Stormwater BMP Planning for Stillhouse Cove

City of Cranston

Cranston, RI

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1 Overview

This memorandum summarizes potential future stormwater best management practices (BMP) for the Stormwater BMP Planning and Implementation Project for Narragansett Boulevard and Stillhouse Cove. The goal of this project is to reduce pollutant loadings to Stillhouse Cove through implementation of stormwater BMPs.

There are several potential opportunities for BMP implementation within the watershed. While funding is only available for one BMP at this time, this memorandum outlines potential future BMPs to further reduce pollutant loading to the Cove.

1.1 Stillhouse Cove Water Quality

As part of the larger Providence River, Stillhouse Cove is impaired by nitrogen, dissolved oxygen and fecal coliform, as listed on the State of Rhode Island's 303(d) list. Stillhouse Cove, specifically, has a significant problem with algal blooms, likely as a result of the nitrogen load directly to the Cove. The goal of this effort is to reduce loading of the key nutrients (nitrogen and bacteria, specifically) to the Cove, through the implementation of stormwater BMPs.

2 Stormwater BMP Design Parameters

Our goal for this project was to select a BMP type that effectively treats both of the key target pollutants and that the Cranston DPW has the resources to maintain. Bioretention is a surface treatment practice that effectively treats both nitrogen (through biologic uptake) and bacteria (through physical filtration), and can be maintained by twice-annual mowing. Bioretention also can treat a relatively high volume of stormwater per unit area as compared to other BMPs, and can be designed as an exfilter, allowing all or a portion of captured stormwater to infiltrate into the subsoil rather than draining to the storm sewer system or flowing back to the street. Due to the reasons noted above, bioretention was selected as the preferred BMP type for this project. Other alternatives were dismissed such as infiltration and other proprietary systems but were not selected because of their inability to effectively remove both target pollutants or their difficult maintenance requirements.

In order to select locations for proposed BMPs, many factors were considered. These are discussed below.

- Availability of public land
    - Locations exist within the public right-of-ways within the watershed and within the public park that could be used for BMP implementation
- Removal of pavement
    - In order to receive grant funding for the original stormwater BMP project, removal of pavement on Narragansett Boulevard was discussed in the grant application. The paved width of Narragansett Boulevard is very wide and includes two parking lanes, two bike lanes and two travel lanes in some sections. By reducing the impervious pavement within the watershed, peak flows and discharge of pollutants to Stillhouse Cove will be reduced.

- Slope
  - Bioretention requires flat areas where water is allowed to pond before it is filtered through the bioretention media. Storage is provided within these flat basins, and within the bioretention soil media. Therefore, bioretention is best suited for flat to mild slopes. In areas with mild slopes, bioretention basins can be tiered, with rock weirs or earthen overflow embankment weirs to carry water from one flat basin to the next, in order to accommodate the grade change.
- Treatment Capacity
  - The majority of pollutants are conveyed by the first one inch of run off from impervious surfaces, known as the water quality volume. In order to most effectively and efficiently treat stormwater, BMPs should be sized to treat the water quality volume, and therefore locations in which there is sufficient available space to treat the full contributing water quality volume are preferred. However, few locations exist in the public right of way within the watershed where there is sufficient space to treat the full water quality volume, so locations were selected which have the space to treat the largest percentages of the contributing water quality volume.
- Location within the Watershed
  - BMP sites within the watershed were selected to provide the most effective treatment systems possible given site constraints. Due to the size of the watershed and its configuration, it is infeasible to treat the entire water quality volume in one location with a single large BMP. Typically, the goal is to incrementally capture and treat water in the upper reaches of a watershed before it runs off to the lower reaches. In this case, there are locations within the watershed which will allow treatment of significant portions of the water quality volume before it runs off steep slopes to the lower portions of the watershed.
  - Treating one pound of nitrogen in one location within the watershed will have the same ultimate impact on overall water quality in the Cove as treating one pound of nitrogen in another location within the watershed. Larger areas contribute larger pollutant loadings; therefore priority was given to BMP locations that will treat larger drainage areas; in combination with selecting a location with adequate space to treat the water quality volume, this will result in the most effective overall removal of pollutants.

2.1 Water Quality Volume Contribution from Residential Properties

While projects proposed in the City ROW as outlined in this report can have a substantial impact on water quality, several smaller scale improvements on residential properties can also have significant cumulative impacts (e.g. disconnected rain spouts or rain barrels from roof drains). Approximately 52% of the impervious surface in the Stillhouse Cove watershed is publicly owned and maintained.[1] These areas include roads and sidewalks. The other 48% of the total impervious surface within the watershed is on private property (this consists of roofs, driveways, private walkways, etc.) While this report focuses

[1] The Statewide Impervious Surface Dataset from RIGIS generated from 2011 aerial photography was used for this calculation. Where necessary for accuracy, some impervious area delineations were modified based on more recent aerial photography.

on identifying potential BMPs that the City could execute on within the public right of way, improvements on homeowner property to reduce connectivity of impervious surface and increase the volume of water infiltrated onsite could also have a significant impact on water quality within the Cove.

3 Potential BMPs for Stillhouse Cove

Based on the above considerations, the BMP sites indicated on Figure 1 have been selected as potential BMPs within the watershed. It should be noted that this is a conceptual-level watershed-wide assessment and future design phases would be required to provide a comprehensive assessment of any selected BMP location to confirm its suitability. As shown on Table 1, not all locations have the available space to treat the entire water quality volume, which was calculated as the volume generated from 1" of runoff over impervious surfaces as required by RIDEM. However, due to the large area treated, some of these sites still have the potential to significantly reduce pollutant loadings to the Cove. Table 2 shows annual pollutant loadings and reductions for each of the BMPs and Table 3 provides site descriptions and design considerations for each BMP.

It should be noted that four of the BMP sites are located within the drainage area of another BMP. Values for water quality volume and pollutant loading were calculated independently for each BMP site, even those with nested drainage areas. This allows each BMP to be considered on its own merits and to be constructed separately if funding is available for implementation at a limited number of sites. It should be noted that if two BMPs with nested watersheds are constructed, the overall treatment efficiency of the down-watershed BMP will increase due to reductions from the up-watershed BMP.

Other areas that were ultimately considered for BMP placement are also indicated in Figure 1 as secondary potential BMP sites; these locations were eliminated from the selection during this phase of the project due to concerns that the sites were too narrow, steep or small for efficient stormwater treatment.

Tables

Table 1: BMP Capacities					
Site	Street Name	Drainage Area (acres)	Percent Impervious Area (%)[1]	Approximate Required Filter Area to Treat Full Water Quality Volume (sq. ft)[2]	Approximate Treatment Capacity Available (Based on Available Area as a Percent of Water Quality Volume)[3]
1	Narragansett Boulevard	1.40	62	1404	>100
2	Narragansett Boulevard	3.68	65	3875	84.2
3	Narragansett Boulevard	5.88	70	6605	64.6
4	Narragansett Boulevard	0.85	39	529	>100
5	Narragansett Boulevard	1.26	46	930	>100
6	Narragansett Boulevard	1.38	72	1597	>100
7	Ocean Drive	8.96	47	6855	18.3
8	Selkirk Road	1.20	71	1381	79.3
9	Commercial Street	0.66	84	891	68.1
10	Commercial Street	1.42	70	1608	30.7
11	Narragansett Boulevard	5.54	71	6348	13.0

[1] Percent Impervious based on statewide impervious surface dataset from RIGS generated from 2011 aerial photography.
[2] Filter Area determined per *Chapter 5.5* of the *RISDISM*, assuming a 4-foot deep filter, 6" ponding depth, 2-day drainage period, and 33% soil porosity.

[3] For this screening-level analysis, while it was presumed that all BMPs would be designed as exfiltrating bioretention basins, the Treatment Capacity was calculated assuming no exfiltration to reach a conservative estimate.

Table 2: Annual Pollutant Loadings and Reduction Capacities[1]														
Site	Street Name	TSS Loading (lbs)	TP Loading (lbs)	TN Loading (lbs)	Bacteria Loading (billions of colonies)	TSS Reduction Capacity (Percent of Pollutant Load)[2]	TP Reduction Capacity (Percent of Pollutant Load)[2]	TN Reduction Capacity (Percent of Pollutant Load)[2]	Bacteria Reduction Capacity (Percent of Pollutant Load)[2]	TSS Load Reduction (lbs)[3]	TP Load Reduction (lbs)	TN Load Reduction (lbs)	Bacteria Load Reduction (billions of colonies)
1	Narragansett Boulevard	818	2	17	260	100.9	33.6	61.7	78.5	818[4]	1	11	204
2	Narragansett Boulevard	2240	7	47	712	75.8	25.3	46.3	59.0	1700	2	22	420
3	Narragansett Boulevard	3815	11	80	1213	58.2	19.4	35.5	45.2	2219	2	28	549
4	Narragansett Boulevard	323	1	7	103	121.6	40.5	74.3	94.5	323[4]	0	5	97
5	Narragansett Boulevard	557	2	12	177	114.4	38.1	69.9	89.0	557[4]	1	8	158
6	Narragansett Boulevard	922	3	19	293	90.5	30.2	55.3	70.4	834	1	11	206
7	Ocean Drive	4096	12	86	1303	16.4	5.5	10.0	12.8	672	1	9	167
8	Selkirk Road	796	2	17	253	71.3	23.8	43.6	55.5	568	1	7	141
9	Commercial Street	508	2	11	162	61.3	20.4	37.5	47.7	311	0	4	77
10	Commercial Street	928	3	19	295	27.6	9.2	16.9	21.5	256	0	3	63
11	Narragansett Boulevard	3661	11	77	1164	11.7	3.9	7.2	20.1	429	0	6	106

[1] Pollutant Loadings, Reduction Capacity, and Load Reduction were determined based on *Appendix H (Section H.3)* of the *RISDISM*
[2] Reduction Capacity was determined by multiplying the treatment efficiency value for bioretention reported in *Table H-3* of the *RISDISM* by the Treatment Capacity (% of Water Quality Volume that can be treated in the area available at each site) in Table 2 (above).
[3]All TSS load reduction values were rounded to three significant figures.
[4]Load Reduction cannot be greater than the Loading at any given site; therefore load reduction was set at 100% of the Loading value at these sites.

Table 3: Site Descriptions and Design Considerations			
Site	**Street Name**	**Suggested BMP Description**	**Considerations[1]**
1	Narragansett Boulevard	Three connected linear bioretention practices in the public right of way; will require pavement removal in a parking lane	Full water quality volume can be treated; large pollutant reductions possible due to interception of large pollutant loads in water draining to this site and to high treatment capacity; recommend constructing in coordination with Sites No. 3 and 11
2	Narragansett Boulevard	Linear bioretention practice in the public right of way; will require pavement removal on the roadway shoulder	Large pollutant reductions are anticipated due to high pollutant loads in draining to this site; full water quality volume can be treated depending on configuration and available space within right-of-way
3	Narragansett Boulevard	Bioretention practice in a public area	Only about 40% of the water quality volume can be treated in the space available upland of the adjacent coastal feature (which is understood to be the top of the slope toward the marsh), it is understood that pending CRMC's approval work in the "lobe" are may be allowed, which could improve the treatment capacity of this BMP; treatment efficiency will improve if constructed in coordination with Sites No. 1 and 11
4	Narragansett Boulevard	Linear bioretention practices in the public right of way; will require pavement removal on the roadway shoulder	Full water quality volume can be treated; large pollutant reductions possible due to high treatment capacity
5	Narragansett Boulevard	Linear bioretention practice in the public right of way; will require pavement removal on the roadway shoulder	Full water quality volume can be treated; large pollutant reductions possible due to high loading at this location and to high treatment capacity
6	Narragansett Boulevard	Linear bioretention practice in the public right of way; will require pavement removal on the roadway shoulder	Full water quality volume can be treated; large pollutant reductions possible due to high loading at this location and to high treatment capacity; treatment efficiency will improve further if constructed in coordination with Site no. 9
7	Ocean Drive	Bioretention system which will divert a portion of stormwater runoff from the existing storm drain system at the bottom of Fort Avenue for treatment; diverted runoff not exfiltrated within the swale will be discharged back into the storm drain system	Available space limits volume of water that can be treated to less than the water quality volume; large pollutant reductions possible due to high loading at this location; treatment efficiency will improve if constructed in combination with Site No. 10

Table 3: Site Descriptions and Design Considerations			
Site	**Street Name**	**Suggested BMP Description**	**Considerations[1]**
8	Selkirk Road	Two connected linear bioretention practices in the public right of way; will require pavement removal on the roadway shoulder	Available space limits volume of water that can be treated to less than the water quality volume; large pollutant reductions possible due to high loading at this location and moderately high treatment capacity
9	Commercial Street	Two linear bioretention practices in the public right of way, on either side of the street; will require pavement removal on the roadway shoulder	Available space limits volume of water that can be treated to less than the water quality volume; recommend constructing in coordination with Site No. 6
10	Commercial Street	Two linear bioretention practices in the public right of way, on either side of the street; will require pavement removal on the roadway shoulder	Available space limits volume of water that can be treated to less than the water quality volume; recommend constructing in coordination with Site No. 7
11	Narragansett Boulevard	Linear bioretention practice in the public right of way; assumes parking lane will be preserved	Available space limits volume of water that can be treated to less than the water quality volume; recommend constructing in coordination with Sites No. 1 and 3.

[1] The Water Quality Volume was calculated using the 1" storm. All sites except Sites No. 5 and 8 have sufficient space to treat the water quality volume when calculated using the 0.5" storm, as required in retrofitting scenarios per *Appendix C* of the *Rhode Island Stormwater Design and Installation Standards Manual* (*RISDISM*).

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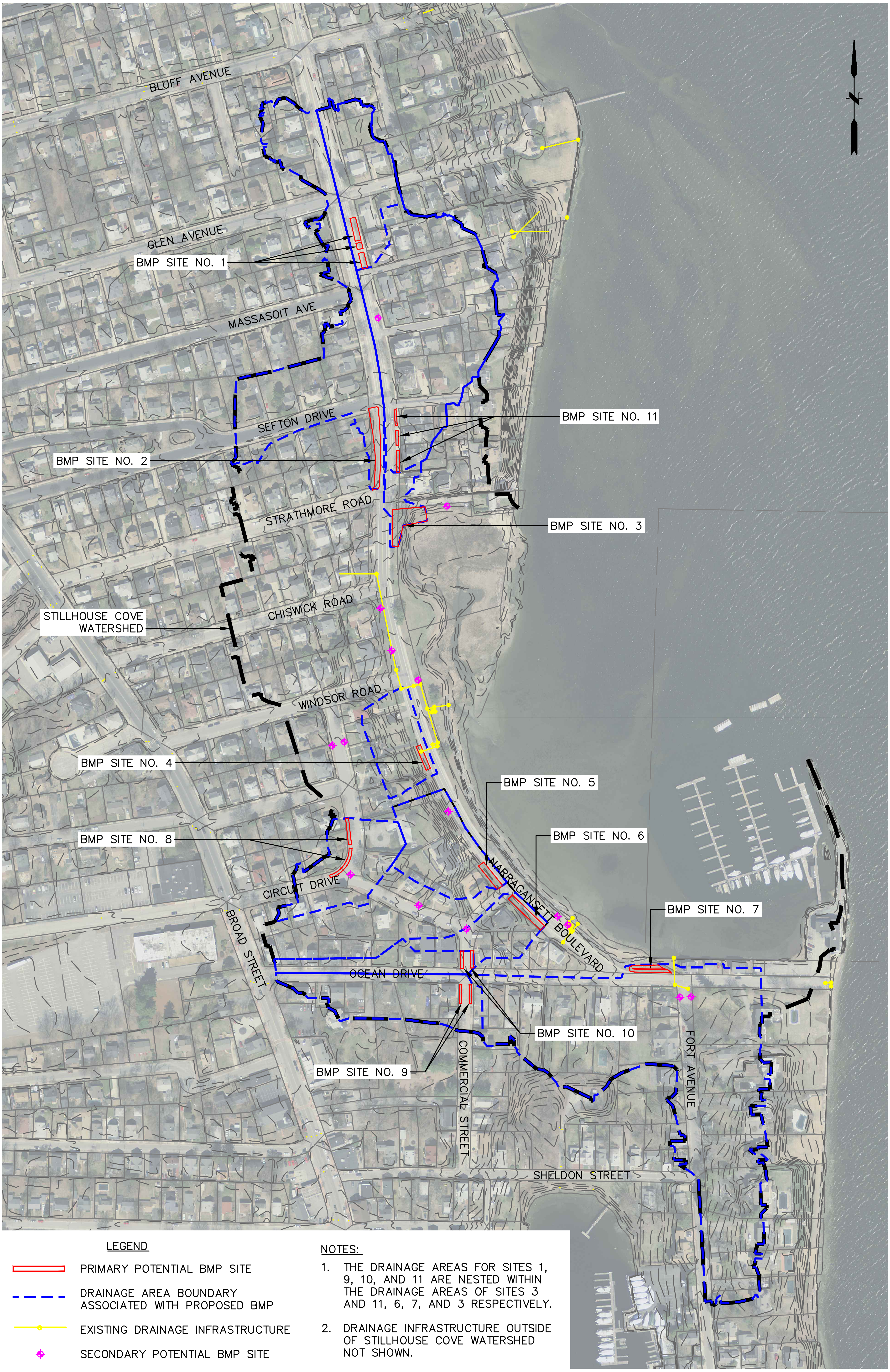
Figure



SCALE:	
HORZ.: 1" = 250'	
VERT.:	
DATUM:	
HORZ.: NAD83	
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0 125 250 GRAPHIC SCALE	

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CITY OF CRANSTON

PRIORITY POTENTIAL STORMWATER BMP SITES

STILLHOUSE COVE BMP PROJECT

CRANSTON RHODE ISLAND

PROJ. No.: 20140594.A20
DATE: MARCH 2017

FIG. 1

MS VIEW:
LAYER STATE: