New Jersey Stormwater Best Management Practices Manual

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C H A P T E R 7

Landscaping

Landscaping is critical to improving both the function and appearance of stormwater best management practices (BMPs). This chapter provides landscaping criteria and plant selection guidance for effective stormwater BMPs. Part 1 describes the natural plant communities of New Jersey based on plant hardiness zones and physiographic regions. Plant selection for stormwater BMPs should match as closely as possible the natural plant communities of that region. Part 2 outlines general guidance that should be considered when landscaping any stormwater BMP. Part 3 presents more specific guidance on landscaping criteria and plant selection for individual BMP designs described in Chapter 9. These include:

- constructed stormwater wetlands;
- infiltration basins and sand filter practices;
- bioretention systems;
- open channels;
- vegetative filters and forested buffers;
- wet ponds; and
- extended detention basins.

Part 4 considers plant acquisition and planting guidelines. Part 5 deals with other plant considerations, such as vegetation maintenance, invasive species, plant availability, and costs.[1]

Native Species

This manual encourages the use of native plants in stormwater management facilities. Native plants are defined as species that evolved naturally to live in this region. Practically speaking, this specifically refers to species that lived in New Jersey before Europeans explored and settled in America. Many introduced species were weeds brought in by accident; others were intentionally introduced and cultivated for use as medicinal herbs, spices, dyes, fiber plants, and ornamentals.

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[1] Parts of this chapter were adopted directly from the 2000 Maryland Stormwater Design Manual (Schueler and Claytor 2000). The chapter also contains material added and adapted to the physiography, plant life, and growing conditions of New Jersey.

Introduced species often escape cultivation and begin reproducing in the wild. This is significant ecologically because many introduced species out-compete or even replace indigenous species in the wild. Some introduced or aggressive species are invasive, have few predators, and can take over naturally occurring species at an alarming rate. These include reed canary grass (Phalaris arundinacea), phragmites (Phragmites communis), kudzu (Pueraria spp.), purple loosetrife (Lythrum salicara), Norway maple (Acer platanoides), autumn olive (Elaeagnus umbellata), Japanese honeysuckle (Lonicera japonica), Japanese rose (Rosa muliflora), garlic mustard (Alliaria officinalis), birdsfoot trefoil (Lotus corniculatus), lesser celandine (Ranunculus ficaria), and cattail (Typha latifolia). By planting non-aggressive, native species in stormwater management facilities, we can protect New Jersey's natural heritage, encourage biodiversity, and provide a legacy for future generations.

Note: Although both phragmites and cattails can be invasive, they also provide water quality and some wildlife benefits. These species should not necessarily be recommended and, if they do appear on site, it is questionable whether a considerable amount of effort or money should be spent controlling or eradicating these species.

Native species have distinct genetic advantages over non-native species for planting in New Jersey. Because they have evolved to live here naturally, indigenous plants are best suited for our local climate. This translates into greater survivorship and less replacement maintenance during the life of a stormwater management facility. Both of these attributes provide cost savings for facility owners.

Finally, people often plant exotic species for their ornamental value. While it is important to plant aesthetic stormwater management facilities for public acceptance and maintenance of property value, it is not necessary to introduce foreign species for this purpose. Many native species can be used as ornamentals. The following species are part of New Jersey's natural heritage and provide high aesthetic value throughout the year: rhododendron (Rhododendron maximum), pink azalea (Rhododendron nudiflorum), red maple (Acer rubrum), pin oak (Quercus palustris), sycamore (Platanus occidentalis), flowering and shrub dogwoods (Cornus spp.), mountain laurel (Kalmia latifolia), willow (Salix spp.), white pine (Pinus strobus), Atlantic white cedar (Chamaecyparis thyoides), American holly (Ilex americana), swamp rose (Rosa palustris), sunflowers (Helianthus spp.), lobelias (Lobelia spp), pickerel weed (Pontederia cordata), swamp rose mallow (Hibiscus moscheutos), and yellow pond lily (Nuphar avena).

When selecting ornamentals for stormwater management facilities, planting preference should be given to native ornamentals. Refer to the plant lists in Part 5 for a list of native species available for stormwater management facility planting.

Part 1: Natural Plant Communities of New Jersey

Plant Hardiness Zones

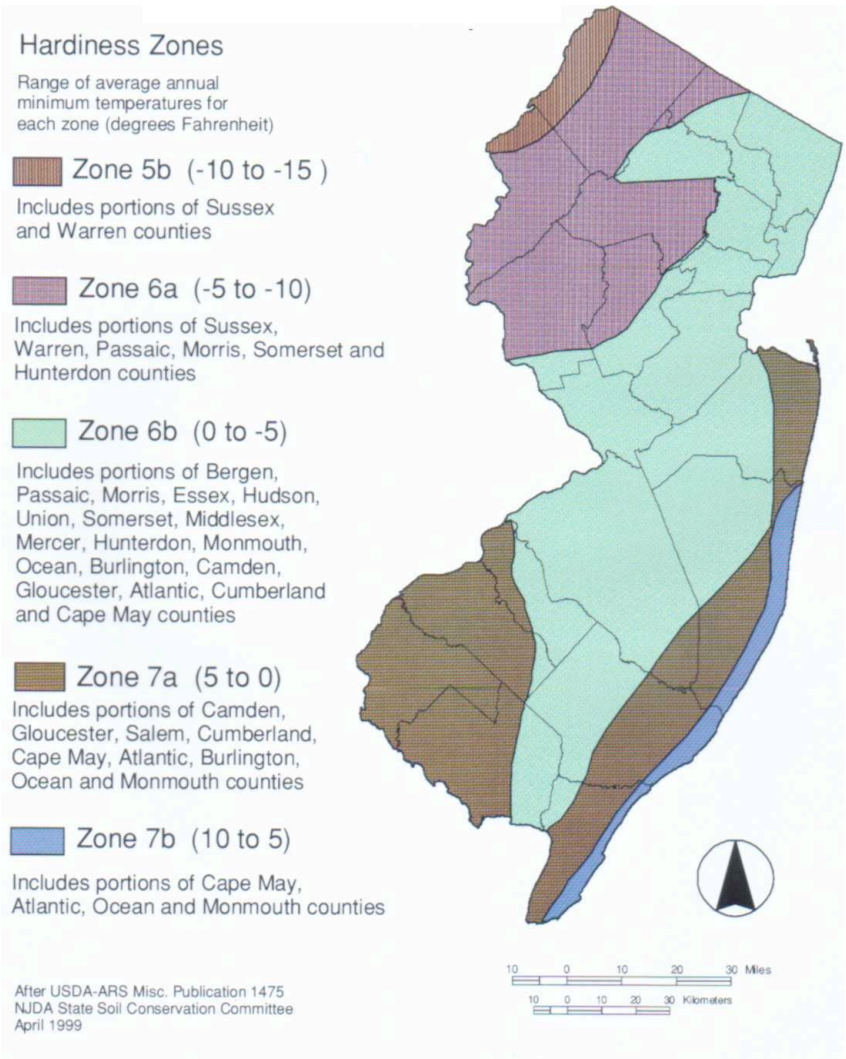
Hardiness zones are based on historical annual minimum temperatures recorded in an area. A BMP's location in relation to plant hardiness zones is important because plants differ in their ability to withstand very cold winters. This does not imply that plants are not affected by summer temperatures; New Jersey summers can be very hot, and heat tolerance should be considered in plant selection as well.

It is best to recommend plants known to thrive in specific hardiness zones. The plant list included at the end of this chapter identifies the hardiness zones for each species listed as a general planting guide. It should be noted, however, that certain site factors can create microclimates or environmental conditions that permit the growth of plants not listed as hardy for that zone. By investigating numerous references and using personal experience, a designer should be able to confidently recommend plants that will survive in microclimates.

Table 7-1: USDA Hardiness Zones for New Jersey

Zone		USDA Minimum Temperature
Temperate Zone 5	a	-20 to -15
	b	-15 to -10
Temperate Zone 6	a	-10 to -5
	b	-5 to 0
Temperate Zone 7	a	0 to 5
	b	5 to 10

Figure 7-1: USDA Plant Hardiness Zones' Average Annual Minimum Temperature (New Jersey)

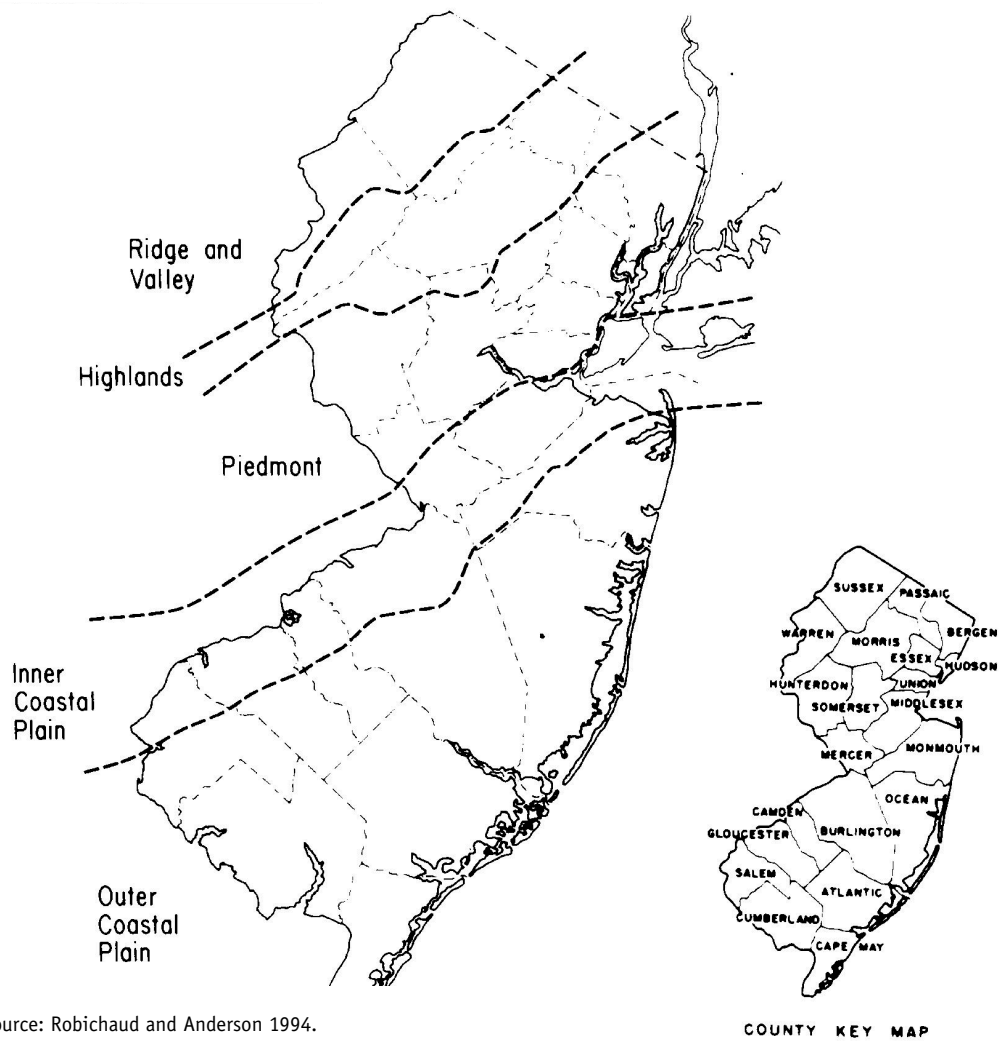


Physiographic Provinces

New Jersey's five physiographic sections describe distinct geographic regions in the state with similar physical and environmental conditions (Figure 7-2). These physiographic provinces include, from west to east, the Ridge and Valley, Highlands, Piedmont, Inner Coastal Plain, and Outer Coastal Plain. Each physiographic region is defined by unique geological strata, soil type, drainage patterns, moisture content, temperature, and degree of slope, which often dictate the predominant vegetation. Because the predominant vegetation has evolved to live in these specific conditions, a successful stormwater management facility planting design can be achieved through mimicking these natural associations.

The five physiographic regions are described below with associated vegetation listed for general planting guidance. [2] For more detailed information and plant listings, please refer to Plant Communities of New Jersey (Robichaud and Anderson 1994).

Figure 7-2: The Five Physiographic Sections of New Jersey



Source: Robichaud and Anderson 1994.

[2] These descriptions were adapted, in part, from Robichaud and Anderson 1994, and Robichaud and Buell 1973.

Ridge and Valley Section

The Ridge and Valley physiographic province in the northwestern corner of New Jersey covers 635 square miles or about 7 per cent of the total land in New Jersey. It occupies a large part of Warren and Sussex counties. Ridges and valleys occur in this section because parent rock formations underlying the ridges and the valleys differ. Softer rocks such as limestone and shale erode faster than the more resistant sandstone and conglomerates. The lowest valley levels occur wherever limestone underlies the surface; the areas of shale, a slightly more resistant rock, are about 200 to 400 feet higher than the limestone, and ridges occur wherever the bedrock material is more resistant to erosion, such as sandstone or conglomerate rock.

Differences in parent rock material not only account for the variation in relief, but also create contrasts in the kind and amount of soil coverage. In general, the soil covering the Kittatinny and other ridges in this section is poor in quality from the standpoint of vegetation. The soil layer is thin on the ridges, with bedrock exposed in many places. Also, the ridge soil tends to be very acidic and of low fertility and, often, very stony.

In contrast, the soils in the valleys, derived from limestone and shale that were covered by glacial till, are for the most part deeper, more fertile, and well drained. Peat or large muck deposits (thick layers of organic material) may occur where shallow glacial lakes once existed. These were later invaded by vegetation, the dead remains of which accumulated as peat or muck.

Highlands Section

The Highlands physiographic province is located southeast of the Ridge and Valley section and covers about 900 square miles or approximately 12 per cent of New Jersey's land area. As shown in Figure 7-2, this section is broader at the north, where it is about 20 miles wide; at its southern end bordering the Delaware River Valley, it is only 10 miles wide. The Highlands region also has parallel ridges and valleys, but these differ from the Ridge and Valley section in the type of parent rock underlying the surface. Also, the ridges are more massive and generally much broader, while the valleys are narrower and have steeper slopes. Frequent rock outcroppings occur. Glacially formed lakes, such as Lake Hopatcong and Green Pond, contrast with adjacent ridges to make the Highlands a very scenic area of New Jersey.

The geologic formations of the Highlands region are estimated to be approximately 1 billion years old. Elevations in the northern part of the basin in the Highlands average approximately 1,000 feet above mean sea level, while the southern part of the Highlands show valley contours reaching a low of 350 feet. Ridges of the Highlands have resisted erosion due to the very hard rock, sandstone, gneiss, granite, marble, quartzite, igneous, and metamorphic material of which they are made. Highland valleys consist of much softer materials of limestone or shale, making them less resistant to erosion. The soils of the Highlands have been weathered from glacial till deposits and eroding bedrock and are generally shallow and stony, with frequent rock outcrops.

Piedmont Section

The Piedmont physiographic province, which occupies about 21 per cent of New Jersey's land area, is composed mostly of shale, sandstone, and argillite formations that are typically red or brownish-red in color. These formations are less resistant to erosion than the adjacent Highland gneissic rock and so, in comparison to the Highlands, the Piedmont is actually a lowland. The Piedmont section slopes gently southeastward from about 400 feet above sea level at its northwestern margin, to an elevation less than 100 feet at its southern margin bordering the Delaware, and to sea level at Newark Bay. Flat in some areas, the Piedmont contour is slightly rolling with mostly gentle slopes; however, in some areas, rivers have cut rather steep-sided valleys.

Interestingly, in the Piedmont, several ridge formations tower over the adjacent lowlands – the three Watchung Mountains (850, 650, and 350 feet high), Cushetunk Mountain, the Sourlands, and the Palisades. These ridges are made of intrusive or extrusive lava material known as diabase and basaltic rocks, both of which are much harder than the shale and sandstone of the Piedmont. While the diabase and basalt have resisted erosion, the less resistant shale and sandstone have been worn down, resulting in the lower elevations.

Differences in rock formations, combined with the fact that glacial deposits of varying age covered only part of the Piedmont, have resulted in a variety of soil types within the area. These variations appear to be less important to vegetation than the variation of soil water drainage.

Exposed rock and soil at the surface of the Piedmont is the product of intense weathering of local bedrock and the influence that glacial ice sheets had on the landscape. Continuous cycles of freezing and thawing in the rocks and soils produced landform characteristics consisting of subsurface depressions and uneven ground. Boulder fields, like those found on the Rocky Hill Ridge, were heaved to the surface by the expanding and contracting of the permafrost during glacial periods. During the interglacial periods when the ice sheets retreated, massive loads of sediment were deposited in meltwater streams. Remnants of these outwash sediments formed thin, patchy deposits known as till on the surface of the Piedmont uplands. Riverbeds, stream valleys, and other lowlands were filled with glacial sediments, forming river terraces and wide outwash plains. Silt, clay, and fine sand deposits filled the bottoms of glacially formed lakes and ponds, which have since become swamps and meadows layered with peat and muck. Subsequent weathering and erosion have continued to shape and reshape the surface and produce the modern soil profile of the Piedmont.

Common Species of Ridge and Valley, Highlands, and Piedmont Sections

Tree Species	Understory
• Hickory • Chestnut oak • Scarlet oak • Scrub oak • White oak • Red oak • Black oak • Scrub pine • Pitch pine • Short leaf pine • White pine • Hemlocks • Beech • Black jack oak • Sugar maple	• Sweet fern • Flowering dogwood • Black haw • Chinquapin • Sassafras • Redbud • Mountain laurel • Blueberry • Fringe tree • Pink azalea • Spicebush • Maple-leaved arrowwood

Inner and Outer Coastal Plain Sections

The Inner and Outer Coastal Plain provinces are recognized by flat or gently rolling topography and elevations rising from sea level to a height of 373 feet. Coastal Plain marshes and swampy tidal flats occur throughout the New Jersey Coastal Zone. Sands, sandy loams, and silt loams resulting from sea deposits make up the soils of the Coastal Plain. The climate is mild and sometimes rainy, similar to that found further south. Because of low topographic relief and proximity to sea level, extensive swamp areas are common to the Coastal Plain province. Most notable are the Atlantic White Cedar swamps found in the Pinelands.

Common Species of the Inner and Outer Coaster Plain Sections

Tree Species	Understory
• Loblolly pine • Virginia pine • Pitch pine • Pond pine • Sweet gum • Willow oak • Water oak • Basket oak • Pin oak • Post oak • Spanish oak • Black cottonwood • Pale hickory • Bitternut hickory • Sweet bay • American holly • Beech • Tulip tree • River birch	• Blueberry • Huckleberry • Greenbrier • Sand blackberry • Beach plum • Beach heather • Bay berry • Sweet pepper bush • Azalea • Maleberry • Stagger bush • Fetter bush • Inkberry • Alder buckhorn

Floodplain Regions

Floodplains occur across New Jersey's physiographic provinces as low-lying areas adjacent to streams and rivers. Floodplain plant communities are similar across most of the state because of common soil characteristics governed by occasional flooding and high groundwater. Stormwater management facilities are often located in floodplains, and plant associations in these areas can provide valuable information for successful BMP plantings.

Common Species of Floodplain Regions

Tree Species	Understory
• River birch • Willows • Silver maple • Sweet gum • Sycamore • Box elder • Green ash • American elm • Swamp white oak • Basswood • Hackberry	• Shrub willows • Ninebark • Silky and redosier dogwoods • Sweet pepperbush • Buttonbush • Spicebush • Winterberry and inkberry holly • Elderberry • Alders

Three Hydrologic Zones

Before planting within a stormwater management facility, it is necessary to determine which hydrologic zones will be created. Hydrologic zones describe the degree to which an area is inundated by water. Plants have differing tolerances to inundation; as an aid to landscape designers, these tolerance levels have been divided into six zones for which corresponding plant species have been identified.

Part 4 includes a native plant list with appropriate hydrologic zones designated for each species. The hydrologic zones that are bracketed "[ ]" are where the plants tend to occur. There may be other zones listed outside of these brackets. These plants may occur in these zones, but are not typically found in them. On occasion, plants may be found outside of their hardiness and hydrologic zone. Plants tend to grow anywhere they can compete and survive. Additionally, hydrologic conditions in a stormwater management facility may fluctuate in unpredictable ways; thus, the use of plants capable of tolerating wide varieties of hydrologic conditions greatly increases a successful planting. Conversely, plants suited for specific hydrologic conditions may perish when hydrologic conditions fluctuate, expose the soil, and increase the chance for erosion.

Part 2: General Landscaping Guidance for all Stormwater BMPs

- Plant trees and shrubs at least 15 feet from a dam's toe of slope.
- Do not plant trees or shrubs known to have long taproots within the vicinity of earth dams or subsurface drainage facilities.
- Plant trees and shrubs at least 15 feet from perforated pipes.
- Plant trees and shrubs at least 25 feet from a riser structure.
- Provide 15-foot clearance from a non-clogging, low flow orifice.
- Herbaceous embankment plantings should be limited to 10 inches in height to ensure visibility for inspectors looking for burrowing rodents that may compromise the integrity of the embankment.
- Provide additional stabilization methods for slopes steeper than 2:1, such as turf reinforcement mats or erosion control blankets. Use seed mixes with quick germination rates in this area. Augment temporary seeding measures with container crowns or root mats of more permanent plant material.
- Use erosion control blankets and fabrics in channels that are subject to frequent wash-outs.
- Stabilize all emergency spillways with plant material that can withstand strong flows.
- Root material should be fibrous and substantial, but lack a taproot.
- Place sod in channels that are not stabilized by erosion control blankets.
- Divert flows temporarily from seeded areas until plants are stabilized.
- Check water tolerances of existing plant materials prior to inundating the area.
- Stabilize aquatic and safety benches with emergent wetland plants and wet seed mixes.
- Do not block maintenance access to structures with trees or shrubs.
- To reduce thermal warming, shade inflow and outflow channels as well as the southern exposure of ponds, when possible.
- Avoid plantings that will require routine or intensive chemical applications, i.e., turf areas.
- Have soil tested to determine whether amendments are needed.
- Indigenous plant species should be specified over exotic or foreign species because they are well adapted to local on-site soil conditions and require few or no additional amendments.
- Decrease the areas where turf is used. Use low-maintenance ground cover to absorb run-off.
- Plant riparian buffers with trees, shrubs, and native grasses, where possible, to stabilize banks and provide shade.
- Maintain and frame desirable views. Be careful not to block views at entrances, exits, or difficult road curves. Screen unattractive views into the site. Aesthetics and visual characteristics should be a prime consideration.
- Use plants to prohibit pedestrian access to pools or slopes that may be unsafe.
- Carefully consider the long-term vegetation management strategy for the BMP, keeping in mind the maintenance legacy for future owners. Keep maintenance areas and access free of vegetation to allow vehicle clearance. Provide a planting surface that can withstand compaction from vehicles using maintenance access roads. Make sure the facility maintenance agreement includes requirements that ensure vegetation cover in perpetuity.
- If a BMP is likely to receive excessive amounts of de-icing salt, salt tolerant plants should be used.
- Provide signage for stormwater management areas to help educate the public, and for wildflower areas, when possible, to designate limits of mowing.
- Avoid the overuse of any plant materials, e.g., maples.
- Preserve existing natural vegetation when possible.

Soil Preparation

It is necessary to test the soil in which you are about to plant in order to determine pH, whether acid, neutral, or alkaline; major soil nutrients, nitrogen, phosphorus, and potassium; and minerals such as chelated iron and lime.

Have soil samples analyzed by experienced and qualified individuals such as those at the Rutgers Cooperative Extension, who will explain the results in writing and recommend which soil amendments would be required. Certain soil conditions, such as marine clays (glauconite), can present serious constraints to the growth of plant materials and may require the guidance of qualified professionals. When poor soils cannot be amended, seed mixes and plant material must be selected to establish ground cover as quickly as possible.

Areas recently involved in construction can become compacted so that plant roots cannot penetrate the soil. Seeds will lie on the surface of compacted soils and are often washed away or eaten by birds. For planting success, soils should be loosened to a 4-inch depth. Hard soils may require discing to a deeper depth. The soil should be loosened regardless of the ground cover to improve seed contact with the soil, increase germination rates, and allow the roots to penetrate the soil. For areas to be sodded, discing is necessary so that roots can penetrate the soil. Good growing conditions can prevent poor vegetative cover, which saves money because vegetation will not need to be replanted.

Whenever possible, topsoil should be spread to a depth of 4 to 6 inches over the entire area to be planted. This provides organic matter and important nutrients for the plant material. The use of topsoil allows vegetation to become established faster and roots to penetrate deeper. This ensures quicker and more complete stabilization, making it less likely that the plants will wash out during a heavy storm.

If topsoil has been stockpiled in deep mounds for a long period of time, it is necessary to test the soil for pH as well as microbial activity. If the microbial activity has been destroyed, inoculate the soil after application.

Because newly installed plant material requires water to recover from the shock of being transplanted, be sure that a source of water is provided, especially during dry periods. This will reduce plant loss and provide the new plant materials a chance to establish root growth.

Part 3: Specific Landscaping Criteria for BMPs

It is important to recognize that plants typically found in wetlands may be cultivated in non-wetland conditions; hence the importance of obtaining plants cultivated in similar hydrologic and soil conditions as those present in the stormwater management facility. A plant typically found in wetlands, but cultivated in non-wetland conditions, may not survive if installed in wetland conditions.

Ponds and Constructed Wetlands

Before planting within a stormwater management facility, determine which hydrologic zones will be created. Hydrologic zones describe the degree to which an area is inundated by water. Plants have differing tolerances to inundation; the six zones described in this section will dictate which plants will survive where. Every facility does not necessarily exhibit all of these zones.

Table 7-2: 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

Zone 1: Deep Water Pool (1 to 6 feet)

Ponds and wetlands both have deep pool areas that comprise Zone 1. These pools range from 1 to 6 feet in depth and are best colonized by submergent plants, if at all. This pondscaping zone has not been routinely planted for several reasons: first, the availability of plant materials that can survive and grow in this zone is limited; and second, it is feared that plants could clog the stormwater facility outlet structure. In many cases, these plants will gradually become established through natural recolonization, i.e., transport of plant fragments from other ponds via the feet and legs of waterfowl. If submerged plant material becomes more commercially available and clogging concerns are addressed, this area can be planted. The function of the planting is to reduce resedimentation and improve oxidation while creating a greater aquatic habitat.

Select plants that can:

- withstand constant inundation of water of 1 foot or greater in depth;
- withstand being submerged partially or entirely;
- enhance pollutant uptake; and
- provide food and cover for waterfowl, desirable insects, and other aquatic life.

Suggested emergent or submergent species include, but are not limited to: spatterdock (Nuphar luteum), water lily (Nymphaea odorata), duckweed (Lemna spp.), duck potato (Saggitaria latifolia), wild celery (Vallisneria americana), sago pondweed (Potamogeton pectinatus), and redhead grass (Potamogeton perfoliatus).

Zone 2: Shallow Water Bench (6 inches to 1 foot)

Zone 2 includes all areas that are inundated below the normal pool to a depth of 1 foot; it is the primary area where emergent plants will grow in stormwater wetlands. Zone 2 also coincides with the aquatic bench found in stormwater ponds. This zone offers ideal conditions for the growth of many emergent wetland species. These areas may be located at the edge of the pond or on low mounds of earth below the surface of the water within the pond. When planted, Zone 2 can be an important habitat for many aquatic and non-aquatic animals, creating a diverse food chain that includes predators that provide natural regulation of mosquito populations, thereby reducing the need for insecticide applications.

Select plants that can:

- withstand constant inundation of water to depths between six inches and 1 foot deep;
- be partially submerged;
- enhance pollutant uptake; and
- provide food and cover for waterfowl, desirable insects, and other aquatic life.

Plants will stabilize the bottom and edge of the pond, absorbing wave impacts and reducing erosion when the water level fluctuates. In addition to slowing water velocities and increasing sediment deposition rates, plants can reduce re-suspension of sediments caused by the wind. Plants can also soften the engineered contours of the pond and conceal drawdowns during dry weather.

Appropriate herbaceous species include: water plantain (Alisma plantago-aquatica), three-sided sedge (Dulchium arundinaceum), managrasses (Glyceria spp.), soft rush (Juncus effusus), arrow arum (Peltandra virginica), smartweeds (Polygonum spp.), pickerelweed (Pontederia cordata), lizard tail (Saururus cernuus), many bulrushes (Scirpus spp.), and giant bur-reed (Sparganium eurycarpum).

Zone 3: Shoreline Fringe (regularly inundated)

Zone 3 encompasses the shoreline of a pond or wetland and extends vertically about 1 foot from the normal pool. This zone may be periodically inundated if storm events are subject to extended detention. This zone occurs in a wet pond or shallow marsh and can be the most difficult to establish since plants must be able to withstand inundation of water during storms, when wind might blow water into the area, or the occasional drought during the summer. To stabilize the soil in this zone, Zone 3 must have a vigorous cover.

Select plants that can:

- stabilize the shoreline to minimize erosion caused by wave and wind action or water fluctuation;
- withstand occasional inundation of water, as plants will be partially submerged at times;
- shade the shoreline, whenever possible, especially the southern exposure, to help reduce water temperature;
- enhance pollutant uptake;
- provide food and cover for waterfowl, songbirds, and wildlife (large plants can be selected and located to control overpopulation of waterfowl);
- be located to reduce human access to potential hazards without blocking maintenance access;
- have very low maintenance requirements because they may be difficult or impossible to reach;

- be resistant to disease and other problems that require chemical applications, since chemical application is not advised in stormwater ponds; and
- be native plants, when possible, because they are low-maintenance and disease-resistant.

Many of the emergent wetlands plants outlined in Table 7-3 also thrive in Zone 3. Some other herbaceous species that do well include: cardinal flower (Lobelia cardinalis), blue flag iris (Iris versicolor), sweet flag (Acorus calamus), Marsh marigold (Caltha palustris), swamp milkweed (Asclepsis incarnata), bentgrass/redtop (Agrostis spp.), switchgrass (Panicum virgatum), Canada bluejoint (Calamagrostis canadensis), many bulrushes (Scirpus spp.), and spike rushes (Eleocharis spp.).

If shading is needed along the shoreline, the following woody species are suggested: river birch (Betula nigra), green ash (Fraxinus pennsylvanica), white ash (Fraxinus americana), pussy willow (Salix discolor), swamp rose (Rosa palustris), buttonbush (Cephalanthus occidentalis), highbush blueberry (Vaccinium spp.), red osier/silky dogwood (Cornus stolonifera/amomum), grey dogwood (Cornus racemosa), arrowood (Viburnum dentatum), spicebush (Lindera Benzoin), sweetbells (Leucothoe racemosa), sweet pepperbush (Clethra alnifolia), winterberry (Ilex verticillata), inkberry holly (Ilex glabra), serviceberry (Amelanchier spp.), black willow (Salix nigra), red maple (Acer rubrum), willow oak (Quercus phellos), swamp white oak (Quercus bicolor), pin oak (Quercus palustris), sweetgum (Liquidambar styraciflua), black gum (Nyssa sylvatica), sweet bay magnolia (Magnolia virginiana), and American sycamore (Platanus occidentalis).

Zone 4: Riparian Fringe (periodically inundated)

Zone 4 extends from 1 to 4 feet above the normal pool. Plants in this zone are subject to periodic inundation after storms and may experience saturated or partly saturated soil. Nearly all of the temporary extended detention area is included within this zone.

Select plants that can:

- withstand periodic inundation of water after storms, as well as occasional drought during the warm summer months;
- stabilize the ground from erosion caused by run-off;
- shade the low-flow channel to reduce pool warming whenever possible;
- enhance pollutant uptake;
- be very low maintenance, as they may be difficult or impossible to access;
- provide food and cover for waterfowl, songbirds, and wildlife (plants may also be selected and located to control overpopulation of waterfowl); and
- be located to reduce pedestrian access to the deeper pools.

Native plants are preferred because they are low-maintenance and disease-resistant. Frequently used plant species in Zone 4 include: many asters (Aster spp.) and goldenrods (Solidago spp.), beebalm (Monarda didyma), bergamont (Monarda fistulosa), lobelias (lobelia spp.), coneflower(Rudbeckia spp.), violets (Viola spp.), lilies (Lilium spp.), primrose (Oenothera spp.), milkwort (Polygala spp.), flatsedge (Cyperus spp.), hollies (Ilex spp.), steeplebush (Spirea tomentosa), serviceberry (Amelanchier arborea), nannyberry (Viburnurn lentago), sweet pepperbush (Clethra alnifolia), bayberry (Morella pensylvanica), elderberry (Sambucus canadensis), sweetbay magnolia (Magnolia virginiana), hawthorn (Crategus), shrub dogwoods (Cornus spp.), green ash (Fraxinus pennsylvanica), river birch (Betula nigra), sweetgum (Liquidambar styraciflua), American hornbeam (Carpinus caroliniana), persimmon (Diospyros virginiana), and red maple (Acer rubrum).

Zone 5: Floodplain Terrace (infrequently inundated)

Zone 5 is periodically inundated by floodwaters that quickly recede in a day or less. Operationally, Zone 5 extends from the maximum two-year or Cpv water surface elevation up to the 10 or 100-year maximum water surface elevation. Key landscaping objectives for Zone 5 are to stabilize the steep slopes characteristic of this zone and establish low maintenance natural vegetation.

Select plants that can:

- withstand occasional but brief inundation during storms and, between storms, typical moisture conditions that may be moist, slightly wet, or even swinging entirely to drought conditions during the dry weather period;
- stabilize the basin slopes from erosion;
- be very low maintenance as ground cover since they may be difficult to access on steep slopes or mowing frequency may be limited (a dense tree cover may help reduce maintenance and discourage resident geese); and
- provide food and cover for waterfowl, songbirds, and wildlife.

Placement of plant material in Zone 5 is often critical. Some commonly planted species in Zone 5 include: phlox (Phlox spp.), solomon's seal (Polygonatum biflorum), many fescues (Festuca spp.), many viburnums (Viburnum spp.), Virginia rose (Rosa virginiana), American hornbeam (Carpinus caroliniana), cherries (Prunus spp.), willow oak (Quercus phellos), hickories (Carya spp.), and witch-hazel (Hamamelis virginiana).

Zone 6: Upland Slopes (seldom or never inundated)

This zone extends above the maximum 100-year water surface elevation and often includes the outer buffer of a pond or wetland. Unlike other zones, this upland area may have sidewalks, bike paths, retaining walls, and maintenance access roads. Care should be taken to locate plants so they will not overgrow these routes or create hiding places that might make the area unsafe. Plant selections should be made based on soil condition, light, and function within the landscape because little or no water inundation will occur. Ground covers should require infrequent mowing to reduce the cost of maintaining this landscape.

Placement of plants in Zone 6 is important since they are often used to create a visual focal point, frame a desirable view, screen undesirable views, serve as a buffer, or provide shade to allow a greater variety of plant materials. Particular attention should be paid to seasonal color and texture of these plantings.

Some frequently used plant species in Zone 6 include: fine fescues (Festuca spp.), basswood (Tilia americana), Flowering dogwood (Cornus florida), Sassafras (Sassafras albidum), American beech (Fagus grandifolia), white ash (Fraxinus americana), scarlet oak (Quercus coccinea), white oak (Quercus alba), Black oak (Quercus velutina), and pine species (Pinus spp.).

Infiltration and Filter Systems

Infiltration and filter systems either take advantage of existing permeable soils or create a permeable medium such as sand for groundwater recharge and stormwater quality control. In some instances where permeability is great, these facilities are used for quantity control as well. The most common systems include infiltration trenches, infiltration basins, sand filters, and organic filters.

