New Jersey Highlands Water Protection and Planning Council

DRAFT

Constructed Examples of Stormwater Best Management Practices (BMP) Projects

Release Date: January 2016

Abstract

This document provides real-world examples of the 13 structural stormwater management measures described in the NJDEP Stormwater Best Management Practices Manual (BMP Manual)[1]. It was developed to assist Highlands municipalities that are engaged in implementing Stormwater Management Programs as part of the Highlands Plan Conformance process. It is intended to be used in conjunction with Chapter 7 (*Landscaping*) and Chapter 9 (*Structural Stormwater Management Measures*) of the NJDEP Stormwater Management BMP Manual of April 2004, as amended.

Although this document is intended primarily for use by municipalities within the Highlands Region (and grant funding is available to support associated planning work for municipalities that are conforming to the Highlands Regional Master Plan) the principles, strategies and methods outlined within are applicable to any municipality in New Jersey and may be of interest to other stakeholders.

[1] http://www.nj.gov/dep/stormwater/bmp_manual2.htm

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Statutory Platform, Purpose and Funding

Through the passage of the New Jersey Highlands Water Protection and Planning Act in 2004, the NJ Highlands Water Protection and Planning Council (the Highlands Council) was created and charged with developing a Regional Master Plan (RMP)[2]. Adopted in 2008, the RMP serves as the guiding document for the long-term protection and restoration of the region's critical resources. In accordance with Goals 1D, 1K, 2B, 2D, 2E, 2G, 6N and 7G of the RMP, the Highlands Council has developed this document to highlight constructed examples of stormwater BMPs.

Stormwater Management is the process of minimizing stormwater runoff and directing stormwater to nonstructural and structural devices so as to control flooding, prevent soil erosion, recharge ground water and avoid pollution of water resources. Transport of stormwater-related pollutants into local surface and ground waters can result in: the destruction of fish, wildlife, and habitats; threats to public health due to contaminated food and drinking water supplies; and losses of recreational and aesthetic values. While low impact and non-structural measures are prioritized over structural means, it is sometimes necessary to install structural measures using designs tailored to each site according to needs and circumstances.

The purpose of this document is to highlight examples of structural stormwater management measures implemented in New Jersey that offer possible application to project sites throughout the Highlands Region and beyond. This document serves to supplement any applicable legal actions, and the Stormwater Management Plans and Stormwater Control Ordinances adopted by the Highlands Region municipalities. It is intended to be used in conjunction with Chapter 7 (*Landscaping*) and Chapter 9 (*Structural Stormwater Management Measures*) of the NJDEP Stormwater Best Management Practices Manual (BMP Manual) of April 2004, as amended. Specifically, this document is intended to identify and illustrate examples of each of the following thirteen structural stormwater measures discussed in the NJDEP BMP manual:

1. Bioretention Systems
2. Standard Constructed Wetlands
3. Dry Wells
4. Extended Detention Basins
5. Infiltration Basins
6. Manufactured Treatment Devices
7. Pervious Paving Systems
8. Rooftop Vegetated Cover (Reserved)
9. Sand Filters
10. Vegetative Filter Strips

[2] *Copies of the Highlands Regional Master Plan are available in most municipal offices and can be obtained by contacting the Highlands Council office.*

11. Wet Ponds
12. Grass Swales
13. Subsurface Gravel Wetlands

The content of this document pertains to the management of stormwater in the use and development of lands located within the municipalities situated in the Highlands Region of New Jersey. Although this document is intended to be used by municipalities in the Highlands Region, the information contained herein, along with applicable rules and ordinances, has application throughout the entire State of New Jersey.

Funding to support stormwater management activities within a Highlands municipality is provided through the Highlands Plan Conformance process. Municipalities with approved Plan Conformance Petitions are eligible for grant funding to cover the reasonable expenses of planning activities associated with the Conformance process and should contact their Highlands Council Municipal Liaison for additional information.

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1.0 Introduction

1.1 Stormwater Management Rules

New Jersey's Stormwater Management Rules (N.J.A.C. 7:8)[3] became effective on February 2, 2004 and are implemented by the New Jersey Department of Environmental Protection (NJDEP) through the review of permits issued by the Division of Land Use Regulation (DLUR - Flood Hazard, Freshwater Wetlands, CAFRA, Waterfront Development and Coastal Wetlands). The Stormwater Management Rules (Stormwater Rules) are also implemented by local authorities through the Municipal Land Use Law (MLUL) and the Residential Site Improvement Standards (RSIS). Per the New Jersey Department of Community Affairs (NJDCA), the RSIS are applicable to any residential application that goes before a local board. Through the RSIS, the Stormwater Rules are activated whenever a municipality requires the control of runoff from a site that is the subject of a site or subdivision application. Therefore, consistent with its duly adopted ordinances, a municipality may require compliance with the Stormwater Rules through the RSIS whether or not a development is a "major development" as defined in the Stormwater Rules.[4]

Additionally, the NJDEP developed and implemented the Municipal Stormwater Regulation Program (MSRP). This program addresses pollutants entering waterbodies from certain storm drainage systems owned or operated by local, county, state, interstate or federal government agencies. These systems are called municipal separate storm sewer systems (MS4s). The NJDEP's MSRP program issues New Jersey Pollutant Discharge Elimination System (NJPDES) general permits to municipalities throughout the state. The MSRP has assigned New Jersey municipalities into Tier A or Tier B and issues Tier A Stormwater Permits (Tier A Permits) or Tier B Stormwater Permits (Tier B Permits), respectively. Tier A municipalities are generally located within the more densely populated regions of the state or along and near the coast while Tier B municipalities are generally located in more rural areas and in non-coastal regions. For purposes of this document, Tier A and Tier B designations do not have significance.

The NJPDES permits discussed above address stormwater quality issues related to new and existing development and redevelopment by requiring the preparation of a stormwater program and the implementation of specific permit requirements referred to as Statewide Basic Requirements (SBRs). SBRs may also require the permitee to implement related Stormwater Best Management Practices (BMPs).

The Stormwater Rules set forth the required components of regional and municipal stormwater management plans, and establish the stormwater management design and performance standards for

[3] N.J.A.C. 7:8, http://www.nj.gov/dep/rules/rules/njac7_8.pdf
[4] Appendix B of the RSIS (N.J.A.C. § 5:21) states that "Department of Community Affairs Note: Consistent with N.J.A.C. 7:8-4.2, municipal stormwater management plan and elements, the Residential Site Improvement Standard requirements **only are triggered** by residential developments that disturb **one or more acres of land**." RSIS is consistent with the Stormwater Management rules at N.J.A.C. 7:8-4.2(a) and requires **only major development (one acre disturbance)** to be subject to the Stormwater Management rules.

new (proposed) development. The design and performance standards for new development include groundwater recharge, runoff quantity controls, runoff quality controls, and special water resource protection areas around Category One (C1) waters. Any project that proposes 1 acre or more of disturbance overall is considered a "major development" and triggers the Stormwater Rules. Additionally, as set forth at Objective 2B8b of the Highlands Regional Master Plan in the Highlands Preservation Area and those towns in the Planning Area which have conformed their stormwater ordiances in HUC14 subwatersheds identified by the Highlands Council as having a deficit of New Water Availability and where an increase in consumptive/depletive water use is projected, the stormwater management designs shall demonstrate through hydrologic and hydraulic analysis that the post-developed project site maintains 125 percent of the site's pre-developed average annual ground water recharge volume. Unmanaged land development often leads to adverse impacts on groundwater recharge and stormwater runoff quality and quantity both at and downstream of a development site. The Harding Township RSIS Special Area Standards for Stormwater Management represents an example of the nature and extent of stormwater management measures for the Highlands Region in accordance with the RMP. A copy of this document can be found at: http://www.state.nj.us/dca/divisions/codes/codreg/pdf_rsis/resolution02-1.pdf.

1.2 Stormwater Management in the Highlands Region

Effective stormwater management is an important element of natural resource protection, and therefore, vital to the success of the Highlands Water Protection and Planning Act (Highlands Act) and Highlands Regional Master Plan (RMP).

Because the Highlands Region provides drinking water for more than half the state's residents[5], the Highlands Stormwater Management Program provides additional guidance, beyond the Stormwater Rules, to ensure the enhanced natural resource protections dictated by the Highlands Act are in place.

The Highlands Stormwater Management Program has four main components:

1. GIS Mapping of Stormwater Structure Locations and Conditions Assessment
2. Adoption of Highlands Area Stormwater Control Ordinance Amendments
3. Review and Update of Municipal Stormwater Mitigation Plan
4. Stormwater Management Training

The Highlands Council's Stormwater Management Program supports the goals of the Highlands RMP as well as the requirements of the Stormwater Rules and the NJDEP Bureau of Nonpoint Pollution Control Municipal Stormwater Regulation Program (MS4 Permits).

[5] *Highlands Regional Master Plan*, 2008

1.3 New Jersey Stormwater Best Management Practices (BMPs) Manual

The New Jersey Stormwater Best Management Practices Manual (BMP Manual) of April 2004, as amended, was developed to provide guidance to implement the standards in the Stormwater Rules. The BMP manual provides examples of ways to meet the standards required by the Stormwater Rules. The BMP manual was developed by the NJDEP, in coordination with the New Jersey Department of Agriculture (NJDA), NJDCA, the New Jersey Department of Transportation (NJDOT), municipal engineers, county engineers, consulting firms, contractors, and environmental organizations. A copy of the BMP Manual can be found on the NJDEP website at www.njstormwater.org.

1.4 Using this Document

The purpose of this document is to highlight examples of structural stormwater management measures implemented in New Jersey that offer possible application to project sites throughout the Highlands Region and beyond. This document serves to supplement the municipal Stormwater Management Plans and Stormwater Control Ordinances adopted by the Highlands Region Municipalities. It is intended to be used in conjunction with Chapter 7 (*Landscaping*) and Chapter 9 (*Structural Stormwater Management Measures*) of the BMP Manual. In addition, the Highlands Council is in the process of developing a Model Highlands Landscaping Ordinance for Municipalities (Landscaping Ordinance) as well as a suggested plant list to complement this document. A copy of the Landscaping Ordinance will be posted to the Highlands Council website once finalized. Appendix A contains the suggested Stormwater Plant Lists for Highlands Region Municipalities.

This document is organized as follows:

1) **Introduction** – discusses the Stormwater Rules and associated guidance materials;
2) **Structural Stormwater BMPs** – description and examples of thirteen stormwater management measures;
3) **Financial/Technical Assistance** – discusses briefly Highlands Council grant funding as part of Plan Conformance and lists potentially available grants for project implementation;
4) **References** – resources used in the development of this Manual
5) **Appendices**

2.0 Structural Stormwater BMPs

The thirteen stormwater management measures identified in Chapter 9 of the NJ BMP Manual are discussed in the sections below. A brief description of each measure is included along with example(s) illustrating one or more of the measures implemented at project sites throughout New Jersey. The intent of this document is to be utilized as a resource by Highlands municipalities when new development projects require the use of structural stormwater management measures. More detailed information regarding each type of measure can be found in Chapter 9 of the NJ BMP manual.

2.1 Bioretention Systems

A bioretention system consists of a soil bed planted with suitable non-invasive, native vegetation. Stormwater runoff entering the bioretention system is filtered through the soil planting bed before being either conveyed downstream by an underdrain system or infiltrated into the existing subsoil below the soil bed. Vegetation in the soil planting bed provides uptake of pollutants and runoff and helps maintain the pores and associated infiltration rates of the soil in the bed.

A bioretention system can be configured as either a bioretention basin or a longer, narrower bioretention swale. In general, a bioretention basin has a flat bottom while a bioretention swale may have a sloping bottom. Runoff storage depths above the soil bed surface are typically shallow. The TSS removal rate for bioretention systems is 80 or 90 percent, depending upon the thickness of the soil planting bed and the type of vegetation grown in the bed.

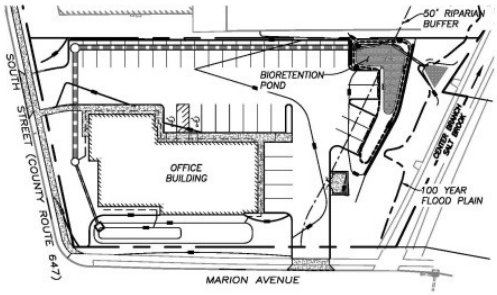
Refer to Chapter 9.1 of the NJ BMP manual for additional information, design criteria and maintenance considerations for bioretention systems.

PROJECT #1: Office Building (New Providence)

- New Providence, Union County, New Jersey
- New proposed headquarters for Data Online, LLC
- Project emphasis on LEED certification and regulation compliance.
- Proposed **bioretention pond** was located adjacent to the South Branch of the Salt Brook while complying with riparian buffer and flood hazard regulations.
- Subject property is 0.77 acres, previously vacant and partially wooded. Proposed impervious coverage was 0.48 acres, or 62% coverage.
- Soil tests confirmed a perched groundwater condition as well as seasonable high water.
- The **bioretention basin** was designed with underdrains due to the low permeability of the on- site soils.
- Tail water conditions were considered to ensure proper function during the water quality storm and up to and including a 100-year storm event.
- A variety of water-tolerant perennials were chosen for the basin. Required yearly maintenance will be minimal and will include removing debris and weedy vegetation.
- The compliance with State water quality and peak flow reduction compliments the LEED certification of the proposed project.

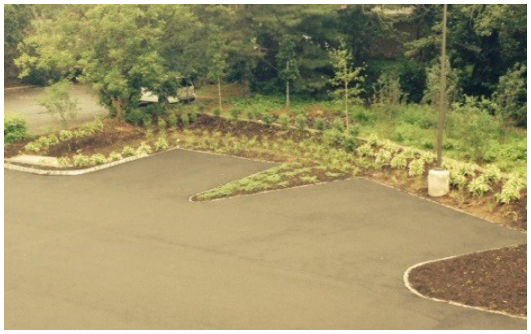
Pre-Construction Conditions

Proposed Site Plan



Under Construction

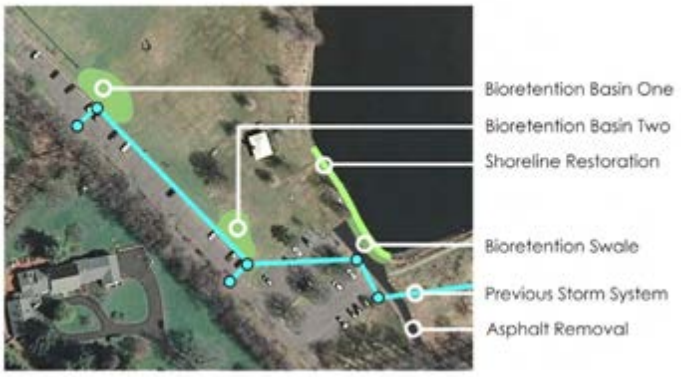
Completed Project



Source: http://nsawra.onefireplace.org/factsheets

PROJECT #2: Loantaka Brook/Kitchell Pond Stormwater Management and Enhancement Project (Morris Township)

This project is a 319(h) funded Watershed Plan Implementation Project conducted under the direction of the Ten Towns Great Swamp Watershed Management Committee (TTC) and its two principle project partners, the Morris County Parks Commission (MCPC) and the Great Swamp Watershed Association (GSWA). Princeton Hydro served as the lead technical service provider. The primary goal of the project was to address Loantaka Brook's degradation by decreasing fecal coliform and related stormwater pollutant loading to stream and Kitchell Pond.



The project specifically consisted of three distinct stormwater treatment and control measures: the construction of two **bioretention basins**; the construction of a **bioretention swale** (see Section 2.12) and associated shoreline stabilization; and the installation of two **manufactured treatment devices (MTDs)** (see Section 2. 6) and removal of portions of existing pavement. The bioretention basins and bioretention swale work in concert to temporarily retain the runoff generated from the park to achieve peak flow reduction. These BMPs also work together with the MTDs to decrease pollutant loading to the pond and brook. This is achieved because the elements of the stormwater management system are for the most part arranged in a "treatment train" configuration. As a result, they cumulatively provide enhanced water quality treatment for TSS, nutrients, and coliform bacteria (pathogens), thus decreasing the loading of these pollutants to both the pond and the brook. As noted above, the project also involved the removal of impervious cover. Specifically, approximately 2,000 square feet of a section of the lower parking lot was removed and replaced with a pervious cover. Additionally, the shoreline stabilization work conducted as part of the bioretention swale's construction expanded the pond's naturalized edge. This further decreased access to and from the pond by Canada geese, which are documented as having a large impact on Kitchell Pond's existing water quality impairments. The goose feces also detract from the overall usage of the park.

Photos of Bioretention Basin One:

Pre-existing conditions

Initial excavation

After plant and soil erosion control fabric installation

Additional information on this project can be obtained from Princeton Hydro, LLC, 1108 Old York Road, Suite 1, P.O. Box 720 Ringoes, NJ 08551.

2.2 Standard Constructed Wetlands

Standard constructed wetlands are stormwater management systems designed to maximize the removal of pollutants from stormwater runoff. Flow is directed through an engineered, open marsh system where pollutants are removed through settling and vegetative uptake/filtration. The total suspended solids (TSS) removal rate is 90%. There are three categories of standard constructed wetlands: pond constructed wetlands; marsh constructed wetlands; and extended detention constructed wetlands.

Refer to Chapter 9.2 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for standard constructed wetlands.

PROJECT: (Reserved)

2.3 Dry Wells

A dry well is a subsurface storage facility that receives and temporarily stores stormwater runoff from roofs of structures. Discharge of this stored runoff from a dry well occurs through infiltration into the surrounding soils. A dry well may be either a structural chamber and/or an excavated pit filled with aggregate. Due to the relatively low level of expected pollutants in roof runoff, a dry well cannot be used to directly comply with the suspended solids and nutrient removal requirements contained in the Stormwater Rules. However, due to its storage capacity, a dry well may be used to reduce the total stormwater quality design storm runoff volume that a roof would ordinarily discharge to downstream stormwater management facilities. In addition, dry wells are also permitted for groundwater recharge.

Refer to Chapter 9.3 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for dry wells.

PROJECT: Millburn Township Dry Wells

In 1999, the Township of Millburn created an ordinance that required increased runoff from new impervious areas to be directed into seepage pits (**dry wells**). Most of the dry wells in Millburn are precast concrete structures, with open bottoms resting on 0.6 m (2 ft.) crushed stone layers and with 0.6 m (2 ft.) crushed stone surrounding the dry wells. Most of the dry wells receive water directly from roof drain leaders.

It is important to note that alternative stormwater options should be used when dry well use should be restricted, such as with the following conditions:

- Poor infiltration capacity of subsurface soil layers;
- Concerns about premature clogging or other failures due to sediment; discharges or snowmelt discharges to dry wells;
- Seasonal or permanent high water tables; and,
- Concerns about groundwater contamination potential.

Additional information on this project can be found online at CHI/Journal of Water Management Modeling: https://www.chijournal.org/Journals/PDF/C376

The Millburn Township dry wells were the focus of a University of Alabama white paper by Leila Talebi and Robert E. Pitt (2014) which evaluated their effectiveness. The paper concluded that although the dry wells provided no significant improvements in water quality for constituents of interest in the infiltrating water, they resulted in reduced mass discharges of flows and pollutants to surface waters and reduced runoff energy, a major cause of local erosion problems.

2.4 Extended Detention Basins

An extended detention basin is a stormwater management facility that temporarily stores and attenuates stormwater runoff. In addition, extended detention basins provide pollutant treatment for runoff from the Water Quality Design Storm through settling. When properly designed, the TSS removal rate is 40 - 60%, depending on the duration of runoff detention.

Refer to Chapter 9.4 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for extended detention basins.

PROJECT: (Reserved)

2.5 Infiltration Basins

An infiltration basin is a facility constructed within highly permeable soils that provides temporary storage of stormwater runoff. An infiltration basin does not normally have a structural outlet to discharge runoff from the stormwater quality design storm. Instead, outflow from an infiltration basin is through the surrounding soil. An infiltration basin may also be combined with an extended detention basin to provide additional runoff storage for both stormwater quality and quantity management. The adopted TSS removal rate for infiltration basins is 80 percent. (It should be noted that a dry well is a specialized infiltration facility intended only for roof runoff. See Section 2.3)

Refer to Chapter 9.5 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for infiltration basins.

Project Example: Please note the listed example includes several stormwater BMPs including infiltration basins. Applicable subsections of Section 2.0 should be consulted for additional details on the other BMPs utilized.

PROJECT: Corporate Campus Design - New Jersey Manufacturer's Insurance Group Campus (Hammonton)

Princeton Hydro was contracted by the NJM Insurance Group (NJM) to provide environmental, geotechnical and stormwater management design services for the construction of their new 55-acre corporate campus. Princeton Hydro worked with the project team to develop a concept plan that could be built within the context of proper stormwater management and meet the stringent requirements of the NJ Pinelands Comprehensive Management Plan.

Due to a number of physical constraints, the site was designed to manage nearly all stormwater runoff on site. To accomplish this ambitious goal, the project infiltrates and retains stormwater in a number of **bioinfiltration basins, parking lot islands, a wetland basin, and a bioretention island**. All infiltration areas were designed using a soil amendment process where the underlying soils were excavated and amended with organic material to improve the underlying recharge capabilities of the soils. Additionally, a 120,000 gallon **below-grade rainwater capture and reuse system** was designed which captures roof runoff for on-site irrigation.

During construction, Princeton Hydro provided monitoring services for all earthwork activities. Princeton Hydro staff was on site full time during critical activities of site work to ensure that the project was built in accordance with the intent of the original design and ensure the maintenance of the project schedule. Princeton Hydro geotechnical engineers reviewed shop drawings of subsurface structures and provided field engineering and consultation to the general contractor when field conditions differed from those anticipated.

The project is one of the first projects in NJ built to infiltrate nearly 100% of the on-site runoff and use site design based stormwater capacity to determine allowable impervious cover.

Source: www.princetonhydro.com

2.6 Manufactured Treatment Devices

A manufactured treatment device (MTD) is a pre-fabricated stormwater treatment structure utilizing settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technology to remove pollutants from stormwater runoff.

The TSS removal rate for manufactured treatment devices is based on the NJDEP certification of the pollutant removal rates on a case-by-case basis. Other pollutants, such as nutrients, metals, hydrocarbons, and bacteria can be included in the verification/certification process if the data supports their removal efficiencies.

Refer to Chapter 9.6 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for manufactured treatment devices. In addition, please see project highlighted in Section 2.12 which also includes MTDs.

PROJECT #1: Filterra® Stormwater Planters (Parsippany Troy-Hills)

As part of a NEIWPCC grant awarded to the Whippany River Watershed Action Committee (WRWAC), Princeton Hydro was contracted to design and implement a project at the Parsippany-Troy Hills police department and court offices. Princeton Hydro worked with the WRWAC to implement projects within the watershed plan to meet the TMDL requirements for the Whippany River.

Princeton Hydro prepared the design plans for three **Filterra® structures** to be installed within the site's parking lot. The Filterra® device is a **bioretention system** within a pre-cast concrete box which is underdrained and connected to the existing storm sewer network. The system includes a mulch layer, engineered bioretention media, and a stone layer with perforated underdrain. The device is planted with a native tree or shrub to provide aesthetic value as well as additional nutrient removal and filtration. The three Filterra® devices collect runoff from over 8,800 square feet of parking lot.

These three Filterra® devices were the first ever to be installed in the State of New Jersey. Since then, Princeton Hydro has designed and implemented eight additional Filterra® units within the state. Bioretention devices have been shown to be highly effective in the removal of nitrogen and phosphorus bound to sediment.

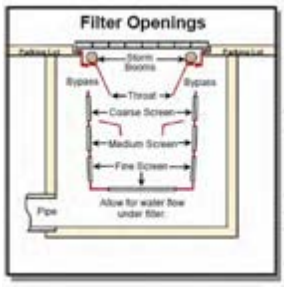
Source: http://nsawra.onefireplace.org/factsheets

Project #2: Loantaka Brook/Kitchell Pond Stormwater Management and Enhancement Project (Morris Township)

Refer to Project #2 in Section 2.1 (Bioretention Systems) for a more complete project summary.

Under the pre-project existing conditions, the stormwater runoff from lower parking lot was directed to two catch basins. The collected runoff was then directed via a pipe to an outfall located approximately 50 feet below the Kitchell Pond dam. The pre-project existing condition amounted to a direct discharge of untreated runoff to Loantaka Brook. The primary pollutants of concern delivered to the brook in the parking lot's runoff were TSS, particulate phosphorus (TP adsorbed to sediment particles) and petroleum hydrocarbons.

Photo of GISB



Schematic of GISB

GISB installed

To correct this problem Grate Inlet Skimmer Boxes (GISBs) manufactured by Suntree Technologies were installed in each catch basin. These inserts were custom fabricated to fit each catch basin and work with the existing Type C grate. Each inlet is approximately 24" x 24" and set flush to the surface of the pavement. The use of the GISB **manufactured treatment devices** provided a low-cost, easily maintained solution to the existing problem. As the inserts did not require any modification of the existing catch basins, the GISBs provided some degree of water quality improvement without the need to disturb the main parking lot and alter the existing collection pipe and headwall infrastructure. As per the manufacturer, as stormwater passes through the marine grade fiberglass and stainless steel GISB, it is initially filtered by a hydrocarbon absorption boom. Each GISB filters approximately 21 cubic feet per second. Larger particulates, including road grit, trash and leaf litter are removed as the stormwater passes through the variously sized course, medium and fine filter screens. The captured solids are retained on the screens, and drain dry after each storm event. The retained material can then be easily removed manually, thus negating the need for expensive vacuum trucks.

Note: GISBs are not currently an MTD certified by the NJDEP. MTDs used in a "major development" must be verified by the NJ Corporation for Advanced Technology (NJCAT) and certified by the NJDEP (N.J.A.C. 7:8-5.7). This project was not associated with a "major development".

Additional information on this project can be obtained from Princeton Hydro, LLC, 1108 Old York Road, Suite 1, P.O. Box 720 Ringoes, NJ 08551.

2.7 Pervious Paving Systems

Pervious paving systems are paved areas that produce less stormwater runoff than areas paved with conventional paving. This reduction is achieved primarily through the infiltration of a greater portion of the rain falling on the area than would occur with conventional paving. This increased infiltration occurs either through the paving material itself or through void spaces between individual paving blocks known as pavers.

Pervious paving systems are divided into three general types. Each type depends primarily upon the nature of the pervious paving surface course and the presence or absence of a runoff storage bed beneath the surface course. Porous paving and permeable pavers with storage bed systems treat the stormwater quality design storm runoff through storage and infiltration. Therefore, these systems have adopted TSS removal rates similar to infiltration structures. Permeable pavers without storage bed systems only reduce the volume of TSS.

Refer to Chapter 9.7 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for pervious paving systems.

PROJECT: USEPA Region 2 Laboratory (Edison)

In October 2009, three types of permeable pavement surfaces were installed in an experimental parking lot at the Edison laboratory, including 28 parking spaces made of **interlocking concrete paver blocks**, 41 **porous concrete** parking spaces, and 28 **porous asphalt** parking spaces. Thirteen conventional asphalt spaces serve as an experimental control for research into the performance and capabilities of the permeable pavement systems. In addition, a **rain garden** was installed to quantify the ability of rain gardens to accept, store, and infiltrate stormwater. The facility compiled extensive documentation during construction to support planned long-term research activity. In November 2010, EPA completed construction of an additional 60 permeable concrete parking spaces at the Region 2 Laboratory, separate from the experimental parking lot.

Parking lot under construction

Finished parking lot

Additional information on this project can be found at:
http://www.epa.gov/greeningepa/stormwater/edison_parking_lot.htm

2.8 Rooftop Vegetated Cover

Green roofs consist of an impermeable roof membrane overlaid with a lightweight planting mix with a high infiltration rate and vegetated with plants tolerant of heat, drought, and periodic inundations. In addition to reducing runoff volume and frequency and improving runoff water quality, a green roof can reduce the effects of atmospheric pollution, reduce energy costs, and create an attractive environment. They have reduced replacement and maintenance costs and longer life cycles compared to traditional roofs.

Refer to Chapter 9.8 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for pervious paving systems.

PROJECT: Butler College Dormitories at Princeton University

Primarily installed as a teaching tool and research project, **green roofs** were installed atop portions of Butler's dormitories A, C and D in the summer of 2008. Monitoring equipment was installed to measure heat flux, soil moisture and temperature. Measurement obtained from the equipment will provide the basis for research on stormwater runoff – how the quantity and quality of water coming off of the green roofs might improve water quality and ecological balance at the University, in Lake Carnegie and throughout the local watershed. 14 varieties of hardy sedum were planted on the Butler rooftops.

The green roof on Dormitory A is viewed here from Dormitory D. (Photo: Brian Wilson)

Additional information on this project can be found at:
http://www.princeton.edu/main/news/archive/S25/01/12M89/index.xml?section=

2.9 Sand Filters

A sand filter is a stormwater management system designed to maximize the removal of pollutants from stormwater. It consists of a pre-treatment zone and a treatment zone, which includes the sand bed, and in underdrained systems, and the underlying components. Pollutants are treated through settling, filtration, and adsorption by the sand bed. The TSS removal rate is 80%.

Refer to Chapter 9.9 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for sand filters.

PROJECT: Parsippany Troy-Hills Department of Public Works (DPW) Property

In an effort to reach toward zero stormwater runoff, the Parsippany Troy-Hills Public Works yard has implemented several stormwater management measures on their property. The DPW facility is adjacent to the Troy Brook in an area of the stream that has been identified from modeling, monitoring and field evaluations as a high priority. Measures at the facility include the installation of **turfstone** (see Section 2.7) on an access road to disconnect 8,000 ft^2 of rooftop and 2,400 ft^2 of road. In addition, a 1,200 ft. linear **bioretention swale** (see Section 2.12) from the parking lot to the riparian buffer along the stream was installed. The bioswale captures the majority of the flow from the main parking lot including the onsite fueling station.

A 5,000-gallon cistern was also placed on this site to disconnect 5,500 ft^2 of impervious roof top; the DPW reuses the water for street sweeping and washing of the DPW trucks.

Photo showing the concrete boxes for the sand filters. Credit: Pat Rector

Four **sand filter chambers** were installed at the entrance to the bioswale to reduce the velocity of the flow of water off of the parking lot and the amount of sediment that enters the bioswales. The sand filter chambers and the installation of the chambers was one of many in-kind contributions from the Township of Parsippany-Troy Hills, with an estimated value for this contribution of $14,570. These projects were made possible through a grant awarded to the Whippany River Watershed Action Committee.

Additional information can be found online at:
http://somerset.njaes.rutgers.edu/environment/tbbkrgd.html

2.10 Vegetative Filter Strips

A vegetative filter strip is a stable, evenly graded area that removes pollutants from stormwater runoff through filtration and biological uptake. In order to provide pollutant treatment, runoff must enter and move through the filter strip as sheet flow; therefore, vegetative filter strips must have shallow enough slopes to maintain sheet flow. When designed in accordance with this chapter, the TSS removal rate is 60 - 80%, depending on the type of vegetation.

Refer to Chapter 9.10 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for vegetative filter strips. The following example acts similarly to a vegetated swale (see Section 2.12).

PROJECT: Rowan University Bio-Infiltration System (Glassboro)

Princeton Hydro was contracted by Rowan University to provide design services for the construction of a stormwater retrofit in one of the University's main parking areas. The existing parking area was constructed prior to the implementation of current stormwater management requirements. Consequently, the original construction of the parking area did not contain any stormwater flow or water quality control measures. The uncontrolled runoff was creating impacts to existing infrastructure and severe stream bank erosion on nearby Mantua Creek. In order to address the runoff volume, peak flow rate, and water quality impacts of the parking area, Princeton Hydro designed a series of **bio-infiltration islands** (**a.k.a. vegetated filter strips**) to capture and infiltrate incoming stormwater runoff as part of the Mantua Creek Implementation Plan.

Under the previous conditions, the series of stormwater inlets created large areas of nuisance ponding due to significant portions of runoff which bypass existing inlets. The bio-infiltration cells reduce the nuisance ponding and will also improve winter weather driving conditions.
The retrofit system was designed in a manner which does not require major infrastructure modifications. Runoff inflow to the bio-infiltration cells and overflow occurs via a series of curb cuts along each cell. Princeton Hydro designed a custom planting plan which focuses on native vegetation ideally suited for the unique hydrologic conditions expected in the bio-infiltration cells.

The project was constructed in the fall of 2011. The bio-infiltration cells provide groundwater recharge, water quality treatment, and peak flow control. In addition to their functional aspect, the bio-infiltration cells provide an aesthetic improvement to the parking area.

Source: www.princetonhydro.com

2.11 Wet Ponds

Wet ponds, also known as retention basins, are used to address the stormwater quantity and quality impacts of land development. This type of stormwater facility has an elevated outlet structure that creates a permanent pool where stormwater runoff is detained and attenuated. Wet ponds can be designed as multi-stage, multi-function systems; extended detention in the permanent pool provides pollutant treatment for runoff from the Water Quality Design Storm through sedimentation and biological processing; detention and attenuation are also provided for larger storm event through the higher elevation outlets. When designed in accordance with this chapter, the TSS removal rate is 50 - 90%, depending upon the storage volume in the permanent pool and the duration of detention time, if extended detention is provided.

Refer to Chapter 9.11 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for wet ponds.

PROJECT: NJTA Interchange 6 to 9 Widening (Mansfield Township and East Brunswick Township)

Overview

The NJ Turnpike Interchange 6 to 9 Widening Program consists of approximately 35 miles of road widening and associated interchange improvements from the vicinity of Interchange 6, in Mansfield Township, Burlington County to just south of Interchange 9 in East Brunswick Township, Middlesex County. When complete, the Widening Program will result in a 12-lane (6 in each direction) roadway capable of accommodating projected traffic needs through the year 2032. Section 5 included 5 miles of widening in East Windsor and Robbinsville and the following features.

Design Considerations

To minimize environmental impacts, over 9400 linear feet of retaining walls were designed to minimize right of way and environmental impacts. Further, **3 wet ponds** and **2 bio-retention basins** were designed to improve the quality of the storm water runoff prior to discharge.

Water Quantity and Quality Benefits

The wet ponds and bio-retention basins provide water quality benefits by allowing roadway sediments to be deposited and filtered in large grass basins and in vegetated treatment basins prior to release to receiving streams and rivers. These features also control the discharge of stormwater to regulate its flow to limit possible flooding and downstream erosion.

Permitting Issues

The project traverses through environmentally sensitive areas. Environmental constraints include the Assunpink Wildlife Management Area, freshwater wetlands, flood hazard and riparian areas, preserved farmlands, Green Acres properties, public parklands, school properties, cemeteries, and historic sites.

Maintenance

As part of an overall NJ Turnpike facility maintenance program, basins and swales are required to be mowed and manicured on a routine basis, with trash and debris removed to ensure they continue to function as designed.

Project Partners include the NJ Turnpike Authority, the NJ Department of Environmental Protection, various Counties, towns and municipalities, environmental and engineering consultants, and many others. Parsons Brinkerhoff was the design engineer for Section 5.

Source: http://nsawra.onefireplace.org/factsheets

2.12 Grass Swales

A grass swale is a stable, parabolic or trapezoidal channel that is lined with turf; it is used to improve water quality and convey stormwater runoff. Grass swales do not rely on the permeability of the underlying soil for pollutant removal; instead, pollutants are removed by settling and filtration through the grass. The maximum total suspended solids (TSS) removal rate is 50%.

Refer to Chapter 9.12 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for grass swales.

PROJECT: Loantaka Brook/Kitchell Pond Stormwater Management and Enhancement Project (Morris Township)

Refer to Project #2 in Section 2.1 (Bioretention Systems) for a more complete project summary.

The construction of the **vegetated, or bioretention swale** along the lake-side edge of the lower parking lot entailed the removal of a section of the impervious parking lot surface. In the pre-construction condition that existed stormwater ran unimpeded into Kitchell Pond. The bioretention swale was designed to intercept this runoff. For storms equal to or less than the water quality event, the swale was designed to retain the full volume of generated runoff. The stored runoff would either infiltrate into the underlying soils or be lost via evapotranspiration as a result of the vegetation established in the swales planting bed.

The swale itself was designed as a shallow (approximately one foot deep) linear depression running parallel to the shoreline for a distance of approximately 70 feet. The swale was designed to capture and treat sheet flow from the adjacent parking areas and remaining impervious cover. Grading was such that the bottom of the swale has a very mild slope. The existing soils were tilled and amended with leaf compost, and then vegetated using both seed and plant plugs. The native vegetation planted in the swale was selected to survive the anticipated high soil moisture conditions that would often exist due to the proximity of the swale to the lake. However, the selected plantings also are fairly drought tolerant. It was anticipated that once the plantings mature, root penetration should be great enough to keep the plants adequately hydrated even during dry periods. The planting pallet consisted of native wet meadow vegetation including Riverbank Wild Rye, Green Headed Coneflower, and New York Aster.

In addition to the direct water quality functions, the swale will also act as a goose deterrent by providing a densely vegetated buffer between the pond and the parking area and the park's adjacent turf grass areas. The swale will also vastly improve the ecological function of this section of the shoreline and provide a drastic aesthetic improvement over the previous asphalt paving which extended almost to the edge of the pond.


Pre-Existing Conditions


Initial Excavation


First Growing Season

2.13 Subsurface Gravel Wetlands

A subsurface gravel wetland is a stormwater management system designed to maximize the removal of pollutants, particularly nitrogen, from stormwater. The system is a combination of a surface marsh and a subsurface gravel bed under anaerobic conditions. Pollutants are treated through settling and both uptake and filtration by vegetation in the surface marsh and denitrification in the subsurface bed. Both the total suspended solids (TSS) removal rate and the nitrogen removal rate are 90%.

Refer to Chapter 9.13 of the NJ BMP manual for additional information, application, design criteria and maintenance considerations for subsurface gravel wetlands.

PROJECT: Ocean County's Subsurface Gravel Stormwater Wetland Program

This planning, design, and construction program was developed by Ocean County in response to the NJDEP's Barnegat Bay Initiative and is intended to address increasing nitrogen loading to Barnegat Bay, a vital water resource for the State and, particularly, Ocean County.

The program has included the planning, design, and permitting of **10 subsurface gravel stormwater wetlands** in the County and the construction of eight. These facilities range in size from approximately one quarter to several acres. They provide stormwater quality treatment, including high rates of nitrogen removal, from drainage areas that range in size from approximately 10 to more than 100 acres and include residential, commercial, institutional, and industrial areas as well as local, county, and state highways.

All of the wetlands were constructed at existing stormwater basin sites that were constructed primarily for runoff quantity control at least a decade ago. As such, the subsurface gravel wetland program represents a significant upgrade to these older, less sophisticated stormwater facilities.

Ocean County College Basin #1 – Before

Ocean County College Basin #1 - After

Todd Road Basin – Before

Todd Road Basin - After

Additional information on this project can be found online at:
http://nsawra.onefireplace.org/ocean_county_stormwater_wetland

3.0 Sources of Financial and Technical Assistance

Identifying and securing technical and financial assistance is a key step in project success. Funding in particular is the key limiter in project implementation, but implementing a technically sound plan and project design is critical for ensuring proper stormwater management. Resources for financial and technical assistance are discussed below.

3.1 Financial Assistance

3.1.1 New Jersey Highlands Council

Conforming Highlands municipalities are eligible to receive grant funding to support activities such as stormwater structure mapping, development of mitigation plans, development of a stormwater control ordinance with added Highlands protections and associated training. To be eligible, a municipality must first submit a draft scope of work. That scope of work is reviewed by Highlands Council Staff and the request, if valid and appropriate, is finalized in accordance with the Plan Conformance Implementation Grant Agreement.

3.1.2 Other Sources

Most grant funding opportunities germane to this document are likely to originate at either the US Environmental Protection Agency (EPA) or New Jersey Department of Environmental Protection (NJDEP). EPA grants that may be applicable to stormwater management projects include the following:

- Clean Water State Revolving Fund: These are low-interest loans that can be used to fund a wide variety of stormwater projects including the repair of existing municipally-owned systems and green stormwater practices that maintain and restore natural hydrology by infiltrating, evapotranspiring and harvesting stormwater. As a loan, this would often require a governmental sponsor to assume the debt.
- Environmental Education Grants: While focused primarily on education and outreach these grants must also meet environmental priorities as well. Several ways this grant could be used in the context of this document would be to use a demonstration project as an educational tool for further expansion in the Highlands. There are of course other avenues that could be and should be explored.
- Environmental Justice Grants: Environmental Justice Small Grants Program seeks to fund grassroots organizations in partnerships (sometimes with government agencies). One of the top priorities is protecting water resources.
- Five Star Restoration Programs: These are relatively modest grants aimed at community-based restoration projects.
- Section 319 Grants and Nonpoint Source (NPS) Mini-grants: The 319 grants are probably the most well-known and among the best funded grants for addressing NPS impairments, which

is directly related to functional impairments in stream corridors. While a Federal grant, this is administered by the State. Formerly, these grants could be used in a variety of ways, including the development of protection plans, but now the focus is on implementation projects.

Other federal agencies that maintain grant programs include the National Oceanic and Atmospheric Administration (NOAA), United States Department of Agricultural (USDA) and especially the Natural Resources Conservation Service (NRCS) section of the USDA, the United States Fish and Wildlife Service (USFWS), and the United States Geological Survey (USGS). More information about these topics can be found at:

http://water.epa.gov/grants_funding/shedfund/federal.cfm and http://www.grants.gov/

The state also maintains a number of grant opportunities. While most of these are administered through the NJDEP, the Department of Agriculture also provides funding opportunities. More information can be found at the New Jersey Grants website, http://www.nj.gov/nj/gov/njgov/grants.html. Some available grant opportunities that may be applicable to stormwater management projects include:

- Community Stewardship Incentive Program Grants: The NJDEP division of Parks and Forestry administers grants with a matching requirement up to $20,000 for projects that aid and promote sustainable, healthy tree cover in New Jersey communities.
- Green Acres Program Grants and Loans: These grants and loans are used to protect environmentally sensitive open space, water resources and other significant natural and historical open space.
- New Jersey Clean Communities Grants: Litter abatement program created by the Clean Communities Act of 1986.

Sustainable Jersey is a certification program for municipalities in New Jersey interested in implementing environmental measures that result in cost savings and the long-term health of their communities. Sustainable Jersey, launched in 2009, is a nonprofit, non-partisan organization that provides tools, training and financial incentives to support and reward communities as they pursue sustainability programs. Sustainable Jersey offers grants intended to help local governments make progress toward a sustainable future in general and specifically toward Sustainable Jersey certification. Green building design is included among the projects eligible to receive funding. Oftentimes, stormwater management is a component of green building design. Additional information regarding Sustainable Jersey's Small Grants Program can be found online at: http://www.sustainablejersey.com/grants-resources/.

In addition, grants for restoration projects are issued by the New Jersey Freshwater Wetlands Mitigation Council (NJDEP Division of Land Use Regulation). The Mitigation Council is responsible for the governance of the Wetlands Mitigation Bank, which serves as a repository for land donations

and monetary contributions collected as a result of freshwater/state open water impacts that cannot be mitigated for on-site, off-site, or at an existing wetland mitigation bank. As such, the Mitigation Council is responsible for the disbursement of funds to purchase land for the enhancement or restoration of degraded freshwater wetlands, to actively enhance or restore degraded freshwater wetlands on any public lands, and to preserve freshwater wetlands and critical transition areas. Eligible applicants include municipalities and nonprofit organizations. More information can be found at: http://www.state.nj.us/dep/landuse/mitigate.html.

Finally, there are also a large number of grant or low-interest loan opportunities available from both public and private sectors. Such opportunities require extensive research and may benefit from collaborative efforts between municipalities and nonprofits.

3.2 Technical Assistance

The technical requirements of the different stormwater management measures identified in this manual vary considerably in design, construction, and monitoring. Most technical demands, project design, and even permitting, will be shouldered by hired consultants with an expertise in stormwater management and engineering. These consultants will also provide other services at need, such as preparing grant submissions, performing additional biological and civil surveys, construction oversight, and others. Contractors may also need to be hired if the implementation projects require earthmoving equipment or other specialized practices. In any case, much of the technical assistance needed to execute any single project is provided by the people hired and ultimately will hinge on their project experience, familiarity with regulatory and engineering requirements, and their ability to adapt to new management paradigms. But there is still much in terms of project development, planning, administration, management, philosophy, design, and other related components that can be gleaned from a number of sources. These sources can vary considerably but include nonprofit organizations like watershed groups, academics and academic institutions, and governmental organizations from the municipal to the federal level. Besides directly interfacing with these groups, there is also a very expansive set of published literature on these topics.

Relatively few agencies will offer true technical assistance and work closely in the design or implementation process and instead primarily function in an advisory or oversight role. A major exception is the North Jersey RC&D which works with the County Soil Conservation Districts and other agencies to promote conservation projects including land conservation, water management, and environmental enhancement all of which are directly applicable to preserving and protecting water resources. The New Jersey Water Supply Authority is another public agency that promotes similar projects, although their goal is more narrowly focused on the protection of water quality and water quantity within the Raritan Basin (and some other portions of New Jersey) specifically to continue to meet consumptive demand needs. In any case, they also promote projects seeking to preserve the functions of stream corridors. The Rutgers Cooperative Extension is another very valuable resource for technical assistance with county offices located throughout the Highlands. The Extension is often

a primary resource for agricultural matters, but they also maintain a number of programs and projects related to environmental and natural resources.

Other agencies that will on occasion render direct technical assistance, usually when working on a defined project of interest, include the EPA, NJDEP, United State Army Corps of Engineers (USACE), USDA NRCS, and the USFWS.

Technical literature resources include:

- NJ Stormwater BMP Manual – www.njstormwater.org
- The River Network – www.rivernetwork.org
- Association of New Jersey Environmental Commissions – www.anjec.org
- Green Values Stormwater Toolbox – http://greenvalues.cnt.org/
- New Jersey NRCS Programs – www.nj.nrcs.usda.gov/programs/

Additional sources of information:

- New Jersey Section American Water Resources Association: http://nsawra.onefireplace.org/
- New Jersey Water Supply Authority: http://www.njwsa.org/
- North Jersey Resource Conservation and Development Program: http://northjerseyrcd.org/
- Rutgers New Jersey Agricultural Experiment Station – Environment and Natural Resources: http://njaes.rutgers.edu/environment/
- Rutgers New Jersey Agricultural Experiment Station – New Jersey Water Resources Institute: http://njwrri.rutgers.edu/
- US Environmental Protection Agency – Stormwater Management webpage: http://www.epa.gov/greeningepa/stormwater/

4.0 References

Highlands Water Protection and Planning Council. 2008. *Highlands Regional Master Plan*. Highlands Council. Chester, NJ.

NJDEP Division of Watershed Management. April 2004. *New Jersey Stormwater Best Management Practices Manual*. Trenton, NJ.

USEPA. 2008. *Handbook for Developing Watershed Plans to Restore and Protect our Waters*. U.S Environmental Protection Agency, Office of Water, Nonpoint Source Control Branch. Washington, D.C.

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Appendix A:

Stormwater Plant Lists and Associated Tables

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Common Name	Scientific Name	Plant Type	Hydrologic Zone	Wetland Indicator	Inundation Tolerance	Commercial Availability
Arrow arum	Peltandra virginica	Grass-like	[1,2],3	OBL	Yes	Plants, Seed
Arrowhead, bull-tongue	Sagittaria lancifolia	Perennial	[1,2],3	OBL	Yes	Plants
Arrowhead, duck potato	Sagittaria latifolia	Perennial	[1,2],3	OBL	0-2'	Plants, Bare-root, Seed
Arrowhead, grass-leaf	Sagittaria graminea	Perennial	[1,2],3	OBL	0-1'	Plants
Aster, calico	Aster lateriflorus	Perennial	[2,3,4]	FACW-	Seasonal	Seed, Plants
Aster, New England	Aster novae-angliae	Perennial	[2,3],4	FACW	Yes	Seed, Plants
Aster, New York	Aster novibelgil	Perennial	[2,3],4	FACW+	Yes	Seed, Plants
Aster, panicled	Aster simplex (lanceolatus)	Perennial	[2,3],4	FACW	Yes	Seed, Plants
Aster, white heath	Aster ericoides	Perennial	3,[4,5,6]	FACU	No	Seed
Aster, white wood	Aster divercatus	Perennial	4,[5,6]	NI	No	Plants
Beachgrass, American	Ammophila breviligulata	Grass	4[5,6]	FACU-	No	Dormant culms Plants
Beardtongue	Penstemon digitalis	Perennial	3,4,5	FAC	No	Plants, Seed
Beebalm	Monarda didyma	Perennial	3,[4,5]	FAC+	Saturated	Plants, Seed
Beggars-tick	Bidens connata	Annual	[2,3],4	FACW+	Yes	Seed
Beggars-tick	Bidens frondosa	Annual	2,[3,4]	FACW	Yes	Seed
Bentgrass, creeping	Agrostis palustris	Grass	[2,3],4	FACW	Yes	Seed
Bergamot, wild	Monarda fistulosa	Perennial	[4,5,6]	UPL	No	Plants, Seed
Black-eyed susan	Rudbeckia hirta	Perennial	4,[5,6]	FACU-	No	Plugs, Seed
Bladderwort, common	Utricularia macrorhiza	Perennial	[1,2],3	OBL	Yes	Plants
Blue lobelia	Lobelia siphilitica	Perennial	1,[2,3],4	FACW+	Yes	Plants, Seed
Bluebells, Virginia	Mertensia virginica	Perennial	[2,31,4	FACW	Yes	Plants, Seed
Bluegrass, fowl	Poa palustris	Grass	[2,3],4	FACW	Yes	Seed
Bluegrass, rough	Poa trivialis	Grass	2,[3,4],5	FACW	Seasonal	Seed
Bluestem, big	Andropogon gerardii	Grass	[4,5],6	FAC	No	Seed, Plants
Bluestem, little	Schizachyrium scoparium	Grass	6	FACU	No	Seed, Plants
Boneset	Eupatorium perfoliatum	Perennial	[2,3],4	FACW+	Yes	Plants, Seed
Broomsedge	Andropogon virginicus	Grass	[4,5],6	FACU	No	Seed
Broomsedge, lowland	Andropogon glomeratus	Grass	[2,3],4	FACW+	Yes	Plants
Bulrush, alkali	Scirpus robustus	Grass-like	1,[2],3	OBL	Salt, edge	Plants
Bulrush, chairmakers	Scirpus americanus	Grass-like	[1,2],3	OBL	0-6"	Plants, Seed
Bulrush, green	Scirpus atrovirens	Grass-like	[1,2,],3	OBL	Yes	Plants, Seed
Bulrush, hardstemmed	Scirpus acutus	Grass-like	[1,2],3	OBL	0-3'	Plants, Seed
Bulrush, river	Scirpus fluviatilis	Grass-like	[1,2],3	OBL	0-1'	Seed
Bulrush, softstem	Scirpus tabermontanii	Grass-like	[1,2],3	OBL	0-1'	Plants, Seed
Bulrush, three-square	Scirpus pungens	Grass-like	[2,3],4	FACW+	0-6"	Plants, Seed
Burnet, Canada	Sanguisorba canadensis	Perennial	4,[5,6]	FACW+	Yes	Plants
Burreed, American	Sparganium americanum	Emergent Perennial	[1,2],3	OBL	0-1'	Plants, Seed
Burreed, giant	Sparganium eurycarpum	Emergent Perennial	[1,2],3	OBL	Yes	Plants, Seed
Bushclover, roundheaded	Lespedeza capitata	Legume	4,5,6	FACU	No	Seed, Plants
Butter-cup, yellow water	Ranunculus flabellaris	Perennial	[2,3,4]	FACW	Yes	Plants
Butterflyweed	Asclepias tuberosa	Perennial	[5,6]	NI	No	Plants, Seed
Cardinal flower	Lobelia cardinalis	Perennial	1,[2,3],4	FACW+	Yes	Plants, Seed
Celery, wild	Vallisneria americana	Perennial	[1,2],3	OBL	Yes	Plants, Seed
Club, golden	Orontium aquaticum	Perennial	[1,2],3	OBL	Yes	Plants
Columbine, wild	Aquilegia canadensis	Perennial	[3,4],5	FAC	No	Plants, Seed
Coneflower, brown-eyed	Rudbeckia triloba	Perennial	4,[5,6]	FACU	No	Plants, Seed
Coneflower, cut-leaf	Rudbeckia laciniata	Perennial	[2,3],4	FACW	Yes	Seed, Plants
Coneflower, orange	Rudbeckia fulgida	Perennial	[3,4],5	FAC	No	Seed
Cordgrass, big	Spartina cynosuroides	Grass	[1,2],3	OBL	Tidal-fresh	Plugs
Cordgrass, prairie	Spartina pectinata	Grass	[1,2],3	OBL	Tidal-fresh	Plants, Seed
Cordgrass, saltmarsh	Spartina alterniflora	Grass	[1,2],3	OBL	Salt, edge	Plants, Seed
Cordgrass, saltmeadow	Spartina patens	Grass	1,[2,3],4	FACW+	Salt, edge	Plants
Coreopsis, dwarf plains	Coreopsis tinctoria	Annual	3,[4,5],6	FAC-	No	Seed, Plants
Coreopsis, lance-leaved	Coreopsis lanceolata	Perennial	5,6	FACU	No	Seed, Plants
Coreopsis, pink	Coreopsis rosea	Perennial	2,[3,4]	FACW	Yes	Seed, Plants

Common Name	Scientific Name	Plant Type	Hydrologic Zone	Wetland Indicator	Inundation Tolerance	Commercial Availability
Coreopsis, tall	Coreopsis tripteris	Perennial	[2,3],4	FAC	Yes	Plants, Seed
Cutgrass, rice	Leersia oryzoides	Grass	[1,2],3	OBL	0-6"	Plants, Seed
Dragon-head, false (obedient plant)	Physostegia virginiana	Perennial	2,[3,4],5	FAC+	Saturated	Plants, Seed
False-hellebore, American	Veratrum viride	Perennial	[2,3,4]	FACW+	Yes	Plants, Seed
False-solomon's-seal	Smilacina racemosa	Perennial	[4,5],6	FACU-	No	Seed
Fern, cinnamon	Osmunda cinnamomea	Fern	[2,3],4	FACW	Saturated	Plants
Fern, New York	Thelypteris noveboracensis	Fern	[3,4],5	FAC	Saturated	Plants, Seed
Fern, royal	Osmunda regalis	Fern	[1,2],3	OBL	Saturated	Plugs
Fern, sensitive	Onoclea sensibilis	Fern	[2,3],4	FACW	Saturated	Plants, Seed
Fescue, hard	Festuca duriuscula	Grass	[3,4,5,6]	NI	No	Seed
Fescue, red	Festuca rubra	Grass	[4,5]	FACU	No	Seed
Fescue, sheeps	Festuca ovina	Grass	[4,5],6	NI	No	Seed
Gamagrass, eastern	Tripsacum dactyloides	Grass	2,[3,4],5	FACW	Yes	Seed
Goldenrod, roughleaf	Solidago patula	Perennial	1,[2,3,]	OBL	Yes	Seed
Goldenrod, seaside	Solidago sempervirens	Perennial	[2,3],4	FACW	Yes	Plants, Seed
Goldenrod, silverrod	Solidago bicolor	Perennial	5,6	NI	No	Plants, Seed
Goldenrod, stiff	Solidago rigida	Perennial	5,6	UPL	No	Plants, Seed
Goldenrod, wrinkleleaf	Solidago rugosa	Perennial	3,[4,5]	FAC	No	Plants, Seed
Grass, alkali	Puccinellia distans	Grass	[1,2],3	OBL	Yes	Seed
Grass, deertongue	Dichanthelium clandestinium	Grass	[2,3],4	FAC+	Seasonal	Seed
Grass, Japanese millet	Echinochloa frumentcea	Annual Grass	[2,3],4	NI	Yes	Seed
Grass, redtop	Agrostis gigantea	Grass	[2,3,],4	FACW	Yes	Seed
Hornwort, common	Ceratopliyilurn dernersurn	Perennial	[1,21,3	OBL	5-Jan	Plants
Horsetail, rough	Equisetum hyemale	Fern-like	[2,3],4	FACW	Yes	Plants
Indiangrass	Sorghastrum nutans	Grass	5,6	UPL	No	Seed, Plants
Iris, blue flag	Iris versicolor	Perennial	[1,2],3	OBL	0-6"	Plants, Seed
Iris, yellow flag	Iris pseudacorus	Perennial	[3,4],5	FAC	No	Plants, Seed
Ironweed, New York	Vernonia noveboracensis	Perennial	[2,3],4	FACW+	Yes	Plants, Seed
Jack-in-the-pulpit, swamp	Arisaerna triphyllurn	Perennial	[2,3],4	FACW	Seasonal	Plants
Jacob's ladder	Polemonium reptans	Perennial	[4,5],6	FACU	No	Seed
Jacob's-ladder, bog	Polernoniurn van- bruntlae	Perennial	[3,4],5	FAC+	Saturated	Plants
Joe-pye, purple	Eupatoriadelphus purpureus	Perennial	3,[4,5]	FAC	Yes	Plants, Seed
Joe-pye, spotted	Eupatorium maculatus	Perennial	2,[3,4]	FACW	Yes	Plants, Seed
Lily, turk's-cap	Lilium superbum	Perennial	[2,3,4]	FACW+	Yes	Plants, Seed
Lizards tail	Saururus cernuus	Perennial	2,3,4	OBL	0-1'	Plants
Lotus, American	Nelumbo lutea	Perennial	[1,2],3	OBL	1-5'	Plants, Seed
Lovegrass, purple/tumble	Eragrostis spectabilis	Grass	[5,6]	NI	No	Plants, Seed
Mallow, swamp rose	Hibiscus moscheutos	Perennial	2,3	OBL	0-3"	Plants
Mallow, Virginia seashore	Kosteletzkya virginica	Perennial	[1,2],3	OBL	Yes, saltedge	Plants
Managrass, American	Glyceria grandis	Grass	[1,2],3	OBL	Yes	Plants, Seed
Managrass, Atlantic	Glyceria obtusa	Grass	[1,2],3	OBL	0-1'	Plants, Seed
Managrass, fowl	Glyceria striata	Grass	[1,2],3	OBL	Seasonal	Plants, Seed
Managrass, rattlesnake	Glyceria canadensis	Grass	[1,2],3	OBL	0-1'	Plants, Seed
Marsh marigold	Caltha palustris	Perennial	3,4	OBL	6", saturated	Plants, Seed
Marsh-mallow, common	Althaea officinalis	Perennial	[1,2,3]	FACW+	Yes	Plants, Seed
Meadow-rue, tall	Thalictrum pubescens	Perennial	[2,3,4]	FACW+	Yes	Seed, Plants
Milkweed, swamp	Asclepias incarnata	Perennial	2,3	OBL	Saturated	Plants, Seed
Monkey-flower	Mimulus ringens	Perennial	[1,2],3	OBL	Yes	Plants, Seed
Mountain-mint, slender	Pycnantheinum tenuifolium	Perennial	[2,3,4]	FACW	Yes	Plants, Seed
Nutsedge/ chufa	Cyperus esculentus	Grass-like	[2,3],4	FACW	Yes	Seed, Plants

