The Morin-Cameron GROUP, INC.

DRAINAGE REPORT

FOR THE

MULTIFAMILY RESIDENTIAL DEVELOPMENT

LOCATED AT

3 BOSTON WAY

NEWBURYPORT, MASSACHUSETTS

October 23, 2019

CIVIL ENGINEERS • LAND SURVEYORS • ENVIRONMENTAL CONSULTANTS • LAND USE PLANNERS

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DRAINAGE REPORT

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LOCATED AT

3 BOSTON WAY

NEWBURYPORT, MASSACHUSETTS

October 23, 2019

SUBMITTED TO:

CITY OF NEWBURYPORT
PLANNING BOARD
60 PLEASANT STREET
P.O. BOX 550
NEWBURYPORT, MA 01950

APPLICANT:

THREE BOSTON WAY, LLC
231 SUTTON STREET
NORTH ANDOVER, MA 01845

PREPARED BY:

THE MORIN-CAMERON GROUP, INC.
66 ELM STREET
DANVERS, MA 01923

Table of Contents

DRAINAGE REPORT NARRATIVE
3 Boston Way Multi-Family Site Development

I. Executive Summary

Three Boston Way, LLC, the applicant, proposes to construct one multi-family residential building located at 3 Boston Way in Newburyport, Massachusetts ("site"). The project will include 84 residential units with surface and underground parking, landscaping improvements, stormwater management system and new utility infrastructure. The subject parcels are shown on the City of Newburyport Assessor's Map 78, Lot 1-I which is situated in the Industrial (1B) Zoning District. Additionally, the site is located within the Smart Growth Overlay District Subdistrict "A" and is within 250 feet of the MBTA right-of-way.

The project will require Site Plan Approval through the Newburyport Planning Board and a Notice of Intent will be filed concurrently with the Newburyport Conservation Commission. As part of the project permitting, the proponent must demonstrate compliance with applicable stormwater best management practices and regulations. The following drainage narrative contains a description of existing and proposed site conditions, stormwater management design methodology and results summaries and other supplemental information in support of the stormwater best management system design.

II. Existing Site Description

The site consists of a total land area of 91,489 square feet (2.1± acres) and is currently developed with two existing commercial buildings with associated parking, drainage, and utility infrastructure. The property is used by an ambulance service company and by a landscape contractor with exterior material storage. The south and east edges of the property consist of a bordering vegetated wetland, mowed lawn areas and wooded areas. The site includes two vegetated drainage swales and is subject to both a drainage easement and an electric easement as shown on the Existing Conditions Plan. The site is bordered to the east by the MBTA right-of-way and railroad, to the south by the Newburyport Commuter Train Station parking and a restaurant, west by Boston Way, and to the north by 1 Boston Way which is currently under construction by the applicant for 76 units of apartment housing. Refer to Figure 1: Ortho Map and Figure 2: USGS Locus Map for illustrations of the site and surrounding features.

Grades on the site vary, with slopes ranging from 1% to 25%. The site has a high elevation of approximately 20.0 (northeast and southeast corners of the site) and low elevation of approximately 11.0 (southwest corner of the site). Stormwater from most of the parking area and the large existing building is captured in an existing catch basin between the two buildings, which leads to a drainage swale along the western edge of the property that flows to a 30" reinforced concrete pipe ("RCP") under Boston Way. The runoff from the small existing building, remaining pavement, and gravel/storage area flows overland in a southwesterly direction towards the existing wetland along the south edge of the property and the 15" RCP at the southwestern corner of the property.

Soils on site are Buxton, 3-8% slopes, Hydrologic Soil Group (HSG) D (228B); and Scantic Silt Loam, 0-3% slopes, Hydrologic Soil Group (HSG) C/D (16A) (See Figure 3: SCS Soils Map). The entire site is shown to be outside of Zone X on the FEMA Federal Insurance Rate Map (FIRM) #25009C0117G, dated July 16, 2014 (See Figure 4: FEMA Flood Map).

III. Proposed Site Description

The applicant proposes to construct an 84-unit multifamily residential building with associated parking, landscaping, stormwater management system and new utility connections. The building footprint area totals approximately 18,400± sf. The proposed building, which is situated in the eastern portion of the site along Boston Way, will have an underground garage with the entrance in the southern end of the building. A surface parking lot and drive aisle is proposed, with the entrance located at the southwestern portion of the property off Boston Way. The drive aisle and surface parking will wrap around the southern and eastern edges of the new building and will connect to 1 Boston Way in the northeastern corner of the property. The wetland located along the eastern and southern edges of the property will be protected. There is minimal work proposed within the 25' wetland buffer, which primarily consists of restoration activities, grading and vegetated stormwater wetland construction. All such work will occur on previously disturbed or degraded land.

Infrastructure associated with the development of the site will include the removal and replacement of the existing water, drainage, overhead-electrical and sewer services and construction of stormwater management infrastructure with other associated utilities including domestic water and fire protection services, natural gas, electrical, communications and fiber optic services.

The proposed stormwater management system for the project will consist of various Best Management Practices ("BMP's") in both mitigating and renovating stormwater runoff. The entire stormwater system was designed in accordance with the City of Newburyport's Stormwater Management and Erosion Control Regulations and the Massachusetts Stormwater Management Handbook ("Handbook"), which the City of Newburyport references in its regulations. The measures to be implemented at the site includes a subsurface detention system utilizing concrete chambers, Vortsentry water quality inlets, vegetated swales and constructed stormwater wetlands. Refer to the Grading & Drainage Plan and associated construction details for more information. The existing watershed characteristics, flow paths and drainage patterns were matched to the extent practicable in the proposed condition to demonstrate that there are no adverse impacts to adjacent properties at the design points.

IV. Stormwater Management

A. Existing Watershed Characteristics

Stormwater runoff exits the site in the existing condition at two (2) distinct locations. The location where stormwater runoff leaves the site boundary is called the design point ("DP"). DP1 is the existing constructed stormwater wetland and 30" RCP to the northwest corner of the site adjacent to Boston Way. DP2 is the 15" culvert in the southwest corner of the site adjacent to Boston Way. The design points and the tributary watersheds (or subcatchments) are illustrated on Figure 5: Existing Site Development Watershed Plan included herein. The table below lists the total area associated with each subcatchment area.

Summary of Existing Subcatchments

Proposed Drainage Area (E)	Total Area (SF)	% Impervious	Composite Curve Number
E1	50,791	55.2%	90
E2	40,698	13.6%	87
Total	**91,489 (2.1 acres)**	**36.7%**	**89**

Description of Existing Subcatchments

The subcatchments analyzed in the existing condition can be described as follows:

- **Subcatchment E1:** Consists of the northwesterly portion of the property. This area includes the larger of the two existing buildings, a majority of the existing pavement, the entire walkway connected to Boston Way, and pervious surfaces to the northwest and northeast of the property. This area flows toward the center of the property, proceeds through a surface drainage swale towards the north property line, and then proceeds northwest along the north property line towards the existing constructed stormwater wetland near the northwest corner of the property on the 1 Boston Way property (DP1).
- **Subcatchment E2:** This area consists of the southeasterly portion of the site. This area includes some pavement, the smaller of the two existing buildings, a large gravel area, storage areas as well as a wetland area. This area flows along the eastern property line, towards the southern property line, then proceeds along the southern property line to a 15" culvert at the southwestern corner of the property adjacent to Boston Way (DP2).

B. Proposed Watershed Characteristics

The proposed development of the site will maintain the design points identified in the existing watershed analysis. In order to understand and analyze the proposed development, smaller subcatchments were delineated to analyze stormwater impacts on more detailed scale. The table below provides the total drainage area and the percentage that will be impervious in the post-development condition. The design points and the tributary watersheds (or subcatchments) are illustrated on Figure 6: Proposed Site Development Watershed Plan included herein. The table below lists the total area associated with each subcatchment area.

Summary of Proposed Subcatchments

Proposed Drainage Area (P)	Total Area (SF)	% Impervious	Composite Curve Number
P1A	9,607	83.4%	95
P1B	16,349	45.9%	88
P2A	23,438	0.4%	80
P2B	24,165	97.3%	98
P2C	17,930	46.7%	88
Totals	**91,489 (2.1 acres)**	**51.9%**	**89**

Description of Proposed Subcatchments

- **Subcatchment P1A:** Includes the northeastern portion of the proposed parking lot, as well as some concrete sidewalk area. Runoff from the pavement will lead to a catch basin which will discharge to the same drainage easement, running along the northern property line leading to the existing constructed stormwater wetland near the northwest property corner at 1 Boston Way (DP1).
- **Subcatchment P1B:** Wraps around the proposed building: from the south of the building and around the west part of the building. Includes some pavement and concrete sidewalk south of the building, the sidewalk west of the building, as well as a drainage swale west of the building. Runoff from this subcatchment flows to the drainage swale west of the building, which leads to the existing constructed pocket wetland near the northwest property corner at 1 Boston Way (DP1).
- **Subcatchment P2A:** Is a subcatchment located along the eastern property lines and southern property line. This area is comprised of grass, woods, and wetlands. This area flows from the northeastern portion of the property along the eastern property line and

then along the southern property line; leading to a 15" culvert at the southwestern corner of the property (DP2).

- **Subcatchment P2B:** Includes the roof area and a portion of the parking lot east of the building, as well as some concrete sidewalk area and patches of pervious surfaces. Runoff from the roof is contained in a gutter system which discharges into a concrete subsurface detention system (PP1) underneath the paved parking lot. This system discharges to DP1.
- **Subcatchment P2C:** This subcatchment is located on the southern portion of the property. It consists of pavement and sidewalk to the south and east of the building as well as a grass swale that will operate as a constructed stormwater wetland to the south of the building. This constructed pocket wetland will treat the runoff and will discharge to the 15" culvert at the southwestern corner of the property (DP2).

C. Hydrologic Analysis:

The purpose of the stormwater analysis is to demonstrate that the proposed development will not adversely impact the land or surrounding land. The industry standard for stormwater management design in Massachusetts is governed by the Massachusetts Stormwater Management Handbook ("Handbook") published by the Mass Department of Environmental Protection, January 2008. The City of Newburyport Stormwater Management and Erosion Control Bylaw and associated Regulations provide additional requirements including analyzing the 2, 10, and 100-year storm events.

The Handbook lists 10 standards covering both mitigation and renovation of stormwater runoff. A full discussion on compliance with the standards can be found at the end of this report. However, the following section will summarize the projects compliance with the mitigation standards 1 and 2 of the Handbook relating to reducing peak rates of runoff and creating no adverse down gradient impacts.

In order to demonstrate that there will be no downstream impacts as a result of the proposed project, a stormwater analysis was performed using the U.S. Soil Conservation Service (S.C.S) method of analysis contained in Technical Release #20 (TR-20) published by the U.S. Conservation Service. The software application HydroCAD was used to analyze the existing and proposed development watershed conditions. This application is widely used in the civil engineering industry and an accepted means of performing a TR-20 analysis. It is a computer aided design program for analyzing the hydrology and hydraulics of storm water runoff. It utilizes the latest techniques of both fields to accurately predict the consequences of any given storm event. This analysis allows the engineer to verify that a given drainage system is adequate for the area under consideration and further allows the engineer to predict where flooding or erosion are most likely to occur. This model was used to analyze the storm drainage system designed for the development to demonstrate that the drainage system is in compliance with the City's Stormwater Management Standards.

The HydroCAD analysis was performed by examining the two design points that were previously referenced. The following is a listing of the total existing and proposed development rates of stormwater runoff for the proposed development for the 2, 10, and 100-year rainfall events:

Runoff Comparison (CFS) **DP1**			
Storm Event	Existing Conditions	Proposed Conditions	Change in Peak
2-yr	2.88	2.69	-0.19
10-yr	4.93	4.59	-0.34
100-yr	9.85	9.35	-0.50

Runoff Comparison (CFS) **DP2**			
Storm Event	Existing Conditions	Proposed Conditions	Change in Peak
2-yr	1.83	1.54	-0.29
10-yr	3.23	2.94	-0.29
100-yr	6.62	6.48	-0.14

D. Review of Stormwater Management Standards

The proposed development project is comprised of a mix of new development and redevelopment. Standard 4 is met to the maximum extent practicable due to site constraints on Boston Way, which is a fixed roadway that cannot be altered other than minor adjustments to ensure proper drainage. The drainage system has been designed to attenuate peak rates of stormwater for all storm events up to and including the 100-year event. Measures will also be implemented to provide the required total suspended solids (TSS) removal where practicable, to ensure the stormwater runoff is renovated prior to discharge. The following is an assessment of each Standard as it relates to the proposed multi-family residential development project:

1. No stormwater conveyance system discharges untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth. The project includes a variety of BMPs to provide treatment of runoff prior to discharge.
   The proposed development meets this standard.
2. The stormwater management system has been designed such that proposed peak rates of runoff do not exceed existing rates for all storm events considered.
   The proposed development meets this standard.
3. Loss of annual recharge to groundwater is required only to the maximum extent practicable since soils present on site are considered to be HSG-D soils. While unaccounted for in the design, some infiltration will occur in the detention system, landscaped areas, water quality swale, and constructed pocket wetland.
   The proposed development meets this standard to the maximum extent practicable.
4. The proposed stormwater management system has been designed to remove a minimum of 80% of the average annual post-construction load of Total Suspended Solids (TSS). The best management practices treatment train utilizes Vortsentry water quality units, filter strips, a water quality swale, a constructed pocket wetland, and an underground detention system to achieve TSS removal. However, due to the poorly drained soils and topographic constraints, 80% TSS removal is not practicable for runoff from Boston Way at the location of the proposed parallel parking spaces.
   The proposed development meets this standard to the maximum extent practicable.

5. Land Uses with Higher Potential Pollutant Load.
   This standard does not apply.

6. Discharges to critical areas.
   This standard does not apply.

7. Redevelopment Projects: the project consists of a mix of new development and redevelopment.
   The project includes a mix of new development and redevelopment. All standards are fully met with the exception of Standard 3 and Standard 4 as described above.

8. A Construction Phase Operation and Maintenance Plan in included herewith. A Stormwater Pollution Prevention Plan following the EPA guidelines under the National Pollutant Discharge Elimination System will be prepared prior to construction.
   The proposed development meets this standard.

9. A long-term operation and maintenance plan: A long-term O&M has been prepared to provide guidance for current and future owners to inspect and maintain the stormwater management systems in perpetuity. A copy of this O&M plan is included herein.
   The proposed development meets this standard.

10. Illicit discharges: To the best of our knowledge and belief there are no illicit discharges to the stormwater management system on this site. A certification is included herein.
    The proposed development meets this standard.

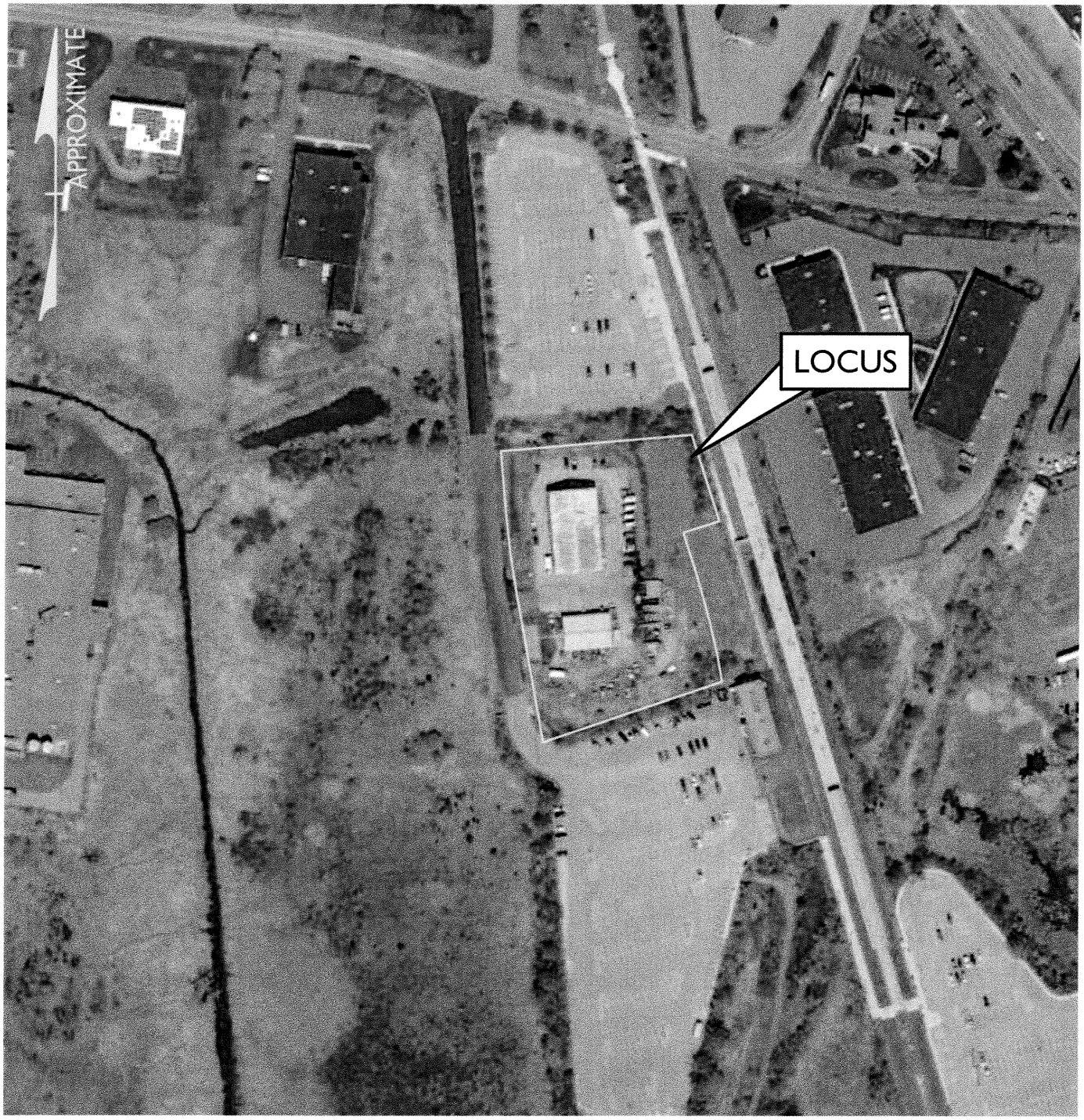
IV. Conclusion

The project at 3 Boston Way, as proposed, is in compliance with the MassDEP Stormwater Management Handbook to the maximum extent practicable as a project involving both new development and redevelopment. The project is also in compliance with the Newburyport Stormwater Management Rules and Regulations, which reference the MA Stormwater Standards. The project will involve the restoration and protection of wetland buffer zone land that was used as a landscape materials storage area by the previous owner, and will utilize naturally vegetated stormwater management systems to treat and attenuate stormwater runoff. Peak rates of stormwater runoff leaving the site under proposed conditions are less than under existing conditions.

For questions regarding this Drainage Report, please contact The Morin-Cameron Group, Inc. between the hours of 8:30am to 4:30pm at (978) 777-8586.

DRAINAGE REPORT NARRATIVE

FIGURES



ORTHO IMAGERY OBTAINED FROM GOOGLE EARTH

0 100 200 400

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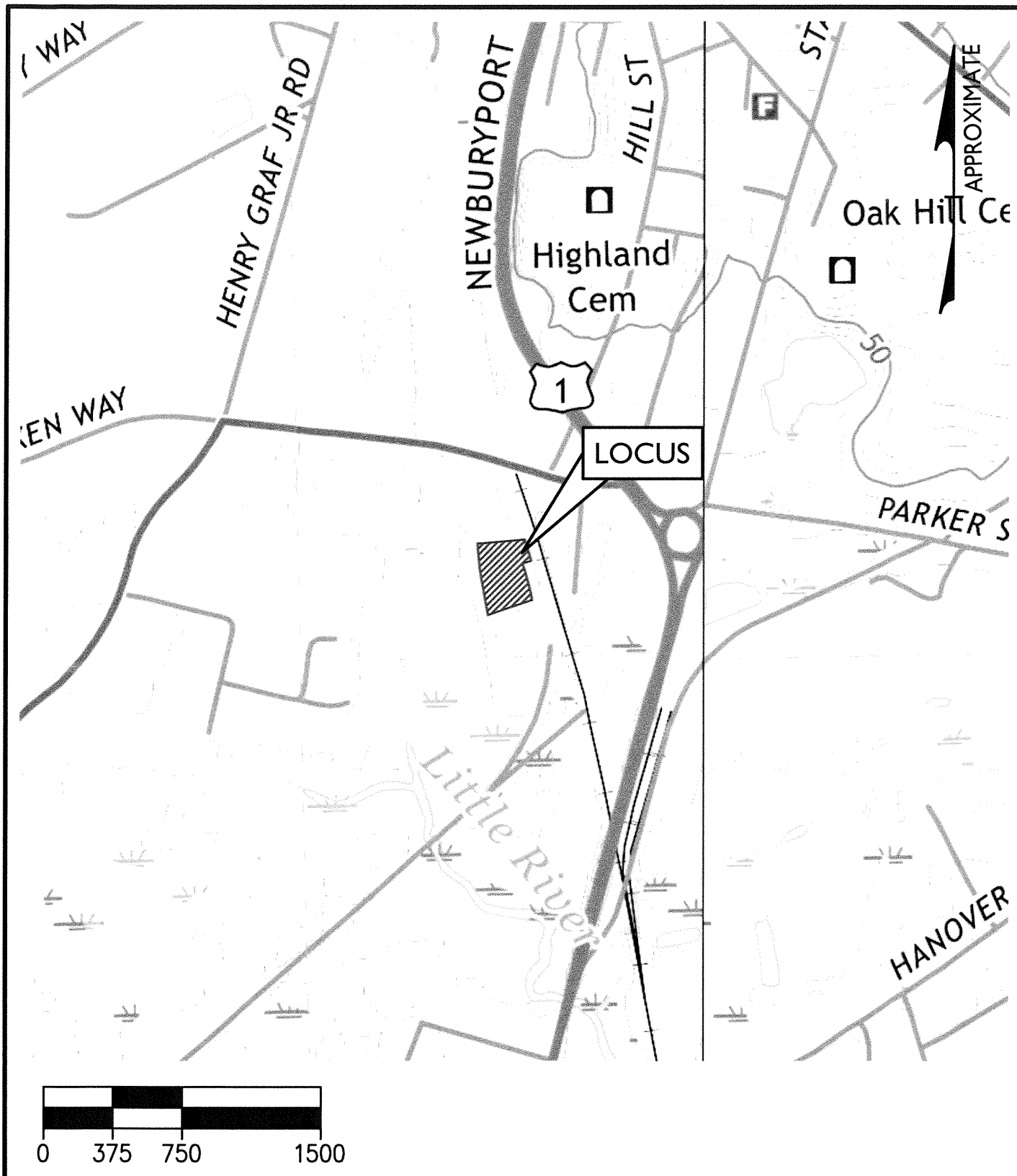
ORTHO MAP
3 BOSTON WAY
IN
NEWBURYPORT, MA

DATE: OCTOBER 23, 2019

Scale: 1" = 200'

FIGURE #1



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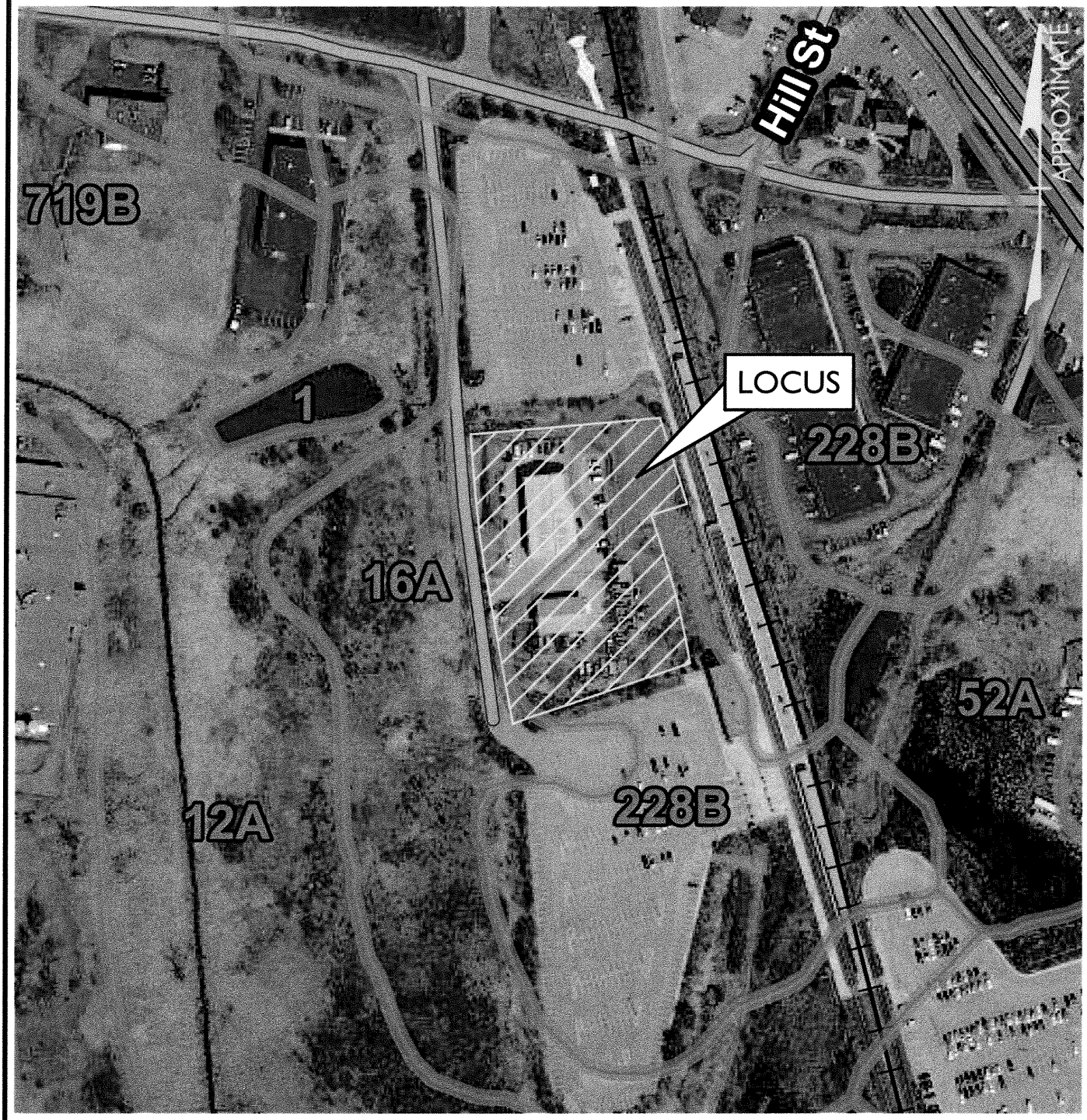
USGS LOCUS MAP
3 BOSTON WAY
IN
NEWBURYPORT, MA

DATE: OCTOBER 23, 2019

Scale: 1" = 750'

FIGURE #2



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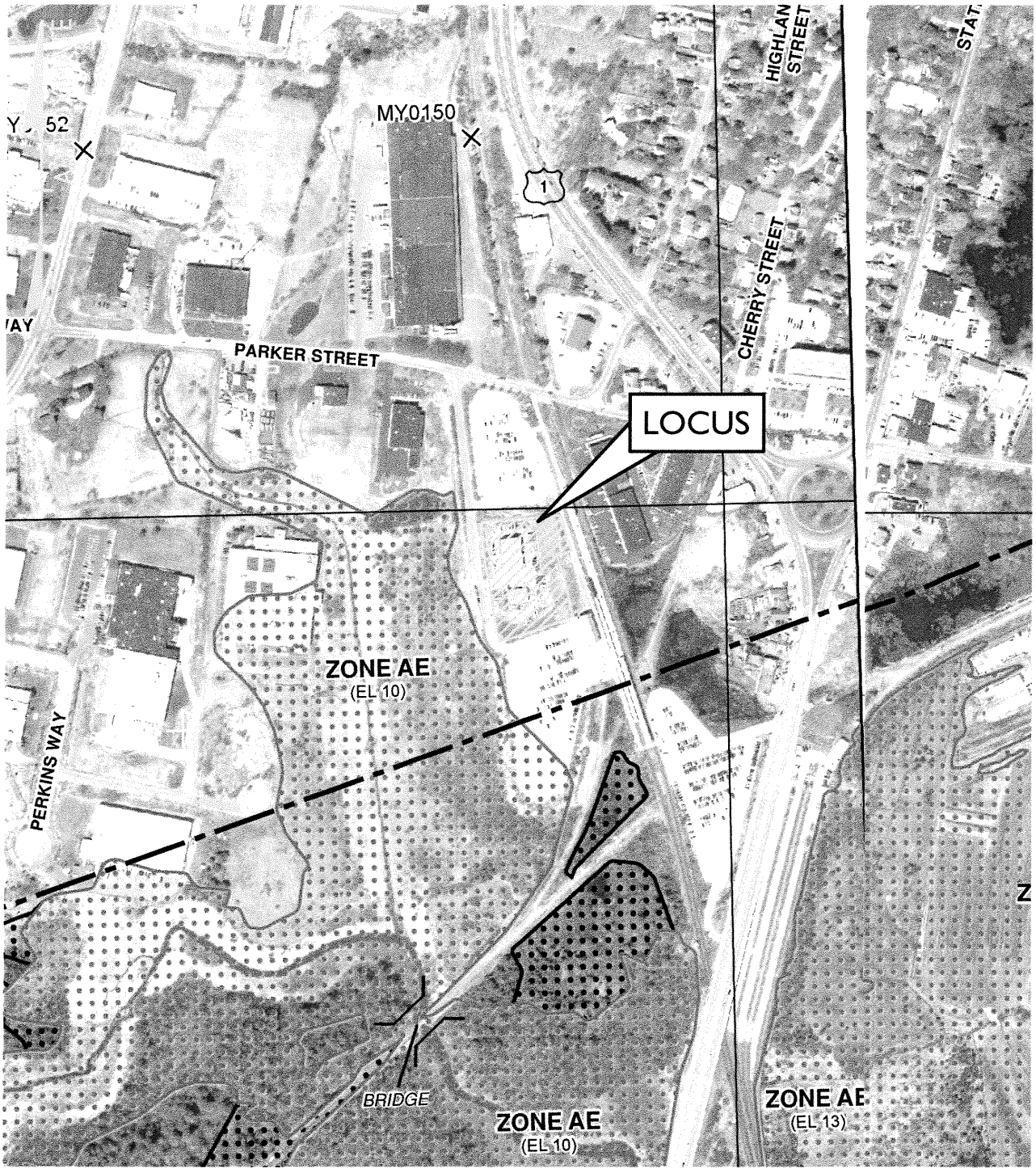
SCS SOILS MAP
3 BOSTON WAY
IN
NEWBURYPORT, MA

DATE: OCTOBER 23, 2019

Scale: 1" = 200'

FIGURE #3



FEMA FLOOD MAP NO. 25009C0117G

0 250 500 1,000

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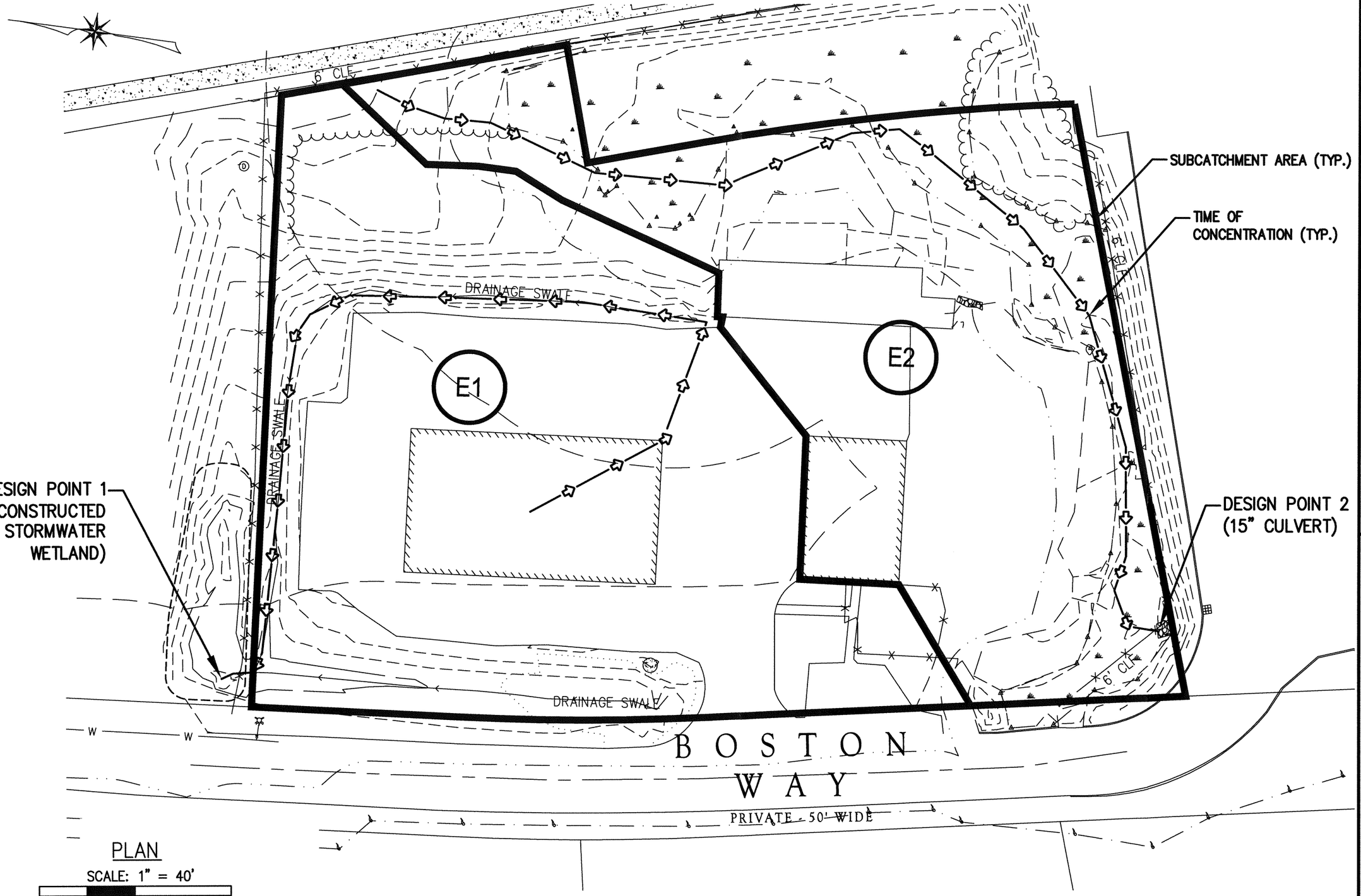
FEMA FLOOD MAP
3 BOSTON WAY
IN
NEWBURYPORT, MA

DATE: OCTOBER 23, 2019

Scale: 1" = 500'

FIGURE #4



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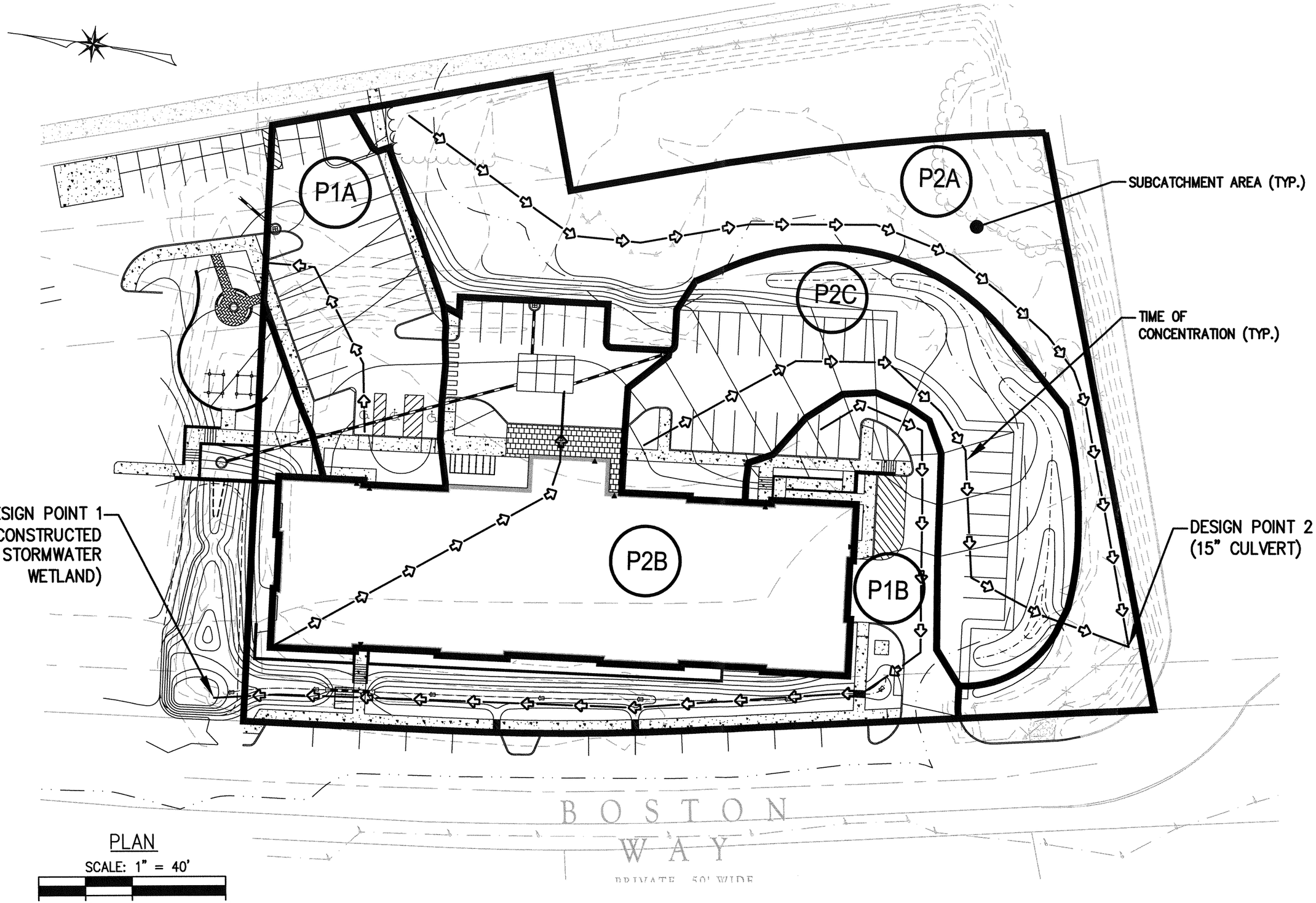
DATE: 10/23/19
SCALE: 1" = 40'

FIGURE 5
EXISTING SITE DEVELOPMENT WATERSHED
AT:
3 BOSTON WAY
NEWBURYPORT, MASSACHUSETTS

PROJ. #3856



PLAN

SCALE: 1" = 40'

0 20 40 80

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DATE: 10/23/19
SCALE: 1" = 40'

FIGURE 6
PROPOSED SITE DEVELOPMENT WATERSHED
AT:
3 BOSTON WAY
NEWBURYPORT, MASSACHUSETTS

PROJ. #3856

APPENDIX A:

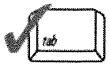
MASSDEP STORMWATER MANAGEMENT REPORT CHECKLIST

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

B. Stormwater Checklist and Certification

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

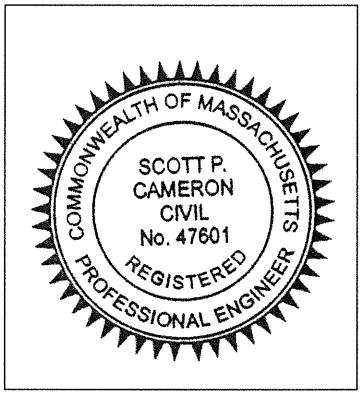
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



Signature and Date 10-23-19

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist (continued)

Checklist for Stormwater Report

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☒ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☒ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☒ Water Quality Swale
- ☒ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): _____

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist (continued)

Checklist for Stormwater Report

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☒ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☐ Soil Analysis provided.

☐ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☐ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☒ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☐ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist (continued)

Checklist for Stormwater Report

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist (continued)

Checklist for Stormwater Report

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☐ The ½" or 1" Water Quality Volume or
- ☒ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☒ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist (continued)

Checklist for Stormwater Report

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☒ Redevelopment portion of mix of new and redevelopment.

☒ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☒ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist (continued)

Checklist for Stormwater Report

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

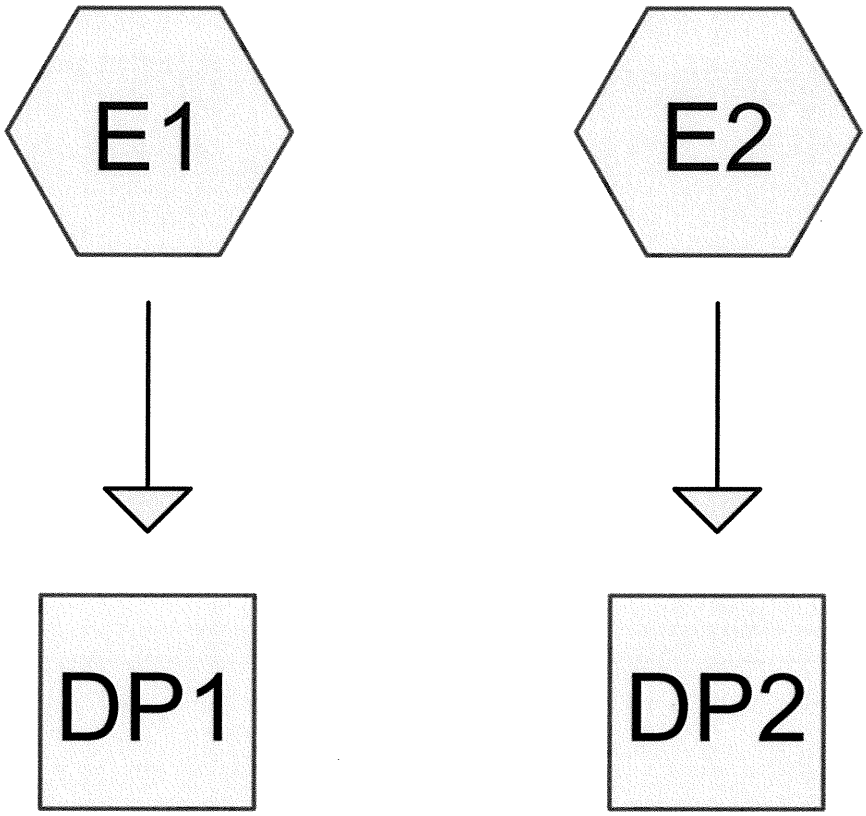
☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

APPENDIX B:

EXISTING CONDITIONS

HYDROLOGIC ANALYSIS REPORT



Subcat Reach Pond Link

Routing Diagram for 3856-pre
Prepared by The Morin-Cameron Group, Inc., Printed 10/22/2019

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
36,539	80	>75% Grass cover, Good, HSG D (E1, E2)
1,009	98	Concrete, HSG D (E1)
5,957	89	Dirt roads, HSG D (E2)
10,314	96	Gravel surface, HSG D (E1, E2)
20,671	98	Paved parking, HSG D (E1)
3,016	98	Paved roads w/curbs & sewers, HSG D (E2)
8,849	98	Roofs, HSG D (E1, E2)
5,134	77	Woods, Good, HSG D (E1, E2)
91,489	**89**	**TOTAL AREA**

Summary for Subcatchment E1:

Runoff = 2.89 cfs @ 12.10 hrs, Volume= 9,257 cf, Depth= 2.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

	Area (sf)	CN	Description
	6,332	98	Roofs, HSG D
	20,671	98	Paved parking, HSG D
*	1,009	98	Concrete, HSG D
	21,750	80	>75% Grass cover, Good, HSG D
	765	77	Woods, Good, HSG D
	264	96	Gravel surface, HSG D
	50,791	90	Weighted Average
	22,779		44.85% Pervious Area
	28,012		55.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	50	0.0010	0.36		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.5	65	0.0123	2.25		**Shallow Concentrated Flow, shallow conc.** Paved Kv= 20.3 fps
3.9	345	0.0096	1.47		**Shallow Concentrated Flow, shallow conc.** Grassed Waterway Kv= 15.0 fps
6.7	460	Total			

Summary for Subcatchment E2:

Runoff = 1.75 cfs @ 12.16 hrs, Volume= 6,554 cf, Depth= 1.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
2,517	98	Roofs, HSG D
3,016	98	Paved roads w/curbs & sewers, HSG D
10,050	96	Gravel surface, HSG D
14,789	80	>75% Grass cover, Good, HSG D
4,369	77	Woods, Good, HSG D
5,957	89	Dirt roads, HSG D
40,698	87	Weighted Average
35,165		86.40% Pervious Area
5,533		13.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0600	0.10		**Sheet Flow, sheet flow** Woods: Light underbrush n= 0.400 P2= 3.15"
3.7	403	0.0149	1.83		**Shallow Concentrated Flow, shallow conc.** Grassed Waterway Kv= 15.0 fps
11.7	453	Total			

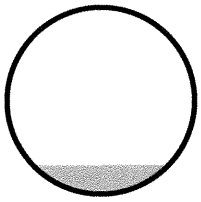
Summary for Reach DP1:

Inflow Area = 50,791 sf, 55.15% Impervious, Inflow Depth = 2.19" for 2-Year event
Inflow = 2.89 cfs @ 12.10 hrs, Volume= 9,257 cf
Outflow = 2.88 cfs @ 12.10 hrs, Volume= 9,257 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.83 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.97 fps, Avg. Travel Time= 0.7 min

Peak Storage= 38 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.39' , Surface Width= 1.82'
Bank-Full Depth= 2.50' Flow Area= 4.9 sf, Capacity= 53.73 cfs

30.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 77.8' Slope= 0.0102 '/'
Inlet Invert= 8.66', Outlet Invert= 7.87'



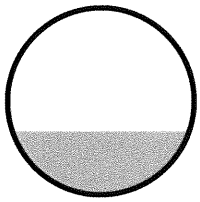
Summary for Reach DP2:

Inflow Area = 40,698 sf, 13.60% Impervious, Inflow Depth = 1.93" for 2-Year event
Inflow = 1.75 cfs @ 12.16 hrs, Volume= 6,554 cf
Outflow = 1.75 cfs @ 12.16 hrs, Volume= 6,554 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.75 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.73 fps, Avg. Travel Time= 0.7 min

Peak Storage= 27 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.43' , Surface Width= 1.19'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 7.01 cfs

15.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 71.8' Slope= 0.0070 '/'
Inlet Invert= 10.70', Outlet Invert= 10.20'



Summary for Subcatchment E1:

Runoff = 4.93 cfs @ 12.09 hrs, Volume= 16,203 cf, Depth= 3.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.95"

	Area (sf)	CN	Description
	6,332	98	Roofs, HSG D
	20,671	98	Paved parking, HSG D
*	1,009	98	Concrete, HSG D
	21,750	80	>75% Grass cover, Good, HSG D
	765	77	Woods, Good, HSG D
	264	96	Gravel surface, HSG D
	50,791	90	Weighted Average
	22,779		44.85% Pervious Area
	28,012		55.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	50	0.0010	0.36		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.5	65	0.0123	2.25		**Shallow Concentrated Flow, shallow conc.** Paved Kv= 20.3 fps
3.9	345	0.0096	1.47		**Shallow Concentrated Flow, shallow conc.** Grassed Waterway Kv= 15.0 fps
6.7	460	Total			

Summary for Subcatchment E2:

Runoff = 3.15 cfs @ 12.16 hrs, Volume= 11,939 cf, Depth= 3.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.95"

Area (sf)	CN	Description
2,517	98	Roofs, HSG D
3,016	98	Paved roads w/curbs & sewers, HSG D
10,050	96	Gravel surface, HSG D
14,789	80	>75% Grass cover, Good, HSG D
4,369	77	Woods, Good, HSG D
5,957	89	Dirt roads, HSG D
40,698	87	Weighted Average
35,165		86.40% Pervious Area
5,533		13.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0600	0.10		**Sheet Flow, sheet flow** Woods: Light underbrush n= 0.400 P2= 3.15"
3.7	403	0.0149	1.83		**Shallow Concentrated Flow, shallow conc.** Grassed Waterway Kv= 15.0 fps
11.7	453	Total			

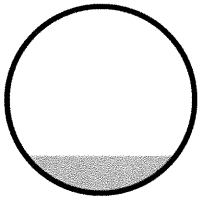
Summary for Reach DP1:

Inflow Area = 50,791 sf, 55.15% Impervious, Inflow Depth = 3.83" for 10-Year event
Inflow = 4.93 cfs @ 12.09 hrs, Volume= 16,203 cf
Outflow = 4.93 cfs @ 12.10 hrs, Volume= 16,203 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.82 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.25 fps, Avg. Travel Time= 0.6 min

Peak Storage= 56 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.51' , Surface Width= 2.02'
Bank-Full Depth= 2.50' Flow Area= 4.9 sf, Capacity= 53.73 cfs

30.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 77.8' Slope= 0.0102 '/'
Inlet Invert= 8.66', Outlet Invert= 7.87'



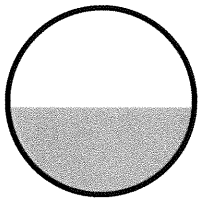
Summary for Reach DP2:

Inflow Area = 40,698 sf, 13.60% Impervious, Inflow Depth = 3.52" for 10-Year event
Inflow = 3.15 cfs @ 12.16 hrs, Volume= 11,939 cf
Outflow = 3.15 cfs @ 12.16 hrs, Volume= 11,939 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.56 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.98 fps, Avg. Travel Time= 0.6 min

Peak Storage= 41 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.59' , Surface Width= 1.25'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 7.01 cfs

15.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 71.8' Slope= 0.0070 '/'
Inlet Invert= 10.70', Outlet Invert= 10.20'



Summary for Subcatchment E1:

Runoff = 9.85 cfs @ 12.09 hrs, Volume= 33,731 cf, Depth= 7.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.18"

	Area (sf)	CN	Description
	6,332	98	Roofs, HSG D
	20,671	98	Paved parking, HSG D
*	1,009	98	Concrete, HSG D
	21,750	80	>75% Grass cover, Good, HSG D
	765	77	Woods, Good, HSG D
	264	96	Gravel surface, HSG D
	50,791	90	Weighted Average
	22,779		44.85% Pervious Area
	28,012		55.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	50	0.0010	0.36		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.5	65	0.0123	2.25		**Shallow Concentrated Flow, shallow conc.** Paved Kv= 20.3 fps
3.9	345	0.0096	1.47		**Shallow Concentrated Flow, shallow conc.** Grassed Waterway Kv= 15.0 fps
6.7	460	Total			

Summary for Subcatchment E2:

Runoff = 6.56 cfs @ 12.16 hrs, Volume= 25,783 cf, Depth= 7.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.18"

Area (sf)	CN	Description
2,517	98	Roofs, HSG D
3,016	98	Paved roads w/curbs & sewers, HSG D
10,050	96	Gravel surface, HSG D
14,789	80	>75% Grass cover, Good, HSG D
4,369	77	Woods, Good, HSG D
5,957	89	Dirt roads, HSG D
40,698	87	Weighted Average
35,165		86.40% Pervious Area
5,533		13.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0600	0.10		**Sheet Flow, sheet flow** Woods: Light underbrush n= 0.400 P2= 3.15"
3.7	403	0.0149	1.83		**Shallow Concentrated Flow, shallow conc.** Grassed Waterway Kv= 15.0 fps
11.7	453	Total			

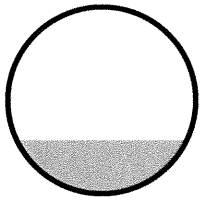
Summary for Reach DP1:

Inflow Area = 50,791 sf, 55.15% Impervious, Inflow Depth = 7.97" for 100-Year event
Inflow = 9.85 cfs @ 12.09 hrs, Volume= 33,731 cf
Outflow = 9.85 cfs @ 12.09 hrs, Volume= 33,731 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.33 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.73 fps, Avg. Travel Time= 0.5 min

Peak Storage= 92 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.72' , Surface Width= 2.27'
Bank-Full Depth= 2.50' Flow Area= 4.9 sf, Capacity= 53.73 cfs

30.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 77.8' Slope= 0.0102 '/'
Inlet Invert= 8.66', Outlet Invert= 7.87'



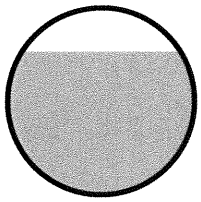
Summary for Reach DP2:

Inflow Area = 40,698 sf, 13.60% Impervious, Inflow Depth = 7.60" for 100-Year event
Inflow = 6.56 cfs @ 12.16 hrs, Volume= 25,783 cf
Outflow = 6.56 cfs @ 12.16 hrs, Volume= 25,783 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.49 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.40 fps, Avg. Travel Time= 0.5 min

Peak Storage= 73 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.96' , Surface Width= 1.06'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 7.01 cfs

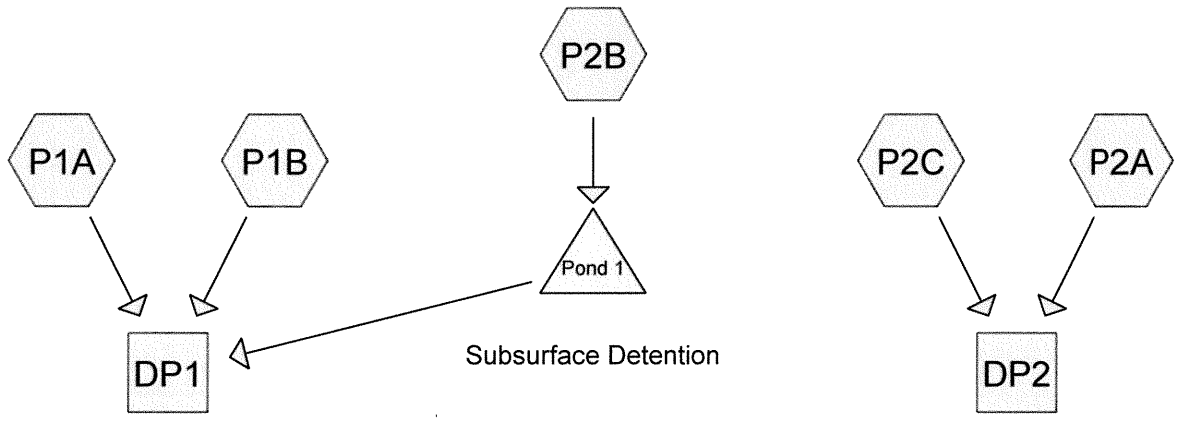
15.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 71.8' Slope= 0.0070 '/'
Inlet Invert= 10.70', Outlet Invert= 10.20'



APPENDIX C:

PROPOSED CONDITIONS

HYDROLOGIC ANALYSIS REPORT



Subcat Reach Pond Link

Routing Diagram for 3856-post

Prepared by The Morin-Cameron Group, Inc., Printed 10/22/2019

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
40,009	80	>75% Grass cover, Good, HSG D (P1A, P1B, P2A, P2B, P2C)
22,831	98	Paved parking, HSG D (P1A, P1B, P2B, P2C)
18,410	98	Roofs, HSG D (P2B)
6,237	98	Sidewalks, HSG D (P1A, P1B, P2A, P2B, P2C)
4,002	77	Woods, Good, HSG D (P2A)
91,489	**89**	**TOTAL AREA**

Summary for Subcatchment P1A:

Runoff = 0.65 cfs @ 12.08 hrs, Volume= 2,133 cf, Depth= 2.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

	Area (sf)	CN	Description
	6,788	98	Paved parking, HSG D
*	1,220	98	Sidewalks, HSG D
	1,599	80	>75% Grass cover, Good, HSG D
	9,607	95	Weighted Average
	1,599		16.64% Pervious Area
	8,008		83.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	50	0.0010	0.36		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.2	45	0.0250	3.21		**Shallow Concentrated Flow, shallow conc.** Paved Kv= 20.3 fps
2.5	95	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P1B:

Runoff = 0.88 cfs @ 12.09 hrs, Volume= 2,745 cf, Depth= 2.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

	Area (sf)	CN	Description
	4,182	98	Paved parking, HSG D
*	3,323	98	Sidewalks, HSG D
	8,844	80	>75% Grass cover, Good, HSG D
	16,349	88	Weighted Average
	8,844		54.10% Pervious Area
	7,505		45.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	50	0.0010	0.36		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.6	115	0.0250	3.21		**Shallow Concentrated Flow, shallow conc.** Paved Kv= 20.3 fps
2.9	165	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P2A:

Runoff = 0.89 cfs @ 12.09 hrs, Volume= 2,768 cf, Depth= 1.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

	Area (sf)	CN	Description
	19,342	80	>75% Grass cover, Good, HSG D
	4,002	77	Woods, Good, HSG D
*	94	98	Sidewalks, HSG D
	23,438	80	Weighted Average
	23,344		99.60% Pervious Area
	94		0.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
3.1	400	0.0205	2.15		**Shallow Concentrated Flow, shallow conc** Grassed Waterway Kv= 15.0 fps
4.0	450	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P2B:

Runoff = 1.73 cfs @ 12.08 hrs, Volume= 6,016 cf, Depth= 2.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

	Area (sf)	CN	Description
	18,410	98	Roofs, HSG D
*	1,226	98	Sidewalks, HSG D
	3,871	98	Paved parking, HSG D
	658	80	>75% Grass cover, Good, HSG D
	24,165	98	Weighted Average
	658		2.72% Pervious Area
	23,507		97.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.5	145	0.0100	5.00	1.75	**Pipe Channel, downspout** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.009 PVC, smooth interior
1.9	244	0.0205	2.15		**Shallow Concentrated Flow, shallow conc** Grassed Waterway Kv= 15.0 fps
3.3	439	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P2C:

Runoff = 0.78 cfs @ 12.17 hrs, Volume= 3,011 cf, Depth= 2.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

