

UNH Stormwater Center Update and Completed Tasks

Tisbury, MA

2/28/2020



Figure 1: Tisbury, MA watersheds of the completed conceptual BMP designs as numbered in this report.

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BMP 1: Beach Street Extension

Beach Street Extension was the site described by town and public works staff as top priority. The intersection of Five Corners just west of the outfall saw frequent nuisance flooding due to high volumes of runoff, steep slopes, and high impervious cover upstream in the watershed, as well as a frequently clogged or submerged tidal outfalls. The public works staff stated that maintenance before storms included digging into the sand with a backhoe to clear the outfalls. They were nearly completely filled with sand during every site visit during high and low tides. One of the three outfall pipes was never located under the sand. The proposed concept design's objective was to reduce the clogging of tidal sand and backpressure during high tides as well as give an easy access point for maintenance on the street instead of the beach. The watershed, as calculated in GIS, was very large due to storm sewer network which extended up gradient.

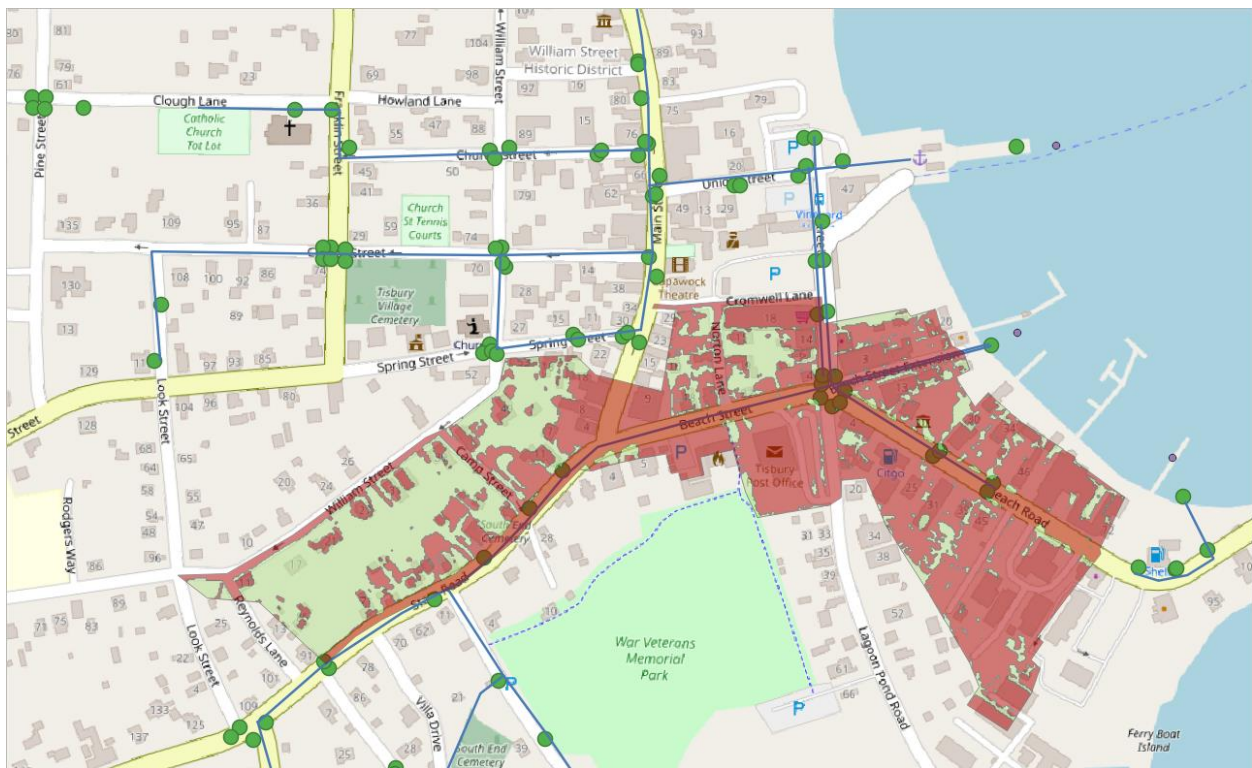


Figure 2: Watershed with impervious cover shown in red to Five Corners intersection upstream of BMP 1.

Figure 2 shows the large watershed and great areas of impervious cover (IC) contributing to Five Corners. While BMPs 2-3 aim to reduce the volume of runoff that reaches the intersection, BMP 1 was designed to reduce the clogging and keep the outfall clear and free-flowing. The following three design pages show the conceptual designs developed by UNHSC and given to MA DOT as the owners of this road and storm sewer system.

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Beach Street Extension

Tisbury, MA

May, 2019

UNH Stormwater Center



Conceptual Design Approach v3

(NOT FOR CONSTRUCTION)

Drawn By: DRM

Reviewed By: JJH

Approved By:

Date: May 15, 2019

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Sheet 1: Title Sheet

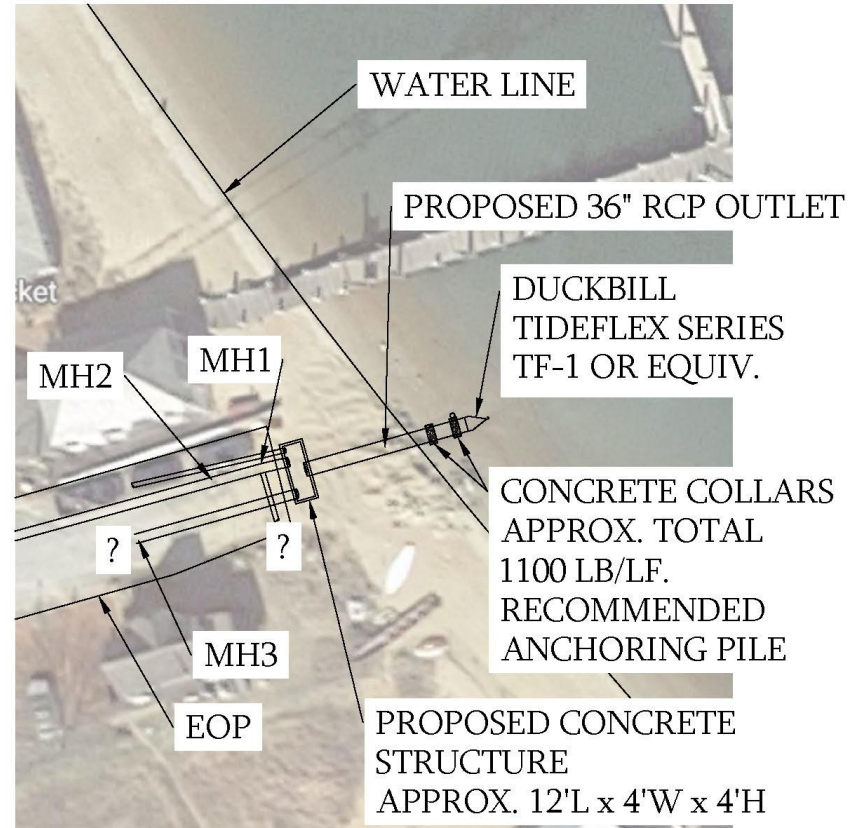
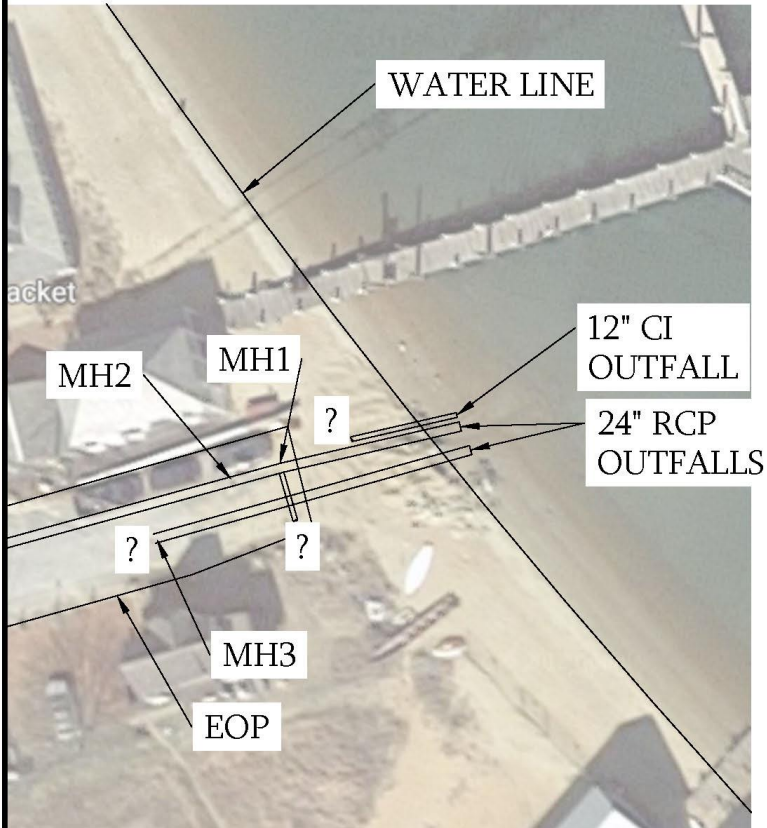
Sheet 2: Plan Overview

