



WORKSHOP I: Green Infrastructure Overview Construction, Inspection, and Maintenance

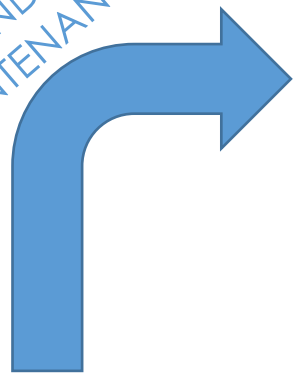
- Stormwater BMP Maintenance
DPW Staff and Municipal
Stormwater Managers
- 10.31.17



WHY DOES THIS MATTER?



OPERATION
AND
MAINTENANCE



BARNSTABLE
CLEAN
WATER
COALITION



APCC
Association to
Preserve Cape Cod

STATE AND LOCAL AGENCIES

REGULATIONS AND
DESIGN MANUALS

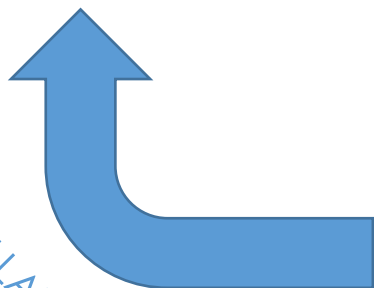


OWNERS & OPERATORS

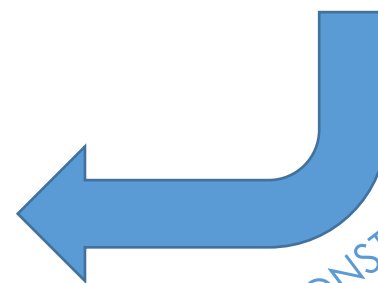


DESIGNERS

INSTALLATION



CONTRACTORS



CONSTRUCTION
DRAWINGS



HOW CAN WE AVOID THIS?



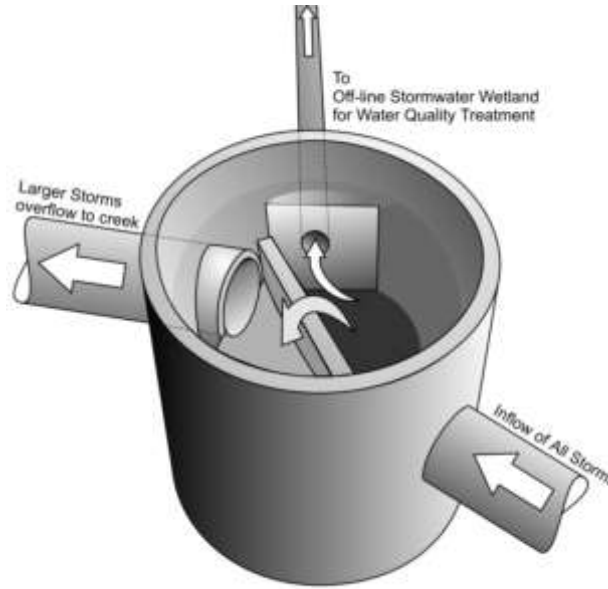
- ① Drainage Inlets
- ② Swales & Conveyance
- ③ Sediment Forebays
- ④ Treatment Areas
(Bioretention/ Gravel Wetland)
- ⑤ Overflow & Spillways
- ⑥ Surrounding Area

Vegetation

Long-Term Maintenance

1 DRAINAGE INLETS

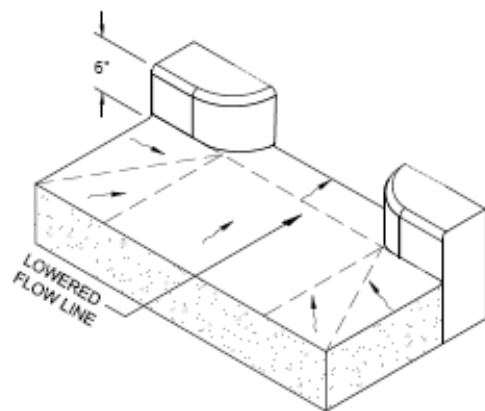
- Diversion structures
- Pipe Inlets
- Trench grates
- Curb Cuts
- Paved inlet flumes
- Catch basins



