WQ-03 STORMWATER WETLAND

1.0 Stormwater Wetland

1.1 Description

Constructing wetlands to treat stormwater runoff is an attempt to reproduce the excellent pollutant removal capability of natural wetlands. Stormwater wetlands remove pollutants primarily through physical filtration and settling, by biological processes of wetland plants, and bacteria in substrates. The stormwater wetland is similar in design to the wet pond but has significant vegetation differences.

The major difference in the wetland design is the creation of varying depth zones in the shallow marsh area of the wetland to support emergent wetland vegetation. Because consideration must be paid to creating various depth zones and establishing a plant community that can survive in the different zones, the design, construction and maintenance of stormwater wetlands is more complex than wet ponds.

Although stormwater wetlands are modeled after natural wetlands, they have many differences. Natural wetlands are self-maintaining while stormwater wetlands will cease to exist without human maintenance. Because stormwater wetlands typically do not contain natural wetland soils conductive to wetland plant growth, stormwater wetlands do not possess the diversity of wildlife and plant communities that natural wetlands possess.

Sustaining moisture conditions where the wetland planting will survive is crucial to making stormwater wetlands successful. Therefore, stormwater wetlands should be implemented only where the drainage area to the wetland is greater than 20 acres. It is also important to determine the elevation of the water table, examine the water balance accounting for evapotranspiration, and determine if the wetland can survive during dry weather conditions.

Permanent access to an irrigation supply may be necessary to sustain the wetland if the water balance within the wetland area is insufficient. Table 1 lists the recommended constructed wetland water surface area to drainage areas ratios.

Table 1: Wetland Permanent Pool Surface Area to Drainage Area Ratios (SA/DA)

Percent of Site Built-Upon	**10**	**20**	**30**	**40**	**50**	**60**	**70**
SA/DA	0.59	0.97	1.34	1.73	2.00	2.39	2.75

Natural wetlands shall not be converted to stormwater wetlands, and natural wetland soils and vegetation shall not be removed to provide a "seedbank" for a constructed stormwater wetland without the regulating approval from the US Army Corps of Engineers by obtaining a Section 404 permit.

Water quantity storage may be incorporated into the vegetated wetland if the vegetation selected can withstand being submerged for the depth and duration of the water quantity storage time.

The wetland shall have a minimum 2:1 length to width ratio, with 3:1 being the preferred ratio. The distance between the stormwater wetland inlet and outlet shall be maximized to increase the flow length. The flow path within the wetland can be increased through the use of internal berms and shelves used to create the desired varying depth zones within the wetland.

The stormwater wetland shall fit within the natural contours of the land. Wetlands should be narrower at the inlet forebay and become wider at the outlet. One forebay shall be created and all wetland inlet structures shall discharge to the single forebay area.

Creating varying depth zones within the wetland will increase the pollutant removal efficiency of the wetland. These depth zones can be classified as deep-water zones, which consist of the forebay and outlet micropool, and the shallow water zone that consists of the high marsh, and low marsh area of the wetland. Designing the wetland with varying depth zones will prevent the wetland from being taken over by a dominant plant species such as cattails.

To increase the aesthetic value of the wetland, a 25-foot wetland buffer shall be established around the perimeter of the wetland. To promote a more diverse wildlife habitat, a wetland buffer should consist of a variety of trees, shrubs and plants. The amount of open grass shall be limited to reduce the amount of geese congregating around the wetlands.

1.2 Stormwater Wetland Applications

There are several different wetland applications including:

- Stormwater Wetland, Standard Drawing WQ-03A. Constructed shallow marsh system that is designed to treat both urban stormwater runoff and control runoff volume. As stormwater runoff flows through the wetland, pollutant removal is achieved through settling and uptake by marsh vegetation.

- Shallow Wetland, Standard Drawing WQ-03B. Most of the water quality treatment takes place in the shallow high marsh or low marsh depths. The only deep sections of the wetland are the forebay and the micropool at the outlet. A disadvantage of shallow wetlands is that a relatively large amount of land is required to store the desired water quality volume.

