

STORMWATER MANAGEMENT REPORT

FOR

**2 OLD POINT RD,
NEWBURY, MA 01951**

Prepared for:

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1.0 INTRODUCTION

The client is proposing to redevelop the site located at 2 Old Point Road and construct a new restaurant area with a mobile kitchen and outdoor seating, along with 54 parking spaces. The parking will be on gravel while maintaining some existing pavement.

2.0 STORMWATER MANAGEMENT POLICY

This project is a redevelopment of an existing site that falls under the jurisdiction of the Massachusetts Wetlands Protection (M.G.L. Ch. 131 Section 40). The reference documents used for the proposed stormwater management system for the project were the MassDEP's Stormwater Management Handbook. The following report explains how these policies are met.

3.0 EXISTING CONDITION

The limit of work for the project is the parcels of land shown in the Town of Newbury's Assessor's Database as Parcel ID U02-153 and U02-154. The approximate total land area is 0.959 acres (43,059 SF). The parcel is bound by Old Point Road to the west, residential dwellings to the north and east and Plum Island Turnpike to the south. The site is bisected by Mcleod Ave, which splits the two parcels. Across Old Point Road to the west is the salt marsh connected to the Merrimack River. The parcels currently consists of four 1-story buildings, pavement, gravel and some grass area. The existing site is 45% impervious.

According to the FEMA Flood Insurance Rate Map Number 25009C0141G, with an effective date of 7/16/2014, the site is located within a Zone AE with a Base Flood Elevation (BFE) El. 13 FT. The entire site is below the BFE. *(See Appendix C: FEMA Flood Insurance Rate Map)*

3.1 Soils

According to the Natural Resources Conservation Service (NRCS) Web Soil Survey, the site includes two categories of soils. The majority of the site is classified as Hooksan-Urban land complex, 0 to 8 percent slopes. This soil classification is recognized as Hydrologic Soil Group (HSG) A. A small western portion of the site abutting the marsh, is classified as Ipswich and Westbrook mucky peats, 0 to 2 percent slopes, very frequently flooded. This soil classification is recognized as HSG D.

Soil investigations were completed at the site in 2004 by Environmental Compliance Services (ECS). The boring sheets are included with this report. These investigations found almost entirely sand at the subsurface below the site. Well readings were done at the site during the soil investigations and 4 months following in 2004 and they found groundwater between 4 and 4.5 feet Below Ground Surface (BGS). See Soils Information for the Boring Sheets included.

4.0 PROPOSED CONDITION

The project proposes to demolish two of the buildings currently located at the site and convert the use of the existing garage structure into a restaurant space with adjacent outdoor seating. A movable kitchen is proposed to be brought to the property to service the food preparations. The existing pavement at the entrance along the south side of the property will be maintained. The remaining parking area will consist of gravel, with the exception of the handicapped parking, which will be pavement. The paved/gravel parking area will provide 54 parking spaces. The outdoor seating area will consist of landscaping, sand and dune grass, pea-stone gravel and permeable pavers making up the rest of the site.

4.1 Hydrologic Model

The hydrologic model was developed in HydroCAD, a computer program based on USDA's Technical Release TR-55, Urban Hydrology for Small Watersheds. Both existing and proposed conditions are modeled for the 2-year, 10-year, 25-year, and 100-year 24-hour storm events. HydroCAD allows for variable rainfall intensity throughout the storm duration, peaking near the middle of the Type III, 24-hour storm. The drainage area's time of concentration (t_c) is assumed to be six minutes for this site, which is the minimum recommended by TR-55. Complete calculations, performed using the HydroCAD software, are included in the appendix.

5.0 CONSISTENCY WITH DEP STORMWATER MANAGEMENT POLICY

The project was designed with the consideration of the MassDEP's Stormwater Management Policy and associated standards. The project is also recognized as a redevelopment project under the MassDEP Stormwater Management Policy, and therefore meets the standards as a redevelopment project. The ways in which these standards are met is detailed below:

5.1 Standard 1 – Untreated Stormwater

"No New untreated stormwater conveyances (e.g. outfalls) will discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth."

The proposed drainage system does not include any new conveyances that discharge stormwater directly to wetlands or water of the Commonwealth without pre-treatment. The design discharge point currently discharges directly to a resource area without any pretreatment and the proposed design will remedy that with the use of bioretention areas, stone swales, and stone sump sediment forebays. These BMP's are proposed to treat stormwater and to prevent any excess erosion to the surrounding resource areas. Since no new conveyances will directly discharge untreated stormwater, the project meets Standard 1.

5.2 Standard 2 – Post Development Peak Discharge Rates

"Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates."

The site was analyzed under both the existing and proposed conditions to compare the pre and post development peak discharge rates at the single design discharge point leaving the property that drains to the salt marsh across Old Point Road. The design point was analyzed to ensure that there is no impact on abutting properties and resource areas as a result of the project. A detailed description of both the existing conditions hydrology and proposed condition hydrology is described below. A copy of the HydroCAD reports for both existing and proposed conditions are provided in Appendix E.

Existing Conditions Hydrology

The existing hydrology on site consists of a single subcatchment that flows to a single design discharge point at the salt marsh that connects to the Merrimack River. The drainage area that flows to this design discharge point extends beyond the boundaries of the projects property line. However, due to limited survey information, this study is constrained in the size of the drainage area that can be accurately analyzed. Nevertheless, we have used additional available topographic

Table 5.2.1: Hydrological Calculation Summary

Description	Existing Conditions		Proposed Conditions	
Drainage Area	78,510 +/- Square Feet		78,510 +/- Square Feet	
Storm Event (Year)	Offsite Peak Runoff (CFS)	Offsite Runoff Volume (CF)	Offsite Peak Runoff (CFS)	Offsite Runoff Volume (CF)
2	3.24	9,526	0.46	834
10	6.23	18,520	2.61	5,362
25	8.65	26,099	4.15	10,303
100	13.73	45,516	8.47	22,667

5.3 Standard 3 – Recharge to Groundwater

“Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post development site shall approximate the annual recharge from pre-development conditions based on soil type. This condition is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.”

This project has been designed to fully comply with Standard 3. The standard states that “the annual recharge from the post development site shall approximate the annual recharge from pre-development conditions based on soil type.” This project is a redevelopment project, such that it results in a decrease in net impervious area, in this case from 45% to 18%. With **no new** net impervious area in the proposed design, therefore there would be no additional groundwater recharge required at a minimum based on pre-development conditions, the way that it is addressed in the standard.

However, groundwater recharge is still provided through the two proposed bioretention areas. Therefore, if groundwater recharge is to be calculated based on total impervious area in the proposed conditions rather than net **new** impervious area, and Hydrologic Group A is used for the recharge calculations as 0.6”, then the calculations are as follows:

$$8,016 \text{ SF of impervious area} \times 0.6'' = 401 \text{ CF of groundwater recharge}$$

In the proposed conditions, 319 CF of groundwater recharge is provided in Bioretention Area 1 and 151 CF of groundwater recharge is provided by Bioretention Area 2. This results in a total of 470 CF of total provided groundwater recharge.

5.4 Standard 4 – Removal of 80% Total Suspended Solids

“Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This Standard is met when: (a) Suitable practices for source control and pollution prevention are identified in long-term pollution prevention plan, and thereafter implemented and maintained; (b) Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and (c) Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.”

Stormwater management standards shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). As mentioned above, this project is a redevelopment project, therefore the impervious area is decreased in the proposed conditions. However, the project still provides two bioretention areas, with adequate pretreatment, that have been selected to remove a total of 90% of TSS from the on-site runoff. The pretreatment, mentioned above, includes the stone trench, which will collect and direct the runoff from the paved handicapped parking area, as well as a stone sump sediment forebay, that all runoff from the parking area will be directed through prior to entering the bioretention area. There is an additional sediment forebay located at bioretention area 2, which will also collect all runoff from the paved driveway apron adjacent to the street. These sediment forebays have been sized according to the Massachusetts Stormwater Handbook, where it is designed to hold 0.1"/impervious acre in order to pretreat:

Sediment Forebay 1:

Collects runoff from 5,080 SF of paved area, therefore –

$$= 0.1"/\text{acre} \times 1 \text{ acre}/43,560 \text{ SF} \times 5,080 \text{ SF}$$

$$= .012" \text{ of runoff}$$

$$\text{Total Volume Produced} = 0.012" \times 1'/12" \times 5,080 \text{ SF} = \mathbf{5 \text{ CF}}$$

This stone sump will be 6" deep with 55 SF of surface, therefore it provides 28 CF, far beyond the minimum required adequate pretreatment volume.

