VILLAGE OF TEQUESTA
STORMWATER MANAGEMENT PRACTICESMANUAL

To Be Used With
The Village of Tequesta Code of Ordinance

February 2022

VILLAGE OF TEQUESTA
STORMWATER MANAGEMENT PRACTICES MANUAL

Prepared for:

Village of Tequesta

345 Tequesta Drive

Tequesta, Florida 33469

Prepared by:

Jones Edmunds & Associates, Inc.

2240 Palm Beach Lakes Boulevard, Suite 300

West Palm Beach, Florida 33409

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1 INTRODUCTION

The Village of Tequesta enjoys a waterfront environment between the Loxahatchee River, Indian River, and Atlantic Ocean. Due to the importance of its aquatic environment, the Village has adopted a Stormwater Management Manual to help protect these resources from the harmful effects of unmanaged stormwater runoff.

Stormwater results from a rain event, whereas runoff is the portion of stormwater that does not infiltrate into the ground or evaporate and is not intercepted before reaching a stormwater management system. Stormwater runoff from undeveloped lands usually does not present a management problem since it is relatively clean with lower volumes and peaks due to natural filtration and higher infiltration. When natural land is converted to higher-intensity land use, stormwater becomes a problem and should be managed. Soil is often paved over, and impervious surfaces are created. These impervious surfaces prevent stormwater from infiltrating into the ground and recharging local surficial aquifers. This reduces uptake by plants and increases accumulation on the surface. Increased runoff can also create flooding in some areas. Impervious areas also create an environment where pollutants can accumulate, degrading the quality of stormwater runoff and rendering it a pollution source. To combat this, stormwater management practices are implemented in developed areas to help mitigate potential increases in flood risk (water quantity) and pollution (water quality).

Stormwater runoff conveys many types of pollutants from the landscape to natural receiving waters. The quality of stormwater runoff varies with land use. Pollutants in stormwater can consist of excess nutrients, solid waste, litter, lead, petroleum products (from automobiles), chemicals, fertilizers, herbicides applied to lawns, and atmospheric deposition. Higher nutrient loads are typically generated by residential and industrial land uses, whereas commercial, mixed urban, and roadways generate higher concentrations of metal contamination. Heavy metals are of particular concern because several are toxic to many aquatic plant and animal species. Motor vehicles and road surfaces are the main sources of heavy metals in stormwater runoff. Nutrients and pesticides from lawn fertilizers and atmospheric deposition can cause algal blooms and similar environmentally harmful occurrences if untreated runoff is allowed to enter surface waters. During a rainfall event, stormwater runoff flows over these surfaces, picking up pollutants and carrying them to surface waters.

Polluted stormwater not only causes adverse environmental impacts but also economic impacts. An increase in the number of impervious surfaces raises the potential for flooding and property damage. Polluted stormwater can also lead to reduced fisheries production because of the degradation of water quality. For these reasons, stormwater management practices have been implemented throughout Florida and the United States. This manual is designed as a guide to best management practices (BMPs) for stormwater management in the Village of Tequesta.

A stormwater management practice is one that shapes and improves the quality and quantity of stormwater runoff being discharged to receiving waters. BMPs for stormwater are those that meet discharge quantity and quality criteria at a minimal cost (Wanielista and Yousef, 1985).

Although this stormwater manual does have general criteria for water quantity and flood protection, its main purpose is to provide guidelines related to the control of stormwater-generated pollution and is therefore water-quality based.

The practices and procedures described in this manual are those in common use throughout Florida and apply to the Village. This manual will be used to review and approve stormwater management systems permitted by the Village and will be modified as appropriate technology and regional stormwater rules dictate. The following appendices with more detailed information have been included with the manual:

- Appendix 1 – Stormwater Management Plan Checklist
- Appendix 2 – Wet-Detention Facilities
- Appendix 3 – Dry-Retention Facilities
- Appendix 4 – Control Structures
- Appendix 5 – Single-Family/Duplex Lots Sample Calculations
- Appendix 6 – Bibliography

2 APPLICABILITY

This manual supplements the *Village of Tequesta Code of Ordinances* and is incorporated into the Village Code by Section 66-334. A Stormwater Management Plan will be required as part of all building permit applications that increase the impervious area of a site. The definitions used in this manual are consistent with the *Village of Tequesta Code of Ordinances*.

3 CONTENTS OF A STORMWATER MANAGEMENT PLAN

A stormwater management plan is required to be submitted as part of the Village building permit application pursuant to Section 66-334 of the Village Code. The plan will indicate how a project design will incorporate the required stormwater treatment criteria. The elements that may be required as part of a stormwater management plan are listed below. Appendix 1 is a checklist of these elements that Village staff will use to determine which of the elements a specific plan should or should not require for each site. Some of these elements are required for other parts of a Village building permit, but also need to be considered as part of the stormwater management plan. In these instances, specific criteria are the same as those already required by the Village and are not discussed further in this manual.

1. Site Information:

    a. Detailed location map.
    b. Description of existing vegetative cover including wetlands.
    c. Location and size of preservation or mitigation areas (if applicable).
    d. Site paving, grading, and drainage plans.
    e. Vegetation protection plan.
    f. Soils map and percolation test results.
    g. Wet-season water-table elevation.
    h. Future wet-season water-table elevation (30-year).
    i. Description of measures to be used during construction to eliminate adverse off-site impacts, such as increased turbidity or siltation.
    j. Recent aerial photograph including the year that the photograph was taken.
    k. Map of drainage basin boundaries including any off-site areas.
    l. Map of floodplain and elevations.

2. Master Stormwater Management Plan:

    a. Location of all existing and proposed on-site waterbodies including wetlands.
    b. Location of all off-site wetlands, water courses, and waterbodies affected by on-site drainage patterns.
    c. Location and detail of all major control structures and elevations. Preliminary construction plans may be submitted for conceptual approval.
    d. Right-of-way and easement locations for stormwater management systems including all areas reserved for stormwater management purposes.
    e. Location and size of on-site stormwater management facilities.
    f. Square footages, acreages, and percentage of property proposed as:
        (1) Impervious surface (excluding waterbodies).
        (2) Impervious surface (waterbodies).
        (3) Pervious surface.
        (4) Total square footage or acreage of the project site.
    g. Proposed grading plan.
    h. Treatment volumes and discharge rates (if applicable) for stormwater runoff.

3. Legal and Institutional Information:

   a. Entity responsible for operation and maintenance of surface-water management system.
   b. If the operation and maintenance entity is to be a public body, a letter from the public body confirming this must be submitted before staff approval. If the entity is a homeowners association, documents verifying the existence of such organization and its ability to accept operation and maintenance responsibility must be submitted before staff approval.

