Callaway Gardens: Stormwater Quality Management Guidelines

Guidelines to Protect and Enhance Stormwater Quality for the Next Phase of Development at Callaway Gardens. Presented in Three Parts:

1. Introduction, Goals, and Targets **2.** The Best Management Practice Prescription **3.** Incorporating the Concepts

1. Project Introduction

The Project:

Located in Harris County Georgia, Callaway Gardens is within the Chattahoochee River watershed, Georgia's most important body of water and a major source of water for Georgia, Alabama, and Florida. Callaway Gardens is also situated above significant groundwater recharge areas.

A new residential development is being proposed on the grounds of the gardens. In order to ensure that the highest level of protection is provided for the water resources in the area, the Owner requested that the design team produce guidelines to help guide the development as it relates to stormwater quality.

Role of the Landscape Architect:

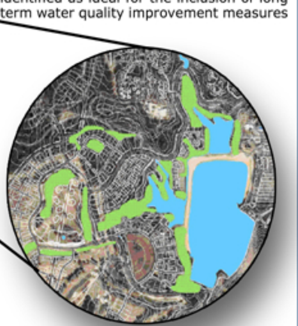
The Landscape Architect was hired to produce the Stormwater Quality Design Guidelines that provide the framework for a sustainable and progressive approach to the development of the site.

The Landscape Architect created the stormwater design guidelines to help manage stormwater in such a way that the Chattahoochee River watershed and the Blue Ridge and Piedmont aquifers are protected at the highest feasible level. Proper protection of these regional resources begins on site with localized streams and stormwater conveyance channels.

It is the purpose of this design guideline manual to present tools and strategies specifically related to the treatment of water quality.

The Site:

The plan to the left shows the site with existing bodies of water highlighted in blue and the proposed residential development in white. The plan below shows areas identified as ideal for the inclusion of long term water quality improvement measures



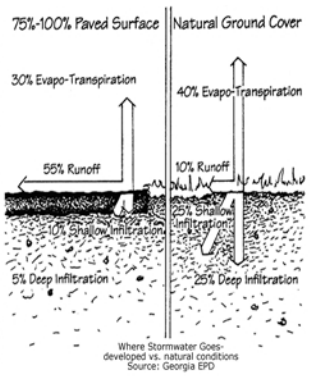
Basics of Stormwater and the Ecological Model

The Model:

In natural, predevelopment conditions, the majority of stormwater evaporates or is taken up by plant material. Approximately 10% runs directly into bodies of water and 50% infiltrates into the ground. Of that 50%, half becomes subsurface flow that discharges into bodies of water and the other half infiltrates and recharges aquifers.

In conventionally developed conditions which typically are 75% or greater impervious surface, the percentage of runoff is increased approximately 550% which causes tremendous erosion downstream. These impervious areas also contain concentrated amounts of pollutants. Stormwater infiltration is drastically reduced to the detriment of soils and aquifer health.

These water quality design guidelines work to mimic the natural hydrology of the site and avoid the unsustainable traps of conventional stormwater management.



Pollutant Targets:

These Callaway Gardens Stormwater Quality Management Guidelines are primarily focused on the proper treatment of this Country's largest pollution source- nonpoint source pollution.

Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water. These pollutants include:

- Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas
- Oil, grease, and toxic chemicals from urban runoff and energy production
- Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks
- Salt from irrigation practices and acid drainage from abandoned mines
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems

Typical Stormwater Targets to be Exceeded:

Harris County: No Standards for Water Quality.

LEED- Version 2.1 80% of Total Suspended Solids. 40% Nitrogen 40% Phosphorous LEED- Version 2.2 80% of Total Suspended Solids.

Earthcraft Communities 80% of Total Suspended Solids.

Georgia Storm Water Management Manual. 80% of Total Suspended Solids.

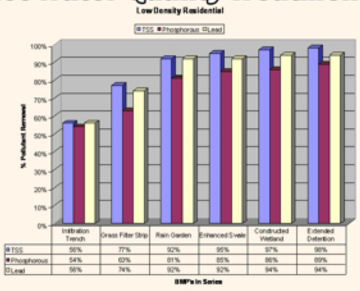
3. Incorporating the Concepts:

This report analyzes several different typical scenarios that are similar to areas of development in the proposed Phase I development at Callaway Gardens. After the general descriptions for each of these scenarios for combining BMP's is discussed, a pollutant removal efficiency analysis will be provided for typical scenarios based on differing levels of BMP treatment.

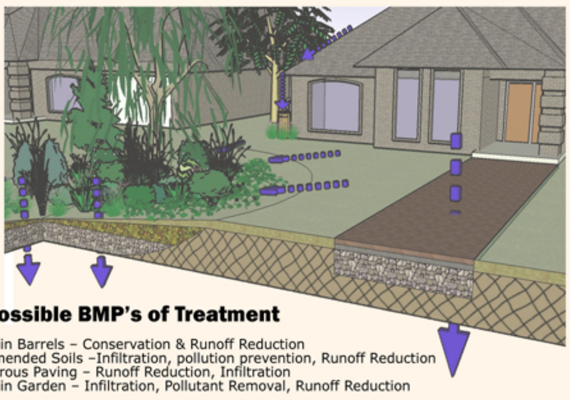
Individual Residential Lot Water Quality Treatment

General Description:

On the residential lot level, there are many opportunities to treat runoff at or near the source. Starting at the roof, the use of rain barrels or cisterns can be utilized to capture and hold storm water and its pollutants and hold it until such a time that it can be distributed as irrigation. This will provide water conservation, volume reduction, and peak flow reduction. The next component is to provide a disconnect between impervious areas. The roof water not captured for irrigation should be released onto pervious areas such as a grass filter strip. The soil beneath the lawn and other vegetated areas should consist of organically amended soils that provide environmental functions similar to those that native soils and their related vegetation typically provide. Paved walkways, patios, and parking spaces include porous pavements when applicable. Finally, when possible, lots should have a depression that allows water to pond in a small rain garden that offers many levels of water quality treatment.



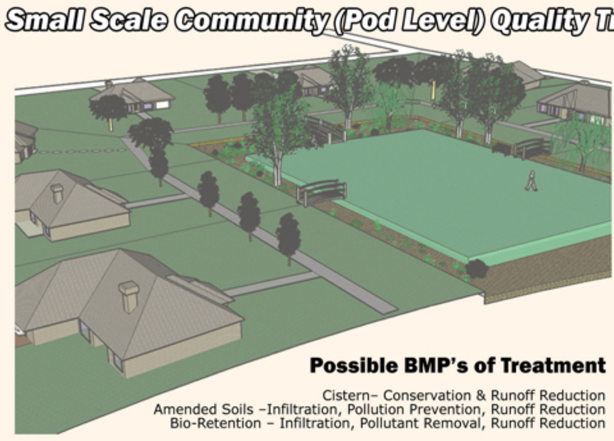
Land Cover Assumptions



Possible BMP's of Treatment

Rain Barrels – Conservation & Runoff Reduction
Amended Soils –Infiltration, pollution prevention, Runoff Reduction
Porous Paving – Runoff Reduction, Infiltration
Rain Garden – Infiltration, Pollutant Removal, Runoff Reduction

Small Scale Community (Pod Level) Quality Treatment

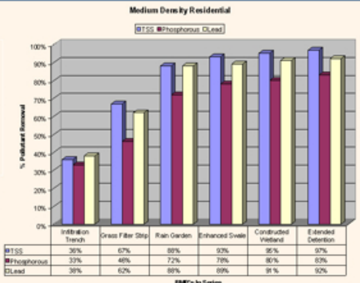


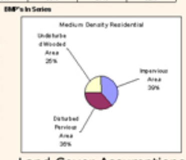
Possible BMP's of Treatment

Cistern– Conservation & Runoff Reduction
Amended Soils –Infiltration, Pollution Prevention, Runoff Reduction
Bio-Retention – Infiltration, Pollutant Removal, Runoff Reduction

General Description:

On the pod level, there are many opportunities to treat runoff near the source in shared BMP's that serve more than one lot. These possible treatment practices should be used in addition to individual BMP's on the lot level whenever applicable. In a typical pod level scenario, eight to ten homes may be configured in an area that would allow them to share a common community green space. Utility corridors and visitor parking areas could also be shared to reduce disturbed and impervious areas. On the pod level, community cisterns could be installed for routing roof drainage to be saved for reuse as irrigation. Impervious areas should be allowed to drain onto pervious areas such as a grass filter strip or wooded buffers. The community green space should have amended soils in areas of disturbance that will provide environmental functions that native soils and their related vegetation typically provide. Paved walkways, patios, and parking spaces should include porous pavements when applicable. The pod level gives an excellent opportunity to provide a larger shared bio-filtration BMP, such as bio-retention, enhanced swale, constructed wetland, or a sand filter. In the scenario shown left, depressed bio-retention cell surrounds a community green space. This functional landscape can be integrated into community spaces to serve as an amenity.