Common Name	Scientific Name	Plant Type	Hydrologic Zone	Wetland Indicator	Inundation Tolerance	Commercial Availability
Panicgrass, coastal	Panicum amarulum	Grass	3,4,[5,6]	FACU-	Yes	Seed, Plants
Partridge-berry	Mitchella repens	Groundcover	[4,5],6	FACU	No	Plants
Pennsylvania smartweed	Polygonum pensylvanicum	Annual	[2,3]	FACW	0-6"	Plants, Seed
Phlox, meadow	Phlox maculata	Perennial	[2,3,4]	FACW	Yes	Plants
Phlox, thick-leaf	Phlox carolina	Perennial	4,[5,6]	FACU	No	Plants
Pickerelweed	Pontederia cordata	Perennial	2,3	OBL	0-1'	Plants, Seed
Pondweed, long-leaf	Potamogeton nodosus	Perennial	[1,2]	OBL	1' min-6'	Plants
Pondweed, sago	Potamogeton pectinatus	Perennial	[1,2]	OBL	1' min-24'	Plants
Primrose, evening	Oenothera biennis	Perennial	4,[5,6]	FACU-	No	Seed
Reedgrass, bluejoint	Calamagrostis canadensis	Grass	1,[2,3]	FACW+	6", saturated	Seed, Plants
Reedgrass, wood	Cinna arundinacea	Perennial	2,[3,4]	FACW+	Yes	Plants, Seed
Rush, baltic	Juncus balticus	Grass	[2,3],4	FACW	Yes	Plants, Seed
Rush, bayonet	Juncus militaris	Grass-like	[2,3],4	OBL	Yes	Plants, Seed
Rush, blackgrass	Juncus gerardili	Grass-like	[2,3],4	FACW+	Yes, saltedge	Plants, Seed
Rush, Canada	Juncus canadensis	Grass-like	[1,2],3	OBL	Yes	Plants, Seed
Rush, needlegrass	Juncus roemerianus	Grass-like	[1,2],3	OBL	Yes, saltedge	Plants, Seed
Rush, soft	Juncus effusus	Grass-like	[2,3],4	FACW+	0-1	Plants, Seed
Saltgrass, seashore	Distichlis spicata	Grass	[2,3,],4	FACW+	Salt, edge	Plants
Sedge, awl	Carex stipata	Grass-like	[4,5],6	NI	No	Plants, Seed
Sedge, bearded	Carex comosa	Grass-like	[1,2],3	OBL	6" , saturated	Plants, Seed
Sedge, bladder	Carex intumescens	Grass-like	1,[2,3]	FACW+	Yes	Plants, Seed
Sedge, broom	Carex scoparia	Grass-like	[3,4],5	FACW	Yes	Plants, Seed
Sedge, fox	Carex vulpinoidea	Grass-like	[1,2],3	OBL	Sat. 0-6"	Plants, Seed
Sedge, fringed	Carex crinita	Grass-like	[1,2],3	OBL	Yes	Plants, Seed
Sedge, hop	Carex lupulina	Grass-like	[1,2],3	OBL	Yes	Seed
Sedge, lakebank	Carex lacustris	Grass-like	[1,2],3	OBL	Sat. 0-2	Plants, Seed
Sedge, pennsylvania	Carex pennsylvanica	Grass-like	[5,6]	NI	No	Plants
Sedge, shallow	Carex lurida	Grass-like	[1,2],3	OBL	Yes	Plants, Seed
Sedge, short's	Carex shortiana	Grass-like	3,[4,5]	FAC	Yes	Plants
Sedge, three-sided	Dulichium arundinaceum	Grass-like	1,[2,3]	OBL	Yes	Plants, Seed
Sedge, tussock	Carex stricta	Grass-like	[1,2],3	OBL	Sat, 0-6"	Plants, Seed
Sedge, yellow-fruit	Carex annectens	Grass-like	[2,3]4	FACW+	Yes	Plants, Seed
Seedbox	Ludwigia x lacustris	Annual	[1,2],3	OBL	Yes	Plants, Seed
Senna, Maryland	Cassia marilandica	Legume	3,[4,5]	FAC	Saturated	Seed
Sneezeweed, common	Helenium autumnale	Perennial	[2,3],4	FACW+	Yes	Seed
Solomon's-seal, small	Polygonatum biflorum	Perennial	[4,5],6	FACU	No	Plants
Spikerush, blunt	Eleocharis obtusa	Grass-like	[1,2],3	OBL	0-6"	Plants
Spikerush, creeping	Eleocharis palustris	Grass-like	[1,2],3	OBL	Seasonal	Plants,Seed
Spikerush, square-stem	Eleocharis quadrangulata	Grass-like	[1,2],3	OBL	0-1'	Plants
St. John'swort, marsh	Triadenum virginicum	Perennial	[1,2],3	OBL	Yes	Seed
Swamp-loosestrife, hairy	Decodon verticillatus	Perennial	[1,2],3	OBL	Yes	Plants
Sweetflag	Acorus americanus	Perennial	1,[2,3]	OBL	Yes	Plants, Seed
Switchgrass	Panicum virgatum	Grass	2,[3,4],5	FAC	Seasonal	Seed & Plants
Turtlehead, red	Chelone obliqua	Perennial	[1,2],3	OBL	Yes	Plants
Turtlehead, white	Chelone glabra	Perennial	[1,2],3	OBL	Yes	Plants, Seed
Vervain, blue	Verbena hastata	Perennial	[2,3]4	FACW+	Yes	Plants, Seed
Virginia/riparian wild rye	Elymus virginicus/riparius	Grass	2,[3,4]	FACW-	Yes	Seed & Plants
Water-lily, white	Nymphaea odorata	Perennial	[1,2],3	OBL	1-3'	Plants
Water-lily, yellow (spatterdock)	Nuphars luteum	Perennial	[1,2],3	OBL	1-3'	Plants
Water-plantain	Alisma plantago- aquatica	Perennial	[2,3],4	OBL	Yes	Plants, Seed
Woolgrass	Scirpus cyperinus	Grass-like	[2,3],4	FACW	Yes	Plants, Seed

Source: New Jersey Stormwater Best Management Practices Manual - Chapter 7: Landscaping - February 2004

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Stormwater Plant List - Woody

Common Name	Scientific Name	Form	Zone	Indicator	Inundation	Commercial Availability
Alder, brook-side	Alnus serrulata	Tree	[1,2],3	OBL	0-3"	Yes
Alder, speckled	Alnus rugosa	Tree	[2,3]	FACW+	Yes	Yes
Arrow-wood, southern	Viburnum dentatum	Shrub	[3,4],5	FAC	Seasonal	Yes
Ash, black	Fraxinus nigra	Tree	[2,3],4	FACW	Saturated	Yes
Ash, green	Fraxinus pennsylvanica	Tree	[2,3],4	FACW	Seasonal	Yes
Ash, white	Fraxinus americana	Tree	[4,5],6	FACU	No	Yes
Aspen, big-tooth	Populus grandidentata	Tree	[4,5,6]	FACU	No	Yes, limited
Aspen, quaking	Populus tremuloides	Tree	[4,5],6	FACU	Yes	Yes, limited
Azalea, dwarf	Rhododendron atlanticum	Shrub	[2,3,4],5	FAC	Yes	No
Azalea, smooth	Rhododendron arborescens	Shrub	[3,4],5	FAC	Yes	Yes
Azalea, swamp	Rhododendron viscosum	Shrub	[1,2,3],4	OBL	Seasonal	Yes
Basswood, American	Tilia americana	Tree	3,[4,5],6	FACU	No	Yes
Bayberry, northern	Myrica pennsylvanica	Shrub	[3,4],5	FAC	Seasonal	Yes
Bayberry, southern	Myrica cerifera	Shrub	2,[3,4],5	FAC	Reg.inunda	Yes
Beech, American	Fagus grandifolia	Tree	[4,5],6	FACU	No	Yes
Birch, gray	Betula populifolia	Tree	[3,4],5	FAC	Seasonal	Yes
Birch, river	Betula nigra	Tree	[2,3],4	FACW	Seasonal	Yes
Birch, yellow	Betula lutea	Tree	[3,4],5	FAC	Yes	No
Black gum, swamp tupelo	Nyssa sylvatica	Tree	1,[2,3]	FACW+	Seasonal	Yes
Black-haw	Viburnum prunifolium	Shrub	[3,4,5],6	FACU	Yes	Yes
Blueberry, bog	Vaccinium uliginosum	Shrub	2,3,4,5,6	FACU+	Yes	No
Blueberry, highbush	Vaccinium corymbosum	Shrub	[2,3]	FACW-	Seasonal	Yes
Blueberry, lowbush	Vaccinium angustifolium	Shrub	3,[4,5,6]	FACU-	No	Yes
Box-elder	Acer negundo	Tree	2,[3,4]	FAC+	Seasonal	Yes
Butternut	Juglans cinerea	Tree	[3,4,5,6]	FACU+	Yes	Yes
Buttonbush, common	Cephalanthus occidentalis	Shrub	[1,2],3	OBL	0-3'	Yes
Cedar, atlantic white	Chamaecyparis thyoides	Tree	[1,2],3	OBL	Saturated	Yes
Cedar, eastern red	Juniperus virginiana	Shrub	4,5,6	FACU	No	Yes
Cedar, northern wh1te	Thuja occidentalis	Tree	[2,3],4	FACW	Seasonal	Yes
Cherry, black	Prunus serotina	Tree	[4,5],6	FACU	No	Yes
Cherry, choke	Prunus virginiana	Tree	4,5,6	FACU	Yes	Yes
Cotton-wood, eastern	Populus deltoides	Tree	[3,4],5	FAC	Seasonal	Yes
Dangle-berry	Gaylussacia frondosa	Shrub	2,[3,4],5	FAC	Yes	Yes, limited
Dog-hobble, coastal	Leucothoe axillaris	Shrub	[2,3,4],5	FACW+	Yes	Yes, limited
Dogwood, flowering	Cornus florida	Shrub-Tree	4,5,6	FACU-	No	Yes
Dogwood, gray	Cornus racemosa	Shrub	[3,4],5	UPL	Seasonal	Yes
Dogwood, redtwig	Cornus serecia	Shrub	1,2[3,4],5	FACW+	Yes	Yes
Dogwood, silky	Cornus amomum	Shrub	[2,3],4	FACW	Seasonal	Yes
Elm, slippery	Ulmus rubra	Tree	[3,4],5	FAC	Yes	Yes
Fetterbush	Leucothoe racemosa	Shrub	3,[4,5],6	FACW	Yes	Yes, limited
Fetter-bush	Lyonia lucida	Shrub	[2,3,4],5	FACW	Yes	Yes, limited
Germander, American	Teucrium canadense	Shrub	[2,3,4],5	FACW	Yes	No
Groundsel tree	Baccheris halimifolia	Shrub	[2,3],4	FACW	0-6"	Yes
Gum, sweet	Liquidambar styraciflua	Tree	[3,4],5	FAC	Yes	Yes