4 DESIGN CRITERIA

4.1 HYDRAULIC DESIGN CRITERIA

Stormwater management facilities for development shall be designed in accordance with the following:

1. All projects shall control the volume of discharge from developed areas at predevelopment volume of discharge for the design level-of-service storm event adopted in the Village Code.
2. All project sites shall control the timing of discharges to preclude any off-site impact for any storm event.
3. Peak discharge rate shall not exceed predevelopment discharge rate for the design level-of-service storm event adopted in the Village Code.

4.2 WATER QUALITY DESIGN CRITERIA

Stormwater designs must demonstrate a net improvement in nutrient loads or a 95-percent reduction in pollutant loads for the design level-of-service storm event adopted in the Village Code. This can be demonstrated through methods that are accepted by the South Florida Water Management District (SFWMD). An example of one of these methods is using BMPTrains, modeling software that is freely available from the University of Central Florida Stormwater Management Academy (https://stars.library.ucf.edu/bmptrains/).

5 METHODS OF STORMWATER TREATMENT

Stormwater treatment facilities are designed to treat stormwater runoff to a level that meets the design criteria defined in Section 4 of this manual. The volume to be treated depends on the type of stormwater management facility(ies) used and the land use of the property. The two most used methods of stormwater treatment are wet detention and dry retention. A detention facility collects and temporarily stores a treatment volume to provide for treatment through physical, chemical, or biological processes with subsequent gradual release of the stormwater to a surface-water system. A retention facility is designed to prevent the discharge of a given volume; however, it is slowly released from the facility through infiltration and evapotranspiration. A retention or detention facility built above the groundwater table is *dry*. A facility with the bottom below the control elevation is *wet*. Figures 1a and 1b conceptually illustrate the differences between each. The wet-season water table plays an important part in the functioning of retention systems. To ensure that stormwater facilities continue to function in the future, a stormwater design will need to include a determination of the wet-season water table and an estimate of the future wet-season water table. The future wet-season water table will be assumed to increase by the difference in sea level in the year that the wet-season water table determination was made and the projected sea level 30 years after permitting. The estimated sea-level rise projections adopted by the *Southeast Florida Climate Change Compact* must be used for this determination.

Figure 1a Schematic of Basic Wet Detention Stormwater Management Systems

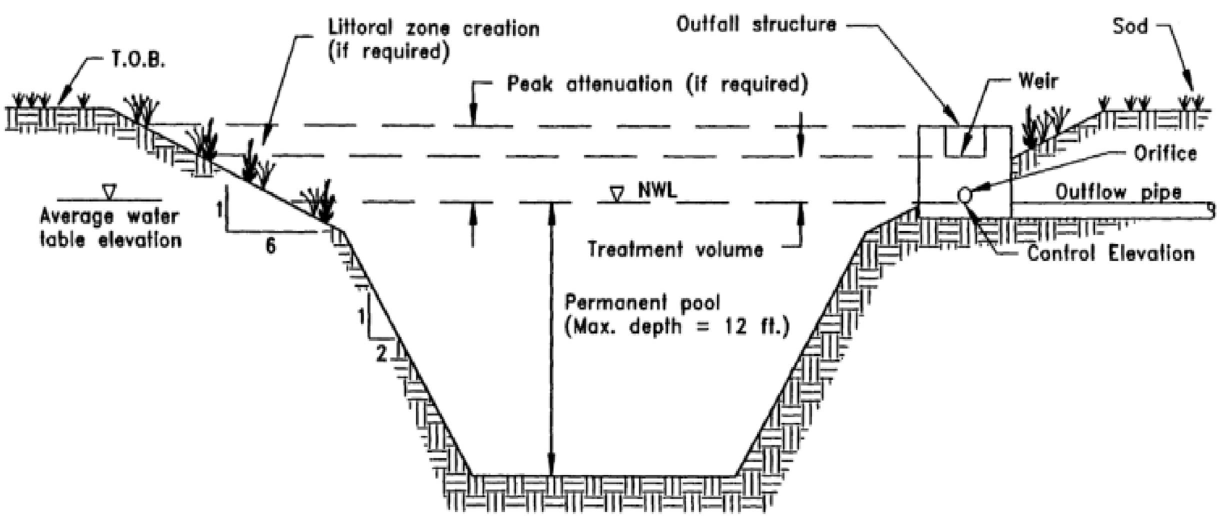
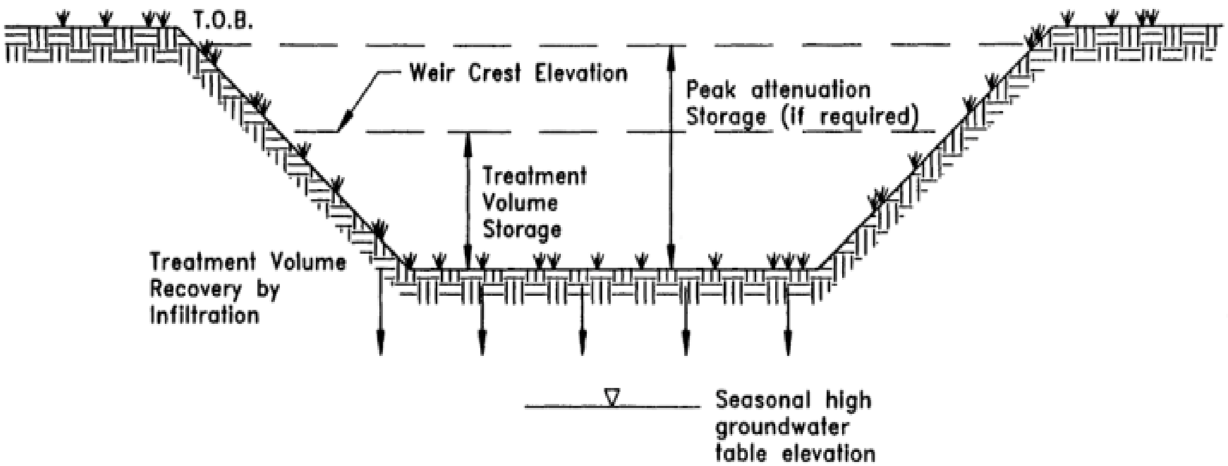


Figure 1b Schematic of Basic Dry Retention Stormwater Management Systems



Source: Adapted from the St. Johns River Water Management District *Environmental Resource Permit (ERP) Applicant's Handbook* Volume II, 2018.