Sediment Forebay 2:

Collects runoff from 306 SF of paved area, therefore –

$$= 0.1"/\text{acre} \times 1 \text{ acre}/43,560 \text{ SF} \times 306 \text{ SF}$$

$$= 0.0007" \text{ of runoff}$$

$$\text{Total Volume Produced} = 0.0007" \times 1'/12" \times 306 \text{ SF} = \mathbf{.02 \text{ CF}}$$

This stone sump will be 6" deep with 21 SF of surface, therefore it provides 11 CF, far beyond the minimum required adequate pretreatment volume.

The project does not fall within a Zone II or Interim Wellhead Protection Area. However, it does discharge directly to an Outstanding Resource Water (ORW), which is part of the Great Marsh Area of Environmental Concern (ACEC). Therefore, Water Quality Volumes (WQV) should be

information to, to the best of our ability, extend the catchment area as far as we believe can be adequately represented.

The existing site has a catch basin owned by the Town of Newbury on the west side of the property and another catch basin on the south side along Plum Island Boulevard, located just off the property. The catch basin along Old Point Road collects runoff from the western paved portion of the site and the roof area. Its rim is located at El. 6.30 (NAVD88) which sits low enough that it is flooded via tidal influence from the marsh during king tide events. There is also runoff from the other properties up along Mcleod Ave, however this area is largely sandy, so runoff should likely not be significant. Via the two catch basins, and any runoff that flows directly from the site across the road, the entire site drains to the salt marsh located across Old Point Road. This salt marsh is directly connected to the Merrimack River. The existing site is 45% impervious. *(See Appendix B: Existing & Proposed Drainage Areas)*

Proposed Conditions Hydrology

Under the proposed conditions, the site will still have a single design discharge point at the adjacent salt marsh which connects to the Merrimack River. Within the site there will be two separate subcatchment areas. Subcatchment 10S consists of the majority of the site, including the landscaped area, the existing paved area, the new handicapped paved area and the gravel parking area. The handicapped parking area will drain to the southeast, along the wall where it will enter a stone trench which will direct it toward the bioretention area. The majority of the gravel parking area to the northwest of the property will drain via sheet flow southward, toward the bioretention area, and the eastern portion of the parking area, both gravel and pavement, will drain via sheet flow either directly toward the catch basin, or toward the stone trench, where it will be directed to the bioretention area. Prior to entering the bioretention area, the runoff will be directed to a stone sump sediment forebay, which will provide pretreatment to the runoff prior to being collected in the bioretention area. This subcatchment also includes the majority of the runoff the enters the site via the properties off Mcleod Ave.

The smaller, northwest portion of the site, including roof, gravel, pavement and landscaping will drain to the smaller bioretention area. A high point at the fenceline by the garage and the along the gravel driveway will separate these two drainage areas. These bioretention areas will collect, filter and infiltrate runoff. The proposed site is 18.6% impervious *(See Appendix B: Site Plans)* *(See Appendix F: Existing & Proposed Conditions)*

calculated under the Massachusetts Stormwater Standards where 1" of WQV storage is required for all pavement areas, the calculations are as follows:

5,118 SF of paved area x 1" = **426 CF of WQV storage required**

The proposed design includes 470 CF of WQV storage between the two bioretention areas, provided with adequate pretreatment. Therefore, this project meets Standard 4.

5.5 Standard 5 – Lands Uses with Higher Potential Pollutant Loads

"For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMP's determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook."

This project is not considered a Land Use with Higher Potential Pollutant Loads. Therefore, this standard is not applicable to this project.

5.6 Standard 6 – Critical Areas

"Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply and stormwater discharges near or to any other critical area require the use of specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas as provided in the Massachusetts Stormwater Handbook."

As mentioned above, this project is not located within a Zone II wellhead protection area. However, the project does discharge directly to an ORW which is part of the Great Marsh ACEC. Therefore, the project requires 1" of WQV be provided for all pavement areas.

The project may not be located within a Wellhead Protection Area, however it does discharge to the adjacent salt marsh and it also falls within a Zone AE Flood Zone, or the 100 YR Flood Zone. Both of these areas are resource areas protected under the Massachusetts Wetlands Protection Act (M.G.L. c. 131 Section 40) and its implementing regulations (310 CMR 10.00). These resource areas have been heavily taken into consideration during the planning and stormwater design of this project, and an NOI will be filed with the Newbury Conservation Commission for work within the 100 YR Flood Zone and salt marsh 100-FT buffer zone.

5.7 Standard 7 – Redevelopment

"A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5 and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions."

A “redevelopment project” is defined in the Massachusetts Stormwater Handbook as “development, rehabilitation, expansion, and phased projects on previously developed sites, provided the redevelopment results in no increase in impervious area.” The proposed project meets the definition as the project proposes no net increase in impervious area. However, the project has been designed to meet all Stormwater Standards to the maximum extent practicable.

5.8 Standard 8 – Erosion and Sediment Controls

“A plan to control construction related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.”

Erosion and sediment controls will be in place throughout the site during all phases of demolition and construction. All existing catch basins in the project area will have a silt sack installed under the grate. Compost socks will line the edge of the site to protect the adjacent salt marsh from silted off-site runoff. The contractor will be responsible for checking all of the erosion and sediment control measures periodically and after every major storm. The contractor will repair, replace, and maintain all erosion/sediment control measures through construction until all disturbed areas have been stabilized. An Erosion Control Plan is provided in Appendix A.

5.9 Standard 9 – Operation and Maintenance Plan

“A long-term operation and maintenance plan shall be delivered and implemented to ensure that stormwater management systems function as designed.”

A long term Operation and Maintenance Plan is included in Appendix F. The plan includes provisions for Construction Phase measures, as well as long term maintenance and inspections.

5.10 Standard 10 – Illicit Discharge to Drainage System

“All illicit discharges to the stormwater management system are prohibited.”

There are no known or suspected illicit discharges to the stormwater management system at the project site. Therefore, this project complies with Standard 10.

