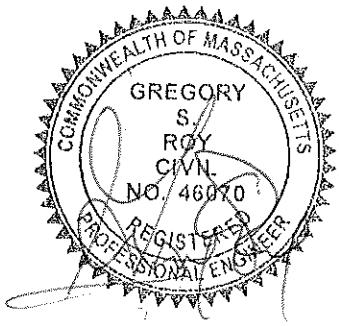
STORMWATER REPORT

649 Main Street

Common Driveway

BOLTON, MASSACHUSETTS



Prepared For: **PAUL & JENNIFER LANDERS**
649 MAIN STREET
BOLTON, MA 01740

Prepared By: **DUCHARME & DILLIS CIVIL DESIGN GROUP, INC.**
1092 MAIN STREET
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June 8, 2017

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CIVIL ENGINEERS · LAND SURVEYORS · WETLAND CONSULTANTS

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1.0 Project Narrative

1.1 Project Type

The proposed project includes the development of 4 additional housing lots in for a total of 5 lots including the existing dwelling. The 4 lots will be accessed through a Common Driveway being permitted by Special Permit form the Bolton Planning Board.

The proposed common driveway will be approximately 975 feet in length and will involve 1 wetland crossing.

1.2 Purpose and Scope

This report has been prepared to comply with the requirements of the Stormwater Management Standards incorporated in the Massachusetts Wetlands Protection Act Regulations, 310 CMR 10.00 to the maximum extent practical. These standards are intended to promote increased groundwater recharge and prevent stormwater discharges from causing or contributing to the pollution of surface waters and ground waters of the Commonwealth. The standards aim to accomplish these goals by encouraging the greater use of low impact development techniques and improving the operation and maintenance of stormwater best management practices.

This report addresses compliance of the proposed development with each of the ten stormwater standards, it provides calculations to support the compliance information, and it provides a Construction Period Pollution Prevention Plan and an Operation and Maintenance Plan for the stormwater management system.

1.3 LID Measures

Care has been taken to lay out the proposed site in a manner that works with existing topography and to use LID, such as swales where possible given the driveway grades.

1.4 Site Description

The site is located on the Northerly side of Main Street approximately 0.5 miles West of I-495.

The site includes an existing single family dwelling with an associated on-site well, septic system and a barn. Surrounding the house is lawn area. Much of the site including the area to be developed is mature woodland.

A rather large Bordering Vegetated Wetland exists on the property as depicted on the plans. This wetland cuts off a significant portion of upland from the Main Street side of the site. An existing cart path traverses the wetland near the

Easterly property line at a narrow point in the wetland.

The NRCS soils survey (See appendix C) shows a mix of Class B, C and D soils.

1.5 Proposed Stormwater Management System

A stormwater management system has been designed to accommodate the runoff from the proposed common driveway and upstream tributary areas. This management system includes the use of grass swales and infiltration areas.

1.6 Methods of Analysis

United States Department of Agriculture Natural Resources Conservation Service (NRCS) soil cover complex methods (TR-20) were employed to compute runoff quantities for the subject property and, where appropriate, adjacent property that drains toward a common discharge point with runoff from the subject site. HydroCAD 10.0 computer software was employed in this hydrologic analysis. A comparison of pre- and post-development runoff quantities at two different analysis point was performed in order to design a stormwater management system that will limit peak rates of runoff from the development to predevelopment levels for 24-hour rainfall events of 2-, 10-, and 100-year return frequencies. Watershed boundaries for existing conditions are depicted on the attached Predevelopment Watershed Plan. Post-Developed watershed boundaries are indicated on the Post-development Watershed Plan.

2.0 Stormwater Standards Compliance

2.1 Standard 1 – Untreated Discharge

The stormwater management system for the proposed development will not result in any new discharges of untreated stormwater to wetland resource areas.

Outlet structures have been designed such that there is no erosion or scour wetlands areas or waters of the commonwealth.

2.2 Standard 2 – Peak Rate Attenuation

Hydrologic calculations for existing and proposed site conditions are included in Appendices D and E respectively. Calculations for 24-hour rainfall events of 2-, 10- and 100-year return frequencies are provided. The following table provides a summary of peak rates of runoff related to each of these storms for a design point at the property boundary through which all runoff from the subject property must flow. For all rainfall events considered, the proposed stormwater management system will control runoff from the development such that corresponding peak flows at the design point will match pre-developed rates.

Table 1: Peak Runoff Rates Design Point A

	Pre-Developed (cfs)	**Post-Developed (cfs)**
2-year	21.08	20.78
10-year	48.60	46.87
100-year	106.4	101.4

2.3 Standard 3 – Recharge

The proposed pavement will cover Class B and C soils. Recharge Calculations have been performed for the proposed infiltration area (see Appendix F).

2.4 Standard 4 – Water Quality

TSS removal calculations have been provided (Appendix F) showing calculations for both TSS treatment trains that are proposed for the project.

2.5 Standard 5 – Land Uses with Higher Pollutant Loads

The current and proposed uses of the subject site do not constitute land use with higher potential pollutant load, thus Standard 5 does not apply to the proposed project.

2.6 Standard 6 –Critical Areas

The proposed project does not involve a stormwater discharge within or near to any of the areas defined as "Critical Areas" at 314 CMR 9.02 and 310 CMR 10.04.

2.7 Standard 7 – Redevelopment

The proposed project does not meet the standards to be considered a Redevelopment project.

2.8 Standard 8 – Construction Period Pollution Prevention and Erosion and Sediment Control

Refer to Appendix G for a copy of the Construction Period Pollution Prevention and Erosion Control Plan. Because the project is subject to the filing of an Environmental Protection Agency Notice of Intent (EPA NOI), a copy of the Stormwater Pollution Prevention Plan (SWPPP) has been included. This document has been prepared to satisfy the requirements of the EPA NOI and the Standard 8 Construction Period Pollution prevention and Erosion and Sedimentation Control Plan.

2.9 Standard 9 – Operation and Maintenance Plan

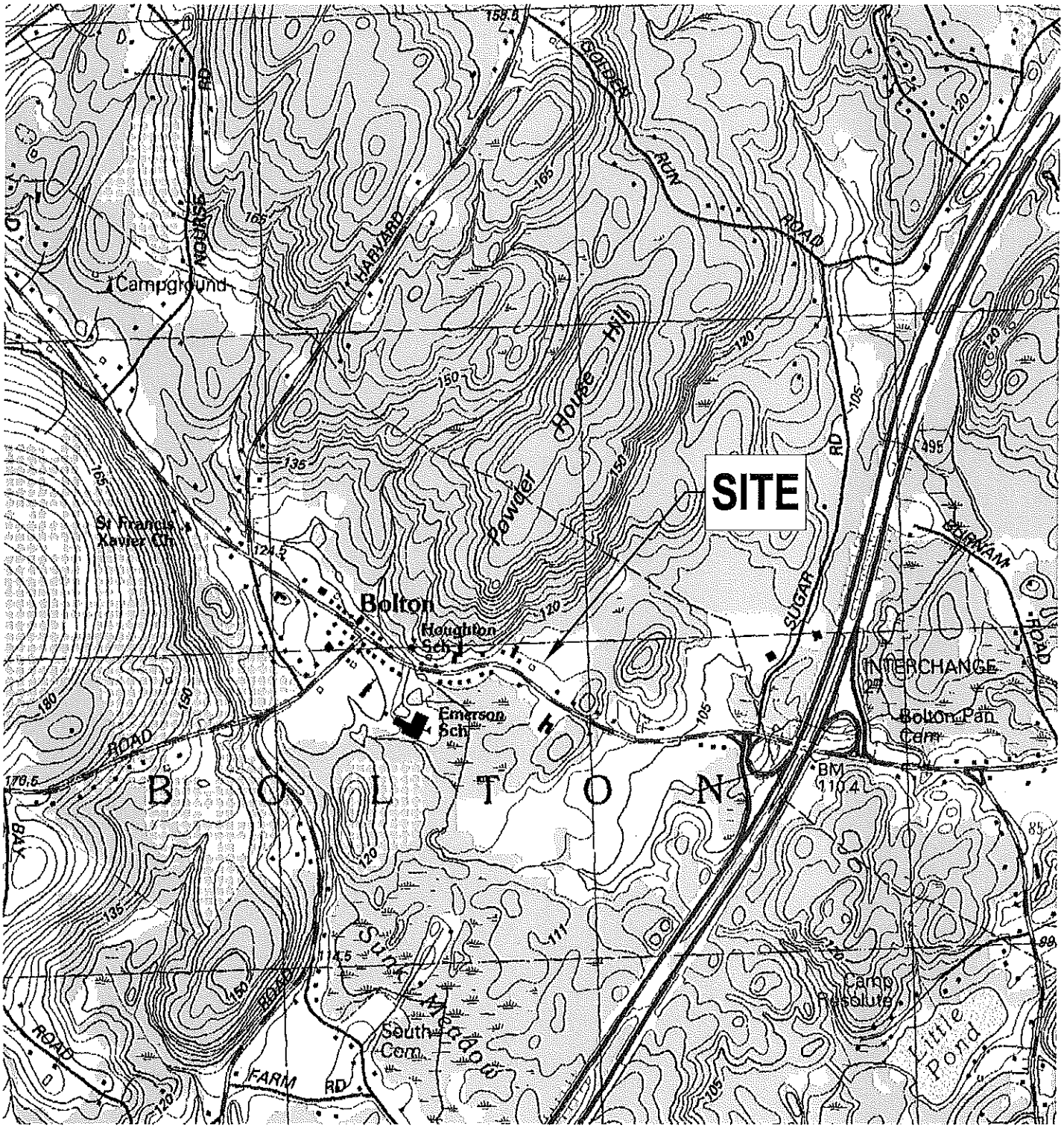
Refer to Appendix H for a complete copy of the Stormwater Operation and Maintenance Plan.