When properly planted, vegetation will thrive and enhance the functioning of these systems. For example, pre-treatment buffers will trap sediments that often are binded with phosphorous and metals. Vegetation planted in the facility will aid in nutrient uptake and water storage. Additionally, plant roots will provide arteries for stormwater to permeate soil for groundwater recharge. Successful plantings provide aesthetic value and wildlife habitat, making these facilities more desirable to the public.

Figure 7-3: Plan View of Hydrologic Zones Around Stormwater Basin

PONDSCAPING ZONE 3

New England Aster, Marsh Aster, Marsh Marigold, Tussock Sedge, Spotted Joe Pye Weed, Forget Me Nots, Inkberry, Willow species, Shrub Dogwood, Pin Oak, River Birch, Sycamore, Swamp White Oak.

PONDSCAPING ZONE 4

Purple Cone Flower, Birds Foot Trefoil, Slender Rush, Deer Tongue Grass, Switch Grass, Serviceberry, Gray Birch, Hackberry, Sweet Pepper Bush (Coastal Plain), Gray Stem Dogwood, Redosier Dogwood, Green Ash, Black Gum.

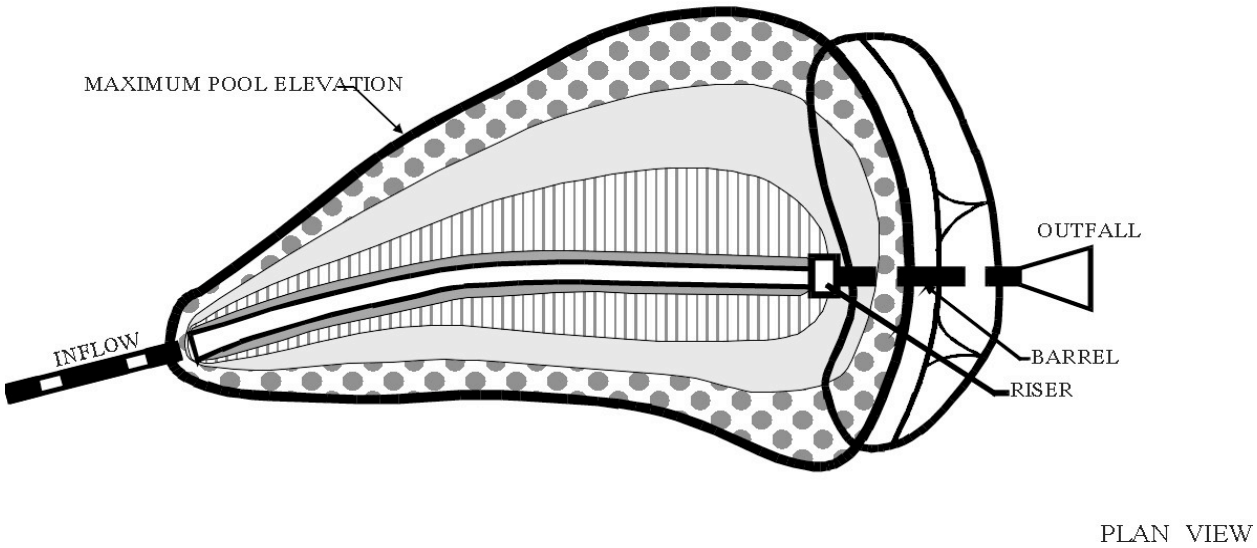
PONDSCAPING ZONE 5

Many wildflowers and native grasses. American Holly, Witch Hazel, Ninebark, Red Oak, American Elderberry, Lowbush Blueberry, Maple Leaf Viburnum, Nannyberry, Blackhaw Viburnum.

PONDSCAPING ZONE 6

(Floodplain) Mostly native ornamentals as long as soils drain well. Many natives. All species must be able to tolerate flood plain conditions. Hackberry, Pitch Pine, Sheep Fescue, Wildflowers, many native grasses.

Note: Tree and shrub setback requirements from the dam embankment, riser, and pipes should be strictly followed.



Source: Adapted from Schueler and Claytor 2000.

Figure 7-4: Plan View of a Shallow Marsh Planting

PONDSCAPING ZONE 1
12”-36” depth: Water Lily, Deep Water Duck Potato, Sago Pond Plant

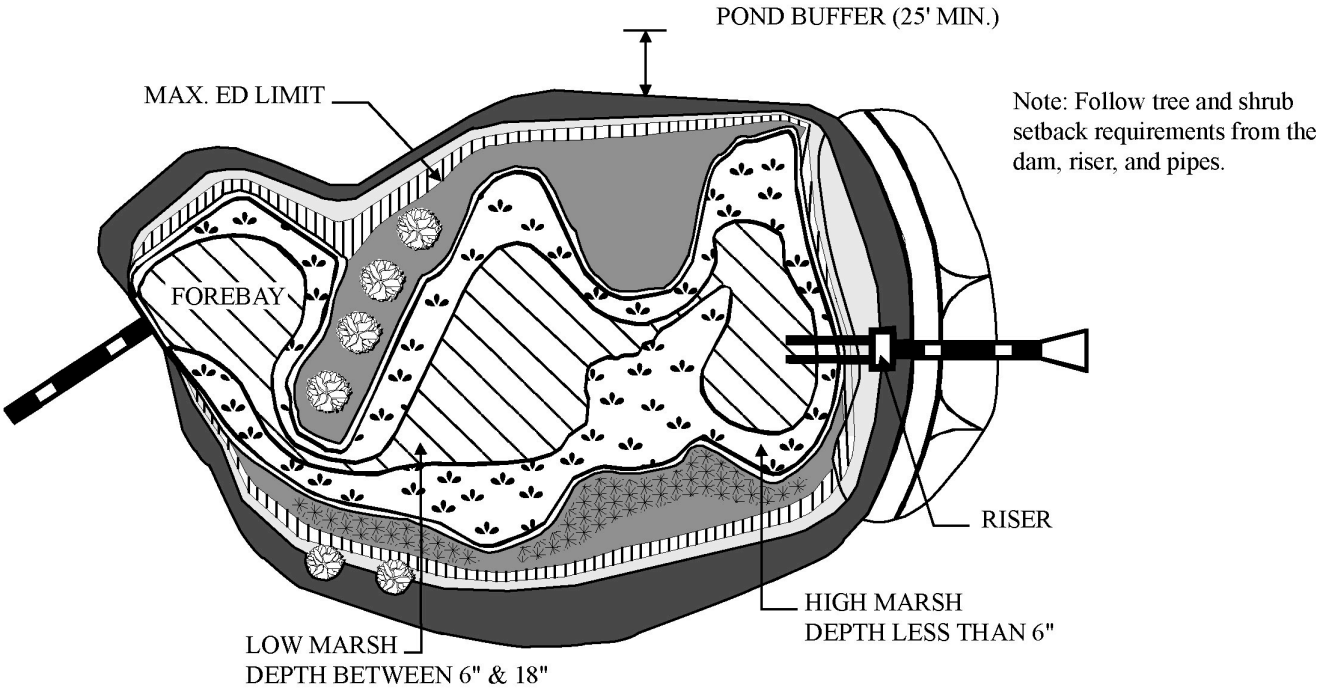
PONDSCAPING ZONE 2
0”-12” depth: Blue Flag Iris, Duck Potato, Flowering Bulrush, Softrush, Sedges

PONDSCAPING ZONE 3
New England Aster, Marsh Aster, Tussock Sedge, Spotted Joe Pye Weed, Inkberry, Shrub willow and Dogwood species, Pin Oak, River Birch, Sycamore, Swamp White Oak

PONDSCAPING ZONE 4
Slender Rush, Deer Tongue Grass, Switch Grass, Service Berry, Gray Birch, Hackberry, Sweet Pepper Bush, Gray Stem Dogwood, Red Osier Dogwood, Green Ash, Black Gum

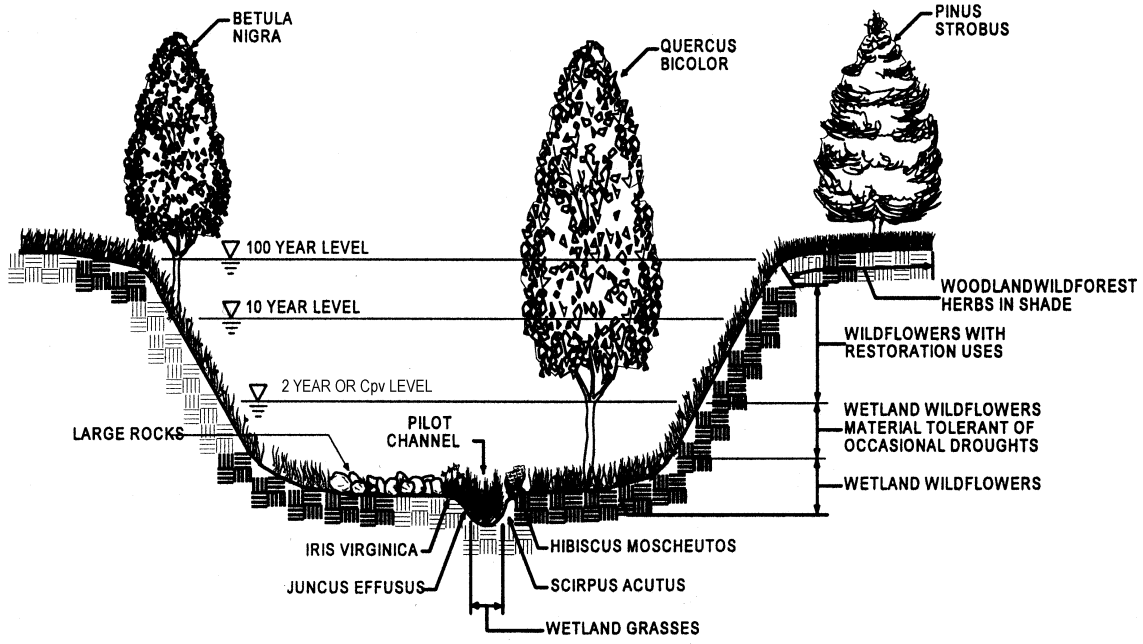
PONDSCAPING ZONE 5
(Many Wildflowers & Native Grasses), American Holly, Witch Hazel, Ninebark, Red Oak, American Elderberry, American Hemlock, Lowbush Blueberry, Nannyberry, Blackhaw Viburnum

PONDSCAPING ZONE 6
(Floodplain) Mostly ornamentals as long as soil drains well, many natives. All species must be able to tolerate floodplain conditions. Hackberry, Pitch Pine, Sheep Fescue, Wildflowers, Grasses



Source: Adapted from Schueler and Claytor 2000.

Figure 7-5: Section of a Typical Stormwater Management Detention Pond



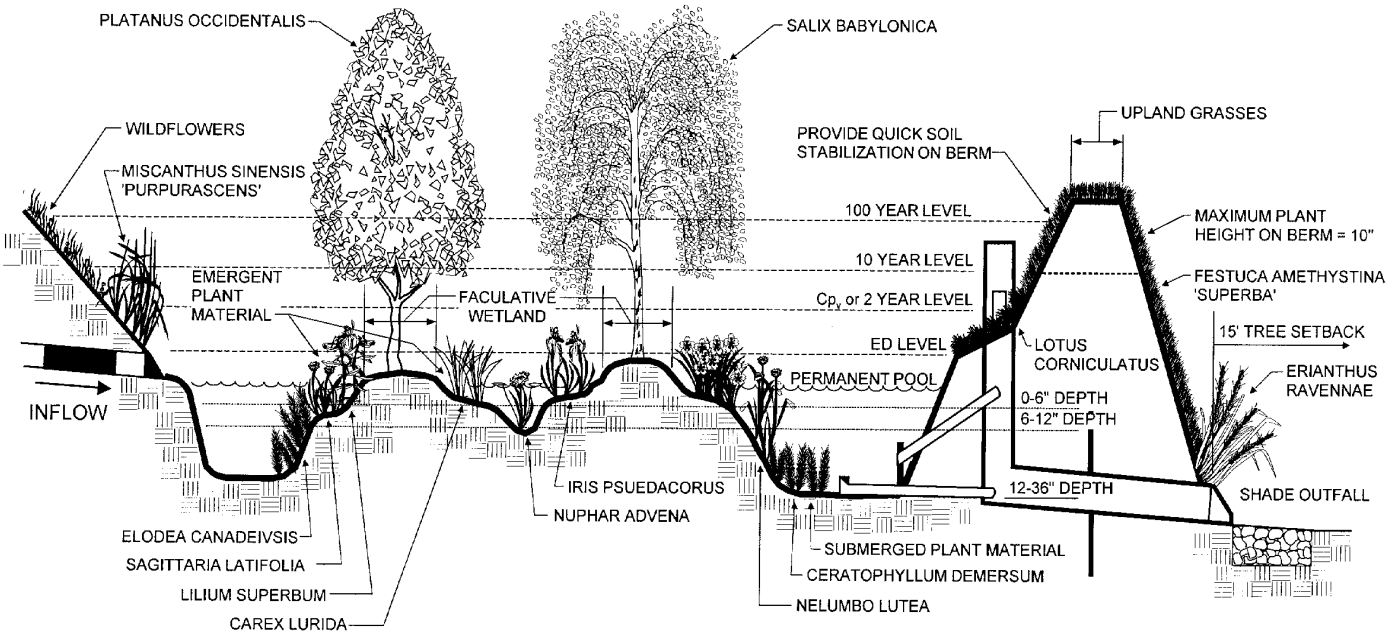
Source: Claytor and Schueler 1997.

Design Constraints

- Planting buffer strips of at least 20 feet will cause sediments to settle out before reaching the facility, thereby reducing the possibility of clogging.
- Determine areas that will be saturated with water as well as water table depth so that appropriate plants may be selected (hydrology will be similar to bioretention facilities, see Figure 7-7 and Table 7-4 for planting material guidance).
- Plants known to send down deep taproots should be avoided in systems where filter fabric is used as part of the facility design.
- Test soil conditions to determine whether soil amendments are necessary.
- Plants should be located to allow access for structure maintenance.
- Stabilize heavy flow areas with erosion control mats or sod.
- Temporarily divert flows from seeded areas until vegetation is established.

See Figure 7-6 for additional design considerations.

Figure 7-6: Section of Typical Shallow Extended Detention Marsh System



Source: Claytor and Schueler 1997.

Part 4: Bioretention

Soil Bed Characteristics

The characteristics of the soil for the bioretention facility are perhaps as important as the facility location, size, and treatment volume. The soil must be permeable enough to allow runoff to filter through the media, while having characteristics suitable to promote and sustain a robust vegetative cover crop. In addition, much of the nutrient pollutant uptake (nitrogen and phosphorus) is accomplished through absorption and microbial activity within the soil profile. Therefore, the soils must balance soil chemistry and physical properties to support biotic communities above and below ground.

Table 7-3: Common Emergent Wetland Plant Species Used for Stormwater Wetlands and on Aquatic Benches of Stormwater Ponds

Common Name	Scientific Name	Inundation Tolerance
Arrow arum	Peltandra virginica	up to 12″
Arrowhead/Duck potato	Saggitaria latifolia	up to 12″
Pickerelweed	Pontederia cordata	up to 12″
Blunt spike rush	Eleocharis obtusa	up to 3″
Bushy beardgrass	Andropogon glomeratus	up to 3″
Common three-square	Scirpus pungens	up to 6″
Iris (blue flag)	Iris versicolor	up to 6″
Marsh hibiscus	Hibiscus moscheutos	up to 3″
Spatterdock	Nuphar luteum	up to 36″
Sedges	Carex spp.	up to 6″
Soft rush	Juncus effusus	up to 6″
Switchgrass	Panicum virgatum	up to 3″

Note 1: Inundation tolerance is maximum inches below the normal pool; most plants prefer shallower depths than the maximum indicated.

Note 2: For additional plant options, consult the stormwater planting list in Section 5. Other good sources include the NJDA Standards for Soil Erosion and Sediment Control in New Jersey, Design of Stormwater Wetland Systems (Schueler 1992), and Wetland Planting Guide for the Northeastern United States (Thunhorst 1993).

Details of the planting soil are discussed in *Chapter 9.1 Standard for Bioretention Systems*. The soil should be free of stones, stumps, roots, or other woody material over 1 inch in diameter. Brush or seeds from noxious weeds, such as Johnson grass, Mugwort, Nutsedge, Purple loosestrife, and Canadian thistle should not be present in the soils. Placement of the planting soil should be in lifts of 12 to 18 inches, loosely compacted (tamped lightly with a dozer or backhoe bucket). Specific soil characteristics are presented in Table 7-4.

Mulch Layer

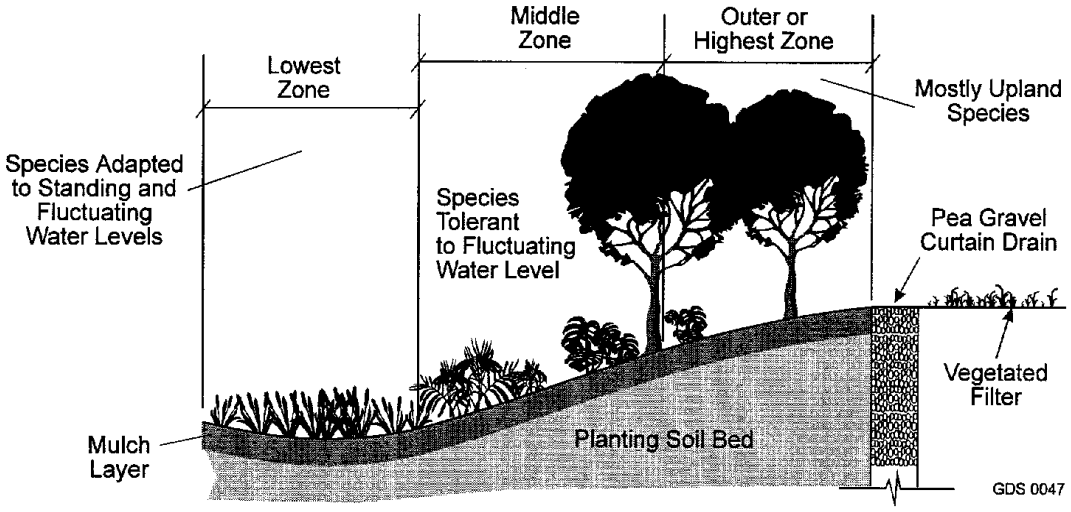
The mulch layer plays an important role in the performance of the bioretention system by helping to maintain soil moisture and avoiding surface sealing that reduces permeability. Mulch helps prevent erosion and provides a microenvironment suitable for soil biota at the mulch/soil interface. It also serves as a pre-treatment layer, trapping the finer sediments that remain suspended after the primary pretreatment.

The mulch layer should be standard landscape style, single or double, shredded hardwood mulch or chips. The mulch layer should be well aged (stockpiled or stored for at least 12 months), uniform in color, and free of other materials such as weed seeds, soil, roots, etc. The mulch should be applied to a maximum depth of 3 inches. Grass clippings should not be used as a mulch material.

Table 7-4: Planting Soil Characteristics

Parameter	Value
pH range	5.2 to 7.00
Organic matter	1.5 to 4.0%
Magnesium	35 lbs. per acre, minimum
Phosphorus (P2O5)	75 lbs. per acre, minimum
Potassium (K2O)	85 lbs. per acre, minimum
Soluble salts	< = 500 ppm
Clay	10 to 25%
Silt	30 to 55%
Sand	35 to 60%
Source: Adapted from Schueler and Claytor 2000.	

Figure 7-7: Planting Zones for a Bioretention Facility



Source: Schueler and Claytor 1997.

Plant Material Guidance

Plant materials should conform to the American Nursery and Landscape Association publication American Standard Nursery Stock and be selected from certified, reputable nurseries. A landscape architect or other qualified designer should specify a sequence of construction, a description of the contractor's responsibilities, planting schedule and installation specifications, initial maintenance, and a warranty period stipulating expectations of plant survival. *Planting Guidance* below presents some typical issues for planting specifications.

Open Channels

Consult Table 7-7 for grass species that perform well in the stressful environment of an open channel. For more detailed information, consult the Standards for Soil Erosion and Sediment Control in New Jersey. If a BMP is likely to receive excessive amounts of de-icing salt, salt tolerant plants should be used.

Planting Guidance

Plant material selection should be based on the goal of simulating a terrestrial forested community of native species. Bioretention simulates an upland-species ecosystem. The community should be dominated by trees, but have a distinct community of understory trees, shrubs, and herbaceous materials. By creating a diverse, dense plant cover, a bioretention facility will be able to treat stormwater runoff and withstand urban stresses from insects, disease, drought, temperature, wind, and exposure.

Planting Plan Design Considerations

- Native plant species should be specified, not exotic or foreign species.
- Appropriate vegetation should be selected based on the zone of hydric tolerance (see Table 7-2).
- Species layout should generally be random and natural.
- A canopy should be established with an understory of shrubs and herbaceous materials.
- Woody vegetation should not be specified in the vicinity of inflow locations.
- Trees should be planted primarily along the perimeter of the bioretention area.
- Exotic (non-native) vegetation should not be specified.
- Urban stressors (e.g., wind, sun, exposure, insect and disease infestation, and drought) should be considered when laying out the planting plan.
- Aesthetics and visual characteristics should be a prime consideration.
- Traffic and safety issues must be considered.
- Existing and proposed utilities must be identified and considered.

The proper selection and installation of plant materials is key to a successful system. There are essentially three zones within a bioretention facility (Figure 7-7). The lowest elevation supports plant species adapted to standing and fluctuating water levels. The middle elevation supports plants that prefer drier soil conditions but can tolerate occasional inundation by water. The outer edge is the highest elevation and generally supports plants adapted to dryer conditions. A sample of appropriate plant materials for bioretention facilities is included in Table 7-5. The layout of plant material should be flexible, but should follow the general principals described in Table 7-6. The objective is to have a system that resembles a random and natural plant layout while maintaining optimal conditions for plant establishment and growth. For a more extensive bioretention plan, consult the Design Manual for Use of Bioretention in Stormwater Management (ETA&B 1993) or Design of Stormwater Filtering Systems (Schueler and Claytor 1997).

Table 7-5: Commonly Used Species for Bioretention Areas

Trees	Shrubs	Herbaceous Species
Acer rubrum Red maple	*Clethra alnifolia* Sweet pepperbush	*Andropogon glomeratus* Lowland broomsedge
Betula nigra River birch	*Ilex verticillata* Winterberry	*Eupatorium purpureum* Sweet-scented Joe Pye weed
Juniperus virginiata Eastern red cedar	*Cephalathus occidentalis* Buttonbush	*Scripus pungens* Three square bulrush
Chionanthus virginicus Fringe-tree	*Hamemelis virginiana* Witch hazel	*Iris versicolor* Blue flag
Nyssa sylvatica Black gum	*Vaccinium corymbosum* Highbush blueberry	*Lobelia cardinalis* Cardinal flower
Diospyros virginiana Persimmon	*Ilex glabra* Inkberry	*Panicum virgatum* Switchgrass
Platanus occidentalis Sycamore	*Ilex verticillata* Winterberry	*Dichanthelium clandestinium* Deertongue
Quercus palustris Pin oak	*Viburnum dentatum* Arrowwood	*Rudbeckia laciniata* Cutleaf coneflower
Quercus phellos Willow oak	*Lindera benzoin* Spicebush	*Scirpus cyperinus* Woolgrass
Salix nigra Black willow	*Morella pennsylvanica* Bayberry	*Vernonia noveboracensis* New York ironweed
Note: For more plant section options for bioretention, consult Design Manual for Use of Bioretention in Stormwater Management (ETA&B 1993) or Design of Stormwater Filtering Systems (Claytor and Schueler 1997).		

Table 7-6: Planting Specification Issues for Bioretention Areas

Specification Element	Elements
Sequence of construction	Describe site preparation activities, soil amendments, etc.; address erosion and sediment control procedures; specify step-by-step procedure for plant installation through site clean up.
Contractor's responsibilities	Specify the contractor's responsibilities, such as watering, care of plant material during transport, timeliness of installation, repairs due to vandalism, etc.
Planting schedule and specifications	Specify the plants to be installed, the type of materials (e.g., B&B, bare root, containerized); time of year of installations, sequence of installation of types of plants; fertilization, stabilization seeding, if required; watering and general care.
Maintenance	Specify inspection periods; mulching frequency (annual mulching is most common); removal and replacement of dead and diseased vegetation; treatment of diseased trees; watering schedule after initial installation (once per day for 14 days is common); repair and replacement of staking and wires.
Warranty	Specify the warranty period, the required survival rate, and the expected condition of plant species at the end of the warranty period.

Table 7-7: Common Grass Species for Open Channels

Common Name	Scientific Name	Notes
Alkali saltgrass	Puccinellia distans	Cool, good for wet, saline swales
Fowl bluegrass	Poa palustris	Cool, good for wet swales
Canada bluejoint	Calamagrostis canadensis	Cool, good for wet swales
Creeping bentgrass	Agrostis palustris	Cool, good for wet swales, salt tolerant
Red fescue	Festuca rubra	Cool, not for wet swales
Redtop	Agrostis gigantea	Cool, good for wet swales
Rough bluegrass	Poa trivialis	Cool, good for wet, shady swales
Switchgrass	Panicum virgatum	Warm, good for wet swales, some salt tolerance
Wildrye	Elymus virginicus/riparius	Cool, good for shady, wet swales

Notes: These grasses are sod forming and can withstand frequent inundation, and are ideal for the swale or grass channel environment. A few are also salt-tolerant. Cool refers to cool season grasses that grow during the cooler temperatures of spring and fall. Warm refers to warm season grasses that grow most vigorously during the hot, mid-summer months.

Where possible, one or more of these grasses should be in the seed mixes. For a more thorough listing of seed mixes see Table 7-8 in Part 5 or consult the Standards for Soil Erosion and Sediment Control in New Jersey.

Vegetative Filters and Stream Buffers

For design and plant selection of vegetative filter strips and stream buffers, consult the USDA Natural Resources Conservation Service, New Jersey Conservation Practice Standards No. 342 "Critical Area Planting," No. 393 "Filter Strip," or No. 391 "Riparian Stream Buffers," available on the web at www.nj.nrcs.usda.gov through the Electronic Field Office Technical Guide (eFOTG).

Part 5: Obtaining and Planting Native Wetland Plant Propagules

There are many ways to obtain plant materials for wetland revegetation, not all of which are appropriate for every project. The process of choosing which plants will be used, in what form, and how they will be obtained should be thought out as far ahead of time as possible. Several criteria will help you make these decisions:

- Have a clear idea of the project goals and objectives (as basic as whether restoration includes woody or herbaceous vegetation or both, and what wetland functions are desired – wildlife food and habitat, water quality improvement, or soil stabilization).
- Know the hydrology on site. Some plants will tolerate only certain water levels, and some plant materials can be established only under particular hydrologic regimes. For example, it makes no sense to select seeds of a shallow water emergent for an area with standing water over 3 feet deep. The seeds will not germinate, and even if they did, the plant would not tolerate those conditions.
- Determine other unique site factors. What are the soils like? Are there micro-topographies that can be exploited? Are geese or deer a problem? Is the site shaded or in full sun?

Once you have decided on the list of potential species for the site, you need to choose the appropriate plant form. Often, this decision is based on project budget, material cost, and the acceptable level of failure. Seeds are usually less expensive than container plants, but generally do not yield great successes and take longer to establish.

Part of the choice of appropriate plant forms depends on what is available. See Tables 7-9 and 7-10 for a complete listing of plant species and available plant forms. Into this mix comes the issue of ecotypes. An ecotype is a population of plants that has become genetically differentiated in response to the conditions of a particular habitat, and it has a distinctive limit of tolerance to environmental factors. For example, wetland plants growing around a pond in Maine are likely to have later flowering times and be more cold hardy than plants of the same species growing around a pond in Florida. When restoring wetland vegetation, consider using local ecotypes as much as possible. Using plants that are already adapted to your conditions can contribute greatly to the success of a revegetation project.

Herbaceous Plants

Herbaceous (non-woody) plants such as grasses, sedges, rushes, and wildflowers are available in many forms, some of which you can readily assemble for a project.

Seed

Using seed to revegetate a wetland is often a low-cost technique, especially if you plan to collect seed yourself. Purchasing seed is more expensive than collecting, but a collection made by a professional ensures that you have good quality seed and allows you to use some species with which you may be unfamiliar. Seeding a wetland can be tricky, since water levels must be carefully controlled. Seed needs to remain close to the soil surface to receive the three elements necessary for germination: moisture (not inundation), heat, and light. Most herbaceous wetland seed requires some pre-germination treatment, either stratification, a period of exposure to cold, moist conditions, and/or scarification (abrasion of the seedcoat) before they will germinate. If seeds are planted in the fall right after cleaning, winter freeze-thaw and bacterial activity may take care of these requirements. For a spring seeding, it is important to know whether the seed has been treated. Generally, there is a greater chance for failure when using seeds rather than plants for revegetation, and little information is available for direct seeding many species. However, seeding can be used in conjunction with other planting methods to enhance restoration.

Dormant Propagules

Dormant propagules are overwintering, underground plant parts such as rhizomes, bulbs, corms, and tubers. These parts are fairly easy to work with; they can be purchased from vendors and transplanted into project sites. Revegetating a wetland with these materials is recommended over seeding because plant material is more likely to survive. Some important points to keep in mind:

- Store collected propagules in a cool, moist (not wet) location until needed. These materials have a much shorter shelf-life than seeds, so collect as close to planting time as possible.
- Dormant propagules are best purchased from local wetland plant vendors. This helps ensure that local ecotypes are used. Locally purchased plants are usually of high quality since long distance shipping is eliminated. When the plant materials shipment arrives, inspect the plants; propagules should be firm, not mushy. If they appear to be decomposing or smell bad, do not accept them.
- In temperate regions, wetland plant materials require a cold treatment to break dormancy. Planting propagules during fall, winter, or early spring will ensure that they receive the cold period necessary to develop normally.

Bare Root Plants and Plugs

Herbaceous plants are commonly grown in greenhouse flats, producing plants with a 2-inch root ball or "plug." Some, however, may be sold as bare-root clumps. Bare-root plants are best planted in the early spring, whereas plants grown in a potting mix can generally be planted through mid-summer. Some nurseries grow deeper rooting species such as warm-season grasses in cone shaped containers referred to as Cone-tainers™ or Deep '38s™ (referring to the number of plants in a flat).

Container Plants

Using container plants (quart size or larger) to restore vegetation on a site can be costly, but healthy plants with intact root balls have an advantage over other plant materials in that they do not need to expend energy on re-growing fine roots (as is the case with bareroot materials), germinating, and growing roots and shoots (as is the case with seeds and dormant vegetative propagules). Container materials can be planted at any time of the year, as long as the ground is not frozen and there is adequate moisture. Some nurseries only contract-grow container material since this size plant requires more time to grow.

Handling Herbaceous Plants

While you will most likely not be propagating and growing your own container plants, you may find, especially if a project is delayed, that you will have to pot up and store bareroot plants, dormant propagules, donor plugs, or even seeds that have limited longevity. Wetland plants are not particularly fussy, so they do not require special soil. Clean topsoil is fine for most species. Be careful not to use soil with a lot of weed seeds, or you may end up transporting problem plants into the wetland. If clean topsoil is not available, you can use bagged topsoil. A 1:1 mix of sand and peat is also useful, especially for germinating small seeds of herbaceous species. While many wetland plants can grow under normal watering regimes, you can cut down on watering and acclimate them to the intended site by letting containers sit in tubs partially filled with water.

In the normal scheme of things, you will be buying your container plants from a wetland plant vendor. As with the other materials discussed, try to find as local a supplier as possible to minimize any difficulties the plants will have adapting to local climate conditions. Inspect container plants for overall health and appearance – plant leaves should not appear pale or have yellowing or brown tips, and stems should be

firm, not spindly. Look for evidence of pests or diseases – holes, wilting, or actual bug sightings should be cause to question the quality of materials. Pull plants from containers to look for strong root systems, with lots of white roots. If you specify particular sizes for materials, be sure that plants' roots fill the containers. Herbaceous materials can be sold in various sizes, but are most commonly available as plugs, quarts, or gallon sized containers. They are grown from seed, cuttings, vegetative propagules, or division. Containers may be made of plastic or biodegradable material such as peat, paper, or fiber.

Woody Plants

Woody plants for wetland revegetation are available in many of the same forms as herbaceous species; however, working with woody plants can take a bit more planning since they grow more slowly than herbaceous plants and it can take several growing seasons for materials to be ready for transplanting.

Seed

The advantages and disadvantages to working with woody plant seed are similar to those for herbaceous seed, that is, using seed is generally inexpensive, but can be tricky, particularly with species whose seed is preferred animal food (e.g., acorns).

Woody plant seed vendors can provide seeds for your project, but these suppliers are rare and, depending on your area, it may be difficult to obtain seed of local origin unless you collect it yourself. Try to get viability or germination information for any seeds you purchase.

Hardwood Cuttings

Stem cuttings from woody plants made during the dormant season are known as hardwood cuttings. These types of plant materials are particularly useful for revegetation on wetland edges and banks, just above the water line within the saturated soil zone. Cuttings are available to a limited extent from nurseries. Disadvantages to using hardwood cuttings include that they can dry out quickly, and that they may have high mortality rates, depending on site conditions.

The best candidates for hardwood cuttings are species of willow, poplar, and shrub dogwoods; these root readily without special treatment. Generally, cuttings are made from one to three-year-old stems, at least 18 inches long and .5 to 1.25 inches in diameter for best results; older materials do not root as readily.

Hardwood cuttings should be stored cold and moist until spring planting. To prime cuttings to form roots quickly after planting, soak cuttings in water for at least 24 hours prior to planting. This process swells the tissue that will expand from the cuttings to form roots.

Bareroot Plants

Bareroot trees and shrubs are commonly grown by native plant nurseries, and are fairly low-cost materials to work with. They are easy to store, transport, and plant, but survival is not as good as with materials that have intact roots.

When purchasing bareroot plants, look for good quality seedlings with a height of at least 18 inches and a root collar of 3/8 inches. Plants should have a substantial root mass left – about equal to the top. Do not accept materials that appear to have too much top growth to the amount of root. Plants should be firm and the growing layer underneath the bark should be green when a small area of the bark is scratched off.

Store bareroot plants in a cool, damp, dark location. Moist sawdust or soil can be packed loosely around the plants to prevent the roots from drying out. Bareroot plants can be stored successfully for several months prior to planting, as long as their roots do not dry out or freeze, and they do not leaf out.

Container Plants and Balled and Burlapped Material

The most expensive and cumbersome restoration materials, but also the most successful in terms of survival, are container plants. Balled and burlapped (B&B) plants are expensive, but can have lower survival rates because of the loss of roots when dug from nursery beds (similar to bareroot materials). Both types can be planted at any time of the year, so long as hydrologic conditions are favorable and the ground is not frozen.

There are probably few instances when you would actually go through the process of ordering container materials for a project, and it is therefore useful to know what to expect when you purchase trees and shrubs from commercial growers. Order early – as soon as you know what you need for a project, start shopping. It can take two growing seasons or longer to propagate woody plants, especially seedlings. Be sure to specify plant size: if you ask only for specific container sizes, you may end up with tiny plants.

Before you accept delivery of container or B&B stock, look at the quality of the materials, particularly the roots. With container plants, remove several plants from the pots and check roots to be sure they fill the pots and are large enough to support the top growth without being pot-bound. Large, thick roots circling inside the pots or girdling other roots are indicative of plants that have outgrown their containers and were not transplanted to larger pots in time. B&B plants should have solid root balls with enough of the root systems present to support the top growth of the plants.

Overall quality is important. Plants for revegetation sites need not be perfect landscape specimens, but they should be vigorous and healthy, with no leaf damage, wilting, or pest insects. Healthy plant material is most able to tolerate less than ideal conditions and survive on a restoration site.

Direct Seeding of Wetland Plants

Many wetland plants are very difficult to seed in the wild. Wetland plant seeds usually require three things to germinate: heat, water, and light. The need for light means that wetland plant seeds must be seeded on the surface and cannot be covered with soil. Planting the seed with a drill will cover the seed, especially if packer wheels or drag chains are used.

Many species have a very hard seed coat that takes up to a year or longer to break down enough for the embryo to germinate. Many species require special stratification treatments to prepare the seed for planting. These treatments include everything from acid wash to mechanical scarification, from pre-chilling to extremely high temperature soil conditions. Occasionally, dormant seeding (seeding during the late fall or winter after the plants have gone dormant) can be successful, but it depends on the species.

Not having absolute control of the water going into the wetland or riparian area is the most common mistake that occurs when seeding wetland plants. Without good water control, when water enters the system the newly planted seeds will float to the water surface and move to the water's edge, where wave action will deposit the seed in a very narrow zone. The seed will germinate here and the stand will generally be quite successful so long as the hydrologic conditions are maintained for the various species deposited there. With good water control, the seeds, for the most part, will stay in place, and the stand will cover the wetland bottom instead of just around the fringe.

Some species, when seeded in a greenhouse setting, require a cold-hot stratification environment for successful germination. This means that the seeds are placed in cold storage at 32-36° F for 30 to 60 days and are then planted in moist soil containers at about 100° F. Heat is one of the essential requirements for germination and growth.

Based on these difficulties, using direct seeding of herbaceous plants as the primary means of revegetating a site will require more attention to planning and control of site hydrology during the establishment period. It also means you will need to know the specific germination/stratification requirements (if any) the targeted species require. Typically, direct seeding of herbaceous species is not used as the primary means of active revegetation, but as a method to increase the overall species diversity in a wetland, especially around the perimeter, and to establish populations of specific target species. The use of wetland herbaceous plugs is recommended over the use of wetland seed. However, the grass seeding mixtures in Table 7-8 may be used to quickly vegetate newly prepared wetland or fringe areas. Seeding alone may also be used if natural regeneration of indigenous species is desired.

Table 7-8: Grass Mixtures for Quickly Vegetating Wetland Sites

Species	Common Name	Remarks
Agrostis gigantea	Redtop	SP,I,CG
Agrostis palustris	Creeping bentgrass	P,I,CG
Calamagrostis candensis	Canada bluejoint	P,N,CG
Cinna arundinacea	Wood reedgrass	P,N,CG
Dicanthelium clandestinum	Deertongue	P,N,WG
Elymus virginicus VA./riparius	Riparian wildrye	P,N,CG
Lolium multiflorum	Annual ryegrass	A,I,CG
Panicum virgatum	Switchgrass	P,N,WG
Poa trivialis	Rough bluegrass	P,I,CG
Poa palustris	Fowl bluegrass	P,N,CG
Puccinellia distans	Alkali saltgrass	P,N,CG
Tripsacum dactyloides	Eastern gamagrass	P,N,WG

Legend:

P = perennial	CG = cool-season grass
A = annual	WG = warm-season grass
I = introduced	CL = cool-season legume
N = native	SP = short-lived perennial

Note: Warm-season grass seeding rates are based on Pure Live Seed (PLS).

Suitable Seed Mixtures

SEED MIX 1: Warm-season mixture suitable for highly acid soils. Provides excellent wildlife value.

Blackwell switchgrass	3 lbs./ac. PLS
Tioga deertongue	5 lbs./ac. PLS
Annual ryegrass (nurse)	5 lbs./ac. PLS

SEED MIX 2: Cool-season mixture suitable for highly erosive areas. Provides fair wildlife value.

Canada bluejoint	2 lbs./ac.
Redtop	1 lbs./ac.

SEED MIX 3: All native mixture suitable for somewhat acid soils. Provides good to excellent wildlife value.

Blackwell switchgrass	3 lbs./ac. PLS
Tioga deertongue	5 lbs./ac. PLS
Wild rye	5 lbs./ac.

SEED MIX 4: Turfgrass mixture suitable for moist, shady areas.

Rough bluegrass	25 lbs./ac.
Creeping bentgrass	10 lbs./ac.

SEED MIX 5: Native grass mixture for shady sites/forested floodplains.

Wood reedgrass	2 lbs./ac.
VA or Riparian wildrye	5 lbs./ac.

SEED MIX 6: Mixture for providing quick, temporary cover in areas where planting may be delayed due to seasonal restrictions, e.g, seed in late fall, plant permanent vegetation the following spring. Excellent wildlife value.

Redtop	1 lbs./ac.
Annual ryegrass	8 lbs./ac.

SEED MIX 7: This mixture is suitable for wet, saline areas, i.e., along roadsides, adjacent to tidal areas.

Creeping bentgrass	10 lbs./ac.
Alkali saltgrass	5 lbs./ac.

SEED MIX 8: Permanent cover mix providing quick perennial cover for saturated areas that will not be planted with other species.

Eastern gamagrass	5 lbs./ac. PLS
Redtop or creeping bentgrass	2 lbs./ac.
Fowl bluegrass	5 lbs./ac.
Wild rye	8 lbs./ac.
Switchgrass	5 lbs./ac. PLS

If aesthetics are desired, the following wildflowers are tolerant of saturated conditions and any or all may be added to the above mixtures at the rates specified:

Asclepias incarnata (Swamp milkweed)	2 lbs./ac.
Aster novae-angliae (New England aster)	0.5 lb./ac.
Aster novi-belgii (New York aster)	0.5 lb./ac.
Bidens frondosa (Beggar's tick sunflower)	1 lb./ac.
Caltha palustris (Marsh marigold)	0.5 lb./ac.
Chelone glabra (Turtlehead)	1 lb./ac.
Eupatorium fistulosum (Joe-pye weed)	1 lb./ac.
Helenium autumnale (Sneezeweed)	1 lb./ac.
Lobelia cardinalis (Cardinal flower)	0.5 lb./ac.
Lobelia siphilitica (Blue lobelia)	0.5 lb./ac.
Mimulus ringens (Monkey flower)	1 lb./ac.
Rudbeckia laciniata (Green-headed coneflower)	1 lb./ac.
Solidago rugosa (Wrinkle-leaf goldenrod)	0.5 lb./ac.
Solidago patula (Rough goldenrod)	0.5 lb./ac.
Verbena hastata (Blue vervain)	1 lb./ac.
Vernonia noveboracensis (New York ironweed)	2 lbs./ac.

Wetland Transplanting with Plugs

Natural wetland systems normally have high species diversity. When selecting plant species for the project wetland, try to copy a nearby natural wetland using these techniques:

- Identify the particular hydrology in areas where the individual plant species are growing.
- Make note of how deep the water is.
- Try to imagine how long the plants will be inundated.
- Determine whether the plants are in flowing or relatively stagnant water.

Rarely will a natural wetland be totally stagnant through time. Generally, there is water flowing into the wetland from somewhere, either above ground or from groundwater. Spring and fall overturn, as well as wind mixing, helps to circulate the water.

Next, prepare the planting area. The easiest way to plant wetland species plugs is by flooding your planting site. Standing water is much easier to plant than dry soil (this also ensures that the watering system, whatever it may be, works before you plant). Make sure the soil is saturated enough so that you can dig a hole with your hand. This is more successful with fine soils than with coarse soils. Take the plug trays and place them in a Styrofoam cooler (you will not need the lid). Try to cover most of the roots with water while in transit. At the planting site, drain off most of the water so the cooler will float. Use the cooler to move the plugs around the wetland as you plant. Select a spot in your wetland to put a plug, reach into the water with your hand and dig out a hole deep enough for the plug to fit all the way in. Push the plug into the hole and pack around it with your hand. Make sure all of the roots are covered with soil. Be careful to not dislodge the plug and expose the roots when moving around. Start at one end of the planting site and work toward the opposite end.

Spacing of the plugs is a common concern. Research has indicated that many wetland plants will typically spread about 9 to 12 inches in a full growing season. Typically, wetland species are planted on 18 inch centers. Even though it takes fewer plants to plant an area at a wider spacing, plantings at wider spacing have less overall success than planting at a closer spacing. The exact reason for this is unknown, but it could be a sympathetic response to plants of the same species. If the project budget does not allow for the purchase of enough plants to cover the wetland bottom, plant the plugs on 18 inch centers, but plant them in copses or patches that are about 10 feet square or in diameter. Space the copses about 10 feet apart. The copses can be planted to different species according to the hydrology. For hydrologic Zone 2, Scheuler (1996) recommends planting at least five to seven species of emergent plants, three of which should be arrowhead (Sagittaria latifolia), three square (Scirpus pungens), and soft-stem bulrush (Scirpus tabernaemontanii). Based on experience, these three species will establish readily and spread quickly without being too aggressive. Over time, the plants will spread out into the unplanted areas. The additional species selected for the wetland system can be chosen to mimic natural wetlands in the area and/or enhance water quality, wildlife value, or aesthetics. Generally, it is best to keep water levels as shallow as possible to promote greater species diversity and assimilate a higher concentration of pollutants. High nutrient inflows and greatly fluctuating water levels tend to promote the more aggressive species such as reed canarygrass, cattails, and phragmites.

The optimum planting window for wetland plants is from March through late July. Planting plugs in the fall and winter has resulted in frost heaving of the plugs so that only about one-third of the plug remained in the ground. The availability of water is critical – wetland plants like it hot and wet. They tend to spread faster with warmer temperatures. If you plant in the spring, it will take the plants a while to get going, but they will have a longer establishment period. Fall planting will generally result in lower establishment success because of the shorter growing season and frost heaving damage.

The plants can be successfully established in a wide variety of soil textures. Successful wetland plantings have occurred in areas that are clay with no organic matter to gravelly textures. The biggest problem is

digging the holes. The soil texture will often limit the equipment available to dig the holes. In clay bottoms, a small bulldozer or tractor with a ripper tooth can be used to dig lines across the bottom about 8 inches deep.

In general, fertilizer is not necessary, but its use depends on the site and the soils. If during construction the bottoms have been cut down to the subsoil and all of the naturally present nutrients have been removed, fertilization will probably be necessary unless the water coming into the wetland has a high nutrient load.

After planting, release the water into the site slowly. The young plants have not fully developed the aerenchymous material necessary for them to survive in anaerobic soils and standing water. After the initial planting, be careful not to raise the water level to more than about 1 inch above the substrate. Too much water at this time may stress the new plants. Maintain the water at about 1 inch for about one week, to inhibit the germination and growth of any terrestrial species that may be present in the restored wetland. The water level can then be lowered to the substrate surface for 15 to 20 days. This will expose the mud surface, stimulating any wetland seeds that were brought in with your transplants to germinate as well as increase the rate of spread of the transplants. You can then raise the water level 1 to 2 inches for another week. Then lower the water to the substrate surface for another 15 to 20 days. After this period, slowly raise the water level to 4 to 6 inches for three to five days. Continue to gradually increase the water depth to 6 to 8 inches. The aerenchymous tissues in the plant shoots are what supply the roots with oxygen, so be careful not to raise the water over the tops of the emergent vegetation. If the plants are not showing any stress, continue to carefully raise the water level to 12 to 20 inches, if possible. These suggested water level depths must be modified based on the species used. Some species will not tolerate inundation at these suggested depths or durations. When in doubt, defer to the hydrology conditions on natural reference sites where the species occurs. The goal here is to inundate the transition zone between wetland and upland as much as possible to control any invading terrestrial species. After about 20 days lower the water level to about 2 to 3 inches (Hammer 1992). For the rest of the growing season, adjust the water level to maximize the desired community type. The key to determining the appropriate water level is to monitor the emergent wetland plant community. Raise the water level if weed problems surface. Lower the water level to encourage emergent wetland plant growth and spread. The key is to fluctuate the water level. Natural wetlands rarely have a constant water level. Many species cannot tolerate a constant water level and will begin to die out; species more tolerant to standing water will increase, and the plant diversity that was so carefully planned for will be lost.