	Area (sf)	CN	Description
*	374	98	Sidewalks, HSG D
	7,990	98	Paved parking, HSG D
	9,566	80	>75% Grass cover, Good, HSG D
	17,930	88	Weighted Average
	9,566		53.35% Pervious Area
	8,364		46.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0100	0.08		**Sheet Flow, sheet flow** Grass: Dense n= 0.240 P2= 3.15"
1.9	244	0.0205	2.15		**Shallow Concentrated Flow, shallow conc** Grassed Waterway Kv= 15.0 fps
12.8	294	Total			

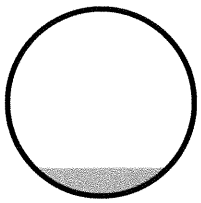
Summary for Reach DP1:

Inflow Area = 50,121 sf, 77.85% Impervious, Inflow Depth = 2.61" for 2-Year event
Inflow = 2.69 cfs @ 12.12 hrs, Volume= 10,893 cf
Outflow = 2.69 cfs @ 12.12 hrs, Volume= 10,893 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.71 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.76 fps, Avg. Travel Time= 0.7 min

Peak Storage= 37 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.38' , Surface Width= 1.80'
Bank-Full Depth= 2.50' Flow Area= 4.9 sf, Capacity= 53.73 cfs

30.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 77.8' Slope= 0.0102 '/'
Inlet Invert= 8.66', Outlet Invert= 7.87'



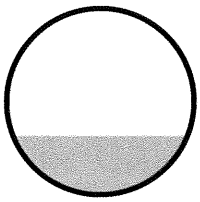
Summary for Reach DP2:

Inflow Area = 41,368 sf, 20.45% Impervious, Inflow Depth = 1.68" for 2-Year event
Inflow = 1.54 cfs @ 12.12 hrs, Volume= 5,779 cf
Outflow = 1.54 cfs @ 12.12 hrs, Volume= 5,779 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.58 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.63 fps, Avg. Travel Time= 0.7 min

Peak Storage= 24 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.40' , Surface Width= 1.16'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 7.01 cfs

15.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 71.8' Slope= 0.0070 '/'
Inlet Invert= 10.70', Outlet Invert= 10.20'



Summary for Pond Pond 1: Subsurface Detention

Inflow Area = 24,165 sf, 97.28% Impervious, Inflow Depth = 2.99" for 2-Year event
Inflow = 1.73 cfs @ 12.08 hrs, Volume= 6,016 cf
Outflow = 1.35 cfs @ 12.15 hrs, Volume= 6,015 cf, Atten= 22%, Lag= 3.8 min
Primary = 1.35 cfs @ 12.15 hrs, Volume= 6,015 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 16.11' @ 12.15 hrs Surf.Area= 384 sf Storage= 691 cf

Plug-Flow detention time= 13.8 min calculated for 6,013 cf (100% of inflow)
Center-of-Mass det. time= 13.8 min (770.0 - 756.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	14.00'	0 cf	**16.00'W x 24.00'L x 5.17'H Field A** 1,984 cf Overall - 1,984 cf Embedded = 0 cf x 40.0% Voids
#2A	14.00'	1,477 cf	**retain_it retain_it 4.5'** x 6 Inside #1 Inside= 84.0"W x 54.0"H => 32.64 sf x 8.00'L = 261.1 cf Outside= 96.0"W x 62.0"H => 41.33 sf x 8.00'L = 330.7 cf 2 Rows adjusted for 89.7 cf perimeter wall
		1,477 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	14.00'	**12.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 14.00' / 13.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	14.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	14.75'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	15.75'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	17.00'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Device 1	18.20'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.34 cfs @ 12.15 hrs HW=16.10' TW=9.03' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.34 cfs of 4.47 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.58 cfs @ 6.70 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.46 cfs @ 5.25 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.30 cfs @ 2.03 fps)
  ├─**5=Orifice/Grate** (Controls 0.00 cfs)
  └─**6=Orifice/Grate** (Controls 0.00 cfs)

Summary for Subcatchment P1A:

Runoff = 1.04 cfs @ 12.08 hrs, Volume= 3,499 cf, Depth= 4.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.95"

	Area (sf)	CN	Description
	6,788	98	Paved parking, HSG D
*	1,220	98	Sidewalks, HSG D
	1,599	80	>75% Grass cover, Good, HSG D
	9,607	95	Weighted Average
	1,599		16.64% Pervious Area
	8,008		83.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	50	0.0010	0.36		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.2	45	0.0250	3.21		**Shallow Concentrated Flow, shallow conc.** Paved Kv= 20.3 fps
2.5	95	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P1B:

Runoff = 1.56 cfs @ 12.09 hrs, Volume= 4,934 cf, Depth= 3.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.95"

	Area (sf)	CN	Description
	4,182	98	Paved parking, HSG D
*	3,323	98	Sidewalks, HSG D
	8,844	80	>75% Grass cover, Good, HSG D
	16,349	88	Weighted Average
	8,844		54.10% Pervious Area
	7,505		45.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	50	0.0010	0.36		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.6	115	0.0250	3.21		**Shallow Concentrated Flow, shallow conc.** Paved Kv= 20.3 fps
2.9	165	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P2A:

Runoff = 1.80 cfs @ 12.09 hrs, Volume= 5,565 cf, Depth= 2.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.95"

	Area (sf)	CN	Description
	19,342	80	>75% Grass cover, Good, HSG D
	4,002	77	Woods, Good, HSG D
*	94	98	Sidewalks, HSG D
	23,438	80	Weighted Average
	23,344		99.60% Pervious Area
	94		0.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
3.1	400	0.0205	2.15		**Shallow Concentrated Flow, shallow conc** Grassed Waterway Kv= 15.0 fps
4.0	450	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P2B:

Runoff = 2.69 cfs @ 12.08 hrs, Volume= 9,491 cf, Depth= 4.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.95"

	Area (sf)	CN	Description
	18,410	98	Roofs, HSG D
*	1,226	98	Sidewalks, HSG D
	3,871	98	Paved parking, HSG D
	658	80	>75% Grass cover, Good, HSG D
	24,165	98	Weighted Average
	658		2.72% Pervious Area
	23,507		97.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.5	145	0.0100	5.00	1.75	**Pipe Channel, downspout** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.009 PVC, smooth interior
1.9	244	0.0205	2.15		**Shallow Concentrated Flow, shallow conc** Grassed Waterway Kv= 15.0 fps
3.3	439	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P2C:

Runoff = 1.38 cfs @ 12.17 hrs, Volume= 5,411 cf, Depth= 3.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.95"

	Area (sf)	CN	Description
*	374	98	Sidewalks, HSG D
	7,990	98	Paved parking, HSG D
	9,566	80	>75% Grass cover, Good, HSG D
	17,930	88	Weighted Average
	9,566		53.35% Pervious Area
	8,364		46.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0100	0.08		**Sheet Flow, sheet flow** Grass: Dense n= 0.240 P2= 3.15"
1.9	244	0.0205	2.15		**Shallow Concentrated Flow, shallow conc** Grassed Waterway Kv= 15.0 fps
12.8	294	Total			

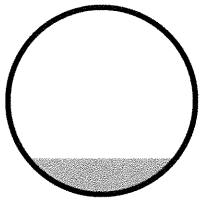
Summary for Reach DP1:

Inflow Area = 50,121 sf, 77.85% Impervious, Inflow Depth = 4.29" for 10-Year event
Inflow = 4.59 cfs @ 12.10 hrs, Volume= 17,923 cf
Outflow = 4.59 cfs @ 12.10 hrs, Volume= 17,923 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.68 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.00 fps, Avg. Travel Time= 0.6 min

Peak Storage= 53 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.49' , Surface Width= 1.99'
Bank-Full Depth= 2.50' Flow Area= 4.9 sf, Capacity= 53.73 cfs

30.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 77.8' Slope= 0.0102 '/'
Inlet Invert= 8.66', Outlet Invert= 7.87'



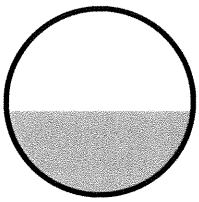
Summary for Reach DP2:

Inflow Area = 41,368 sf, 20.45% Impervious, Inflow Depth = 3.18" for 10-Year event
Inflow = 2.94 cfs @ 12.11 hrs, Volume= 10,976 cf
Outflow = 2.94 cfs @ 12.11 hrs, Volume= 10,976 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.46 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.89 fps, Avg. Travel Time= 0.6 min

Peak Storage= 39 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.56' , Surface Width= 1.24'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 7.01 cfs

15.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 71.8' Slope= 0.0070 '/'
Inlet Invert= 10.70', Outlet Invert= 10.20'



Summary for Pond Pond 1: Subsurface Detention

Inflow Area = 24,165 sf, 97.28% Impervious, Inflow Depth = 4.71" for 10-Year event
Inflow = 2.69 cfs @ 12.08 hrs, Volume= 9,491 cf
Outflow = 2.15 cfs @ 12.14 hrs, Volume= 9,490 cf, Atten= 20%, Lag= 3.5 min
Primary = 2.15 cfs @ 12.14 hrs, Volume= 9,490 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 16.86' @ 12.14 hrs Surf.Area= 384 sf Storage= 938 cf

Plug-Flow detention time= 12.0 min calculated for 9,488 cf (100% of inflow)
Center-of-Mass det. time= 12.0 min (760.2 - 748.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	14.00'	0 cf	**16.00'W x 24.00'L x 5.17'H Field A** 1,984 cf Overall - 1,984 cf Embedded = 0 cf x 40.0% Voids
#2A	14.00'	1,477 cf	**retain_it retain_it 4.5'** x 6 Inside #1 Inside= 84.0"W x 54.0"H => 32.64 sf x 8.00'L = 261.1 cf Outside= 96.0"W x 62.0"H => 41.33 sf x 8.00'L = 330.7 cf 2 Rows adjusted for 89.7 cf perimeter wall
		1,477 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	14.00'	**12.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 14.00' / 13.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	14.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	14.75'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	15.75'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	17.00'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Device 1	18.20'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.15 cfs @ 12.14 hrs HW=16.86' TW=9.14' (Dynamic Tailwater)
└─**1=Culvert** (Passes 2.15 cfs of 5.21 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.69 cfs @ 7.90 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.59 cfs @ 6.71 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.87 cfs @ 4.46 fps)
  ├─**5=Orifice/Grate** (Controls 0.00 cfs)
  └─**6=Orifice/Grate** (Controls 0.00 cfs)

Summary for Subcatchment P1A:

Runoff = 1.97 cfs @ 12.08 hrs, Volume= 6,867 cf, Depth= 8.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.18"

	Area (sf)	CN	Description
	6,788	98	Paved parking, HSG D
*	1,220	98	Sidewalks, HSG D
	1,599	80	>75% Grass cover, Good, HSG D
	9,607	95	Weighted Average
	1,599		16.64% Pervious Area
	8,008		83.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	50	0.0010	0.36		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.2	45	0.0250	3.21		**Shallow Concentrated Flow, shallow conc.** Paved Kv= 20.3 fps
2.5	95	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P1B:

Runoff = 3.19 cfs @ 12.08 hrs, Volume= 10,524 cf, Depth= 7.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.18"

	Area (sf)	CN	Description
	4,182	98	Paved parking, HSG D
*	3,323	98	Sidewalks, HSG D
	8,844	80	>75% Grass cover, Good, HSG D
	16,349	88	Weighted Average
	8,844		54.10% Pervious Area
	7,505		45.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	50	0.0010	0.36		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.6	115	0.0250	3.21		**Shallow Concentrated Flow, shallow conc.** Paved Kv= 20.3 fps
2.9	165	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P2A:

Runoff = 4.15 cfs @ 12.09 hrs, Volume= 13,162 cf, Depth= 6.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.18"

	Area (sf)	CN	Description
	19,342	80	>75% Grass cover, Good, HSG D
	4,002	77	Woods, Good, HSG D
*	94	98	Sidewalks, HSG D
	23,438	80	Weighted Average
	23,344		99.60% Pervious Area
	94		0.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
3.1	400	0.0205	2.15		**Shallow Concentrated Flow, shallow conc** Grassed Waterway Kv= 15.0 fps
4.0	450	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P2B:

Runoff = 5.00 cfs @ 12.08 hrs, Volume= 18,002 cf, Depth= 8.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.18"

	Area (sf)	CN	Description
	18,410	98	Roofs, HSG D
*	1,226	98	Sidewalks, HSG D
	3,871	98	Paved parking, HSG D
	658	80	>75% Grass cover, Good, HSG D
	24,165	98	Weighted Average
	658		2.72% Pervious Area
	23,507		97.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow, sheet flow** Smooth surfaces n= 0.011 P2= 3.15"
0.5	145	0.0100	5.00	1.75	**Pipe Channel, downspout** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.009 PVC, smooth interior
1.9	244	0.0205	2.15		**Shallow Concentrated Flow, shallow conc** Grassed Waterway Kv= 15.0 fps
3.3	439	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P2C:

Runoff = 2.83 cfs @ 12.17 hrs, Volume= 11,542 cf, Depth= 7.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.18"

	Area (sf)	CN	Description
*	374	98	Sidewalks, HSG D
	7,990	98	Paved parking, HSG D
	9,566	80	>75% Grass cover, Good, HSG D
	17,930	88	Weighted Average
	9,566		53.35% Pervious Area
	8,364		46.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0100	0.08		**Sheet Flow, sheet flow** Grass: Dense n= 0.240 P2= 3.15"
1.9	244	0.0205	2.15		**Shallow Concentrated Flow, shallow conc** Grassed Waterway Kv= 15.0 fps
12.8	294	Total			

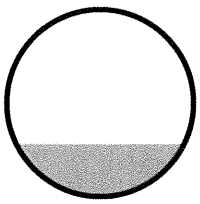
Summary for Reach DP1:

Inflow Area = 50,121 sf, 77.85% Impervious, Inflow Depth = 8.47" for 100-Year event
Inflow = 9.37 cfs @ 12.11 hrs, Volume= 35,392 cf
Outflow = 9.35 cfs @ 12.11 hrs, Volume= 35,392 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.21 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.41 fps, Avg. Travel Time= 0.5 min

Peak Storage= 89 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.71' , Surface Width= 2.25'
Bank-Full Depth= 2.50' Flow Area= 4.9 sf, Capacity= 53.73 cfs

30.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 77.8' Slope= 0.0102 '/'
Inlet Invert= 8.66', Outlet Invert= 7.87'



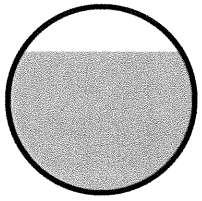
Summary for Reach DP2:

Inflow Area = 41,368 sf, 20.45% Impervious, Inflow Depth = 7.17" for 100-Year event
Inflow = 6.49 cfs @ 12.10 hrs, Volume= 24,704 cf
Outflow = 6.48 cfs @ 12.11 hrs, Volume= 24,704 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.48 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.32 fps, Avg. Travel Time= 0.5 min

Peak Storage= 72 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.95' , Surface Width= 1.07'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 7.01 cfs

15.0" Round Pipe
n= 0.010 Concrete pipe, straight & clean
Length= 71.8' Slope= 0.0070 '/'
Inlet Invert= 10.70', Outlet Invert= 10.20'



Summary for Pond Pond 1: Subsurface Detention

Inflow Area = 24,165 sf, 97.28% Impervious, Inflow Depth = 8.94" for 100-Year event
Inflow = 5.00 cfs @ 12.08 hrs, Volume= 18,002 cf
Outflow = 4.55 cfs @ 12.12 hrs, Volume= 18,001 cf, Atten= 9%, Lag= 2.3 min
Primary = 4.55 cfs @ 12.12 hrs, Volume= 18,001 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 18.33' @ 12.12 hrs Surf.Area= 384 sf Storage= 1,422 cf

Plug-Flow detention time= 10.2 min calculated for 17,996 cf (100% of inflow)
Center-of-Mass det. time= 10.3 min (749.8 - 739.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	14.00'	0 cf	**16.00'W x 24.00'L x 5.17'H Field A** 1,984 cf Overall - 1,984 cf Embedded = 0 cf x 40.0% Voids
#2A	14.00'	1,477 cf	**retain_it retain_it 4.5'** x 6 Inside #1 Inside= 84.0"W x 54.0"H => 32.64 sf x 8.00'L = 261.1 cf Outside= 96.0"W x 62.0"H => 41.33 sf x 8.00'L = 330.7 cf 2 Rows adjusted for 89.7 cf perimeter wall
		1,477 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	14.00'	**12.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 14.00' / 13.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	14.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	14.75'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	15.75'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	17.00'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Device 1	18.20'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=4.55 cfs @ 12.12 hrs HW=18.33' TW=9.36' (Dynamic Tailwater)
↑└─**1=Culvert** (Passes 4.55 cfs of 6.42 cfs potential flow)
  ↑├─**2=Orifice/Grate** (Orifice Controls 0.86 cfs @ 9.83 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.78 cfs @ 8.90 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 1.44 cfs @ 7.35 fps)
  ├─**5=Orifice/Grate** (Orifice Controls 0.98 cfs @ 5.01 fps)
  └─**6=Orifice/Grate** (Weir Controls 0.49 cfs @ 1.18 fps)

APPENDIX D:

CONSTRUCTION PHASE

BEST MANAGEMENT PRACTICES PLAN

Construction Phase Best Management Practices (BMP's)

Erosion and Sedimentation will be controlled at the site by utilizing structural practices, stabilization practices, and dust control. These practices correspond with the site development plans entitled "3 Boston Way in Newburyport, Massachusetts" prepared by The Morin-Cameron Group, Inc. dated October 23, 2019 as revised and approved by the Newburyport Planning Board, hereinafter referred to as the Site Plans.

Responsible Party Contact Information:

Stormwater Management System Owner:	Three Boston Way, LLC 231 Sutton Street North Andover, MA 01845 P: (978) 688-5422
General Contractor:	TBD
Site Contractor:	TBD

Town Contact Information:

Newburyport Engineering Department:	Department of Public Services 16C Perry Way Newburyport, MA 01950 P: (978) 465-4464
Newburyport Planning Board:	Planning Board 60 Pleasant Street P.O. Box 550 Newburyport, MA 01950 P: (978) 465-4400
Site Design Engineer Information:	The Morin-Cameron Group, Inc. 66 Elm Street Danvers, MA 01923 Phone: (978) 777-8586
Other Contacts:	TBD

Structural Practices:

1) **Silt Fence** –siltation fence shall be installed in accordance with the approved plans where high rates of stormwater runoff are anticipated.
   a) Installation Schedule: Prior to Start of land disturbance

   b) Maintenance and Inspection: The site supervisor shall inspect the silt fence at least once per week and shall repair any damaged or affected areas of the fence at the time they are noted.

2) **Hay-Bales/Silt Fence** – Hay-bales and siltation fence shall be installed in accordance with the approved plans where high rates of stormwater runoff are anticipated.
   c) Installation Schedule: Prior to Start of land disturbance

   d) Maintenance and Inspection: The site supervisor shall inspect the silt fence at least once per week and shall repair any damaged or affected areas of the fence at the time they are noted.

3) **Inlet Protection** – Inlet Protection will be utilized around the catch basin grates in the street layout along the frontage of the property. The inlet protection will allow the storm drain inlets to be used before final stabilization. This structural practice will allow early use of the drainage system. Siltsack or equivalent will be utilized for the inlet protection. Siltsack is manufactured by ACF Environmental. The telephone number is 800-448-3636. Regular flow siltsack will be utilized, and if it does not allow enough storm water flow, hi-flow siltsack will be utilized.

Silt Sack (or equivalent) Inlet Protection Inspection/Maintenance Requirements *

a) The silt sack trapping device and the catch basin should be inspected after every rain storm and repairs made as necessary.

b) Sediment should be removed from the silt sack after the sediment has reached a maximum depth of one-half the depth of the trap.

c) Sediment should be disposed of in a suitable area and protected from erosion by either structural or vegetative means. Sediment material removed shall be disposed of in accordance with all applicable local, state, and federal regulations.

d) The silt sack must be replaced if it is ripped or torn in any way.

e) Temporary traps should be removed and the area repaired as soon as the contributing drainage area to the inlet has been completely stabilized.

4) **Sediment Track-Out:** Stabilized Construction Exit: Prior to the commencement of site work, crushed stone anti-tracking pads will be installed at the entrance to the site. This will prevent trucks from tracking material onto the road from the construction site. If, at any point during the project, the tracking pad becomes ineffective due to accumulation of soil, the crushed stone shall be replaced. Details for construction of the stabilized entrance can be found in the Erosion Control Details sheet that is part of the comprehensive permit plan set associated with the project. The site supervisor will inspect the tracking pads weekly to ensure that they are properly limiting the tracking of soil onto the road. If tracking onto the roadway is noted, it shall be removed immediately via a mechanical street sweeper.

Stabilization Practices:

Stabilization measures shall be implemented as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased, with the following exceptions.

- Where the initiation of stabilization measures by the 14th day after construction activity temporary or permanently cease is precluded by snow cover, stabilization measures shall be initiated as soon as practicable.

- Where construction activity will resume on a portion of the site within 21 days from when activities ceased, (e.g. the total time period that construction activity is temporarily ceased is less than 21 days) then stabilization measures do not have to be initiated on that portion of the site by the 14th day after construction activity temporarily ceased.

1) **Temporary Seeding** – Temporary seeding will allow a short-term vegetative cover on disturbed site areas that may be in danger of erosion. Temporary seeding will be done at stock piles and disturbed portions of the site where construction activity will temporarily cease for at least 21 days. The temporary seeding will stabilize cleared and unvegetated areas that will not be brought into final grade for several weeks or months.

   Temporary Seeding Planting Procedures *

   a) Planting should preferably be done between April 1st and June 30th, and September 1st through September 31st. If planting is done in the months of July and August, irrigation may be required. If planting is done between October 1st and March 31st, mulching should be applied immediately after planting. If seeding is done during the summer months, irrigation of some sort will probably be necessary.

   b) Before seeding, install structural practice controls. Utilize Amoco supergro or equivalent.

   c) Select the appropriate seed species for temporary cover from the following table.

Species	Seeding Rate (lbs./1,000 sq.)	Seeding Rate (lbs./acre)	Recommended Seeding Dates	Seed Cover required
Annual Ryegrass	1	40	April 1st to June 1st August 15th to Sept. 15th	¼ inch
Foxtail Millet	0.7	30	May 1st to June 30th	½ to ¾ inch
Oats	2	80	April 1st to July 1st August 15th to Sept. 15th	1 to 1-½ inch
Winter Rye	3	120	August 15th to Oct. 15th	1 to 1-½ inch

Apply the seed uniformly by hydroseeding, broadcasting, or by hand.

d) Use effective mulch, such as clean grain straw; tacked and/or tied with netting to protect seedbed and encourage plant growth.

Temporary Seeding Inspection/Maintenance *

a) Inspect within 6 weeks of planting to see if stands are adequate. Check for damage within 24 hours of the end to a heavy rainfall, defined as a 2-year storm event (i.e., 3.2 inches of rainfall within a twenty-four-hour period). Stands should be uniform and dense. Reseed and mulch damaged and sparse areas immediately. Tack or tie down mulch as necessary.

b) Seeds should be supplied with adequate moisture. Furnish water as needed, especially in abnormally hot or dry weather. Water application rates should be controlled to prevent runoff.

2) **Geotextiles** - Geotextiles such as jute netting will be used in combination with other practices such as mulching to stabilize slopes. The following geotextile materials or equivalent are to be utilized for structural and nonstructural controls as shown in the following table.

Practice	Manufacturer	Product	Remarks
Sediment Fence	Amoco	Woven polypropylene 1198 or equivalent	0.425 mm opening
Construction Entrance	Amoco	Woven polypropylene 2002 or equivalent	0.300 mm opening
Outlet Protection	Amoco	Nonwoven polypropylene 4551 or equivalent	0.150 mm opening
Erosion Control (slope stability)	Amoco	Supergro or equivalent	Erosion control revegetation mix, open polypropylene fiber on degradable polypropylene net scrim

Amoco may be reached at (800) 445-7732

Geotextile Installation

a) Netting and matting require firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material.

Geotextile Inspection/Maintenance *

a) In the field, regular inspections should be made to check for cracks, tears, or breaches in the fabric. The appropriate repairs should be made.

3) **Mulching and Netting** – Mulching will provide immediate protection to exposed soils during the period of short construction delays, or over winter months through the application of plant residues, or other suitable materials, to exposed soil areas. In areas, which have been seeded either for temporary or permanent cover, mulching should immediately follow seeding. On steep slopes, mulch must be supplemented with netting. The preferred mulching material is straw.

Mulch (Hay or Straw) Materials and Installation

a) Straw has been found to be one of the most effective organic mulch materials. The specifications for straw are described below, but other material may be appropriate. The straw should be air-dried; free of undesirable seeds & coarse materials. The application rate per 1,000 sq. is 90-100 lbs. (2-3 bales) and the application rate per acre is 2 tons (100-120 bales). The application should cover about 90% of the surface. The use of straw mulch is appropriate where mulch is maintained for more than three months. Straw mulch is subject to wind blowing unless anchored, is the most commonly used mulching material, and has the best microenvironment for germinating seeds.

Mulch Maintenance *

a) Inspect after rainstorms to check for movement of mulch or erosion. If washout, breakage, or erosion occurs, repair surface, reseed, remulch, and install new netting.

b) Straw or grass mulches that blow or wash away should be repaired promptly.

c) If plastic netting is used to anchor mulch, care should be taken during initial mowing to keep the mower height high. Otherwise, the netting can wrap up on the mower blade shafts. After a period of time, the netting degrades and becomes less of a problem.

d) Continue inspections until vegetation is well established.

4) **Land Grading** – Grading on fill slopes, cut slopes, and stockpile areas will be done with full siltation controls in place.

Land Grading Design/Installation Requirements

a) Areas to be graded should be cleared and grubbed of all timber, logs, brush, rubbish, and vegetated matter that will interfere with the grading operation. Topsoil should be stripped and stockpiled for use on critical disturbed areas for establishment of vegetation. Cut slopes to be topsoiled should be thoroughly scarified to a minimum depth of 3-inches prior to placement of topsoil.

b) Fill materials should be generally free of brush, rubbish, rocks, and stumps. Frozen materials or soft and easily compressible materials should not be used in fills intended to support buildings, parking lots, roads, conduits, or other structures.

c) Earth fill intended to support structural measures should be compacted to a minimum of 90 percent of Standard Proctor Test density with proper moisture control, or as otherwise specified by the engineer responsible for the design. Compaction of other fills should be to the density required to control sloughing, erosion or excessive moisture content. Maximum thickness of fill layers prior to compaction should not exceed 9 inches.

d) The uppermost one foot of fill slopes should be compacted to at least 85 percent of the maximum unit weight (based on the modified AASHTO compaction test). This is usually accomplished by running heavy equipment over the fill.

e) Fill should consist of material from borrow areas and excess cut will be stockpiled in areas shown on the Site Plans. All disturbed areas should be free draining, left with a neat and finished appearance, and should be protected from erosion.

Land Grading Stabilization Inspection/Maintenance *

a) All slopes should be checked periodically to see that vegetation is in good condition. Any rills or damage from erosion and animal burrowing should be repaired immediately to avoid further damage.

b) If seeps develop on the slopes, the area should be evaluated to determine if the seep will cause an unstable condition. Subsurface drains or a gravel mulch may be required to solve seep problems. However, no seeps are anticipated.

c) Areas requiring revegetation should be repaired immediately. Control undesirable vegetation such as weeds and woody growth to avoid bank stability problems in the future.

5) **Topsoiling *** – Topsoiling will help establish vegetation on all disturbed areas throughout the site during the seeding process. The soil texture of the topsoil to be used will be a sandy loam to a silt loam texture with 15% to 20% organic content.

Topsoiling Placement

a) Topsoil should not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed seeding.

b) Do not place topsoil on slopes steeper than 2.5:1, as it will tend to erode.

c) If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method is to actually work the topsoil into the layer below for a depth of at least 6 inches.

6) **Permanent Seeding** – Permanent Seeding should be done immediately after the final design grades are achieved. Native species of plants should be used to establish perennial vegetative cover on disturbed areas. The revegetation should be done early enough in the fall so that a good cover is established before cold weather comes and growth stops until the spring. A good cover is defined as vegetation covering 75 percent or more of the ground surface.

Permanent Seeding Seedbed Preparation

a) In infertile or coarse-textured subsoil, it is best to stockpile topsoil and re-spread it over the finished slope at a minimum 2 to 6-inch depth and roll it to provide a firm seedbed. The topsoil must have a sandy loam to silt loam texture with 15% to 20% organic content. If construction fill operations have left soil exposed with a loose, rough, or irregular surface, smooth with blade and roll.

b) Loosen the soil to a depth of 3-5 inches with suitable agricultural or construction equipment.

c) Areas not to receive topsoil shall be treated to firm the seedbed after incorporation of the lime and fertilizer so that it is depressed no more than ½ - 1 inch when stepped on with a shoe. Areas to receive topsoil shall not be firmed until after topsoiling and lime and fertilizer is applied and incorporated, at which time it shall be treated to firm the seedbed as described above.

Permanent Seeding Grass Selection/Application

a) Select an appropriate cool or warm season grass based on site conditions and seeding date. Apply the seed uniformly by hydro-seeding, broadcasting, or by hand. Uniform seed distribution is essential. On steep slopes, hydroseeding may be the most effective seeding method. Surface roughening is particularly important when preparing slopes for hydroseeding.

b) Lime and fertilize. Organic fertilizer shall be utilized in areas within the 100-foot buffer zone to a wetland resource area.

c) Mulch the seedings with straw applied at the rate of ½ tons per acre. Anchor the mulch with erosion control netting or fabric on sloping areas. Amoco supergro or equivalent should be utilized.

Permanent Seeding Inspection/Maintenance *

a) Frequently inspect seeded areas for failure and make necessary repairs and reseed immediately. Conduct or follow-up survey after one year and replace failed plants where necessary.

b) If vegetative cover is inadequate to prevent rill erosion, overseed and fertilize in accordance with soil test results.

c) If a stand has less than 40% cover, reevaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand following seedbed preparation and seeding recommendations, omitting lime and fertilizer in the absence of soil test results. If the season prevents resowing, mulch or jute netting is an effective temporary cover.

d) Seeded areas should be fertilized during the second growing season. Lime and fertilize thereafter at periodic intervals, as needed. Organic fertilizer shall be utilized in areas within the 100-foot buffer zone to a wetland resource area.

Dust Control:

Dust control will be utilized throughout the entire construction process of the site. For example, keeping disturbed surfaces moist during windy periods will be an effective control measure, especially for construction access roads. The use of dust control will prevent the movement of soil to offsite areas. However, care must be taken to not create runoff from excessive use of water to control dust. The following are methods of Dust Control that may be used on-site:

- Vegetative Cover – The most practical method for disturbed areas not subject to traffic.
- Calcium Chloride – Calcium chloride may be applied by mechanical spreader as loose, dry granules or flakes at a rate that keeps the surface moist but not so high as to cause water pollution or plant damage.
- Sprinkling – The site may be sprinkled until the surface is wet. Sprinkling will be effective for dust control on haul roads and other traffic routes.
- Stone – Stone will be used to stabilize construction roads; will also be effective for dust control.

The general contractor shall employ an on-site water vehicle for the control of dust as necessary.

Non-Stormwater Discharges:

The construction de-watering and all non-stormwater discharges will be directed into a sediment dirt bag (or equivalent inlet protection) or a sediment basin. Sediment material removed shall be disposed of in accordance with all applicable local, state, and federal regulations.

The developer and site general contractor will comply with the E.P.A.'s Final General Permit for Construction De-watering Discharges, (N.P.D.E.S., Section 402 and 40 C.F.R. 122.26(b) (14) (x).

Inspection/Maintenance:

Operator personnel must inspect the construction site at least once every 14 calendar days and within 24 hours of a storm event of ½-inch or greater. The applicant shall be responsible to secure the services of a design professional or similar professional (inspector) on an on-going basis throughout all phases of the project. Refer to the Inspection/Maintenance Requirements presented earlier in the "Structural and Stabilization Practices." The inspector should review the erosion and sediment controls with respect to the following:

- Whether or not the measure was installed/performed correctly.
- Whether or not there has been damage to the measure since it was installed or performed.
- What should be done to correct any problems with the measure.

The inspector should complete a Stormwater Management Construction Phase BMP Inspection Schedule and Evaluation Checklist for documenting the findings and should request the required maintenance or repair for the pollution prevention measures when the inspector finds that it is necessary for the measure to be effective. The inspector should notify the appropriate person to make the changes and submit copies of the form to the Newburyport Engineering Department.

It is essential that the inspector document the inspection of the pollution prevention measures. These records will be used to request maintenance and repair and to prove that the inspection and maintenance were performed. The forms list each of the measures to be inspected on the site, the inspector's name, the date of the inspection, the condition of the measure/area inspected, maintenance or repair performed and any changes which should be made to the Operation and Maintenance Plan to control or eliminate unforeseen pollution of storm water.

APPENDIX E:

LONG TERM BEST MANAGEMENT PRACTICES O&M PLAN

Long Term Stormwater Best Management Practices
Operation and Maintenance Plan
for
3 Boston Way
Newburyport, Massachusetts
October 23, 2019

The following operation and maintenance plan has been provided to satisfy the requirements of Standard 9 of the Mass DEP Stormwater Management Handbook associated with development of the site and associated infrastructure. The success of the Stormwater Management Plan depends on the proper implementation, operation and maintenance of several management components. The following procedures shall be implemented to ensure success of the Stormwater Management Plan:

1. The contractor shall comply with the details of construction of the site as shown on the approved plans.
2. The vegetated stormwater management areas, subsurface detention system and water quality units shall be inspected and maintained as indicated below.
3. Effective erosion control measurers during and after construction shall be maintained until a stable turf is established on all altered areas.

Basic Information

Stormwater Management System Owner:	Three Boston Way, LLC 231 Sutton Street North Andover, MA 01845 P: (978) 687-5422
Newburyport Engineering Department:	Department of Public Services 16C Perry Way Newburyport, MA 01950 P: (978) 465-4464
Newburyport Planning Board:	Planning Board 60 Pleasant Street P.O. Box 550 Newburyport, MA 01950 P: (978) 465-4400

Erosion and Sedimentation Controls during Construction:

The site and drainage construction contractor shall be responsible for maintaining the stormwater system during construction. Routine maintenance of all items shall be performed to ensure adequate runoff and pollution control during construction.

A proposed silt fence will be placed downgradient of the work area prior to the commencement of any clearing, grubbing, and earth removal or construction activity. The integrity of the erosion control barrier will be maintained by periodic inspection and replacement as necessary. The erosion control barrier will remain in place until the first course of pavement has been placed and all side slopes have been loamed and seeded and vegetation has been established. A silt sack will also be placed over the new catch basins once constructed.

Operations and maintenance plans for the Stormwater Management construction phase and long term operation of the system have been attached to this report.

General Conditions

1. The developer shall be responsible for scheduling regular inspections and maintenance of the stormwater BMP's. The BMP maintenance shall be conducted as detailed in the following long-term pollution prevention plan and illustrated on the approved design plans:
   "3 Boston Way in Newburyport, Massachusetts", prepared by The Morin-Cameron Group, Inc. dated October 23, 2019 as revised and approved by the Newburyport Planning Board.
2. All Stormwater BMP's shall be operated and maintained in accordance with the design plans and the following Long-Term Pollution Prevention Plan.
3. The owner shall:
   a. Maintain an Operation and Maintenance Log for the last three years. The Log shall include all BMP inspections, repairs, replacement activities and disposal activities (disposal material and disposal location shall be included in the Log);
   b. Make the log available to the Newburyport Engineering Department and Planning Board upon request;
   c. Allow members and agents of the Newburyport Engineering Department and Planning Board to enter the premises and ensure that the Owner has complied with the Operation and Maintenance Plan requirements for each BMP.
4. A recommended inspection and maintenance schedule is outlined below based on statewide averages. This inspection and maintenance schedule shall be adhered to at a minimum for the first year of service of all BMP's referenced in this document. At the commencement of the first year of service, a more accurate inspection/maintenance schedule shall be determined based on the level of service for this site.

Long-Term Pollution Prevention Plan (LTPPP)

Vegetated Areas:

Immediately after construction, monitoring of the erosion control systems shall occur until establishment of natural vegetation. Afterwards, vegetated areas shall be maintained as such. Vegetation shall be replaced as necessary to ensure proper stabilization of the site.

Cost: Included with annual landscaping budget. Consult with local landscape contractors.

Paved Areas:

Sweepers shall sweep paved areas periodically during dry weather to remove excess sediments and to reduce the amount of sediments that the drainage system shall have to remove from the runoff. The sweeping shall be conducted primarily between March 15th and November 15th. Special attention should be made to sweeping paved surfaces in March and April before spring rains wash residual sand into the drainage system.

Cost: The owner shall consult local landscaping contractor for details.

Salt used for de-icing on the driveway during winter months shall be limited as much as possible as this will reduce the need for removal and treatment. Sand containing the minimum amount of calcium chloride (or approved equivalent) needed for handling may be applied as part of the routine winter maintenance activities.

Vortsentry Water Quality Units:

The Vortsentry Water Quality Units shall be inspected after every major storm event for the first 3 months after construction; a major storm event is 3.9 inches of rainfall in a 24-hour period (5 year storm). Thereafter, the system shall be inspected twice per year in April and October. The units shall be cleaned per manufacturer's instructions included herein.

Cost: The owner shall consult local landscaping contractor for details.

Public Safety Concerns: The manhole covers shall not be left open and unattended at any time during inspection, cleaning or otherwise. Broken covers or frames shall be replaced immediately.

Subsurface Detention System:

The subsurface detention system shall be monitored annually to ensure it is draining properly. The outlet structure shall be checked for debris accumulation twice per year, in the spring and fall. In the case that water remains in the detention system for greater than three (3) days after a storm event, an inspection is warranted and maintenance or repairs should be addressed as necessary. Confirm that the low flow outlet in the outlet structure is not obstructed by debris. The inspections shall be conducted by qualified personnel.

Cost: Consult with local landscaping companies for associated costs if necessary.

Public Safety Concerns: Manhole covers or inspection port covers shall not be left open and unattended at any time during inspection, cleaning or otherwise. Broken covers or frames shall be replaced immediately. At no time shall any person enter the subsurface structure unless measures have been taken to ensure safe access in accordance with OSHA enclosed space regulations.

Grass & Gravel Filter Strip:
The filter strip shall be checked regularly to ensure that the surface is free of debris such as leaves, sticks and trash. Remove and dispose of any debris. If surface ponding is visible, remove top course of stone and accumulated sediment and replace with clean stone. Material removed shall be disposed of in accordance with all applicable local, state, and federal regulations

Constructed Wetland:
The constructed wetland shall remain free from foreign objects and contamination. During the first growing season, vegetation should be inspected every 2 to 3 weeks. During the first 2 years, the constructed wetland should be inspected at least 4 times per year and after major storms (greater than 2 inches in 24 hours). Inspections should access the vegetation, erosion, flow channelization, bank stability, outlet conditions, and sediment/debris accumulation. Problems should be corrected as soon as possible. Wetland and buffer vegetation may require support – watering, weeding, mulching, replanting, etc. – during the first 3 years. Undesirable species should be removed, and desirable replacements planted, if necessary. Once established, the constructed wetland should require little maintenance aside from regular inspections and removal of litter and debris.

Overall Site Grading and Stormwater Management:
After construction, and during the initial vegetation establishment period, the site should be inspected after every rainfall. Mowing, litter removal, and spot vegetation repair should be performed on a regular basis.

Debris & Litter:
All debris and litter shall be removed from the driveway/parking area as necessary to prevent migration into the drainage system.

Pesticides, Herbicides, and Fertilizers:
Pesticides and herbicides shall be used sparingly. Fertilizers shall be restricted to the use of organic, slow release nitrogen fertilizers only. All fertilizers, herbicides, pesticides, sand and salt for deicing and the like shall be stored in dry area that is protected from weather.

Cost: Included in the routine landscaping maintenance schedule. The Owner shall consult local landscaping contractors for details.

Public Safety Concerns: Chemicals shall be stored in a secure area to prevent children from obtaining access to them. Any major spills shall be reported to municipal officials.

Prevention of Illicit Discharges:
Illicit discharges to the stormwater management system are not allowed. Illicit discharges are discharges that are not comprised entirely of stormwater. Pursuant to Mass DEP Stormwater Standards the following activities or facilities are not considered illicit discharges: firefighting, water line flushing, landscape irrigation, uncontaminated groundwater, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, DE chlorinated water from swimming pools, water used for street washing and water used to clean residential building without detergents.

To prevent illicit discharges to the stormwater management system the following policies should be implemented:

1. Provisions For Storing Materials And Waste Products Inside Or Under Cover
2. Vehicle Maintenance And Washing Controls
3. Requirements for Routine Inspections of the Stormwater Management System (i.e.: catch basins, sediment forebays and area drains, CDS water quality units & subsurface infiltration and detention systems.)
4. Spill Prevention and Response Plans.

APPENDIX F:

ILLICIT DISCHARGE

COMPLIANCE STATEMENT

Illicit Discharge Compliance Statement

I, Scott P. Cameron, P.E., hereby notify the Newburyport Planning Board that I have not witnessed, nor am aware of any existing illicit discharges at the site known as 3 Boston Way in Newburyport, Massachusetts. I also hereby certify that the development of said property as illustrated on the final plans entitled "Multifamily Site Development Plans in Newburyport, Massachusetts, 3 Boston Way," prepared by The Morin-Cameron Group, Inc. dated October 22, 2019 and as revised and approved by the Newburyport Planning Board and maintenance thereof in accordance with the "Construction Period Pollution Prevention Plan" and "Long-Term Pollution Prevention Plan" prepared by The Morin-Cameron Group, Inc dated October 22, 2019 and as revised and approved by the Newburyport Planning Board will not create any new illicit discharges. There is no warranty implied regarding future illicit discharges that may occur as a result of improper construction or maintenance of the stormwater management system or unforeseen accidents.

Name: Scott P. Cameron, P.E.

Company: The Morin-Cameron Group, Inc.

Title: Owner's Representative

Signature:

Date: 10-23-19

APPENDIX G:

TSS REMOVAL CALCULATIONS

THE MORIN-CAMERON GROUP, INC.
66 Elm Street
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for P1B

Name: 3 Boston Way
Location: 3 Boston Way
Newburyport, MA
County: Essex County
Applicant: Turnpike Redevelopment, LLC

Proj. No.: 3856
Date: 10/23/2019
Revised:
Computed by: Daniel Powers
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	**0.50**	**1.00**	**0.50**	**0.50**
Constructed Stormwater Wetland	**0.80**	**0.50**	**0.40**	**0.10**
	0.00	**0.10**	**0.00**	**0.10**
	0.00	**0.10**	**0.00**	**0.10**
	0.00	**0.10**	**0.00**	**0.10**

Note: Grass & gravel filter strip utilized for pretreatment as referenced on Page 25 of Structural BMPs in Volume 2 Chapter 2 of the Massachusetts Stormwater Handbook

Total TSS Removal = **90%**

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet
must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

THE MORIN-CAMERON GROUP, INC.
66 Elm Street
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for P1A & P2B

Name: 3 Boston Way
Location: 3 Boston Way
Newburyport, MA
County: Essex County
Applicant: Turnpike Redevelopment, LLC

Proj. No.: 3856
Date: 10/23/2019
Revised:
Computed by: Daniel Powers
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Proprietary Treatment Practice	**0.80**	**1.00**	**0.80**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**

Total TSS Removal = **80%**

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet
must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

THE MORIN-CAMERON GROUP, INC.
66 Elm Street
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for P2C

Name: 3 Boston Way
Location: 3 Boston Way
Newburyport, MA
County: Essex County
Applicant: Turnpike Redevelopment, LLC

Proj. No.: 3856
Date: 10/23/2019
Revised:
Computed by: Daniel Powers
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Drainage Channel	**0.00**	**1.00**	**0.00**	**1.00**
Constructed Stormwater Wetland	**0.80**	**1.00**	**0.80**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**

Note: Grass & gravel filter strip utilized for pretreatment as referenced on Page 25 of Structural BMPs in Volume 2 Chapter 2 of the Massachusetts Stormwater Handbook

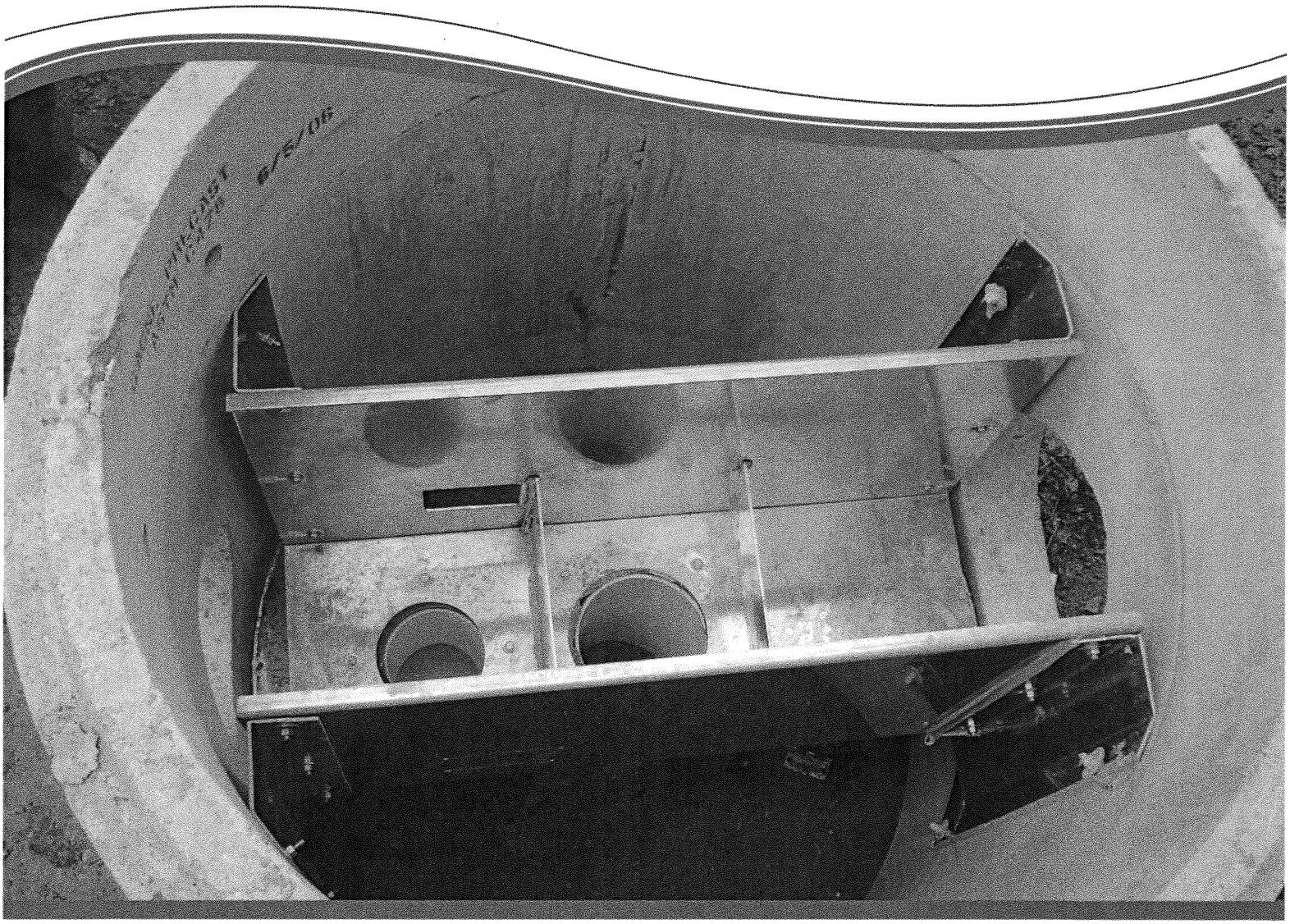
Total TSS Removal = **80%**

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet
must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

URBANGREEN®

VortSentry® HS Guide
Operation, Design, Performance and Maintenance



CONTECH®
ENGINEERED SOLUTIONS

VortSentry® HS

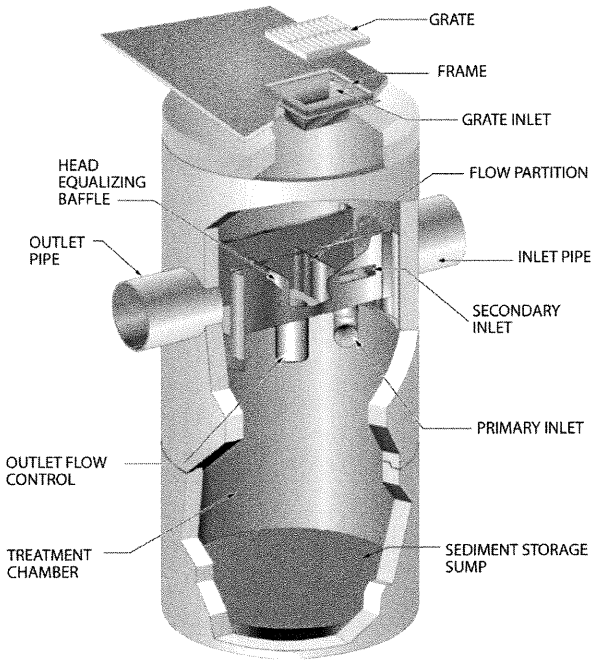
The VortSentry HS is a compact, below grade stormwater treatment system that employs helical flow technology to enhance gravitational separation of floating and settling pollutants from stormwater flows. With the ability to accept a wide range of pipe sizes, the VortSentry HS can treat and convey flows from small to large sites. A unique internal bypass design means higher flows can be diverted without the use of external bypass structures. The VortSentry HS is also available in a grate inlet configuration, which is ideal for retrofit installations.

Operation Overview

Low, frequently occurring storm flows are directed into the treatment chamber through the primary inlet. The tangentially oriented downward pipe induces a swirling motion in the treatment chamber that increases capture and containment abilities. Moderate storm flows are directed into the treatment chamber through the secondary inlet, which allows for capture of floating trash and debris. The secondary inlet also provides for treatment of higher flows without significantly increasing the velocity or turbulence in the treatment chamber. This allows for a more quiescent separation environment. Settleable solids and floating pollutants are captured and contained in the treatment chamber.

Flow exits the treatment chamber through the outlet flow control, which manages the amount of flow that is treated and helps maintain the helical flow patterns developed within the treatment chamber.

Flows exceeding the system's rated treatment flow are diverted away from the treatment chamber by the flow partition. Internal diversion of high flows eliminates the need for external bypass structures. During bypass, the head equalizing baffle applies head on the outlet flow control to limit the flow through the treatment chamber. This helps prevent re-suspension of previously captured pollutants.



Design Basics

There are two primary methods of sizing a VortSentry HS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow for a defined particle size. The summation process of the Rational Rainfall Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically, VortSentry HS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a particle gradation with an average particle size (d_{50}) of 240-microns (μm).

Water Quality Flow Rate Method

In many cases, regulations require that a specific flow rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval (i.e. the six-month storm) or a water quality depth (i.e. 1/2-inch of rainfall).

The VortSentry HS is designed to treat all flows up to the WQQ. Due to its internal bypass weir configuration, flow rates in the treatment chamber only increase minimally once the WQQ is surpassed. At influent rates higher than the WQQ, the flow partition will allow most flow exceeding the treatment flow rate to bypass the treatment chamber. This allows removal efficiency to remain relatively constant in the treatment chamber and reduces the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the VortSentry HS will remove a specific gradation of sediment at a specific removal efficiency. Therefore they are variable based on the gradation and removal efficiency specified by the design engineer and the unit size is scaled according to the project goal.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. The Rational Rainfall Method is a sizing program Contech uses to estimate a net annual sediment load reduction for a particular VortSentry HS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics. For more information on the Rational Rainfall Method, see *Vortechs Technical Bulletin 4: Modeling Long Term Load Reduction: The Rational Rainfall Method*, available at **www.ContechES.com/stormwater**

Treatment Flow Rate

The outlet flow control is sized to allow the WQQ to pass entirely through the treatment chamber at a water surface elevation equal to the crest of the flow partition. The head equalizing baffle applies head on the outlet flow control to limit the flow through the treatment chamber when bypass occurs, thus helping to prevent re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The VortSentry HS is available in three standard configurations: inline (with inlet and outlet pipes at 180° to each other), grated inlet, and a combination of grate and pipe inlets. All three configurations are available in 36-inch (900-mm) through 96-inch (2400-mm) diameter manholes.

The configuration of the system is determined by the suffix of the model name:

- A model name without a suffix denotes a standard pipe inlet (Example HS48).
- A "G" at the end of the model designation denotes a grate inlet (Example HS48G).
- A "GP" at the end of the model designation denotes a combination of grate and pipe inlets (Example HS48GP).

Performance

Full-Scale Laboratory Test Results

Laboratory testing of the VortSentry HS was conducted using F-55 Silica, a commercially available sand product with an average particle size of 240-μm (Table 1). This material was metered into a model HS48 VortSentry HS at an average concentration of between 250-mg/L and 300-mg/L at flow rates ranging from 0.50-cfs to 1.5-cfs (14-L/s to 56-L/s).

US Standard Sieve Size	Particle Size Micron (μm)	Cumulative Passing %
30	600	99.7%
40	425	95.7%
50	300	74.7%
70	212	33.7%
100	150	6.7%
140	106	0.7%

Table 1 : US Silica F-55 Particle Size Distribution

Removal efficiencies at each flow rate were calculated based on net sediment loads passing the influent and effluent sampling points. Results are illustrated in Figure 1.

Assuming that sediment in the inlet chamber is ideally mixed, removal rates through the system will decay according to the percentage of flow bypassed. This effect has been observed in the laboratory where the test system is designed to produce a

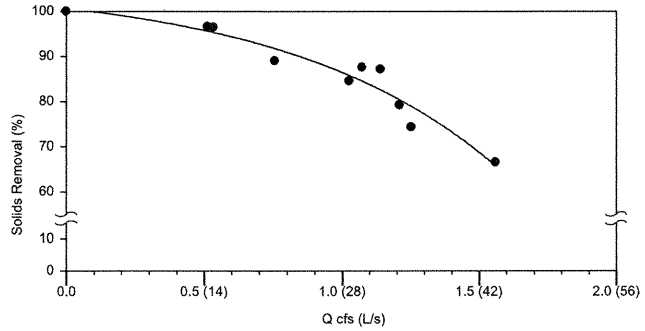


Figure 1: VortSentry HS Removal Efficiencies for 240-μm Particle Gradation

thoroughly mixed inlet stream. All VortSentry HS models have the same aspect ratio regardless of system diameter (i.e. an increase in diameter results in a corresponding increase in depth). Operating rates are expressed volumetrically.

Removal efficiency at each operating rate is calculated according to the average of volumetric and Froude scaling methods and is described by Equation 1.

Equation 1: $$\left(\frac{\text{Diameter Prototype}}{\text{Diameter Model}}\right)^{2.75} = \left(\frac{\text{Flow Rate Prototype}}{\text{Flow Rate Model}}\right)$$

Equation 1 and actual laboratory test results were used to determine the flow rate which would be required for the various VortSentry HS models to remove 80% of solids.

View report at **www.ContechES.com/stormwater**

Maintenance

The VortSentry HS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit, i.e., unstable soils or heavy winter sanding will cause the treatment chamber to fill more quickly, but regular sweeping will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant deposition and transport may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (i.e. spring and fall) however more frequent inspections may be necessary in equipment washdown areas and in climates where winter sanding operations may lead to rapid accumulations of a large volume of sediment. It is useful and often required as part of a permit to keep a record of each inspection. A simple inspection and maintenance log form for doing so is available for download at **www.ContechES.com/stormwater**

The VortSentry HS should be cleaned when the sediment has accumulated to a depth of two feet in the treatment chamber. This determination can be made by taking two measurements with a stadia rod or similar measuring device; one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the distance given in Table 2, the VortSentry HS should be maintained to ensure effective treatment.

Cleaning

Cleaning of the VortSentry HS should be done during dry weather conditions when no flow is entering the system. Cleanout of the VortSentry HS with a vacuum truck is generally the most effective and convenient method of excavating pollutants from the system. Simply remove the manhole cover and insert the vacuum hose into the sump. All pollutants can be removed from this one access point from the surface with no requirements for Confined Space Entry.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use adsorbent pads, which solidify the oils. These are usually much easier to remove from the unit individually, and less expensive to dispose than the oil/water emulsion that may be

created by vacuuming the oily layer. Floating trash can be netted out if you wish to separate it from the other pollutants.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure proper safety precautions. If anyone physically enters the unit, Confined Space Entry procedures need to be followed.

Disposal of all material removed from the VortSentry HS should be done is accordance with local regulations. In many locations, disposal of evacuated sediments may be handled in the same manner as disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

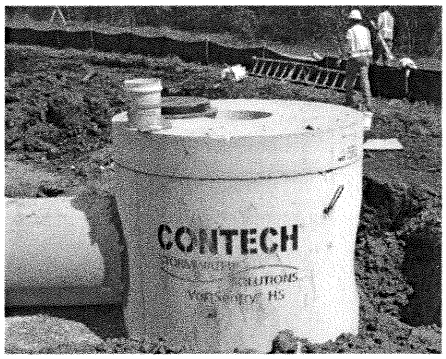
VortSentry HS Model	Diameter		Distance Between Water Surface and Top of Storage Sump		Sediment Storage		Oil Spill Storage	
	in.	m	ft.	m	yd^3	m^3	gal.	liter
HS36	36	0.9	3.6	1.1	0.5	0.4	83	314
HS48	48	1.2	4.7	1.4	0.9	0.7	158	598
HS60	60	1.5	6.0	1.8	1.5	1.1	258	978
HS72	72	1.8	7.1	2.2	2.1	1.6	372	1409
HS84	84	2.1	8.4	2.6	2.9	2.2	649	2458
HS96	96	2.4	9.5	2.9	3.7	2.8	845	3199

Table 2: VortSentry HS Maintenance Indicators and Sediment Storage Capacities.

Note: To avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile. Finer, silty particles at the top of the pile may be more difficult to feel with the measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.

Logon to **www.ContechES.com/stormwater** to download the VortSentry HS Inspection and Maintenance Log.

For assistance with maintaining your VortSentry HS, contact us regarding the Contech Maintenance compliance certification program.



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The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266; related foreign patents or other patents pending.

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Support

- Drawings and specifications are available at contechstormwater.com.
- Site-specific design support is available from our engineers.

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