Sheet 3: Box Detailed View

EXISTING CONDITIONS

PROPOSED DESIGN

NOTE: DIMENSIONS AND LOCATIONS ARE APPROXIMATE AND MAY VARY. MUST FIELD VERIFY LOCATIONS



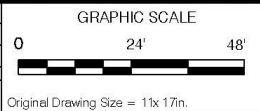
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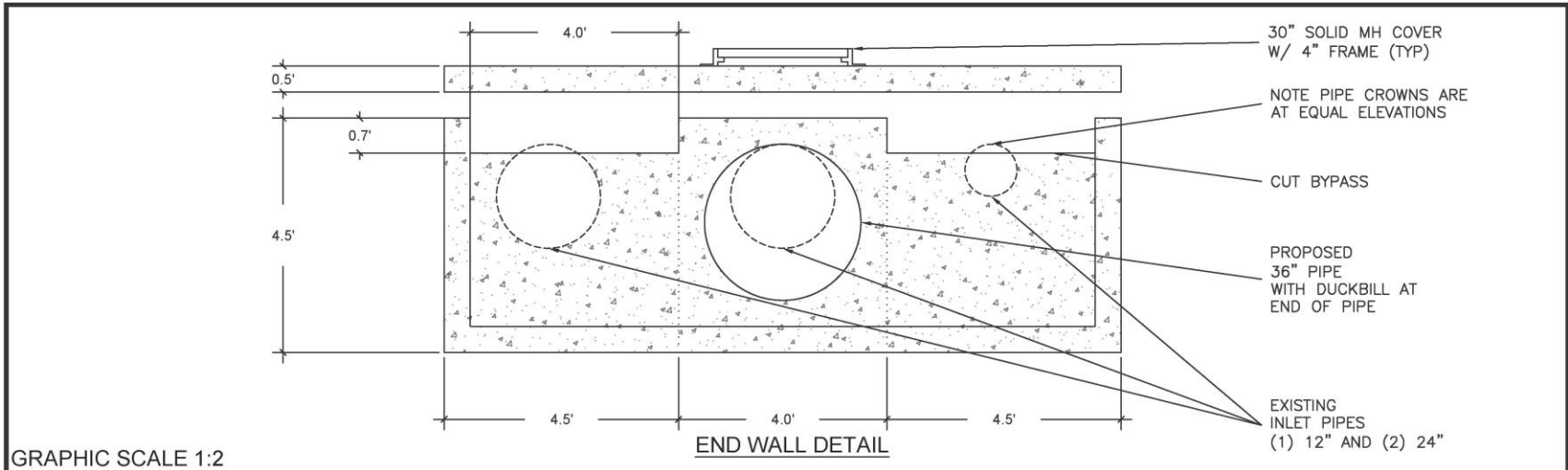
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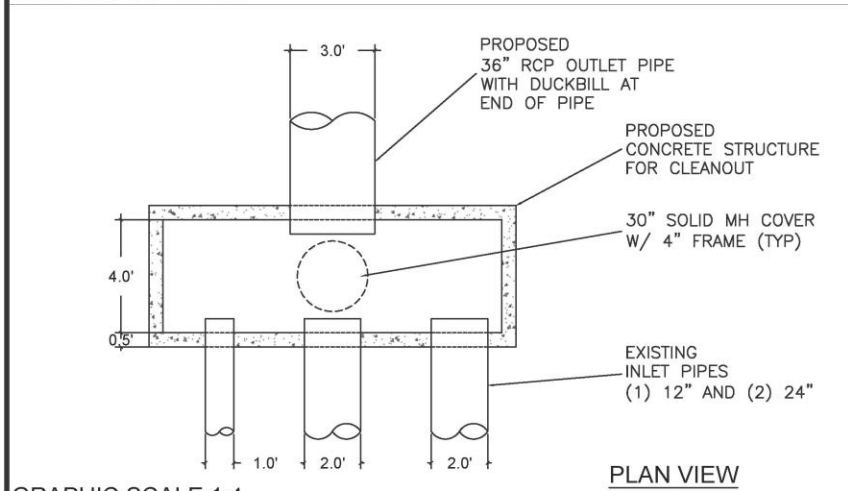


Project: **PLAN OVERVIEW**
Beach St. Ext
 Tisbury, MA

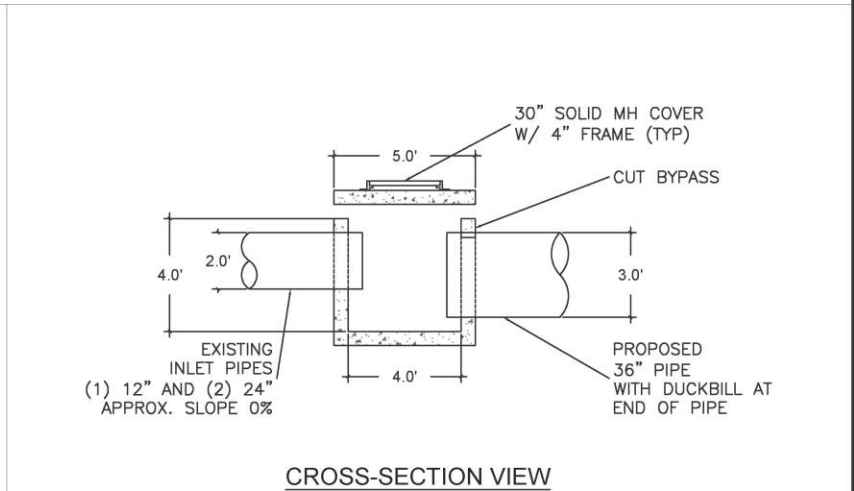
Date: **May 15, 2019**
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GRAPHIC SCALE 1:2



GRAPHIC SCALE 1:4



GRAPHIC SCALE 1:4

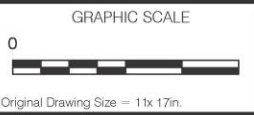
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Project: **BOX DETAILS**
Beach St. Ext
Tisbury, MA

Date: **May 15, 2019**
Sheet No. **3 of 3**

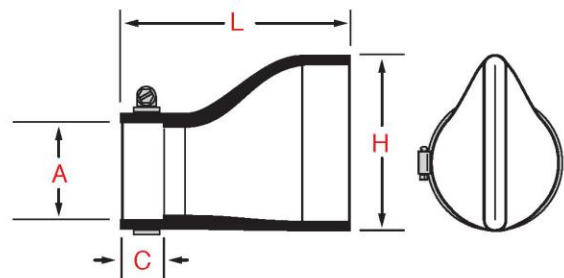
Series TF-1—Tideflex® Check Valve

Features & Benefits

- Ideal for manhole installations
- Lightweight, all-elastomer design
- Seals around entrapped solids
- Cost-effective, maintenance-free design

Materials of Construction

- Elastomers available in Pure Gum Rubber, Neoprene, Hypalon®, Chlorobutyl, Buna-N, EPDM, and Viton®



We are pleased to announce the introduction of the revolutionary TF-1 Check Valve. It functions and operates under the same simple principle of operation as the original TF-2 Tideflex®.

This design is ideal for existing manhole installations where the invert of the pipe is close to the floor of the vault. There are many check valves in interceptors, manholes, and vaults. These vaults are designed so that there would be a maximum gravity head; thus, the invert pipe is as close to the base as possible. The TF-1 allows installations in such applications.

The Tideflex® Technologies Series TF-1 Tideflex® Check Valve is designed for applications in manholes, where the bottom of the manhole is close to the invert of the pipe. The TF-1 configuration allows the valve to be properly installed without manhole modification, ensuring positive backflow prevention and a lifetime of maintenance-free performance.

Pipe O.D. (A)	Length (L)	Bill Height (H)	Cuff Length (C)
4	10	8	1 1/2
5	10	8	1 1/2
6	16	12	2
8	18	16	2
10	23	19	3
12	27	23	4
14	27	23	4
16	35	30	5
18	36	34	6
20	44	37	8
22	44	37	8
24	48	43	8
26	48	43	8
28	48	43	8
30	56	55	9
32	56	55	9
36	67	69	10
38	67	69	10
40	67	69	10
42	61	71	10
44	61	71	10
48	66	78	10
50	66	78	10
54	66	78	10
58	66	78	10
60	73	91	14
68	73	91	14
72	96	115	16

Numbers indicate maximum dimensions in inches.

The watershed summary and export loads of the watershed are summarized in Table 1.

Table 1: Summary of watershed characteristics and loading for BMP 1.

Parameter	Units	Value
Watershed	ac	22
Percent Impervious Cover	-	68%
Water Quality Volume	cf	54,220
P - Pre-BMP export	lb/yr	30
N - Pre-BMP export	lb/yr	216
TSS - Pre-BMP export	lb/yr	6,738

BMP 2 & 3: Municipal Lot & Veterans Memorial Park

The municipal gravel parking lot and Veterans Memorial Park were identified as large parcels owned by the town where BMPs could be installed to reduce the pressure on Five Corners intersection. The proposed design would install catch basin on the south side of Beach Street just upgradient of the parking lot and tie into the existing storm sewer. The parking lot would be retrofitted with a stone infiltration basin (BMP 2) to hold runoff, infiltrate the water, and provided treatment. The effluent would be piped subsurface south to a linear subsurface gravel wetland (SGW) (BMP 3) along the eastern sidewalk swale of Veterans Memorial Park. After discussions with EPA, the town, and public works staff, the SGW was to be completely subsurface to not interfere with the functionality or maintenance of the existing park.

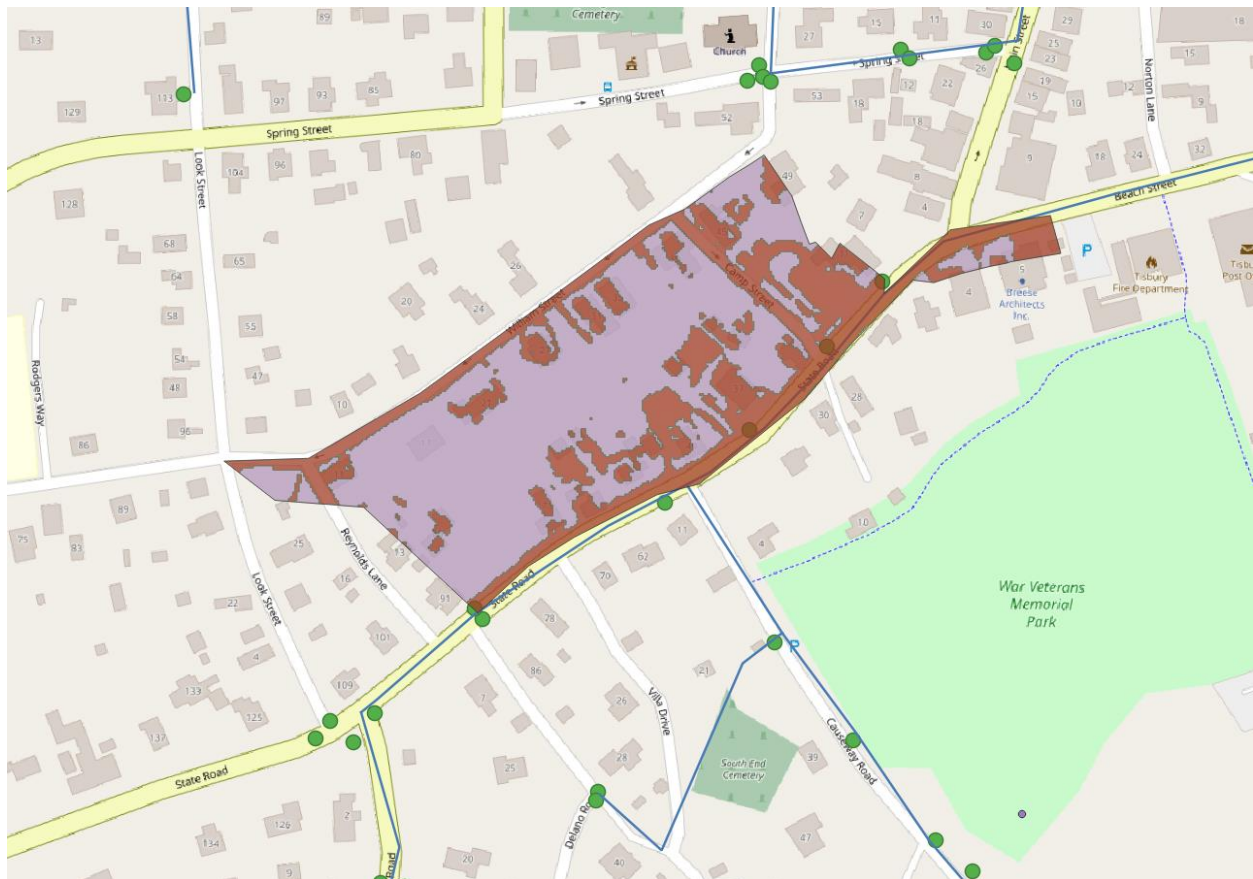


Figure 3: Watershed with impervious cover shown in red to BMPs 2 & 3.

The watershed summary is shown in Table 2 for BMPs 2 and 3.

Table 2: Summary of watershed characteristics and for BMP 2 & 3.

Parameter	Units	Value
Watershed	ac	6.5
Percent Impervious Cover	-	38%
Water Quality Volume	cf	9,270
P - Pre-BMP export	lb/yr	4.9
N - Pre-BMP export	lb/yr	35.0
TSS - Pre-BMP export	lb/yr	1088

BMP 2 was sized to have a Design Storage Volume (DSV) capable of treating 0.31 inches of direct runoff. BMP 2 was sized to leave about 20 ft. of space on the side edges to protect neighboring structures.

Beach Street Municipal Lot & Veterans Park
Tisbury, MA
May, 2019

UNH Stormwater Center



Conceptual Design Approach

(NOT FOR CONSTRUCTION)

Drawn By: DRM

Reviewed By: JJH

Approved By:

Date: May 15, 2019

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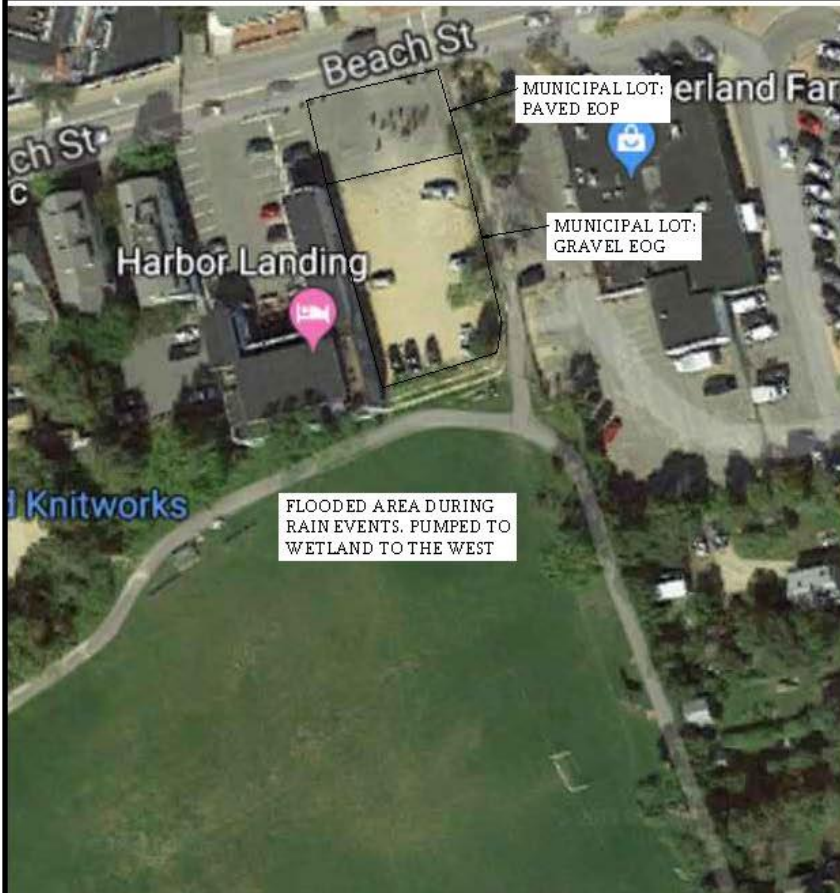
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Sheet 2: Plan Overview

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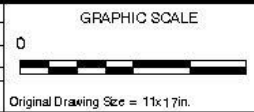
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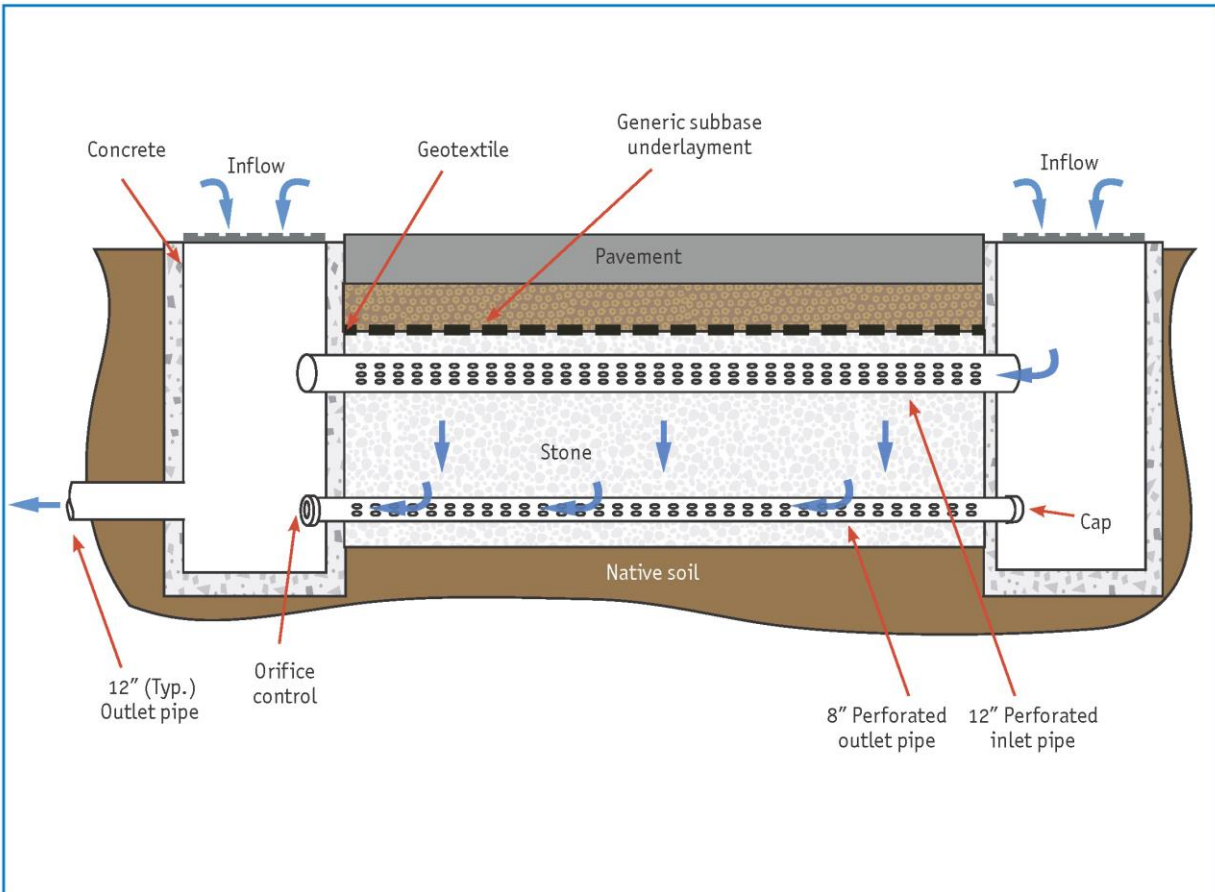
No.	Date	Revision

Designed: DRM	Checked: JJH	Approved:
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Project: **PLAN OVERVIEW**
Veterans Park
Tisbury, MA

Date: May 15, 2019
Sheet No. 2 of 2



Notes

1. Similar to subsurface gravel filters, infiltration trenches tend to be linear and are best used in narrow sites.
2. The storage layer (stone shown here) can be comprised of natural or manufactured materials to hold the design storage volume (DSV).
3. Locate the bypass to drain through the outlet pipe to existing drainage. The elevation may vary to meet existing infrastructure inverts, and flow is controlled through orifices and weirs.
4. Hydraulic inlets should drain by gravity where possible.
5. Surface cover may vary—pavement, grass, soil, or any combination of these can be used to meet end user needs and site requirements.
6. Add cleanouts and/or inlet protection, such as a snout or the Eliminator, as needed.

Figure 4: UNHSC generic design detail for an infiltration trench.

The individual BMP design and performance of BMP 2 and 3 are summarized in Table 3.

Table 3: Watershed characteristics, design, and performance for BMP 2 and 3.

Parameter	Abbrev.	Units	BMP 2	BMP 3
BMP ID/Name			Veteran's Park 1	Veteran's Park 2
Description/Notes			Parking lot SGF + 2' pipes 6" spacing	Park linear SGW
Watershed	DA	ac	6.5	6.5
Percent Impervious Cover	%IC	-	38%	38%
Impervious Cover	IA	ac	2.5	2.5
Land Use	LU	-	Medium-Density Residential	Medium-Density Residential
Design Precipitation	P	in	1	1
BMP	-	-	Subsurface Infiltration	Gravel Wetland
Infiltration Rate (Choose next lowest)	IR	in/hr	2.41	
Area footprint of pretreatment	$A_{\text{pretreatment}}$	sf		2,400
Depth of pretreatment	$D_{\text{pretreatment}}$	ft		1.2
Area footprint of ISR	A_{ISR}	sf		330
Depth of gravel/stone	D_{gravel}	ft		3
Porosity of gravel/stone (typical 0.4)	η_{gravel}	-	0.4	0.4
Depth BMP	D	ft	3	
Width BMP	W	ft	30	6
Length BMP	L	ft	80	55
Water Quality Volume	WQV	cf	9,270	9,270
Design Storage Volume	DSV	cf	2,880	3,276
Infiltration Rate	IR	in/hr	2.41	-
BMP Capacity: Depth of Runoff from Impervious Area	PSC	in	0.31	0.35
Runoff Volume Reduction	Volume	-	68%	0%
Phosphorus Load Reduction	TP	-	69%	38%
Nitrogen Load Reduction	TN	-	90%	45%
Cumulative TSS Load Reduction	TSS	-	88%	77%
Cumulative Zinc Load Reduction	TZn	-	99%	80%

Table 3 Continued: Watershed characteristics, design, and performance for BMP 2 and 3.

P - Pre-BMP export	P_{Pre}	lb/yr	4.86	4.86
P - Post-BMP export	P_{Post}	lb/yr	1.49	<i>3.02</i>
N - Pre-BMP export	N_{Pre}	lb/yr	34.95	34.95
N - Post-BMP export	N_{Post}	lb/yr	3.62	<i>19.39</i>
TSS - Pre-BMP export	TSS_{Pre}	lb/yr	1,088.04	1,088.04
TSS - Post-BMP export	TSS_{Post}	lb/yr	129.86	<i>249.13</i>
P Reduction	P_{Red}	lb/yr	3.37	<i>1.84</i>
N Reduction	N_{Red}	lb/yr	31.33	<i>15.55</i>
TSS Reduction	TSS_{Red}	lb/yr	958.17	<i>838.91</i>
Volume Reduction (depth on IA)	$Precip_{Red}$	in/yr	31	0
Volume Reduction	Vol_{Red}	cf/yr	274,950	0

Table 3 shows the individual performance for BMP 2 and 3. They are designed to be in series. Therefore, the combined removal efficiency (RE) of the treatment train is a combination of the two systems. The total RE of the train is calculated using Equation (1).

$$RE_T = RE_1 + (1 - RE_1)RE_2 \quad (1)$$

Note that the individual RE for the second system in series is higher than the total RE. In this case, the individual Post-BMP export rate of the second system is not accurate as it is not operating individually. These values have been italicized in Table 3 to indicate they do not apply in this scenario. The total RE efficiency (also called reduction here) of the treatment series is shown in Table 4.

Table 4: Combined performance for BMP 2 and 3 series.

Parameter	Abbrev.	Units	Value
Runoff Volume Reduction	Volume	-	68%
Phosphorus Load Reduction	TP	-	81%
Nitrogen Load Reduction	TN	-	94%
Cumulative TSS Load Reduction	TSS	-	97%
Cumulative Zinc Load Reduction	TZn	-	100%
P - Pre-BMP export	P _{Pre}	lb/yr	4.86
P - Post-BMP export	P _{Post}	lb/yr	0.92
N - Pre-BMP export	N _{Pre}	lb/yr	34.95
N - Post-BMP export	N _{Post}	lb/yr	2.01
TSS - Pre-BMP export	TSS _{Pre}	lb/yr	1,088.04
TSS - Post-BMP export	TSS _{Post}	lb/yr	29.74
P Reduction	P _{Red}	lb/yr	3.93
N Reduction	N _{Red}	lb/yr	32.94
TSS Reduction	TSS _{Red}	lb/yr	1,058.30
Volume Reduction (depth on IA)	Precip _{Red}	in/yr	31
Volume Reduction	Vol _{Red}	cf/yr	274,950

BMP 4 & 5: Grove Ave.

The end of the street on Grove Ave. was observed by municipal staff as a problem area and as a typical example of the end-of-road issues common to neighboring roads. The steep slopes produce very high-velocity runoff that dead-ends into sandy beaches, causing erosion. At this location, there was an older open-bottom, leaching catch basin originally installed to enhance infiltration. UNHSC proposed rehabilitating and enhancing this structure with a closed bottom leaching catch basin. The closed sump would provide a maintenance point where sediment and trash could be vactored and disposed of. The upper portion of the structure would be perforated and infiltrate into the surrounding sandy soils. The area around the basin could be backfilled with gravel as available to enhance the storage and infiltration capacities. This practice could replace typical solid catch basins as a standard installation where infiltration is judged acceptable and will not damage or jeopardize other subsurface infrastructure or building foundations and basements.



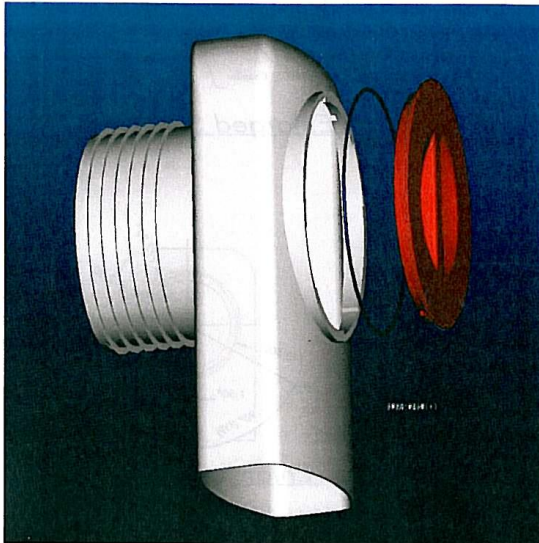
Figure 5: Watershed with impervious cover shown in red to BMPs 4 & 5.

In addition to the standard closed-bottom leaching catch basin, this location could be enhanced by the addition of a subsurface gravel filter in the road. This infiltration trench would provide

additional storage and infiltration to the runoff, therefore reducing the volume and energy of the runoff currently degrading the beach entrance. The proposed system would include another leaching catch basin as described with inlet protection such as hood or other inlet protection device. Inlet protection devices are relatively inexpensive and can be chosen to suit the municipal maintenance preferences. They can vary between outlet inserts such as snouts or eliminators, or inlet inserts. Details of common inlet protection devices are shown in Figure 6 through Figure 9. The catch basin inlet would feed a subsurface gravel filter via a slotted or perforated pipe before exiting into another leaching basin. The effluent and bypass would continue to the existing outlet east of the edge of pavement where the pipe would daylight into a rip-rap armoring pad. This design would enhance infiltration, treatment of runoff, armor the current high erosion area, and not lose any area for parking or public use. The following page shows the concept design of the leaching basins and the subsurface gravel filter. Leaching catchbasins are not unique and should be able to be provided by local precasters. The configuration here is recommended for ease of maintenance and provides for a solid 2-4' base, a perforated middle and a standard top with frame and grate suitable to the town. The solid base allows for sediment accumulation and routine removal with a vactor truck. The generic details shown in Figure 10 and Figure 11 are examples of configurations and details may be altered according to the precaster's capacity. For example, the weir wall may be replaced by a cap and orifice on the underdrain pipe. See the detail notes for more information.

The Eliminator

Oil & Floating Debris Trap For Catch Basins



The ELIMINATOR Catch Basin Oil and Debris Trap is the most advanced trap of its kind on the market. Its clever design provides several unique features. Designed to follow the contours of round catch basins it offers the best clearance from the catch basin opening of any similar trap. Its unique neck design both seals and retains the trap in the outlet pipe. Manufactured from High Density Polyethylene it is lightweight, durable and resistant to the widest range of storm water contaminants. Its large inspection and maintenance port allows easy access to the outlet pipe with a quick quarter turn of the gasket sealed cover. Clearly the ELIMINATOR is the smart choice for your Catch Basins.

THE ELIMINATOR

- Eliminates oil and floating debris from the storm water waste stream.
- Eliminates prolonged exposure of workers to confined spaces as it installs in minutes.
- Eliminates waste as it is partially manufactured from recycled materials.
- Eliminates labor costs as it installs in minutes without fasteners, or adhesives.
- Eliminates maintenance problems as its low and contoured profile prevents dislodgment during catch basin cleaning.
- Eliminates confusion, it's the catch basin trap you will always want to use.



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Figure 6: The Eliminator specifications for inlet protection.

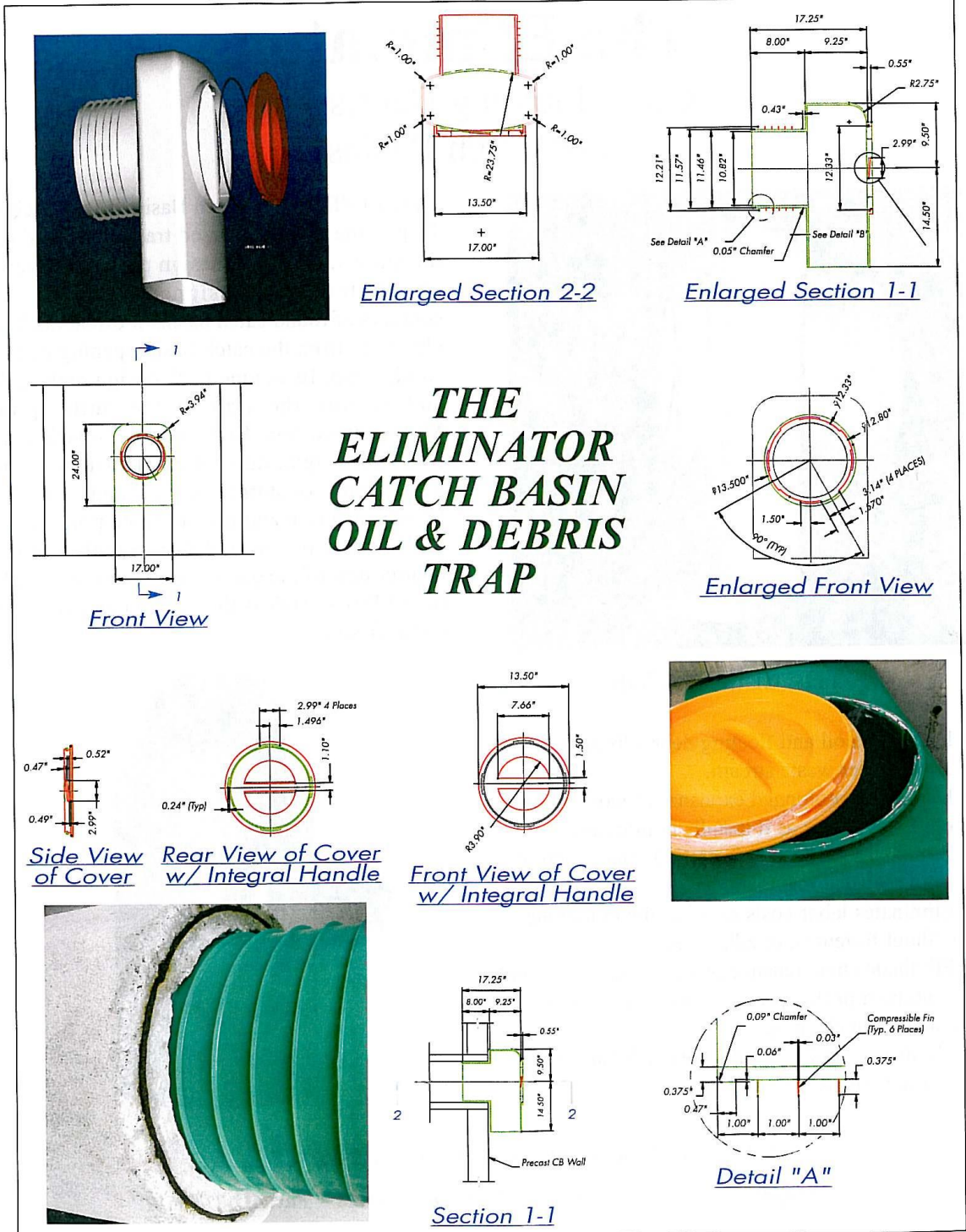
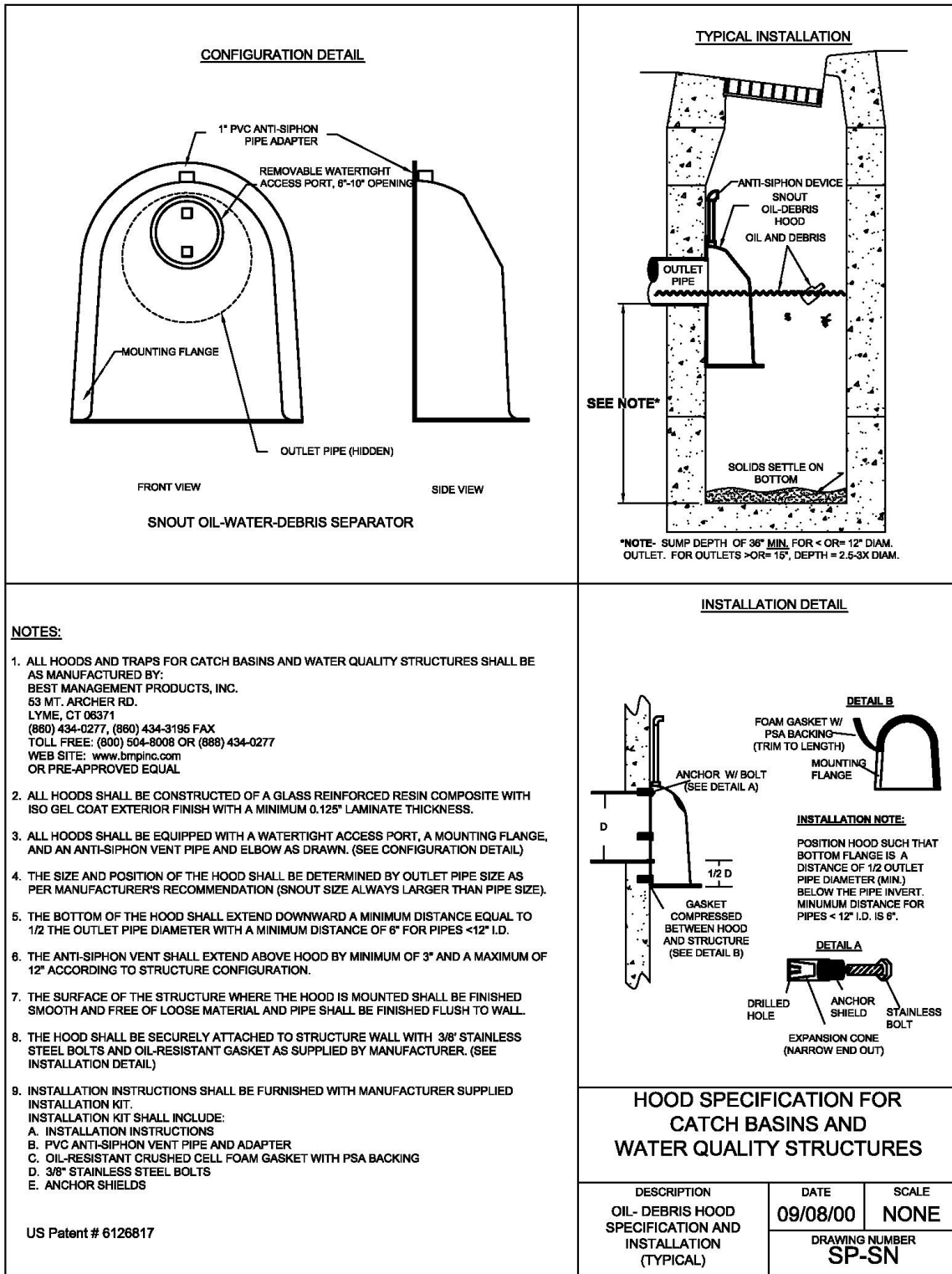


Figure 7: The Eliminator specifications for inlet protection.



HOOD SPECIFICATION FOR CATCH BASINS AND WATER QUALITY STRUCTURES

DESCRIPTION	DATE	SCALE
OIL- DEBRIS HOOD SPECIFICATION AND INSTALLATION (TYPICAL)	09/08/00	NONE
	DRAWING NUMBER SP-SN	

Figure 8: Hood specifications for inlet protection.

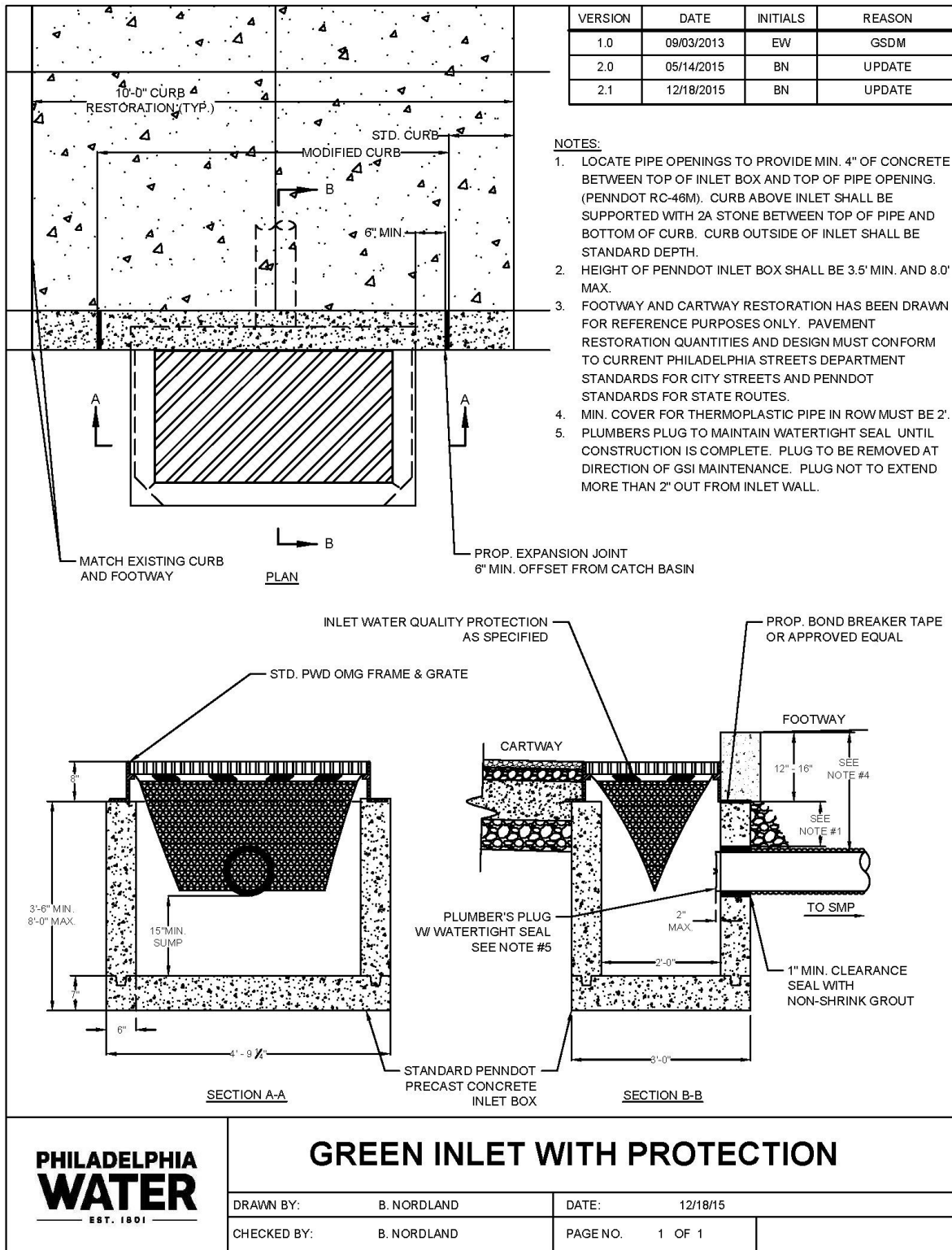


Figure 9: Philadelphia Water Department specifications for green inlet with protection.

EXISTING CONDITIONS

PROPOSED DESIGN

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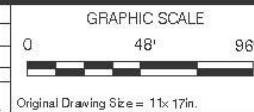
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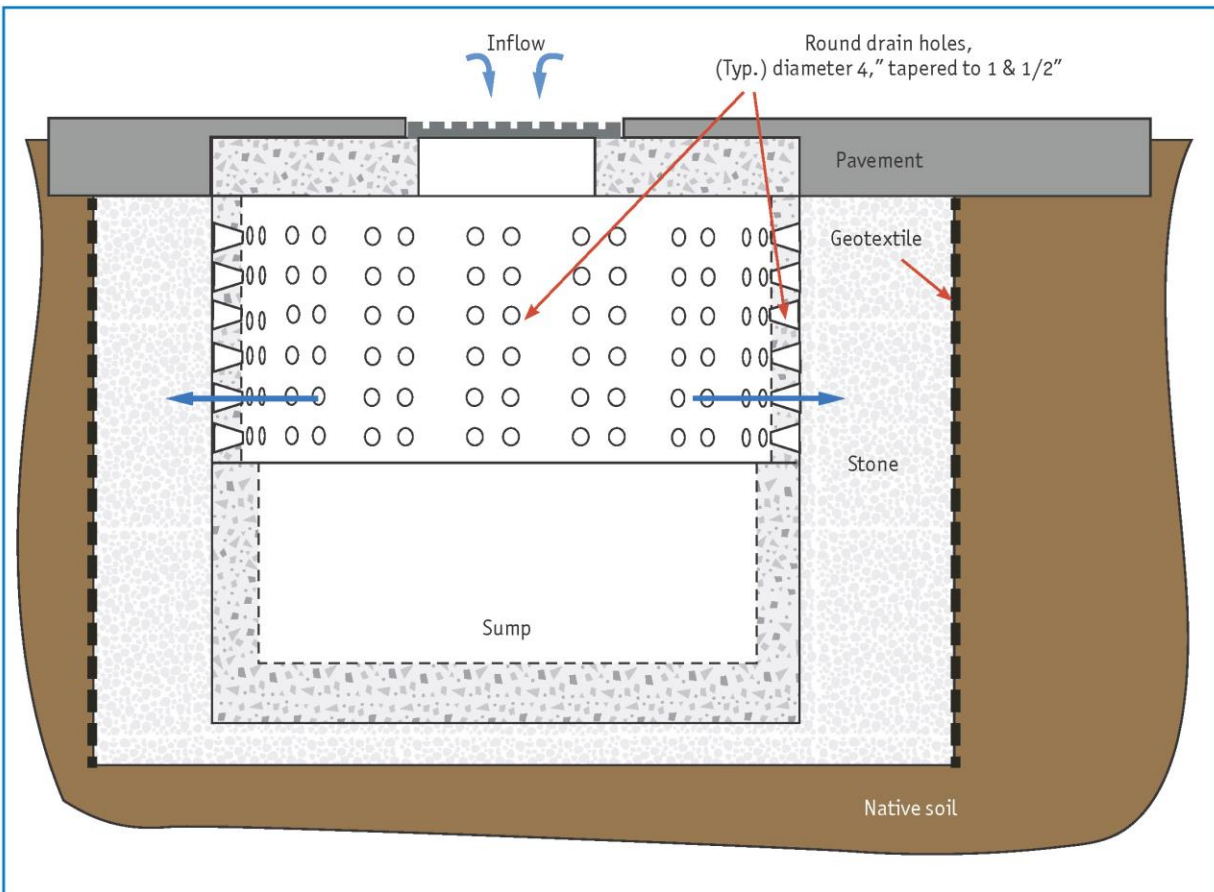
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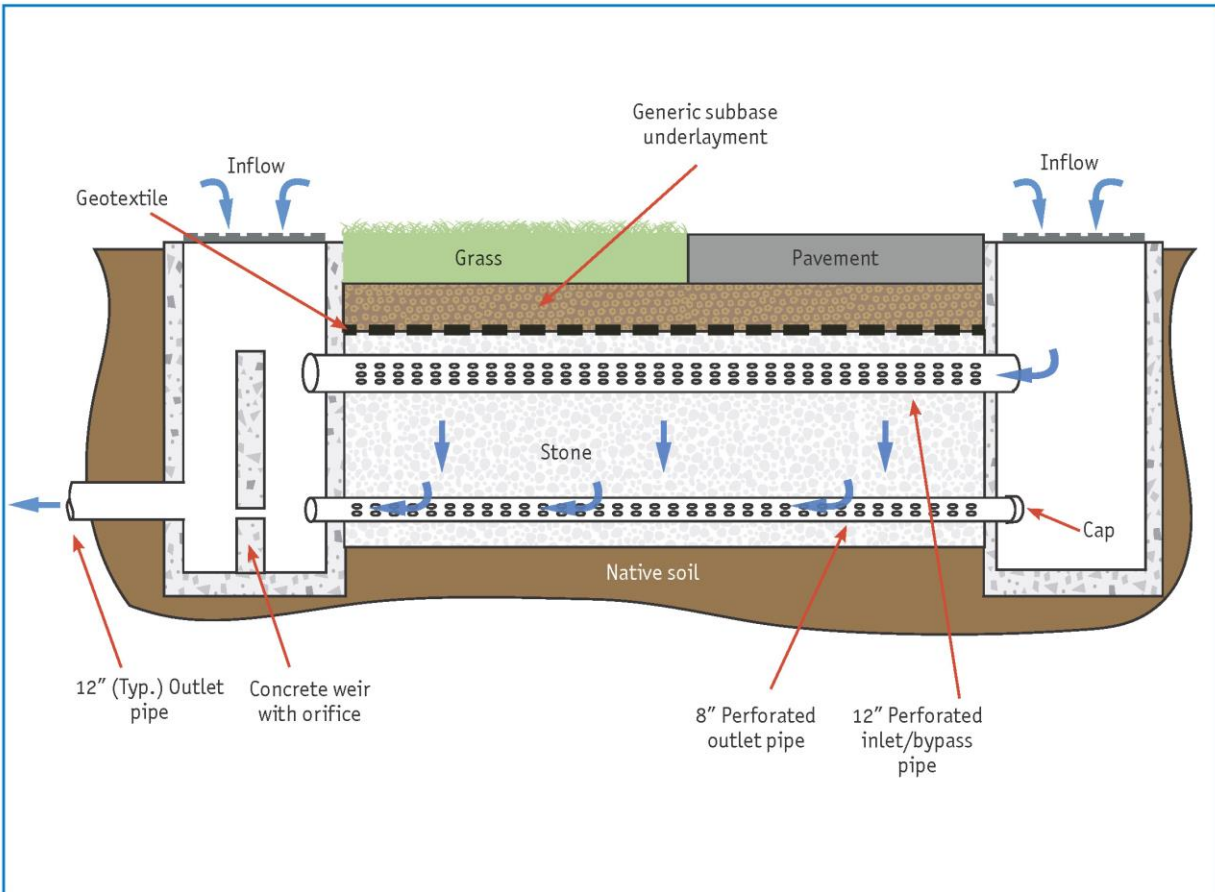
Project: **PLAN OVERVIEW**
 Grove Ave
 Tisbury, MA

Date: Sept. 12, 2019
 Sheet No. 2 of 2



Notes

1. Leaching catch basins are appropriate for sites with higher conductivity soils or where infiltration is suitable.
2. These systems can replace conventional deep sump catch basins where infiltration is appropriate.
3. The bottom should remain solid (as shown here) to function as a deep sump catch basin and to facilitate long term maintenance.
4. The excavation may be oversized and backfilled with stone to accommodate larger design storage volumes (DSV).
5. As with other infiltration systems, to limit clogging a geotextile may be used to curtain the excavation sidewalls but not on the bottom of the excavation.



Notes

1. Similar to infiltration trenches, subsurface gravel filters are appropriate for sites that can accommodate larger system footprints and widths.
2. The storage layer (stone shown here) can be comprised of natural or manufactured materials to hold the design storage volume (DSV).
3. Locate the bypass to drain through the outlet pipe to existing drainage. The elevation may vary to meet existing infrastructure inverts, and flow is controlled through orifices and weirs.
4. Hydraulic inlets should drain by gravity where possible.
5. Surface cover may vary—pavement, grass, soil, or any combination of these can be used to meet end user needs and site requirements.
6. Add cleanouts and/or inlet protection, such as a snout or The Eliminator, as needed.

The individual BMP design and performance for BMP 4 and 5. As they form a treatment train, the Post-BMP export rates do not apply to the train.

Table 5: Watershed characteristics, design, and performance for BMP 4 and 5.

Parameter	Abbrev.	Units	BMP 4	BMP 5
BMP ID/Name			Grove Ave 1	Grove Ave 2
Description/Notes			Leaching CB + 32" stone	SGF at end of road
Watershed	DA	ac	0.79	6.0
Percent Impervious Cover	%IC	-	53%	24%
Impervious Cover	IA	ac	0.42	1.42
Land Use	LU	-	Medium-Density Residential	Medium-Density Residential
Design Precipitation	P	in	1	1
BMP	-	-	Subsurface Infiltration	Gravel Wetland
Infiltration Rate (Choose next lowest)	IR	in/hr	8.27	8.27
Depth of gravel/stone	D_{gravel}	ft		4
Porosity of gravel/stone (typical 0.4)	η_{gravel}	-	0.4	0.4
Area footprint of bed	A_{bed}	Sf	76	360
Depth BMP	D	ft	5	
Width BMP	W	ft	8.7	10
Length BMP	L	ft	8.7	36
Water Quality Volume	WQV	cf	1,519	5,713
Design Storage Volume	DSV	cf	152	576
Infiltration Rate	IR	in/hr	8.27	8.27
BMP Capacity: Depth of Runoff from Impervious Area	PSC	in	0.10	0.10
Runoff Volume Reduction	Volume	-	54%	54%
Phosphorus Load Reduction	TP	-	50%	50%
Nitrogen Load Reduction	TN	-	76%	76%
Cumulative TSS Load Reduction	TSS	-	98%	98%
Cumulative Zinc Load Reduction	TZn	-	93%	93%

Table 5 Continued: Watershed characteristics, design, and performance for BMP 4 and 5.

P - Pre-BMP export	P _{Pre}	lb/yr	0.82	2.77
P - Post-BMP export	P _{Post}	lb/yr	0.41	1.38
N - Pre-BMP export	N _{Pre}	lb/yr	5.93	19.96
N - Post-BMP export	N _{Post}	lb/yr	1.42	4.75
TSS - Pre-BMP export	TSS _{Pre}	lb/yr	184.77	621.47
TSS - Post-BMP export	TSS _{Post}	lb/yr	3.70	12.87
P Reduction	P _{Red}	lb/yr	0.41	1.40
N Reduction	N _{Red}	lb/yr	4.51	15.21
TSS Reduction	TSS _{Red}	lb/yr	181.07	608.60
Volume Reduction (depth on IA)	Precip _{Red}	in/yr	23	26
Volume Reduction	Vol _{Red}	cf/yr	35,650	134,686

The combined removal efficiency of the treatment series including two leaching catch basins immediately upstream and downstream of the subsurface gravel filter for maintenance is shown in Table 6.

Table 6: Combined performance for BMP 4 and 5 series.

Parameter	Abbrev.	Units	Value
Runoff Volume Reduction	Volume	-	95%
Phosphorus Load Reduction	TP	-	94%
Nitrogen Load Reduction	TN	-	100%
Cumulative TSS Load Reduction	TSS	-	100%
Cumulative Zinc Load Reduction	TZn	-	100%
P - Pre-BMP export	P _{Pre}	lb/yr	2.77
P - Post-BMP export	P _{Post}	lb/yr	0.17
N - Pre-BMP export	N _{Pre}	lb/yr	19.96
N - Post-BMP export	N _{Post}	lb/yr	0.07
TSS - Pre-BMP export	TSS _{Pre}	lb/yr	621.47
TSS - Post-BMP export	TSS _{Post}	lb/yr	0.00
P Reduction	P _{Red}	lb/yr	2.60
N Reduction	N _{Red}	lb/yr	19.90
TSS Reduction	TSS _{Red}	lb/yr	621.47
Volume Reduction (depth on IA)	Precip _{Red}	in/yr	46
Volume Reduction	Vol _{Red}	cf/yr	238,583

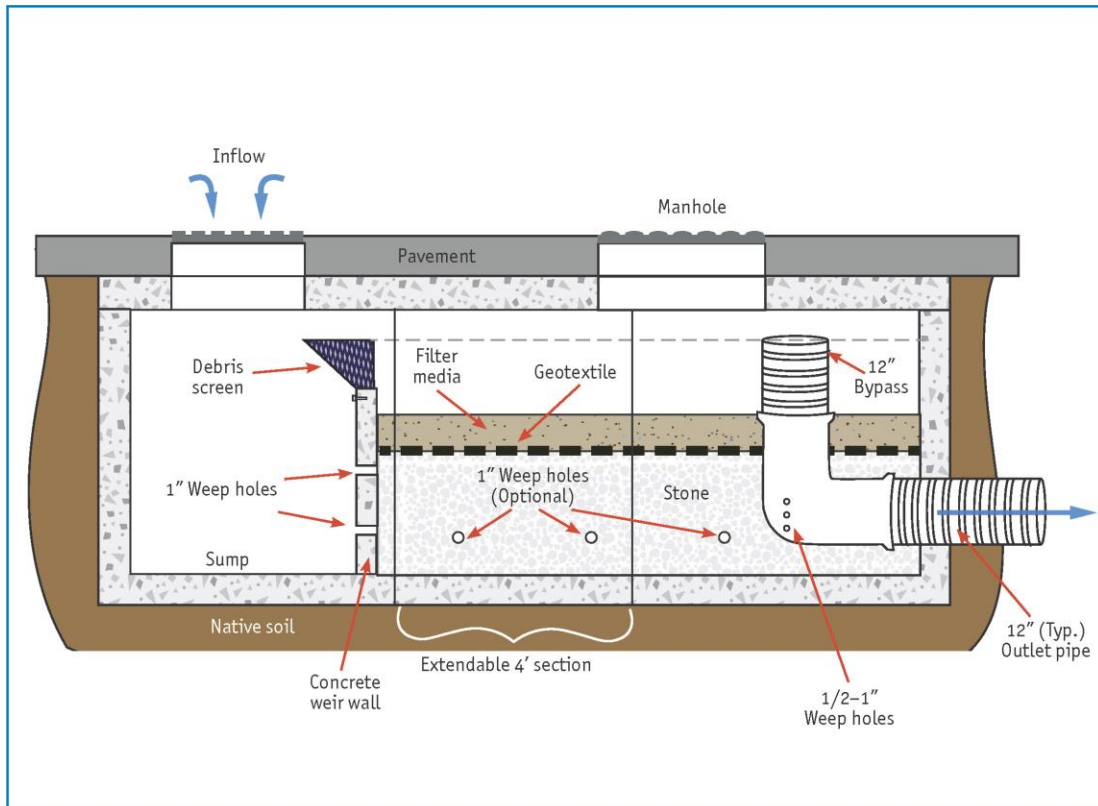
BMP 6: Spring St. and Pine Tree Rd.

Another location of concern for occasional hazard flooding was at the intersection of Spring St. and Pine Tree Rd. near the Vineyard Haven Fire Department. The best proposed site is in the right of way on Pine Tree Rd. at the existing curb inlet. Because of the small watershed area and busy intersection, UNHSC proposes installing a pre-cast media filter under the roadway to enhance the treatment of runoff. Maintenance is similar to that of typical catch basins. This was discussed during meetings with municipal public works staff and viewed favorably by them.



Figure 12: Watershed with impervious cover shown in red to BMP 6.

With a watershed area of about 2.8 acres and 52% impervious cover, the media box filter is far too small to adequately treat the runoff, but it is a simple measure by replacing a standard catch basin to improve water quality by filtration. Additional center sections may be added to the box to have a larger filter area and increase treatment capacity. See Figure 13 for the design detail. As this media box filter is designed as shown to treat 0.25 ac impervious cover, to fully treat the Spring St. watershed, 10 extendable sections would be needed. This makes the filter area impractically large to install under the road. We would suggest installing as many sections as practicable for improved treatment over current conditions.



Notes

- Media box filters may replace deep sump catch basins to enhance water quality treatment.
- Generally sized to treat 0.25 acre of impervious cover, the system may be expanded to treat larger areas with the addition of 4-foot sections in the middle to increase the filter media area.
- The system may be lined if infiltration is not suitable, or weep holes may be added to facilitate infiltration if appropriate.
- Filter media mixes may vary but should be comprised of sandy soils with high conductivity. Amendments may be added to enhance water quality treatment.
- Depth of soil may vary between 6 and 12 inches as most filtration occurs at the surface.
- To facilitate annual maintenance and/or filter media replacement, a woven textile may be added between filter media and stone reservoir.



Figure 13: UNHSC generic design detail for a sectional media box filter.

BMP 7: Vineyard Haven Terminal Traffic Circle

The traffic circle near the Vineyard Haven Terminal parking lot was identified as a potential location for a rain garden. While there are municipal basins near the parking lot and on Water Street, runoff from the traffic circle could be routed to a small rain garden for treatment. See Figure 10 for a standard detail of a bioretention design. The bioretention has a high flow bypass and a perforated underdrain that would be plumbed into the nearby stormwater sewer system. If the underdrain is not desired, it may be removed along with the gravel layer to be replaced with bioretention soil mix. This would be a simpler installation and would perform very well as the subsoils are very sandy with high hydraulic conductivity.

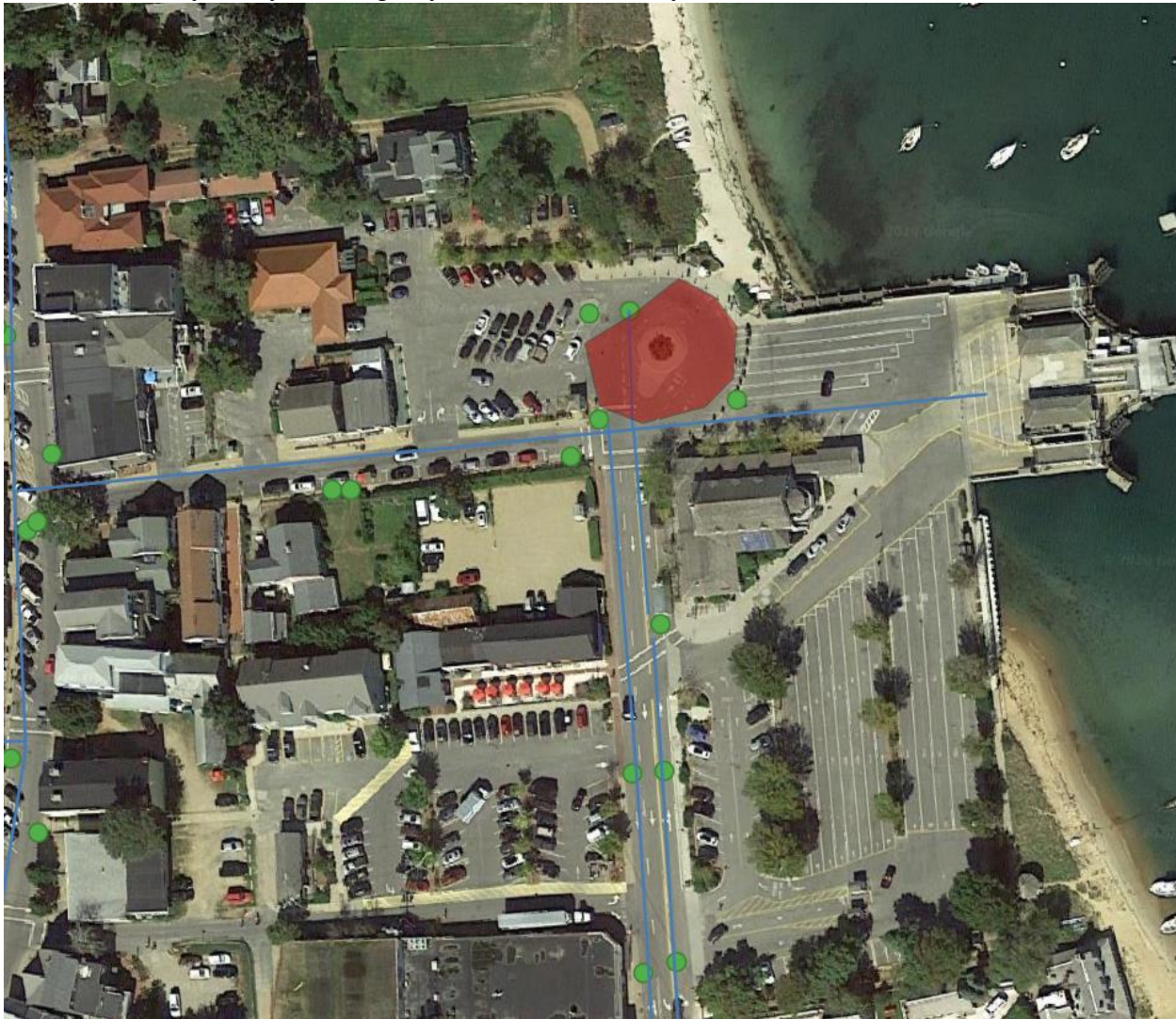


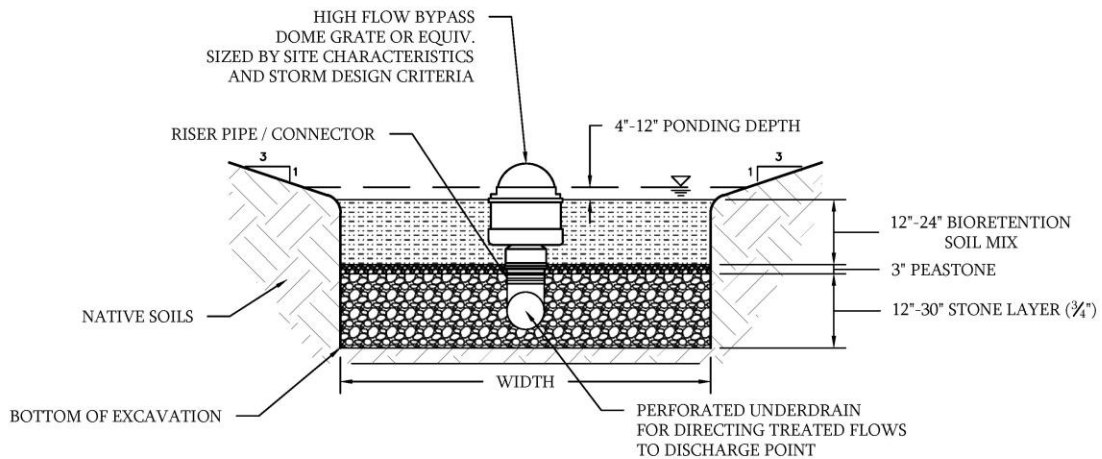
Figure 14: Watershed with impervious cover shown in red to BMP 7.

BIORETENTION SOIL MIX - PARTICLE SIZE DISTRIBUTION

PSD Upper Limit		PSD Lower Limit	
Sieve #	% Passing	Sieve #	% Passing
4	100	4	100
10	95	10	95
40	40	40	15
200	20	200	15
>200	5	>200	5

GENERAL NOTES:

1. BIORETENTION SOIL MIX:
 - a. 60% SAND
 - b. 20% WOODCHIPS
 - c. 20% TOPSOIL
2. DO NOT COMPACT SUBGRADE AT BOTTOM OF EXCAVATION
3. THIS DETAIL IS PROVIDED FOR GENERAL GUIDANCE. ACTUAL SYSTEM DESIGN BASED ON SPECIFIC SITE CHARACTERISTICS AND DESIGN CRITERIA.



Best Management Practice (from EPA Opti-Tool)	Storage Volume Cost (\$/ft ³) ¹	Cost (\$/ft ³) 2015 dollars ⁴
Bioretention (includes Rain Garden)	\$13.37 ^{2/3}	\$14.63
¹ Includes 35% add on for engineering and contingencies		
² Costs in 2010 dollars		
³ From UNHSC Cost Estimates		
⁴ Conversions made using U.S. Department of Labor Bureau of Labor Statistics consumer price index inflation calculator (2012)		



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Figure 15: UNHSC standard detail of a bioretention filter.

The watershed of the traffic circle was estimated to be about 0.16 acres of impervious cover. A rain garden (without an underdrain) could be constructed from standard details with a depth of ponding of 6 in., 3 ft. of bioretention soil media, and a footprint of about 130 sq. ft.

The watershed characteristics and BMP performance are described in Table 7.

Table 7: Watershed characteristics, design, and performance for BMP 7.

Parameter	Abbrev.	Units	BMP 7
BMP ID/Name			Vineyard Haven Terminal
Description/Notes			Traffic Circle
Watershed	DA	ac	0.16
Percent Impervious Cover	%IC	-	100%
Impervious Cover	IA	ac	0.16
Land Use	LU	-	Commercial and Industrial
Design Precipitation	P	in	1
BMP	-	-	Subsurface Infiltration
Infiltration Rate (Choose next lowest)	IR	in/hr	2.41
Area footprint of pond	A_{pond}	ft	130
Depth of ponding	D_{ponding}	-	0.5
Area footprint of soil (BMP media)	A_{soil}	Sf	130
Depth of soil (BMP media)	D_{soil}	ft	3
Porosity of soil (BMP media) (typical 0.2)	η_{soil}	ft	0.2
Water Quality Volume	WQV	cf	562
Design Storage Volume	DSV	cf	143
Infiltration Rate	IR	in/hr	2.41
BMP Capacity: Depth of Runoff from Impervious Area	PSC	in	0.25
Runoff Volume Reduction	Volume	-	60%
Phosphorus Load Reduction	TP	-	72%
Nitrogen Load Reduction	TN	-	86%
Cumulative TSS Load Reduction	TSS	-	91%
Cumulative Zinc Load Reduction	TZn	-	96%

Table 7 Continued: Watershed characteristics, design, and performance for BMP 7.

P - Pre-BMP export	P_{Pre}	lb/yr	0.29
P - Post-BMP export	P_{Post}	lb/yr	0.08
N - Pre-BMP export	N_{Pre}	lb/yr	2.44
N - Post-BMP export	N_{Post}	lb/yr	0.35
TSS - Pre-BMP export	TSS_{Pre}	lb/yr	61.46
TSS - Post-BMP export	TSS_{Post}	lb/yr	5.70
P Reduction	P_{Red}	lb/yr	0.21
N Reduction	N_{Red}	lb/yr	2.09
TSS Reduction	TSS_{Red}	lb/yr	55.76
Volume Reduction (depth on IA)	$Precip_{Red}$	in/yr	25
Volume Reduction	Vol_{Red}	cf/yr	14,835

BMP 8 & 9: Lake Street

The boat launch on the western end of the road on Lake Street was identified as an area with high volume and velocity of runoff, causing erosion to the gravel lot and boat launch. A combination of BMPs proposed at Grove Ave. and Spring St. would be suggested here to mitigate the volume and energy of the runoff in this area. A leaching catch basin would intercept runoff to provide a deep sump for some removal of TSS and provide some infiltration. It would be too small to be credited for removal, however. The overflow would be piped to a subsurface gravel filter as described in BMP 5 for enhanced filtration, storage, and infiltration. This would be sized to treat the 0.1 inches of runoff from impervious cover.

The watershed was estimated to be 13.8 acres and 19% impervious cover as shown in Figure 16.

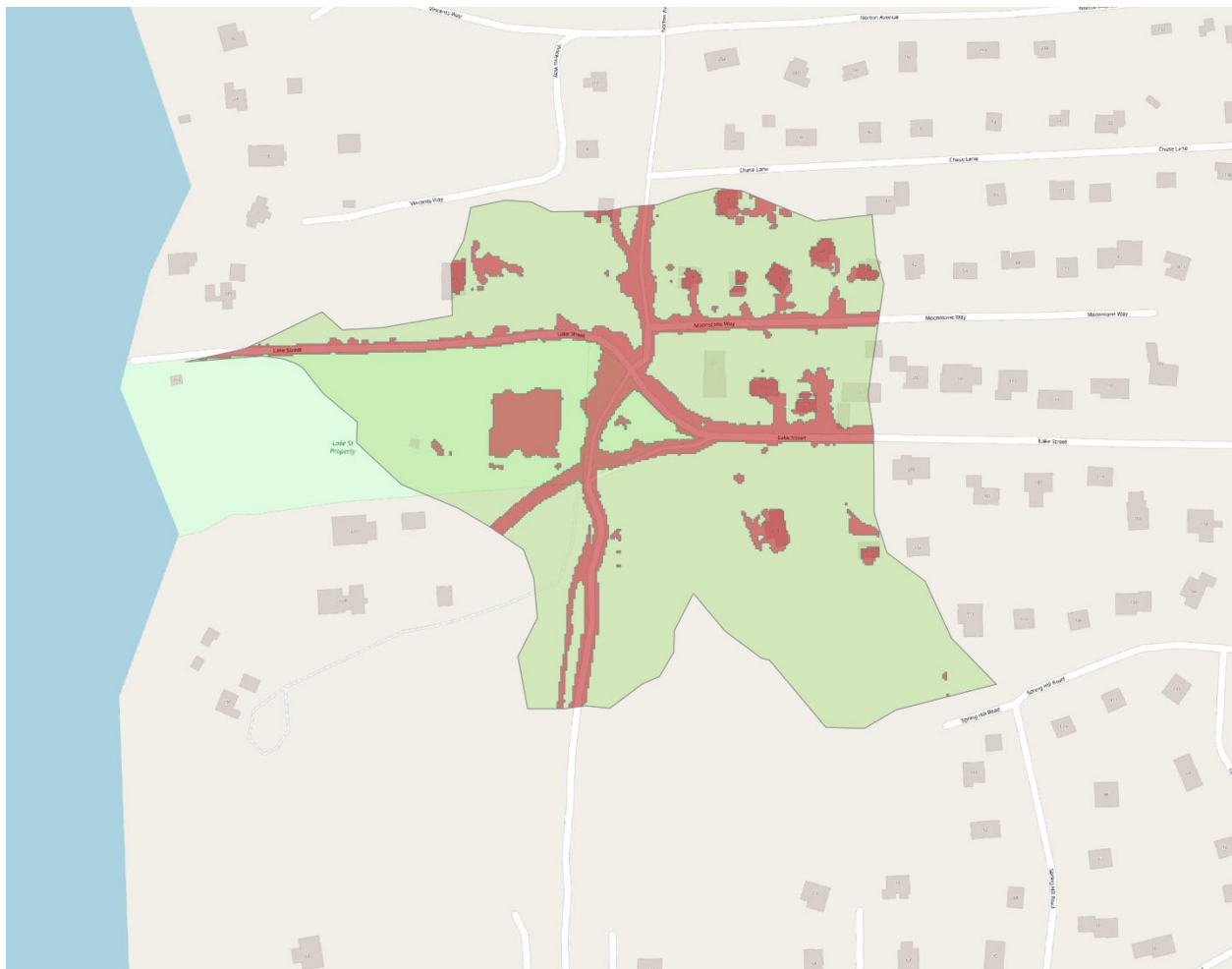


Figure 16: Watershed with impervious cover shown in red to BMPs 8 & 9.

Table 8: Watershed characteristics, design, and performance for BMP 8 and 9.

Parameter	Abbrev.	Units	BMP 8	BMP 9
BMP ID/Name			Lake St	Lake St
Description/Notes			Leaching CB + 32" stone	SGF at end of road
Watershed	DA	ac	13.81	13.81
Percent Impervious Cover	%IC	-	19%	19%
Impervious Cover	IA	ac	2.64	2.64
Land Use	LU	-	Medium-Density Residential	Medium-Density Residential
Design Precipitation	P	in	1	1
BMP	-	-	Subsurface Infiltration	Infiltration Trench
Infiltration Rate (Choose next lowest)	IR	in/hr	8.27	8.27
Depth of gravel/stone	D_{gravel}	ft	-	4
Porosity of gravel/stone (typical 0.4)	η_{gravel}	-	0.4	0.4
Area footprint of bed	A_{bed}	Sf	76	700
Depth BMP	D	ft	5	-
Width BMP	W	ft	8.7	20
Length BMP	L	ft	8.7	35
Water Quality Volume	WQV	cf	11,119	11,119
Design Storage Volume	DSV	cf	152	1,120
Infiltration Rate	IR	in/hr	8.27	8.27
BMP Capacity: Depth of Runoff from Impervious Area	PSC	in	0.01	0.10
Runoff Volume Reduction	Volume	-	0%	54%
Phosphorus Load Reduction	TP	-	0%	50%
Nitrogen Load Reduction	TN	-	0%	76%
Cumulative TSS Load Reduction	TSS	-	0%	98%
Cumulative Zinc Load Reduction	TZn	-	0%	93%

Table 8 Continued: Watershed characteristics, design, and performance for BMP 8 and 9.

P - Pre-BMP export	P _{Pre}	lb/yr	5.17	5.17
P - Post-BMP export	P _{Post}	lb/yr	5.17	2.57
N - Pre-BMP export	N _{Pre}	lb/yr	37.17	37.17
N - Post-BMP export	N _{Post}	lb/yr	37.17	8.88
TSS - Pre-BMP export	TSS _{Pre}	lb/yr	1,157.28	1,157.28
TSS - Post-BMP export	TSS _{Post}	lb/yr	1,157.28	23.65
P Reduction	P _{Red}	lb/yr	0.00	2.59
N Reduction	N _{Red}	lb/yr	0.00	28.29
TSS Reduction	TSS _{Red}	lb/yr	0.00	1,133.63
Volume Reduction (depth on IA)	Precip _{Red}	in/yr	0	27
Volume Reduction	Vol _{Red}	cf/yr	0	261,654

The combined removal efficiency of the treatment series is the same as BMP 9. See Figure 10 and Figure 11 for the generic design details.