Stormwater Management Report

140 Tihonet Road PV+ES Project

140 Tihonet Road (aka 0 & 169 Tihonet Road)
Wareham, Massachusetts

Prepared for:

Borrego Solar Systems, Inc.
55 Technology Drive, Suite 102
Lowell, MA 01851

Prepared by:

BEALS + THOMAS
BEALS AND THOMAS, INC.
32 Court Street
Plymouth, MA 02360

June 2, 2020
Revised: January 19, 2021

Calculated by: **Nathaniel B. Bautz, EIT**

Checked by: **Jeffrey R. Murphy, PE**

Approved by:

COMMONWEALTH OF MASSACHUSETTS
JEFFREY R. MURPHY
CIVIL
No. 51800
REGISTERED PROFESSIONAL ENGINEER

Jeffrey R Murphy 1/19/2021

Jeffrey R. Murphy, PE

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LIST OF ATTACHMENTS

1.0 INTRODUCTION

The proposed project includes a stormwater management system designed to mitigate potential impacts the proposed project could have on the existing watershed. Stormwater controls are proposed to control peak runoff rates, provide water quality, promote groundwater recharge and sediment removal. The proposed system has been designed to comply with:

- The 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Handbook,
- The Massachusetts Wetland Protection Act (310 CMR 10.00), and
- Town of Wareham Zoning Bylaw

The pre- and post-development hydrologic conditions were modeled using HydroCAD™ version 10.00 to demonstrate that post-development stormwater runoff rates will be less than or equal to the pre-development rates. Watershed maps with soil types as well as detailed analysis of the model results are also included. The following table summarizes the peak runoff rates for the pre- and post-development conditions.

Table 1: Pre- & Post-development Peak Runoff Rate Comparison, units are in cubic feet per second (cfs).

Storm Event	2 Year		10 Year		100 Year	
	Pre	Post	*Pre*	Post	*Pre*	Post
Design Point 1	*0.0*	0.0	*0.0*	0.0	*0.3*	0.2
Design Point 2	*0.0*	0.0	*0.1*	0.1	*1.9*	1.7
Design Point 3	*0.0*	0.0	*0.0*	0.0	*1.0*	0.6
Design Point 4	*0.0*	0.0	*0.0*	0.0	*0.5*	0.1
Design Point 5	*0.0*	0.0	*0.0*	0.0	*0.4*	0.3

2.0 PRE-DEVELOPMENT CONDITIONS

2.1 Site Conditions

The site is accessed by the unpaved portion of Tihonet Road behind the A.D. Makepeace Company headquarters. The site is currently undeveloped and is primarily wooded with an existing gravel cart path to the south and east. Runoff from the site drains radially outward from the existing hilltop ridge. Flows to the west go towards Tihonet Road and Tihonet Pond. Flows to the southwest are directed to an existing agricultural channel that flows southeast from Tihonet Pond into existing bogs south of the proposed array. Runoff also flows to existing bogs both on-site as well as off-site to the southeast, and easterly to an existing wetland system. North of the proposed solar array, there is an existing cleared utility transmission easement.

The site does not contain, nor is it tributary to any Critical Areas.

The site does not discharge to a surface water with a TMDL or draft TMDL.

2.2 Soil Description

The Natural Resources Conservation Service (NRCS) lists the on-site soils types as predominantly hydrologic soil class A. These soil groups include Poquonock sand, Plymouth-Carver complex, Carver loamy coarse sand, and Hinckley loamy sand, and Gloucester-Canton complex. A small area of hydrologic soil class D soils is present at the southwestern corner of the proposed project locus, which is classified as Udipsamments-wet substratum.

Poquonock sand is a well-drained soil comprised of sandy eolian or glaciofluvial deposits over coarse-loamy lodgment till. Generally, this soil is in areas with drumlins, ground moraines, and till plains and has a sand layer that extends to about 30 inches below the surface followed by a gravelly sandy loam layer which extends to about 70 inches below the surface. Plymouth-Carver complex is an excessively drained soil that is characterized by sandy gravelly glaciofluvial deposits. Carver loamy coarse sand and Hinckley loamy sand and Gloucester-Canton complex are also excessively drained sandy glaciofluvial outwash soil types. Udipsamments-wet substratum are defined as sandy human transported material over sandy and gravelly glaciofluvial deposits.

2.3 Hydrologic Analysis

Sub-catchment areas were delineated based on existing runoff patterns and topographic information. This information is shown on the *Pre-Development Conditions Hydrologic Areas Map* included in Attachment 2. Summaries of each area with respect to Curve Number and Time of Concentration calculations can be found in the model results also in Attachment 2.

3.0 POST-DEVELOPMENT CONDITIONS

3.1 Design Strategy

During the design phase of the site layout, consideration was given to conserving environmentally sensitive features and minimizing impact on the existing hydrology. To achieve this, the proposed grading endeavored to match the existing drainage patterns where feasible.

Wetlands in the vicinity of the site were excluded from the development envelope and will not be altered by the proposed project. The hydrology analysis considers these wetlands in order to maintain their existing hydrology.

The proposed solar panels are raised above the ground with the leading edge tilted to the south. Stormwater that lands on the panels will sheet down off the front edge to the pervious sandy ground below, which will be vegetated with an herbaceous seed mix.

There will be several concrete pads associated with the utility equipment that will produce a negligible amount of runoff which will flow to adjacent pervious soils. These have been accounted for in the stormwater design and analysis.

3.2 Hydrologic Analysis Methodology

The established design points used in the pre-development conditions analysis were used in the post-development analysis for direct comparison. The tributary areas and flow paths were modified to reflect post-development conditions. See Attachment 3 for the *Post-Development Conditions Hydrologic Areas Map*. Summaries of each area with respect to Curve Number and Time of Concentration calculations can be found in the model results in Attachment 3.

3.3 Compliance with MassDEP Stormwater Management Standards

The proposed stormwater management system was designed in compliance with the ten (10) MassDEP Stormwater Management Standards. The following summary provides key information related to the design approach and mitigation measures for stormwater.

STANDARD 1: **No new stormwater conveyance (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.**

There will be no direct discharge of untreated stormwater from the site. Erosion control barriers will be installed as depicted on the plans and will remain in place throughout construction and until the site is stabilized with vegetation.

STANDARD 2: **Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.**

The proposed stormwater management system will effectively maintain the post-development peak discharge rates for the 2-, 10-, and 100-year, 24-hour storms. Refer to Section 1.0 Introduction for a summary of the peak runoff rates.

STANDARD 3: **Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater management practices and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil types. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.**

The proposed solar panels, while covering a large footprint, will allow water to sheet flow to the ground below where it can be absorbed into the sandy on-site soils. Other minimal areas of impervious (i.e. concrete pads) as well as the proposed changes in vegetative cover have been accounted for in the design. Proposed infiltration basins and infiltration trenches will provide the required recharge based on the footprint of the impervious concrete pads. Therefore, recharge of groundwater will be maintained under the post-development condition.

STANDARD 4: **Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).**

The proposed project does not include any proposed impervious surfaces requiring treatment for water quality. Therefore, the 80% TSS removal requirement does not apply.

STANDARD 5: **For land uses with higher potential pollutant loads (LUHPPLs), source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.**

The proposed project is not associated with stormwater discharges from land uses with higher potential pollutant loads.

STANDARD 6: **Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas. Critical areas are Outstanding Resource Waters, shellfish beds, swimming beaches, coldwater fisheries and recharge areas for public water supplies.**

There are no stormwater discharges to critical areas associated with this project.

STANDARD 7: **Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. However, if it is not practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions.**

The proposed project is new development, and therefore this standard does not apply.

STANDARD 8: **A plan to control construction-related impacts during erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.**

Since the project will disturb greater than 1 acre, a DRAFT Stormwater Pollution Prevention Plan (SWPPP) has been developed and is included in Attachment 5. The SWPPP will be finalized prior to construction to comply with Section 3 of the NPDES Construction General Permit for Stormwater Discharges; therefore the requirements of Standard 8 are fulfilled.

STANDARD 9: **A Long-Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed.**

The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 MassDEP Stormwater Management Standards. The Manual outlines source control and pollution prevention measures and maintenance requirements associated with the proposed development.

STANDARD 10: **All illicit discharges to the stormwater management system are prohibited.**

There will be no illicit discharges to the proposed stormwater management system associated with the proposed project. An Illicit Discharge Compliance Statement is provided on the following page.

3.5 Illicit Discharge Compliance Statement

An illicit discharge is any discharge to a stormwater management system that is not comprised entirely of stormwater, discharges from fire-fighting activities, and certain non-designated non-stormwater discharges.

To the best of my knowledge, no detectable illicit discharge exists on site. The site plans included with this report detail the storm sewers that convey stormwater on the site and demonstrate that these systems do not include the entry of an illicit discharge. A Site Owner's Manual is included, which contains the Long Term Pollution Prevention Plan that outlines measures to prevent future illicit discharges. As the Site Owner, I will ultimately be responsible for implementing the Long Term Pollution Prevention Plan.

Signature: _____

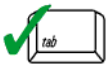
Owner's Name

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.

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[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.

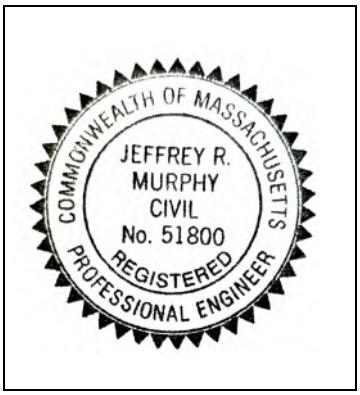
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



Jeffrey R Murphy 1/19/2021
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): _____

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

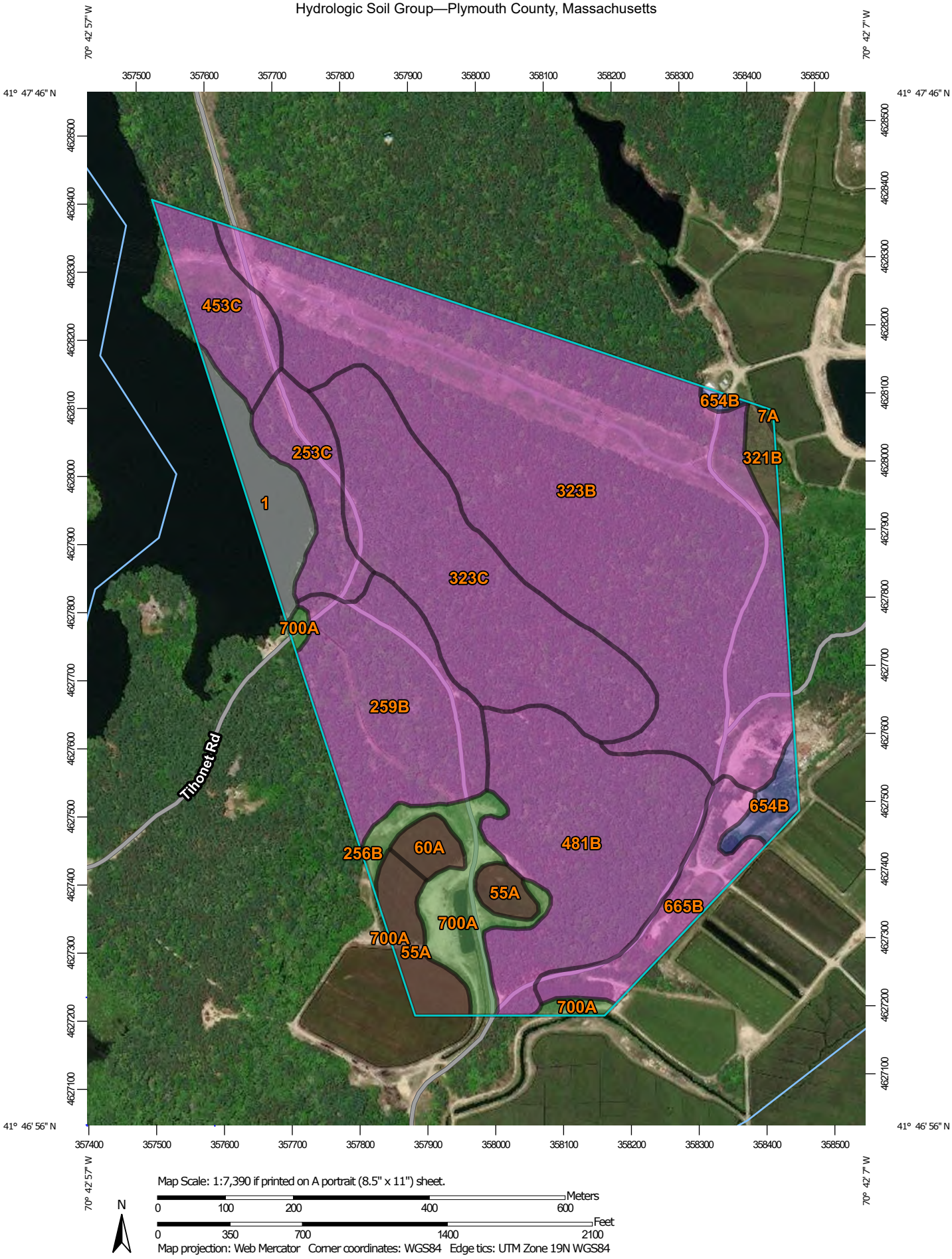
☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ 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.

Attachment 1
Soil Data

Hydrologic Soil Group—Plymouth County, Massachusetts



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 1:12,000.

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: Plymouth County, Massachusetts
Survey Area Data: Version 12, Sep 12, 2019

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

Date(s) aerial images were photographed: Dec 31, 2009—Jul 3, 2017

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		5.1	2.9%
7A	Rainberry coarse sand, 0 to 3 percent slopes, sanded surface	A/D	0.1	0.0%
55A	Freetown coarse sand, 0 to 3 percent slopes, sanded surface	B/D	5.0	2.9%
60A	Swansea coarse sand, 0 to 2 percent slopes	B/D	1.6	0.9%
253C	Hinckley loamy sand, 8 to 15 percent slopes	A	6.4	3.7%
256B	Deerfield loamy fine sand, 3 to 8 percent slopes	A	0.0	0.0%
259B	Carver loamy coarse sand, 3 to 8 percent slopes	A	17.0	9.7%
321B	Birchwood sand, 3 to 8 percent slopes, very stony	B/D	1.4	0.8%
323B	Poquonock sand, 3 to 8 percent slopes, very stony	A	67.2	38.5%
323C	Poquonock sand, 8 to 15 percent slopes, very stony	A	24.3	13.9%
453C	Gloucester - Canton complex, 8 to 15 percent slopes, extremely bouldery	A	6.6	3.8%
481B	Plymouth - Carver complex, 3 to 8 percent slopes, bouldery	A	23.3	13.3%
654B	Udorthents, loamy, 0 to 8 percent slopes	B	2.3	1.3%
665B	Udipsamments, 0 to 8 percent slopes	A	6.4	3.7%
700A	Udipsamments, wet substratum, 0 to 3 percent slopes	A/D	8.1	4.7%
Totals for Area of Interest			**174.8**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Plymouth County, Massachusetts

253C—Hinckley loamy sand, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2svm9
Elevation: 0 to 1,480 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landform: Outwash plains, moraines, outwash deltas, eskers, outwash terraces, kames, kame terraces
Landform position (two-dimensional): Shoulder, toeslope, footslope, backslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, riser
Down-slope shape: Convex, linear, concave
Across-slope shape: Linear, convex, concave
Parent material: Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 8 inches: loamy sand
Bw1 - 8 to 11 inches: gravelly loamy sand
Bw2 - 11 to 16 inches: gravelly loamy sand
BC - 16 to 19 inches: very gravelly loamy sand
C - 19 to 65 inches: very gravelly sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water storage in profile: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Merrimac

Percent of map unit: 5 percent
Landform: Moraines, outwash plains, eskers, outwash terraces, kames
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Side slope, crest, head slope, nose slope, riser
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Windsor

Percent of map unit: 5 percent
Landform: Outwash plains, outwash deltas, moraines, outwash terraces, eskers, kames, kame terraces
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, riser
Down-slope shape: Convex, linear, concave
Across-slope shape: Linear, convex, concave
Hydric soil rating: No

Sudbury

Percent of map unit: 5 percent
Landform: Moraines, outwash deltas, outwash terraces, kame terraces, outwash plains
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Hydric soil rating: No

Data Source Information

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 12, Sep 12, 2019

Plymouth County, Massachusetts

259B—Carver loamy coarse sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2y07t
Elevation: 0 to 240 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Carver, loamy coarse sand, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Carver, Loamy Coarse Sand

Setting

Landform: Outwash plains, moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
Oe - 2 to 3 inches: moderately decomposed plant material
A - 3 to 7 inches: loamy coarse sand
E - 7 to 10 inches: coarse sand
Bw1 - 10 to 15 inches: coarse sand
Bw2 - 15 to 28 inches: coarse sand
BC - 28 to 32 inches: coarse sand
C - 32 to 67 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water storage in profile: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: Dry Outwash (F149BY005MA)
Hydric soil rating: No

Minor Components

Deerfield

Percent of map unit: 10 percent
Landform: Outwash plains, outwash terraces, outwash deltas, kame terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Hinckley

Percent of map unit: 5 percent
Landform: Moraines, kames, outwash terraces, eskers, kame terraces, outwash plains, outwash deltas
Landform position (two-dimensional): Summit, toeslope, shoulder, backslope, footslope
Landform position (three-dimensional): Side slope, crest, head slope, nose slope, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Merrimac

Percent of map unit: 3 percent
Landform: Outwash terraces, outwash deltas, kame terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Mashpee

Percent of map unit: 2 percent
Landform: Terraces, drainageways, depressions
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 12, Sep 12, 2019

Plymouth County, Massachusetts

323B—Poquonock sand, 3 to 8 percent slopes, very stony

Map Unit Setting

National map unit symbol: bcz7
Elevation: 0 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Poquonock, very stony, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Poquonock, Very Stony

Setting

Landform: Drumlins, ground moraines, till plains
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy eolian deposits and/or glaciofluvial deposits over coarse-loamy lodgment till

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oe - 1 to 2 inches: moderately decomposed plant material
A - 2 to 4 inches: sand
E - 4 to 5 inches: sand
Bs - 5 to 7 inches: loamy sand
Bw - 7 to 26 inches: sand
BC - 26 to 35 inches: loamy sand
2Cd1 - 35 to 49 inches: gravelly sandy loam
2Cd2 - 49 to 71 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Percent of area covered with surface fragments: 1.5 percent
Depth to restrictive feature: 20 to 39 inches to densic material
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 22 to 35 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Birchwood, very stony

Percent of map unit: 8 percent
Landform: Drumlins, ground moraines, till plains
Landform position (two-dimensional): Summit, footslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Mattapoisett, extremely stony

Percent of map unit: 7 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Montauk, very stony

Percent of map unit: 3 percent
Landform: Drumlins, ground moraines, till plains
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Scituate, very stony

Percent of map unit: 2 percent
Landform: Ridges, drumlins
Landform position (two-dimensional): Footslope, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Data Source Information

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 12, Sep 12, 2019

Plymouth County, Massachusetts

323C—Poquonock sand, 8 to 15 percent slopes, very stony

Map Unit Setting

National map unit symbol: bcz6
Elevation: 0 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Poquonock, very stony, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Poquonock, Very Stony

Setting

Landform: Drumlins, ground moraines, till plains
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy eolian deposits and/or glaciofluvial deposits over coarse-loamy lodgment till

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oe - 1 to 2 inches: moderately decomposed plant material
A - 2 to 4 inches: sand
E - 4 to 5 inches: sand
Bs - 5 to 7 inches: loamy sand
Bw - 7 to 26 inches: sand
BC - 26 to 35 inches: loamy sand
2Cd1 - 35 to 49 inches: gravelly sandy loam
2Cd2 - 49 to 71 inches: gravelly sandy loam

Properties and qualities

Slope: 8 to 15 percent
Percent of area covered with surface fragments: 1.5 percent
Depth to restrictive feature: 20 to 39 inches to densic material
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 22 to 35 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Birchwood, very stony

Percent of map unit: 10 percent
Landform: Ground moraines, till plains, drumlins
Landform position (two-dimensional): Summit, footslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Scituate, very stony

Percent of map unit: 5 percent
Landform: Drumlins, ridges
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Montauk, very stony

Percent of map unit: 5 percent
Landform: Till plains, drumlins, ground moraines
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Data Source Information

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 12, Sep 12, 2019

Plymouth County, Massachusetts

481B—Plymouth - Carver complex, 3 to 8 percent slopes, bouldery

Map Unit Setting

National map unit symbol: bcz2
Elevation: 0 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Plymouth, bouldery, and similar soils: 45 percent
Carver, bouldery, and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plymouth, Bouldery

Setting

Landform: Outwash plains, moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy and gravelly supraglacial meltout till over sandy and gravelly glaciofluvial deposits

Typical profile

Oi - 0 to 4 inches: slightly decomposed plant material
Oe - 4 to 6 inches: moderately decomposed plant material
A - 6 to 7 inches: loamy coarse sand
E - 7 to 11 inches: coarse sand
Bs - 11 to 15 inches: loamy coarse sand
Bw - 15 to 20 inches: coarse sand
BC - 20 to 29 inches: coarse sand
C - 29 to 64 inches: gravelly coarse sand

Properties and qualities

Slope: 3 to 8 percent
Percent of area covered with surface fragments: 0.1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Available water storage in profile: Low (about 3.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A
Hydric soil rating: No

Description of Carver, Bouldery

Setting

Landform: Outwash plains, moraines, pitted outwash plains
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy glaciofluvial deposits

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
Oe - 2 to 3 inches: moderately decomposed plant material
A - 3 to 7 inches: coarse sand
E - 7 to 10 inches: coarse sand
Bw1 - 10 to 15 inches: coarse sand
Bw2 - 15 to 28 inches: coarse sand
BC - 28 to 32 inches: coarse sand
C - 32 to 67 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Percent of area covered with surface fragments: 0.1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Barnstable, bouldery

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve

Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Poquonock, bouldery

Percent of map unit: 5 percent
Landform: Drumlins, ground moraines, till plains
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent
Landform: Outwash plains, terraces, kames
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Data Source Information

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 12, Sep 12, 2019

Attachment 2
Pre-Development Hydrologic Analysis

BEALS + THOMAS

B E A L S + T H O M A S
BEALS AND THOMAS, INC.
Reservoir Corporate Center
144 Turnpike Road
Southborough, MA 01772-2104

CALCULATION SUMMARY

T 508.366.0560
F 508.366.4391
www.bealsandthomas.com
Regional Office: Plymouth, MA

JOB NO./LOCATION:

1833.112
Wareham, MA

CLIENT/PROJECT:

Borrego Solar Systems, Inc.
140 Tihonet Road PV+ES Project

SUBJECT/TITLE:

Pre-Development Hydrologic Calculations

OBJECTIVE OF CALCULATION:

- To determine the pre-development peak rates of runoff from the site for the 2, 10, & 100-year storm events at design points DP-1 through 5.

CALCULATION METHOD(S):

- Runoff curve numbers (CN), time-of-concentration (Tc), and runoff rates were calculated based on TR-55 methodology.
- Autodesk Civil 3D 2019 computer program was utilized for digitizing ground cover areas.
- Peak runoff rates were computed using HydroCAD version 10.00.

ASSUMPTIONS:

- The ground cover types were determined using MassGIS aerial imagery and hydrologic soil groups based on United States Department of Agriculture, NRCS Soil Survey map information.
- Watershed boundaries have been estimated based upon contour information depicted on the Existing Conditions Plan as well as MassGIS contours in offsite areas outside limits of those shown on the existing conditions plan.
- Wetland systems were not included in the hydrologic analysis.

SOURCES OF DATA/EQUATIONS:

- Pre-Development Conditions Hydrologic Areas Map prepared by Beals and Thomas, Inc. File No. 1833112P593B-001.
- NRCS Soil Survey for Plymouth County, hydrologic soil group report, downloaded from Web Soil Survey on 3/12/2020.
- TR-55 urban Hydrology for Small Watersheds, SCS, 1986.
- Massachusetts DEP Stormwater Management Handbook, February 2008.

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	N. Bautz	05/31/2020	J. Murphy	6/1/2020	J. Murphy	6/1/2020
1	N. Bautz	1/14/2021	J. Murphy	1/19/2021	J. Murphy	1/19/2021

B E A L S + T H O M A S
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Southborough, MA 01772-2104

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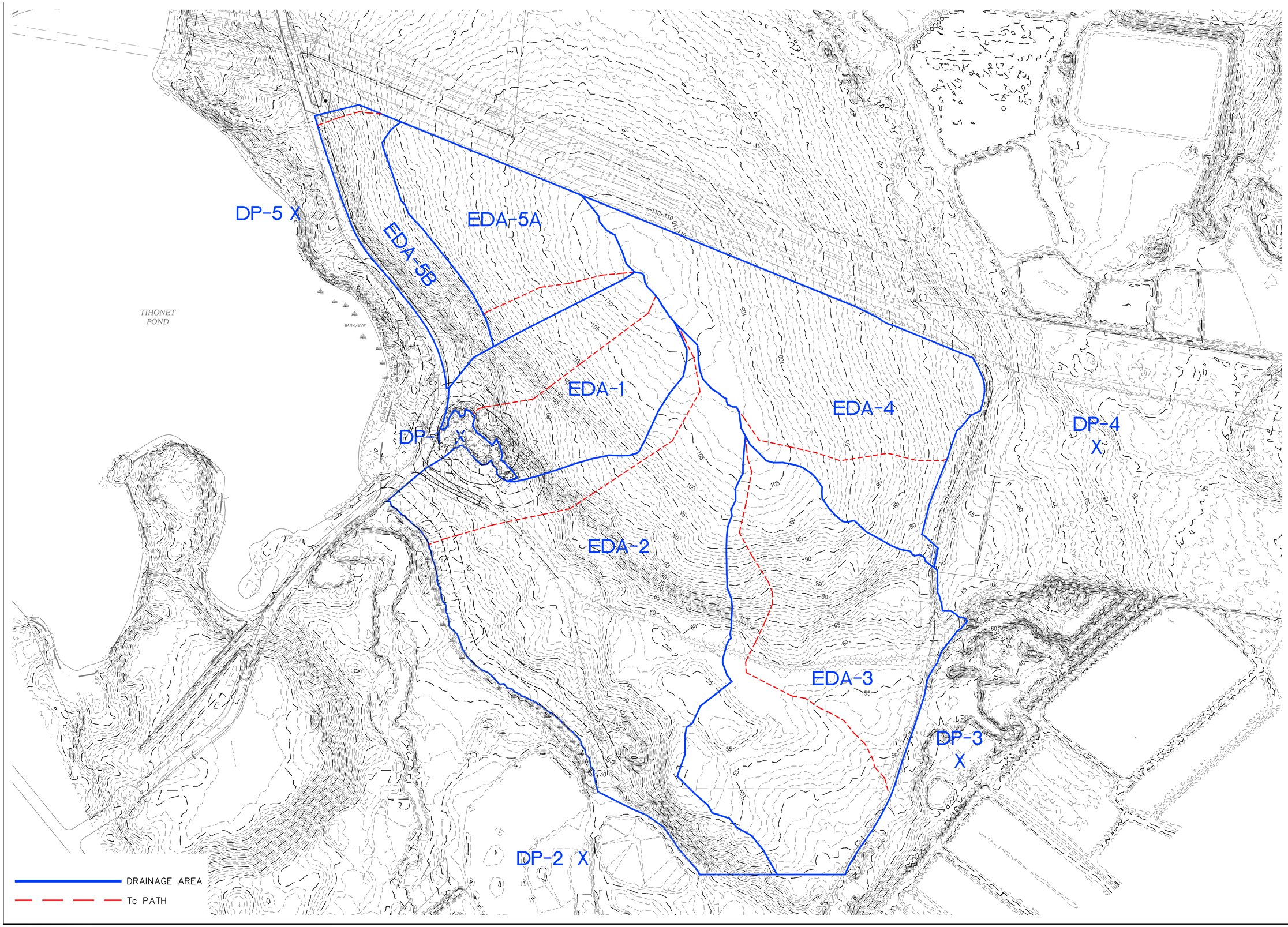
F 508.366.4391
www.bealsandthomas.com
Regional Office: Plymouth, MA

CONCLUSIONS:

Storm Event	2-Year	10-Year	100-Year
DP-1 (cfs)	0.0	0.0	0.3
DP-2 (cfs)	0.0	0.1	1.9
DP-3 (cfs)	0.0	0.0	1.0
DP-4 (cfs)	0.0	0.0	0.5
DP-5 (cfs)	0.0	0.0	0.4

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	N. Bautz	05/31/2020	J. Murphy	6/1/2020	J. Murphy	6/1/2020
1	N. Bautz	1/14/2021	J. Murphy	1/19/2021	J. Murphy	1/19/2021



Pre-Development Conditions Hydrologic Areas Map

Figure Number 001

Scale: 1" = 150'

Date: 01/04/2021

Plan 1833112P593B-001

B+T Project No. 1833.112

140 Tihonet Road PV+ES Project

Wareham, Massachusetts

Borrego Solar Systems, Inc.

55 Technology Drive, Suite 102

Lowell, Massachusetts

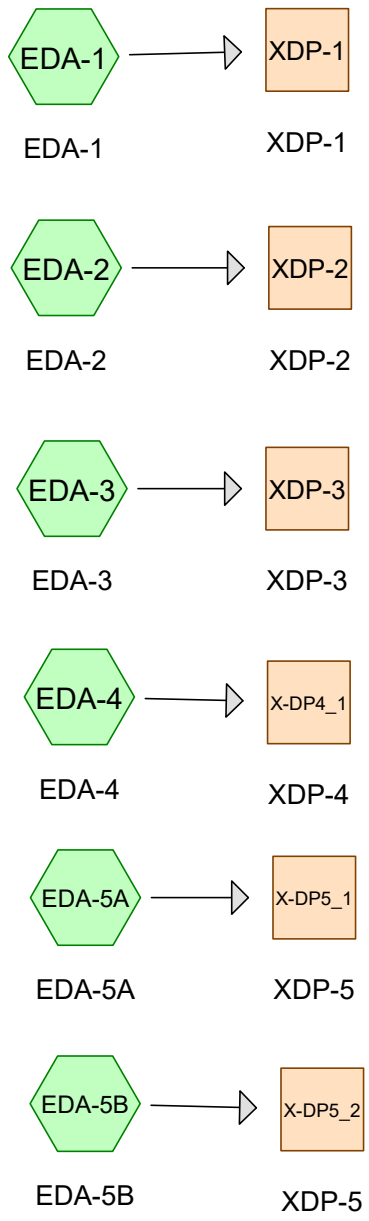
North Arrow

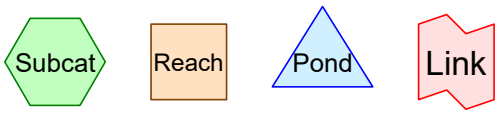
NORTH

BEALS AND THOMAS, INC.

140 Tihonet Road
Solar

Pre-Development
Conditions Hydrology





Routing Diagram for 1833112HC001B
Prepared by Beals and Thomas, Inc., Printed 1/14/2021
HydroCAD® 10.10-4a s/n 04493 © 2020 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.403	39	>75% Grass cover, Good, HSG A (EDA-5B)
1.032	96	Gravel surface, HSG A (EDA-2, EDA-3, EDA-4)
0.190	96	Gravel surface, HSG D (EDA-2)
87.129	30	Woods, Good, HSG A (EDA-1, EDA-2, EDA-3, EDA-4, EDA-5A, EDA-5B)
0.569	77	Woods, Good, HSG D (EDA-2)
89.323	**31**	**TOTAL AREA**

Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EDA-1: EDA-1 Runoff Area=9.142 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=820' Tc=22.5 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment EDA-2: EDA-2 Runoff Area=27.900 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=1,436' Tc=39.1 min CN=33 Runoff=0.00 cfs 0.000 af

Subcatchment EDA-3: EDA-3 Runoff Area=21.829 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=1,626' Tc=46.8 min CN=32 Runoff=0.00 cfs 0.000 af

Subcatchment EDA-4: EDA-4 Runoff Area=16.948 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=845' Tc=30.3 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment EDA-5A: EDA-5A Runoff Area=8.440 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=577' Tc=19.6 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment EDA-5B: EDA-5B Runoff Area=5.064 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=241' Tc=8.8 min CN=31 Runoff=0.00 cfs 0.000 af

Reach X-DP4_1: XDP-4 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach X-DP5_1: XDP-5 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach X-DP5_2: XDP-5 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach XDP-1: XDP-1 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach XDP-2: XDP-2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach XDP-3: XDP-3 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 89.323 ac Runoff Volume = 0.000 af Average Runoff Depth = 0.00"
100.00% Pervious = 89.323 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment EDA-1: EDA-1

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
9.142	30	Woods, Good, HSG A
9.142		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	50	0.0200	0.07		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
5.6	327	0.0380	0.97		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
1.6	131	0.0760	1.38		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
0.7	83	0.1690	2.06		**Shallow Concentrated Flow, Tc-4** Woodland Kv= 5.0 fps
1.4	101	0.0590	1.21		**Shallow Concentrated Flow, Tc-5** Woodland Kv= 5.0 fps
0.5	66	0.2270	2.38		**Shallow Concentrated Flow, Tc-6** Woodland Kv= 5.0 fps
0.5	34	0.0590	1.21		**Shallow Concentrated Flow, Tc-7** Woodland Kv= 5.0 fps
0.2	28	0.2500	2.50		**Shallow Concentrated Flow, Tc-8** Woodland Kv= 5.0 fps
22.5	820	Total			

Summary for Subcatchment EDA-2: EDA-2

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
26.629	30	Woods, Good, HSG A
0.569	77	Woods, Good, HSG D
0.512	96	Gravel surface, HSG A
0.190	96	Gravel surface, HSG D
27.900	33	Weighted Average
27.900		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
5.6	204	0.0150	0.61		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
4.4	206	0.0240	0.77		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
4.9	344	0.0550	1.17		**Shallow Concentrated Flow, Tc-4** Woodland Kv= 5.0 fps
1.8	203	0.1430	1.89		**Shallow Concentrated Flow, Tc-5** Woodland Kv= 5.0 fps
6.6	429	0.0470	1.08		**Shallow Concentrated Flow, Tc-6** Woodland Kv= 5.0 fps
39.1	1,436	Total			

Summary for Subcatchment EDA-3: EDA-3

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
21.330	30	Woods, Good, HSG A
0.499	96	Gravel surface, HSG A
21.829	32	Weighted Average
21.829		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
6.0	308	0.0290	0.85		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
5.0	439	0.0840	1.45		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
20.0	829	0.0190	0.69		**Shallow Concentrated Flow, Tc-4** Woodland Kv= 5.0 fps
46.8	1,626	Total			

Summary for Subcatchment EDA-4: EDA-4

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
16.927	30	Woods, Good, HSG A
0.021	96	Gravel surface, HSG A
16.948	30	Weighted Average
16.948		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
5.9	208	0.0140	0.59		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
8.6	587	0.0520	1.14		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
30.3	845	Total			

Summary for Subcatchment EDA-5A: EDA-5A

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
8.440	30	Woods, Good, HSG A
8.440		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	50	0.0200	0.07		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
7.6	527	0.0540	1.16		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
19.6	577	Total			

Summary for Subcatchment EDA-5B: EDA-5B

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
4.661	30	Woods, Good, HSG A
0.403	39	>75% Grass cover, Good, HSG A
5.064	31	Weighted Average
5.064		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	50	0.0900	0.13		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
2.2	191	0.0820	1.43		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
8.8	241	Total			

Summary for Reach X-DP4_1: XDP-4

Inflow Area = 16.948 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach X-DP5_1: XDP-5

Inflow Area = 8.440 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach X-DP5_2: XDP-5

Inflow Area = 5.064 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach XDP-1: XDP-1

Inflow Area = 9.142 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach XDP-2: XDP-2

Inflow Area = 27.900 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach XDP-3: XDP-3

Inflow Area = 21.829 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EDA-1: EDA-1 Runoff Area=9.142 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=820' Tc=22.5 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment EDA-2: EDA-2 Runoff Area=27.900 ac 0.00% Impervious Runoff Depth=0.02"
Flow Length=1,436' Tc=39.1 min CN=33 Runoff=0.07 cfs 0.045 af

Subcatchment EDA-3: EDA-3 Runoff Area=21.829 ac 0.00% Impervious Runoff Depth=0.01"
Flow Length=1,626' Tc=46.8 min CN=32 Runoff=0.04 cfs 0.017 af

Subcatchment EDA-4: EDA-4 Runoff Area=16.948 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=845' Tc=30.3 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment EDA-5A: EDA-5A Runoff Area=8.440 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=577' Tc=19.6 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment EDA-5B: EDA-5B Runoff Area=5.064 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=241' Tc=8.8 min CN=31 Runoff=0.00 cfs 0.001 af

Reach X-DP4_1: XDP-4 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach X-DP5_1: XDP-5 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach X-DP5_2: XDP-5 Inflow=0.00 cfs 0.001 af
Outflow=0.00 cfs 0.001 af

Reach XDP-1: XDP-1 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach XDP-2: XDP-2 Inflow=0.07 cfs 0.045 af
Outflow=0.07 cfs 0.045 af

Reach XDP-3: XDP-3 Inflow=0.04 cfs 0.017 af
Outflow=0.04 cfs 0.017 af

Total Runoff Area = 89.323 ac Runoff Volume = 0.064 af Average Runoff Depth = 0.01"
100.00% Pervious = 89.323 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment EDA-1: EDA-1

Runoff = 0.00 cfs @ 24.13 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
9.142	30	Woods, Good, HSG A
9.142		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	50	0.0200	0.07		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
5.6	327	0.0380	0.97		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
1.6	131	0.0760	1.38		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
0.7	83	0.1690	2.06		**Shallow Concentrated Flow, Tc-4** Woodland Kv= 5.0 fps
1.4	101	0.0590	1.21		**Shallow Concentrated Flow, Tc-5** Woodland Kv= 5.0 fps
0.5	66	0.2270	2.38		**Shallow Concentrated Flow, Tc-6** Woodland Kv= 5.0 fps
0.5	34	0.0590	1.21		**Shallow Concentrated Flow, Tc-7** Woodland Kv= 5.0 fps
0.2	28	0.2500	2.50		**Shallow Concentrated Flow, Tc-8** Woodland Kv= 5.0 fps
22.5	820	Total			

Summary for Subcatchment EDA-2: EDA-2

Runoff = 0.07 cfs @ 22.09 hrs, Volume= 0.045 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
26.629	30	Woods, Good, HSG A
0.569	77	Woods, Good, HSG D
0.512	96	Gravel surface, HSG A
0.190	96	Gravel surface, HSG D
27.900	33	Weighted Average
27.900		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
5.6	204	0.0150	0.61		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
4.4	206	0.0240	0.77		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
4.9	344	0.0550	1.17		**Shallow Concentrated Flow, Tc-4** Woodland Kv= 5.0 fps
1.8	203	0.1430	1.89		**Shallow Concentrated Flow, Tc-5** Woodland Kv= 5.0 fps
6.6	429	0.0470	1.08		**Shallow Concentrated Flow, Tc-6** Woodland Kv= 5.0 fps
39.1	1,436	Total			

Summary for Subcatchment EDA-3: EDA-3

Runoff = 0.04 cfs @ 23.45 hrs, Volume= 0.017 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
21.330	30	Woods, Good, HSG A
0.499	96	Gravel surface, HSG A
21.829	32	Weighted Average
21.829		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
6.0	308	0.0290	0.85		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
5.0	439	0.0840	1.45		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
20.0	829	0.0190	0.69		**Shallow Concentrated Flow, Tc-4** Woodland Kv= 5.0 fps
46.8	1,626	Total			

Summary for Subcatchment EDA-4: EDA-4

Runoff = 0.00 cfs @ 24.20 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
16.927	30	Woods, Good, HSG A
0.021	96	Gravel surface, HSG A
16.948	30	Weighted Average
16.948		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
5.9	208	0.0140	0.59		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
8.6	587	0.0520	1.14		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
30.3	845	Total			

Summary for Subcatchment EDA-5A: EDA-5A

Runoff = 0.00 cfs @ 24.11 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
8.440	30	Woods, Good, HSG A
8.440		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	50	0.0200	0.07		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
7.6	527	0.0540	1.16		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
19.6	577	Total			

Summary for Subcatchment EDA-5B: EDA-5B

Runoff = 0.00 cfs @ 24.00 hrs, Volume= 0.001 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
4.661	30	Woods, Good, HSG A
0.403	39	>75% Grass cover, Good, HSG A
5.064	31	Weighted Average
5.064		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	50	0.0900	0.13		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
2.2	191	0.0820	1.43		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
8.8	241	Total			

Summary for Reach X-DP4_1: XDP-4

Inflow Area = 16.948 ac, 0.00% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.00 cfs @ 24.20 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 24.20 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach X-DP5_1: XDP-5

Inflow Area = 8.440 ac, 0.00% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.00 cfs @ 24.11 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 24.11 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach X-DP5_2: XDP-5

Inflow Area = 5.064 ac, 0.00% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.00 cfs @ 24.00 hrs, Volume= 0.001 af
Outflow = 0.00 cfs @ 24.00 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach XDP-1: XDP-1

Inflow Area = 9.142 ac, 0.00% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.00 cfs @ 24.13 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 24.13 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach XDP-2: XDP-2

Inflow Area = 27.900 ac, 0.00% Impervious, Inflow Depth = 0.02" for 10-Year event
Inflow = 0.07 cfs @ 22.09 hrs, Volume= 0.045 af
Outflow = 0.07 cfs @ 22.09 hrs, Volume= 0.045 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach XDP-3: XDP-3

Inflow Area = 21.829 ac, 0.00% Impervious, Inflow Depth = 0.01" for 10-Year event
Inflow = 0.04 cfs @ 23.45 hrs, Volume= 0.017 af
Outflow = 0.04 cfs @ 23.45 hrs, Volume= 0.017 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EDA-1: EDA-1 Runoff Area=9.142 ac 0.00% Impervious Runoff Depth=0.21"
Flow Length=820' Tc=22.5 min CN=30 Runoff=0.26 cfs 0.162 af

Subcatchment EDA-2: EDA-2 Runoff Area=27.900 ac 0.00% Impervious Runoff Depth=0.37"
Flow Length=1,436' Tc=39.1 min CN=33 Runoff=1.90 cfs 0.864 af

Subcatchment EDA-3: EDA-3 Runoff Area=21.829 ac 0.00% Impervious Runoff Depth=0.32"
Flow Length=1,626' Tc=46.8 min CN=32 Runoff=1.03 cfs 0.573 af

Subcatchment EDA-4: EDA-4 Runoff Area=16.948 ac 0.00% Impervious Runoff Depth=0.21"
Flow Length=845' Tc=30.3 min CN=30 Runoff=0.48 cfs 0.300 af

Subcatchment EDA-5A: EDA-5A Runoff Area=8.440 ac 0.00% Impervious Runoff Depth=0.21"
Flow Length=577' Tc=19.6 min CN=30 Runoff=0.24 cfs 0.149 af

Subcatchment EDA-5B: EDA-5B Runoff Area=5.064 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=241' Tc=8.8 min CN=31 Runoff=0.20 cfs 0.110 af

Reach X-DP4_1: XDP-4 Inflow=0.48 cfs 0.300 af
Outflow=0.48 cfs 0.300 af

Reach X-DP5_1: XDP-5 Inflow=0.24 cfs 0.149 af
Outflow=0.24 cfs 0.149 af

Reach X-DP5_2: XDP-5 Inflow=0.20 cfs 0.110 af
Outflow=0.20 cfs 0.110 af

Reach XDP-1: XDP-1 Inflow=0.26 cfs 0.162 af
Outflow=0.26 cfs 0.162 af

Reach XDP-2: XDP-2 Inflow=1.90 cfs 0.864 af
Outflow=1.90 cfs 0.864 af

Reach XDP-3: XDP-3 Inflow=1.03 cfs 0.573 af
Outflow=1.03 cfs 0.573 af

Total Runoff Area = 89.323 ac Runoff Volume = 2.158 af Average Runoff Depth = 0.29"
100.00% Pervious = 89.323 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment EDA-1: EDA-1

Runoff = 0.26 cfs @ 14.03 hrs, Volume= 0.162 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
9.142	30	Woods, Good, HSG A
9.142		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	50	0.0200	0.07		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
5.6	327	0.0380	0.97		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
1.6	131	0.0760	1.38		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
0.7	83	0.1690	2.06		**Shallow Concentrated Flow, Tc-4** Woodland Kv= 5.0 fps
1.4	101	0.0590	1.21		**Shallow Concentrated Flow, Tc-5** Woodland Kv= 5.0 fps
0.5	66	0.2270	2.38		**Shallow Concentrated Flow, Tc-6** Woodland Kv= 5.0 fps
0.5	34	0.0590	1.21		**Shallow Concentrated Flow, Tc-7** Woodland Kv= 5.0 fps
0.2	28	0.2500	2.50		**Shallow Concentrated Flow, Tc-8** Woodland Kv= 5.0 fps
22.5	820	Total			

Summary for Subcatchment EDA-2: EDA-2

Runoff = 1.90 cfs @ 13.00 hrs, Volume= 0.864 af, Depth= 0.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
26.629	30	Woods, Good, HSG A
0.569	77	Woods, Good, HSG D
0.512	96	Gravel surface, HSG A
0.190	96	Gravel surface, HSG D
27.900	33	Weighted Average
27.900		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
5.6	204	0.0150	0.61		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
4.4	206	0.0240	0.77		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
4.9	344	0.0550	1.17		**Shallow Concentrated Flow, Tc-4** Woodland Kv= 5.0 fps
1.8	203	0.1430	1.89		**Shallow Concentrated Flow, Tc-5** Woodland Kv= 5.0 fps
6.6	429	0.0470	1.08		**Shallow Concentrated Flow, Tc-6** Woodland Kv= 5.0 fps
39.1	1,436	Total			

Summary for Subcatchment EDA-3: EDA-3

Runoff = 1.03 cfs @ 13.44 hrs, Volume= 0.573 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
21.330	30	Woods, Good, HSG A
0.499	96	Gravel surface, HSG A
21.829	32	Weighted Average
21.829		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
6.0	308	0.0290	0.85		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
5.0	439	0.0840	1.45		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
20.0	829	0.0190	0.69		**Shallow Concentrated Flow, Tc-4** Woodland Kv= 5.0 fps
46.8	1,626	Total			

Summary for Subcatchment EDA-4: EDA-4

Runoff = 0.48 cfs @ 14.16 hrs, Volume= 0.300 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
16.927	30	Woods, Good, HSG A
0.021	96	Gravel surface, HSG A
16.948	30	Weighted Average
16.948		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
5.9	208	0.0140	0.59		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
8.6	587	0.0520	1.14		**Shallow Concentrated Flow, Tc-3** Woodland Kv= 5.0 fps
30.3	845	Total			

Summary for Subcatchment EDA-5A: EDA-5A

Runoff = 0.24 cfs @ 13.98 hrs, Volume= 0.149 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
8.440	30	Woods, Good, HSG A
8.440		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	50	0.0200	0.07		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
7.6	527	0.0540	1.16		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
19.6	577	Total			

Summary for Subcatchment EDA-5B: EDA-5B

Runoff = 0.20 cfs @ 12.55 hrs, Volume= 0.110 af, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
4.661	30	Woods, Good, HSG A
0.403	39	>75% Grass cover, Good, HSG A
5.064	31	Weighted Average
5.064		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	50	0.0900	0.13		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
2.2	191	0.0820	1.43		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
8.8	241	Total			

Summary for Reach X-DP4_1: XDP-4

Inflow Area = 16.948 ac, 0.00% Impervious, Inflow Depth = 0.21" for 100-Year event
Inflow = 0.48 cfs @ 14.16 hrs, Volume= 0.300 af
Outflow = 0.48 cfs @ 14.16 hrs, Volume= 0.300 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach X-DP5_1: XDP-5

Inflow Area = 8.440 ac, 0.00% Impervious, Inflow Depth = 0.21" for 100-Year event
Inflow = 0.24 cfs @ 13.98 hrs, Volume= 0.149 af
Outflow = 0.24 cfs @ 13.98 hrs, Volume= 0.149 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach X-DP5_2: XDP-5

Inflow Area = 5.064 ac, 0.00% Impervious, Inflow Depth = 0.26" for 100-Year event
Inflow = 0.20 cfs @ 12.55 hrs, Volume= 0.110 af
Outflow = 0.20 cfs @ 12.55 hrs, Volume= 0.110 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach XDP-1: XDP-1

Inflow Area = 9.142 ac, 0.00% Impervious, Inflow Depth = 0.21" for 100-Year event
Inflow = 0.26 cfs @ 14.03 hrs, Volume= 0.162 af
Outflow = 0.26 cfs @ 14.03 hrs, Volume= 0.162 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach XDP-2: XDP-2

Inflow Area = 27.900 ac, 0.00% Impervious, Inflow Depth = 0.37" for 100-Year event
Inflow = 1.90 cfs @ 13.00 hrs, Volume= 0.864 af
Outflow = 1.90 cfs @ 13.00 hrs, Volume= 0.864 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach XDP-3: XDP-3

Inflow Area = 21.829 ac, 0.00% Impervious, Inflow Depth = 0.32" for 100-Year event
Inflow = 1.03 cfs @ 13.44 hrs, Volume= 0.573 af
Outflow = 1.03 cfs @ 13.44 hrs, Volume= 0.573 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Attachment 3
Post-Development Hydrologic Analysis

BEALS + THOMAS
BEALS AND THOMAS, INC.
Reservoir Corporate Center
144 Turnpike Road
Southborough, MA 01772-2104

CALCULATION SUMMARY

T 508.366.0560
F 508.366.4391
www.bealsandthomas.com
Regional Office: Plymouth, MA

JOB NO./LOCATION:

1833.112
Wareham, MA

CLIENT/PROJECT:

Borrego Solar Systems, Inc.
140 Tihonet Road PV+ES Project

SUBJECT/TITLE:

Post Development Hydrologic Calculations

OBJECTIVE OF CALCULATION:

- To determine the pre-development peak rates of runoff from the site for the 2, 10, & 100-year storm events at design points DP-1 through 5.

CALCULATION METHOD(S):

- Runoff curve numbers (CN), time-of-concentration (Tc), and runoff rates were calculated based on TR-55 methodology.
- Autodesk Civil 3D 2019 computer program was utilized for digitizing ground cover areas.
- Peak runoff rates were computed using HydroCAD version 10.00.

ASSUMPTIONS:

- The ground cover types were determined using MassGIS aerial imagery and hydrologic soil groups based on United States Department of Agriculture, NRCS Soil Survey map information.
- Watershed boundaries have been estimated based upon contour information depicted on the Existing Conditions Plan as well as MassGIS contours in offsite areas outside limits of those shown on the existing conditions plan.
- Wetland systems were not included in the hydrologic analysis.

SOURCES OF DATA/EQUATIONS:

- Post-Development Conditions Hydrologic Areas Map prepared by Beals and Thomas, Inc. File No. 1833112P593B-002.
- 140 Tihonet Road PV+ES Project Grading and Drainage Plans, prepared by Borrego Solar Systems, Inc., plan numbers C-4.0 – C4.4.
- NRCS Soil Survey for Plymouth County, hydrologic soil group report, downloaded from Web Soil Survey on 3/12/2020.
- TR-55 urban Hydrology for Small Watersheds, SCS, 1986.
- Massachusetts DEP Stormwater Management Handbook, February 2008

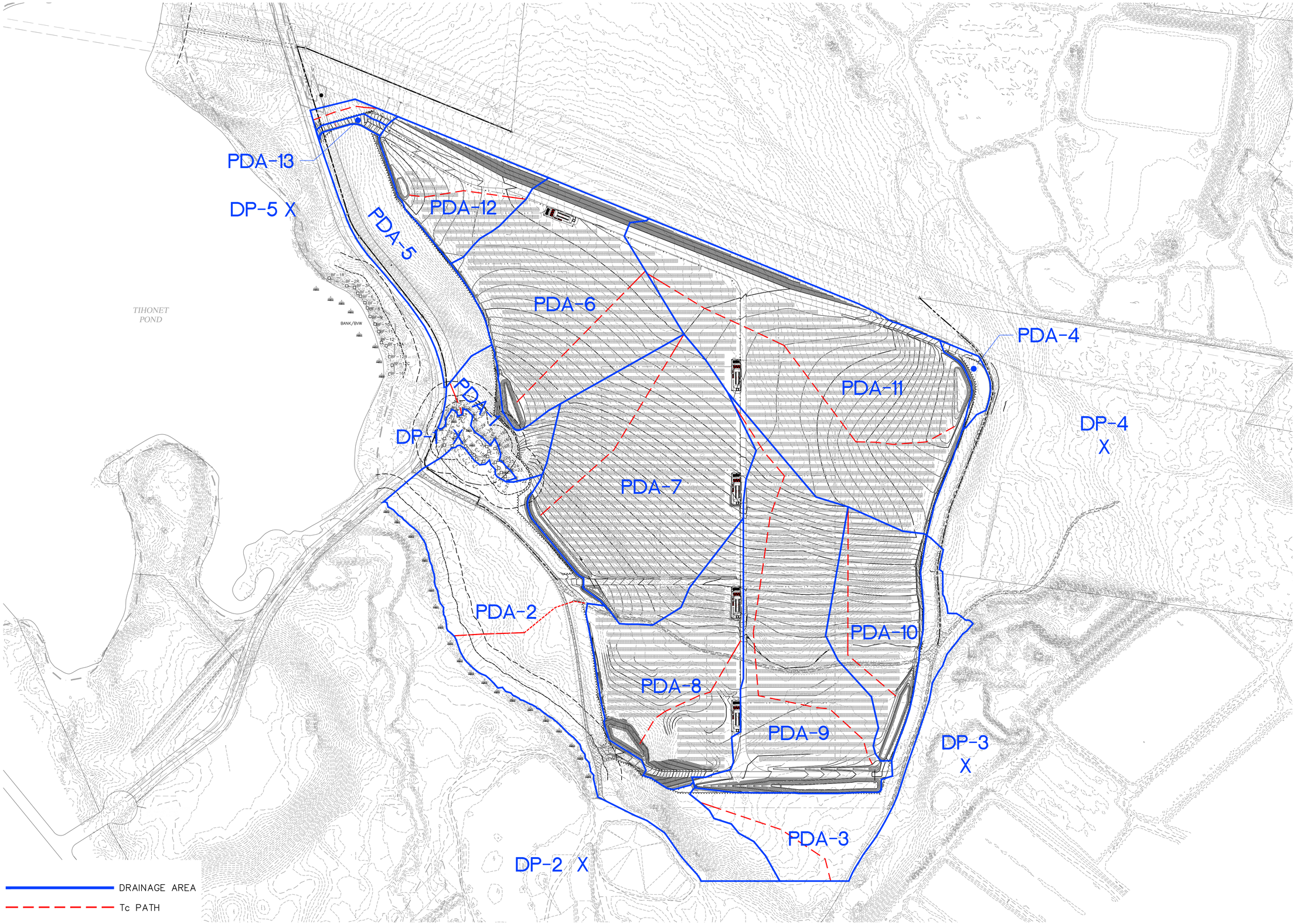
REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	N. Bautz	5/31/2020	J. Murphy	6/1/2020	J. Murphy	6/1/2020
1	N. Bautz	1/14/2021	J. Murphy	1/19/2021	J. Murphy	1/19/2021

CONCLUSIONS:

Storm Event	2-Year	10-Year	100-Year
DP-1 (cfs)	0.0	0.0	0.2
DP-2 (cfs)	0.0	0.1	1.7
DP-3 (cfs)	0.0	0.0	0.6
DP-4 (cfs)	0.0	0.0	0.1
DP-5 (cfs)	0.0	0.0	0.3

- Post-development peak runoff rates are less than or equal to pre-development rates in accordance with the Mass DEP Stormwater Handbook.

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	N. Bautz	5/31/2020	J. Murphy	6/1/2020	J. Murphy	6/1/2020
1	N. Bautz	1/14/2021	J. Murphy	1/19/2021	J. Murphy	1/19/2021



Post-Development Conditions Hydrologic Areas Map

Figure Number 002

Scale: 1" = 150'

Date: 01/19/2021

Plan 1833112P593B-002

B+T Project No. 1833.112

140 Tihonet Road PV+ES Project

Wareham, Massachusetts

Borrego Solar Systems, Inc.

55 Technology Drive, Suite 102

Lowell, Massachusetts

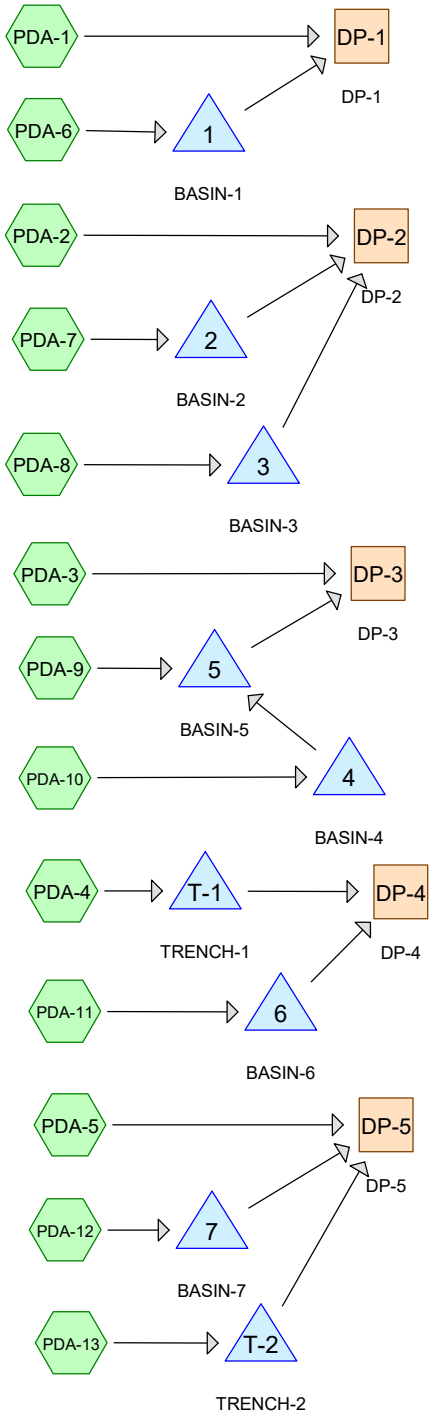
North Arrow

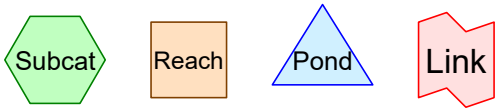
NORTH

BEALS AND THOMAS, INC.

140 Tihonet Road
Solar

Post-Development
Conditions Hydrology





Routing Diagram for 1833112HC002B
Prepared by Beals and Thomas, Inc., Printed 1/19/2021
HydroCAD® 10.10-4a s/n 04493 © 2020 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
62.671	39	>75% Grass cover, Good, HSG A (PDA-1, PDA-10, PDA-11, PDA-12, PDA-13, PDA-2, PDA-3, PDA-4, PDA-5, PDA-6, PDA-7, PDA-8, PDA-9)
0.235	80	>75% Grass cover, Good, HSG D (PDA-2, PDA-8)
0.235	30	Brush, Good, HSG A (PDA-4, PDA-5)
0.128	98	Equipment Pad Area, HSG A (PDA-6, PDA-7, PDA-8)
0.766	96	Existing Gravel surface, HSG A (PDA-11, PDA-2, PDA-3)
0.190	96	Existing Gravel surface, HSG D (PDA-2)
3.389	96	Gravel surface, HSG A (PDA-11, PDA-12, PDA-13, PDA-2, PDA-3, PDA-4, PDA-5, PDA-6, PDA-7, PDA-8, PDA-9)
0.038	96	Gravel surface, HSG D (PDA-2)
21.375	30	Woods, Good, HSG A (PDA-1, PDA-2, PDA-3, PDA-4, PDA-5)
0.296	77	Woods, Good, HSG D (PDA-2)
89.323	**40**	**TOTAL AREA**

Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PDA-1: Runoff Area=1.878 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=122' Tc=17.5 min CN=33 Runoff=0.00 cfs 0.000 af

Subcatchment PDA-10: Runoff Area=4.720 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=756' Tc=13.3 min CN=39 Runoff=0.00 cfs 0.002 af

Subcatchment PDA-11: Runoff Area=15.358 ac 0.00% Impervious Runoff Depth=0.03"
Flow Length=1,352' Tc=35.2 min CN=42 Runoff=0.05 cfs 0.036 af

Subcatchment PDA-12: Runoff Area=3.707 ac 0.00% Impervious Runoff Depth=0.09"
Flow Length=421' Tc=13.6 min CN=46 Runoff=0.04 cfs 0.027 af

Subcatchment PDA-13: Runoff Area=0.185 ac 0.00% Impervious Runoff Depth=2.09"
Tc=6.0 min CN=87 Runoff=0.44 cfs 0.032 af

Subcatchment PDA-2: Runoff Area=12.678 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=449' Tc=29.8 min CN=35 Runoff=0.00 cfs 0.000 af

Subcatchment PDA-3: Runoff Area=5.139 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=577' Tc=43.5 min CN=35 Runoff=0.00 cfs 0.000 af

Subcatchment PDA-4: Runoff Area=0.439 ac 0.00% Impervious Runoff Depth=0.05"
Tc=6.0 min CN=44 Runoff=0.00 cfs 0.002 af

Subcatchment PDA-5: Runoff Area=4.880 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=241' Tc=8.8 min CN=31 Runoff=0.00 cfs 0.000 af

Subcatchment PDA-6: Runoff Area=9.635 ac 0.33% Impervious Runoff Depth=0.02"
Flow Length=657' Tc=14.5 min CN=41 Runoff=0.02 cfs 0.015 af

Subcatchment PDA-7: Runoff Area=12.565 ac 0.25% Impervious Runoff Depth=0.02"
Flow Length=835' Tc=15.2 min CN=41 Runoff=0.03 cfs 0.019 af

Subcatchment PDA-8: Runoff Area=7.437 ac 0.86% Impervious Runoff Depth=0.05"
Flow Length=540' Tc=14.7 min CN=44 Runoff=0.05 cfs 0.033 af

Subcatchment PDA-9: Runoff Area=10.702 ac 0.00% Impervious Runoff Depth=0.04"
Flow Length=1,639' Tc=36.9 min CN=43 Runoff=0.05 cfs 0.036 af

Reach DP-1: DP-1 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach DP-2: DP-2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach DP-3: DP-3 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach DP-4: DP-4 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach DP-5: DP-5 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond 1: BASIN-1 Peak Elev=64.01' Storage=19 cf Inflow=0.02 cfs 0.015 af
Discarded=0.02 cfs 0.015 af Primary=0.00 cfs 0.000 af Outflow=0.02 cfs 0.015 af

Pond 2: BASIN-2 Peak Elev=52.00' Storage=15 cf Inflow=0.03 cfs 0.019 af
Discarded=0.03 cfs 0.019 af Primary=0.00 cfs 0.000 af Outflow=0.03 cfs 0.019 af

Pond 3: BASIN-3 Peak Elev=32.01' Storage=52 cf Inflow=0.05 cfs 0.033 af
Discarded=0.05 cfs 0.033 af Primary=0.00 cfs 0.000 af Outflow=0.05 cfs 0.033 af

Pond 4: BASIN-4 Peak Elev=48.00' Storage=2 cf Inflow=0.00 cfs 0.002 af
Discarded=0.00 cfs 0.002 af Primary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.002 af

Pond 5: BASIN-5 Peak Elev=45.00' Storage=28 cf Inflow=0.05 cfs 0.036 af
Discarded=0.05 cfs 0.036 af Primary=0.00 cfs 0.000 af Outflow=0.05 cfs 0.036 af

Pond 6: BASIN-6 Peak Elev=66.01' Storage=36 cf Inflow=0.05 cfs 0.036 af
Discarded=0.05 cfs 0.036 af Primary=0.00 cfs 0.000 af Outflow=0.05 cfs 0.036 af

Pond 7: BASIN-7 Peak Elev=76.02' Storage=30 cf Inflow=0.04 cfs 0.027 af
Discarded=0.04 cfs 0.027 af Primary=0.00 cfs 0.000 af Outflow=0.04 cfs 0.027 af

Pond T-1: TRENCH-1 Peak Elev=64.00' Storage=0.000 af Inflow=0.00 cfs 0.002 af
Discarded=0.00 cfs 0.002 af Primary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.002 af

Pond T-2: TRENCH-2 Peak Elev=57.16' Storage=0.011 af Inflow=0.44 cfs 0.032 af
Discarded=0.06 cfs 0.032 af Primary=0.00 cfs 0.000 af Outflow=0.06 cfs 0.032 af

Total Runoff Area = 89.323 ac Runoff Volume = 0.202 af Average Runoff Depth = 0.03"
99.86% Pervious = 89.195 ac 0.14% Impervious = 0.128 ac

Summary for Subcatchment PDA-1:

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
1.222	30	Woods, Good, HSG A
0.656	39	>75% Grass cover, Good, HSG A
1.878	33	Weighted Average
1.878		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
1.7	72	0.0210	0.72		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
17.5	122	Total			

Summary for Subcatchment PDA-10:

Runoff = 0.00 cfs @ 23.53 hrs, Volume= 0.002 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
4.720	39	>75% Grass cover, Good, HSG A
4.720		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	50	0.0500	0.22		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
5.4	448	0.0390	1.38		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
4.1	258	0.0230	1.06		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
13.3	756	Total			

Summary for Subcatchment PDA-11:

Runoff = 0.05 cfs @ 17.38 hrs, Volume= 0.036 af, Depth= 0.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

	Area (ac)	CN	Description
	14.490	39	>75% Grass cover, Good, HSG A
	0.836	96	Gravel surface, HSG A
*	0.032	96	Existing Gravel surface, HSG A
	15.358	42	Weighted Average
	15.358		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
13.5	506	0.0080	0.63		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
8.6	429	0.0140	0.83		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
5.9	367	0.0220	1.04		**Shallow Concentrated Flow, Tc-4** Short Grass Pasture Kv= 7.0 fps
35.2	1,352	Total			

Summary for Subcatchment PDA-12:

Runoff = 0.04 cfs @ 14.78 hrs, Volume= 0.027 af, Depth= 0.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
3.237	39	>75% Grass cover, Good, HSG A
0.470	96	Gravel surface, HSG A
3.707	46	Weighted Average
3.707		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
6.4	371	0.0190	0.96		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
13.6	421	Total			

Summary for Subcatchment PDA-13:

Runoff = 0.44 cfs @ 12.09 hrs, Volume= 0.032 af, Depth= 2.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.028	39	>75% Grass cover, Good, HSG A
0.157	96	Gravel surface, HSG A
0.185	87	Weighted Average
0.185		100.00% Pervious Area

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

Summary for Subcatchment PDA-2:

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

	Area (ac)	CN	Description
	11.089	30	Woods, Good, HSG A
	0.296	77	Woods, Good, HSG D
	0.569	39	>75% Grass cover, Good, HSG A
	0.068	80	>75% Grass cover, Good, HSG D
	0.064	96	Gravel surface, HSG A
	0.038	96	Gravel surface, HSG D
*	0.364	96	Existing Gravel surface, HSG A
*	0.190	96	Existing Gravel surface, HSG D
	12.678	35	Weighted Average
	12.678		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
14.0	399	0.0090	0.47		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
29.8	449	Total			

Summary for Subcatchment PDA-3:

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

	Area (ac)	CN	Description
	4.636	30	Woods, Good, HSG A
	0.113	39	>75% Grass cover, Good, HSG A
	0.020	96	Gravel surface, HSG A
*	0.370	96	Existing Gravel surface, HSG A
	5.139	35	Weighted Average
	5.139		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.8	50	0.0050	0.04		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
22.7	527	0.0060	0.39		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
43.5	577	Total			

Summary for Subcatchment PDA-4:

Runoff = 0.00 cfs @ 15.20 hrs, Volume= 0.002 af, Depth= 0.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.236	30	Woods, Good, HSG A
0.060	30	Brush, Good, HSG A
0.058	39	>75% Grass cover, Good, HSG A
0.085	96	Gravel surface, HSG A
0.439	44	Weighted Average
0.439		100.00% Pervious Area

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

Summary for Subcatchment PDA-5:

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
4.192	30	Woods, Good, HSG A
0.175	30	Brush, Good, HSG A
0.470	39	>75% Grass cover, Good, HSG A
0.043	96	Gravel surface, HSG A
4.880	31	Weighted Average
4.880		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	50	0.0900	0.13		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
2.2	191	0.0820	1.43		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
8.8	241	Total			

Summary for Subcatchment PDA-6:

Runoff = 0.02 cfs @ 21.19 hrs, Volume= 0.015 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

	Area (ac)	CN	Description
	9.378	39	>75% Grass cover, Good, HSG A
	0.225	96	Gravel surface, HSG A
*	0.032	98	Equipment Pad Area, HSG A
	9.635	41	Weighted Average
	9.603		99.67% Pervious Area
	0.032		0.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	50	0.0200	0.15		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
9.0	607	0.0260	1.13		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
14.5	657	Total			

Summary for Subcatchment PDA-7:

Runoff = 0.03 cfs @ 21.15 hrs, Volume= 0.019 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
12.168	39	>75% Grass cover, Good, HSG A
0.365	96	Gravel surface, HSG A
0.032	98	Equipment Pad Area, HSG A
12.565	41	Weighted Average
12.533		99.75% Pervious Area
0.032		0.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	50	0.0200	0.15		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
9.7	785	0.0370	1.35		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
15.2	835	Total			

Summary for Subcatchment PDA-8:

Runoff = 0.05 cfs @ 15.34 hrs, Volume= 0.033 af, Depth= 0.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
6.768	39	>75% Grass cover, Good, HSG A
0.167	80	>75% Grass cover, Good, HSG D
0.438	96	Gravel surface, HSG A
0.064	98	Equipment Pad Area, HSG A
7.437	44	Weighted Average
7.373		99.14% Pervious Area
0.064		0.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
2.3	164	0.0300	1.21		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
4.0	175	0.0110	0.73		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
1.2	151	0.0930	2.13		**Shallow Concentrated Flow, Tc-4** Short Grass Pasture Kv= 7.0 fps
14.7	540	Total			

Summary for Subcatchment PDA-9:

Runoff = 0.05 cfs @ 16.02 hrs, Volume= 0.036 af, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
10.016	39	>75% Grass cover, Good, HSG A
0.686	96	Gravel surface, HSG A
10.702	43	Weighted Average
10.702		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
6.5	273	0.0100	0.70		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
7.1	572	0.0370	1.35		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
5.7	228	0.0090	0.66		**Shallow Concentrated Flow, Tc-4** Short Grass Pasture Kv= 7.0 fps
10.4	516	0.0140	0.83		**Shallow Concentrated Flow, Tc-5** Short Grass Pasture Kv= 7.0 fps
36.9	1,639	Total			

Summary for Reach DP-1: DP-1

Inflow Area = 11.513 ac, 0.28% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2: DP-2

Inflow Area = 32.680 ac, 0.29% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3: DP-3

Inflow Area = 20.561 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-4: DP-4

Inflow Area = 15.797 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-5: DP-5

Inflow Area = 8.772 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Pond 1: BASIN-1

Inflow Area = 9.635 ac, 0.33% Impervious, Inflow Depth = 0.02" for 2-Year event
Inflow = 0.02 cfs @ 21.19 hrs, Volume= 0.015 af
Outflow = 0.02 cfs @ 21.38 hrs, Volume= 0.015 af, Atten= 0%, Lag= 11.4 min
Discarded = 0.02 cfs @ 21.38 hrs, Volume= 0.015 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 64.01' @ 21.38 hrs Surf.Area= 2,239 sf Storage= 19 cf

Plug-Flow detention time= 14.7 min calculated for 0.015 af (100% of inflow)
Center-of-Mass det. time= 14.8 min (1,213.3 - 1,198.5)

Volume	Invert	Avail.Storage	Storage Description
#1	64.00'	24,450 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
64.00	2,230	0	0
65.00	3,230	2,730	2,730
66.00	4,280	3,755	6,485
67.00	5,390	4,835	11,320
68.00	6,550	5,970	17,290
69.00	7,770	7,160	24,450

Device	Routing	Invert	Outlet Devices
#1	Discarded	64.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	68.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.12 cfs @ 21.38 hrs HW=64.01' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.12 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=64.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 2: BASIN-2

Inflow Area = 12.565 ac, 0.25% Impervious, Inflow Depth = 0.02" for 2-Year event
Inflow = 0.03 cfs @ 21.15 hrs, Volume= 0.019 af
Outflow = 0.03 cfs @ 21.30 hrs, Volume= 0.019 af, Atten= 0%, Lag= 9.2 min
Discarded = 0.03 cfs @ 21.30 hrs, Volume= 0.019 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 52.00' @ 21.30 hrs Surf.Area= 4,260 sf Storage= 15 cf

Plug-Flow detention time= 8.9 min calculated for 0.019 af (100% of inflow)
Center-of-Mass det. time= 8.9 min (1,208.0 - 1,199.2)

Volume	Invert	Avail.Storage	Storage Description
#1	52.00'	25,740 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.00	4,250	0	0
53.00	6,970	5,610	5,610
54.00	9,900	8,435	14,045
55.00	13,490	11,695	25,740

Device	Routing	Invert	Outlet Devices
#1	Discarded	52.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	54.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.24 cfs @ 21.30 hrs HW=52.00' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.24 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=52.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 3: BASIN-3

Inflow Area = 7.437 ac, 0.86% Impervious, Inflow Depth = 0.05" for 2-Year event
Inflow = 0.05 cfs @ 15.34 hrs, Volume= 0.033 af
Outflow = 0.05 cfs @ 15.63 hrs, Volume= 0.033 af, Atten= 1%, Lag= 17.5 min
Discarded = 0.05 cfs @ 15.63 hrs, Volume= 0.033 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 32.01' @ 15.63 hrs Surf.Area= 3,039 sf Storage= 52 cf

Plug-Flow detention time= 17.2 min calculated for 0.033 af (100% of inflow)
Center-of-Mass det. time= 17.0 min (1,119.3 - 1,102.3)

Volume	Invert	Avail.Storage	Storage Description
#1	32.00'	28,028 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
32.00	3,025	0	0
33.00	3,970	3,498	3,498
34.00	4,990	4,480	7,978
35.00	6,080	5,535	13,513
36.00	7,310	6,695	20,208
37.00	8,330	7,820	28,028

Device	Routing	Invert	Outlet Devices
#1	Discarded	32.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	36.00'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.17 cfs @ 15.63 hrs HW=32.01' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=32.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 4: BASIN-4

Inflow Area = 4.720 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 23.53 hrs, Volume= 0.002 af
Outflow = 0.00 cfs @ 23.65 hrs, Volume= 0.002 af, Atten= 0%, Lag= 7.6 min
Discarded = 0.00 cfs @ 23.65 hrs, Volume= 0.002 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 48.00' @ 23.65 hrs Surf.Area= 4,941 sf Storage= 2 cf

Plug-Flow detention time= 5.9 min calculated for 0.002 af (100% of inflow)
Center-of-Mass det. time= 6.0 min (1,305.7 - 1,299.7)

Volume	Invert	Avail.Storage	Storage Description
#1	48.00'	13,330 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
48.00	4,940	0	0
49.00	6,650	5,795	5,795
50.00	8,420	7,535	13,330

Device	Routing	Invert	Outlet Devices
#1	Discarded	48.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	49.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.28 cfs @ 23.65 hrs HW=48.00' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.28 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=48.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 5: BASIN-5

Inflow Area = 15.422 ac, 0.00% Impervious, Inflow Depth = 0.03" for 2-Year event
Inflow = 0.05 cfs @ 16.02 hrs, Volume= 0.036 af
Outflow = 0.05 cfs @ 16.17 hrs, Volume= 0.036 af, Atten= 0%, Lag= 8.5 min
Discarded = 0.05 cfs @ 16.17 hrs, Volume= 0.036 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 45.00' @ 16.17 hrs Surf.Area= 7,580 sf Storage= 28 cf

Plug-Flow detention time= 8.9 min calculated for 0.036 af (100% of inflow)
Center-of-Mass det. time= 8.9 min (1,158.7 - 1,149.8)

Volume	Invert	Avail.Storage	Storage Description
#1	45.00'	34,785 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
45.00	7,570	0	0
46.00	10,180	8,875	8,875
47.00	12,940	11,560	20,435
48.00	15,760	14,350	34,785

Device	Routing	Invert	Outlet Devices
#1	Discarded	45.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	47.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.42 cfs @ 16.17 hrs HW=45.00' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.42 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=45.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 6: BASIN-6

Inflow Area = 15.358 ac, 0.00% Impervious, Inflow Depth = 0.03" for 2-Year event
Inflow = 0.05 cfs @ 17.38 hrs, Volume= 0.036 af
Outflow = 0.05 cfs @ 17.54 hrs, Volume= 0.036 af, Atten= 0%, Lag= 9.5 min
Discarded = 0.05 cfs @ 17.54 hrs, Volume= 0.036 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 66.01' @ 17.54 hrs Surf.Area= 3,861 sf Storage= 36 cf

Plug-Flow detention time= 11.8 min calculated for 0.036 af (100% of inflow)
Center-of-Mass det. time= 11.8 min (1,191.7 - 1,179.9)

Volume	Invert	Avail.Storage	Storage Description
#1	66.00'	49,580 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
66.00	3,840	0	0
67.00	6,120	4,980	4,980
68.00	8,170	7,145	12,125
69.00	18,320	13,245	25,370
70.00	30,100	24,210	49,580

Device	Routing	Invert	Outlet Devices
#1	Discarded	66.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	69.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.22 cfs @ 17.54 hrs HW=66.01' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.22 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=66.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 7: BASIN-7

Inflow Area = 3.707 ac, 0.00% Impervious, Inflow Depth = 0.09" for 2-Year event
Inflow = 0.04 cfs @ 14.78 hrs, Volume= 0.027 af
Outflow = 0.04 cfs @ 14.97 hrs, Volume= 0.027 af, Atten= 0%, Lag= 11.7 min
Discarded = 0.04 cfs @ 14.97 hrs, Volume= 0.027 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 76.02' @ 14.97 hrs Surf.Area= 1,282 sf Storage= 30 cf

Plug-Flow detention time= 11.8 min calculated for 0.027 af (100% of inflow)
Center-of-Mass det. time= 11.9 min (1,069.5 - 1,057.7)

Volume	Invert	Avail.Storage	Storage Description
#1	76.00'	22,385 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
76.00	1,270	0	0
77.00	1,780	1,525	1,525
78.00	3,170	2,475	4,000
79.00	8,280	5,725	9,725
80.00	17,040	12,660	22,385

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	79.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.07 cfs @ 14.97 hrs HW=76.02' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=76.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond T-1: TRENCH-1

Inflow Area = 0.439 ac, 0.00% Impervious, Inflow Depth = 0.05" for 2-Year event
Inflow = 0.00 cfs @ 15.20 hrs, Volume= 0.002 af
Outflow = 0.00 cfs @ 15.26 hrs, Volume= 0.002 af, Atten= 0%, Lag= 3.6 min
Discarded = 0.00 cfs @ 15.26 hrs, Volume= 0.002 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 64.00' @ 15.26 hrs Surf.Area= 0.013 ac Storage= 0.000 af

Plug-Flow detention time= 3.6 min calculated for 0.002 af (100% of inflow)
Center-of-Mass det. time= 3.6 min (1,097.8 - 1,094.2)

Volume	Invert	Avail.Storage	Storage Description
#1	64.00'	0.015 af	**3.00'W x 185.00'L x 3.00'H Prismatoid**
			0.038 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Discarded	64.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	66.99'	**3.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.03 cfs @ 15.26 hrs HW=64.00' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=64.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond T-2: TRENCH-2

Inflow Area =	0.185 ac,	0.00% Impervious,	Inflow Depth =	2.09"	for 2-Year event
Inflow =	0.44 cfs @	12.09 hrs,	Volume=	0.032 af	
Outflow =	0.06 cfs @	11.70 hrs,	Volume=	0.032 af,	Atten= 87%, Lag= 0.0 min
Discarded =	0.06 cfs @	11.70 hrs,	Volume=	0.032 af	
Primary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 57.16' @ 12.72 hrs Surf.Area= 0.023 ac Storage= 0.011 af

Plug-Flow detention time= 62.6 min calculated for 0.032 af (100% of inflow)
Center-of-Mass det. time= 62.5 min (878.8 - 816.3)

Volume	Invert	Avail.Storage	Storage Description
#1	56.00'	0.037 af	**4.00'W x 254.00'L x 4.00'H Prismatoid** 0.093 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Discarded	56.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	59.99'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.06 cfs @ 11.70 hrs HW=56.04' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=56.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PDA-1: Runoff Area=1.878 ac 0.00% Impervious Runoff Depth=0.02"
Flow Length=122' Tc=17.5 min CN=33 Runoff=0.00 cfs 0.003 af

Subcatchment PDA-10: Runoff Area=4.720 ac 0.00% Impervious Runoff Depth=0.14"
Flow Length=756' Tc=13.3 min CN=39 Runoff=0.09 cfs 0.056 af

Subcatchment PDA-11: Runoff Area=15.358 ac 0.00% Impervious Runoff Depth=0.24"
Flow Length=1,352' Tc=35.2 min CN=42 Runoff=0.66 cfs 0.305 af

Subcatchment PDA-12: Runoff Area=3.707 ac 0.00% Impervious Runoff Depth=0.39"
Flow Length=421' Tc=13.6 min CN=46 Runoff=0.58 cfs 0.121 af

Subcatchment PDA-13: Runoff Area=0.185 ac 0.00% Impervious Runoff Depth=3.29"
Tc=6.0 min CN=87 Runoff=0.69 cfs 0.051 af

Subcatchment PDA-2: Runoff Area=12.678 ac 0.00% Impervious Runoff Depth=0.05"
Flow Length=449' Tc=29.8 min CN=35 Runoff=0.08 cfs 0.052 af

Subcatchment PDA-3: Runoff Area=5.139 ac 0.00% Impervious Runoff Depth=0.05"
Flow Length=577' Tc=43.5 min CN=35 Runoff=0.03 cfs 0.021 af

Subcatchment PDA-4: Runoff Area=0.439 ac 0.00% Impervious Runoff Depth=0.31"
Tc=6.0 min CN=44 Runoff=0.05 cfs 0.011 af

Subcatchment PDA-5: Runoff Area=4.880 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=241' Tc=8.8 min CN=31 Runoff=0.00 cfs 0.001 af

Subcatchment PDA-6: Runoff Area=9.635 ac 0.33% Impervious Runoff Depth=0.20"
Flow Length=657' Tc=14.5 min CN=41 Runoff=0.37 cfs 0.164 af

Subcatchment PDA-7: Runoff Area=12.565 ac 0.25% Impervious Runoff Depth=0.20"
Flow Length=835' Tc=15.2 min CN=41 Runoff=0.47 cfs 0.214 af

Subcatchment PDA-8: Runoff Area=7.437 ac 0.86% Impervious Runoff Depth=0.31"
Flow Length=540' Tc=14.7 min CN=44 Runoff=0.75 cfs 0.193 af

Subcatchment PDA-9: Runoff Area=10.702 ac 0.00% Impervious Runoff Depth=0.27"
Flow Length=1,639' Tc=36.9 min CN=43 Runoff=0.61 cfs 0.245 af

Reach DP-1: DP-1 Inflow=0.00 cfs 0.003 af
Outflow=0.00 cfs 0.003 af

Reach DP-2: DP-2 Inflow=0.08 cfs 0.052 af
Outflow=0.08 cfs 0.052 af

Reach DP-3: DP-3 Inflow=0.03 cfs 0.021 af
Outflow=0.03 cfs 0.021 af

Reach DP-4: DP-4 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach DP-5: DP-5 Inflow=0.00 cfs 0.001 af
Outflow=0.00 cfs 0.001 af

Pond 1: BASIN-1 Peak Elev=64.67' Storage=1,719 cf Inflow=0.37 cfs 0.164 af
Discarded=0.16 cfs 0.164 af Primary=0.00 cfs 0.000 af Outflow=0.16 cfs 0.164 af

Pond 2: BASIN-2 Peak Elev=52.26' Storage=1,204 cf Inflow=0.47 cfs 0.214 af
Discarded=0.28 cfs 0.214 af Primary=0.00 cfs 0.000 af Outflow=0.28 cfs 0.214 af

Pond 3: BASIN-3 Peak Elev=32.63' Storage=2,188 cf Inflow=0.75 cfs 0.193 af
Discarded=0.20 cfs 0.193 af Primary=0.00 cfs 0.000 af Outflow=0.20 cfs 0.193 af

Pond 4: BASIN-4 Peak Elev=48.01' Storage=33 cf Inflow=0.09 cfs 0.056 af
Discarded=0.09 cfs 0.056 af Primary=0.00 cfs 0.000 af Outflow=0.09 cfs 0.056 af

Pond 5: BASIN-5 Peak Elev=45.08' Storage=593 cf Inflow=0.61 cfs 0.245 af
Discarded=0.43 cfs 0.245 af Primary=0.00 cfs 0.000 af Outflow=0.43 cfs 0.245 af

Pond 6: BASIN-6 Peak Elev=66.71' Storage=3,294 cf Inflow=0.66 cfs 0.305 af
Discarded=0.30 cfs 0.305 af Primary=0.00 cfs 0.000 af Outflow=0.30 cfs 0.305 af

Pond 7: BASIN-7 Peak Elev=77.16' Storage=1,837 cf Inflow=0.58 cfs 0.121 af
Discarded=0.11 cfs 0.121 af Primary=0.00 cfs 0.000 af Outflow=0.11 cfs 0.121 af

Pond T-1: TRENCH-1 Peak Elev=64.10' Storage=0.000 af Inflow=0.05 cfs 0.011 af
Discarded=0.03 cfs 0.011 af Primary=0.00 cfs 0.000 af Outflow=0.03 cfs 0.011 af

Pond T-2: TRENCH-2 Peak Elev=58.17' Storage=0.020 af Inflow=0.69 cfs 0.051 af
Discarded=0.06 cfs 0.051 af Primary=0.00 cfs 0.000 af Outflow=0.06 cfs 0.051 af

Total Runoff Area = 89.323 ac Runoff Volume = 1.440 af Average Runoff Depth = 0.19"
99.86% Pervious = 89.195 ac 0.14% Impervious = 0.128 ac

Summary for Subcatchment PDA-1:

Runoff = 0.00 cfs @ 21.70 hrs, Volume= 0.003 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
1.222	30	Woods, Good, HSG A
0.656	39	>75% Grass cover, Good, HSG A
1.878	33	Weighted Average
1.878		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
1.7	72	0.0210	0.72		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
17.5	122	Total			

Summary for Subcatchment PDA-10:

Runoff = 0.09 cfs @ 13.88 hrs, Volume= 0.056 af, Depth= 0.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
4.720	39	>75% Grass cover, Good, HSG A
4.720		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	50	0.0500	0.22		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
5.4	448	0.0390	1.38		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
4.1	258	0.0230	1.06		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
13.3	756	Total			

Summary for Subcatchment PDA-11:

Runoff = 0.66 cfs @ 12.95 hrs, Volume= 0.305 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (ac)	CN	Description
	14.490	39	>75% Grass cover, Good, HSG A
	0.836	96	Gravel surface, HSG A
*	0.032	96	Existing Gravel surface, HSG A
	15.358	42	Weighted Average
	15.358		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
13.5	506	0.0080	0.63		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
8.6	429	0.0140	0.83		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
5.9	367	0.0220	1.04		**Shallow Concentrated Flow, Tc-4** Short Grass Pasture Kv= 7.0 fps
35.2	1,352	Total			

Summary for Subcatchment PDA-12:

Runoff = 0.58 cfs @ 12.44 hrs, Volume= 0.121 af, Depth= 0.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
3.237	39	>75% Grass cover, Good, HSG A
0.470	96	Gravel surface, HSG A
3.707	46	Weighted Average
3.707		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
6.4	371	0.0190	0.96		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
13.6	421	Total			

Summary for Subcatchment PDA-13:

Runoff = 0.69 cfs @ 12.09 hrs, Volume= 0.051 af, Depth= 3.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
0.028	39	>75% Grass cover, Good, HSG A
0.157	96	Gravel surface, HSG A
0.185	87	Weighted Average
0.185		100.00% Pervious Area

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

Summary for Subcatchment PDA-2:

Runoff = 0.08 cfs @ 16.01 hrs, Volume= 0.052 af, Depth= 0.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (ac)	CN	Description
	11.089	30	Woods, Good, HSG A
	0.296	77	Woods, Good, HSG D
	0.569	39	>75% Grass cover, Good, HSG A
	0.068	80	>75% Grass cover, Good, HSG D
	0.064	96	Gravel surface, HSG A
	0.038	96	Gravel surface, HSG D
*	0.364	96	Existing Gravel surface, HSG A
*	0.190	96	Existing Gravel surface, HSG D
	12.678	35	Weighted Average
	12.678		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
14.0	399	0.0090	0.47		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
29.8	449	Total			

Summary for Subcatchment PDA-3:

Runoff = 0.03 cfs @ 16.29 hrs, Volume= 0.021 af, Depth= 0.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (ac)	CN	Description
	4.636	30	Woods, Good, HSG A
	0.113	39	>75% Grass cover, Good, HSG A
	0.020	96	Gravel surface, HSG A
*	0.370	96	Existing Gravel surface, HSG A
	5.139	35	Weighted Average
	5.139		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.8	50	0.0050	0.04		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
22.7	527	0.0060	0.39		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
43.5	577	Total			

Summary for Subcatchment PDA-4:

Runoff = 0.05 cfs @ 12.37 hrs, Volume= 0.011 af, Depth= 0.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
0.236	30	Woods, Good, HSG A
0.060	30	Brush, Good, HSG A
0.058	39	>75% Grass cover, Good, HSG A
0.085	96	Gravel surface, HSG A
0.439	44	Weighted Average
0.439		100.00% Pervious Area

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

Summary for Subcatchment PDA-5:

Runoff = 0.00 cfs @ 24.00 hrs, Volume= 0.001 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
4.192	30	Woods, Good, HSG A
0.175	30	Brush, Good, HSG A
0.470	39	>75% Grass cover, Good, HSG A
0.043	96	Gravel surface, HSG A
4.880	31	Weighted Average
4.880		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	50	0.0900	0.13		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
2.2	191	0.0820	1.43		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
8.8	241	Total			

Summary for Subcatchment PDA-6:

Runoff = 0.37 cfs @ 12.60 hrs, Volume= 0.164 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (ac)	CN	Description
	9.378	39	>75% Grass cover, Good, HSG A
	0.225	96	Gravel surface, HSG A
*	0.032	98	Equipment Pad Area, HSG A
	9.635	41	Weighted Average
	9.603		99.67% Pervious Area
	0.032		0.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	50	0.0200	0.15		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
9.0	607	0.0260	1.13		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
14.5	657	Total			

Summary for Subcatchment PDA-7:

Runoff = 0.47 cfs @ 12.61 hrs, Volume= 0.214 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
12.168	39	>75% Grass cover, Good, HSG A
0.365	96	Gravel surface, HSG A
0.032	98	Equipment Pad Area, HSG A
12.565	41	Weighted Average
12.533		99.75% Pervious Area
0.032		0.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	50	0.0200	0.15		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
9.7	785	0.0370	1.35		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
15.2	835	Total			

Summary for Subcatchment PDA-8:

Runoff = 0.75 cfs @ 12.50 hrs, Volume= 0.193 af, Depth= 0.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
6.768	39	>75% Grass cover, Good, HSG A
0.167	80	>75% Grass cover, Good, HSG D
0.438	96	Gravel surface, HSG A
0.064	98	Equipment Pad Area, HSG A
7.437	44	Weighted Average
7.373		99.14% Pervious Area
0.064		0.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
2.3	164	0.0300	1.21		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
4.0	175	0.0110	0.73		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
1.2	151	0.0930	2.13		**Shallow Concentrated Flow, Tc-4** Short Grass Pasture Kv= 7.0 fps
14.7	540	Total			

Summary for Subcatchment PDA-9:

Runoff = 0.61 cfs @ 12.90 hrs, Volume= 0.245 af, Depth= 0.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
10.016	39	>75% Grass cover, Good, HSG A
0.686	96	Gravel surface, HSG A
10.702	43	Weighted Average
10.702		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
6.5	273	0.0100	0.70		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
7.1	572	0.0370	1.35		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
5.7	228	0.0090	0.66		**Shallow Concentrated Flow, Tc-4** Short Grass Pasture Kv= 7.0 fps
10.4	516	0.0140	0.83		**Shallow Concentrated Flow, Tc-5** Short Grass Pasture Kv= 7.0 fps
36.9	1,639	Total			

Summary for Reach DP-1: DP-1

Inflow Area = 11.513 ac, 0.28% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.00 cfs @ 21.70 hrs, Volume= 0.003 af
Outflow = 0.00 cfs @ 21.70 hrs, Volume= 0.003 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2: DP-2

Inflow Area = 32.680 ac, 0.29% Impervious, Inflow Depth = 0.02" for 10-Year event
Inflow = 0.08 cfs @ 16.01 hrs, Volume= 0.052 af
Outflow = 0.08 cfs @ 16.01 hrs, Volume= 0.052 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3: DP-3

Inflow Area = 20.561 ac, 0.00% Impervious, Inflow Depth = 0.01" for 10-Year event
Inflow = 0.03 cfs @ 16.29 hrs, Volume= 0.021 af
Outflow = 0.03 cfs @ 16.29 hrs, Volume= 0.021 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-4: DP-4

Inflow Area = 15.797 ac, 0.00% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-5: DP-5

Inflow Area = 8.772 ac, 0.00% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.00 cfs @ 24.00 hrs, Volume= 0.001 af
Outflow = 0.00 cfs @ 24.00 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Pond 1: BASIN-1

Inflow Area = 9.635 ac, 0.33% Impervious, Inflow Depth = 0.20" for 10-Year event
Inflow = 0.37 cfs @ 12.60 hrs, Volume= 0.164 af
Outflow = 0.16 cfs @ 17.24 hrs, Volume= 0.164 af, Atten= 56%, Lag= 278.3 min
Discarded = 0.16 cfs @ 17.24 hrs, Volume= 0.164 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 64.67' @ 17.24 hrs Surf.Area= 2,900 sf Storage= 1,719 cf

Plug-Flow detention time= 128.3 min calculated for 0.164 af (100% of inflow)
Center-of-Mass det. time= 128.1 min (1,139.0 - 1,010.9)

Volume	Invert	Avail.Storage	Storage Description
#1	64.00'	24,450 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
64.00	2,230	0	0
65.00	3,230	2,730	2,730
66.00	4,280	3,755	6,485
67.00	5,390	4,835	11,320
68.00	6,550	5,970	17,290
69.00	7,770	7,160	24,450

Device	Routing	Invert	Outlet Devices
#1	Discarded	64.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	68.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.16 cfs @ 17.24 hrs HW=64.67' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.16 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=64.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 2: BASIN-2

Inflow Area = 12.565 ac, 0.25% Impervious, Inflow Depth = 0.20" for 10-Year event
Inflow = 0.47 cfs @ 12.61 hrs, Volume= 0.214 af
Outflow = 0.28 cfs @ 15.83 hrs, Volume= 0.214 af, Atten= 42%, Lag= 193.0 min
Discarded = 0.28 cfs @ 15.83 hrs, Volume= 0.214 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 52.26' @ 15.83 hrs Surf.Area= 4,961 sf Storage= 1,204 cf

Plug-Flow detention time= 41.2 min calculated for 0.214 af (100% of inflow)
Center-of-Mass det. time= 41.2 min (1,052.7 - 1,011.5)

Volume	Invert	Avail.Storage	Storage Description
#1	52.00'	25,740 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.00	4,250	0	0
53.00	6,970	5,610	5,610
54.00	9,900	8,435	14,045
55.00	13,490	11,695	25,740

Device	Routing	Invert	Outlet Devices
#1	Discarded	52.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	54.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.28 cfs @ 15.83 hrs HW=52.26' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.28 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=52.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 3: BASIN-3

Inflow Area = 7.437 ac, 0.86% Impervious, Inflow Depth = 0.31" for 10-Year event
Inflow = 0.75 cfs @ 12.50 hrs, Volume= 0.193 af
Outflow = 0.20 cfs @ 16.14 hrs, Volume= 0.193 af, Atten= 73%, Lag= 218.4 min
Discarded = 0.20 cfs @ 16.14 hrs, Volume= 0.193 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 32.63' @ 16.14 hrs Surf.Area= 3,616 sf Storage= 2,188 cf

Plug-Flow detention time= 124.2 min calculated for 0.193 af (100% of inflow)
Center-of-Mass det. time= 124.0 min (1,100.4 - 976.4)

Volume	Invert	Avail.Storage	Storage Description
#1	32.00'	28,028 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
32.00	3,025	0	0
33.00	3,970	3,498	3,498
34.00	4,990	4,480	7,978
35.00	6,080	5,535	13,513
36.00	7,310	6,695	20,208
37.00	8,330	7,820	28,028

Device	Routing	Invert	Outlet Devices
#1	Discarded	32.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	36.00'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.20 cfs @ 16.14 hrs HW=32.63' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.20 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=32.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 4: BASIN-4

Inflow Area =	4.720 ac,	0.00% Impervious,	Inflow Depth =	0.14"	for 10-Year event
Inflow =	0.09 cfs @	13.88 hrs,	Volume=	0.056 af	
Outflow =	0.09 cfs @	13.98 hrs,	Volume=	0.056 af,	Atten= 0%, Lag= 6.0 min
Discarded =	0.09 cfs @	13.98 hrs,	Volume=	0.056 af	
Primary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 48.01' @ 13.98 hrs Surf.Area= 4,951 sf Storage= 33 cf

Plug-Flow detention time= 5.9 min calculated for 0.056 af (100% of inflow)
Center-of-Mass det. time= 6.0 min (1,046.9 - 1,040.9)

Volume	Invert	Avail.Storage	Storage Description
#1	48.00'	13,330 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
48.00	4,940	0	0
49.00	6,650	5,795	5,795
50.00	8,420	7,535	13,330

Device	Routing	Invert	Outlet Devices
#1	Discarded	48.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	49.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.28 cfs @ 13.98 hrs HW=48.01' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.28 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=48.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 5: BASIN-5

Inflow Area =	15.422 ac,	0.00% Impervious,	Inflow Depth =	0.19"	for 10-Year event
Inflow =	0.61 cfs @	12.90 hrs,	Volume=	0.245 af	
Outflow =	0.43 cfs @	14.03 hrs,	Volume=	0.245 af,	Atten= 29%, Lag= 68.0 min
Discarded =	0.43 cfs @	14.03 hrs,	Volume=	0.245 af	
Primary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 45.08' @ 14.03 hrs Surf.Area= 7,772 sf Storage= 593 cf

Plug-Flow detention time= 13.0 min calculated for 0.244 af (100% of inflow)
Center-of-Mass det. time= 13.1 min (1,020.3 - 1,007.3)

Volume	Invert	Avail.Storage	Storage Description
#1	45.00'	34,785 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
45.00	7,570	0	0
46.00	10,180	8,875	8,875
47.00	12,940	11,560	20,435
48.00	15,760	14,350	34,785

Device	Routing	Invert	Outlet Devices
#1	Discarded	45.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	47.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.43 cfs @ 14.03 hrs HW=45.08' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.43 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=45.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 6: BASIN-6

Inflow Area = 15.358 ac, 0.00% Impervious, Inflow Depth = 0.24" for 10-Year event
Inflow = 0.66 cfs @ 12.95 hrs, Volume= 0.305 af
Outflow = 0.30 cfs @ 17.20 hrs, Volume= 0.305 af, Atten= 54%, Lag= 254.7 min
Discarded = 0.30 cfs @ 17.20 hrs, Volume= 0.305 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 66.71' @ 17.20 hrs Surf.Area= 5,456 sf Storage= 3,294 cf

Plug-Flow detention time= 130.6 min calculated for 0.305 af (100% of inflow)
Center-of-Mass det. time= 130.5 min (1,147.7 - 1,017.2)

Volume	Invert	Avail.Storage	Storage Description
#1	66.00'	49,580 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
66.00	3,840	0	0
67.00	6,120	4,980	4,980
68.00	8,170	7,145	12,125
69.00	18,320	13,245	25,370
70.00	30,100	24,210	49,580

Device	Routing	Invert	Outlet Devices
#1	Discarded	66.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	69.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.30 cfs @ 17.20 hrs HW=66.71' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.30 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=66.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 7: BASIN-7

Inflow Area = 3.707 ac, 0.00% Impervious, Inflow Depth = 0.39" for 10-Year event
Inflow = 0.58 cfs @ 12.44 hrs, Volume= 0.121 af
Outflow = 0.11 cfs @ 16.36 hrs, Volume= 0.121 af, Atten= 81%, Lag= 235.1 min
Discarded = 0.11 cfs @ 16.36 hrs, Volume= 0.121 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 77.16' @ 16.36 hrs Surf.Area= 2,009 sf Storage= 1,837 cf

Plug-Flow detention time= 213.0 min calculated for 0.121 af (100% of inflow)
Center-of-Mass det. time= 213.0 min (1,170.6 - 957.6)

Volume	Invert	Avail.Storage	Storage Description
#1	76.00'	22,385 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
76.00	1,270	0	0
77.00	1,780	1,525	1,525
78.00	3,170	2,475	4,000
79.00	8,280	5,725	9,725
80.00	17,040	12,660	22,385

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	79.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.11 cfs @ 16.36 hrs HW=77.16' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.11 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=76.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond T-1: TRENCH-1

Inflow Area =	0.439 ac,	0.00% Impervious,	Inflow Depth =	0.31"	for 10-Year event
Inflow =	0.05 cfs @	12.37 hrs,	Volume=	0.011 af	
Outflow =	0.03 cfs @	12.30 hrs,	Volume=	0.011 af,	Atten= 38%, Lag= 0.0 min
Discarded =	0.03 cfs @	12.30 hrs,	Volume=	0.011 af	
Primary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 64.10' @ 12.58 hrs Surf.Area= 0.013 ac Storage= 0.000 af

Plug-Flow detention time= 4.6 min calculated for 0.011 af (100% of inflow)
Center-of-Mass det. time= 4.6 min (972.9 - 968.3)

Volume	Invert	Avail.Storage	Storage Description
#1	64.00'	0.015 af	**3.00'W x 185.00'L x 3.00'H Prismatoid**
			0.038 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Discarded	64.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	66.99'	**3.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.03 cfs @ 12.30 hrs HW=64.04' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=64.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond T-2: TRENCH-2

Inflow Area =	0.185 ac,	0.00% Impervious,	Inflow Depth =	3.29"	for 10-Year event
Inflow =	0.69 cfs @	12.09 hrs,	Volume=	0.051 af	
Outflow =	0.06 cfs @	11.50 hrs,	Volume=	0.051 af,	Atten= 92%, Lag= 0.0 min
Discarded =	0.06 cfs @	11.50 hrs,	Volume=	0.051 af	
Primary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 58.17' @ 13.16 hrs Surf.Area= 0.023 ac Storage= 0.020 af

Plug-Flow detention time= 129.8 min calculated for 0.051 af (100% of inflow)
Center-of-Mass det. time= 129.7 min (933.2 - 803.5)

Volume	Invert	Avail.Storage	Storage Description
#1	56.00'	0.037 af	**4.00'W x 254.00'L x 4.00'H Prismatoid** 0.093 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Discarded	56.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	59.99'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.06 cfs @ 11.50 hrs HW=56.04' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=56.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PDA-1: Runoff Area=1.878 ac 0.00% Impervious Runoff Depth=0.37"
Flow Length=122' Tc=17.5 min CN=33 Runoff=0.17 cfs 0.058 af

Subcatchment PDA-10: Runoff Area=4.720 ac 0.00% Impervious Runoff Depth=0.77"
Flow Length=756' Tc=13.3 min CN=39 Runoff=1.75 cfs 0.302 af

Subcatchment PDA-11: Runoff Area=15.358 ac 0.00% Impervious Runoff Depth=1.00"
Flow Length=1,352' Tc=35.2 min CN=42 Runoff=6.52 cfs 1.274 af

Subcatchment PDA-12: Runoff Area=3.707 ac 0.00% Impervious Runoff Depth=1.32"
Flow Length=421' Tc=13.6 min CN=46 Runoff=3.44 cfs 0.408 af

Subcatchment PDA-13: Runoff Area=0.185 ac 0.00% Impervious Runoff Depth>5.47"
Tc=6.0 min CN=87 Runoff=1.12 cfs 0.084 af

Subcatchment PDA-2: Runoff Area=12.678 ac 0.00% Impervious Runoff Depth=0.49"
Flow Length=449' Tc=29.8 min CN=35 Runoff=1.71 cfs 0.522 af

Subcatchment PDA-3: Runoff Area=5.139 ac 0.00% Impervious Runoff Depth=0.49"
Flow Length=577' Tc=43.5 min CN=35 Runoff=0.59 cfs 0.212 af

Subcatchment PDA-4: Runoff Area=0.439 ac 0.00% Impervious Runoff Depth=1.15"
Tc=6.0 min CN=44 Runoff=0.42 cfs 0.042 af

Subcatchment PDA-5: Runoff Area=4.880 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=241' Tc=8.8 min CN=31 Runoff=0.19 cfs 0.106 af

Subcatchment PDA-6: Runoff Area=9.635 ac 0.33% Impervious Runoff Depth=0.92"
Flow Length=657' Tc=14.5 min CN=41 Runoff=4.79 cfs 0.737 af

Subcatchment PDA-7: Runoff Area=12.565 ac 0.25% Impervious Runoff Depth=0.92"
Flow Length=835' Tc=15.2 min CN=41 Runoff=6.18 cfs 0.961 af

Subcatchment PDA-8: Runoff Area=7.437 ac 0.86% Impervious Runoff Depth=1.15"
Flow Length=540' Tc=14.7 min CN=44 Runoff=5.47 cfs 0.716 af

Subcatchment PDA-9: Runoff Area=10.702 ac 0.00% Impervious Runoff Depth=1.07"
Flow Length=1,639' Tc=36.9 min CN=43 Runoff=5.00 cfs 0.958 af

Reach DP-1: DP-1 Inflow=0.22 cfs 0.079 af
Outflow=0.22 cfs 0.079 af

Reach DP-2: DP-2 Inflow=1.74 cfs 0.684 af
Outflow=1.74 cfs 0.684 af

Reach DP-3: DP-3 Inflow=0.59 cfs 0.212 af
Outflow=0.59 cfs 0.212 af

Reach DP-4: DP-4 Inflow=0.06 cfs 0.005 af
Outflow=0.06 cfs 0.005 af

Reach DP-5: DP-5 Inflow=0.30 cfs 0.110 af
Outflow=0.30 cfs 0.110 af

Pond 1: BASIN-1 Peak Elev=68.03' Storage=17,458 cf Inflow=4.79 cfs 0.737 af
Discarded=0.37 cfs 0.498 af Primary=0.16 cfs 0.021 af Outflow=0.53 cfs 0.519 af

Pond 2: BASIN-2 Peak Elev=54.10' Storage=15,008 cf Inflow=6.18 cfs 0.961 af
Discarded=0.57 cfs 0.736 af Primary=0.83 cfs 0.162 af Outflow=1.40 cfs 0.899 af

Pond 3: BASIN-3 Peak Elev=35.60' Storage=17,559 cf Inflow=5.47 cfs 0.716 af
Discarded=0.38 cfs 0.516 af Primary=0.00 cfs 0.000 af Outflow=0.38 cfs 0.516 af

Pond 4: BASIN-4 Peak Elev=48.70' Storage=3,867 cf Inflow=1.75 cfs 0.302 af
Discarded=0.34 cfs 0.302 af Primary=0.00 cfs 0.000 af Outflow=0.34 cfs 0.302 af

Pond 5: BASIN-5 Peak Elev=46.89' Storage=19,044 cf Inflow=5.00 cfs 0.958 af
Discarded=0.71 cfs 0.917 af Primary=0.00 cfs 0.000 af Outflow=0.71 cfs 0.917 af

Pond 6: BASIN-6 Peak Elev=69.00' Storage=25,461 cf Inflow=6.52 cfs 1.274 af
Discarded=1.03 cfs 1.105 af Primary=0.03 cfs 0.001 af Outflow=1.05 cfs 1.106 af

Pond 7: BASIN-7 Peak Elev=78.75' Storage=7,818 cf Inflow=3.44 cfs 0.408 af
Discarded=0.39 cfs 0.377 af Primary=0.00 cfs 0.000 af Outflow=0.39 cfs 0.377 af

Pond T-1: TRENCH-1 Peak Elev=67.02' Storage=0.015 af Inflow=0.42 cfs 0.042 af
Discarded=0.03 cfs 0.038 af Primary=0.06 cfs 0.004 af Outflow=0.09 cfs 0.042 af

Pond T-2: TRENCH-2 Peak Elev=60.04' Storage=0.037 af Inflow=1.12 cfs 0.084 af
Discarded=0.06 cfs 0.081 af Primary=0.12 cfs 0.003 af Outflow=0.17 cfs 0.084 af

Total Runoff Area = 89.323 ac Runoff Volume = 6.380 af Average Runoff Depth = 0.86"
99.86% Pervious = 89.195 ac 0.14% Impervious = 0.128 ac

Summary for Subcatchment PDA-1:

Runoff = 0.17 cfs @ 12.59 hrs, Volume= 0.058 af, Depth= 0.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
1.222	30	Woods, Good, HSG A
0.656	39	>75% Grass cover, Good, HSG A
1.878	33	Weighted Average
1.878		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
1.7	72	0.0210	0.72		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
17.5	122	Total			

Summary for Subcatchment PDA-10:

Runoff = 1.75 cfs @ 12.36 hrs, Volume= 0.302 af, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
4.720	39	>75% Grass cover, Good, HSG A
4.720		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	50	0.0500	0.22		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
5.4	448	0.0390	1.38		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
4.1	258	0.0230	1.06		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
13.3	756	Total			

Summary for Subcatchment PDA-11:

Runoff = 6.52 cfs @ 12.64 hrs, Volume= 1.274 af, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

	Area (ac)	CN	Description
	14.490	39	>75% Grass cover, Good, HSG A
	0.836	96	Gravel surface, HSG A
*	0.032	96	Existing Gravel surface, HSG A
	15.358	42	Weighted Average
	15.358		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
13.5	506	0.0080	0.63		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
8.6	429	0.0140	0.83		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
5.9	367	0.0220	1.04		**Shallow Concentrated Flow, Tc-4** Short Grass Pasture Kv= 7.0 fps
35.2	1,352	Total			

Summary for Subcatchment PDA-12:

Runoff = 3.44 cfs @ 12.23 hrs, Volume= 0.408 af, Depth= 1.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
3.237	39	>75% Grass cover, Good, HSG A
0.470	96	Gravel surface, HSG A
3.707	46	Weighted Average
3.707		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
6.4	371	0.0190	0.96		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
13.6	421	Total			

Summary for Subcatchment PDA-13:

Runoff = 1.12 cfs @ 12.09 hrs, Volume= 0.084 af, Depth> 5.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.028	39	>75% Grass cover, Good, HSG A
0.157	96	Gravel surface, HSG A
0.185	87	Weighted Average
0.185		100.00% Pervious Area

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

Summary for Subcatchment PDA-2:

Runoff = 1.71 cfs @ 12.71 hrs, Volume= 0.522 af, Depth= 0.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

	Area (ac)	CN	Description
	11.089	30	Woods, Good, HSG A
	0.296	77	Woods, Good, HSG D
	0.569	39	>75% Grass cover, Good, HSG A
	0.068	80	>75% Grass cover, Good, HSG D
	0.064	96	Gravel surface, HSG A
	0.038	96	Gravel surface, HSG D
*	0.364	96	Existing Gravel surface, HSG A
*	0.190	96	Existing Gravel surface, HSG D
	12.678	35	Weighted Average
	12.678		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
14.0	399	0.0090	0.47		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
29.8	449	Total			

Summary for Subcatchment PDA-3:

Runoff = 0.59 cfs @ 12.94 hrs, Volume= 0.212 af, Depth= 0.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

	Area (ac)	CN	Description
	4.636	30	Woods, Good, HSG A
	0.113	39	>75% Grass cover, Good, HSG A
	0.020	96	Gravel surface, HSG A
*	0.370	96	Existing Gravel surface, HSG A
	5.139	35	Weighted Average
	5.139		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.8	50	0.0050	0.04		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
22.7	527	0.0060	0.39		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
43.5	577	Total			

Summary for Subcatchment PDA-4:

Runoff = 0.42 cfs @ 12.12 hrs, Volume= 0.042 af, Depth= 1.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.236	30	Woods, Good, HSG A
0.060	30	Brush, Good, HSG A
0.058	39	>75% Grass cover, Good, HSG A
0.085	96	Gravel surface, HSG A
0.439	44	Weighted Average
0.439		100.00% Pervious Area

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

Summary for Subcatchment PDA-5:

Runoff = 0.19 cfs @ 12.55 hrs, Volume= 0.106 af, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
4.192	30	Woods, Good, HSG A
0.175	30	Brush, Good, HSG A
0.470	39	>75% Grass cover, Good, HSG A
0.043	96	Gravel surface, HSG A
4.880	31	Weighted Average
4.880		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	50	0.0900	0.13		**Sheet Flow, Tc-1** Woods: Light underbrush n= 0.400 P2= 3.40"
2.2	191	0.0820	1.43		**Shallow Concentrated Flow, Tc-2** Woodland Kv= 5.0 fps
8.8	241	Total			

Summary for Subcatchment PDA-6:

Runoff = 4.79 cfs @ 12.31 hrs, Volume= 0.737 af, Depth= 0.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

	Area (ac)	CN	Description
	9.378	39	>75% Grass cover, Good, HSG A
	0.225	96	Gravel surface, HSG A
*	0.032	98	Equipment Pad Area, HSG A
	9.635	41	Weighted Average
	9.603		99.67% Pervious Area
	0.032		0.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	50	0.0200	0.15		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
9.0	607	0.0260	1.13		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
14.5	657	Total			

Summary for Subcatchment PDA-7:

Runoff = 6.18 cfs @ 12.32 hrs, Volume= 0.961 af, Depth= 0.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
12.168	39	>75% Grass cover, Good, HSG A
0.365	96	Gravel surface, HSG A
0.032	98	Equipment Pad Area, HSG A
12.565	41	Weighted Average
12.533		99.75% Pervious Area
0.032		0.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	50	0.0200	0.15		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
9.7	785	0.0370	1.35		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
15.2	835	Total			

Summary for Subcatchment PDA-8:

Runoff = 5.47 cfs @ 12.27 hrs, Volume= 0.716 af, Depth= 1.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
6.768	39	>75% Grass cover, Good, HSG A
0.167	80	>75% Grass cover, Good, HSG D
0.438	96	Gravel surface, HSG A
0.064	98	Equipment Pad Area, HSG A
7.437	44	Weighted Average
7.373		99.14% Pervious Area
0.064		0.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
2.3	164	0.0300	1.21		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
4.0	175	0.0110	0.73		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
1.2	151	0.0930	2.13		**Shallow Concentrated Flow, Tc-4** Short Grass Pasture Kv= 7.0 fps
14.7	540	Total			

Summary for Subcatchment PDA-9:

Runoff = 5.00 cfs @ 12.65 hrs, Volume= 0.958 af, Depth= 1.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
10.016	39	>75% Grass cover, Good, HSG A
0.686	96	Gravel surface, HSG A
10.702	43	Weighted Average
10.702		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0100	0.12		**Sheet Flow, Tc-1** Grass: Short n= 0.150 P2= 3.40"
6.5	273	0.0100	0.70		**Shallow Concentrated Flow, Tc-2** Short Grass Pasture Kv= 7.0 fps
7.1	572	0.0370	1.35		**Shallow Concentrated Flow, Tc-3** Short Grass Pasture Kv= 7.0 fps
5.7	228	0.0090	0.66		**Shallow Concentrated Flow, Tc-4** Short Grass Pasture Kv= 7.0 fps
10.4	516	0.0140	0.83		**Shallow Concentrated Flow, Tc-5** Short Grass Pasture Kv= 7.0 fps
36.9	1,639	Total			

Summary for Reach DP-1: DP-1

Inflow Area = 11.513 ac, 0.28% Impervious, Inflow Depth = 0.08" for 100-Year event
Inflow = 0.22 cfs @ 16.96 hrs, Volume= 0.079 af
Outflow = 0.22 cfs @ 16.96 hrs, Volume= 0.079 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2: DP-2

Inflow Area = 32.680 ac, 0.29% Impervious, Inflow Depth = 0.25" for 100-Year event
Inflow = 1.74 cfs @ 13.95 hrs, Volume= 0.684 af
Outflow = 1.74 cfs @ 13.95 hrs, Volume= 0.684 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3: DP-3

Inflow Area = 20.561 ac, 0.00% Impervious, Inflow Depth = 0.12" for 100-Year event
Inflow = 0.59 cfs @ 12.94 hrs, Volume= 0.212 af
Outflow = 0.59 cfs @ 12.94 hrs, Volume= 0.212 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-4: DP-4

Inflow Area = 15.797 ac, 0.00% Impervious, Inflow Depth = 0.00" for 100-Year event
Inflow = 0.06 cfs @ 13.45 hrs, Volume= 0.005 af
Outflow = 0.06 cfs @ 13.45 hrs, Volume= 0.005 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach DP-5: DP-5

Inflow Area = 8.772 ac, 0.00% Impervious, Inflow Depth = 0.15" for 100-Year event
Inflow = 0.30 cfs @ 12.80 hrs, Volume= 0.110 af
Outflow = 0.30 cfs @ 12.80 hrs, Volume= 0.110 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Pond 1: BASIN-1

Inflow Area = 9.635 ac, 0.33% Impervious, Inflow Depth = 0.92" for 100-Year event
Inflow = 4.79 cfs @ 12.31 hrs, Volume= 0.737 af
Outflow = 0.53 cfs @ 16.98 hrs, Volume= 0.519 af, Atten= 89%, Lag= 280.3 min
Discarded = 0.37 cfs @ 16.98 hrs, Volume= 0.498 af
Primary = 0.16 cfs @ 16.98 hrs, Volume= 0.021 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 68.03' @ 16.98 hrs Surf.Area= 6,581 sf Storage= 17,458 cf

Plug-Flow detention time= 438.6 min calculated for 0.519 af (70% of inflow)
Center-of-Mass det. time= 326.2 min (1,252.6 - 926.4)

Volume	Invert	Avail.Storage	Storage Description
#1	64.00'	24,450 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
64.00	2,230	0	0
65.00	3,230	2,730	2,730
66.00	4,280	3,755	6,485
67.00	5,390	4,835	11,320
68.00	6,550	5,970	17,290
69.00	7,770	7,160	24,450

Device	Routing	Invert	Outlet Devices
#1	Discarded	64.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	68.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.37 cfs @ 16.98 hrs HW=68.03' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.37 cfs)

Primary OutFlow Max=0.11 cfs @ 16.98 hrs HW=68.03' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 0.11 cfs @ 0.45 fps)

Summary for Pond 2: BASIN-2

Inflow Area = 12.565 ac, 0.25% Impervious, Inflow Depth = 0.92" for 100-Year event
Inflow = 6.18 cfs @ 12.32 hrs, Volume= 0.961 af
Outflow = 1.40 cfs @ 14.03 hrs, Volume= 0.899 af, Atten= 77%, Lag= 102.2 min
Discarded = 0.57 cfs @ 14.03 hrs, Volume= 0.736 af
Primary = 0.83 cfs @ 14.03 hrs, Volume= 0.162 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 54.10' @ 14.03 hrs Surf.Area= 10,243 sf Storage= 15,008 cf

Plug-Flow detention time= 276.0 min calculated for 0.899 af (93% of inflow)
Center-of-Mass det. time= 244.2 min (1,171.3 - 927.1)

Volume	Invert	Avail.Storage	Storage Description
#1	52.00'	25,740 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.00	4,250	0	0
53.00	6,970	5,610	5,610
54.00	9,900	8,435	14,045
55.00	13,490	11,695	25,740

Device	Routing	Invert	Outlet Devices
#1	Discarded	52.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	54.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.57 cfs @ 14.03 hrs HW=54.10' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.57 cfs)

Primary OutFlow Max=0.83 cfs @ 14.03 hrs HW=54.10' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 0.83 cfs @ 0.87 fps)

Summary for Pond 3: BASIN-3

Inflow Area = 7.437 ac, 0.86% Impervious, Inflow Depth = 1.15" for 100-Year event
Inflow = 5.47 cfs @ 12.27 hrs, Volume= 0.716 af
Outflow = 0.38 cfs @ 17.93 hrs, Volume= 0.516 af, Atten= 93%, Lag= 340.0 min
Discarded = 0.38 cfs @ 17.93 hrs, Volume= 0.516 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 35.60' @ 17.93 hrs Surf.Area= 6,823 sf Storage= 17,559 cf

Plug-Flow detention time= 450.3 min calculated for 0.516 af (72% of inflow)
Center-of-Mass det. time= 343.6 min (1,255.1 - 911.6)

Volume	Invert	Avail.Storage	Storage Description
#1	32.00'	28,028 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
32.00	3,025	0	0
33.00	3,970	3,498	3,498
34.00	4,990	4,480	7,978
35.00	6,080	5,535	13,513
36.00	7,310	6,695	20,208
37.00	8,330	7,820	28,028

Device	Routing	Invert	Outlet Devices
#1	Discarded	32.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	36.00'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.38 cfs @ 17.93 hrs HW=35.60' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.38 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=32.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 4: BASIN-4

Inflow Area =	4.720 ac,	0.00% Impervious,	Inflow Depth =	0.77" for 100-Year event
Inflow =	1.75 cfs @	12.36 hrs,	Volume=	0.302 af
Outflow =	0.34 cfs @	15.36 hrs,	Volume=	0.302 af, Atten= 80%, Lag= 180.2 min
Discarded =	0.34 cfs @	15.36 hrs,	Volume=	0.302 af
Primary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 48.70' @ 15.36 hrs Surf.Area= 6,134 sf Storage= 3,867 cf

Plug-Flow detention time= 125.2 min calculated for 0.302 af (100% of inflow)
Center-of-Mass det. time= 125.0 min (1,062.5 - 937.5)

Volume	Invert	Avail.Storage	Storage Description
#1	48.00'	13,330 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
48.00	4,940	0	0
49.00	6,650	5,795	5,795
50.00	8,420	7,535	13,330