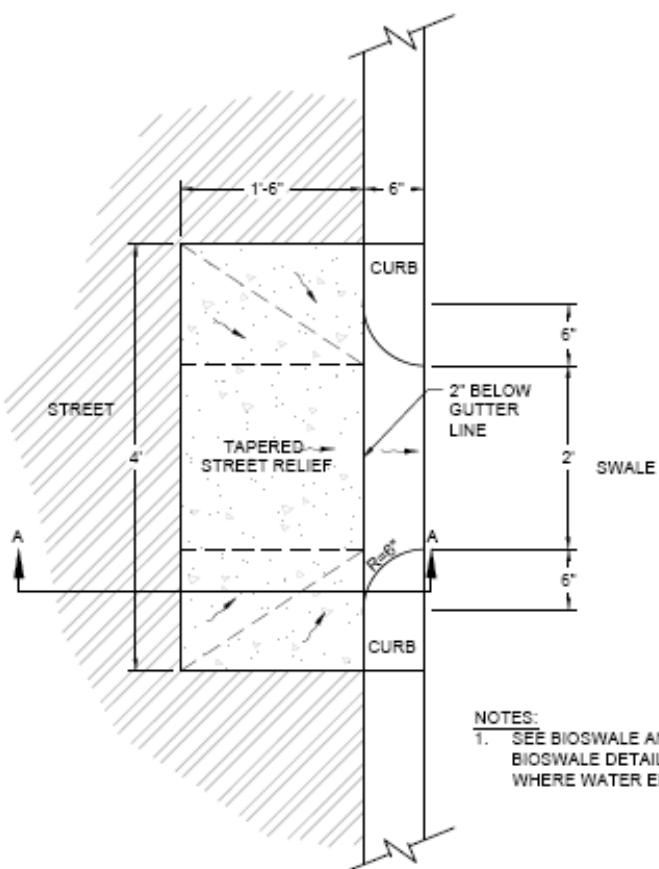
CONSTRUCTION

- Ensure it is located at the low point and water can enter easily.
- Set stones flush to allow water to flow in.
- Watch for sediment accumulation



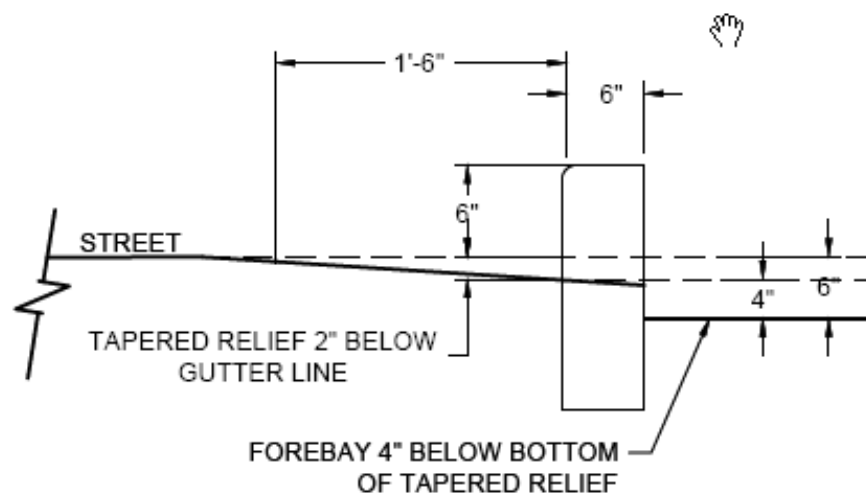


ISOMETRIC



PLAN

- NOTES:**
1. SEE BIOSWALE AND CURB EXTENSION BIOSWALE DETAILS FOR DETAIL ON WHERE WATER ENTERS THE BIOSWALES.



SECTION A-A

CURB INLET DETAIL
NOT TO SCALE

MAINTENANCE

- Clean sediment/lead litter from inlets
- Watch for scouring



LESSONS LEARNED

- Stones prone to clogging
- Curbing increases side slope and depth
- When applicable zero curb
 - Allow for sheet flow
- Diversion structure can problematic for retrofits
- Retrofit existing structures
- Benefits
 - Improved Aesthetics
 - Shallow depth
 - Easier maintenance
 - Reduce cost