2.10 Standard 10 – Prohibition of Illicit Discharge

An illicit discharge statement will be prepared after approvals are received and prior to construction.

3.0 Appendices

Appendix A - Locus Map



LOCUS MAP

Prepared By: Ducharme & Dillis, Civil Design Group, Inc.
1092 Main Street
P.O. Box 428
Bolton, Massachusetts

DATE: JUNE 2017

Prepared For: Paul & Jennifer Landers
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Bolton, Massachusetts

SCALE: 1" = 800'

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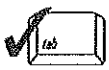
Appendix B - Checklist for Stormwater Report

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 must be submitted with the Stormwater Report.

[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.

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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.

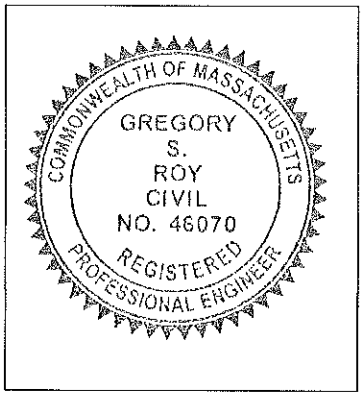
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the 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 6/8/17

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 for Stormwater Report

Checklist (continued)

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): Inifltration Basin

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 for Stormwater Report

Checklist (continued)

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 for Stormwater Report

Checklist (continued)

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 for Stormwater Report

Checklist (continued)

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 for Stormwater Report

Checklist (continued)

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 for Stormwater Report

Checklist (continued)

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 C - Soils Data

Hydrologic Soil Group—Worcester County, Massachusetts, Northeastern Part
(Landers HSG Map)

Map Scale: 1:5,010 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Worcester County, Massachusetts, Northeastern Part
Survey Area Data: Version 11, Sep 14, 2016

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

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Worcester County, Massachusetts, Northeastern Part (MA613)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
52A	Freetown muck, 0 to 1 percent slopes	B/D	11.7	8.7%
72A	Whitman loam, 0 to 3 percent slopes	D	6.3	4.7%
73A	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	D	1.3	1.0%
102C	Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes	B	31.3	23.4%
102D	Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes	D	42.0	31.4%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	5.4	4.1%
306B	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	C	2.1	1.6%
310A	Woodbridge fine sandy loam, 0 to 3 percent slopes	C/D	14.5	10.8%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	6.9	5.2%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	6.7	5.0%
651	Udorthents, smoothed		5.6	4.2%
Totals for Area of Interest			**134.0**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

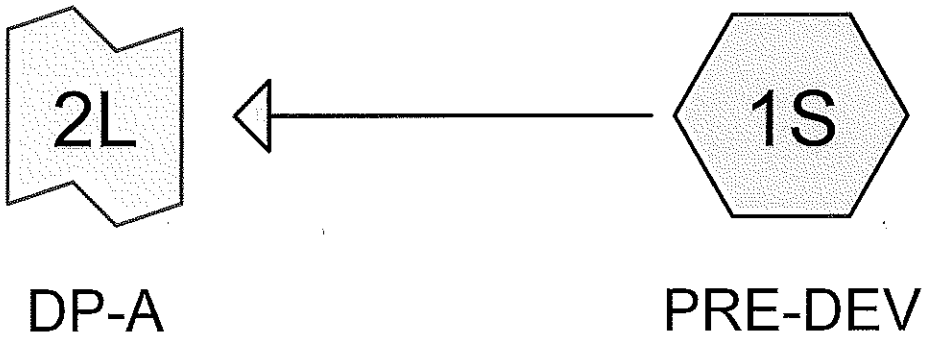
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix D - Existing Conditions Hydrologic Calculations



Subcat Reach Pond Link

Routing Diagram for 5244-PRE
Prepared by Microsoft, Printed 6/7/2017

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

Subcatchment 1S: PRE-DEV Runoff Area=1,882,081 sf 0.32% Impervious Runoff Depth>0.73"
Flow Length=1,706' Tc=30.0 min CN=71 Runoff=21.08 cfs 2.632 af

Link 2L: DP-A Inflow=21.08 cfs 2.632 af
Primary=21.08 cfs 2.632 af

Total Runoff Area = 43.207 ac Runoff Volume = 2.632 af Average Runoff Depth = 0.73"
99.68% Pervious = 43.066 ac 0.32% Impervious = 0.140 ac

Summary for Subcatchment 1S: PRE-DEV

Runoff = 21.08 cfs @ 12.47 hrs, Volume= 2.632 af, Depth> 0.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
6,114	98	Roofs, HSG A
282,407	55	Woods, Good, HSG B
628,685	70	Woods, Good, HSG C
819,349	77	Woods, Good, HSG D
138,077	74	>75% Grass cover, Good, HSG C
7,449	80	>75% Grass cover, Good, HSG D
1,882,081	71	Weighted Average
1,875,967		99.68% Pervious Area
6,114		0.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	50	0.2000	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
6.5	873	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.9	283	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.6	500	0.0130	0.57		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
30.0	1,706	Total			

Summary for Link 2L: DP-A

Inflow Area = 43.207 ac, 0.32% Impervious, Inflow Depth > 0.73" for 2-year event
Inflow = 21.08 cfs @ 12.47 hrs, Volume= 2.632 af
Primary = 21.08 cfs @ 12.47 hrs, Volume= 2.632 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

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

Subcatchment 1S: PRE-DEV Runoff Area=1,882,081 sf 0.32% Impervious Runoff Depth>1.59"
Flow Length=1,706' Tc=30.0 min CN=71 Runoff=48.60 cfs 5.721 af

Link 2L: DP-A Inflow=48.60 cfs 5.721 af
Primary=48.60 cfs 5.721 af

Total Runoff Area = 43.207 ac Runoff Volume = 5.721 af Average Runoff Depth = 1.59"
99.68% Pervious = 43.066 ac 0.32% Impervious = 0.140 ac

Summary for Subcatchment 1S: PRE-DEV

Runoff = 48.60 cfs @ 12.44 hrs, Volume= 5.721 af, Depth> 1.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

Area (sf)	CN	Description
6,114	98	Roofs, HSG A
282,407	55	Woods, Good, HSG B
628,685	70	Woods, Good, HSG C
819,349	77	Woods, Good, HSG D
138,077	74	>75% Grass cover, Good, HSG C
7,449	80	>75% Grass cover, Good, HSG D
1,882,081	71	Weighted Average
1,875,967		99.68% Pervious Area
6,114		0.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	50	0.2000	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
6.5	873	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.9	283	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.6	500	0.0130	0.57		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
30.0	1,706	Total			

Summary for Link 2L: DP-A

Inflow Area = 43.207 ac, 0.32% Impervious, Inflow Depth > 1.59" for 10-year event
Inflow = 48.60 cfs @ 12.44 hrs, Volume= 5.721 af
Primary = 48.60 cfs @ 12.44 hrs, Volume= 5.721 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

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

Subcatchment 1S: PRE-DEV Runoff Area=1,882,081 sf 0.32% Impervious Runoff Depth>3.44"
Flow Length=1,706' Tc=30.0 min CN=71 Runoff=106.35 cfs 12.376 af

Link 2L: DP-A Inflow=106.35 cfs 12.376 af
Primary=106.35 cfs 12.376 af

Total Runoff Area = 43.207 ac Runoff Volume = 12.376 af Average Runoff Depth = 3.44"
99.68% Pervious = 43.066 ac 0.32% Impervious = 0.140 ac

Summary for Subcatchment 1S: PRE-DEV

Runoff = 106.35 cfs @ 12.42 hrs, Volume= 12.376 af, Depth> 3.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
6,114	98	Roofs, HSG A
282,407	55	Woods, Good, HSG B
628,685	70	Woods, Good, HSG C
819,349	77	Woods, Good, HSG D
138,077	74	>75% Grass cover, Good, HSG C
7,449	80	>75% Grass cover, Good, HSG D
1,882,081	71	Weighted Average
1,875,967		99.68% Pervious Area
6,114		0.32% Impervious Area

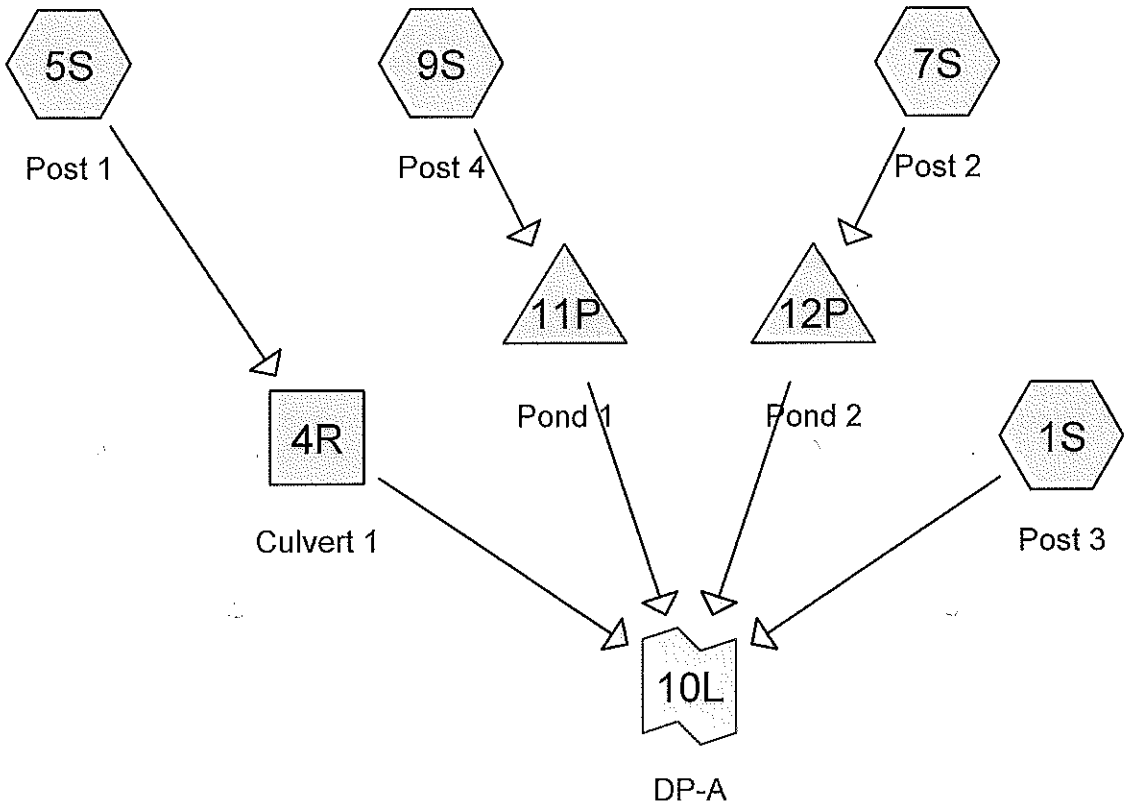
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	50	0.2000	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
6.5	873	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.9	283	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.6	500	0.0130	0.57		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
30.0	1,706	Total			

Summary for Link 2L: DP-A

Inflow Area = 43.207 ac, 0.32% Impervious, Inflow Depth > 3.44" for 100-year event
Inflow = 106.35 cfs @ 12.42 hrs, Volume= 12.376 af
Primary = 106.35 cfs @ 12.42 hrs, Volume= 12.376 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Appendix E - Proposed Conditions Hydrologic Calculations



Subcat Reach Pond Link

Routing Diagram for 5244-POST
Prepared by Microsoft, Printed 6/7/2017

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Post 3 Runoff Area=1,003,303 sf 1.64% Impervious Runoff Depth=0.77"
Flow Length=1,406' Tc=28.2 min CN=70 Runoff=10.67 cfs 1.479 af

Subcatchment 5S: Post 1 Runoff Area=749,868 sf 1.24% Impervious Runoff Depth=0.97"
Flow Length=1,514' Tc=31.6 min CN=74 Runoff=10.15 cfs 1.395 af

Subcatchment 7S: Post 2 Runoff Area=114,926 sf 10.63% Impervious Runoff Depth=1.03"
Flow Length=1,240' Tc=13.8 min CN=75 Runoff=2.33 cfs 0.226 af

Subcatchment 9S: Post 4 Runoff Area=13,990 sf 34.80% Impervious Runoff Depth=1.46"
Tc=6.0 min CN=82 Runoff=0.54 cfs 0.039 af

Reach 4R: Culvert 1 Avg. Flow Depth=0.71' Max Vel=4.45 fps Inflow=10.15 cfs 1.395 af
)" x 33.0", R=25.1"/77.3" Pipe Arch Pipe n=0.030 L=50.0' S=0.0200 '/' Capacity=54.22 cfs Outflow=10.14 cfs 1.395 af

Pond 11P: Pond 1 Peak Elev=98.93' Storage=1,364 cf Inflow=0.54 cfs 0.039 af
Discarded=0.01 cfs 0.033 af Primary=0.00 cfs 0.000 af Outflow=0.01 cfs 0.033 af

Pond 12P: Pond 2 Peak Elev=99.56' Storage=8,367 cf Inflow=2.33 cfs 0.226 af
Discarded=0.04 cfs 0.150 af Primary=0.00 cfs 0.000 af Outflow=0.04 cfs 0.150 af

Link 10L: DP-A Inflow=20.78 cfs 2.874 af
Primary=20.78 cfs 2.874 af

Total Runoff Area = 43.207 ac Runoff Volume = 3.139 af Average Runoff Depth = 0.87"
97.72% Pervious = 42.223 ac 2.28% Impervious = 0.984 ac

Summary for Subcatchment 1S: Post 3

Runoff = 10.67 cfs @ 12.45 hrs, Volume= 1.479 af, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
187,726	55	Woods, Good, HSG B
279,768	70	Woods, Good, HSG C
394,207	77	Woods, Good, HSG D
43,729	61	>75% Grass cover, Good, HSG B
65,027	74	>75% Grass cover, Good, HSG C
16,372	80	>75% Grass cover, Good, HSG D
7,572	98	Paved parking, HSG B
902	98	Paved parking, HSG C
6,400	98	Roofs, HSG B
1,600	98	Roofs, HSG C
1,003,303	70	Weighted Average
986,829		98.36% Pervious Area
16,474		1.64% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.3000	0.20		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
3.0	485	0.3000	2.74		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.7	198	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.9	108	0.0350	0.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.8	67	0.0800	1.41		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.6	498	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
28.2	1,406	Total			

Summary for Subcatchment 5S: Post 1

Runoff = 10.15 cfs @ 12.48 hrs, Volume= 1.395 af, Depth= 0.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
21,160	55	Woods, Good, HSG B
206,636	70	Woods, Good, HSG C
370,364	77	Woods, Good, HSG D
142,394	74	>75% Grass cover, Good, HSG C
9,314	98	Roofs, HSG C
749,868	74	Weighted Average
740,554		98.76% Pervious Area
9,314		1.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.1	50	0.0600	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.3	318	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.9	686	0.3500	2.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	460	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
31.6	1,514	Total			

Summary for Subcatchment 7S: Post 2

Runoff = 2.33 cfs @ 12.21 hrs, Volume= 0.226 af, Depth= 1.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
18,220	55	Woods, Good, HSG B
3,730	70	Woods, Good, HSG C
43,822	77	Woods, Good, HSG D
36,938	74	>75% Grass cover, Good, HSG C
10,616	98	Paved parking, HSG C
1,600	98	Roofs, HSG C
114,926	75	Weighted Average
102,710		89.37% Pervious Area
12,216		10.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	50	0.2000	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.0	536	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.1	130	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	23	0.5000	4.95		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	35	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	135	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	193	0.0650	3.82		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
1.7	138	0.0080	1.34		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
13.8	1,240	Total			

Summary for Subcatchment 9S: Post 4

Runoff = 0.54 cfs @ 12.09 hrs, Volume= 0.039 af, Depth= 1.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
9,121	74	>75% Grass cover, Good, HSG C
4,869	98	Paved parking, HSG C
13,990	82	Weighted Average
9,121		65.20% Pervious Area
4,869		34.80% Impervious Area

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

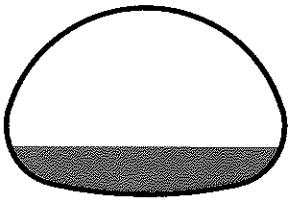
Summary for Reach 4R: Culvert 1

Inflow Area = 17.215 ac, 1.24% Impervious, Inflow Depth = 0.97" for 2-year event
Inflow = 10.15 cfs @ 12.48 hrs, Volume= 1.395 af
Outflow = 10.14 cfs @ 12.49 hrs, Volume= 1.395 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.45 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.78 fps, Avg. Travel Time= 0.5 min

Peak Storage= 114 cf @ 12.48 hrs
Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 2.75' Flow Area= 8.9 sf, Capacity= 54.22 cfs

49.0" W x 33.0" H, R=25.1"/77.3" Pipe Arch Pipe
n= 0.030 Stream, clean & straight
Length= 50.0' Slope= 0.0200 '/'
Inlet Invert= 99.00', Outlet Invert= 98.00'



Summary for Pond 11P: Pond 1

Inflow Area =	0.321 ac, 34.80% Impervious,	Inflow Depth =	1.46"	for 2-year event
Inflow =	0.54 cfs @	12.09 hrs, Volume=	0.039 af	
Outflow =	0.01 cfs @	23.54 hrs, Volume=	0.033 af,	Atten= 99%, Lag= 686.5 min
Discarded =	0.01 cfs @	23.54 hrs, Volume=	0.033 af	
Primary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 98.93' @ 23.54 hrs Surf.Area= 1,681 sf Storage= 1,364 cf

Plug-Flow detention time= 1,629.3 min calculated for 0.033 af (84% of inflow)
Center-of-Mass det. time= 1,560.3 min (2,398.1 - 837.8)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	9,076 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	1,249	145.0	0	0	1,249
99.00	1,713	163.0	1,475	1,475	1,716
100.00	3,797	766.0	2,687	4,162	46,297
101.00	6,124	784.0	4,914	9,076	48,649

Device	Routing	Invert	Outlet Devices
#1	Primary	100.60'	**25.0' long x 5.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.35 2.51 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.69 2.73 2.77 2.86
#2	Discarded	98.00'	**0.170 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 90.00'

Discarded OutFlow Max=0.01 cfs @ 23.54 hrs HW=98.93' (Free Discharge)
↑**2=Exfiltration** (Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=98.00' (Free Discharge)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 12P: Pond 2

Inflow Area = 2.638 ac, 10.63% Impervious, Inflow Depth = 1.03" for 2-year event
Inflow = 2.33 cfs @ 12.21 hrs, Volume= 0.226 af
Outflow = 0.04 cfs @ 24.14 hrs, Volume= 0.150 af, Atten= 98%, Lag= 716.0 min
Discarded = 0.04 cfs @ 24.14 hrs, Volume= 0.150 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 99.56' @ 24.14 hrs Surf.Area= 7,939 sf Storage= 8,367 cf
Flood Elev= 101.00' Surf.Area= 13,392 sf Storage= 23,421 cf

Plug-Flow detention time= 1,657.6 min calculated for 0.150 af (67% of inflow)
Center-of-Mass det. time= 1,547.3 min (2,415.3 - 868.0)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	23,421 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	2,656	236.0	0	0	2,656
99.00	6,316	327.0	4,356	4,356	6,743
100.00	9,321	514.0	7,770	12,126	19,265
101.00	13,392	539.0	11,295	23,421	21,425

Device	Routing	Invert	Outlet Devices
#1	Primary	100.60'	**20.0' long x 5.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.35 2.51 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.69 2.73 2.77 2.86
#2	Discarded	98.00'	**0.170 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 90.00'

Discarded OutFlow Max=0.04 cfs @ 24.14 hrs HW=99.56' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=98.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link 10L: DP-A

Inflow Area = 43.207 ac, 2.28% Impervious, Inflow Depth = 0.80" for 2-year event
Inflow = 20.78 cfs @ 12.47 hrs, Volume= 2.874 af
Primary = 20.78 cfs @ 12.47 hrs, Volume= 2.874 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Post 3 Runoff Area=1,003,303 sf 1.64% Impervious Runoff Depth=1.67"
Flow Length=1,406' Tc=28.2 min CN=70 Runoff=25.39 cfs 3.213 af

Subcatchment 5S: Post 1 Runoff Area=749,868 sf 1.24% Impervious Runoff Depth=1.97"
Flow Length=1,514' Tc=31.6 min CN=74 Runoff=21.65 cfs 2.829 af

Subcatchment 7S: Post 2 Runoff Area=114,926 sf 10.63% Impervious Runoff Depth=2.05"
Flow Length=1,240' Tc=13.8 min CN=75 Runoff=4.87 cfs 0.451 af

Subcatchment 9S: Post 4 Runoff Area=13,990 sf 34.80% Impervious Runoff Depth=2.64"
Tc=6.0 min CN=82 Runoff=0.97 cfs 0.071 af

Reach 4R: Culvert 1 Avg. Flow Depth=1.09' Max Vel=5.65 fps Inflow=21.65 cfs 2.829 af
)" x 33.0", R=25.1"/77.3" Pipe Arch Pipe n=0.030 L=50.0' S=0.0200 '/' Capacity=54.22 cfs Outflow=21.64 cfs 2.829 af

Pond 11P: Pond 1 Peak Elev=99.50' Storage=2,547 cf Inflow=0.97 cfs 0.071 af
Discarded=0.01 cfs 0.046 af Primary=0.00 cfs 0.000 af Outflow=0.01 cfs 0.046 af

Pond 12P: Pond 2 Peak Elev=100.51' Storage=17,420 cf Inflow=4.87 cfs 0.451 af
Discarded=0.05 cfs 0.228 af Primary=0.00 cfs 0.000 af Outflow=0.05 cfs 0.228 af

Link 10L: DP-A Inflow=46.87 cfs 6.042 af
Primary=46.87 cfs 6.042 af

Total Runoff Area = 43.207 ac Runoff Volume = 6.563 af Average Runoff Depth = 1.82"
97.72% Pervious = 42.223 ac 2.28% Impervious = 0.984 ac

Summary for Subcatchment 1S: Post 3

Runoff = 25.39 cfs @ 12.42 hrs, Volume= 3.213 af, Depth= 1.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

Area (sf)	CN	Description
187,726	55	Woods, Good, HSG B
279,768	70	Woods, Good, HSG C
394,207	77	Woods, Good, HSG D
43,729	61	>75% Grass cover, Good, HSG B
65,027	74	>75% Grass cover, Good, HSG C
16,372	80	>75% Grass cover, Good, HSG D
7,572	98	Paved parking, HSG B
902	98	Paved parking, HSG C
6,400	98	Roofs, HSG B
1,600	98	Roofs, HSG C
1,003,303	70	Weighted Average
986,829		98.36% Pervious Area
16,474		1.64% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.3000	0.20		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
3.0	485	0.3000	2.74		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.7	198	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.9	108	0.0350	0.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.8	67	0.0800	1.41		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.6	498	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
28.2	1,406	Total			

Summary for Subcatchment 5S: Post 1

Runoff = 21.65 cfs @ 12.46 hrs, Volume= 2.829 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

Area (sf)	CN	Description
21,160	55	Woods, Good, HSG B
206,636	70	Woods, Good, HSG C
370,364	77	Woods, Good, HSG D
142,394	74	>75% Grass cover, Good, HSG C
9,314	98	Roofs, HSG C
749,868	74	Weighted Average
740,554		98.76% Pervious Area
9,314		1.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.1	50	0.0600	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.3	318	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.9	686	0.3500	2.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	460	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
31.6	1,514	Total			

Summary for Subcatchment 7S: Post 2

Runoff = 4.87 cfs @ 12.20 hrs, Volume= 0.451 af, Depth= 2.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

Area (sf)	CN	Description
18,220	55	Woods, Good, HSG B
3,730	70	Woods, Good, HSG C
43,822	77	Woods, Good, HSG D
36,938	74	>75% Grass cover, Good, HSG C
10,616	98	Paved parking, HSG C
1,600	98	Roofs, HSG C
114,926	75	Weighted Average
102,710		89.37% Pervious Area
12,216		10.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	50	0.2000	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.0	536	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.1	130	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	23	0.5000	4.95		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	35	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	135	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	193	0.0650	3.82		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
1.7	138	0.0080	1.34		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
13.8	1,240	Total			

Summary for Subcatchment 9S: Post 4

Runoff = 0.97 cfs @ 12.09 hrs, Volume= 0.071 af, Depth= 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

Area (sf)	CN	Description
9,121	74	>75% Grass cover, Good, HSG C
4,869	98	Paved parking, HSG C
13,990	82	Weighted Average
9,121		65.20% Pervious Area
4,869		34.80% Impervious Area

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

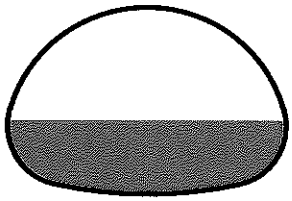
Summary for Reach 4R: Culvert 1

Inflow Area = 17.215 ac, 1.24% Impervious, Inflow Depth = 1.97" for 10-year event
Inflow = 21.65 cfs @ 12.46 hrs, Volume= 2.829 af
Outflow = 21.64 cfs @ 12.46 hrs, Volume= 2.829 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.65 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.14 fps, Avg. Travel Time= 0.4 min

Peak Storage= 192 cf @ 12.46 hrs
Average Depth at Peak Storage= 1.09'
Bank-Full Depth= 2.75' Flow Area= 8.9 sf, Capacity= 54.22 cfs

49.0" W x 33.0" H, R=25.1"/77.3" Pipe Arch Pipe
n= 0.030 Stream, clean & straight
Length= 50.0' Slope= 0.0200 '/'
Inlet Invert= 99.00', Outlet Invert= 98.00'



Summary for Pond 11P: Pond 1

Inflow Area =	0.321 ac, 34.80% Impervious,	Inflow Depth =	2.64"	for 10-year event
Inflow =	0.97 cfs @	12.09 hrs, Volume=	0.071 af	
Outflow =	0.01 cfs @	23.56 hrs, Volume=	0.046 af, Atten= 99%, Lag= 687.8 min	
Discarded =	0.01 cfs @	23.56 hrs, Volume=	0.046 af	
Primary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 99.50' @ 23.56 hrs Surf.Area= 2,644 sf Storage= 2,547 cf

Plug-Flow detention time= 1,582.3 min calculated for 0.046 af (66% of inflow)
Center-of-Mass det. time= 1,481.1 min (2,301.8 - 820.7)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	9,076 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	1,249	145.0	0	0	1,249
99.00	1,713	163.0	1,475	1,475	1,716
100.00	3,797	766.0	2,687	4,162	46,297
101.00	6,124	784.0	4,914	9,076	48,649

Device	Routing	Invert	Outlet Devices
#1	Primary	100.60'	**25.0' long x 5.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.35 2.51 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.69 2.73 2.77 2.86
#2	Discarded	98.00'	**0.170 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 90.00'

Discarded OutFlow Max=0.01 cfs @ 23.56 hrs HW=99.50' (Free Discharge)
↑**2=Exfiltration** (Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=98.00' (Free Discharge)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 12P: Pond 2

Inflow Area = 2.638 ac, 10.63% Impervious, Inflow Depth = 2.05" for 10-year event
Inflow = 4.87 cfs @ 12.20 hrs, Volume= 0.451 af
Outflow = 0.05 cfs @ 24.16 hrs, Volume= 0.228 af, Atten= 99%, Lag= 717.8 min
Discarded = 0.05 cfs @ 24.16 hrs, Volume= 0.228 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 100.51' @ 24.16 hrs Surf.Area= 11,321 sf Storage= 17,420 cf
Flood Elev= 101.00' Surf.Area= 13,392 sf Storage= 23,421 cf

Plug-Flow detention time= 1,698.5 min calculated for 0.228 af (51% of inflow)
Center-of-Mass det. time= 1,577.9 min (2,425.2 - 847.3)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	23,421 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	2,656	236.0	0	0	2,656
99.00	6,316	327.0	4,356	4,356	6,743
100.00	9,321	514.0	7,770	12,126	19,265
101.00	13,392	539.0	11,295	23,421	21,425

Device	Routing	Invert	Outlet Devices
#1	Primary	100.60'	**20.0' long x 5.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.35 2.51 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.69 2.73 2.77 2.86
#2	Discarded	98.00'	**0.170 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 90.00'

Discarded OutFlow Max=0.05 cfs @ 24.16 hrs HW=100.51' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.05 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=98.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link 10L: DP-A

Inflow Area = 43.207 ac, 2.28% Impervious, Inflow Depth = 1.68" for 10-year event
Inflow = 46.87 cfs @ 12.44 hrs, Volume= 6.042 af
Primary = 46.87 cfs @ 12.44 hrs, Volume= 6.042 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Post 3 Runoff Area=1,003,303 sf 1.64% Impervious Runoff Depth=3.62"
Flow Length=1,406' Tc=28.2 min CN=70 Runoff=56.62 cfs 6.945 af

Subcatchment 5S: Post 1 Runoff Area=749,868 sf 1.24% Impervious Runoff Depth=4.04"
Flow Length=1,514' Tc=31.6 min CN=74 Runoff=44.96 cfs 5.799 af

Subcatchment 7S: Post 2 Runoff Area=114,926 sf 10.63% Impervious Runoff Depth=4.15"
Flow Length=1,240' Tc=13.8 min CN=75 Runoff=9.95 cfs 0.912 af

Subcatchment 9S: Post 4 Runoff Area=13,990 sf 34.80% Impervious Runoff Depth=4.92"
Tc=6.0 min CN=82 Runoff=1.78 cfs 0.132 af

Reach 4R: Culvert 1 Avg. Flow Depth=1.81' Max Vel=6.83 fps Inflow=44.96 cfs 5.799 af
)" x 33.0", R=25.1"/77.3" Pipe Arch Pipe n=0.030 L=50.0' S=0.0200 '/' Capacity=54.22 cfs Outflow=44.94 cfs 5.799 af

Pond 11P: Pond 1 Peak Elev=100.18' Storage=4,870 cf Inflow=1.78 cfs 0.132 af
Discarded=0.02 cfs 0.078 af Primary=0.00 cfs 0.000 af Outflow=0.02 cfs 0.078 af

Pond 12P: Pond 2 Peak Elev=100.75' Storage=20,237 cf Inflow=9.95 cfs 0.912 af
Discarded=0.06 cfs 0.244 af Primary=2.80 cfs 0.427 af Outflow=2.86 cfs 0.671 af

Link 10L: DP-A Inflow=101.36 cfs 13.170 af
Primary=101.36 cfs 13.170 af

Total Runoff Area = 43.207 ac Runoff Volume = 13.788 af Average Runoff Depth = 3.83"
97.72% Pervious = 42.223 ac 2.28% Impervious = 0.984 ac

Summary for Subcatchment 1S: Post 3

Runoff = 56.62 cfs @ 12.40 hrs, Volume= 6.945 af, Depth= 3.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
187,726	55	Woods, Good, HSG B
279,768	70	Woods, Good, HSG C
394,207	77	Woods, Good, HSG D
43,729	61	>75% Grass cover, Good, HSG B
65,027	74	>75% Grass cover, Good, HSG C
16,372	80	>75% Grass cover, Good, HSG D
7,572	98	Paved parking, HSG B
902	98	Paved parking, HSG C
6,400	98	Roofs, HSG B
1,600	98	Roofs, HSG C
1,003,303	70	Weighted Average
986,829		98.36% Pervious Area
16,474		1.64% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.3000	0.20		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
3.0	485	0.3000	2.74		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.7	198	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.9	108	0.0350	0.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.8	67	0.0800	1.41		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.6	498	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
28.2	1,406	Total			

Summary for Subcatchment 5S: Post 1

Runoff = 44.96 cfs @ 12.44 hrs, Volume= 5.799 af, Depth= 4.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
21,160	55	Woods, Good, HSG B
206,636	70	Woods, Good, HSG C
370,364	77	Woods, Good, HSG D
142,394	74	>75% Grass cover, Good, HSG C
9,314	98	Roofs, HSG C
749,868	74	Weighted Average
740,554		98.76% Pervious Area
9,314		1.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.1	50	0.0600	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.3	318	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.9	686	0.3500	2.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	460	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
31.6	1,514	Total			

Summary for Subcatchment 7S: Post 2

Runoff = 9.95 cfs @ 12.19 hrs, Volume= 0.912 af, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
18,220	55	Woods, Good, HSG B
3,730	70	Woods, Good, HSG C
43,822	77	Woods, Good, HSG D
36,938	74	>75% Grass cover, Good, HSG C
10,616	98	Paved parking, HSG C
1,600	98	Roofs, HSG C
114,926	75	Weighted Average
102,710		89.37% Pervious Area
12,216		10.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	50	0.2000	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.0	536	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.1	130	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	23	0.5000	4.95		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	35	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	135	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	193	0.0650	3.82		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
1.7	138	0.0080	1.34		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
13.8	1,240	Total			

Summary for Subcatchment 9S: Post 4

Runoff = 1.78 cfs @ 12.09 hrs, Volume= 0.132 af, Depth= 4.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
9,121	74	>75% Grass cover, Good, HSG C
4,869	98	Paved parking, HSG C
13,990	82	Weighted Average
9,121		65.20% Pervious Area
4,869		34.80% Impervious Area

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

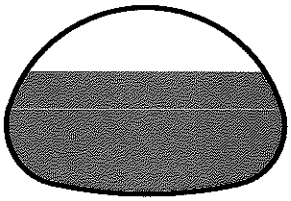
Summary for Reach 4R: Culvert 1

Inflow Area = 17.215 ac, 1.24% Impervious, Inflow Depth = 4.04" for 100-year event
Inflow = 44.96 cfs @ 12.44 hrs, Volume= 5.799 af
Outflow = 44.94 cfs @ 12.44 hrs, Volume= 5.799 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.83 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.58 fps, Avg. Travel Time= 0.3 min

Peak Storage= 329 cf @ 12.44 hrs
Average Depth at Peak Storage= 1.81'
Bank-Full Depth= 2.75' Flow Area= 8.9 sf, Capacity= 54.22 cfs

49.0" W x 33.0" H, R=25.1"/77.3" Pipe Arch Pipe
n= 0.030 Stream, clean & straight
Length= 50.0' Slope= 0.0200 '/'
Inlet Invert= 99.00', Outlet Invert= 98.00'



Summary for Pond 11P: Pond 1

Inflow Area =	0.321 ac, 34.80% Impervious,	Inflow Depth =	4.92"	for 100-year event
Inflow =	1.78 cfs @ 12.09 hrs,	Volume=	0.132 af	
Outflow =	0.02 cfs @ 23.84 hrs,	Volume=	0.078 af,	Atten= 99%, Lag= 704.8 min
Discarded =	0.02 cfs @ 23.84 hrs,	Volume=	0.078 af	
Primary =	0.00 cfs @ 0.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 100.18' @ 23.84 hrs Surf.Area= 4,171 sf Storage= 4,870 cf

Plug-Flow detention time= 1,619.6 min calculated for 0.078 af (59% of inflow)
Center-of-Mass det. time= 1,516.4 min (2,319.4 - 803.0)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	9,076 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	1,249	145.0	0	0	1,249
99.00	1,713	163.0	1,475	1,475	1,716
100.00	3,797	766.0	2,687	4,162	46,297
101.00	6,124	784.0	4,914	9,076	48,649

Device	Routing	Invert	Outlet Devices
#1	Primary	100.60'	**25.0' long x 5.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.35 2.51 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.69 2.73 2.77 2.86
#2	Discarded	98.00'	**0.170 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 90.00'

Discarded OutFlow Max=0.02 cfs @ 23.84 hrs HW=100.18' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=98.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 12P: Pond 2

Inflow Area = 2.638 ac, 10.63% Impervious, Inflow Depth = 4.15" for 100-year event
Inflow = 9.95 cfs @ 12.19 hrs, Volume= 0.912 af
Outflow = 2.86 cfs @ 12.65 hrs, Volume= 0.671 af, Atten= 71%, Lag= 27.4 min
Discarded = 0.06 cfs @ 12.65 hrs, Volume= 0.244 af
Primary = 2.80 cfs @ 12.65 hrs, Volume= 0.427 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 100.75' @ 12.65 hrs Surf.Area= 12,315 sf Storage= 20,237 cf
Flood Elev= 101.00' Surf.Area= 13,392 sf Storage= 23,421 cf

Plug-Flow detention time= 714.8 min calculated for 0.671 af (74% of inflow)
Center-of-Mass det. time= 625.0 min (1,452.0 - 826.9)

Volume	Invert	Avail.Storage	Storage Description
#1	98.00'	23,421 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
98.00	2,656	236.0	0	0	2,656
99.00	6,316	327.0	4,356	4,356	6,743
100.00	9,321	514.0	7,770	12,126	19,265
101.00	13,392	539.0	11,295	23,421	21,425

Device	Routing	Invert	Outlet Devices
#1	Primary	100.60'	**20.0' long x 5.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.35 2.51 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.69 2.73 2.77 2.86
#2	Discarded	98.00'	**0.170 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 90.00'

Discarded OutFlow Max=0.06 cfs @ 12.65 hrs HW=100.75' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.06 cfs)

Primary OutFlow Max=2.79 cfs @ 12.65 hrs HW=100.75' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 2.79 cfs @ 0.92 fps)

Summary for Link 10L: DP-A

Inflow Area = 43.207 ac, 2.28% Impervious, Inflow Depth = 3.66" for 100-year event
Inflow = 101.36 cfs @ 12.42 hrs, Volume= 13.170 af
Primary = 101.36 cfs @ 12.42 hrs, Volume= 13.170 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Appendix F - TSS Removal Calculations

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Pond 1

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Infiltration Basin	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

Total TSS Removal = 90%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 649 Main St., Bolton MA
Prepared By: JPL
Date: 8-Jun-17

*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

Landers
Bolton, MA

June 8, 2017
5244

Stormwater Recharge & Water Quality Calculations

Ponds 1 and 2

Impervious Area tabulation:

Hydrologic Soil Group	Impervious Area (Ac)	Target Depth (F)	Recharge Volume (Rv) Ac-feet
B	0.315	0.35	0.009
C	0.673	0.25	0.014

Table 2.3.2: Recharge Target Depth by Hydrologic Soil Group

NRCS Hydrologic Soil Group	Approx. Soil Texture	Target Depth Factor (F)
A	sand	0.6 inch
B	loam	0.35 inch
C	silty loam	0.25 inch
D	clay	0.1 inch

Total Recharge Volume Required (Rv) = 0.023 Ac-ft

Total Recharge Volume Required (Rv) = 1,011 C.ft

Water Quality Calculation:

Water Quality Depth = 0.5 in
Required Water Quality Volume = 572 C.ft.

1 inch depth
Zone II discharges
IWPA discharges
Critical Area
Runoff from LUHPPL
Infiltration rate >2.4 inches/hour
1/2 inch depth
Discharge to other ares
8 inch
9 inch
10 inch
11 inch

Total Recharge Volume Provided (Rv) = 818 C.ft @ EL=248.9, Sed. Forbay and Ext. D Basin

Proposed Infiltration Area Calculations:

Bottom Surface Area (A): 1,315.00 SF (elevation 248.0)

Drawdown Calculations:

Soil Texture: 6 Sandy Clay Loam

Rawls Rate: 0.17 in/hr

Drawdown: 54.27 hr

Drawdown is less than 72 Hours as Required

Table 2.3.3: 1982 Rawls Rates

Texture Class	NRCS Hydrologic Soil Group	Infiltration Rate
1 Sand	A	8.27 in/hr
2 Loamy Sand	A	2.41 in/hr
3 Sandy Loam	B	1.02 in/hr
4 Loam	B	0.52 in/hr
5 Silt Loam	C	0.27 in/hr
6 Sandy Clay Loan	C	0.17 in/hr
7 Clay Loam	D	0.09 in/hr
8 Silty Clay Loam	D	0.06 in/hr
9 Sandy Clay	D	0.05 in/hr
10 Silty Clay	D	0.04 in/hr
11 Clay	D	0.02 in/hr

Appendix G – Operation & Maintenance Plan

STORMWATER OPERATION & MAINTENANCE MANUAL

649 Main Street

Common Driveway

BOLTON, MASSACHUSETTS

Prepared For: PAUL & JENNIFER LANDERS
649 MAIN STREET
BOLTON, MA 01740

Prepared By: DUCHARME & DILLIS CIVIL DESIGN GROUP, INC
1092 MAIN STREET
BOLTON, MA 01740

June 8, 2017
5244

TABLE OF CONTENTS:

1.0 Project Narrative

1.1 Proposed Stormwater Management System

Runoff from the proposed development will be conveyed and treated through a combination of catch basins, fore bays, grass swales and conventional stormwater detention basins.

Grass Swales

Runoff from the driveway will be conveyed to the stormwater management area through grassed lined swales. The swales have been designed to accommodate the runoff from the driveway and the up-gradient areas.

Infiltration Basins

Runoff from the site will be conveyed to infiltration basins in the location shown on the site. The basins have been designed to accommodate the runoff associated with the 100-year rainfall event. Emergency spillways will be installed to prevent the infiltration basins from overflowing onto the proposed common driveway.

1.2 Operation & Maintenance Tasks

The following activities should be performed routinely to allow for proper functioning of the stormwater system. The following are guidelines referring to each major component of the stormwater management system.

1.2.1 *Driveway Sweeping*

Driveway sweeping should be preformed at least semi annually. For most effective results, sweeping should be preformed by a vacuum style truck in the early spring before spring rain events can was silt and sediment into the stormwater system. Silt and sediment should be disposed of in accordance with local, state and federal guidelines for hazardous waste.

1.2.2 *Stone Rip Rap*

The proposed emergency spillway for the infiltration basin is equipped with angular stone riprap. The stone riprap will be placed approximately 1-foot deep over Tencate Mirafi filter fabric.

Rip Rap should be inspected periodically for signs of failure. Such signs would include, undermining, high velocity wear (displacement of stones downstream), sliding, settlement, siltation, etc. Riprap should be repaired immediately upon the observation of such conditions mentioned.

Periodically, rip rap should be cleaned of silt. Siltation will be most prevalent in low velocity areas (such as directly up-stream of outlet control structures). Silt and sediment should be removed from these areas by hand.

1.2.3 *Grass Swales*

The grass swale should be inspected periodically for signs of erosion, scour, buildup of silt/sediment and for the presence of litter and debris. The grass in the swale should be maintained in good growing condition and be mowed regularly as part of the annual maintenance of the common driveway.

Erosion and scour should be repaired immediately upon detection, and silt/sediment should be removed when levels have reached a point where the flow is being restricted.

1.2.4 *Infiltration Basins*

The infiltration basins are conventionally designed to infiltrate the runoff from routine rainfall events. The basins have shallow side slopes which can be easily maintained. The intent of the design is to blend the basins into the surrounding terrain but not that they would become overgrown.

The basins should be maintained routinely. Refer to Section 2 for a schedule of routine tasks.

The basins should be cleaned when silt and sediment has collected such that 1/3 of the capacity has been filled with silt/sediment. After removal of silt, repair or replace the stone riprap spillway if it was disturbed by the cleaning effort.

The infiltration basins should be inspected for the presence of woody vegetation and mowed periodically. In the spring, the basins should be inspected, and leaves, branches and trees that's have fallen should be removed to preserve the functionality of the basins.

1.3 O&M Schedule

	O&M Task	Monthly	Quarterly	Spring	Fall	2-years	As-required
1.	**Driveway Sweeping**			x	x		
2.	**Stone Rip Rap**						
	Inspection			x			
	Remove Debris			x			x
	Remove Silt/Sediment					x	x
	Repair						x
3.	**Grass Swale**						
	Inspect			x	x		
	Mowing (growing season)	x					
	Remove silt/sediment, repair						x
4.	**Infiltration Basins**						
	Inspection			x	x		
	Mowing			x	x		
	Remove branches and dead trees			x			

APPENDIX A

Stormwater System Plan

APPENDIX B

Stormwater Management System Owners/Operators

1.	Stormwater Management System Owners:	TBD
2.	Current and future operators:	TBD
3.	Emergency contact information:	TBD
4.	Change of trustee:	TBD
5.	Financial Responsible Party:	TBD
6.	Routine Maintenance:	TBD
7.	O&M activities:	TBD
8.	Record keeping	TBD

Appendix H – Long Term Pollution Prevention Plan

LONG-TERM POLLUTION PREVENTION PLAN

649 Main Street

COMMON DRIVEWAY

BOLTON, MASSACHUSETTS

Prepared For: PAUL & JENNIFER LANDERS
649 MAIN STREET
BOLTON, MA 01740

Prepared By: DUCHARME & DILLIS CIVIL DESIGN GROUP, INC
1092 MAIN STREET
BOLTON, MA 01740

June 8, 2017

5244

1.0 Summary

This Long-Term Pollution Prevention Plan (LTPPP) has been prepared by Ducharme & Dillis Civil Design Group, Inc. pursuant to the Massachusetts Stormwater Regulations. The proposed development consists of 4 proposed house lots to be accessed through a new common driveway.

The layout of the proposed developed site has been carefully planned so as to maximize the distance form resource areas. The stormwater management system has been designed in accordance with the Massachusetts Stormwater Regulations to provide pretreatment of the stormwater prior to discharge to the resource areas.

2.0 Spill Prevention Plan

No hazardous materials other than normal and household cleaning items are expected to be stored on site after the construction period has ended (refer to the Stormwater Pollution Prevention Plan for details pertaining to spill prevention during construction).

It is expected that normal DEP notification procedures would be triggered for major spills such as heating oil or propane and natural gas leaks.

3.0 Stormwater System O&M

A Stormwater Operation & Maintenance plan has been prepared for the proposed stormwater management system. Refer to this document for details pertaining to the required inspections, routine maintenance and operation details including erosion stabilization.

4.0 Fertilizers, herbicides and pesticides

The application of fertilizer, herbicides and pesticides shall be performed in a manner consistent with the industry standards for the application.

No application of chemicals is to be performed within the stormwater management areas on the site.

5.0 Snow/Salt Management

5.1 Snow Plowing

It is expected that the site will be plowed by a local contractor on a contract basis. Snow storage will be away from wetland resource areas to the maximum extent feasible and practical.

5.2 Salt/Sand Usage

It is expected that sanding and salting will be performed on an "as needed" basis during times when unusually icy conditions persist for periods of time.

5.3 Driveway Sweeping

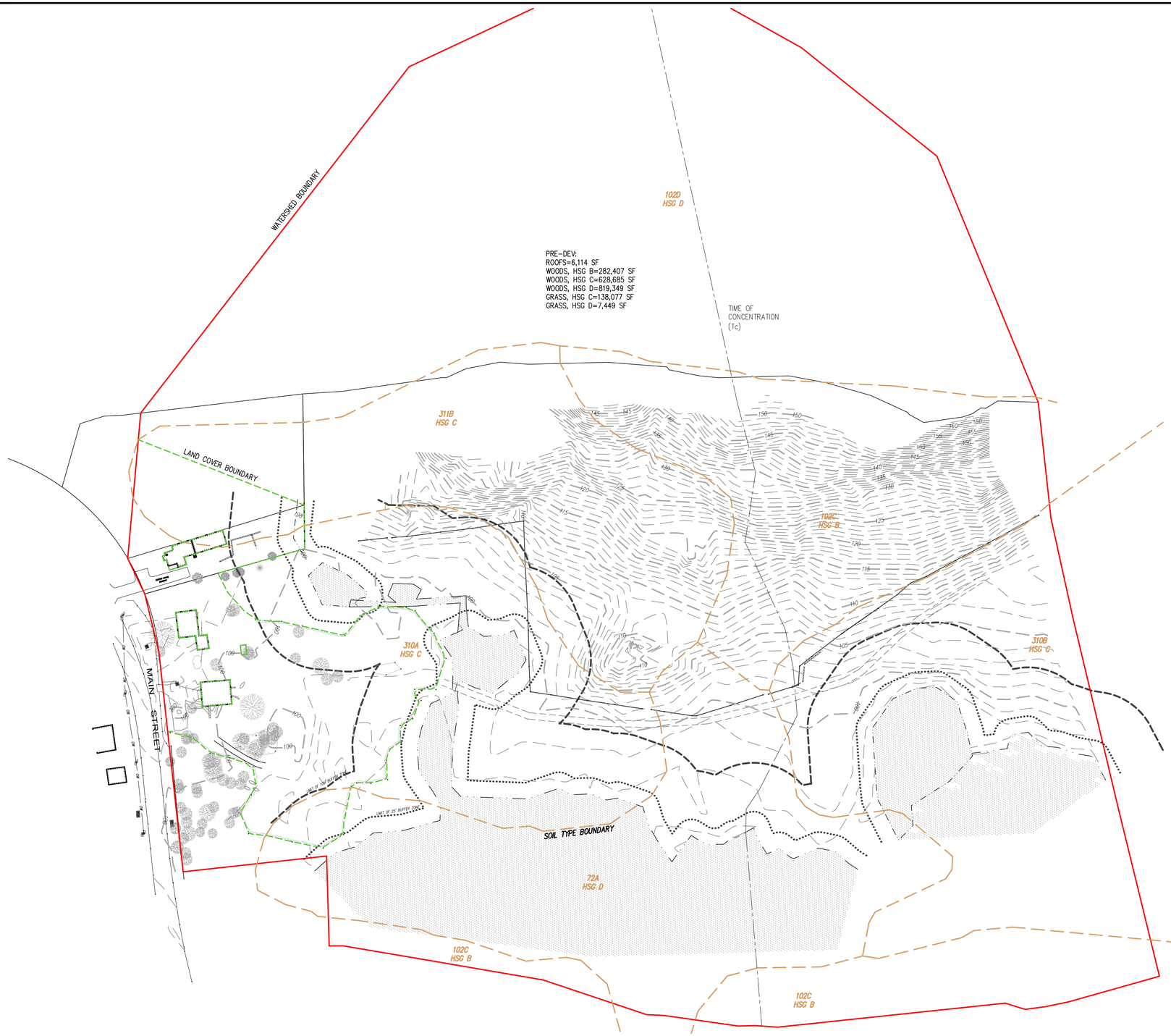
The Stormwater Operation & Maintenance Plan calls for the driveway to be swept in the fall and spring annually.

6.0 Waste Management

6.1 Septic Systems

It is the responsibility of each homeowner to operate and maintain their individual septic system in a manner consistent with current standards. This includes routine pumping of the septic tanks and periodic inspection of the pumping systems.

The septic systems have been designed in accordance with Title V regulations, and therefore will provide adequate protection against potential pollution.



PREPARED BY:

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OWNER:
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649 MAIN STREET
BOLTON, MASSACHUSETTS

APPLICANT:
JOHN POWERS & LILIAN LANDERS
649 MAIN STREET
BOLTON, MASSACHUSETTS

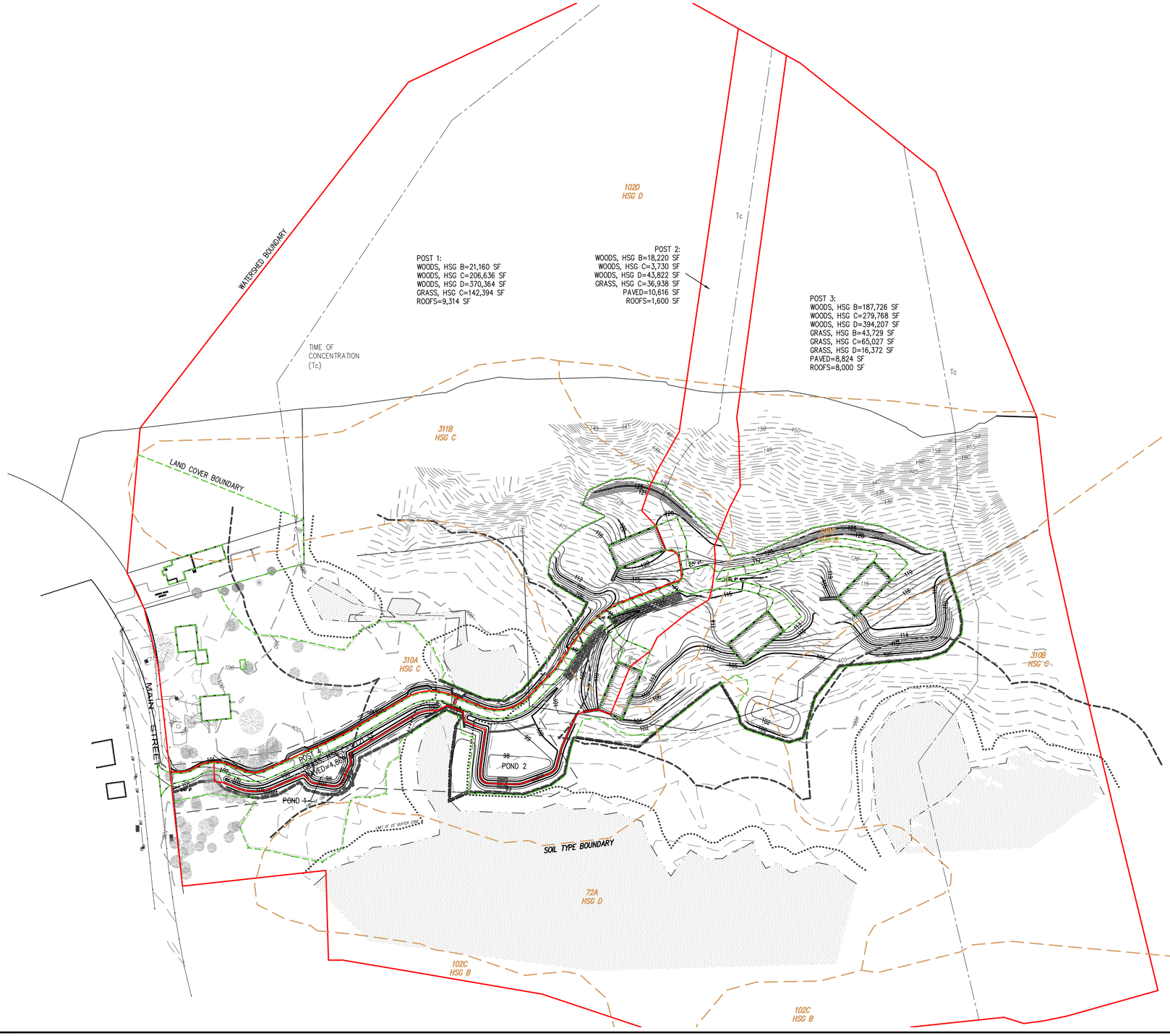
SCALE:
80 0 40 80 160 320
1 in. = 80 ft.

DATE: 6/8/17
DESIGN BY: JPL
DRAWN BY: JPL
CHECKED BY: GSR

EXISTING CONDITIONS DRAINAGE
649 MAIN STREET
BOLTON, MASSACHUSETTS

NO.	DATE	DESCRIPTION	BY

JOB NO. 5244
DRAWING NO. 5244-PRE
SHEET NO. 1 OF 1



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SHEET NO. 1 OF 1