Management during the establishment year is important to ensure that the plants do not get too much water or too little. Weed control is important especially during the establishment year because of the low water levels and exposed, unvegetated areas. A good weed control plan needs to be in place before planting. Monitoring the planting for three to five years after the establishment year will help maintain the planting and provide useful information for future plantings.

Recommendations

- Always match the plant species to the hydrology associated with that species. In general, purchase the largest plugs you can. Planting technique will often determine the size of the plugs and the ease of planting.
- Plant the plugs on 18 to 24 inch centers. Plant in patches rather than wider spacing.
- Fertilizer is generally not necessary unless the water coming into the site is relatively clean or construction has cut into the subsoil.
- Plants will spread faster under saturated soil conditions than in standing water. However, terrestrial weeds will move in to saturated soils much faster than flooded soils. Fluctuating the water level helps the plants spread and decreases terrestrial weed establishment.

- Water control is extremely important during the establishment year.
- Weed control must be planned and budgeted at the beginning of the project.
- Monitoring is essential for the success of the project. Monitoring requires time and money allocated in the budget, and a specific person identified to carry it out.
- Successful wetland plantings take significant planning and a good understanding of the hydrology at each site.

Upland Seeding

There are three main factors to consider when planning the upland seeding phase of a stormwater basin: season of seeding, seeding rates, and method of application. Season of seeding is important because some seed may require stratification before germination. Other seed, such as legume species, should probably not be seeded until spring. Seeding rate concerns both economics and plant competition. Too much seed on a site puts unnecessary cost into the total process and, at the same time, a thinner stand will emerge because of plant competition for nutrients traditionally in short supply on disturbed soils. Ideally, the site should have been prepared the previous fall if a spring seeding is desired. Usually, spring seedings are conducted between periods of wet and dry weather (commonly in March to the first of May). There may be a problem getting heavy equipment onto the site to prepare a seedbed in the early spring following a wet winter that has saturated the soil profile. (Refer to the USDA-NRCS Conservation Practice Standard-342 "Critical Area Planting" or the Standards for Soil Erosion and Sediment Control in New Jersey for seed mixtures and mulching information.)

Part 6: Other Considerations in Stormwater BMP Landscaping

Use or Function

In selecting plants, consider their desired function in the landscape. Is the plant needed as ground cover, soil stabilizer, or a source of shade? Will the plant be placed to frame a view, create focus, or provide an accent? Does the location require that you provide seasonal interest to neighboring properties? Does the adjacent use provide conflicts or potential problems and require a barrier, screen, or buffer? Nearly every plant and plant location should be provided to serve some function in addition to any aesthetic appeal.

Plant Characteristics

Certain plant characteristics, such as size and shape, are so obvious they may actually be overlooked in the plant selection. For example, tree limbs, after several years, can grow into power lines. A wide growing shrub may block an important line of sight to oncoming vehicular traffic. A small tree, when full grown, could block the view from a second story window. Consider how these characteristics can work for you or against you, today and in the future.

Other plant characteristics must be considered to determine how plants provide seasonal interest and whether plants will fit with the landscape today and through the seasons and years to come. Some of these characteristics are: color, texture, growth rate, and seasonal interest, i.e., flowers, fruit, leaves, and stems/bark.

Growth Rate

If shade is required in large amounts, quickly, a sycamore might be chosen over an oak. In urban or suburban settings, a plant's seasonal interest may be of greater importance. Residents living next to a stormwater system may desire that the facility be appealing or interesting to look at throughout the year. For example, willows are usually the first trees to grow leaves signaling the coming of spring. Pink and white dogwoods bloom in mid-spring to early summer, while witch hazel has a yellow bloom every fall, which can be contrasted with the red fall foliage of a sugar maple. Careful attention to the design and planting of a facility can result in greater public acceptance and increased property value.

Availability and Cost

Often overlooked in plant selection is the availability from wholesalers and the cost of the plant material. Many plants listed in landscape books are not readily available from local nurseries. Without knowledge of what is available, time spent researching and finding the one plant that meets all needs will be wasted. That plant may require shipping, making it more costly than the budget may allow. Some planting requirements may require a special effort to find the specific plant that fulfills the needs of the site and the functions of the plant in the landscape. In some cases, it may be cost effective to investigate nursery suppliers for the availability of wetland seed mixtures. Specifications of the seed mix should include wetland seed types and the relative proportion of each species. Some suppliers provide seed mixtures suitable for specific wetland, upland, or riparian habitat conditions. This option may best be employed in small stormwater facilities, such as pocket wetlands and open swales, or to complement woody vegetation plantings in larger facilities. A complete listing of wetland plant suppliers is available on the USDA-NRCS Plant Materials Program website (www.Plant-Materials.nrcs.usda.gov).

Vegetation Maintenance

To ensure grass vigor, maintain the copse as an upland meadow, which includes cutting no shorter than 6 to 8 inches high. If a more manicured lawn setting is desired, more mowing and special attention to turf health will be needed. Some communities consider the tall wetlands-type vegetation (typically, cattails or rushes) that may grow in dry ponds to be unaesthetic. Some of this vegetation is actually beneficial as it provides water quality benefits and wildlife habitat. Some vegetative needs include:

- pH adjustment (as required);
- pruning;
- pest control;
- reseeding;
- thatch removal; and
- weed removal.

Sediment Filtration

Vegetative cover outside of an embankment filters sediment from runoff as it flows into a pond. It also prevents erosion of the pond banks. A minimum vegetated filter strip BMP is ideal around wet ponds.

Surrounding Vegetation Fertilization (not recommended, except in special cases)

It is important not to over-fertilize the surrounding vegetation. Doing so could result in excess nutrients being washed into the pond, which can contribute to excessive algae growth. As a general rule, the nutrient needs of the surrounding vegetation should be evaluated by testing the pH and nutrient content of the soil prior to fertilization. The adjustment of pH may be necessary to maintain vegetation. Fertilization of all turf areas should occur in the fall.

Purple Loosestrife

If your wetland and/or stormwater management area becomes invaded with purple loosestrife, there are methods to reduce its presence. It is important to catch its presence early, which is evident by the long purple flowering head or inflorescence. To manually rid the wetland and/or stormwater management area of purple loosestrife, it is important to ensure that the rhizomes (large tuberous root systems) are removed as well as the plant (above ground portion) prior to flowering (June through September). Plant parts, immediately upon removal, should be placed in a bag to prevent further spread of the species. If it is not possible to do this, regularly remove the flower heads before the seeds are dispersed. This will help keep this plant at bay. Digging is not recommended as it creates disturbance, which may favor the spread of the species. Herbicides are generally not effective for purple loosestrife as its seeds are long-lived and this solution is therefore short-term. If herbicide applications are used, they will need to be repeated for several years. As a caution, purple loosestrife may be available at local nurseries. Do not introduce this plant into pond areas.

Cattails and Common Reeds (phragmites)

It is important to determine which plants were originally planted when the pond or stormwater wetland was constructed. Cattails planted in these areas are one of the most beneficial plants in improving water quality. It must be noted that ponds and stormwater wetlands were originally designed with the intent of retaining

stormwater and/or treating stormwater. The concept of wildlife habitat was an ancillary benefit at best and not generally the goal prior to the mid-1990s.

Shallow water (less than 2 feet) will often be taken over by water loving plants. Dense, tall emergent vegetation, most commonly cattails and phragmites, may limit waterfowl use of a pond. Cattails provide good wildlife habitat, but can take over a shallow pond. Phragmites is much more invasive, taller, and generally does not provide for a scenic view. Once established, phragmites is very difficult to completely eradicate.

Dense stands of cattails and phragmites can reduce populations of invertebrates, amphibians, and reptiles, and may possibly increase mosquito populations. It is important to keep some areas of open water. Eradication of these species generally requires assistance from a natural resource professional. A natural resource professional is a person who has been trained in ecology and/or environmental assessment, including soils, plants, animals, air quality, human involvement, and water quantity and quality.

With respect to diversity, research has shown that lower pollutant inputs generally yield greater plant diversity. Conversely, higher pollutant inputs yield lower plant diversity. Hence, if your pond becomes populated with phragmites, cattails or both, it may indicate a high pollutant load. These species, among others, are two of the best plants for improving water quality.

Stormwater Plant Lists

The following pages present lists of herbaceous and woody vegetation native to New Jersey and suitable for planting in stormwater management facilities. The lists are intended as a guide for general planting purposes and planning considerations. Knowledgeable landscape designers and nursery suppliers may provide additional information for considering specific conditions for successful plant establishment and accounting for the variable nature of stormwater hydrology.

The planting lists are in alphabetical order according to the common name, with the scientific name also provided. Life forms indicate whether a plant species is an annual, perennial, grass, grass-like, fern, tree, or shrub.

Each plant species has a corresponding hydrology zone to indicate the most suitable planting location for successful establishment. While the most common zones for planting are listed in parenthesis, the listing of additional zones indicates that a plant may survive over a broad range of hydrological conditions.

The wetland indicator status has been included to show "the estimated probability of a species occurring in wetlands versus nonwetlands." The indicator categories are defined as follows:

- Obligate wetland (OBL): Plants that nearly always (more than 99 per cent of the time) occur in wetlands under natural conditions.
- Facultative Wetland (FACW): Plants that usually occur in wetlands (from 67 to 99 per cent of the time), but are occasionally found in nonwetlands.
- Facultative (FAC): Plants that are equally likely to occur in wetlands and nonwetlands and are found in wetlands from 34 to 66 per cent of the time.
- Facultative Upland (FACU): Plants that usually occur in nonwetlands (from 67 to 99 per cent of the time), but are occasionally found in wetlands (from 1 to 33 per cent of the time).
- Upland (UPL): Plants that almost always (more than 99 per cent of the time), under natural conditions, occur in nonwetlands.

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.

Since the wetland indicator status alone does not provide an indication of the depth or duration of flooding that a plant will tolerate, the "Inundation Tolerance" section is designed to provide further guidance. Where a plant species is capable of surviving in standing water, a "Yes" is designated in this column. Additional information is provided for depth of inundation for aquatic vegetation and tolerance for seasonal inundation, saturated soil conditions, or tolerance to salt. Because individual plants often have unique life requirements difficult to convey in a general listing, it will be necessary to research specific information on the plant species proposed in order to ensure successful plant establishment.

Commercial availability indicates whether the plant is available as seed, plant form (bare-root, plug, or container), or both. The plant form listed first is the most common form supplied by nurseries. The availability of some species varies from one year to the next. It is best to determine the quantity needed and the plant form desired for each individual species well ahead of time (at least six months).

Table 7-9, a list of herbaceous stormwater plants, begins on the next page, followed by Table 7-10, a list of woody vegetation.

Table 7-9: Stormwater Plant List – Herbaceous Vegetation

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

Common Name	Scientific Name	Plant Type	Hydrologic Zone	Wetland Indicator	Inundation Tolerance	Commercial Availability
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
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

Common Name	Scientific Name	Plant Type	Hydrologic Zone	Wetland Indicator	Inundation Tolerance	Commercial Availability
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	1-5	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

Common Name	Scientific Name	Plant Type	Hydrologic Zone	Wetland Indicator	Inundation Tolerance	Commercial Availability
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
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

Common Name	Scientific Name	Plant Type	Hydrologic Zone	Wetland Indicator	Inundation Tolerance	Commercial Availability
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

Table 7-10: Stormwater Plant List – Woody Vegetation

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

Common Name	Scientific Name	Form	Zone	Indicator	Inundation	Commercial Availability
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
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

Common Name	Scientific Name	Form	Zone	Indicator	Inundation	Commercial Availability
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
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
Rh000dendron, 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

Common Name	Scientific Name	Form	Zone	Indicator	Inundation	Commercial Availability
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	0-6~	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

References

The following is a list of resources used in compiling these guidelines and lists of plant materials, including references from the Maryland Stormwater Design Manual, from which some parts were adopted.

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