- Extended Detention Shallow Wetland, Standard Drawing WQ-03C. This design is similar to the shallow wetland, but part of the water quality treatment volume is provided as extended detention above the surface of the marsh and is released over a period of 24-hours. This application can treat a greater volume of stormwater in a smaller space than the shallow wetland design. Plants that can tolerate both wet and dry periods are required in the extended detention area.

- Pond/Wetland System, Standard Drawing WQ-03D.The system has two separate cells, a wet pond and a shallow marsh. The wet pond is designed to trap sediment and reduce runoff velocities before the runoff enters the shallow marsh. The primary water quality benefits are achieved in the shallow wetland. Less land is required for the pond/wetland system than the shallow wetland and the extended detention shallow wetland.

- Pocket Wetland, Standard Drawing WQ-03E. A pocket wetland is intended for smaller drainage areas of 5 to 10 acres, and requires excavation down to the water table for a reliable source of water to support the wetland vegetation.

Table 2 lists typical design criteria for the different wetland applications.

Table 2: Design Criteria for Different Wetland Applications

Design Criteria	Shallow Wetland	Extended Detention Shallow Wetland	Pond / Wetland System	Pocket Wetland
Length to Width Ratio	2:1	2:1	2:1	2:1
Extended Detention (ED)	No	Yes	Optional	Optional
Allocation of Water Quality Volume (pool / marsh / ED) %	25/75/0	25/25/50	70/30/0	25/75/0
Allocation of Surface Area (deep water / low marsh / high marsh / semi-wet) %	20/35/40/5	10/35/45/10	45/25/25/5	10/45/40/5
Forebay	Required	Required	Required	Optional
Micropool	Required	Required	Required	Required
Outlet	Reverse slope pipe or hooded broad crest weir	Reverse slope pipe or hooded broad crest weir	Reverse slope pipe or hooded broad crest weir	Hooded broad crest weir

Source: Georgia Stormwater Manual, Volume 2: Policy Guidebook, First Edition, Atlanta Regional Commission, March 2001.

1.2.1 Shallow Water Zones

The shallow water zone is defined as being the zones within the constructed stormwater wetland that have water depths ranging from 0- to 18 -inches. The shallow water zone is designed to promote the growth of emergent wetland plantings and variations in depth allow for a diversity species to survive. The bottom elevation across the width of a wetland cross-section shall remain level to promote sheet flow and prevent short circuiting or the creation of stagnate dead areas.

1.2.2 High Marsh

One-half of the total shallow water zone shall be designated as being a high marsh. This zone extends up from 6-inches below the permanent pool water level (6-inches deep). This zone supports a greater density and diversity of wetland species than the low marsh zone.

1.2.3 Low Marsh

One-half (1/2) of the total shallow water zone shall be designated as low marsh. This zone extends from a depth of 18- to 6-inches below the permanent pool water level. This zone is suitable for the growth of several emergent wetland plant species.

1.2.4 Deep Water Zones

The deep water zones range from a depth of 1.5- to 6-feet and includes the forebay, low flow channels, and the outlet micropool. This zone supports little emergent wetland vegetation, but may support submerged or floating vegetation.

1.2.5 Forebay

The forebay is designed to reduce the incoming velocities into the wetland and provides an initial settling for sediments, therefore minimizing the amount of suspended sediments that enter the constructed wetland area.

The forebay shall also be designed as a level spreader to distribute the flow evenly and equally across the width of the wetland area. The forebay shall be constructed of an earthen berm that shall be no lower than the normal permanent pool depth.

All inlets to the constructed stormwater wetland shall discharge to the forebay, and be protected with a properly designed Turf Reinforcement Mat.

1.2.6 Low Flow Channels

A minimum dry weather flow path is required from the inlet to the outlet for stormwater wetlands.

1.2.7 Outlet Micropool

The outlet micropool shall be required to allow adequate depth for the extended detention release outlet to function properly and allow a drain to be installed to drain the wetland when needed. The outlet micropool shall be 4- to 6-feet deep.

