Green Infrastructure Champion Training: Part 3

"Maintaining green infrastructure practices/projects"

March 6, 2019
Rutgers EcoComplex
Bordentown, NJ

RUTGERS
New Jersey Agricultural Experiment Station

Water Resources Program

Green Infrastructure Systems:

- *Vegetative Systems*
  - Bioretention Systems/Rain Gardens
  - Stormwater Planters
- *Harvesting Systems*
  - Cistern/Rain Barrel
  - Downspout Planter Boxes
- *Storage Systems*
  - Street Trees/Stormwater Tree Pits
  - Pervious Pavement

Difference between the types of systems:

- *Vegetative Systems*: focus on reducing water quality impacts
  These systems are typically located close to the sources of runoff and can manage the smaller storms of several inches. The main treatment mechanisms are infiltration, filtration, and evapotranspiration.

- *Harvesting Systems*: focus on the conservation, capture, storage, and reuse of rainwater.
  These systems are located close to residential and commercial buildings.

- *Storage Systems*: provide storage of stormwater, quantity control, and infiltration of stormwater runoff.
  These systems are typically located close to runoff sources within residential, commercial, and industrial landscapes. The main treatment mechanism is reducing peak flows of stormwater by storing it before it enters the sewer system.

Bioretention Systems/Rain Gardens

Landscaped, shallow depression that captures, filters, and infiltrates stormwater runoff

Vegetative System

Bioretention Systems / Rain Gardens

How it works:

These systems capture, filter, and infiltrate stormwater runoff using soils and plant material. They are designed to capture the first few inches of rainfall from rooftops, parking areas, and streets.

Benefits:

Removes nonpoint source pollutants from stormwater runoff while recharging groundwater

Restore/"mimic" predevelopment site hydrology

- Infiltration
- Evapotranspiration

Improve water quality

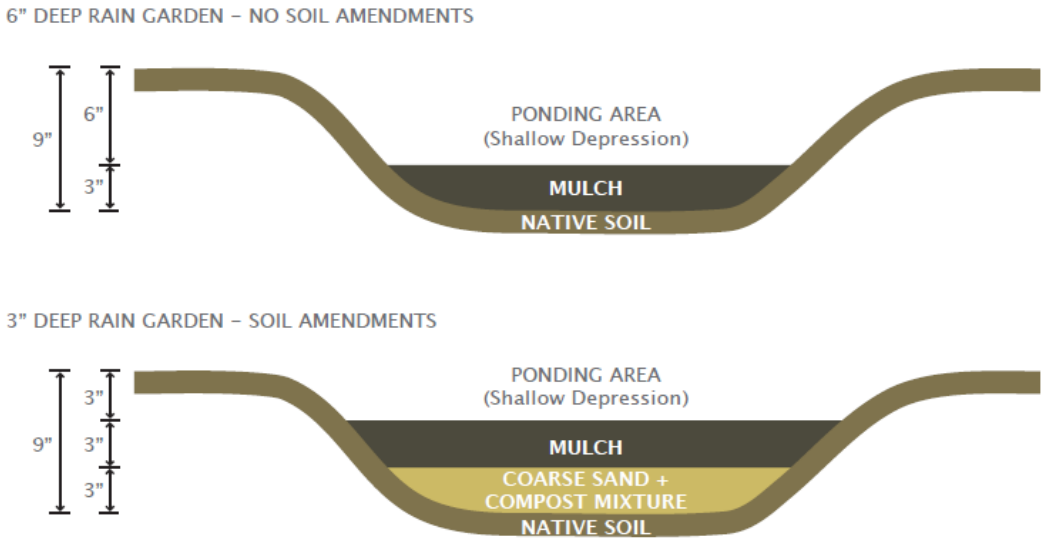
- Sedimentation, filtration, & plant uptake
- Microbial activity

Add aesthetic value

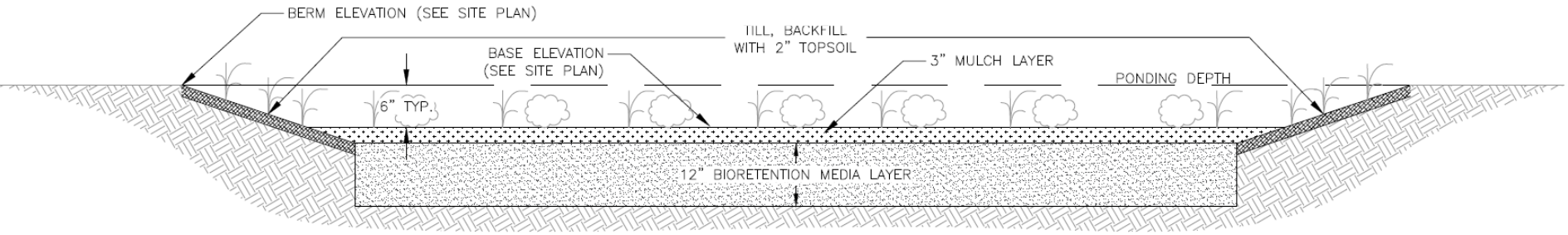
- Plant selection

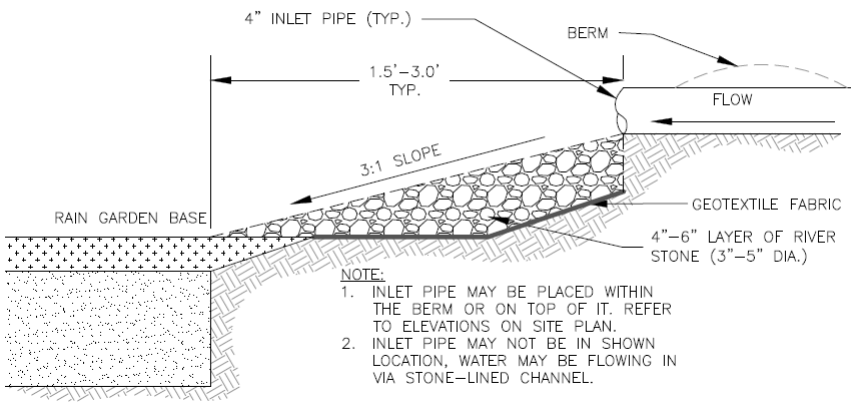
Design Criteria

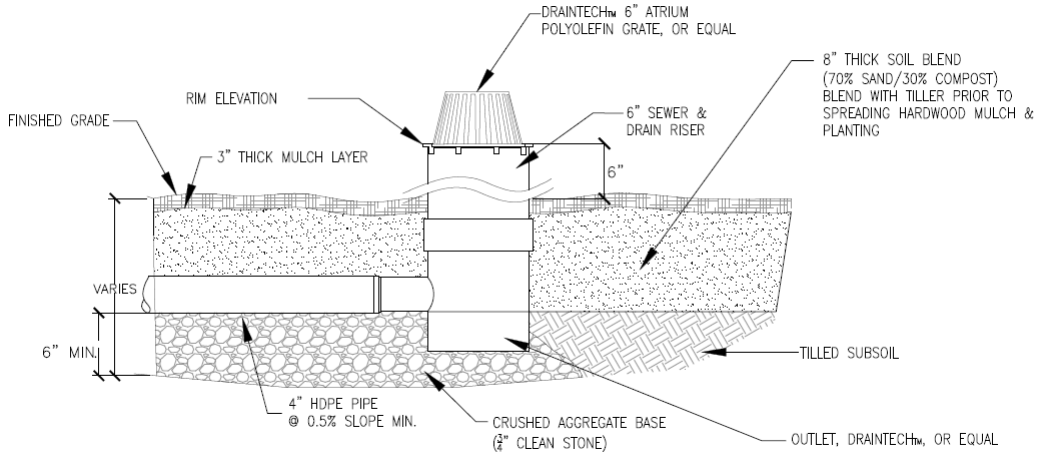
- The size of the rain garden is a function of volume of runoff to be treated and recharged.
- Typically, a rain garden is sized to handle the two-year design storm (3.3 inches of rain over 24 hours).
- Rain gardens range from 75 to 2,500 square feet.