6.0 CONCLUSION

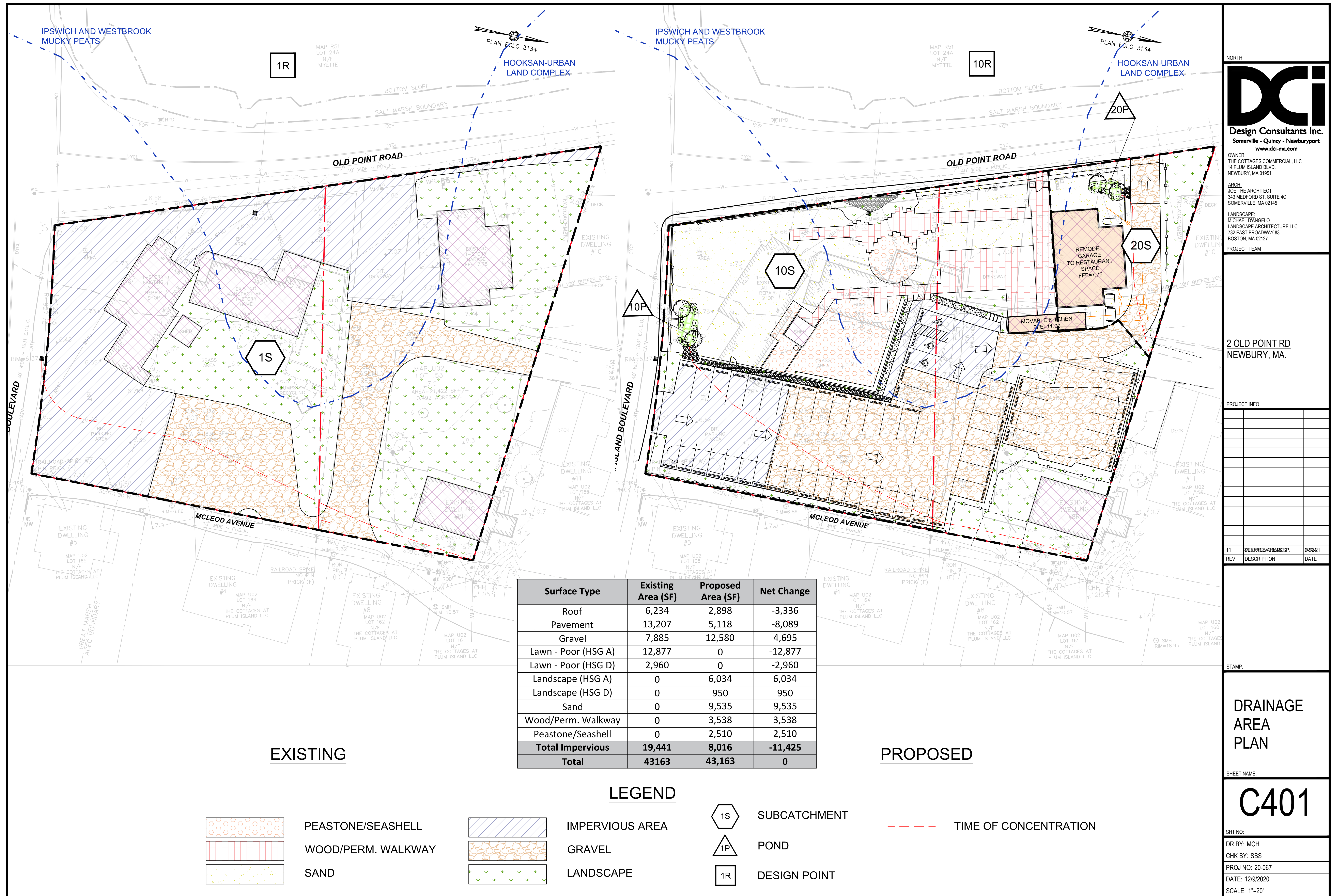
Based on DCI’s analysis of the existing and proposed conditions, the proposed site conditions meet the stormwater management criteria set. Design Point runoff volumes and peak flow rates for the 2-year, 10-year, 25-year, and 100-year storm events are decreased and each MassDEP Stormwater Standard is met. DCI concludes that the proposed redevelopment at 2 Old Point Road, Newbury, MA adheres to all applicable stormwater management policies.

Appendix A

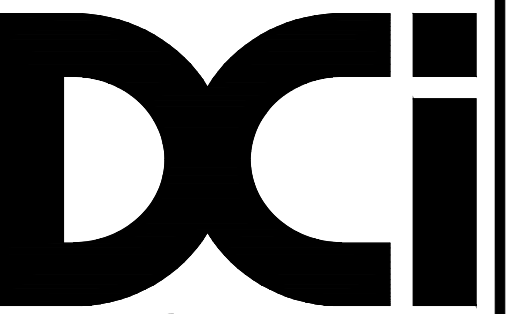
SITE PLANS (SEPARATE ATTACHMENT)

Appendix B

EXISTING & PROPOSED DRAINAGE AREAS



NORTH



Design Consultants Inc.
Somerville - Quincy - Newburyport
www.dci-ma.com

OWNER:
THE COTTAGES COMMERCIAL, LLC
14 PLUM ISLAND BLVD.
NEWBURY, MA 01951

ARCH:
JOE THE ARCHITECT
343 MEDFORD ST, SUITE 4C
SOMERVILLE, MA 02145

LANDSCAPE:
MICHAEL D'ANGELO
LANDSCAPE ARCHITECTURE LLC
732 EAST BROADWAY #3
BOSTON, MA 02127

PROJECT TEAM

2 OLD POINT RD
NEWBURY, MA.

PROJECT INFO

[illegible]

STAMP:

DRAINAGE AREA PLAN

SHEET NAME:

C401

HT NO:

DR BY: MCH

CHK BY: SBS

PROJ NO: 20-067

DATE: 12/9/2020

SCALE: 1"=20'

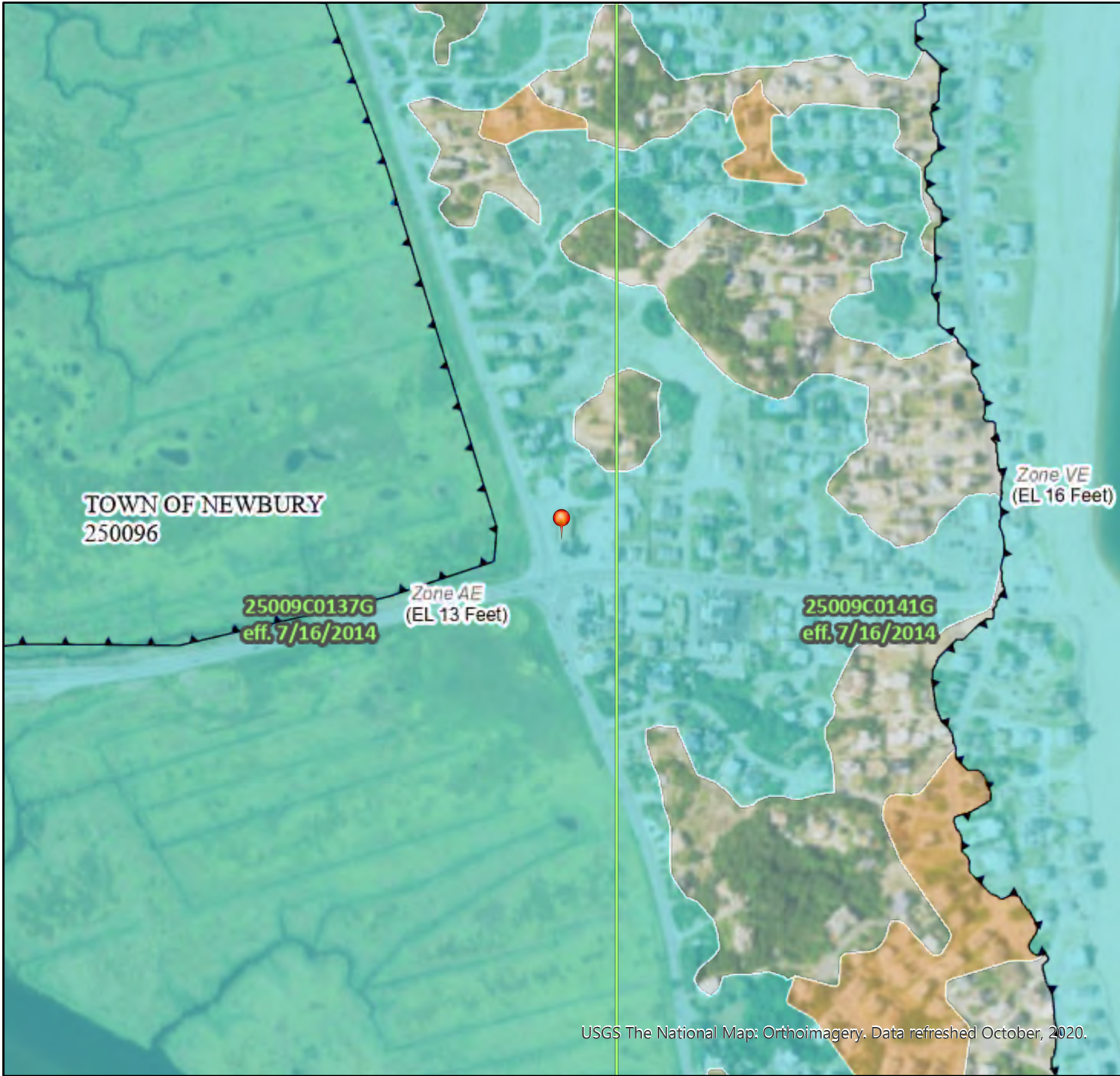
Appendix C

FEMA FLOOD INSURANCE RATE MAP

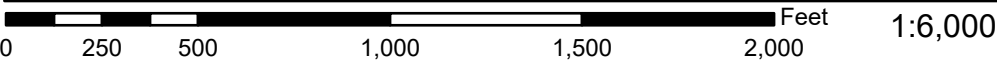
National Flood Hazard Layer FIRMette



70°49'6"W 42°48'10"N



USGS The National Map: Orthoimagery. Data refreshed October, 2020.



70°48'28"W 42°47'43"N

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **12/8/2020 at 4:19 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Appendix D

SOILS INFORMATION

Soil Map—Essex County, Massachusetts, Northern Part



Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

12/7/2020
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MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Essex County, Massachusetts, Northern Part

Survey Area Data: Version 16, Jun 9, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Sep 12, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

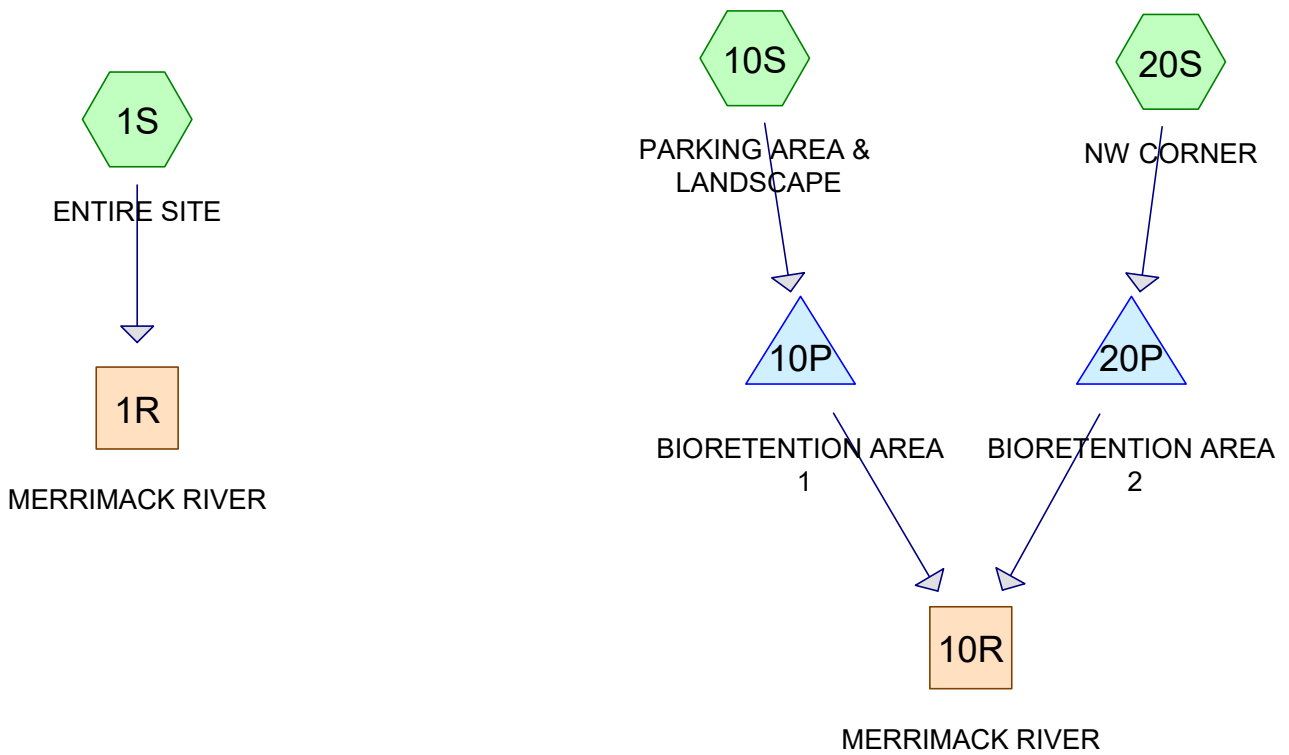
Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
638B	Hooksan-Urban land complex, 0 to 8 percent slopes	18.3	56.9%
712A	Ipswich and Westbrook mucky peats, 0 to 2 percent slopes, very frequently flooded	13.8	43.1%
Totals for Area of Interest		32.1	100.0%

Environmental Compliance Services, Inc.
588 Silver Street, Andover, Massachusetts 01001

Appendix E

EXISTING AND PROPOSED HYDROLOGY



20-067 DR - large catchment

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Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
38,773	68	<50% Grass cover, Poor, HSG A (1S)
2,960	89	<50% Grass cover, Poor, HSG D (1S)
32,193	39	>75% Grass cover, Good, HSG A (10S, 20S)
911	80	>75% Grass cover, Good, HSG D (10S)
23,428	96	Gravel surface, HSG A (1S, 10S, 20S)
23,437	98	Paved parking, HSG A (1S, 10S)
2,499	45	Peastone/Seashell (10S)
3,538	55	Perm/Wood Walkway (10S)
19,691	98	Roofs, HSG A (1S, 10S, 20S)
9,559	30	Sand (10S, 20S)

20-067 DR - large catchment

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Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
137,522	HSG A	1S, 10S, 20S
0	HSG B	
0	HSG C	
3,871	HSG D	1S, 10S
15,596	Other	10S, 20S

20-067 DR - large catchment

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Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover
38,773	0	0	2,960	0	41,733	<50% Grass cover, Poor
32,193	0	0	911	0	33,104	>75% Grass cover, Good
23,428	0	0	0	0	23,428	Gravel surface
23,437	0	0	0	0	23,437	Paved parking
0	0	0	0	2,499	2,499	Peastone/Seash ell
0	0	0	0	3,538	3,538	Perm/Wood Walkway
19,691	0	0	0	0	19,691	Roofs
0	0	0	0	9,559	9,559	Sand

20-067 DR - large catchment*Type III 24-hr 2-Year Rainfall=3.15"*

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: ENTIRE SITE	Runoff Area=78,510 sf 34.73% Impervious Runoff Depth>1.46" Tc=6.0 min CN=83 Runoff=3.24 cfs 9,526 cf
Subcatchment 10S: PARKING AREA &	Runoff Area=64,461 sf 19.82% Impervious Runoff Depth>0.40" Tc=6.0 min CN=62 Runoff=0.52 cfs 2,165 cf
Subcatchment 20S: NW CORNER	Runoff Area=14,018 sf 22.00% Impervious Runoff Depth>0.25" Tc=6.0 min CN=57 Runoff=0.04 cfs 292 cf
Reach 1R: MERRIMACK RIVER	Inflow=3.24 cfs 9,526 cf Outflow=3.24 cfs 9,526 cf
Reach 10R: MERRIMACK RIVER	Inflow=0.46 cfs 834 cf Outflow=0.46 cfs 834 cf
Pond 10P: BIORETENTION AREA 1	Peak Elev=6.79' Storage=319 cf Inflow=0.52 cfs 2,165 cf Discarded=0.04 cfs 1,093 cf Primary=0.46 cfs 834 cf Outflow=0.50 cfs 1,927 cf
Pond 20P: BIORETENTION AREA 2	Peak Elev=5.01' Storage=47 cf Inflow=0.04 cfs 292 cf Discarded=0.01 cfs 291 cf Primary=0.00 cfs 0 cf Outflow=0.01 cfs 291 cf

20-067 DR - large catchment

Type III 24-hr 2-Year Rainfall=3.15"

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Summary for Subcatchment 1S: ENTIRE SITE

Runoff = 3.24 cfs @ 12.09 hrs, Volume= 9,526 cf, Depth> 1.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
15,776	98	Paved parking, HSG A
11,489	98	Roofs, HSG A
2,960	89	<50% Grass cover, Poor, HSG D
38,773	68	<50% Grass cover, Poor, HSG A
9,512	96	Gravel surface, HSG A
78,510	83	Weighted Average
51,245		65.27% Pervious Area
27,265		34.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 10S: PARKING AREA & LANDSCAPE

Runoff = 0.52 cfs @ 12.12 hrs, Volume= 2,165 cf, Depth> 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
7,661	98	Paved parking, HSG A
5,118	98	Roofs, HSG A
24,267	39	>75% Grass cover, Good, HSG A
911	80	>75% Grass cover, Good, HSG D
12,527	96	Gravel surface, HSG A
* 2,499	45	Peastone/Seashell
* 3,538	55	Perm/Wood Walkway
* 7,940	30	Sand
64,461	62	Weighted Average
51,682		80.18% Pervious Area
12,779		19.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

20-067 DR - large catchment

Type III 24-hr 2-Year Rainfall=3.15"

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Summary for Subcatchment 20S: NW CORNER

Runoff = 0.04 cfs @ 12.29 hrs, Volume= 292 cf, Depth> 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
7,926	39	>75% Grass cover, Good, HSG A
1,389	96	Gravel surface, HSG A
3,084	98	Roofs, HSG A
* 1,619	30	Sand
14,018	57	Weighted Average
10,934		78.00% Pervious Area
3,084		22.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Reach 1R: MERRIMACK RIVER

Inflow Area = 78,510 sf, 34.73% Impervious, Inflow Depth > 1.46" for 2-Year event
 Inflow = 3.24 cfs @ 12.09 hrs, Volume= 9,526 cf
 Outflow = 3.24 cfs @ 12.09 hrs, Volume= 9,526 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach 10R: MERRIMACK RIVER

Inflow Area = 78,479 sf, 20.21% Impervious, Inflow Depth = 0.13" for 2-Year event
 Inflow = 0.46 cfs @ 12.30 hrs, Volume= 834 cf
 Outflow = 0.46 cfs @ 12.30 hrs, Volume= 834 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Pond 10P: BIORETENTION AREA 1

Inflow Area = 64,461 sf, 19.82% Impervious, Inflow Depth > 0.40" for 2-Year event
 Inflow = 0.52 cfs @ 12.12 hrs, Volume= 2,165 cf
 Outflow = 0.50 cfs @ 12.30 hrs, Volume= 1,927 cf, Atten= 4%, Lag= 10.5 min
 Discarded = 0.04 cfs @ 12.25 hrs, Volume= 1,093 cf
 Primary = 0.46 cfs @ 12.30 hrs, Volume= 834 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 6.79' @ 12.30 hrs Surf.Area= 200 sf Storage= 319 cf

Plug-Flow detention time= 66.2 min calculated for 1,927 cf (89% of inflow)
 Center-of-Mass det. time= 32.5 min (887.0 - 854.4)

20-067 DR - large catchment

Type III 24-hr 2-Year Rainfall=3.15"

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Volume	Invert	Avail.Storage	Storage Description
#1	3.70'	319 cf	Custom Stage Data (Irregular) Listed below (Recalc) 532 cf Overall x 60.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
3.70	173	50.0	0	0	173
4.70	173	50.0	173	173	223
5.70	173	53.0	173	346	280
6.70	200	56.0	186	532	340

Device	Routing	Invert	Outlet Devices
#1	Primary	6.70'	5.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Discarded	3.70'	8.270 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.04 cfs @ 12.25 hrs HW=6.76' (Free Discharge)↑**2=Exfiltration** (Exfiltration Controls 0.04 cfs)**Primary OutFlow** Max=0.45 cfs @ 12.30 hrs HW=6.79' (Free Discharge)↑**1=Sharp-Crested Rectangular Weir** (Weir Controls 0.45 cfs @ 0.99 fps)**Summary for Pond 20P: BIORETENTION AREA 2**

Inflow Area = 14,018 sf, 22.00% Impervious, Inflow Depth > 0.25" for 2-Year event
 Inflow = 0.04 cfs @ 12.29 hrs, Volume= 292 cf
 Outflow = 0.01 cfs @ 12.10 hrs, Volume= 291 cf, Atten= 66%, Lag= 0.0 min
 Discarded = 0.01 cfs @ 12.10 hrs, Volume= 291 cf
 Primary = 0.00 cfs @ 5.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 5.01' @ 13.09 hrs Surf.Area= 77 sf Storage= 47 cf

Plug-Flow detention time= 27.1 min calculated for 290 cf (100% of inflow)

Center-of-Mass det. time= 26.6 min (903.9 - 877.4)

Volume	Invert	Avail.Storage	Storage Description
#1	4.00'	151 cf	Custom Stage Data (Irregular) Listed below (Recalc) 252 cf Overall x 60.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
4.00	77	40.0	0	0	77
5.00	77	40.0	77	77	117
6.00	77	40.0	77	154	157
7.00	120	46.0	98	252	216

Device	Routing	Invert	Outlet Devices
#1	Primary	7.00'	3.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Discarded	4.00'	8.270 in/hr Exfiltration over Surface area

20-067 DR - large catchment

Type III 24-hr 2-Year Rainfall=3.15"

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Discarded OutFlow Max=0.01 cfs @ 12.10 hrs HW=4.04' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=4.00' (Free Discharge)

↑**1=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

20-067 DR - large catchment*Type III 24-hr 10-Year Rainfall=4.83"*

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: ENTIRE SITE	Runoff Area=78,510 sf 34.73% Impervious Runoff Depth>2.83" Tc=6.0 min CN=83 Runoff=6.23 cfs 18,520 cf
Subcatchment 10S: PARKING AREA &	Runoff Area=64,461 sf 19.82% Impervious Runoff Depth>1.21" Tc=6.0 min CN=62 Runoff=2.08 cfs 6,492 cf
Subcatchment 20S: NW CORNER	Runoff Area=14,018 sf 22.00% Impervious Runoff Depth>0.91" Tc=6.0 min CN=57 Runoff=0.31 cfs 1,060 cf
Reach 1R: MERRIMACK RIVER	Inflow=6.23 cfs 18,520 cf Outflow=6.23 cfs 18,520 cf
Reach 10R: MERRIMACK RIVER	Inflow=2.61 cfs 5,362 cf Outflow=2.61 cfs 5,362 cf
Pond 10P: BIORETENTION AREA 1	Peak Elev=7.00' Storage=319 cf Inflow=2.08 cfs 6,492 cf Discarded=0.04 cfs 1,186 cf Primary=2.61 cfs 4,988 cf Outflow=2.65 cfs 6,174 cf
Pond 20P: BIORETENTION AREA 2	Peak Elev=7.11' Storage=151 cf Inflow=0.31 cfs 1,060 cf Discarded=0.02 cfs 604 cf Primary=0.37 cfs 374 cf Outflow=0.39 cfs 978 cf

20-067 DR - large catchment

Type III 24-hr 10-Year Rainfall=4.83"

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Summary for Subcatchment 1S: ENTIRE SITE

Runoff = 6.23 cfs @ 12.09 hrs, Volume= 18,520 cf, Depth> 2.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
15,776	98	Paved parking, HSG A
11,489	98	Roofs, HSG A
2,960	89	<50% Grass cover, Poor, HSG D
38,773	68	<50% Grass cover, Poor, HSG A
9,512	96	Gravel surface, HSG A
78,510	83	Weighted Average
51,245		65.27% Pervious Area
27,265		34.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 10S: PARKING AREA & LANDSCAPE

Runoff = 2.08 cfs @ 12.10 hrs, Volume= 6,492 cf, Depth> 1.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
7,661	98	Paved parking, HSG A
5,118	98	Roofs, HSG A
24,267	39	>75% Grass cover, Good, HSG A
911	80	>75% Grass cover, Good, HSG D
12,527	96	Gravel surface, HSG A
* 2,499	45	Peastone/Seashell
* 3,538	55	Perm/Wood Walkway
* 7,940	30	Sand
64,461	62	Weighted Average
51,682		80.18% Pervious Area
12,779		19.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