1.2.8 Semi-Wet Zones

The semi wet zones includes the areas above the permanent pool that will be submerged during larger storm events. This zone supports vegetation that can survive during flooding.

1.2.9 Wetland Planting Plan

A wetland planting plan shall be designed and submitted as part of all constructed wetland design submittals. The selection of the proper plant species and planting locations is an integral part in designing a successful stormwater wetland. A wetland planting plan shall be prepared by a qualified landscape architect or wetland ecologist.

The wetland planting plan shall include all vegetation types, total number of each species, and the location of each species. A description of the contractor's responsibilities including a planting schedule, installation specifications, initial maintenance, a warranty period, and expectations of plant survival. Long-term inspection and maintenance guidelines should also be included in the planting plan.

Suitable planting soils shall be specified in the wetland planting areas. The soils shall have adequate texture and organic matter to retain moisture for plant growth. A soil analysis shall be done on the soil before it is placed in the wetland.

Appropriate species shall be selected for the high and low marsh zones and the edge of the wetlands. Attention must be placed on the inundation tolerance of the planting along with the depth of water experienced during extended detention. A well-planned wetland shall utilize a variety of emergent, submergent, and floating wetland plants along with buffer trees and plantings.

1.2.10 Wetland Vegetation Selection

Ensure all wetland vegetation and plantings conform to the American Standard Nursery Stock, published by the American Association of Nurserymen, and are selected from certified nurseries. Avoid certain plants such as:

Extremely aggressive species:

- Cattails
- Common Reed

Non-native species:

- Chinese Privet
- Asiatic Dayflower

1.2.10.1 Deep Water Zone Vegetation

Deep Water Vegetation species are capable of surviving in depth of water ranging from a depth of 1 to 6 feet. This vegetation type is not typically planned or planted. In many locations, these plants will gradually begin to establish through natural colonization. The availability of plant materials that can withstand and grow in 1 to 6 feet water depth is limited.

Vegetation Common Name	
American Water Lotus	Spadderdock
Deepwater Duck Potato	Wild Celery
Fragrant Water Lily	Yellow Water Lily
Redhead Grass	
Tree Common Name	
Bald Cypress	

1.2.10.2 Shallow Water Zone Vegetation

Shallow Water Vegetation species are capable of surviving in depth of water ranging from 1 foot deep to the top of the permanent pool. These species are the primary emergent vegetation found in wet stormwater detention ponds and constructed vegetated wetlands.

Vegetation Common Name		
Alligator Flag	Lance -leaf Arrowhead	Swamp Hibiscus
Arrow Arum	Lizard's Tail	Swamp Lily
Caric Sedge	Louisiana Iris	Swamp Rose
Coastal Spikerush	Pickerelweed	Swamp Sunflower
Duck Potato	Pond Cyprus	Sweetflag
Flat Sedge	Rice Cutgrass	Switchgrass
Giant Bulrush	Soft Rush	Tickseed
Golden Canna	Softstem Bulrush	Three-square
Green Arum	Southern Blue-Flag Iris	Virginia Chain Fern
Jointed Spikerush	Smartweed	Wool Grass

1.2.10.3 Semi-Wet Zone A

Semi wet Zone A Vegetation species are capable of surviving along the edge of the permanent pool up to an elevation of 1 foot above the normal pool. These species are the most difficult to establish because the vegetation will be submerged during storm events and it must be able to survive during larger flooding periods. Many of the plants listed in the Shallow Water Vegetation classification are also capable of surviving in the Semi Wet classification. In some situations vegetation in the classification may be required to provide shade to the water quality structure and shoreline. Several species of trees are suitable for this classification.

Vegetation Common Name		
Bushy Broom Grass	Dwarf Tickseed	Spiked Gayfeather

Cardinal Flower	Hawthorns	Upland Sea-Oats
Cinnamon Fern	Royal Fern	
Tree Common Name		
American Sycamore	Pumpkin Ash	Willow
Boxelder	Red Maple	Willow Oak
Green Ash		

1.2.10.4 Semi-Wet Zone B

Semi wet Zone B Vegetation species are capable of surviving along the edge of the permanent pool from an elevation of 1 to 4 feet above the normal pool. Vegetation in this zone is subject to periodic flooding after larger storm events and may experience saturated or partially saturated soil conditions.

Vegetation Common Name		
Black-eyed Susan	Hawthorn	Lilies
Broom Grass	Hollies	Lovegrass
Flatsedge	Ironweed	Yellow Indian Grass
Forsythia	Joe Pye Weed	
Tree Common Name		
Silver Maple	Sugar Maple	

1.2.11 Water Quality Treatment Orifice

A low flow orifice shall be used to slowly release the water quality volume over a period of 24-hours. Additional orifices at outlet structures may be placed above the temporary water quality pool to provide water quantity control.

The water quality orifice shall be protected from clogging by incorporating an appropriate trash guard. The trash guard selected shall be durable and extend at least 6-inches below the normal pool surface of the wetland. Acceptable trash guards include:

Hoods that extend 6-inches below the permanent pool water surface elevation.

Reverse flow pipes where the outlet structure inlet is located 6-inches below the permanent pool water surface elevation.

Trash boxes made of sturdy wire mesh.

1.2.12 Principal Spillway

The principal spillway of the constructed stormwater wetland shall be designed to safely pass the 25-year, 24-hour storm event. The spillway shall be equipped with a trash rack.

1.2.13 Emergency Spillway

The emergency spillway of constructed stormwater wetlands shall be designed to safely convey discharges resulting from the 100-year, 24-hour storm event. The 100-year water surface elevation shall be a minimum of 1 foot below the top of the embankment. The emergency spillway may be incorporated into the principal spillway where accommodating the emergency spillway elsewhere is not feasible for the given site characteristics.

1.3 Maintenance

Regular inspection and maintenance is critical to the effective operation of stormwater wetlands. Maintenance responsibility for the constructed stormwater wetland shall be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

Maintenance requirements for constructed stormwater wetlands are particularly high while vegetation is being established. Monitoring during the first year is critical to the success of the wetland. Wetlands shall be monitored after all storm events greater than 2-inches of rainfall during the first year to assess erosion, flow channelization and sediment accumulation. Inspection shall be made at least once every six months during the first three years of establishment.

A sediment cleanout stake shall be placed in the forebay area to determine when sediment removal is required.

Debris shall be removed from the inlet and outlet structures monthly.

Wetland vegetation shall be monitored and replaced as necessary once every 6-months during the first three years of establishment.

The depth of the zones within the wetland shall be inspected and maintained annually.
Invasive vegetation shall be removed annually.

Repair all eroded or undercut areas as needed.

1.4 IDEAL Model

The County’s preferred method of demonstrating compliance with its water quality standard is to use the IDEAL model. To facilitate use of this model, the table below shows how to represent this BMP and BMPs similar to this one in the IDEAL model. It lists the parameters needed to successfully run the model and the parameters that affect the trapping efficiency of the BMP.

Table 7: IDEAL Modeling Guide

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<tr><td rowspan="6">Similar BMPs</td><td colspan="2">Retention or Irrigation Ponds</td></tr>
<tr><td colspan="2">Extended Detention Wetland</td></tr>
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<tr><td rowspan="7">Specifications Needed for IDEAL</td><td colspan="2">Soil texture and degree of saturation of the soil within the pond</td></tr>
<tr><td colspan="2">At least 3 area measurements at varying stages of the pond</td></tr>
<tr><td colspan="2">Type, shape, and size of the emergency spillway if applicable</td></tr>
<tr><td colspan="2">Riser type, shape, and dimensions</td></tr>
<tr><td colspan="2">Number of orifices with corresponding inverts and sizes</td></tr>
<tr><td colspan="2">Size, slope, Manning’s roughness coefficient, entrance loss coefficient, and invert height of the barrel</td></tr>
<tr><td colspan="2">Direct loading of bacteria that will be entering the pond</td></tr>
<tr><td rowspan="4">Parameters that Drive Performance</td><td>Feature</td><td>How Value Affects Sediment Trapping Efficiency (TE)</td></tr>
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