BLUE Williston

Small-Scale Green Stormwater Infrastructure Practices
for Poorly Draining Soil Types in Williston, VT

This BLUE Williston document builds on the Basis of Design Manual for Burlington, VT. This document includes two stormwater treatment practices that are eligible for BLUE rebates only in Williston. These stormwater treatment practices are designed to reduce runoff water in areas where the soils are unsuitable for infiltration practices.

Sea Grant
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Vegetated Filter Berm

Introduction

A vegetated filter berm is a raised earthen mound created by piling soil or other media. A berm used for stormwater should be placed in an area where it can intercept the flow of runoff and reduce erosion. The inner portion of the berm should be composed of stable well-drained soil, sand, or gravel which enables this feature to slow and infiltrate stormwater. The berm should be fully vegetated with plants appropriate to its size and scale, which could include: a conservation seed mix, native grasses, perennials, shrubs, or trees to stabilize soil and prevent erosion. A shallow uphill depression in front of the berm will help encourage infiltration and serve as an overflow avenue during heavy rains.

A series of berms may be constructed to slow the flow of stormwater over a sloped area. Pooling at each berm may occur depending on the amount of rainfall and infiltration capacity of the berm interior. Filter berms may be paired with vegetated or rock lined swales to help buffer and direct stormwater toward a desired location.

Minimum Design Requirements

- Berms should be properly located to intercept stormwater flow on sites with a shallow slope of 10 percent or less and armored appropriately at the base with stone, wood logs, or vegetation to prevent erosion.
- The interior of the berm should include well-draining soil, gravel, or sand to ensure infiltration.
- Design berms to be at least 2 feet wide at the top with a height between 2 feet and 3 feet depending on the flow and speed of stormwater that the berm will intercept. Larger berms can intercept more stormwater flow at higher speeds.
- The sides of the berm should not exceed 4 horizontal feet over 1 vertical foot of slope and should connect areas of similar elevation.
- The shallow uphill depression should be at least 2 feet wide and 6 inches deep with no more than a half of a percent slope directing stormwater to a stable overflow area.
- If the native soil has poor infiltration, it should be replaced with a minimum 1 foot of well-draining topsoil spread over the berm. Lightly smooth the uphill depression and avoid over-compaction of soil.
- Plant berm with native plants tolerant of wet and dry conditions to help absorb excess water and stabilize the berm.

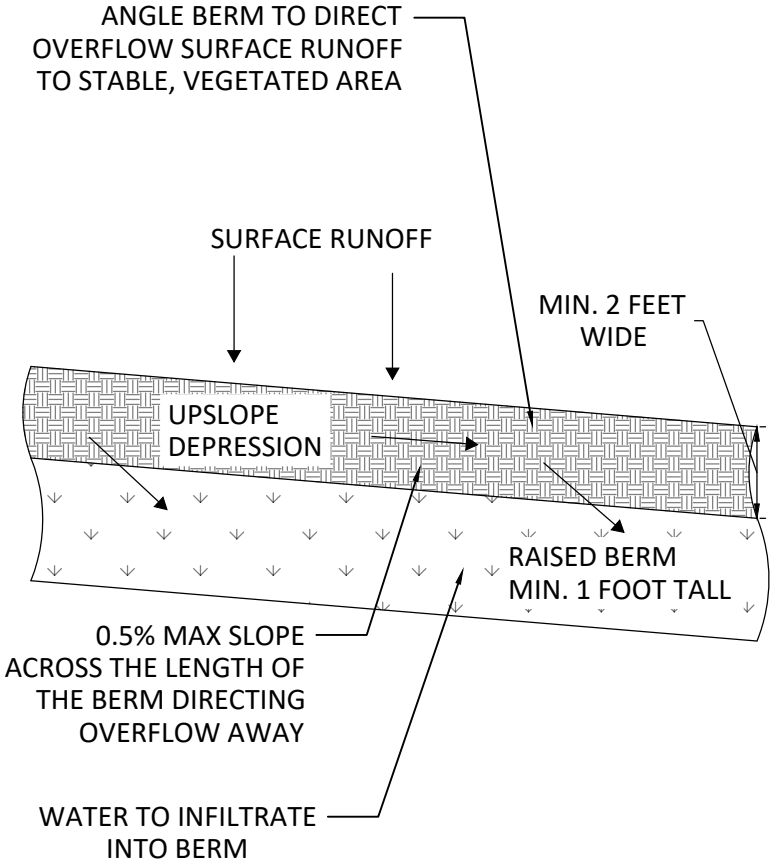
Design Guidance: [*considerations for good practice]*

- Consider directing water away from the berm until plants are established.
- Consider shaping the berm to have a higher end on one side to produce a more organic looking berm.

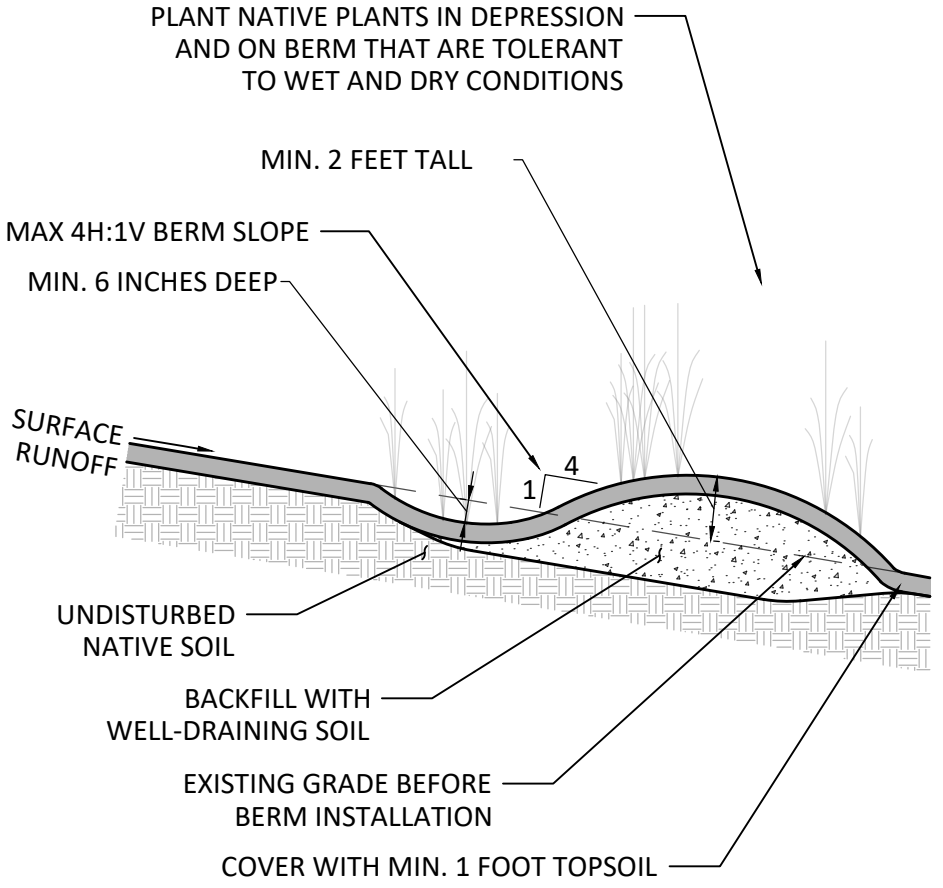
Maintenance

- Prevent erosion over time by keeping the berm well vegetated by reseeding, re-planting, or covering any bare areas that develop.
- Maintain plants seasonally by mowing grass, pruning, or replacing dead vegetation as needed.

PLAN VIEW



PROFILE VIEW



VEGETATED BERM
NOT TO SCALE

High Density Plantings

Introduction

High density plantings are sited in areas to intercept, slow, filter, infiltrate, and transpire stormwater in poorly draining soils where other practices such as rain gardens or dry wells, which rely on quickly draining soils, are not suitable. Hardy native plants are ideal for high density plantings as they have deep roots to promote infiltration and canopies that intercept rain, reducing stormwater runoff. [1]

High density planting rebate eligibility is determined by the size of the area planted (square footage), density of plantings, and the species planted.

Minimum Design Requirements

- All plants must be selected from the approved *Water-Loving Clay Tolerant* plant list.
- Plantings must be located in mostly flat areas where water pools and is therefore given time to infiltrate in poorly draining soils such as: existing saturated areas, areas where stormwater control is desired, or areas where stormwater is being sent via run-on from another location or gutters.
- Plant spacing must be as dense as possible with at least one plant every 12-24 inches for meadow plantings with grasses and herbaceous perennials. For a mixed garden incorporating shrubs, trees, or larger perennials, use the 'Form' column on the *Water-Loving Clay Tolerant* plant list to guide spacing. Large perennials should be planted at least 3 feet from trees and shrubs to give plants enough space to establish.
- Minimize the application of fertilizer containing phosphorus when planting in areas where stormwater will pool. If desired, a few handfuls of compost can be added around roots (i.e., spot application).

Design Guidance *(considerations for good practice)*

- Plant during the spring or fall when plants are dormant.
- Locate plantings outside existing tree canopies when possible to avoid damaging roots of mature trees.
- A mixture of perennials, shrubs, and trees may be planted, or just perennials can be planted for a meadowy-garden look. If less maintenance is desired, a cluster of trees or shrubs may be planted.
- Plantings should be located at least 2 feet away from homes and other built structures to minimize moisture along walls and foundations.
- Plantings should be located at least 10 feet away from wastewater systems, such as septic, to not impact the system.
- If mulch is used, it should be applied in the shape of a donut around the base of the plant and not piled closely around the trunk or central stem. Mulch retains moisture in wetter clay soils. Over-mulching can kill both juvenile and mature plants.
- Obtain native plants from local growers such as: Intervale Conservation Nursery (Burlington), Full Circle Gardens (Essex), Bird and Bee Native Plants (Jericho), The Farm

[1] For research on the ecosystem services, including stormwater management, of trees in developed areas see: Kuehler, Eric; Hathaway, Jon; Tirpak, Andrew. 2017. Quantifying the benefits of urban forest systems as a component of the green infrastructure stormwater treatment network. Ecohydrology. 10(3): e1813-e1822. 10 p. https://doi.org/10.1002/eco.1813.

Upstream (Jericho), Verterra Nursery (Hinesburg), or Horseford Gardens and Nursery (Charlotte).

Maintenance

- After installation, water plants a couple times a week through the entire growing season. Water during dry spells for the first few years after planting. For clay soils, do not over-water or water during periods of heavy rain. Gator bags can be applied to newly planted trees.
- Mulch or other organic material such as leaf litter or 'chop and drop' scraps can be applied around the base of plantings as needed.
- Remove invasive plants and weeds as needed.
- Inspect vegetation and replace dead material as needed.
- Prune trees and shrubs yearly.

Water-Loving Clay Tolerant Plants: Northeast Natives

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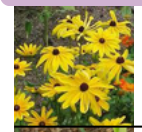
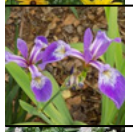
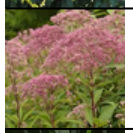
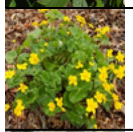
Perennials

	Plant Name	Preferred Site	Light	Soil	Form	Notes
	**Black-Eyed Susan** *Rudbeckia hirta*	Meadow	Full Sun	Dry, Medium, Wet	1-3' H 1-2' W (clumps)	Yellow flowers with black centers bloom throughout the summer. Deer resistant, attractive to pollinators and birds.
	**Blue Flag Iris** *Iris versicolor*	Forest edge	Partial Sun	Medium, Wet	2-3' H 1' W (spreads)	Lovely blue flowers with delicate petals. Deer resistant, attractive to pollinators, and suitable for rain gardens.
	**Boneset** *Eupatorium perfoliatum*	Meadow	Full Sun	Medium, Wet	4-6' H 3-4' W (clumps)	Large white wildflowers bloom in late summer. Attractive to pollinators, suitable for rain gardens.
	**Cardinal Flower** *Lobelia cardinalis*	Forest edge, Wetland	Partial Sun	Medium, Wet	2-4' H 1-2' W (spreads)	Brilliant red flowers that bloom in late fall. Deer resistant, attractive to pollinators.
	**Dense Blazingstar** *Liatris spicata*	Meadow, Wetland	Full Sun	Medium, Wet	3-5' H 1-2' W (clumps)	Purple flower stalks bloom in late summer. Attractive to birds and pollinators.
	**Goldenrod** *Solidago sp.*	Meadow	Full Sun	Dry, Medium, Wet	3-4' H 2-6' W (spreads)	Bright yellow flowers bloom in late summer. Attractive to pollinators, deer and rabbit resistant.
	**Joe-Pye Weed** *Eutrochium dubium*	Meadow, Wetland	Full Sun	Medium, Wet	3-6' H 2-4' W (spreads)	Showy pink flowers on stalks with toothed leaves. Attractive to pollinators, suitable for rain gardens.
	**King Solomon's Seal** *Polygonatum biflorum*	Forest edge, Forest	Partial Sun	Medium, Wet	1-3' H 1-2' W (spreads)	Arching stems with dangling cream flowers. Attractive to birds and pollinators.
	**Marsh Marigold** *Caltha palustris*	Meadow, Forest, Wetland	Full Shade	Medium, Wet	1-1.5' H 1-1.5' W (clumps)	Yellow buttercup-like flowers. Attractive to pollinators, suitable for rain gardens or as a groundcover if planted densely.
	**Mountain Mint** *Pycnanthemum sp.*	Meadow, Forest edge	Partial Sun	Medium, Wet	1-4' H 1-3' W (spreads)	Highly fragrant with soft leaves and white flowers blooming in late summer. Attractive to pollinators.
	**New England Aster** *Aster novae-angliae*	Meadow, Forest edge	Partial Sun	Medium, Wet	3-6' H 1-3' W (spreads)	Showy purple flowers bloom in late summer. Deer resistant, attractive to pollinators.

Plant photo credits to Missouri Botanical Garden

Full Sun Partial Sun Full Shade

Water-Loving Clay Tolerant Plants: Northeast Natives

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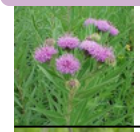
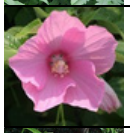
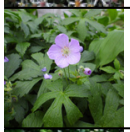
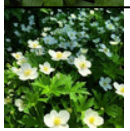
Perennials

	Plant Name	Preferred Site	Light	Soil	Form	Notes
	**New York Ironweed** *Veronia noveboracensis*	Meadow, Forest edge	Full Sun, Partial Sun	Medium, Wet	4-7' H 3-4' W (spreads)	Tall upright stalks with intense purple flowers. Great for meadow gardens.
	**Nodding Onion** *Allium cernuum*	Meadow	Full Sun	Medium, Wet	1-2' H 1' W (spreads)	Grassy stems with delicate umbels of pink flowers. Deer resistant, attractive to pollinators.
	**Oxeye Sunflower** *Heliopsis helianthoides*	Meadow	Full Sun	Dry, Medium, Wet	3-6' H 1-3' W (spreads)	Bright yellow sunflowers bloom through the summer. Deer resistant, attractive to birds and pollinators, suitable for rain gardens.
	**Sensitive Fern** *Onoclea sensibilis*	Meadow, Forest, Wetland	Full Sun, Full Shade	Medium, Wet	3-4' H 3-4' W (spreads)	Hardy fern with triangular, bright green fronds. Deer resistant.
	**Swamp Mallow** *Hibiscus moscheutos*	Meadow	Full Sun	Medium, Wet	3-7' H 2-4' W (spreads)	Large pink hibiscus flowers. Attractive to pollinators.
	**Swamp Milkweed** *Asclepias incarnata*	Meadow	Full Sun	Medium, Wet	2-4' H 1-3' W (clumps)	Showy pink flowers. Host plant for monarch and swallowtail butterflies, suitable for rain gardens.
	**Tall Bellflower** *Campanula americana*	Forest edge	Partial Sun, Full Shade	Medium, Wet	3-5' H 1-2' W (spreads)	Tall stalks boast bright blue blooms. Attractive to pollinators.
	**White Turtlehead** *Chelone glabra*	Meadow, Forest edge	Full Sun, Partial Sun	Medium, Wet	2-4' H 1-2' W (spreads)	Distinctive white turtlehead-shaped flowers. Attractive to pollinators, suitable for rain gardens.
	**White Wood Aster** *Eurybia divaricata*	Forest edge	Partial Sun	Medium, Wet	2-4' H 1-2' W (clumps)	Small daisy-like flowers bloom in late summer. Attractive to pollinators.
	**Wild Geranium** *Geranium maculatum*	Forest edge	Partial Sun	Medium, Wet	1-2' H 1' W (spreads)	Bright lavender flowers bloom in spring. Attractive to pollinators, can be a groundcover if planted densely.
	**Windflower** *Anemone canadensis*	Meadow, Forest edge	Full Sun, Partial Sun	Medium, Wet	1-2' H 1-2' W (spreads)	Bright white flowers with yellow centers. Suitable for rain gardens or as a groundcover.

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Full Sun Partial Sun Full Shade

Water-Loving Clay Tolerant Plants: Northeast Natives

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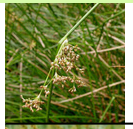
Grasses

	Plant Name	Preferred Site	Light	Soil	Form	Notes
	**Common Rush** *Juncus effusus*	Wetland	Full Sun	Wet	2-4' H 2-4' W (spreads)	Smooth upright grass with showy brown seedheads and yellow fall foliage.
	**Fox Sedge** *Carex vulpinoidea*	Meadow	Full Sun	Medium, Wet	1-3' H 1' W (spreads)	Densely mounded grass with bronze seedheads. Deer resistant, suitable for rain gardens.
	**Gray Sedge** *Carex grayi*	Forest edge, Wetland	Partial Sun	Medium, Wet	2-3' H 1-2' W (clumps)	Showy spiked seedheads can be used in floral arrangements. Deer resistant, suitable for rain gardens.
	**Switchgrass** *Panicum virgatum*	Meadow	Full Sun	Dry, Medium, Wet	3-6' H 2' W (clumps)	Upright grass with beautiful, showy seedheads. Deer resistant, suitable for rain gardens.

Shrubs

	Plant Name	Preferred Site	Light	Soil	Form	Notes
	**Aronia** *Aronia melanocarpa*	Meadow, Forest edge	Partial Sun	Dry, Medium, Wet	3-10' H 3-6' W (spreads)	White flowers in early spring, black berries in summer can be used for jams or syrups, red foliage in fall. Suitable for rain gardens.
	**Buttonbush** *Cephalanthus occidentalis*	Meadow, Forest edge	Partial Sun	Medium, Wet	5-12' H 4-8' W (clumps)	Showy globe-like white flowers. Attractive to birds and pollinators, suitable for rain gardens.
	**Elderberry** *Sambucus canadensis*	Meadow, Forest edge	Partial Sun	Medium, Wet	5-12' H 5-12' W (spreads)	Dark berries have medicinal properties, but need to be cooked first. Attractive to pollinators, birds, and deer.
	**Highbush Cranberry** *Viburnum trilobum*	Forest edge, Wetland	Partial Sun	Medium, Wet	8-12' H 5-10' W (clumps)	Tart red berries excellent for jam and desirable to many birds. Cross pollination from at least two shrubs needed for fruit.
	**Meadowsweet** *Spirea alba*	Meadow, Forest edge	Partial Sun	Medium, Wet	2-5' H 2-4' W (clumps)	Whitish-pink flowers attractive to pollinators and birds. Suitable for rain gardens.

Plant photo credits to Missouri Botanical Garden

Full Sun Partial Sun Full Shade

Water-Loving Clay Tolerant Plants: Northeast Natives

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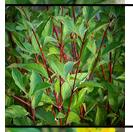
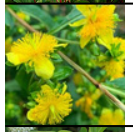
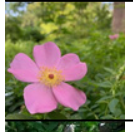
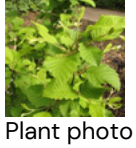
Shrubs

	Plant Name	Preferred Site	Light	Soil	Form	Notes
	**Nannyberry** *Viburnum lentago*	Meadow, Forest edge	●◐	Medium, Wet	10-15' H 5-10' W (clumps)	Large upright shrub with edible blue berries and burgundy fall foliage. Cross pollination from at least two shrubs needed for fruit.
	**Red Twig Dogwood** *Cornus sericea*	Meadow, Forest edge	●◐	Medium, Wet	6-9' H 5-10' W (clumps)	White ornamental fruits in late summer and beautiful red branches are showy in winter. Attractive to birds.
	**Shrubby St. John's Wort** *Hypericum prolificum*	Meadow	●◐	Medium, Wet	2-4' H 3-4' W (clumps)	Dense foliage of small green leaves with yellow flowers in the summer. Attractive to pollinators and birds.
	**Silky Dogwood** *Cornus amomum*	Meadow, Forest edge	●◐	Medium, Wet	6-12' H 6-12' W (clumps)	Large shrub with attractive blue berries and reddish-orange fall foliage.
	**Spicebush** *Lindera benzoin*	Meadow, Forest edge, Forest	●◐	Medium, Wet	6-12' H 6-12' W (clumps)	Plant gives off a spicy citrus aroma. Leaves and twigs can be used in tea. Host plant for swallowtail butterfly.
	**Swamp Rose** *Rosa palustris*	Meadow	●	Wet	3-6' H 3-6' W (spreads)	Fragrant pink roses with yellow centers can bloom to be 2" in diameter. Leaves may turn red in fall.
	**Sweet Pepperbush** *Clethra anlifolia*	Meadow, Forest edge, Wetland	●◐	Medium, Wet	3-8' H 4-6' W (clumps)	Fragrant white flowers in summer followed by dark brown seed capsules. Attractive to birds and butterflies, suitable for rain gardens.
	**Winterberry** *Ilex verticillata*	Meadow, Forest edge	●◐	Medium, Wet	4-10' H 4-10' W (clumps)	Fabulous, showy red fruit in the fall and winter. Attractive to birds. Suitable for rain gardens.
	**Pussy Willow** *Salix discolor*	Wetland	●	Wet	10-20' H 5-10' W (spreads)	Silky catkin blooms provide pollen for native bees. Suitable for rain gardens.
	**Speckled Alder** *Alnus incana*	Forest edge, Wetland	●◐	Medium, Wet	10-25' H 15-25' W (spreads)	Multi-stemmed trunk with spotted bark. Great for forming hedges or thickets.

Plant photo credits to Missouri Botanical Garden

●Full Sun ◐Partial Sun ●Full Shade

Water-Loving Clay Tolerant Plants: Northeast Natives

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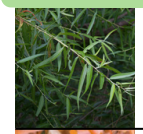
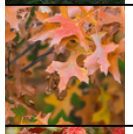
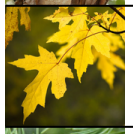
Trees

	Plant Name	Preferred Site	Light	Soil	Form	Notes
	**Black Willow** *Salix nigra*	Meadow, Forest edge, Wetland	●◐	Medium, Wet	30-60' H 30-60' W (spreads)	Fast growing tree with finely toothed leaves. Excellent for erosion control. Leaves may have a yellow hue in fall.
	**Pin Oak** *Quercus palustris*	Meadow, Forest	●	Medium, Wet	50-70' H 40-60' W (clumps)	Glossy dark green leaves, rounded acorns, and deep bronze to red fall foliage.
	**Red Maple** *Acer rubrum*	Meadow, Forest	●◐	Medium, Wet	40-70' H 30-50' W (clumps)	Showy red fall foliage. Attractive to birds, suitable for rain gardens.
	**River Birch** *Betula nigra*	Meadow, Forest edge, Wetland	●◐	Medium, Wet	40-70' H 40-60' W (clumps)	Quickly growing tree with beautifully mottled bark and yellow fall foliage. Suitable for rain gardens.
	**Silver Maple** *Acer saccharinum*	Meadow, Forest	●◐	Medium, Wet	50-80' H 35-70' W (clumps)	Quickly growing tree, leaves have silvery undersides and turn yellow in fall. Suitable for rain gardens.
	**Tamarack** *Larix laricina*	Meadow, Wetland	●	Medium, Wet	40-80' H 15-30' W (clumps)	Needles turn a showy yellow before shedding in the fall. Tall tree with an open pyramid shape.
	**Swamp White Oak** *Quercus bicolor*	Meadow, Wetland	●	Medium, Wet	50-60' H 50-60' W (clumps)	Silver scaled bark, green leaves with silver undersides. Host plant to many native insects. Suitable for rain gardens.
	**Sycamore** *Platanus occidentalis*	Meadow, Wetland	●	Medium, Wet	75-100' H 75-100' W (clumps)	Lovely whitish-brown mottled bark. Female trees produce fuzzy spherical seed pods.

Plant photo credits to Missouri Botanical Garden

● Full Sun ◐ Partial Sun ● Full Shade