20-067 DR - large catchment

Type III 24-hr 10-Year Rainfall=4.83"

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Summary for Subcatchment 20S: NW CORNER

Runoff = 0.31 cfs @ 12.11 hrs, Volume= 1,060 cf, Depth> 0.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
7,926	39	>75% Grass cover, Good, HSG A
1,389	96	Gravel surface, HSG A
3,084	98	Roofs, HSG A
* 1,619	30	Sand
14,018	57	Weighted Average
10,934		78.00% Pervious Area
3,084		22.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Reach 1R: MERRIMACK RIVER

Inflow Area = 78,510 sf, 34.73% Impervious, Inflow Depth > 2.83" for 10-Year event
 Inflow = 6.23 cfs @ 12.09 hrs, Volume= 18,520 cf
 Outflow = 6.23 cfs @ 12.09 hrs, Volume= 18,520 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach 10R: MERRIMACK RIVER

Inflow Area = 78,479 sf, 20.21% Impervious, Inflow Depth > 0.82" for 10-Year event
 Inflow = 2.61 cfs @ 12.10 hrs, Volume= 5,362 cf
 Outflow = 2.61 cfs @ 12.10 hrs, Volume= 5,362 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Pond 10P: BIORETENTION AREA 1

Inflow Area = 64,461 sf, 19.82% Impervious, Inflow Depth > 1.21" for 10-Year event
 Inflow = 2.08 cfs @ 12.10 hrs, Volume= 6,492 cf
 Outflow = 2.65 cfs @ 12.10 hrs, Volume= 6,174 cf, Atten= 0%, Lag= 0.0 min
 Discarded = 0.04 cfs @ 12.00 hrs, Volume= 1,186 cf
 Primary = 2.61 cfs @ 12.10 hrs, Volume= 4,988 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 7.00' @ 12.10 hrs Surf.Area= 200 sf Storage= 319 cf

Plug-Flow detention time= 22.9 min calculated for 6,154 cf (95% of inflow)
 Center-of-Mass det. time= 6.1 min (831.6 - 825.5)

20-067 DR - large catchment

Type III 24-hr 10-Year Rainfall=4.83"

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Volume	Invert	Avail.Storage	Storage Description
#1	3.70'	319 cf	Custom Stage Data (Irregular) Listed below (Recalc) 532 cf Overall x 60.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
3.70	173	50.0	0	0	173
4.70	173	50.0	173	173	223
5.70	173	53.0	173	346	280
6.70	200	56.0	186	532	340

Device	Routing	Invert	Outlet Devices
#1	Primary	6.70'	5.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Discarded	3.70'	8.270 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.04 cfs @ 12.00 hrs HW=6.91' (Free Discharge)↑**2=Exfiltration** (Exfiltration Controls 0.04 cfs)**Primary OutFlow** Max=2.58 cfs @ 12.10 hrs HW=6.99' (Free Discharge)↑**1=Sharp-Crested Rectangular Weir** (Weir Controls 2.58 cfs @ 1.78 fps)**Summary for Pond 20P: BIORETENTION AREA 2**

Inflow Area = 14,018 sf, 22.00% Impervious, Inflow Depth > 0.91" for 10-Year event
 Inflow = 0.31 cfs @ 12.11 hrs, Volume= 1,060 cf
 Outflow = 0.39 cfs @ 12.20 hrs, Volume= 978 cf, Atten= 0%, Lag= 5.3 min
 Discarded = 0.02 cfs @ 12.15 hrs, Volume= 604 cf
 Primary = 0.37 cfs @ 12.20 hrs, Volume= 374 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 7.11' @ 12.20 hrs Surf.Area= 120 sf Storage= 151 cf

Plug-Flow detention time= 59.6 min calculated for 975 cf (92% of inflow)

Center-of-Mass det. time= 34.5 min (872.1 - 837.6)

Volume	Invert	Avail.Storage	Storage Description
#1	4.00'	151 cf	Custom Stage Data (Irregular) Listed below (Recalc) 252 cf Overall x 60.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
4.00	77	40.0	0	0	77
5.00	77	40.0	77	77	117
6.00	77	40.0	77	154	157
7.00	120	46.0	98	252	216

Device	Routing	Invert	Outlet Devices
#1	Primary	7.00'	3.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Discarded	4.00'	8.270 in/hr Exfiltration over Surface area

20-067 DR - large catchment

Type III 24-hr 10-Year Rainfall=4.83"

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Discarded OutFlow Max=0.02 cfs @ 12.15 hrs HW=7.04' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.34 cfs @ 12.20 hrs HW=7.11' (Free Discharge)

↑**1=Sharp-Crested Rectangular Weir** (Weir Controls 0.34 cfs @ 1.07 fps)

20-067 DR - large catchment*Type III 24-hr 25-Year Rainfall=6.16"*

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: ENTIRE SITE	Runoff Area=78,510 sf 34.73% Impervious Runoff Depth>3.99" Tc=6.0 min CN=83 Runoff=8.65 cfs 26,099 cf
Subcatchment 10S: PARKING AREA &	Runoff Area=64,461 sf 19.82% Impervious Runoff Depth>2.02" Tc=6.0 min CN=62 Runoff=3.62 cfs 10,826 cf
Subcatchment 20S: NW CORNER	Runoff Area=14,018 sf 22.00% Impervious Runoff Depth>1.61" Tc=6.0 min CN=57 Runoff=0.61 cfs 1,880 cf
Reach 1R: MERRIMACK RIVER	Inflow=8.65 cfs 26,099 cf Outflow=8.65 cfs 26,099 cf
Reach 10R: MERRIMACK RIVER	Inflow=4.15 cfs 10,303 cf Outflow=4.15 cfs 10,303 cf
Pond 10P: BIORETENTION AREA 1	Peak Elev=7.07' Storage=319 cf Inflow=3.62 cfs 10,826 cf Discarded=0.04 cfs 1,283 cf Primary=3.65 cfs 9,228 cf Outflow=3.69 cfs 10,511 cf
Pond 20P: BIORETENTION AREA 2	Peak Elev=7.16' Storage=151 cf Inflow=0.61 cfs 1,880 cf Discarded=0.02 cfs 683 cf Primary=0.60 cfs 1,075 cf Outflow=0.62 cfs 1,758 cf

20-067 DR - large catchment

Type III 24-hr 25-Year Rainfall=6.16"

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Summary for Subcatchment 1S: ENTIRE SITE

Runoff = 8.65 cfs @ 12.09 hrs, Volume= 26,099 cf, Depth> 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.16"

Area (sf)	CN	Description
15,776	98	Paved parking, HSG A
11,489	98	Roofs, HSG A
2,960	89	<50% Grass cover, Poor, HSG D
38,773	68	<50% Grass cover, Poor, HSG A
9,512	96	Gravel surface, HSG A
78,510	83	Weighted Average
51,245		65.27% Pervious Area
27,265		34.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 10S: PARKING AREA & LANDSCAPE

Runoff = 3.62 cfs @ 12.10 hrs, Volume= 10,826 cf, Depth> 2.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.16"

Area (sf)	CN	Description
7,661	98	Paved parking, HSG A
5,118	98	Roofs, HSG A
24,267	39	>75% Grass cover, Good, HSG A
911	80	>75% Grass cover, Good, HSG D
12,527	96	Gravel surface, HSG A
* 2,499	45	Peastone/Seashell
* 3,538	55	Perm/Wood Walkway
* 7,940	30	Sand
64,461	62	Weighted Average
51,682		80.18% Pervious Area
12,779		19.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

20-067 DR - large catchment

Type III 24-hr 25-Year Rainfall=6.16"

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Summary for Subcatchment 20S: NW CORNER

