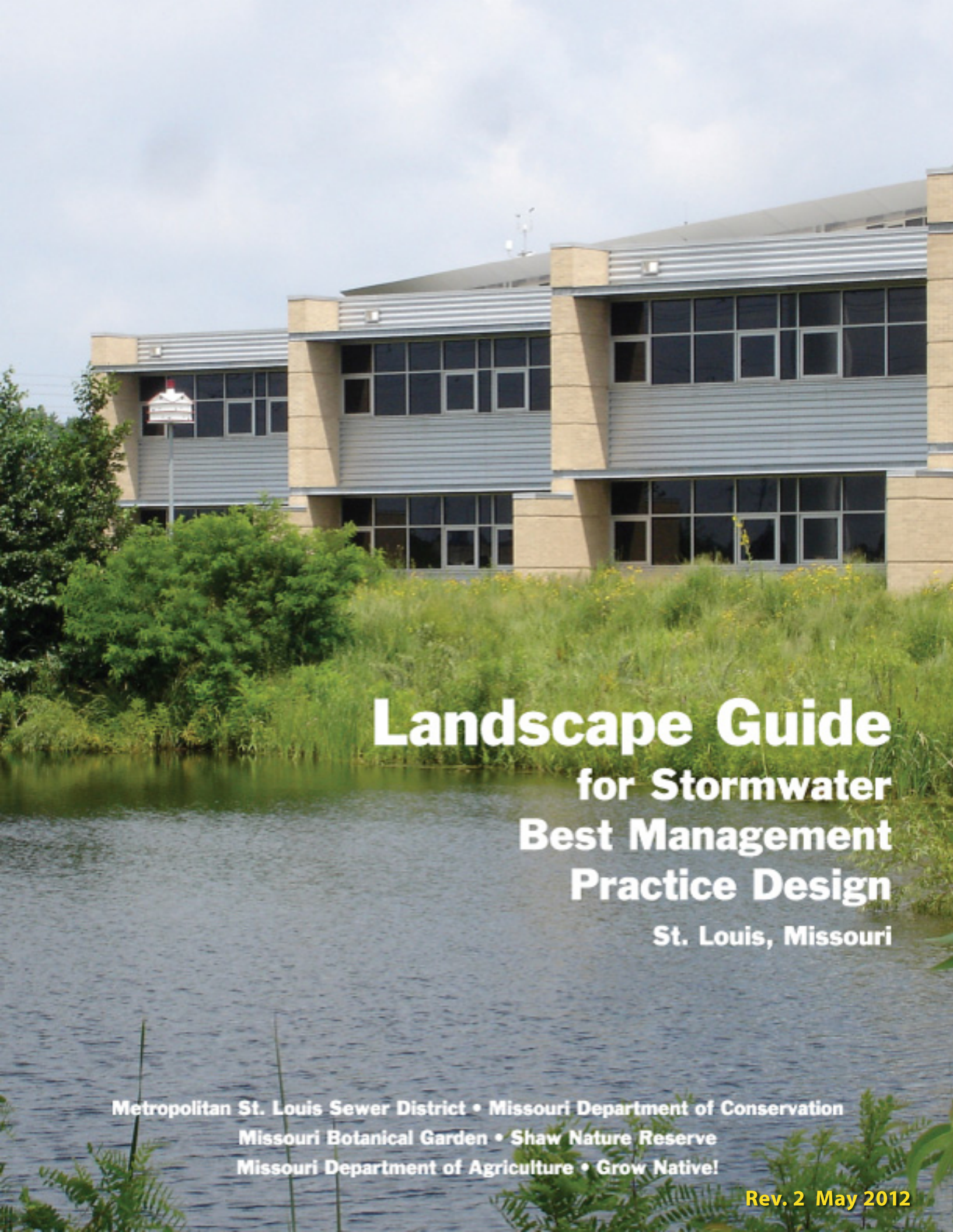

Landscape Guide
for Stormwater Best Management Practice Design
St. Louis, Missouri

Metropolitan St. Louis Sewer District • Missouri Department of Conservation
Missouri Botanical Garden • Shaw Nature Reserve
Missouri Department of Agriculture • Grow Native!

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Chapter One: Planting Guide
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In the preparation of this document reference was made to the following publications and resources:

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Figure 2: Courtesy of Mid-America Regional Council www.marc.org

Figure 3: Sources: www.rwmwd.org and www.ci.austin.tx.us/

Figure 4 Source: Ellerbe Creek Watershed Association www.ellerbecreek.org

Figure 5-7: Source: Maryland Stormwater Design Manual

Figure 8 Source: Plants for Stormwater Design

Figures 9 and 10: Courtesy of Ted Spaid, SWT Design www.swtdesign.com

Figure 1: From left, *Aesculus pavia, Equisetum hyemale, Chleone obliqua*, Courtesy Missouri Botanical Garden Plantfinder

2. Introduction

In recent years interest has increased in the use of innovative methods to retain and treat stormwater. These methods, often called stormwater best management practices (BMPs), rely on natural processes, such as microbial activity, filtration, infiltration, denitrification, nutrient reduction and evapotranspiration, to attain water quality and water quantity goals. Although technical information is available on the design of many types of stormwater BMPs, less information is available on plant species appropriate for these systems.

This guide has been developed to assist designers through the process of selecting and planting native plant species appropriate for a variety of stormwater BMPs in St. Louis, Missouri. This guide is by no means a substitute for employing the proper professionals to ensure project success. It is broken down into seven major sections.

Section 1 provides an acknowledgement to the contributors. In Section 3, key factors in selecting plant material for stormwater landscaping are reviewed, including native species, invasive species, site preparation, planting design, plant selection and installation and management. Section 4 presents more specific guidance on landscaping criteria and plant selection for the following BMP design types:

Wet Ponds

Wetlands

Infiltration Basins and Dry Swales

Surface Sand Filters

Bioretention and Organic Filters

Section 5 provides further plant selection considerations and Section 6 lists valuable local resources. The final section, Section 7 lists various plants specific for each BMP type outlined.

3. General Guidance

Native Species

The Landscaping Guide for Stormwater Design requires the use of native plants in stormwater management facilities. Native plants are defined as those species that evolved naturally to live in this region. Native species are those that lived in Missouri before Europeans explored and settled in America and brought many common, but non-native species, with them. 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.

Because they evolved to live here naturally, native plants are best suited for our local conditions. This translates into greater survivorship when planted and less replacement or maintenance during the life of a stormwater management facility. The deep root systems (See Figure 2) help develop pore space in the soil to promote infiltration of rainfall, reducing stormwater runoff during rain events. The deep root systems also sustain the plants during dry periods, reducing dependence on irrigation. These attributes provide cost savings for the facility owner. Cost savings are even more substantial due to the reduced need for mowing, compared to turf.

The benefits of native plants go beyond practical issues for the installer and property manager. Reduced mowing also contributes to improved air quality. Native plants also provide food and cover for birds and butterflies, further contributing to the aesthetics and biodiversity.

The list in this guide contains plants that are readily available and have proven suitability to these stormwater practices. Additional native plant species will be added as experience proves their adaptability and performance. Other non-invasive adaptive species will be considered for approval on a case by case basis.

Finally, many native species provide high aesthetic value important for public acceptance and maintenance of property value. Species that are part of Missouri's natural heritage and provide high aesthetic value throughout the year include culver's root, river oats, cardinal flower, blue lobelia, golden alexander, lizards tail, mountain mint, New England aster, palm sedge, sneezeweed, wild bergamot, southern blue flag iris and copper iris.

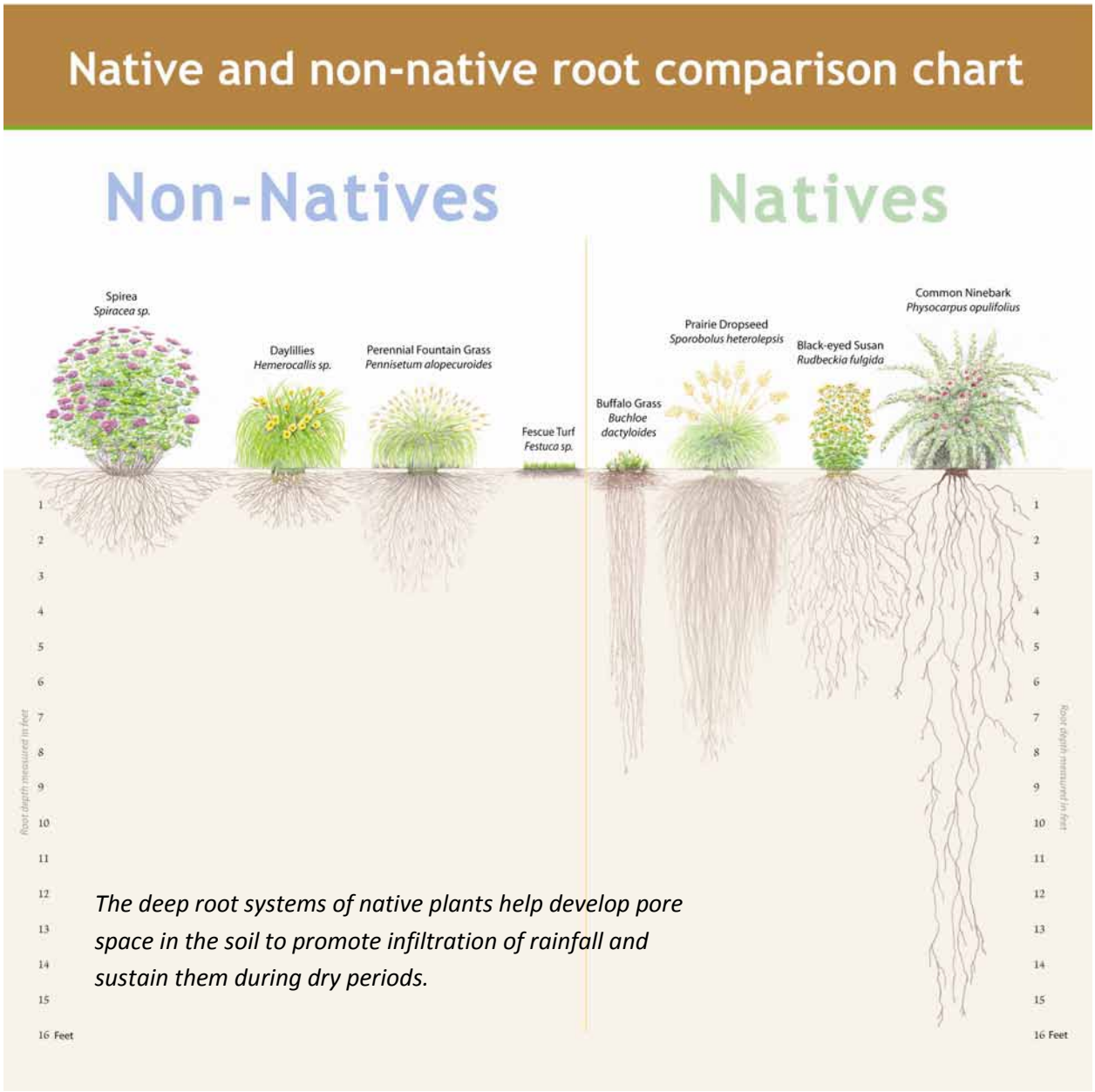


Figure 2: Native versus Non-Native Root Systems. Source: Mid America Regional Council of Governments

Invasive Species

Introduced species can escape cultivation and begin reproducing in the wild, causing significant damage to native ecosystems. This is ecologically significant because some species out-compete indigenous species and begin to replace them in the wild. Early detection and eradication is the best way to control invasive plants. Invasive species common to the region include:

- **Bush honeysuckle** (*Lonicera x bella, Lonicera maackii*). Shrub or bush honeysuckles were once touted for their red fruit and extended green season. They colonize in forest areas throughout the state, especially in metropolitan areas. Their aggressive behavior shades out native shrubs and wildflowers and their weak root system contributes to erosion problems.

- **Wintercreeper euonymus** (*Euonymus fortunei*). Brought from Asia as an ornamental groundcover, wintercreeper forms a dense ground cover and climbs on rocks and trees. It can eliminate spring wildflowers that would otherwise grow on the forest floor.

- **Garlic mustard** (*Alliaria petiolata*). A European native, it came to the United States for use as a culinary herb. Today it carpets forest floors, stealing space used by woodland wildflowers.

The invasive plants listed here are only a few of the aggressors. Information on exotic invasive species identification and management can be found at:

- Midwest Invasive Plant Network www.mipn.org
- Missouri Botanical Garden Shaw Nature Reserve
  http://www.shawnature.org/nativeland/NativeLandscapingManual/ChapterThree.aspx
- Missouri Department of Conservation www.mdc.mo.gov/nathis/exotic
- The Nature Conservancy http://www.nature.org/initiatives/invasivespecies/

Site Preparation

Test soil to determine if there is a need for amendments. Proper soil nutrients promote planting success. Soil testing determines:

- pH; whether acid, neutral, or alkaline
- major soil nutrients; nitrogen, phosphorus, potassium
- minerals; such as chelated iron, lime

Have soil samples analyzed by experienced and qualified individuals, such as those at University of Missouri Extension (http://extension.missouri.edu/stlouis/services.shtml). A soil analysis explains the results, what they mean and what soil amendments are needed.

If topsoil has been removed during construction, put it back in place. Whenever possible, topsoil should be spread to a depth of four inches (two inch minimum) over the entire area to be planted. This provides organic matter and important nutrients for the plant material. Without topsoil, plants may not survive and any that do will be slow to establish. The use of imported planting soil, required in certain practices, allows vegetation to establish faster and roots to penetrate deeper. This ensures quicker and more complete stabilization, making it less likely that plants will wash out during a heavy storm. See Section 4 for soil specifications for planting soil.

Minimize soil compaction and ensure compacted soils are loosened. Soil compaction should be minimized, as it is very difficult to reverse. Compacted soils inhibit penetration of plant roots, reduce planting success and increase costs as vegetation will need to be replaced. In seeding applications, seeds will lie on the surface of compacted soils and be washed away or eaten by birds. For establishment success, soils should be loosened to a four -inch depth. Hard soils may require discing or subsoiling (deep plowing without turning the soil) to a deeper depth.

Test soils on site for infiltration capacity. Site soils should have the capacity sufficient to meet the desired BMP performance. Infiltration capacity is critical in determining the effectiveness and ultimately the success of an infiltration practice.

Planting Design

Make aesthetics and viewsheds a prime consideration. Careful attention to the design and planting of a stormwater BMP can result in greater public acceptance and increased property value. Maintain and frame desirable views. Be careful not to block views at entrances, exits, or difficult road curves. Screen unattractive views into or from the site. Keep overhead utilities in mind when selecting plants to ensure the mature size will fit beneath the wires. Consider all key design issues when selecting plant material:

- Shape
- Color
- Texture
- Seasonal Interest (e.g., flowers, fruit, leaves, stems/bark)
- Growth Rate
- Mature Size

Ensure trees and shrubs permit maintenance and inspection access. Plant trees and shrubs at least 15 feet from the toe of slope of a dam or embankment. Limiting embankment plantings to herbaceous (non-woody) plants allows visibility for inspection for burrowing rodents that may compromise the integrity of the embankment. Plant trees and shrubs to allow access to the overflow riser.

Stabilize key areas with erosion control mats. Use erosion control mats in channels that are subject to frequent wash outs. If permanent mats are used, ensure they remain embedded in soil to retain functionality, permit plant growth and protect wildlife. Stabilize emergency spillways with suitable material or plants that can withstand strong flows. Root material should be fibrous and substantial, but lack a taproot, when used on dams and embankments. Stabilize aquatic and safety benches with emergent wetland plants or seed mixes.

Design aquatic features to prevent warming and pollutant inflows. Shade inflow and outflow channels and the southern exposure of ponds to prevent thermal warming, which damages aquatic systems and is considered a pollutant. Buffer strips help prevent other pollutants from entering water bodies.

When mulch is used, it should be standard landscape style, single or double shredded hardwood mulch. The mulch layer should be free of other materials, such as weed seeds, soil, roots, etc. The mulch should be applied to a maximum depth of three inches. Grass clippings should not be used as a mulch. Alternatively, pea gravel or other similar natural gravel may be used.

A "natural" (i.e. river-run) source of sand and gravel should be used. Additionally, washed materials are needed to prevent fines from clogging the sand and gravel layers. The gradation of gravel selected should be large enough to prevent "wash-out" through the perforated pipe, but small enough to prevent the sand from migrating through the gravel.

Plant Selection

Preserve existing natural vegetation where possible. Existing vegetation intercepts and infiltrates stormwater and can provide aesthetic benefits at little or no cost. Vegetation to be retained must be protected from construction damage by installing a construction fence and enforcing preservation. Construction equipment and stockpiled materials shall be kept away from vegetation to be retained and, in the case of trees, beyond the dripline at a minimum.

Select a diverse plant palette. Diversity in plant materials provides aesthetic benefits in terms of structure, color and seasonal interest. By creating a diverse, dense plant cover, stormwater BMPs will be able to intercept and treat stormwater runoff and withstand urban stresses from insects, disease, drought, temperature, wind and exposure. Various root types (shallow, deep, fibrous, etc.) provide the best stability. Diverse plant types, i.e. trees, shrubs and herbaceous plants, intercept rainfall at multiple levels before it reaches the ground. A diverse

plant community also ensures that a disease, insect, or other problem does not completely wipe out the vegetation. Requirements in Section 7, the plant list, help achieve this goal.

Minimize turf use. Turf grass does little to prevent erosion. It functions much like an impervious surface as the root system is shallow and it provides little above-ground structure to intercept rainfall and slow stormwater runoff. It also requires intensive chemical applications and mowing that increases cost and exacerbates stormwater quality problems.

Select plants carefully for cultural tolerances. The plant lists in Section 7 are organized to make this process easy. Ensure plants are appropriate to their location in the stormwater BMP.

Use salt tolerant plants and buffer stormwater BMPs where deicing salt is used heavily. Roadways and parking lots in the Midwest are salted heavily during winter months. During melting and rainfall events, salt is washed into a stormwater system. Biesboer and Jacobson (1994) found salt concentrations were highest within three feet of the road and then rapidly declined within 30 feet. Most warm-season grasses were tolerant of conditions beyond 10 feet from the road. Native warm-season grasses germinate later in the season, after spring rains reduce the concentration of salts in the soil. Buffer strips should be used to reduce salt inflow into stormwater BMPs. The plant lists in Section 7 provide information on salt tolerance.

Keep management requirements in mind. Carefully consider the long term vegetation management strategy for the BMP, keeping in mind the maintenance legacy for the future owners. Avoid pushing the tolerances for plants to ensure their survival. Select plants that have a suitable form and mature size to minimize the need for trimming or replacement. Provide a planting surface that can withstand the compaction of vehicles using maintenance access roads.

Installation and Management

Provide water until plants become established. Remember that 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 new plant material a chance to establish root growth. See Section 5 for planting, water and mulch requirements.

Ensure soil to root contact. When a site is mulched prior to planting, ensure container grown plants are installed directly into the soil and mulch is less than two to three inches deep. Mulch should not be tilled into the soil prior to planting because the mulch decomposition process will compete with plant nutrient needs.

Establish plant cover as quickly as possible. In all cases, seed mixes and plant material must be selected to establish ground cover as quickly as possible. Temporarily divert concentrated flows from planted or seeded areas until stabilized.

Plan for the long-term. Make sure the facility maintenance agreement includes requirements to ensure vegetation cover in perpetuity.

Provide signage. Use signage in Stormwater Management Areas to help educate the public. Signage helps guide the limits of mowing and encourages public support during the establishment period.

4. Stormwater Best Management Practices

For the purpose of this guide, stormwater BMPs are grouped into five categories: wet ponds, wetlands, infiltration basins and dry swales, surface filters and bioretention and organic filters. This section provides a brief description of the types of stormwater BMPs and planting considerations for each.

Wet Ponds

Wet ponds (including extended detention ponds, multiple pond systems and pocket ponds) are constructed stormwater retention basins designed to retain a permanent pool of water. Wet ponds are generally located on-line, meaning in the flow-path of the runoff. Stormwater from each runoff event is detained in the wet pond until displaced by a subsequent event. The permanent wet pond provides for sedimentation, which removes metals, nutrients, sediment and organics from stormwater. Biological uptake of pollutants and nitrogen is provided by vegetation in and around the pond. Wet ponds are suitable for sites with high nutrient loads.

This wet pond lies between an elementary school and a high school in Oakdale, Washington. The perimeter of the pond was planted by volunteers with emergent, wet meadow and prairie species, shrubs and trees. The project was a cooperative effort between the Ramey-Washington Metro Watershed District and the school district. The areas is used as part of the environmental education program for elementary and high school students.

Facing rapid growth, Austin, Texas recognized the importance of protecting their water supply and environmentally sensitive watersheds, leading to the creation of the development zones designed to direct development away from sensitive areas and drinking water sources. The wet pond in Austin's Central Park is one of the stormwater practices implemented in a 39-acre mixed use development created under the new regulations.

Figure 3: Wet Ponds, Oakdale, WA (upper left), Source: www.rwmwd.org, Austin, TX Source: www.ci.austin.tx.us/

Wet ponds should include safety and aquatic benches to add areas for plant growth that aid in biological uptake, evapotranspiration and provide wildlife habitat. Vegetation may also act as a barrier to keep children away from open water areas, or as a screen. Wet ponds often fill quickly and then slowly decrease in water level. As a result, wet ponds may experience significant water fluctuations after storms and plants must be chosen that can handle these conditions. Species suitable for planting in wet ponds are included in Section 7, Plant Lists, of this document.

Wetlands

The use of wetlands for the treatment of stormwater runoff stems from earlier attempts to use wetlands for wastewater treatment and flood control. Given that natural wetlands provide flood control, surface water storage, groundwater recharge and natural filtration. it may be tempting to turn to natural wetlands to provide treatment for stormwater pollutants. However, directing stormwater to natural wetlands damages the hydrology and functioning of the wetland. Wetlands perform a critical role in our natural systems and an estimated 87% of Mis-

souri wetlands were lost by the mid- 1980's, 53% nationwide (Dahl, 1990). As a result, environmental and permitting requirements exist to preserve our remaining natural wetlands. Therefore, artificial or constructed wetlands are required for use in stormwater treatment.

Figure 4: Stormwater Wetland, Ellerbee Creek, North Carolina Source: www.ellerbeecreek.org

Like their natural counterparts constructed wetlands offer natural aesthetic qualities, wildlife habitat, erosion control and pollutant removal. Wetlands may be used alone or in conjunction with other BMPs. It is very important that a sufficient supply of water be provided to ensure proper functioning of the wetland. Like wet ponds the water surfaces in wetlands may vary considerably. As a result, plants must be chosen that can handle these conditions. Species suitable for planting in wetlands are included in Section 7, Plant Lists, of this document.

Infiltration Basins and Dry Swales

Infiltration basins take advantage of existing permeable soils to provide groundwater recharge. In an infiltration basin a given runoff volume is captured and allowed to infiltrate into the ground and be lost to evapotranspiration. Pollutants are removed as water flows through the soil and by bacterial action. In some instances where permeability is great, these facilities are used for quantity control as well.

When properly planted, vegetation thrives and enhances the functioning of these systems. For example, pretreatment buffers trap sediments which often are bound with phosphorous and metals. Vegetation planted in the facility takes up nutrients and their roots provide arteries for stormwater to permeate soil for groundwater recharge. Finally, successful plantings provide aesthetic value and wildlife habitat making these facilities desirable to the public.

Dry swales are open, vegetated channels that are designed to filter and slow stormwater. Check dams are often used to detain water and settle pollutants. These swales are often used along roadways. If the existing soils are not sufficiently permeable, more permeable soils may be added. If a BMP is likely to receive high levels of deicing salt, salt tolerant plants should be used.

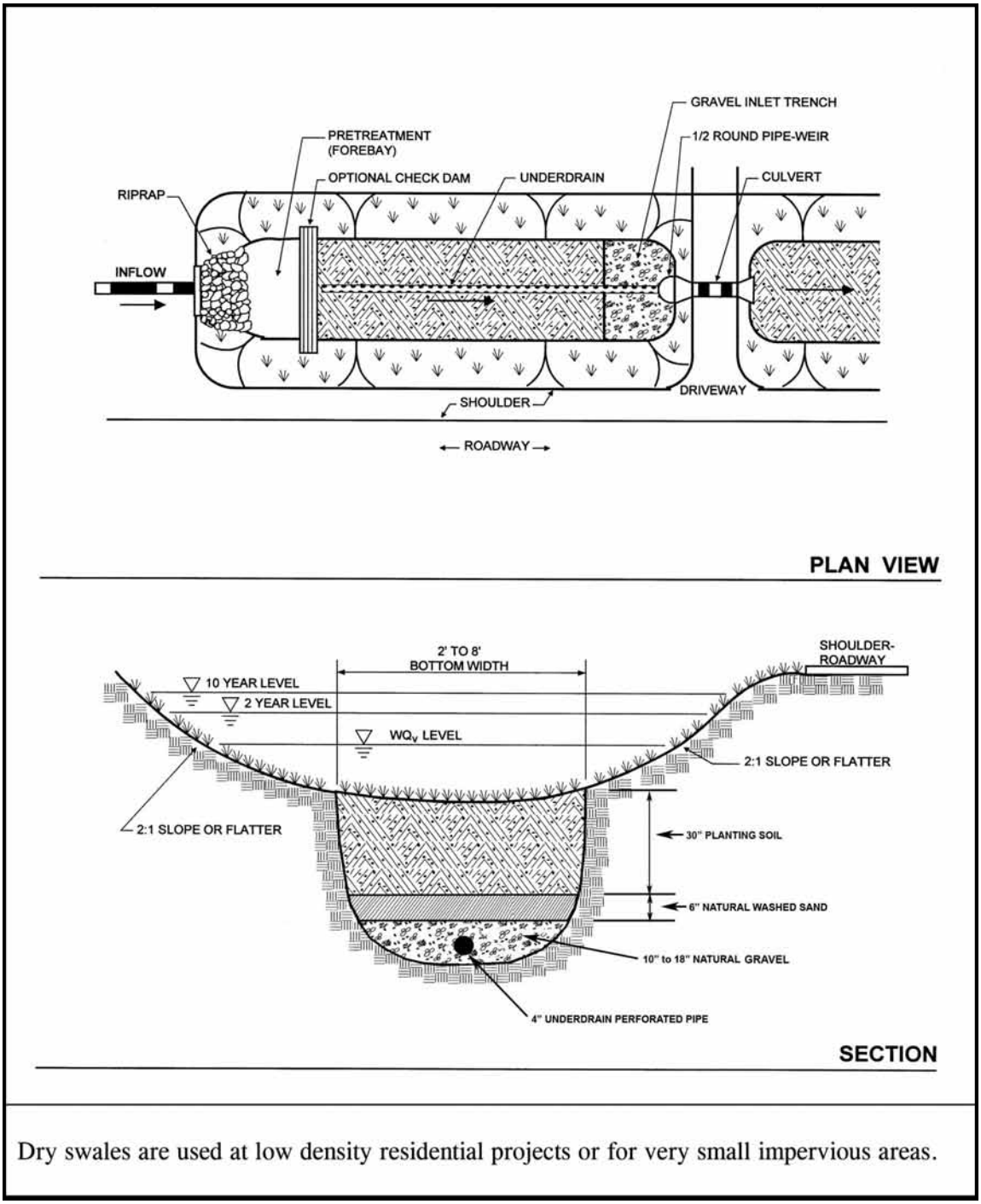


Figure 5: Dry Swale Source: Maryland Stormwater Design Manual

Where areas will be inundated or saturated with water, particular attention should be paid to plant selection. Deep-rooted plants may be particularly effective in these situations as they will encourage infiltration. Species suitable for planting in infiltration basins and dry swales are included in Section 7, Plant Lists, of this document.

Surface Sand Filters

Surface filters (including pocket sand filters) include a permeable medium such as sand for stormwater quality control. One of the main advantages of sand filters is their adaptability. They can be used on areas with low-soil infiltration rates, high evaporation rates and hot-spots. Sand filters for stormwater runoff treatment have been used extensively in some mid-Atlantic states and even longer in Austin, Texas.