Device	Routing	Invert	Outlet Devices
#1	Discarded	48.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	49.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.34 cfs @ 15.36 hrs HW=48.70' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.34 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=48.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 5: BASIN-5

Inflow Area =	15.422 ac,	0.00% Impervious,	Inflow Depth =	0.75"	for 100-Year event
Inflow =	5.00 cfs @	12.65 hrs,	Volume=	0.958 af	
Outflow =	0.71 cfs @	16.92 hrs,	Volume=	0.917 af,	Atten= 86%, Lag= 256.0 min
Discarded =	0.71 cfs @	16.92 hrs,	Volume=	0.917 af	
Primary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 46.89' @ 16.92 hrs Surf.Area= 12,640 sf Storage= 19,044 cf

Plug-Flow detention time= 328.4 min calculated for 0.915 af (96% of inflow)
Center-of-Mass det. time= 306.8 min (1,243.6 - 936.8)

Volume	Invert	Avail.Storage	Storage Description
#1	45.00'	34,785 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
45.00	7,570	0	0
46.00	10,180	8,875	8,875
47.00	12,940	11,560	20,435
48.00	15,760	14,350	34,785

Device	Routing	Invert	Outlet Devices
#1	Discarded	45.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	47.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.71 cfs @ 16.92 hrs HW=46.89' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.71 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=45.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 6: BASIN-6

Inflow Area = 15.358 ac, 0.00% Impervious, Inflow Depth = 1.00" for 100-Year event
Inflow = 6.52 cfs @ 12.64 hrs, Volume= 1.274 af
Outflow = 1.05 cfs @ 16.48 hrs, Volume= 1.106 af, Atten= 84%, Lag= 230.6 min
Discarded = 1.03 cfs @ 16.48 hrs, Volume= 1.105 af
Primary = 0.03 cfs @ 16.48 hrs, Volume= 0.001 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 69.00' @ 16.48 hrs Surf.Area= 18,378 sf Storage= 25,461 cf

Plug-Flow detention time= 328.6 min calculated for 1.104 af (87% of inflow)
Center-of-Mass det. time= 269.0 min (1,209.3 - 940.2)

Volume	Invert	Avail.Storage	Storage Description
#1	66.00'	49,580 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
66.00	3,840	0	0
67.00	6,120	4,980	4,980
68.00	8,170	7,145	12,125
69.00	18,320	13,245	25,370
70.00	30,100	24,210	49,580

Device	Routing	Invert	Outlet Devices
#1	Discarded	66.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	69.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=1.03 cfs @ 16.48 hrs HW=69.00' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 1.03 cfs)

Primary OutFlow Max=0.01 cfs @ 16.48 hrs HW=69.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 0.01 cfs @ 0.20 fps)

Summary for Pond 7: BASIN-7

Inflow Area = 3.707 ac, 0.00% Impervious, Inflow Depth = 1.32" for 100-Year event
Inflow = 3.44 cfs @ 12.23 hrs, Volume= 0.408 af
Outflow = 0.39 cfs @ 15.38 hrs, Volume= 0.377 af, Atten= 89%, Lag= 188.7 min
Discarded = 0.39 cfs @ 15.38 hrs, Volume= 0.377 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 78.75' @ 15.38 hrs Surf.Area= 7,005 sf Storage= 7,818 cf

Plug-Flow detention time= 291.5 min calculated for 0.377 af (92% of inflow)
Center-of-Mass det. time= 254.9 min (1,157.0 - 902.1)

Volume	Invert	Avail.Storage	Storage Description
#1	76.00'	22,385 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
76.00	1,270	0	0
77.00	1,780	1,525	1,525
78.00	3,170	2,475	4,000
79.00	8,280	5,725	9,725
80.00	17,040	12,660	22,385

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	79.00'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.39 cfs @ 15.38 hrs HW=78.75' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.39 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=76.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond T-1: TRENCH-1

Inflow Area =	0.439 ac,	0.00% Impervious,	Inflow Depth =	1.15"	for 100-Year event
Inflow =	0.42 cfs @	12.12 hrs,	Volume=	0.042 af	
Outflow =	0.09 cfs @	13.45 hrs,	Volume=	0.042 af,	Atten= 79%, Lag= 80.0 min
Discarded =	0.03 cfs @	12.00 hrs,	Volume=	0.038 af	
Primary =	0.06 cfs @	13.45 hrs,	Volume=	0.004 af	

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 67.02' @ 13.45 hrs Surf.Area= 0.013 ac Storage= 0.015 af

Plug-Flow detention time= 232.4 min calculated for 0.042 af (100% of inflow)
Center-of-Mass det. time= 232.4 min (1,135.8 - 903.5)

Volume	Invert	Avail.Storage	Storage Description
#1	64.00'	0.015 af	**3.00'W x 185.00'L x 3.00'H Prismatoid**
			0.038 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Discarded	64.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	66.99'	**3.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.03 cfs @ 12.00 hrs HW=64.08' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.05 cfs @ 13.45 hrs HW=67.02' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 0.05 cfs @ 0.52 fps)

Summary for Pond T-2: TRENCH-2

Inflow Area =	0.185 ac,	0.00% Impervious,	Inflow Depth >	5.47"	for 100-Year event
Inflow =	1.12 cfs @	12.09 hrs,	Volume=	0.084 af	
Outflow =	0.17 cfs @	12.80 hrs,	Volume=	0.084 af,	Atten= 84%, Lag= 42.6 min
Discarded =	0.06 cfs @	10.75 hrs,	Volume=	0.081 af	
Primary =	0.12 cfs @	12.80 hrs,	Volume=	0.003 af	

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 60.04' @ 12.80 hrs Surf.Area= 0.023 ac Storage= 0.037 af

Plug-Flow detention time= 249.4 min calculated for 0.084 af (100% of inflow)
Center-of-Mass det. time= 249.1 min (1,038.9 - 789.8)

Volume	Invert	Avail.Storage	Storage Description
#1	56.00'	0.037 af	**4.00'W x 254.00'L x 4.00'H Prismatoid** 0.093 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Discarded	56.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	59.99'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.06 cfs @ 10.75 hrs HW=56.04' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=0.11 cfs @ 12.80 hrs HW=60.04' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 0.11 cfs @ 0.60 fps)

Attachment 4
Hydraulic Analysis

BEALS + THOMAS
BEALS AND THOMAS, INC.
Reservoir Corporate Center
144 Turnpike Road
Southborough, MA 01772-2104

CALCULATION SUMMARY

T 508.366.0560
F 508.366.4391
www.bealsandthomas.com
Regional Office: Plymouth, MA

JOB NO./LOCATION:

1833.112
Wareham, MA

CLIENT/PROJECT:

Borrego Solar Systems, Inc.
140 Tihonet Road PV+ES Project

SUBJECT/TITLE:

Hydraulic Calculations

OBJECTIVE OF CALCULATION:

- To size culvert pipes to adequately convey flows from the proposed project and to meet the design standards of the Massachusetts DEP Stormwater Handbook for inlet capacity, pipe flow, and scour.

CALCULATION METHOD(S):

- Culverts are designed using the Rational Formula, based on a 50-year storm event for the Town of Barnstable (see attached IDF curve).

ASSUMPTIONS:

- Runoff coefficient C=0.3 for pervious areas and C=0.9 for impervious areas.
- Manning's n=0.012 for HDPE pipe.
- The times of concentration for contributing subcatchments are approximately 40 minutes for flows to FE-9.
- The minimum full-flow (scour) velocity is 2 feet per second.
- The maximum full-flow (scour) velocity is 10 feet per second.

SOURCES OF DATA/EQUATIONS:

- 140 Tihonet Road PV+ES Project Grading and Drainage Plans, prepared by Borrego Solar Systems, Inc., plan numbers C-4.0 – C4.4.
- Rational Method (Q=CiA) was used to calculate peak runoff rates tributary to FE-9.
- Manning's Equation was used to determine pipe capacities.
- 50-year storm intensity obtained from the Intensity/Duration rainfall curve for Plymouth, MA in S.C.S Technical Report No. 40.
- Massachusetts DEP Stormwater Management Handbook, February 2008.

CONCLUSIONS:

- The proposed culvert pipes will adequately convey the 50-year storm event runoff rates.
- The proposed stormwater management design has been reviewed for compliance with the stormwater management standards described in the Massachusetts DEP Stormwater Management Handbook.

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	N. Bautz	05/31/2020	J. Murphy	06/01/2020	J. Murphy	06/01/2020
1	N. Bautz	1/14/2021	J. Murphy	1/19/2021	J. Murphy	1/19/2021

Hydraulic Areas Map

Figure Number 003

Scale: 1" = 150'

Date: 01/19/2021

Plan 1833112P593B-003

B+T Project No. 1833.112

140 Tihonet Road PV+ES Project

Wareham, Massachusetts

Borrego Solar Systems, Inc.

55 Technology Drive, Suite 102
Lowell, Massachusetts

North Arrow

NORTH

BEALS AND THOMAS, INC.

B E A L S + T H O M A S

Hydraulic Drainage Areas & Corresponding Rational Method Flows

Using the Rational Method:

$$Q = CIA$$

Where:

Q = flow (cfs)
C = Runoff Coefficient (0.9 for impervious areas)
I = Rainfall Intensity, 50-year storm (in/hr) (from Barnstable IDF curve, see attache
A = Contributing Area (acres)

Assumptions: - Coefficient of runoff for Gravel Surfaces = 0.9
- Coefficient of runoff for Pervious Surfaces = 0.3

Inlet	Contributing Area (Acres)	Weighted Average Rational Coefficients	Rainfall Intensity for Barnstable (in/hr)	Contributing Flow (cfs)
FE-9	9.592	0.30	3.00	8.63

JOB NO.	1833.112	COMPUTED BY	NBB
FILE	140 Tihonet Road PV+ES Project		1/14/2021
		CHECKED BY	JRM
		DATE	1/19/2021

B E A L S + T H O M A S

Hydraulic Pipe Sizing Calculations

Using the Manning Equation to Verify Pipe Capacities Versus Pipe Flows:

$$Q = \frac{1.49}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Where:

Q = flow (cfs)
n = Manning's roughness coefficient
A = Cross Sectional Area (sf)
R = Hydraulic Radius (ft)
S = Pipe Slope

Assumptions: n = 0.012 for HDPE pipe
Pipe velocity shall be between 2.0 ft/sec and 10 ft/sec

Pipe Connection	Contributing Flow-50 Year Storm(cfs)	Proposed Pipe Size and Material	Proposed Pipe Slope (rise/run)	Full-Flow Capacity of Pipe from Manning Equation (cfs)	Adequate	Full Flow Velocity (ft/sec)
FE-9 to FE-10	8.63	15" HDPE	0.024	10.87	OK	8.9

JOB NO.	1833.112	COMPUTED BY	NBB	CHECKED BY	JRM
FILE	140 Tihonet Road PV+ES Project	DATE	1/14/2021	DATE	1/19/2021

Storm Data Detailed Report: Barnstable Rainfall

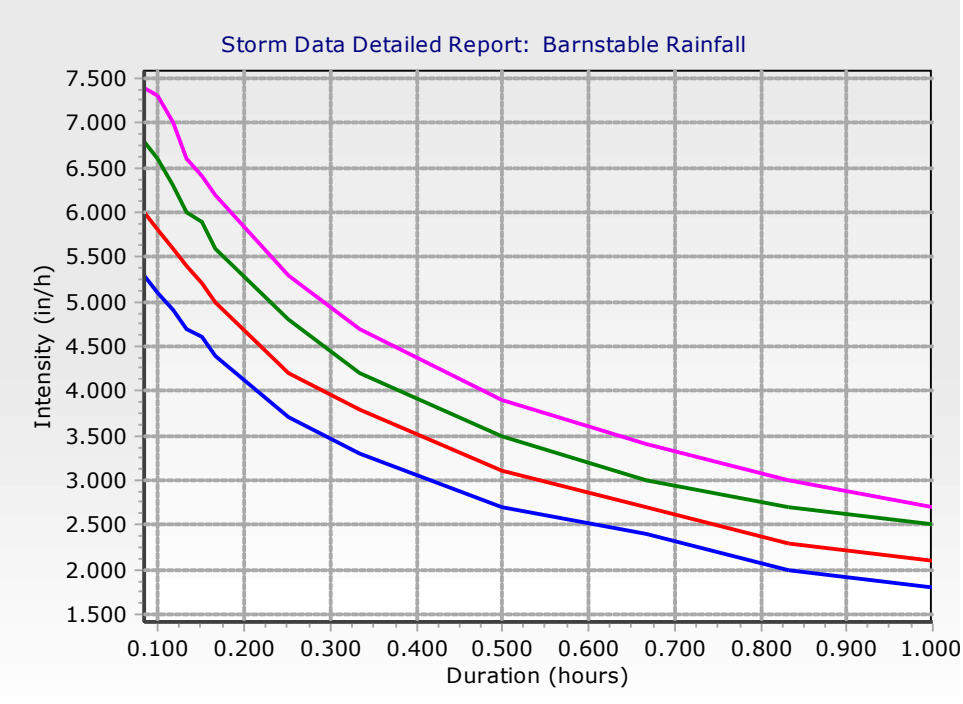
Element Details			
ID	30	Notes	
Label	Barnstable Rainfall		

Duration (hours)	10 Year (in/h)	25 Year (in/h)	50 Year (in/h)	100 Year (in/h)
0.083	5.300	6.000	6.800	7.400
0.100	5.100	5.800	6.600	7.300
0.117	4.900	5.600	6.300	7.000
0.133	4.700	5.400	6.000	6.600
0.150	4.600	5.200	5.900	6.400
0.167	4.400	5.000	5.600	6.200
0.250	3.700	4.200	4.800	5.300
0.333	3.300	3.800	4.200	4.700
0.500	2.700	3.100	3.500	3.900
0.667	2.400	2.700	3.000	3.400
0.833	2.000	2.300	2.700	3.000
1.000	1.800	2.100	2.500	2.700

Library Status Summary

	Synchronization Details
ID	30
Label	Barnstable Rainfall
Modified Date	3/11/2020 4:13:38 PM
Library Source	G:\Corp-Data\Qags\StormCAD\8 XM\Rainfall .xml
Library Modified Date	10/16/2008 3:19:18 PM
Synchronization Status	Synchronize to Library
Engineering Reference Guid	686ed606-a18a-4e03-9cab-f4a1ec6f02ac

Storm Data Detailed Report: Barnstable Rainfall



Attachment 5
Drawdown and Groundwater Recharge Calculations

B E A L S + T H O M A S

Standard 3: Drawdown

$$\text{Drawdown Time} = \frac{Rv}{(K)\ (\text{Bottom Area})}$$

where:

Rv = Storage Volume Below Outlet [Ac-ft]

K= Infiltration Rate [in/hr]

Bottom Area= Bottom Area of Recharge System [Ac]

Infiltration Basin-1

Rv =	0.397	Ac-ft	
K =	2.410	in/hr	
Bottom Area =	0.051	Acres	
Drawdown Time =	**38.760**	**Hours**	*< 72 Hours, Design is in compliance with the standard.*

Infiltration Basin-2

Rv =	0.322	Ac-ft	
K =	2.410	in/hr	
Bottom Area =	0.098	Acres	
Drawdown Time =	**16.360**	**Hours**	*< 72 Hours, Design is in compliance with the standard.*

Infiltration Basin-3

Rv =	0.464	Ac-ft	
K =	2.410	in/hr	
Bottom Area =	0.069	Acres	
Drawdown Time =	**33.484**	**Hours**	*< 72 Hours, Design is in compliance with the standard.*

Infiltration Basin-4

Rv =	0.133	Ac-ft	
K =	2.410	in/hr	
Bottom Area =	0.113	Acres	
Drawdown Time =	**5.861**	**Hours**	*< 72 Hours, Design is in compliance with the standard.*

Infiltration Basin-5

Rv =	0.470	Ac-ft	
K =	2.410	in/hr	
Bottom Area =	0.174	Acres	
Drawdown Time =	**13.450**	**Hours**	*< 72 Hours, Design is in compliance with the standard.*

Infiltration Basin-6

Rv =	0.582	Ac-ft	
K =	2.410	in/hr	
Bottom Area =	0.088	Acres	
Drawdown Time =	**32.931**	**Hours**	*< 72 Hours, Design is in compliance with the standard.*

Infiltration Basin-7

Rv =	0.223	Ac-ft	
K =	2.410	in/hr	
Bottom Area =	0.029	Acres	
Drawdown Time =	**38.289**	**Hours**	*< 72 Hours, Design is in compliance with the standard.*

Infiltration Trench-1

Rv =	0.015	Ac-ft	
K =	2.410	in/hr	
Bottom Area =	0.013	Acres	
Drawdown Time =	**5.745**	**Hours**	*< 72 Hours, Design is in compliance with the standard.*

Infiltration Trench-2

Rv =	0.037	Ac-ft	
K =	2.410	in/hr	
Bottom Area =	0.023	Acres	
Drawdown Time =	**8.010**	**Hours**	*< 72 Hours, Design is in compliance with the standard.*

Note:

1. The infiltration BMPs have been designed to fully drain within 72 hours, therefore the proposed stormwater management design is in compliance with Standard 3 .

2. Infiltration Rate based on Volume 3, Chapter 1, Table 2.3.3 *Rawls Rates* from the 2008 MA DEP Stormwater Management Handbook.

JOB NO.	1833.112	COMPUTED BY:	NBB	CHECKED BY:	JRM
JOB:	140 Tihonet Road PV+ES Project	DATE:	1/14/2021	DATE:	1/19/2021

Stage-Area-Storage for Pond 1: BASIN-1

Elevation (feet)	Surface (acres)	Storage (acre-feet)
64.00	0.051	0.000
64.05	0.052	0.003
64.10	0.053	0.005
64.15	0.055	0.008
64.20	0.056	0.011
64.25	0.057	0.014
64.30	0.058	0.016
64.35	0.059	0.019
64.40	0.060	0.022
64.45	0.062	0.025
64.50	0.063	0.028
64.55	0.064	0.032
64.60	0.065	0.035
64.65	0.066	0.038
64.70	0.067	0.041
64.75	0.068	0.045
64.80	0.070	0.048
64.85	0.071	0.052
64.90	0.072	0.055
64.95	0.073	0.059
65.00	0.074	0.063
65.05	0.075	0.066
65.10	0.077	0.070
65.15	0.078	0.074
65.20	0.079	0.078
65.25	0.080	0.082
65.30	0.081	0.086
65.35	0.083	0.090
65.40	0.084	0.094
65.45	0.085	0.098
65.50	0.086	0.103
65.55	0.087	0.107
65.60	0.089	0.112
65.65	0.090	0.116
65.70	0.091	0.120
65.75	0.092	0.125
65.80	0.093	0.130
65.85	0.095	0.134
65.90	0.096	0.139
65.95	0.097	0.144
66.00	0.098	0.149
66.05	0.100	0.154
66.10	0.101	0.159
66.15	0.102	0.164
66.20	0.103	0.169
66.25	0.105	0.174
66.30	0.106	0.179
66.35	0.107	0.185
66.40	0.108	0.190
66.45	0.110	0.196
66.50	0.111	0.201
66.55	0.112	0.207
66.60	0.114	0.212
66.65	0.115	0.218
66.70	0.116	0.224
66.75	0.117	0.230
66.80	0.119	0.236
66.85	0.120	0.242
66.90	0.121	0.248
66.95	0.122	0.254
67.00	0.124	0.260
67.05	0.125	0.266
67.10	0.126	0.272
67.15	0.128	0.279
67.20	0.129	0.285
67.25	0.130	0.292
67.30	0.132	0.298
67.35	0.133	0.305
67.40	0.134	0.311
67.45	0.136	0.318
67.50	0.137	0.325
67.55	0.138	0.332
67.60	0.140	0.339
67.65	0.141	0.346
67.70	0.142	0.353
67.75	0.144	0.360
67.80	0.145	0.367
67.85	0.146	0.375
67.90	0.148	0.382
67.95	0.149	0.389
68.00	0.150	0.397
68.05	0.152	0.404
68.10	0.153	0.412
68.15	0.155	0.420
68.20	0.156	0.428
68.25	0.157	0.435
68.30	0.159	0.443
68.35	0.160	0.451
68.40	0.162	0.459
68.45	0.163	0.467
68.50	0.164	0.476
68.55	0.166	0.484
68.60	0.167	0.492
68.65	0.169	0.501
68.70	0.170	0.509
68.75	0.171	0.518
68.80	0.173	0.526
68.85	0.174	0.535
68.90	0.176	0.544
68.95	0.177	0.552
69.00	**0.178**	**0.561**

Stage-Area-Storage for Pond 2: BASIN-2

Elevation (feet)	Surface (acres)	Storage (acre-feet)
52.00	0.098	0.000
52.05	0.101	0.005
52.10	0.104	0.010
52.15	0.107	0.015
52.20	0.110	0.021
52.25	0.113	0.026
52.30	0.116	0.032
52.35	0.119	0.038
52.40	0.123	0.044
52.45	0.126	0.050
52.50	0.129	0.057
52.55	0.132	0.063
52.60	0.135	0.070
52.65	0.138	0.077
52.70	0.141	0.084
52.75	0.144	0.091
52.80	0.148	0.098
52.85	0.151	0.105
52.90	0.154	0.113
52.95	0.157	0.121
53.00	0.160	0.129
53.05	0.163	0.137
53.10	0.167	0.145
53.15	0.170	0.154
53.20	0.173	0.162
53.25	0.177	0.171
53.30	0.180	0.180
53.35	0.184	0.189
53.40	0.187	0.198
53.45	0.190	0.208
53.50	0.194	0.217
53.55	0.197	0.227
53.60	0.200	0.237
53.65	0.204	0.247
53.70	0.207	0.257
53.75	0.210	0.268
53.80	0.214	0.278
53.85	0.217	0.289
53.90	0.221	0.300
53.95	0.224	0.311
54.00	0.227	0.322
54.05	0.231	0.334
54.10	0.236	0.346
54.15	0.240	0.357
54.20	0.244	0.370
54.25	0.248	0.382
54.30	0.252	0.394
54.35	0.256	0.407
54.40	0.260	0.420
54.45	0.264	0.433
54.50	0.268	0.446
54.55	0.273	0.460
54.60	0.277	0.474
54.65	0.281	0.488
54.70	0.285	0.502
54.75	0.289	0.516
54.80	0.293	0.531
54.85	0.297	0.545
54.90	0.301	0.560
54.95	0.306	0.576
55.00	**0.310**	**0.591**

Stage-Area-Storage for Pond 3: BASIN-3

Elevation (feet)	Surface (acres)	Storage (acre-feet)
32.00	0.069	0.000
32.05	0.071	0.004
32.10	0.072	0.008
32.15	0.073	0.012
32.20	0.074	0.016
32.25	0.075	0.020
32.30	0.076	0.024
32.35	0.077	0.028
32.40	0.078	0.032
32.45	0.079	0.036
32.50	0.080	0.040
32.55	0.081	0.044
32.60	0.082	0.048
32.65	0.084	0.052
32.70	0.085	0.056
32.75	0.086	0.060
32.80	0.087	0.064
32.85	0.088	0.068
32.90	0.089	0.072
32.95	0.090	0.076
33.00	0.091	0.080
33.05	0.092	0.085
33.10	0.093	0.091
33.15	0.095	0.096
33.20	0.096	0.101
33.25	0.097	0.106
33.30	0.098	0.111
33.35	0.099	0.116
33.40	0.101	0.121
33.45	0.102	0.127
33.50	0.103	0.132
33.55	0.104	0.137
33.60	0.105	0.142
33.65	0.106	0.147
33.70	0.108	0.152
33.75	0.109	0.157
33.80	0.110	0.163
33.85	0.111	0.168
33.90	0.112	0.173
33.95	0.113	0.178
34.00	0.115	0.183
34.05	0.116	0.189
34.10	0.117	0.196
34.15	0.118	0.202
34.20	0.120	0.209
34.25	0.121	0.215
34.30	0.122	0.221
34.35	0.123	0.228
34.40	0.125	0.234
34.45	0.126	0.240
34.50	0.127	0.247
34.55	0.128	0.253
34.60	0.130	0.259
34.65	0.131	0.266
34.70	0.132	0.272
34.75	0.133	0.278
34.80	0.135	0.285
34.85	0.136	0.291
34.90	0.137	0.297
34.95	0.138	0.304
35.00	0.140	0.310
35.05	0.141	0.318
35.10	0.142	0.326
35.15	0.144	0.333
35.20	0.145	0.341
35.25	0.147	0.349
35.30	0.148	0.356
35.35	0.149	0.364
35.40	0.151	0.372
35.45	0.152	0.379
35.50	0.154	0.387
35.55	0.155	0.395
35.60	0.157	0.402
35.65	0.158	0.410
35.70	0.159	0.418
35.75	0.161	0.425
35.80	0.162	0.433
35.85	0.164	0.441
35.90	0.165	0.449
35.95	0.166	0.456
36.00	0.168	0.464
36.05	0.169	0.473
36.10	0.170	0.482
36.15	0.171	0.491
36.20	0.172	0.500
36.25	0.174	0.509
36.30	0.175	0.518
36.35	0.176	0.527
36.40	0.177	0.536
36.45	0.178	0.545
36.50	0.180	0.554
36.55	0.181	0.563
36.60	0.182	0.572
36.65	0.183	0.581
36.70	0.184	0.590
36.75	0.185	0.599
36.80	0.187	0.608
36.85	0.188	0.616
36.90	0.189	0.625
36.95	0.190	0.634
37.00	**0.191**	**0.643**

Stage-Area-Storage for Pond 4: BASIN-4

Elevation (feet)	Surface (acres)	Storage (acre-feet)
48.00	0.113	0.000
48.02	0.114	0.002
48.04	0.115	0.005
48.06	0.116	0.007
48.08	0.117	0.009
48.10	0.117	0.012
48.12	0.118	0.014
48.14	0.119	0.016
48.16	0.120	0.019
48.18	0.120	0.021
48.20	0.121	0.023
48.22	0.122	0.026
48.24	0.123	0.028
48.26	0.124	0.031
48.28	0.124	0.033
48.30	0.125	0.036
48.32	0.126	0.038
48.34	0.127	0.041
48.36	0.128	0.043
48.38	0.128	0.046
48.40	0.129	0.049
48.42	0.130	0.051
48.44	0.131	0.054
48.46	0.131	0.056
48.48	0.132	0.059
48.50	0.133	0.062
48.52	0.134	0.064
48.54	0.135	0.067
48.56	0.135	0.070
48.58	0.136	0.072
48.60	0.137	0.075
48.62	0.138	0.078
48.64	0.139	0.081
48.66	0.139	0.083
48.68	0.140	0.086
48.70	0.141	0.089
48.72	0.142	0.092
48.74	0.142	0.095
48.76	0.143	0.098
48.78	0.144	0.100
48.80	0.145	0.103
48.82	0.146	0.106
48.84	0.146	0.109
48.86	0.147	0.112
48.88	0.148	0.115
48.90	0.149	0.118
48.92	0.150	0.121
48.94	0.150	0.124
48.96	0.151	0.127
48.98	0.152	0.130
49.00	0.153	0.133
49.02	0.153	0.136
49.04	0.154	0.139
49.06	0.155	0.142
49.08	0.156	0.145
49.10	0.157	0.149
49.12	0.158	0.152
49.14	0.158	0.155
49.16	0.159	0.158
49.18	0.160	0.161
49.20	0.161	0.164
49.22	0.162	0.168
49.24	0.162	0.171
49.26	0.163	0.174
49.28	0.164	0.177
49.30	0.165	0.181
49.32	0.166	0.184
49.34	0.166	0.187
49.36	0.167	0.191
49.38	0.168	0.194
49.40	0.169	0.197
49.42	0.170	0.201
49.44	0.171	0.204
49.46	0.171	0.208
49.48	0.172	0.211
49.50	0.173	0.214
49.52	0.174	0.218
49.54	0.175	0.221
49.56	0.175	0.225
49.58	0.176	0.228
49.60	0.177	0.232
49.62	0.178	0.235
49.64	0.179	0.239
49.66	0.179	0.243
49.68	0.180	0.246
49.70	0.181	0.250
49.72	0.182	0.253
49.74	0.183	0.257
49.76	0.184	0.261
49.78	0.184	0.264
49.80	0.185	0.268
49.82	0.186	0.272
49.84	0.187	0.276
49.86	0.188	0.279
49.88	0.188	0.283
49.90	0.189	0.287
49.92	0.190	0.291
49.94	0.191	0.294
49.96	0.192	0.298
49.98	0.192	0.302
50.00	**0.193**	**0.306**

Stage-Area-Storage for Pond 5: BASIN-5

Elevation (feet)	Surface (acres)	Storage (acre-feet)
45.00	0.174	0.000
45.05	0.177	0.009
45.10	0.180	0.018
45.15	0.183	0.027
45.20	0.186	0.036
45.25	0.189	0.045
45.30	0.192	0.055
45.35	0.195	0.064
45.40	0.198	0.074
45.45	0.201	0.084
45.50	0.204	0.094
45.55	0.207	0.105
45.60	0.210	0.115
45.65	0.213	0.126
45.70	0.216	0.136
45.75	0.219	0.147
45.80	0.222	0.158
45.85	0.225	0.169
45.90	0.228	0.181
45.95	0.231	0.192
46.00	0.234	0.204
46.05	0.237	0.216
46.10	0.240	0.227
46.15	0.243	0.240
46.20	0.246	0.252
46.25	0.250	0.264
46.30	0.253	0.277
46.35	0.256	0.289
46.40	0.259	0.302
46.45	0.262	0.315
46.50	0.265	0.329
46.55	0.269	0.342
46.60	0.272	0.355
46.65	0.275	0.369
46.70	0.278	0.383
46.75	0.281	0.397
46.80	0.284	0.411
46.85	0.288	0.425
46.90	0.291	0.440
46.95	0.294	0.454
47.00	0.297	0.469
47.05	0.300	0.484
47.10	0.304	0.499
47.15	0.307	0.514
47.20	0.310	0.530
47.25	0.313	0.545
47.30	0.316	0.561
47.35	0.320	0.577
47.40	0.323	0.593
47.45	0.326	0.609
47.50	0.329	0.626
47.55	0.333	0.642
47.60	0.336	0.659
47.65	0.339	0.676
47.70	0.342	0.693
47.75	0.346	0.710
47.80	0.349	0.727
47.85	0.352	0.745
47.90	0.355	0.763
47.95	0.359	0.781
48.00	**0.362**	**0.799**

Stage-Area-Storage for Pond 6: BASIN-6

Elevation (feet)	Surface (acres)	Storage (acre-feet)
66.00	0.088	0.000
66.05	0.091	0.004
66.10	0.093	0.009
66.15	0.096	0.014
66.20	0.099	0.019
66.25	0.101	0.024
66.30	0.104	0.029
66.35	0.106	0.034
66.40	0.109	0.039
66.45	0.112	0.045
66.50	0.114	0.051
66.55	0.117	0.056
66.60	0.120	0.062
66.65	0.122	0.068
66.70	0.125	0.075
66.75	0.127	0.081
66.80	0.130	0.087
66.85	0.133	0.094
66.90	0.135	0.101
66.95	0.138	0.107
67.00	0.140	0.114
67.05	0.143	0.121
67.10	0.145	0.129
67.15	0.148	0.136
67.20	0.150	0.143
67.25	0.152	0.151
67.30	0.155	0.159
67.35	0.157	0.166
67.40	0.159	0.174
67.45	0.162	0.182
67.50	0.164	0.190
67.55	0.166	0.199
67.60	0.169	0.207
67.65	0.171	0.216
67.70	0.173	0.224
67.75	0.176	0.233
67.80	0.178	0.242
67.85	0.180	0.251
67.90	0.183	0.260
67.95	0.185	0.269
68.00	0.188	0.278
68.05	0.199	0.288
68.10	0.211	0.298
68.15	0.223	0.309
68.20	0.234	0.321
68.25	0.246	0.333
68.30	0.257	0.345
68.35	0.269	0.358
68.40	0.281	0.372
68.45	0.292	0.386
68.50	0.304	0.401
68.55	0.316	0.417
68.60	0.327	0.433
68.65	0.339	0.449
68.70	0.351	0.467
68.75	0.362	0.485
68.80	0.374	0.503
68.85	0.386	0.522
68.90	0.397	0.542
68.95	0.409	0.562
69.00	0.421	0.582
69.05	0.434	0.604
69.10	0.448	0.626
69.15	0.461	0.649
69.20	0.475	0.672
69.25	0.488	0.696
69.30	0.502	0.721
69.35	0.515	0.746
69.40	0.529	0.772
69.45	0.542	0.799
69.50	0.556	0.827
69.55	0.569	0.855
69.60	0.583	0.883
69.65	0.596	0.913
69.70	0.610	0.943
69.75	0.623	0.974
69.80	0.637	1.005
69.85	0.650	1.038
69.90	0.664	1.070
69.95	0.677	1.104
70.00	**0.691**	**1.138**

Stage-Area-Storage for Pond 7: BASIN-7

Elevation (feet)	Surface (acres)	Storage (acre-feet)
76.00	0.029	0.000
76.05	0.030	0.001
76.10	0.030	0.003
76.15	0.031	0.005
76.20	0.031	0.006
76.25	0.032	0.008
76.30	0.033	0.009
76.35	0.033	0.011
76.40	0.034	0.013
76.45	0.034	0.014
76.50	0.035	0.016
76.55	0.036	0.018
76.60	0.036	0.020
76.65	0.037	0.021
76.70	0.037	0.023
76.75	0.038	0.025
76.80	0.039	0.027
76.85	0.039	0.029
76.90	0.040	0.031
76.95	0.040	0.033
77.00	0.041	0.035
77.05	0.042	0.037
77.10	0.044	0.039
77.15	0.046	0.041
77.20	0.047	0.044
77.25	0.049	0.046
77.30	0.050	0.049
77.35	0.052	0.051
77.40	0.054	0.054
77.45	0.055	0.057
77.50	0.057	0.059
77.55	0.058	0.062
77.60	0.060	0.065
77.65	0.062	0.068
77.70	0.063	0.071
77.75	0.065	0.075
77.80	0.066	0.078
77.85	0.068	0.081
77.90	0.070	0.085
77.95	0.071	0.088
78.00	0.073	0.092
78.05	0.079	0.096
78.10	0.085	0.100
78.15	0.090	0.104
78.20	0.096	0.109
78.25	0.102	0.114
78.30	0.108	0.119
78.35	0.114	0.124
78.40	0.120	0.130
78.45	0.126	0.136
78.50	0.131	0.143
78.55	0.137	0.150
78.60	0.143	0.157
78.65	0.149	0.164
78.70	0.155	0.172
78.75	0.161	0.179
78.80	0.167	0.188
78.85	0.172	0.196
78.90	0.178	0.205
78.95	0.184	0.214
79.00	0.190	0.223
79.05	0.200	0.233
79.10	0.210	0.243
79.15	0.220	0.254
79.20	0.230	0.265
79.25	0.240	0.277
79.30	0.250	0.289
79.35	0.260	0.302
79.40	0.271	0.315
79.45	0.281	0.329
79.50	0.291	0.343
79.55	0.301	0.358
79.60	0.311	0.374
79.65	0.321	0.389
79.70	0.331	0.406
79.75	0.341	0.422
79.80	0.351	0.440
79.85	0.361	0.457
79.90	0.371	0.476
79.95	0.381	0.495
80.00	**0.391**	**0.514**

Stage-Area-Storage for Pond T-1: TRENCH-1

Elevation (feet)	Surface (acres)	Storage (acre-feet)
64.00	**0.013**	0.000
64.05	0.013	0.000
64.10	0.013	0.001
64.15	0.013	0.001
64.20	0.013	0.001
64.25	0.013	0.001
64.30	0.013	0.002
64.35	0.013	0.002
64.40	0.013	0.002
64.45	0.013	0.002
64.50	0.013	0.003
64.55	0.013	0.003
64.60	0.013	0.003
64.65	0.013	0.003
64.70	0.013	0.004
64.75	0.013	0.004
64.80	0.013	0.004
64.85	0.013	0.004
64.90	0.013	0.005
64.95	0.013	0.005
65.00	0.013	0.005
65.05	0.013	0.005
65.10	0.013	0.006
65.15	0.013	0.006
65.20	0.013	0.006
65.25	0.013	0.006
65.30	0.013	0.007
65.35	0.013	0.007
65.40	0.013	0.007
65.45	0.013	0.007
65.50	0.013	0.008
65.55	0.013	0.008
65.60	0.013	0.008
65.65	0.013	0.008
65.70	0.013	0.009
65.75	0.013	0.009
65.80	0.013	0.009
65.85	0.013	0.009
65.90	0.013	0.010
65.95	0.013	0.010
66.00	0.013	0.010
66.05	0.013	0.010
66.10	0.013	0.011
66.15	0.013	0.011
66.20	0.013	0.011
66.25	0.013	0.011
66.30	0.013	0.012
66.35	0.013	0.012
66.40	0.013	0.012
66.45	0.013	0.012
66.50	0.013	0.013
66.55	0.013	0.013
66.60	0.013	0.013
66.65	0.013	0.014
66.70	0.013	0.014
66.75	0.013	0.014
66.80	0.013	0.014
66.85	0.013	0.015
66.90	0.013	0.015
66.95	0.013	0.015
67.00	0.013	**0.015**

Stage-Area-Storage for Pond T-2: TRENCH-2

Elevation (feet)	Surface (acres)	Storage (acre-feet)
56.00	**0.023**	0.000
56.05	0.023	0.000
56.10	0.023	0.001
56.15	0.023	0.001
56.20	0.023	0.002
56.25	0.023	0.002
56.30	0.023	0.003
56.35	0.023	0.003
56.40	0.023	0.004
56.45	0.023	0.004
56.50	0.023	0.005
56.55	0.023	0.005
56.60	0.023	0.006
56.65	0.023	0.006
56.70	0.023	0.007
56.75	0.023	0.007
56.80	0.023	0.007
56.85	0.023	0.008
56.90	0.023	0.008
56.95	0.023	0.009
57.00	0.023	0.009
57.05	0.023	0.010
57.10	0.023	0.010
57.15	0.023	0.011
57.20	0.023	0.011
57.25	0.023	0.012
57.30	0.023	0.012
57.35	0.023	0.013
57.40	0.023	0.013
57.45	0.023	0.014
57.50	0.023	0.014
57.55	0.023	0.014
57.60	0.023	0.015
57.65	0.023	0.015
57.70	0.023	0.016
57.75	0.023	0.016
57.80	0.023	0.017
57.85	0.023	0.017
57.90	0.023	0.018
57.95	0.023	0.018
58.00	0.023	0.019
58.05	0.023	0.019
58.10	0.023	0.020
58.15	0.023	0.020
58.20	0.023	0.021
58.25	0.023	0.021
58.30	0.023	0.021
58.35	0.023	0.022
58.40	0.023	0.022
58.45	0.023	0.023
58.50	0.023	0.023
58.55	0.023	0.024
58.60	0.023	0.024
58.65	0.023	0.025
58.70	0.023	0.025
58.75	0.023	0.026
58.80	0.023	0.026
58.85	0.023	0.027
58.90	0.023	0.027
58.95	0.023	0.028
59.00	0.023	0.028
59.05	0.023	0.028
59.10	0.023	0.029
59.15	0.023	0.029
59.20	0.023	0.030
59.25	0.023	0.030
59.30	0.023	0.031
59.35	0.023	0.031
59.40	0.023	0.032
59.45	0.023	0.032
59.50	0.023	0.033
59.55	0.023	0.033
59.60	0.023	0.034
59.65	0.023	0.034
59.70	0.023	0.035
59.75	0.023	0.035
59.80	0.023	0.035
59.85	0.023	0.036
59.90	0.023	0.036
59.95	0.023	0.037
60.00	0.023	**0.037**

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Standard 3: Groundwater Recharge

Groundwater Recharge Volume Required:

Rv = F x Impervious Area, where:

Rv = Required Recharge Volume [Ac-ft]

F = Target Depth Factor associated with each Hydrologic Soil Group (HSG) [in]

Impervious Area = Total Impervious Area under Post-development Conditions [Ac] (equipment pads)

			Impervious Area [Acres]	Required Recharge Volume [Ac-ft]	
HSG "A", use F =	0.6	in	0.159	0.008	
HSG "B", use F =	0.35	in	0.000	0.000	
HSG "C", use F =	0.25	in	0.000	0.000	
HSG "D", use F =	0.1	in	0.000	0.000	
Total Required Recharge Volume (Rv) =				**0.008**	**Ac-ft**

Capture Area Adjustment: (Ref: DEP Handbook V.3 Ch.1 P.27-28)

Total Site Impervious Area (Total)=	0.159	Acres
Impervious Area Draining to Infiltrative BMPs (infil) =	0.159	Acres
Percent Imp. Area Draining to Infiltrative BMPs =	100.0%	
Capture Area Adjustment Factor = (Total)/(Infil) = Ca =	1.00	
Adjusted Required Recharge Volume = Ca x Rv	**0.008**	**Ac-ft**

Groundwater Recharge Volume Provided :

BMP	Provided Recharge Volume [Ac-ft] (Below Lowest Basin Outlet)	
Infiltration Basin 1 =	0.397	
Infiltration Basin 2 =	0.322	
Infiltration Basin 3 =	0.464	
Infiltration Basin 4 =	0.133	
Infiltration Basin 5 =	0.470	
Infiltration Basin 6 =	0.582	
Infiltration Basin 7=	0.223	
Infiltration Trench 1 =	0.015	
Infiltration Trench 2 =	0.037	
Total Provided Recharge Volume =	**2.643**	**Ac-ft**

PROVIDED GROUNDWATER RECHARGE VOLUME IS GREATER THAN OR EQUAL TO THE REQUIRED RECHARGE VOLUME, THEREFORE PROPOSED STORMWATER MANAGEMENT DESIGN IS IN COMPLIANCE WITH STANDARD 3.

JOB NO.	1833.112	COMPUTED BY:	NBB	CHECKED BY:	JRM
JOB:	140 Tihonet Road PV+ES Project	DATE:	01/14/21	DATE:	1/19/2021

Attachment 6
Site Owner's Manual

BEALS + THOMAS

Site Owner's Manual

140 Tihonet Road PV+ES Project

140 Tihonet Road (aka 0 & 169 Tihonet Road)
Wareham, Massachusetts

Prepared for:

Borrego Solar Systems, Inc.
55 Technology Drive, Suite 102
Lowell, MA 01851

Prepared by:

BEALS + THOMAS
BEALS AND THOMAS, INC.
32 Court Street
Plymouth, MA 02360

June 2, 2020

Revised: January 19, 2021

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APPENDICES

1.0 INTRODUCTION

The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Handbook. The Manual outlines source control and pollution prevention measures and maintenance requirements of stormwater best management practices (BMPs) associated with the proposed development.

2.0 SITE OWNER'S AGREEMENT

2.1 Operation and Maintenance Compliance Statement

Site Owner: Borrego Solar Systems, Inc.
55 Technology Drive, Suite 102
Lowell, MA 01851

Responsible Party: Borrego Solar Systems, Inc.

Borrego Solar Systems, Inc. or their successors shall maintain ownership of the on-site stormwater management system as well as the responsibility for operation and maintenance during the post-development stages of the project. The site has been inspected for erosion and appropriate measures have been taken to permanently stabilize any eroded areas. All aspects of stormwater best management practices (BMPs) have been inspected for damage, wear and malfunction, and appropriate steps have been taken to repair or replace the system or portions of the system so that the stormwater at the site may be managed in accordance with the Stormwater Management Standards. Future responsible parties shall be notified of their continuing legal responsibility to operate and maintain the BMPs. The operation and maintenance plan for the stormwater BMPs is being implemented.

_____ _____
Responsible Party Signature Date

2.2 Stormwater Maintenance Easements

The Site Owner will have access to all stormwater practices for inspection and maintenance, including direct maintenance access by heavy equipment to structures requiring regular maintenance.

2.3 Record Keeping

The Site Owner shall maintain a rolling log in which all inspections and maintenance activities for the past three years shall be recorded. The Operation and Maintenance Log includes information pertaining to inspections, repairs, and disposal relevant to the project's stormwater management system. The Log is located in Appendix A.

The Operation and Maintenance Log shall be made available to the Conservation Commission and the DEP upon request. The Conservation Commission and the DEP shall be allowed to enter and inspect the premises to evaluate and ensure that the responsible party complies with the maintenance requirements for each BMP.

2.4 Training

Employees involved in grounds maintenance and emergency response will be educated on the general concepts of stormwater management and groundwater protection. The Site Owner's Manual will be reviewed with the maintenance staff. The staff will be trained on the proper course of action for specific events expected to be incurred during routine maintenance or emergency situations.

3.0 LONG-TERM POLLUTION PREVENTION PLAN

In compliance with Standard 4 of the 2008 DEP Stormwater Management Handbook, this section outlines source control and pollution prevention measures to be employed on-site after construction.

3.1 Storage of Materials and Waste

The site shall be kept clear of trash and debris at all times. Certain materials and waste products shall be stored inside or outside upon an impervious surface and covered, as required by local and state regulations.

3.2 Vehicle Washing

No commercial vehicle washing shall take place on-site.

3.3 Routine Inspections and Maintenance of Stormwater BMPs

See Section 4.0 Long-Term Operation and Maintenance Plan, for routine inspection and maintenance requirements for all proposed stormwater BMPs.

3.4 Spill Prevention and Response

A contingency plan shall be implemented to address the spill or release of petroleum products and hazardous materials and will include the following measures:

1. Equipment necessary to quickly attend to inadvertent spills or leaks shall be stored on-site in a secure but accessible location. Such equipment shall include but not be limited to the following: safety goggles, chemically resistant gloves and overshoe boots, water and chemical fire extinguishers, sand and shovels, suitable absorbent materials, storage containers and first aid equipment (i.e. Indian Valley Industries, Inc. 55-gallon Spill Containment kit or approved equivalent).

2. Spills or leaks shall be treated properly according to material type, volume of spillage and location of spill. Mitigation shall include preventing further spillage, containing the spilled material in the smallest practical area, removing spilled material in a safe and environmentally-friendly manner, and remediation of any damage to the environment.

3. For large spills, MassDEP Hazardous Waste Incident Response Group shall be notified immediately at 888-304-1133 and an emergency response contractor shall be consulted.

3.5 Maintenance of Grassed Areas

Grassed areas shall be maintained regularly by the facility operator. Vegetated and landscaped BMPs will be maintained as outlined in Section 4.0.

3.6 Snow and Deicing Chemical Management

Snow removal at the site shall comply with the following requirements:

- Plowed snow shall not be placed in wetland resource areas or associated buffer zones. The following maintenance measures shall be undertaken at all snow disposal sites:
  - Debris shall be cleared from an area prior to using it for snow disposal.
  - Debris and accumulated sediments shall be cleared from the site and properly disposed of at the end of the snow season and no later than May 15.
- The use of deicing materials and sand shall not be used at the proposed project site to protect off-site areas.

4.0 LONG-TERM OPERATION AND MAINTENANCE PLAN

This section outlines the general maintenance activities for the stormwater best management practices (BMPs) associated with the proposed stormwater management system and identifies the long-term inspection and maintenance requirements for each BMP.

4.1 Stormwater Management System Components

The following table outlines the type and quantity of the BMPs and their general location. Please reference the site plan(s) provided in the Figures section for exact location.

BMP Type	Quantity	Location
Infiltration Basin	7	Throughout the site
Infiltration Trench	2	Northwest entrance, northeast access

4.2 Inspection and Maintenance Schedules

4.2.1 Infiltration Basins

Infiltration basins shall be inspected and maintained after major storm events (rainfall totals greater than 2.5 inches in 24 hours) during the first three months of operation and twice a year and when there are discharges through the outlet control structure thereafter. Additionally, all pretreatment BMPs shall be inspected in accordance with the minimal requirements specified for those practices and after all major storm events. Inspections shall include the following measures:

- During and after major storm events, the length of time standing water remains in the basin shall be recorded.
    - If the time is greater than 72 hours, thoroughly inspect the basin for signs of clogging.
    - A corrective action plan shall be developed by a qualified professional to restore infiltrative function. The Site Owner shall take immediate action to implement these corrective measures.
- Examine the outlet structure for evidence of clogging or outflow release velocities that are greater than the design velocity.
- Identify areas of sediment accumulation, differential settlement, cracking, and erosion within the basin.
- Inspect embankments for leakage and tree growth.
- Examine the health of the vegetation within the basin and on the embankments.

Corrective measures shall be taken immediately as warranted by the inspections. If any evidence of hydrocarbons is found during inspection, the

material shall be immediately removed using absorbent pads or other suitable measures and legally disposed.

Preventative maintenance shall include the following activities:

- Mow the buffer area and basin bottom and side slopes, if vegetated.
- Remove trash, debris, and accumulated organic matter.
- Remove clippings after mowing.

4.2.2 Infiltration Trenches

Inspections and preventative maintenance shall be performed at all infiltration trenches after major storm events (rainfall totals greater than 2.5 inches in 24 hours) during the first three months of operation and twice a year thereafter. Additionally, all pretreatment BMPs shall be inspected in accordance with the minimal requirements specified for those practices and after major storm events. Inspections and maintenance activities shall include the following measures:

- Inlet and outlet pipes shall be inspected every 6 months and after major storm events for evidence of clogging.
- Accumulated sediment, trash, debris, leaves, and clippings from mowing shall be removed every 6 months and after major storm events.
- Tree seedlings shall be removed before they become firmly established.
- The vegetated trench surface shall be mowed on a seasonal basis to maintain a vegetation height of no more than 4 inches.
- The trench shall be inspected 24 hours or several days after a rain event to look for ponded water. If there is ponded water at the surface of the trench, the following measures shall be employed to address surficial clogging:
    - Remove and replace topsoil or first layer of stone aggregate and the filter fabric.
- If there is ponded water inside the trench, the following measures shall be employed to address trench failure:
    - All accumulated sediments must be stripped from the bottom of the trench.
    - The bottom of the trench must be scarified and tilled to induce infiltration, and all of the stone aggregate and filter fabric or media shall be removed and replaced.

4.2.3 Stormwater Outfalls

Flared end sections and associated riprap aprons, and overflow spillways shall be inspected at least once per year and after major storm events (rainfall totals greater than 2.5 inches in 24 hours) to ensure that the stability of the outlet area is maintained. The outfall area shall be kept clear of debris such as trash, branches, and sediment. Repairs shall be made immediately if riprap displacement or downstream channel scour is observed.

4.3 Estimated Operation and Maintenance Budget

An operations and maintenance budget was prepared to approximate the annual cost of the inspections required in compliance with the DEP Stormwater Management Policy. The table below estimates the annual cost to inspect and maintain each proposed BMP, based on the requirements in Section 4.2.

BMP Type	# of BMPS	Annual O&M Cost (per BMP)[1]	Total Cost
Infiltration Basin	7	$50-$100	$350-$700
Infiltration Trench	2	$50-$100	$350-$700
Riprap Spillway/Flared Ends	7	$200-$400	$1400-$2800
		Total	$2100-$4200

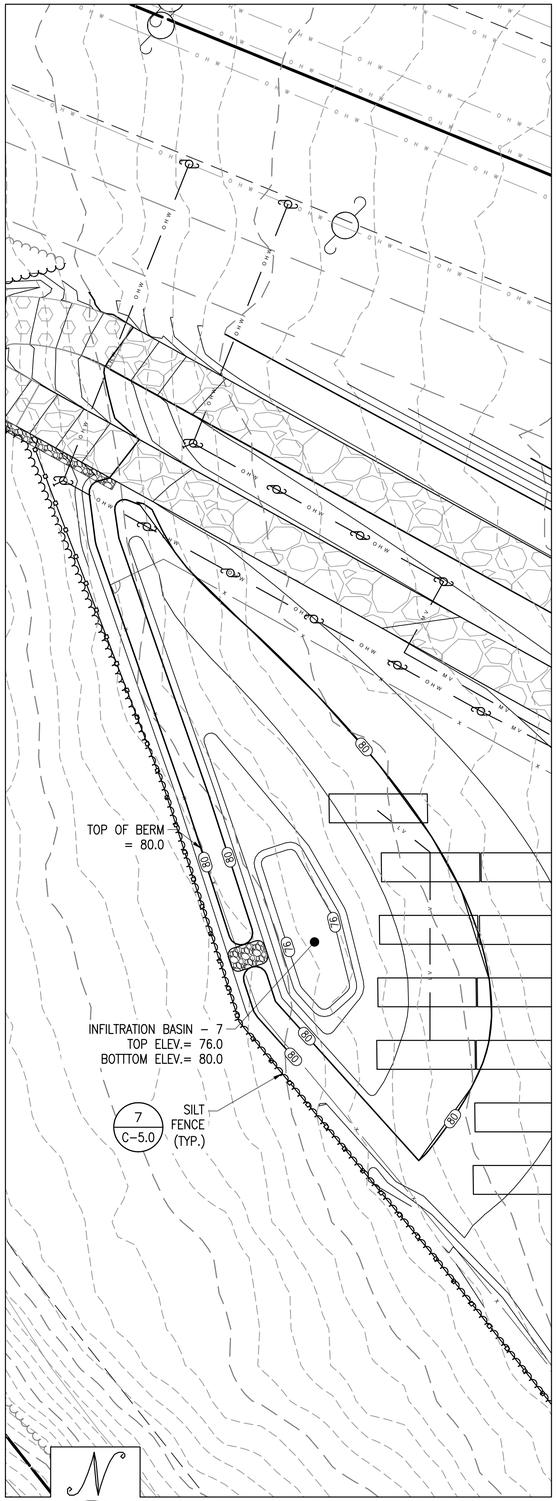
4.4 Public Safety Features

The site is not open to the public. A locked vehicle gate will be located at the entrance to the gravel access driveway. In addition, a 7' chain-link-fence will surround the array. Operation and maintenance of the facility will be conducted in accordance with the safety requirements of the facility operator and applicable OSHA regulations.

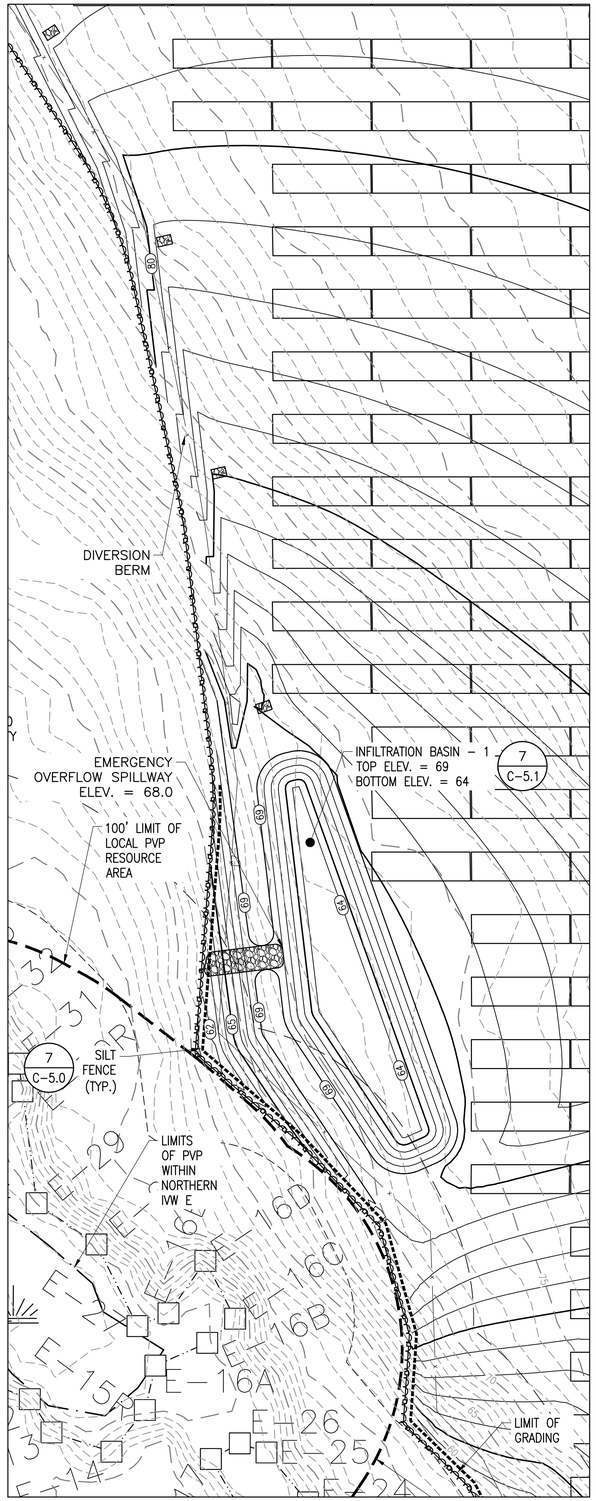
[1] Annual maintenance cost is based on estimate of the cost to complete all inspection and maintenance measures outlined in Section 4.2. For BMPs that require sediment removal at regular intervals (i.e. every 5 or 10 years), the annual cost includes the annual percentage of that cost.

Figures

Figure 1: Site Plan



BASINS 7



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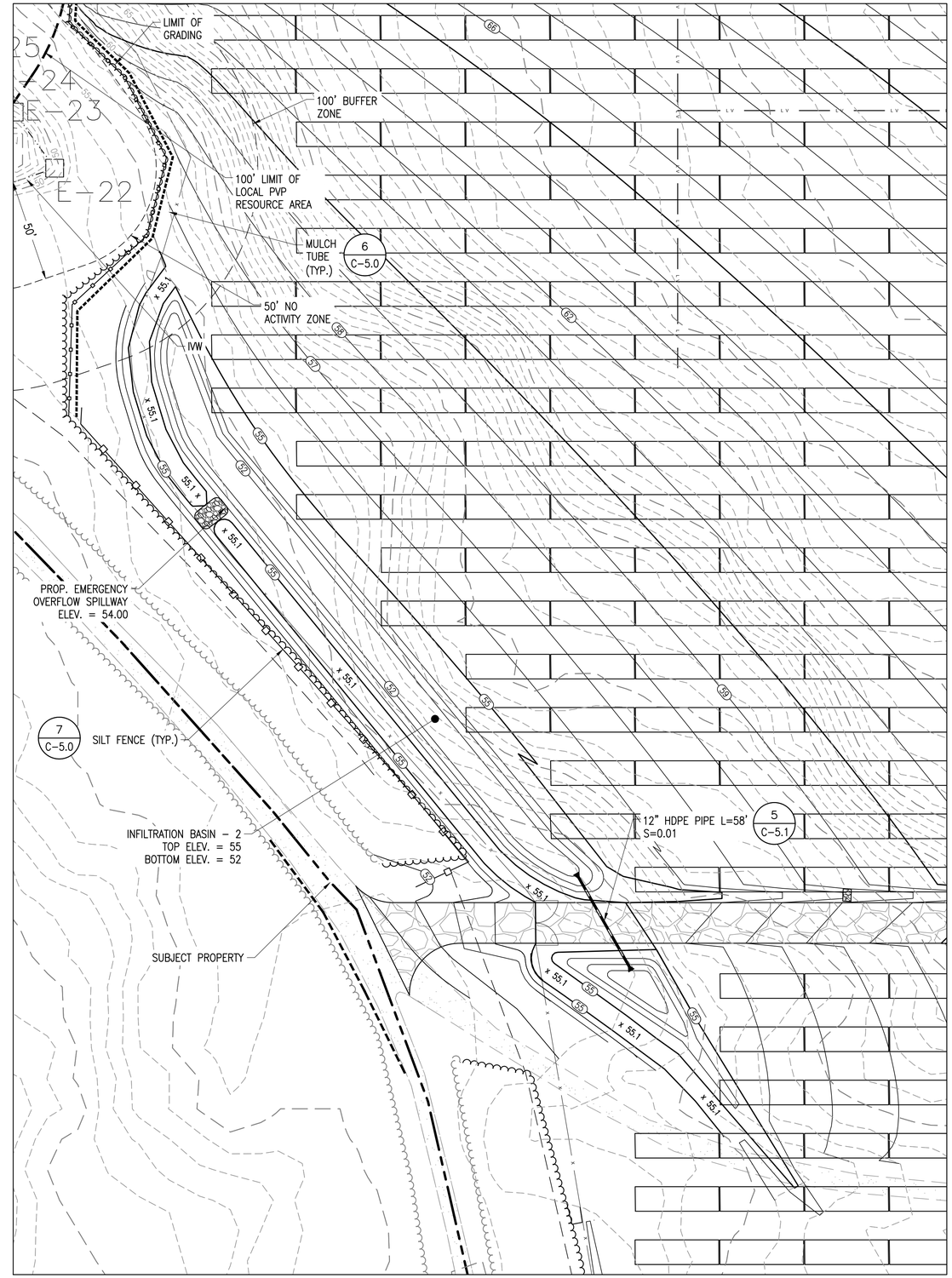


BASIN 2

SCALE: 1" = 30'

0 30' 60'

BORREGO SOLAR
55 TECHNOLOGY DRIVE, SUITE 102
LOWELL, MA 01851
PHONE: (888) 898-6273
FAX: (888) 843-6778
WWW.BORREGOSOLAR.COM

NOT FOR CONSTRUCTION

COMMONWEALTH OF MASSACHUSETTS
JEFFREY R. MURPHY
CIVIL
No. 51800
REGISTERED PROFESSIONAL ENGINEER
1/19/2021

SITE USE PLAN
140 TIHONET ROAD
WAREHAM, MA 02571

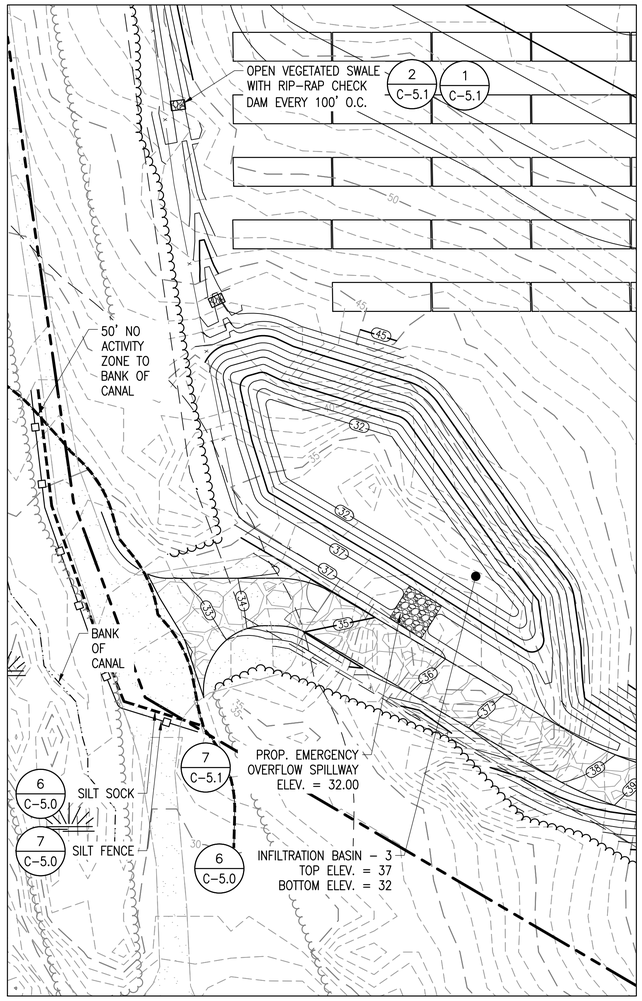
PROJECT NUMBER:
905-2708

REV	DATE	DRAWN	CHECKED	RELEASE LEVEL
	03/26/20	WS	CDS	SUP SET CREATION
	05/07/20	WS	CDS	REVISIONS PER NEW FIELD DATA
	06/01/20	LBD	CDS	UPDATED SET TO MATCH DESIGN CHANGES
	06/02/20	WS	CDS	ISSUED FOR LOCAL PERMITTING
	08/19/20	WS	CDS	CREATE SIGHT LINE EXHIBIT
	01/19/21	WS	JM	RESUBMISSION TO LOCAL AHJ

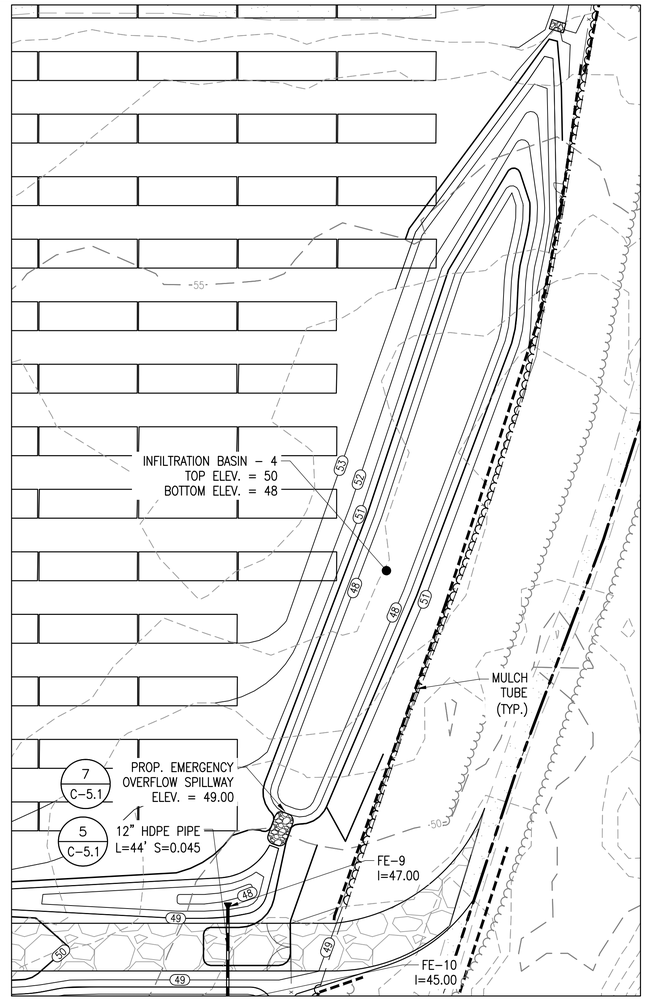
SCALES STATED ON DRAWINGS ARE VALID ONLY WHEN PLOTTED ARCH D 24" X 36"

C-4.3

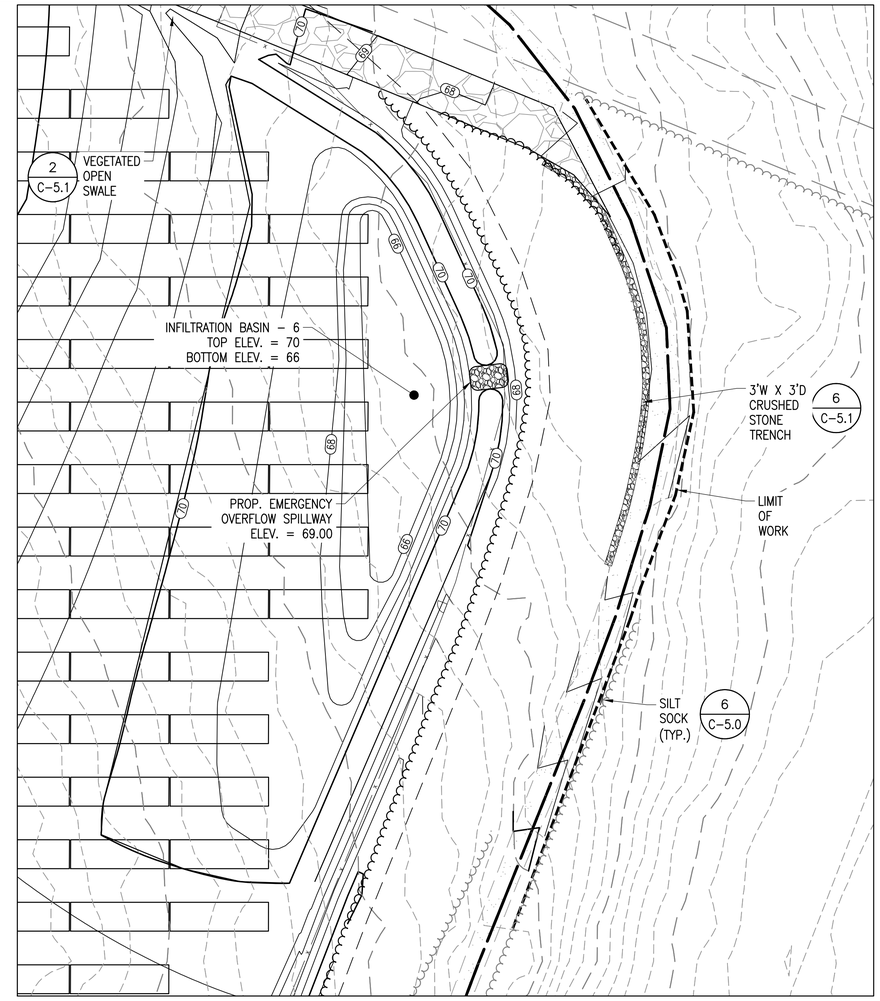
GRADING AND EROSION CONTROL PLAN - BASIN 7, 1, 2



BASIN 3



BASIN 4



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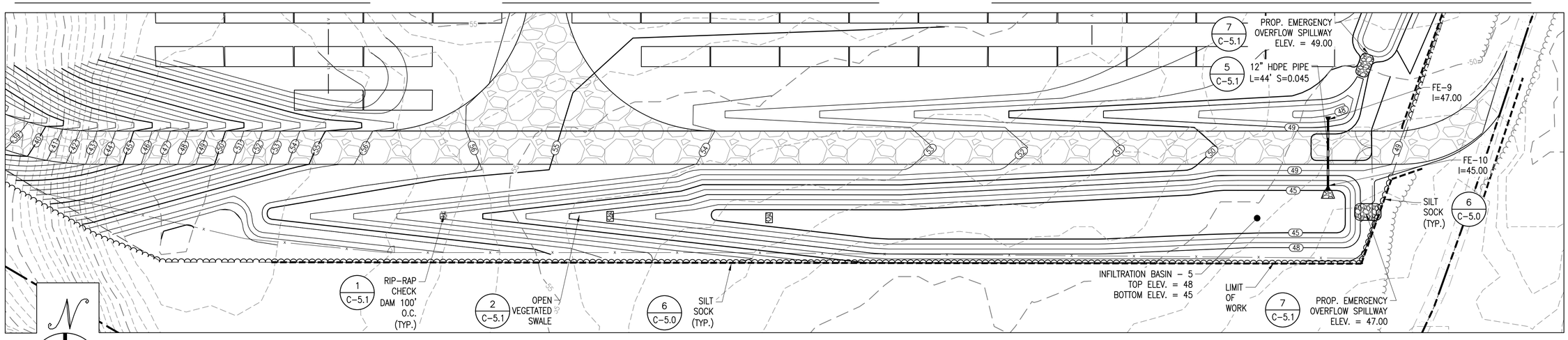

BASIN 5

SCALE: 1" = 30'

0 30' 60'

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SITE USE PLAN
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	03/26/20	WS	CDS	SUP SET CREATION
	05/07/20	WS	CDS	REVISIONS PER NEW FIELD DATA
	06/01/20	LBD	CDS	UPDATED SET TO MATCH DESIGN CHANGES
	06/02/20	WS	CDS	ISSUED FOR LOCAL PERMITTING
	08/19/20	WS	CDS	CREATE SIGHT LINE EXHIBIT
	01/19/21	WS	JM	RESUBMISSION TO LOCAL AHJ

SCALES STATED ON DRAWINGS ARE VALID ONLY WHEN PLOTTED ARCH D 24" X 36"

C-4.4

GRADING AND EROSION CONTROL PLAN - BASIN 3, 4, 5, 6

Appendices

Appendix A

Operation and Maintenance Log

OPERATION AND MAINTENANCE LOG

This template is intended to comply with the operation and maintenance log requirements of the 2008 MassDEP Stormwater Management Handbook. Copies of this log should be made for all inspections and kept on file for three years from the inspection date.

Name/Company of Inspector:
Date/Time of Inspection:
Weather Conditions: (Note current weather and any recent precipitation events)

Stormwater BMP	Inspection Observations	Actions Required

Appendix B

List of Emergency Contacts

List of Emergency Contacts

MassDEP Hazardous Waste Incident Response Group
(617) 792-7653

Town of Wareham Municipal Maintenance
95 Charge Pond Road
Wareham, MA 02571
(508) 295-5300

Town of Wareham Fire Department
20 Church Street
Wareham, MA 02571
(508) 295-2973

Town of Wareham Police Department
2515 Cranberry Highway
Wareham, MA 02571
(508) 295-1212

Attachment 7
Draft Stormwater Pollution Prevention Plan

BEALS + THOMAS

Draft Stormwater Pollution Prevention Plan

140 Tihonet Road PV+ES Project

140 Tihonet Road (aka 0 & 169 Tihonet Road)
Wareham, Massachusetts

Prepared for:

Borrego Solar Systems, Inc.
55 Technology Drive, Suite 102
Lowell, MA 01851

BORREGO SOLAR

Prepared by:

BEALS + THOMAS
BEALS AND THOMAS, INC.
32 Court Street
Plymouth, MA 02360

June 2, 2020

Revised: January 19, 2021

TABLE OF CONTENTS

LIST OF APPENDICES

1.0 CONTACT INFORMATION/RESPONSIBLE PARTIES

1.1 OPERATOR(S)/ SUBCONTRACTORS

Operator(s)

Company:	Borrego Solar Systems, Inc.				
Name:					
Address:					
City:		State:		ZIP Code:	
Telephone:		Email:			

Company:	TBD				
Name:					
Address:					
City:		State:		ZIP Code:	
Telephone:		Email:			

Subcontractor(s)

Company:	TBD				
Name:					
Address:					
City:		State:		ZIP Code:	
Telephone:		Email:			
Area of Control:		Site Work Contractor			

24-Hour Emergency Contact

Company:	TBD
Name:	
Telephone:	

1.2 STORMWATER TEAM

SWPPP Preparer

Company:	Beals and Thomas, Inc.				
Name:	Nathaniel Bautz, EIT				
Address:	144 Turnpike Road				
City:	Southborough	State:	MA	ZIP Code:	01772
Telephone:	508-366-0560	Email:			

Personnel Responsible for Installation & Maintenance of Stormwater BMPs

Company:	TBD				
Name:					
Address:					
City:		State:		ZIP Code:	
Telephone:		Email:			

Inspection Personnel

Company:	TBD				
Name:					
Address:					
City:		State:		ZIP Code:	
Telephone:		Email:			

Personnel Responsible for Taking Corrective Actions

Company:	TBD				
Name:					
Address:					
City:		State:		ZIP Code:	
Telephone:		Email:			

2.0 SITE EVALUATION, ASSESSMENT AND PLANNING

2.1 PROJECT/SITE INFORMATION

Project/Site Name:	140 Tihonet Road PV+ES Project				
Project Street/Location:	140 Tihonet Road (aka 0 & 169 Tihonet Road)				
City:	Wareham	State:	MA	ZIP Code:	02571
County or Similar Subdivision:		Plymouth			

Latitude:	41°47’23” N	Longitude:	70°42’29”W
Method for Determining Latitude/Longitude: ☐ USGS Topographic Map (specify scale: _____) ☐ EPA Website ☐ GPS ☒ Other (please specify): Google Earth			
Horizontal Reference Datum: ☐ NAD 27 ☐ WGS 84 ☒ NAD 83 ☐ Unknown			

Is the project located on Indian country lands, or located on a property of religious of cultural significance to an Indian tribe? ☐ Yes ☒ No

If yes, provide the name of the Indian tribe associated with the area of Indian country (including the name of Indian reservation if applicable), or if not in Indian country, provide the name of the Indian tribe associated with the property:

_____

Is this project considered a federal facility? ☐ Yes ☒ No

Are you applying for permit coverage as a “federal operator” as defined in Appendix A of the 2017 CGP? ☐ Yes ☒ No

NPDES project or permit tracking number: TBD

2.1.1 Emergency-Related Projects

Is this project in response to a public emergency? ☐ Yes ☒ No

If yes, document the cause of the public emergency *(e.g., natural disaster, extreme flooding conditions)*, information substantiating its occurrence *(e.g., state disaster declaration)*, and a description of the construction necessary to reestablish effective public services:

2.2 NATURE AND SEQUENCE OF CONSTRUCTION ACTIVITY

2.2.1 Function of the Construction Activity

Function of the construction activity:

☐ Single-Family Residential ☐ Commercial
☐ Multi-Family Residential ☐ Industrial
☐ Institutional ☐ Highway or Road Construction
☐ Utility ☒ Other (please specify): Renew. Energy

2.2.2 Building Demolition

Will there be demolition of any structure built or renovated before January 1, 1980? ☐ Yes ☒ No

If yes, do any of the structures being demolished have at least 10,000 square feet of floor space? ☐ Yes ☒ No

2.2.3 Agricultural Land

Was the pre-development land use used for agriculture? ☐ Yes ☒ No

2.2.4 Estimated Project Dates

Estimated Project Start Date: TBD
Estimated Project Completion Date: TBD

Estimated Timeline of Activity	Construction Activity and BMP Descriptions
TBD	***Before any site grading activities begin*** 1. Stake Limit of Construction. Workers shall be informed that no construction activity is to occur beyond this limit at any time. 2. Install sediment controls as shown on the plans. An adequate stockpile of erosion control materials shall be on site at all times for emergency or routine replacement and shall include materials to repair silt fences, compost mulch tubes, or any other devices planned for use during construction. 3. Construct stabilized construction exits. 4. Construct staging and materials storage area. 5. Install temporary sanitary facilities and dumpsters.
TBD	***Site grading*** 1. Begin overall site grading. 2. Establish topsoil stockpile. 3. Install silt fences around stockpile. 4. Build stormwater basins and complete overall site grading. 5. Disturbed areas where construction will cease for more than 14 days shall be stabilized with erosion controls.
TBD	***Infrastructure (utilities, solar panels, etc.)*** 1. Construct temporary concrete washout area. 2. Install utilities, solar panels.
TBD	***Final stabilization and landscaping*** 1. Finalize grading activities. 2. Remove all temporary erosion control BMPs and stabilize any areas disturbed by their removal with erosion controls. 3. Monitor stabilized areas until final stabilization is reached.

2.3 SOILS, SLOPES, VEGETATION, AND CURRENT DRAINAGE PATTERNS

Soil type(s): The Natural Resources Conservation Service (NRCS) lists the on-site soils types as predominantly hydrologic soil class A. These soil groups include Poquonock sand, Plymouth-Carver complex, Carver loamy coarse sand, and Hinckley loamy sand, and Gloucester-Canton complex. A small area of hydrologic soil class D soils is present at the southwestern corner of the proposed project locus, which is classified as Udipsamments-wet substratum.

Slopes: 1-30%

Drainage Patterns: Runoff from the site drains to the south, east, and west.

Vegetation: The existing site is comprised of woodland area.

2.4 CONSTRUCTION SITE ESTIMATES

Total construction site area to be disturbed:	±66.2 acres
Maximum area to be disturbed at one time:	±66.2 acres
Percentage impervious area before construction:	<1%
Runoff curve number before construction:	31
Percentage impervious area after construction:	<1%
Runoff coefficient after construction:	40

2.5 DISCHARGE INFORMATION

2.5.1 Description of Receiving Storm Sewer Systems

Does your project/site discharge stormwater into a Municipal Separate Storm Sewer System (MS4)? ☐ Yes ☒ No

2.5.2 Receiving Waters

Runoff from the site drains to Tihonet Pond to the west, and to existing cranberry bogs to the south which eventually flow to Parker Mills Pond. Runoff also flows east to an off-site wetland that drains to off-site cranberry bogs that drain to Harlow Brook.

2.5.3 Impaired Waters/ TMDLs

Has the surface water been listed as "impaired?" ☐ Yes ☒ No

If yes, list the pollutant(s) causing the impairment: N/A

Describe the method(s) used to determine whether or not your project site discharges to an impaired water:

Has a TMDL been completed? ☐ Yes ☒ No

If yes, list the title of the TMDL document: N/A

List the pollutant(s) for which there is a TMDL: N/A

2.5.4 Tier 2, 2.5, or 3 Waters

Is this surface water designated as a Tier 2, 2.5 or 3 water? ☐ Yes ☐ No

If yes specify which Tier the surface water is designated as:
☐ Tier 2 ☐ Tier 2.5 ☐ Tier 3

2.6 UNIQUE SITE FEATURES AND SENSITIVE AREAS

The site contain wetlands and a potential vernal pool; these features will not be impacted by the project. The hydrology of these areas is maintained by the proposed stormwater design. Additionally, they will be protected by sediment control barriers as needed to avoid potential sedimentation.

2.7 CONSTRUCTION SUPPORT ACTIVITIES

Construction support activities are not required for the project.

2.8 POTENTIAL SOURCES OF POLLUTION

2.8.1 Potential Sources of Sediment

- Grading and site excavation operations
- Vehicle tracking
- Soil stripping and stockpiling

2.8.2 Potential Sources of Non-Sediment Pollutants

- Combined Staging Area — small fueling activities, minor equipment maintenance, sanitary facilities, and hazardous waste storage.
- Materials Storage Area — general building materials, solvents, adhesives, paints, aggregates, trash, and so on.
- Construction Activity — concrete pouring, and array construction
- Concrete Washout Area

Material/ Chemical	Physical Description	Stormwater Pollutants	Location[1]
[2]Fertilizer	Liquid or solid grains	Nitrogen, phosphorous	Newly seeded areas
Cleaning solvents	Colorless, blue, or yellow-green liquid	Perchloroethylene, methylene chloride, trichloroethylene, petroleum distillates	No equipment cleaning allowed in project limits
Curing compounds	Creamy white liquid	Naphtha	Concrete Equipment Pads
Hydraulic oil/fluids	Brown oily petroleum hydrocarbon	Mineral oil	Leaks or broken hoses from equipment
Gasoline	Colorless, pale brown or pink petroleum hydrocarbon	Benzene, ethyl benzene, toluene, xylene, MTBE	Contractor staging area
Diesel Fuel	Clear, blue-green to yellow liquid	Petroleum distillate, oil & grease, naphthalene, xylenes	Contractor staging area
Kerosene	Pale yellow liquid petroleum hydrocarbon	Coal oil, petroleum distillates	Contractor staging area
Antifreeze/ coolant	Clear green/yellow liquid	Ethylene glycol, propylene glycol, heavy metals (copper, lead, zinc)	Leaks or broken hoses from equipment
Sanitary toilets	Various colored liquid	Bacteria, parasites, and viruses	Staging area

[1] Area where material/chemical is used on-site.
[2] Use of fertilizers containing nitrogen and/or phosphorus in ratios greater than recommended by the manufacture must be documented.

2.9 SITE PLANS

The Existing Conditions Plan shows the undeveloped site and its current features. The Site Plans show the developed site.

These Site Plans include:

- ☐ Delineation of construction phasing, if applicable
- ☒ Areas of soil disturbance and areas that will not be disturbed
- ☒ Direction(s) of stormwater flow and approximate slopes before and after major grading activities
- ☒ Natural features to be preserved
- ☒ Locations of major structural and non-structural BMPs identified in the SWPPP
- ☐ Location(s) of sediment, soil or other construction materials will be stockpiled
- ☐ Locations of stabilization measures
- ☐ Locations of off-site material, waste, borrow, or equipment storage areas
- ☒ Location of all waters of the U.S., including wetlands on or near the site. Indicate if water bodies are listed as impaired, or are identified as Tier 2, 2.5 or 3 waters.
- ☒ Boundary lines of any natural buffers,
- ☒ Locations of stormwater discharges and/ or locations where authorized non-stormwater will be discharged to surface water(s)
- ☒ Locations of storm drain inlets and stormwater control measures on the site and in the immediate vicinity of the site
- ☐ Locations of all pollutant-generating activities
- ☐ Locations where polymers, flocculants, or other treatment chemicals will be used and stored
- ☐ Areas of federally listed critical habitat for endangered or threatened species

See Appendix B: Site Plans

3.0 COMPLIANCE WITH APPLICABLE FEDERAL & STATE REQUIREMENTS

3.1 ENDANGERED SPECIES CERTIFICATION

Are endangered or threatened species and critical habitats on or near the project area?
☐Yes ☐No

Describe how this determination was made:
PLACEHOLDER LANGUAGE PENDING SITE SPECIFIC REVIEW: A project review package was submitted to USFWS on DATE, addressing Northern Long-Eared Bat (NLEB) and Plymouth Red-Belly Turtle. In summary:

A habitat assessment for Northern Long-Eared Bat was performed on DATE by GZA GeoEnvironmental, Inc. (GZA) and concluded that the project site does not provide important habitat for NLEB, and hibernacula or maternity roosting tree habitat are not known within ¼ mile of the site. The assessment also indicates that the closest location of documented overwintering for this species is located ># miles from the site, and further, that summer forage habitat is not present within the proposed work area.

GZA also performed a Plymouth Red-Belly Turtle assessment of the site, dated DATE. The assessment found that the project site does not occur within mapped Critical Habitat for the turtle, and a general habitat assessment and limited site survey found that the project site has low to moderate potential to support this species and no individual turtles were found. Accordingly, a "may affect, but is unlikely to adversely affect" concurrence letter was issued by USFWS on April 10, 2019.

If yes, describe the species and/or critical habitat:

If yes, describe or refer to documentation that determines the likelihood of an impact on the identified species and/or habitat and the steps taken to address that impact.

3.2 HISTORIC PRESERVATION

Step 1
Will stormwater controls that require subsurface earth disturbance be installed on the site?

☒ Yes ☐No

Step 2
If you answered yes in Step 1, have prior surveys or evaluations conducted on the site already determined that historic properties do not exist, or that prior disturbances at the site have precluded the existence of historic properties?

☐ Yes ☐No

Step 3
If you answered no in Step 2, has it been determined that the installation of subsurface earth-disturbing stormwater controls will have no effect on historic properties?

☐ Yes ☐ No

PLACEHOLDER LANGUAGE PENDING SITE SPECIFIC REVIEW: Historic sites are not present. See Appendix M: Historic Preservation Documentation.

Step 4
If you answered no in Step 3, did the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Office (THPO), or other tribal representative (whichever applies) respond within 15 calendar days to indicate whether the subsurface earth disturbances caused by the installation of stormwater controls affect historic properties?

☐ Yes ☐ No

If no, no further documentation is required. If yes, describe the nature of their response and include documentation in the Appendix:

☐ Written indication that adverse effects to historic properties from the installation of stormwater controls can be mitigated by agreed upon actions.

☐ No agreement has been reached regarding measures to mitigate effects to historic properties from the installation of stormwater controls.

☐ Other:

3.3 SAFE DRINKING WATER ACT UNDERGROUND INJECTION CONTROL REQUIREMENTS

Do you plan to install any of the following controls?

☐ Infiltration trenches (if stormwater is directed to any bored, drilled, driven shaft or dug hole that is deeper than its widest surface dimension, or has a subsurface fluid distribution system)

☐ Commercially manufactured pre-cast or pre-built proprietary subsurface detention vaults, chambers, or other devices designed to capture and infiltrate stormwater flow

☐ Drywells, seepage pits, or improved sinkholes (if stormwater is directed to any bored, drilled, driven shaft or dug hole that is deeper than its widest surface dimension, or has a subsurface fluid distribution system)

If yes, attach documentation of contact between you and the applicable state agency or EPA Regional Office responsible for implementing the requirements for underground injection wells in the Safe Drinking Water Act and EPA's implementing regulations at 40 CFR Parts 144-147.

3.4 APPLICABLE STATE OR LOCAL PROGRAMS

This SWPPP complies with the requirements of Standard 8 of the Massachusetts Department of Environmental Protection Stormwater Handbook, which states:

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

4.0 EROSION AND SEDIMENT CONTROL BMPS

This SWPPP contains a listing of the erosion and sediment control best management practices (BMPs) that will be implemented to control pollutants in stormwater discharges. The BMPs are categorized under one of the areas of BMP activity as described below:

- Natural Buffers or Equivalent Sediment Controls
- Phased construction activity
- Control stormwater flowing onto and through the project
- Stabilize soils
- Protect slopes
- Protect storm drain inlets
- Establish perimeter controls and sediment barriers
- Retain sediment on-site and control dewatering practices
- Establish stabilized construction exits

4.1 NATURAL BUFFERS OR EQUIVALENT SEDIMENT CONTROLS

Are there any surface waters located within 50 feet of your construction disturbances that receive stormwater discharges from the site? ☐ Yes ☒ No

4.2 PHASED CONSTRUCTION ACTIVITY

Phased construction is not proposed. To minimize erosion during grading activities, grading and site work shall be conducted after snowmelt and during periods of predicted dry weather. The areas of the site that will remain vegetated after construction shall be stabilized with hydromulch or seeding immediately after grading activities are completed. All other areas of the construction site shall be stabilized if site work is not planned for more than 14 days. Disturbed areas shall be stabilized immediately after construction but no later than 14 days after construction ceases. Areas graded shall be stabilized with hydromulch immediately after construction but no later than 14 days after construction ceases.

4.3 STABILIZE SOIL

4.3.1 Temporary Stabilization

Description:	Initiation of temporary vegetative cover shall occur immediately where construction will cease for more than 7 days. Temporary vegetative cover shall be established using hydroseeding for areas of exposed soil (including stockpiles).
Installation Schedule:	Temporary stabilization measures shall be initiated immediately where construction activities will temporarily cease for more than 14 days. Stabilization will be completed as soon as practicable, but no later than 7 calendar days after stabilization has been initiated.
Maintenance and Inspection:	Stabilized areas shall be inspected weekly and after storm events until a dense cover of vegetation has become established. If failure is noticed at the seeded area, the area shall be reseeded, fertilized, and mulched immediately.

4.3.2 Hydromulching

Description:	Hydromulching shall provide immediate protection to exposed soils during short periods of disturbance. Hydromulch shall also be applied in areas that have been seeded for temporary or permanent stabilization.
Installation Schedule:	Hydromulch shall be applied to soil exposed temporarily for >14 days during construction.
Maintenance and Inspection:	Hydromulched areas shall be inspected weekly and after storm events to check for movement of mulch or erosion. If washout, breakage, or erosion occurs, the surface shall be repaired, and new hydromulch shall be applied to the damaged area.

4.3.3 Permanent Stabilization

Description:	Initiation of permanent stabilization measures shall occur immediately after the final design grades are achieved and earth moving activities cease. Vegetative cover shall be established on exposed soils. Permanent stabilization shall be completed in accordance with the procedures outlined in Section 6.0 Final Stabilization.
Installation Schedule:	Portions of the site where construction activities have permanently ceased shall be stabilized as soon as possible, but no later than 7 calendar days after stabilization has been initiated.
Maintenance and Inspection:	All seeded areas shall be inspected weekly during construction activities and after storm events until a dense cover of vegetation has been established. If failure is noticed at the seeded area, the area shall be reseeded in accordance with the plans. Care shall be taken to avoid compacting newly placed topsoil. After construction is completed at the site, permanently stabilized areas shall be monitored until final stabilization is reached.

4.3.4 Dust Control

Description:	Dust from the site shall be controlled by using a mobile pressure-type distributor truck to apply water to disturbed areas. The mobile unit shall apply water at a maximum rate of 300 gallons per acre and minimized as necessary to prevent runoff and ponding.
Installation Schedule:	Dust control shall be implemented as needed once site grading has been initiated and during windy conditions (forecasted or actual wind conditions of 20 mph or greater) while site grading is occurring. Spraying of water shall be performed no more than three times a day during the months of May–September and once per day during the months of October–April or whenever the dryness of the soil warrants it.
Maintenance and Inspection:	At least one mobile unit shall be available at all times to distribute water to control dust on the site. Each mobile unit shall be equipped with a positive shutoff valve to prevent over watering of the disturbed area.

4.4 ESTABLISH PERIMETER CONTROLS AND SEDIMENT BARRIERS

4.4.1 Sediment Control Barrier

☐ Permanent ☒ Temporary

Description:	A sediment control barrier, consisting of silt fence and compost mulch tube shall be installed along the down-gradient side of the proposed project to decrease the velocity of sheet flows and intercept and detain small amounts of sediment from disturbed areas.
Installation Schedule:	Sediment Control Barrier shall be installed prior to clearing and grubbing.
Maintenance and Inspection:	Sediment Control Barrier shall be inspected weekly, following storms, and daily during rainy periods. Damaged fencing or tubes shall be replaced. Concentrated flows shall be intercepted and rerouted. Sediment accumulations shall be removed when reaching a depth of 6-inches, or one-half of the above ground height of the barrier, whichever is less. Deteriorated sediment control material shall be replaced. Used mulch tubes and fencing shall be properly disposed of.

4.5 ESTABLISH STABILIZED CONSTRUCTION ENTRANCE/EXIT

☐ Permanent ☒ Temporary

Description:	Temporary gravel or crushed stone construction entrance/exit or other means shall be used to minimize off-site movement of soil with vehicles. Construction access points shall be maintained to minimize tracking of soil onto public roads. If the rock entrance is not working to keep streets clean, then install wheel wash, sweep streets, or wash streets if wash water can be collected.
Installation Schedule:	Stabilized construction entrance shall be installed prior to earthmoving activities.
Maintenance and Inspection:	Stabilized construction entrances shall be inspected daily. Gravel or crushed stone shall be added if the pad is no longer in accordance with the specifications. If the rock entrance is not working to keep public streets clean, then install wheel wash, sweep streets, or wash streets if wash water can be collected. When sediment has been tracked off of the site onto public roads, it shall be removed by the end of the same working day, or by the end of the next working day if track-out occurs on a non-work day. Remove sediment by sweeping, shoveling or vacuuming public roadways were sediment has been tracked-out.

4.6 DEWATERING PRACTICES

Description:	All groundwater or stormwater discharged from excavations, trenches, or other similar points shall be treated by sediment basins, sediment traps, sediment socks, dewatering tanks, tube settlers or filtration systems specifically designed to remove sediment from the excavations. All dewatering practices shall conform to the following: • Visible floating solids or foam shall not be discharged; • An oil-water separator or suitable filtration device (such as a cartridge filter) that is designed to remove oil, grease, or other products if dewatering water is found to contain these materials shall be used; • To the extent feasible, utilize vegetated, upland areas of the site to infiltrate dewatering water before discharge. In no case will surface waters be considered part of the treatment area; • Velocity dissipaters shall be installed at all points where dewatering activities are discharged to the surface. • With backwash water, either haul it away for disposal or return it to the beginning of the treatment process; and • Replace and clean the filter media used in dewatering devices when the pressure differential equals or exceeds the manufacturer's specifications.
Installation Schedule:	Install settling or filtration methods prior to commencing dewatering. Engineer is required to approve settling of filtration method design prior to installation.
Maintenance and Inspection:	Settling of filtration controls shall be inspected weekly and following storms. Sediment shall be removed when it reaches a depth of one foot, or half the design capacity whichever is less.

5.0 GOOD HOUSEKEEPING BMPS

This SWPPP contains a listing of the good housekeeping best management practices (BMPs) that shall be implemented to control pollutants in stormwater discharges during construction-related work. The BMPs are categorized below:

- Material Handling and Waste Management
- Establish Proper Building Material Staging Areas
- Designate Washout Areas
- Establish Proper Equipment/Vehicle Fueling and Maintenance Practices
- Allowable Non-Stormwater Discharges and Control Equipment/Vehicle Washing
- Spill Prevention and Control Plan

5.1 MATERIAL HANDLING AND WASTE MANAGEMENT

Several management procedures and practices are proposed to prevent and/or reduce the discharge of pollutants to stormwater from solid or liquid wastes that will be generated at the site. These measures are grouped into the following categories: (1) solid or construction waste disposal, (2) recycling, (3) sanitary and septic waste, and (4) hazardous materials.

5.1.1 Solid or Construction Waste Disposal

Description:	All waste materials shall be collected and disposed of into metal trash dumpsters or enclosed trash containers in the materials storage area. Dumpsters shall have a secure watertight lid, be placed away from stormwater conveyances and drains, and meet all federal, state, and municipal regulations. Only trash and construction debris from the site shall be deposited in the dumpster. No construction materials shall be buried on-site unless authorized by a program for recycling/beneficial use. All personnel shall be instructed regarding the correct disposal of trash and construction debris. Notices that state these practices shall be posted in the office trailer and the individual who manages day-to-day site operations shall be responsible for seeing that these practices are followed.
Installation Schedule:	Trash dumpsters shall be installed once the materials storage area has been established.
Maintenance and Inspection:	The dumpsters shall be inspected weekly and immediately after storm events. The dumpsters shall be emptied weekly and taken to an approved landfill or recycling facility. If trash and construction debris are exceeding the dumpsters' capacity, the dumpsters shall be emptied more frequently. Waste container lids shall be closed when not in use and at the end of the business day. For waste containers that do not have lids, provide cover or a similarly effective means to minimize the discharge of pollutants.

5.1.2 Recycling

Description:	Wood pallets, cardboard boxes, and other recyclable construction scraps shall be disposed of in a designated dumpster for recycling. The dumpster shall have a secure watertight lid, be placed away from stormwater conveyances and drains and meet all local and state solid-waste management regulations. Only solid recyclable construction scraps from the site shall be deposited in the dumpster. All personnel shall be instructed regarding the correct procedure for disposal of recyclable construction scraps. Notices that state these procedures shall be posted in the office trailer, and the individual who manages day-to-day site operations shall be responsible for seeing that these procedures are followed.
Installation Schedule:	Designated recycling dumpsters shall be installed when building materials arrive on-site.
Maintenance and Inspection:	The recycling dumpster shall be inspected weekly and immediately after storm events. The recycling dumpster shall be emptied weekly and taken to an approved recycling center. If recyclable construction wastes are exceeding the dumpsters' capacity, the dumpsters shall be emptied more frequently.

5.1.3 Sanitary and Septic Waste

Description:	Temporary sanitary facilities (portable toilets) shall be provided at the site throughout the construction phase. The portable toilets shall be located in the staging area, away from concentrated flow paths and traffic flow.
Installation Schedule:	The portable toilets shall be brought to the site once the staging area has been established.
Maintenance and Inspection:	All sanitary waste shall be collected from the portable facilities on a regular basis. The portable toilets shall be inspected weekly for evidence of leaking holding tanks. Toilets with leaking holding tanks shall be removed from the site and replaced with new portable toilets.

5.1.4 Hazardous Materials and Waste

Description:	All hazardous waste materials such as oil filters, petroleum products, paint, and equipment maintenance fluids shall be stored in structurally sound and sealed shipping containers, within the hazardous materials storage area. Hazardous waste materials shall be stored in appropriate and clearly marked containers and segregated from other non-waste materials. Secondary containment shall be provided for all waste materials in the hazardous materials storage area and shall consist of commercially available spill pallets. Additionally, all hazardous waste materials shall be disposed of in accordance with federal, state, and municipal regulations. Hazardous waste materials shall not be disposed of into the on-site dumpsters. All personnel shall be instructed regarding proper procedures for hazardous waste disposal. Notices that state these procedures shall be posted in the office trailer and the individual who manages day-to-day site operations shall be responsible for seeing that these procedures are followed.
Installation Schedule:	Shipping containers used to store hazardous waste materials shall be installed once such materials arrive on-site.
Maintenance and Inspection:	The hazardous waste material storage areas shall be inspected weekly and after storm events. The storage areas shall be kept clean, well-organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Material safety data sheets, material inventory, and emergency contact numbers shall be maintained in the office trailer.

5.2 ESTABLISH PROPER BUILDING MATERIAL STAGING AREAS

Description:	Construction equipment and maintenance materials shall be stored at the combined staging area and materials storage areas. A watertight shipping container shall be used to store hand tools, small parts, and other construction materials. Nonhazardous building materials such as packaging material (wood, plastic, and glass), and construction scrap material (steel, metal scraps, and pipe cuttings) shall be stored in a separate covered storage facility adjacent to the shipping container. All hazardous-waste materials such as oil filters, petroleum products, paint, and equipment maintenance fluids shall be stored in structurally sound and sealed containers under cover within the storage area. Very large items, shall be stored in the open in the materials storage area. Such materials shall be elevated on blocks to minimize contact with runoff.

Installation Schedule:	The materials storage area shall be installed after grading and before any infrastructure is constructed at the site.
Maintenance and Inspection:	The storage area shall be inspected weekly and after storm events. The storage area shall be kept clean, well-organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers, and liners shall be repaired or replaced as needed to maintain proper function.

5.3 DESIGNATE WASHOUT AREAS

5.3.1 Concrete Washout

Description:	A designated temporary, above-grade concrete washout area shall be constructed. The temporary concrete washout area shall be constructed with a recommended minimum length and minimum width of 10 feet, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations. The washout area shall be lined with plastic sheeting at least 10 mils thick and free of any holes or tears. Signs shall be posted marking the location of the washout area to ensure that concrete equipment operators use the proper facility. Concrete pours shall not be conducted during or before an anticipated storm event. Concrete mixer trucks and chutes shall be washed in the designated area or concrete wastes shall be properly disposed of off-site. When the temporary washout area is no longer needed for the construction project, the hardened concrete and materials used to construct the area shall be removed and disposed of according to the maintenance section below, and the area shall be stabilized.
Installation Schedule:	The washout area shall be constructed before concrete pours occur at the site.
Maintenance and Inspection:	The washout areas shall be inspected daily to ensure that all concrete washing is being discharged into the washout area, no leaks or tears are present, and to identify when concrete wastes need to be removed. The washout areas shall be cleaned out once the area is filled to 75 percent of the holding capacity. Once 75% of the area's holding capacity has been reached, the concrete wastes shall be allowed to harden; the concrete shall be broken up, removed, and taken to an approved landfill for disposal or recycled on-site or off-site in accordance with applicable laws. The plastic sheeting shall be replaced if tears occur during removal of concrete wastes from the washout area.

Design Specifications:

1. Temporary concrete washout type Above Grade shall be constructed as detailed above.
2. The washout shall be a minimum of 50 feet from storm drain inlets.
3. Plastic lining shall be free of holes, tears, or other defects that compromise the impermeability of the material.

5.4 ESTABLISH PROPER EQUIPMENT/VEHICLE FUELING AND MAINTENANCE PRACTICES

Description:	Several types of vehicles and equipment will likely be used on-site throughout the project, including graders, scrapers, excavators, loaders, rollers, trucks and trailers, backhoes, and forklifts. All major equipment/vehicle fueling and maintenance shall be performed outside of wetland resource areas and associated buffer zones. When vehicle fueling must occur on-site, the fueling activity shall occur in the staging area. Only minor equipment maintenance shall occur on-site. All equipment fluids generated from maintenance activities shall be disposed of into designated drums stored on spill pallets in accordance with the Material Handling and Waste Management Section 5.1. Absorbent, spill-cleanup materials and spill kits shall be available at the combined staging and materials storage area. Drip pans shall be placed under all equipment receiving maintenance and vehicles and equipment parked overnight.
Installation Schedule:	BMPs implemented for equipment and vehicle maintenance and fueling activities shall begin at the start of the project.
Maintenance and Inspection:	Inspect equipment/vehicle storage areas weekly and after storm events. Vehicles and equipment shall be inspected on each day of use. Leaks shall be repaired immediately, using dry cleanup measures where possible and eliminating the source of the discharge. Problem vehicle(s) or equipment shall be removed from the project site. Keep ample supply of spill-cleanup materials on-site and immediately clean up spills and dispose of materials properly. Do not clean surfaces by hosing-down the area.

5.5 ALLOWABLE NON-STORMWATER DISCHARGES AND CONTROL EQUIPMENT / VEHICLE WASHING

Description:	All equipment and vehicle washing shall be performed off-site, except as required for wheel washes and concrete washout areas.
Installation Schedule:	N/A
Maintenance and Inspection:	N/A

5.6 SPILL PREVENTION AND CONTROL PLAN

Description:	i. Employee Training: All employees shall be trained as detailed in the Inspection and Maintenance Section 8.0 of this report. ii. Vehicle Maintenance: Vehicles and equipment shall be maintained off-site, except for minor maintenance as needed. All vehicles and equipment including subcontractor vehicles shall be checked for leaking oil and fluids. Vehicles leaking fluids shall not be allowed on-site. iii. Hazardous Material Storage: Hazardous materials shall be stored in accordance with this report and applicable regulations. iv. Spill Kits: Spill kits shall be kept within the materials storage area. Spills: All spills shall be cleaned up immediately upon discovery. Spent absorbent materials and rags shall be hauled off-site immediately after the spill is cleaned up for disposal at an approved landfill. Spills shall be reported to the National Response Center at 1-800-424-8802 and MassDEP at 888-304-1133 as applicable in accordance with state and federal requirements. v. Material safety data sheets: A material inventory and emergency contact information shall be maintained at the on-site project trailer.
Installation Schedule:	The spill prevention and control procedures shall be implemented once construction begins on-site.
Maintenance and Inspection:	All personnel shall be instructed on the correct procedures for spill prevention and control. Notices that state these practices shall be posted in the office trailer, and the individual who manages day-to-day site operations shall be responsible for seeing that these procedures are followed.

5.7 FERTILIZER DISCHARGE RESTRICTIONS

Description:	Discharges from fertilizers containing nitrogen and phosphorus shall be minimized. Fertilizers shall be applied at rates and amounts consistent with the manufacture's specification, and shall at no time exceed local, state, or federal specifications. See project landscape specifications for acceptable fertilizers that can be used for the project.
Installation Schedule:	Fertilizers shall be applied at an appropriate time of year, timed to coincide as closely as possible to the period of maximum vegetation uptake and growth. Avoid applying fertilizers before heavy rains. Do not apply fertilizers to frozen ground or stormwater conveyance channels flowing with water.
Maintenance and Inspection:	N/A

5.8 ALLOWABLE NON-STORMWATER DISCHARGE MANAGEMENT

Any changes in construction activities that produce other allowable non-stormwater discharges shall be identified, and the SWPPP shall be amended and the appropriate erosion and sediment control shall be implemented.

The following is a list of allowable non-stormwater discharges:

- Water Used to Control Dust
- Uncontaminated Excavation Dewatering
- Firefighting
- Non-Detergent Laden Vehicle Wash Water

Except for water used to control dust and irrigation water, the above discharges shall not be routed to areas of exposed soil.

6.0 FINAL STABILIZATION

In compliance with the Construction General Permit, soil stabilization measures must be implemented immediately whenever earth-disturbing activities are temporarily or permanently ceased on any portion of the site. Earth-disturbing activities are temporarily ceased when clearing, grading, and excavation within any area of a site that will not include a permanent structure will not resume for a period of 7 or more calendar days, but such activities will resume in the future.

In the context of this provision, "immediately" means as soon as practicable, but no later than the end of the next work day, following the day when the earth-disturbing activities have temporarily or permanently ceased. The following activities constitute the initiation of stabilization:

- Preparing the soil for vegetative or non-vegetative stabilization;
- Applying mulch or other non-vegetative product to the exposed area;
- Seeding or planting the exposed area;
- Starting any of the activities in listed above on a portion of the area to be stabilized, but not on the entire area; and
- Finalizing arrangements to have stabilization product fully installed in compliance with the applicable deadline for completing stabilization.

As soon as practicable, but no later than 7 calendar days after the initiation of soil stabilization measures the following activities are required to be completed:

- For vegetative stabilization, all activities necessary to initially seed or plant the area to be stabilized; and/or
- For non-vegetative stabilization, the installation or application of all such non-vegetative measures.

The following sections detail the management practices proposed to achieve final stabilization of the site.

6.1 PERMANENT SEEDING

Description:	Permanent seeding shall be applied immediately after the final design grades are achieved on portions of the site but no later than 7 days after construction activities have permanently ceased. After the entire site is stabilized, any sediment that has accumulated shall be removed and hauled off-site for disposal at an approved landfill. Construction debris, trash and temporary BMPs (including sedimentation controls, material storage areas, sanitary toilets, and inlet protection) shall also be removed and any areas disturbed during removal shall be seeded immediately. Seeding shall be performed in accordance to the Site Plans and Landscape Specifications for the project.
Installation Schedule:	Seeding shall occur at portions of the site where construction activities have permanently ceased shall be stabilized, as soon as possible but no later than 7 days after construction ceases.
Maintenance and Inspection:	All seeded areas shall be inspected weekly during construction activities for failure and after storm events until a dense cover of vegetation has been established. If failure is noticed at the seeded area, the area shall be reseeded in accordance with the plans. After construction is completed at the site, permanently stabilized areas shall be monitored until final stabilization is achieved.

7.0 INSPECTIONS AND MAINTENANCE

7.1 INSPECTIONS

7.1.1 Inspection Schedule and Procedures

Inspections of the site will be performed once every 7 days and within 24 hours of the end of a storm event of 0.25-inch) or greater unless otherwise specified. The inspections will verify that all BMPs required are implemented, maintained, and effectively minimizing erosion and preventing stormwater contamination from construction materials.

To determine if a storm event of 0.25 inches or greater has occurred on the site, either a properly maintained rain gauge will be kept on the site or the storm event information will be obtained from a weather station that is representative of the location. If an inspection is conducted because of rainfall measuring 0.25 inches or greater, the applicable rain gauge or weather station readings that triggered the inspection will be noted in the inspection report.

Inspections shall include all areas of the site disturbed by construction activity and areas used for storage of materials that are exposed to precipitation. Inspectors shall look for evidence of, or the potential for, pollutants entering the storm water conveyance system. Sedimentation and erosion control measures identified in the SWPPP shall be observed to ensure proper operation. Discharge locations shall be inspected to ascertain whether sediment and erosion control measures are effective in preventing significant impacts to waters of the United States, where accessible. Where discharge locations are inaccessible, nearby downstream location shall be inspected to the extent that such inspections are practicable. Locations where vehicles enter or exit the site shall be inspected for evidence of off-site sediment tracking.

For detailed inspection procedures, see Sections 4 and 5.

All inspections shall be coordinated with a representative from Owner Company. An Owner Company representative shall accompany the Inspector, when possible, during inspections.

Inspection reports are required to be completed within 24-hours of an inspection. If corrective actions are identified by the Inspector during the inspection, he/she shall notify and submit a copy of the inspection report to the Operator(s). For corrective actions identified, the Site Owner/Site Operator shall be responsible for initiating the corrective action within 24 hours of the report and completing maintenance as soon as possible or before the next storm event. For any corrective actions requiring a SWPPP amendment or change to a stormwater conveyance or control design, the

Site Owner/Site Operator shall notify Owner, as soon as possible, before initiating the corrective action.

The business days for the project construction are ***7:00 am to 5:00 pm***, ***Monday through Friday***.

For a copy of the inspection report template, see Appendix E.

7.2 REDUCTIONS IN INSPECTION FREQUENCY

Once an area is stabilized, inspections may be reduced to twice per month for the first month, no more than 14 calendar days apart, then once per month. If construction resumes at the stabilized area the inspection frequency shall increase as outlined in Section 7.1.

If earth-disturbing activities are suspended due to frozen conditions inspections can be temporarily suspended until a thaw occurs.

7.3 CORRECTIVE ACTION LOG

The corrective action log describes repairs, replacements, and maintenance of BMPs undertaken as a result of the inspections and maintenance procedures. Additionally, remedies of permit violations and clean and proper disposal of spills, releases other deposits should be recorded.

If it is determined the stormwater controls have not been installed as required, or that they are not functioning adequately corrective action is required within 7 calendar days.

The operator will document the completion of the corrective action within 24 hours.

See Appendix F – Corrective Action Log.

8.0 RECORDKEEPING AND TRAINING

8.1 RECORDKEEPING

A copy of the SWPPP, along with all inspection reports and corrective action logs are required to be stored at an accessible location at the site or other location easily accessible during normal business hours, and shall be made available upon request of the EPA, or state or local agency approving stormwater management plans.

The following records shall be kept at the project site and shall be available for inspectors to review. These records shall be retained for a minimum period of at least 3 years after the permit is terminated.

Date(s) when major grading activities occur:
See Appendix I – Grading and Stabilization Activities Log

Date(s) when construction activities temporarily or permanently cease on a portion of the site:
See Appendix I – Grading and Stabilization Activities Log

Date(s) when an area is either temporarily or permanently stabilized:
See Appendix I – Grading and Stabilization Activities Log

8.2 LOG OF CHANGES TO THE SWPPP

The log of changes to the SWPPP is maintained in Appendix G and includes additions of new BMPs, replacement of failed BMPs, significant changes in the activities or their timing on the project, changes in personnel, changes in inspection and maintenance procedures and updates to site plans.

8.3 TRAINING

Prior to the commencement of earth-disturbing activities or pollutant-generating activities, whichever occurs first, training on the pollution prevention measures outlined in this SWPPP shall be provided to staff and subcontractors.

8.3.1 Individual(s) Responsible for Training

Company/Organization: TBD

Name: TBD

8.3.2 Description of Training Conducted

Informal training shall be conducted for all staff, including subcontractors, on the site. The training shall be conducted primarily via tailgate sessions and shall focus on avoiding damage to stormwater BMPs and preventing illicit discharges. The tailgate sessions shall be conducted biweekly and shall address the following topics: Erosion Control BMPs, Sediment Control BMPs, Non-Stormwater BMPs, Waste Management and Materials Storage BMPs, and Emergency Procedures specific to the construction site. (See Appendix J – Training Log)

Formal training shall be provided to all staff and subcontractors with specific stormwater responsibilities, such as installing and maintaining BMPs. The formal training shall cover all design and construction specifications for installing the BMPs and proper procedures for maintaining each BMP. Training shall also cover inspection schedules and procedures for personnel whose job duties are related to inspections. Formal training shall occur before any BMPs are installed on the site. (See Appendix J – Training Log)

9.0 CERTIFICATION AND NOTIFICATION

9.1 SIGNATURE, PLAN REVIEW, AND MAKING PLANS AVAILABLE

A copy of the SWPPP (including a copy of the Construction General Permit, NOI, and acknowledgement letter from EPA) shall be retained at the construction site (or other location easily accessible during normal business hours to EPA, a state, tribal or local agency approving sediment and erosion plans, grading plans, or storm water management plans; local government officials; the operator of a municipal separate storm sewer receiving discharges from the site; and representatives of the U.S. Fish and Wildlife Service or the National Marine Fisheries Service) from the date of commencement of construction activities to the date of final stabilization. A copy of the SWPPP shall be available at a central location on-site for the use of all those identified as having responsibilities under the SWPPP. If an on-site location is unavailable to store the SWPPP when no personnel are present, notice of the plan's location shall be posted near the main entrance at the construction site.

9.2 NOTICE OF PERMIT COVERAGE

A sign must be posted at a safe, publicly accessible location in close proximity to the construction site detailing the permit coverage. The notice must be located so that it is visible from the public road that is nearest to the active part of the construction site, and it must use a font large enough to be readily viewed from a public right-of-way. At a minimum, the notice must include:

- The NPDES Permit Tracking Number,
- A contact name and phone number for obtaining additional construction site information,
- The Uniform Resource Locator (URL) for the SWPPP (if available), or the following statement: "If you would like to obtain a copy of the Stormwater Pollution Prevention Plan (SWPPP) for this site, contact the EPA Regional 1 Office at (617) 918-1038,
- The following statement "If you observe indicators of stormwater pollutants in the discharge or in the receiving waterbody, contact the EPA through the following website: https://www.epa.gov/enforcement/report-environmental-violations."

9.3 OWNER CERTIFICATION

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

Name:_____ Title:_____

Signature:_____ Date:_____

9.4 OPERATOR CERTIFICATION

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

Name:_____ Title:_____

Signature:_____ Date:_____

APPENDICES

Appendix A

General Location Map

Appendix B

Site Plans

Appendix C

Construction General Permit

https://www.epa.gov/sites/production/files/2017-02/documents/2017_cgp_final_permit_508.pdf

Appendix D

NOI and Acknowledgement Letter from EPA

Appendix E

Inspection Reports

Inspections under this SWPPP shall be conducted in accordance with each installed BMPs recommended maintenance requirements. This inspection frequency may be reduced to at least once every month if: a) the entire site is temporarily stabilized, b) runoff is unlikely due to winter conditions (e.g. site is covered with snow, ice, or the ground is frozen), or c) construction is occurring during seasonal arid periods in arid areas and semi-arid areas. If an inspection report is filed according to this modified schedule it shall be noted at the end of the report under the "NOTES" section.

The following pages should be copied and completed for each inspection. All inspection forms should be compiled in a binder to prove compliance with this SWPPP.

Stormwater Pollution Prevention Plan: Inspection Checklist

General Information			
Project Name			
NPDES Tracking No.		**Location**	
Date of Inspection		**Start/End Time**	
Inspector's Name(s)			
Inspector's Title(s)			
Inspector's Contact Information			
Inspector's Qualifications			
Describe present phase of construction			
Type of Inspection: ❑ Regular ❑ Pre-storm event ❑ During storm event ❑ Post-storm event			
Weather Information			
Has there been a storm event since the last inspection? ❑Yes ❑No **If yes, provide:** Storm Start Date & Time: Storm Duration (hrs): Approx. Amount of Precipitation (in):			
Weather at time of this inspection? ❑ Clear ❑Cloudy ❑ Rain ❑ Sleet ❑ Fog ❑ Snowing ❑ High Winds ❑ Other: Temperature:			
Have any discharges occurred since the last inspection? ❑Yes ❑No **If yes, describe:**			
Are there any discharges at the time of inspection? ❑Yes ❑No **If yes, describe:**			

Site-specific BMPs

- *Number the structural and non-structural BMPs identified in your SWPPP on your site map and list them below (add as many BMPs as necessary). Carry a copy of the numbered site map with you during your inspections. This list will ensure that you are inspecting all required BMPs at your site.*
- *Describe corrective actions initiated, date completed, and note the person that completed the work in the Corrective Action Log.*

BMP	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	
	❑Yes ❑No	❑Yes ❑No	

Overall Site Issues

Below are some general site issues that should be assessed during inspections. Customize this list as needed for conditions at your site.

BMP/activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
Are all slopes and disturbed areas not actively being worked properly stabilized?	❑Yes ❑No	❑Yes ❑No	
Are natural resource areas (e.g., streams, wetlands, mature trees, etc.) protected with barriers or similar BMPs?	❑Yes ❑No	❑Yes ❑No	
Are perimeter controls and sediment barriers adequately installed (keyed into substrate) and maintained?	❑Yes ❑No	❑Yes ❑No	
Are discharge points and receiving waters free of any sediment deposits?	❑Yes ❑No	❑Yes ❑No	
Are storm drain inlets properly protected?	❑Yes ❑No	❑Yes ❑No	
Is the construction exit preventing sediment from being tracked into the street?	❑Yes ❑No	❑Yes ❑No	
Is trash/litter from work areas collected and placed in covered dumpsters?	❑Yes ❑No	❑Yes ❑No	
Are washout facilities (e.g., paint, stucco, concrete) available, clearly marked, and maintained?	❑Yes ❑No	❑Yes ❑No	
Are vehicle and equipment fueling, cleaning, and maintenance areas free of spills, leaks, or any other deleterious material?	❑Yes ❑No	❑Yes ❑No	

BMP/activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
Are materials that are potential stormwater contaminants stored inside or under cover?	❑Yes ❑No	❑Yes ❑No	
Are non-stormwater discharges (e.g., wash water, dewatering) properly controlled?	❑Yes ❑No	❑Yes ❑No	
(Other)	❑Yes ❑No	❑Yes ❑No	

Non-Compliance

Describe any incidents of non-compliance not described above:

CERTIFICATION STATEMENT

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

Print name and title:

_____

Signature:_____

Date:_____

Appendix F

Corrective Action Log

Corrective Action Log

Use this form to note the date and activity for accurate record keeping (make additional copies as necessary). Examples include the restaking or reinforcement of the erosion control barrier, site watering to prevent dust erosion, street sweeping, equipment and machinery repair, etc.

Date	Activity Description	Additional Action Items

Appendix G

SWPPP Amendment Log

The SWPPP, including the site plans, shall be amended whenever there is a change in design, construction, operation, or maintenance at the construction site that has or could have a significant effect on the discharge of pollutants to the waters of the United States that has not been previously addressed in the SWPPP.

The SWPPP shall be amended if during inspections or investigations by site staff, or by local, state, tribal or federal officials, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in storm water discharges from the construction site.

Based on the results of an inspection, the SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) calendar days following the inspection. Implementation of these additional or modified BMPs shall be accomplished as described in Subpart 3.6B of the Construction General Permit (located in Appendix C).

SWPPP Amendment Log

Amendment No.	Description of the Amendment	Date of Amendment	Amendment Prepared by (Name(s) and Title)

Appendix H

Subcontractor Certifications/Agreements

Sample Subcontractor Certifications/Agreements

SUBCONTRACTOR CERTIFICATION
STORMWATER POLLUTION PREVENTION PLAN

Project Number: _____

Project Title: _____

Operator(s): _____

As a subcontractor, you are required to comply with the Stormwater Pollution Prevention Plan (SWPPP) for any work that you perform on-site. Any person or group who violates any condition of the SWPPP may be subject to substantial penalties or loss of contract. You are encouraged to advise each of your employees working on this project of the requirements of the SWPPP. A copy of the SWPPP is available for your review at the office trailer.

Each subcontractor engaged in activities at the construction site that could impact stormwater must be identified and sign the following certification statement:

I certify under the penalty of law that I have read and understand the terms and conditions of the SWPPP for the above designated project and agree to follow the practices described in the SWPPP.

This certification is hereby signed in reference to the above named project:

Company: _____

Address: _____

Telephone Number: _____

Type of construction service to be provided: _____

_____

_____

Signature: _____

Title: _____

Date: _____

Appendix I

Grading and Stabilization Activities Log

Site Plans in Appendix B should be annotated to indicate areas where final stabilization has been accomplished and no further construction-phase permit requirements apply.

The following records are to be kept by each Site Operator throughout the construction period and maintained in the SWPPP. Insert additional documentation for record keeping as necessary.

Grading and Stabilization Activities Log

Date	Location on Property	Description

Appendix J

Training Log

Training Log

Date	Training Topic	Attendee	Signature of Training Coordinator

Appendix K

Delegation of Authority

Sample Delegation of Authority Form

Delegation of Authority

I, _____ (name), hereby designate the person or specifically described position below to be a duly authorized representative for the purpose of overseeing compliance with environmental requirements, including the Construction General Permit, at the _____ construction site. The designee is authorized to sign any reports, stormwater pollution prevention plans and all other documents required by the permit.

_____ (name of person or position)
_____ (company)
_____ (address)
_____ (city, state, zip)
_____ (phone)

By signing this authorization, I confirm that I meet the requirements to make such a designation as set forth in Appendix I of EPA's Construction General Permit (CGP), and that the designee above meets the definition of a "duly authorized representative" as set forth in Appendix I.

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

Name: _____

Company: _____

Title: _____

Signature: _____

Date: _____

Appendix L

Endangered Species Documentation

BEALS + THOMAS

Appendix M

Historic Preservation Documentation

BEALS + THOMAS