A newer approach to stormwater management is called Low-Impact Development or Design (LID) or Green Stormwater Infrastructure (GSI). This approach seeks to replicate a more natural hydrologic function on the landscape and uses several stormwater management practices to meet the objective stated above. Some of these practices include pervious pavement, vegetated swales, vegetated filter strips, bioretention systems, cisterns, and green roofs.

A stormwater management system frequently incorporates several treatment methods. Describing all the possible combinations in this manual is not feasible. The criteria for each individual type of treatment are detailed to ensure that the proper volume of runoff is treated in an appropriate manner for the land use. References to guidelines for LID approaches to stormwater management are also provided.

Appendices 2 through 5 provide the design criteria for each type of management system.

5.1 Wet Detention

5.1.1 Definition

Wet detention is the collection and temporary storage of stormwater runoff – before controlled discharge into receiving waters – in a permanently wet impoundment to provide treatment through physical, chemical, and biological processes with subsequent gradual controlled release of the stormwater. A wet-detention facility is a basin or pond with a bottom elevation below the wet-season water table or control elevation.

5.1.2 Method of Achievement

Constructed ponds on the site are generally used for wet detention. These ponds must meet the design criteria in Appendix 2 of this manual.

5.2 Dry Retention

5.2.1 Definition

Dry retention is a stormwater system designed to prevent the discharge of a given volume of stormwater runoff into surface waters by complete on-site storage of that volume. A dry-retention facility has a bottom elevation at least 1 foot above the future wet-season water table and is usually dry. Stormwater is released only during times of heavy rainfall or flooding.

5.2.2 Method of Achievement

Examples of dry-retention facilities include infiltration systems (e.g., vegetated swales and bioretention systems) and seepage systems (e.g., exfiltration trenches, pervious pavement, and exfiltration vaults). Of these two, infiltration systems provide better pollution attenuation. The vegetation takes up a percentage of the nutrients commonly found in stormwater runoff. Most heavy metals bind with the soils above the water table and the potential for them entering the groundwater is reduced.

Seepage systems consist of an underground facility that relies on a mostly outward dispersion of stormwater from the facility to the groundwater. These structures are constructed a minimum of 1 foot above the future wet-season water table. These systems are most suitable for areas where the soil has high transmissivity. However, they do not provide the nutrient uptake that is offered with vegetated infiltration systems.

Infiltration systems and seepage systems need a highly permeable substratum to allow the stormwater runoff to percolate into the ground. Seepage systems do not require as much land area as infiltration systems since they can be installed underground. However, the future wet-season water table at the project site must be at least 1 foot below the seepage structure.

5.3 Low-Impact Development or Design

5.3.1 Definition

LID is an approach to stormwater and land use management that aims to replicate a more natural hydrologic function by promoting infiltration, filtration, storage, and evaporation of stormwater runoff. This approach focuses on conservation, use of on-site natural features, site planning, and distributed stormwater management practices that are integrated into a project's design especially its landscaping and open space. Stormwater management through LID often includes a treatment train consisting of several different stormwater management practices that combine to meet the stormwater quality objectives for the site. Examples of practices that are often included in LID are:

- Minimizing clearing, grading, soil disturbance, and compaction on a site.
- Minimizing the impervious area on site.
- Constructing pervious pavement.
- Installing shallow bioretention systems.
- Providing vegetated or grassed swales.
- Providing vegetated filter strips.
- Minimizing directly connected impervious areas.

- Installing cisterns.
- Harvesting stormwater.

5.3.2 Method of Achievement

A LID approach to stormwater management starts during the planning and site evaluation and continues through the selection and design of the most appropriate stormwater treatment practices for the site. The goal of stormwater management should be to retain, detain, recharge, filter, and use as much stormwater as possible on a site. A variety of LID design manuals in Florida describe this approach to stormwater management. These include but are not limited to the following:

- *Low-Impact Development and Green Infrastructure: Pollution Reduction Guidance for Water Quality in Southeast Florida* (FDEP).
- *Sarasota County Low-Impact Development Guidance Document* (Sarasota County).
- *Duval County Low-Impact Development Stormwater Manual* (Duval County).
- *Pinellas County Stormwater Manual* (Pinellas County).

The manuals listed above provide design guidelines for a variety of LID stormwater practices including:

- Grassed conveyance swales.
- Shallow bioretention.
- Pervious pavement.
- Stormwater harvesting.
- Green roofs.
- Rainwater harvesting (cisterns).
- Detention with biofiltration.

The Village will generally accept the LID practices and design considerations described in the LID manuals referenced above, although the performance curves and tables provided in these manuals do not necessarily apply to the Village's hydrologic conditions. Pollutant-load reductions and sizing will need to be determined by a Florida-registered and licensed professional engineer.

6 CONTROL STRUCTURES

6.1 DEFINITION

A *control structure* is a device through or over which water is discharged from a stormwater management system. Direct discharge occurs when stormwater is released through a control structure to the receiving waterbody. If the discharge from the stormwater management system is by a means other than a control structure (e.g., sheet flow or spreader swale), it is considered indirect discharge.

6.2 PURPOSE

The primary purpose of a control structure in a detention facility is to release the calculated runoff volume slowly over a specified period. In a retention facility, the control structure allows for volumes exceeding the calculated retention volume to leave the system in a manner that provides adequate downstream flood protection.

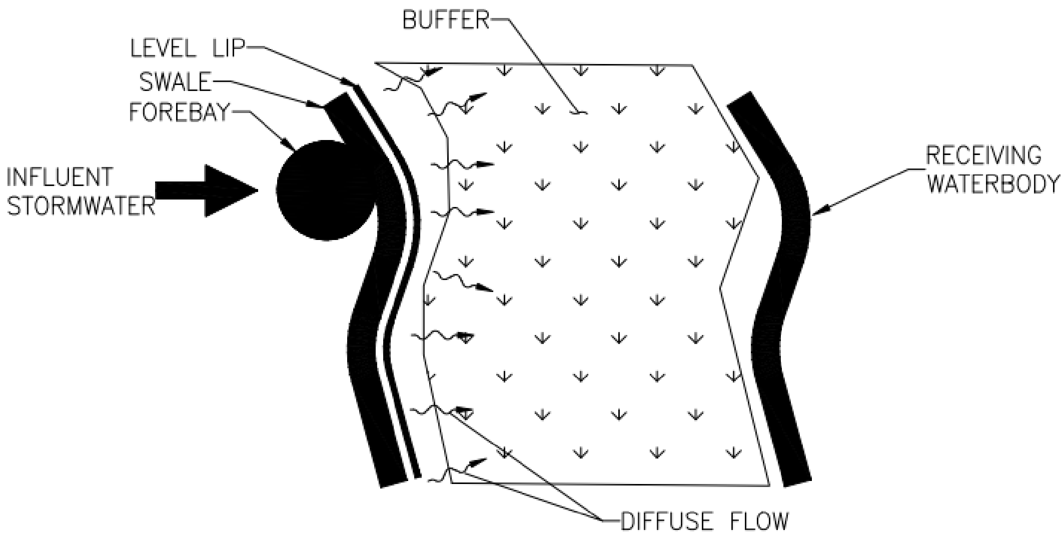
6.3 TYPES OF CONTROL STRUCTURES

Direct discharge from a water management facility to the receiving body is usually achieved through control structures such as weirs and orifices. The following criteria must be met for all methods of direct discharge:

1. Trash-collecting gratings must be on the intake of all structures that discharge to surface waters.
2. Detention facilities discharge must be above the permanent pool.
3. If a non-single-family residential property is greater than 50-percent impervious or contains a system with inlets in paved areas, discharge structures must include a baffle, skimmer, or other suitable mechanism for preventing oil and grease from being discharged.
4. Direct discharge will only be allowed to those areas that due to their large capacity or configuration are able to absorb concentrated discharges without erosion.

When using indirect discharge to release stormwater, a spreader swale is commonly used. The swale is positioned parallel to the receiving body, and the side adjacent to the receiving body is lower than the side opposite the receiving body. Figure 2 illustrates this form of discharge. The swale allows the water to flow into the receiving body but not flood the adjoining property. This method works well when trying to maintain a proper water level in wetlands that are used for stormwater management. The spreader swale is also a treatment facility for stormwater runoff. Runoff exceeding the first flush is allowed to enter the wetland system via sheet flow.

Figure 2 Spreader Swale (Indirect Discharge)



7 CRITERIA FOR SINGLE-FAMILY/DUPLEX LOTS

7.1.1 Lots Within Subdivisions With Approved Stormwater Management Plans

In all subdivisions that have an approved stormwater management plan, all new development must comply with the approved plan. A lot grading plan, complete with topographic information that complies with this manual, must be submitted for review before the issuance of the building permit. If the approved stormwater management plan does not contain sufficient lot grading information to verify that the lot being permitted will drain in accordance with the plan, the requirements of Section 7.1.2 of this manual shall apply.

7.1.2 Lots Within Subdivisions Without Approved Stormwater Management Plans

Single-family and duplex homes that are not part of a master stormwater drainage system shall provide a Stormwater Management Plan following the guidelines established in the Village of Tequesta *Residential Stormwater Guidelines Brochure*. The *Stormwater Brochure* and the following design criteria generally use vegetated swales. However, other retention practices may be used. The retention volume specified in these design criteria will provide adequate stormwater treatment on a single-family/duplex lot to meet the Village stormwater treatment requirements. However, calculations demonstrating a net improvement or 95-percent reduction in nutrient loads may be submitted as an alternative to using the retention volume specified in these design criteria. The stormwater calculations must be completed by a Florida-registered and -licensed professional engineer.

The retention volume depends on the lot size and the stormwater management system used. Stormwater treatment can also be provided using other retention systems such as pervious pavement, exfiltration trenches, or shallow stormwater vault systems.

Table 1 provides the required retention depths for single-family/duplex lots that are not part of a master stormwater treatment system. These are based on the effective impervious area, which is the sum of all the directly connected impervious areas and half the unconnected impervious area. Unconnected impervious area is an impervious area that must drain over more than 20 feet of pervious area before entering the stormwater system or retention system. Directly connected impervious is an impervious area where stormwater runoff is conveyed directly to a stormwater system without an opportunity to infiltrate.

Table 1 Required Retention Depth for Single Family/Duplex Lots

Effective Impervious Area to Property Area Ratio	Required Retention Depth (feet)	Required Retention Depth (inches)
0.20	0.138	1.66
0.25	0.142	1.70
0.30	0.15	1.80
0.35	0.161	1.93
0.40	0.175	2.10
0.45	0.186	2.23
0.50	0.201	2.41
0.55	0.214	2.57

Effective Impervious Area to Property Area Ratio	Required Retention Depth (feet)	Required Retention Depth (inches)
0.60	0.228	2.74
0.65	0.242	2.90
0.70	0.256	3.07
0.75	0.269	3.23
0.80	0.283	3.40

If swale(s) are used, they must meet the following criteria:

- Runoff from the site must be drained to the swale.
- The swale length must be greater than its width.
- The swale side slope must be 4:1 (horizontal to vertical) or shallower.
- The swale must be placed so that any natural areas to be preserved are not disturbed.
- The swale must be at least 6 inches deep.
- Swales should be vegetated. If a swale is not vegetated, a 6-inch layer of soil amendment formulated to reduce nutrient loading must be installed directly below the swale. Specifications and published nutrient-reduction test results for the soil amendment media must be provided at the time of testing. Examples of acceptable media are NutriGone™ (distributed by EcoSense International) and Bold and Gold® (distributed by Environmental Conservation Solutions).

Retention systems must discharge off site to prevent flooding, but should not discharge onto adjacent private property. For retention systems, a control structure will allow runoff exceeding the volume of the swale to be discharged to the receiving body. More than one retention system may be on the property provided that each meets these criteria, and the total volume of the retention is at least the calculated volume. Vegetated swales may be incorporated into the set-back area of land required by the Village. Appendix 5 contains sample calculations for single-family/duplex lots. Florida-Friendly Landscaping™ is encouraged for vegetated swales.

Appendices

The Appendices contain the specific design criteria for the BMPs discussed in this manual. These criteria are based on best available knowledge in stormwater management. As technology dictates, these criteria will change.

Appendix 1

Stormwater Management Plan Checklist

APPENDIX 1 – STORMWATER MANAGEMENT PLAN CHECKLIST

	Required	Not Required	Sufficient
A. Site Information			
▪ Detailed location map			
▪ Description of vegetative cover			
▪ Location and size of preservation or mitigation areas			
▪ Vegetation protection plan			
▪ Soils map			
▪ Percolation test results			
▪ Current wet-season high-water table			
▪ Future wet-season water table			
▪ Measures to be taken to eliminate off-site adverse impacts, such as turbidity, flooding, etc.			
▪ Recent aerial photo (with year aerial was taken)			
▪ Map of drainage basin boundaries including off-site areas			
▪ Map of floodplain and elevations			
B. Master Stormwater Management Plan			
▪ Location of all existing and proposed on-site waterbodies (including wetlands)			
▪ Location of all off-site wetlands and waterbodies to be affected by on-site drainage patterns			
▪ Location of all major control structures and elevations (preliminary construction plan may be submitted for conceptual review)			

	Required	Not Required	Sufficient
▪ Right-of-way and easement locations for stormwater management systems, including all areas reserved for stormwater management purposes			
▪ Location and size of on-site water management facilities			
▪ Square footages, acreages, and percentage of property proposed as: ▪ Impervious surface (excluding waterbodies) ▪ Impervious surface (waterbodies) ▪ Pervious surface ▪ Total square footage or acreage of project site			
▪ Proposed grading plan			
▪ Treatment volume and discharge rate (if applicable) for stormwater management system			
C. Legal and Institutional Information			
▪ Entity responsible for operation and maintenance of stormwater management facility*			

* If the operation and maintenance entity is to be a public body, a letter from the public body confirming this must be submitted before staff approval. If the entity is a homeowners' association, documents verifying the existence of such organization and its ability to accept operation and maintenance responsibility must be submitted before staff approval.