Common Name	Scientific Name	Form	Zone	Indicator	Inundation	Commercial Availability
Hackberry, common	Celtis occidentalis	Shrub-Tree	4,5,6	FACU	Seasonal	Yes
Hawthorn, cockspur	Crataegus crus-galli	Tree	2,[3,4,5],6	FACU	Yes	No
Hawthorn, downy	Crataegus mollis	Tree	1,2,[3,4,5]	FACU	Yes	Yes, limited
Hawthorn, parsley	Crataegus marshallii	Tree	[1,2,3,4],5,	FACU+	Yes	Yes, limited
Hazel-nut, American	Corylus americana	Shrub	3,[4,5,6]	FACU-	No	Yes
Hazel-nut, beaked	Corylus cornuta	Shrub	3,[4,5,6]	FACU-	No	No
Hemlock, eastern	Tsuga canadensis	Tree	4,5,6	FACU	No	Yes
Hickory, big shellbark	Carya laciniosa	Tree	[3,4],5	FAC	Yes	Yes
Hickory, bitter-nut	Carya cordiformis	Tree	4,[5,6]	FACU+	No	Yes
Hickory, pecan	Carya illinoensis	Tree	[4,5],6	FACU	Yes	Yes
Hickory, red	Carya ovalis	Tree	4,[5,6]	FACU-	No	No
Hickory, shag-bark	Carya ovata	Tree	4,[5,6]	FACU-	Yes	Yes
Hickory, sweet pignut	Carya glabra	Tree	[4,5],6	FACU-	No	No
Holly, American	Ilex opaca	Shrub	4,5,6	FACU	Limited	Yes
Holly, deciduous	Ilex decidua	Shrub	1,[2,3,4,5]	FACW-, FACW	Seasonal	Yes
Hop-hornbeam, eastern	Ostrya virginiana	Shrub-Tree	[3,4,5,6]	FACU-	Seasonal	Yes
Hornbeam, American	Carpinus caroliniana	Tree	[3,4],5	FAC	Some	Yes
Huckleberry, black	Gaylussacia baccata	Shrub	3,[4,5],6	FACU	No	No
Huckleberry, dwarf	Gaylussacia dumosa	Shrub	2,[3,4],5	FAC	Yes	No
Hydrangea, wild	Hydrangea arborescens	Shrub	3,[4,5,6]	UPL, FACU	No	No
Inkberry	Ilex glabra	Shrub	[2,3],4	FACW-	Seasonal	Yes
Laurel, mountain	Kairnia latifolia	Shrub	4,5,6	FACU	No	Yes
Locust, black	Robinia pseudoacacia	Tree	4,[5,6]	FACU	Yes	Yes
Magnolia, sweet bay	Magnolia virginiana	Tree	[3,4],5	FAC	Yes	Yes
Maleberry	Lyonia ligustrina	Shrub	[2,3,4],5	FACW	Yes	Yes, limited
Maple, mountain	Acer spicaturn	Tree	4,5,6	FACU	No	No
Maple, red	Acer rubrurn	Tree	[3,4],5	FAC	Seasonal	Yes
Maple, silver	Acer saccharinum	Tree	[2,3],4	FACW	Seasonal	Yes
Maple, striped	Acer pensylvanicum	Shrub-Tree	3,[4,5,6]	FACU	No	No
Marsh elder	Iva frutescens	Shrub	1,[2,3]	FACW+		Yes
Meadow-sweet, broad-leaf	Spiraea latifolia	Shrub	[2,3,4]	FACW+	Yes	Yes
Meadow-sweet, narrow- leaf	Spiraea alba	Shrub	[1,2,3,4],5	FACW+	Yes	No
Nannyberry	Vi burn urn lentago	Shrub	[3,4],5	FAC	Seasonal	Yes
Ninebark, eastern	Physocarpus opulifolius	Shrub	[2,3],4	FACW-	Yes	Yes
Oak, bur	Quercus rnacrocarpa	Tree	3,[4,5],6	FAC-	Yes	Yes
Oak, chestnut	Quercus prinus	Tree	4,5,6	FACU	No	Yes
Oak, chinkapin	Quercus rnuhlenbergii	Tree	[3,4],5	FAC	Yes	Yes
Oak, overcup	Quercus lyrata	Tree	[1,2],3	OBL	Yes	Yes
Oak, pin	Quercus palustris	Tree	[2,3],4	FACW	Seasonal	Yes
Oak, post	Quercus stellata	Tree	3,[4,5,6]	NI	No	Yes, limited
Oak, red	Quercus rubra	Tree	6	FACU-	No	Yes
Oak, scarlet	Quercus coccinea	Tree	6		No	Yes
Oak, shumard	Quercus shumardii	Tree	2,[3,4]	FAC+	Yes	Yes
Oak, swamp chestnut	Quercus michauxii	Tree	1,[2,3,4,5]	FACW	Yes	Yes

Stormwater Plant List - Woody (con't.)

Common Name	Scientific Name	Form	Zone	Indicator	Inundation	Commercial Availability
Oak, swamp white	Quercus bicolor	Tree	1,[2,3]	FACW+	Seasonal	Yes
Oak, water	Quercus nigra	Tree	[3,4],5	FAC	Seasonal	Yes
Oak, white	Quercus alba	Tree	[4,5,6]	FACU	Yes	Yes
Oak, willow	Quercus phellos	Tree	2,[3,4]	FAC+	Seasonal	Yes
Pepper-bush, sweet	Clethra alnifolia	Shrub	2[3,4]	FAC+	Seasonal	Yes
Pine, eastern white	Pinus strobus	Tree	4,5,6	FACU	No	Yes
Pine, loblolly	Pinus taeda	Tree	3,[4,5],6	FAC-	Seasonal	Yes
Pine, pitch	Pinus rigida	Tree	4,5,6	FACU	Seasonal	Yes
Pine, pond	Pinus serotina	Tree	[1,2],3	OBL	Yes	No
Pine, virginia	Pinus viginiana	Tree	6		No	Yes
Redbud, eastern	Cercis canadensis	Shrub-Tree	3[4,5,6]	UPL, FACU	No	Yes
Rhododendron, rosebay	Rhododendron maximum	Shrub	[3,4],5	FAC	Yes	No
Rhododendron	Rhododendron canadense	Shrub	1,[2,3,4],5	FACW	Yes	Yes, limited
Rose, pasture	Rosa carolina	Shrub	[5,6]	NI	No	Yes
Rose, swamp	Rosa palustris	Shrub	[2,3]4	OBL	Yes	Yes
Rose, virginia	Rosa virginiana	Shrub	[3,4]5	FAC	Seasonal	Yes
Rosemary, bog	Andromeda polifolia	Shrub	[1,2],3	OBL	Yes	No
Sand-myrtle	Leiophyllum buxifolium	Shrub	3,4[5,6]	FACU-	No	No
Sassafras	Sassafras albidum	Tree	3,[4,5,6]	FACU-	No	Yes
Service-berry, downy	Amelanchier arborea	Shrub-Tree	2,[3,4,5]	FAC-	Yes	Yes
Sheep-laurel	Kalmia angustifolia	Shrub	3,[4,5],6	FAC	Yes	Yes
Silver-berry, American	Elaeagnus commutata	Shrub	[6]	NI	No	No
Stagger-bush, piedmont	Lyonia mariana	Shrub	[3,4],5,6	FAC-	Yes	Yes, limited
Steeple-bush	Spiraea tomentosa	Shrub	1,[2,3,4],5	FACW	Yes	Yes
Strawberry-bush, American	Euonymus americanus	Shrub	1,[2,3,4,5]	FAC	Yes	Yes
Sugar-berry	Celtis laevigata	Shrub	1,[2,3,4,5],6	FACW	Yes	Yes
Sycamore, amer1can	Platanus occidentalis	Tree	[2,3],4	FACW-	Saturated	Yes
Teaberry	Gaultheria procumbens	Shrub	3,[4,5],6	FACU	No	Yes
Tree, tulip	Liriodendron tulipifera	Tree	[4,5],6	FACU	Yes	Yes
Viburnum, maple-leaf	Viburnum acerifolium	Shrub	3,[4,5,6]	NI	No	Yes
Viburnum, possum-haw	Viburnum nudum	Shrub	[1,2],3	OBL	Yes	Yes
Willow, black	Salix nigra	Tree	[2,3]	FACWI-	Seasonal	Yes
Willow, pussy	Salix discolor	Shrub	[2,3],4	FACW	Yes	Yes
Willow, silky	Salix sericea	Shrub	[1,2],3	OBL	Yes	Yes
Willow, tall prairie	Salix humilis	Shrub	3,[4,5],6	FACU	No	No
Willow, virginia	Itea virginica	Shrub	[1,2],3	OBL	O-6~	Yes
Winterberry, common	Ilex verticillata	Shrub	1,[2,3]	FACW+	Seasonal	Yes
Witch-alder, dwarf	Fothergilla gardenii	Shrub	1,[2,3,4],5	FACW	Yes	Yes
Witch-hazel, American	Hamamelis virginiana	Shrub-Tree	3,[4,5],6	FAC-	No	Yes
Withe-rod	Viburnum cassinoides	Shrub	1,[2,3,4],5	FACW	Yes	Yes
Yew, American	Taxus canadensis	Shrub	[3,4,5],6	FAC	Yes	Yes

Source: New Jersey Stormwater Best Management Practices Manual - Chapter 7: Landscaping - February 2004

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Hydrologic Zones

Zone	Zone Description	Hydrologic Conditions
Zone 1	Deep water pool	1-6 feet deep permanent pool
Zone 2	Shallow water bench	6 inches to 1 foot deep
Zone 3	Shoreline fringe	Regularly inundated
Zone 4	Riparian fringe	Periodically inundated
Zone 5	Floodplain terrace	Infrequently inundated
Zone 6	Upland slopes	Seldom or never inundated

Source: New Jersey Stormwater Best Management Practices Manual - Chapter 7: Landscaping - February 2004

Wetland Indicator Designations

Indicator Code	Indicator Status	Designation	Comment
OBL	Obligate Wetland	Hydrophyte	Almost always occur in wetlands
FACW	Facultative Wetland	Hydrophyte	Usually occur in wetlands, but may occur in non-wetlands
FAC	Facultative	Hydrophyte	Occur in wetlands and non-wetlands
FACU	Facultative Upland	Nonhydrophyte	Usually occur in non-wetlands, but may occur in wetlands
UPL	Obligate Upland	Nonhydrophyte	Almost never occur in wetlands

Note: A given indicator status shown with a "+" or a "-" means that the species is more (+) or less (-) often found in wetlands than other plants with the same indicator status without the "+" or "-" designation.