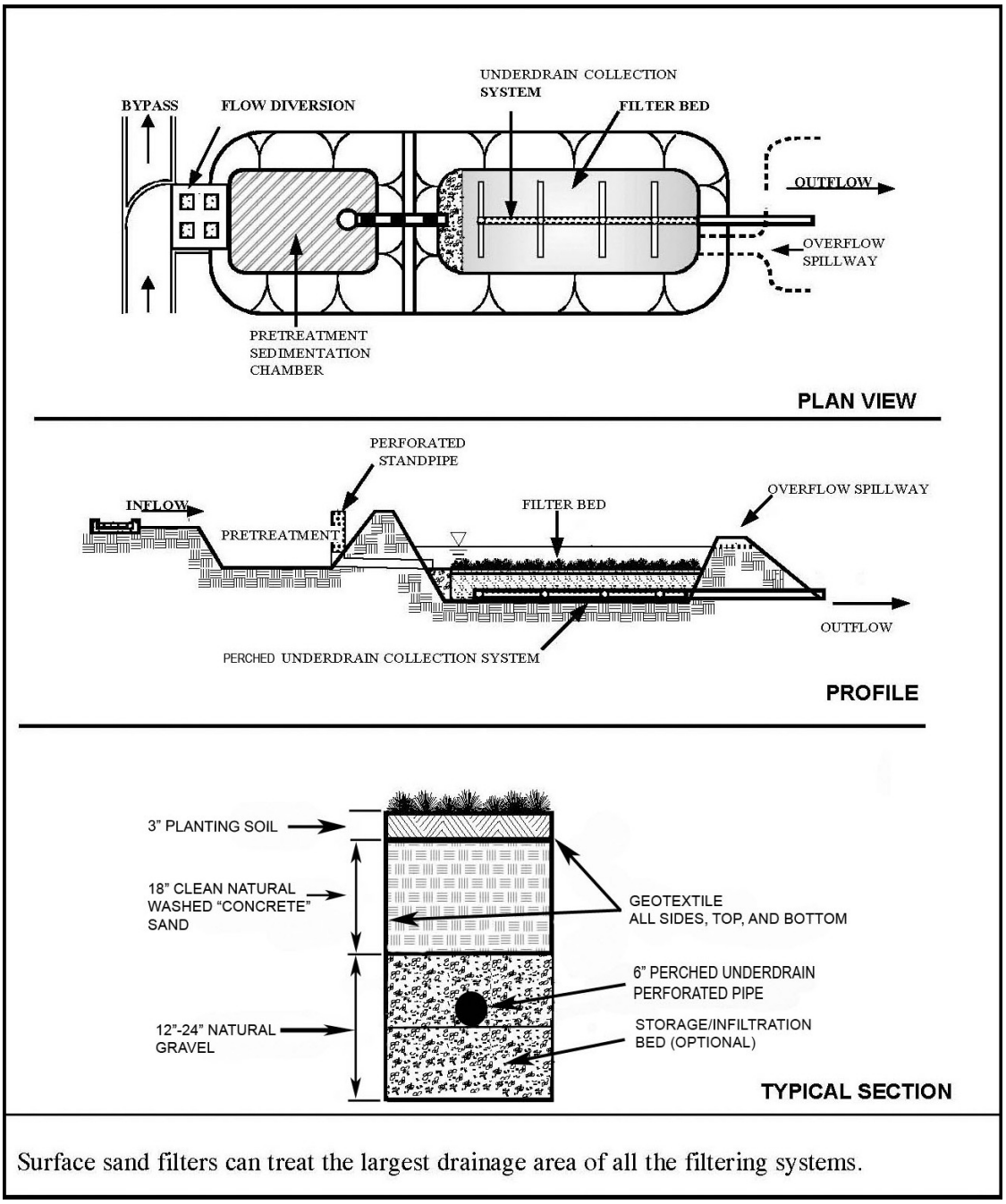
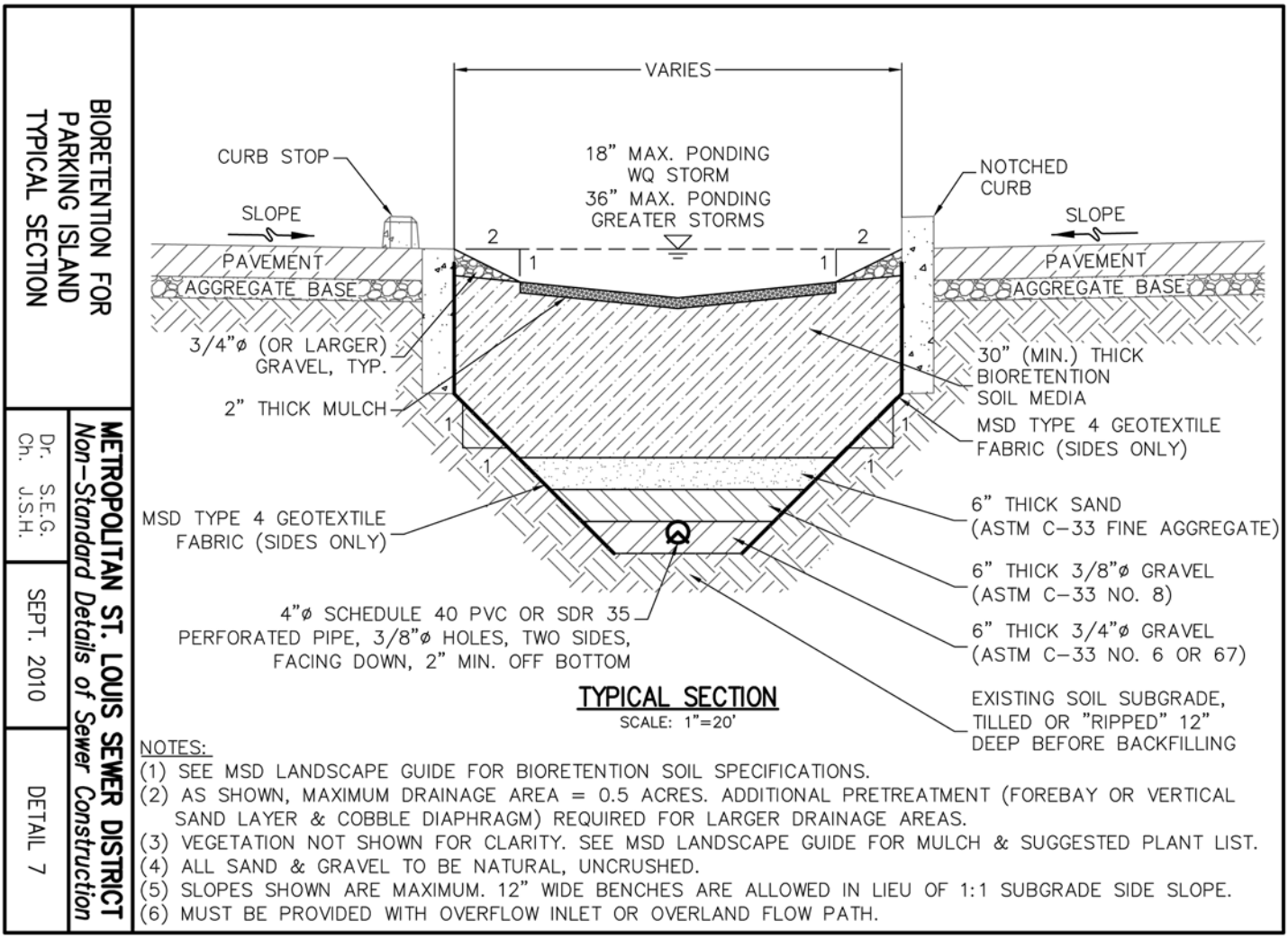


Figure 6: Surface Sand Filter Source: Maryland Stormwater Design Manual

Given the small planting soil cover utilized in most vegetated surface sand filters, particular attention should be paid to the plants used. The planting soil layer may not include significant clay content that would hinder infiltration. Species suitable for planting in surface sand filters are included in Section 7, Plant Lists, of this document.

Bioretention and Organic Filters

Bioretention areas and organic filters are attractive landscaping features planted with perennial native plants. They are designed to absorb stormwater run-off from impervious surfaces such as roofs and parking lots. These BMPs can be used in settings from residential landscapes to "big box" sites, or anywhere in between. They should not be confused with rain gardens promoted for homeowner installation, which are beneficial but do not involve rigorous engineering to meet stormwater standards.



Bioretention areas are generally designed with underdrains. However, where proper infiltration testing indicates an infiltration rate greater than 0.52 inches per hour, consideration may be given to eliminating underdrains or limiting their use. Given this practice would encourage groundwater infiltration, it should be carefully considered and where possible encouraged. In areas where significant infiltration is possible, or it is desired to limit the use of underdrains, the underdrains may be perched as shown in Figure 7.

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 that 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.

The planting soil should be a sandy loam or loamy sand (should contain a minimum of 60 percent sand, by volume). The clay content for these soils should be less than 10 percent by volume. A saturated hydraulic conductivity of at least 1.0 feet per day (0.5 inches per hour) is required. (Without post-construction verification, a conservative default value of 0.5 feet per day is acceptable. The design rate may be increased to 2 feet/day if field observation, post-construction infiltration testing, or other equivalent testing (as determined by the District) is provided to confirm the design rate is achieved.) The soil should be free of stones, stumps, roots, or other woody material over 1 inch in diameter. For best results, brush or seeds from noxious weeds, such as Johnson grass, mugwort, nutsedge 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 (rubber wheeled heavy equipment and mechanical tamping devices are not recommended for compaction). The specific characteristics are presented in the following table.

Table 1: Planting Soil Characteristics. Source: Maryland Stormwater Manual

Parameter	**Value**
pH range	5.2 to 8.00
Organic matter	1.5 to 5.0%
Magnesium	35 lbs. per acre, minimum
Phosphorus (P_2O_5)	75 lbs. per acre, minimum
Potassium (K_2O)	85 lbs. per acre, minimum
Soluble salts	≤ 500 ppm

The mulch layer plays an important role in the performance of the bioretention system. It helps maintain soil moisture and avoids 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 pretreatment 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. The mulch layer should be free of other materials, such as weed seeds, soil, roots, etc. The mulch should be applied to a maximum depth of three inches. Grass clippings should not be used as a mulch. Alternatively, pea gravel or other similar natural gravel may be used.

A “natural” (i.e. river-run) source of sand and gravel should be used. Materials must be washed to prevent fines from clogging the sand and gravel layers.

Bioretention areas and organic filters are full of water during storms and dry out during dry weather. The plants recommended in this guide generally tolerate both extremes. Species suitable for planting in bioretention areas and organic filters are included in Section 7, Plant Lists, of this document.

5. Plant Selection Considerations

Landscape Zones

Hydrology is a critical factor in plant success in stormwater practices. Plant species have evolved to tolerate particular hydrologic conditions. Matching plants with the right tolerances to the conditions created on a site is key.

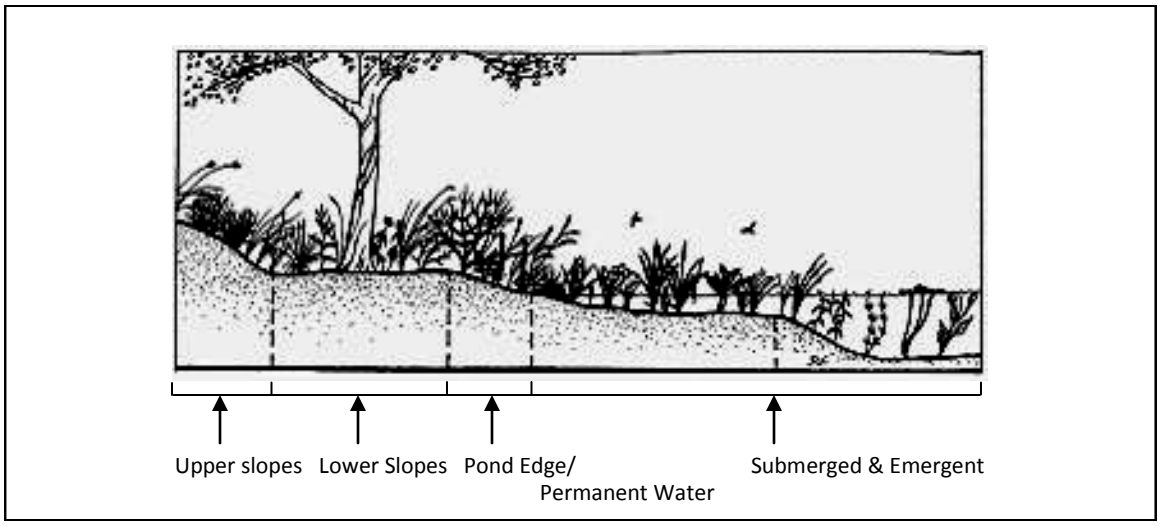


Figure 8: Landscape Zones Source: Plants for Stormwater Design

Table 2: Landscape Zone Descriptions

Landscape Zone	Conditions
Submerged & Emergent	1-6 feet deep permanent pool
Pond Edge & Permanent Water	6 inches to 1 foot deep
Lower slopes	Infrequently inundated
Upper Slopes	Seldom or never inundated
Over Sand	Periodically inundated but rapidly drained

BMPs create a variety of conditions, some of which mimic natural landscapes while others are highly artificial. This manual categorizes those conditions into six landscape zones or conditions. These zones describe the presence of water, from inundated areas to dry upland slopes.

Section 7 includes native plant lists organized by stormwater practice. The lists indicate the appropriate landscape zone(s) for each species. The plants have been selected to tolerate potentially wide fluctuations in conditions which occur in a stormwater BMP.

Submerged & Emergent - The submerged zone is found in areas of 3 to 6 feet of water in wet ponds. Submergent species may float free in the water column or may root in the pool bottom and have stems and leaves that generally stay under water. Submergent species are important for wildlife habitat and pollutant removal, especially nitrates and phosphorus. The emergent zone of a wet pond is generally 0 to 18 inches deep. This natural community is often created as benches within ponds to optimize the area for emergent plants.

Emergent plants are important for wildlife and evapotranspiration. They also provide habitat for phytoplankton, which play an important role in nutrient removal (Ogle and Hoag 2000). A wide variety of wetland species are adapted to the emergent zone.

Pond Edge & Permanent Water – The pond edge is a constantly moist area that can become inundated. The transition area between open water and the shoreline is prone to erosion. Therefore, it is an important area for plant establishment.

Lower Slopes – This zone is normally dry but may flood during snowmelt and after large storms. These areas face the challenges of overlaying native soils which may have high clay content and potentially swinging between high moisture content during wet seasons and extended dry periods.

Upper Slopes – The upper slopes are seldom or never inundated. A wide variety of species are well adapted to these dry conditions.

Over Sand – Plants over sand filter face significant challenges. Soil depth is limited, creating challenges for sufficient nutrient availability. The distinct layers between the soil and sand causes short-term saturation in the soil layer followed by extremely droughty conditions.

Planting, Water and Mulch Requirements for Stormwater BMPs

Table 3: Planting, Water and Mulch Requirements

Water Availability	**Required Planting Period**	**Minimum Container Size**	**Water Requirement First 3 Weeks***	**Water Requirement After 3 Weeks***	**Maximum Mulch Depth****
No ability to water after	Late Feb. – April only	2.25" x 3.75" or larger	Water each plug immediately		1.5 for plugs
Manual watering with standard sprinkler	Late Feb. – Early June Sept. – October	4.5" x 5" (quart) or larger in summer & fall	1" (60 min) every 4 days	1" (60 min) every 7 days until plants established***	1.5" for plugs 2.5" for quarts
Automatic irrigation (set to water more frequently than normal during first two months after planting)	Late Feb. – Early Oct.	2.25" x 3.75" (plug) or larger in spring 4.5" x 5" (quart) or larger in summer & fall	1" (60 min) every 4 days in spring and fall 1" (60 min) every 3 days in summer	1" (60 min) every 7 days until plants established***	1.5" for plugs 2.5" for quarts

**This water amount includes natural rainfall. If you get a ½ inch of natural rain then you will need to add a ½ inch of water to meet the 1 inch requirement.*

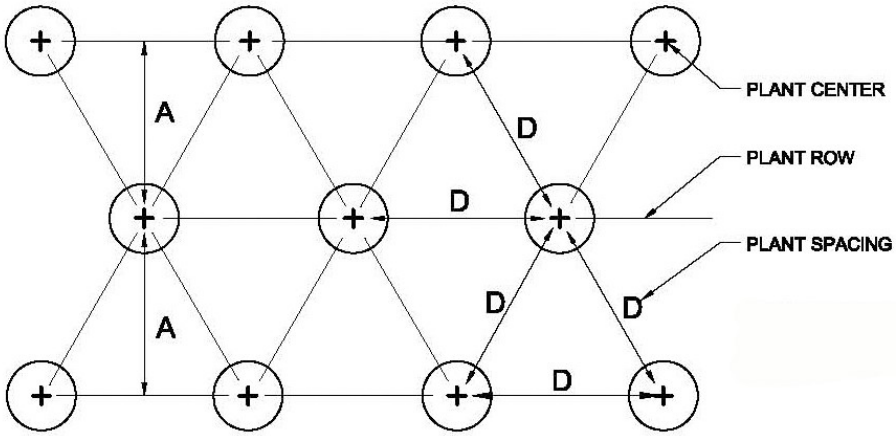
***Requires transport of water to the planting site in large containers and pouring enough water onto each plant (after planting) to moisten the entire planting pit.*

****Plants are established when roots have grown out of the container soil and into the native soil by 3-5 inches. This normally takes 3-4 months for most perennials and grasses and up to 6-7 months for trees and shrubs.*

*****Shredded leaf compost is recommended for use with perennials and grasses. Shredded bark mulch is recommended for tree and shrub plantings at a depth of 3 inches.*

SPACING "D"	ROW "A"	NUMBER OF PLANTS/SQ. FT.
30"	26"	.160
24"	20.8"	.25
18"	15.6"	.450
15"	13.0"	.640
12"	10.4"	1.00
10"	8.66"	1.44
8"	6.93"	2.25

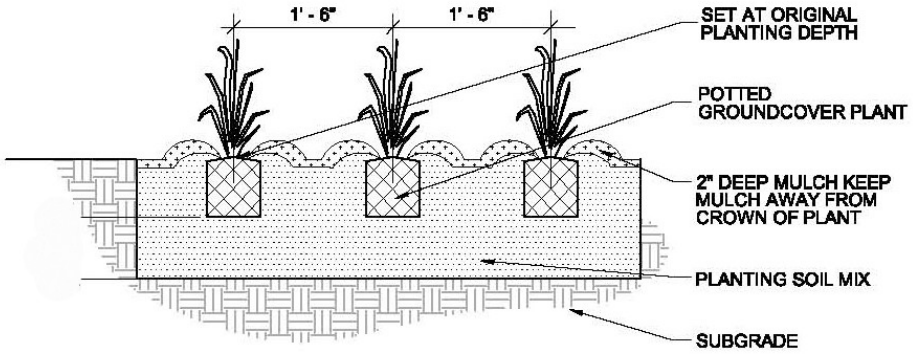
NOTE: PLANT QUANTITIES WERE DETERMINED BY MULTIPLYING AREA (SQ. FT.) BY NUMBER OF PLANTS/SQ. FT. FOR REQUIRED SPACING.



Quantity of plants as noted in planting schedule.

GROUNDCOVER SPACING

SEE PLANTING LIST FOR PLANT SPACING



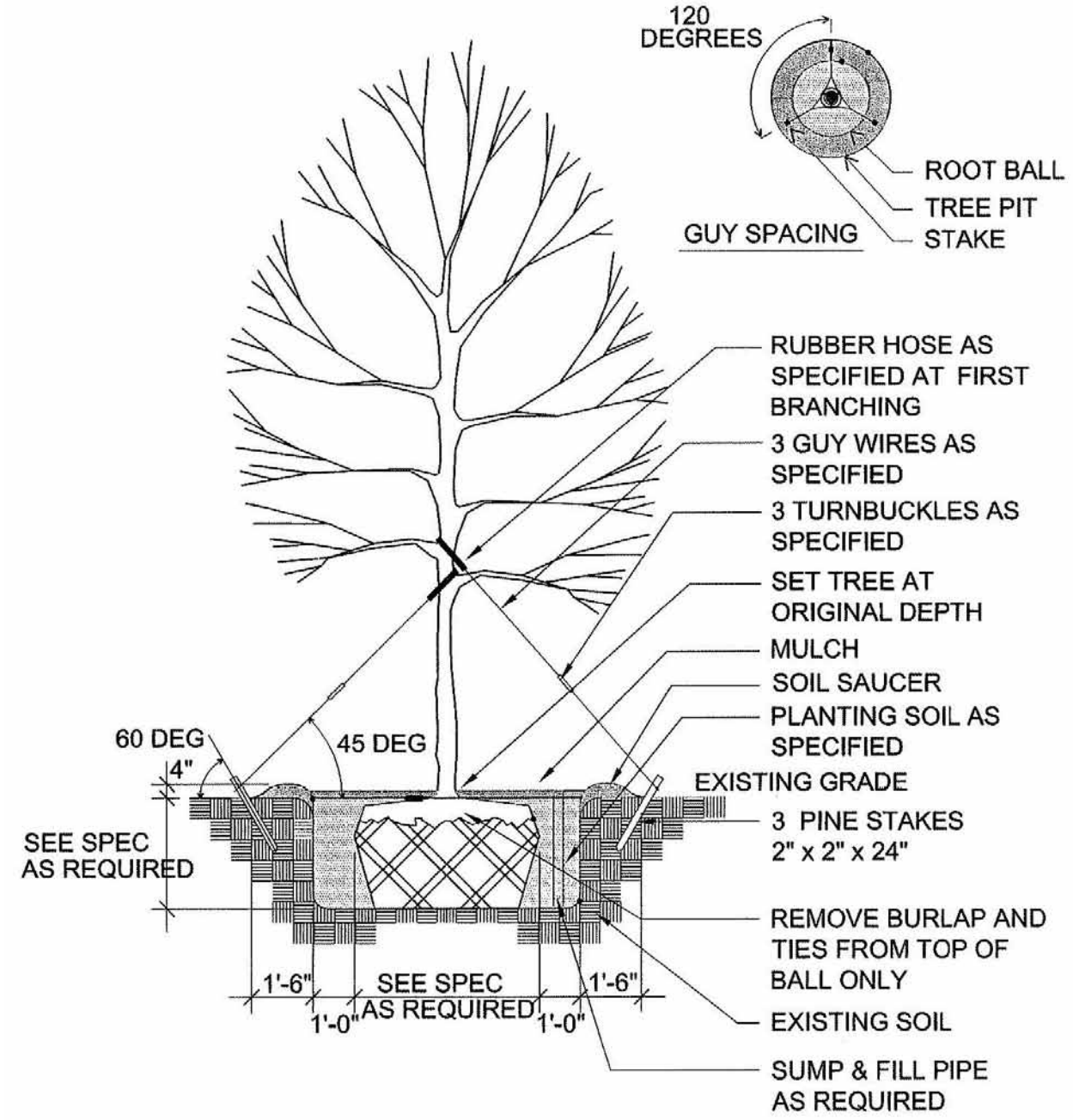
NOTES:
1. REMOVE SPENT FLOWERS PRIOR TO PLANTING.
2. LOOSEN ROOT MASS AT BOTTOM OF ROOTBALL.
3. TOP OF ROOTBALL STRIPPED OF ¼" SURFACE GROWING MEDIA AND COVEREDWITH ¼" LANDSCAPE BED MIX PLUS SURFACE MULCH.

Plant Spacing Plan

N.T.S.

Planting Detail Courtesy of Ted Spaid
SWT Design, St. Louis, MO

Figure 9



A TREE PLANTING DETAIL

NOT TO SCALE

Figure 10

Tree Planting Detail Courtesy of Ted Spaid. SWT Design, St. Louis, Mo.

6. Resources

Native Plant Nurseries

For an up-to-date list of native plant sources, go to www.grownative.org

Web Site Resources

Environmental Protection Agency www.epa.gov/nps/lid/

Grow Native! www.grownative.org

Hinkson Creek Watershed www.helpthehinkson.org

Shaw Nature Reserve www.shawnature.org

Show Me Raingardens www.showmeraingardens.com

Ten Thousand Rain Gardens www.rainkc.com

Publications

Aquatic and Wetland Plants of Missouri
By Daniel L. Combs and Ronald D. Drobney. U.S. Fish and Wildlife Service; University of Missouri Columbia, MO 65211

LID for Big Box Retailers.
Low Impact Development Center, 2005. PDF available at www.lowimpactdevelopment.org/bigbox/#bbpdfs

Native Plant Rain Gardens brochure.2004.
Grow Native! Missouri Department of Conservation

Prairie Raingardens: Joining Habitat Restoration and Watershed Health
By Scott Hamilton. Winter 2005. Missouri Prairie Journal Vol. 26, Number 1. Pg. 12-17.

Rain Gardens
By Janet Marinelli. Spring 2004. Brooklyn Botanic Garden Plants & Gardens News, Vol. 19, Number 1

Rain Gardens – A How-to Manual for Homeowners
By Roger Bannerman and Ellen Considine. 2003. Univ. of Wisconsin-Extension and Wisconsin Dept. of Natural Resources . PDF available at http://www.dnr.state.wi.us/runoff/rg/

Raingardens: Managing Water Sustainability in the Garden and Designed Landscape
By Nigel Dunnett and Andy Clayden Timberpress 2007.

Water Plants for Missouri Ponds
By James R. Whitley, Barbara Bassett, Joe G. Dillard and Rebecca A. Haefner. 1999. Missouri Department of Conservation

7. Plant List

The following pages present grasses, sedges, forbs, shrubs and trees native to Missouri and suitable for planting in stormwater BMPs. The lists are intended as a basic guide for general planting purposes and planning considerations. Knowledgeable landscape architects, 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 plants in these lists were selected to be readily available in the nursery trade. Often overlooked in plant selection is the availability and the cost of plant material. There are many plants listed in landscape books that are not readily available from local nurseries. Without knowledge of what is available, time spent researching and finding the one plant that meets all the needs is wasted.

The planting lists are organized by stormwater BMP, then by plant type – grasses/sedges, forbs and trees/shrubs – and, finally, in alphabetical order according to the scientific name, with the common name provided. The lists are in Microsoft Excel to make sorting and creation of project plant lists easy. Each plant species has a corresponding landscape zone noted to indicate the most suitable planting location or locations for successful establishment.

Where the frequency, depth or duration of flooding that a plant will tolerate is known, that information is provided. Pollution tolerance and salt tolerance information are indicated to identify plantings that would be most appropriate in pollution hot spots. Because individual plants often have unique requirements difficult to convey in a general listing, additional research is recommended to ensure successful plant establishment.

Because of the limited area for which this plant list is to be used, hardiness zone information is not provided. All plants on the list are hardy in the St. Louis Region.

Figure 11: From left: *Cephalanthus occidentalis, Iris fulva, Coreopsis lanceolata* Courtesy Missouri Botanical Garden Plantfinder

Latin Name	Common Name	Submerged & Emergent (water depth in feet)	Pond Edge & Permanent Water	Over sand	Lower slopes & bioretention base	Upper slopes	Height (feet)	Spacing (feet)	Seasonal Interest - Color and Months	J	F	M	A	M	J	J	A	S	O	N	D	Sun	Pt Sun	Pt Shade	Shade	Dry	Medium	Wet	Birds	Butterflies	Fall Color	Winter interest	Flood frequency tolerance	Flood height tolerance	Flood duration tolerance (days)	Salt tolerance	Aggressiveness	Silt tolerance
Grasses/Sedges																																								
Carex annectans	Yellow fruited sedge		x		x		2-3	1.5	tan				x	x	x								x	x	x			x	x	x			x	H	12	3		L	
Carex grayi	Bur sedge		x		x		1-2	1.5	tan				x	x	x									x	x	x		x	x	x				M	12	2		L	M
Carex crinita	Fringed sedge		x		x		2-3	1.5	brown					x	x								x	x	x			x	x	x				H	12	3	U	L	
Carex muskingumensis	Palm sedge		x	x	x		2-3	1.5	tan				x	x	x	x	x						x	x	x	x		x	x	x			x	H	24	3		M	M
Carex vulpinoidea	Fox sedge		x		x		2-3	1.5	tan					x	x	x							x	x	x			x	x				x	H	24	3	L	L	
Juncus effusus	Soft rush	0-1	x				2-3	1.5	green									x	x	x	x		x	x				x	x	x			x	H	24	4	L	M	M
Scirpus atrovirens	Great green bullrush		x	x	x		2-3	1.5	green				x	x	x								x	x				x	x	x			x	M	12	3		L	
Scirpus cyperinus*	Wool grass		x				3-4	1.5	orange					x	x	x	x	x	x	x	x		x	x					x	x		x	x	H	24	3		M	
Forbs																																								
Asclepias incarnata	Marsh milkweed		x	x	x		2-4	2	pink							x	x	x	x				x	x				x	x		x			M	18	3	M	M	
Chelone obliqua	Rose turtlehead		x		x		3-4	2	rose/purple								x	x	x				x	x	x	x		x	x					M	12	1		M	
Equisetum hyemale	Horsetail		x	x	x		2-4	2.5	green				x	x					x	x			x	x	x			x	x			x	x	H	36	5		H	H
Helenium autumnale	Sneezeweed		x		x		3-4	2	yellow							x	x	x	x				x	x	x			x	x	x	x			M	18	3	M	M	
Hibiscus lasiocarpos	Rose mallow		x	x	x		3-7	2.5	white/pink							x	x	x	x				x	x	x			x	x		x	x		H	36	5		M	M
Iris fulva	Copper iris		x	x	x		2-3	1.5	copper					x	x								x	x				x	x	x				M	12	1		M	
Iris virginica	Southern blueflag iris		x		x		2-3	2	blue							x	x						x	x					x	x			x	H	36	4		M	M
Lobelia cardinalis	Cardinal flower		x	x	x		2-3	1.5	red							x	x	x					x	x	x	x		x	x	x	x			H	18	5	L	M	U
Mimulus ringens*	Allegehny monkey flower		x	x	x		1-2	1.5	lavender							x	x	x					x	x				x	x					M	24	1		M	
Nymphaea odorata	Fragrant water lily	1-5					1	10	white							x	x	x					x						x					H	36			H	
Pontedaria cordata	Pickeral weed	0-1	x				1-2	2.5	blue						x	x	x	x	x				x	x	x				x					M	12	4	L	L	U
Sagittaria latifolia	Arrowleaf	0-1	x				1-4	2.5	white							x	x	x					x						x	x				M	18	3	M	M	L
Saururus cernuus	Lizard tail	0-1	x				1-2	2.5	white						x	x	x	x					x	x	x	x			x					H	24			H	
Thalia dealbata	Wild canna	0-2	x				4-7	5	purple							x	x	x					x						x					H	24			M	H
Trees/Shrubs																																								
Aesculus pavia	Red buckeye		x		x		10-20	15	red				x	x									x	x	x			x	x	x				H	18	2		L	M
Cephalanthus occidentalis	Buttonbush	x	x		x		5-10	7.5	white							x	x	x					x	x	x			x	x		x			H	36	7		M	H
Quercus macrocarpa	Bur oak		x		x	x	40-60	35	green										x	x			x	x	x			x	x				x	H	36	5	H	L	H
Taxodium disticum	Bald cypress	x	x	x	x		40-60	20	orange										x	x			x	x	x			x	x			x	x	H	36	7		L	H

Requirements

Local Ecotype Rule: Plants of Missouri or Southern Illinois ecotype are required.

It is recommended that a minimum of 5 grass/sedge species and 8 forb species be provided for each BMP. It is recommended that this list be provided to landscape contractors/buyers in case substitutions are required.

Where a diverse landscape is desired, each species should consist of between 5% - 15% of the total plant count for each BMP.

Refer to Planting, Water, and Mulch Requirements for Stormwater BMP's for plant sizes and irrigation requirements

Biodegradable erosion blanket must be used on slopes greater than 10%.

Erosion blankets must be coarse to allow varying leaf sizes (examples include Geojute, Curlex #1 and NorthAmerican Green S75 single net straw blanket, or equivalent)

*Experimental for practice and/or limited availability in commercial trade

Latin Name	Common Name	Submerged & Emergent (water depth in feet)	Pond Edge & Permanent Water	Over sand	Lower slopes	Upper slopes	Height (feet)	Spacing (feet)	Seasonal Interest - Color and Months J F M A M J J A S O N D	Sun	Pt Sun	Pt Shade	Shade	Dry	Medium	Wet	Birds	Butterflies	Fall Color	Winter interest	Flood frequency tolerance	Flood height tolerance	Flood duration tolerance (days)	Salt tolerance	Aggressiveness	Silt tolerance
Grasses/Sedges																											
Carex annectans	Yellow fruited sedge		x		x		2-3	1.5	tan	x	x	x			x	x	x			x	H	12	3		L	
Carex grayi	Bur sedge		x		x		1-2	1.5	tan		x	x	x		x	x	x				M	12	2		L	M
Carex crinita	Fringed sedge		x		x		2-3	1.5	brown	x	x	x			x	x	x				H	12	3	U	L	
Carex muskingumensis	Palm sedge		x	x	x		2-3	1.5	tan	x	x	x	x		x	x	x			x	H	24	3		M	M
Carex vulpinoidea	Fox sedge		x		x		2-3'	1.5'	tan	x	x	x			x	x				x	H	24	3	L	L	
Chasmanthium latifolium	River oats			x	x	x	2-5	1.5	green		x	x	x	x	x		x		x	x	M	12	1		H	
Juncus effusus	Soft rush	0-1	x				2-3	1.5	green	x	x				x	x	x			x	H	24	4	L	M	M
Scirpus atrovirens	Great green bullrush		x	x	x		2-3	1.5	green	x	x				x	x	x			x	M	12	3		L	
Spartina pectinata	Prairie cordgrass		x		x		4-5	2.5	green	x	x				x	x	x		x	x	H	36	5		H	H
Forbs																										
Amsonia illustris	Shining bluestar		x	x	x		2-3	2.5	lt. blue	x	x			x	x	x		x	x		H	36	5		L	H
Asclepias incarnata	Marsh milkweed		x	x	x		2-4	2	pink	x	x				x	x		x			M	18	3	M	M	
Chelone obliqua	Rose turtlehead		x		x		3-4	2	rose/purple	x	x	x	x		x	x					M	12	1		M	
Equisetum hyemale	Horsetail		x	x	x		2-4	2.5	green	x	x	x			x	x			x	x	H	36	5		H	H
Eupatorium coelestinum	Mist flower; wild ageratum		x	x	x		1-2	1.5	lavender	x	x				x	x		x			H	12	3		M	H
Helenium autumnale	Sneezeweed		x		x		3-4	2	yellow	x	x	x			x	x	x	x			M	18	3	M	M	
Hibiscus lasiocarpos	Rose mallow		x	x	x		3-7	2.5	white/pink	x	x	x			x	x		x	x		H	36	5		M	M
Iris fulva	Copper iris		x	x	x		2-3	1.5	copper	x	x				x	x	x				M	12	1		M	
Iris virginica	Southern blueflag iris		x		x		2-3	2	blue	x	x					x	x			x	H	36	4		M	M
Lobelia cardinalis	Cardinal flower		x	x	x		2-3	1.5	red	x	x	x	x		x	x	x	x			H	18	5	L	M	U
Mimulus ringens	Allegehny monkey flower		x	x	x		1-2	1.5	lavender	x	x				x	x					M	24	1		M	
Monarda fistulosa	Wild bergamont			x	x	x	3-4	2	pink	x	x	x		x	x		x	x			L	12	1	M	M	M
Penstemon digitalis	Smooth beard-tongue			x	x		2-3	1.5	white	x	x			x	x		x				M	12	1		M	M
Phlox paniculata	Meadow phlox				x		3-4	1.5	purple/pink	x	x	x	x		x	x	x	x			L	12	1		M	
Rudbeckia subtomentosa	Sweet coneflower				x	x	3-4	2	yellow	x	x				x	x		x		x	H	12	2		M	
Trees/Shrubs																										
Asimina triloba	Paw paw		x		x		15-25	15	purple		x	x			x	x	x	x	x		H	36	5	L	M	H
Crataegus viridis	Green hawthorne		x		x	x	15-20	15	white	x	x	x			x	x	x		x	x	M	12	1	H	L	
Ilex verticillata	Winterberry holly		x	x	x		5-10	10	red	x	x	x			x	x	x		x	x	H	12	3		L	M
Nyssa sylvatica	Black gum			x	x		40-50	25	red	x	x	x		x	x		x		x	x	L			H	L	

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Grasses/Sedges																																								
Andropogon virginicus	Broomsedge			x		x	1-2	1.5	orange								x	x	x	x	x	x					x				x			x	L		1		M	L
Bouteloua curtipendula	Sideoats grama			x		x	1-2	1	tan								x	x	x	x	x	x					x	x			x			x	L		1		L	L
Carex muskingumensis	Palm sedge		x	x	x		1-2	1.5	tan					x	x	x	x						x	x	x	x	x	x	x	x				H	24	3+		M	H
Carex praegracilis*	Tollway sedge		x		x	x	1-2	2	tan				x	x	x								x	x			x	x	x	x				H	12	2	H	H	H
Carex vulpinoidea	Fox sedge		x		x		2-3	1.5	tan					x	x	x							x	x	x			x	x					H	24	3+	L	L	H
Panicum virgatum	Switchgrass			x	x	x	3-6	2.5	pink	x	x					x	x	x	x	x	x		x	x	x			x	x	x		x		M	12	2	M	M	M
Schizachyrium scoparium	Little bluestem			x		x	2-4	1.5	bronze								x	x	x	x	x		x				x	x		x		x	x	L	12	1	M	L	L
Sporobolus heterolepis	Prairie dropseed				x	x	2-3	1.5	tan								x	x	x	x	x		x				x	x		x			x	L				L	
Forbs																																								
Asclepias tuberosa	Butterfly milkweed			x		x	1-2	1.5	orange							x	x	x					x				x	x			x			L			V	M	
Baptisia australis	Blue wild indigo					x	3-4	3-4	blue						x	x							x	x	x		x	x			x			L				M	
Blephilia ciliata	Ohio horsemint					x	1-2	1.5	pink					x	x									x	x	x	x	x			x		x	L					
Coreopsis lanceolata	Lanceleaf coreopsis			x		x	1-2	1.5	yellow				x	x	x								x	x			x	x			x			L		1		L	
Echinacea purpurea	Purple coneflower					x	2-3	1.5	lt. purple							x	x	x						x	x	x	x	x		x	x			L				L	
Eryngium yuccifolium	Rattlesnake master				x	x	4-5	1.5	green							x	x	x	x				x				x	x			x		x	M	12	2	M	L	
Pycnanthemum tenuifolium	Slender mountain mint			x	x	x	2-3	1.5	white								x	x	x				x	x	x		x	x						L		1		M	
Ratibida pinnata	Yellow/Grey coneflower			x	x	x	3-5	1.5	yellow							x	x	x					x	x			x	x		x	x			M	12	1	M	H	L
Rudbeckia subtomentosa	Sweet coneflower				x	x	3-4	2	yellow							x	x	x	x				x	x				x	x		x		x	H	12	2		M	
Scutellaria incana	Hoary skullcap				x		2-3	2	blue							x	x	x							x	x	x	x			x			L					L
Solidago rigida	Stiff goldenrod				x	x	3-5	1.5	yellow									x	x				x					x					x	L	12	2	M	H	L
Verbesina helianthoides	Yellow wingstem			x	x	x	2-3	1.5	yellow							x	x						x	x	x		x	x		x	x							M	
Zizia aurea	Golden alexander					x	1-3	1.5	yellow					x	x								x	x	x			x			x			H	12	1	M	H	U
Trees/Shrubs																																								
Cornus florida	Flowering dogwood			x	x	x	10-20	15	white			x	x					x	x	x	x			x	x	x	x	x		x		x	x	L			L	L	L
Diospyos virginiana	Persimmon			x	x	x	30-40	20	orange				x	x				x	x	x			x	x	x		x	x		x		x	x	M	12	1		M	M
Ostrya virginiana	Hophornbeam				x	x	20-30	20	green									x	x					x	x	x	x	x						L					L	L
Quercus muhlenbergii	Chinquapin oak				x	x	40-50	35	green									x	x					x	x	x	x	x					x	L			H	L	L

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Grasses/Sedges																																								
Andropogon gerardii	Big bluestem			x		x	4-6	2-5	plum	x	x							x	x	x	x	x				x	x				x	x	M	12	2		M	
Andropogon ternarius	Splitbeard bluestem			x		x	1-2	1.5	silver	x	x							x	x	x	x	x				x			x		x	x	L				L	L
Andropogon virginica	Broomsedge			x		x	1-2	1.5	orange	x	x						x	x	x	x	x	x				x			x		x	x	L				M	L
Carex hirsutella*	Fuzzy wuzzy sedge			x	x		1	1	green/tan				x	x	x	x	x	x				x	x			x	x		x				L				L	
Juncus biflorus*	Bog rush			x	x		2	1	green/orange						x	x	x	x	x	x		x	x				x		x	x		x	x	M	6	2		L	
Panicum virgatum	Switchgrass			x	x	x	3-6	2.5	pink	x	x					x	x	x	x	x	x	x	x	x			x	x	x	x		x		M	12	2	M	M	M
Schizachyrium scoparium	Little bluestem			x		x	2-4	1.5	bronze	x	x						x	x	x	x	x	x				x	x		x		x	x	L				M	L	L
Forbs																																								
Amsonia illustris	Shining bluestar		x	x	x		2-3	2.5	lt. blue				x	x								x	x	x		x	x	x		x	x		H	36	5		L	H
Chrysopsis camporum* (C. vil	Golden aster			x		x	2-3	1-5	yellow								x	x	x	x		x	x			x				x			M	12	1		M	
Coreopsis lanceolata	Lanceleaf coreopsis			x		x	1-2	1.5	yellow				x	x	x							x	x			x	x			x			L		1		L	
Coreopsis triptris	Tall coreopsis			x			2-8	2	yellow							x	x	x				x				x	x			x							M	
Lespedeza virginica	Slender bush clover			x	x	x	1-2	1-5	pink									x	x			x	x			x	x		x				L				L	
Monarda fistulosa	Wild bergamont			x	x	x	3-4	2	pink							x	x	x				x	x	x		x	x		x	x			L	12	1	M	M	M
Parthenium integrifolium	Wild quinine			x	x	x	2-3	1.5	white							x	x	x	x			x	x			x	x						L				M	L
Penstemon digitalis	Smooth beard-tongue			x	x		2-3	1.5	white					x	x							x	x			x	x		x				M	12	1		M	M
Solidago nemoralis	Old field goldenrod			x		x	4-6	1.5	yellow								x	x	x			x	x			x	x		x				L				L	L
Tephrosia virginiana	Goatsbeard			x		x	1-2	1.5	pink & white						x	x	x	x				x	x	x	x	x	x						L				L	
Verbesina helianthoides	Yellow wingstem			x		x	2-3	1.5	yellow						x	x	x					x	x	x		x	x			x		x	M	6	1		M	L
Trees/Shrubs																																								
Amelanchier arborea	Serviceberry			x	x	x	10-15	10	white			x	x							x			x	x	x	x	x		x		x		L				L	
Quercus coccinea	Scarlet oak			x	x	x	30-40	30	red										x	x		x	x	x		x	x				x		L	6	1	H	L	
Nyssa sylvatica	Black gum			x	x		40-50	25	red										x	x	x	x	x	x		x	x		x		x	x	L			H	L	
Pinus echinata	Short-leaf pine			x	x	x	40-50	20	green									x	x	x	x	x	x	x		x	x		x		x		L			L	L	

Requirements

Local Ecotype Rule: Plants of Missouri or Southern Illinois ecotype are required.

It is recommended that a minimum of 5 grass/sedge species and 8 forb species be provided for each BMP. It is recommended that this list be provided to landscape contractors/buyers in case substitutions are required.

Where a diverse landscape is desired, each species should consist of between 5% - 15% of the total plant count for each BMP.

Refer to Planting, Water, and Mulch Requirements for Stormwater BMP's for plant sizes and irrigation requirements

Biodegradable erosion blanket must be used on slopes greater than 10%.

Erosion blankets must be coarse to allow varying leaf sizes (examples include Geojute, Curlex #1 and NorthAmerican Green S75 single net straw blanket, or equivalent)

*Experimental for practice and/or limited availability in commercial trade

Latin Name	Common Name	Submerged & Emergent (water depth in feet)	Pond Edge & Permanent Water	Over sand	Lower slopes & bioretention base	Upper slopes	Height (feet)	Spacing (feet)	Seasonal Interest - Color and Months	J	F	M	A	M	J	J	A	S	O	N	D	Sun	Pt Sun	Pt Shade	Shade	Dry	Medium	Wet	Birds	Butterflies	Fall Color	Winter interest	Flood frequency tolerance	Flood height tolerance	Flood duration tolerance (days)	Salt tolerance	Aggressiveness	Silt tolerance
Grasses/Sedges																																								
Andropogon gerardii	Big bluestem			x	x	x	4-6	2	plum	x	x							x	x	x	x	x				x	x		x		x	x	M	12	2		M	
Bouteloua curtipendula	Sideoats grama			x		x	1-2	1	tan							x	x	x	x	x		x	x			x	x		x			x	L				L	
Carex praegracilis*	Tollway sedge		x		x	x	1-2	1.5	tan				x	x	x							x	x			x	x	x	x				H	12	2	H	H	H
Carex grayi	Bur sedge		x		x		1-2	1.5	tan				x	x	x							x	x	x	x		x	x	x				H	24	3		L	
Carex shortiana	Short's sedge		x		x	x	2	1.5	bluish				x	x	x							x	x	x		x	x	x	x			x	M	24	3		L	
Carex vulpinoidea	Fox sedge		x		x		2-3	1.5	tan					x	x	x						x	x	x			x	x				x	H	24	3	L	L	
Chasmanthium latifolium	River oats			x	x	x	2-4	1.5	green						x	x	x	x	x	x			x	x	x	x	x		x		x	x	M	12	1		H	
Schizachyrium scoparium	Little bluestem			x		x	2-3	1.5	bronze	x	x						x	x	x	x	x	x				x	x		x		x	x	L			M	L	L
Sporobolus heterolepis	Prairie dropseed				x	x	2-3	1.5	tan								x	x	x	x	x	x				x	x		x			x	L				L	
Forbs																																								
Amsonia illustris	Shining bluestar		x	x	x		2-3	2.5	lt. blue				x	x								x	x	x		x	x	x		x	x		H	36	5		L	H
Aster novae-angliae	New England aster		x		x		3-4	2	violet								x	x				x	x			x	x		x	x		M	24	3	L	H	
Chelone obliqua	Rose turtlehead		x		x		3-4	2	se/purple								x	x	x			x	x	x	x	x	x					M	12	1		M	
Coreopsis lanceolata	Lanceleaf coreopsis			x		x	1-2	1.5	yellow			x	x	x								x	x			x	x		x			L		1		L	
Echinacea pallida	Pale purple coneflower					x	2-3	1.5	violet						x	x						x	x			x	x		x			L				L	
Echinacea purpurea	Purple coneflower					x	2-3	1.5	lt. purple						x	x	x						x	x	x	x	x		x	x		L				L	
Eryngium yuccifolium	Rattlesnake master				x	x	4-5	1.5	green						x	x	x	x				x				x	x			x		x	M	12	2	M	L	
Eupatorium coelestinum	Mist flower; wild ageratum		x	x	x		1-2	1.5	avender							x	x	x	x			x	x				x	x		x			H	12	3		M	H
Hibiscus lasiocarpos	Rose mallow		x	x	x		3-7	2.5	hite/pink							x	x	x	x			x	x	x		x	x		x	x		H	36	5		M	M
Iris virginica	Southern blueflag iris		x		x		2-3	2	blue							x	x					x	x			x	x				x	H	36	4		M	M
Pycnanthemum tenuifolium	Slender mountain mint			x	x	x	2-3	1.5	white								x	x	x			x	x	x		x	x					L		1		M	
Ratibida pinnata	Yellow/Grey coneflower			x	x	x	3-5	1.5	yellow						x	x	x					x	x			x	x		x	x			M	12	1	M	H	L
Rudbeckia fulgida	Orange coneflower				x		2	2	yellow						x	x	x	x				x	x			x	x			x		x	L				M	
Rudbeckia hirta	Black-eyed Susan						2-3	1.5	yellow						x	x	x	x				x				x	x			x			L				M	
Solidago rugosa	Rough-leaved goldenrod				x	x	2-3	1.5	yellow								x	x				x	x	x	x	x	x			x		x	L			M	H	L
Solidago speciosa	Showy goldenrod				x	x	2-3	1.5	yellow								x	x				x	x	x		x	x			x		x	L			M	H	L
Verbesina helianthoides	Yellow wingstem						2-3	1.5	yellow						x							x	x	x		x	x		x	x		L				M	
Zizia aurea	Golden alexander					x	1-3	1.5	yellow					x	x							x	x	x		x	x			x			L			M	H	
Trees/Shrubs																																							
Carpinus caroliniana	Musclewood				x	x	15-20	20	yellow	x	x	x							x	x	x	x	x	x		x	x				x	x	M	6	1		L	
Cercis canadensis	Redbud			x	x	x	10-20	15	pink				x	x								x	x			x	x						L	M	L	L	M	L
Hamamelus virginiana	Eastern witchazel		x		x	x	10-15	15	yellow										x	x	x		x	x	x	x	x				x	x	L			L	L	
Quercus alba	White oak				x	x	40-60	30	green				x	x					x	x		x	x	x	x	x	x		x	x	x	x	H			H	L	

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									J	F	M	A	M	J	J	A	S	O	N	D																				
Grasses/Sedges																																								
Carex annectans	Yellow fruited sedge		x		x		2-3	1.5	tan			x	x	x										x	x	x			x	x	x			x	H	12	3		L	
Carex albicans	Oak sedge				x	x	10"	1	vergree	x		x	x					x	x	x				x	x	x	x	x	x					x	M	12	1		L	
Carex eburnea	Bristle-leaf sedge					x			evergree	x		x	x					x	x	x						x	x	x	x					x	L				L	
Carex grayii	Bur sedge		x		x		1-2	1.5	vergree	x			x	x	x			x	x	x				x	x		x	x							M	12	2		L	M
Carex muskingumensis	Palm sedge		x	x	x		2-3	1.5	lt. yellov	x			x	x	x			x	x	x				x	x	x	x		x	x	x			x	H	24	3		M	M
Juncus effusus	Soft rush	0-1	x				2-3	1.5	vergreen									x	x	x				x	x				x	x	x			x	H	24	4	L	M	M
Schizachyrium scoparium	Little bluestem			x		x	2-3	1.5	bronze	x	x						x	x	x	x				x				x	x		x		x	x	L	12	1	M	L	L
Sporobolus heterolepis	Prairie dropseed				x	x	2-3	1.5	yellow								x	x	x	x				x				x	x		x			x	L				L	
Forbs																																								
Amsonia illustris**	Shining bluestar		x	x	x		2-3	2.5	lt. blue				x	x										x	x	x		x	x	x		x	x		H	36	5		L	H
Aster oblongifolius	Aromatic aster					x	2	1.5	lav. Blue								x	x						x	x			x	x		x		x		L				M	L
Asclepias tuberosa	Butterfly milkweed			x		x	1-2	1.5	orange						x	x	x							x	x			x	x						L			V	M	
Baptisia sphaerocarpa	Yellow wild indigo					x	2	2	yellow				x	x										x	x			x	x				x		L				L	
Chelone obliqua	Rose turtlehead		x		x		3-4	2	se/purple								x	x	x					x	x	x	x		x	x					M	12	1		M	
Coreopsis palmata	Finger coreopsis			x		x	2	1	yellow					x	x									x	x			x	x						L				L	
Echinacea purpurea	Purple coneflower					x	2-3	1.5	lt. purple						x	x	x								x	x	x	x	x		x				L				L	
Heuchera americana	American alumroot					x	1	1.5	cream					x	x									x	x	x		x	x						L				L	
Heuchera parviflora	Late-flowering alumroot					x	1	1.5	white									x	x						x		x	x	x						L				L	
Heuchera richardsonii	Prairie alumroot				x	x	1	1.5	cream				x	x										x	x	x	x	x	x		x				M	12	1		L	
Heuchera villosa	Maple-leaf alumroot					x	1	1.5	white									x	x						x		x	x	x						L				L	
Hibiscus lasiocarpos**	Rose mallow		x	x	x		3-7	2.5	white/pink							x	x	x	x					x	x			x	x		x	x			H	36	5		M	M
Iris cristata	Dwarf crested iris					x	1	1	Violet			x	x												x		x	x	x						L				L	
Iris fulva	Copper iris		x	x	x		2-3	1.5	copper					x	x									x	x				x	x	x				M	12	1		M	
Liatris spicata	Dense blazingstar			x	x	x	2-3	1.5	5lavender						x	x								x	x			x	x	x	x	x			M	12	1		L	
Lobelia cardinalis*	Cardinal flower		x	x	x		2-3	1.5	red							x	x	x						x	x	x	x		x	x	x	x			H	18	5	L	M	U
Lobelia siphilitica	Blue lobelia		x		x	x	1-2	1.5	blue								x	x						x	x			x	x		x				H	24	3		L	H
Parthenium hispidim	American feverfew					x	1-2	1.5	white					x	x	x								x	x				x		x				L				M	
Pycnanthemum tenuifolium	Slender mountain mint			x	x	x	2	1.5	white							x	x	x						x	x				x		x				L				L	
Rudbeckia fulgida	Orange coneflower		x	x	x		2	1.5	yellow								x	x							x			x	x	x	x		x	H	24	3		M	
Sedum ternatum	Woodland stonecrop					x	6"	1	hite/evrg	x				x	x					x	x	x				x	x	x	x					x	L				L	
Solidago flexicaulis	Zig-zag goldenrod					x	x	2	1.5	yellow									x	x					x		x	x	x						L				L	
Spigelia marylandica	Indian pink					x	x	1-2	1.5	red/yel						x	x	x								x	x	x	x		x				L				L	
Trees/Shrubs																																								
Aesculus pavia	Red buckeye		x		x		10-20	15	red			x	x											x	x	x			x	x	x				H	24	2		L	M
Aronia melanocarpa**	Black chokeberry				x	x	5-7	5	white				x	x				x	x						x	x	x	x	x	x	x		x	x	M	12	2		L	
Betula nigra*	River birch		x		x	x	30-40	15-2(	cream			x	x											x	x	x		x	x	x	x			x	H	36	5		H	H
Calicarpa americana	Beautyberry					x	3-5	4-6	pink/pur					x	x			x	x	x					x	x	x	x				x				L				L	
Carpinus caroliniana	Musclewood				x	x	15-20	20	yellow	x	x	x							x	x	x			x	x	x		x	x				x	x	M	6	1		L	
Cercis canadensis	Redbud			x	x	x	10-20	15	pink			x	x											x	x	x		x	x						L			L	M	L
Chionanthus virginicus	Fringetree					x	10-15	10	white				x	x				x	x					x	x			x	x		x		x		L				L	
Cornus alternifolia	Pagoda dogwood					x	10-15	10	white				x	x				x	x					x	x	x	x	x	x		x		x	x	L				L	
Crataegis viridis			x		x	x	15-20	15	white				x	x				x	x					x	x	x		x	x				x	x	M	12	1		L	M
Diospyos virginiana	Persimmon			x	x	x	30-40	20	orange				x	x				x	x					x	x	x		x	x		x		x	x	M	12	1		M	M

Trees/Shrubs continued next page

Latin Name Trees/Shrubs (cont.)	Common Name	Submerged & Emergent (water depth in feet)	Pond Edge & Permanent Water	Over sand	Lower slopes & bioretention base	Upper slopes	Height (feet)	Spacing (feet)	Seasonal Interest - Color and Months	J	F	M	A	M	J	J	A	S	O	N	D	Sun	Pt Sun	Pt Shade	Shade	Dry	Medium	Wet	Birds	Butterflies	Fall Color	Winter Interest	Flood frequency tolerance	Flood height tolerance	Flood duration tolerance (days)	Salt tolerance	Aggressiveness	Silt tolerance
Dirca palustrus	Leatherwood					x	5-7	5	lt. yel			x	x										x	x	x	x				x	x	L				L	
Hamamelus virginiana	Eastern witchazel		x		x	x	10-15	15	yellow										x	x	x		x	x	x	x				x	x	L			L	L	
Hydrangea arborescens	Wild Hydrangea				x	x	5-7	5	white					x	x	x	x	x	x			x	x	x	x	x	x		x	x	x	x	L			L	L	L
Ilex verticillata	Winterberry holly		x	x	x		5-10	10	red				x	x				x	x	x	x	x	x	x			x	x		x	x	x	H	12	3		L	M
Neviusia alabamense** ***	Alabama snowreath				x	x	8-10	7	white				x	x									x	x			x	x				x	M				M	
Nyssa sylvatica	Black gum			x	x		40-50	25	white				x	x				x	x			x	x	x		x	x		x		x	x	L			H	L	
Quercus bicolor	Swamp white oak		x		x	x	40-50	25	white				x	x								x	x	x	x	x	x	x		x		x	H	24	3		H	
Quercus muehlenbergii	Chinquapin oak				x	x	40-50	35	white				x	x								x	x	x	x	x	x					x	L			H	L	L
Quercus phellos	Willow oak		x		x	x	40-50	25	white				x	x								x	x	x			x	x	x	x		x	M	24	3		L	
Quercus shumardi	Shumard oak						40-50	25	white				x	x								x	x	x		x	x		x			x	L				L	
Ribes odoratum	Golden current					x	5-7	5	yellow			x	x	x								x	x	x		x	x		x				L				L	
Taxodium disticum	Bald cypress	x	x	x	x		40-60	20	orange										x	x		x	x	x			x			x	x	x	H	36	7		L	H
Tilia americana	American linden		x		x	x	50-60	30	cream				x	x								x	x	x	x		x	x	x	x		x	H	36	7		M	H

Requirements

Local Ecotype Rule: Plants of Missouri or Southern Illinois ecotype are required.
It is recommended that a minimum of 5 grass/sedge species and 8 forb species be provided for each BMP. Deviation to this is acceptable for aesthetic variation if desired for more formal planting areas.
Refer to Planting, Water, and Mulch Requirements for Stormwater BMP's for plant sizes and irrigation requirements
Biodegradable erosion blanket must be used on slopes greater than 10%.
Erosion blankets must be coarse to allow varying leaf sizes (examples include Geojute, Curlex #1 and NorthAmerican Green S75 single net straw blanket, or equivalent)

This plant list was created for more formal aesthetics; plants have been selected for 3-4 season interest (foliage, flowers, fruits), long-lived and compact habit. See notations below for exceptions.
Exceptions:
* not long-lived
** habit not compact
*** not readily available from nurseries

Chapter Two: Seeding Guide

Contents

1. Seeding Flood Detention Basins and Buffer Areas

Native plants evolved to live here naturally making them best suited for our local conditions. This translates into greater survivorship when planted and less replacement or maintenance during the life of a stormwater management facility. Both of these attributes provide cost savings for the facility owner. Life cycle cost savings are even more substantial due to the reduced need for mowing, compared to turf detention basins and buffer areas. A simple mowed border can be maintained to create a "managed" look.

The benefits of natives go beyond practical issues for the installer and property manager. Reduced mowing also contributes to improved air quality. The deep root systems of native plants help develop pore space in the soil to promote infiltration of rainfall, which reduces stormwater runoff. The root systems also sustain the plants during dry periods reducing their dependence on irrigation. Natives also provide food and cover for native wildlife such as birds and butterflies, further contributing to aesthetics and biodiversity.

Site Preparation

For new construction or bare soil: Once a rough-finished grade is completed, sample the soil according to MU University Extension specifications. Obtain a soil analysis for warm season grasses (equivalent of University Extension Code 7) from University Extension or other certified laboratory. Amend based on the test result recommendations and till into the top six inches of soil. Loosen any areas compacted greater than 300 psi with an agricultural compaction tester to a depth of 8" then firm with a cultipacker. Construction sediment control areas should not be converted to native plant areas until upstream areas are stabilized, sediment is removed, and final grading is completed.

For areas with existing turf lawn: Removing existing vegetation is critical. This process is more important than any other step, so ensure it is done thoroughly before seeding. Use an herbicide like Roundup (generically called glyphosate) to kill existing turf. Use Rodeo[1] in areas within ten feet of water. Apply once in late summer and apply again in late fall (after the next flush of growth, generally a minimum of one month) for early winter seed sowing. Herbicides must be applied by a certified commercial applicator.

For non-turf vegetated areas: Old fields typically have tall fescue, a diversity of grasses, broadleaf weeds and brush. Tall fescue requires special treatment due to its presence in the seed bank that persists for one year. To prevent fescue seed from sprouting in the first year of a seeding, prevent the fescue from flowering and going to seed in the previous season. This is done by repetitive mowing in spring and summer. It may take more than one season to control difficult weed species. The preferred method is to use glyphosate (or Rodeo within ten feet of water) to kill grasses and broadleaf weeds. Use Roundup Pro or Garlon to kill undesired tree saplings, shrubs and vines (if woody plants are too large, they must be cut down and removed from the site). Apply in mid-summer, late-summer and fall for early winter seed sowing. The table below lists difficult weeds and suggestions for their control.

Control Methods for Difficult Plants	
Thistle *Cirsium arvense,* C. vulgare	Spray 2% solution of Roundup in spring or early summer before plants flower.
Crown Vetch *Coronilla varia*	Spray 2% solution of Roundup over several-year period. Seeds are long-lived in the soil. Prescribed burning can stimulate spread.

[1] Brand names are used generically; equivalent substitutes are acceptable. Always use an herbicide in accord with the instructions on the label.

Yellow Nut Grass *Cyperus esculentus*	Spray Sedge Hammer (1 gram per gallon of water) during the growing season.
Sericea Lespedeza *L. cuneata*	Spray 2% solution of Garlon or equivalent over several-year period. Seeds are long-lived in the soil. Prescribed burning can stimulate spread.
Sweet Clover *Melilotus spp.*	Mow over several-year period or spray with a 2% solution of 2,4-D amine and surfactant. Do not let sweet clover make seeds as it is difficult to control.
Curly Dock *Rumex crispus*	Spray 2% solution of Roundup in spring or early summer before plants flower.
Tall Goldenrod *Solidago altissima*	Spray 2% solution of Roundup in spring or early summer before plants flower.
Johnson Grass *Sorghum halepense*	Spray Outrider before plants flower.
Red Clover *Trifolium pretense*	Spray 2% solution of Roundup in spring or early summer before plants flower.
Herbaceous Vines	For vines such as Japanese hop (*Humulus japonicus*), Japanese honeysuckle (*Lonicera japonica*), common periwinkle (*Vinca minor*), and bigleaf periwinkle (*Vinca major*), spray 2% solution of Roundup to foliage prior to flowering or seed set. Wintercreeper (*Euonymus fortunei*) foliage can be controlled in this way with multiple applications, but woody stems can be treated as described below.
Tree Saplings, shrubs and woody vines	Apply 20% solution of Garlon4 mixed in commercially available basal oil to bark of uncut stems. Apply 20% solution of Roundup Pro mixed in water with a surfactant (e.g. methylated seed oil or ammonium sulfate) to cut stumps. These applications can take place in any season but are easiest applied in winter.

After existing vegetation is killed, **the ground should not be tilled**, disked, or plowed. Disturbing soil brings up weed seed resulting in additional weeds. Dead vegetation should be cut to a few inches high, using a mower or weed whip. Having some dead vegetation on the ground helps to hold seed in place and prevent erosion during winter months. Seeding can be done directly into the mowed dead vegetation in early winter. Please see the "Seeding" section on page four for more information.

Vegetation and dam safety: The design engineer shall evaluate and select appropriate vegetation for ground cover on dam embankments.[2] Trees and other woody vegetation should not be used on dams, because decaying roots can cause seepage problems. Uprooted trees can also create voids and erosion problems. Dense, tall vegetation on emergency spillways can limit hydraulic capacity. In addition, deep rooted vegetation may not be appropriate on the embankment side of the wet pond or wetland.

Some factors to consider when selecting vegetation type for detention basins include:

- Duration of ponding (permanent or intermittent during storms)
- Ponding depth, duration and fluctuation during storms
- Overflow structure elevations
- Drainage area tributary to the basin

Dams should be inspected periodically to evaluate the structural integrity of the dam, crest, slope, outlet channel, spillway, and toe of slope. Dense vegetation can obscure animal burrows and other defects. Inspections should be completed in late winter, after annual mowing and before vegetation starts to leaf out for best visibility of the dam.

[2] This does not replace state dam safety requirements.

After heavy rains, dams should be inspected for erosion problems. These should be repaired as soon as possible, filled with good soil, compacted, reseeded and mulched as appropriate. Wave action can also cause damage on the pond side of the dam. Plantings, or if necessary, rock rip rap can be placed to help reduce wave induced erosion.

Selecting plants around fluctuation zones: Plant pond edge and emergent aquatic species in the areas of the detention basin that are frequently inundated by storms. These species must be planted in permanent shallow water (up to 12 inches in depth). Failure to do so can result in frequent exposure to conditions that stress and potentially kill vegetation. It is recommended that the mature height of the plants used in these areas exceed the ponding depth of the one year 24 hour storm (see Plant List: Pond Edge and Emergent in Chapter One) For new detention basins within the MSD service area, this is the portion of the pond up to the storage of the Channel Protection Volume.

Seeding

Seed Mixes: Seed mixes for both wet and dry areas are provided in the section of this chapter titled "Seed Mix List." Each mix contains a component of grass and sedge species as well as forb species. The grasses, sedges and forbs shall be sown together as one mix. Listed native annuals can be added to provide color in the first few growing seasons. The annual seed weights are to be used in addition to perennial grass, sedge and forb quantities. Please note that at times blooming annuals may need to be mowed down to control weeds in the first two growing seasons.

Seed quantities must be calculated based on the percentage of Pure Live Seed (PLS) per acre. PLS is the viable seed of the specified variety and calculated as the product of the germination rate times the purity. All seed is to be planted within nine months of the testing date. Seed mixture should be provided in containers showing percentage of each seed species in the mix, year of production, net weight, date of packaging and seed provenance. Containers must be shipped with certificates of inspection as required by the U. S. Department of Agriculture. The weights of seed needed for the wet and dry mixtures have already been calculated. These weights have been doubled due to typical construction site subsoil conditions, which usually provide less than optimal growing medium for germination. A nurse crop such as oats is required to prevent erosion and reduce weed growth during the first growing season. Nurse crops typically disappear by the second growing season. Either seed oats (*Avena sativa*) or winter wheat (*Triticum aestivum*) can be used at a rate of 60 lbs. per acre. If winter wheat is used, cut before seed heads mature to avoid reseeding.

Beginning in March and through September, during this time if the soil bed is ready, the first seeding of annuals and "nurse" or cover crop seeds can be installed. The required native seed mix for the area cannot be installed at this time. Beginning in October and through February, the native seed mix can be sown. If the soil bed was not ready earlier in the year and this is the first seed sowing for the area, the cover crop and annual seeds can be sown at the same time as the native seeds.

Sowing seeds: Seeding should be done only during periods when the ground may be traversed with equipment without rutting or placing seed at depths over one quarter inch. Seed should be sown in a grid pattern, spreading half the seed mixture over the entire area in one direction then spreading the other half over the same area, in a perpendicular direction. Seed can be sown on snow, although some seed may be eaten by birds. During winter freezes and thawing, seeds sown on the surface work their way into the soil to the proper depth.

For areas less than 20,000 square feet: Seed sowing can be done by hand if the basin or buffer is less than 20,000 s.f. excluding filter bed areas, which shall be plug planted per Chapter One.

For areas over 20,000 square feet: Cultipacker type seeders (Brillion) or no-till seed drills (Truax or Great Plains) specifically designed for the seeding of native grasses and forbs must be used. The seeding depth must be set to provide a final seed depth of one quarter inch or less. Prior to starting work, all seeding equipment must be calibrated and adjusted to sow seeds at the proper rate. Equipment shall be operated in a manner to ensure complete coverage of the area. This equipment plants the seed in rows by cutting slits into the soil and planting the seed at the proper distance, and depth. No-till drills cause minimal soil disturbance which results in less weed seed germination.

If soil conditions are too wet or slopes are too steep for drilling, the broadcasting of seed is acceptable on exposed soil only. If seed is broadcast, it must be mixed with an equal amount of inert filter (such as perlite, sand, vermiculite, ground corn cobs) to enable an even distribution of seed. Mix ratios of seed and inert filters at *1:1 or 2:1* of filter to seed. A mechanical broadcast seeder, such as Truax Seed Slinger, may be used. Fluffy seed will not go through a traditional gravity flow seeder.

Seed should be broadcast in two applications of half the seed, where the second application of seed overlaps the previous application in a grid pattern. Broadcast seeded areas should be raked, rolled or dragged perpendicular to the slope within 24 hours after seeding, or as soon as site conditions permit. The use of compaction wheels on the seed drill is acceptable. Hydroseeding is not acceptable.

Seed drills may be borrowed from various state agencies or hired through a landscape contractor that specializes in prairie seeding. To learn how to borrow and use a no-till seed drill, contact your local Missouri Department of Conservation office to locate the Private Land Conservationist in your county.

Erosion Control Mats

Erosion control mats are an important component of seeding a detention basin or a stream buffer. Without them, uniform seed-soil contact can be compromised and costly seed is lost. Because establishing a thorough cover of native vegetation from seed may take 2-3 years, it is important that the erosion control mat be rated for similar longevity. However, care must be taken in selecting an erosion control mat because longer life erosion control mats typically are more tightly woven, which may impede seedling germination.

MSD recommends a wood shavings mat (Curlex #1 or Curlex #2 or equivalent) to be laid over seed placed from the bottom of the basin (or normal water level) and up to the 1-yr ponding elevation. Coir fiber blankets are recommended for establishing stream buffers, up to the bankfull elevation, and where more than 100' of overland flow is upgradient (uphill) of the seedbed. Outside of these areas, and where slopes are steeper than 10:1, either a coir fiber blanket or (lighter and less expensive) straw blanket (North American Green S75 or equivalent) should be laid over seed and anchored into prepared soil.

Erosion Control Mats		
Type	**Brand name**	**Description**
Wood shavings mat	Curlex® #1 or Curlex® #2 in areas of concentrated flow	Expands when wet causing the material to adhere to the surface and releases moisture to germinating seeds. Product is entirely biodegradable in two months.
Straw mat	North American Green® S75® Single Net Straw Blanket	The interwoven strands can move independently of each other providing better moisture absorption, flexibility, and conformance with the soil surface. Decomposes in one year.
Coir fiber	North American Green® C125® Blanket	Intermediate weight coconut based product with a rated longevity of 24 months. Typical applications include high flow areas and shorelines.

Germination: Prairie seed begins to germinate in April and continues through June. Some germination even occurs the next spring. Seedlings may be difficult to see because of their small size and the annual weed competition. A seedling identification guide is available through the Natural Resources Conservation Service and images can be found at:

http://www.plant-materials.nrcs.usda.gov/pubs/mopmcpu6313.pdf

Vegetation Establishment

Post planting establishment practices for three full growing seasons are critical to the success of seeded projects. Fast-growing annual and biennial weeds can shade out slower growing native forbs, grasses and sedges. Common biennial weeds include Queen Anne's lace, bull and Canada thistle and curly dock. Common annual weeds include moth mullein, fleabane, mare's tail, foxtail grass, chicory, ragweed, lambsquarters, mustard and smartweed. The forthcoming Chapter Three will contain information regarding weed management and identification.

Year one: Control weeds by keeping them mowed to a height of 6-12 inches throughout the first growing season. Most prairie seedlings are less than 6 inches tall in their first growing season and are seldom damaged by mowing. Do not allow weeds to get over 12 inches before cutting because tall weeds will shade out small prairie seedlings and long clippings can smother small seedlings. Keeping weeds cut back the first year also prevents production of more weed seeds that could become a problem in the future.

Pulling weeds in year one can cause problems because prairie seedlings are small the first year and are easily pulled up with the weeds and the disturbed soil can expose new weed seeds. However, if you know how to identify young weeds, it is safe to pull them, as long as you do not disturb nearby prairie seedlings. To remove large weeds, cut them off at the base and remove any seed heads from the site.

Year two: If weeds are a problem, mow them at a height of 12 inches since prairie seedlings will be taller the second year. If biennials are a problem, mow them at 12 inches when they are in full bloom. This should kill them or set them back severely. It may be desirable to re-seed areas that are thinly covered by plants or bare.

Equipment: String trimmers work well on projects less than 20,000 square feet as tractor-driven mowers are needed for larger areas. Adjust mower to cut higher than 6 inches. Where lawn mowers are the only available or size-appropriate machine, set the mower deck to highest setting (this in normally 4-5 inches).

Seeding and Vegetation Establishment Schedule Summary	
March - September	If BMP soil bed is ready during this time, install first seeding consisting of cover crop and annuals only. *Required native seed mix may only be seeded October – February.*
October - February	Sow native seed mix. Include cover crop and annuals if first seed sowing.
March – May	Seed mix germinates. Survey seedlings to determine germination success. 80% cover and 60% species survival is required. Begin mowing annual weeds. Do not let weeds grow over 12 inches.
June - September	Continue mowing weeds as needed. Do not let weeds grow over 12 inches.
Year 2	If required seeding success is not met, over-seed October through February. Continue mowing if annual weeds continue to dominate.
Year 3	Mow or burn annually in late winter or early spring (January-March).

First year prairie receiving mowing, left. Established prairie receiving annual late winter mowing, right.

Long-term maintenance: After year three, a late winter or early spring burn or mowing is recommended once every year or two to set back trees and shrubs. Standing prairie plants are full of over-wintering insects and provide food and cover for winter birds. It may be desirable to sow more seed or plant seedlings to maintain or increase species diversity. Chapter Three will contain information on weed management and weed identification for established native plant areas, because yearly monitoring of weeds is important so that they do not become a problem.

Educational Signage

Simple educational signage goes a long way to promote public acceptance of native plantings. In the early potentially "awkward" years, signs simply indicating "Native prairie restoration in progress" help the public understand that a process is at work. More complex signs can be used to raise awareness of particular plant species or the function of the stormwater basin or buffer. Signage can be particularly helpful adjacent to a public facility like a trail or a public building such as a school or library. Signage can also help promote the "green" image of a private business or local government.

2. Resources

Examples of Reconstructed Prairies in the St. Louis Area
(prairies created from agricultural fields, lawns, roadsides, and construction sites)

- Shaw Nature Reserve http://www.shawnature.org/
- Missouri Botanical Garden http://www.mobot.org/hort/gardens/kemper/prairie/index.shtml
- Powder Valley Nature Center http://mdc.mo.gov/regions/st-louis/powder-valley-conservation-nature-center
- The Green Center http://www.thegreencenter.org/
- Forest Park, Kennedy Woods Prairie-Savanna http://www.treeswallow.com/fp/savanna/index.html
- Weldon Spring Conservation Area , Howell Island Prairie
  http://cbc.audubon.org/iba/viewSiteProfile.do?siteId=2615&navSite=state
- Erb Crossing Subdivision, Newton Terrace and Arbor Green Pointe intersection
- Hawkins Glen Subdivision, 4366 Hawkins Glen Way

Related Links:

- Missouri Dept. of Conservation Grow Native! www.grownative.org
- Wild Ones Natural Landscapers www.for-wild.org
- The Missouri Prairie Foundation http://www.moprairie.org
- Local Ecotype Seed http://www.for-wild.org/download/LocalEcotypeBrochure.pdf
- American Prairie Foundation www.americanprairie.org
- The Tallgrass Prairie in Illinois http://www.inhs.uiuc.edu/~kenr/tallgrass.html
- http://www.ecologicalrestoration.info/
- Prairie Crossing Housing Development http://www.prairiecrossing.com/pc/site/about-us.html
- Diary of a Prairie Restoration http://www.illinoisraptorcenter.org/diarydirectory.html
- Prairies for Children http://www.dnr.state.wi.us/org/caer/ce/eek/nature/habitat/whatprai.htm
- Missouri Native Grasses http://mdc.mo.gov/landwater-care/plant-management/native-plants/establishing-native-warm-season-grasses
- Using Local Seeds in Prairie Restoration - Data Support the Paradigm (PDF)

Bibliography:

- *The Tallgrass Restoration Handbook: For Prairies, Savannas, and Woodlands*, by Stephen Packard and Cornelia F. Mutel, editors. 1997. Society for Ecological Restoration by Island Press, 1718 Connecticut Avenue NW, Suite 300, Washington, D.C. 2009-1148. xxxii + 463 pages
- *Restoring the Tallgrass Prairie: An Illustrated Manual for Iowa and the Upper Midwest* by Shirley Shirley. 1994. University of Iowa Press, Iowa City. xiii + 330 pages.
- *Prairies, Forests, and Wetlands: The Restoration of Natural Landscape Communities in Iowa* by Janette R. Thompson. 1992. University of Iowa Press, Iowa City. viii + 139 pages.
- *Ecological Restoration* edited by Dave Egan, the University of Wisconsin-Madison Arboretum, University of Wisconsin Press. Subscriptions available on the web:
  http://www.wisc.edu/wisconsinpress/journals/journals/er.html
- *Prairie Establishment and Landscaping* by William E. McClain. 1997. Division of Natural Heritage, Illinois Department of Natural Resources, Springfield, IL
  Natural Heritage Technical Publication #2. Available on the web:
  http://dnr.state.il.us/conservation/naturalheritage/prairie/table.htm
- *Prairie Plants and Their Use in the Landscape* by Neil Diboll. Article available on the web:
  http://www.prairienursery.com/NeilsPage/AchWriting/PrairiePlantsUse.htm

Latin Name	Common Name	Height (feet)	Spacing (feet)	Seasonal Interest - Color and Months	J	F	M	A	M	J	J	A	S	O	N	D	Sun	Pt Sun	Pt Shade	Shade	Birds	Butterflies	Fall Color	Winter interest	Salt tolerance	Aggressiveness	Silt tolerance	Ounces per Acre
DRY AREA MIX																												
Grasses/Sedges																												
Andropogon ternarius	Splitbeard bluestem	1-2	1.5	silver	x	x							x	x	x	x	x				x		x	x		L	L	32
Andropogon virginicus	Broomsedge	1-2	1.5	orange								x	x	x	x	x	x				x		x	x		M	L	32
Bouteloua curtipendula	Sideoats grama	1-2	1	tan							x	x	x	x	x		x				x			x		L	L	64
Schizachyrium scoparium	Little bluestem	2-3	1.5	bronze	x	x						x	x	x	x	x	x				x		x	x	M	L	L	64
Sporobolus heterolepis	Prairie dropseed	2-3	1.5	tan								x	x	x	x	x	x				x			x		L		16
Forbs																												
Asclepias tuberosa	Butterfly milkweed	1-2	1.5	orange						x	x	x					x					x			V	M		32
Aster oblongifolium	Aromatic aster	1-3	1.5	lavender								x	x				x				x	x				M		12
Coreopsis lanceolata	Lanceleaf coreopsis	1-2	1.5	yellow			x	x	x								x	x				x				L		20
Echinacea pallida	Pale purple coneflower	2-3	1.5	violet						x	x						x	x			x					L		48
Ratibida pinnata	Yellow/Grey coneflower	3-5	1.5	yellow						x	x	x					x	x			x	x			M	H	L	8
Solidago nemoralis	Old field goldenrod	4-6	1.5	yellow							x	x	x				x	x			x					L	L	4
Zizia aureas	Golden alexander	1-3	1.5	yellow				x	x								x	x	x			x			M	M	U	32
Annuals (optional)																												
Chamaecrista fasciculate	Partridge pea	1-3	1	yellow							x	x	x				x	x			x	x						32
Coreopsis tinctoria	Plains coreopsis	2-4	1	yellow						x	x	x	x				x					x						4
Palafoxia callosa	Palafoxia	2-3	2	pink								x	x	x			x	x										4
Rudbeckia hirta	Black-eyed Susan	2-3	1.5	yellow						x	x	x	x				x					x						4
WET AREA MIX																												
Grasses/Sedges																												
Carex annectans	Yellow fruited sedge	2-3	1.5	tan				x	x	x							x	x	x		x			x		L		5
Carex grayi	Bur sedge	1-2	1.5	tan				x	x	x								x	x	x	x					L	M	64
Carex muskingumensis	Palm sedge	2-3	1.5	tan				x	x	x	x	x					x	x	x	x	x			x		M	M	8
Carex shortiana	Short's sedge	2	1.5	bluish				x	x	x							x	x	x		x			x		L		32
Chasmanthium latifolium	River oats	2-4	1.5	green						x	x	x	x	x	x			x	x	x	x		x	x		H		64
Elymus virginicus	Virginia wild rye	2-3	1.5	yellow			x	x	x										x		x	x						32
Panicum virgatum	Switchgrass	3-6	2.5	pink	x	x					x	x	x	x	x	x	x	x	x		x		x		M	M	M	16
Scirpus atrovirens	Great green bullrush	2-3	1.5	green				x	x	x							x	x			x			x		L		4
Forbs																												
Asclepias incarnata	Marsh milkweed	3-5	1.5	pink							x	x	x				x	x				x				M		16
Chelone obliqua	Rose turtlehead	3-4	2	rose/purple								x	x	x			x	x	x	x						M		2
Eupatorium coelestinum	Mist flower; wild ageratum	1-2	1.5	lavender							x	x	x	x			x	x			x					M	H	2
Helenium autumnale	Sneezeweed	3-4	2	yellow							x	x	x	x			x	x	x		x	x			M	M		4
Iris virginica	Southern blueflag iris	2-3	2	blue							x	x					x	x			x			x		M	M	20
Lobelia siphilitica	Blue lobelia	2-3	1.5	blue							x	x	x				x	x	x							M		2
Ludwigia alternifolia	Seedbox	2-3	1	yellow						x	x	x					x	x	x									2
Penstemon digitalis	Smooth beard-tongue	2-3	1.5	white				x	x								x	x			x					M	M	2
Physostegia virginiana	Obedient Plant	2-3	1.5	pink							x	x	x				x	x	x		x	x				H		4
Rudbeckia fulgida	Orange coneflower	2	2	yellow						x	x	x	x				x	x				x		x		M		8
Annuals (optional)																												
Bidens aristosa	Bur marigold	3-6	1.5	yellow							x	x	x				x					x				H		4

Requirements

Local Ecotype Rule: Plants of Missouri or Southern Illinois ecotype are required.

PLS means pure live seed; or seed that has been tested for purity and viability. This is done by most seed nurseries and should be included in your seed order.

Dry denotes an area above the 1 year ponding or bank flow elevation.

Wet denotes an area that is at or below the 1 year ponding or bank flow elevation.

Must use a minimum of 6 grass/sedge species and 8 forb species for each BMP. It is recommended that this list be provided to landscape contractors/buyers in case substitutions are required.

Latin Name	Common Name	Height (feet)	Spacing (feet)	Seasonal Interest - Color and Months	J	F	M	A	M	J	J	A	S	O	N	D	Sun	Pt Sun	Pt Shade	Shade	Birds	Butterflies	Fall Color	Winter Interest	Salt tolerance	Aggressiveness	Silt tolerance	Ounces per Acre
DRY AREA MIX																												
Grasses/Sedges																												
Andropogon gerardii	Big bluestem	4-6	2-5	plum	x	x							x	x	x	x	x					x	x		M			32
Elymus canadensis	Canada wild rye	2-5	2	green							x	x	x				x				x			x				32
Panicum virgatum	Switchgrass	3-6	2.5	pink	x	x					x	x	x	x	x	x	x	x	x		x		x		M	M	M	16
Schizachyrium scoparium	Little bluestem	2-3	1.5	bronze	x	x						x	x	x	x	x	x				x		x	x	M	L	L	64
Sorghastrum nutans	Indian grass	3-5	1.5	tan	x	x							x	x	x	x	x				x		x					16
Sporobolus heterolepis	Prairie dropseed	2-3	1.5	tan								x	x	x	x	x	x				x			x		L		16
Forbs																												
Asclepias syriaca	Common milkweed	2-3	1	pink						x	x	x					x					x			M			32
Aster oblongifolius	Aromatic aster	1-3	1.5	lavender								x	x				x				x	x						12
Baptisia australis	Blue wild indigo	3-4	3.5	blue					x	x							x	x	x			x			M			32
Coreopsis lanceolata	Lanceleaf coreopsis	1-2	1.5	yellow			x	x	x								x	x				x			L			20
Echinacea pallida	Pale purple coneflower	2-3	1.5	violet						x	x						x	x			x				L			48
Eryngium yuccifolium	Rattlesnake master	4-5	1.5	green						x	x	x	x				x					x		x	M	L		16
Grindelia lanceolata	Gum weed	2-3	1.5	yellow						x	x	x	x				x									M		8
Heliopsis helianthoides	False sunflower	3-6	3	yellow						x	x	x					x					x						16
Lespedeza capitata	Roundheaded bush clover	2-4	1.5	cream							x	x	x				x	x	x							L		16
Liatris pycnostachya	Prairie blazing star	2-5	1.5	lilac							x	x					x				x	x				L		16
Monarda fistulosa	Wild bergamont	3-4	2	pink						x	x	x					x	x	x		x	x			M	M	M	4
Ratibida pinnata	Yellow/Grey coneflower	3-5	1.5	yellow						x	x	x					x	x			x	x			M	H	L	8
Rudbeckia hirta	Black-eyed Susan	2-3	1.5	yellow						x	x	x	x				x					x				M		4
Solidago speciosa	Showy goldenrod	2-3	1.5	yellow								x	x				x	x	x			x		x	M	H	L	4
Verbesina helianthoides	Yellow wingstem	2-3	1.5	yellow					x	x	x						x	x	x			x		x		M	L	16
Veronia arkansana	Arkansas ironweed	4-6	3.5	purple									x	x			x									M		8
Veronicastrum virginicum	Culversroot	4-7	3	white					x	x	x	x					x					x				L		1
Zizia aurea	Golden alexander	1-3	1.5	yellow				x	x								x	x	x			x			M	M	U	32
Annuals (optional)																												
Chamaecrista fasciculate	Partridge pea	1-3	1	yellow							x	x	x				x	x			x	x						32
Coreopsis tinctoria	Plains coreopsis	2-4	1	yellow						x	x	x	x				x					x						4
Palafoxia callosa	Palafoxia	2-3	2	pink								x	x	x			x	x										4
WET AREA MIX																												
Grasses/Sedges																												
Carex annectans	Yellow fruited sedge	2-3	1.5	tan				x	x	x							x	x	x		x			x		L		5
Carex muskingumensis	Palm sedge	2-3	1.5	tan				x	x	x	x	x					x	x	x	x	x			x		M	M	8
Carex shortiana	Short's sedge	2	1.5	bluish				x	x	x							x	x	x		x			x		L		32
Carex frankii	Frank's sedge	3	1.5	tan					x	x	x						x	x			x	x						4
Carex vulpinoidea	Fox sedge	2-3	1.5	tan					x	x	x						x	x	x						L	L	H	4
Chasmanthium latifolium	River oats	2-4	1.5	green						x	x	x	x	x	x			x	x	x	x		x	x		H		32
Scirpus atrovirens	Great green bullrush	2-3	1.5	green				x	x	x							x	x			x			x		L		4
Spartina pectinata	Prairie cordgrass	4-5	2.5	green							x	x	x				x	x			x		x	x		H	H	8
Forbs																												
Amsonia illustris	Shining bluestar	2-3	2.5	lt. blue				x	x								x	x	x			x	x			L	H	32
Asclepias incarnata	Marsh milkweed	2-4	2	pink							x	x	x	x			x	x				x			M	M		16
Aster novae-angliae	New England aster	3-4	2	violet								x	x				x	x				x	x		L	H		4
Eupatorium perfoliatum	Common boneset	2-3	1.5	white							x	x	x				x	x	x			x				M		8
Iris virginica	Southern blueflag iris	2-3	2	blue							x	x					x	x			x			x		M	M	20
Hibiscus lasiocarpus	Rose mallow	4-5	2	white									x	x	x		x	x			x	x				M		16
Lobelia cardinalis	Cardinal flower	2-3	1.5	red							x	x	x	x			x	x	x	x	x	x			L	M	U	1
Ludwigia alternifolia	Seedbox	2-3	1	yellow						x	x	x					x	x	x									1
Mimulus ringens*	Allegehny monkey flower	1-2	1.5	lavender								x	x	x			x	x								M		2
Penstemon digitalis	Smooth beard-tongue	2-3	1.5	white					x	x							x	x			x					M	M	4
Rudbeckia fulgida	Orange coneflower	2	2	yellow						x	x	x	x				x	x				x		x		M		8
Rudbeckia subtomentosa	Sweet coneflower	3-4	2	yellow						x	x	x	x				x	x				x		x		M		8
Verbena hastata	Blue vervain	2-6	2	purple							x	x	x				x					x				M		2
Annuals (optional)																												
Bidens aristosa	Bur marigold	3-6	1.5	yellow							x	x	x				x					x				H		4

Requirements

Local Ecotype Rule: Plants of Missouri or Southern Illinois ecotype are required.

PLS means pure live seed; or seed that has been tested for purity and viability. This is done by most seed nurseries and should be included in your seed order.

Dry denotes an area above the 1 year ponding or bank flow elevation.

Wet denotes an area that is at or below the 1 year ponding or bank flow elevation.

Must use a minimum of 6 grass/sedge species and 8 forb species for each BMP. It is recommended that this list be provided to landscape contractors/buyers in case substitutions are required.

Metropolitan St. Louis Sewer District

Missouri Botanical Garden
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Missouri Department of Agriculture

GROW native!
Missouri Department of Conservation
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Conservation Great Rivers Missouri
Serving nature and you