APPENDIX E

ECOSYSTEM MANAGEMENT AGREEMENT

STORMWATER SYSTEM DESIGN AND REVIEW CRITERIA MANUAL

February 2004

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PART I -- POLICY AND PROCEDURES

1.0 Introduction

The purpose of the Manual is to provide design criteria and a review process for the stormwater management systems within the Agreement Area. The design criteria are based the FDEP ERP rules developed for the Northwest District.

1.1 Applicability

The design criteria and review process presented in the Manual is applicable to all new stormwater systems within the Agreement area, with the following exceptions:

- Activities below the thresholds given in Section 2.1.1 of the Manual.
- Activities that are qualified exemptions under chapter 62-25.030, FAC, except for 62-25.030(1) (c).
- Activities that qualify for a noticed general permit under chapter 62-341, F.A.C.

1.2 Review Process

As outlined in the EMA, the applicant will prepare an environmental and stormwater design for the project area in accordance with the design criteria contained in the EMA and the Manual. A pre-application meeting will be held to review the intent of the design. During the pre-application meeting, the stormwater design strategy will be presented and reviewed. At a minimum, the following stormwater information will be presented:

- A map of the site showing pre-development conditions including topographic contours, soils, natural watercourses, man-made stormwater features, areas of off-site flow entering the site, and generalized surface water flow patterns across the site.
- A map of the site showing the proposed site plan along with a conceptual design for the stormwater system serving the site including routing of off-site flows. The conceptual design will address water quality and quantity (if required) design techniques.
- If a site plan is not available for the pre-application meeting, a design strategy for the water quality, quantity, and off-site flow requirements will be presented.

The stormwater design will be prepared in conjunction with the environmental design, and will be presented for review during the individual project approval process.

If the activity falls below the thresholds given in Section 2.1.1 or the activity qualifies for an exemption under Chapter 62-25.030, F.A.C., evidence supporting such will be provided at the pre-application meeting. If the activity qualifies for a noticed general permit under Chapter 62-341, FAC, the permit will be provided prior to approval of the Individual Project as outlined in the EMA. All other activities that would require a standard or individual permit will be reviewed for compliance with this Manual during the Individual Project Approval process outlined in the EMA. A finding of compliance of the activity with the Manual and the EMA constitutes approval of the activity. A separate stormwater permit is not required. All designs for activities including those below the thresholds given in Section 2.1.1 of the Manual, qualified exemptions under Chapter 62-341, FAC, and those qualified for a noticed general permit under Chapter 62-341, FAC shall conform with the environmental requirements in the EMA.

1.3 Forms

Application will be made using Form, # **17-1.215(2),** Notice of Intent to Use General Permit for New Stormwater Discharge Facility Construction.

PART II -- GENERAL CRITERIA

2.0 General Design and Performance Criteria for all Surface Water Management Systems

2.1 Systems Requiring Engineered Stormwater Management Systems

2.1.1 All activities within the Agreement Area that would require a permit under chapter 62-25, F.A.C., but do not qualify for a noticed general permit under chapter 62-341, F.A.C., shall include an Engineered Stormwater Management system designed, constructed, operated, and maintained in accordance with this **Manual**, if they exceed any of the following criteria:

(a) Systems involving the construction or alteration of more than 4,000 square feet of impervious or semi-impervious surface area subject to vehicular traffic. This area includes roads, parking lots, driveways, and loading zones;

(b) Systems involving the construction or alteration of more than 5,000 square feet of building area or other impervious area not subject to vehicular traffic; or

(c) Systems involving the construction or alteration of more than 1 acre of recreational area. Recreational areas include but are not limited to golf courses, tennis courts, putting greens, driving ranges, or ball fields.

2.1.2 All activities that require an Engineered Stormwater Management system under **section 2.1.1 of the Manual** shall be designed, constructed, operated, and maintained in conformance with the Stormwater Quality provisions of **Part IV of the Manual**.

2.1.3 In addition to complying with the criteria in **Part IV of the Manual**, systems that exceed any of the following thresholds must additionally be designed, constructed, operated, and maintained to comply with the Stormwater Quantity/Flood Control criteria of **Part III of the Manual**:

(a) Systems that serve projects of 40 or more acres of total land area;

(b) Systems that provide for the placement of 12 or more acres of impervious surface, which constitutes more than 40 percent of the total land area;

(c) Systems that are capable of impounding a volume of water of 40 or more acre-feet.

2.1.4 Activities that require an Engineered Stormwater Management System under this Handbook shall additionally meet all the other applicable design and performance criteria requirements of **Part II of the Manual**.

2.2 Criteria for Evaluation

2.2.1 Reasonable Assurance

In order to obtain an environmental resource permit for a system that requires an engineered stormwater management system under **section 2.1 of the Applicant's Handbook Volume II**, an applicant must give reasonable assurance that the stormwater management system will meet the criteria in this **Manual**. This includes a determination that the activity:

(a) Will not cause adverse water quantity impacts to receiving waters and adjacent lands;

(b) Will not cause adverse flooding to on-site or off-site property;

(c) Will not cause adverse impacts to existing surface water storage and conveyance capabilities;

(d) Will not adversely impact the value of functions provided to fish and wildlife and listed species by wetlands and other surface waters;

(e) Will not result in discharges from the system to surface and ground water of the state that cause or contribute to violations of state water quality standards as set forth in chapters 62-4, 62-302 and 62-520, F.A.C., including any antidegradation provisions of paragraphs 62-4.242(1)(a) and (b), subsections 62-4.242(2) and (3), and section 62-302.300, F.A.C., and any special standards for Outstanding Florida Waters and Outstanding National Resource Waters set forth in subsections 62-4.242(2) and (3), F.A.C.;

(f) Will not cause adverse secondary impacts to the water resources;

(g) Will not adversely impact the maintenance of surface or ground water levels or surface water flows established pursuant to Section 373.042, F.S.;

(h) Will be capable, based on generally accepted engineering and scientific principles, of being performed and of functioning as proposed;

(i) Will be conducted by an entity with the financial, legal, and administrative capability of ensuring that the activity will be undertaken in accordance with the terms and conditions of the permit, if issued; and

(j) Will comply with any applicable special basin or geographic area criteria rules within the EMA area. This includes, but is not limited, to the following:

   a. For those stormwater systems discharging to the Lake Powell Basin, the water quality design and performance criteria shall meet OFW standards.

2.3 Professional Certification

All construction plans and supporting calculations submitted for surface water management systems that require the services of a registered professional (i.e., engineer, geologist, or landscape architect) under Chapters 471, 481, or 492, F.S., must be signed, sealed, and dated by the appropriate registered professional.

2.4 Maintenance Access

Regular maintenance is crucial to the long-term effectiveness of stormwater management systems. Such systems must be designed to permit personnel and equipment access and to accommodate regular maintenance activities. For example, high maintenance features such as inlets, outlets, and pumps should be easily accessible to maintenance equipment and personnel.

Legal authorization, such as an easement, deed restrictions, or other instrument must be provided establishing a right-of-way or access for maintenance of the stormwater management system unless the operation and maintenance entity wholly owns or retains ownership of the property. The following are requirements for specific types of maintenance access easements:

(a) Easements must cover at least the primary and high maintenance components of the system (i.e., inlets, outlets, littoral zones, filters, pumps, etc.).

(b) Easements for waterbodies, open conveyance systems, stormwater basins and storage areas must meet the following requirements:

1. Include the area of the water surface measured at the control elevation; and

2. Be a minimum of 20 feet from the edge of water at the control elevation or top of bank and include side slopes no steeper than 4H:1V.

(c) Easements adjacent to water control structures must be a minimum of 20 feet wide.

(d) Easements for piped stormwater conveyance must be a minimum of the width of the pipe plus 4 times the depth of the pipe invert.

(e) Access easements must be 20 feet wide from a public road or public right-of-way to the stormwater management system.

(f) As an alternative, the applicant may propose other authorization for maintenance access provided the applicant affirmatively demonstrates that equipment can enter and perform the necessary maintenance on the system.

2.5 Legal Authorization

Applicants who propose to utilize offsite areas not under their control must obtain sufficient legal authorization prior to permit issuance to use the area. For example, an applicant who proposes to locate the outfall pipe from the stormwater basin to the receiving water on an adjacent property owner's land must obtain a drainage easement or other appropriate legal authorization from the adjacent owner. A copy of the legal authorization should be submitted with the application.

2.6 Public Safety

2.6.1 Normally dry basins designed to impound more than two feet of water or permanently wet basins must contain side slopes that are no steeper than 4:1 (horizontal to vertical) out to a depth of two feet below the control elevation. As an alternative, the basins can be fenced or otherwise restricted from public access if the slopes must be deeper due to space or other constraints.

2.6.2 Detention and retention basins must be designed with side slopes of 4:1 (horizontal to vertical) to a depth at least two feet below the control elevation. Side slopes must be stabilized with vegetation to prevent erosion and provide pollutant removal.

2.6.3 Basin Side Slope Stabilization

All stormwater basin side slopes shall be stabilized by either vegetation or other material to minimize erosion of the basin.

2.6.4 Control Structures

Control structures that are designed to contain more than two feet of water within the structure under the design storm and have openings of greater than one-foot minimum dimension must be restricted from public access.

2.7 Conveyance and Flood Storage

2.7.1 Projects that alter existing conveyance systems (e.g., rerouting an existing ditch) must not adversely affect existing conveyance capabilities. It is presumed a system will meet this criterion if one of the following is met:

(a) The existing hydraulic capacity is maintained in the new system. This can be accomplished by maintaining existing headwater and tailwater conditions.

(b) The applicant demonstrates that changes in flood elevation and velocities will not adversely impact upstream or downstream off-site property. For example, this criterion may be satisfied by demonstrating that there is no increase in damages to existing off-site property (e.g., roads, buildings) resulting from changes in the existing flood elevations. Also, the applicant should demonstrate that proposed velocities are non-erosive or that erosion control measures (e.g., riprap, concrete lined channels, etc.) are sufficient to safely convey the flow.

(c) The criteria in **section 3.4 of the** Manual are met.

(d) As an alternative, the applicant may propose to utilize an applicable criteria established by a local government, state agency, or stormwater utility with jurisdiction over the project. However, Department staff must approve the use of these criteria.

2.7.2 There must be no net decrease in storage volume below the 10-year flood elevation within the project area that may result in increased flood hazards.

2.7.3 All storage volumes in detention or retention systems shall be calculated so as not to include any volumes below the average seasonal high-water table for the project area.

2.8 Tailwater for Water Quality

"Tailwater" refers to the water elevation (or pressure) at the final discharge part of the stormwater management system. Tailwater is an important component of the design and operation of nearly all stormwater management systems and can affect any of the following management objectives of the system:

(a) Peak discharge from the stormwater management system;

(b) Peak stage in the stormwater management system;

(c) Level of flood protection in the project;

(d) Recovery of peak attenuation and stormwater treatment volumes; and

(e) Control elevations, normal water elevation regulation schedules, and ground water management.

2.8.1 Tailwater Design and Performance Criteria

Stormwater management systems (except retention and exfiltration systems) must provide gravity or pumped discharge that effectively operates (i.e., meets applicable rule criteria) under one of the following tailwater conditions:

(a) Maximum stage in the receiving water resulting from the two-year, 24-hour storm. This storm depth is shown on the isopluvial map in **Figure 2.7-1**. Generally, applicants utilizing this option would model the receiving waters utilizing standard hydrologic and hydraulic methods for the two-year, 24-hour storm to determine peak stages at various points of interest. Lower stages may be utilized if the applicant demonstrates that flow from the project will reach the receiving water prior to the time of maximum stage in the receiving water.

(b) Mean annual high tide for tidal areas. This elevation is the average of all the high tides for each year. This elevation may be determined from tide charts or other similar information.

(c) Mean annual seasonal high water elevation. This elevation may be determined by water lines on vegetation or structures, historical data, adventitious roots or other hydrological or biological indicators, design of man-made systems, or estimated by a registered professional using standard hydrological methods based on the site and receiving water characteristics.

(d) The applicant may propose applicable criteria established by a local government, state agency, or stormwater utility with jurisdiction over the project. However, the Department must approve the use of alternative criteria. In this case, the applicant is encouraged to consult with Department staff prior to submitting an application.

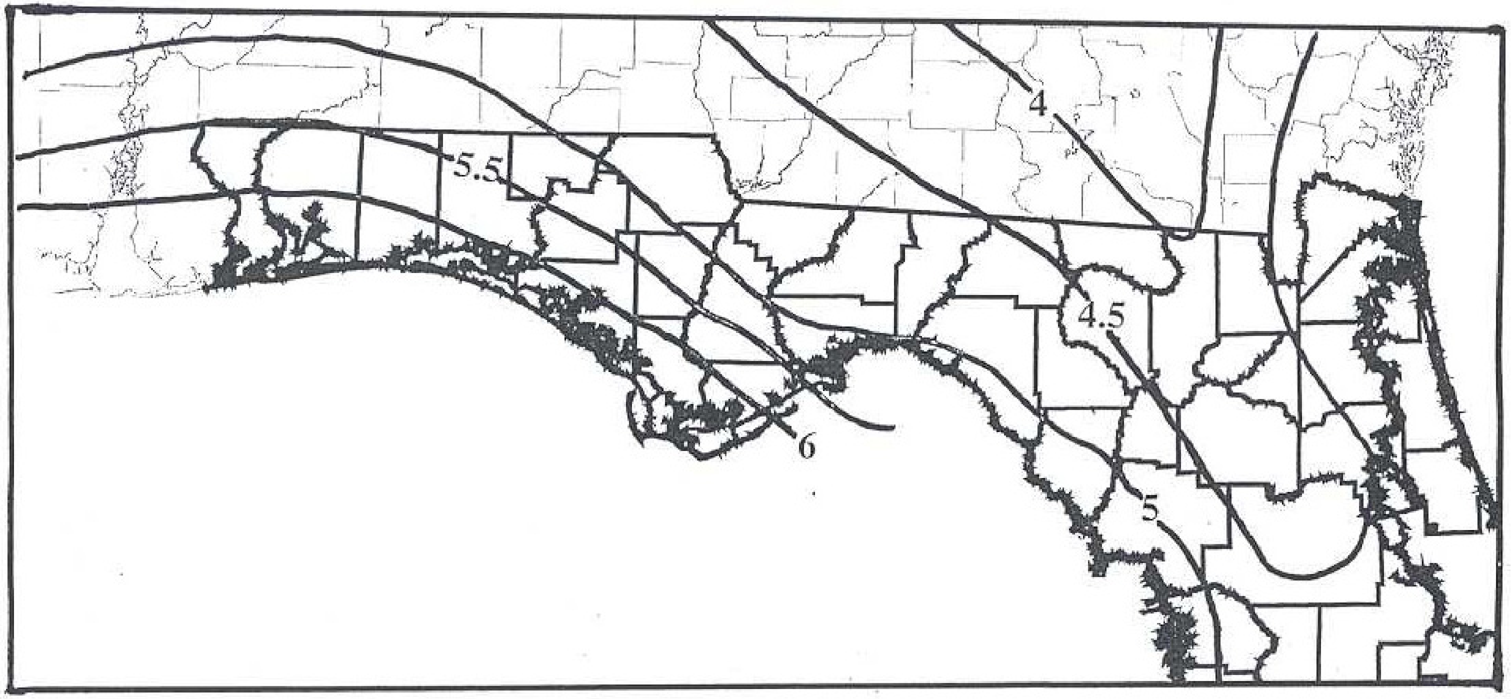


Figure 2.7-1 2 year - 24-Hour Maximum Rainfall, inches (Source: FDEP modified Technical Paper No. 40 Rainfall Frequency Atlas of the United States)

2.9 Applicant Responsibility

2.9.1 The applicant must provide for an operation and maintenance entity as required in **section 2.10 of the Manual.**

2.9.2 The applicant is responsible for transferring the permit from the construction phase to the operation and maintenance phase.

2.9.3 The applicant is responsible for notifying the Department of any transfer of ownership, including applying to the Department for applicable transfer of ownership within 30 days of such transfer.

2.10 Operation and Maintenance

All systems requiring an engineered stormwater management system under the **Manual** must be transferred to an operation and maintenance phase as follows.

2.10.1 Operation Phase

All authorization to construct, alter and maintain a surface water management system also constitutes a permit to operate the system. An applicant must submit the information described in this section to specify the entity that will operate and maintain the system with the construction, alteration or maintenance permit application. A permit authorizing construction, alteration, or maintenance will be converted to the operation phase once the Department determines the system or independent portion of a system has been constructed in compliance with the permit, and an appropriate entity has accepted responsibility for operation and maintenance of the system or independent portion of a system. The Department also will transfer the operation permit to an operation and maintenance entity upon request once all conditions for converting the construction, alteration, or maintenance permit have been met.

2.10.2 The following entities are acceptable for ensuring that a surface water management system will be operated and routine custodial maintenance will be performed in compliance with the **Manual**.

(a) local governmental units including counties and municipalities, and Municipal Service Taxing Units,

(b) active water control districts created pursuant to chapter 298, F.S., drainage districts created by special act, special districts defined in chapter 189, Community Development District created pursuant to chapter 190, F.S., Special Assessment Districts created pursuant to chapter 170, F.S., or water management districts created pursuant to chapter 373, F.S.,

(c) state or federal agencies,

(d) duly constituted communication, water, sewer, stormwater, electrical or other public utilities,

(e) profit or non-profit corporations as indicated below, or

(f) property owners or developers provided:

1. the property owner or developer provides written proof, either by letter or resolution, that a governmental entity or an acceptable entity set forth in **paragraphs 6.2.1(a) through (e) above** will accept the operation and maintenance of the stormwater management system when construction of the system is completed;

2. the property owner or developer provides proof of bonding or other assurance of a similar nature in an amount sufficient to cover the costs of the operation and maintenance of the system for a period of 10 years;

3. The property owner or developer wholly owns the property, and intends to retain this ownership; or

4. The property owner or developer will retain ownership of the property and will lease or rent it to third parties.

If the property owner or developer is to serve as the operation and maintenance entity, the property owner or developer must provide a copy of legal documentation demonstrating that the property owner or developer will have the right to enter upon the property and maintain the system. Bonding or other financial assurances provided to other governmental entities is acceptable under paragraph 2.10.2(f)2 of the Manual, provided such bonding or other financial assurance covers the costs of operating and maintaining the system for a period of ten years in addition to the cost of any other activity the bond or other financial assurance secures.

If the proposed maintenance entity falls within paragraph 2.10.2(a), (b), (c), or (d) above, a letter of intent from such entity must be submitted to the Department as part of the permit application, indicating the entity's intention to accept responsibility for operation and maintenance of the permitted system when construction of the system is complete. The letter of intent shall also specify any portions of the system that the governmental entity will operate and maintain.

The documentary assurances required under paragraph 2.10.2(f) above or section 2.10.3 below must be submitted to the Department as a part of the permit application and approved by the staff before a recommendation for approval of the permit will be made.

2.10.3 Profit or non-profit corporations such as homeowners associations, property owners associations, condominium owners associations or master associations are acceptable operation and maintenance entities only if the corporation has the financial, legal, and administrative capability to provide for the long term operation and routine custodial maintenance of the surface water management system.

(a) If a homeowner, property owner, condominium or master association is proposed, the applicant must submit draft Articles of Incorporation, Declaration, Restrictive Covenants, Deed Restrictions or other organizational or operation documents, or draft amendments thereto, that affirmatively assign responsibility for the operation or routine custodial maintenance of the surface water management system. These documents must be submitted to the Department as part of the permit application.

(b) The association must have sufficient powers reflected in its organizational or operational documents to:

1. operate and perform routine custodial maintenance of the surface water management system as exempted or permitted by the Department,

2. establish rules and regulations,

3. assess members for the cost of operating and maintaining the system, and enforce the collection of such assessments,

4. contract for services to provide for operation and routine custodial maintenance (if the association contemplates employing a maintenance company), and

5. exist in perpetuity; the articles of incorporation must provide that if the association is dissolved, the system shall be transferred to and maintained by an entity described in **paragraphs 6.2.1(a) through (e) of the Maunal** prior to the association's dissolution.

2.10.4 If an operation and maintenance entity is proposed for a project which will be constructed in phases, and subsequent phases will utilize the same surface water management system as the initial phase or phases, the entity must have the ability to accept responsibility for the operation and routine custodial maintenance of the surface water management system for future phases of the project.

If the development scheme contemplates independent operation and maintenance entities for different phases, and the system is integrated throughout the project, the entities, either separately or collectively, must have the responsibility and authority to operate and perform routine custodial maintenance of the system for the entire project area. That authority must include cross easements for surface water management and the ability to enter and maintain the various works, should any sub-entity fail to maintain a portion of the system within the project area.

2.10.5 When the applicant intends to convey the property to multiple third parties, the applicant will be an approved operation and maintenance entity from the time construction begins until the system is dedicated to and accepted by an established legal entity as described in **paragraphs 2.10.2(a) through (e) of the Manual,** provided that the applicant provides adequate proof that such an entity (as described in **subsection 2.10.2 of the Manual**) will exist when construction of the system is complete, and of the future acceptance of the system by such entity.

2.10.6 The operation phase of a noticed general permit shall automatically commence when construction is completed in conformance with all the terms, conditions, and limitations of the applicable noticed general permit; a formal request to transfer a noticed general permit to the operation phase is not required.

2.11 Retrofits of Existing Surface Water Management Systems

2.11.1 Stormwater retrofit projects are those that are intended only to reduce stormwater pollutant loadings from existing systems and are not intended to serve new developments. Such systems can be exempted from complying with some or all of the water quality and water quantity design and performance requirements in **Parts II, III, and IV of the Manual** if the applicant has conducted an alternatives analysis that documents why such design and performance requirements cannot be met. In such cases, the applicant shall seek to achieve the highest level of stormwater treatment in the most cost effective manner, which may include the use of sophisticated treatment technologies such as alum injection or stormwater reuse. Any alum injection system must provide for disposal of alum sludge in a manner that does not dispose of such sludge in waters of the state, complies with applicable industrial waste rules, and does not result in violations of state water quality standards.

PART III -- STORMWATER QUANTITY/FLOOD CONTROL

3.0 General Flood Control Requirements

3.1 Engineered Stormwater Management Systems That Must Meet Water Quantity Criteria

Systems that trip any of the following thresholds must be designed, constructed, operated, and maintained in accordance with this Part:

(a) Systems that serve projects of 40 or more acres of total land area;

(b) Systems that provide for the placement of 12 or more acres of impervious surface, which constitutes more than 40 percent of the total land area; or

(c) Systems that are capable of impounding a volume of water of 40 or more acre-feet.

Surface water management systems that do not exceed the above thresholds are not required to meet the stormwater quantity and flood control criteria of this Part.

3.2 Standards that Apply and Relationship to Part IV

In addition to the criteria in this Part, all activities that require an engineered stormwater management system (in accordance with **section 2.1.1 of the Manual**) must also comply with the Water Quality criteria in **Part IV of the Manual**.

As an example, a system that has 6 acres of impervious surface that comprises 26 percent of the total land area of 100 acres would have to meet the Stormwater Quantity/Flood Control criteria of this Part, because such a system trips the 40-acre total land area threshold. The applicant for such a system therefore must design the surface water management system to meet the flood control peak discharge criteria of **section 3.3 of the Manual** in addition to the **streambank protection discharge criteria as required in section 4.5.2 of the Manual**. This can be accomplished by designing a multi-staged outlet structure to attenuate both the flood control and 2-year, 24-hour storm events. See **Figure 3.2-1** for a conceptual design of a multi-staged outlet structure. Examples of multi-staged outlet structures include two staged weirs, risers with multiple orifice controls, and combinations of weir and orifice controls.

3.3 Peak Discharge Attenuation

<u>Criterion</u>: The post-development peak rate of discharge must not exceed the pre-development peak rate of discharge.

(a) If the project is located totally within a stream or open-lake watershed, detention systems must be installed such that the peak rate of post-development runoff will not exceed the peak-rate of pre-development runoff for storm events up through and including either:

1. A design storm with a 10-year, 24-hour rainfall depth with SCS (NRCS) Type II Florida Modified distribution falling on average antecedent moisture conditions for projects serving exclusively agricultural, forest, conservation, or recreational land uses; or

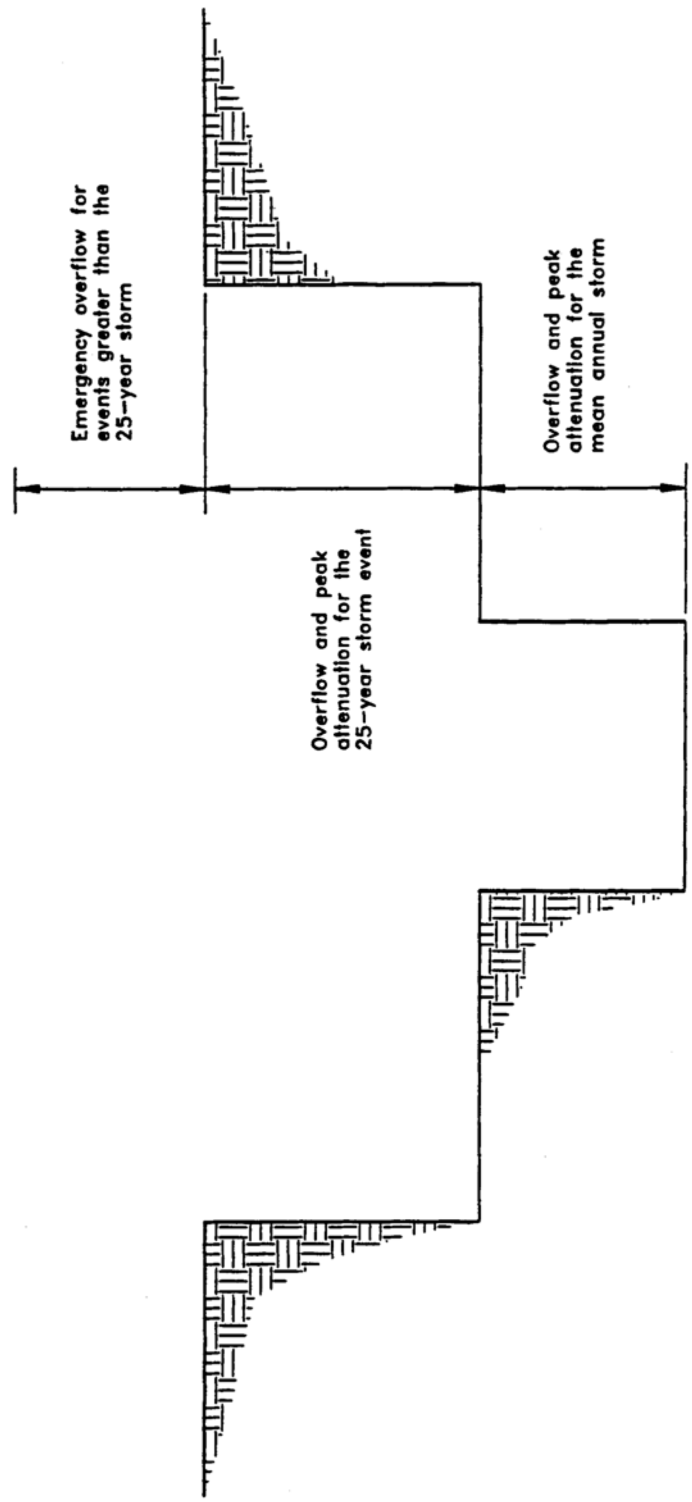


Figure 3.2-1 Conceptual design of a multi-stage outlet structure

2. A design storm with a 25-year, 24-hour rainfall depth for projects serving any land uses other than agricultural, silvicultural, conservation, or recreational uses.

(b) If the project area falls within an internally drained or closed-lake watershed or any part of the project area is in a stream-to-sink watershed, the retention volume shall be the total post-development runoff less the pre-development runoff resulting from a 25-year, 24-hour storm.

Storage volumes designed into retention or detention systems to meet the requirements of (a) and (b), above must be available as follows:

1. One-half of the total volume within seven days following the end of the design storm event, and

2. The total volume within 30 days following the end of the design storm event.

3.3.1 Alternative Peak Discharge Criteria

As an alternative to the peak discharge criteria in **section 3.2 of Manual**, applicants may propose to utilize applicable storm event, duration, or criteria specified by a local government, state agency (including FDOT), or stormwater utility with jurisdiction over the project. However, the Department must approve the use of the alternative criteria. Applicants proposing to use alternative criteria are encouraged to have a pre-application conference with Department staff.

3.3.2 Methodologies

A peak discharge analysis typically consists of generating predevelopment and post development runoff hydrographs, routing the post development hydrograph through a detention basin, and sizing an overflow structure to control post development discharges at or below predevelopment rates.

Peak discharge computations should consider the duration, frequency, and intensity of rainfall, the antecedent moisture conditions, upper soil zone and surface storage, time of concentration, tailwater conditions, changes in land use or land cover, and any other changes in topographic and hydrologic characteristics. Large systems should be divided into subbasins according to artificial or natural drainage divides to allow for more accurate hydrologic simulations. Examples of accepted methodologies for computation of runoff are as follows:

(a) Soil Conservation Service Method (see U.S. Department of Agriculture, Soil Conservation Service "National Engineering Handbook, Section 4, Hydrology," TR-55 ("Urban Hydrology for Small Watershed") or TR-20 users manuals).

(b) Santa Barbara Urban Hydrograph Method.

(c) U.S. Army Corps of Engineers HEC-1 Computer Programs.

(d) Other hydrograph methods approved by the Department.

3.3.3 Aggregate Discharge

Depending on the location and design of large systems where multiple off-site discharges are designed to occur, the Department may allow the total post-development peak discharge not to exceed the pre-development peak discharge for the combined discharges rather than for each individual discharge. Such a consideration shall be made only if the combined discharges meet all other requirements of the **Manual**, and discharge to the same receiving water body.

3.3.4 Rainfall Intensity and Volume

In determining peak discharge rates, intensity of rainfall values shall be obtained through a statistical analysis of historical long-term rainfall data or from sources or methods generally accepted as good engineering practice.

(a) Examples of acceptable sources include:

1. USDA Soil Conservation Service, "Rainfall Frequency Atlas of Alabama, Florida, Georgia, and South Carolina for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years" January 1978; Gainesville, Florida.

2. U.S. Weather Bureau Technical Paper No. 49.

3. U.S. Weather Bureau Technical Paper No. 40.

4. U.S. Department of Interior, Bureau of Reclamation, "Design of Small Dams", 2nd Edition.

5. F.D.O.T. Drainage Handbook, Hydrology, Latest Edition

(b) For a drainage basin greater than 10 square miles, the areal rainfall can be calculated from point rainfall using a method that has been well documented. The converting factor as described in U.S. Weather Bureau Technical Paper No. 49 may be used.

3.3.5 Tailwater for Quantity

Receiving water stage can affect the amount of flow, which will discharge from the project to the receiving water. This stage may be such that tailwater exists in portions of the project system, reducing the effective flow or storage area. Typical examples of this are illustrated in **Figures 3.3.5-1** (gravity) and **3.3.5-2** (pumped).

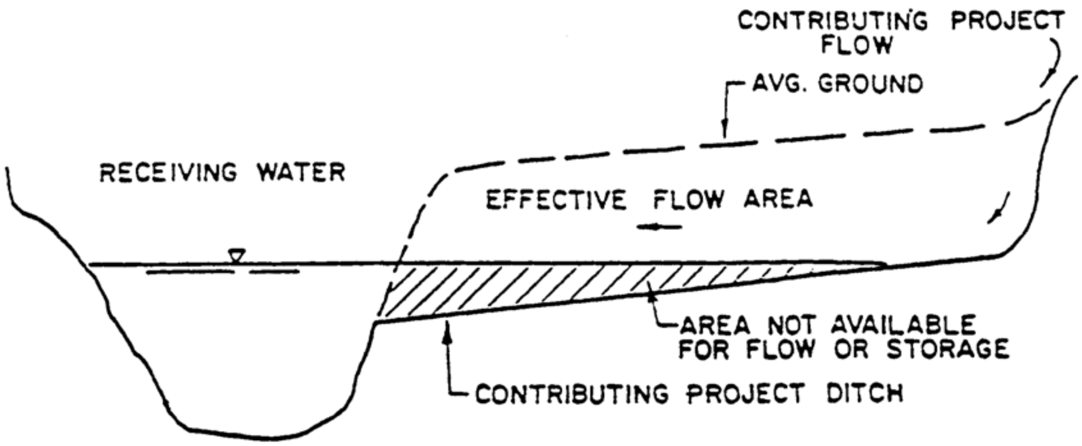


Figure 3.3.5-1

The stage in the receiving water should be considered to be the maximum stage, which would exist in the receiving water from a storm equal to the project design storm. Lower stages may be used if the applicant can show that the flow from his project will reach the receiving water prior to the time of maximum stage in the receiving water.

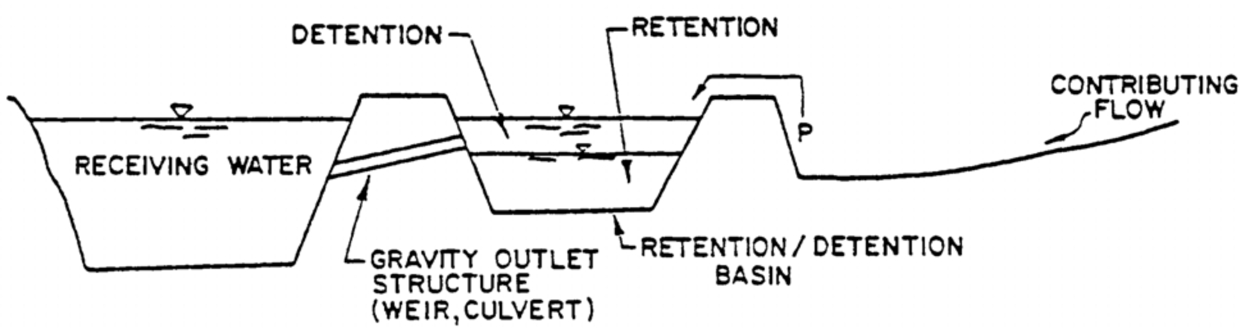


Figure 3.3.5-2

3.3.6 Design Techniques

Various design techniques are available to the engineer to estimate approximate pre-development peak discharge rates for the system through a reduction in excess runoff. Acceptable design techniques include detention basins, the use of grassed waterways, and any other storage capability that the particular system may have.

3.3.7 Upper Soil Zone Storage and Surface Storage

In most instances, the upper soil zone storage and surface storage capacities will have an effect on the pre-development and post-development peak discharges and should be considered in these computations. Any generally accepted and well-documented method may be used to develop the upper soil zone storage and surface storage values.

(a) The soil zone storage at the beginning of a storm should be estimated by using reasonable and appropriate parameters to reflect drainage practices, average wet season water table elevation, the antecedent moisture condition (AMC II) and any underlying soil characteristics which would limit or prevent percolation of storm water into the entire soil column. In no case should the soil storage used in the computation exceed the difference between the maximum soil water capacity and the field capacity (i.e., gravitational water) for the soil columns above any impervious layer or seasonal ground water table.

(b) Surface storage, including that available in wetlands and low-lying areas, shall be considered as depression storage. Depression storage shall be analyzed for its effect on peak discharge and the time of concentration. Depression storage can also be considered in post-development storage routing, which would require development of stage-storage relationships; if depression storage is considered, then both pre-development and post-development storage routing must be considered.

3.4 Storage and Conveyance

3.4.1 Criterion: Floodways and floodplains, and levels of flood flows or velocities of adjacent streams, impoundments or other water courses must not be altered so as to adversely impact the off-site storage and conveyance capabilities of the water resource.

3.4.2 (a) A system may not cause a net reduction in flood storage within a 10-year floodplain except for structures elevated on pilings or traversing works. Traversing works, works or other structures shall cause no more than a one-foot increase in the 100-year flood elevation immediately upstream and no more than one tenth of a foot increase in the 100-year flood elevation 500 feet upstream. A system will not cause a net reduction in flood storage within a 10-year floodplain if compensating storage is provided outside the 10-year floodplain.

(b) A system may not cause a reduction in the flood conveyance capabilities provided by a floodway except for structure elevated on pilings or traversing works. Such works, or other structures shall cause no more than a one-foot increase in the 100-year flood elevation immediately upstream and no more than one tenth of a foot increase in the 100-year flood elevation 500 feet upstream.

(c) An applicant may only be permitted to contravene the requirements of (a) or (b) if the applicant gives reasonable assurance that, if all other persons who could impact the surface water of any impoundment, stream, or other watercourse by floodplain encroachment exceed

(a) and (b) above to the same degree as the applicant proposes, the cumulative impacts would not contravene subsection 2.2.1 of the **Manual**.

3.5 Stabilization of Side Slopes

Stabilization of side slopes is necessary in order to prevent erosion due to flow velocity and runoff from the banks. Good engineering practices shall be employed, taking into consideration soil, flow, and drainage characteristics. Again, the retardation of overland runoff and soil stabilization using naturally occurring vegetation coverage shall be considered before paving, riprap, lining, energy dissipation and other structural measures are employed.

3.6 Low Flow and Base Flow Maintenance

3.6.1 Criterion: Flows of adjacent streams, impoundments or other watercourses must not be decreased so as to cause adverse impacts.

3.6.2 Low Flow:

(a) Only systems with both of the following conditions must meet the low flow performance criteria in (b) and (c), below.

1. Systems that impound water for purposes in addition to temporary detention storage. Water impounded longer than a 14-day bleed down period is considered conservation storage for benefits other than detention storage (i.e., recreation, irrigation, etc.).

2. Systems that impound a stream or other watercourse which, under pre-development conditions, discharged surface water off-site to receiving water during 5-year, 30-day drought frequency conditions.

(b) Any system meeting the conditions of (a) above shall be designed with an outlet structure to maintain a low flow discharge of available conservation storage. When the conservation storage is at the average dry season design stage, the low flow discharge should equal the average pre-development surface water discharge, which occurred from the project site to receiving waters during the 5-year, 30-day drought.

(c) The system shall be operated to provide a low flow discharge whenever water is impounded. However, discharge may be discontinued, if desired, during the wet season (considered as June through October) unless a water shortage condition is declared by a water management district. The actual discharge will vary according to the water stage in the impoundment. When conservation storage is at the average dry season design stage, the discharge will be the average 5-year, 30-day low flow. When storage is below the average dry season design stage, the discharge may be less than the average 5-year, 30- day low flow.

3.6.3 Base Flow

It is presumed that an adverse impact will result if the system causes the ground water table to be lowered:

a) More than an average three feet lower, over the project area, than the average dry season low water table; or

b) At any location, more than five feet lower than the average dry season low water table; or

c) To a level that would decrease the flows or levels of surface water bodies below any minimum level or flow established by a water management district Governing Board pursuant to Section 373.042, F.S.

PART IV -- STORMWATER QUALITY

4.0 Purpose and Background

4.1 Thresholds for Designing in Conformance with Stormwater Quality Criteria

Surface water management systems that meet all the following are not required to meet the Stormwater Quality design criteria in this Part:

(a) The construction or alteration involves less than 4,000 square feet of impervious or semi-impervious surface area subject to vehicular traffic. This area includes roads, parking lots, driveways, and loading zones;

(b) The construction or alteration involves less than 5,000 square feet of building area or other impervious area not subject to vehicular traffic; and

(c) The construction or alteration involves less than 1 acre of recreational area. Recreational areas include but are not limited to golf courses, tennis courts, putting greens, driving ranges, or ball fields.

All other activities requiring a permit under chapter 62-25, F.A.C., require an engineered stormwater management system that is designed, constructed, operated, and maintained in conformance with the criteria in this Part. In addition, those systems that exceed the thresholds in **section 2.1 of the Manual** must also be designed, constructed, operated, and maintained in accordance with **section III of the Manual**.

4.2 Criterion

Florida's stormwater quality regulations are "technology-based" not "water quality effluent-based." The design criteria in this handbook are presumed to meet the minimum levels of stormwater treatment established in chapter 62-40, F.A.C., the State Water Resource Implementation Rule.

4.3 Integration with State Resource Implementation Rule

4.3.1 General

Paragraph 62-40.432(2), F.A.C. (State Water Resource Implementation Rule), provides:

> (2) Minimum Stormwater Treatment Performance Standards.
>
> (a) When a stormwater management system complies with rules establishing the design and performance criteria for such systems, there shall be a rebuttable presumption that the discharge from such systems will comply with state water quality standards. The Department and the Districts, pursuant to Section 373.418, F.S., shall, when adopting rules pertaining to stormwater management systems, specify design and performance criteria for new stormwater management systems which:
>
> 1. Achieve at least 80 percent reduction of the average annual load of pollutants that would cause or contribute to violations of state water quality standards.

2. Achieve at least 95 percent reduction of the average annual load of pollutants that would cause or contribute to violations of state water quality standards in Outstanding Florida Waters.

3. If a District or the Department adopts basin-specific design and performance criteria in order to achieve an adopted TMDL or the pollutant load reduction goals established in a watershed management plan, such design and performance criteria shall replace those specified in subparagraphs 1. and 2. above.

(b) Erosion and sediment control plans detailing appropriate methods to retain sediment on-site shall be required for land disturbing activities.

(c) The pollutant loading from older stormwater management systems shall be reduced as necessary to restore or maintain the designated uses of waters.

4.3.2 Systems meeting the design and performance criteria of the **Manual** are presumed to meet the State Water Resource Implementation Rule performance standards stated above. However, as new research on the design and effectiveness of stormwater treatment systems becomes available, the design and performance criteria of this Handbook may be revised as appropriate through future rulemaking.

4.4 State Water Quality Standards

4.4.1 Surface Water Quality Standards

State surface water quality standards are set forth in chapters 62-4 and 62-302, F.A.C., including the antidegradation provisions of sections 62-4.242(1)(a) and (b), 62-4.242(2) and (3), and 62-302.300, F.A.C., and the special standards for Outstanding Florida Waters and Outstanding National Resource Waters set forth in sections 62-4.242(2) and (3), F.A.C. Furthermore, the Department cannot authorize permits that modify the quantity of water-discharged offsite if such discharge will cause adverse environmental or water quality impacts.

4.4.2 Ground Water Quality Standards

State water quality standards for ground water are set forth in chapter 62-520, F.A.C. In addition to the minimum criteria, Class G-I and G-II ground water must meet primary and secondary drinking water quality standards for public water systems established pursuant to the Florida Safe Drinking Water Act, which are listed in sections 62-550.310 and .320, F.A.C.

Only the minimum criteria apply within a zone of discharge, as determined in section 62-520.400**,** F.A.C. A zone of discharge is defined as a volume underlying or surrounding the site and extending to the base of a specifically designated aquifer or aquifers, within which an opportunity for the treatment, mixture or dispersion of wastes into receiving ground water is afforded. Generally, stormwater systems have a zone of discharge 100 feet from the system boundary or to the project's property boundary, whichever is less.

4.4.3 How Standards are Applied

The quality of stormwater discharged to receiving waters is presumed to meet the surface water standards in chapters 62-4, and 62-302, F.A.C., and the ground water standards in chapter 62-550, F.A.C., if the system is permitted, constructed, operated and maintained in accordance with the **Manual**. However, this determination is rebuttable.

4.5 Criteria for Evaluation

4.5.1 Reasonable Assurance

In addition to complying with the criteria in **section 2.2 of the Manual,** in order to obtain an environmental resource permit for a system that requires an engineered stormwater management system under **section 2.1 of the Manual**, an applicant must give reasonable assurance that the stormwater management system will:

(a) Not adversely affect drainage and flood protection on adjacent or nearby properties not owned or controlled by the applicant in accordance with **Section 2.6**;

(b) Be capable of being effectively operated and maintained;

(c) Meet any applicable Sensitive Karst Area Basin requirements in **Section 11.0** of this Handbook; and

(e) For systems serving a use that produces or stores hazardous or toxic substances, be designed to have no stormwater discharge that contains such substances.

4.5.2 Peak Discharge Criteria to Protect Streambanks

4.5.2.1 Overview

Urbanization increases total runoff volume, peak discharge rates, and the magnitude and frequency of flood events. With an increase in the number of flood events a stream is subjected to, the potential for accelerated erosion of both the stream banks and channel bottom is enhanced. Proper design of detention systems to limit post development peak discharge rates to predevelopment rates can minimize some of the stormwater effects of urbanization.

4.5.2.2 Two-Year, 24-Hour Storm Requirements

Proper selection of the design storm for peak discharge control is crucial to determining the effectiveness of the detention basin. Historically, stormwater programs only regulated the peak discharge from large storm events (i.e., 25-year, 24-hour storm) Unfortunately that approach suffers from the following drawbacks:

(a) If a detention pond is only designed to reduce the peak of the 25-year storm, the discharge rates from lesser events such as the 2, 5, and 10-year flood events may not be controlled. The ineffectiveness of controlling small flood events may appear to be unimportant with respect to flood damages. However, these more frequent events do cause localized flood damage and are of prime importance as a cause of channel and streambank erosion.

(b) Cumulative water quantity impacts may occur from several projects below the chapter 62.343, F.A.C., thresholds located within the same watershed.

To address these concerns, peak discharge rate must be controlled for the 2-year, 24-hour storm event and potentially for a larger storm event. The 2-year, 24-hour was selected as the design event for this rule because the shape and form of natural channels is controlled by approximately the 2-year return frequency storm. The rainfall depth for the 2-year, 24-hour storm for the Florida panhandle is shown in **Figure 2.7.1-1**. The rainfall depth at a particular location may be established by interpolating between the nearest isopluvial lines.

4.5.2.3 Peak Discharge Attenuation Criteria to Protect Streambanks

The post development peak discharge rate must not exceed predevelopment rates for the 2-year, 24-hour storm for systems serving new construction area greater than 50 percent impervious (excluding water bodies).

This condition must be met before a project is required to comply with the peak discharge criterion. Projects that modify existing systems without adding new impervious surfaces are exempt from this criterion. However, if a project modifies an existing system by adding new impervious surfaces, the peak discharge criteria requirements must be met only for the newly added impervious surfaces. Pervious concrete and turf blocks are not considered impervious surface for this purpose. However, compacted soils and limerock are considered impervious for this purpose.

4.6 Erosion and Sediment Control Criteria for Surface Water Management Systems

Land clearing activities, including the construction of stormwater management systems, shall be designed, constructed, and maintained at all times so that erosion and sedimentation from the system, including the areas served by the system, do not cause violations of applicable state water quality standards in receiving waters. Further, because sedimentation of off site lands can lead to public safety concerns, erosion and sediment controls shall be designed and implemented to retain sediment on-site as required by subsection 62-40.432(2), F.A.C. In particular, the erosion and sediment control requirements described in **Part IV of the Applicant's Handbook Volume I,** shall be followed during construction of the system.

4.7 Oil and Grease Control

Systems that receive stormwater from areas with a greater than 50 percent impervious area (excluding water bodies) or which are a potential source of oil and grease (e.g., parking lots and gasoline stations) must include a baffle, skimmer, grease trap or other mechanism suitable for preventing oil and grease from leaving the stormwater system in concentrations that would cause a violation of water quality standards. A typical illustration of a skimmer on an outlet structure is shown is **Figure 4.7-1**.

4.8 On-Line and Off-line Stormwater Systems

Each stormwater treatment Best Management Practice (BMP) specifies a required volume of stormwater runoff to be captured and treated (i.e., treatment volume) prior to release to surface or ground water. There are two basic types of configurations for capturing the treatment volume: on-line and off-line systems. On-line systems (**Figure 4.8-1**) consist of a storage area which provides storage of the required treatment volume for smaller storm events and, if required, temporary detention storage for peak discharge control during larger storm events. Runoff

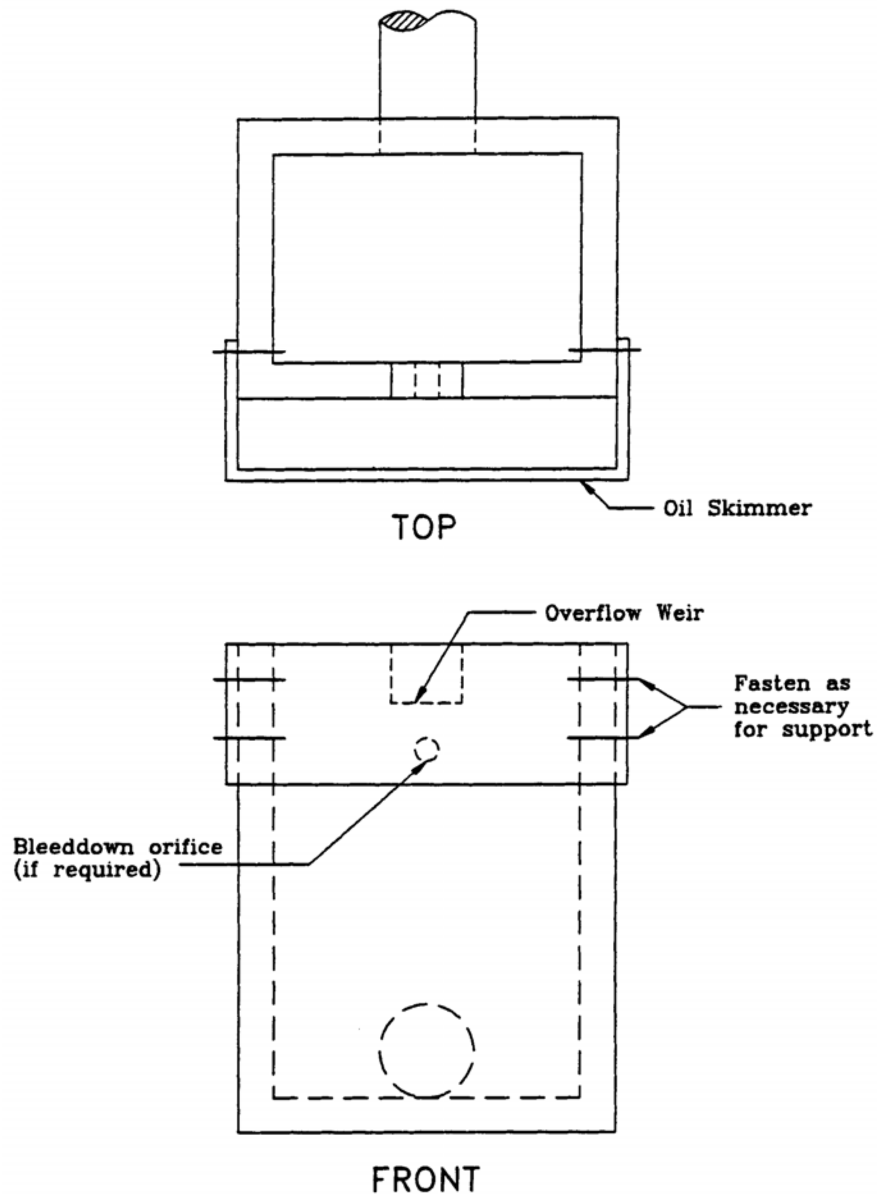


Figure 4.7-1 Oil skimmer detail for a typical outfall structure (N.T.S.)

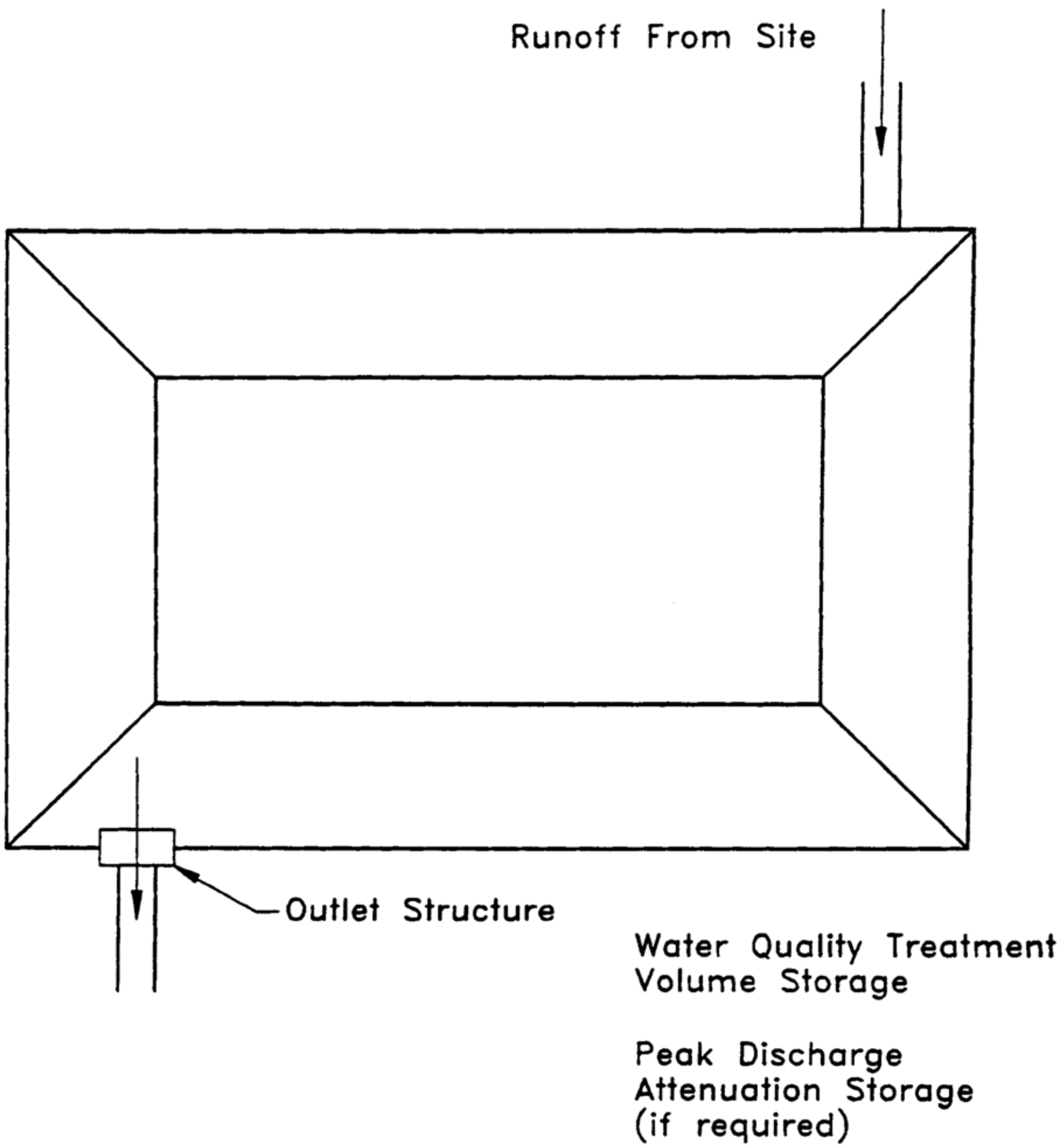


Figure 4.8-1 On-line treatment system

volumes in excess of the treatment volume mix with the treatment volume in the basin and transport a portion of the pollutant mass load over the basin control structure.

Off-line treatment systems (**Figure 4.8-2**) divert the treatment volume into a BMP that is designed for storage and treatment of the applicable treatment volume. Runoff volumes in excess of the treatment volume by-pass the off-line BMP and are discharged to the receiving water or routed to a detention basin if peak discharge attenuation is required. A diversion box (**Figure 4.8-3**) typically is used to divert the treatment volume to the off-line BMP and route subsequent flows away from it. .

Off-line systems are generally more effective at removing pollutants than on-line systems because accumulated pollutants cannot be "flushed out" during storm events that produce runoff volumes exceeding the treatment storage volume. Consequently, on-line systems must treat a greater volume of runoff than off-line systems to reduce the likelihood of flushing accumulated pollutants out of the system and achieve the minimum stormwater treatment levels required by State Water Resource Implementation Rule (chapter 62-40, F.A.C.). Treatment volumes for each of the stormwater treatment practices described in this handbook are discussed in **Sections 5 through 11 of the Manual.**

The treatment storage provided in an off-line system can be considered in the stage/storage calculations for peak discharge attenuation. Off-line systems should be designed to bypass essentially all additional stormwater runoff volumes greater than the treatment volume to a discharge point or other detention storage area. Of course, there will be some incremental additional storage in the off-line system associated with the hydraulic grade line at the weir structure in the typical diversion structure. This will depend on the size of the weir, but the weir should be sized to pass the design flow with minimal headwater.

Proposed off-line systems that will also serve to provide significant detention storage above the off-line treatment volume storage will be considered to function as on-line systems. These systems should either be designed to meet on-line treatment volume requirements or the designer should discuss the merits of the particular system (in terms of potential of flushing accumulated pollutants) with Department staff in a pre-application conference.

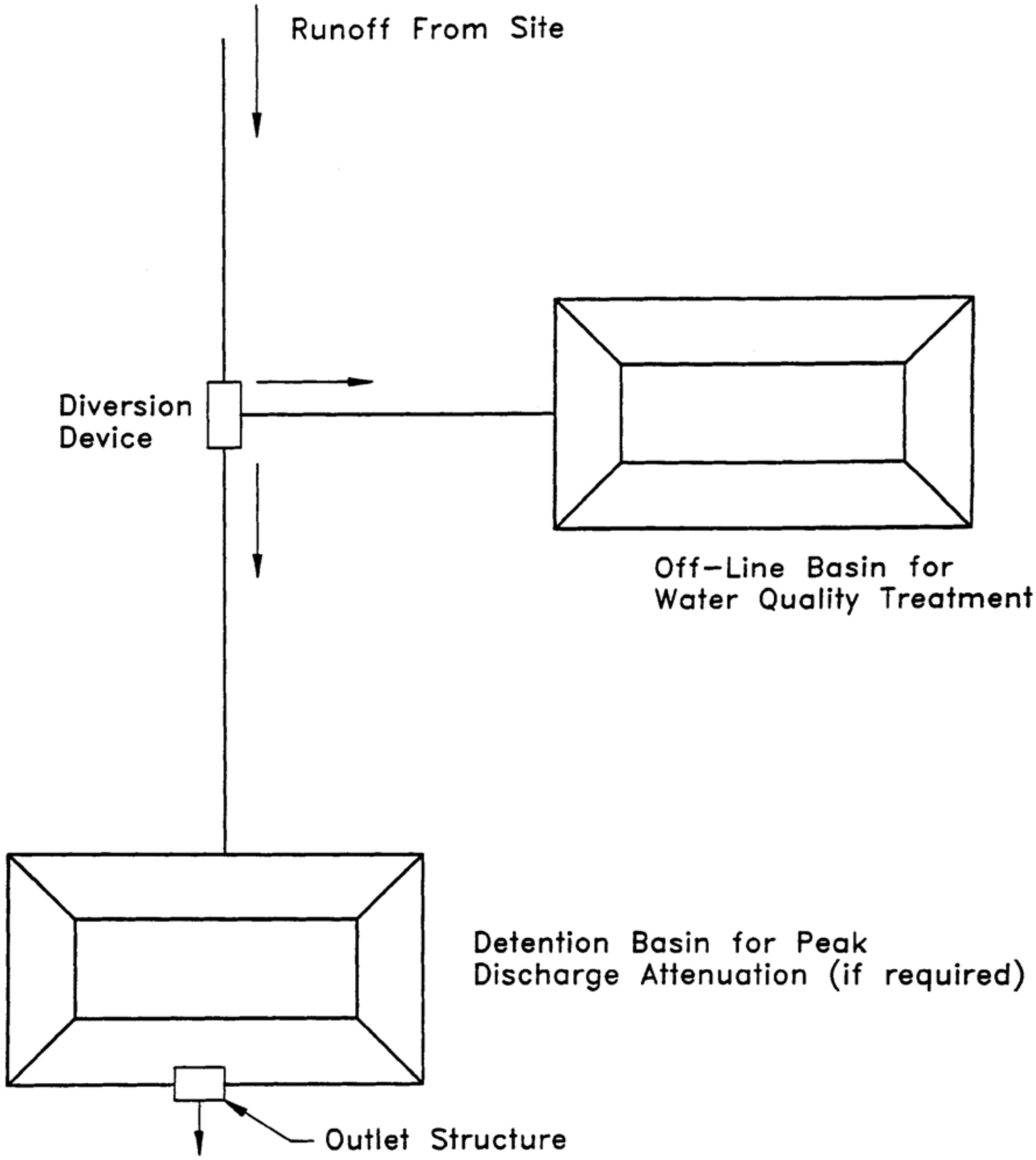


Figure 4.8-2 Off-line treatment system

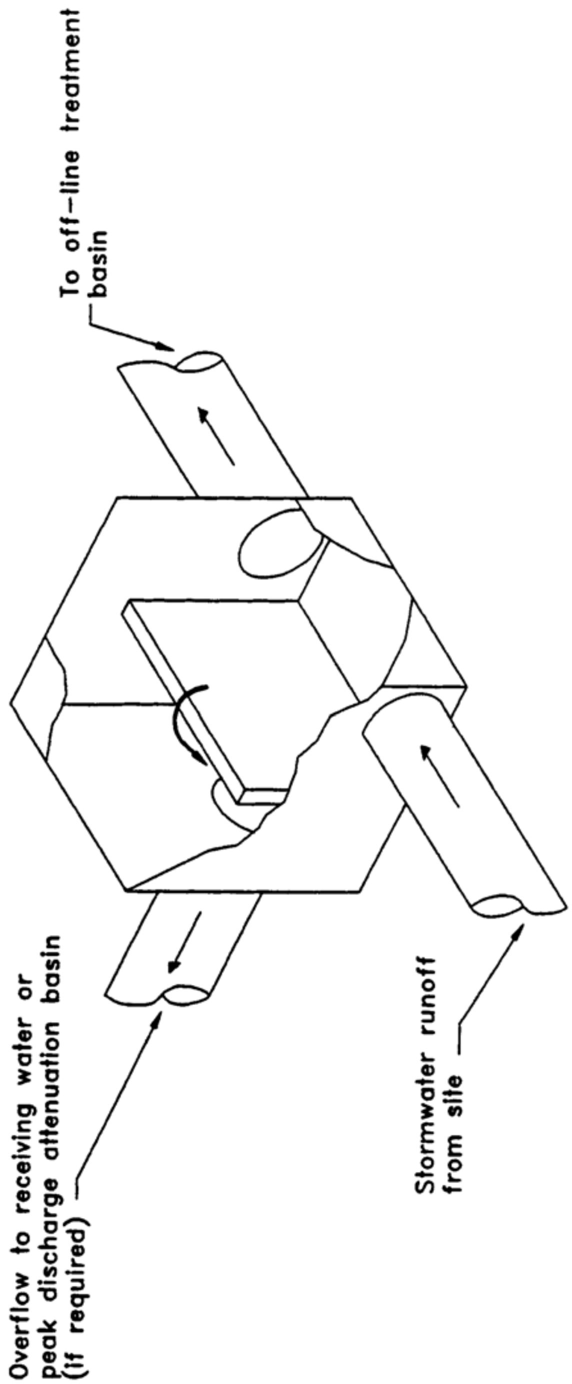


Figure 4.8-3 Diversion box (N.T.S.)

PART V -- BEST MANAGEMENT PRACTICES

5.0 Design Criteria and Guidelines for Retention Systems

5.1 Description

The term “retention system” is defined as a storage area designed to store a defined quantity of runoff, allowing it to percolate through permeable soils into the shallow ground water aquifer. Stormwater retention works best using a variety of retention systems throughout the project site. Examples of retention systems include:

- Man-made or natural depressional areas where the floor is graded as flat as possible and turf is established to promote infiltration and stabilize the basin slopes (see **Figure 5.1-1**);
- Shallow landscaped areas designed to store stormwater;
- Vegetated swales with swale blocks or raised inlets; and
- Pervious concrete with continuous curb.

Soil permeability and water table conditions must be such that the retention system can percolate the desired runoff volume within a specified time following a storm event. After drawdown has been completed, the basin does not hold any water, thus the system is normally “dry.” Unlike detention basins, the treatment volume for retention systems is not discharged to surface waters.

Retention systems provide excellent removal of stormwater pollutants. Substantial amounts of suspended solids, oxygen demanding materials, heavy metals, bacteria, some varieties of pesticides and nutrients such as phosphorus are removed as runoff percolates through the vegetation and soil profile.

Retention systems should not be located in close proximity to drinking water supply wells. Chapter 62-22, F.A.C., requires stormwater treatment facilities to be at least 100 feet from any public supply well. **Section 11 of the Manual**, provides additional design features for systems constructed in Sensitive Karst Areas where the drinking water aquifer is close to the land surface.

Besides pollution control, retention systems can be utilized to promote the recharge of ground water to prevent saltwater intrusion in coastal areas or to maintain groundwater levels in aquifer recharge areas. Retention systems can also be used to meet the runoff volume criteria for projects that discharge to land-locked lakes (see **section 3.3(b) of** the **Manual**).

There are several design and performance criteria specific to retention systems that are described below.

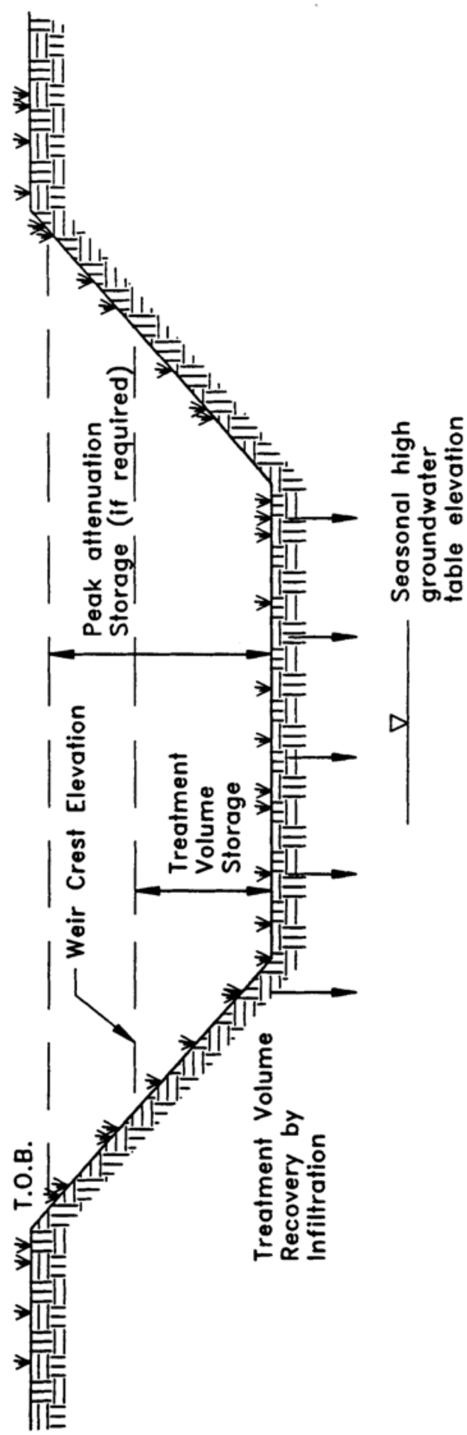


Figure 5.1-1 Retention (N.T.S.)

5.2 Treatment Volume

The first flush of runoff should be routed to the retention basin and percolated into the ground. For systems which discharge to Class III receiving water bodies, the rule specifies one of the following:

(a) Off-line retention of the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater.

(b) On-line retention of an additional one half inch of runoff from the drainage area over that volume specified for off-line treatment.

(c) On-line retention that provides for percolation of the runoff from the three-year, one-hour storm.

(d) On-line retention of the runoff from one inch of rainfall or 1.25 inches of runoff from the impervious area, whichever is greater, for systems which serve an area with less than 40 percent impervious surface and that contain only U.S. Department of Agriculture Natural Resources Conservation Service (NRCS, SCS) hydrologic group "A" soils.

For direct discharges to Class I, Class II, OFWs, or Class III waters that are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, the applicant should provide retention for one of the following:

(a) At least an additional fifty percent of the applicable treatment volume specified for off-line retention in (a), above. Off-line retention must be provided for at least the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater, of the total amount of runoff required to be treated.

(b) On-line retention of an additional fifty percent of the treatment volume specified in (b), above.

(c) On-line retention of the runoff from the three-year, one-hour storm.

(d) On-line retention that provides at least an additional 50 percent of the runoff volume specified in (d), above, for systems which serve an area with less that 40 percent impervious surface and that contain only U.S. Department of Agriculture Natural Resources Conservation Service (NRCS, or SCS) hydrologic group "A" soils.

5.3 Recovery Time

The retention system must provide the capacity for the appropriate treatment volume of stormwater specified in **Section 5.2 of the Manual** within 72 hours following a storm event assuming average antecedent moisture conditions. In retention systems, the stormwater is drawn down by natural soil infiltration and dissipation into the ground water table, evaporation, or evapotranspiration, as opposed to underdrain systems which rely on artificial methods like drainage pipes.

Antecedent moisture condition (AMC) refers to the amount of moisture and storage in the soil profile prior to a storm event. Antecedent soil moisture is an indicator of wetness and availability of soil to infiltrate water. The AMC can vary from dry to saturated depending on the amount of rainfall received prior to a given point in time. Therefore, "average AMC" means the soil is neither dry or saturated, but at an average moisture condition at the beginning of a storm event when calculating recovery time for retention systems.

The antecedent condition has a significant effect on runoff rate, runoff volume, infiltration rate, and infiltration volume. The infiltration volume is also known as the upper soil zone storage. Both the infiltration rate and upper soil zone storage are used to calculate the recovery time of retention systems and should be estimated using any generally accepted and well documented method with appropriate parameters to reflect drainage practices, seasonal high water table elevation, the AMC, and any underlying soil characteristics which would limit or prevent percolation of storm water into the soil column.

5.4 Basin Stabilization

The retention basin should be stabilized with pervious material or permanent vegetative cover. To provide proper treatment of the runoff in very permeable soils, permanent vegetative cover must be utilized when U.S. Department of Agriculture Natural Resources Conservation Service (NRCS, SCS) hydrologic group "A" soils underlie the retention basin, except for pervious pavement systems.

5.5 Retention Basin Construction

5.5.1 Overview

Retention basin construction procedures and the overall sequence of site construction are two key factors that can control the effectiveness of retention basins. Sub-standard construction methods or construction sequence can render the basin inoperable prior to completion of site development.

Since stormwater management systems typically are required to be constructed during the initial phases of site development, retention basins are often exposed to poor quality surface runoff. Stormwater runoff during construction contains considerable amounts of suspended solids, organics, clays, silts, trash and other undesirable materials. For example, the subgrade stabilization material utilized during construction of roadways and pavement areas typically consist of clayey sand or soil cement. If a storm occurs when these materials are exposed (prior to placement of the roadway wearing surface), considerable amounts of these materials end up in the retention basin. Another source of fine material generated during construction is disturbed surface soil that can release large quantities of organics and other fine particles. Fine particles of clay, silt, and organics at the bottom of a retention basin create a poor infiltrating surface (Andreyev and Wiseman 1989).

5.5.2 Construction Requirements

The following construction procedures are recommended to avoid degradation of retention basin infiltration capacity due to construction practices (Andreyev and Wiseman 1989):

(a) Initially construct the retention basin to rough grade by under-excavating the basin bottom and sides by approximately 12 inches.

(b) After the drainage area contributing to the basin has been fully stabilized, the interior side slopes and basin bottom should be excavated to final design specifications. The excess soil and undesirable material should be carefully excavated and removed from the pond so that all accumulated silts, clays, organics, and other fine sediment material has been removed from the pond area. The excavated material should be disposed of beyond the limits of the drainage area of the basin.

(c) Once the basin has been excavated to final grade, the entire basin bottom should be deep raked and loosened for optimal infiltration.

(d) Finally, the basin should be stabilized according the **Section 5.4 of the Manual**.

5.6 References

Andreyev, N.E., and L.P. Wiseman. 1989. *Stormwater Retention Pond Infiltration Analysis in Unconfined Aquifers*. Prepared for Southwest Florida Water Management District, Brooksville, Florida.

6.0 Underdrain Design and Performance Criteria

6.1 Description

Stormwater underdrain systems consist of a dry basin underlain with perforated drainage pipe which collects and conveys stormwater following percolation from the basin through suitable soil. Underdrain system are generally used where high water table conditions dictate that recovery of the stormwater treatment volume cannot be achieved by natural percolation (i.e., retention systems) and suitable outfall conditions exist to convey flows from the underdrain system to receiving waters. Schematics of a typical underdrain system are shown in **Figures 6.1-1 and 6.1-2.**

Underdrain systems are intended to control both the water table elevation over the entire area of the treatment basin and provide for the drawdown of the treatment volume. Underdrains are utilized where the soil permeability is adequate to recover the treatment volume since the on-site soils overlay the perforated drainage pipes.

Underdrain systems provide excellent removal of stormwater pollutants. Substantial amounts of suspended solids, oxygen demanding materials, heavy metals, bacteria, some varieties of pesticides and nutrients such as phosphorus are removed as runoff percolates through the vegetation and soil profile.

There are several design and performance criteria which must be met in order for an underdrain system to meet the rule requirements. The underdrain rule criteria are described below.

6.2 Treatment Volume

The first flush of runoff should be detained in a dry detention basin and percolated through the soil. For discharges to Class III receiving water bodies, the rule specifies either of the following treatment volumes:

(a) Off-line retention of the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater, or

(b) On-line retention of an additional one half inch of runoff from the drainage area over that volume specified for off-line treatment.

For direct discharges to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting the applicant should provide retention for either of the following:

(a) At least an additional fifty percent of the applicable treatment volume specified for off-line retention in (a), above. Off-line retention must be provided for at least the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater, of the total amount of runoff required to be treated; or

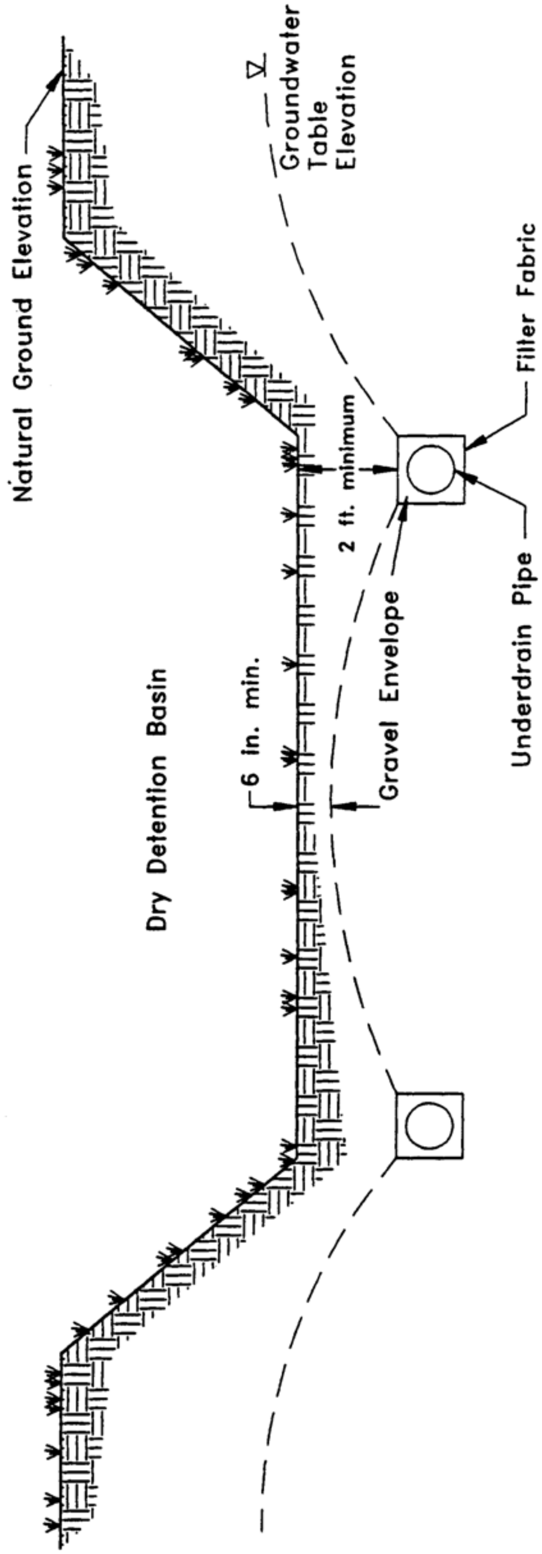


Figure 6.1-1   Cross-section of underdrain system (N.T.S.)

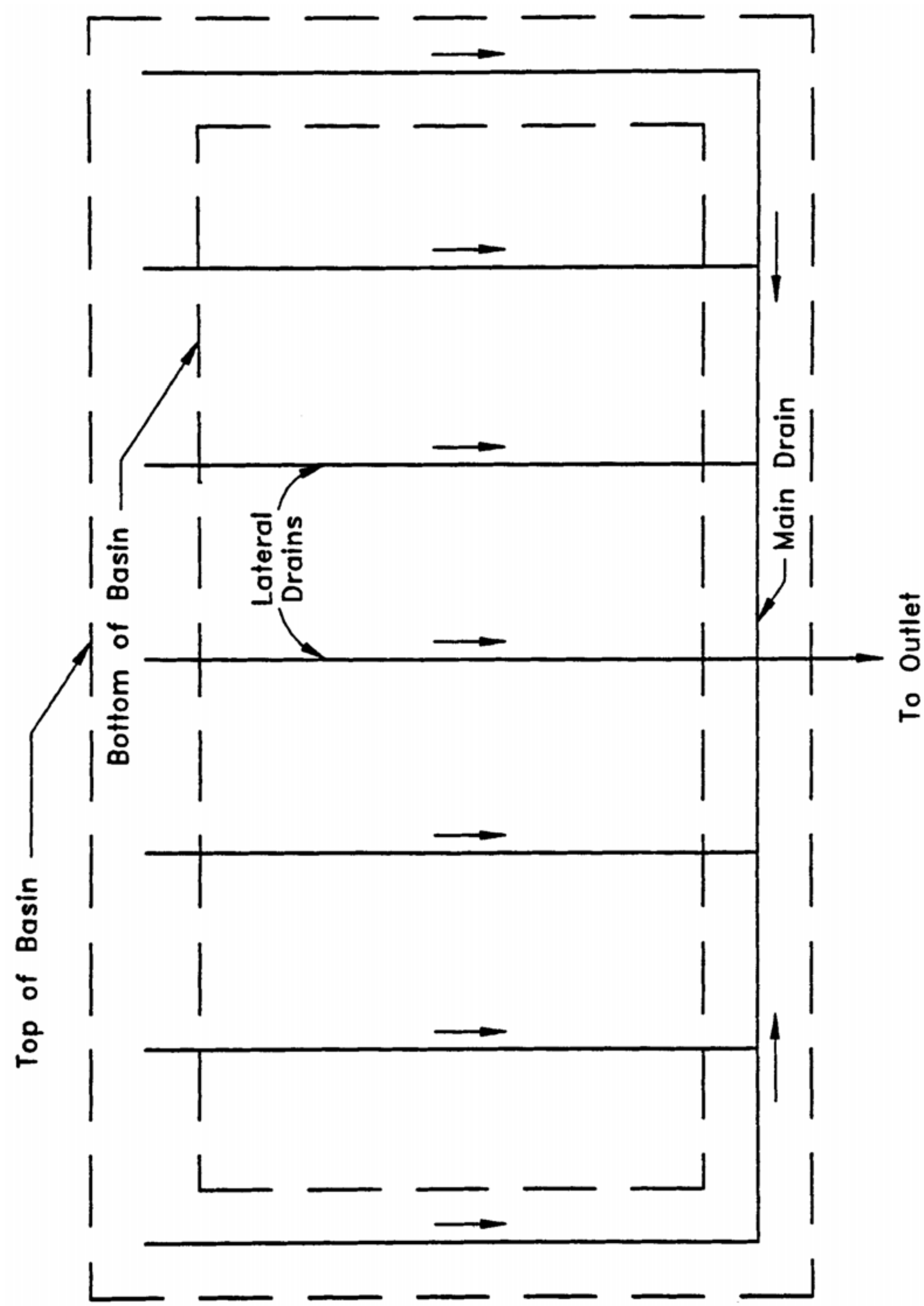


Figure 6.1-2 Top view of underdrain system (N.T.S.)

(b) On-line retention of the runoff from the three-year, one-hour storm or an additional fifty percent of the treatment volume specified in (b), above, whichever is greater.

6.3 Recovery Time

The system should be designed to provide for the drawdown of the appropriate treatment volume specified in **Section 6.2 of the Manual** within 72 hours following a storm event. The treatment volume is recovered by percolation through the soil with subsequent transport through the underdrain pipes. The system should only contain standing water within 72 hours of a storm event.

The pipe system configuration (e.g., pipe size, depth, pipe spacing, and pipe inflow capacity) of the underdrain system must be designed to achieve the recovery time requirement. Underdesign of the system will result in reduced hydraulic capacity. This, in turn, will result in a reduction in storage between subsequent rainfall events and an associated decrease in the annual average volume of stormwater treated resulting in a reduction of pollutant removal (Livingston et al. 1988). Such circumstances also reduce the aesthetic value of the system and may promote mosquito production.

6.4 Safety Factor

The underdrain system must be designed with a safety factor of at least two unless the applicant affirmatively demonstrates based on plans, test results, calculations or other information that a lower safety factor is appropriate for the specific site conditions. Examples of how to apply this factor include but are not limited to the following:

(a) Reducing the design percolation rate by half; and

(b) Designing for the required drawdown within 36 hours instead of 72 hours.

6.5 Underdrain Media

To provide proper treatment of the runoff, at least two feet of indigenous soil must be between the bottom of the basin storing the treatment volume and the outside of the underdrain pipes (or gravel envelope as applicable).

6.6 Filter Fabric

Underdrain systems should utilize filter fabric or other means to prevent the soil from moving into and clogging perforated pipe.

6.7 Inspection and Cleanout Ports

To facilitate maintenance of the underdrain system, capped and sealed inspection and cleanout ports which extend to the surface of the ground should be provided, at a minimum, at the following locations for each drainage pipe:

(a) The terminus; and

(b) At every 400 feet or every bend of 45 or more degrees, whichever is shorter.

6.8 Basin Stabilization

The underdrain basin should be stabilized with permanent vegetative cover and should contain standing water only immediately following a rainfall event.

6.9 References

Livingston, E.H., E. McCarron, J. Cox, P. Sanzone. 1988. *The Florida Land Development Manual: A Guide to Sound Land and Water Management*. Florida Department of Environmental Regulation, Nonpoint Source Management Section, Tallahassee, Florida.

7.0 Exfiltration Trench Design and Performance Criteria

7.1 Description

Exfiltration trench is a subsurface system consisting of a conduit such as perforated pipe surrounded by natural or artificial aggregate which temporarily stores and infiltrates stormwater runoff (**Figure 7.1-1**). Stormwater passes through the perforated pipe and infiltrates through the trench walls and bottom into the shallow groundwater aquifer. The perforated pipe increases the storage available in the trench and helps promote infiltration by making delivery of the runoff more effective and evenly distributed over the length of the system (Livingston et al. 1988). Generally, exfiltration trench systems are utilized where space is limited and/or land costs are high (i.e., downtown urban areas).

Soil permeability and water table conditions must be such that the trench system can percolate the required stormwater runoff treatment volume within a specified time following a storm event. The trench system is returned to a normally "dry" condition when drawdown of the treatment volume is completed. Like retention basins, the treatment volume in exfiltration trench systems is not discharged to surface waters. Thus, exfiltration is considered a type of retention system.

Like other types of retention systems, exfiltration trench systems provide excellent removal of stormwater pollutants. Substantial amounts of suspended solids, oxygen demanding materials, heavy metals, bacteria, some varieties of pesticides and nutrients such as phosphorus are removed as runoff percolates through the soil profile. Exfiltration trench systems should not be located in close proximity to drinking water supply wells. Chapter 62-22, F.A.C., requires stormwater treatment systems to be at least 100 feet from any public supply well. **Section 11 of Volume II of the Manual**, provides additional design features for systems constructed in Sensitive Karst Areas where the drinking water aquifer is close to the land surface.

Besides pollution control, exfiltration trench systems can be utilized to promote the recharge of ground water and to prevent saltwater intrusion in coastal areas, or to maintain groundwater levels in aquifer recharge areas. Exfiltration trench systems can also be used to meet the runoff volume criteria for projects which discharge to land-locked lakes (see **section 3.3(b) of the Manual).**

The operational life of an exfiltration trench is believed to be short (possibly 5 to 10 years) for most exfiltration systems. Sediment accumulation and clogging by fines can reduce the life of an exfiltration trench (Wanielista et al. 1991). Total replacement of the trench may be the only possible means of restoring the treatment capacity and recovery of the system. Periodic replacement of the trench should be considered routine operational maintenance when selecting this management practice.

There are several design and performance criteria which must be met in order for an exfiltration trench system to meet the rule requirements. A description of each criterion is presented below.

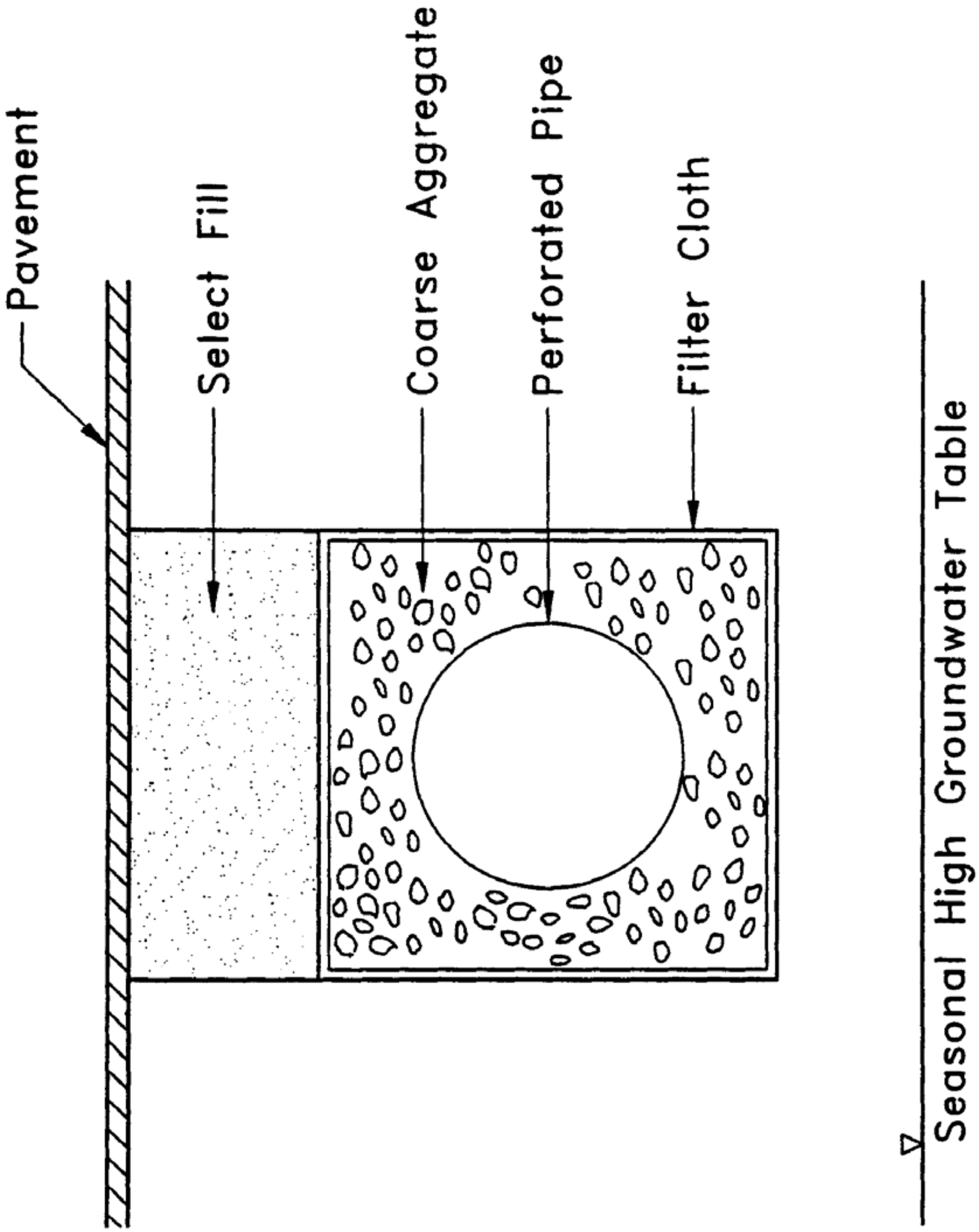


Figure 7.1-1 Cross-section of typical underground exfiltration trench (N.T.S.)

7.2 Treatment Volume

The first flush of runoff should be collected in the exfiltration trench and infiltrated into the surrounding soil. For systems which discharge to Class III receiving water bodies, the rule specifies either of the following:

(a) Off-line storage of the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater; or

(b) On-line storage of an additional one half inch of runoff from the drainage area over that volume specified for off-line treatment.

For direct discharges to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting the applicant should provide storage for either of the following:

(a) At least an additional fifty percent of the applicable treatment volume specified for off-line storage in (a), above. Off-line storage must be provided for at least the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater, of the total amount of runoff required to be treated; or

(b) On-line storage of the runoff from the three-year, one-hour storm or an additional fifty percent of the treatment volume specified in (b), above, whichever is greater.

Exfiltration trench systems must be designed to have the capacity to retain the required treatment volume without considering discharges to ground or surface waters.

7.3 Recovery Time

The system should be designed to provide for the appropriate treatment volume of stormwater runoff specified in **Section 7.2 of the Manual** within 72 hours following a storm event assuming average antecedent moisture conditions. The stormwater is drawn down by infiltration into the soil.

Antecedent moisture condition (AMC) refers to the amount of moisture and storage in the soil profile prior to a storm event. Antecedent soil moisture is an indicator of wetness and availability of soil to infiltrate water. The AMC can vary from dry to saturated depending on the amount of rainfall received prior to a given point in time. Therefore, “average AMC” means the soil is neither dry or saturated, but at average moisture condition at the beginning of a storm event when calculating recovery time for exfiltration systems.

The antecedent condition has a significant effect on runoff rate, runoff volume, infiltration rate, and infiltration volume. The infiltration volume is also known as the upper soil zone storage. Both the infiltration rate and upper soil zone storage are used to calculate the recovery time of retention systems and should be estimated using any generally accepted and well documented method with appropriate parameters to reflect drainage practices, seasonal high water table elevation, the AMC, and any underlying soil characteristics which would limit or prevent percolation of storm water into the soil column.

7.4 Safety Factor

The exfiltration trench system must be designed with a safety factor of at least two unless the applicant affirmatively demonstrates based on plans, test results, calculations or other information that a lower safety factor is appropriate for the specific site conditions. For example, two possible ways to apply this factor are:

(a) Reducing the design percolation rate by half; and

(b) Designing for the required drawdown within 36 hours instead of 72 hours.

7.5 Minimum Dimensions

The perforated pipe should be designed with a 12 inch minimum pipe diameter and a three 3 foot minimum trench width. The perforated pipe should be located within the trench section to minimize the accumulation of sediment in the aggregate void storage and maximize the preservation of this storage for stormwater treatment. To meet this goal, it is recommended that the perforated pipe be located at or within 6 inches of the trench bottom. The maximum trench width will be limited by the rate at which stormwater can effectively fill the void storage within the trench.

7.6 Filter Fabric

Exfiltration trench systems should be designed so that aggregate in the trench is enclosed in filter fabric. This serves to prevent migration of fine materials from the surrounding soil that could result in clogging of the trench. Wanielista et al. (1991) reports that woven fabric (Mirafi 700XG) performed better in mixed sand and silty soil than non-woven fabric (Mirafi 140N). On the other hand, the 140N had higher exfiltration rates in sandy soils than the woven fabric.

Filter fabric may also be utilized directly surrounding the perforated pipe. In this instance, sedimentation of particulates will occur in the perforated pipe. Consequently, the pipe is more prone to clogging and reductions in capacity will occur more often than usual. Livingston et al. (1988) points out that while this may seem unacceptable, the pipe may be cleaned relatively easy using high pressure hoses, vacuum systems, etc. On the other hand, designs without the fabric directly surrounding the perforated pipe requires complete replacement when clogging occurs.

7.7 Inspection and Cleanout Structures

Inspection and cleanout structures that extend to the surface of the ground should be provided, at a minimum, at the inlet and terminus of each exfiltration pipe. Inlet structures should include sediment sumps. These inspection and cleanout structures provide four primary functions:

(a) Observation of how quickly the trench recovers following a storm;

(b) Observation of how quickly the trench fills with sediment;

(c) Maintenance access to the perforated pipe; and

(d) Sediment control (sumps).

Standard precast concrete inlets and manholes are widely used to furnish the inspection and cleanout access.

7.8 Ground Water Table

The exfiltration trench system should be designed so that the invert elevation of the trench is at least two feet above the seasonal high ground water table elevation unless the applicant affirmatively demonstrates based on plans, test results, calculations or other information that an alternative design is appropriate for the specific site conditions.

7.9 Construction

During construction, every effort should be made to limit the parent soil and debris from entering the trench. Wanielista (1991) reports complete failure (no exfiltration) when a 1 inch to 2 inch thickness of parent soil and stormwater solids were added to an exfiltration trench. Applicants and system designers should consult chapters 3 and 6 of *The Florida Land Development Manual* (Livingston et al. 1988) for information on erosion and sediment control. Any method used to reduce the amount of fines entering the exfiltration trench during construction will extend the life of the system (Wanielista et al. 1991). The use of an aggregate with minimal fines is also recommended (Wanielista et al. 1991).

7.10 References

Branscome, J., and R.S. Tomasello. 1987. *Field Testing of Exfiltration Systems.* South Florida Water Management District Technical Publication 87-5. West Palm Beach, Florida.

Livingston, E.H., E. McCarron, J. Cox, and P. Sanzone. 1988. *The Florida Land Development Manual: A Guide to Sound Land and Water Management*. Florida Department of Environmental Regulation, Nonpoint Source Management Section, Tallahassee, Florida.

South Florida Water Management District. 1987. *Management and Storage of Surface Waters Permit Information Manual, Volume IV*. West Palm Beach, Florida.

Wanielista, M.P., M.J. Gauthier, and D.L. Evans. 1991. *Design and Performance of Exfiltration Systems*. Department of Civil and Environmental Engineering, University of Central Florida, Orlando, Florida.

8.0 Wet Detention Design and Performance Criteria

8.1 Description

To meet the objectives of this Handbook, the traditional flood attenuation pond was modified to maximize water quality treatment processes. These modified detention ponds are identified by the name "wet detention systems." These systems are permanently wet ponds which are designed to slowly release collected stormwater runoff through an outlet structure. A schematic of a typical wet detention system is shown in **Figure 8.1-1**.

Wet detention systems are the recommended BMP for sites with moderate to high water table conditions. The Department strongly encourages the use of wet detention treatment systems for the following two reasons. First, wet detention systems provide significant removal of both dissolved and suspended pollutants by taking advantage of physical, chemical, and biological processes within the pond (CDM 1985). Second, the complexity of BMPs such as underdrains are not encountered in a wet detention pond control structure. Wet detention systems offer an effective alternative for the long term control of water levels in the pond, provide a predictable recovery of storage volumes within the pond, and are easily maintained by the maintenance entity.

In addition to providing good removal of pollutants from runoff, wet detention systems also provide other benefits such as flood detention, passive recreation activities related adjacent to ponds, storage of runoff for irrigation, and pleasing aesthetics. As stormwater treatment systems, these ponds should not be designed to promote in-water recreation (i.e., swimming, fishing, and boating).

There are several components in a wet detention system which must be properly designed to achieve the level of stormwater treatment required bythe **Manual**. A description of each design feature and its importance to the treatment process is presented below. The design and performance criteria for wet detention systems are discussed below.

8.2 Treatment Volume

For wet detention systems, the design treatment volume is the greater of the following:

(a) One inch of runoff over the drainage area; or

(b) 2.5 inches times the impervious area (excluding water bodies).

Additional treatment volume may be required for systems that discharge directly to Class I, Class II, Outstanding Florida Waters, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting (see **Section 8.13 of the Manual**).

8.3 Recovery Time

The outfall structure should be designed to drawdown one-half the required treatment volume between 48 and 60 hours.

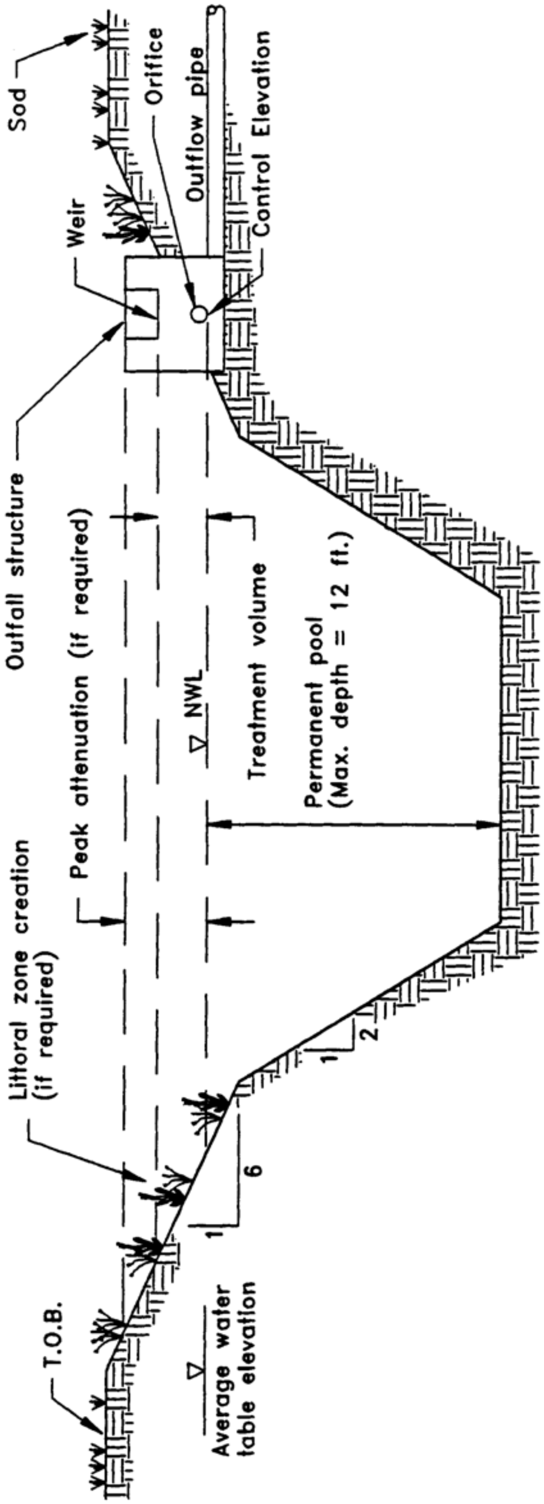


Figure 8.1-1 Wet detention (N.T.S.)

8.4 Outlet Structure

The outlet structure generally includes a drawdown device (such as an orifice, "V" or square notch weir) set to establish a normal water control elevation and slowly release the treatment volume (see **Figures 8.4-1 and 8.4-2** for schematics). The design of the outfall structure must also accommodate the passage of ground water baseflows and flows from upstream stormwater management systems (see **Figure 8.4-3**).

The control elevation should be set at or above the design tailwater elevation so the pond can effectively recover the treatment storage. Also, drawdown devices smaller than 3 inches minimum width or less than 20 degrees for "V" notches shall include a device to eliminate clogging. Examples of such devices include baffles, grates, screens, and pipe elbows.

8.5 Permanent Pool

A significant component and design criterion for the wet detention system is the storage capacity of the permanent pool (i.e., section of the pond which holds water at all times). The permanent pool should be sized to provide at least a 14-day residence time based upon annual rainfall.

Important pollutant removal processes which occur within the permanent pool include: uptake of nutrients by algae, adsorption of nutrients and heavy metals onto bottom sediments, biological oxidation of organic materials, and sedimentation (CDM 1985). Uptake by algae is probably the most important process for the removal of nutrients. Sedimentation and adsorption onto bottom sediments is likely the primary means of removing heavy metals (CDM 1985).

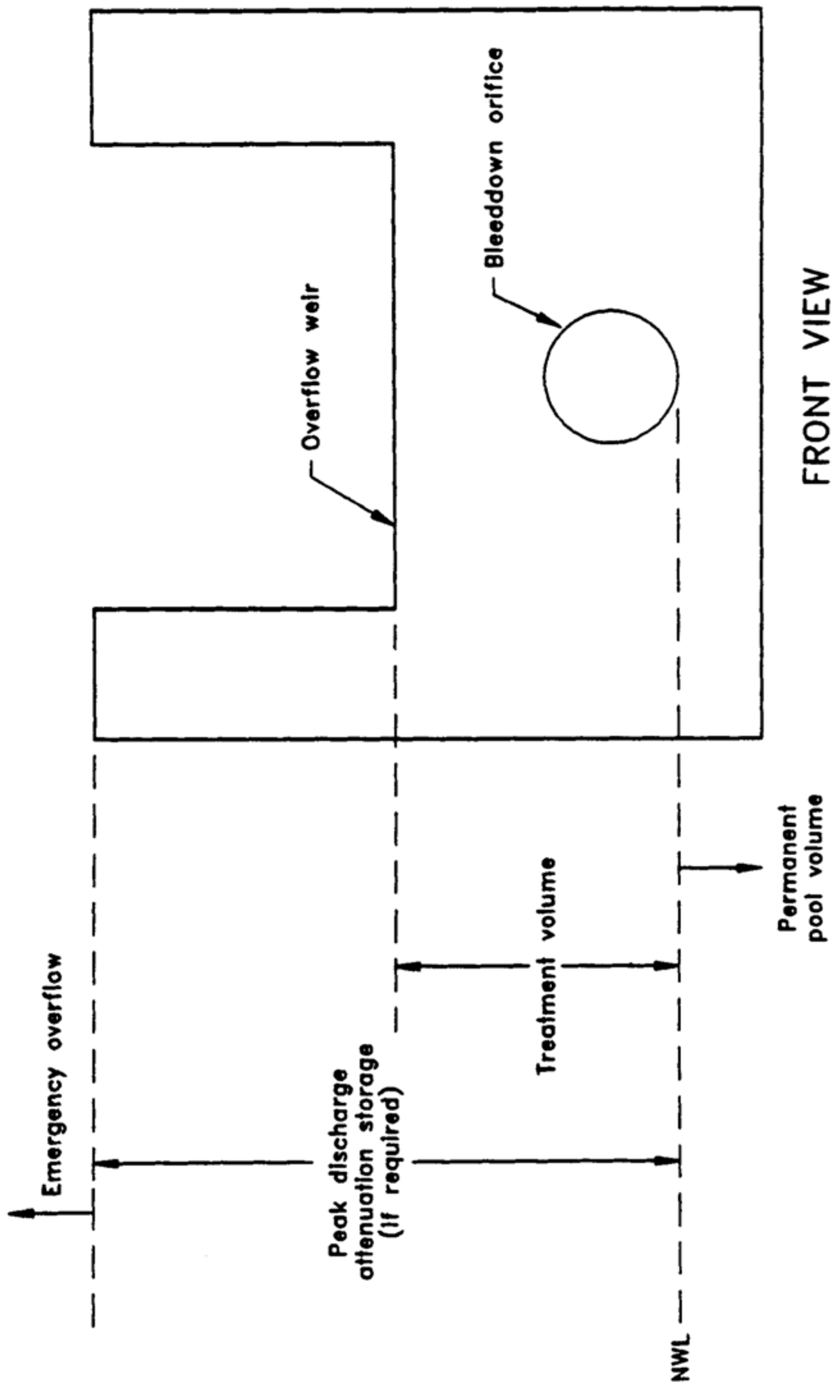
The storage capacity of the permanent pool must be large enough to detain the untreated runoff long enough for the treatment processes described above to take place. Since one of the major biological mechanisms for pollutant removal in a wet detention basin is phytoplankton growth, the average hydraulic residence time of the pond must be long enough to ensure adequate algal growth (CDM 1985). A residence time of 2 weeks is considered to be the minimum duration that ensures adequate opportunity for algal growth (CDM 1985).

Additional permanent pool volume may be required for wet detention systems which directly discharge to Class I, Class II, or Outstanding Florida Waters (see **Section 8.13 of the Manual**)

8.6 Littoral Zone

The littoral zone is that portion of a wet detention pond which is designed to contain rooted aquatic plants. The littoral area is usually provided by extending and gently sloping the sides of the pond down to a depth of 2 to 3 feet below the normal water level or control elevation. Also, the littoral

Figure 8.4-1 Typical wet detention outfall structure (N.T.S.)



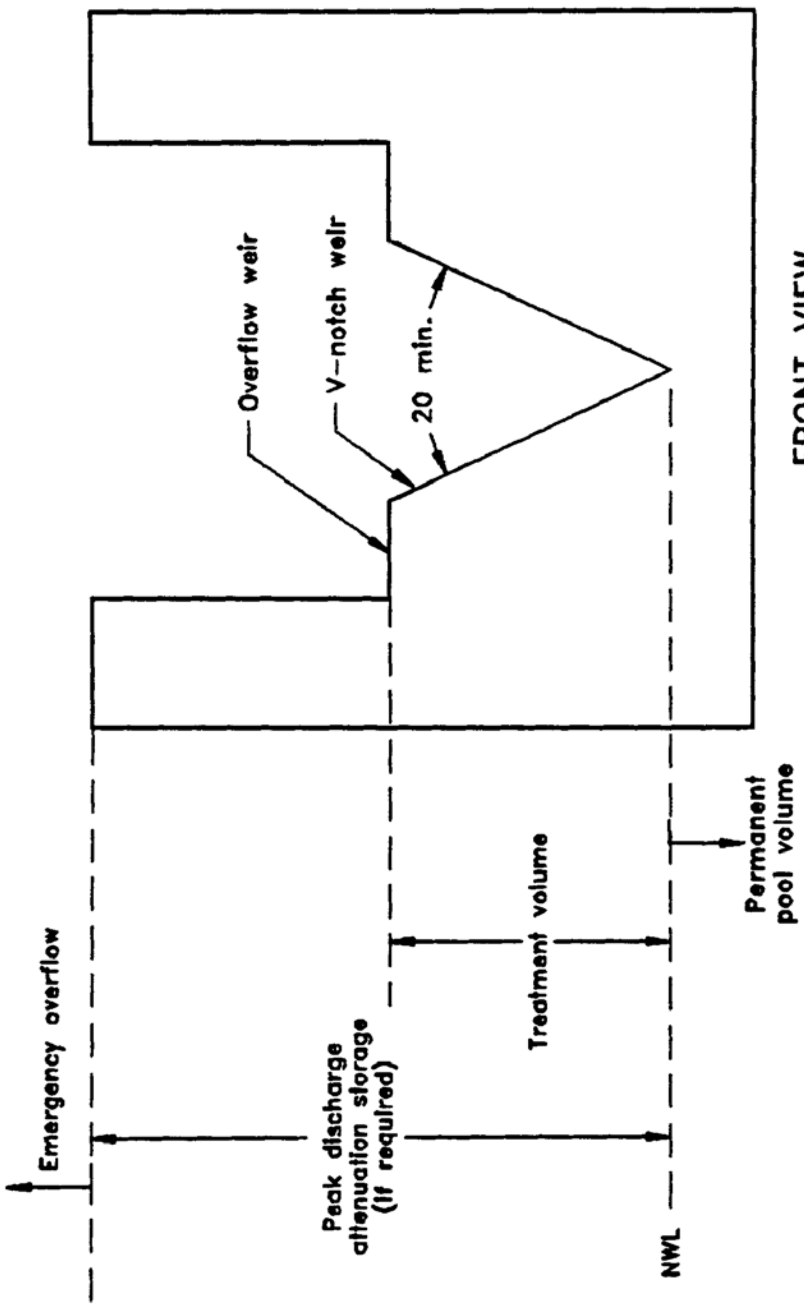


Figure 8.4-2 Typical wet detention outfall structure with "V"-notch weir (N.T.S.)

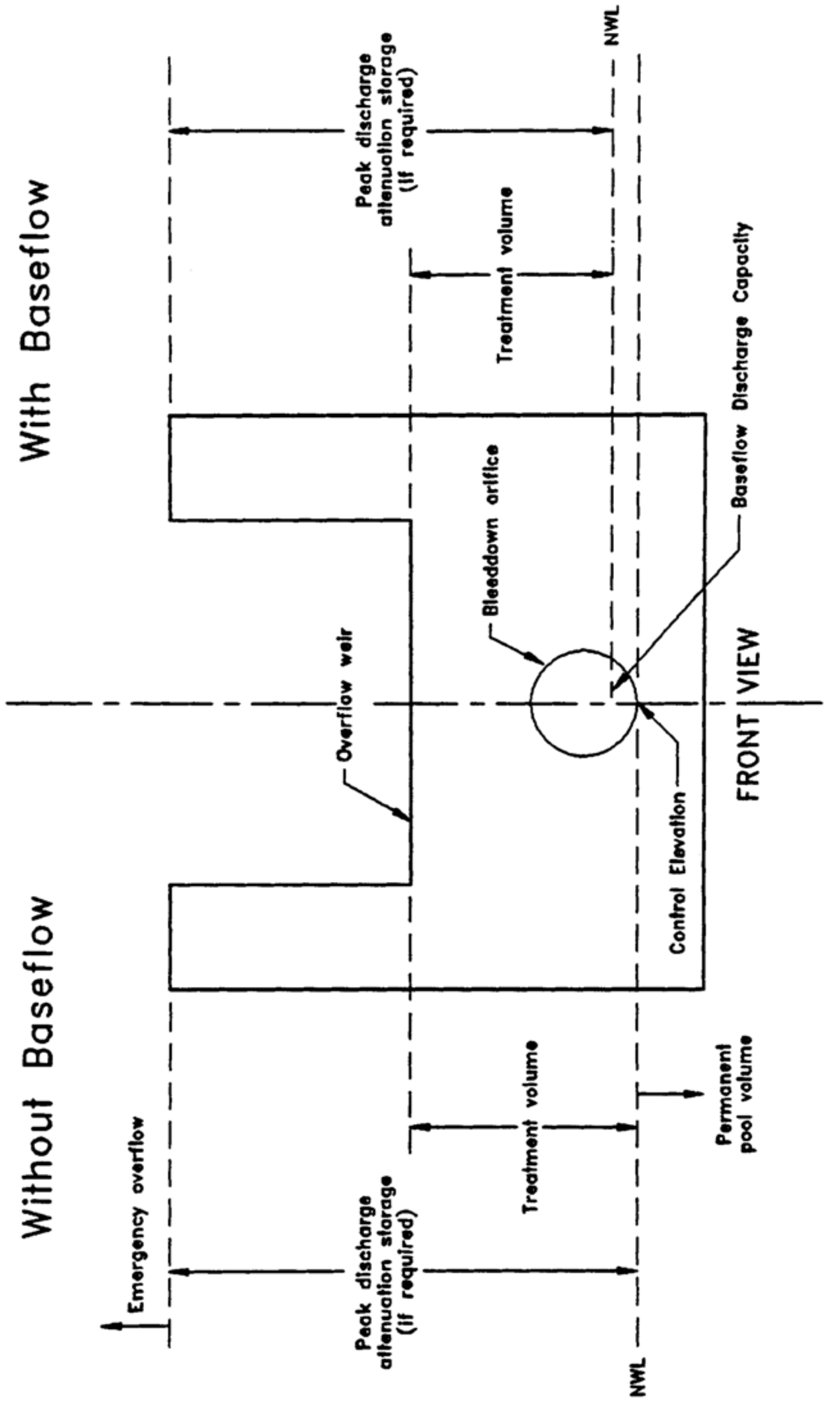


Figure 8.4-3 Typical wet detention outfall structure with and without baseflow conditions (N.T.S.)

zone can be provided in other areas of the pond that have suitable depths (i.e., a shallow shelf in the middle of the lake).

The littoral zone is established with native aquatic plants by planting and/or the placement of wetland soils containing seeds of native aquatic plants. A specific vegetation establishment plan must be prepared for the littoral zone. The plan must consider the hydroperiod of the pond and the type of plants to be established. Livingston et al. (1988) has published a list of recommended native plant species suitable for littoral zone planting. In addition, a layer of muck can be incorporated into the littoral area to promote the establishment of the wetland vegetation. When placing muck, special precautions must be taken to prevent erosion and turbidity problems in the pond and at its discharge point while vegetation is becoming established in the littoral zone.

The following is a list of the design criteria for wet detention littoral zones:

(a) The littoral zone shall be gently sloped (6:1 Horizontal:Vertical or flatter). At least 30 percent of the wet detention pond surface area shall consist of a littoral zone. The percentage of littoral zone is based on the ratio of vegetated littoral zone to surface area of the pond at the control elevation.

(b) The treatment volume should not cause the pond level to rise more than 18 inches above the control elevation unless the applicant affirmatively demonstrates that the littoral zone vegetation can survive at greater depths.

(c) Within 24 months of completion of the system, 80 percent coverage of the littoral zone by suitable aquatic plants is required.

(d) Planting of the littoral zone is recommended to meet the 80% coverage requirement. As an alternative to planting, portions of the littoral zone may be established by placement of wetland top soils (at least a four inch depth) containing a seed source of desirable native plants. When utilizing this alternative, the littoral zone must be stabilized by mulching or other means and at least the portion of the littoral zone within 25 feet of the inlet and outlet structures must be planted.

8.7 Littoral Zone Alternatives

As an option to establishing and maintaining vegetative littoral zones as described in **Section 8.6 of the Manual,** the applicant can provide either:

(a) An additional 50% of the appropriate permanent pool volume as required in **Sections 8.5 or 8.13 of the Manual**, or

(b) Pre-treatment of the stormwater prior to the stormwater entering the wet detention pond. The level of pre-treatment must be at least that required for retention, underdrain, exfiltration, or swale systems. See **Section 8.11 of the Manual** for additional information on pre-treatment.

Providing a larger permanent pool or pre-treatment will compensate for the pollutant removal benefits associated with a well vegetated littoral zone. However, even under the above alternatives, shallow portions of the wet detention pond may be colonized with nuisance species such as cattails that will need to be controlled. This should be considered routine operational maintenance.

8.8 Pond Depth

The rule requires a maximum pond depth of 12 feet and a mean depth (pond volume divided by the pond area at the control elevation) between 2 and 8 feet. Many of the nutrients and metals removed from the water column accumulate in the top few inches of the pond bottom sediments (Yousef et al. 1990). If a pond is deep enough, it will have a tendency to stratify, creating the potential for anaerobic conditions developing at the bottom of the pond (CDM 1985). An aerobic environment should be maintained throughout the water column in wet detention ponds in order to minimize the release of nutrients and metals from the bottom sediments (Yousef et al. 1990). The maximum depth criteria minimizes the potential for significant thermal stratification which will help maintain aerobic conditions in the water column that should maximize sediment uptake and minimize sediment release of pollutants.

On the other hand, the minimum mean depth criteria minimizes aquatic plant growth which may be excessive if the pond is too shallow.

The Department will consider pond depths in excess of 12 feet providing the applicant can provide reasonable assurance that the proposed pond depth will not cause adverse water quality conditions due to anaerobic bottom conditions.

8.9 Pond Configuration

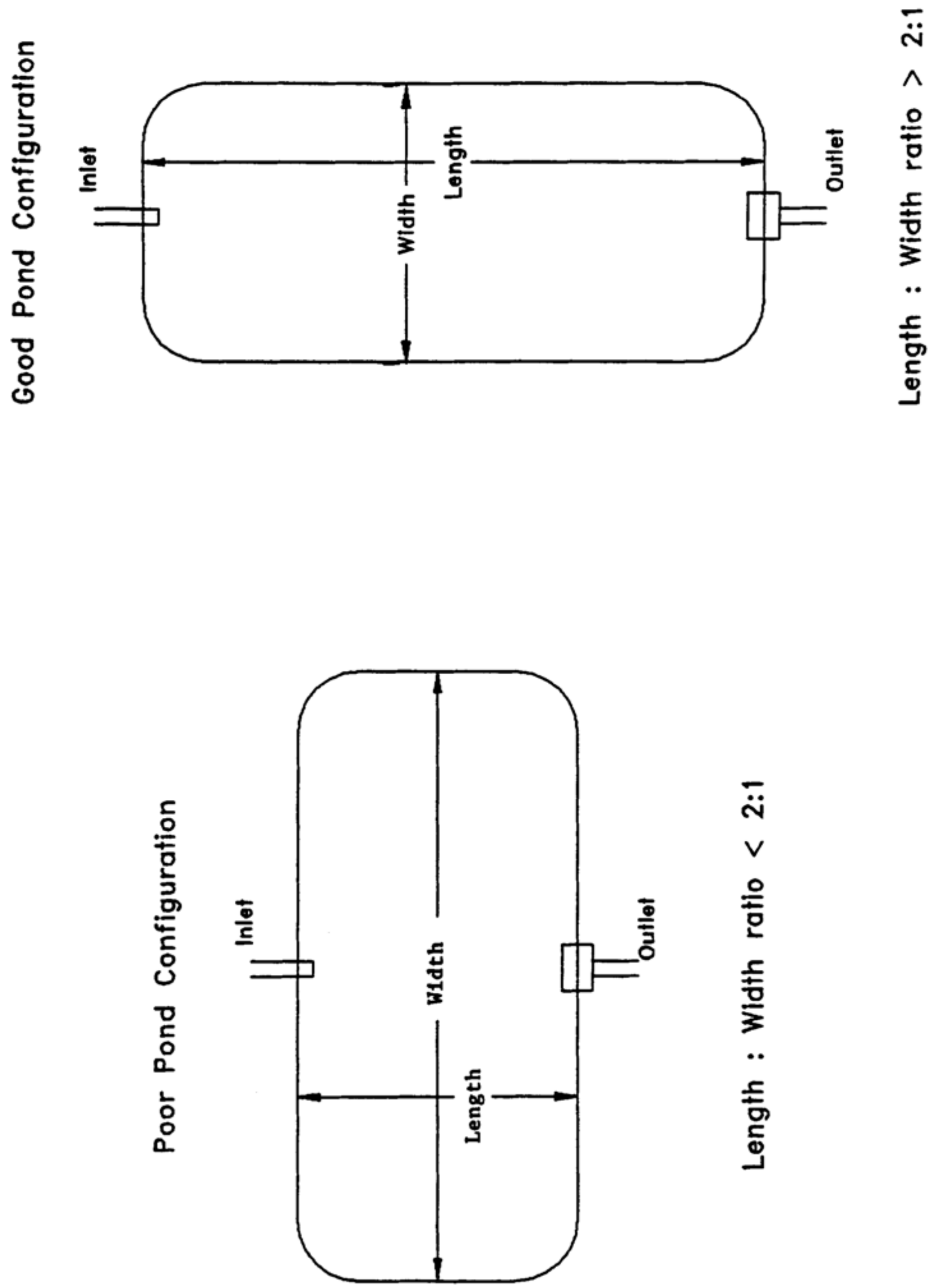
The average length to width ratio of the pond must be at least 2:1. Yousef et al. (1990) reports that it is important to maximize the flow path of water from the inlets to the outlet of the pond to promote good mixing (i.e., no dead spots). Under these design conditions, short circuiting is minimized and pollutant removal efficiency and mixing is maximized.

If short flow paths are unavoidable, the effective flow path can be increased by adding diversion barriers such as islands, peninsulas, or baffles to the pond. Inlet structures should be designed to dissipate the energy of water entering the pond. Examples of good and poor pond configurations are given in **Figure 8.9-1**.

The Department will consider pond configurations with the average length to width ratio less than 2:1 if the applicant can demonstrate reasonable assurance that the alternate design of the pond minimizes short circuiting.

8.10 Ground Water Table

To minimize ground water contributions which may lower treatment efficiencies, the control elevation should be set at or above the normal on-site ground water table elevation (Yousef et al. 1990). This elevation may be determined by calculating the average of the seasonal high and seasonal low ground water table elevations.



Ground water inflow (baseflow) must be considered when the control elevation is set below the normal ground water table elevation or the project utilizes underdrains (i.e., road underdrains) to control ground water conditions on-site. The design of the outfall structure must provide for the discharge of baseflow at the design normal water level in the pond. Baseflow rates must be included in the drawdown calculations for the outfall structure. Baseflow should also be considered

Figure 8.9-1 Examples of good and poor wet detention pond configurations (N.T.S.)

in the permanent pool residence time design. Establishment of the normal water level in the pond will also be influenced by baseflow conditions (see **Figure 8.4-3**).

8.11 Pre-treatment

"Pre-treatment" is defined as the treatment of a portion of the runoff prior to its entering the wet detention pond. Pre-treatment increases the pollutant removal efficiency of the overall stormwater system by reducing the pollutant loading to the wet detention pond. Pre-treatment may be used to enhance the appearance of the wet detention pond or meet the additional treatment criteria for discharges to receiving water which are classified as Class I, Class II, Outstanding Florida Waters (OFWs), or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting.

For developments where the appearance of the lake is important, pre-treatment can reduce the chances of algal blooms and slow the eutrophication process. Some types of pre-treatment practices include utilizing vegetative swales for conveyance instead of curb and gutter, perimeter swales or berms around the lake, oil and grease skimmers on inlet structures, retention storage in swales with raised inlets, or shallow landscaped retention areas (when soils and water table conditions will allow for adequate percolation).

For systems in which pre-treatment is utilized to meet the additional design criteria requirements for systems which direct discharge to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, pre-treatment practices must meet the appropriate design and performance criteria for that BMP. Acceptable types of pre-treatment include the following:

(a) Retention systems which meet the design and performance criteria in **Section 5 of the Manual**;

(b) Underdrain systems which meet the design and performance criteria in **section 6 of the Manual**;

(c) Exfiltration trench (see **section 7 of the Manual**); or

(d) Swales systems which meet the design and performance criteria in **section 8 of the Manual**.

Alternative pre-treatment methods will be evaluated on a case-by-case basis by the Department. Applicants or system designers are encouraged to meet with Department staff in a pre-application conference if alternative methods are proposed.

8.12 Pond Side Slopes

The pond must be designed so that the average pond side slope measured between the control elevation and two feet below the control elevation is no steeper than 3:1 (horizontal:vertical). Because the pond sediments are an important component in the wet detention treatment processes, this criterion will ensure sufficient pond bottom/side slope area for the appropriate processes to occur.

8.13 Direct Discharges to Class I, Class II, OFWs, or Shellfishing Waters

Wet detention systems which discharge to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, must provide either:

(a) An additional fifty percent of both the required treatment and permanent pool volumes

(b) Pre-treatment of the stormwater prior to the stormwater entering the wet detention pond. The level of pre-treatment must be at least that required for retention, underdrain, exfiltration, or swale systems (see **Section 8.11 of the Manual**).

8.14 References

Camp Dresser & McKee Inc (CDM). 1985. *An Assessment of Stormwater Management Programs.* Prepared for Florida Department of Environmental Regulation, Tallahassee, Florida.

Livingston, E.H., E. McCarron, J. Cox, P. Sanzone. 1988. *The Florida Land Development Manual: A Guide to Sound Land and Water Management*. Florida Department of Environmental Regulation, Nonpoint Source Management Section, Tallahassee, Florida.

Yousef, Y.A., M.P. Wanielista, L.Y. Lin, and M. Brabham. 1990. *Efficiency Optimization of Wet Detention Ponds for Urban Stormwater Management (Phase I and II).* University of Central Florida, Orlando, Florida.

9.0 Design Criteria and Guidelines for Swale Systems

9.1 Description

Swales are a man-made or natural system shaped or graded to required dimensions and designed for the conveyance and rapid infiltration of stormwater runoff. Swales are designed to infiltrate a defined quantity of runoff through the permeable soils of the swale floor and side slopes into the shallow ground water aquifer (**Figure 9.1-1**). Turf is established to promote infiltration and stabilize the side slopes. Soil permeability and water table conditions must be such that the swale can percolate the desired runoff volume from the 3-year, 1-hour storm event. The swale holds water only during and immediately after a storm event, thus the system is normally “dry.” Unlike retention basins, swales are “open” conveyance systems. This means there are no physical barriers such as berms or check-dams to impound the runoff in the swale prior to discharge to the receiving water.

Swales provide excellent removal of stormwater pollutants. Substantial amounts of suspended solids, oxygen demanding materials, heavy metals, bacteria, some varieties of pesticides and nutrients such as phosphorus are removed as runoff percolates through the vegetation and soil profile. Swale systems should not be located in close proximity to drinking water supply wells. As required by chapter 62-22, F.A.C., stormwater treatment facilities must be at least 100 feet from any public supply well. Additional design criteria are established for swale systems constructed in Karst Sensitive Areas where the drinking water aquifer is close to the land surface (see **section 11 of the Manual**).

Besides pollution control, swale systems can be utilized to promote the recharge of groundwater to prevent saltwater intrusion in coastal areas, and to maintain ground water levels in aquifer recharge areas. Swales can be incorporated into the design of a stormwater management system to meet the runoff volume criteria for projects which discharge to land-locked lakes (see **section 3.3(b) of the Manual**).

Swales can also be utilized to provide pre-treatment of runoff prior to its release to another treatment BMP such as wet detention (see **Section 8.11 of the Manual**) or wetlands stormwater management systems (see **Section 10.4**). Pre-treatment reduces the pollutant loading to the downstream treatment system, increases the pollutant efficiency of the overall stormwater management system, and reduces maintenance. In some cases, pre-treatment may be used to meet the additional treatment criteria for discharges to sensitive receiving waters (Class I, Class II, and OFWs). For developments where the appearance of the downstream system (i.e., wet detention lake) is important, pre-treatment can reduce the probability of algal blooms occurring and slows the eutrophication process.

The design and performance criteria specific to swale systems are described below.

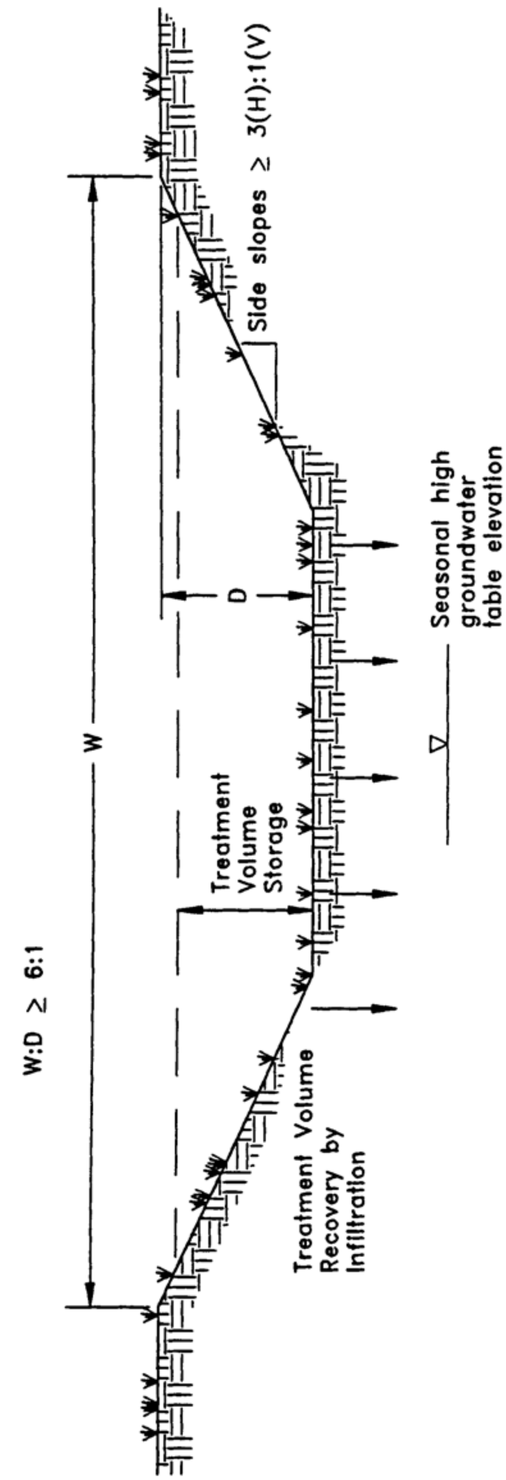


Figure 9.1-1 Cross-section of swale system (N.T.S.)

9.2 Treatment Volume

The runoff from the site should be routed to the swale system for conveyance and percolation into the ground. For systems which discharge to Class III receiving water bodies, the swales should be designed to percolate 80% of the runoff from the 3-year, 1-hour storm. The remaining 20% of the runoff from the 3-year, 1-hour storm event may be discharged offsite by the swale system.

Swale systems which directly discharge to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, should be designed to percolate all of the runoff from the 3-year, 1-hour storm.

9.3 Recovery Time

Swale systems must provide the capacity for the specified treatment volume of stormwater and contain no contiguous areas of standing or flowing water within 72 hours following the storm event referenced in **section 9.2 of the Manual** assuming average antecedent moisture conditions. The treatment volume must be provided by percolation through the soil, evaporation, or evapotranspiration.

Antecedent moisture condition (AMC) refers to the amount of moisture and storage in the soil profile prior to a storm event. Antecedent soil moisture is an indicator of wetness and availability of soil to infiltrate water. The AMC can vary from dry to saturated depending on the amount of rainfall received prior to a given point in time. Therefore, “average AMC” means the soil is neither dry or saturated, but at an average moisture condition at the beginning of a storm event when calculating recovery time for swale systems.

The antecedent condition has a significant effect on runoff rate, runoff volume, infiltration rate, and infiltration volume. The infiltration volume is also known as the upper soil zone storage. Both the infiltration rate and upper soil zone storage are used to calculate the recovery time of retention systems and should be estimated using any generally accepted and well documented method with appropriate parameters to reflect drainage practices, seasonal high water table elevation, the AMC, and any underlying soil characteristics which would limit or prevent percolation of storm water into the soil column.

9.4 Dimensional Requirements

Swales must have a top width to depth ratio of the cross-section equal to or greater than 6:1 or side slopes equal to or greater than 3:1 (horizontal to vertical).

9.5 Stabilization

Swales should be stabilized with vegetative cover suitable for soil stabilization, stormwater treatment, and nutrient uptake. Also, the swale should be designed to take into account the soil erodibility, soil percolation, slope, slope length, and drainage area so as to prevent erosion and reduce pollutant concentrations.

10.0 Design Criteria and Guidelines for Wetlands Stormwater Management Systems

10.1 Description

Wetlands are an essential part of nature's stormwater management system. Important wetland functions include the conveyance and storage of stormwater. These function to dampen flooding impacts; reduce flood flows and velocity of stormwater which in turn reduces erosion, increases sedimentation, and helps the assimilation of pollutants typically carried in stormwater. Accordingly, there is interest in the incorporation of natural wetlands into stormwater management systems, especially wetlands which have been previously drained. This concept provides an opportunity to use wetlands to meet the requirements of the stormwater rule. In addition, by using wetlands for stormwater management, drained wetlands can be revitalized and landowners and developers have greater incentive to preserve or restore wetlands (Livingston 1989).

For wetlands stormwater management systems the District must attempt to ensure that a proposed wetlands stormwater management system is compatible with the existing ecological characteristics of the wetlands proposed to be utilized for stormwater treatment. The District must also ensure that water quality standards will not be violated by discharges from wetlands stormwater management system. To achieve these goals, specific performance criteria are set forth in the stormwater rule and are described below for systems which incorporate wetlands for stormwater treatment.

10.2 Types of Wetlands that may be Utilized for Stormwater Treatment

The only wetlands which may be considered for use to provide stormwater treatment are those which:

(a) Are isolated wetlands; and

(b) Would be isolated wetlands, but for a hydrologic connection to other wetlands or surface waters via another watercourse that was excavated through uplands.

10.3 Treatment Volume

The system should be part of a comprehensive stormwater management system that utilizes wetlands in combination with other best management practices to provide treatment of the runoff from the project. For systems discharging to Class III waters, the rule specifies treatment of the runoff from the greater of the following:

(a) First one inch of runoff, or

(b) 2.5 inches times the impervious area.

Those systems which directly discharge to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, shall provide an additional fifty percent of the applicable treatment volume specified above.

If the wetland alone cannot provide the treatment volume, then other best management practices should be incorporated upstream and outside of the wetland to store the proper level of runoff. Utilization of other BMPs must not adversely affect the ability of the wetlands stormwater management system from meeting the requirements of this section.

10.4 Recovery Time

The system should be designed to bleed down one-half the applicable treatment volume specified above between 60 and 72 hours following a storm event.

10.5 Inlet Structures

Inlet structures should be designed to dissipate the energy of runoff entering the wetland and minimize the channelized flow of stormwater. Methods include, but are not limited to, sprinklers, pipe energy dissipators, overland flow or spreader swales.

10.6 Wetland Function

Pre-treatment can reduce the impact of untreated stormwater upon the wetland. In addition, pre-treatment can be utilized to attenuate stormwater volumes and peak discharge rates so that the wetland's hydroperiod is not adversely altered (Livingston 1989). Swale conveyances and lakes adjacent to the wetland are typical pre-treatment practices.

10.7 Residence Time

The design features of the system should maximize residence time of the stormwater within the wetland to enhance the opportunity for the stormwater to come into contact with the wetland sediment, vegetation, and micro-organisms (Livingston 1989). This can be accomplished by several means. The inlets and outlets should be located to maximize the flow path through the wetland. Energy dissipators and spreader swales can promote overland flow and reduce the possibility of channelized flow occurring. In some instances, berms in wetlands can act as baffles to increase the flow path of surface flow through the wetland.

10.8 Monitoring

In order to establish a reliable, scientifically valid data base upon which to evaluate the performance criteria and the performance of the wetlands stormwater management system, a monitoring program may be required. Monitoring programs shall provide the Department with comparable data for different types of wetlands and drainage designs. Data to be collected may include but not be limited to:

(a) Sedimentation rate;

(b) Sediment trace metal concentrations;

(c) Sediment nitrogen and phosphorus concentrations;

(d) Changes in the frequency, abundance and distribution of vegetation; and

(e) Inflow and outflow water quality for nutrients, metals, turbidity, oils and greases, bacteria and other parameters related to the specific site conditions.

Inflow and outflow water quality parameters will be monitored on such storm event occurrences as established by the District based on a site specific basis. The District shall eliminate the requirement to continue the monitoring program upon its determination that no further data is necessary to evaluate the performance criteria or ensure compliance with the performance criteria and applicable water quality standards.

10.9 Dredge and Fill

Dredge or fill in wetlands or other surface waters to construct or alter a stormwater treatment system is an allowable impact providing the impact meets the criteria in Section VII of the EMA.

11.0 Karst Sensitive Area Criteria

Section 2.2 of the **Manual** provides that a condition for issuance of a permit includes compliance with any applicable special basin or geographic area criteria rules. The only areas within the geographical extent of the Northwest Florida Water Management District (NWFWMD) for which additional geographic area criteria have been developed are two Sensitive Karst Areas (SKAs). These areas cover seven counties the central and eastern regions of the geographical extent of the NWFWMD **(**See **Figure 11.0-1).** These areas were identified using the same methodology, and the design criteria for both of these SKAs are the same.

11.1 Background of the Sensitive Karst Area Design Criteria

The following additional surface water management criteria are used in reviewing applications for permits in the SKAs.

The Floridan aquifer system is the drinking water source for most of the population in the geographical extent of the NWFWMD. In parts of **some** of the counties within the NWFWMD, the limestones that make up or comprise this aquifer system are at or very near the land surface. Potential contamination of the Floridan aquifer from surface pollutant sources in these areas is greater than within the rest of the geographical extent of the NWFWMD due to the hydrogeology and geology of these "sensitive karst areas." "Karst" is a geologic term used to describe areas where sinkhole formation is common and landscapes are formed by the dissolution of limestone/dolomite.

11.2 Hydrogeology of the Sensitive Karst Areas

Throughout the majority of the geographical extent of the NWFWMD the highly porous limestone that comprises the Floridan aquifer system is generally overlain by tens to hundreds of feet of sands, clays, and other material. Where present, this material may act as a buffer, protecting the Floridan aquifer from surface pollutants. Surface water seeps through this material slowly, which allows for filtration, adsorption, and biological neutralization of contaminants.

However, in SKAs, the limestone that comprises the Floridan aquifer system exists at, or near the land surface (**Figure 11.2-1**), and sand overburden, confining clays, or other confining cover material is discontinuous or absent. As a result, there is rapid movement of surface water into the aquifer. The SKAs are areas of high recharge to the Floridan aquifer system. According to the Florida Geological Survey, the Floridan aquifer ground water levels vary from land surface to approximately 60 feet below land surface in the SKAs.

One factor which makes the SKAs particularly prone to stormwater contamination is the formation of solution pipe sinkholes. Solution pipe sinkholes are common in these areas and form due to the collapse of surficial material into vertical cavities that have been dissolved in the upper portion of the limestone (**Figure 11.2-2**). They are also formed by the movement of surface material into the underlying porous limestone of the SKAs. In most cases, the solution pipes are capped by a natural plug of sands and clays (**Figures 11.2-1 and 11.2-2**). If the cap is washed out, the resulting solution pipe sinkhole (**Figure 11-2-3**) can act as a direct avenue for the movement of inadequately treated stormwater into the Floridan aquifer.

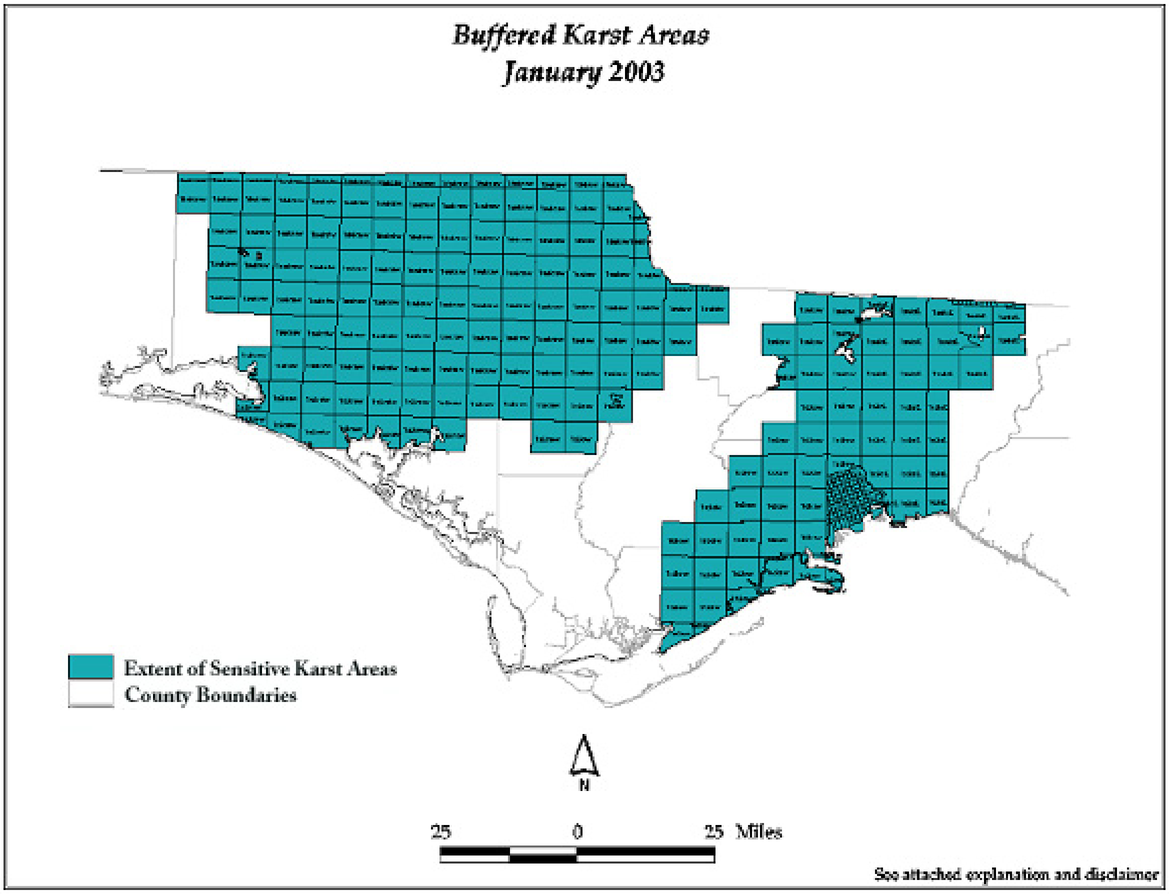


Figure 11.0-1. Karst areas in the Northwest ERP

DISCLAIMER
This geologic data was developed by the Florida Department of Environmental Protection (FDEP) - Florida Geological Survey (FGS) to carry out agency responsibilities related to management, protection, and development of Florida's natural resources. Although efforts have been made to make the information accurate and useful, the FDEP/FGS assumes no responsibility for errors in the information and does not guarantee that the data are free from errors or inaccuracies. Similarly FDEP/FGS assumes no responsibility for the consequences of inappropriate uses or interpretations of the data. As such, these data are distributed on "as is" basis and the user assumes all risk as to their quality, the results obtained from their use, and the performance of the data. FDEP/FGS bears no responsibility to inform users of any changes made to this data. Anyone using this data is advised that precision implied by the data may far exceed actual precision. Comments on this data are invited and FDEP/FGS would appreciate that documented errors be brought to staff attention. The development of these data sets represents a major investment of staff time and effort. As a professional responsibility, we expect that the FDEP/FGS will receive proper credit when you utilize these data sets. Further, since part of this data was developed and collected with U.S. Government or State of Florida funding, no proprietary rights may be attached to it in whole or in part, nor may it be sold to the U.S. Government or the Florida State Government as part of any procurement of products or services.

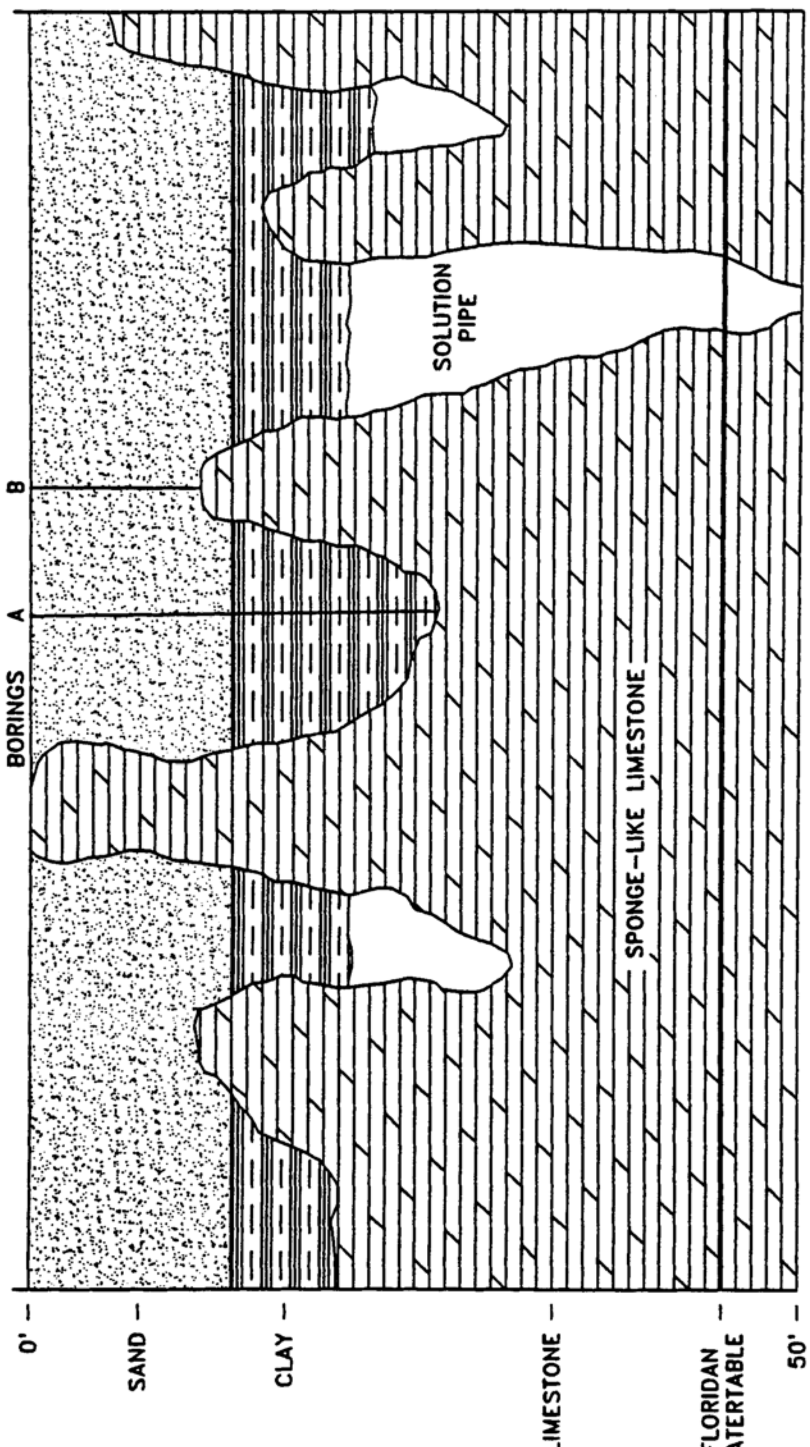


Figure 11.2-1 Generalized geologic section in karst sensitive area

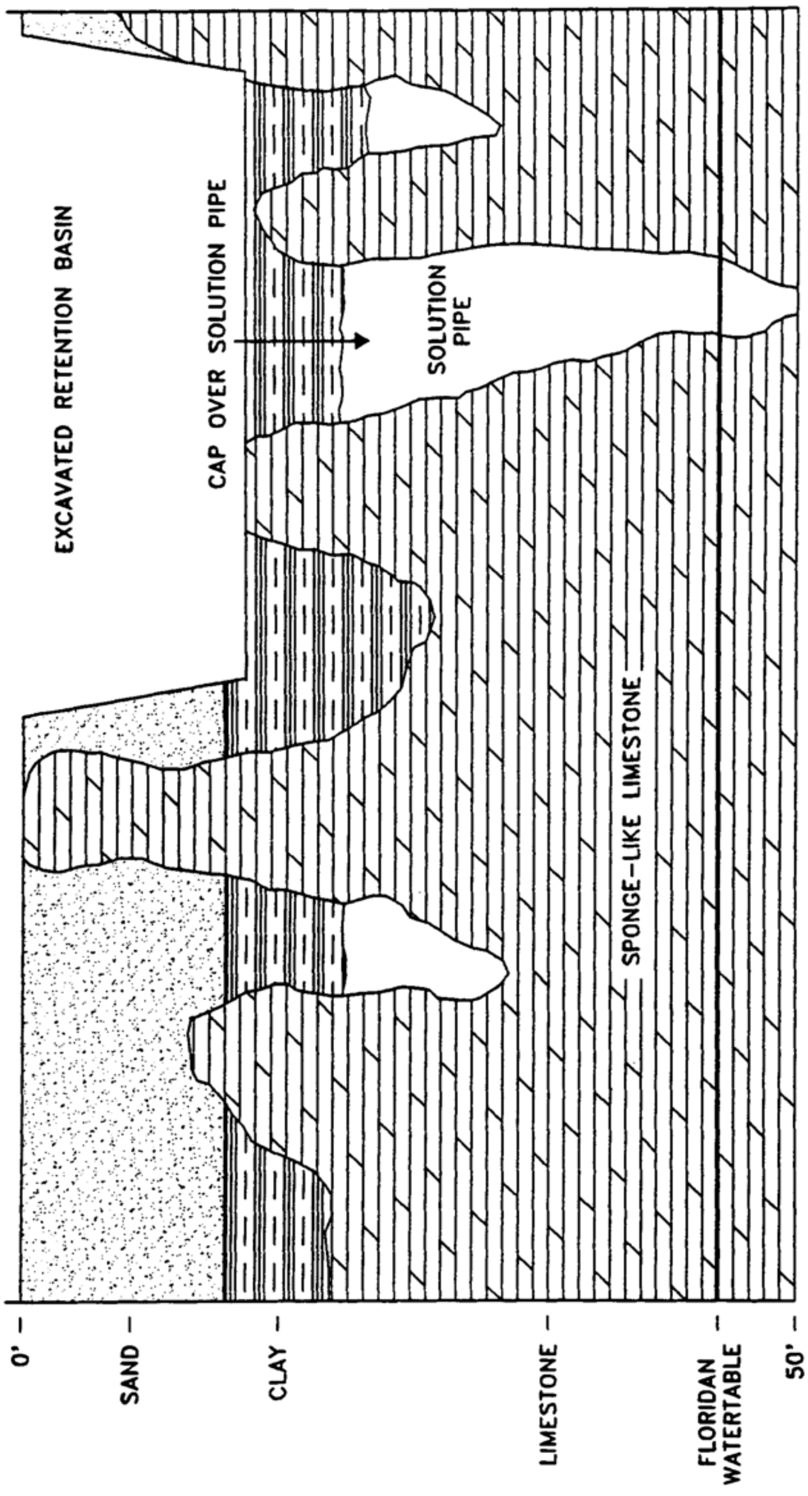


Figure 11.2-2 Generalized geologic section in karst sensitive area with excavated retention basin

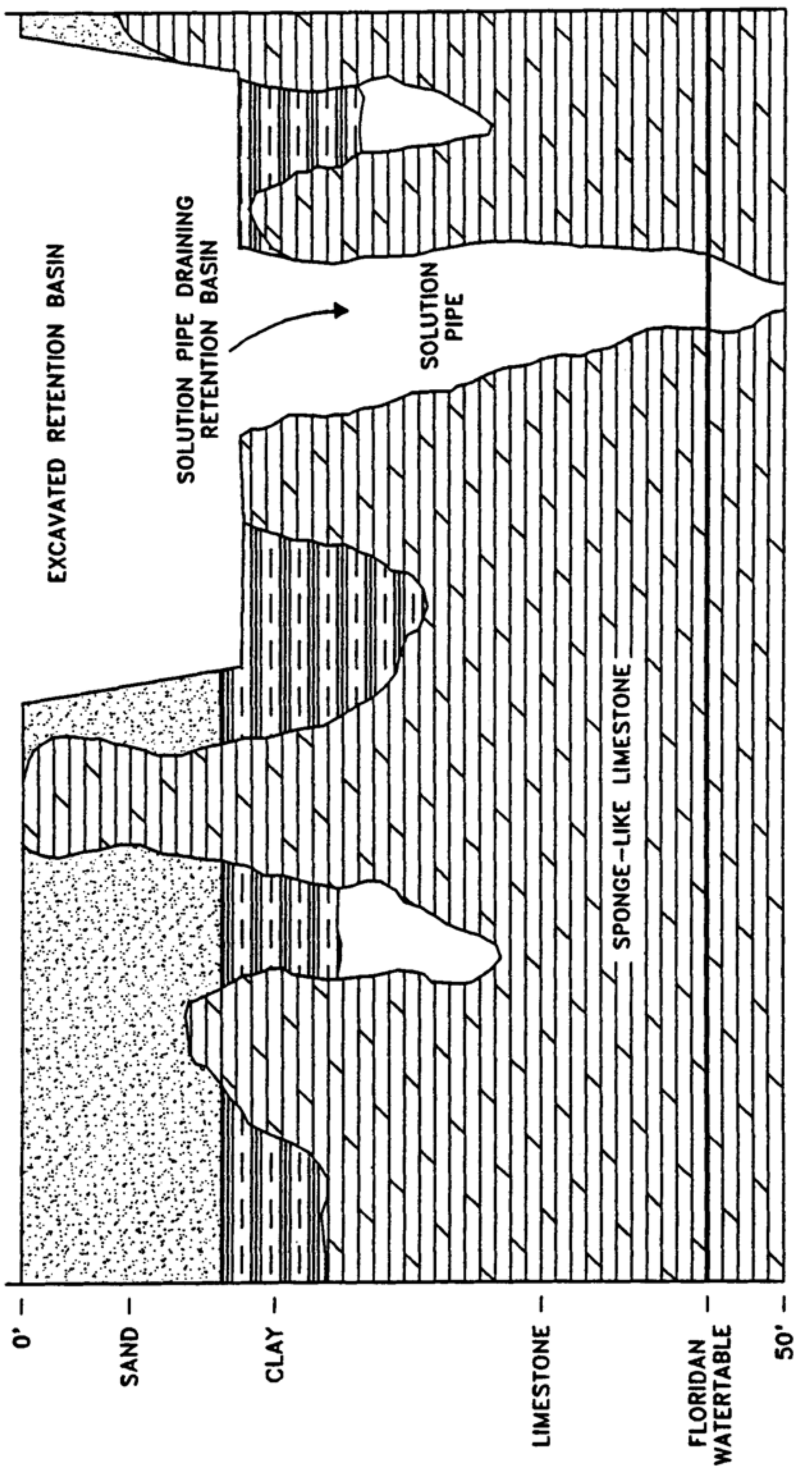


Figure 11.2-3. Generalized geologic section in karst sensitive area with excavated retention basin

Solution pipe sinkholes may open in the bottom of stormwater retention basins. The capping plug or sediment fill may be reduced by excavation of the basin. Stormwater in the basin may increase the hydraulic head on the remaining material in the pipe throat. Both of these factors can wash material down the solution pipe. Solution pipes act as natural drainage wells and can drain stormwater basins.

The irregular weathering of the limestone surface in the SKAs contributes to uncertainty and errors in predicting the depth from land surface to limestone. For example, in **Figure 11.2-2**, boring A would show limestone much deeper than it would actually be encountered during excavation, shown at boring B. This potential for error must be considered for site investigations when evaluating site borings, and load-specific geological analyses must be included to base site designs.

The SKAs have been delineated within the geographical extent of NWFWMD as follows:

(a) First, a map depicting the elevation of the Floridan aquifer system in the Florida panhandle relative to sea level (Pratt and others, 1996) was subtracted from a land surface elevation model (FGS, 2003). The output reflects overburden thickness. A map was then produced to represent all areas that had overburden thickness values of less than or equal to 100 feet. This value represents a conservative estimate of sediment thickness (assuming clean quartz sand) needed to minimize significant adverse impact to the Floridan aquifer system due to natural or human-induced phenomena. Additional research would be required to refine this thickness value to account for sediments of variable permeability (e.g., silt and clay). The resulting map was merged with a map indicating areas affected by karst topography in Northwest Florida (Scott, 1991). Groundwater in Florida is generally considered vulnerable to surface sources of contamination in areas dominated by karst topography.

(b) The "Top of Floridan aquifer system map" (Pratt and others, 1996) is based on lithologic and hydrologic data from a variety of public-agency sources, such as the Florida Geological Survey, the U.S. Geological Survey and the NWFWMD (Jeff Wagner, personal communication, 2003). Based on an estimated average spacing of wells used to generate the top of Floridan aquifer system map (Pratt, 1996) in karst topography areas, a conservative five-mile buffer is included in the Sensitive Karst Area Map to accommodate the estimated level of uncertainty in the source map.

11.3 Design Criteria for Sensitive Karst Areas

11.3.1 Stormwater management systems should be designed to avoid direct discharge of untreated stormwater into sinkholes and into the Floridan aquifer. Such systems shall be designed and constructed in a manner that avoids breaching an aquitard and such that construction excavation will not allow direct commingling of lesser quality water between surface and groundwater systems. The system design also should prevent the triggering of solution pipe sinkholes in the SKAs.

11.3.2 Systems that are designed as follows shall be presumed to comply with **Sections 11.3.1(a) and (b) of the Manual**:

(a) A minimum of three feet of unconsolidated soil material between the surface of the limestone bedrock and the bottom and sides of the stormwater basin. Excavation and backfill of suitable material may be made to meet this criteria. This provides reasonable assurance of adequate treatment of stormwater before it enters the Floridan aquifer.

(b) Stormwater storage areas should be as shallow as possible with a horizontal bottom (no deep spots). In general, the size of a stormwater storage basin can be minimized by providing retention throughout the project site by using shallow landscaped areas and swales.

(c) Maximum basin depth of 10 feet. (Items (b) and (c) reduce the potential for solution pipe sinkhole formation cause by a large hydraulic head.).

(d) Fully vegetated basin side slopes and bottom. Vegetation plays a critical role in the removal of contaminants from stormwater and stabilization of side slopes. In the SKAs, droughty, highly alkaline soils are common and prevent successful establishment of commonly used grasses such as bahia. Typically poor survival of vegetation in stormwater basins in the SKAs has demonstrated the need for mat-forming vegetation which can tolerate these conditions.

Two species of grasses are best suited for use in retention basins in the SKAs. These grasses are:

St. Augustine: This grass can tolerate high alkalinity and brief inundation. However, irrigation is required to foster a healthy cover during dry periods.

Bermuda: This grass can grow in alkaline conditions, is drought resistant, and can stand brief inundation. It is also a low maintenance species which provides excellent cover and soil stabilization. Bermuda grass grows in a thick mat, eventually covering all exposed soil. It recovers quickly after even extended drought. Mowing is rarely required because bermuda creeps laterally rather than growing vertically. Seed is available commercially and is inexpensive.

11.3.3 Applicants who choose not to design their system in conformance with **Section 11.3.2 of the Manual** shall furnish the Department with reasonable assurance that the alternate design and construction of the stormwater management system on the site complies with **Section 11.3.1** of the **Manual**. Such reasonable assurance shall include:

(a) An analysis including existing soil, geologic, and lithographic data of the site or immediately surrounding lands that demonstrates the presence of an aquitard that will not be breached by the proposed design and construction;

(b) The presence of more than three feet of unconsolidated soil material between the surface of the limestone bedrock and the bottom and sides of the stormwater basin that will not be breached by the proposed design and construction; and

(c) Ground penetrating radar (GPR) analyses to detect pre-existing buried cavities on the site.

A Professional Geologist registered in Florida in accordance with Section 492, F.S., shall be required to certify that the submitted information, the site characteristics, and the project design provide reasonable assurance of compliance with **Section 11.3.1** of the **Manual.** The analyses shall not include new core borings on the site, which if drilled, may create or promote the formation of direct conduits to the Floridan aquifer.

11.3.4 In addition to sites that are not identified on **Figure 11.0-1,** the Department may require compliance with the criteria in **Section 11.3.2 of the Manual** when available data and information indicate that a substantial likelihood exists that a proposed stormwater management system on a site has the potential to be located in a karst feature and has the potential to adversely affect the Floridan aquifer.

11.3.5 The criteria in **Sections 11.3.2 and 11.3.3 of the Manual** represent the minimum design requirements for systems in the SKA. Depending on the potential for contamination to the Floridan aquifer, more stringent criteria may apply. Industrial and some commercial sites will normally require more stringent design features. Some of the more stringent site specific design requirements which may be necessary include:

(a) More than 3 feet of material between the limestone bedrock surface and the bottoms and sides of retention basins;

(b) Basin liners (Clay or geotextile);

(c) Sediment trapping structures at stormwater inlets;

(d) Off-line treatment

(e) Special stormwater system design

(f) Ground water monitoring

(g) Paint/solvent and water separators

If the design of the proposed stormwater management systems does not include the minimum design criteria discussed in this section, an analysis must be submitted to the Department that provides reasonable assurance that the ground water quality standards as set forth in chapters 62-4, 62-302, and 62-520, 62-522, and 62-550, F.A.C., are met.

11.4 References

Florida Geological Survey/Florida Department of Environmental Protection, 2003, Digital Elevation Model (DEM) of Northwest Florida (unpublished data).

Livingston, E.H. 1989. The Use of Wetlands for Urban Stormwater Management. In *Design of Urban Runoff Quality Controls*, ed. L.A. Roesner, B. Urbonas, and M.B. Sonnen, pages 467-490. American Society of Civil Engineers. New York.

Pratt, T.R., Richards, C.J., Milla, K.A., Wagner, J.R., Johnson, J.L., and Curry, R.J., 1996, Hydrogeology of the Northwest Florida Water Management District, Northwest Florida Water Management District Water Resources Special Report 96-4, 98 p.

Scott, T.M., 1991, A geological overview of Florida, in: Florida's ground water quality monitoring program – Hydrogeological framework, Scott, T.M., Lloyd. J.M., and Maddox, G., (eds.), Florida Geological Survey Special Publication No.32, pp. 97.

PART VI – APPENDICES

APPENDIX A
CRITERIA/PERFORMANCE CRITERIA

The following is intended to provide the applicant/consultant an abbreviated compilation of the performance criteria outlined within the rule and Handbook. Refer to the Applicant's Handbook section noted.

I. Engineered stormwater management systems required to meet the criteria in **Manual**(Section 2.1.1)

  A. Requirements for professional certification (Section 2.2), legal authorization (Section 2.4), Public Safety (Section 2.5), and Operation and Maintenance (Section 2.9)

  B. Conveyance and Storage—systems that alter existing conveyances must not adversely affect existing conveyance capabilities (Section 2.6)

  C. All systems must meet tailwater criteria for water quality in receiving waters at discharge point of stormwater management system (Section 2.7)

II. Engineered stormwater management systems that must meet stormwater quantity/flood control (Section 3.1)

  A. Peak Discharge Attenuation: Post-development peak rate of discharge must not exceed pre-development peak rate of discharge (Section 3.3).

    1. For systems falling totally within a stream or open-lake watershed (Section 3.3(a)).

    2. For systems within an internally drained or closed-lake watershed, or within any part of a stream-to-sink watershed (Section 3.3(b)).

  B. Storage and Conveyance (Section 3.4)

    1. A system may not cause a net reduction in flood storage within a 10 year floodplain (Section 3.4.2(a));

    2. A system may not cause a reduction of flood conveyance capabilities within a floodway (Section 3.4.2(b));

    3. For exceptions refer to 3.4.2(a), 3.4.2(b) and 3.4.2(c).

  C. Low Flow and Base Flow Maintenance (Section 3.6)

    1. Systems that impound water for purposes in addition to temporary detention storage or systems that discharged water off-site during a 5-year, 30-day drought frequency shall be designed with outlet structure to maintain a low flow discharge of available conservation storage (Section 3.6.2(b)) and be operated to provide a low flow discharge whenever water is impounded (Section 3.6.2 (c)).

2. System will not cause the ground water table to decline more than an average of three feet over the project area than the average dry season low water table (Section 3.6.3(a)) or more than five feet than the average dry season low water table at any location (Section 3.6.3(b);

3. Systems will not cause ground water table to be lowered to a level that would decrease flows or levels below any minimum level of flow established by a water management district.

III. Engineered stormwater management systems that must meet stormwater quality (Section 4.1)

A. No water quality degradation below standards in Chapters 62-4, 62-302, 62-520, or 62-55-, F.A.C. (Section 4.4).

B. Peak Discharge Criteria to Protect Streambanks

1. Peak discharge rates must be controlled for the 2-year, 24-hour storm event, and potentially for a larger storm event (Section 4.5.2.2)

2. Post development peak discharge rate must not exceed pre-development rates for the 2-year, 24-hour storm for systems werving new construction area greater than 50 percent impervious (Section 4.5.2.3)

APPENDIX B
LEGAL DESCRIPTION OF SENSITIVE KARST AREA

All lands contained in he following Section:
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Township 6 North, Range 19 West
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