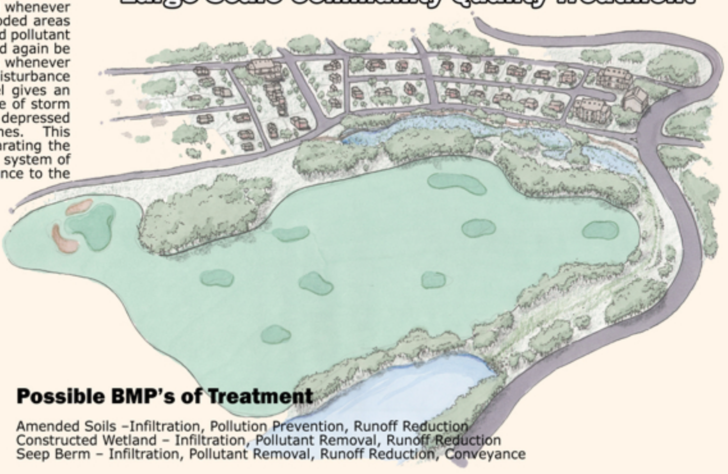


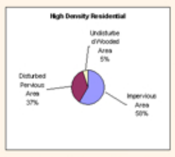
Land Cover Assumptions

General Description:

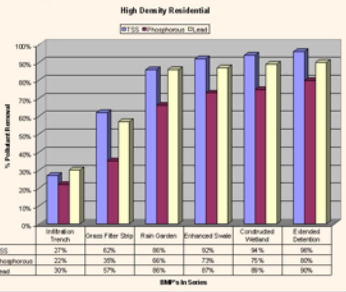
On the neighborhood level, there are still even more opportunities to catch storm water and slow it down for further flow reduction and pollutant removal. These possible treatment practices should be used in addition to BMP's on the lot level and smaller pod level whenever possible. On the community level it is important to leave large undisturbed wooded areas throughout the development. This will greatly reduce water quantity, flow rate, and pollutant loadings as well as provide important habitat for wildlife. Impervious areas should again be allowed to drain onto pervious areas such as a grass filter strip or wooded buffers whenever possible. The community green spaces should have amended soils in areas of disturbance that will provide flow reduction and pollutant removal. The neighborhood level gives an opportunity to provide a linear bio-filtration BMP while also providing conveyance of storm water through and around community spaces. In the scenario shown below, depressed constructed wetlands receive storm water from several smaller pods of homes. This constructed wetland wraps around the driving range with a wooded buffer separating the two. The wetland's overflow would enter into a seep berm, which is essentially a system of enhanced swales that will provide further treatment capacity, as well as conveyance to the downstream pond that would provide detention for the larger storms.

Large Scale Community Quality Treatment





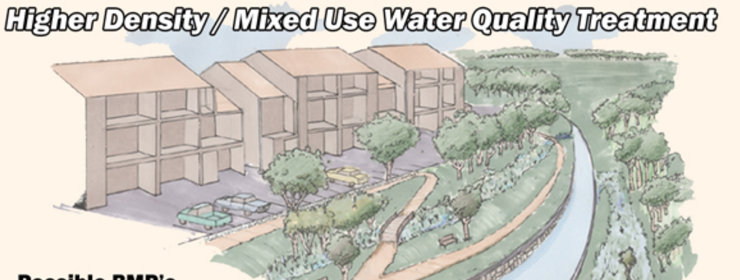
Land Cover Assumptions

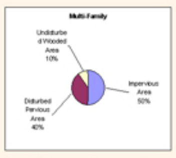


Possible BMP's of Treatment

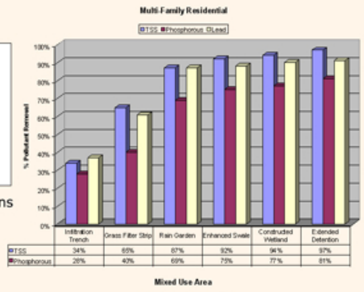
Amended Soils –Infiltration, Pollution Prevention, Runoff Reduction
Constructed Wetland – Infiltration, Pollutant Removal, Runoff Reduction
Seep Berm – Infiltration, Pollutant Removal, Runoff Reduction, Conveyance

Higher Density / Mixed Use Water Quality Treatment



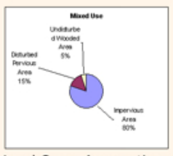


Land Cover Assumptions

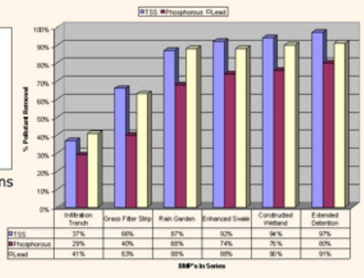


Possible BMP's of Treatment

Infiltration Trench –Infiltration, Pollutant Removal, Runoff Reduction
Grass Filter Strip – Filtration, Pollutant Removal, Velocity Reduction
Bio-retention – Infiltration, Pollutant Removal, Runoff Reduction



Land Cover Assumptions



General Description:

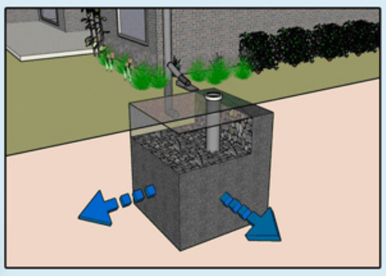
In higher density mixed use type developments, BMP's can be creatively woven into the landscape to provide storm water treatment as well as create aesthetic spaces that can be enjoyed by the users. At this level of development, community cisterns can be installed for routing roof drainage to be saved for reuse as irrigation. Impervious areas should be allowed to drain onto pervious areas such as a grass filter strip. The scenario above shows a higher density development adjacent to the improved canal that will convey storm drainage. In this case the storm water from the impervious parking areas will be caught in a linear infiltration trench capped with river stone for an aesthetically pleasing appearance. The storm water that is not infiltrated here will sheet flow through a grass filter strip into a linear bio-retention cell, which treats storm water and provides wildlife habitat along this mixed-use development while providing a park like environment for an added amenity. The overflow would discharge into the canal in multiple locations or be allowed to sheet flow when possible.

2. The Best Management Practice Prescription:

The BMP's covered in this section are grouped in order from the point in which a rain drop falls at the highest point of a watershed (here a residential roof) to the point in which millions of rain drops have combined to form significant runoff flows common to the lower portions of a watershed.

Rain Barrell

In Central Georgia, a measurable amount of rain falls on about 120 days each year, producing amounts averaging between 45 and 50 inches. Through the use of rain barrels (shown right), small cisterns, and other collections devices, community members can capture and utilize stormwater for irrigation needs. The use of such devices do not deliver much in the way of water quality treatment but they reduce overall peak flow. They also connect users to the water cycle, promote responsible water management, and reduce potable water irrigation use and associated costs. These devices also give individuals ownership over stormwater management and work to expand education and appreciation for the sensible and sustainable management of water resources.

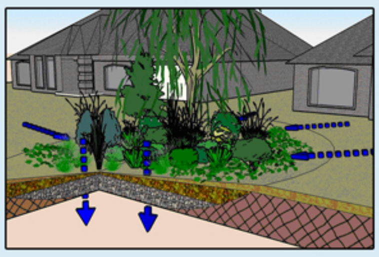


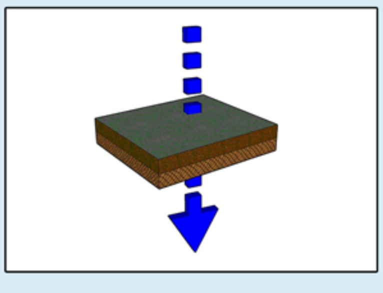
Dry Wells

Dry Wells are intended to capture rainwater within an underground chamber and slowly infiltrate the water quality volume into the soil. Typically dry wells are prefabricated concrete structures with bore holes to allow water to pass through it. The structure is filled with aggregate such as #57 stone or recycled crushed concrete. Stormwater volume is contained with the voids of the aggregate (typically around 40% of the total volume) until it can properly infiltrate into the substrate. These wells should be as wide and shallow as possible to maximize the area of infiltration. These wells are ideal for downspout connections for residential structures but the concept can be integrated into parking lots and other impervious areas.

Rain Garden

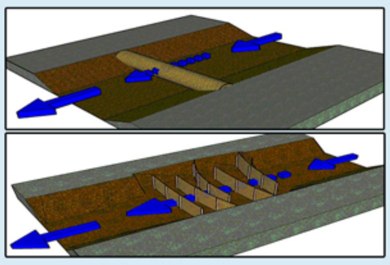
Rain Gardens are depressed low points in the landscape planted with native or adapted vegetation that are capable of withstanding durations of standing water. They are intended to drain quickly and to filter out excess nutrients, pollutants, and sediment. These gardens work to slow stormwater and recharge groundwater through the promotion of stormwater infiltration. Rain Gardens can be formal or informal in appearance. Commonly associated with bioretention, Rain Gardens are less expensive to construct, use little to no engineered soil, and do not have an underdrain. They are ideal for residential environments as owners can take responsibility of long term maintenance, landscaping and improvements.





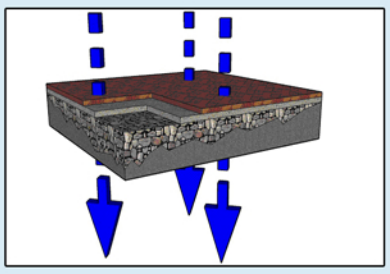
Soil Amendments

A soil amendment is any material added to a soil to improve its physical properties, such as water retention, permeability, water infiltration, drainage, aeration and structure. The goal of amended soils is to provide a better environment for roots. To do this, an amendment must be thoroughly mixed into the soil. There are two broad categories of soil amendments: organic and inorganic. Organic amendments include sphagnum peat, wood chips, grass clippings, straw, compost, manure, biosolids, sawdust and wood ash. Inorganic amendments include vermiculite, perlite, tire chunks, pea gravel and sand.



Polyacryamide (PAM)

Polyacrylamide (PAM) is a synthetic polymer that, in it's negatively charged (anionic) form, binds soil particles together to help reduce sediment escape in stormwater runoff. PAM is available as a crystalline powder, an emulsion, or as a solid block or 'log'. The powder form can be mixed with seed to help hold soil together during the germination process. Emulsions are applied to silt fence or jute mat to help bind soil particles that pass through. PAM logs are used in channels and swales which convey stormwater and work to filter and separate sediment from runoff.

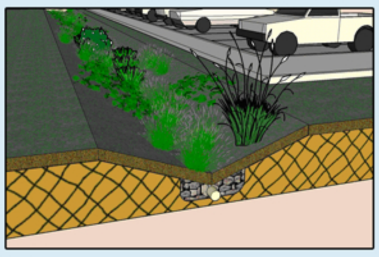


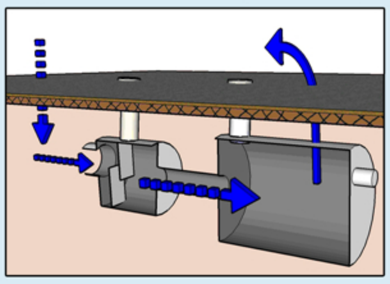
Pervious Pavements

Pervious Pavements are hard surfaces, both vehicular and residential grade, which allow for the infiltration of stormwater. These pavements provide water quality benefits and work to reduce the overall detention volume of a watershed. Pervious Pavement types are varied and include porous asphalt, porous concrete, interlocking concrete pavers with void spaces, interlocking bricks, plastic mats with hollow rings and cells that are filled with sod or stone, and many others. These systems vary by cost and application and can be used for pedestrian walkways and sidewalks, residential driveways, parking aisles, patios and plazas but are not recommended for areas that receive heavy vehicular use.

Enhanced Swales

Enhanced Swales are vegetated open channels that are intended to capture and treat stormwater water runoff. These channels can be design to be either wet or dry; a factor which is dependant on whether an underdrain system is designed integral with the swale. Berms and check dams are typically integrated in the swale to help slow stormwater velocity, promote infiltration, limit erosion forces, and settle pollutants and sediment. Enhanced swales can be integrated into a multitude of situations, including both residential and commercial environments, and are excellent in conveying and treating stormwater runoff from parking lots and roadways.



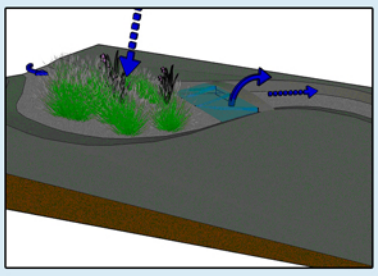


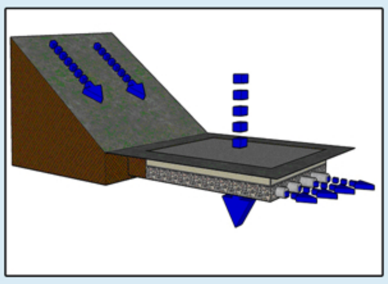
Cistern

Cisterns are large, underground tanks designed to capture runoff for the purpose of using the stormwater to meet irrigation needs. The materials used to construct Cisterns vary, but poured in place concrete, precast concrete vaults, and fiberglass tanks are among the most common. In order to screen debris and contamination from entering the holding tank, a pre-treatment system is needed such as an oil / grit separator. Cisterns require a significant financial investment during construction but will help to reduce potable water consumption by supplementing irrigation needs for landscape areas. Cisterns can also provide water for internal building appliances that do not need potable water, such as toilets.

Seep Berms

Seep Berms function in much the same manner as enhanced swales in that they are slightly excavated channels designed to capture and infiltrate stormwater. Seep Berms are designed to handle larger flows and velocities and can transport and infiltrate runoff over larger areas with steep terrain. Seep Berms are designed with a series of intermediate check dams that slow down runoff velocity and promote infiltration. When running water comes in contact with these dams, the water spreads over a larger area. Seeps Berms can be landscaped with grasses or ornate planting designs of groundcovers, shrubs and trees.



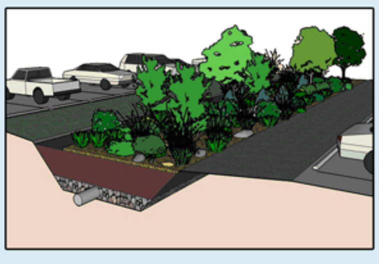


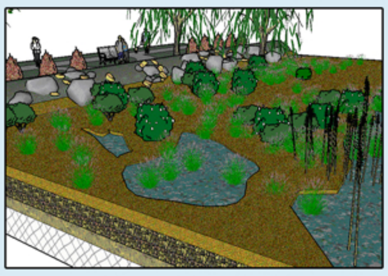
Sand Filters

A sand filter is designed to treat stormwater through infiltration into a sand bed, which acts as its primary filter media. An underdrain system is necessary to ensure that once stormwater is treated through the filter that it can adequately drain away from the sand bed to allow treatment of additional stormwater volume. Generally, there are three sand filter types. Surface Sand Filters are a ground level and open air structure. Perimeter Sand Filters are enclosed in a vault or underground chamber in which the top acts as an inlet. These are typically found in parking lots. The third type is an underground Sand Filter which is entirely enclosed. These are common in urban settings with space constraints.

Bioretention Cell

A properly designed, installed, and maintained bioretention cell can be expected to filter and remove pollutants using physical, chemical and biological mechanisms. The fundamental principles of bio-retention areas are to infiltrate, filter, store, evaporate, and detain runoff and pollutants as close to the source as possible. Specifically, they use absorption, microbial action, plant uptake, sedimentation, and filtration to treat and enhance water quality. In addition to the unparalleled pollutant removal and runoff reduction capacities, the aesthetic value of bio-retention cells is another major benefit. Unlike traditional landscape areas, the landscaping within bio-retention cells requires little or no irrigation and / or fertilization.





Constructed Wetland

A Constructed Wetland and Stormwater Wetland are among the most efficient BMP's available. Constructed Wetlands capture water in a marsh condition and pollutants are removed from runoff through infiltration and stormwater uptake through vegetation. These systems provide a striking aesthetic and are valuable wildlife habitats. Types of Constructed Wetlands include Shallow Wetlands, Extended Detention Shallow Wetlands, Pond/Wetland Systems, and Pocket Wetlands. Each of these different design types offer varying degrees of permanent and intermediate water depth as well as dry storage above the wetland. Constructed Wetlands can also be designed to varying degrees of required maintenance.