Runoff = 0.61 cfs @ 12.10 hrs, Volume= 1,880 cf, Depth> 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.16"

Area (sf)	CN	Description
7,926	39	>75% Grass cover, Good, HSG A
1,389	96	Gravel surface, HSG A
3,084	98	Roofs, HSG A
* 1,619	30	Sand
14,018	57	Weighted Average
10,934		78.00% Pervious Area
3,084		22.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Reach 1R: MERRIMACK RIVER

Inflow Area = 78,510 sf, 34.73% Impervious, Inflow Depth > 3.99" for 25-Year event
 Inflow = 8.65 cfs @ 12.09 hrs, Volume= 26,099 cf
 Outflow = 8.65 cfs @ 12.09 hrs, Volume= 26,099 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach 10R: MERRIMACK RIVER

Inflow Area = 78,479 sf, 20.21% Impervious, Inflow Depth > 1.58" for 25-Year event
 Inflow = 4.15 cfs @ 12.10 hrs, Volume= 10,303 cf
 Outflow = 4.15 cfs @ 12.10 hrs, Volume= 10,303 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Pond 10P: BIORETENTION AREA 1

Inflow Area = 64,461 sf, 19.82% Impervious, Inflow Depth > 2.02" for 25-Year event
 Inflow = 3.62 cfs @ 12.10 hrs, Volume= 10,826 cf
 Outflow = 3.69 cfs @ 12.10 hrs, Volume= 10,511 cf, Atten= 0%, Lag= 0.0 min
 Discarded = 0.04 cfs @ 11.75 hrs, Volume= 1,283 cf
 Primary = 3.65 cfs @ 12.10 hrs, Volume= 9,228 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 7.07' @ 12.10 hrs Surf.Area= 200 sf Storage= 319 cf

Plug-Flow detention time= 14.6 min calculated for 10,511 cf (97% of inflow)
 Center-of-Mass det. time= 3.9 min (817.8 - 813.8)

20-067 DR - large catchment

Type III 24-hr 25-Year Rainfall=6.16"

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Volume	Invert	Avail.Storage	Storage Description
#1	3.70'	319 cf	Custom Stage Data (Irregular) Listed below (Recalc) 532 cf Overall x 60.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
3.70	173	50.0	0	0	173
4.70	173	50.0	173	173	223
5.70	173	53.0	173	346	280
6.70	200	56.0	186	532	340

Device	Routing	Invert	Outlet Devices
#1	Primary	6.70'	5.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Discarded	3.70'	8.270 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.04 cfs @ 11.75 hrs HW=6.79' (Free Discharge)↑**2=Exfiltration** (Exfiltration Controls 0.04 cfs)**Primary OutFlow** Max=3.63 cfs @ 12.10 hrs HW=7.07' (Free Discharge)↑**1=Sharp-Crested Rectangular Weir** (Weir Controls 3.63 cfs @ 1.99 fps)**Summary for Pond 20P: BIORETENTION AREA 2**

Inflow Area = 14,018 sf, 22.00% Impervious, Inflow Depth > 1.61" for 25-Year event
 Inflow = 0.61 cfs @ 12.10 hrs, Volume= 1,880 cf
 Outflow = 0.62 cfs @ 12.14 hrs, Volume= 1,758 cf, Atten= 0%, Lag= 2.1 min
 Discarded = 0.02 cfs @ 12.05 hrs, Volume= 683 cf
 Primary = 0.60 cfs @ 12.14 hrs, Volume= 1,075 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 7.16' @ 12.14 hrs Surf.Area= 120 sf Storage= 151 cf

Plug-Flow detention time= 36.3 min calculated for 1,752 cf (93% of inflow)

Center-of-Mass det. time= 14.5 min (838.2 - 823.7)

Volume	Invert	Avail.Storage	Storage Description
#1	4.00'	151 cf	Custom Stage Data (Irregular) Listed below (Recalc) 252 cf Overall x 60.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
4.00	77	40.0	0	0	77
5.00	77	40.0	77	77	117
6.00	77	40.0	77	154	157
7.00	120	46.0	98	252	216

Device	Routing	Invert	Outlet Devices
#1	Primary	7.00'	3.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Discarded	4.00'	8.270 in/hr Exfiltration over Surface area

20-067 DR - large catchment

Type III 24-hr 25-Year Rainfall=6.16"

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Discarded OutFlow Max=0.02 cfs @ 12.05 hrs HW=7.15' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.56 cfs @ 12.14 hrs HW=7.15' (Free Discharge)

↑**1=Sharp-Crested Rectangular Weir** (Weir Controls 0.56 cfs @ 1.27 fps)

20-067 DR - large catchment*Type III 24-hr 100-Year Rainfall=8.94"*

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: ENTIRE SITE	Runoff Area=78,510 sf 34.73% Impervious Runoff Depth>6.50" Tc=6.0 min CN=83 Runoff=13.73 cfs 42,516 cf
Subcatchment 10S: PARKING AREA &	Runoff Area=64,461 sf 19.82% Impervious Runoff Depth>3.99" Tc=6.0 min CN=62 Runoff=7.29 cfs 21,410 cf
Subcatchment 20S: NW CORNER	Runoff Area=14,018 sf 22.00% Impervious Runoff Depth>3.40" Tc=6.0 min CN=57 Runoff=1.34 cfs 3,969 cf
Reach 1R: MERRIMACK RIVER	Inflow=13.73 cfs 42,516 cf Outflow=13.73 cfs 42,516 cf
Reach 10R: MERRIMACK RIVER	Inflow=8.47 cfs 22,667 cf Outflow=8.47 cfs 22,667 cf
Pond 10P: BIORETENTION AREA 1	Peak Elev=7.29' Storage=319 cf Inflow=7.29 cfs 21,410 cf Discarded=0.04 cfs 1,467 cf Primary=7.25 cfs 19,623 cf Outflow=7.29 cfs 21,090 cf
Pond 20P: BIORETENTION AREA 2	Peak Elev=7.27' Storage=151 cf Inflow=1.34 cfs 3,969 cf Discarded=0.02 cfs 773 cf Primary=1.32 cfs 3,044 cf Outflow=1.34 cfs 3,817 cf

20-067 DR - large catchment

Type III 24-hr 100-Year Rainfall=8.94"

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Summary for Subcatchment 1S: ENTIRE SITE

Runoff = 13.73 cfs @ 12.09 hrs, Volume= 42,516 cf, Depth> 6.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
15,776	98	Paved parking, HSG A
11,489	98	Roofs, HSG A
2,960	89	<50% Grass cover, Poor, HSG D
38,773	68	<50% Grass cover, Poor, HSG A
9,512	96	Gravel surface, HSG A
78,510	83	Weighted Average
51,245		65.27% Pervious Area
27,265		34.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 10S: PARKING AREA & LANDSCAPE

Runoff = 7.29 cfs @ 12.09 hrs, Volume= 21,410 cf, Depth> 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
7,661	98	Paved parking, HSG A
5,118	98	Roofs, HSG A
24,267	39	>75% Grass cover, Good, HSG A
911	80	>75% Grass cover, Good, HSG D
12,527	96	Gravel surface, HSG A
* 2,499	45	Peastone/Seashell
* 3,538	55	Perm/Wood Walkway
* 7,940	30	Sand
64,461	62	Weighted Average
51,682		80.18% Pervious Area
12,779		19.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

20-067 DR - large catchment

Type III 24-hr 100-Year Rainfall=8.94"

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Summary for Subcatchment 20S: NW CORNER

Runoff = 1.34 cfs @ 12.10 hrs, Volume= 3,969 cf, Depth> 3.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
7,926	39	>75% Grass cover, Good, HSG A
1,389	96	Gravel surface, HSG A
3,084	98	Roofs, HSG A
* 1,619	30	Sand
14,018	57	Weighted Average
10,934		78.00% Pervious Area
3,084		22.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Reach 1R: MERRIMACK RIVER

