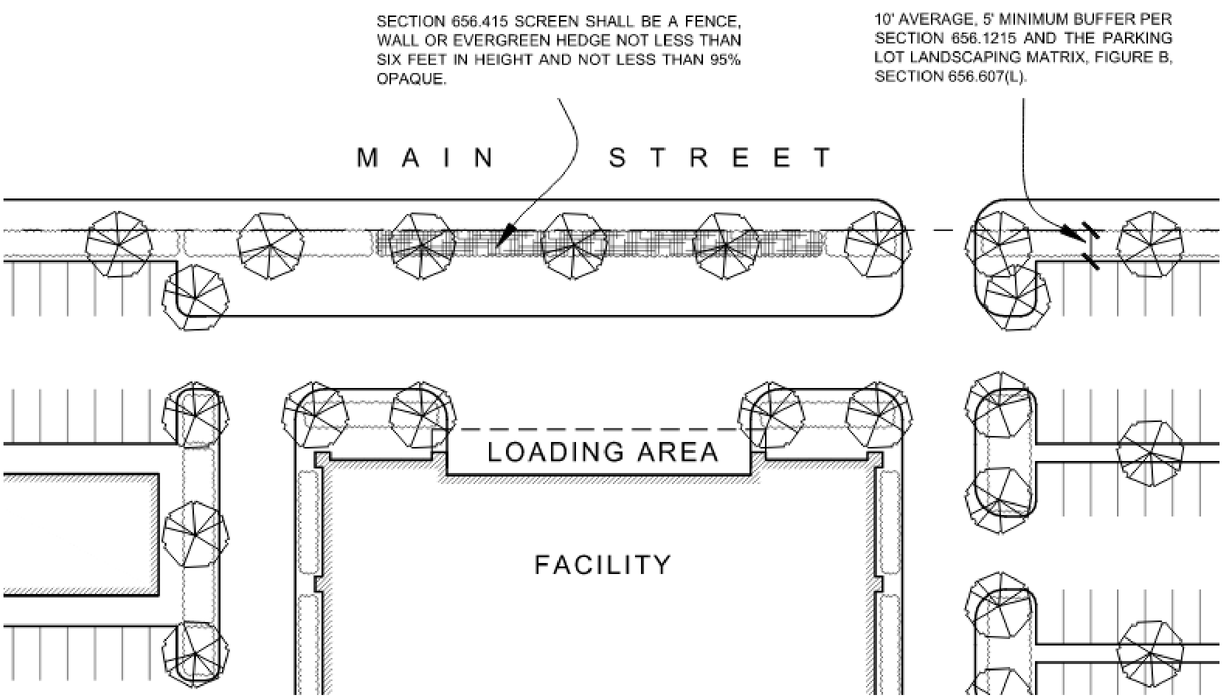


Figure 5.5-3 Design Standards for Loading Facilities (not to scale)

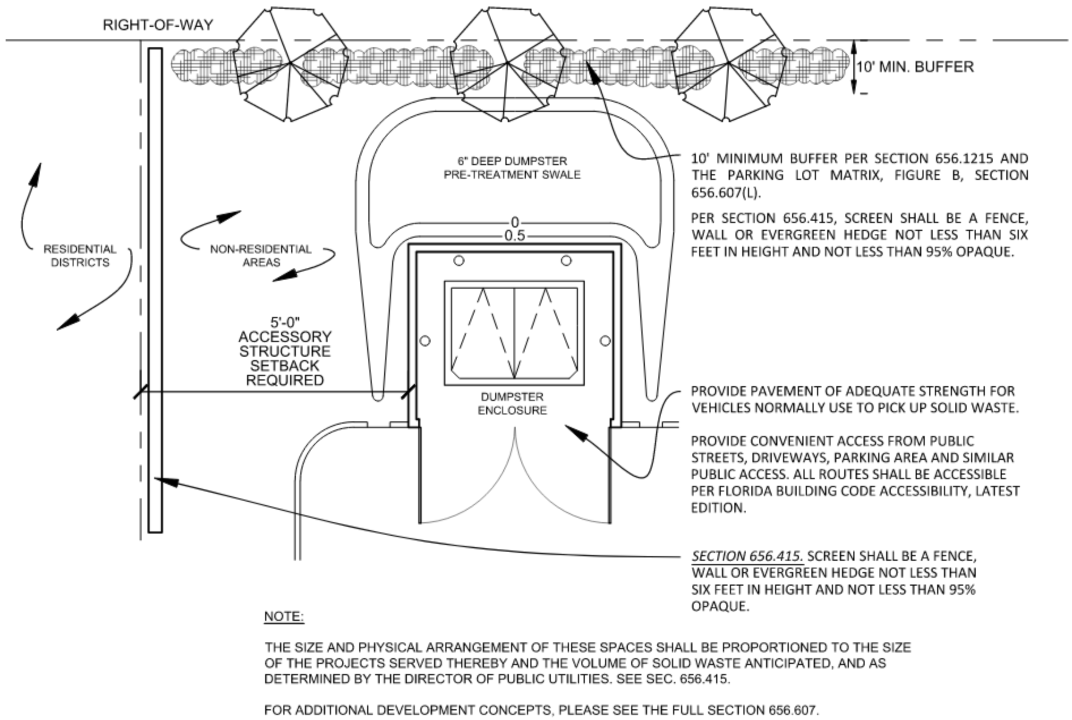


Figure 5.5-4 Design Standards for Solid Waste Loading Facility (not to scale)

5.5.2 Buffer Standards

Code of City Ordinance, Section 656.1216

Where uncomplementary land uses or zoning districts are adjacent, without an intervening street, a buffer strip shall be required between the uses or zoning districts according to Section 6565.1216.

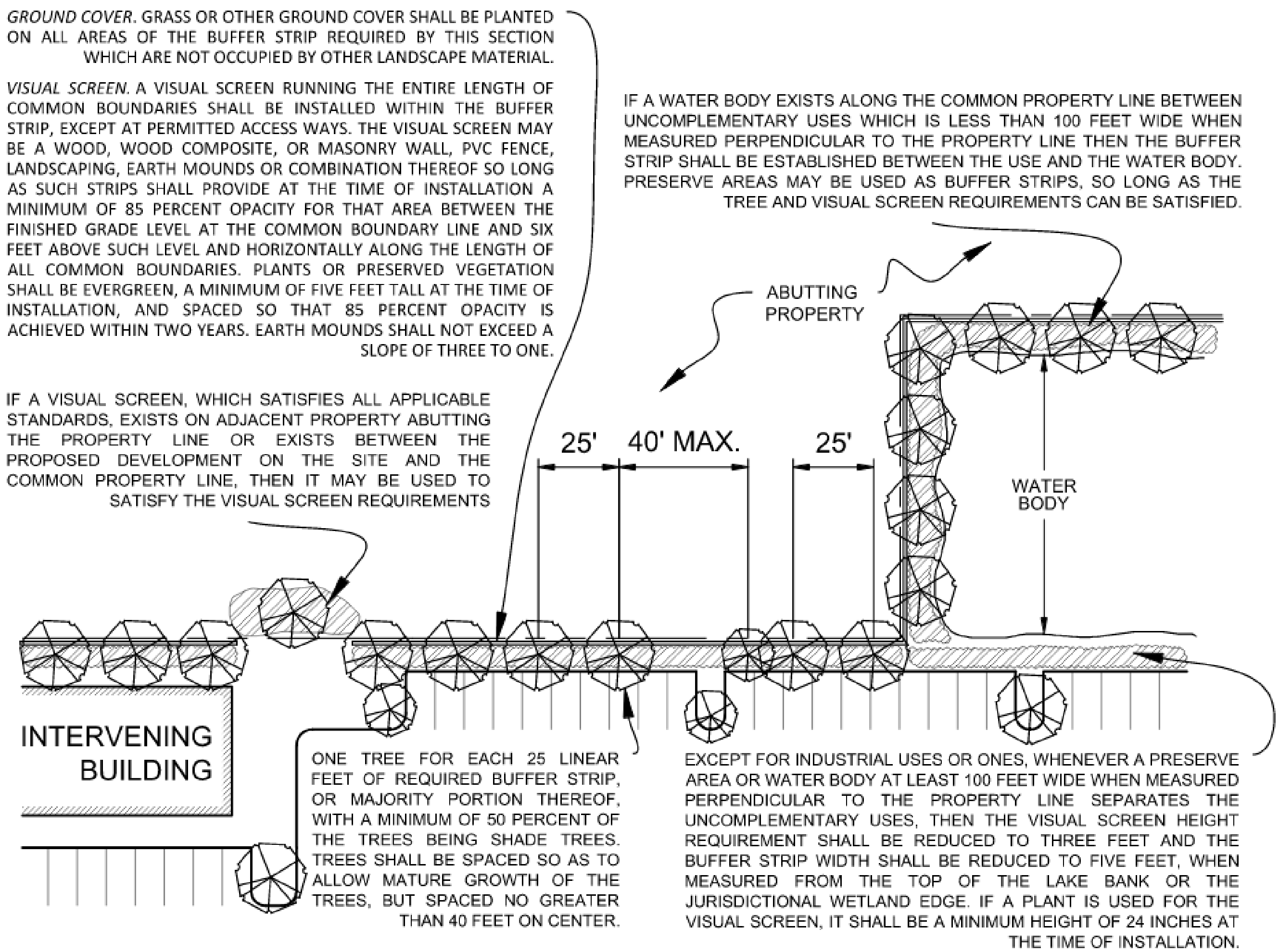


Figure 5.5-5 Buffer Standards Related to Uncomplementary Land Use and Zoning (not to scale)

5.5.3 Vehicular Use Areas

Code of Ordinance, Section 656.1214

VUAs shall be landscaped in accordance with the requirements of Section 6565.1214. Design guideline for shallow bioretention and grassed conveyance swales appropriate for VUAs are included in Section 4.0 Green Infrastructure Design Guidelines.