2 SWALES & CONVEYANCE



- Grass swales
- Vegetated swales
- Turf reinforced (TRM) swales
- Stone swales



CONSTRUCTION

- Ensure positive drainage
- Check dams to prevent erosion
- No by-pass

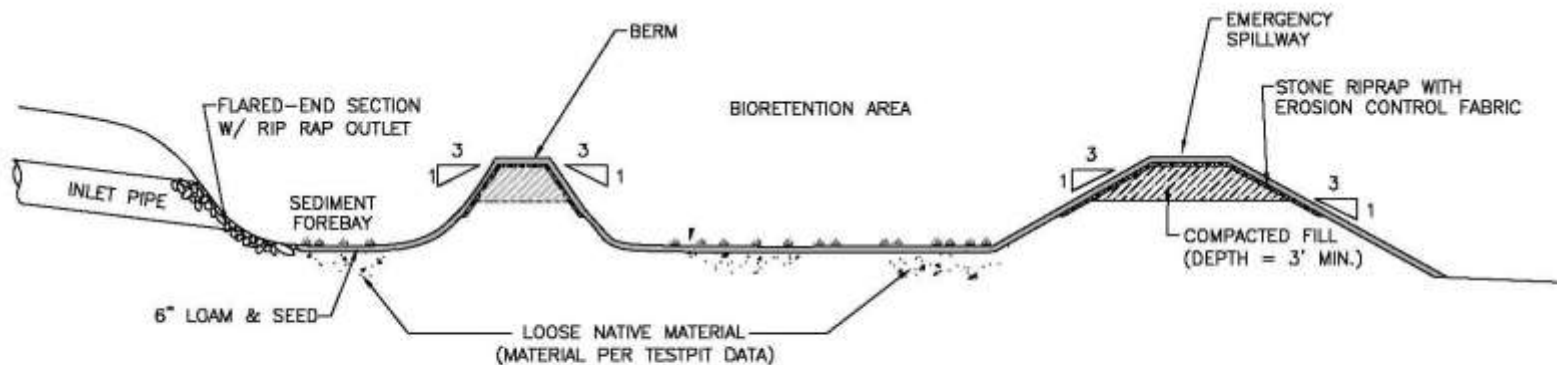


MAINTENACE

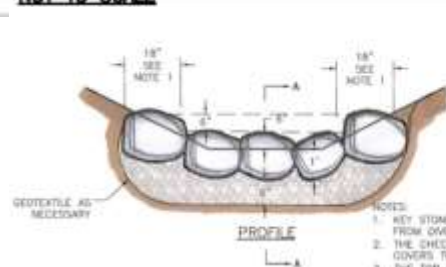
- Debris Cleanout
- Sediment/Organic Debris Removal
- Check for areas of erosion/gullies in the swale, particularly along the swale bottom.
- Repair/reseed as necessary



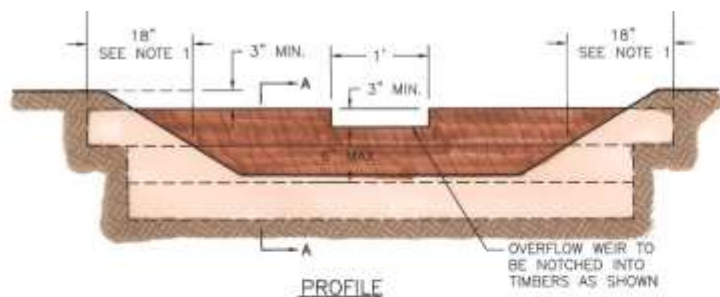
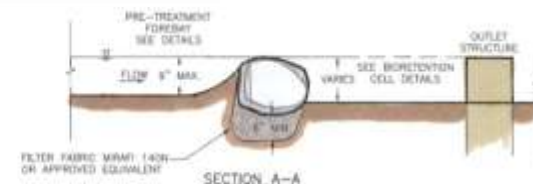




**TYPICAL SECTION THROUGH
BIORETENTION**
NOT TO SCALE



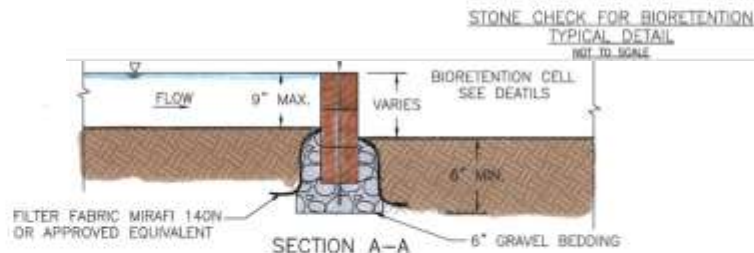
- NOTES:
1. KEY STONE INTO THE BIORETENTION BANKS AND EXTEND INTO THE ABUTMENTS A MINIMUM OF 18" TO PREVENT FLOW FROM OVERTOPPING THE CHECK DAM.
 2. THE CHECK DAM SHALL BE CONSTRUCTED OF 18"-24" STONE. THE STONE SHALL BE PLACED SO THAT IT COMPLETELY COVERS THE WIDTH OF THE BIORETENTION AND KEYED IN THE BIORETENTION BANKS.
 3. THE TOP OF THE CHECK DAM SHALL BE CONSTRUCTED SO THE CENTER IS APPROXIMATELY 8" LOWER THAN THE OUTER EDGES, FORMING A WEIR THAT WATER CAN FLOW ACROSS.
 4. THE MAXIMUM HEIGHT OF THE CHECK DAM AT THE CENTER SHALL NOT EXCEED 8".
 5. THE UPSTREAM SIDE OF THE DAM SHALL BE LINED WITH APPROXIMATELY 1" OF 3/4" TO 1 1/2" CRUSHED AGGREGATE.



NOTES:

1. KEY TIMBERS INTO THE SWALE BANKS AND EXTEND INTO THE ABUTMENTS A MINIMUM OF 18" TO PREVENT FLOW FROM DIVERTING THE CHECK DAM.
2. THE MINIMUM DESIGN CAPACITY SHALL CONVEY A 2 YEAR-24 HOUR PEAK FLOW.

TIMBER CHECK FOR BIORETENTION
TYPICAL DETAIL
NOT TO SCALE



CHECK DAMS



SEDIMENT FOREBAYS



Source:
www.flickr.com/photos/thetransitcamera



Source: Aaron Volkening bioretention Pabst
Brewery



SEDIMENT FOREBAYS



MAINTENANCE

- Remove trash and debris from the surface.
- Signs of erosion gullies, animal burrowing, overtopping or slumping are observed. Repair as necessary.
- Remove sediment accumulation and properly dispose when accumulation is greater than or equal to 3 inches or you cannot see stones.*



LESSONS LEARNED

- Early Designs
 - Inlets/forebays with rip/rap or stone
 - Forebays large/difficult to clean
- Lessons Learned
 - Smaller forebay/more frequent cleaning
 - Use a hardscape smooth surface at the bottom



4

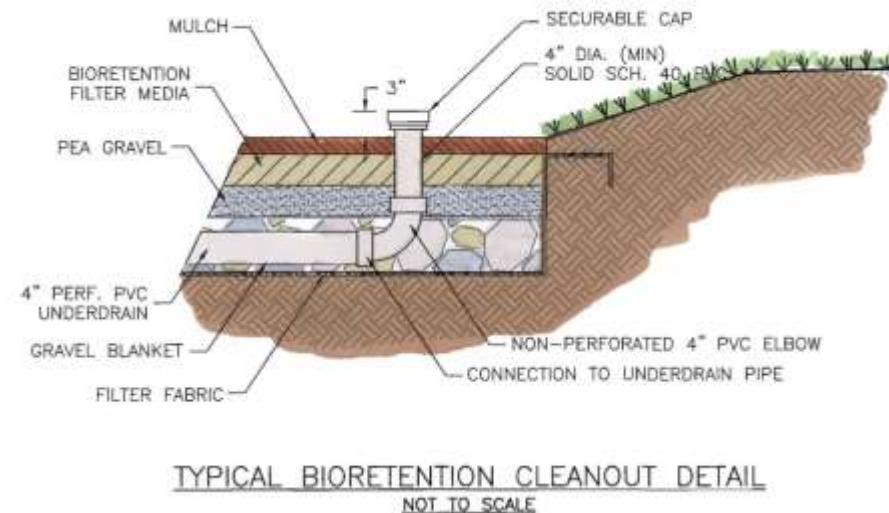
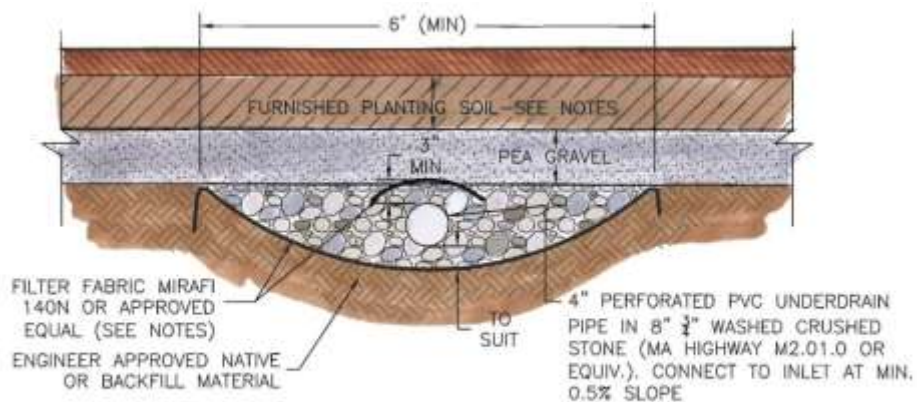
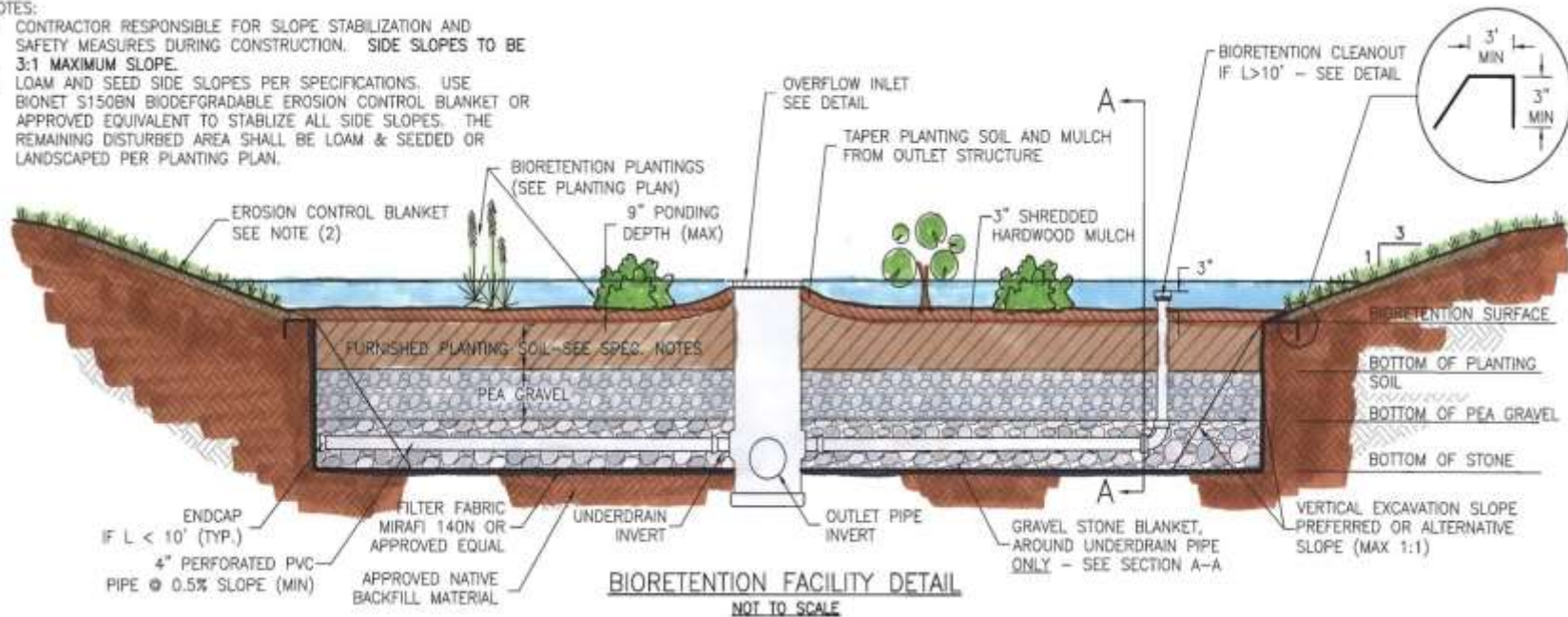
TREATMENT AREAS



CONSTRUCTION ELEMENTS

NOTES:

1. CONTRACTOR RESPONSIBLE FOR SLOPE STABILIZATION AND SAFETY MEASURES DURING CONSTRUCTION. SIDE SLOPES TO BE 3:1 MAXIMUM SLOPE.
2. LOAM AND SEED SIDE SLOPES PER SPECIFICATIONS. USE BIONET S150BN BIODEGRADABLE EROSION CONTROL BLANKET OR APPROVED EQUIVALENT TO STABILIZE ALL SIDE SLOPES. THE REMAINING DISTURBED AREA SHALL BE LOAM & SEED OR LANDSCAPED PER PLANTING PLAN.



GRAVEL UNDERDRAIN JACKET

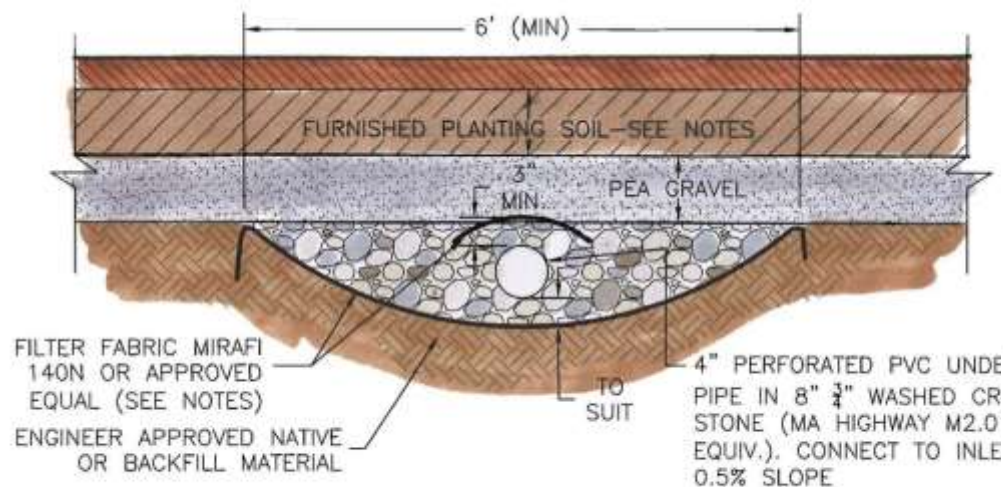
- AASHTO M-43 standard
- Washed, clean and free of all fines



UNDERDRAIN PIPE CLEANOUT

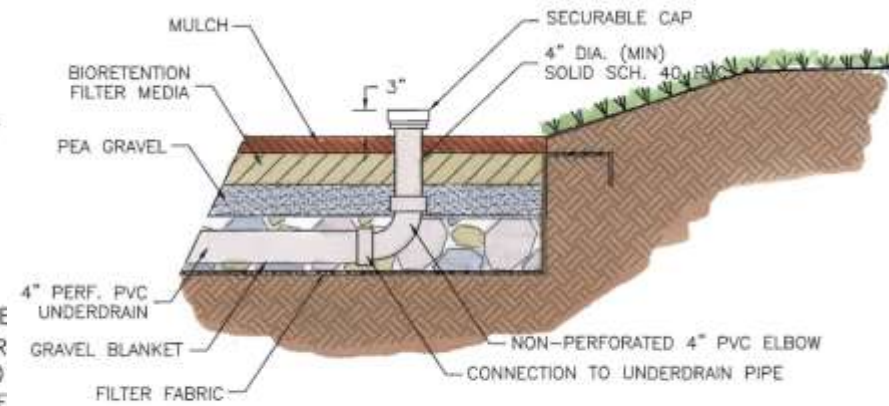


- 4" rigid schedule 40 PVC pipe with 3/8" perforations @ 6" O.C. meeting ASTM D 1785
- T's and Y's as needed depending upon the underdrain configuration



BIORETENTION FACILITY SECTION A-A

NOT TO SCALE



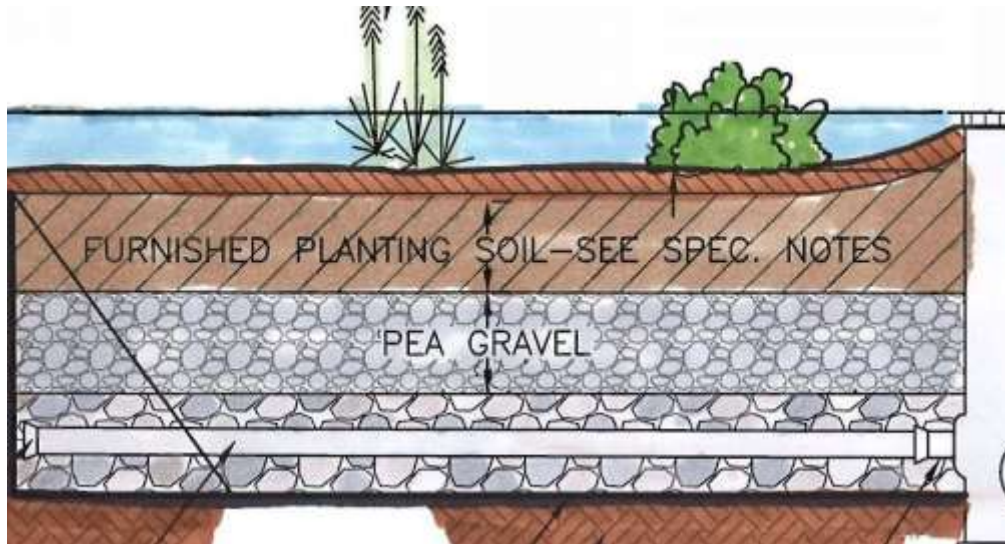
TYPICAL BIORETENTION CLEANOUT DETAIL

NOT TO SCALE

PEA GRAVEL



- 3/8" Washed stone
- Between the soil media layer and approved sub grade, underdrain gravel chambers, etc.



SOIL MIXES



- USDA soil type loamy sand or sandy loam
- Filter Media to contain:
 - 85-88% sand
 - 8-12% Soil Fines
 - < 2% clay
 - 3-5% Organic Matter
- Organic Matter
 - Well aged (6-12 months), well aerated, leaf compost or approved equivalent

MAINTENANCE

- Debris Cleanout
- Signs of erosion gullies, animal burrowing, overtopping or slumping
- Sediment/Organic Debris Removal
- Vegetation Maintenance & Replacement
- Water Draining properly
 - If standing water is observed for more than 48 hours after a storm event maintenance required



LESSONS LEARNED

- Early Designs
 - 6"-12" depth
 - Flat bottom – zero slope
 - Became too deep
 - Side slope stabilization
 - Curb and gutter systems
- Lessons Learned
 - Shallower depth has advantages
 - Use check dams
 - More cells
- Benefit
 - Aesthetics
 - Improved Function
 - Easier Maintenance



Source: Los Angeles Zoo designed by others





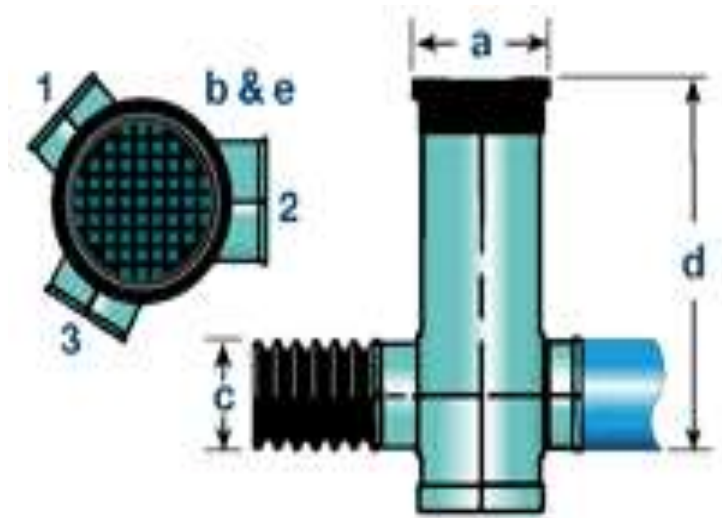
- Overflow/Outlet Structures
- Spillways



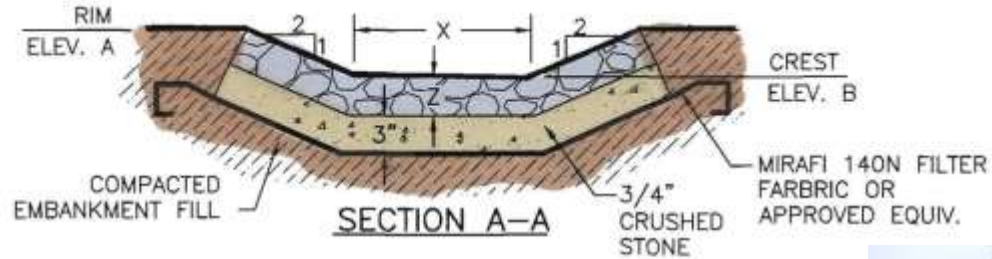
CONSTRUCUTION



- Fiberglass Nyloplast (ADS, Inc.) catch basin structures
 - With frame and grate
- Typically 24" Diameter with main outlet and 1 to 2 underdrain inlets



CONSTRUCUTION



NOTES:

1. FILTER FABRIC SHALL EXTEND AT LEAST 12 INCHES BEYOND THE RIPRAPPED AREA IN ALL DIRECTIONS AND SHALL BE KEYED INTO THE SOIL AS SHOWN.

TYPICAL RIPRAP SPILLWAY DETAIL
NOT TO SCALE



MAINTENANCE

- EMERGENCY SPILLWAYS
 - Check for settling gulling, erosion damage, settling & clogging
 - Repair as necessary and return to design grades
- OVERFLOW STRUCTURE
 - Check for sediment accumulation that impacts inflow. If sediment accumulation. Schedule cleaning
 - Check for leaf litter, debris and inlet clogging



6 SURROUNDING AREA



- Debris Removal
 - Remove trash from perimeter areas.
- Pavement Sweeping
 - Sweep parking lot minimum once a year after spring thaw.
- Drainage Network
 - Ensure proper operation.
- Contributing drainage area stabilized



VEGETATION





WEEDING

- Why Weed?
 - Control invasive plants
 - Promote native non-invasive plant growth
- When to weed?
 - April thru October
 - Monthly
- Do not use chemical herbicides
- Remove by hand
- A list of invasive species can be found at:
 - www.hort.uconn.edu/cipwg
 - <http://www.hort.uconn.edu/cipwg/invplantsCT05.pdf>



WEEDS



Images of Smartweed (*Polygonum* species) at different stages of life



WEEDS



Images of Japanese Knotweed (*Polygonum cuspidatum*) at different stages of life. This is considered an invasive species.



WEEDS



Images of Multiflora Rose (*Rosa multiflora*) This is considered an invasive species.



Images of Oriental Bittersweet (*Celastrus orbiculatus*) This is considered an invasive species.



WEEDS



Foxtail Grass



Crabgrass



Amaranth



Barnyard Grass

PRUNING AND THINNING



- Why Prune?
 - Maintain plant health and vigor
 - Removal of dead or broken wood
 - Encouragement of flowering and fruiting
 - Control of overgrowth of plant material



Image courtesy of Rutgers New Jersey
Agricultural Experiment Station

TOO MOW OR NOT TO MOW ?



THAT IS THE QUESTION ?



WORK WITH NATURE



GRASS SEED/SOD



- Low Mow Fescue, New England Conservation/Wildlife mix or approved equivalent
 - <http://www.newp.com>
- To be used on side slopes and bottoms
- Sod can be used for faster results, but will increase the cost



FERTILIZING

- Fertilization should not be necessary
 - Compromises pollutant reduction effectiveness
 - Leads to weak plant growth
 - Promotes disease and pests
 - Inhibits soil life



SHORT-TERM MAINTENANCE



- Why Inspect?
 - Ensure proper design function after construction
- When to inspect?
 - 6 months period after construction
 - Monthly during an immediately after construction
 - After rain events of 1" and greater

What to inspect?

- Erosion and Gullying
- Grass/Plant growth
- Washouts Inlet flumes or pipes inlets
- Sediment forebay



Bioretention Maintenance Schedule		
<i>General Maintenance</i>		
Task	Frequency	Time of the Year
Site Inspection	<u>Min. once per year & after major storm events.</u>	Spring thru Fall
Debris removal	<u>Min. once per year & after major storm events.</u>	Spring thru Fall
Sediment removal	Min. once per year or when sediment is > 3" in stone-lined swale/sediment forebay; Ensure sediment does not cause blockage of flume inlet	April
<i>Plant Maintenance</i>		
Task	Frequency	Time of the Year
Plant Cutting/Thinning	Annually	Early Spring
Weeding	As needed	April-October
Watering	Drought conditions only	July-August
Plant Replacement	As required	Spring or Fall preferred
Fertilizing	Should not be required	
<i>Mulch Maintenance</i>		
Task	Frequency	Time of the Year
Remove & replace existing mulch	Once every two years or as required	April
Re-mulch void areas	Min. 2x per year & after major storm events as needed	July & November
<i>Filter Bed Maintenance</i>		
Task	Frequency	Time of the Year
Tilling	As needed	If standing water does not drain after 48 hours
Soil Media Replacement	As needed	If standing water does not drain after tilling (see above)
Snow Removal	Not required	Not required

Long Term
Operation
and
Maintenance



INSPECTIONS

- When to inspect?
 - Spring thru fall
 - During the typical routine landscape maintenance:
 - Once per month
 - After large storm events
 - During other extreme weather events
- What to Inspect?
 - Debris Accumulation
 - Sediment build up
 - Weeds and invasive plants
 - Plant and grass health
 - Erosion/Gullyying
 - Inlet/Outlet structure clogging



SEDIMENT & DEBRIS

- When?
 - Upon completion of construction
 - After Construction
- Debris
 - Once per month or as required
- Sediment
 - Minimum of once per year
 - After major storm events
 - After 1" of sediment accumulation.
 - Typically early Spring



SEDIMENT & DEBRIS

- Excessive sediment accumulation
 - Check surrounding site stabilization
- Hand remove with a flat shovel
- If surface becomes clogged
 - Core aerate or cultivate bare areas annually