Appendix 2

Wet-Detention Facilities

APPENDIX 2 – WET-DETENTION FACILITIES

A wet-detention facility is usually wet and allows for 1/2 inch of the required detained volume (1 inch or the total of 2.5 inches times the percent of impervious area, whichever is greater) to be discharged through a control structure in no less than 24 hours. Catch basins, pipes, swales, or channels are used in areas with large amounts of impervious surface to collect runoff and convey it to the detention facility. The required design criteria of a wet-detention facility are detailed below:

- The pond must be at least 0.5 acre and at least 100 feet wide for lakes exceeding 200 feet in length.
- Irregularly shaped lakes may be narrower than 100 feet in some portions but should average 100 feet in width.
- Projects with single-owner entities or entities with a full-time maintenance staff with obvious interests in maintaining the areas for water-quality purposes may have the area and width criteria waived.
- The lake slopes should be at least 4:1 (horizontal to vertical) to a depth of 2 feet for safety reasons and to allow a littoral habitat to form.
- The control structure is at one point in the detention facility. Trash collection screens are required on structures discharging to surface waters.
- The control structure must be opposite from the runoff entry into the facility to prevent hydraulic short-circuiting and to ensure full treatment.

Wet detention cannot be used as the sole form of stormwater treatment. If wet detention is used, at least 2.5 inches of dry-retention pre-treatment must be provided before discharging into a wet-detention facility.

Guidance on sizing, designing, and permitting wet-detention facilities or exfiltration trenches can be found in the SFWMD *ERP Applicant's Handbook*.

Appendix 3

Dry-Retention Facilities

APPENDIX 3 – DRY-RETENTION FACILITIES

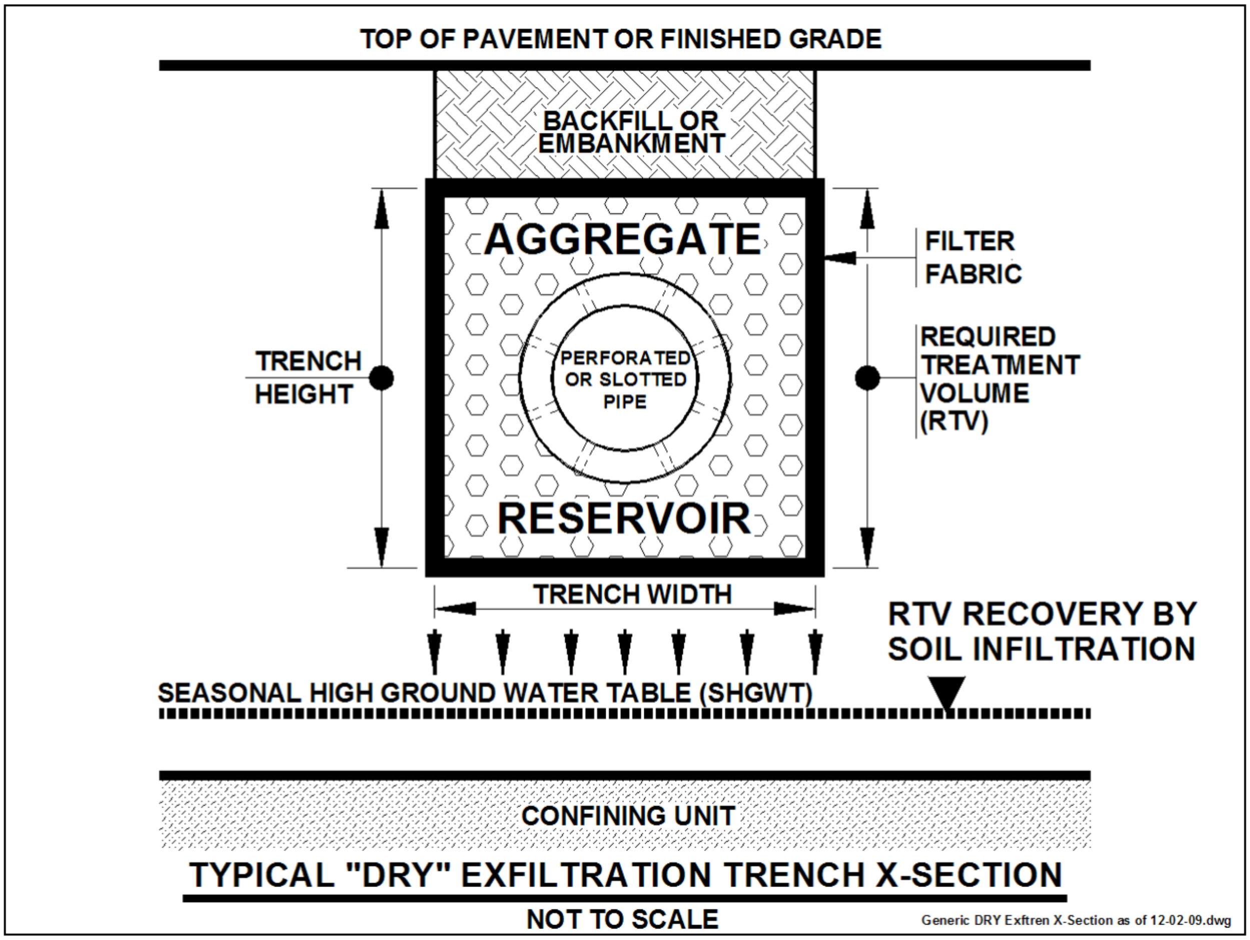
Two types of dry-retention facilities exist – infiltration facilities and seepage facilities. The most common form of infiltration is vegetated swales or dry-retention basins. Runoff is routed to a vegetated swale or dry-retention basin directly or through a catch basin and conveyance system. A control structure, usually a rectangular weir, is at one end of the swale or basin to allow excess runoff to be discharged to a receiving body. A spreader swale can also be used with this form of treatment. This type of discharge is most often used to release water through sheet flow to wetland areas or to prevent erosion.

The seepage method of dry retention involves allowing the water to disperse outward from an underground facility. The runoff is routed to a catch basin and is conveyed to a seepage system. Exfiltration trenches are the most used type of seepage systems. They are used with catch basins and consist of a perforated pipe surrounded by coarse rock. Figure A1 shows that the system is in the ground, but above the future-condition wet-season water table. The length of the pipe depends on several factors – the volume of runoff to be treated, the width of the trench, the depth to the water table, and the hydraulic conductivity of the soils.

An overflow system allowing for volumes exceeding the retained volume is usually at the end of the trench opposite the point where the runoff enters the system and discharges to the receiving waters. Although exfiltration trenches provide adequate stormwater treatment and allow more land for development, they must be inspected regularly and periodically cleaned. The pipe can become clogged and not allow proper seepage. When this occurs, the pipe acts like a conduit for untreated stormwater. Ensuring that the upstream catch basins are well maintained is one way of preventing failure of the trench.

Guidance on sizing, designing, and permitting dry-retention basins or exfiltration trenches can be found in the SFWMD *ERP Applicant's Handbook*.

Figure A1 Typical Exfiltration Trench



Source: Florida Department of Environmental Protection and Water Management Districts *Environmental Resource Permit Stormwater Quality Applicant's Handbook* (March 2010 – Draft).

Appendix 4

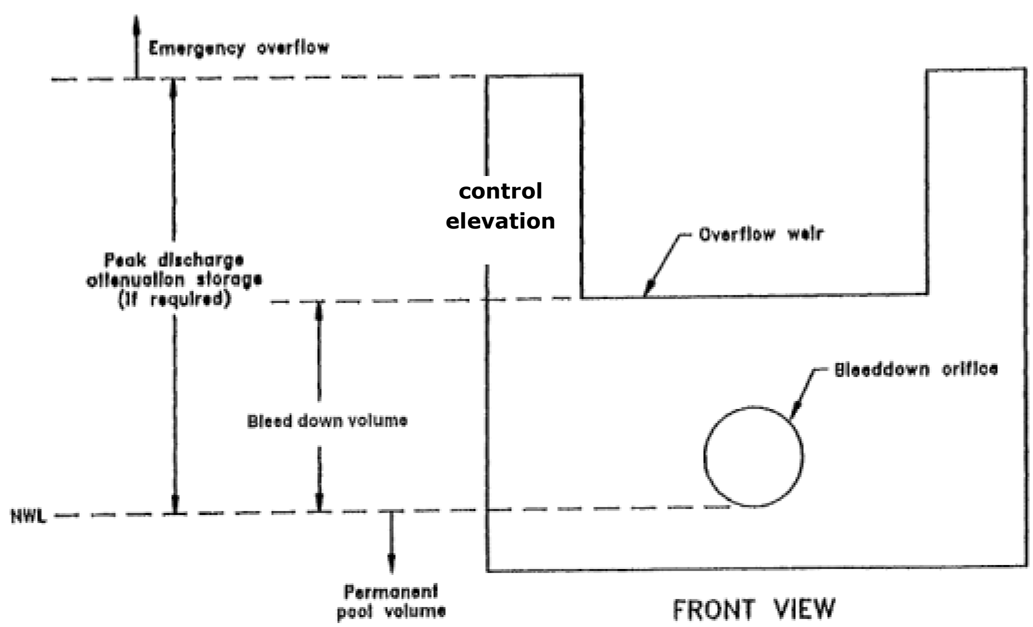
Control Structures

APPENDIX 4 – CONTROL STRUCTURES

This Appendix contains design details for four types of control structures: a circular orifice, a triangular orifice, a v-notched weir, and a rectangular weir.

Orifices and V-notched weirs are generally used with control structures associated with detention facilities. These structures are commonly referred to as bleed-down mechanisms and allow controlled release of a portion of detained volume over a specified period (usually 1/2 inch in 24 hours). Rectangular weirs are commonly used with detention and retention facilities. In retention facilities, a rectangular weir allows excess runoff of the retained volume to leave the facility. Rectangular weirs serve the same purpose as detention facilities, using a circular or triangular orifice as the bleed-down device. Figures A2 through A4 (adapted from the SJRWMD *ERP Applicant's Handbook* Volume II, 2018) illustrate these different types of control structures and their use. The retained (permanent pool) and detained (attenuation storage) volumes used in determining the dimensions of the control structures are calculated from the equations following each drawing.

Figure A2 Orifice Weirs



$$A = \frac{Q}{4.8H^{3/2}}$$

Where: Q = discharge (cubic feet per second [cfs]).
A = Area of orifice (square feet).
H = Head above orifice centroid* (feet).

*Centroid for a circular orifice is the center; centroid for a triangular orifice is two-thirds the distance from the vertex.

An orifice is a device that allows discharge from the center of the control structure. Simply, it is an opening in the structure that lets water slowly pass. Detention facilities use orifices. The rate that water is discharged depends on the cross-sectional area of the orifice. Figure A2 shows a circular-type orifice.

The circular orifice, as the name and illustration imply, is a round opening. The bottom of the opening is at the control elevation. In the case of dry detention, the bottom of the circle is at ground elevation. The most common method for constructing a circular orifice is placing a polyvinyl chloride (PVC) pipe in the control structure. This pipe then discharges to the receiving body or to a conveyance system discharging to the receiving body.

For maintenance purposes, the cross-sectional area of the orifice in any control structure must be more than 6 square inches to ensure that the structure allows free flow of water and does not become clogged. The formula following Figure A2 is used to calculate the cross-sectional area of the orifice.

Below is an example calculation for an orifice in a control structure that is part of a wet-detention facility. The following assumptions are made:

- H = 3 feet.
- One-half inch of retained stormwater = 400,000 cubic feet.
    - The discharge rate (Q) must be calculated:

$$Q = \frac{400{,}000\ ft^3}{24\ hours} \times \frac{1\ hour}{3600\ sec}$$

$$Q = 4.63\ cfs$$

$$A = \frac{Q}{4.8H^{\frac{1}{2}}}$$

$$A = \frac{4.63}{\left(4.8 \times 3^{\frac{1}{2}}\right)}$$

$$A = \frac{4.63}{8.31}$$

$$A = 0.56\ ft^2$$

This meets the minimum dimensional criteria for orifices in detention facilities.

Figure A3 V-Notched Weir

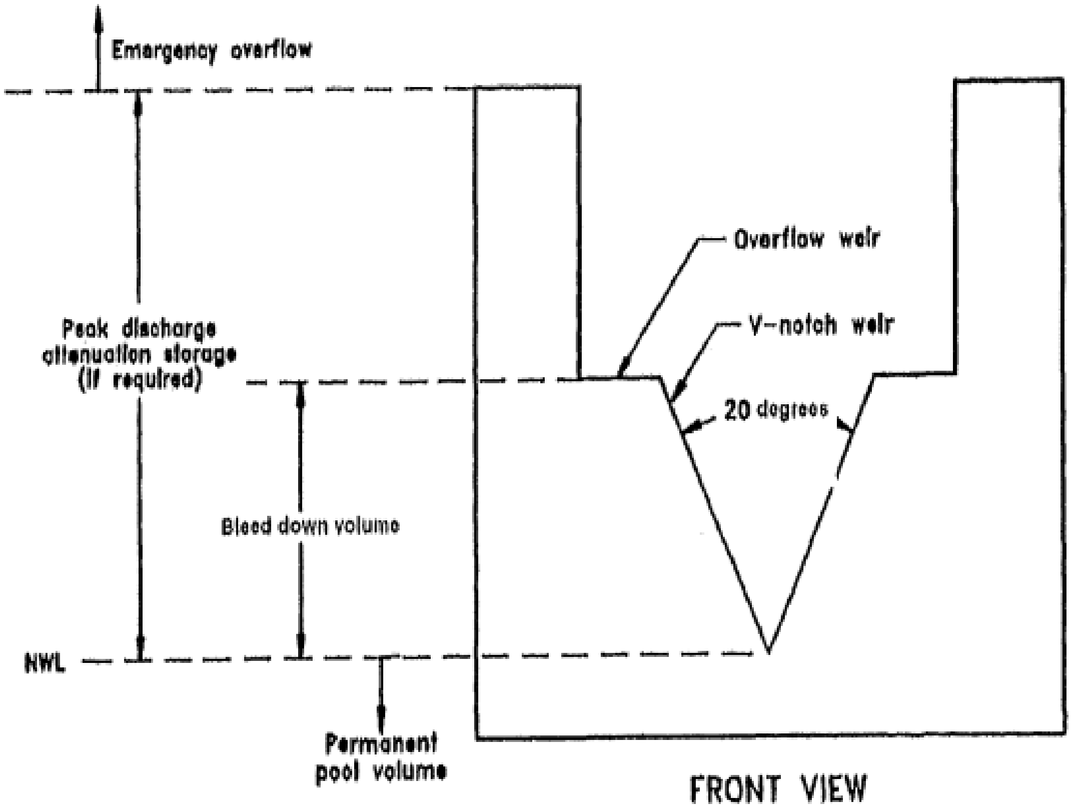


Figure A-3 shows the V-notched weirs, which are used with wet- and dry-detention facilities. The configuration of the opening allows slow discharge of detained water over time. The rate of discharge depends on the angle of the V-notch. When designing a control structure with a V-notch weir, the angle is calculated using the formula below. V_{det} refers to 1/2 inch of the detained volume that must be discharged within 24 hours.

For maintenance and functional purposes, the angle of the V-notch should not be less than 20 degrees, that being the minimum to allowed for adequate flow of water and to prevent blockage of the weir.

The following is an example calculation for a V-notched weir, which is part of a 2-foot-deep dry-detention facility, making the following assumptions:

$$H = 2.0\ feet\ (depth\ of\ detention\ facility).$$

$$V_{det} = 500\ ft^2\ , therefore, V_{det} = 0.01\ acre\ foot.$$

$$\theta = 2\arctan\ [(0.492)((V\_det/H \hat{} 2.5\ ))].$$

$$\theta = 2\arctan\ [(0.492)((0.01/2 \hat{} 2.5\ ))].$$

$$\theta = 2\arctan\ (0.03).$$

$$\theta = 3.19\ degrees.$$

Since the calculated angle is less than 20 degrees, and the angle of the V-notch must be at least 20 degrees, this facility will need a 20-degree angle. Since most of the stormwater management facilities reviewed by Village staff will be small, calculations in which the angle of the notch is less than 20 degrees will be common.

Figure A4 Rectangular Weir

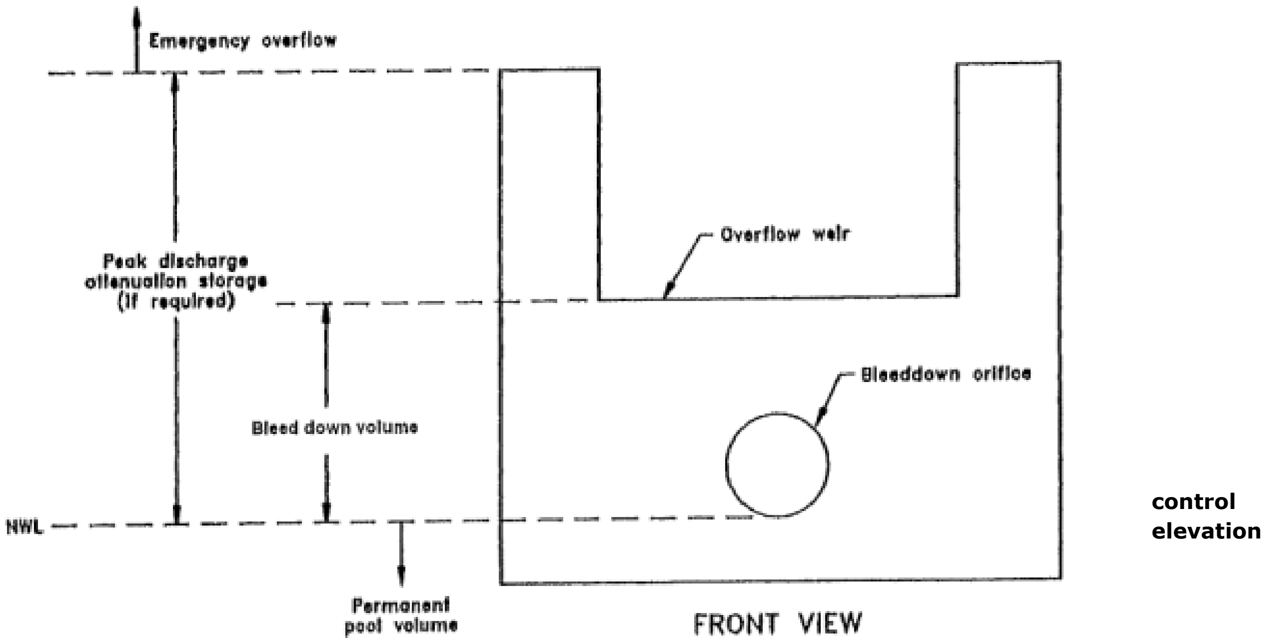


Figure A-4 shows a rectangular weir, a structure that allows excess volumes of water to leave a stormwater management facility. A rectangular weir is used with retention facilities to discharge runoff exceeding the retained volume. A rectangular weir can also be used with a detention facility that has an orifice for the delayed release of stormwater runoff. The rectangular weir allows the discharge of excess runoff during severe rain events. The weir is constructed on top of the control structure. Rectangular weirs are used in areas where a receiving waterbody exists for excess runoff or a method of conveying excess runoff to a receiving waterbody.

Control structures can be made of several different types of materials. Those commonly used include concrete, aluminum, and earthen material. PVC pipe is often used as a bleed-down mechanism (circular orifice).

All control structures must discharge to a receiving body of water that has the capacity to handle the discharge without causing erosion. If no receiving waterbody exists adjacent to the stormwater management facility, some system for conveying the stormwater must be provided and is commonly achieved by using swales, culverts, or similar mechanisms.

Appendix 5

Single-Family/Duplex Lot

Sample Calculations

APPENDIX 5 – SINGLE-FAMILY/DUPLEX LOT SAMPLE CALCULATIONS

An 8,000-square-foot lot with a house, patio, and driveway using dry-retention swales:

- House 1,600 square feet (800 directly connected and 800 unconnected).
- Driveway 560 square feet.
- Concrete Patio 840 square feet.

Total impervious 3,000 square feet.

Effective Impervious (sum of directly connected impervious and half the unconnected impervious) 2,600 square feet.

Total lot size = 8,000 square feet.

Ratio of effective impervious area to lot area = 32.5 percent.

Required retention depth = 0.161 feet (from Table 1).

The following equation is used to size the swale:

- Required swale volume (cubic feet) = effective impervious area (square feet) x 0.161-foot required retention depth (feet).
- Required swale volume = 2,600 square feet x 0.161 foot.
- Required swale volume = 418.6 cubic feet.

Assuming a 4:1 (horizontal to vertical) slope for the swales to a 1-foot depth and a 2-foot bottom width, the cross-sectional area (A) of the swale is 6.0 square feet.

Therefore, the required length of the swale is determined as follows:

- Required length of swale (feet) = required volume/A.
- Required length of swale = 418.6 cubic feet/6 square feet.
- Required length of swale = 69.8 feet.

In areas where a receiving waterbody is adjacent to the property, a rectangular weir should be placed at one end of the swale for discharge of excess runoff. To reduce the required length of the swale, explore opportunities to reduce the directly connected impervious area by replacing impervious surfaces with pervious surfaces or disconnecting impervious surfaces. These changes would reduce the required swale length.

Appendix 6

Bibliography

APPENDIX 6 – BIBLIOGRAPHY

Ammon, DC; Huber, WC; and Heany, JP. 1981. *Wetlands' Use for Water Management in Florida.* J. Water Res. Planning Management Div. Proceeding of ASCE 107 (WR2):315-327.

Branscome, J; and Tomasello, RS. 1988. *Field Testing of Exfiltration Systems.* South Florida Water Management District, Technical Publication 87-5, West Palm Beach, Florida. pp. 50.

Camp Dresser and McKee, Inc. (CDM). 1985. *An Assessment of Stormwater Management Programs.* JP Hartiganm, SV Plante, and LA Rosner. Maitland, Florida.

Chesters, G; and Schierow, LJ. 1985. *A Primer on Nonpoint Pollution.* J. Soil Water Conserv. 40(1):9-13.

Cox, JH. 1985. *Overview of BMP's and Urban Stormwater Management. Proceedings: Stormwater Management – "an update".* MP Wanielista and YA Yousef, Eds. Univ. of Central Florida Environ. Systems Engr. Institute, Publication #85-1, Orlando, Florida.

Duval County. *Duval County Low-Impact Development Stormwater Manual*. Jacksonville, Florida.

Florida Department of Environmental Protection (FDEP). 2019. *Low-Impact Development and Green Infrastructure: Pollution Reduction Guidance for Water Quality in Southeast Florida.*

Florida Department of Environmental Protection (FDEP). 2010. *Draft Environmental Resource Permit Stormwater Quality Applicant's Handbook*.

Harper, HH; Yousef, YA; and Wanielista, MP. 1984. *Efficiency of Roadside Swales in Removing Heavy Metals from Highway Associated Nonpoint Source Runoff.* Conference on Options for Reaching Water Quality Goals, American Water Res. Assoc.

Livingston, EH. 1985. *Overview of Stormwater Management.* Florida Department of Environmental Regulation (now Florida Department of Environmental Protection), Tallahassee, Florida.

Mason, Jr., JM. 1984. *Development of a Stormwater Management Plan.* In the international symposium on Urban Hydrology, Hydraulics, and Sediment Control, University of Kentucky, Lexington, Kentucky, pp. 201-205.

Mass, RP; Smolen, MD; and Dressing, SA. 1985. *Selecting Critical Areas for Nonpoint-Source Pollution Control.* J. Soil Water Conserv. 40(1):68-71.

Pinellas County. 2017. *Stormwater Manual*. Pinellas County, Florida

Sarasota County. 2015. *Sarasota County Low-Impact Development Guidance Document*. Sarasota, Florida.

South Florida Water Management District (SFWMD). 2020. In review. *An Assessment of Land Use and Related Stormwater Runoff Quality Treatment Efficiencies Associated with Selected Stormwater Management Systems.* Resource Planning Department, West Palm Beach, Florida.

South Florida Water Management District (SFWMD). 2020. *Environmental Resource Permit Applicant's Handbook, Volumes I and II*. West Palm Beach, Florida.

St. Johns River Water Management District (SJRWMD). 2018. *Environmental Resource Applicant's Handbook, Volume II*.

Wanielista, MP; and Yousef, YA. 1985. *Overview Stormwater Manage Practices. Proceedings: Stormwater Management – "an update".* MP Wanielista and YA Yousef, Eds. Univ. of Central Florida, Environ. Systems Engr. Institute, Publication #85-1., Orlando, Florida.

Whalen, PJ, and Cullum, MG. 1988. *As Assessment of Urban Land Use/Stormwater Runoff Quality Relationships and Treatment Efficiencies of Selected Stormwater Management System*. Technical Publication 88-9, South Florida Water Management District. West Palm Beach, Florida.