5.5.4 Intersection Visibility with Vehicular Use Areas

Code of Ordinance, Section 656.1218

Where an accessway, such as a drive aisle, intersects with another accessway within a VUA, where an accessway is located within a VUA, or where an accessway intersects with a street right-of-way, cross visibility shall be unobstructed at a level between two and eight feet above elevation of adjacent pavement as described in Section 656.1218.

5.7 Landscaping in Specific Overlay Zones

The following special overlay zones have been established with special landscaping requirements. . The landscaping requirements within the special overlay zone take precedence over the landscaping requirements detailed above.

5.7.1 Downtown Overlay Zone

Reference City Ordinance Section 656.361 for urban landscaping, open space features, parking lot landscaping, and street trees within the Downtown Zoning Overlay.

5.7.2 Mayport Road Overlay Zone

Reference City Ordinance Section 656.394 for landscaping and required buffers within Mayport Road Zoning Overlay.

5.7.3 Riverside/Avondale Zoning Overlay

Reference City Ordinance Section 656.399.30 and Section 656.399.32 for urban landscaping and street trees within the Riverside/Avondale Zoning Overlay

5.7.4 Renew Arlington Community Redevelopment Agency Overlay

Reference City Ordinance Section 656.399.62 for landscaping and street trees within the Renew Arlington Redevelopment Area.

5.8 Irrigation Systems

City Ordinance Section 656.1217, Section 656.1211, Section 366.505

The City Code of Ordinance Section 656.1217 and Section 656.1211 outlines requirements for irrigation systems to support the planned landscaping elements. Where possible, the City endorses the use of the use of BMPs to reduce the amount of irrigation required, including the FDEP guidance document Landscape Irrigation and Florida-Friendly Landscape Design Standards

SECTION 6.0 Solid Waste

6.1 Solid Waste - General

6.1.1 Application

This section applies to all commercial buildings and developments except single-family residences.

6.1.2 Developer's Responsibility

It shall be the developer's responsibility to provide adequate loading facilities for the proper handling of any and all solid waste generated by the development. Calculations shall be provided to show that the size and number of containers will accommodate all solid waste generated on the project at all times, to include that waste generated as a result of any single incidence, such as weekend parties, holidays, etc. There shall be no spillage of the solid waste from the containers.

6.2 Solid Waste Containers

6.2.1 Types of Containers

Containers for solid waste collection shall be of the standard type used by the City of Jacksonville Sanitation Division or the type used by local contract collection agencies. These generally are the large volume containers, for either front or rear loading; or roll-on, roll-off, on-site compaction unit containers. The containers shall be leak-proof and totally enclosed. Doors of adequate size and design shall be provided so that users can open and close them with ease.

6.2.2 Number of Containers

There shall be a sufficient number of containers of adequate volume placed at convenient locations to handle the solid waste generated by the facilities to be served.

6.2.3 Location of Containers

Large volume containers shall be placed in such locations so as to avoid blockage of the containers by parked vehicles. The sites of containers should be such that the vehicles servicing them can reach the containers with a minimum of maneuvering. Careful consideration should be given to both horizontal and vertical obstructions. Special concern of horizontal and vertical obstructions should be considered when working inside a building. Adequate information shall be provided on the drawings to indicate the turning and loading parameters for both horizontal and vertical clearances.

In apartment-type complexes, containers should not be located further than 200 feet apart.

Solid waste containers placed to service buildings or developments constructed after August 13, 1974, shall not be on any part of publicly owned property.

6.2.4 Paving Under containers

All solid waste containers shall be placed on a concrete pad. The pad shall be designed in accordance with acceptable engineering practices, including steel reinforcing, etc. The pad shall extend at least two feet beyond the edges of the containers used and shall be enclosed by a 6-inch high header curb. The pad shall be shaped to drain to a common point within the curb.

Either concrete or asphalt may be utilized in the area to be used by the container service vehicles. It is suggested that the immediate area around the container on which the service vehicle will operate be concrete.

6.2.5 Drainage Requirements

In order to adhere to the city's NPDES permit and prevent potential illicit connections to the municipal storm drainage system, the pad on which a large volume garbage container (e.g., a dumpster) sits must either drain into a pre-treatment swale that is a minimum of 6 inches deep and equal in area to that of the pad or drain directly into a sanitary sewer system.

6.2.6 Enclosure

Enclosure of large volume containers shall be required if location and/or containers are allowed to overflow, thereby creating a public nuisance.