Bioretention Systems / Rain Gardens







Rain garden installation at Ferry Avenue Library in Camden

Rain garden at Woods Road School in Hillsborough

Rain garden at Hillsborough Municipal Building

Stormwater Detention Basins

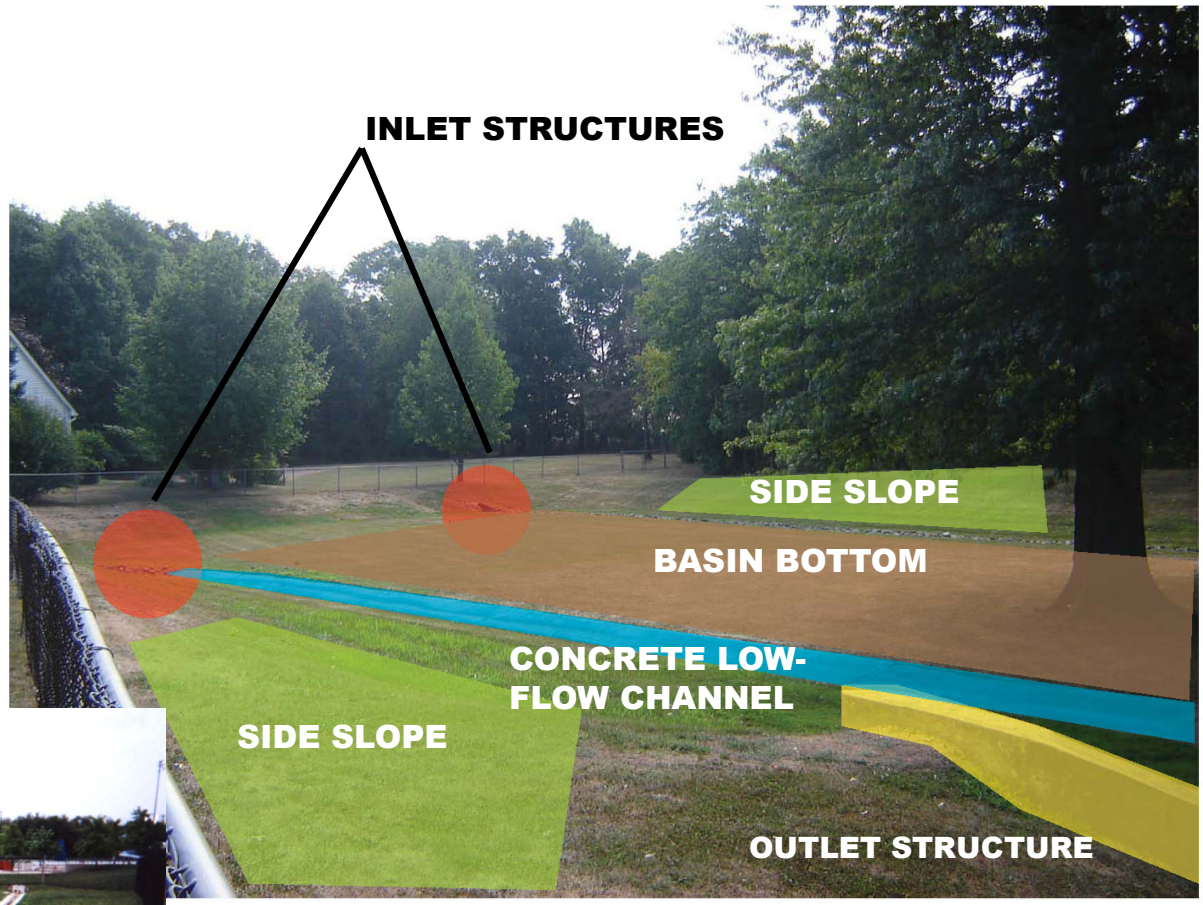
How it works:

Basins have outlets that have been designed to detain stormwater runoff for some minimum time to prevent downstream flooding. The basins provide quantity control; they need to be mowed regularly. The concrete low-flow channels should be dry except during and immediately following a storm event (typically 48 hours). Basins can treat stormwater runoff through settling of particles.

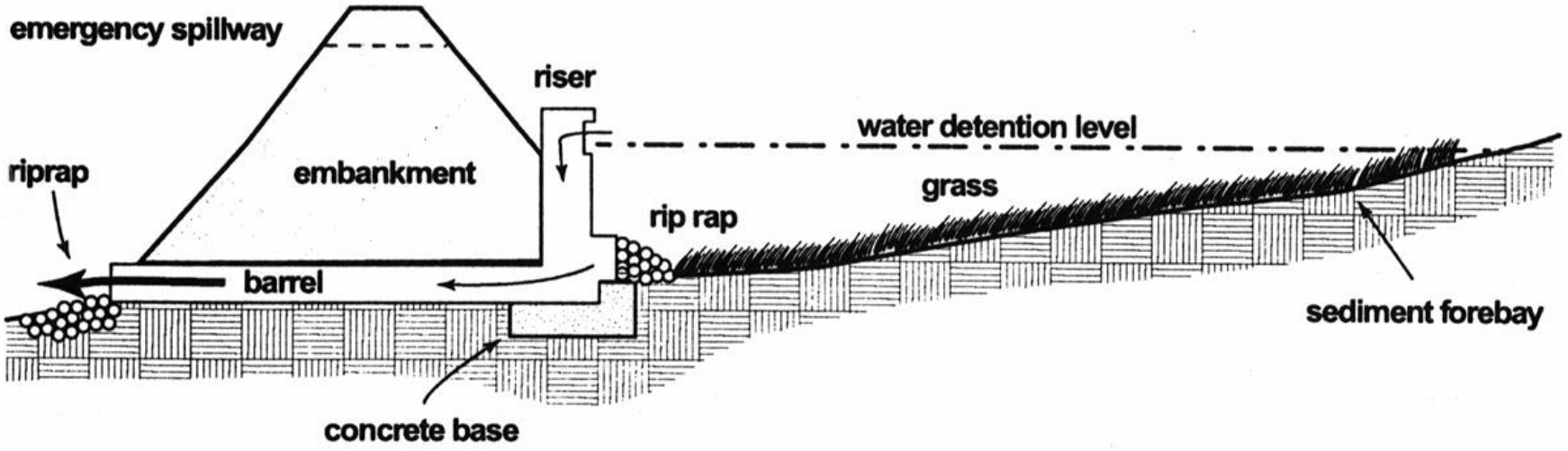
Benefits:

- Reduces flooding
- Reduces the need to mow
- Eliminates any use of commercial fertilizers and pesticides

Design Criteria



Stormwater Detention Basins



Storage System

Maintained Detention Basins

Common Concerns with Detention Basins

1. Embankment and outlet stabilization
2. Sedimentation
3. Outlet blockages
4. Broken or clogged low-flow channels
5. Standing water or wet soils
6. Floatables and debris
7. Weeds or woody vegetation

1. Embankment and Outlet Stabilization

Embankment Destabilization

Outlet Destabilization

2. Sedimentation

Accumulation of sediment in basin

3. Outlet Blockage

Outlet blockage by debris

Outlet blockage by sediment

4. Broken or Clogged Low-Flow Channels

Broken low-flow channel

Clogged low-flow channel

5. Standing Water or Wet Soils

Standing water in detention basin

6. Floatables and Debris

Accumulation of floatables in basin

Basin is a dumping ground

7. Weeds and Woody Vegetation

Woody vegetation in basin

Invasive species have overtaken the basin

Additional Best Management Practices Green Infrastructure Systems

Stormwater Planters

Vegetated structures that are built into the sidewalk to intercept stormwater runoff from the roadway or sidewalk.

