Operation and Maintenance Plan

for

Subsurface Gravel Wetland BMP Retrofit for Control of Nitrogen in Stormwater: An EPA Green Infrastructure Demonstration and Outreach Project for Oyster Pond and the Town of Chatham, MA

Intersection of Abesegami Run & Oyster Pond Furlong
Chatham, MA

February 2016

Prepared For:
Town of Chatham
Department of Natural Resources
261 George Ryder Road
Chatham, MA 02633

Prepared By:
Comprehensive Environmental Inc.
225 Cedar Hill Street
Marlborough, MA 017552

Introduction

This Operation and Maintenance (O&M) Plan is prepared for the **Subsurface Gravel Wetland BMP Retrofit constructed for Control of Nitrogen in Stormwater as part of a USEPA Green Infrastructure Demonstration and Outreach Project for Oyster Pond and the Town of Chatham, MA.** Final as-built plans for the project are dated January 2016. The Plan is broken into two main components:

1) A narrative that provides background information on the project and describes the BMP; and
2) Plan elements to be used in performing maintenance of the BMP, included in attachments as follows:

Plan Elements:

Attachment A:	Operations Plan
Attachment B:	Inspection and Maintenance Checklist
Attachment C:	Operation and Maintenance Plans

Background

The Town of Chatham is partnered with the Environmental Protection Agency (EPA) and WaterVision, LLC, and Comprehensive Environmental Inc. (CEI) for a Green Infrastructure (GI) Education and Outreach Project located near Oyster Pond.

Oyster Pond is located on the southeastern part of Chatham and flows into the Oyster Pond River which dumps into Stage Harbor. Oyster Pond has been listed on the state's 303(d) list for several water quality parameters, including high levels of nitrogen. The Total Maximum Daily Load (TMDL) covering these impairments was prepared in February 2008 by the MassDEP. To improve water quality, a combination of wastewater treatment, tidal flushing, nutrient trading, and/or stormwater control and management were recommended to treat and reduce runoff volumes. In response to the TMDL, a Water Quality Management Plan (WQMP) was prepared for Oyster Pond and estuaries that in part recommends stormwater best management practices (BMPs) capable of treating stormwater and improving water quality.

As outlined in the 2003 Massachusetts Estuaries Project Embayment Restoration and Guidance for Implementation Strategies, stormwater transports nutrients, pathogens and bacteria, metals, suspended solids, and other constituents into embayments via point sources (e.g., stormwater outfall pipes) and nonpoint sources (e.g., runoff from fertilizer). Nitrogen compounds are present in the stormwater and eventually discharge into embayments. Anthropogenic sources carried by stormwater include fertilizers (from agricultural, suburban, and urban areas), septic system leachate, farm animal and pet waste, and atmospheric deposition and precipitation of nitrogen compounds from power plants and automobiles. Human activities that attract a concentration of birds can also cause nitrogen loading via stormwater. Stormwater mitigation may be necessary in areas where pollution from stormwater affects local resources such as local fisheries or public swimming beaches.

Goal

The goal of this project is to demonstrate the efficacy of an innovative subsurface gravel wetland stormwater best management practice (BMP) retrofit for the control of nitrogen and improve the water quality of Oyster Pond, Chatham, MA.

Site Location & Description

The project is located at the intersection of Oyster Pond Furlong and Absegami Run, just west of the former and south of the latter. Soils consist of loose, fine sand and some silt. Groundwater depth is located approximately two feet below the native ground surface based on soil borings performed on-site.

Owner and Operator:

BMP Owner:	Town of Chatham
O&M Responsible Party:	Department of Natural Resources
Source of Long Term O&M Funding:	Annual Department Budgets

BMP Description

Design and construction of a stormwater BMP retrofit, consisting of a hybrid bioretention area and subsurface gravel wetland (hereafter, subsurface gravel wetland (SGW); BMP; BMP retrofit) was constructed at the above location. As noted by the UNH Stormwater Center, "the majority of nitrogen washoff in parking lots occurs with the first 0.3-inch of precipitation" (Gunderson et al., 2012). Therefore, the BMP was generally designed according to guidance provided in the Massachusetts Stormwater Manual and modeled using a combination of Autodesk Storm and Sanitary Analysis and University of New Hampshire Stormwater Center guidance to store and treat stormwater from up to a 0.3-inch rainfall event over the impervious area from the contributing 16.9 acre subwatershed (approx. 9.3 acres impervious cover consisting of roadways, driveways and rooftops) that discharges into the existing municipal separate storm sewer system (MS4). MS4 stormwater flow merges to a 24-inch diameter reinforced concrete pipe (RCP) trunk line that runs down Oyster Pond Furlong and eventually discharges to Oyster Pond.

A. BMP Inlet

To feed the BMP, a new deep sump Inlet Control Structure and Pretreatment Manhole (ISCPM), equipped with an oil/water separator, was installed just south of the intersection between Oyster Pond Furlong and Absegami Run and into the existing 24-inch RCP that runs down Oyster Pond Furlong parallel to the site. This structure provides limited pretreatment by removing some sediment and other floatables prior to entering the BMP. A diversion wall was also constructed within this manhole to direct runoff from small stormwater events into the stormwater BMP while allowing storms exceeding BMP capacity to bypass through the existing drainage pipe and continue down Oyster Pond Furlong.

Upon commencement of a storm event, stormwater is collected in upstream catch basins, directed into the 24-inch RCP where it meets the diversion wall in the newly-installed ISCPM. The ISCPM then surcharges by approximately 3-feet, directing low flow events through an oil/water separator hood and into a 10-inch pipe. Diverted stormwater then flows to an Inlet

Sampling Manhole (ISM) which is designed to monitor incoming flows and nitrogen concentrations, and finally into the BMP via a flared end section of pipe onto a riprap pad.

B. Bioretention Area of BMP

Once in the BMP, stormwater will pass through the bioretention portion of the treatment train. The bioretention area consist of 8-inches of a loam and compost mix (biosoil) planted with grass seed for nitrogen uptake through the root systems to provide partial stormwater treatment. This area also functions to oxidize sources of nitrogen, including total nitrogen, in preparation for treatment within the subsurface gravel wetland cell (described below). Side slopes varying from 2H:1V to 3H:1V are grassed and provide surface storage for up to the 0.3-inch storm event. Due to safety concerns, total stormwater depth will not exceed 3-feet.

The bioretention area is partially lined along the bottom with an impervious membrane, and thus stormwater is only allowed to infiltrate through the bioretention soils through an infiltration zone located at the northern end of the BMP. This infiltration zone consists of a permeable mix of gravel, sand, loam, and compost with augmented shredded newspaper[1] to promote and ensure oxidation of nitrogen sources prior to the subsurface gravel wetland cell. An additional perforated riser pipe is present to provide additional infiltration capacity (i.e., infiltration zone bypass) in the event that the infiltration zone gets clogged.

C. Subsurface Gravel Wetland Cell

Once stormwater passes through the infiltration zone or bypasses via the perforated riser pipe, it enters an underlying gravel storage reservoir (or, Internal Storage Reservoir (ISR)). This area consists of a 24-inch deep zone of crushed stone, lined on the sides and bottom of the BMP with an impervious liner to prevent infiltration into native soils and contact between stormwater and groundwater.[2] A 4-inch perimeter drain installed on the eastern side of the liner also helps to drain groundwater from the surrounding area. As stormwater flows north to south through the ISR and towards the BMP outlet, s denitrification occurs. To date, information on the operation of gravel wetland cells indicates that some 24 to 33 hours of treatment time is required for complete denitrification. Typically however, the 0.3 inch storm will 'push out' the prior 0.3 inch storm volume held within the ISR. In this way, the BMP operates not unlike a plug flow reactor.

D. BMP Outlet

Once at the southern (outlet) end of the BMP, stormwater within the ISR drains into a 2-foot diameter high density polyethylene (HDPE) Outlet Control Structure. This structure has two 1-inch outlet orifices, with the first located at the top of the gravel reservoir and the second located approximately six-inches below. Orifices are sized to slowly release stormwater from the BMP over at least a 24-hour period while always maintaining a water level within the subsurface gravel layer. Again, the requisite retention time helps to maximize stormwater contact with anaerobic bacteria and thus provide maximum nitrogen removal. **It is both important and**

[1]In the bioretention area, the compost and newspaper provide a source of 'donor' electrons for microbially-assisted (aerobic) oxidation of nitrogen (ideally to nitrate (NO_3^{2-})), which is subsequently used in the subsurface gravel wetland cell as the source of electrons for microbially-assisted (anaerobic) reduction (i.e., denitrification) of nitrate to, ideally, nitrogen gas (N2).

[2]Because the ISR cell is essentially an anerobic bioreactor, it must be entirely self-contained and isolated from atmosphere to promote anoxic conditions favorable for denitrification.

helpful to understand that retention time of stormwater in the ISR – hence, BMP operation – is partially controlled by the sizing of the outlet orifice(s). Although both the number and sizes of the orifices can be modified, these orifices have already been set for proper BMP operation. In addition, due to potential concerns regarding the presence and breeding of mosquitos, stormwater ponding that occurs after a storm is designed to drain down into the ISR in less than 48 hours.

Stormwater exiting the outlet orifices then flows through a 10-inch pipe into the Outlet Sampling Manhole (OSM) which is designed to monitor outlet flow and nitrogen concentrations, and then into a 4-foot diameter Overflow Structure, which is connected to a new 10-inch HDPE overflow pipe which outlets excess stormwater into a wetland area at the southwest corner of the site. This discharge flow to the wetland eventually intercepts an existing mosquito control ditch in the wetland which in turn merges into a RCP that ties back into the main MS4 RCP trunk line under Oyster Pond Furlong and just prior to discharge to Oyster Pond.

A maintenance access road, accessible from Oyster Pond Furlong, is located along the southern and western edges of the BMP to facilitate maintenance access. This roadway has an integrated emergency overflow spillway consisting of 2-inch to 4-inch crushed stone.

Attachment A:
Operations Plan

Operations Plan

Project: Subsurface Gravel Wetland BMP Retrofit for Control of Nitrogen in Stormwater: An EPA Green Infrastructure Demonstration and Outreach Project for Oyster Pond and the Town of Chatham, MA

Location: Intersection of Abesegami Run and Oyster Pond Furlong

This BMP has been designed with several adjustable features to allow fine tuning of stormwater flow into and out of the BMP. Items and procedures are outlined in detail below.

CAUTION!

ALTERING ANY OF THE FOLLOWING CAN SEVERLY IMPACT THE FUNCTION OF THE BMP. IT IS HIGHLY RECOMMENDED THAT COMPREHENSIVE ENVIRONMENTAL, INC. BE CONTACTED AT 800-725-2550 PRIOR TO MAKING ANY ALTERATIONS.

O&M Calibration

As construction, operation and maintenance of this BMP is part of a pilot program, the first year of operation (fall 2015 through summer 2016) will consist of some fine-tuning to optimize BMP functionality. Due to space constraints for this retrofit project, a typical sediment forebay could not be constructed. Instead, a deep-sump manhole (Inlet Control Structure and Pretreatment Manhole) was installed to provide some sediment removal prior to entering the BMP. As the system is designed to surcharge before entering the BMP, it is possible that sediment could accumulate in the deep sump manhole and against the diversion wall, potentially impacting stormwater flow capacity. The manhole should be inspected at least quarterly during the first year of operation to establish a benchmark for sediment removal.

Additionally, the BMP should be periodically inspected after large storm events (>1") to ensure that it is draining in MORE THAN 24-hours but LESS THAN 48 hours. Should either condition occur, the Outlet Control Structure should be modified as outlined in the Outlet Control Structure section.

Inlet Control Structure and Pretreatment Manhole Diversion Wall

Description:

The Inlet Control Structure and Pretreatment Manhole (ICSPM) is equipped with a diversion wall to direct a portion of stormwater from the municipal separate storm sewer system (MS4) 24-inch diameter RCP trunk line either (a) into the BMP or (b) to bypass the BMP and flow into Oyster Pond. The center portion of the wall is constructed of stoplogs which may either be added or removed to increase or decrease

stormwater flow into the BMP. The top of the wall is designed to be at elevation 16.40 (NAVD88 datum), or approximately 3.2-feet above the 24-inch inlet pipe invert. At this elevation, the BMP ponding capacity will store the entire 0.3-inch storm event. At lower diversion wall elevations, storage will be decreased and bypass events will be more frequent.

Procedure in the Event of Excessive Winter Sand Accumulation:

It is expected that sediment accumulation will be highest during the winter and spring months due to winter sanding operations conducted on upstream roadways. Should sediment accumulation during these months exceed the maintenance abilities of the Town, the stoplogs could be removed prior to winter sanding operations (approximately November) and reinstalled at the conclusion (approximately April).

Procedure in the Event of BMP Flooding:

Should the BMP flood or otherwise fail to sufficiently pass large storm events, one or more stoplogs may be temporarily removed to allow for additional unrestricted flow. Stop logs should only be removed one at a time. For each stop log modification, evaluate BMP function during at least two future rain events before determining whether or not additional stoplogs must be removed. Removal of stoplogs is not a long-term fix for reoccurring problems since it reduces the efficiency of the BMP to remove stormwater pollutants. If a situation occurs that requires the long-term removal of stoplogs to prevent flooding or failure, contact CEI for BMP evaluation. In the event of a forecasted very large storm event (e.g. hurricane, 100-year event), it is recommended that the stoplogs be removed prior to the event to protect BMP integrity. Although designed to safely handle large storm events, very large events that overwhelm the upstream drainage system may cause undesired effects, particularly if accompanied by an oceanic storm surge event.

Effect:

Note that stormwater storage is key to nitrogen removal, and by removing stoplogs the storage capacity of the BMP will be reduced below the design storage volume. Stoplogs should only be removed if stormwater bypass capacity is insufficient during large storm events and causing issues such as flooding, system surcharging, erosion, etc.

Maintenance Item	Effect	To Be Used When
a. Remove stoplogs	Reduces stormwater storage capacity of the BMP	• If excessive winter sand is accumulating during winter and spring months, impacting drainage system functionality. • If adverse effects such as flooding, surcharging, or insufficient flow. • If a very large storm event is forecasted (e.g. hurricane, 100-year event).
b. Replace stoplogs	Increases stormwater storage capacity of the BMP	• If previously removed prior to commencement of winter sanding. • If insufficient stormwater is remaining in the BMP. • At the conclusion of a very large storm event.

Outlet Control Structure

Description:

The outlet control structure is currently equipped with two 1-inch diameter holes, with the first located at the top of the underground gravel cell and the second located approximately six inches lower. The combined orifices are designed to drain the aboveground portion within 24 to 48 hours.

Procedure in the Event the BMP is Draining in less than 24-hours:

Should the aboveground bioretention area drain too fast, one or more holes should be plugged to decrease outlet capacity. Note that holes should only be plugged one at a time. Evaluate BMP function during at least three future rain events before determining whether or not additional plug(s) are needed.

Procedure in the Event the BMP is Not Draining within 48-hours:

Should the aboveground bioretention area fail to drain within the desired timeframe, an additional hole(s) may be cored within the sidewalls of the HDPE structure. Note that holes should be small diameter (1-inch or less) and only be cored one at a time. Evaluate BMP function during at least three future rain events before determining whether or not additional hole(s) are needed.

Effect:

Note that residence time is key to nitrogen removal, and the **BMP should not drain in LESS than 24-hours or MORE THAN 48-hours**. If this occurs, one or more holes will need to be plugged, unplugged, or cored until the BMP retains at least some water for the desired timeframe.

Maintenance Item	Effect	To Be Used When
a. Unplug existing hole	Reduces stormwater retention time of the BMP	• If BMP is taking more than 48-hours to drain dry.
b. Core new holes	Reduces stormwater retention time of the BMP	• If BMP is taking more than 48-hours to drain dry and the existing two 1-inch diameter holes provide insufficient flow when unplugged.
c. Plug holes	Increases stormwater retention time of the BMP	• If stormwater BMP is draining in less than 24-hours.

Attachment B:
Inspection and Maintenance Checklist

Inspection and Maintenance Checklist

Project: Subsurface Gravel Wetland BMP Retrofit for Control of Nitrogen in Stormwater: An EPA Green Infrastructure Demonstration and Outreach Project for Oyster Pond and the Town of Chatham, MA

Location: Intersection of Abesegami Run and Oyster Pond Furlong

Name of Person Conducting Inspection: _____ **Date of Inspection:** _____

Maintenance Item	Action	Frequency	Satisfactory/ Unsatisfactory	Comments
1. MS4 and Inlet Control Structure and Pretreatment Manhole (ICSPM)				
Structural condition	Visually inspect overflow riser for structural integrity. Repair or replace if necessary.	Inspect minimum of once a year.		
Inlet and outlet pipes	Ensure inlet and outlet pipes are clear of debris and free flowing.	Inspect spring & fall.		
Sediment accumulation	Check for excess sediment accumulation within the sump. Note depth in comments. Remove if necessary.	Inspect quarterly for the first year. Establish a schedule based on first year accumulation (min. 1x/yr).		
Debris and litter removal	Inspect for floatable debris or other materials behind the diversion wall. Remove if necessary.	Inspect spring & fall. Remove as needed.		
Diversion weir integrity	Inspect diversion weir for structural integrity and repair if necessary.	Inspect spring and fall.		
Stoplog removal (if needed, see Operations Plan)	Remove stoplogs at the end of the fall season to allow unrestricted water passage during freezing months.	Once in fall (if required, see Operations Plan).		
Stoplog replacement (if needed, see Operations Plan)	Reinsert stoplogs at the conclusion of freezing weather, typically at the start of spring.	Once in spring (if required, see Operations Plan).		
Oil-water separator hood	Verify that the oil/water separator hood is in place. Repair or replace if necessary.	Inspect spring and fall. Repair or replaced as needed.		

Inspection and Maintenance Checklist

Project: Subsurface Gravel Wetland BMP Retrofit for Control of Nitrogen in Stormwater: An EPA Green Infrastructure Demonstration and Outreach Project for Oyster Pond and the Town of Chatham, MA

Location: Intersection of Abesegami Run and Oyster Pond Furlong

Maintenance Item	Action	Frequency	Satisfactory/ Unsatisfactory	Comments
1. MS4 and Inlet Control Structure and Pretreatment Manhole (ISCPM) (continued)				
Upgradient catch basins	Inspect catch basins upgradient of BMP for sediment accumulation. Remove sediment from catch basins as required.	Inspect spring after winter sanding operations, and fall. Remove sediment as needed.		
2. Surface Bioretention Area				
Sediment accumulation	Visually inspect bioretention area to ensure that there is no sediment build-up.	Inspect quarterly. Establish a schedule based on first year accumulation (min. 1x/yr). Do not let sediment build up to 12 inches at any spot or completely cover vegetation.		
Debris & litter removal	Inspect for the presence of floatable debris or other materials within the surface BMP. Remove if necessary.	Inspect spring and fall. Remove as needed.		
Standing water	Verify that standing water is not present for more than 48 hours.	Twice a year, 48 hours after a storm.		
Erosion	Inspect area to ensure that there is no erosion, channelization or scouring, particularly near high velocity areas. Regrade as needed.	Inspect spring and fall. Regrade as needed.		
Flared end & riprap pad	Inspect flared end section and riprap pad to ensure stone is not displaced or filled with sediment. Remove sediment as necessary.	Inspect spring and fall. Repair or maintain as needed.		
Animal burrows	Inspect side slopes and surrounding area for animal burrows, holes, or other damage.	Inspect spring and fall, or more frequently if persistent damage is found. Repair or maintain as needed.		

Inspection and Maintenance Checklist

Project: Subsurface Gravel Wetland BMP Retrofit for Control of Nitrogen in Stormwater: An EPA Green Infrastructure Demonstration and Outreach Project for Oyster Pond and the Town of Chatham, MA

Location: Intersection of Abesegami Run and Oyster Pond Furlong

Maintenance Item	Action	Frequency	Satisfactory/ Unsatisfactory	Comments
3. Subsurface Gravel Wetland Cell (ISR)				
Inlet stand pipe	Check vertical standpipe for leaves and debris to ensure that the system is not obstructed.	Spring and fall.		
Outlet control structure	Inspect outlet control structure and verify that 1" orifice(s) are free flowing.	Spring and fall.		
Proper function of wetland	Visually inspect the infiltration area just in front of the vertical standpipe. Ensure that it is adequately draining water and is not filled with sediment.	Twice a year, 72 hours after a storm.		
4. Overflow Structure				
Structural condition	Visually inspect overflow riser for structural integrity (cracking, signs of collapse, etc.) Repair or replace if necessary.	Minimum once a year.		
Inlet & outlet pipes	Ensure inlet & outlet pipes are clear of debris & free flowing.	Inspect spring and fall. Remove as needed.		
Overflow grate clear of debris	Ensure overflow grate is clear of debris and is functioning properly.	Inspect spring and fall. Remove as needed.		
Perimeter drain	Ensure perimeter drain inlet orifice is clear of debris and free flowing.	Inspect spring and fall. Remove as needed.		
5. Vegetation and Plantings				
Vegetation cover adequate	Inspect bioretention side slopes for adequate vegetation coverage. Re-seed and water bare areas as necessary.	Minimum once a year.		

Inspection and Maintenance Checklist

Project: Subsurface Gravel Wetland BMP Retrofit for Control of Nitrogen in Stormwater: An EPA Green Infrastructure Demonstration and Outreach Project for Oyster Pond and the Town of Chatham, MA

Location: Intersection of Abesegami Run and Oyster Pond Furlong

Maintenance Item	Action	Frequency	Satisfactory/ Unsatisfactory	Comments
5. Vegetation and Plantings (continued)				
Vegetation suitably watered	Inspect vegetation health during dry conditions, particularly new plantings. Water thoroughly on a daily basis until health is reestablished.	Inspect during dry conditions (>7 days of no rain).		
Remove excess vegetation	Inspect for grass clippings and dead vegetation and remove.	Inspect monthly during growing season. Remove as needed.		
Invasive species absent	Inspect for invasive species encroachment. Remove if necessary.	Inspect monthly during growing season. Remove as needed.		
Weeds absent	Inspect for weed growth in the basin & around plants. Remove as required, at least twice per year.	Inspect monthly during growing season. Remove as needed (minimum twice/year).		
No evidence of insect infestation	Visually inspect for insect infestation. Treat with environmentally friendly pesticides.	Inspect monthly during growing season. Treat as needed.		

Additional Comments:

Action(s) to be Taken (Complete a Maintenance Record Form when any Maintenance is performed):

Inspection and Maintenance Checklist

Project: Subsurface Gravel Wetland BMP Retrofit for Control of Nitrogen in Stormwater: An EPA Green Infrastructure Demonstration and Outreach Project for Oyster Pond and the Town of Chatham, MA

Location: Intersection of Abesegami Run and Oyster Pond Furlong

Maintenance Record

Date(s) of Maintenance:	**Maintained By:**
Date of Previous Maintenance:	**Material Hauled Away By:**
Maintenance Item & Type of Maintenance*:	**Material Sent To:**
	Depth of Material Removed:
	Volume of Material Removed:
	Material Description:
Comments:	

*Types of Maintenance: 1) Debris & Litter Removal 2) Sediment Removal 3) Structural Integrity / Repairs

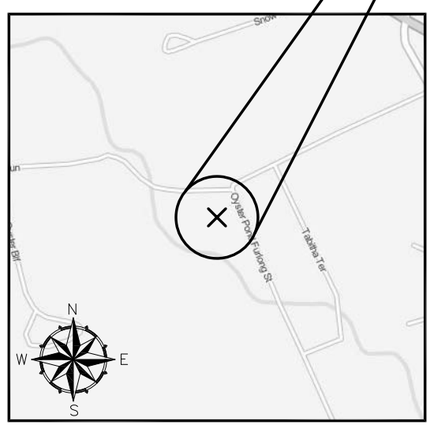
Attachment C:
Operation and Maintenance Plans

EPA Green Infrastructure
Stormwater BMP Retrofit for Two Cape Cod Municipalities
A Demonstration and Outreach Project

CHATHAM, MA
JANUARY 2016 - OPERATIONS AND MAINTENANCE

CHATHAM, MA
Oyster Pond BMP - Gravel Bioretention Cell,
Oyster Pond Furlong & Absegami Run

SHEET	TITLE
C-1	BMP LAYOUT
C-2	LANDSCAPING
C-3	DETAILS

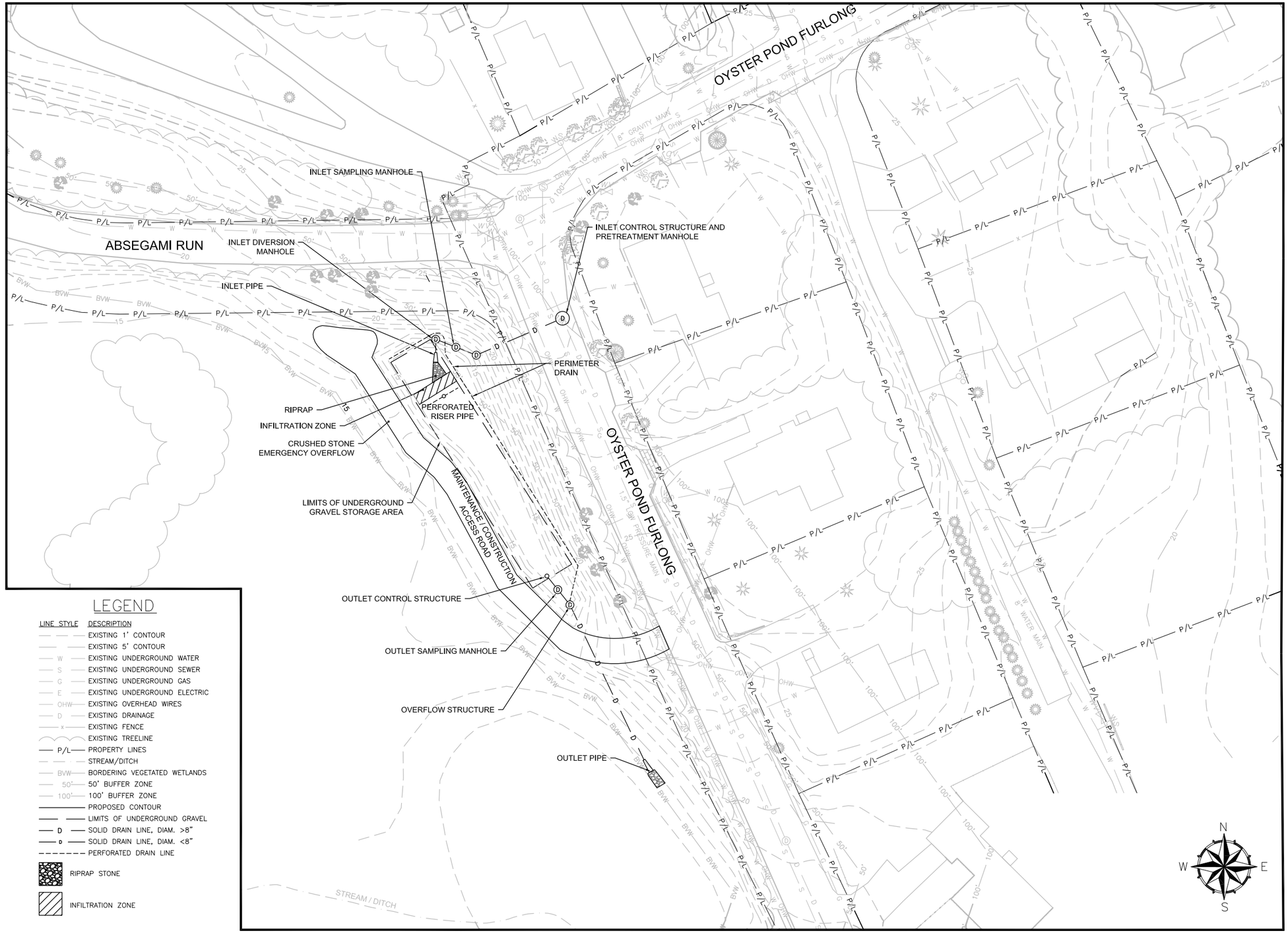


PROJECT LOCATION
SCALE: 1" = 200'

EPA United States Environmental Protection Agency, Region 1
5 POST OFFICE SQUARE, SUITE 100
BOSTON, MA 02109

WaterVision, LLC
481 GREAT ROAD, SUITE 3
ACTON, MA 01720

COMPREHENSIVE ENVIRONMENTAL INCORPORATED
21 DEPOT STREET
MERRIMACK, NH 03054



LEGEND

LINE STYLE	DESCRIPTION
	EXISTING 1' CONTOUR
	EXISTING 5' CONTOUR
W	EXISTING UNDERGROUND WATER
S	EXISTING UNDERGROUND SEWER
G	EXISTING UNDERGROUND GAS
E	EXISTING UNDERGROUND ELECTRIC
OHW	EXISTING OVERHEAD WIRES
D	EXISTING DRAINAGE
x	EXISTING FENCE
	EXISTING TREELINE
P/L	PROPERTY LINES
	STREAM/DITCH
BVW	BORDERING VEGETATED WETLANDS
50'	50' BUFFER ZONE
100'	100' BUFFER ZONE
	PROPOSED CONTOUR
	LIMITS OF UNDERGROUND GRAVEL
D	SOLID DRAIN LINE, DIAM. >8"
d	SOLID DRAIN LINE, DIAM. <8"
	PERFORATED DRAIN LINE

RIPRAP STONE

INFILTRATION ZONE

0 20 40 60

SCALE: 1"=20'

BMP LAYOUT

General Notes

No.	Revision/Issue	Date
6	Design for Const. As-Built	11/15
5	Revised Design for Const.	06/15
4	100% Design for Const.	04/15
3	90% Design	03/15
2	60% Design	02/15
1	Conceptual	01/15

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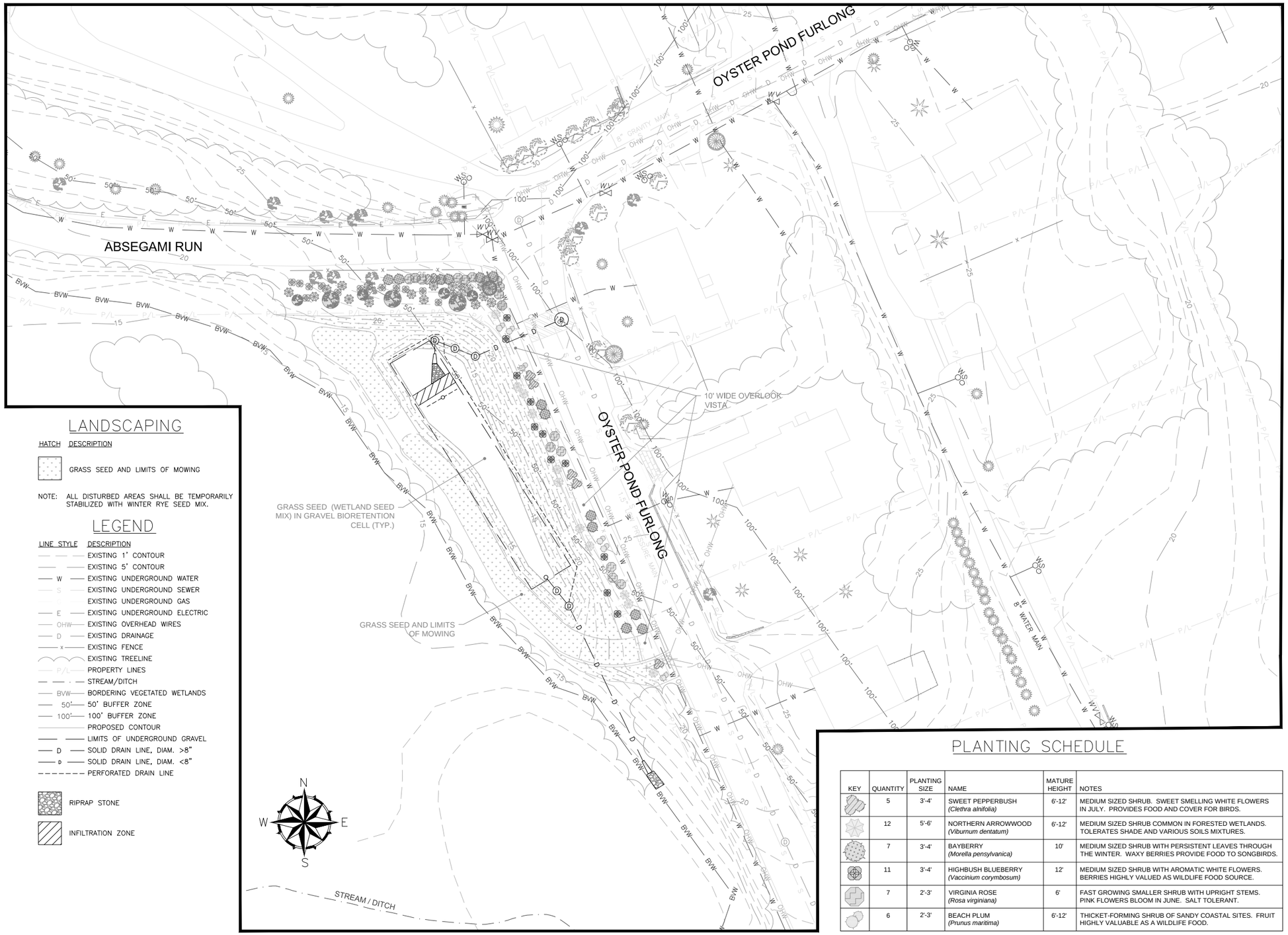
EPA Green Infrastructure Education and Outreach Project

OYSTER POND BMP, GRAVEL BIORETENTION CELL

Oyster Pond Furlong and Absegami Run, Chatham, MA

Project No.: 677-2	Sheet
Date: NOVEMBER 2015	C-1
Drawn By: NC	
Checked By: ML	
Horizontal Datum: NAD88	
Vertical Datum: NAVD88	



LANDSCAPING

HATCH	DESCRIPTION
	GRASS SEED AND LIMITS OF MOWING

NOTE: ALL DISTURBED AREAS SHALL BE TEMPORARILY STABILIZED WITH WINTER RYE SEED MIX.

LEGEND

LINE STYLE	DESCRIPTION
	EXISTING 1' CONTOUR
	EXISTING 5' CONTOUR
W	EXISTING UNDERGROUND WATER
S	EXISTING UNDERGROUND SEWER
G	EXISTING UNDERGROUND GAS
E	EXISTING UNDERGROUND ELECTRIC
OHW	EXISTING OVERHEAD WIRES
D	EXISTING DRAINAGE
x	EXISTING FENCE
	EXISTING TREELINE
P/L	PROPERTY LINES
	STREAM/DITCH
BVW	BORDERING VEGETATED WETLANDS
50'	50' BUFFER ZONE
100'	100' BUFFER ZONE
	PROPOSED CONTOUR
	LIMITS OF UNDERGROUND GRAVEL
D	SOLID DRAIN LINE, DIAM. >8"
D	SOLID DRAIN LINE, DIAM. <8"
	PERFORATED DRAIN LINE
	RIPRAP STONE
	INFILTRATION ZONE

0 20 40 60

SCALE: 1"=20'

PLANTING SCHEDULE

KEY	QUANTITY	PLANTING SIZE	NAME	MATURE HEIGHT	NOTES
	5	3'-4'	SWEET PEPPERBUSH *(Clethra alnifolia)*	6'-12'	MEDIUM SIZED SHRUB. SWEET SMELLING WHITE FLOWERS IN JULY. PROVIDES FOOD AND COVER FOR BIRDS.
	12	5'-6'	NORTHERN ARROWWOOD *(Viburnum dentatum)*	6'-12'	MEDIUM SIZED SHRUB COMMON IN FORESTED WETLANDS. TOLERATES SHADE AND VARIOUS SOILS MIXTURES.
	7	3'-4'	BAYBERRY *(Morella pensylvanica)*	10'	MEDIUM SIZED SHRUB WITH PERSISTENT LEAVES THROUGH THE WINTER. WAXY BERRIES PROVIDE FOOD TO SONGBIRDS.
	11	3'-4'	HIGHBUSH BLUEBERRY *(Vaccinium corymbosum)*	12'	MEDIUM SIZED SHRUB WITH AROMATIC WHITE FLOWERS. BERRIES HIGHLY VALUED AS WILDLIFE FOOD SOURCE.
	7	2'-3'	VIRGINIA ROSE *(Rosa virginiana)*	6'	FAST GROWING SMALLER SHRUB WITH UPRIGHT STEMS. PINK FLOWERS BLOOM IN JUNE. SALT TOLERANT.
	6	2'-3'	BEACH PLUM *(Prunus maritima)*	6'-12'	THICKET-FORMING SHRUB OF SANDY COASTAL SITES. FRUIT HIGHLY VALUABLE AS A WILDLIFE FOOD.

LANDSCAPING

General Notes

No.	Revision/Issue	Date
7	Landscaping Design As-Built	11/15
6	Landscaping Design	08/15
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EPA Green Infrastructure Education and Outreach Project

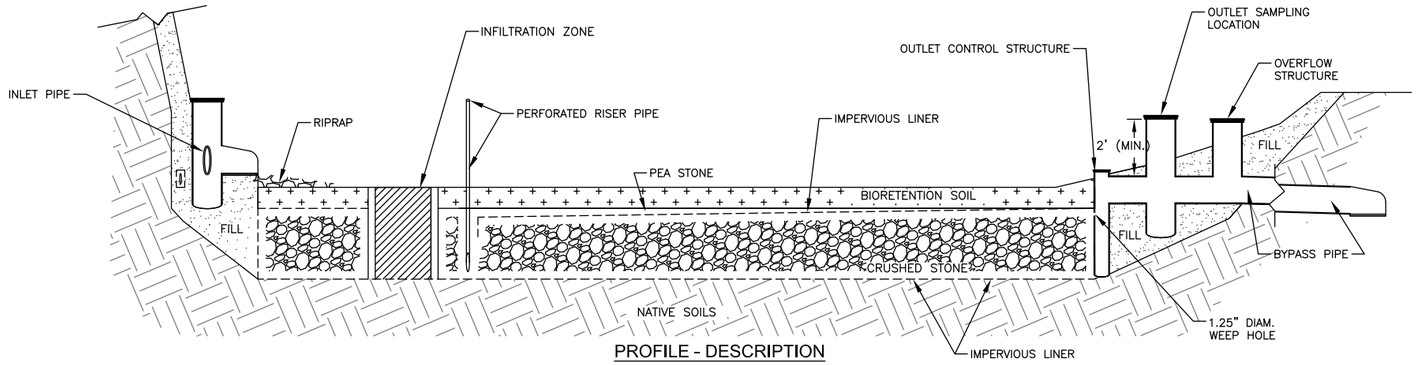
OYSTER POND BMP, GRAVEL BIORETENTION CELL

Oyster Pond Furlong and Absegami Run, Chatham, MA

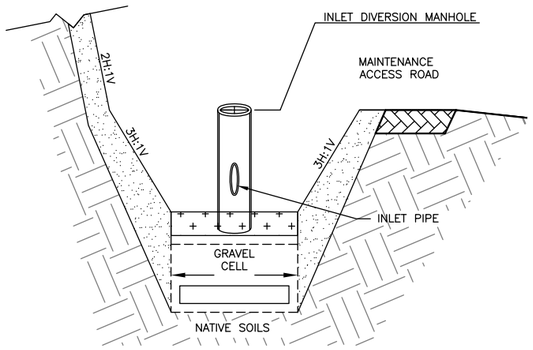
Project No.:	677-2
Date:	NOVEMBER 2015
Drawn By:	NC
Checked By:	ML
Horizontal Datum:	NAD88
Vertical Datum:	NAVD88

Sheet C-2

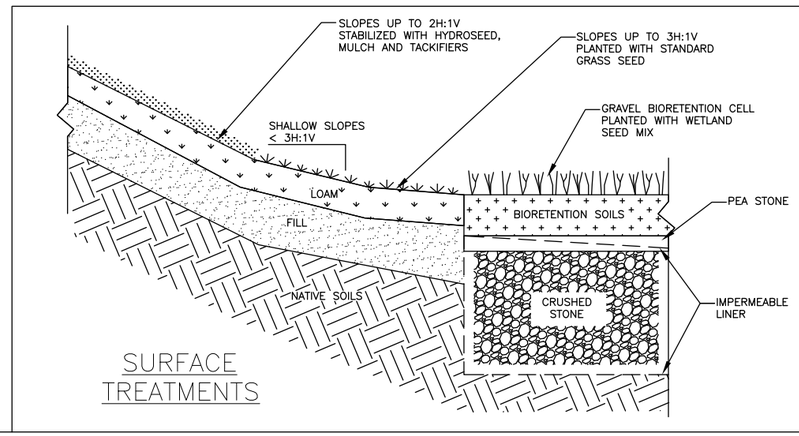
STORMWATER BMP DETAILS



PROFILE - DESCRIPTION

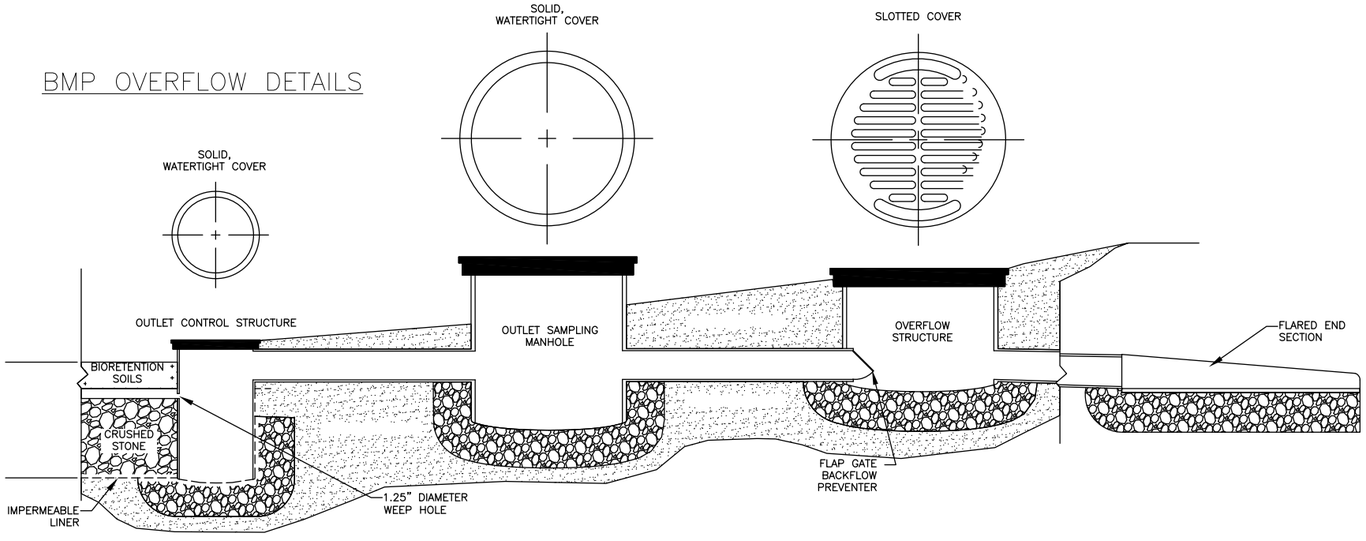


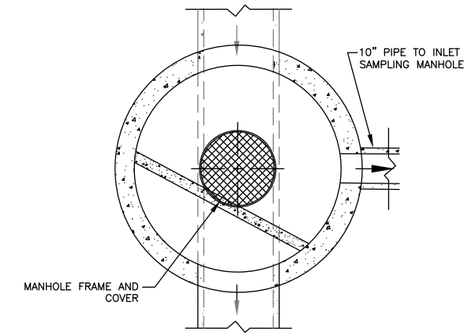
CROSS-SECTION A-A - DESCRIPTION



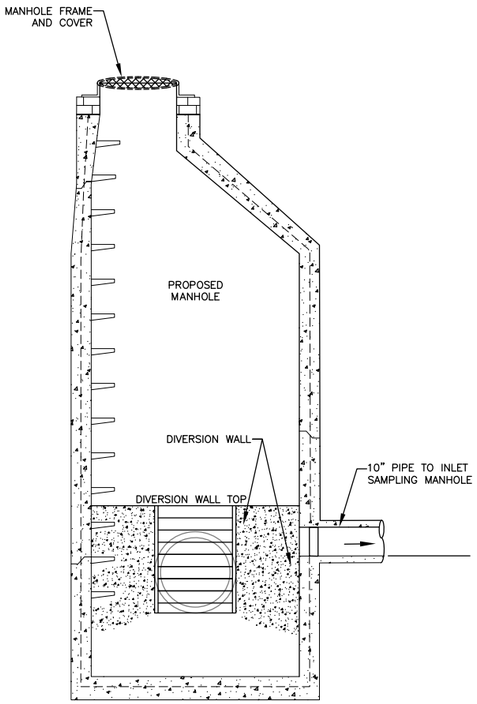
SURFACE TREATMENTS

BMP OVERFLOW DETAILS





TOP VIEW



ELEVATION VIEW

INLET CONTROL STRUCTURE AND PRETREATMENT MANHOLE

General Notes

No.	Revision/Issue	Date
6	As-Builts	11/15
5	Revised Design for Const.	06/15
4	100% Design for Const.	04/15
3	90% Design	03/15
2	60% Design	02/15
1	Conceptual	01/15

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EPA Green Infrastructure Education and Outreach Project

OYSTER POND BMP, GRAVEL BIORETENTION CELL

Oyster Pond Furlong and Absegami Run, Chatham MA

Project No.: 677-2	Sheet
Date: NOVEMBER 2015	C-3
Drawn By: NC	
Checked By: ML	
Horizontal Datum: NAD88	
Vertical Datum: NAVD88	

DETAILS