STORMWATER ANALYSIS & CALCULATIONS REPORT

for

5 & 5R HATFIELD STREET WILLIAMSBURG, MASSACHUSETTS

Prepared for:

ZPT Energy Solutions II, LLC
6 Park Avenue, Suite 100
Worcester, MA 01605

Prepared by:

Meridian Associates, Inc.
500 Cummings Center, Suite 5950
Beverly, Massachusetts 01915
(978) 299-0447

Date: February 19, 2019

MERIDIAN ASSOCIATES
100% employee owned

TABLE OF CONTENTS

Calculation Methods

Source of Data

Report Summary:

* Calculation Objectives
* Classification of Soils
* Selection of Storm Events
* Existing Conditions Overview
* Proposed Conditions Overview
* Stormwater Management Standards
* Conclusion

Stormwater Analysis:

* Existing Conditions
  - Watershed Routing Diagram
  - 2-Year 24 Hour Storm Event Analysis
  - 10-Year 24 Hour Storm Event Analysis
  - 100-Year 24 Hour Storm Event Analysis

* Proposed Conditions
  - Watershed Routing Diagram
  - 2-Year 24 Hour Storm Event Analysis
  - 10-Year 24 Hour Storm Event Analysis
  - 100-Year 24 Hour Storm Event Analysis

Appendix:

* Pre-Development Drainage Plan
* Post-Development Drainage Plan
* Operation & Maintenance Program
* National Oceananic and Atmospheric Administration Atals 14
* USDA Natural Resource Conservation Service – Soil Survey
* Flood Insurance Rate Map
* Checklist for Stormwater Report

CALCULATION METHODS

- TR 20 SCS Unit Hydrograph Procedure
- Runoff Curve Numbers
- Time of Concentration by TR55 Methodology
- Reach and Pond Rating by the Storage-Indication Method
- Manning Equation

SOURCE OF DATA

- Technical Report No. 20
- Technical Report No. 55
- National Oceanic and Atmospheric Administration Atlas 14
- Field Survey by Meridian Associates, Inc.
- Massachusetts Stormwater Handbook February 2008

REPORT SUMMARY

REPORT SUMMARY:

Calculation Objective

The purpose of this drainage analysis is to design a stormwater management system that will not increase peak rates or volume of stormwater runoff that will flow offsite from pre to post-development conditions. Three Design Points have been chosen around the perimeter of the site for measurement during the 2, 10, and 100-year design storm events, and these are represented in the calculations included in this report.

The following analysis is separated into existing conditions and proposed conditions for ease of comparison. Drainage maps have been incorporated into this report to depict existing and proposed watershed areas and subcatchments for the site.

This stormwater management hydrological study has been prepared in accordance with the Performance Standards set forth in the Massachusetts Department of Environmental Protection (DEP) Stormwater Handbook.

Classification of Soils:

Existing soil conditions within the limits of the watershed analyzed for this study have been categorized as:

- Paxton fine sandy loam, Hydrological Soil Group C
- Paxton fine sandy loam, Hydrological Soil Group C
- Ridgebury fine sandy loam, Hydrological Soil Group D
- Charlton-Rock outcrop-Hollis complex, Hydrological Soil Group C

These classifications are based upon the Natural Resource Conservation Service Maps obtained through its web soil survey website on July 31, 2018. A copy of this soil map is contained in the Appendix of this report. In addition, onsite soil testing was conducted by Meridian Associates Inc. (MAI) on September 13, 2018 in the areas depicted on the attached plans. This testing revealed a sandy loam parent material, and the soil test logs can be found in the design plan set.

Selection of Storm Events

The storm event rainfall frequencies used for this analysis have been selected based upon the National Oceanic and Atmospheric Administration Atlas 14, and the data was obtained from their website in July, 2018 and updated on September 28, 2018. Rainfall frequency data obtained is as follows for Williamsburg, MA:

Frequency (Years)	NOAA Precipitation [24 hour event (inches)]
2	3.13
10	4.94
100	7.82

Existing Site Overview

The project consists of two lots (5 & 5R Hatfield Street) encompassing 100.36± total acres of land in Williamsburg, Massachusetts. The majority of the project area is currently undeveloped woodland. The project area is bordered by land now or formerly Lawrence E & Linda A. West to the west, land now or formerly Lee. H. Lashaway to the north, land now or formerly Andrew Erwin, Trustee of Opus 40 to the East, land now or formerly Chester B & Ann K. Kopa, Donald C. Owens, Branther M. & Shoshana Deatley, Hatfield Road Trust, and Hatfield Street to the south. The area included within the drainage analysis currently drains towards either bordering vegetated wetlands to the west, abutters to the south, or abutters to the east. The stormwater runoff patterns established within the pre-development conditions are based on existing topography indicating that the runoff flows in general to three (3) design point areas which are listed below:

- **Design Point #1 (DP1)** is the western bordering vegetated wetlands.
- **Design Point #2 (DP2)** is the eastern abutters.
- **Design Point #3 (DP3)** is the southern abutters.

The existing site has been broken into three (3) subcatchment as depicted on the Pre-Development Drainage Plan. The following summarizes the hydraulic condition and area comprising the pre-hydrologic model:

- **Subcatchment SC1.0 –** This is denoted as SC1.0 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists entirely of wooded land. Stormwater runoff generated in this subcatchment flows westerly towards bordering vegetated wetlands. **(DP1)**

- **Subcatchment SC2.0 –** This is denoted as SC2.0 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists entirely of wooded land. Stormwater runoff generated in this subcatchment flows southernly towards abutting land. **(DP2)**

• **Subcatchment SC3.0 –** This is denoted as SC3.0 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists entirely of wooded land. Stormwater runoff generated in this subcatchment flows easterly towards abutting land. **(DP3)**

Proposed Site Overview

The proposed project entails the development of the existing wooded land into a solar energy generating facility, the improvement and extension of an existing gravel access drive, infiltration basins, grassed and stone lined drainage swales, stone trenches, concrete equipment pads, battery storage, electrical and interconnection equipment, electrical conduit, fencing, gates, and associated seeding and soil stabilization. The existing general runoff patterns will be largely maintained, with selective grading. The proposed solar facility racking will be installed using a screw and/or driven post system which minimizes impact on the existing topography and reduces the need for excess earthwork.

The proposed site has been broken into subcatchments as depicted on the Post-Development Drainage Plan. The following summarizes the various hydraulic conditions and areas comprising the post-hydrologic model.

Subcatchment SC100 – This is denoted as SC100 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of wooded land, proposed gravel, and proposed meadow seeded with Conservation Wildlife Mix and a proposed concrete pad. Stormwater runoff generated in this subcatchment flows westerly towards bordering vegetated wetlands. **(DP1)**

Subcatchment SC101 – This is denoted as SC101 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of a portion of wooded land, and a large section of proposed meadow seeded with Conservation Wildlife Mix. Stormwater runoff generated in this subcatchment flows westerly to a stone lined swale that directs flow into a proposed infiltration basin (P101) within SC102 then towards abutting land to the west. **(DP1)**

Subcatchment SC102 – This is denoted as SC102 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists entirely proposed meadow seeded with Conservation Wildlife Mix. Stormwater runoff generated in this subcatchment flows westerly to a proposed infiltration basin (P101) then towards abutting land to the west. **(DP1)**

Subcatchment SC103 – This is denoted as SC103 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists entirely proposed meadow seeded with Conservation Wildlife Mix. Stormwater runoff generated in this subcatchment flows westerly to a grass lined swale that directs flow into a proposed infiltration basin (P101) within SC102 then towards abutting land to the west. **(DP1)**

Subcatchment SC200 – This is denoted as SC200 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of wooded land, and proposed meadow seeded with Conservation Wildlife Mix. Stormwater runoff generated in this subcatchment flows southernly to abutting land. **(DP2)**

Subcatchment SC201 – This is denoted as SC201 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists entirely proposed meadow seeded with Conservation Wildlife Mix. Stormwater runoff generated in this subcatchment flows southernly to a proposed infiltration basin (P201) then towards abutting land now or formally owned by Chester B & Ann K. Kopka, Donald C. Owens, and Branther M & Shoshana Deatley to the south. **(DP2)**

Subcatchment SC300 – This is denoted as SC300 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of wooded land, proposed meadow seeded with Conservation Wildlife Mix, Stormwater runoff generated in this subcatchment flows easterly to abutting land now or formerly owned by Andrew Erwin, Trustee of Opus 40. **(DP3)**

Stormwater Management Standards

Standard 1: No new stormwater conveyances may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

This project does not direct any untreated stormwater towards neighboring resource areas. All runoff from the project will either be treated in one of two (2) surface basin BMP's before reaching an outlet with a large riprap apron or level spreader, or will run overland across large areas of vegetated land before reaching any resource area.

Standard 2: Peak Rate Attenuation - Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This standard may be waived for discharges to land subject to coastal storm flowage as defined in 310 CMR 10.04.

For the purpose of analyzing pre and post-development stormwater peak rates of runoff, design points have been selected based on existing topographic conditions and were used for both the pre and the post-development calculations. Comparison values for pre and post-development stormwater peak rates are given for the design points only.

The storm events used to calculate peak runoff rates for pre and post construction conditions, as previously mentioned, have been selected based upon the National Oceanic and Atmospheric Administration Atlas 14 and taken directly from the NOAA website. Full detail of peak rate attenuation along with supplemental stormwater calculations utilizing HydroCAD software as well as pre and post-construction drainage site plans can be found in the Appendix of this Stormwater Analysis report. The details of this report show that the peak rates of runoff for the 2-year, 10-year and 100-year events have been

matched or reduced from pre to post conditions, and that overall stormwater volume leaving the site is also reduced.

The hydrologic calculations from HydroCAD model's Design Points have been included in the "Stormwater Analysis & Calculations Report".

Summary of Flows at Design Point 1

Storm Event	Existing Conditions (Pre) Peak Flow (CFS)	Existing Conditions (Pre) Volume (AF)	Proposed Conditions (Post) Peak Flow (CFS)	Proposed Conditions (Post) Volume (AF)
2-Year	14.0	2.00	10.5	1.64
10-Year	38.9	5.07	31.3	4.70
100-Year	86.1	10.97	83.4	10.62

Summary of Flows at Design Point 2

Storm Event	Existing Conditions (Pre) Peak Flow (CFS)	Existing Conditions (Pre) Volume (AF)	Proposed Conditions (Post) Peak Flow (CFS)	Proposed Conditions (Post) Volume (AF)
2-Year	7.2	0.84	6.6	0.62
10-Year	20.2	2.12	18.7	1.82
100-Year	44.9	4.58	41.8	4.22

Summary of Flows at Design Point 3

Storm Event	Existing Conditions (Pre) Peak Flow (CFS)	Existing Conditions (Pre) Volume (AF)	Proposed Conditions (Post) Peak Flow (CFS)	Proposed Conditions (Post) Volume (AF)
2-Year	9.9	1.21	9.9	1.21
10-Year	27.8	3.07	27.8	3.07
100-Year	61.5	6.65	61.5	6.65

Standard 3: Recharge - Loss of annual recharge to groundwater shall be eliminated or minimized…at a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This standard is met when the stormwater management system is designed to infiltrate the required recharge volume in accordance with the Mass Stormwater Handbook.

Loss of annual recharge to groundwater has been minimized through the use of two (2) infiltration basins and a proposed operation and maintenance program.

Based on soil maps provided by U.S. Department of Agriculture Soil Conservation Service (map located in the Appendix to the narrative) the site falls within four soil types, all with a hydrologic soil group of C, with the exception of the soil within the wetlands being HSG of D.

Utilizing the current regulations, the proposed design will meet this standard as per the following calculation:

Rv = Fx
Rv = Required Recharge Volume for Subcatchment
F = Target Depth Factor associated with hydrologic soil groups located in table 2.3.2 in Volume 3 of the Stormwater Management Handbook
x = Total impervious area proposed for Subcatchment

Subcatchment SC100&101 - Concrete Equipment Pads

Proposed Impervious area within SC100&101 = 2,472 sf (HSG C)
Required recharge volume depth factor for C type soils: 0.25 inches
Therefore SC100&100 Rv = (2,472 sf)(0.25 inches/12 inches per foot)
SC100&101 Rv = 51.5 cubic feet (cf)

The proposed infiltration trench surrounding the concrete equipment pad has an approximate volume of: 390LF x (1.5'Wx1'D)=585cf x 0.25 void ratio=146.3 cf
146.3 cf > 51.5 cf

In accordance with the Stormwater Handbook, a minimum of 65% of the site impervious areas must be directed into recharge facilities. The proposed project directs 100% of the site's proposed impervious surface areas towards recharge facilities.

72-HOUR BASIN DRAW DOWN CALCULATIONS

$$\text{Time} = \frac{Rv}{(K)(BottomArea)}$$

R_v = Storage Volume
K = Saturated Hydraulic Conductivity for Sandy Loam= 1.02 in/hour
Bottom Area = Bottom Area of Recharge Structure

Pond 101

R_v = 7,873 cf
Bottom Area = 15,302 sf

Time = 7,873/(1.02(1/12)(15,302) = 6.05 hours

6.05 hours < 72 hours

Pond 201

R_v = 4,064 cf
Bottom Area = 7,625 sf

Time = 4,064/(1.02(1/12)(7,625) = 6.27 hours

6.27 hours < 72 hours

Standard 4: Water Quality – Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). The standard is met with pollution prevention plans, stormwater BMP's sized to capture required water quality volume, and pretreatment measures.

As discussed above, there are no untreated stormwater discharges from the proposed project. Each treatment BMP is sized to capture the required water quality volume as calculated in accordance with the Handbook.

The following are water quality treatment calculations:

General Equation from Stormwater Management Handbook

Vwq = (Dwq)(A)
Vwq = required water quality volume
Dwq = water quality depth (1" for critical areas, 0.5" for non-critical areas)
A = impervious area

The following are treatment sizing calculations for the proposed subsurface infiltration facility:

Vwq = (2,472)(0.5"/12) = 103 cf

The proposed infiltration trench surrounding the concrete equipment pad has an approximate volume of: 390LF x (1.5'Wx1'D)=585cf x 0.25 void ratio=146.3 cf
146.3 cf > 103 cf

An Operation and Maintenance Program for a Proposed Stormwater Management System is included with this report as noted in Standard 9 below. The long-term operation and maintenance section of the program provides details and the schedule for routine and non-routine maintenance tasks to be implemented at the completion of the project.

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs) – Source control and pollution prevention shall be implemented in accordance with the Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.

Stormwater Standard 5 is not applicable to this project. The proposed development will not subject the site to higher potential pollutant loads as defined in the Massachusetts Department of Environmental Protection Wetlands and Water Quality Regulations.

LUHPPLs are identified in 310 CMR 22.20B(2) and C(2)(a)-(k) and (m) and CMR 22.21(2)(a)(1)-(8) and (b)(1)-(6), areas within a site that are the location of activities that are subject to an individual National Pollutant Discharge Elimination System (NPDES) permit or the NPDES Multi-sector General Permit; auto fueling facilities, exterior fleet storage areas, exterior vehicle service and equipment cleaning areas; marinas and boatyards; parking lots with high-intensity-use; confined disposal facilities and disposal sites.

Standard 6: Critical Areas – Stormwater discharges to critical areas require the use of specific source control and pollution prevention measures and specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas.

Stormwater Standard 6 is not applicable to this project given that proposed stormwater does not discharge to a critical area. Critical areas being Outstanding Resource Waters and Special Resource Waters as designated in 314 CMR 4.0, recharge areas for public water supplies as defined in 310 CMR 22.02, bathing beaches as defined in 105 CMR 445.000, cold-water fisheries and shellfish growing areas as defined in 314 CMR 9.02 and 310 CMR 10.04. The existing wetlands and streams are not considered critical areas therefore Standard #6 does not apply to this project.

Standard 7: Redevelopments – A redevelopment project is required to meet Standards 1-6 only to the maximum extent practicable. Remaining standards shall be met as well as the project shall improve the existing conditions.

Stormwater Standard 7 is not applicable to this project. Within the Stormwater Management Handbook (volume 1 chapter 1 page 20), the definition of a redevelopment project includes, "development, rehabilitation, expansion and phased projects on previously developed sites, provided the redevelopment results in no net increase in impervious area".

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan shall be implemented.

An *Operation and Maintenance Program* is included with this report. The program details the construction period operation and maintenance plan and sequencing for pollution prevention measures and erosion and sedimentation controls. Locations of erosion control measures for the project are depicted on the design plan set accompanying this report.

Standard 9: A long term Operation and Maintenance Plan shall be implemented.

An *Operation and Maintenance Program for a Proposed Stormwater Management System* is included with this report. The long-term operation and maintenance section of the program provides details and the schedule for routine and non-routine maintenance tasks to be implemented at the completion of the project.

Standard 10: Prohibition of Illicit Discharges – Illicit discharges to the stormwater management system are prohibited.

Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater. Discharges to the stormwater management system from the following activities or facilities are permissible: 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, dechlorinated water from swimming pools, water used for street washing and water used to clean residential buildings without detergents. All other illicit discharges are prohibited.

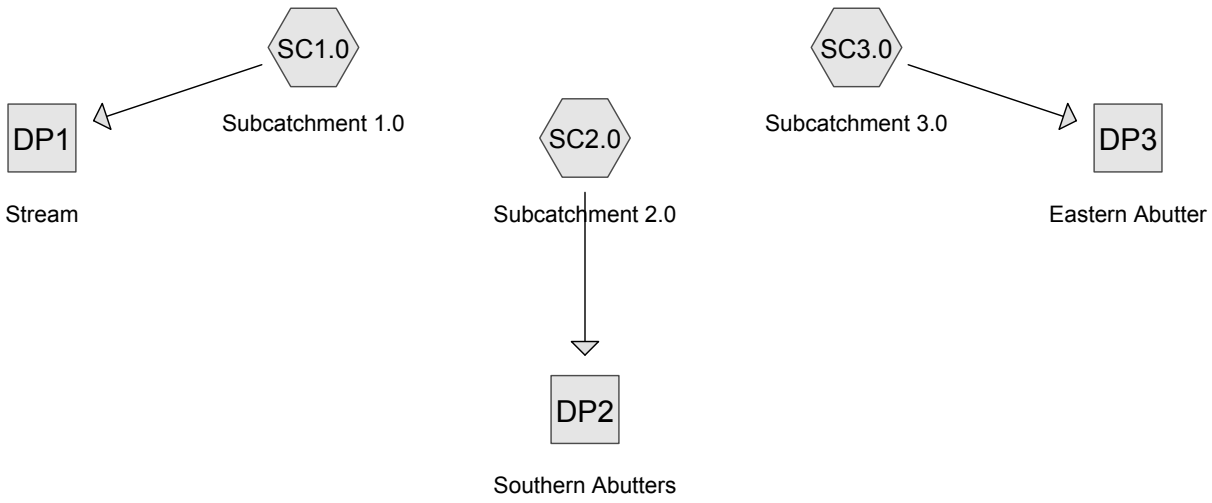
There are no known illicit discharges anticipated through the completion of this project. During construction and post construction procedures are provided to dissipate the potential for illicit discharges to the drainage system. Post construction preventions of illicit discharges are described in the Operation and Maintenance Program under the Good Housekeeping Practices section of the report.

Conclusion

The calculations demonstrate that the proposed development will not result in an increase in the peak rate or overall volume of stormwater runoff leaving the project site in the 2-year, 10-year, or 100-year 24-hour storm events.

STORMWATER ANALYSIS

EXISTING CONDITIONS
WATERSHED ROUTING DIAGRAM AND
DRAINAGE CALCULATIONS



Subcat Reach Pond Link

Routing Diagram for 6091_PRE PENNY
Prepared by Hewlett-Packard Company, Printed 2/19/2019
HydroCAD® 10.00 s/n 00814 © 2011 HydroCAD Software Solutions LLC

Summary for Subcatchment SC1.0: Subcatchment 1.0

Runoff = 14.0 cfs @ 12.49 hrs, Volume= 2.00 af, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.13"

Area (sf)	CN	Description
1,323,369	70	Woods, Good, HSG C
242	77	Brush, Poor, HSG C
2,558	77	Woods, Good, HSG D
3,763	83	Brush, Poor, HSG D
1,329,932	70	Weighted Average
1,329,932		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
6.9	426	0.0420	1.0		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.3	1,404	0.1710	2.1		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
30.7	1,880	Total			

Summary for Subcatchment SC2.0: Subcatchment 2.0

Runoff = 7.2 cfs @ 12.29 hrs, Volume= 0.84 af, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.13"

Area (sf)	CN	Description
555,810	70	Woods, Good, HSG C
555,810		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	50	0.0400	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
3.6	311	0.0840	1.4		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.3	638	0.1630	2.0		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.4	999	Total			

Summary for Subcatchment SC3.0: Subcatchment 3.0

Runoff = 9.9 cfs @ 12.34 hrs, Volume= 1.21 af, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.13"

Area (sf)	CN	Description
806,265	70	Woods, Good, HSG C
806,265		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0800	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
13.9	1,758	0.1790	2.1		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
21.1	1,808	Total			

Summary for Reach DP1: Stream

Inflow Area = 30.531 ac, 0.00% Impervious, Inflow Depth = 0.79" for 2-Year event
Inflow = 14.0 cfs @ 12.49 hrs, Volume= 2.00 af
Outflow = 14.0 cfs @ 12.49 hrs, Volume= 2.00 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Southern Abutters

Inflow Area = 12.760 ac, 0.00% Impervious, Inflow Depth = 0.79" for 2-Year event
Inflow = 7.2 cfs @ 12.29 hrs, Volume= 0.84 af
Outflow = 7.2 cfs @ 12.29 hrs, Volume= 0.84 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP3: Eastern Abutter

Inflow Area = 18.509 ac, 0.00% Impervious, Inflow Depth = 0.79" for 2-Year event
Inflow = 9.9 cfs @ 12.34 hrs, Volume= 1.21 af
Outflow = 9.9 cfs @ 12.34 hrs, Volume= 1.21 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Subcatchment SC1.0: Subcatchment 1.0

Runoff = 38.9 cfs @ 12.45 hrs, Volume= 5.07 af, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.94"

Area (sf)	CN	Description
1,323,369	70	Woods, Good, HSG C
242	77	Brush, Poor, HSG C
2,558	77	Woods, Good, HSG D
3,763	83	Brush, Poor, HSG D
1,329,932	70	Weighted Average
1,329,932		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
6.9	426	0.0420	1.0		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.3	1,404	0.1710	2.1		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
30.7	1,880	Total			

Summary for Subcatchment SC2.0: Subcatchment 2.0

Runoff = 20.2 cfs @ 12.27 hrs, Volume= 2.12 af, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.94"

Area (sf)	CN	Description
555,810	70	Woods, Good, HSG C
555,810		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	50	0.0400	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
3.6	311	0.0840	1.4		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.3	638	0.1630	2.0		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.4	999	Total			

Summary for Subcatchment SC3.0: Subcatchment 3.0

Runoff = 27.8 cfs @ 12.31 hrs, Volume= 3.07 af, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.94"

Area (sf)	CN	Description
806,265	70	Woods, Good, HSG C
806,265		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0800	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
13.9	1,758	0.1790	2.1		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
21.1	1,808	Total			

Summary for Reach DP1: Stream

Inflow Area = 30.531 ac, 0.00% Impervious, Inflow Depth = 1.99" for 10-Year event
Inflow = 38.9 cfs @ 12.45 hrs, Volume= 5.07 af
Outflow = 38.9 cfs @ 12.45 hrs, Volume= 5.07 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Southern Abutters

Inflow Area = 12.760 ac, 0.00% Impervious, Inflow Depth = 1.99" for 10-Year event
Inflow = 20.2 cfs @ 12.27 hrs, Volume= 2.12 af
Outflow = 20.2 cfs @ 12.27 hrs, Volume= 2.12 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP3: Eastern Abutter

Inflow Area = 18.509 ac, 0.00% Impervious, Inflow Depth = 1.99" for 10-Year event
Inflow = 27.8 cfs @ 12.31 hrs, Volume= 3.07 af
Outflow = 27.8 cfs @ 12.31 hrs, Volume= 3.07 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Subcatchment SC1.0: Subcatchment 1.0

Runoff = 86.1 cfs @ 12.43 hrs, Volume= 10.97 af, Depth= 4.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.82"

Area (sf)	CN	Description
1,323,369	70	Woods, Good, HSG C
242	77	Brush, Poor, HSG C
2,558	77	Woods, Good, HSG D
3,763	83	Brush, Poor, HSG D
1,329,932	70	Weighted Average
1,329,932		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
6.9	426	0.0420	1.0		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.3	1,404	0.1710	2.1		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
30.7	1,880	Total			

Summary for Subcatchment SC2.0: Subcatchment 2.0

Runoff = 44.9 cfs @ 12.26 hrs, Volume= 4.58 af, Depth= 4.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.82"

Area (sf)	CN	Description
555,810	70	Woods, Good, HSG C
555,810		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	50	0.0400	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
3.6	311	0.0840	1.4		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.3	638	0.1630	2.0		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.4	999	Total			

Summary for Subcatchment SC3.0: Subcatchment 3.0

Runoff = 61.5 cfs @ 12.29 hrs, Volume= 6.65 af, Depth= 4.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.82"

Area (sf)	CN	Description
806,265	70	Woods, Good, HSG C
806,265		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0800	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
13.9	1,758	0.1790	2.1		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
21.1	1,808	Total			

Summary for Reach DP1: Stream

Inflow Area = 30.531 ac, 0.00% Impervious, Inflow Depth = 4.31" for 100-Year event
Inflow = 86.1 cfs @ 12.43 hrs, Volume= 10.97 af
Outflow = 86.1 cfs @ 12.43 hrs, Volume= 10.97 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Southern Abutters

Inflow Area = 12.760 ac, 0.00% Impervious, Inflow Depth = 4.31" for 100-Year event
Inflow = 44.9 cfs @ 12.26 hrs, Volume= 4.58 af
Outflow = 44.9 cfs @ 12.26 hrs, Volume= 4.58 af, Atten= 0%, Lag= 0.0 min

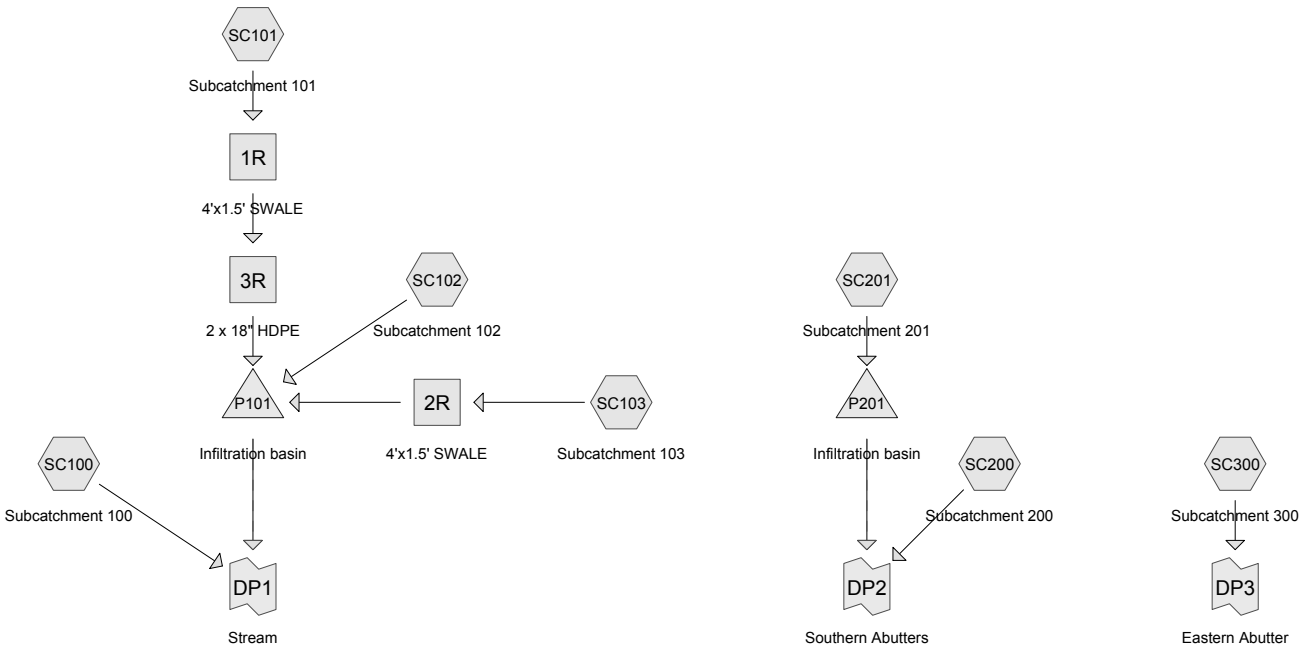
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP3: Eastern Abutter

Inflow Area = 18.509 ac, 0.00% Impervious, Inflow Depth = 4.31" for 100-Year event
Inflow = 61.5 cfs @ 12.29 hrs, Volume= 6.65 af
Outflow = 61.5 cfs @ 12.29 hrs, Volume= 6.65 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

PROPOSED CONDITIONS
WATERSHED ROUTING DIAGRAM AND
DRAINAGE CALCULATIONS



Subcat Reach Pond Link

Routing Diagram for 6091_POST PENNY
Prepared by Hewlett-Packard Company, Printed 2/19/2019
HydroCAD® 10.00 s/n 00814 © 2011 HydroCAD Software Solutions LLC

Summary for Subcatchment SC100: Subcatchment 100

Runoff = 10.3 cfs @ 12.42 hrs, Volume= 1.37 af, Depth= 0.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.13"

	Area (sf)	CN	Description
*	26,539	89	Proposed gravel road, HSG C
	126,751	71	Meadow, non-grazed, HSG C
	691,823	70	Woods, Good, HSG C
*	2,137	91	Proposed gravel road, HSG D
	486	78	Meadow, non-grazed, HSG D
	109	77	Woods, Good, HSG D
	3,588	83	Brush, Poor, HSG D
	601	77	Brush, Poor, HSG C
*	1,872	98	Concrete Pad, HSG C
	853,906	71	Weighted Average
	852,034		99.78% Pervious Area
	1,872		0.22% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.3	50	0.0120	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
8.4	908	0.1290	1.8		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.7	363	0.1040	2.3		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	43	0.3690	3.0		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
26.6	1,364	Total			

Summary for Subcatchment SC101: Subcatchment 101

Runoff = 3.4 cfs @ 12.25 hrs, Volume= 0.37 af, Depth= 0.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.13"

Area (sf)	CN	Description
210,679	71	Meadow, non-grazed, HSG C
17,623	70	Woods, Good, HSG C
2,203	89	Gravel roads, HSG C
230,505	71	Weighted Average
230,505		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0280	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
1.1	85	0.0680	1.3		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.7	503	0.1070	2.3		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	28	0.3333	4.0		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
15.8	666	Total			

Summary for Subcatchment SC102: Subcatchment 102

Runoff = 3.5 cfs @ 12.12 hrs, Volume= 0.28 af, Depth= 1.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.13"

Area (sf)	CN	Description
15,206	98	Water Surface, HSG C
600	98	Paved parking, HSG C
8,797	89	Gravel roads, HSG C
116,788	71	Meadow, non-grazed, HSG C
141,391	75	Weighted Average
125,585		88.82% Pervious Area
15,806		11.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.0420	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
3.6	517	0.1160	2.4		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	50	0.3333	4.0		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.0	617	Total			

Summary for Subcatchment SC103: Subcatchment 103

Runoff = 1.8 cfs @ 12.16 hrs, Volume= 0.17 af, Depth= 0.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.13"

Area (sf)	CN	Description
103,897	71	Meadow, non-grazed, HSG C
270	89	Gravel roads, HSG C
104,167	71	Weighted Average
104,167		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	50	0.0260	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
4.5	616	0.1040	2.3		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	28	0.3333	4.0		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	694	Total			

Summary for Subcatchment SC200: Subcatchment 200

Runoff = 6.6 cfs @ 12.15 hrs, Volume= 0.60 af, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.13"

Area (sf)	CN	Description
166,056	71	Meadow, non-grazed, HSG C
231,824	70	Woods, Good, HSG C
237	89	Gravel roads, HSG C
398,117	70	Weighted Average
398,117		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.0420	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
4.8	796	0.1590	2.8		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.0	846	Total			

Summary for Subcatchment SC201: Subcatchment 201

Runoff = 3.2 cfs @ 12.12 hrs, Volume= 0.27 af, Depth= 0.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.13"

Area (sf)	CN	Description
149,975	71	Meadow, non-grazed, HSG C
90	89	Gravel roads, HSG C
7,625	98	Water Surface, HSG C
157,690	72	Weighted Average
150,065		95.16% Pervious Area
7,625		4.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0600	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
3.5	524	0.1240	2.5		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	118	0.0420	7.3	20.11	**Trap/Vee/Rect Channel Flow,** Bot.W=4.00' D=0.50' Z= 3.0 '/' Top.W=7.00' n= 0.022 Earth, clean & straight
7.5	692	Total			

Summary for Subcatchment SC300: Subcatchment 300

Runoff = 9.9 cfs @ 12.34 hrs, Volume= 1.21 af, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.13"

Area (sf)	CN	Description
62,640	71	Meadow, non-grazed, HSG C
740,157	70	Woods, Good, HSG C
3,467	89	Gravel roads, HSG C
806,264	70	Weighted Average
806,264		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0800	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
13.9	1,758	0.1790	2.1		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
21.1	1,808	Total			

Summary for Reach 1R: 4'x1.5' SWALE

Inflow Area = 5.292 ac, 0.00% Impervious, Inflow Depth = 0.84" for 2-Year event
Inflow = 3.4 cfs @ 12.25 hrs, Volume= 0.37 af
Outflow = 3.4 cfs @ 12.32 hrs, Volume= 0.37 af, Atten= 2%, Lag= 4.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.6 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 0.9 fps, Avg. Travel Time= 7.2 min

Peak Storage= 519 cf @ 12.28 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 1.50' Flow Area= 12.8 sf, Capacity= 85.4 cfs

4.00' x 1.50' deep channel, n= 0.040 Earth, cobble bottom, clean sides
Side Slope Z-value= 3.0 '/' Top Width= 13.00'
Length= 400.0' Slope= 0.0350 '/'
Inlet Invert= 700.00', Outlet Invert= 686.00'

‡

Summary for Reach 2R: 4'x1.5' SWALE

Inflow Area = 2.391 ac, 0.00% Impervious, Inflow Depth = 0.84" for 2-Year event
Inflow = 1.8 cfs @ 12.16 hrs, Volume= 0.17 af
Outflow = 1.8 cfs @ 12.22 hrs, Volume= 0.17 af, Atten= 4%, Lag= 4.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.2 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.8 fps, Avg. Travel Time= 6.4 min

Peak Storage= 237 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.50' Flow Area= 12.8 sf, Capacity= 95.8 cfs

4.00' x 1.50' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 13.00'
Length= 300.0' Slope= 0.0133 '/'
Inlet Invert= 690.00', Outlet Invert= 686.00'

‡

Summary for Reach 3R: 2 x 18" HDPE

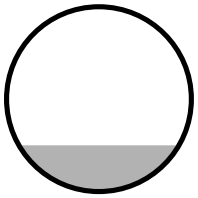
Inflow Area = 5.292 ac, 0.00% Impervious, Inflow Depth = 0.84" for 2-Year event
Inflow = 3.4 cfs @ 12.32 hrs, Volume= 0.37 af
Outflow = 3.3 cfs @ 12.33 hrs, Volume= 0.37 af, Atten= 1%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.8 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.0 fps, Avg. Travel Time= 0.2 min

Peak Storage= 15 cf @ 12.32 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 1.50' Flow Area= 3.5 sf, Capacity= 24.5 cfs

A factor of 2.00 has been applied to the storage and discharge capacity
18.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 22.0' Slope= 0.0136 '/'

Inlet Invert= 689.00', Outlet Invert= 688.70'



Summary for Pond P101: Infiltration basin

Inflow Area = 10.929 ac, 3.32% Impervious, Inflow Depth = 0.90" for 2-Year event
Inflow = 7.0 cfs @ 12.25 hrs, Volume= 0.82 af
Outflow = 1.5 cfs @ 13.08 hrs, Volume= 0.82 af, Atten= 79%, Lag= 49.7 min
Discarded = 0.4 cfs @ 13.08 hrs, Volume= 0.54 af
Primary = 1.1 cfs @ 13.08 hrs, Volume= 0.28 af
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0.00 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 685.84' @ 13.08 hrs Surf.Area= 16,802 sf Storage= 13,417 cf

Plug-Flow detention time= 219.2 min calculated for 0.82 af (100% of inflow)
Center-of-Mass det. time= 219.3 min (1,098.8 - 879.5)

Volume	Invert	Avail.Storage	Storage Description
#1	685.00'	75,965 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)
685.00	15,302	590.0	0	0	15,302
685.50	16,195	600.0	7,873	7,873	16,295
686.00	17,103	609.0	8,323	16,197	17,212
688.00	20,875	647.0	37,915	54,112	21,212
689.00	22,845	666.0	21,853	75,965	23,303

Device	Routing	Invert	Outlet Devices
#1	Primary	680.00'	**18.0" Round Culvert** L= 58.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 680.00' / 678.00' S= 0.0345 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	685.50'	**6.0" Vert. Orifice X 4.00** C= 0.600
#3	Device 1	687.00'	**24.0" x 24.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	688.00'	**25.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#5	Discarded	685.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.4 cfs @ 13.08 hrs HW=685.84' (Free Discharge)
└**5=Exfiltration** (Exfiltration Controls 0.4 cfs)

Primary OutFlow Max=1.1 cfs @ 13.08 hrs HW=685.84' (Free Discharge)
└**1=Culvert** (Passes 1.1 cfs of 19.2 cfs potential flow)
  └**2=Orifice** (Orifice Controls 1.1 cfs @ 2.0 fps)
  └**3=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=685.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond P201: Infiltration basin

Inflow Area = 3.620 ac, 4.84% Impervious, Inflow Depth = 0.89" for 2-Year event
Inflow = 3.2 cfs @ 12.12 hrs, Volume= 0.27 af
Outflow = 0.3 cfs @ 14.58 hrs, Volume= 0.27 af, Atten= 92%, Lag= 147.6 min
Discarded = 0.2 cfs @ 14.58 hrs, Volume= 0.25 af
Primary = 0.1 cfs @ 14.58 hrs, Volume= 0.02 af
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0.00 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 685.64' @ 14.58 hrs Surf.Area= 8,926 sf Storage= 5,293 cf

Plug-Flow detention time= 263.1 min calculated for 0.27 af (100% of inflow)
Center-of-Mass det. time= 263.1 min (1,134.8 - 871.7)

Volume	Invert	Avail.Storage	Storage Description
#1	685.00'	47,190 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)
685.00	7,625	673.0	0	0	7,625
685.50	8,643	683.0	4,064	4,064	8,756
686.00	9,676	693.0	4,577	8,642	9,904
688.00	13,952	731.0	23,498	32,140	14,439
689.00	16,176	750.0	15,050	47,190	16,798

Device	Routing	Invert	Outlet Devices
#1	Discarded	685.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	680.00'	**12.0" Round Culvert** L= 79.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 680.00' / 678.00' S= 0.0253 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	685.50'	**6.0" Vert. Orifice** C= 0.600
#4	Device 2	687.00'	**12.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	688.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.2 cfs @ 14.58 hrs HW=685.64' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.2 cfs)

Primary OutFlow Max=0.1 cfs @ 14.58 hrs HW=685.64' (Free Discharge)
└**2=Culvert** (Passes 0.1 cfs of 8.5 cfs potential flow)
  └**3=Orifice** (Orifice Controls 0.1 cfs @ 1.3 fps)
  └**4=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=685.00' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Link DP1: Stream

Inflow Area = 30.532 ac, 1.33% Impervious, Inflow Depth = 0.65" for 2-Year event
Inflow = 10.5 cfs @ 12.44 hrs, Volume= 1.64 af
Primary = 10.5 cfs @ 12.44 hrs, Volume= 1.64 af, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP2: Southern Abutters

Inflow Area = 12.760 ac, 1.37% Impervious, Inflow Depth = 0.58" for 2-Year event
Inflow = 6.6 cfs @ 12.15 hrs, Volume= 0.62 af
Primary = 6.6 cfs @ 12.15 hrs, Volume= 0.62 af, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP3: Eastern Abutter

Inflow Area = 18.509 ac, 0.00% Impervious, Inflow Depth = 0.79" for 2-Year event
Inflow = 9.9 cfs @ 12.34 hrs, Volume= 1.21 af
Primary = 9.9 cfs @ 12.34 hrs, Volume= 1.21 af, Atten= 0%, Lag= 0.0 min

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

Summary for Subcatchment SC100: Subcatchment 100

Runoff = 27.8 cfs @ 12.39 hrs, Volume= 3.38 af, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.94"

	Area (sf)	CN	Description
*	26,539	89	Proposed gravel road, HSG C
	126,751	71	Meadow, non-grazed, HSG C
	691,823	70	Woods, Good, HSG C
*	2,137	91	Proposed gravel road, HSG D
	486	78	Meadow, non-grazed, HSG D
	109	77	Woods, Good, HSG D
	3,588	83	Brush, Poor, HSG D
	601	77	Brush, Poor, HSG C
*	1,872	98	Concrete Pad, HSG C
	853,906	71	Weighted Average
	852,034		99.78% Pervious Area
	1,872		0.22% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.3	50	0.0120	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
8.4	908	0.1290	1.8		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.7	363	0.1040	2.3		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	43	0.3690	3.0		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
26.6	1,364	Total			

Summary for Subcatchment SC101: Subcatchment 101

Runoff = 9.3 cfs @ 12.23 hrs, Volume= 0.91 af, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.94"

Area (sf)	CN	Description
210,679	71	Meadow, non-grazed, HSG C
17,623	70	Woods, Good, HSG C
2,203	89	Gravel roads, HSG C
230,505	71	Weighted Average
230,505		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0280	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
1.1	85	0.0680	1.3		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.7	503	0.1070	2.3		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	28	0.3333	4.0		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
15.8	666	Total			

Summary for Subcatchment SC102: Subcatchment 102

Runoff = 8.4 cfs @ 12.12 hrs, Volume= 0.65 af, Depth= 2.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.94"

Area (sf)	CN	Description
15,206	98	Water Surface, HSG C
600	98	Paved parking, HSG C
8,797	89	Gravel roads, HSG C
116,788	71	Meadow, non-grazed, HSG C
141,391	75	Weighted Average
125,585		88.82% Pervious Area
15,806		11.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.0420	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
3.6	517	0.1160	2.4		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	50	0.3333	4.0		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.0	617	Total			

Summary for Subcatchment SC103: Subcatchment 103

Runoff = 5.0 cfs @ 12.15 hrs, Volume= 0.41 af, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.94"

Area (sf)	CN	Description
103,897	71	Meadow, non-grazed, HSG C
270	89	Gravel roads, HSG C
104,167	71	Weighted Average
104,167		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	50	0.0260	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
4.5	616	0.1040	2.3		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	28	0.3333	4.0		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	694	Total			

Summary for Subcatchment SC200: Subcatchment 200

Runoff = 18.5 cfs @ 12.14 hrs, Volume= 1.52 af, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.94"

Area (sf)	CN	Description
166,056	71	Meadow, non-grazed, HSG C
231,824	70	Woods, Good, HSG C
237	89	Gravel roads, HSG C
398,117	70	Weighted Average
398,117		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.0420	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
4.8	796	0.1590	2.8		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.0	846	Total			

Summary for Subcatchment SC201: Subcatchment 201

Runoff = 8.5 cfs @ 12.11 hrs, Volume= 0.65 af, Depth= 2.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.94"

Area (sf)	CN	Description
149,975	71	Meadow, non-grazed, HSG C
90	89	Gravel roads, HSG C
7,625	98	Water Surface, HSG C
157,690	72	Weighted Average
150,065		95.16% Pervious Area
7,625		4.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0600	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
3.5	524	0.1240	2.5		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	118	0.0420	7.3	20.11	**Trap/Vee/Rect Channel Flow,** Bot.W=4.00' D=0.50' Z= 3.0 '/' Top.W=7.00' n= 0.022 Earth, clean & straight
7.5	692	Total			

Summary for Subcatchment SC300: Subcatchment 300

Runoff = 27.8 cfs @ 12.31 hrs, Volume= 3.07 af, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.94"

Area (sf)	CN	Description
62,640	71	Meadow, non-grazed, HSG C
740,157	70	Woods, Good, HSG C
3,467	89	Gravel roads, HSG C
806,264	70	Weighted Average
806,264		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0800	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
13.9	1,758	0.1790	2.1		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
21.1	1,808	Total			

Summary for Reach 1R: 4'x1.5' SWALE

Inflow Area = 5.292 ac, 0.00% Impervious, Inflow Depth = 2.07" for 10-Year event
Inflow = 9.3 cfs @ 12.23 hrs, Volume= 0.91 af
Outflow = 9.1 cfs @ 12.29 hrs, Volume= 0.91 af, Atten= 2%, Lag= 3.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.6 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 1.2 fps, Avg. Travel Time= 5.6 min

Peak Storage= 1,032 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.48'
Bank-Full Depth= 1.50' Flow Area= 12.8 sf, Capacity= 85.4 cfs

4.00' x 1.50' deep channel, n= 0.040 Earth, cobble bottom, clean sides
Side Slope Z-value= 3.0 '/' Top Width= 13.00'
Length= 400.0' Slope= 0.0350 '/'
Inlet Invert= 700.00', Outlet Invert= 686.00'

‡

Summary for Reach 2R: 4'x1.5' SWALE

Inflow Area = 2.391 ac, 0.00% Impervious, Inflow Depth = 2.07" for 10-Year event
Inflow = 5.0 cfs @ 12.15 hrs, Volume= 0.41 af
Outflow = 4.8 cfs @ 12.20 hrs, Volume= 0.41 af, Atten= 4%, Lag= 3.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.2 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.0 fps, Avg. Travel Time= 5.0 min

Peak Storage= 466 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.31'
Bank-Full Depth= 1.50' Flow Area= 12.8 sf, Capacity= 95.8 cfs

4.00' x 1.50' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 13.00'
Length= 300.0' Slope= 0.0133 '/'
Inlet Invert= 690.00', Outlet Invert= 686.00'

‡

Summary for Reach 3R: 2 x 18" HDPE

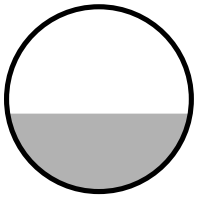
Inflow Area = 5.292 ac, 0.00% Impervious, Inflow Depth = 2.07" for 10-Year event
Inflow = 9.1 cfs @ 12.29 hrs, Volume= 0.91 af
Outflow = 9.1 cfs @ 12.29 hrs, Volume= 0.91 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.4 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.5 fps, Avg. Travel Time= 0.1 min

Peak Storage= 31 cf @ 12.29 hrs
Average Depth at Peak Storage= 0.63'
Bank-Full Depth= 1.50' Flow Area= 3.5 sf, Capacity= 24.5 cfs

A factor of 2.00 has been applied to the storage and discharge capacity
18.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 22.0' Slope= 0.0136 '/'

Inlet Invert= 689.00', Outlet Invert= 688.70'



Summary for Pond P101: Infiltration basin

Inflow Area = 10.929 ac, 3.32% Impervious, Inflow Depth = 2.17" for 10-Year event
Inflow = 18.9 cfs @ 12.20 hrs, Volume= 1.98 af
Outflow = 4.6 cfs @ 12.82 hrs, Volume= 1.98 af, Atten= 76%, Lag= 37.1 min
Discarded = 0.4 cfs @ 12.82 hrs, Volume= 0.66 af
Primary = 4.1 cfs @ 12.82 hrs, Volume= 1.31 af
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0.00 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 686.94' @ 12.82 hrs Surf.Area= 18,826 sf Storage= 33,048 cf

Plug-Flow detention time= 153.2 min calculated for 1.98 af (100% of inflow)
Center-of-Mass det. time= 153.1 min (1,004.7 - 851.6)

Volume	Invert	Avail.Storage	Storage Description
#1	685.00'	75,965 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)
685.00	15,302	590.0	0	0	15,302
685.50	16,195	600.0	7,873	7,873	16,295
686.00	17,103	609.0	8,323	16,197	17,212
688.00	20,875	647.0	37,915	54,112	21,212
689.00	22,845	666.0	21,853	75,965	23,303

Device	Routing	Invert	Outlet Devices
#1	Primary	680.00'	**18.0" Round Culvert** L= 58.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 680.00' / 678.00' S= 0.0345 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	685.50'	**6.0" Vert. Orifice X 4.00** C= 0.600
#3	Device 1	687.00'	**24.0" x 24.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	688.00'	**25.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#5	Discarded	685.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.4 cfs @ 12.82 hrs HW=686.94' (Free Discharge)
└**5=Exfiltration** (Exfiltration Controls 0.4 cfs)

Primary OutFlow Max=4.1 cfs @ 12.82 hrs HW=686.94' (Free Discharge)
└**1=Culvert** (Passes 4.1 cfs of 21.2 cfs potential flow)
  └**2=Orifice** (Orifice Controls 4.1 cfs @ 5.2 fps)
  └**3=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=685.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond P201: Infiltration basin

Inflow Area = 3.620 ac, 4.84% Impervious, Inflow Depth = 2.15" for 10-Year event
Inflow = 8.5 cfs @ 12.11 hrs, Volume= 0.65 af
Outflow = 1.0 cfs @ 13.02 hrs, Volume= 0.65 af, Atten= 88%, Lag= 54.6 min
Discarded = 0.2 cfs @ 13.02 hrs, Volume= 0.34 af
Primary = 0.7 cfs @ 13.02 hrs, Volume= 0.31 af
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0.00 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 686.36' @ 13.02 hrs Surf.Area= 10,397 sf Storage= 12,297 cf

Plug-Flow detention time= 222.6 min calculated for 0.65 af (100% of inflow)
Center-of-Mass det. time= 222.8 min (1,067.3 - 844.5)

Volume	Invert	Avail.Storage	Storage Description
#1	685.00'	47,190 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)
685.00	7,625	673.0	0	0	7,625
685.50	8,643	683.0	4,064	4,064	8,756
686.00	9,676	693.0	4,577	8,642	9,904
688.00	13,952	731.0	23,498	32,140	14,439
689.00	16,176	750.0	15,050	47,190	16,798

Device	Routing	Invert	Outlet Devices
#1	Discarded	685.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	680.00'	**12.0" Round Culvert** L= 79.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 680.00' / 678.00' S= 0.0253 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	685.50'	**6.0" Vert. Orifice** C= 0.600
#4	Device 2	687.00'	**12.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	688.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.2 cfs @ 13.02 hrs HW=686.36' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.2 cfs)

Primary OutFlow Max=0.7 cfs @ 13.02 hrs HW=686.36' (Free Discharge)
└**2=Culvert** (Passes 0.7 cfs of 9.0 cfs potential flow)
  └**3=Orifice** (Orifice Controls 0.7 cfs @ 3.8 fps)
  └**4=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=685.00' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Link DP1: Stream

Inflow Area = 30.532 ac, 1.33% Impervious, Inflow Depth = 1.85" for 10-Year event
Inflow = 31.3 cfs @ 12.40 hrs, Volume= 4.70 af
Primary = 31.3 cfs @ 12.40 hrs, Volume= 4.70 af, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP2: Southern Abutters

Inflow Area = 12.760 ac, 1.37% Impervious, Inflow Depth = 1.72" for 10-Year event
Inflow = 18.7 cfs @ 12.14 hrs, Volume= 1.82 af
Primary = 18.7 cfs @ 12.14 hrs, Volume= 1.82 af, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP3: Eastern Abutter

Inflow Area = 18.509 ac, 0.00% Impervious, Inflow Depth = 1.99" for 10-Year event
Inflow = 27.8 cfs @ 12.31 hrs, Volume= 3.07 af
Primary = 27.8 cfs @ 12.31 hrs, Volume= 3.07 af, Atten= 0%, Lag= 0.0 min

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

Summary for Subcatchment SC100: Subcatchment 100

Runoff = 60.6 cfs @ 12.37 hrs, Volume= 7.23 af, Depth= 4.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.82"

	Area (sf)	CN	Description
*	26,539	89	Proposed gravel road, HSG C
	126,751	71	Meadow, non-grazed, HSG C
	691,823	70	Woods, Good, HSG C
*	2,137	91	Proposed gravel road, HSG D
	486	78	Meadow, non-grazed, HSG D
	109	77	Woods, Good, HSG D
	3,588	83	Brush, Poor, HSG D
	601	77	Brush, Poor, HSG C
*	1,872	98	Concrete Pad, HSG C
	853,906	71	Weighted Average
	852,034		99.78% Pervious Area
	1,872		0.22% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.3	50	0.0120	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
8.4	908	0.1290	1.8		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.7	363	0.1040	2.3		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	43	0.3690	3.0		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
26.6	1,364	Total			

Summary for Subcatchment SC101: Subcatchment 101

Runoff = 20.3 cfs @ 12.22 hrs, Volume= 1.95 af, Depth= 4.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.82"

Area (sf)	CN	Description
210,679	71	Meadow, non-grazed, HSG C
17,623	70	Woods, Good, HSG C
2,203	89	Gravel roads, HSG C
230,505	71	Weighted Average
230,505		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0280	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
1.1	85	0.0680	1.3		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.7	503	0.1070	2.3		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	28	0.3333	4.0		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
15.8	666	Total			

Summary for Subcatchment SC102: Subcatchment 102

Runoff = 17.1 cfs @ 12.11 hrs, Volume= 1.32 af, Depth= 4.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.82"

Area (sf)	CN	Description
15,206	98	Water Surface, HSG C
600	98	Paved parking, HSG C
8,797	89	Gravel roads, HSG C
116,788	71	Meadow, non-grazed, HSG C
141,391	75	Weighted Average
125,585		88.82% Pervious Area
15,806		11.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.0420	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
3.6	517	0.1160	2.4		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	50	0.3333	4.0		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.0	617	Total			

Summary for Subcatchment SC103: Subcatchment 103

Runoff = 10.8 cfs @ 12.14 hrs, Volume= 0.88 af, Depth= 4.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.82"

Area (sf)	CN	Description
103,897	71	Meadow, non-grazed, HSG C
270	89	Gravel roads, HSG C
104,167	71	Weighted Average
104,167		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	50	0.0260	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
4.5	616	0.1040	2.3		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	28	0.3333	4.0		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	694	Total			

Summary for Subcatchment SC200: Subcatchment 200

Runoff = 40.9 cfs @ 12.13 hrs, Volume= 3.28 af, Depth= 4.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.82"

Area (sf)	CN	Description
166,056	71	Meadow, non-grazed, HSG C
231,824	70	Woods, Good, HSG C
237	89	Gravel roads, HSG C
398,117	70	Weighted Average
398,117		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.0420	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
4.8	796	0.1590	2.8		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.0	846	Total			

Summary for Subcatchment SC201: Subcatchment 201

Runoff = 18.1 cfs @ 12.11 hrs, Volume= 1.37 af, Depth= 4.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.82"

Area (sf)	CN	Description
149,975	71	Meadow, non-grazed, HSG C
90	89	Gravel roads, HSG C
7,625	98	Water Surface, HSG C
157,690	72	Weighted Average
150,065		95.16% Pervious Area
7,625		4.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0600	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.12"
3.5	524	0.1240	2.5		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	118	0.0420	7.3	20.11	**Trap/Vee/Rect Channel Flow,** Bot.W=4.00' D=0.50' Z= 3.0 '/' Top.W=7.00' n= 0.022 Earth, clean & straight
7.5	692	Total			

Summary for Subcatchment SC300: Subcatchment 300

Runoff = 61.5 cfs @ 12.29 hrs, Volume= 6.65 af, Depth= 4.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.82"

Area (sf)	CN	Description
62,640	71	Meadow, non-grazed, HSG C
740,157	70	Woods, Good, HSG C
3,467	89	Gravel roads, HSG C
806,264	70	Weighted Average
806,264		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0800	0.1		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.12"
13.9	1,758	0.1790	2.1		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
21.1	1,808	Total			

Summary for Reach 1R: 4'x1.5' SWALE

Inflow Area = 5.292 ac, 0.00% Impervious, Inflow Depth = 4.42" for 100-Year event
Inflow = 20.3 cfs @ 12.22 hrs, Volume= 1.95 af
Outflow = 19.9 cfs @ 12.27 hrs, Volume= 1.95 af, Atten= 2%, Lag= 2.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.5 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.5 fps, Avg. Travel Time= 4.6 min

Peak Storage= 1,787 cf @ 12.24 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 1.50' Flow Area= 12.8 sf, Capacity= 85.4 cfs

4.00' x 1.50' deep channel, n= 0.040 Earth, cobble bottom, clean sides
Side Slope Z-value= 3.0 '/' Top Width= 13.00'
Length= 400.0' Slope= 0.0350 '/'
Inlet Invert= 700.00', Outlet Invert= 686.00'

‡

Summary for Reach 2R: 4'x1.5' SWALE

Inflow Area = 2.391 ac, 0.00% Impervious, Inflow Depth = 4.42" for 100-Year event
Inflow = 10.8 cfs @ 12.14 hrs, Volume= 0.88 af
Outflow = 10.4 cfs @ 12.18 hrs, Volume= 0.88 af, Atten= 4%, Lag= 2.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.1 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.2 fps, Avg. Travel Time= 4.1 min

Peak Storage= 795 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.50' Flow Area= 12.8 sf, Capacity= 95.8 cfs

4.00' x 1.50' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 13.00'
Length= 300.0' Slope= 0.0133 '/'
Inlet Invert= 690.00', Outlet Invert= 686.00'

‡

Summary for Reach 3R: 2 x 18" HDPE

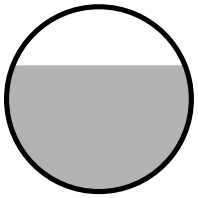
Inflow Area = 5.292 ac, 0.00% Impervious, Inflow Depth = 4.42" for 100-Year event
Inflow = 19.9 cfs @ 12.27 hrs, Volume= 1.95 af
Outflow = 19.9 cfs @ 12.27 hrs, Volume= 1.95 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.7 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.9 fps, Avg. Travel Time= 0.1 min

Peak Storage= 57 cf @ 12.27 hrs
Average Depth at Peak Storage= 1.02'
Bank-Full Depth= 1.50' Flow Area= 3.5 sf, Capacity= 24.5 cfs

A factor of 2.00 has been applied to the storage and discharge capacity
18.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 22.0' Slope= 0.0136 '/'

Inlet Invert= 689.00', Outlet Invert= 688.70'



Summary for Pond P101: Infiltration basin

Inflow Area = 10.929 ac, 3.32% Impervious, Inflow Depth = 4.56" for 100-Year event
Inflow = 41.2 cfs @ 12.18 hrs, Volume= 4.15 af
Outflow = 23.4 cfs @ 12.47 hrs, Volume= 4.15 af, Atten= 43%, Lag= 17.4 min
Discarded = 0.5 cfs @ 12.47 hrs, Volume= 0.76 af
Primary = 22.9 cfs @ 12.47 hrs, Volume= 3.39 af
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0.00 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 688.00' @ 12.47 hrs Surf.Area= 20,867 sf Storage= 54,023 cf

Plug-Flow detention time= 103.9 min calculated for 4.15 af (100% of inflow)
Center-of-Mass det. time= 103.8 min (933.3 - 829.5)

Volume	Invert	Avail.Storage	Storage Description
#1	685.00'	75,965 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)
685.00	15,302	590.0	0	0	15,302
685.50	16,195	600.0	7,873	7,873	16,295
686.00	17,103	609.0	8,323	16,197	17,212
688.00	20,875	647.0	37,915	54,112	21,212
689.00	22,845	666.0	21,853	75,965	23,303

Device	Routing	Invert	Outlet Devices
#1	Primary	680.00'	**18.0" Round Culvert** L= 58.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 680.00' / 678.00' S= 0.0345 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	685.50'	**6.0" Vert. Orifice X 4.00** C= 0.600
#3	Device 1	687.00'	**24.0" x 24.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	688.00'	**25.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#5	Discarded	685.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.5 cfs @ 12.47 hrs HW=687.99' (Free Discharge)
└**5=Exfiltration** (Exfiltration Controls 0.5 cfs)

Primary OutFlow Max=22.9 cfs @ 12.47 hrs HW=687.99' (Free Discharge)
└**1=Culvert** (Inlet Controls 22.9 cfs @ 13.0 fps)
  └**2=Orifice** (Passes < 5.7 cfs potential flow)
  └**3=Grate** (Passes < 19.2 cfs potential flow)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=685.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond P201: Infiltration basin

Inflow Area = 3.620 ac, 4.84% Impervious, Inflow Depth = 4.54" for 100-Year event
Inflow = 18.1 cfs @ 12.11 hrs, Volume= 1.37 af
Outflow = 4.2 cfs @ 12.54 hrs, Volume= 1.37 af, Atten= 77%, Lag= 26.0 min
Discarded = 0.3 cfs @ 12.54 hrs, Volume= 0.43 af
Primary = 3.9 cfs @ 12.54 hrs, Volume= 0.94 af
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0.00 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 687.49' @ 12.54 hrs Surf.Area= 12,785 sf Storage= 25,308 cf

Plug-Flow detention time= 190.7 min calculated for 1.37 af (100% of inflow)
Center-of-Mass det. time= 190.9 min (1,013.9 - 822.9)

Volume	Invert	Avail.Storage	Storage Description
#1	685.00'	47,190 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)
685.00	7,625	673.0	0	0	7,625
685.50	8,643	683.0	4,064	4,064	8,756
686.00	9,676	693.0	4,577	8,642	9,904
688.00	13,952	731.0	23,498	32,140	14,439
689.00	16,176	750.0	15,050	47,190	16,798

Device	Routing	Invert	Outlet Devices
#1	Discarded	685.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	680.00'	**12.0" Round Culvert** L= 79.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 680.00' / 678.00' S= 0.0253 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	685.50'	**6.0" Vert. Orifice** C= 0.600
#4	Device 2	687.00'	**12.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	688.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.3 cfs @ 12.54 hrs HW=687.49' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.3 cfs)

Primary OutFlow Max=3.9 cfs @ 12.54 hrs HW=687.49' (Free Discharge)
└**2=Culvert** (Passes 3.9 cfs of 9.7 cfs potential flow)
  └**3=Orifice** (Orifice Controls 1.2 cfs @ 6.3 fps)
  └**4=Grate** (Orifice Controls 2.6 cfs @ 3.4 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=685.00' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Link DP1: Stream

Inflow Area = 30.532 ac, 1.33% Impervious, Inflow Depth = 4.17" for 100-Year event
Inflow = 83.4 cfs @ 12.37 hrs, Volume= 10.62 af
Primary = 83.4 cfs @ 12.37 hrs, Volume= 10.62 af, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP2: Southern Abutters

Inflow Area = 12.760 ac, 1.37% Impervious, Inflow Depth = 3.97" for 100-Year event
Inflow = 41.8 cfs @ 12.13 hrs, Volume= 4.22 af
Primary = 41.8 cfs @ 12.13 hrs, Volume= 4.22 af, Atten= 0%, Lag= 0.0 min

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

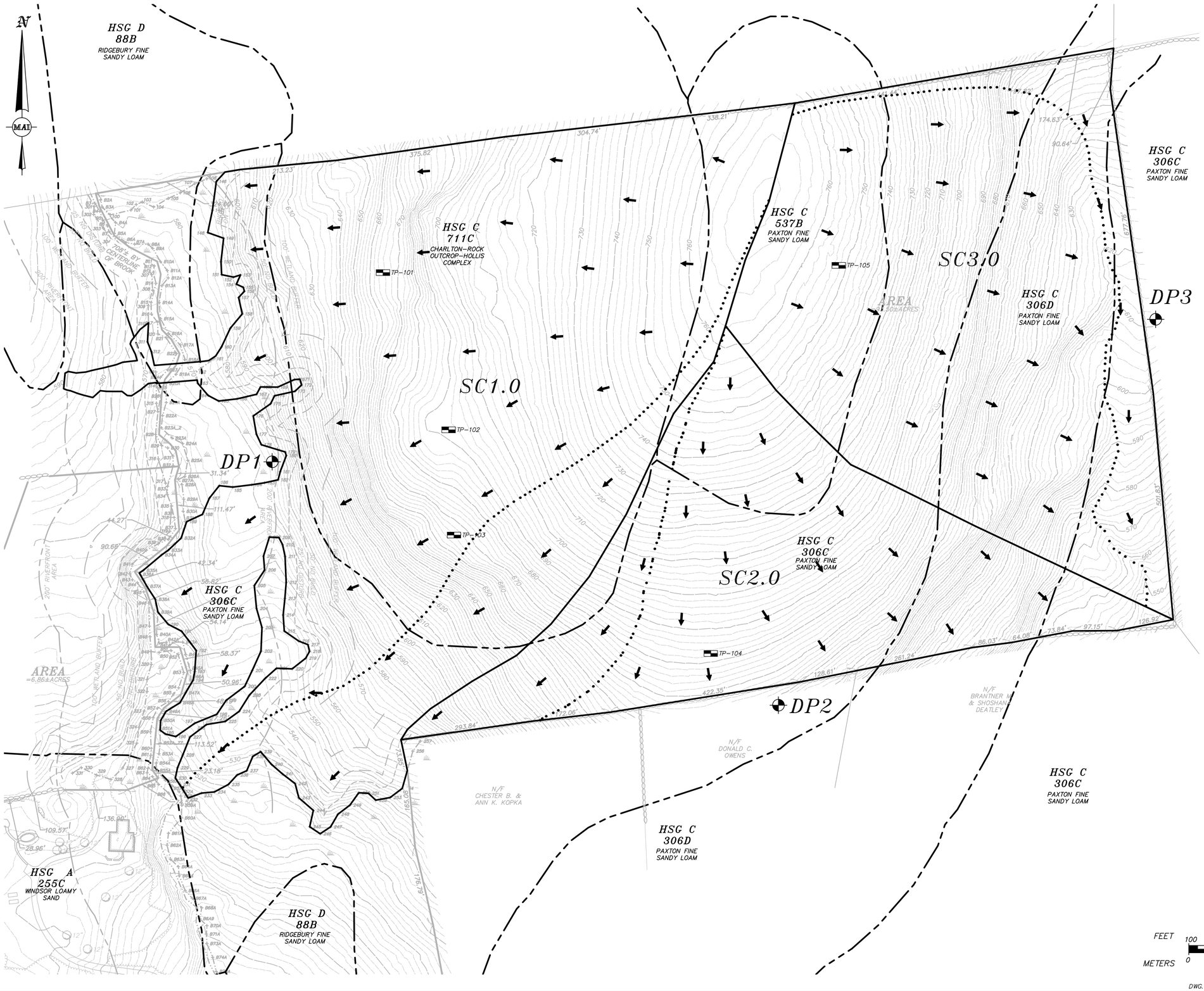
Summary for Link DP3: Eastern Abutter

Inflow Area = 18.509 ac, 0.00% Impervious, Inflow Depth = 4.31" for 100-Year event
Inflow = 61.5 cfs @ 12.29 hrs, Volume= 6.65 af
Primary = 61.5 cfs @ 12.29 hrs, Volume= 6.65 af, Atten= 0%, Lag= 0.0 min

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

APPENDIX

PRE-DEVELOPMENT DRAINAGE MAP



LEGEND:

- OVERLAND FLOW DIRECTION
- SUBCATCHMENT DIVIDE
- SOIL TYPE DIVIDE
- HYDROLOGIC FLOW PATH
- SC1 — SUBCATCHMENT
- DP1 — DESIGN POINT
- 254B — SOIL TYPE
- HSG — HYDROLOGIC SOIL GROUP
- TP–2 — TEST PIT LOCATION

UNOFFICIAL SOILS INFORMATION

DATE: SEPTEMBER 13, 2018
CONDUCTED BY: ANDREW RODRIGUEZ, SE (13890)

TEST PIT TP–101
ELEV.=665±

0"–6" A HORIZON: FINE SANDY LOAM
6"–34" B HORIZON: FINE SANDY LOAM
34"–92" LAYER C: GRAVELY SANDY LOAM
REDOX NOT OBSERVED
REFUSAL @ 92"

TEST PIT TP–102
ELEV.=691±

0"–8" A HORIZON: FINE SANDY LOAM
8"–43" B HORIZON: FINE SANDY LOAM
43"–100R" LAYER C: GRAVELY SANDY LOAM
REDOX NOT OBSERVED
REFUSAL @ 100"

TEST PIT TP–103
ELEV.=666±

0"–7" A HORIZON: FINE SANDY LOAM
7"–23" B HORIZON: FINE SANDY LOAM
23"–105R" LAYER C: GRAVELY SANDY LOAM
REDOX NOT OBSERVED
REFUSAL @ 100"

TEST PIT TP–104
ELEV.=683±
ASSUMED E.S.H.G.W. ELEV.=680.7

0"–7" A HORIZON: FINE SANDY LOAM
7"–23" B HORIZON: FINE SANDY LOAM
23"–108" LAYER C: GRAVELY SANDY LOAM
WEEPING @ 27"
STANDING @ 100"

TEST PIT TP–105
ELEV.=753±
ASSUMED E.S.H.G.W. ELEV.=750.9

0"–7" A HORIZON: FINE SANDY LOAM
7"–23" B HORIZON: FINE SANDY LOAM
23"–105" LAYER C: GRAVELY SANDY LOAM
REDOX @ 25"
WEEPING @ 39"
STANDING @ 100"

GRAPHIC SCALE
SCALE: 1"=100'

FEET: 100 0 50 100 200 400
METERS: 0 25 50 100 150

DWG. No. P:\6091_ZPII–HAYDENVILLE\CAD\CIVIL 3D\6091_REC(PENNY).DWG

REVISIONS

DESCRIPTION	DATE	BY

5 & 5R HATFIELD STREET
PRE–DEVELOPMENT DRAINAGE PLAN
LOCATED IN
WILLIAMSBURG, MASSACHUSETTS
(HAMPSHIRE COUNTY)
PREPARED FOR
ZPT ENERGY SOLUTIONS II, LLC

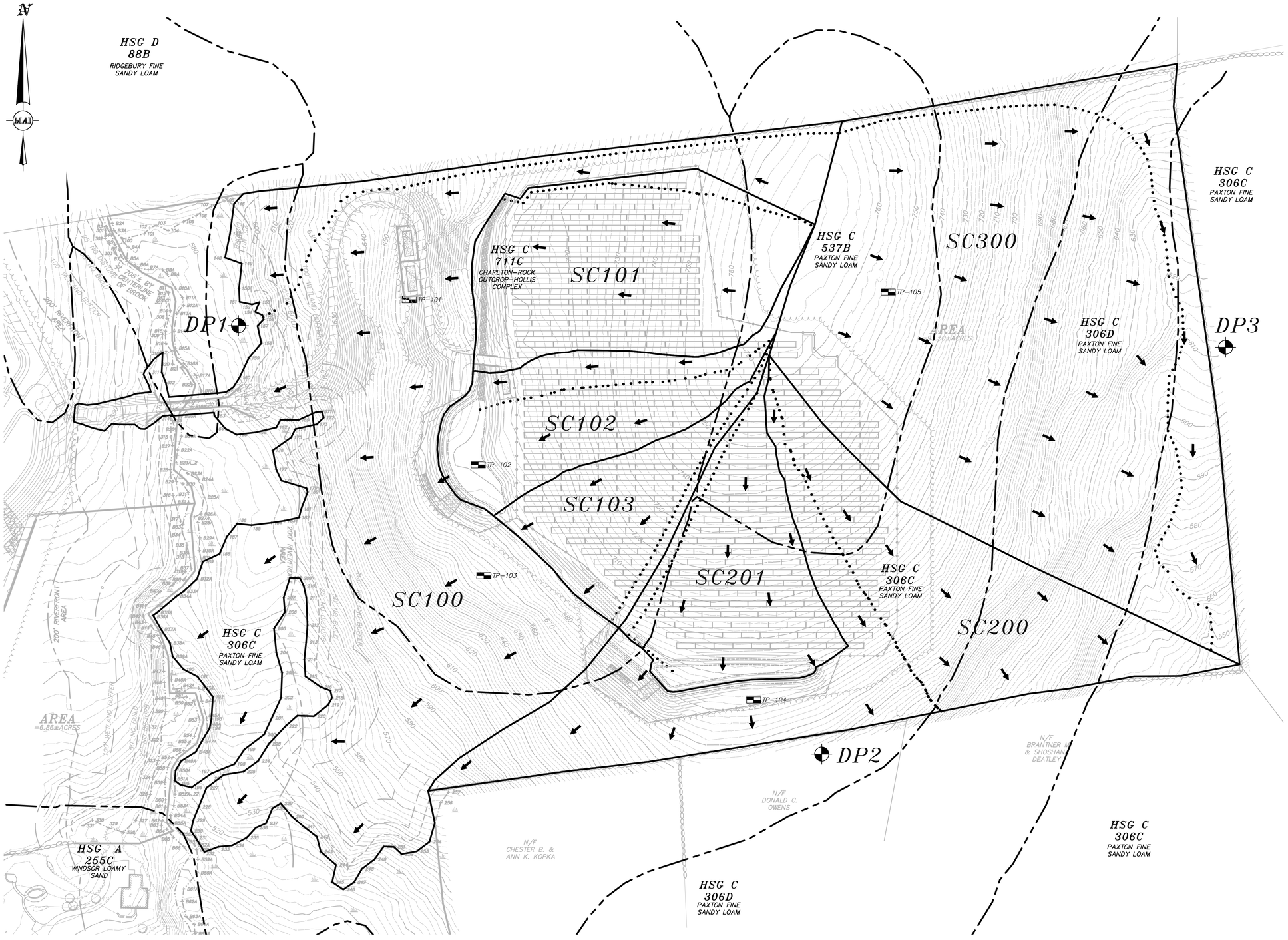
MERIDIAN ASSOCIATES
500 CUMMINGS CENTER, SUITE 5950
BEVERLY, MASSACHUSETTS 01915
TELEPHONE: (978) 299-0447
60 WALKE STREET, SUITE 102
WESTBOROUGH, MASSACHUSETTS 01581
TELEPHONE: (508) 871-7030
WWW.MERIDIANASSOC.COM

DESIGNED BY:
CHECKED BY:

DATE: FEBRUARY 19, 2019
SCALE: 1"=100'
SHEET No. 1 OF 2
PROJECT No. 6091

Copyright © by Meridian Associates, Inc. All rights reserved.

POST-DEVELOPMENT DRAINAGE MAP



LEGEND:

- OVERLAND FLOW DIRECTION
- SUBCATCHMENT DIVIDE
- SOIL TYPE DIVIDE
- HYDROLOGIC FLOW PATH
- SC100 SUBCATCHMENT
- DP1 DESIGN POINT
- 254B SOIL TYPE
- HSG HYDROLOGIC SOIL GROUP
- TP-2 TEST PIT LOCATION

UNOFFICIAL SOILS INFORMATION

DATE: SEPTEMBER 13, 2018
CONDUCTED BY: ANDREW RODRIGUEZ, SE (13890)

TEST PIT TP-101
ELEV.=665±

0"-6" A HORIZON: FINE SANDY LOAM
6"-34" B HORIZON: FINE SANDY LOAM
34"-92R" LAYER C: GRAVELY SANDY LOAM
REDOX NOT OBSERVED
REFUSAL @ 92"

TEST PIT TP-102
ELEV.=691±

0"-8" A HORIZON: FINE SANDY LOAM
8"-43" B HORIZON: FINE SANDY LOAM
43"-100R" LAYER C: GRAVELY SANDY LOAM
REDOX NOT OBSERVED
REFUSAL @ 100"

TEST PIT TP-103
ELEV.=666±

0"-7" A HORIZON: FINE SANDY LOAM
7"-23" B HORIZON: FINE SANDY LOAM
23"-105R" LAYER C: GRAVELY SANDY LOAM
REDOX NOT OBSERVED
REFUSAL @ 100"

TEST PIT TP-104
ELEV.=683±
ASSUMED E.S.H.G.W. ELEV.=680.7

0"-7" A HORIZON: FINE SANDY LOAM
7"-23" B HORIZON: FINE SANDY LOAM
23"-108" LAYER C: GRAVELY SANDY LOAM
WEEPING @ 27"
STANDING @ 100"

TEST PIT TP-105
ELEV.=753±
ASSUMED E.S.H.G.W. ELEV.=750.9

0"-7" A HORIZON: FINE SANDY LOAM
7"-23" B HORIZON: FINE SANDY LOAM
23"-105" LAYER C: GRAVELY SANDY LOAM
REDOX @ 25"
WEEPING @ 39"
STANDING @ 100"

GRAPHIC SCALE
SCALE: 1"=100'

FEET: 100 0 50 100 200 400
METERS: 0 25 50 100 150

DWG. No. P:\6091_ZPII-HAYDENVILLE\CAD\CIVIL 3D\6091_SITE(PENNY).DWG

Copyright © by Meridian Associates, Inc. All rights reserved.

REVISIONS

BY	DESCRIPTION	DATE

5 & 5R HATFIELD STREET
POST-DEVELOPMENT DRAINAGE PLAN
LOCATED IN
WILLIAMSBURG, MASSACHUSETTS
(HAMPSHIRE COUNTY)
PREPARED FOR
ZPT ENERGY SOLUTIONS II, LLC

MERIDIAN ASSOCIATES
500 CUMMINGS CENTER, SUITE 5950
BEVERLY, MASSACHUSETTS 01915
TELEPHONE: (978) 299-0447
40 MILL ST. STREET, SUITE 302
WEST BOYLSTON, MASSACHUSETTS 01581
TELEPHONE: (508) 871-7030
WWW.MERIDIANASSOC.COM

DESIGNED BY:
CHECKED BY:

DATE: FEBRUARY 19, 2019
SCALE: 1"=100'
SHEET No. 2 OF 2
PROJECT No. 6091

OPERATION & MAINTENANCE PROGRAM

OPERATION AND MAINTENANCE PROGRAM
for
A PROPOSED STORMWATER MANAGEMENT SYSTEM
located at
5 & 5R HATFIELD STREET
WILLIAMSBURG, MASSACHUSETTS

Applicant:

ZPT Energy Solutions II, LLC
6 Park Avenue, Suite 100
Worcester, MA 01605

Prepared by:

Meridian Associates, Inc.
500 Cummings Center, Suite 5950
Beverly, Massachusetts 01915
(978) 299-0447

February 19, 2019

Project Name: ZPTII-241 SOLAR ARRAY
5 & 5R Hatfield Street
Williamsburg, Massachusetts 01039

Owner Name: **5 & 5R Hatfiled Street:**
Penelope Johnson
5 Hatfield Street
Haydenville, Massachusetts 01039

Party Responsible for Maintenance During and After Construction: ZPT Energy Solutions II, LLC
6 Park Avenue, Suite 100
Worcester, MA 01605

Erosion and Sedimentation Control Measures during Construction Activities

Strawbales/ Silt Fence/Silt Sock erosion control barriers

Staked strawbales and silt fencing will be installed upgradient of the resource areas as depicted on the Erosion & Sediment Control Plan. The strawbales and silt fence shall be installed prior to the commencement of any work on-site and in accordance with the design plans. An additional supply of strawbales and silt fence shall be on-site to replace and/or repair any strawbales or silt fence that have been disturbed or are in poor condition. The line of strawbales and silt fence shall be inspected and maintained on a weekly basis and after every major storm event (0.5 inches of rain or greater) during construction. No construction activities are to occur beyond the strawbale line at any time. Deposited sediments shall be removed when the volume of the deposition reaches approximately one-half the height of the straw bale.

Silt sock (filtermitt) barrier locations are shown on the design plans and shall be installed at the intervals and locations along the slope as dimensioned on those plans. If, during construction, a barrier needs to be temporarily moved in order to allow construction in a specific area, the barrier shall be returned to its original location or as close to its original location as possible after the work is complete. These barriers shall be inspected at the same time intervals as the strawbale barriers, and accumulated sediment shall be removed as needed to maintain proper functioning of the barrier. The means of creating new lengths of silt sock barrier shall be maintained on site during construction in order to replace damaged sections quickly as necessary.

Infiltration/Stormwater Basins

The Stormwater/Infiltration surface basins shall be checked weekly and after major storm events during construction for rilling, erosion, and debris removal. Avoid compaction of the parent material by working from the edge of the areas proposed as the locations of the Sedimentation Basins. Any uphill erosion control barriers shall be maintained so that runoff and sediment does not accumulate inside the basins, and allows vegetative cover to take hold. Care should be taken during regular inspections to remove any plants other than the recommended seed mix to avoid possible compromise of the interior side slopes. Any accumulated sediment shall be promptly removed.

Grassed/Stone lined Swales with Checkdams

Any Grassed Swales on site shall be checked weekly and after major storm events during construction for rilling, erosion, and debris removal. Avoid compaction of the parent material by working from the edge of the areas proposed as the locations of the Swales. Debris and any sediment accumulated at the checkdams is to be removed.

Level Spreader

Any Level Spreader within swales or at stormwater basins outfalls shall be checked weekly and after major storm events during construction for rilling, erosion, and debris removal. Debris and any sediment accumulated at the level spreader is to be removed.

Gravel Drive

During construction the gravel access drive and shall be inspected daily. The gravel drive shall be inspected for ruts, channelized drainage, gullying and sedimentation. Repairs to the drive shall be made with new clean stone, and shall be compacted into place. Large ruts may be filled with larger stone and set in place with dense grade material, then overlain by new crushed stone.

Stockpiles

All unused debris, soil, and other material shall be stockpiled in locations of relatively flat grades upgradient of the strawbales. Stockpile side slopes shall not be greater than 2:1. All stockpiles shall be surrounded by a row of strawbales. Surrounding strawbales shall be inspected and maintained on a daily basis.

Surface Stabilization

The surface of all disturbed areas shall be stabilized during and after construction. Temporary measures shall be taken during construction to prevent erosion and siltation. All disturbed slopes will be stabilized with a permanent vegetative cover. Once the forested areas have been cleared and grubbed, the entire area will be tilled following the installation of the array; areas of exposed soils will be seeded with a 50/50 mix of *"New England Conservation/Wildlife Mix"* and *"New England Erosion Control/Restoration Mix"* provided by New England Wetland Plants, Inc. This seed mix contains a variety of low-growing, low-maintenance fescues that will stabilize the ground surface.

Construction Tracking Pad

The construction tracking pad shall be installed at the designated entrance/exit west of the site to reduce the amount of sediment transported off site. The construction tracking pads shall be inspected weekly.

Removal of Sediment and Erosion Controls

At the completion of construction activities, when a permanent vegetative cover has been established on the site, and only after receiving approval from the Town of Williamsburg Conservation Commission, all physical sediment and erosion controls shall be removed from the site. The areas where the controls have been removed shall be seeded and stabilized immediately upon removal.

Long-Term Inspection and Maintenance Measures after Construction

Infiltration/Stormwater Basins

These basins should be inspected after the first several rainfall events or first few months after construction is complete, after all major storms (0.5 inches of rain or greater), and on regular bi-annual scheduled dates. Ponded water in the basin after several days often indicates that the bottom of the pond is clogged. At this point, material at the bottom of the pond shall be excavated to a minimum depth of 8 inches and replaced with sandy material to ensure infiltration. The area shall be re-seeded and monitored weekly until a new, permanent vegetative cover is established.

Grassed/Stone lined Swales with Checkdams

Any Grassed Swales on site shall be checked bi-annually and after every major storm event for rilling, gullying, erosions and debris removal. Maintenance mowing shall occur at a minimum of twice per year. Debris and any sediment accumulated at the checkdams is to be removed manually at least once per year.

Erosion Control

Eroded sediments can adversely affect the performance of the stormwater management system. Any eroding or barren areas should be immediately re-compacted and re-vegetated.

Gravel Drive

The gravel drive shall be inspected bi-annually and after every major storm event for ruts, channelized drainage, gullying and sedimentation. Repairs to the drive shall be made with new clean stone, and shall be compacted into place. Large ruts may be filled with larger stone and set in place with dense grade material, then overlain by new crushed stone. This access drive must be maintained in order to facilitate emergency vehicles moving through the site.

Debris and Litter Removal

Trash may collect in the BMP's, potentially causing clogging of the facilities. All debris and litter shall be removed when necessary, and after each storm event. Sediment and debris collected from vacuuming and/or sweeping should be disposed of at a permitted waste disposal facility. Avoid disposing of this material on site.

Grass Mowing

Grass shall be inspected annually and maintenance mowing shall occur as needed. All lawn mowing to take place will be done with a mulch mower so grass clippings will not be an issue. Any grassed access paths and driveways shall be mowed and maintained as necessary to allow movement of vehicles throughout the site.

Good Housekeeping Practices (in accordance with Standard 10 of the Stormwater Management Handbook to prevent illicit discharges)

Provisions for storing paints, cleaners, automotive waste and other potentially hazardous household waste products inside or under cover

- All materials on site will be stored inside in a neat, orderly, manner in their appropriate containers with the original manufacturer's label.
- Only store enough material necessary. Whenever possible, all of a product shall be used up before disposing of container.
- Manufacturer, local, and State recommendations for proper use and disposal shall be followed.

Vehicle washing controls

- A commercial car wash shall be used when possible. Car washes treat and/or recycle water.
- Cars shall be washed on gravel, grass, or other permeable surfaces to allow filtration to occur.
- Use biodegradable soaps.
- A water hose with a nozzle that automatically turns off when left unattended.

Requirements for routine inspection and maintenance of stormwater BMPs

See Inspection and Maintenance Measures after Construction.

Spill prevention and response plans

Spill Control Practices shall be in conformance with the guidelines set forth in the National Pollutant Discharge Elimination System (NPDES) Stormwater Pollution Prevention Plan (SWPPP)

Provisions for maintenance of lawns, gardens, and other landscaped areas

- Grass shall not be cut shorter than 2 to 3 inches and mulch clipping should be left on lawn as a natural fertilizer.
- Use low volume water approaches such as drip-type or sprinkler systems. Water plants only when needed to enhance root growth and avoid runoff problems.
- The use of mulch shall be utilized where possible. Mulch helps retain water and prevents erosion.

Requirements for storage and use of fertilizers, herbicides and pesticides

- Fertilizers to be used will be applied only in the minimum amounts recommended by the manufacturer. Once applied, fertilizer will be worked into the soil to limit exposure to storm water. Storage will be in a covered shed. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills.
- Do not fertilize before a rainstorm.
- Consider using organic fertilizers. They release nutrients more slowly.
- Pesticides shall be applied on lawns and gardens only when necessary and applied only in the minimum amounts recommended by the manufacturer.

Pet waste management

- Scoop up and seal pet wastes in a plastic bag. Dispose of properly, in the garbage.

Provisions for operation and management of septic systems

Not Applicable

Provisions for solid waste management

- All solid waste shall be disposed of or recycled in accordance with local town regulations.

Snow disposal and plowing plans relative to Resource Area

- Snow shall be plowed and stored on gravel, grass, or other permeable surfaces to allow filtration to occur.
- Once snow melts all sand salt and debris shall be extracted from surface and properly disposed of.
- Snow shall not be disposed of in any resource area or waterbody.
- Avoid disposing snow on top of storm drain catch basins or stormwater drainage swale.

Winter Road Salt and/or Sand use and storage restrictions

- Salt storage piles should be located outside the 100-year buffer zone and shall be covered at all times.
- The amount of road salt applied should be regulated to prevent over salting of roadways and increasing runoff concentrations. Alternative materials, such as sand or gravel, should be used in especially sensitive areas.

Roadway and Parking Lot sweeping schedule

- Pavement sweeping shall be conducted at a frequency of not less than once per year.
- Removal of any accumulated sand, grit, and debris from driveway after the snow melts shall be completed shortly after snow melts for the season.

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

Not Applicable

Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan

To be determined by the owner.

List of Emergency contacts for implementing Long-Term Pollution Prevention Plan

To be determined by the owner.

STORMWATER MANAGEMENT
CONSTRUCTION PHASE

INSPECTION SCHEDULE AND EVALUATION CHECKLIST

PROJECT LOCATION: 5 & 5R Hatfield Street, Williamsburg, Massachusetts **WEATHER:** _____

Inspection Date	***Inspector***	***Area Inspected***	***Required Inspection Frequency if BMP***	***Comments***	***Recommendation***	***Follow-up Inspection Required (yes/no)***
		Erosion Barriers	*Weekly and After Major Storm Events*			
		Construction Tracking Pads	*Weekly and After Major Storm Events*			
		Gravel Drive	*Weekly and After Major Storm Events*			
		Stormwater Basins and Outlets	*Weekly and After Major Storm Events*			
		Grassed/Stone lined Swales	*Weekly and After Major Storm Events*			
		Riprap Areas	*Weekly and After Major Storm Events*			

(1) Refer to the Massachusetts Stormwater Handbook, Volume Two: Stormwater Technical Handbook (February 2008) for recommendations regarding frequency for inspection and maintenance of specific BMP's.
(2) Inspections to be conducted by a qualified professional such as an environmental scientist or civil engineer.
(3) Copies of inspection report and evaluation checklist shall be submitted to the Williamsburg Conservation Commission.

Limited or no use of sodium chloride salts, fertilizers, herbicides or pesticides recommended.
Other notes: (Include deviations from: Con. Comm. Order of Conditions, PB Approval, Construction Sequence and Approved Plan)
Stormwater Control Manager: _____

STORMWATER MANAGEMENT
POST- CONSTRUCTION

INSPECTION SCHEDULE AND EVALUATION CHECKLIST

PROJECT LOCATION: 5 & 5R Hatfield Street, Williamsburg, Massachusetts **WEATHER:** _____

Inspection Date	*Inspector*	*Area Inspected*	*Required Inspection Frequency if BMP*	*Comments*	*Recommendation*	*Follow-up Inspection Required (yes/no)*
		Gravel Access Drive	*Bi-annually and After Major Storm Event*			
		Sedimentation Basins and Outlets	*Bi-annually and After Major Storm Event*			
		Grassed/Stone lined Swales	*Bi-annually and After Major Storm Event*			
		Riprap Areas	*Bi-annually and After Major Storm Event*			

(1) Refer to the Massachusetts Stormwater Handbook, Volume Two: Stormwater Technical Handbook (February 2008) for recommendations regarding frequency for inspection and maintenance of specific BMP's.
(2) Inspections to be conducted by a qualified professional such as an environmental scientist or civil engineer.
(3) Copies of inspection report and evaluation checklist shall be submitted to the Williamsburg Conservation Commission.

Limited or no use of sodium chloride salts, fertilizers, herbicides or pesticides recommended.
Other notes: (Include deviations from: Con. Comm. Order of Conditions, PB Approval, Construction Sequence and Approved Plan)
Stormwater Control Manager: _____

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION ATLAS 14

NOAA Atlas 14, Volume 10, Version 2
Location name: Haydenville, Massachusetts, USA*
Latitude: 42.378°, Longitude: -72.7049°
Elevation: 460.07 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.324** (0.250-0.417)	**0.382** (0.295-0.491)	**0.476** (0.366-0.615)	**0.555** (0.424-0.720)	**0.662** (0.491-0.895)	**0.745** (0.541-1.03)	**0.828** (0.584-1.18)	**0.924** (0.621-1.36)	**1.05** (0.681-1.60)	**1.15** (0.726-1.78)
10-min	**0.459** (0.355-0.590)	**0.541** (0.417-0.696)	**0.675** (0.519-0.871)	**0.786** (0.601-1.02)	**0.938** (0.695-1.27)	**1.06** (0.766-1.46)	**1.17** (0.827-1.68)	**1.31** (0.880-1.92)	**1.49** (0.965-2.26)	**1.63** (1.03-2.52)
15-min	**0.541** (0.417-0.694)	**0.637** (0.491-0.819)	**0.794** (0.610-1.02)	**0.924** (0.707-1.20)	**1.10** (0.818-1.49)	**1.24** (0.902-1.71)	**1.38** (0.973-1.97)	**1.54** (1.04-2.26)	**1.75** (1.14-2.66)	**1.91** (1.21-2.96)
30-min	**0.751** (0.580-0.965)	**0.885** (0.683-1.14)	**1.11** (0.849-1.43)	**1.29** (0.984-1.67)	**1.54** (1.14-2.08)	**1.73** (1.26-2.39)	**1.92** (1.36-2.74)	**2.15** (1.44-3.15)	**2.44** (1.58-3.71)	**2.66** (1.69-4.13)
60-min	**0.962** (0.743-1.24)	**1.13** (0.875-1.46)	**1.42** (1.09-1.83)	**1.65** (1.26-2.14)	**1.97** (1.46-2.66)	**2.22** (1.61-3.06)	**2.47** (1.74-3.52)	**2.75** (1.85-4.04)	**3.13** (2.03-4.75)	**3.41** (2.16-5.29)
2-hr	**1.22** (0.951-1.56)	**1.44** (1.12-1.85)	**1.80** (1.40-2.31)	**2.10** (1.62-2.71)	**2.52** (1.88-3.39)	**2.83** (2.07-3.90)	**3.15** (2.24-4.50)	**3.56** (2.40-5.19)	**4.09** (2.66-6.19)	**4.50** (2.86-6.94)
3-hr	**1.40** (1.09-1.78)	**1.66** (1.29-2.11)	**2.08** (1.62-2.66)	**2.43** (1.88-3.12)	**2.91** (2.18-3.92)	**3.29** (2.42-4.52)	**3.66** (2.62-5.23)	**4.16** (2.81-6.06)	**4.83** (3.14-7.28)	**5.34** (3.39-8.21)
6-hr	**1.74** (1.37-2.20)	**2.09** (1.64-2.64)	**2.66** (2.08-3.37)	**3.13** (2.43-3.99)	**3.78** (2.86-5.07)	**4.28** (3.18-5.88)	**4.78** (3.46-6.85)	**5.52** (3.74-8.00)	**6.49** (4.24-9.74)	**7.23** (4.61-11.1)
12-hr	**2.13** (1.69-2.67)	**2.60** (2.06-3.27)	**3.38** (2.66-4.25)	**4.02** (3.14-5.09)	**4.90** (3.73-6.54)	**5.58** (4.17-7.64)	**6.26** (4.57-8.96)	**7.31** (4.97-10.5)	**8.69** (5.69-13.0)	**9.73** (6.23-14.8)
24-hr	**2.52** (2.00-3.14)	**3.13** (2.48-3.90)	**4.12** (3.26-5.15)	**4.94** (3.89-6.22)	**6.08** (4.65-8.08)	**6.95** (5.23-9.48)	**7.82** (5.76-11.2)	**9.23** (6.30-13.2)	**11.1** (7.27-16.5)	**12.5** (8.01-18.9)
2-day	**2.88** (2.31-3.56)	**3.61** (2.89-4.47)	**4.80** (3.83-5.97)	**5.79** (4.59-7.24)	**7.15** (5.52-9.47)	**8.20** (6.22-11.2)	**9.25** (6.87-13.2)	**11.0** (7.55-15.7)	**13.4** (8.79-19.8)	**15.1** (9.74-22.8)
3-day	**3.15** (2.53-3.88)	**3.95** (3.17-4.87)	**5.25** (4.20-6.50)	**6.33** (5.04-7.88)	**7.82** (6.06-10.3)	**8.97** (6.83-12.2)	**10.1** (7.55-14.4)	**12.1** (8.30-17.2)	**14.7** (9.70-21.7)	**16.7** (10.8-25.1)
4-day	**3.39** (2.73-4.16)	**4.24** (3.41-5.21)	**5.62** (4.51-6.93)	**6.77** (5.40-8.40)	**8.35** (6.48-11.0)	**9.57** (7.30-12.9)	**10.8** (8.06-15.4)	**12.9** (8.86-18.3)	**15.6** (10.3-23.0)	**17.7** (11.5-26.6)
7-day	**4.06** (3.29-4.96)	**5.00** (4.05-6.11)	**6.53** (5.27-8.01)	**7.80** (6.25-9.63)	**9.55** (7.44-12.5)	**10.9** (8.34-14.6)	**12.2** (9.15-17.3)	**14.5** (9.99-20.4)	**17.4** (11.5-25.5)	**19.6** (12.7-29.3)
10-day	**4.74** (3.86-5.77)	**5.72** (4.65-6.97)	**7.33** (5.93-8.96)	**8.66** (6.96-10.6)	**10.5** (8.18-13.6)	**11.9** (9.11-15.9)	**13.3** (9.93-18.6)	**15.5** (10.7-21.9)	**18.4** (12.3-26.9)	**20.7** (13.4-30.8)
20-day	**6.85** (5.61-8.27)	**7.88** (6.45-9.53)	**9.57** (7.80-11.6)	**11.0** (8.89-13.4)	**12.9** (10.1-16.5)	**14.4** (11.0-18.9)	**15.9** (11.8-21.7)	**17.9** (12.4-24.9)	**20.5** (13.7-29.7)	**22.4** (14.6-33.3)
30-day	**8.59** (7.06-10.3)	**9.66** (7.93-11.6)	**11.4** (9.33-13.8)	**12.9** (10.5-15.6)	**14.9** (11.6-18.9)	**16.4** (12.5-21.3)	**17.9** (13.2-24.2)	**19.7** (13.8-27.4)	**22.1** (14.8-31.9)	**23.9** (15.6-35.3)
45-day	**10.7** (8.85-12.8)	**11.8** (9.77-14.2)	**13.7** (11.3-16.5)	**15.2** (12.4-18.5)	**17.4** (13.6-21.9)	**19.0** (14.5-24.4)	**20.6** (15.2-27.4)	**22.2** (15.6-30.8)	**24.4** (16.4-35.1)	**26.0** (17.0-38.3)
60-day	**12.5** (10.3-14.9)	**13.7** (11.3-16.3)	**15.6** (12.9-18.8)	**17.3** (14.1-20.9)	**19.5** (15.4-24.5)	**21.3** (16.3-27.2)	**23.0** (16.9-30.4)	**24.5** (17.3-33.9)	**26.6** (17.9-38.1)	**28.1** (18.4-41.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

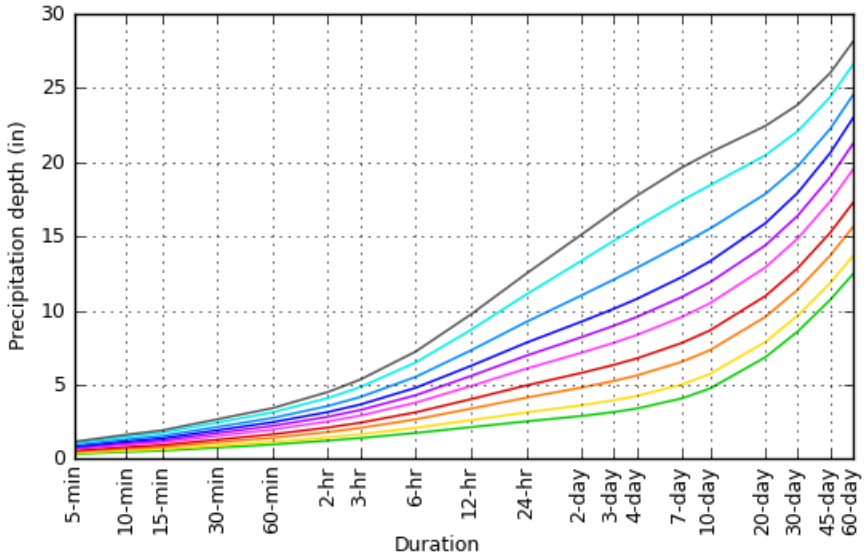
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

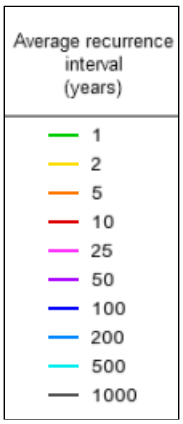
Please refer to NOAA Atlas 14 document for more information.

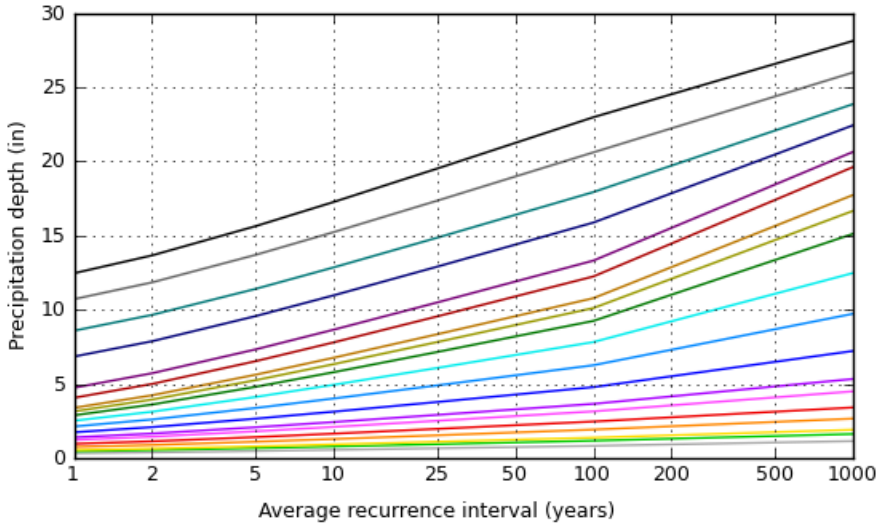
Back to Top

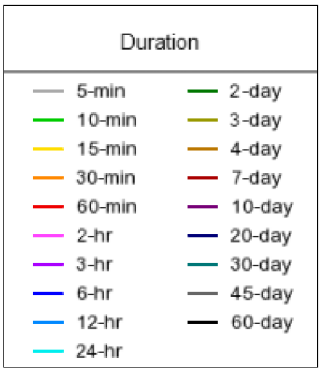
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 42.3780°, Longitude: -72.7049°









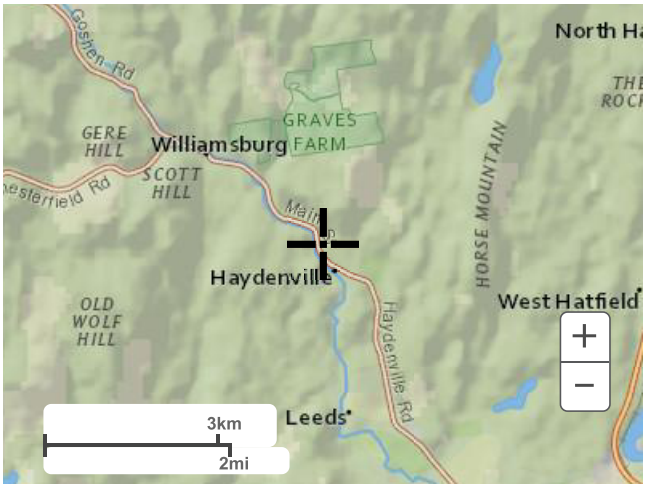
NOAA Atlas 14, Volume 10, Version 2

Created (GMT): Fri Sep 28 13:48:56 2018

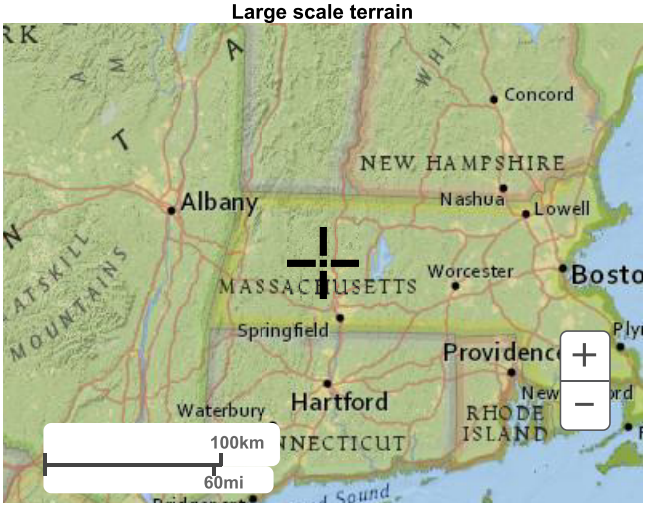
Back to Top

Maps & aerials

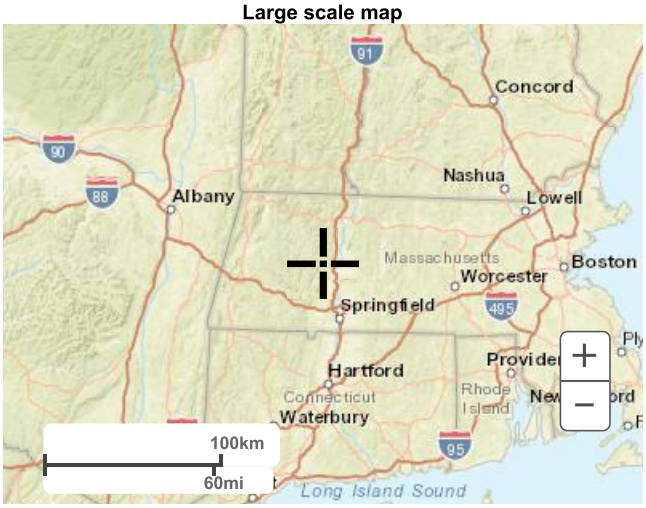
Small scale terrain



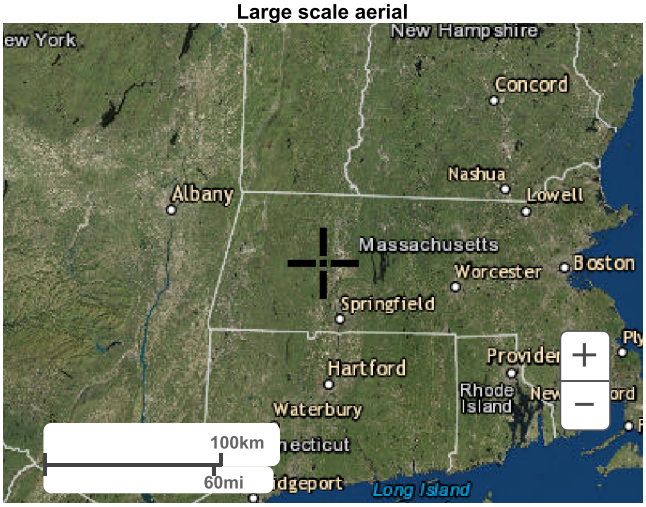
Large scale terrain



Large scale map



Large scale aerial



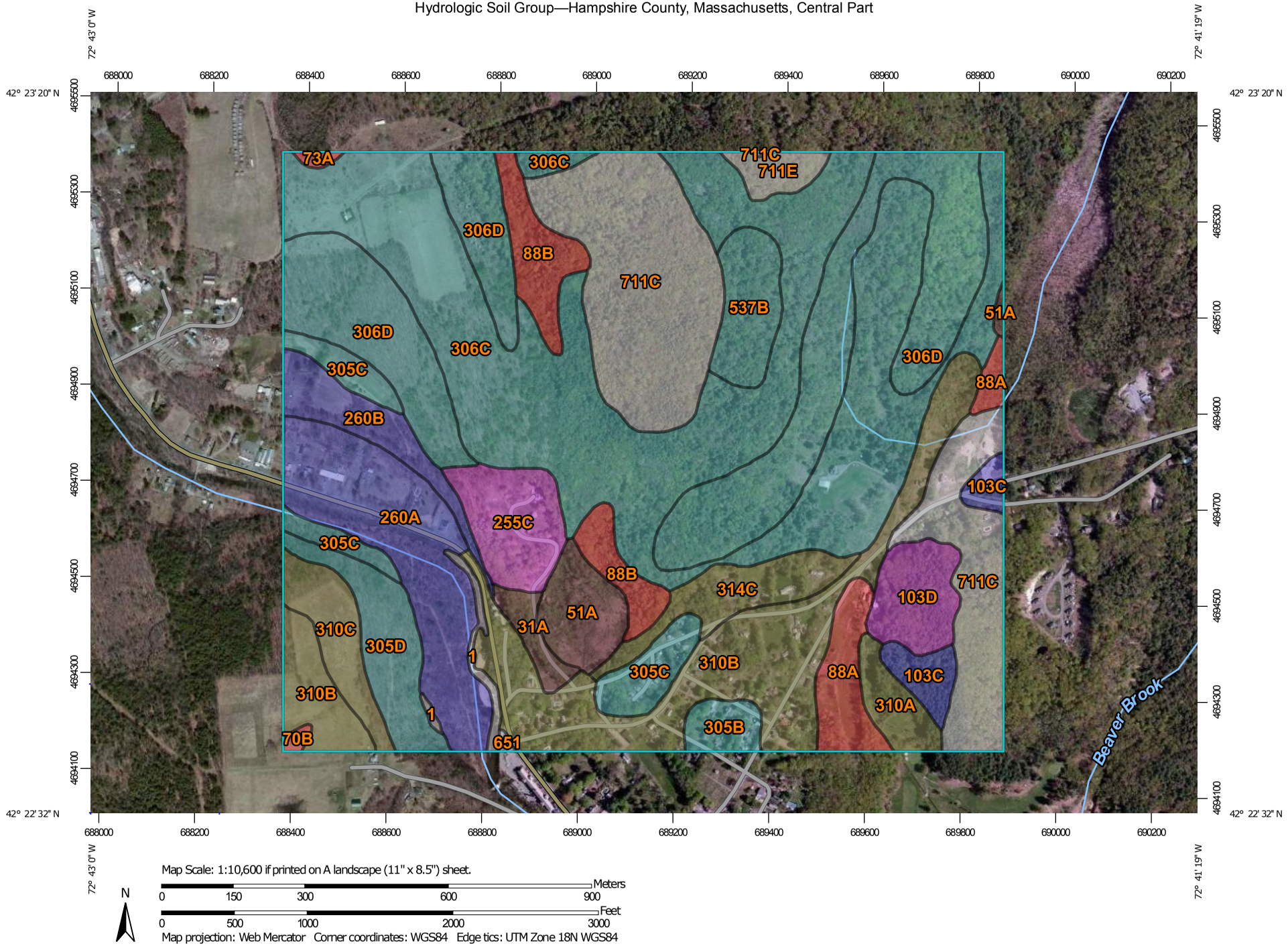
Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

USDA NATURAL RESOURCE CONSERVATION SERVICE

NATIONAL COOPERATIVE SOIL SURVEY


72° 43' 0" W
72° 41' 19" W
42° 23' 20" N
42° 22' 32" N
688000
688200
688400
688600
688800
689000
689200
689400
689600
689800
690000
690200
4695500
4695300
4695100
4694900
4694700
4694500
4694300
4694100
73A
306C
711C
711E
306D
88B
711C
537B
51A
306D
306C
306D
88A
305C
260B
103C
260A
255C
305C
88B
314C
711C
103D
51A
31A
310C
305D
1
305C
310B
88A
103C
310B
310A
1
305B
70B
651
Beaver Brook
Map Scale: 1:10,600 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0
150
300
600
900
Feet
0
500
1000
2000
3000
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N 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 1:15,800.

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: Hampshire County, Massachusetts, Central Part
Survey Area Data: Version 12, Oct 6, 2017

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

Date(s) aerial images were photographed: Mar 28, 2011—Mar 27, 2012

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

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Water		2.1	0.5%
31A	Walpole sandy loam, 0 to 3 percent slopes	B/D	3.4	0.7%
51A	Swansea muck, 0 to 1 percent slopes	B/D	8.9	1.9%
70B	Ridgebury fine sandy loam, 3 to 8 percent slopes	D	0.6	0.1%
73A	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	D	0.6	0.1%
88A	Ridgebury fine sandy loam, 0 to 3 percent slopes, very stony	D	9.6	2.1%
88B	Ridgebury fine sandy loam, 3 to 8 percent slopes, very stony	D	13.0	2.8%
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes	B	5.8	1.2%
103D	Charlton-Hollis- Rock outcrop complex, 15 to 25 percent slopes	A	9.1	2.0%
255C	Windsor loamy sand, 8 to 15 percent slopes	A	11.7	2.5%
260A	Sudbury fine sandy loam, 0 to 3 percent slopes	B	29.3	6.3%
260B	Sudbury fine sandy loam, 3 to 8 percent slopes	B	9.1	1.9%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	C	4.0	0.9%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	C	12.1	2.6%
305D	Paxton fine sandy loam, 15 to 25 percent slopes	C	12.0	2.6%
306C	Paxton fine sandy loam, 8 to 15 percent slopes, very stony	C	124.4	26.7%
306D	Paxton fine sandy loam, 15 to 25 percent slopes, very stony	C	68.4	14.7%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
310A	Woodbridge fine sandy loam, 0 to 3 percent slopes	C/D	5.4	1.2%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	47.0	10.1%
310C	Woodbridge fine sandy loam, 8 to 15 percent slopes	C/D	8.7	1.9%
314C	Woodbridge fine sandy loam, 8 to 15 percent slopes, stony	C/D	10.0	2.2%
537B	Paxton fine sandy loam, 3 to 8 percent slopes, stony	C	9.4	2.0%
651	Udorthents, smoothed		0.2	0.1%
711C	Charlton-Rock outcrop-Hollis complex, sloping		57.6	12.4%
711E	Charlton-Rock outcrop-Hollis complex, steep		3.7	0.8%
Totals for Area of Interest			**466.4**	**100.0%**

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLOOD INSURANCE RATE MAP

KEY TO MAP

500-Year Flood Boundary	ZONE B
100-Year Flood Boundary	ZONE B
Zone Designations* With Date of Identification e.g., 12/2/74	ZONE A1 DATE / ZONE A5 DATE
100-Year Flood Boundary	ZONE B
500-Year Flood Boundary	ZONE B
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7 ×
River Mile	•M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

For adjoining map panels, see separately printed Index To Map Panels.

INITIAL IDENTIFICATION:
SEPTEMBER 13, 1974

FLOOD HAZARD BOUNDARY MAP REVISIONS:
OCTOBER 8, 1976

FLOOD INSURANCE RATE MAP EFFECTIVE:
JUNE 1, 1981

FLOOD INSURANCE RATE MAP REVISIONS:

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program at (800) 638-6620, or (800) 424-8872.

APPROXIMATE SCALE
600 0 600 FEET

ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION IN FT. (NGVD)[1]	DESCRIPTION OF LOCATION
RM 1	490.00	Chiseled square on the southeast corner of a concrete header on the **western** side of Mountain Street, 6 feet south of Haddenville-Whately town line.
RM 2	437.25	Chiseled square on northeast corner of concrete header for Beaver Brook located on the east side of Mountain Street, about 2000 feet south of the intersection with Adams Road, and about 65 feet north of pole 101/90.
RM 3	441.42	Chiseled square on boulder on east side of Mountain Street, about 300 feet north of intersection with North Farms Road, 12 feet northeast of pole 8/28/70 and 15 feet east of the centerline of Mountain Street.
RM 4	480.56	Chiseled square on ledge outcrop 15 feet south of Mountain Street, about 2200 feet west of intersection with North Farms Road and 50 feet east and opposite Pole 44, and about 300 feet east and opposite the drive to the landfill.
RM 5	454.30	Top of most easterly holddown bolt on hydrant over main discharge nozzle (closest to road), on the western side of Mountain Street, about 2400 feet northeast of intersection of Mountain Street and State Route 9 and 10 feet southwest of pole 43/13.
RM 6	417.54	Top of hydrant, directly on the number tag (No. 1891) on the south side of State Route 9, in front of house No. 116. Point is opposite pole 159/7 and opposite entrance to Beaver Brook Country Club, Inc.
RM 7	427.9	Standard tablet stamped C 49 1933 428 located on top of the east retaining wall, 40 feet north of the South Main Street bridge over Mill River, 448 feet north of Congregational Church, and 60 feet west of State Route 9.
RM 8	458.67	Chiseled square on the large boulder on the southwest side of State Route 9, about 2500 feet southeast of intersection with Depot Road.
RM 9	496.07	Chiseled square on the northeast corner of a bridge abutment on southwest end of bridge over Mill River on State Route 9 about 1100 feet northwest of intersection of Depot Road and State Route 9.

[1] National Geodetic Vertical Datum of 1929

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

TOWN OF
WILLIAMSBURG, MASSACHUSETTS
HAMPSHIRE COUNTY

PANEL 2 OF 4
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
250174 0002 B

EFFECTIVE DATE:
JUNE 1, 1981

federal emergency management agency
federal insurance administration

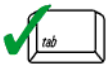
CHECKLIST FOR
STORMWATER REPORT

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.

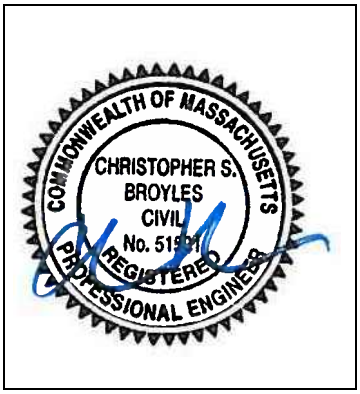
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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): Low Impact Design screw & post racking system

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.