Stormwater Planters

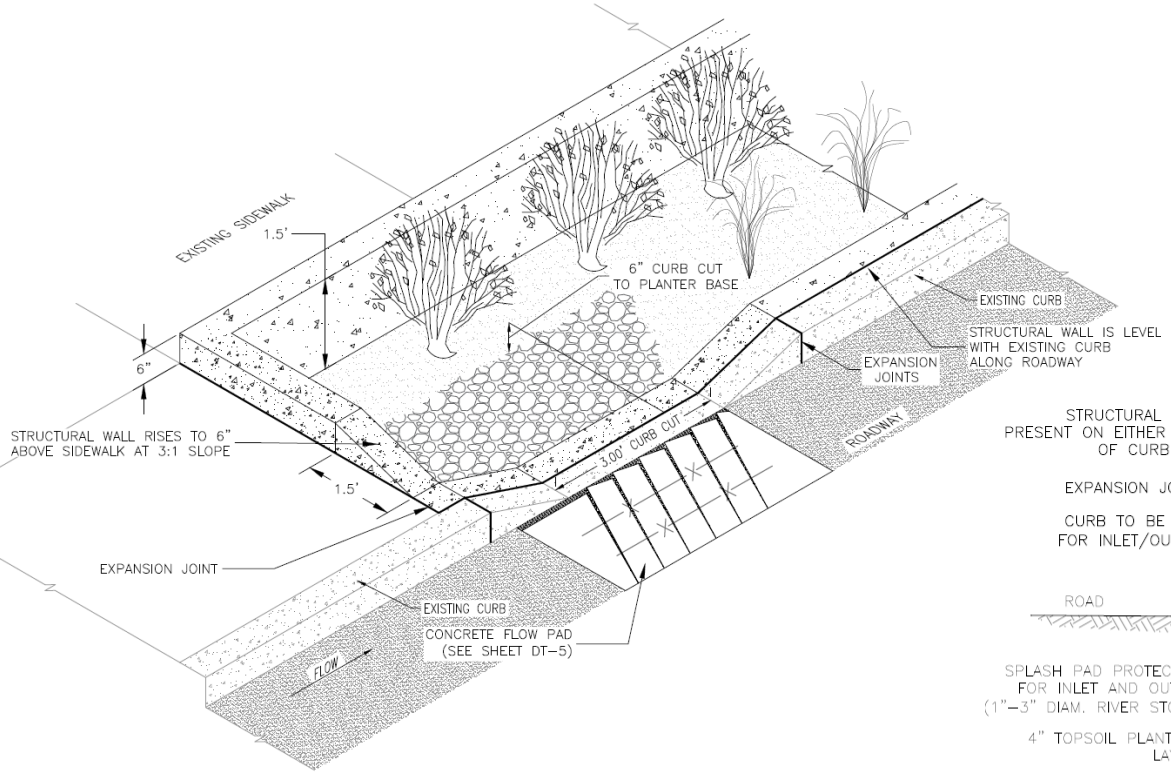
How it works:

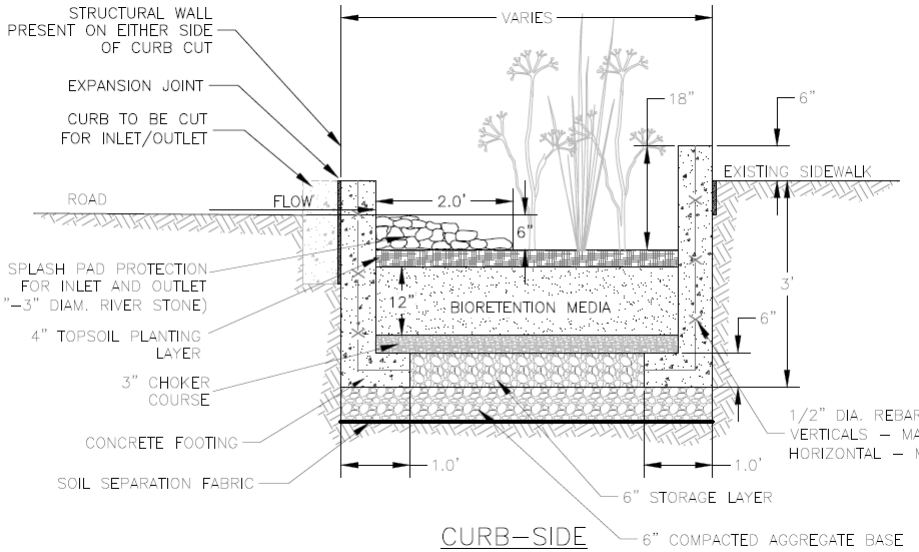
- It is a structural bioretention system that is installed in a sidewalk
- Contains a layer of stone that is topped with bioretention media and plants or trees
- Captures stormwater runoff from the roadway and sidewalk
- Once the system fills up, runoff flows back into the street or into an overflow drain which connects to the sewer system

Benefits:

- Allows water to infiltrate into the ground

Stormwater Planters





Vegetative System

Stormwater Planter at the Brimm School

Vegetative System

Stormwater Planters at the Vietnamese Community Garden

Vegetative System

Cisterns/ Rain Barrels

These systems capture rainwater, mainly from rooftops, in cisterns or rain barrels. The water can then be used to water a garden, wash vehicles, or for other *non-potable* uses.

Cistern/ Rain Barrel

How it works:

- Capture, diversion, and storage of rainwater

Benefits:

- Eliminates need for complex and costly distribution systems
- Provides additional water source
- Landscape irrigation
- Reduces flow to stormwater drains
- Reduces non-point source pollution
- Delays expansion of existing water treatment plants
- Reduces consumers' utility bills

Cistern at the Neighborhood Center

Harvesting System

Cistern at the St. Bartholomew's Church

Harvesting System

Cistern at Front Street Community Garden

Harvesting System

Downspout Planters

Wooden or concrete boxes with plants installed at the base of the downspout that provide an opportunity to beneficially reuse rooftop runoff.

Downspout Planter: Harvesting System

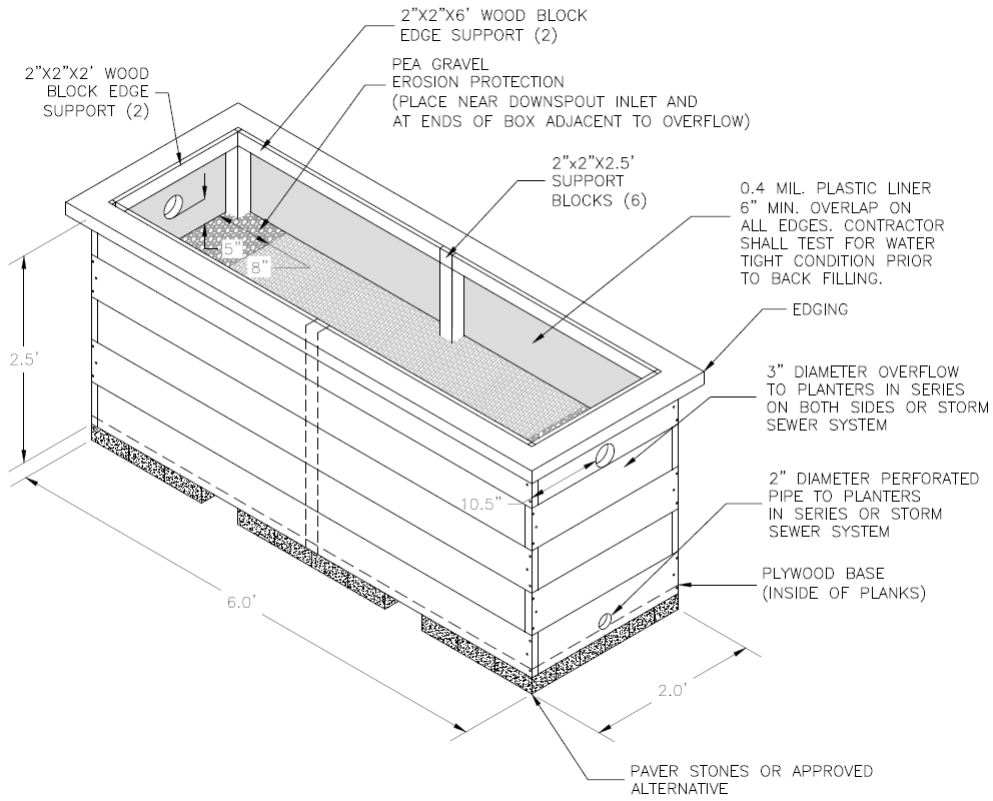
How it works:

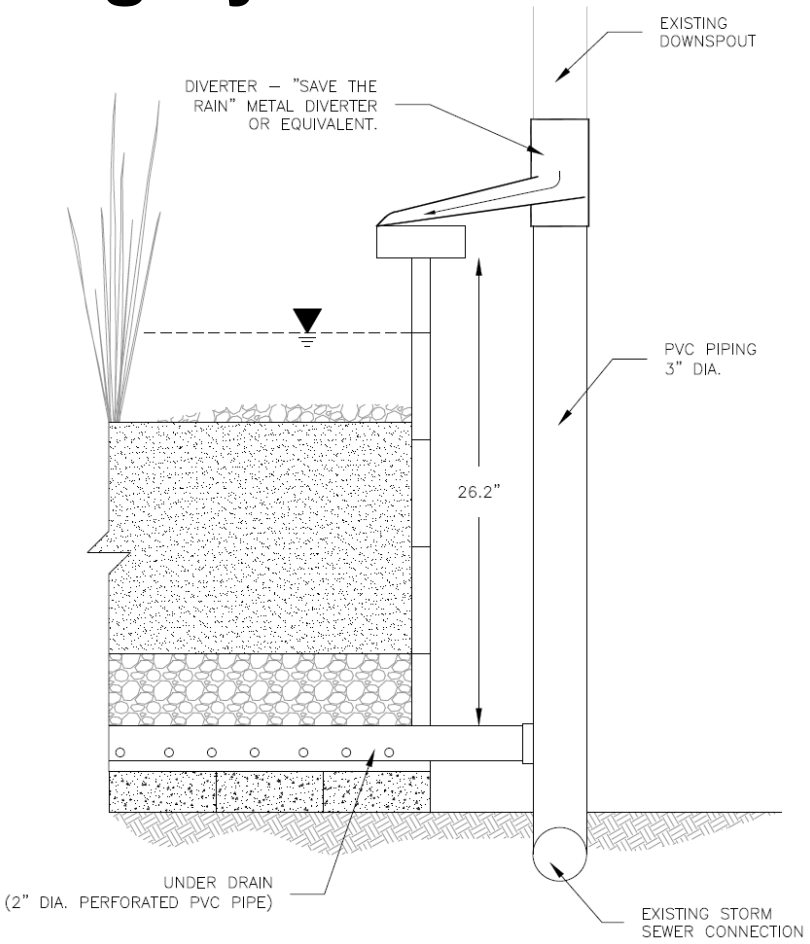
- Constructed boxes placed against buildings
- Contains stone/gravel topped with sandy compost mixture and plants
- Designed with underdrain and overflows
- Disconnects downspouts

Benefits:

- Aesthetics
- Provide some rainfall storage

Downspout Planter: Harvesting System





Harvesting System

Downspout Planter Boxes at Acelero

Harvesting System

Downspout Planter Boxes at Davis School

Harvesting System

Stormwater Tree Pits/Street Trees

Pre-manufactured concrete boxes or enhanced tree pits that contain a special soil mix and are planted with a tree or shrub

Stormwater Tree Pits/Street Trees

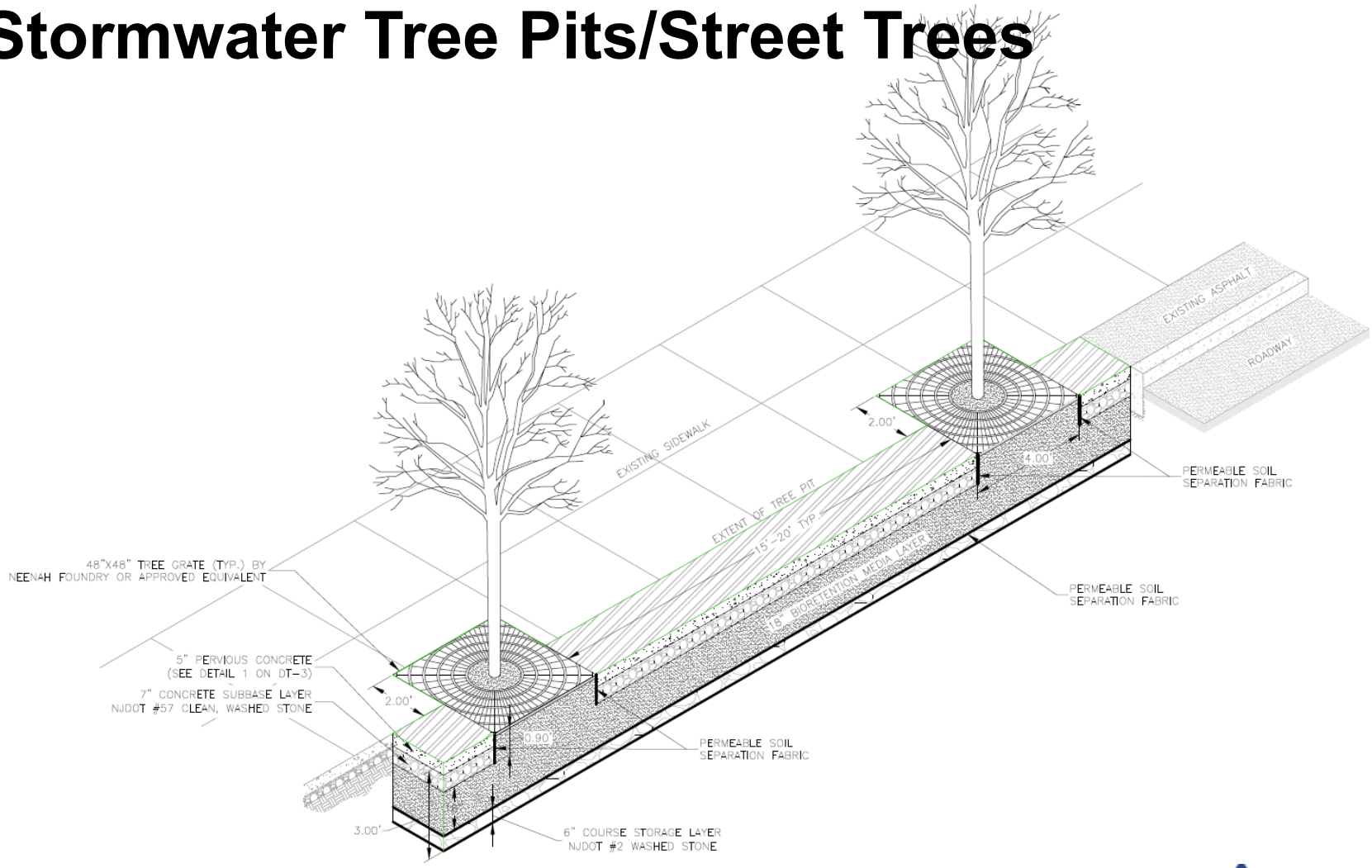
How it works:

- They filter stormwater runoff from a roadway or parking lot but provide limited storage capacity
- They are typically designed to quickly filter stormwater and then discharge it to the local sewer system

Benefits:

- Improved aesthetics
- Improved air quality
- Creation of wildlife habitat
- Increased groundwater infiltration and recharge
- Reduced heat island effect

Stormwater Tree Pits/Street Trees



Storage System

Pervious Pavements

These surfaces include pervious concrete, porous asphalt, interlocking concrete pavers, and grid pavers. These materials allow water to quickly pass through the material into an underlying layered system of stone that holds the water, allowing it to infiltrate into the underlying uncompacted soil.

Pervious Pavement

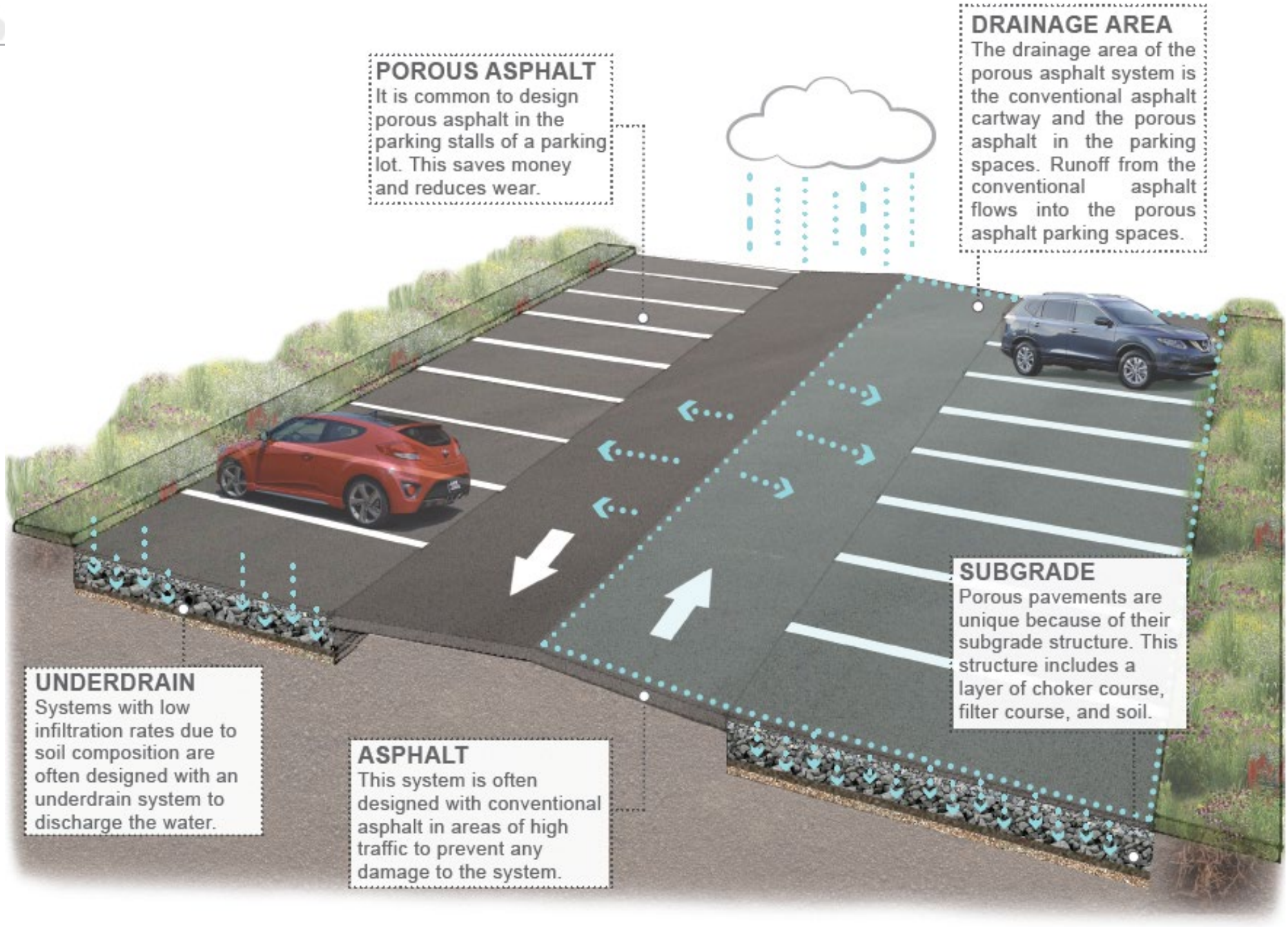
How it works:

- Underlying stone reservoir
- Porous asphalt and pervious concrete are manufactured without "fine" materials to allow infiltration
- Grass pavers are concrete interlocking blocks with open areas
- Ideal application for porous pavement includes treating a low traffic or overflow parking area

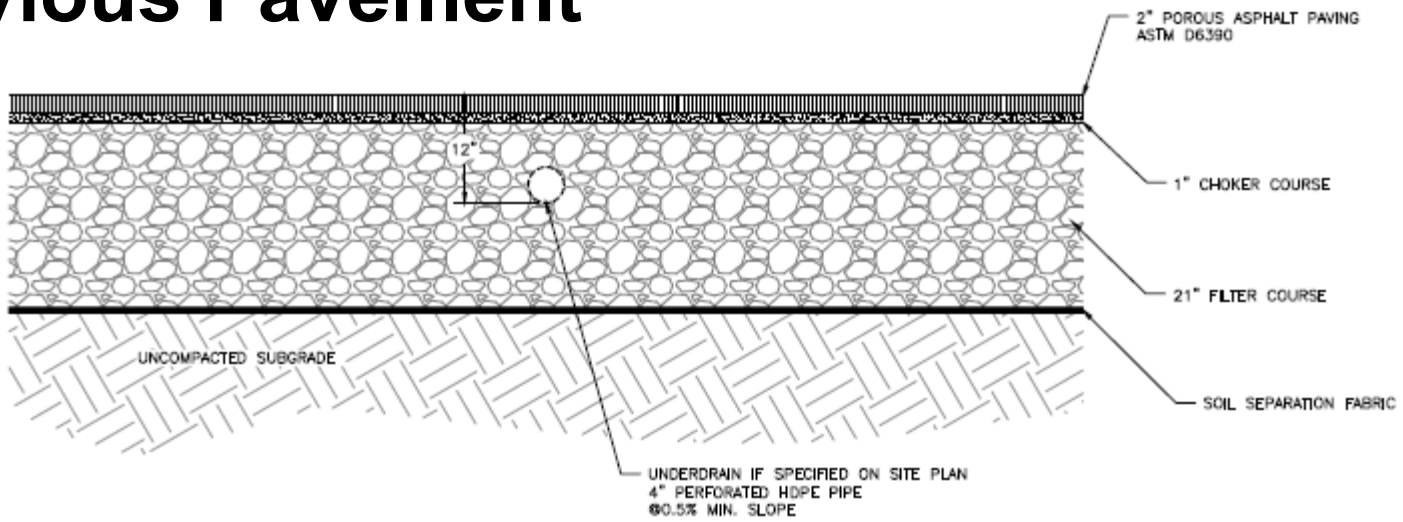
Benefits:

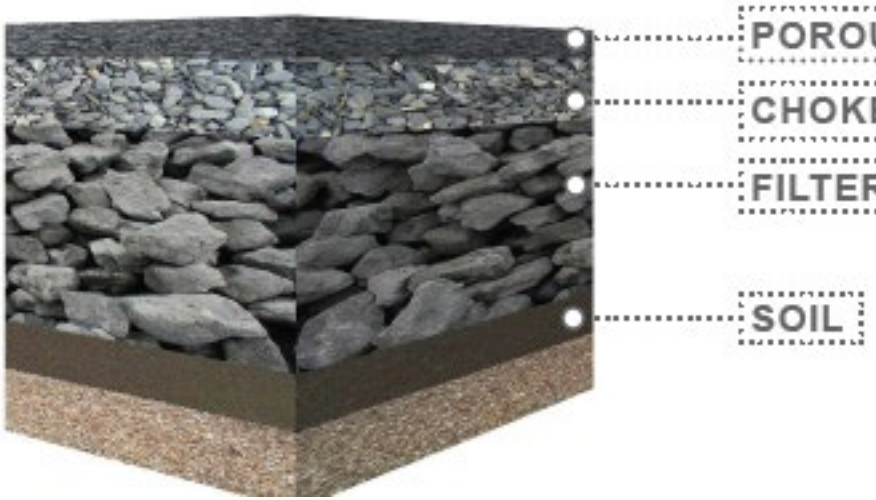
- Manage stormwater runoff, minimize site disturbance, promote groundwater recharge
- Low life cycle costs, alternative to costly traditional stormwater management methods
- Contaminant removal as water moves through layers of system
- Allows runoff to flow through the surface to an underlying storage layer

Storage System


POROUS ASPHALT
It is common to design porous asphalt in the parking stalls of a parking lot. This saves money and reduces wear.
DRAINAGE AREA
The drainage area of the porous asphalt system is the conventional asphalt cartway and the porous asphalt in the parking spaces. Runoff from the conventional asphalt flows into the porous asphalt parking spaces.
SUBGRADE
Porous pavements are unique because of their subgrade structure. This structure includes a layer of choker course, filter course, and soil.
UNDERDRAIN
Systems with low infiltration rates due to soil composition are often designed with an underdrain system to discharge the water.
ASPHALT
This system is often designed with conventional asphalt in areas of high traffic to prevent any damage to the system.

Pervious Pavement





Storage System

Porous Pavement at Yorkship School (Asphalt)

Storage System

Porous Pavement at Wiggins School (Concrete)

Storage System

MAINTENANCE PROCEDURES

Rain Garden/Bioretention System Maintenance

- Remove litter, weeds, water, mulch, and trim
- Inspect for sediment build up, the health of the vegetation, and erosion
- Clean out and inspect outlets, inlets, overflow risers, etc.
- Keep inlets free and clear so water does not bypass the system

Landscape Maintenance

- Trees
  - Watering
  - Pruning
- Vegetation
  - Weeding
  - Mulching
  - Watering
  - Pruning/cutback
  - Landscape replacement

Landscape Maintenance

- General Maintenance
  - Frequency:
    - Annually
  - Tools and supplies:
    - Trash bags, gloves, shovels
  - Soil amendment with organic matter:
    - Years 2 and 4
    - Apply 2 inches of compost into 2 inches of top soil
    - No contact with exposed roots or the trunk of the tree/ shrub
  - Keep weed whackers and lawn mowers more than 2 feet from the trunk

Landscape Maintenance

- Pruning (improves the strength of plants, prevents pest problem, improves safety/security for residents/visitors, reduces future maintenance)
  - Frequency:
    - Year one remove damaged and dead branches
    - Year three correction of structural issues
  - Tools and supplies:
    - Trash bags, gloves, saw, pruners, loppers

Landscape Maintenance

- Maintenance of Vegetation
  - Frequency:
    - Checking vegetation for damage caused by a lawnmower, string trimmers, edger, or other power equipment
    - Weeding: early and often - 3x spring, 1x fall and summer
      - Pull weeds from their roots, use a tool if it is difficult
      - Avoid compacting the soil and other plants
      - Remove invasive plants
  - Tools and supplies:
    - Trash bags, gloves, shovels, trowels, weed id guide

Types of Common Invasive Plants:

Asiatic Bittersweet

Japanese Stilt Grass

Japanese Honeysuckle

http://www.invasivespeciesinfo.gov/unitedstates/nj.shtml

Types of Common Invasive Plants:

Garlic Mustard

Mugwort

Multiflora Rose

http://www.invasivespeciesinfo.gov/unitedstates/nj.shtml

Landscape Maintenance

- Mulching
  - Frequency:
    - apply 2-3 inches of mulch in the spring
      - Keep mulch away from the stem of the plants
      - May need to remove or mix up old mulch that is already there
  - Tools and supplies:
    - Trash bags, gloves, shovels, hardwood mulch

Landscape Maintenance

- Watering:
  - Frequency:
    - 1 inch the first week installed
    - ½ inch the first 4-6 weeks of the growing season for years 2 and 3 and for drought in years 2 and 3
    - Water the roots not the leaves
    - Soil should be moist 2-3 inches below grade
    - Properly used hoses are more efficient then sprinklers
  - Tools and supplies:
    - Hose and water source
    - Gator bags

Landscape Maintenance

- Removal of dead vegetation:
  - Frequency:
    - After winter ends but before new growth appears in the spring
  - Tools and supplies:
    - Trash bags, gloves, gardening scissors, clippers
- Landscape Cutback:
  - Fall cleanup includes cutting perennials back 4 inches above the ground
  - Some plants like Iris shouldn't be cut back while they are still green

Landscape Maintenance

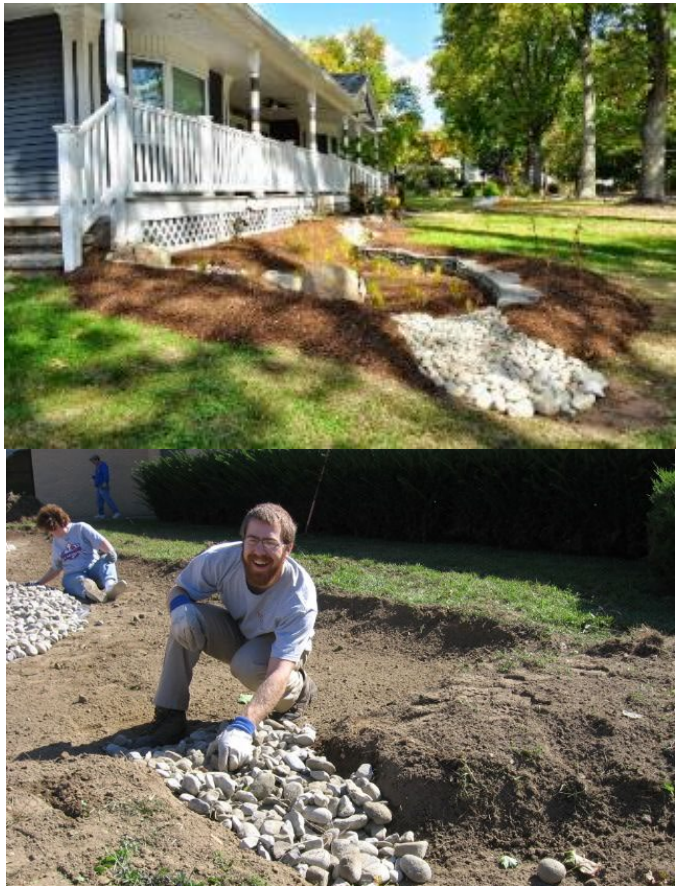
- Landscape Plant Replacement (Involves replacing dead, missing, dead or diseased plants)
  - Frequency:
    - Planting should be done in the spring or the fall
  - Tools and supplies:
    - Trash bags, gloves, shovels, replacement plants

Inlet and Outlet Maintenance

1) Inspect:
   - Remove catch basin lid/grate with manhole pick and visually inspect for evidence of defects and deterioration
   - Record observations
2) Clean Structure:
   - Use an industrial vacuum or vacuum truck hose to remove any collected materials
   - Inspect hardware and replace once inspected
   - Record observations
3) Replace lid/grate; and clean up

River Stone Specific Maintenance

- River Stone Maintenance
  - Remove trash or debris from the site
  - Remove weed growth
  - Rake out the rock to make it even and replenish the river stone if it seems shallow or needed
  - Frequency:
    - Annually in the spring
  - Tools and supplies:
    - Rack
    - River stone if there are some missing or not enough
    - Trash bags, gloves



Detention Basin Maintenance

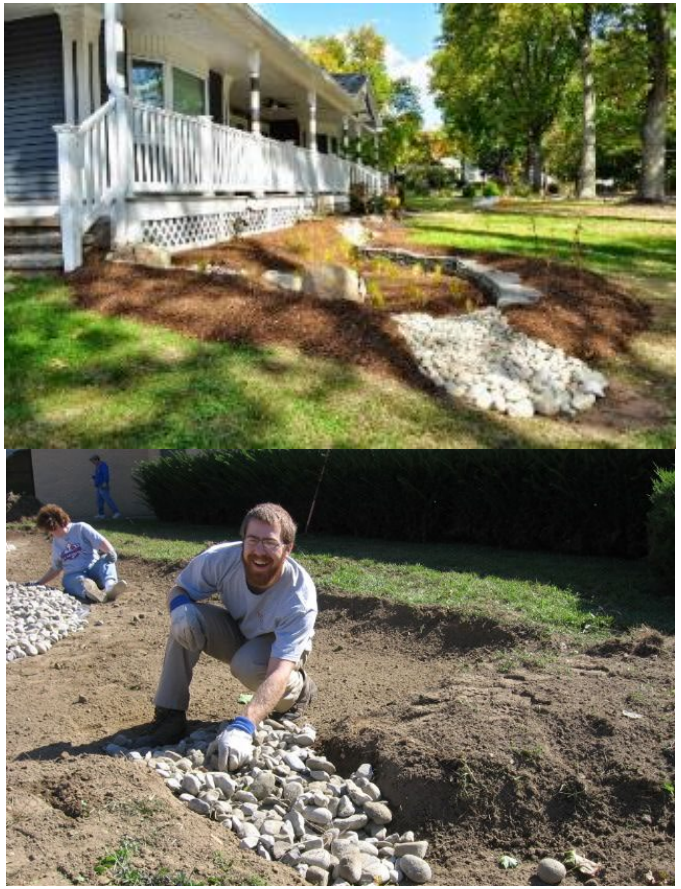
1. Vegetation management
   - Mowing should be done where/when it is needed (traditionally, 10-14 times per year)

   Effective groundcovers must be kept healthy to prevent erosion and damage to the system

2. Debris and litter removal
   - Inlets and outlets should be regularly cleared of debris and litter to prevent obstructions and reduced efficiency of the system

3. Mechanical components maintenance
   - All mechanical equipment, such as gates, valves, locks, or other components must be kept in working order should an emergency arise

4. Inspections
   - Regular inspections by designated personnel, owner, or operator should be made and clear records kept



NJ BMP Maintenance Manual Requirements

1. Identify person/s responsible for preventive and corrective maintenance
2. Identify specific preventive and corrective maintenance tasks and detailed information on specific structural components or nonstructural measures
3. Provide a schedule of regular inspections and tasks
4. Provide cost estimates of maintenance tasks
5. Include detailed logs of all preventive and corrective maintenance performed
6. Identify specialized tools or equipment needed
7. Recommend corrective responses if emergency arises
8. Provide guidance for safety during inspections and maintenance
9. Identify approved disposal and recycling sites and procedures for sediment, trash and debris
10. Include an as-built construction plan

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
NJ STORMWATER.ORG
Stormwater in New Jersey

Stormwater Management
- Green Infrastructure in NJ
- Stormwater Management Rule
- Stormwater Management Rule FAQs
- NJ Stormwater BMP Manual
- Maintenance Guidance
- BMP Manual Chapters for Comment
- MTD Certifications and Guidance
- Additional Guidance Documents

Stormwater Permitting
- Municipal Stormwater P
- General St

Maintenance Guidance

The guidance on this page is intended to assist design engineers and responsible parties with complying with the maintenance requirements for stormwater management measures. The Maintenance Guidance can be customized to allow for specific considerations in design, site conditions, and responsible party needs.

Note: Documents were drafted using Microsoft Office® 2010, dependin
settings, format of the texts and graphics in the files may change

Introduction of NJDEP St

This Video provi
Plan, Fiel

https://www.nj.gov/dep/stormwater/maintenance_guidance.htm

See handout.

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uctural Stormwater
Stormwater Management
with the preparation of their

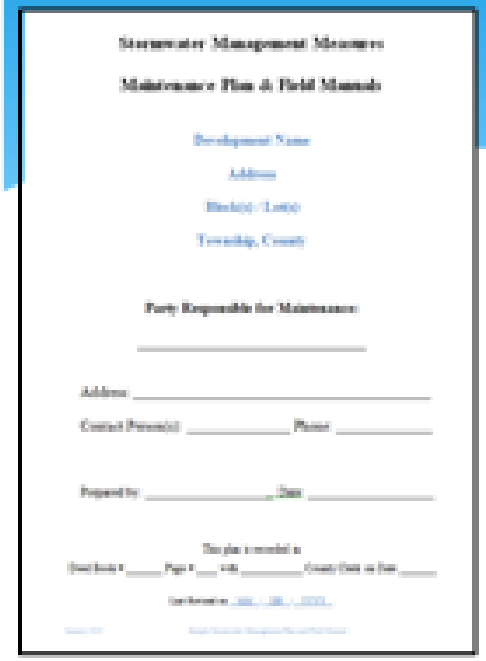
Field Manual includes templates for basic design information, checklists, visual aids, reference documents, and maintenance records. This provides a systematic method to assist maintenance crews in performing field work and retaining records. Each Field Manual was developed with the consideration of essential maintenance requirements for each type of stormwater measure addressed in the corresponding Structural Stormwater Management Measures subchapters within the NJ Stormwater Best Management Practices Manual.

- Bioretention Systems
- Dry Wells
- Grass Swales
- Infiltration Basins
  - Surface Infiltration - Extended Detention
  - Surface Infiltration
- Manufactured Treatment Devices
- Pervious Paving Systems
- Sand Filters
  - Sand Filter with Infiltration
  - Sand Filter with Underdrain
- Standard Constructed Wetlands
- Subsurface Gravel Wetlands
- Surface Extended Detention Basins
- Vegetative Filter Strips
- Wet Ponds

Maintenance Logs and Inspection Records

- Maintenance Logs and Inspection Records

Overview of Maintenance Guidance


Stormwater Management Measures

Maintenance Plan & Field Manuals

Development Name

Address

Block(s) / Lot(s)

Township, County

Party Responsible for Maintenance

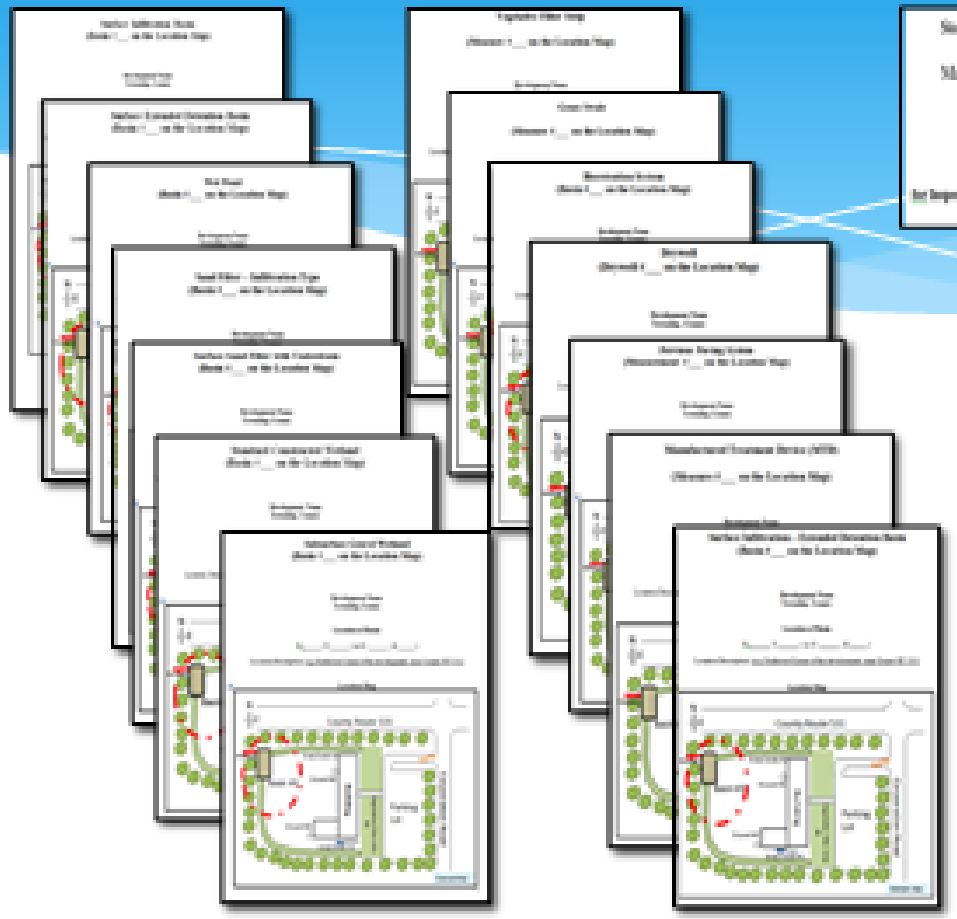
Address: _____

Contact Person(s): _____ Phone: _____

Prepared by: _____ Date: _____

This plan is recorded in
Deed Book # _____ Page # ____ with _____ County Clerk on Date _____

Last Revised on: ___/___/____



Stormwater Management Measures

Maintenance Plan & Field Manuals

Record Log
for Inspection Checklists and Maintenance Work Orders

One Template
of
Maintenance Plan

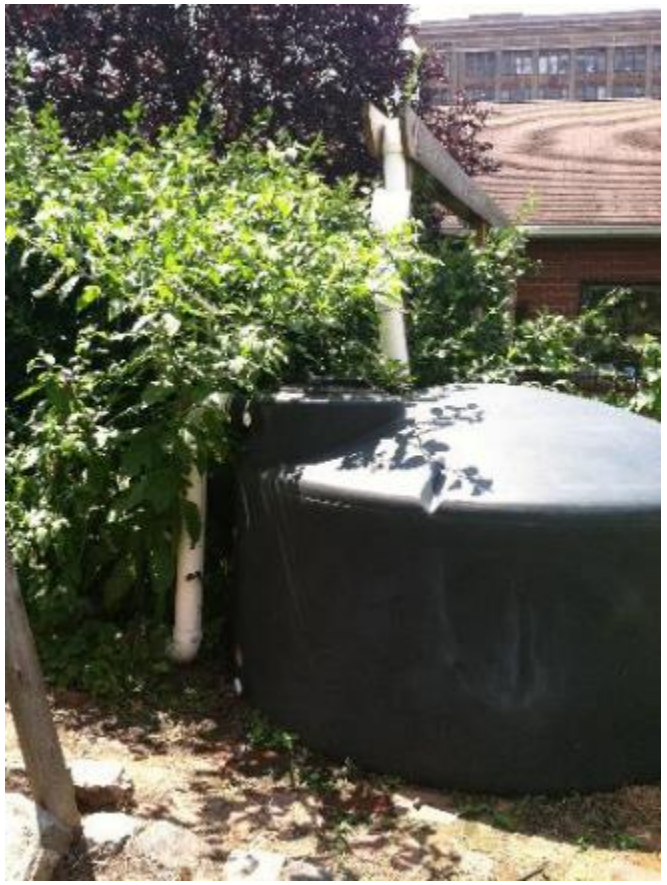
Fourteen Templates of Field Manuals
for Fourteen Types of
Stormwater Management Measures

One Template
of
Maintenance Log

Additional Best Management Practices Maintenance Procedures

Cistern / Rain Barrel Maintenance

- Release the water in the cistern/barrel before the next rain event
- Rain barrels, cisterns, and downspouts should be inspected and cleaned regularly
- Seals on the infrastructure need to be inspected to prevent mosquito infestation
- Winterize



Cistern/ Rain Barrel Maintenance

- Cistern/Rain Barrel (provides supplemental water supply for irrigation and other nonpotable water use)
  - Frequency:
    - Annually release all the water before the winter
  - Tools and supplies:
    - Trash bags, gloves, wrench
  - Procedure:
    - Refer to guidance document in handout

Planter Box Maintenance

- Apply mulch / stone
- Install plantings
- Remove weeds
- Check/maintain inflow
- Keep overflow clear of debris
- Ensure proper drainage
- Winterize

Permeable Pavement Maintenance

- Porous Pavement Vacuuming
- Porous Pavement Power Washing
- Porous Paver Maintenance (Restoring Aggregate)
- Winter Maintenance for Porous Pavement

Permeable Pavement Maintenance

- Permeable Pavement Vacuuming (process removes sediment which can lead to clogging of the porous surface which prevents infiltration of water)
  - Frequency:
    - Semi Annually for Porous Asphalt, Porous Concrete, Flexible Porous Pavement
    - Annually for Porous Pavers
  - Tools and supplies:
    - Porous pavement vacuum
    - Water source
    - Trash bags, gloves, safety cones, street broom

Permeable Pavement Maintenance

- Porous Pavement Power Washing (should be done if pavement is clogged; NEVER power wash porous pavers)
  - Frequency:
    - Once every three years
    - Power wash after thorough vacuuming
    - Perform task in the spring
  - Tools and supplies:
    - Power washer
    - Water source
    - Trash bags, gloves, safety cones, street broom

Permeable Pavement Maintenance

Porous Pavers Maintenance

1) Inspect:
   - Look for damage to the surface of the porous pavement (clogs)
   - Record observations in maintenance report log
2) Prepare Site:
   - Dispose of trash and debris
   - Sweep away any loose debris
3) Clean out clogged Voids
   - Use a manhole pick to clean out the voids till you are able to see clean aggregate

Permeable Pavement Maintenance

Porous Pavers Maintenance (restoring aggregate)

- Frequency:
  - When gravel infill is less then ½ inch of the paver surface
  - Perform after vacuuming
- Tools and supplies:
  - Shovel, manhole pick, wheelbarrow
  - Cleaned washed small aggregate
  - Trash bags, gloves, safety cones, street broom

Permeable Pavement Maintenance

- Winter Maintenance for Permeable Pavements Procedures
  - Frequency:
    - As necessary following snowfall and/or icy conditions
  - Tools and supplies:
    - Truck with snow plow
    - Salt
    - Hand shovel

Permeable Pavement Maintenance

Winter Maintenance for Porous Pavements Procedures

1) Inspect:
    - If location is no longer visible, look at site plan to identify where it's located
    - Locate obstacles like speed bumps, bushes, trees so the snowplow can be raised
    - Record observations in maintenance report log
2) Plow Site:
    - Use a rubber plow blade
    - Plow 1” above the pavement to prevent hitting the plow on an edge or a paver and ripping it up
3) Storage of snow piles:
    - Don’t store snow piles on top of porous pavement surfaces; move the snow piles on lawn or non-porous pavement
4) Salting
    - Use in moderation
5) Record observations in maintenance report log and clean up

TROUBLESHOOTING AND PLANNING

Issues and Concerns: Vehicle Safety

- Branches/debris in roadway or parking area
- Lines of sight at intersections or parking areas
- Water overflow and icing in the roadway

Issues and Concerns: Sediment & Debris

- Trash accumulation
- Sediment accumulation
- Erosion
- Dumping
- Road salt and sand
- Bare soils

Issues and Concerns: Clogging

- Leaves and plant material
- Sediment
- Debris
- Ponding
- Filter screen or fabric
- Stone

Issues and Concerns: Ponding

- Standing water for more than 72 hours
- Saturated soils
- Plant loss
- Poor soil infiltration
- High groundwater
- Insufficient drain piping
- Too much water

Issues and Concerns: Winterizing a Cistern

- Drain all piping, storage drums, and fixtures
- Clean all filters and screens
- Divert flow from storage tanks

Planning for Maintenance: Prescriptive Schedules

- A defined frequency for required maintenance tasks
- Set schedule
- Clear plan
- Straight forward budget
- Refer to the Green Infrastructure Maintenance Log

Green Infrastructure Maintenance Log

RUTGERS New Jersey Agricultural Experiment Station

GREEN INFRASTRUCTURE MAINTENANCE LOG

Project Name: _____ *Year:* _____

Practice: _____

Month:	Inspection Date:	Initial:	Observation Notes:	Contact RCE:		Last Rain Date:
January				Y	N	
February				Y	N	
March				Y	N	
April				Y	N	
May				Y	N	
June				Y	N	
July				Y	N	
August				Y	N	
September				Y	N	
October				Y	N	
November				Y	N	
December				Y	N	

By initialing this document, I agree that I have inspected the above referenced green infrastructure practice on the dates listed above and have abided by the maintenance guidelines provided by the Rutgers Cooperative Extension Water Resources Program.

Setting Prescriptive Schedule & Tasks

- Is the system working properly?
- Does the system meet appearance or aesthetic requirements?
- Are there any safety issues?
- Define routine tasks.

Planning for Maintenance: Adaptive Scheduling

- Relies on frequent or regular inspections to identify specific needs
- Flexible but undefined schedule
- Complete work as needed
- Focus on systems in most need
- More experience required

Planning for Maintenance: Staffing

- Requires a knowledge leader or crew chief
- Basic understanding of system function
- Knowledge of plant materials
- Ability to assess the system
- Observe, document, report

Planning for Maintenance: Staffing

- Ability to make minor repairs
- Ability to install replacement plantings
- Ability to communicate with the public
- Skills in adapting to a variety of conditions and sites

Planning for Maintenance: Tools & Equipment

- Basic landscape & gardening equipment (rakes, shovels, pitch-forks, pruners)
- Wheel barrow
- Weed trimmer, edger
- Mower
- Trash bags and disposal
- Broom

Planning for Maintenance: Tools & Equipment

- Safety vest, tape, cones
- Gloves
- Tool box with basics:
  - Hammers
  - Pliers
  - Drills
  - Screwdrivers
  - Wrenches
  - Tape Measure
  - Cutters

Planning for Maintenance: Materials

- Mulch
- Plantings
- Seed mix
- Topsoil
- Stone
- Filter Fabric
- Trash bags
- Erosion control blanket

Planning for Maintenance: Documenting Maintenance Activity

- Maintenance Report Form
- Digital Camera
- Pen & Paper
- Clip Board

Planning for Maintenance: Documenting Maintenance Activity

Rain Garden Inspection Form

Name of Inspector: _____

Site Name: _____ Date of Inspection: _____

Address: _____ County: _____

_____

When was the last time it rained? _____ how much _____inches

Rain Garden Inspection (please check)

Are there educational signs within the garden?	_____ Yes _____ No
Are there weeds (plants that do not belong there) within the garden? If yes, are these weeds invasive?	_____ Yes _____ No _____ Yes _____ No (Use USDA Invasive Plants Field and Reference Guide to identify invasive plants)
Are the plants in the garden healthy? For example: is there any leaf discoloration, fungal growth on the leaves, or pests?	_____ Yes _____ No Take photographs of the plants.
Are some plants over-shadowing other plants or are certain plants over-taking the other plants within the garden?	_____ Yes _____ No If yes, take photographs and provide description of the plant (if the plant name is known, write it down). Please describe:
Is there litter within the garden?	_____ Yes _____ No
Is there sediment accumulation within the garden?	_____ Yes _____ No If yes, is the sediment accumulation only in one area or throughout the garden? Please describe:
Is there sediment accumulation on the plants within the garden?	_____ Yes _____ No If yes, how many plants are covered with sediment? Please describe:

Rain Garden Inspection Form

Is there evidence of gullying or erosion within the garden?	_____ Yes _____ No If yes, where is the gullying mostly occurring? Describe & take photos.
Is there evidence that the mulch has washed away within the garden?	_____ Yes _____ No If yes, take photographs of exposed areas.
Are gutters or pipes entering and exiting the garden clear of debris?	_____ Yes _____ No _____ N/A If no, take photographs of clogged gutters or pipes.
Is runoff free to enter the garden without any obstructions?	_____ Yes _____ No _____ N/A If no, take photographs of areas of blocked flow within the garden.
Take measurements: drainage area and rain garden footprint	• Drainage area _____ ft^2 • Type of drainage area: _____ (rooftop, parking lot, driveway, sidewalk, grassed area, etc.) • Footprint _____ ft^2
Is there empty space in the garden?	_____ Yes _____ No If yes, estimate how many plants would be needed to fill the gaps.
Say cheese!	**Take photographs of the rain garden from all angles**

Additional Notes:

_____

_____

QUESTIONS?