Inflow Area = 78,510 sf, 34.73% Impervious, Inflow Depth > 6.50" for 100-Year event
 Inflow = 13.73 cfs @ 12.09 hrs, Volume= 42,516 cf
 Outflow = 13.73 cfs @ 12.09 hrs, Volume= 42,516 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach 10R: MERRIMACK RIVER

Inflow Area = 78,479 sf, 20.21% Impervious, Inflow Depth > 3.47" for 100-Year event
 Inflow = 8.47 cfs @ 12.09 hrs, Volume= 22,667 cf
 Outflow = 8.47 cfs @ 12.09 hrs, Volume= 22,667 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Pond 10P: BIORETENTION AREA 1

Inflow Area = 64,461 sf, 19.82% Impervious, Inflow Depth > 3.99" for 100-Year event
 Inflow = 7.29 cfs @ 12.09 hrs, Volume= 21,410 cf
 Outflow = 7.29 cfs @ 12.09 hrs, Volume= 21,090 cf, Atten= 0%, Lag= 0.0 min
 Discarded = 0.04 cfs @ 10.80 hrs, Volume= 1,467 cf
 Primary = 7.25 cfs @ 12.09 hrs, Volume= 19,623 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 7.29' @ 12.09 hrs Surf.Area= 200 sf Storage= 319 cf

Plug-Flow detention time= 8.5 min calculated for 21,090 cf (99% of inflow)
 Center-of-Mass det. time= 2.7 min (801.3 - 798.6)

20-067 DR - large catchment

Type III 24-hr 100-Year Rainfall=8.94"

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Volume	Invert	Avail.Storage	Storage Description
#1	3.70'	319 cf	Custom Stage Data (Irregular) Listed below (Recalc) 532 cf Overall x 60.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
3.70	173	50.0	0	0	173
4.70	173	50.0	173	173	223
5.70	173	53.0	173	346	280
6.70	200	56.0	186	532	340

Device	Routing	Invert	Outlet Devices
#1	Primary	6.70'	5.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Discarded	3.70'	8.270 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.04 cfs @ 10.80 hrs HW=6.74' (Free Discharge)↑**2=Exfiltration** (Exfiltration Controls 0.04 cfs)**Primary OutFlow** Max=7.15 cfs @ 12.09 hrs HW=7.29' (Free Discharge)↑**1=Sharp-Crested Rectangular Weir** (Weir Controls 7.15 cfs @ 2.50 fps)**Summary for Pond 20P: BIORETENTION AREA 2**

Inflow Area = 14,018 sf, 22.00% Impervious, Inflow Depth > 3.40" for 100-Year event
 Inflow = 1.34 cfs @ 12.10 hrs, Volume= 3,969 cf
 Outflow = 1.34 cfs @ 12.07 hrs, Volume= 3,817 cf, Atten= 0%, Lag= 0.0 min
 Discarded = 0.02 cfs @ 11.75 hrs, Volume= 773 cf
 Primary = 1.32 cfs @ 12.07 hrs, Volume= 3,044 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 7.27' @ 12.07 hrs Surf.Area= 120 sf Storage= 151 cf

Plug-Flow detention time= 18.5 min calculated for 3,805 cf (96% of inflow)

Center-of-Mass det. time= 4.8 min (811.6 - 806.8)

Volume	Invert	Avail.Storage	Storage Description
#1	4.00'	151 cf	Custom Stage Data (Irregular) Listed below (Recalc) 252 cf Overall x 60.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
4.00	77	40.0	0	0	77
5.00	77	40.0	77	77	117
6.00	77	40.0	77	154	157
7.00	120	46.0	98	252	216

Device	Routing	Invert	Outlet Devices
#1	Primary	7.00'	3.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Discarded	4.00'	8.270 in/hr Exfiltration over Surface area

20-067 DR - large catchment

Type III 24-hr 100-Year Rainfall=8.94"

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Discarded OutFlow Max=0.02 cfs @ 11.75 hrs HW=7.10' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=1.23 cfs @ 12.07 hrs HW=7.25' (Free Discharge)

↑**1=Sharp-Crested Rectangular Weir** (Weir Controls 1.23 cfs @ 1.65 fps)

Appendix F

OPERATION & MAINTENANCE PLAN

Operation & Maintenance Plan (Permanent BMPs)

FOR

2 Old Point Road

Date: February 2021

Owner/Operator: Vincent Godin
The Cottages Commercial, LLC
14 Plum Island Blvd.
Newbury, MA 01951

Inspection and Maintenance Schedule

Facility personnel will inspect the stormwater management system on a routine basis not less than once per month for the first six (6) months of operation and annually thereafter. Refer to project design and as-built plans for stormwater systems and landscaped area locations. Inspection and maintenance shall be performed as follows:

1. Landscaped Areas:

Landscaped areas shall be inspected and maintained on a regular basis. Areas that may be subject to erosion will be stabilized and reseeded immediately. Inspect soil and repair eroded areas monthly. Re-plant void areas as needed. Remove litter and debris monthly. Remove and replace dead vegetation twice per year in spring and fall. Replace soil media if ponding is witnessed more than 48 hours after rainfall event.

2. Roof Drains:

Inspections: The downspout inlets on the roof of the building will need periodic maintenance to ensure proper function. The required interval for this maintenance will vary by season; however, downspout inlets should be inspected for debris before the rainy season. When trees and other deciduous vegetation shed leaves that drop into the gutters, this will inhibit the flow of water and possibly clog downspouts. The leaves and/or debris must be removed in order for the system to work as designed.

Maintenance: Debris, such as leaves and trash, shall be removed by hand. Sediments shall be swept and collected or vacuumed.

3. Bioretention Areas

Inspections & Maintenance:

Following construction, inspect site following rain events. Add/replace vegetation in any eroded areas. Water to promote plant growth and survival, especially during the first two years and during dry spells.

Monthly:

- prune and weed swale to maintain appearance
- remove accumulated trash and debris
- replace mulch as needed

Annually:

- Inspect inflow area for sediment accumulation. Remove accumulated sediment or debris.
- Inspect site for erosion as well as sediment and mulch which have been moved around in the garden. Add/replace vegetation in any eroded areas.
- Inspect rain garden for dead or dying vegetation. Replace vegetation as needed.
- Test planting bed for pH. If the pH is below 5.2, limestone should be applied. If the pH is above 8.0, iron sulfate and sulfur should be applied.

Every 2 to 3 years:

- Remove and replace mulch

4. Sediment Forebay and Stone Swale

Annually: Forebays and swales to be cleaned each spring prior to growing season

- Remove any potential accumulated trash from forebay.
- Remove sediment from splash pad and sump
- Replace any dislodged stones from splash pad.
- Remove any invasive vegetation.
- Trim and remove overgrown vegetation.
- Confirm weir berm is not clogged or overgrown, remove debris as required.

Stormwater System Inspection Report

General Information			
Location: 2 Old Point Road			
Date of Inspection		Start/End Time	
Inspector's Name(s)			
Inspector's Title(s)			
Inspector's Contact Information			
Purpose of Inspection			
Weather Information			
Has it rained since the last inspection? ☐ Yes ☐ No			
Weather at time of this inspection?			

Site-Specific Stormwater Devices: (See above for inspection frequency)

	Description	Installed and Operating Properly?	Corrective Action Needed	Date for Corrective Action/Responsible Person
1		☐ Yes ☐ No		
2		☐ Yes ☐ No		
3		☐ Yes ☐ No		
4		☐ Yes ☐ No		
5		☐ Yes ☐ No		
6		☐ Yes ☐ No		
7		☐ Yes ☐ No		
8		☐ Yes ☐ No		

Overall Site Issues

	Description		Corrective Action	Date for Corrective Action/Responsible Person
1	Are all slopes properly stabilized?	☐ Yes ☐ No		
2	Are natural resource areas (e.g., streams, wetlands, etc.) being subjected to erosion?	☐ Yes ☐ No		
3	Are discharge points free of sediment deposits?	☐ Yes ☐ No		

Certification Statement:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Print name:

Signature:

Date: