5 | GREEN INFRASTRUCTURE BEST PRACTICES

Bio-Retention Practices

Many of the common green infrastructure techniques serve as examples of bioretention. Whether installed on rights-of-way or in a residential backyard, bioretention practices focus on capturing stormwater runoff, filtering pollutants, and promoting infiltration that recharges the groundwater on-site. All bio-retention practices consist of a basin-like shape that encourages the in-flow of runoff from an adjacent roadway, parking lot, or property. Once runoff has entered the basin, it is distributed evenly across a filtering medium of woody and herbaceous plants, mulch, and engineered soil. The intention of this design is to reduce the velocity of the runoff, and subsequently, to remove pollutants as the runoff slowly infiltrates the soil. As infiltration occurs, the removal of runoff pollutants will be conducted through the work of the site's plants and microorganisms through processes like adsorption, decomposition and the uptake of particulate pollutants by the plant's root structure.

A bio-retention site's ability to reduce or halt the velocity of runoff will greatly increase its capacity to filter pollutants, as all of the previous processes mentioned can only transpire effectively once this has occurred. As infiltration begins, the absorbed stormwater passes slowly through layers of engineered soil and stone aggregate, before it continues through to the subgrade that lies beneath the bioretention site, or alternatively, exiting through a perforated underdrain that has been included in the installation.

Bio-retention practices tend to be most effective when located upstream, and when they have been designed specifically to manage and filter runoff before it enters the sewer system. In turn, these practices should be applied in close proximity to sewer inlets, in places where runoff (and runoff pollution) from impervious surfaces typically collects, and where it can be managed and treated before it enters the sewer.

Bio-retention practices tend to be smaller in size than other forms of green stormwater infrastructure, which is largely a product of the urban, developed locations where they are most commonly found. In turn, while bio-retention practices often are not the only solution needed to address flooding in an area, they can assist with managing a portion of an area's stormwater volumes, as well as treating it before it enters the sewer, and they can reduce occurrences of combined sewer overflows (CSOs), a priority water pollution concern for municipalities with combined sewer systems (CSS).[1] Combined sewer overflows occur when the volume of stormwater or wastewater exceed the capacity of the CSS or treatment plant and results in untreated water discharging directly into nearby water bodies.[2]

Bio-Retention Practices

- Bioswale - Hybrid Ditch
- Rain Garden
- Stormwater Planter

Typical Locations

- Upstream
- Rights of Way (roads, sidewalks)
- Parking Lots
- Building Sets and Backyards

1, 2 https://www.epa.gov/npdes/combined-sewer-overflows-csos

Bioswale/Hybrid Ditch

A bioswale / hybrid ditch functions in some ways like a conventional grass ditch that sits within the right-of-way along the road edge. Rainwater runoff flows across the crown of a road and enters at any point along its length. The main difference between the two is that a bioswale will have herbaceous perennial plantings and a hybrid ditch will have turf grass. In addition to providing biofiltration as discussed in the introductory section, a bioswale / hybrid ditch slopes with the road to act as a conveyance channel which connects to an existing conventional ditch, surface water, or storm sewer.

The significant difference between a bioswale / hybrid ditch and a conventional vegetated swale (GI 6) is beneath the surface. A bioswale/hybrid ditch has an engineered soil sub-base, which is a mixture of sand, and compost (and sometimes topsoil). The importance of the engineered soil cannot be overstated. It provides a sponge to absorb and hold runoff for later use by plant material, a physical filter for removing pollutants and sediment from runoff, and an excellent growing media for herbaceous perennial plants. A specification section for engineered soil that can be incorporated into the construction documents is located in Appendix C.

In the case of the bioswale, a variety of large herbaceous plants in the engineered soil take some of the runoff up through their dense root system. Additionally, an optional perforated underdrain within the stone layer can convey filtered water that does not infiltrate into the subgrade soil.

Customization Options

This practice can be customized in a number of ways. The aesthetics can be tailored through plant selection. It is recommended that large herbaceous plugs be used to establish a bioswale. Gallon-sized plants may be used to more quickly establish plants. Hybrid ditches are typically planted with seed, but sod could be chosen for a more immediate finish.

Figure 5: Bioswale in a suburban setting

An erosion control blanket should be used over the surface of the bioswale, to prevent erosion during vegetation establishment. Seeding should be placed under the blanket. Live plant material will require cutting through the blanket, for each plant. When live planting, leaf mulch could be used as an alternative to erosion control blanket. When a hybrid ditch is vegetated using sod, no erosion blanket is needed.

Other customization options are a function of the site conditions. An overflow structure and perforated underdrain can connect the bioswale to the larger storm network, carrying excess runoff downstream. An overflow structure or culvert must be included at a site with driveway crossings.

There are several ways to manage driveway crossings. Overflow structures with rim elevations above the bottom, but below the street, can be provided at each crossing. Depending on the infiltration capacity of the ditch, rarer overflow events can conversely be allowed to overtop the edge of the ditch, and flow to the street's curb and gutter section to convey runoff past the driveway.

An underdrain will also be required if the site is flat or is found to have poor infiltration in its subgrade soils. Underdrains do not necessarily need to extend the full length of the bioswale and a stub at the downstream end of the bioswale may simply be used. With this design, the aggregate layer serves as the below grade conveyance, but at a lower rate than through an underdrain. This provides additional time for runoff infiltration and utilization by the plant material. Lastly, optional overflow pipes must be connected to the larger storm network, either by connecting to an existing structure, or by installing a new manhole atop an existing pipe.

Maintenance

The herbaceous plants in bioswales have an establishment period and need to be watered 3 times a week for the first 4 weeks after installation. The herbaceous plants also need to be watered twice a week through October of the first year. After that point, the drought tolerant plants should withstand normal weather cycles. Other maintenance includes monthly debris removal, weeding, and pruning. Bioswales would also require a spring clean-up to remove built up debris from the winter, provide pre-emergent plant care, and installation and replacement of mulch. The perennials also need to be cut back in mid-March or November.

A hybrid ditch is maintained like any other roadside ditch, requiring only regular mowing and debris removal. The maintenance costs for green infrastructure practices with large, herbaceous plants and engineered soil is significant. If the installation is not maintained properly and on a regular basis, then the functionality of the system will become compromised. The specific cost will depend on the scale and complexity of the installation and the bidding environment for the labor contract. It is possible to self-perform the maintenance work or to save money by working with a not-for-profit that provides volunteer labor. The design engineer should work to calculate a site-specific life cycle cost that accounts for maintenance when considering the feasibility of the project.

Cost Information

Cost information is provided for each green infrastructure practice. The installed costs are based on project experience, bid tabs, and information from the RS Means Building Construction Costs Data (2020 edition), which is an industry standard compilation of unit costs for various construction activities. The costs in the table below can be used to scope a project, but a project-specific cost estimate should be prepared by the design engineer that takes into account the project scale and complexity, material cost trends, and the labor and bidding environment.

Table 4: Bioswale/hybrid ditch unit costs[1], [2]

	Item	Description	Unit Price	Unit
GI Technique	Bioswale/Hybrid Ditch	Design/Engineering	15% of Construction Cost	LS
		Mobilization	$10,000.00	LS
		Excavation & Haul	$45.00	CY
		Leaf Mulch	$70.00	CY
		Engineered Soil	$80.00	CY
		Open-Grade Crushed Stone	$65.00	CY
		Geotextile Fabric	$5.00	SY
		Erosion Blanket	$3.00	SY
Required Component	Native Plantings	Plugs (12" on center)	$5.00	EA
		Gallons (36" on center)	$15.00	EA
Custom options	Outlet Control/ Overflow structure	Outlet Control Drainage Basin (varies by size)	$2,800.00	EA
	Underdrain	4" HDPE Perforated Pipe	$20.00	LF
	Storm Sewer	12" HDPE storm sewer	$65.00	LF
	Underdrain Cleanout		$600.00	EA
	Connection to existing storm structure		$600.00	EA

1 Installed cost include material and labor based on bid tabs from related projects and RS Means.

2 Unit price based on a 1,000 linear foot installation within the right of way in a residential area with 1/8 acre lots. Unit prices for specific projects will vary based on scale, complexity, labor environment, and material cost trends. A detailed cost estimate should be prepared by the design engineer.

Specifications

Specifications are an important component in the design of green infrastructure. Along with the construction documents, the design engineer should make site-specific customizations to the following sections of the standard specifications from the Illinois Urban Manual in order to have a full set of specifications for a bioswale or hybrid ditch. Other sections can be included on an as-needed basis. Further instructions on the use of specifications are included in Appendix B, and an engineered soil specification is included in Appendix C.

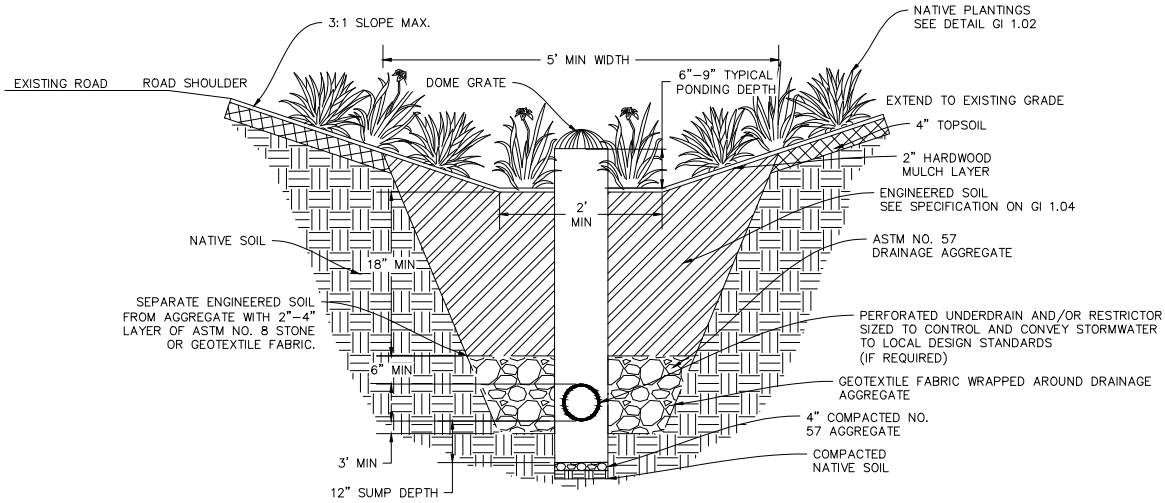
Construction Specifications

2 - Clearing and Grubbing
5 - Pollution Control
6 - Seeding, Sprigging and Mulching
7 - Construction Surveys
8 - Mobilization and Demobilization
21 - Excavation
23 - Earthfill
24 - Drainfill
25 - Rockfill
26 - Topsoiling
44 - Corrugated Polyethylene Tubing
46 - Tile Drains
94 - Contractor Quality Control
95 - Geotextile
707 - Digging, Transporting, Planting, and Establishment of Trees, Shrubs and Vines
752 - Stripping, Stockpiling, Site Preparation and Spreading Topsoil

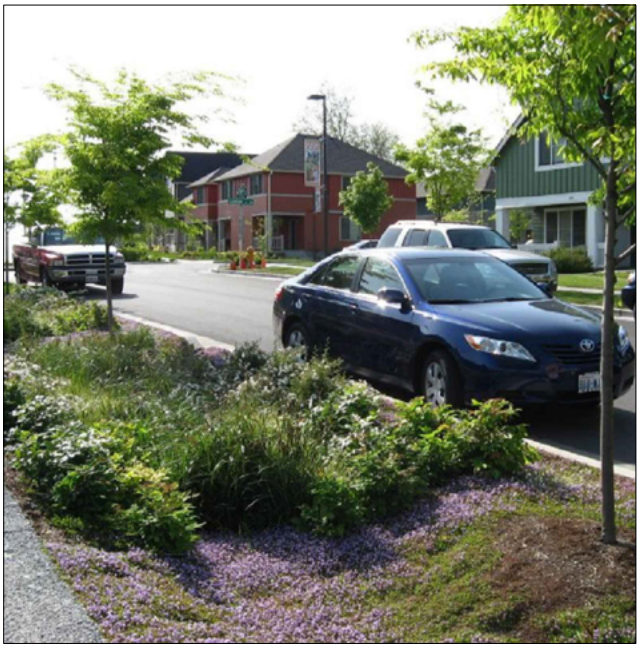
Material Specifications

521 - Aggregates for Drainfill and Filters
548 - Corrugated Polyethylene Tubing
592 - Geotextile
804 - Material for Topsoiling
Appendix C - Engineered Soil

Bioswale with Native Plantings (pt. 1)



BIOSWALE TYPICAL SECTION



BIOSWALE IN RESIDENTIAL INSTALLATION WITH NATIVE PLANTS[7]

DESIGN GUIDANCE

TYPICAL LOCATION: LONG NARROW SPACE WITHIN RIGHT OF WAY, IN PARKING LOT, OR ADJACENT TO BUILDING[1]

WIDTH: 2' MIN BOTTOM / 5' MIN FOR ENGINEERED SOIL
MAX WIDTH DEPENDENT ON SPACE AVAILABLE

LENGTH: SCALABLE

CONTRIBUTING DRAINAGE AREA: < 2 ACRES

AVAILABLE OPTIONS: OVERFLOW STRUCTURE
UNDERDRAIN VS. INFILTRATION
NATIVE PLANT: PLUGS VS. GALLONS

DETAILED DESIGN PRELIMINARY WORKSHEET

- ☐ NATIVE SOIL INFILTRATION[2]: _____ IN/HR
- ☐ REQUIRED STORAGE CAPACITY[3]: _____ CUBIC FT
- ☐ CONNECT TO EXISTING STORM NETWORK: YES/NO[4]
- ☐ DEPTH TO GROUNDWATER TABLE >2 FT: YES/NO[5]
- ☐ ADJACENT TO DRIVEWAY CROSSING: YES/NO[6]
- ☐ OUTLET: STORM SEWER OR DAYLIGHT TO GRADE

1. COULD BE USED IN VARIOUS RESIDENTIAL, COMMERCIAL OR INDUSTRIAL APPLICATIONS.
2. NATIVE SOIL INFILTRATION NEEDS TO BE GREATER THAN 0.5 INCHES/HOUR. IF IT IS NOT, AN UNDERDRAIN MUST BE INCLUDED.
3. IF STORAGE CAPACITY REQUIRED EXCEEDS AVAILABLE FOOTPRINT, INCREASE THICKNESS OF DRAINAGE AGGREGATE OR CONSIDER UNDERGROUND STORAGE.
4. CAPACITY OF DOWNSTREAM SYSTEM TO BE ANALYZED BY DESIGNER.
5. IF NO, TECHNIQUE MAY NOT MEET CODE WITHOUT A LINER.
6. IF YES, AN OVERFLOW AND UNDERDRAIN MUST BE INCLUDED, OVERFLOW STRUCTURE MUST BE A MINIMUM OF 6" BELOW DRIVEWAY.
7. HTTP://WATER.EPA.GOV/INFRASTRUCTURE/GREENINFRASTRUCTURE/GI_WHAT.CFM

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BIOSWALE WITH NATIVE PLANTINGS

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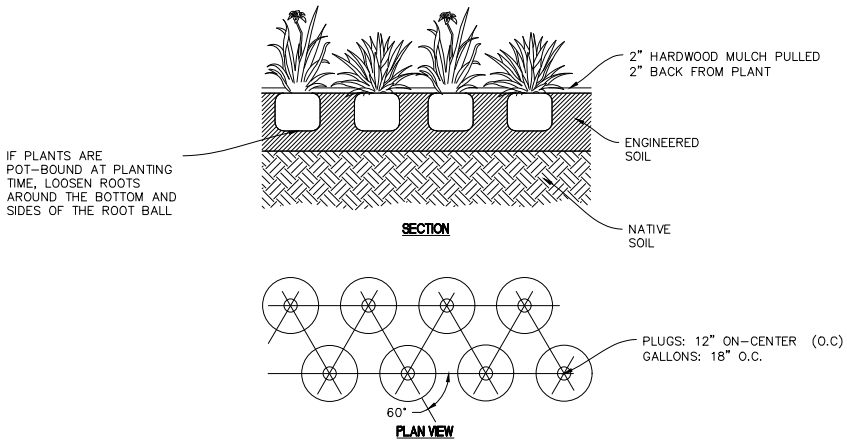
Bioswale with Native Plantings (pt. 2)



NATIVE PLANTINGS PLUG DETAIL

MIX	BOTANICAL NAME	COMMON NAME	RECOMMENDED PLANTING METHOD	NATIVE TO ILLINOIS	MOISTURE
1/3	*GRASSES*				
	PANICUM VIRGATUM	SWITCH GRASS	PLUG	YES	MESIC-WET
	SORGHASTRUM NUTANS	INDIAN GRASS	PLUG	YES	MESIC
	CAREX VULPINOIDEA	FOX SEDGE	PLUG	YES	WET
1/3	*FLOWERS*				
	ASCLEPIAS INCARNATA	SWAMP MILKWEED	PLUG	YES	WET
	ASTER NOVAE-ANGILAE	NEW ENGLAND ASTER	PLUG	YES	MESIC-WET
	ECHINACEA PALLIDA	PALE PURPLE CONE FLOWER	PLUG	YES	MESIC
	IRIS VIRGINICA	BLUE FLAG IRIS	PLUG	YES	WET
	JUNCUS TORREYI	TORREY'S RUSH	PLUG	YES	WET
	LOBELIA CARDINALS	CARDINAL FLOWER	PLUG	YES	WET
	RUDBECKIA HIRTA	BLACK-EYED SUSAN	PLUG	YES	MESIC
	SOLIDAGO GIGANTEA	LATE GOLDENROD	PLUG	YES	MESIC-WET
	VERBENA HASTATA	BLUE VERVAIN	PLUG	YES	WET
1/3	*SEDGES*				
	CAREX LANUGINOSA	WOOLY SEDGE	PLUG	YES	WET
	CAREX SCOPARIA	LANCE-FRUITED OVAL SEDGE	PLUG	YES	WET
	CAREX VULPINOIDEA	FOX SEDGE	PLUG	YES	WET

SUGGESTED NATIVE PLANTING SPECIES AND MIX SCHEDULE[1,2]

DESIGN GUIDANCE

PLUGS

- RECOMMENDED INSTALLATION METHOD FOR NATIVE PLANTS
- STANDARD SIZE IS 2" DIA. (11.3 CUBIC INCH BY VOLUME)
- AVG PRICE = $1.50/SF ($1.10/PLUG)
- OPTIMUM PLANTING WINDOW: APRIL 15–JUNE 15 AND SEPT 15–OCT 15..
- NUMBER OF PLUGS AT 12" O.C. = L X W X 1.10

GALLONS

- USE FOR MORE MATURE LOOKING PLANTS OR WHERE AESTHETICS AT INSTALLATION IS VERY IMPORTANT
- AVG PRICE = $3.00/SF ($5.00/GALLON)
- PLANTING WINDOW IS MORE FLEXIBLE BECAUSE OF GREATER ROOT MASS
- NUMBER OF GALLONS AT 18" O.C. = L X W X 0.50

1 TABLE IS AMENDED FROM THE ILLINOIS NATIVE PLANT GUIDE "SPECIES INFORMATION SUMMARY TABLE": HTTP://WWW.NRCS.USDA.GOV/WPS/PORTAL/NRCS/DETAIL/IL/TECHNICAL/?CID=NRCS141P2_030715#TABLE
2 REFER TO PLANT SELECTION SECTION OF THIS GUIDE FOR FURTHER ADVICE ON SELECTING AN APPROPRIATE PLANT MIX.

BIOSWALE MAINTENANCE GUIDELINES

TASK	FREQUENCY	TIMEFRAME
ESTABLISHMENT WATERING	3XWEEK	FIRST 4 WEEKS AFTER INSTALLATION
1ST YEAR WATERING	2XWEEK	THROUGH OCTOBER OF FIRST YEAR; SUBSEQUENT YEARS ONLY IN DROUGHT
WEEDING	2X MONTH	THROUGH 1ST YEAR
MULCHING	ANNUALLY	THROUGH 3 YEARS
MOWING/COMPLETE CUTBACK	ANNUALLY	THROUGH 3 YEARS
TRASH REMOVAL	1XMONTH	ONGOING
TRIM VEGETATION	AS NEEDED	ONGOING
REPLACE DEAD PLANTS	AS NEEDED	ONGOING

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BIOSWALE WITH NATIVE PLANTINGS

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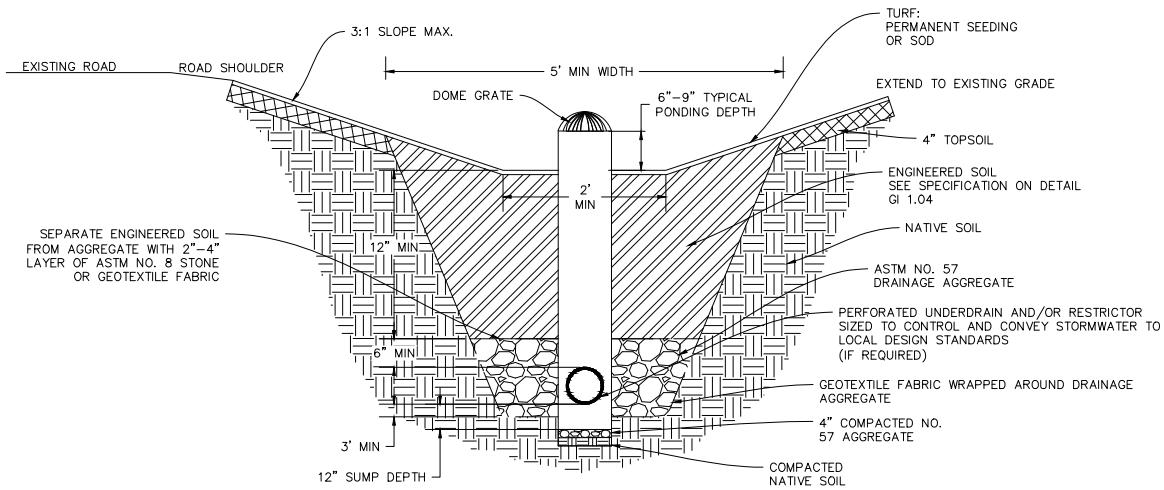
Hybrid Ditch



HYBRID DITCH TYPICAL SECTION

HYBRID DITCH IN RESIDENTIAL INSTALLATION[7]

DESIGN GUIDANCE

TYPICAL LOCATION: LONG NARROW SPACE WITHIN RIGHT OF WAY, IN PARKING LOT, OR ADJACENT TO BUILDING[1]

WIDTH: 2' MIN BOTTOM / 5' MIN FOR ENGINEERED SOIL
MAX WIDTH DEPENDENT ON SPACE AVAILABLE

LENGTH: SCALABLE

CONTRIBUTING DRAINAGE AREA: < 2 ACRES

AVAILABLE OPTIONS: OVERFLOW STRUCTURE
UNDERDRAIN VS. INFILTRATION
TURF: SEEDING VS. SOD

DETAILED DESIGN PRELIMINARY WORKSHEET

- ☐ NATIVE SOIL INFILTRATION[2]:_____ IN/HR
- ☐ REQUIRED STORAGE CAPACITY[3]:_____ CUBIC FT
- ☐ CONNECT TO EXISTING STORM NETWORK: YES/NO[4]
- ☐ DEPTH TO GROUNDWATER TABLE >2 FT: YES/NO[5]
- ☐ ADJACENT TO DRIVEWAY CROSSING: YES/NO[6]
- ☐ OUTLET: STORM SEWER OR DAYLIGHT TO GRADE

1. COULD BE USED IN VARIOUS RESIDENTIAL, COMMERCIAL OR INDUSTRIAL APPLICATIONS.
2. NATIVE SOIL INFILTRATION NEEDS TO BE GREATER THAN 0.5 INCHES/HOUR. IF IT IS NOT, AN UNDERDRAIN MUST BE INCLUDED.
3. IF STORAGE CAPACITY REQUIRED EXCEEDS AVAILABLE FOOTPRINT, INCREASE THICKNESS OF DRAINAGE AGGREGATE OR CONSIDER UNDERGROUND STORAGE.
4. CAPACITY OF DOWNSTREAM SYSTEM TO BE ANALYZED BY DESIGNER.
5. IF NO, TECHNIQUE MAY NOT MEET CODE WITHOUT A LINER.
6. IF YES, AN OVERFLOW AND UNDERDRAIN MUST BE INCLUDED. OVERFLOW STRUCTURE MUST BE A MINIMUM OF 6" BELOW DRIVEWAY.
7. HTTP://WWW.NRCS.USDA.GOV/WPS/PORTAL/NRCS/SITE/NATIONAL/HOME/

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HYBRID DITCH

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Bioswale and Hybrid Ditch Notes

NOTES

1. BIOSWALE PLANTINGS:
   a. THE BIOSWALE SHOULD BE POPULATED WITH PLANTS NATIVE AND/OR ADAPTED TO THE INSTALLATION LOCATION. NATIVE PLANTS, GRASSES AND FLOWERS ESTABLISH DEEPER ROOTS AND IMPROVE SOIL HEALTH TO MAINTAIN PERMEABILITY.
   b. SELECT A MIXTURE OF NATIVE PLANTS BASED ON SITE CONDITIONS TO IMPROVE BIODIVERSITY AND AESTHETICS. SELECTED PLANTS SHOULD BE DROUGHT AND FLOOD TOLERANT. ONE SUCCESSFUL APPROACH USES THE FOLLOWING NATIVE PLANT MIX:
   $\frac{1}{3}$ SEDGES, $\frac{1}{3}$ FLOWERS, AND $\frac{1}{3}$ GRASSES.
2. HYBRID DITCH PLANTINGS:
   a. A DENSE COVER OF WATER TOLERANT, EROSION-RESISTANT GRASS MUST BE ESTABLISHED.
   b. SELECT GRASS SPECIES THAT WILL FORM A DENSE TURF WITH VIGOROUS, UPRIGHT GROWTH.
   c. GRASS SPECIES MUST BE RESISTANT TO PERIODIC INUNDATION AND PERIODIC DROUGHT AND MUST BE SALT TOLERANT.
   d. GRASS MUST BE APPROPRIATE TO THE SOIL TYPE AND AMOUNT OF LIGHT AVAILABLE.
3. SCHEDULE PRE-INSTALLATION MEETING WITH THE DESIGN ENGINEER 72 HOURS IN ADVANCE OF GREEN INFRASTRUCTURE CONSTRUCTION.PLANTING THAT REQUIRES FOOT OR MACHINE TRAFFIC SHALL ONLY BE CONDUCTED ON DRY SOILS.
4. CONSTRUCT GREEN INFRASTRUCTURE AND INSTALL PLANTS AS EARLY AS POSSIBLE TO ALLOW FOR PLANT ESTABLISHMENT PRIOR TO DIRECTING STORMWATER TO IT. CONSIDER THE SELECTED PLANT SPECIES WHEN DETERMINING ESTABLISHMENT PERIOD.
5. AREAS IN AND AROUND GREEN INFRASTRUCTURE SHOULD BE PROTECTED DURING EARTH MOVING AND CONSTRUCTION TO PREVENT COMPACTION THAT WOULD REDUCE INFILTRATION RATES OF SUBGRADE AND ENGINEERED SOILS. ALSO PROTECT AREA THROUGHOUT CONSTRUCTION FROM SEDIMENT TRANSPORT THAT WOULD CLOG THE INFILTRATION CAPACITY OF NATIVE AND ENGINEERED SOILS.
6. CONTRACTOR SHOULD RAKE OR ROTOTILL THE TOP SIX INCHES OF SUBGRADE SOILS AFTER EXCAVATION TO REMEDIATE THE EFFECTS OF COMPACTION AND CLOGGING.
7. LONGITUDINAL SLOPE OF SWALE SHOULD BE BETWEEN 0.5% AND 2.5%. IF SUBGRADE SOILS ARE CONDUCIVE TO INFILTRATION OR AN UNDERDRAIN IS INCLUDED, THE SURFACE OF THE ENGINEERED SOIL CAN BE FLAT.

GEOTEXTILE FABRIC SPECIFICATION

1. A WOVEN, MONOFILAMENT GEOTEXTILE SHALL BE USED CONFORMING TO THE FOLLOWING:
   a. MINIMUM FLOW RATE OF 145 GAL/MIN/FT ASTM D-4491
   b. GRAB TENSILE STRENGTH MIN 365 X 200 LB ASTM D-4632
   c. GRAB ELONGATION MAX 24 X 10%ASTM D-4632
   d. TRAPEZOIDAL TEAR MIN 115 X 75 LBS ASTM D-4533
   e. CBR PUNCTURE RESISTANCE MIN 675 LB ASTM D-6241
   f. APPARENT OPENING SIZE 4060-90 U.S STANDARD SIEVE

ENGINEERED SOIL SPECIFICATION

1. ENGINEERED SOIL MIX SHALL BE A BLEND OF 70% TO 90% COARSE SAND AND 10% TO 25% COMPOST BY VOLUME AND MEET THE FOLLOWING REQUIRMENTS:
   a. COMPOSE SHALL BE WELL AGED AND MEET WISCONSIN DNR TECHNICAL SPECIFICATION S100
   b. ORGANIC MATTER CONTENT OF MIX FROM 3-5% BY WEIGHT
   c. PROPORTION OF CLAY (HYDROMETER ANALYSIS) SHALL BE 2% TO 5%
   d. pH OF MIX SHALL BE 5.5 TO 8.0
   e. THE ENGINEERED SOIL THICKNESS SHALL BE ADEQUATE TO SUPPORT THE ROOTING DEPTH OF THE SELECTED VEGETATION WITH A MINIMUM THICKNESS OF 18 INCHES EXCEPT FOR THE HYBRID DITCH WHERE THE ENGINEERED SOIL MAY BE REDUCED TO 12"
2. ENGINEERED SOIL MAY BE OBTAINED OFF SITE OR CREATED BY TESTING NATIVE SOILS AND MIXING WITH IMPORTED MATERIALS AS NEEDED PROVIDED THE MIX MEETS THE SPECIFICATIONS ABOVE.
3. ENGINEERED SOIL SHALL BE DRY AND FRIABLE AND UNIFORMLY MIXED. ITS CHARACTERISTICS SHALL BE VERIFIED BY MATERIALS TESTING PRIOR TO PLACEMENT.
4. PLACE DRY AND FRIABLE SOIL IN 8-12 INCH LIFTS.
5. AFTER PLACEMENT, LIGHTLY COMPACT DRY SOIL WITH A HAND ROLLER WEIGHING NO MORE THAN 100 LBS PER FOOT OF WIDTH. DO NOT USE A VIBRATORY COMPACTOR.
6. TO PRESERVE INFILTRATION CAPACITY OF NATIVE SOIL, KEEP MACHINERY AND CONSTRUCTION SITE RUNOFFF OUTSIDE OF GREEN INFRASTRUCTURE AREA.

MAINTENANCE GUIDELINES

1. WATER PLANTS THOROUGHLY FOLLOWING PLANTING TO SETTLE THE SOIL AROUND THE ROOTS UNTIL ESTABLISHMENT HAS TAKEN PLACE.
2. REMOVE DEBRIS AND RUBBISH ON A MONTHLY BASIS.
3. PERFORM SPRING MAINTENANCE TO REMOVE BUILT UP DEBRIS FROM WINTER, PROVIDE PRE-EMERGENT PLANT CARE AND INSTALL/REPLACE MULCH AS NECESSARY.
4. TRIM VEGETATION TO ENSURE SAFETY, AESTHETICS, PROPER OPERATION, OR TO SUPPRESS WEEDS AND INVASIVE VEGETATION.
4. CUT BACK PERENNIALS AND REMOVE LEAF DEBRIS AT END OF GROWING SEASON.
5. REPLACE UNSUCCESSFULLY ESTABLISHED PLANTS.
6. INSPECT AND CORRECT EROSION PROBLEMS, DAMAGE TO VEGETATION, AND SEDIMENT AND DEBRIS ACCUMULATION.
7. INSPECT FOR CLOGGED SOILS AS EVIDENCED BY EXTENDED PERIODS OF PONDING. IN SOME CASES CLOGGED SOILS MAY BE REMEDIATED BY SIMPLY RAKING THE SURFACE TO REMOVE CRUSTED SEDIMENT. IN OTHER CASES, THE TOP SEVERAL INCHES OF ENGINEERED SOIL MAY NEED TO BE REMOVED AND REPLACED.
8. INSPECT FOR UNIFORMITY IN CROSS-SECTION AND LONGITUDINAL SLOPE, CORRECT AS NEEDED.
9. REMOVE ALL LABELS, WIRES, ETC. FROM PLANTS.

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BIOSWALE AND
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Rain Garden

Rain gardens present an opportunity for infiltration in a low spot of a property. The rain garden acts like a bowl that fills up with water and then drains slowly to the native soil or an engineered underdrain system.

During rain events, runoff collects inside the rain garden until it reaches the height of an overflow structure, typically set 6 inches to 1 foot above the engineered soil layer. Runoff that doesn't enter the overflow structure filters through the engineered soil layer to subgrade or a layer of stone beneath. A rain garden is planted with native or large herbaceous plants to encourage infiltration and to promote biofiltration. Native plants have a deeper root network than grass, which draws surface water deeper into the ground. Native plants are naturally drought and flood tolerant, which allows them to thrive in the rain garden.

Customization Options

A geotechnical engineer should test the infiltration rate of the underlying soil in the location of the rain garden. The design should consider the infiltration capacity of the subgrade soils when designing the system and determine the need for an underdrain. If the infiltration rate is greater than 0.5 in/ hr, then the volume of runoff infiltrated during the event may be sufficient, so as to not require an underdrain as part of the rain garden's design for managing runoff volumes. Depending on the specifics of the site, an overflow structure may be warranted to prevent flooding of surrounding areas. In certain cases, surface overflow to the adjacent landscape and the street may prove to be minimal, and therefore acceptable. The design engineer should also select whether plugs or gallons will be used, along with the species mix for the herbaceous plants. Establishment through seeding is also an option, however, it will take longer for vegetation to establish and more intensive maintenance will be required during the establishment period to control weeds.

Figure 6: Rain garden in a suburban setting

Maintenance

Native plants need to be watered 3 times per week during an establishment period, typically the first 4 weeks after installation. During the first year of establishment, the plants will need to be watered and weeded twice per week through October of the first year, and during any subsequent years in which there is a drought. Mulching and mowing will occur annually through the first three years of establishment. Establishment can take up to five years if plants are established by seeding. Debris removal and weeding will be necessary as needed throughout the life of the rain garden. Trimming, removal, and replacement of dead plants must occur on an as-needed basis.

Cost Information

Cost information is provided for each green infrastructure practice. The installed costs are based on project experience, bid tabs, and information from the RS Means Building Construction Costs Data (2020 edition), which is an industry standard compilation of unit costs for various construction activities. The costs in the table below can be used to scope a project, but a project-specific cost estimate should be prepared by the design engineer that takes into account the project scale and complexity, material cost trends, and the labor and bidding environment.

Table 5: Rain garden unit costs[1],[2]

	Item	Description	Unit Price	Unit
GI Technique	Rain Garden	Design/Engineering	15% of Construction Cost	LS
		Mobilization	$10,000.00	LS
		Excavation & Haul	$45.00	CY
		Leaf Mulch	$70.00	CY
		Engineered Soil	$80.00	CY
		Open-Grade Crushed Stone	$65.00	CY
		Geotextile Fabric	$5.00	SY
		Erosion Blanket	$3.00	SY
Required Component	Splash Pad	Cobble Splash Pad	$250.00	EA
	Native Plantings	Plugs (12" on center)	$5.00	EA
		Gallons (36" on center)	$15.00	EA
Custom options	Trees	Varies by species and size	$400.00	EA
	Shrub	Varies by species and size	$60.00	EA
	Outlet Control/ Overflow structure	Outlet Control Drainage Basin (varies by size)	$2,800.00	EA
	Underdrain	4" HDPE Perforated Pipe	$20.00	LF
	Storm Sewer	12" HDPE storm sewer	$65.00	LF
	Underdrain Cleanout		$600.00	EA
	Connection to existing storm structure		$600.00	EA

1 Installed cost includes material and labor based on bid tabs from related projects and RS Means.

2 Unit price based on a 2,000 sf rain garden with a 1.0 acre drainage area located within a publicly controlled park. Unit prices will vary. Unit prices for specific projects will vary based on scale, complexity, labor environment, and material cost trends. A detailed cost estimate should be prepared by the design engineer.

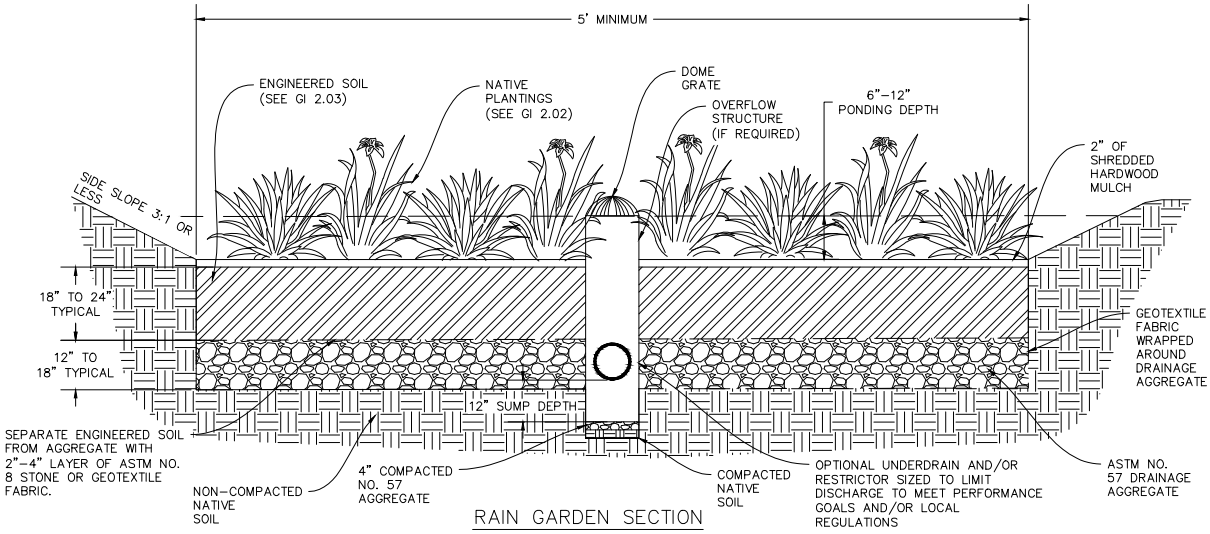
Specifications

The construction techniques and materials involved in a rain garden installation are identical to that of a bioswale. As such, the minimum specification sections required are also the same. For more information on use of the standard specifications from the Illinois Urban Manual, refer to Appendix B.

Construction Specifications
2 - Clearing and Grubbing
5 - Pollution Control
6 - Seeding, Sprigging and Mulching
7 - Construction Surveys
8 - Mobilization and Demobilization
21 - Excavation
23 - Earthfill
24 - Drainfill
25 - Rockfill
26 - Topsoiling
44 - Corrugated Polyethylene Tubing
46 - Tile Drains
94 - Contractor Quality Control
95 - Geotextile
707 - Digging, Transporting, Planting, and Establishment of Trees, Shrubs and Vines
752 - Stripping, Stockpiling, Site Preparation and Spreading Topsoil

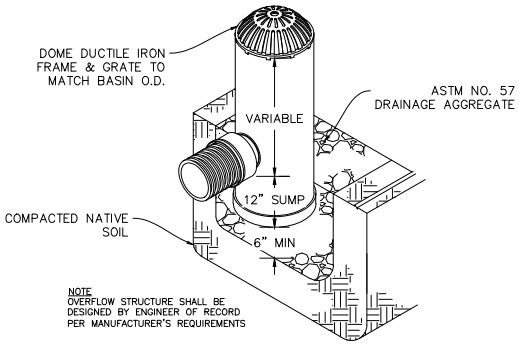
Material Specifications
521 - Aggregates for Drainfill and Filters
548 - Corrugated Polyethylene Tubing
592 - Geotextile
804 - Material for Topsoiling Appendix C – Engineered Soil

Rain Garden



RAIN GARDEN SECTION

RAIN GARDEN IN RESIDENTIAL INSTALLATION[1]



OVERFLOW STRUCTURE

DESIGN GUIDANCE

TYPICAL LOCATION: DEPRESSED AREA LOCATED IN RIGHT OF WAY OR IN DEMOLITION LOCATION

WIDTH: 5' MIN., NO MAX.

LENGTH: SCALABLE, 2L:1W DESIRABLE

CONTRIBUTING DRAINAGE AREA: < 2 ACRES

AVAILABLE OPTIONS: OVERFLOW STRUCTURE
UNDERDRAIN
NATIVE PLANT SELECTION

DETAILED DESIGN PRELIMINARY WORKSHEET

- ☐ NATIVE SOIL INFILTRATION[2]: _____ IN/HR
- ☐ REQUIRED STORAGE CAPACITY[3]: _____ CUBIC FT
- ☐ CONNECT TO EXISTING STORM NETWORK: YES/NO[4]
- ☐ DEPTH TO GROUNDWATER TABLE > 2 FT: YES/NO[5]

1. HTTP://WATER.EPA.GOV/INFRASTRUCTURE/GREENINFRASTRUCTURE/GI_WHAT.CFM
2. NATIVE SOIL INFILTRATION NEEDS TO BE GREATER THAN 0.5 INCHES/HOUR. IF IT IS NOT, AN UNDERDRAIN MUST BE INCLUDED.
3. IF STORAGE CAPACITY EXCEEDS AVAILABLE FOOTPRINT SPACE, INCREASE THICKNESS OF DRAINAGE AGGREGATE OR CONSIDER UNDRERGROUND STORAGE.
4. CAPACITY OF DOWNSTREAM SYSTEM TO BE ANALYZED BY DESIGNER.
5. IF NO, TECHNIQUE MAY NOT MEET CODE WITHOUT A LINER.

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RAIN GARDEN

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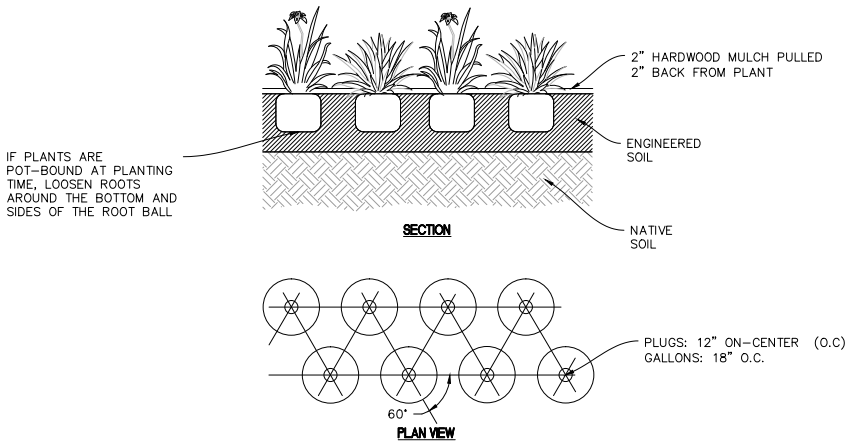
Native Plantings & Maintenance Guidelines



NATIVE PLANTINGS PLUG DETAIL

MIX	BOTANICAL NAME	COMMON NAME	RECOMMENDED PLANTING METHOD	NATIVE TO ILLINOIS	MOISTURE
1/3	*GRASSES*				
	PANICUM VIRGATUM	SWITCH GRASS	PLUG	YES	MESIC-WET
	SORGHASTRUM NUTANS	INDIAN GRASS	PLUG	YES	MESIC
	CAREX VULPINOIDEA	FOX SEDGE	PLUG	YES	WET
1/3	*FLOWERS*				
	ASCLEPIAS INCARNATA	SWAMP MILKWEED	PLUG	YES	WET
	ASTER NOVAE-ANGILAE	NEW ENGLAND ASTER	PLUG	YES	MESIC-WET
	ECHINACEA PALLIDA	PALE PURPLE CONE FLOWER	PLUG	YES	MESIC
	IRIS VIRGINICA	BLUE FLAG IRIS	PLUG	YES	WET
	JUNCUS TORREYI	TORREY'S RUSH	PLUG	YES	WET
	LOBELIA CARDINALS	CARDINAL FLOWER	PLUG	YES	WET
	RUDBECKIA HIRTA	BLACK-EYED SUSAN	PLUG	YES	MESIC
	SOLIDAGO GIGANTEA	LATE GOLDENROD	PLUG	YES	MESIC-WET
	VERBENA HASTATA	BLUE VERVAIN	PLUG	YES	WET
1/3	*SEDGES*				
	CAREX LANUGINOSA	WOOLY SEDGE	PLUG	YES	WET
	CAREX SCOPARIA	LANCE-FRUITED OVAL SEDGE	PLUG	YES	WET
	CAREX VULPINOIDEA	FOX SEDGE	PLUG	YES	WET

SUGGESTED NATIVE PLANTING SPECIES AND MIX[1]

DESIGN GUIDANCE

PLUGS

- RECOMMENDED INSTALLATION METHOD FOR NATIVE PLANTS
- STANDARD SIZE IS 2" DIA. (11.3 CUBIC INCH BY VOLUME)
- AVG PRICE = $1.50/SF ($1.10/PLUG)
- OPTIMUM PLANTING WINDOW: APRIL 15–MAY 15 AND OCT 1–31.
- NUMBER OF PLUGS AT 12" O.C. = L X W X 1.10

GALLONS

- USE FOR MORE MATURE LOOKING PLANTS OR WHERE AESTHETICS AT INSTALLATION IS VERY IMPORTANT
- AVG PRICE = $3.00/SF ($5.00/GALLON)
- PLANTING WINDOW IS MORE FLEXIBLE BECAUSE OF GREATER ROOT MASS
- NUMBER OF GALLONS AT 18" O.C. = L X W X 0.50

1 TABLE IS AMENDED FROM THE ILLINOIS NATIVE PLANT GUIDE "SPECIES INFORMATION SUMMARY TABLE": HTTP://WWW.NRCS.USDA.GOV/WPS/PORTAL/NRCS/DETAIL/IL/TECHNICAL/?CID=NRCS141P2_030715#TABLE

NATIVE PLANTING MAINTENANCE GUIDELINES		
TASK	FREQUENCY	TIMEFRAME
ESTABLISHMENT WATERING	3XWEEK	FIRST 4 WEEKS AFTER INSTALLATION
1ST YEAR WATERING	2XWEEK	THROUGH OCTOBER OF FIRST YEAR; SUBSEQUENT YEARS ONLY IN DROUGHT
WEEDING	2X MONTH	THROUGH 1ST YEAR
MULCHING	ANNUALLY	THROUGH 3 YEARS
MOWING/COMPLETE CUTBACK	ANNUALLY	THROUGH 3 YEARS
TRASH REMOVAL	1XMONTH	ONGOING
TRIM VEGETATION	AS NEEDED	ONGOING
REPLACE DEAD PLANTS	AS NEEDED	ONGOING

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NATIVE PLANTINGS & MAINTENANCE GUIDELINES

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Rain Garden Notes

NOTES

1. RAIN GARDEN PLANTINGS:
   a. THE RAIN GARDEN SHOULD BE POPULATED WITH PLANTS NATIVE AND/OR ADAPTED TO THE INSTALLATION LOCATION. NATIVE GRASSES AND FLOWERS ESTABLISH DEEPER ROOTS AND IMPROVE SOIL HEALTH TO MAINTAIN PERMEABILITY.
   b. SELECT A MIXTURE OF NATIVE PLANTS BASED ON SITE CONDITIONS TO IMPROVE BIODIVERSITY AND AESTHETICS. SELECTED PLANTS SHOULD BE DROUGHT, FLOOD AND SALT TOLERANT. ONE SUCCESSFUL APPROACH USES THE FOLLOWING NATIVE PLANT MIX:
   $\frac{1}{3}$ SEDGES, $\frac{1}{3}$ FLOWERS, AND $\frac{1}{3}$ GRASSES (SEE GI 2.02).
2. SCHEDULE PRE-INSTALLATION MEETING WITH THE DESIGN ENGINEER 72 HOURS IN ADVANCE OF GREEN INFRASTRUCTURE CONSTRUCTION. PLANTING THAT REQUIRES FOOT OR MACHINE TRAFFIC SHALL ONLY BE CONDUCTED ON DRY SOILS.
3. CONSTRUCT GREEN INFRASTRUCTURE AND INSTALL PLANTS AS EARLY AS POSSIBLE TO ALLOW FOR PLANT ESTABLISHMENT PRIOR TO DIRECTING STORMWATER TO IT. CONSIDER THE SELECTED PLANT SPECIES WHEN DETERMINING ESTABLISHMENT PERIOD.
4. AREAS IN AND AROUND GREEN INFRASTRUCTURE SHOULD BE PROTECTED DURING EARTH MOVING AND CONSTRUCTION TO PREVENT COMPACTION THAT WOULD REDUCE INFILTRATION RATES OF SUBGRADE AND ENGINEERED SOILS. ALSO PROTECT AREA THROUGHOUT CONSTRUCTION FROM SEDIMENT TRANSPORT THAT WOULD CLOG THE INFILTRATION CAPACITY OF NATIVE AND ENGINEERED SOILS.
5. CONTRACTOR SHOULD RAKE OR ROTOTILL THE TOP SIX INCHES OF SUBGRADE SOILS AFTER EXCAVATION TO REMEDIATE THE EFFECTS OF COMPACTION AND CLOGGING.

GEOTEXTILE FABRIC SPECIFICATION

1. A WOVEN, MONOFILAMENT GEOTEXTILE SHALL BE USED CONFORMING TO THE FOLLOWING:
   a. MINIMUM FLOW RATE OF 145 GAL/MIN/FT ASTM D-4491
   b. GRAB TENSILE STRENGTH MIN 365 X 200 LB ASTM D-4632
   c. GRAB ELONGATION MAX 24 X 10%ASTM D-4632
   d. TRAPEZOIDAL TEAR MIN 115 X 75 LBS ASTM D-4533
   e. CBR PUNCTURE RESISTANCE MIN 675 LB ASTM D-6241
   f. APPARENT OPENING SIZE 4060-90 U.S STANDARD SIEVE

ENGINEERED SOIL SPECIFICATIONS

1. ENGINEERED SOIL MIX WILL ADHERE TO THE FOLLOWING:
   a. 40% SAND, 30% TOPSOIL, AND 30% COMPOST
   b. ORGANIC CONTENT MATTER FROM 8-10% BY WEIGHT
   c. LESS THAN 5% MINERAL FINES CONTENT (CLAY)
   d. 2 FOOT MINIMUM THICKNESS
   e. COMPACT TO 85% MAXIMUM DENSITY PER ASTM D 1557
   f. MINIMUM LONG-TERM HYDRAULIC CONDUCTIVITY OF 1 INCH/HOUR PER ASTM D2434.
   g. MAXIMUM IMMEDIATE HYDRAULIC CONDUCTIVITY OF 12 INCHES/HOUR.
2. ENGINEERED SOIL MAY BE OBTAINED OFF SITE OR CREATED BY TESTING NATIVE SOILS AND MIXING WITH IMPORTED MATERIALS AS NEEDED TO ACHIEVE SPECIFICATIONS.
3. ENGINEERED SOIL SHOULD BE MIXED UNIFORMLY AND ITS CHARACTERISTICS SHOULD BE VERIFIED BY MATERIALS TESTING PRIOR TO PLACEMENT.
4. PLACE UNSATURATED SOIL IN 6 INCH LIFTS. DO NOT PLACE IF SATURATED.
5. TO PRESERVE INFILTRATION CAPACITY OF NATIVE SOIL, KEEP MACHINERY OUTSIDE OF GREEN INFRASTRUCTURE AREA.
6. AFTER PLACEMENT, COMPACT EACH LIFT TO 85% MAXIMUM DENSITY USING WATER UNTIL JUST SATURATED OR BY WALKING ON THE SURFACE. DO NOT USE A VIBRATORY COMPACTOR.

MAINTENANCE GUIDELINES

1. WATER PLANTS THOROUGHLY FOLLOWING PLANTING TO SETTLE THE SOIL AROUND THE ROOTS UNTIL ESTABLISHMENT HAS TAKEN PLACE.
2. REMOVE DEBRIS AND RUBBISH ON A MONTHLY BASIS.
3. PERFORM SPRING MAINTENANCE TO REMOVE BUILT UP DEBRIS FROM WINTER, PROVIDE PRE-EMERGENT PLANT CARE AND INSTALL/REPLACE MULCH AS NECESSARY.
4. TRIM VEGETATION TO ENSURE SAFETY, AESTHETICS, PROPER OPERATION, OR TO SUPPRESS WEEDS AND INVASIVE VEGETATION.
4. CUT BACK PERENNIALS AND REMOVE LEAF DEBRIS AT END OF GROWING SEASON.
5. CUT BACK PERENNIALS AND REMOVE LEAF DEBRIS AT END OF GROWING SEASON.
6. REPLACE UNSUCCESSFULLY ESTABLISHED PLANTS.
7. INSPECT AND CORRECT EROSION PROBLEMS, DAMAGE TO VEGETATION, AND SEDIMENT AND DEBRIS ACCUMULATION.
8. INSPECT FOR CLOGGED SOILS AS EVIDENCED BY EXTENDED PERIODS OF PONDING. IN SOME CASES CLOGGED SOILS MAY BE REMEDIATED BY SIMPLY RAKING THE SURFACE TO REMOVE CRUSTED SEDIMENT. IN OTHER CASES, THE TOP SEVERAL INCHES OF ENGINEERED SOIL MAY NEED TO BE REMOVED AND REPLACED.
9. REMOVE ALL LABELS, WIRES, ETC. FROM PLANTS.

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RAIN GARDEN NOTES

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Stormwater Planters

A stormwater planter is a linear infiltration basin that typically sits between a street and a sidewalk in the right-of-way and is surrounded by vertical curbing. Rainwater runoff from the sidewalk and/or the street drains into the stormwater planter through openings in the curbing. If the planter is designed to manage street runoff the planter surface must be below the street gutter elevation.

A cobble or concrete splash pad helps to collect the bulk of sediment and to prevent erosion of the mulch and engineered soil. Runoff is filtered through a layer of engineered soil, a mixture of sand and compost (and sometimes topsoil). A variety of herbaceous plants in the engineered soil take some of the runoff up through their dense root system. Beneath the engineered soil, a layer of stone may be provided between the engineered soil and subgrade. Clean runoff that has been filtered by the engineered soil and the plantings can infiltrate into the ground, eventually recharging the groundwater.

During rain events, runoff collects inside the stormwater planter until it reaches the height of an overflow structure, typically set 6 to 9 inches above the engineered soil layer. In other cases, the planter can be allowed to overflow through a curb cut and continue down the curb and gutter system. Additionally, if the native soil infiltration is inadequate, a perforated underdrain is required within the stone layer to convey filtered water that does not infiltrate into the soil. The overflow structure and perforated underdrain connect the stormwater planter to the larger pipe network, carrying excess runoff downstream.

Figure 7: Stormwater planter in a suburban setting

Source: http://water.epa.gov/infrastructure/greeninfrastructure/upload/Pittsburgh-United-Fact-Sheets-508.pdf

Customization Options

Stormwater planters are scalable by both length and width depending on the space available and the target storage volume. During the design phase, the design engineer should strive to integrate the stormwater planters into the surrounding community by considering access to adjacent homes or businesses. Another option is to include an 18-inch wide courtesy walk between the pavement curb and the on the street side of the planter to assist individuals when they exit their vehicles. The curb height surrounding the planter may be increased to 18-inches to provide an ad-hoc seat wall. A planting palette with taller vegetation should be used with taller curb heights.

As previously discussed, a geotechnical engineer should test the infiltration rate of the underlying soil in the location of the rain garden. The design should consider the infiltration capacity of the subgrade soils when designing the system and determine the need for an underdrain. If the infiltration rate is greater than 0.5 in/ hr, then the volume of runoff infiltrated during the event may be sufficient, so as to not require an underdrain as part of the rain garden's design for managing runoff volumes. Depending on the specifics of the site, an overflow structure may be warranted to prevent flooding of surrounding areas. In certain cases, surface overflow to the adjacent landscape and the street may prove to be minimal, and therefore acceptable.

The design engineer should also select whether plugs or gallons will be used, along with the species mix for the native plants. The stormwater planter detail GI 3.04 provides a wide selection of herbaceous plants that can be selected, including many native species. The design engineer could choose any combination and layout to create a custom style. One could even create multiple plant palettes for the same project based on color or ability to attract bees, birds, and butterflies. These palettes could be presented to property owners to choose the type of plants that will be installed in the right-of-way in front of their home or business, as a means of community engagement. Also, the typical concrete splash pad could be substituted with decorative cobbles or glacial boulders for a different look, but at a higher cost.

Another option for the stormwater planter is to include trees. Urban tree infrastructure is an important stormwater management technique, because the leaf area and roots can absorb a tremendous amount of water when mature. Research has shown that street trees survive longer and grow to be larger and more mature when an adequate volume of planting soil is provided7. When trees are planted in compacted soil or put in a tree box, the root structure is abbreviated. Either the tree will die or the surrounding infrastructure will be compromised by the roots. Since trees also cast significant shade when mature, the herbaceous species around the tree may need to be modified to account for the increasing levels of shade as the tree grows.

One potential solution for this is to install Cornell University (CU) Structural Soil around and adjacent to the tree location. CU Structural Soil is a proprietary product developed at Cornell University that combines compacted drainage aggregate (ASTM No. 57 stone) for structural stability with a proven growing medium, loamy soil. In addition to CU soils, there are numerous blends of non-proprietary and sand-based and aggregate-based mixes that can be used. Another option for providing soil volume for trees along with structural support for pavements above is to install a proprietary product like a Silva Cell (www.deeproot.com). Where structural soil or support cells are provided to expand the soil volume beyond the planter, openings in the planter walls will be needed to provide root access to the soil.

Lastly, the shape of a stormwater planter can be modified and expanded into a parallel parking lane or stalls in a parking lot. This is called a stormwater bump out, and it can provide larger storage volumes as well as give flexibility to the aesthetic of an installation.

Maintenance

The maintenance required for a stormwater planter is similar to that of a bioswale. This includes water for plant establishment, watering, trash and debris removal, mulch replacement, weeding and annual trimming of the native plants. Within a couple of years, the native plants will be mature and fill the stormwater planter, choking out invasive species.

Cost Information

Cost information is provided for each green infrastructure technique in the Green Infrastructure Best Practices section of this report. The installed costs are based on project experience, bid tabs, and information from the RS Means trends, and the labor and bidding environment.

Table 6: Stormwater planter unit costs[1], [2]

	Item	Description	Unit Price	Unit
GI Technique	Stormwater planter	Design/Engineering	15% of Construction Cost	LS
		Mobilization	$10,000.00	LS
		Excavation & Haul	$45.00	CY
		Leaf Mulch	$70.00	CY
		Engineered Soil	$80.00	CY
		Open-Grade Crushed Stone	$65.00	CY
		Geotextile Fabric	$5.00	SY
		Erosion Control Blanket	$3.00	SY
Required Component	Stormwater Planter Curb	Curb, stormwater planter (6" barrier curb with 24" total height)	$50.00	LF
	Splash Pad	Cobble Splash Pad	$250.00	EA
Required Selection	Native Plantings	Plugs (12" on center)	$5.00	EA
		Gallons (36" on center)	$15.00	EA
Custom options	Trees	Varies by species and size	$400.00	EA
	Shrub	Varies by species and size	$60.00	EA
	Structured Soil	CU Structural Soil	$120.00	CY
	Outlet Control/ Overflow Structure	Outlet Control Drainage Basin (varies by size)	$2,800.00	EA
	Underdrain	4" HDPE Perforated Pipe	$20.00	LF
	Storm Sewer	12" HDPE storm sewer	$65.00	LF
	Underdrain Cleanout		$600.00	EA
	Connection to existing storm structure		$600.00	EA

1 Installed cost include material and labor based on bid tabs from related projects and RS Means.

2 Unit price based on a 2,400 linear foot installation within the right of way in a residential area with 1/8 acre lots. Unit prices for specific projects will vary based on scale, complexity, labor environment, and material cost trends. A detailed cost estimate should be prepared by the design engineer.

Specifications

Since a stormwater planter is like an enclosed bioswale, the specification sections required closely align to that of bioswales. The main difference is that stormwater planters also include concrete construction for the surrounding curbs and splash pad. Oftentimes existing concrete sidewalks or curbs will need to be repaired as a result of incidental damage during construction. The specification sections listed below are the standard sections from the Illinois Urban Manual (see Appendix B) that the design engineer should customize when creating construction documents for a stormwater planter, along with the engineered soil section (see Appendix C).

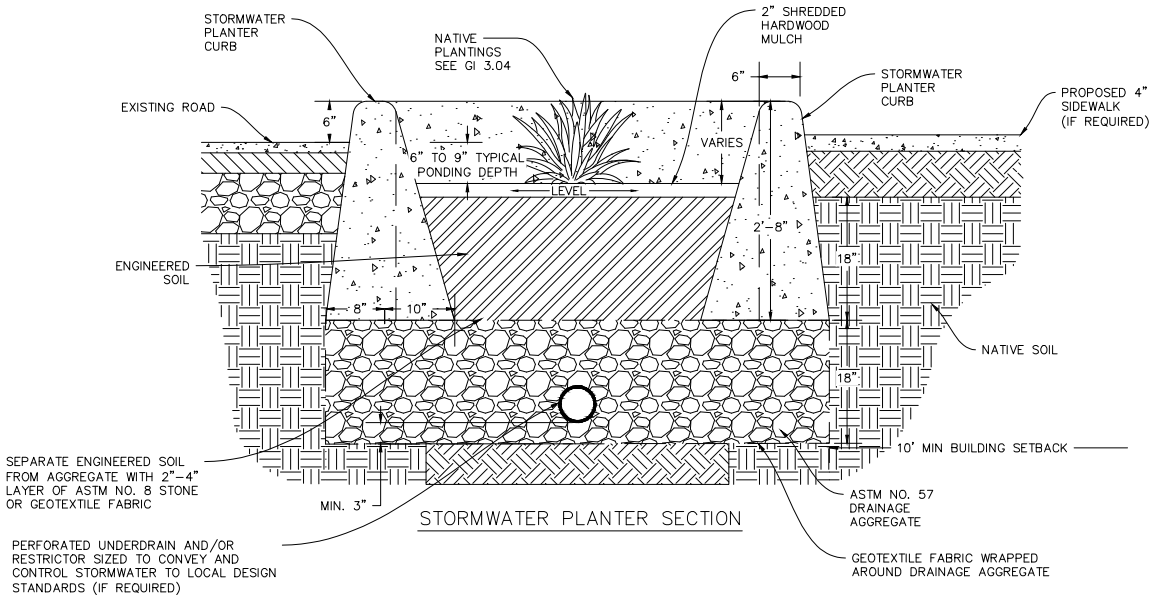
Construction Specifications

2 - Clearing and Grubbing
5 - Pollution Control
6 - Seeding, Sprigging and Mulching
7 - Construction Surveys
8 - Mobilization and Demobilization
10 - Water for Construction
21 - Excavation
23 - Earthfill
24 - Drainfill
25 - Rockfill
26 - Topsoiling
32 - Structure Concrete
34 - Steel Reinforcement
35 - Concrete Repair
44 - Corrugated Polyethylene Tubing
46 - Tile Drains
94 - Contractor Quality Control
95 - Geotextile
707 - Digging, Transporting, Planting, and Establishment of Trees, Shrubs and Vines
752 - Stripping, Stockpiling, Site Preparation and Spreading Topsoil

Material Specifications

521 - Aggregates for Drainfill and Filters
522 - Aggregates for Portland Cement Concrete
531 - Portland Cement
534 - Concrete Curing Compound
535 - Preformed Expansion Joint Filler
536 - Sealing Compound for Joints in Concrete and Concrete Pipe
539 - Steel Reinforcement (for Concrete)
548 - Corrugated Polyethylene Tubing
592 - Geotextile
804 - Material for Topsoiling Appendix C – Engineered Soil

Stormwater Planter



STORMWATER PLANTER SECTION

STORMWATER PLANTER INSTALLATION[5,6]

DESIGN GUIDANCE

TYPICAL LOCATION: WITHIN RIGHT OF WAY, BETWEEN ROAD CURB AND SIDEWALK

WIDTH: SCALABLE

CONTRIBUTING DRAINAGE AREA: < 2 ACRES

AVAILABLE OPTIONS: OVERFLOW STRUCTURE (GI 3.03)
UNDERDRAIN VS. INFILTRATION
NATIVE PLANT: PLUGS VS. GALLONS
TREE INFRASTRUCTURE (GI 3.06)

DETAILED DESIGN PRELIMINARY WORKSHEET

- ☐ NATIVE SOIL INFILTRATION[1]:_____IN/HR
- ☐ REQUIRED STORAGE CAPACITY[2]:_____CUBIC FT
- ☐ CONNECT TO EXISTING STORM NETWORK: YES/NO[3]
- ☐ DEPTH TO GROUNDWATER TABLE > 2 FT: YES/NO[4]

1. NATIVE SOIL INFILTRATION NEEDS TO BE GREATER THAN 0.5 INCHES/HOUR. IF IT IS NOT AN UNDERDRAIN MUST BE INCLUDED.
2. IF STORAGE CAPACITY REQUIRED EXCEEDS AVAILABLE FOOTPRINT, INCREASE THICKNESS OF DRAINAGE AGGREGATE OR CONSIDER UNDERGROUND STORAGE.
3. CAPACITY OF DOWNSTREAM SYSTEM TO BE ANALYZED BY DESIGNER.
4. IF NO, TECHNIQUE MAY NOT MEET CODE WITHOUT A LINER.
5. STORMWATER PLANTER ON INDIANAPOLIS CULTURAL TRAIL, PHOTO BY GUIDON DESIGN.
6. USE DETAIL GI 3.02 CURB CUR AND SPLASH PAD DETAIL WHEN CURB CUT DRAINAGE AREA IS RELATIVELY LARGE ANND POTENTIAL FOR EROSION IS HIGH.
7. PROVIDE MINIMUM 10 FOOT SEPARATION BETWEEN PLANTER AND BUILDING FOUNDATIONS OR A LINER TO PREVENT SEEPAGE AND/OR DRAINAGE TO FOOTING DRAINS.

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STORMWATER PLANTER

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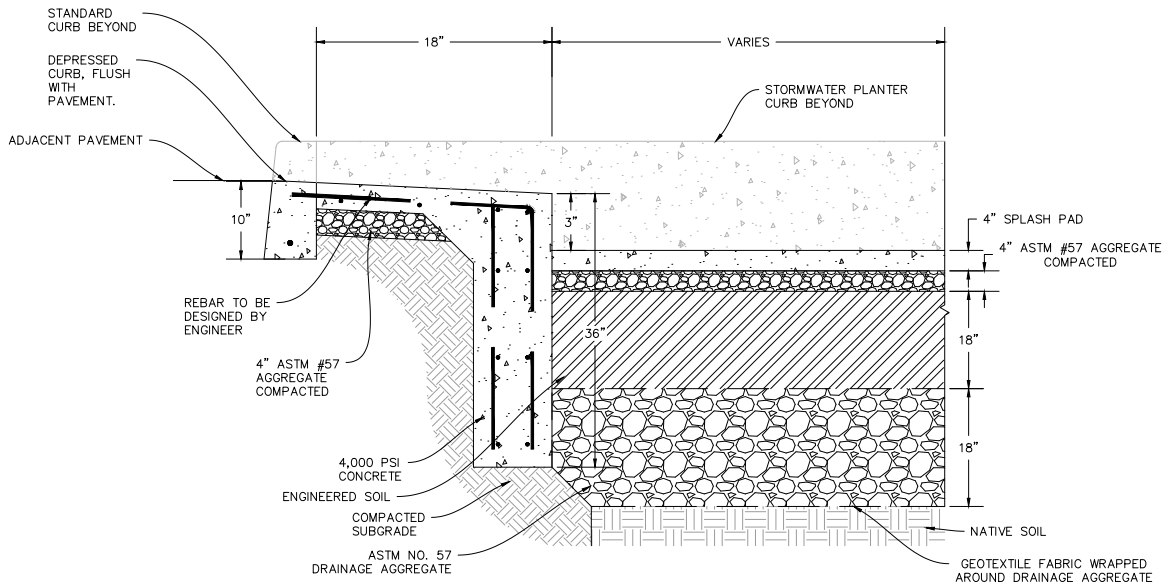
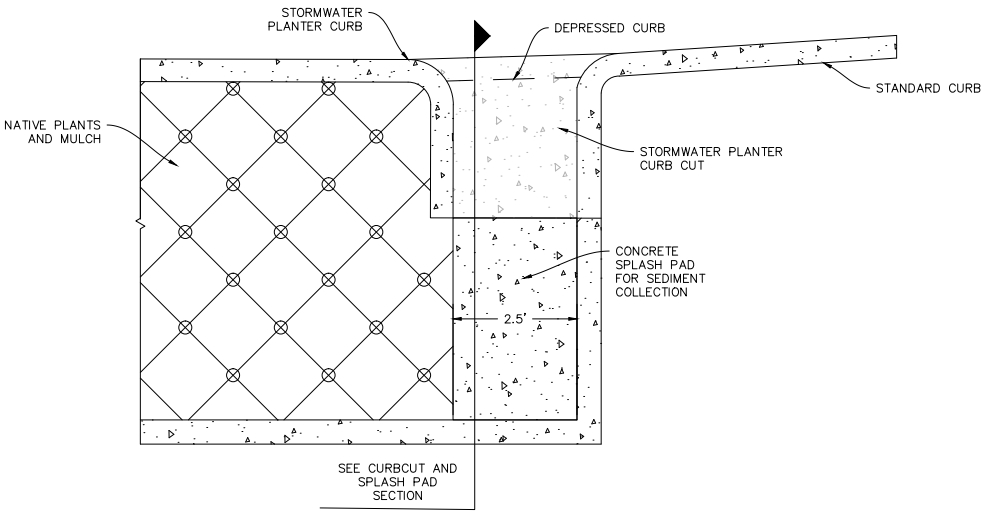
Stormwater Planter Curb Detail and Cut



STORMWATER PLANTER CURB CUT AND SPLASH PAD DETAIL



CURB CUT AND SPLASH PAD PLAN VIEW

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STORMWATER PLANTER CURB DETAIL AND CUT

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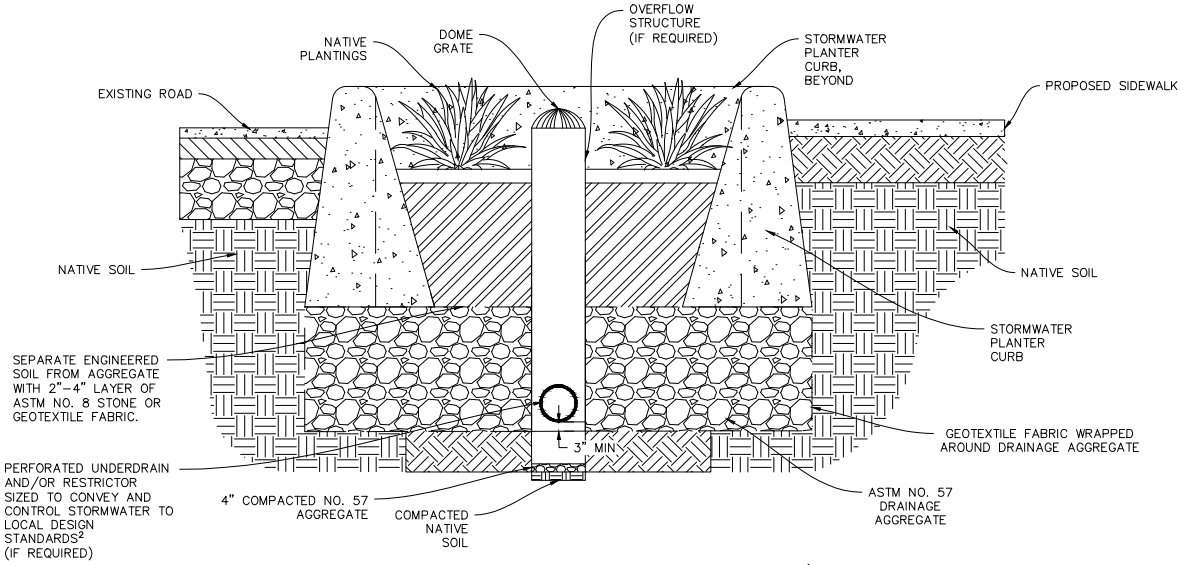
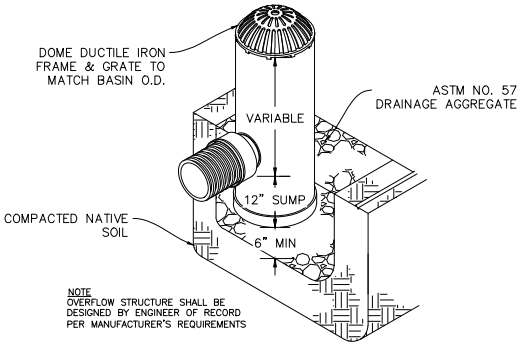
Stormwater Planter with Overflow Structure



STORMWATER PLANTER WITH OVERFLOW SECTION[1]



OVERFLOW STRUCTURE

NOTE

1. STORMWATER PLANTER WITH OVERFLOW STRUCTURE HAS THE SAME DIMENSIONS AS THE STORMWATER PLANTER SECTION SHOWN ON GI 3.01.

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STORMWATER PLANTER WITH OVERFLOW STRUCTURE

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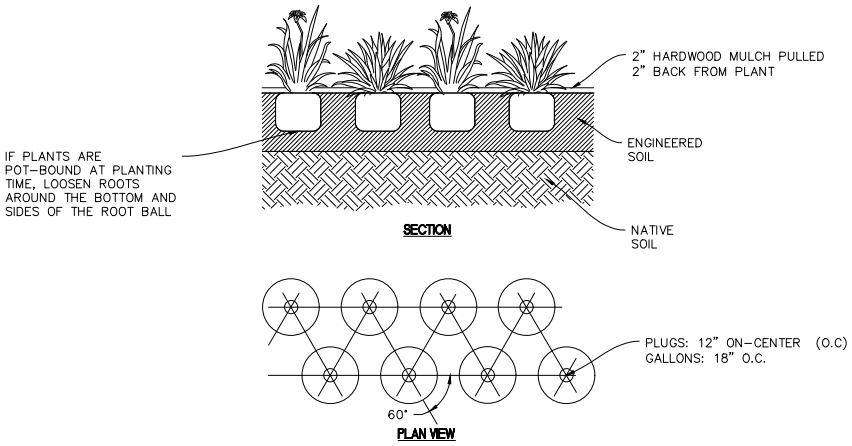

NATIVE PLANTINGS PLUG DETAIL

MIX	BOTANICAL NAME	COMMON NAME	RECOMMENDED PLANTING METHOD	NATIVE TO ILLINOIS	MOISTURE
1/3	*GRASSES*				
	PANICUM VIRGATUM	SWITCH GRASS	PLUG	YES	MESIC-WET
	SORGHASTRUM NUTANS	INDIAN GRASS	PLUG	YES	MESIC
	CAREX VULPINOIDEA	FOX SEDGE	PLUG	YES	WET
1/3	*FLOWERS*				
	ASCLEPIAS INCARNATA	SWAMP MILKWEED	PLUG	YES	WET
	ASTER NOVAE-ANGILAE	NEW ENGLAND ASTER	PLUG	YES	MESIC-WET
	ECHINACEA PALLIDA	PALE PURPLE CONE FLOWER	PLUG	YES	MESIC
	IRIS VIRGINICA	BLUE FLAG IRIS	PLUG	YES	WET
	JUNCUS TORREYI	TORREY'S RUSH	PLUG	YES	WET
	LOBELIA CARDINALS	CARDINAL FLOWER	PLUG	YES	WET
	RUDBECKIA HIRTA	BLACK-EYED SUSAN	PLUG	YES	MESIC
	SOLIDAGO GIGANTEA	LATE GOLDENROD	PLUG	YES	MESIC-WET
	VERBENA HASTATA	BLUE VERVAIN	PLUG	YES	WET
1/3	*SEDGES*				
	CAREX LANUGINOSA	WOOLY SEDGE	PLUG	YES	WET
	CAREX SCOPARIA	LANCE-FRUITED OVAL SEDGE	PLUG	YES	WET
	CAREX VULPINOIDEA	FOX SEDGE	PLUG	YES	WET

SUGGESTED NATIVE PLANTING SPECIES AND MIX[1,2]

DESIGN GUIDANCE

PLUGS

- RECOMMENDED INSTALLATION METHOD FOR NATIVE PLANTS
- STANDARD SIZE IS 2" DIA. (11.3 CUBIC INCH BY VOLUME)
- AVG PRICE = $1.50/SF ($1.10/PLUG)
- OPTIMUM PLANTING WINDOW: APRIL 15–MAY 15 AND OCT 1–31.
- NUMBER OF PLUGS AT 12" O.C. = L X W X 1.10

GALLONS

- USE FOR MORE MATURE LOOKING PLANTS OR WHERE AESTHETICS AT INSTALLATION IS VERY IMPORTANT
- AVG PRICE = $3.00/SF ($5.00/GALLON)
- PLANTING WINDOW IS MORE FLEXIBLE BECAUSE OF GREATER ROOT MASS
- NUMBER OF GALLONS AT 18" O.C. = L X W X 0.50

1 TABLE IS AMENDED FROM THE ILLINOIS NATIVE PLANT GUIDE "SPECIES INFORMATION SUMMARY TABLE": HTTP://WWW.NRCS.USDA.GOV/WPS/PORTAL/NRCS/DETAIL/IL/TECHNICAL/?CID=NRCS141P2_030715#TABLE
2 REFER TO PLANT SELECTION SECTION OF THIS GUIDE FOR FURTHER ADVICE ON SELECTING AN APPROPRIATE PLANT MIX.

NATIVE PLANTING MAINTENANCE GUIDELINES		
TASK	FREQUENCY	TIMEFRAME
ESTABLISHMENT WATERING	3XWEEK	FIRST 4 WEEKS AFTER INSTALLATION
1ST YEAR WATERING	2XWEEK	THROUGH OCTOBER OF FIRST YEAR; SUBSEQUENT YEARS ONLY IN DROUGHT
WEEDING	2X MONTH	THROUGH 1ST YEAR
MULCHING	ANNUALLY	THROUGH 3 YEARS
MOWING/COMPLETE CUTBACK	ANNUALLY	THROUGH 3 YEARS
TRASH REMOVAL	1XMONTH	ONGOING
TRIM VEGETATION	AS NEEDED	ONGOING
REPLACE DEAD PLANTS	AS NEEDED	ONGOING

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Tree Species for Stormwater Planters

RECOMMENDED TREE SPECIES FOR STORMWATER PLANTERS[2]			
COMMON NAME	GENUS	SPECIES	FAMILY
BOXELDER	ACER	NEGUNDO	ACERACEAE
FREEMAN MAPLE	ACER	X FREEMANII (RUBRUMXSACCA RINUM)	ACERACEAE
KENTUCKY COFFEETREE	GYMNOCLADUS	DIOICUS	FABACEAE
SWEETGUM HAPPIDAZE	LIQUIDAMBAR	STYRACIFLUA	HAMAMELIDACEAE
OSAGE ORANGE	MACLURA	POMIFERA	MORACEAE
BLACKGUM	NYSSA	SYLVATICA	CORNACEAE
AMERICAN SYCAMORE	PLATANUS	OCCIDENTALIS	PLATANACEAE
LONDON PLANETREE	PLATANUS X	ACERIFOLIA	PLATANACEAE
AMERICAN BASSWOOD	TILIA	AMERICANA	TILIACEAE
AMERICAN ELM	ULMUS	AMERICANA	ULMACEAE
AMERICAN ELM, PRINCETON	ULMUS	AMERICANA	ULMACEAE
AMERICAN ELM	ULMUS	AMERICANA	ULMACEAE

DIVERSITY OF TREE SPECIES IS AN IMPORTANT FACTOR TO CONSIDER. A COMMON RULE OF THUMB IS KNOWN AS THE 10–20–30 RULE[1]. IT STATES THAT IN AN URBAN FOREST POPULATION, NO SINGLE FAMILY, GENUS AND SPECIES OF TREE SHOULD MAKEUP MORE THAN 30%, 20% AND 10% RESPECTIVELY; OF THE TOTAL POPULATION. THIS IS RECOMMENDED IN ORDER TO MITIGATE RISK OF PEST AND DISEASE FATALITIES IN THE FUTURE.

1. SANTAMOUR, F.S., JR 1990. TREES FOR URBAN PLANTING: DIVERSITY UNIFORMITY, AND COMMON SENSE. TREES FOR THE NINETIES: LANDSCAPE TREE SELECTION, TESTING, EVALUATION, AND INTRODUCTION; PROCEEDINGS OF THE SEVENTH CONFERENCE OF THE METROPOLITAN TREE IMPROVEMENT ALLIANCE. PP 57–65

2 REFER TO PLANT SELECTION SECTION OF THIS GUIDE FOR FURTHER ADVICE ON SELECTING AN APPROPRIATE PLANT MIX.

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TREE SPECIES FOR STORMWATER PLANTERS

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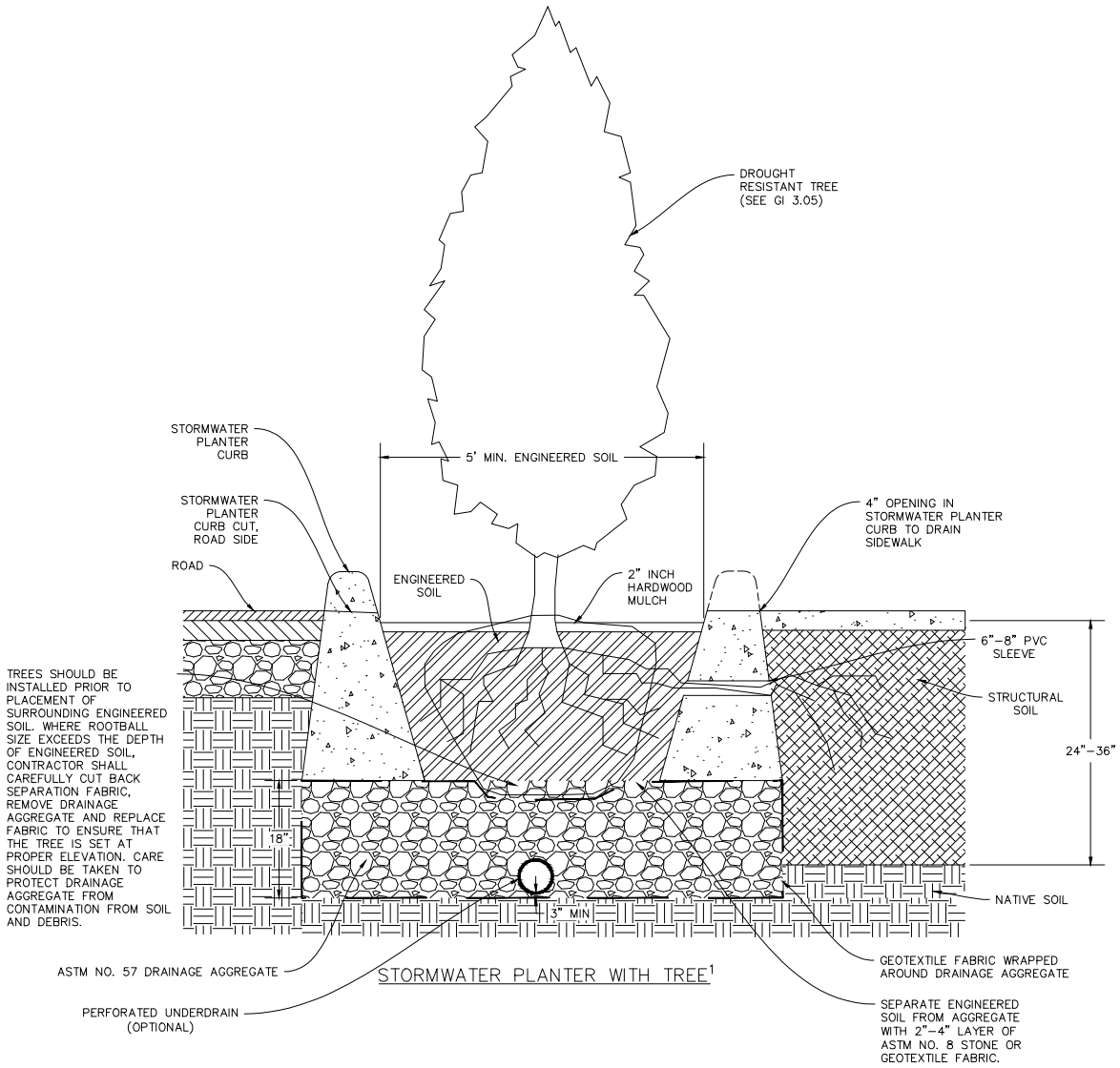
Stormwater Planter with Tree



STORMWATER PLANTER WITH TREE[1]

NOTE

1. STORMWATER PLANTER WITH TREE HAS THE SAME DIMENSIONS AS THE STORMWATER PLANTER SECTION SHOWN ON GI 3.01.

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STORMWATER PLANTER WITH TREE

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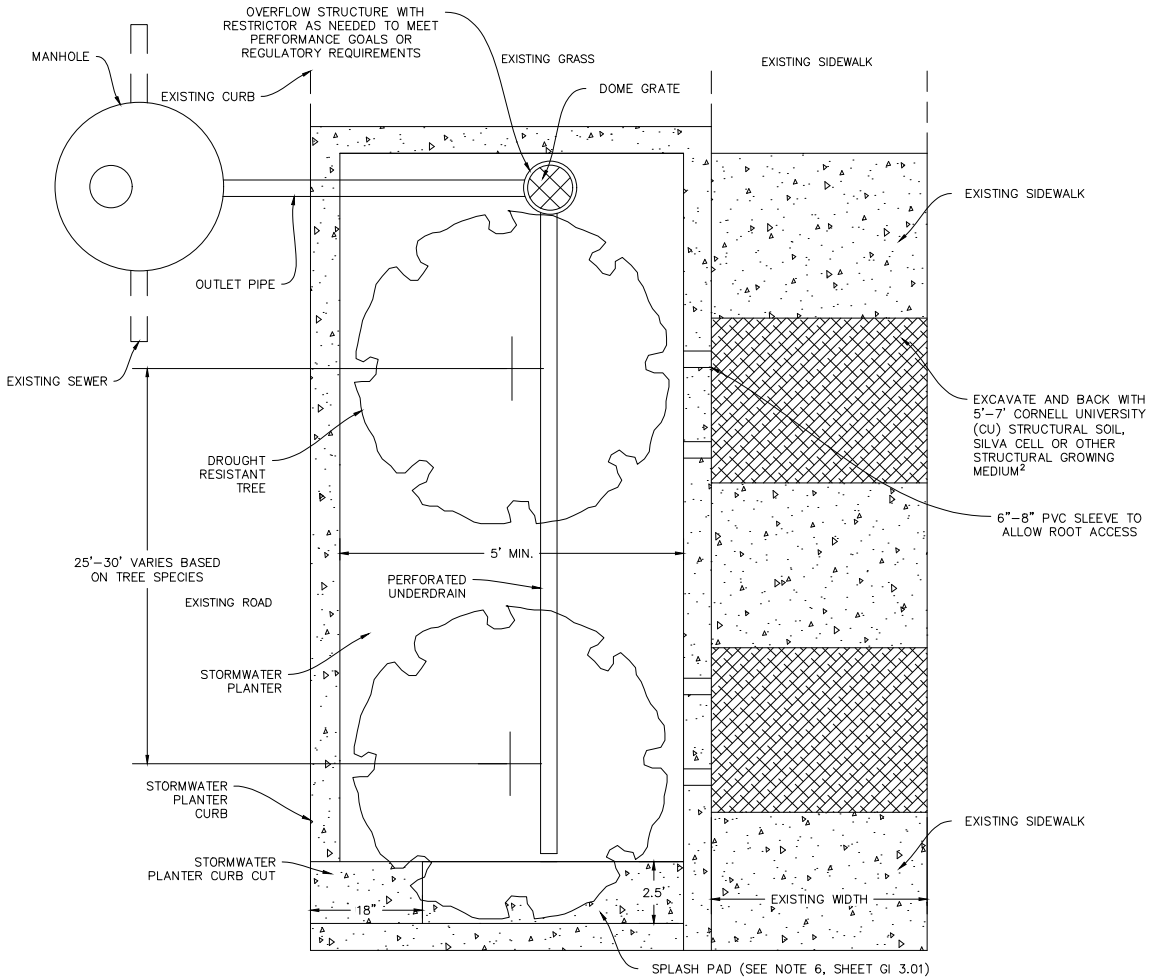
Stormwater Planter with Tree Plan View



STORMWATER PLANTER WITH TREE PLAN VIEW

DESIGN CONSIDERATIONS

- ☐ TREE SPACING[1]: _____ FT
- ☐ TREE PLANTING SOIL VOLUME[2]: _____ CUBIC FT
- ☐ PROVIDE DRAINAGE INTO PLANTER FROM ADJACENT SIDEWALK: YES/NO[3]

1. 40 FT – SPACING FOR BIG SHADE TREE, WILL TAKE MANY YEARS TO ACHIEVE SIGNIFICANT CANOPY.
   25–30 FT – SPACING FOR QUICK ESTABLISHMENT OF CANOPY, SOME CROWDING WHEN TREES REACH MATURITY.
   15–20 FT – SPACING FOR DENSE SPACING, WILL RESULT IN DIE OFF OR NECESSARY REMOVAL OF TREES IN 7–10 YEARS.
2. ULTIMATE TREE SIZE IS DIRECTLY CORRELATED TO GROWING MEDIUM VOLUME. SEE WWW.JAMESURBAN.NET/FLASHCARDS/
3. IF DESIRED, PROVIDE 4" OPENINGS IN STORMWATER PLANTER CURB TO ALLOW FOR DRAINAGE OF ADJACENT SIDEWALK

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STORMWATER PLANTER W/ TREE PLAN VIEW

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Stormwater Planter Notes

NOTES

1. STORMWATER PLANTER PLANTINGS:
   a. THE BIOSWALE SHOULD BE POPULATED WITH PLANTS NATIVE AND/OR ADAPTED TO THE INSTALLATION LOCATION. NATIVE PLANTS, GRASSES AND FLOWERS ESTABLISH DEEPER ROOTS AND IMPROVE SOIL HEALTH TO MAINTAIN PERMEABILITY.
   b. SELECT A MIXTURE OF NATIVE PLANTS BASED ON SITE CONDITIONS TO IMPROVE BIODIVERSITY AND AESTHETICS. SELECTED PLANTS SHOULD BE DROUGHT AND FLOOD TOLERANT. ONE SUCCESSFUL APPROACH USES THE FOLLOWING NATIVE PLANT MIX:
   $\frac{1}{3}$ SEDGES, $\frac{1}{3}$ FLOWERS, AND $\frac{1}{3}$ GRASSES.
2. SCHEDULE PRE-INSTALLATION MEETING WITH THE DESIGN ENGINEER 72 HOURS IN ADVANCE OF GREEN INFRASTRUCTURE CONSTRUCTION. PLANTING THAT REQUIRES FOOT OR MACHINE TRAFFIC SHALL ONLY BE CONDUCTED ON DRY SOILS
3. CONSTRUCT GREEN INFRASTRUCTURE AND INSTALL PLANTS AS EARLY AS POSSIBLE TO ALLOW FOR PLANT ESTABLISHMENT PRIOR TO DIRECTING STORMWATER TO IT. CONSIDER THE SELECTED PLANT SPECIES WHEN DETERMINING ESTABLISHMENT PERIOD.
4. AREAS IN AND AROUND GREEN INFRASTRUCTURE SHOULD BE PROTECTED DURING EARTH MOVING AND CONSTRUCTION TO PREVENT COMPACTION THAT WOULD REDUCE INFILTRATION RATES OF SUBGRADE AND ENGINEERED SOILS. ALSO PROTECT AREA THROUGHOUT CONSTRUCTION FROM SEDIMENT TRANSPORT THAT WOULD CLOG THE INFILTRATION CAPACITY OF NATIVE AND ENGINEERED SOILS.
5. CONTRACTOR SHOULD RAKE OR ROTOTILL THE TOP SIX INCHES OF SUBGRADE SOILS AFTER EXCAVATION TO REMEDIATE THE EFFECTS OF COMPACTION AND CLOGGING.
6. MINIMIZE NATIVE SOIL DISTURBANCE WHILE INSTALLING OVERFLOW STRUCTURE.

TREE NOTES

1. GROWING MEDIUM SHALL BE PLACED ADJACENT TO STORMWATER PLANTER.
2. GROWING MEDIUM TO BE EITHER CU STRUCTURAL SOIL OR SILVA CELL MATERIAL OR APPROVED EQUAL
3. VOLUME OF GROWING MEDIUM TO BE DETERMINED ACCORDING TO THE ABOVE MANUFACTURER'S RECOMMENDATIONS.
4. SELECTION OF THE TREE WILL BE BASED ON REGIONAL AVAILABILITY AND PRICE.

ENGINEERED SOIL SPECIFICATIONS

1. ENGINEERED SOIL MIX SHALL BE A BLEND OF 70% TO 90% COARSE SAND AND 10% TO 25% COMPOST BY VOLUME AND MEET THE FOLLOWING REQUIRMENTS:
   a. COMPOSE SHALL BE WELL AGED AND MEET WISCONSIN DNR TECHNICAL SPECIFICATION S100
   b. ORGANIC MATTER CONTENT OF MIX FROM 3-5% BY WEIGHT
   c. PROPORTION OF CLAY (HYDROMETER ANALYSIS) SHALL BE 2% TO 5%
   d. pH OF MIX SHALL BE 5.5 TO 8.0
   e. THE ENGINEERED SOIL THICKNESS SHALL BE ADEQUATE TO SUPPORT THE ROOTING DEPTH OF THE SELECTED VEGETATION WITH A MINIMUM THICKNESS OF 18 INCHES EXCEPT FOR THE HYBRID DITCH WHERE THE ENGINEERED SOIL MAY BE REDUCED TO 12"
2. ENGINEERED SOIL MAY BE OBTAINED OFF SITE OR CREATED BY TESTING NATIVE SOILS AND MIXING WITH IMPORTED MATERIALS AS NEEDED PROVIDED THE MIX MEETS THE SPECIFICATIONS ABOVE.
3. ENGINEERED SOIL SHALL BE DRY AND FRIABLE AND UNIFORMLY MIXED. ITS CHARACTERISTICS SHALL BE VERIFIED BY MATERIALS TESTING PRIOR TO PLACEMENT.
4. PLACE DRY AND FRIABLE SOIL IN 8-12 INCH LIFTS.
5. AFTER PLACEMENT, LIGHTLY COMPACT DRY SOIL WITH A HAND ROLLER WEIGHING NO MORE THAN 100 LBS PER FOOT OF WIDTH. DO NOT USE A VIBRATORY COMPACTOR.
6. TO PRESERVE INFILTRATION CAPACITY OF NATIVE SOIL, KEEP MACHINERY AND CONSTRUCTION SITE RUNOFFF OUTSIDE OF GREEN INFRASTRUCTURE AREA.

GEOTEXTILE FABRIC SPECIFICATION

1. A WOVEN, MONOFILAMENT GEOTEXTILE SHALL BE USED CONFORMING TO THE FOLLOWING:
   a. MINIMUM FLOW RATE OF 145 GAL/MIN/FT ASTM D-4491
   b. GRAB TENSILE STRENGTH MIN 365 X 200 LB ASTM D-4632
   c. GRAB ELONGATION MAX 24 X 10%ASTM D-4632
   d. TRAPEZOIDAL TEAR MIN 115 X 75 LBS ASTM D-4533
   e. CBR PUNCTURE RESISTANCE MIN 675 LB ASTM D-6241
   f. APPARENT OPENING SIZE 4060-90 U.S STANDARD SIEVE

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