SECTION 6.0

STORMWATER REPORT

(Submitted Under Separate Cover)

DRAINAGE REPORT

ALLEN & MAJOR ASSOCIATES, INC.

6 Forge Parkway
Franklin, Massachusetts

APPLICANT:
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ISSUED:
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6 Forge Parkway

SECTION 1.0 -
DRAINAGE REPORT

Introduction

The purpose of this drainage report is to provide an overview of the proposed stormwater management system (SMS) for the proposed construction of a 36,000 square foot building, 51 parking spaces, and paved loading docks located at 6 Forge Parkway in Franklin, MA. The report will show by means of narrative, calculations and exhibits that the proposed stormwater management system will meet or exceed the Massachusetts Department of Environmental Protection (MassDEP) stormwater standards, and the Town's Stormwater Management Regulations.

The proposed SMS incorporates structural and non-structural Best Management Practices (BMPs) to provide stormwater peak flow mitigation, quality treatment, and conveyance. The SMS for the proposed development includes a series of deep sump catch basins, proprietary water quality devices, chamber infiltration systems, an outlet control structure, and bioretention system.

Site Categorization for Stormwater Regulations

The proposed site improvements at 6 Forge Parkway are considered a new development under the DEP Stormwater Management Standards due to the net increase in impervious area.

Site Location and Access

The site is a single lot with 207± feet of frontage on Forge Parkway, entirely within the Town of Franklin. The parcel is located approximately 1,000± feet west of Interstate 495 and is directly south of Route 140. The parcel is abutted to the west by a hotel, to the east by railroad and undeveloped woodland, and to the south by an office building. The parcel is located within the Town's Industrial zone. The site shares driveway access to Forge Parkway with the Residence Inn, located at 4 Forge Parkway, the abutter to the west.

Existing Site Conditions

The project site is located at 6 Forge Parkway, Franklin, Massachusetts, and is identified on the town Assessor's Map 272 as Parcel 5 and is approximately 5.91 acres. The project site is on the north side of Forge Parkway and is covered by scrub-brush and woods. A significant portion of the property was cleared in the early 2000's but was never developed. The site's topography ranges from moderate to steep slopes. The high point on-site is approximately elevation 296 in the southwestern corner of the site; the low point on-site is approximately elevation 221 in the northeastern corner of the site. The existing impervious area on-site is approximately 6,000 square feet, which includes the existing driveway to 4 Forge Parkway.

On the property presently, stormwater flows to three distinct locations, or "Study Points". Stormwater from the southwestern portion of the site flows towards the adjacent lot, 4 Forge Parkway (Study Point #1). Flow from a small portion in the northwest of the site flows overland towards route 140 (Study Point #2). Stormwater from more than half of the site on the eastern side flows overland and discharges to the wetlands on the northeast side of the site (Study Point #3). It was at these three study points that surface drainage flows were analyzed for the following analysis.

Existing Soil Conditions
The on-site soils were identified using the USDA Natural Resources Conservation Services (NRCS) Soil Survey for Norfolk County, which indicates that the soils on-site consist of Chartlon-Hollis-Rock outcrop complex and Canton fine sandy loam. Charlton-Hollis-Rock outcrop complex is categorized as Hydrologic Soil Group Type "A". Canton fine sandy loam is categorized as Hydrologic Soil Group Type "B". A copy of the NRCS Custom Soil Resource Report is included in the appendix of this report.

Further investigation of the underlying soils has been conducted by performing a series of test pits across the site. On November 15 and 16, 2023, GeoEngineers, the project Geotechnical Engineer, witnessed and logged eight test pits in various locations. The test pits showed that the underlying soils are loamy sands. Copies of the test pit logs are included in the appendix of this report. An exfiltration rate for the loamy sands was determined to be 2.41 inches per hour using Table 2.3.3 1982 Rawls Rate, Massachusetts Stormwater Handbook, Volume 3, Chapter 1.

FEMA Floodplain/Environmental Due Diligence
There are no portions of the site located within the FEMA Zone "AE" Special Flood Hazard Area Subject to Inundation by the 1% Annual Chance Flood (100-year floodplain) per the official Flood Insurance Rate Map (FIRM) effective date July 17, 2012, community panel 25021C0308E. See section 3 of this report for a copy of the FEMA FIRM.

Environmentally Sensitive Zones
The Commonwealth of Massachusetts asserts control over numerous protected and regulated areas including: Areas of Critical Environmental Concern (ACEC); Outstanding Resource Waters (ORWs); Priority and Protected Habitat for rare and endangered species, and areas protected under the Wetlands Protection Act. The subject property is not located within any of these regulated areas.

Drainage Analysis Methodology
A peak rate of runoff will be determined using techniques and data found in the following:

1. Urban Hydrology for Small Watersheds – Technical Release 55 by the United States Department of Agriculture Soils Conservation Service, June 1986. Runoff curve numbers and 24-hour precipitation values were obtained from this reference.
2. HydroCAD © Stormwater Modeling System by HydroCAD Software Solutions LLC, version 10.20-4a. The HydroCAD program was used to generate runoff hydrographs for the watershed areas, to determine discharge/ stage/storage characteristics for the stormwater BMPs, to perform drainage routing and to combine the results of the runoff hydrographs. HydroCAD uses the TR-20 methodology of the SCS Unit Hydrograph procedure (SCS-UH).

Proposed Conditions – Peak Rate of Runoff
The stormwater runoff analysis of the existing and proposed conditions includes an estimate of the peak rate of runoff from various rainfall events. Peak runoff rates were developed using TR55 Urban Hydrology for Small Watersheds, developed by the U.S. Department of Commerce, Engineering Division and the HydroCAD computer program. Further, the analysis has been prepared in accordance with the MassDEP and the Town of Franklin requirements and standard engineering practices. The peak rate of runoff has been estimated for each watershed during the 2, 10, 25, and 100-year storm events.

The proposed stormwater management system for the site consists of deep sump catch basins, proprietary water quality devices, a Stormtech MC-3500 chamber infiltration system with isolator row, a bioretention system, a Stormtech SC-740 chamber infiltration system, and an outlet control structure. These systems have been designed in accordance with the MA DEP Stormwater Management Policy to recharge groundwater and reduce the rate of runoff from the parcel.

A portion of the new driveway entrance and adjacent hillside will continue to generate stormwater that ultimately discharges to the 4 Forge Parkway property (Study Point #1). This runoff will be intercepted by two Rain Guardian Turret devices which are curb inlet structures that provide pretreatment of trash and debris and discharge to the ground surface. The runoff will then spill over a rip rap apron which discharges to a bioretention system. The bioretention system media and plants will provide further treatment of the runoff. The bioretention system is overlaid on top of a Stormtech SC-740 chamber infiltration system. Runoff will flow freely through the bioretention system media into the infiltration system. An overflow grate will be installed into the infiltration system, which will allow stormwater to enter the system, should it be necessary during large storm events. This system will infiltrate all runoff up to the 25-year design storm event while larger storm events will overflow to a landscaped island on the 4 Forge Parkway property. (Study Point #1).

Stormwater generated on the northwesterly corner of the site will flow overland to the Route 140 right-of-way (Study Point #2). The ground cover in this relatively small portion of the site is landscaped and does not include any impervious cover.

Stormwater generated on the main portion of the developed site will be captured within a series of catch basins, directed to one of two proprietary water quality devices and flow to the Stormtech MC-3500 chamber infiltration system. All pavement runoff will be treated within the system's isolator row. Approximately half of the roof runoff will be piped directly to the infiltration. This system will infiltrate the 2-year design storm event while larger storm events will overflow through an outlet control structure to the hillside on the east side of the site and eventually to the easterly wetlands (Study Point #3).

The stormwater runoff model indicates that the proposed site development reduces the rate of runoff during all storm events at the identified Study Points. The following tables provide a summary of the estimated peak rate, in cubic feet per second (CFS) at each of the Study Points for each of the design storm events. The HydroCAD worksheets are included in Section 4 and 5 of this report.

STUDY POINT #1 (Flow to 4 Forge Parkway property)				
	2-Year	10-Year	25-Year	100-Year
Existing Flow (CFS)	0.17	0.26	0.34	0.67
Proposed Flow (CFS)	0.00	0.00	0.01	0.56
Change (CFS)	**-0.17**	**-0.26**	**-0.33**	**-0.11**

STUDY POINT #2 (Flow to Route 140 right-of-way)				
	2-Year	10-Year	25-Year	100-Year
Existing Flow (CFS)	0.00	0.00	0.00	0.06
Proposed Flow (CFS)	0.00	0.00	0.00	0.02
Change (CFS)	**0.00**	**0.00**	**0.00**	**-0.04**

STUDY POINT #3 (Flow to wetlands)				
	2-Year	10-Year	25-Year	100-Year
Existing Flow (CFS)	0.31	2.22	4.53	10.44
Proposed Flow (CFS)	0.24	1.86	3.54	8.15
Change (CFS)	**-0.07**	**-0.36**	**-0.99**	**-2.29**

MASSDEP Stormwater Performance Standards

The MA DEP Stormwater Management Policy was developed to improve water quality by implementing performance standards for stormwater management. The intent is to implement the stormwater management standards through the review of Notice of Intent filings by the issuing authority (Conservation Commission or DEP). The following section outlines how the proposed Stormwater Management System meets the standards set forth by the Policy.

BMP's implemented in the design include:

- Deep Sump Catch Basins
- Proprietary water quality devices
- Stormtech MC-3500 Infiltration System
- Stormtech SC-740 Infiltration System
- Bioretention System
- Outlet Control Structure

Stormwater Best Management Practices (BMP's) have been incorporated into the design of the project to mitigate the anticipated pollutant loading. An Operations and Maintenance Plan has been developed for the project, which addresses the long-term maintenance requirements of the proposed system.

Temporary erosion and sedimentation controls will be incorporated into the construction phase of the project. These temporary controls may include tubular silt barriers, inlet sediment traps, slope stabilization, and stabilized construction entrances.

The Massachusetts Department of Environmental Protection has established ten (10) Stormwater Management Standards. A project that meets or exceeds the standards is presumed to satisfy the regulatory requirements regarding stormwater management. The Standards are enumerated below as well as descriptions and supporting calculations as to how the Project will comply with the Standards:

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

   The proposed development will not introduce any new outfalls with direct discharge to a wetland area or waters of the Commonwealth of Massachusetts. All discharges will be treated for water quality and the rate will not be increased over existing conditions.

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

   The proposed development has been designed so that the post-development peak discharge rates do not exceed the predevelopment peak discharge rates. A summary of the existing and proposed discharge rates is included within this document.

3. *Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This 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 existing annual recharge for the site has been approximated in the proposed condition. The proposed subsurface infiltration systems are designed to meet this requirement. Stormwater runoff generated from the impervious areas of the proposed development are routed through the Stormtech MC-3500 and SC-740 chamber infiltration systems. The proposed Recharge Volume is based on the Static Method per the MA DEP Stormwater Management Standards, Volume 3, Chapter 1. See the appendix located in section 6 of this report for stormwater recharge calculations.

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

   Standard #4 is met when structural stormwater best management practices are sized to capture and treat the required water quality volume and pretreatment is provided in accordance with the Massachusetts Stormwater Handbook. Standard #4 also requires that suitable source control measures are identified in the Long-term Pollution Prevention Plan. The water quality volume for the site development is captured and treated using proprietary water quality devices, the Stormtech MC-3500 and SC-740 chamber infiltration systems, and the bioretention system.

   The implemented BMPs have been designed to treat the contributing water quality volume. These water quality calculations can be seen within the appendix of this report.

   The proposed stormwater management system has been designed to remove greater than 80% of the average annual post-construction load for each treatment train. The TSS removal calculations can be seen within the appendix of this report.

5. *For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53 and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.*

   The site is not considered a land use with higher potential pollutant loads..

6. *Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to*

   Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "storm water discharge" as defined in 314 CMR 3.04(2)(a)1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of a public water supply.

   The project site does not discharge stormwater within a Zone II or Interim Wellhead Protection Area or near a critical area. Critical Areas are Outstanding Resource Waters as designated in 314 CMR 4.00, Special Resource Waters as designated in 314 CMR 4.00, recharge areas for public water supplies as defined in 310 CMR 22.02, bathing beaches as defined in 105 CMR 445.000, cold-water fisheries as defined in 314 CMR 9.02 and 310 CMR 10.04, and shellfish growing areas as defined in 314 CMR 9.02 and 310 CMR 10.04.

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

   The proposed project is not considered a re-development project under the Stormwater Management Handbook guidelines as there is an increase in the amount of impervious area.

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

   A plan to control construction-related impacts, including erosion, sedimentation and other pollutant sources during construction has been developed. A detailed Site Preparation Plan in the Permit Drawings has been prepared, outlining the erosion and sedimentation controls to be used. The proponent will prepare and submit a Stormwater Pollution Prevention Plan (SWPPP) prior to commencement of construction activities that will result in the disturbance of one acre of land or more.

9. *A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.*

   A Long-Term Operation & Maintenance (O&M) Plan has been developed for the proposed stormwater management system and is included within this document. See Section 2.0 of this report.

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

    There are no expected illicit discharges to the stormwater management system.

See the following pages for the MassDEP Stormwater Checklist.

Town of Franklin Stormwater Management Bylaw Standards

In addition to the MassDEP Stormwater Standards, the Town of Franklin has established its own Stormwater Management Bylaw, the standards of which are outlined in Section 153-16 of the General Legislation Bylaws. In addition to requiring that project's meet federal and state requirements, including the MassDEP Stormwater Standards above, the Stormwater Management Bylaw requires that all stormwater management systems for new developments shall be designed to:

(a) Retain the volume of runoff equivalent to one inch multiplied by the impervious surface on the site.

The project proposes to increase the impervious area on site by 97,622 square feet. One inch over this area is 8,132 cubic feet. The two systems that use infiltration provide a total of 13,205 cubic feet of storage below the lowest overflow outlet. This standard is met.

(b) Remove 90% of the average annual load of total suspended solids (TSS) and 60% of the average annual load of total phosphorus (TP)

Stormwater runoff from the proposed parking lot will be treated by the various BMPs described above prior to discharge to the subsurface infiltration systems. The subsurface infiltration systems have been designed to infiltrate a volume that far exceeds the Water Quality Volume. The treatment provided by the combination of these BMPs exceeds 90% TSS removal. TSS removal calculations can be found in the appendix of this report. Phosphorus removal is provided by the infiltration systems. As mentioned above, the infiltration systems are designed to infiltrate a volume that far exceeds the Water Quality Volume. The systems have been designed such that **all** runoff from the 2-year storm event is infiltrated. The MassDEP Stormwater handbook, Volume 2, Chapter 2 specifies that infiltration basins provide between 60% and 70% phosphorus removal. Therefore, this requirement is met.

MASSDEP Stormwater Checklist

Checklist for Stormwater Report

A. Introduction

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

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

The Stormwater Report must include:

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

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

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

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

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

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

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

02-01-24

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.

SECTION 2.0 -
OPERATION & MAINTENANCE PLAN

Introduction

In accordance with the standards set forth by the Stormwater Management Policy issued by the Massachusetts Department of Environmental Protection (MassDEP), Allen & Major Associates, Inc. has prepared the following Operations & Maintenance (O&M) Plan for the development at 6 Forge Parkway, Franklin, Massachusetts.

The plan is broken down into three major sections. The first section describes construction-related erosion and sedimentation controls (Demolition & Construction Maintenance Plan). The second section describes the long-term pollution prevention measures (Long Term Pollution Prevention Plan). The third section is a post-construction operation and maintenance plan designed to address the long-term maintenance needs of the stormwater management system (Long-Term Maintenance Plan – Facilities Description).

Notification Procedures for Change of Responsibility for O&M

The Stormwater Management System (SMS) for this project is owned by Donegal LLC (owner). The owner shall be legally responsible for the long-term operation and maintenance of this SMS as outlined in this Operation and Maintenance Plan.

The owner shall submit an annual summary report and the completed Operation & Maintenance Schedule & Checklist to the DPW and Conservation Commission (via email or print copy), highlighting inspection and maintenance activities including performances of BMPs. Should ownership of the SMS change, the owner will continue to be responsible until the succeeding owner has notified the Commission that the succeeding owner has assumed such responsibility. Upon subsequent transfers, the responsibility shall continue to be that of transferring owner until the transferee owner notifies the Commission of its assumption of responsibility. The owner must notify the Director of Public Works of changes in ownership or assignment of financial responsibility.

In the event the SMS will serve multiple lots/owners, such as the subdivision of the existing parcel or creation of lease areas, the owner(s) shall establish an association on other legally enforceable arrangements under which the association or a single party shall have legal responsibility for the operation and maintenance of the entire SMS. The legal instrument creating such responsibility shall be recorded with the Registry of Deeds and promptly following its recording, a copy thereof shall be furnished to the Commission.

Contact Information

Stormwater Management System Owner:	Donegal LLC PO Box 4430 Manchester, NH 03108 Phone: (603) 623-8811

Owner Signature

____

____
Date

Emergency Contact Information:

Donegal LLC (Owner/Operator)	Phone: (603) 623-8811
Allen & Major Associates, Inc. (Site Civil Engineer)	Phone: (603) 627-5500
Franklin Department of Public Works	Phone: (508) 553-5500
Franklin Conservation Commission	Phone: (508) 520-4929
Franklin Fire Department (non-emergency line)	Phone: (508) 528-2323
MassDEP Emergency Response	Phone: (888) 304-1133
Clean Harbors Inc (24-Hour Line)	Phone: (800) 645-8265

Demolition & Construction Maintenance Plan

1. Call Digsafe: 1-888-344-7233
2. Contact the Town at least three (3) days prior to start of demolition and/or construction activities.
3. Install Erosion Control measures as shown on the Site Preparation Plan prepared by A&M. The Town shall review the installation of catch basin filters and tubular barrier protection prior to the start of any site demolition work. Install Construction fencing if determined to be necessary at the commencement of construction.
4. Install construction entrances, catch basin filters, and tubular sediment barriers at the locations shown on the Site Preparation Plan prepared by A&M.
5. Site access shall be achieved only from the designated construction entrances.
6. Cut and clear trees in construction areas only (within the limit of work; see plans).

7. Stockpiles of materials subject to erosion shall be stabilized with erosion control matting or temporary seeding whenever practicable, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased.
8. Install silt sacks at each drain inlet prior to any demolition and or construction activities.
9. All erosion control measures shall be inspected weekly and after every rainfall event. Records of these inspections shall be kept on-site for review.
10. All erosion control measures shall be maintained, repaired, or replaced as required or at the direction of the owner's engineer or the Town.
11. Sediment accumulation up-gradient of the tubular sediment barriers greater than 6" in depth shall be removed and disposed of in accordance with all applicable regulations.
12. If it appears that sediment is exiting the site, silt sacks shall be installed in all catch basins adjacent to the site. Sediment accumulation on all adjacent catch basin inlets shall be removed and the silt sack replaced if torn or damaged.
13. Install stone check dams on-site during construction as needed. Refer to the erosion control details. Temporary sediment basins combined with stone check dams shall be installed on-site during construction to control and collect runoff from upland areas of this site during demolition and construction activities.
14. The contractor shall comply with the Sedimentation and Erosion Control Notes as shown on the Site Development Plans and Specifications.
15. The stabilized construction entrances shall be inspected weekly and records of inspections kept. The entrances shall be maintained by adding additional clean, angular, durable stone to remove the soil from the construction vehicle's tires when exiting the site. If soil is still leaving the site via the construction vehicle tires, adjacent roadways shall be kept clean by street sweeping.
16. Dust pollution shall be controlled using on-site water trucks and/or an approved soil stabilization product.
17. During demolition and construction activities, Status Reports on compliance with this O&M Document shall be submitted weekly. The report shall document any deficiencies and corrective actions taken by the applicant.

Long-Term Pollution Prevention Plan
Standard #4 from the MassDEP Stormwater Management Handbook requires that a Long-Term Pollution Prevention Plan (LTPPP) be prepared and incorporated as part of the Operation and Maintenance Plan of the Stormwater Management System. The purpose of the LTPPP is to identify potential sources of pollution that may affect the quality of stormwater discharges, and to describe the implementation of practices to reduce the pollutants in stormwater discharges. The following items describe the source control and proper procedures of the LTPPP.

- Housekeeping
  The existing development has been designed to maintain a high level of water quality treatment for all stormwater discharge to the wetland areas. An Operation and Maintenance (O&M) plan has been prepared and is included in this section of the report. The owner (or its designee) is responsible for adherence to the O&M plan in a strict and complete manner.

- Storing of Materials & Water Products
  The trash and waste program for the site includes exterior dumpsters. There is a trash contractor used to pick up the waste material in the dumpsters. The stormwater drainage system has water quality inlets designed to capture trash and debris.
- Vehicle Washing
  Outdoor vehicle washing has the potential to result in high loads of nutrients, metals, and hydrocarbons during dry weather conditions, as the detergent-rich water used to wash the grime off the vehicle enters the stormwater drainage system. The existing development does not include any designated vehicle washing areas, nor is it expected that any vehicle washing will take place on-site.
- Spill Prevention & Response
  Sources of potential spill hazards include vehicle fluids, liquid fuels, pesticides, paints, solvents, and liquid cleaning products. The majority of the spill hazards would likely occur within the buildings and would not enter the stormwater drainage system. However, there are spill hazards from vehicle fluids or liquid fuels located outside of the buildings. These exterior spill hazards have the potential to enter the stormwater drainage system and are to be addressed as follows:
  1. Spill hazards of pesticides, paints, and solvents shall be remediated using the Manufacturers' recommended spill cleanup protocol.
  2. Vehicle fluids and liquid fuel spill shall be remediated according to the local and state regulations governing fuel spills.
  3. The owner shall have the following equipment and materials on hand to address a spill clean-up: brooms, dust pans, mops, rags, gloves, absorptive material, sand, sawdust, plastic and metal trash containers.
  4. All spills shall be cleaned up immediately after discovery.

  5. Spills of toxic or hazardous material shall be reported, regardless of size, to the Massachusetts Department of Environmental Protection at (888) 304-1333.
  6. Should a spill occur, the pollution prevention plan will be adjusted to include measures to prevent another spill of a similar nature. A description of the spill, along with the causes and cleanup measures will be included in the updated pollution prevention plan.

- Maintenance of Lawns, Gardens, and Other Landscaped Areas
  It should be recognized that this is a general guideline towards achieving high quality and well-groomed landscaped areas. The grounds staff/landscape contractor must recognize the shortcomings of a general maintenance plan such as this, and modify and/or augment it based on weekly, monthly, and yearly observations. In order to assure the highest quality conditions, the staff must also recognize and appreciate the need to be aware of the constantly changing conditions of the landscaping and be able to respond to them on a proactive basis. No trees shall be planted over the drain lines or recharge area, and that only shallow rooted plants and shrubs will be allowed.
  - Fertilizer
    Maintenance practices should be aimed at reducing environmental, mechanical and pest stresses to promote healthy and vigorous growth. When necessary, pest outbreaks should be treated with the most sensitive control measure available. Synthetic chemical controls should be used only as a last resort to organic and biological control methods. Fertilizer, synthetic chemical controls and pest management applications (when necessary) shall be performed only by licensed applicators in accordance with the manufacturer's label instructions when environmental conditions are conducive to controlled product application.

    Only slow-release organic fertilizers should be used in the planting and mulch areas to limit the amount of nutrients that could enter downstream resource areas. Fertilization of the planting and mulch areas will be performed within manufacturers labeling instructions and shall not exceed an NPK ration of 1:1:1 (i.e. Triple 10 fertilizer mix), considered a low nitrogen mixture. Fertilizers approved for the use under this O&M Plan are as follows:

    Type: LESCO® 28-0-12 (Lawn Fertilizer)
    MERIT® 0.2 Plus Turf Fertilizer
    MOMENTUM™ Force Weed & Feed
  - Suggested Aeration Program
    In-season aeration of lawn areas is good cultural practice, and is recommended whenever feasible. It should be accomplished with a solid thin tine aeration method to reduce disruption to the use of the area. The depth of solid tine aeration is similar to core type, but should be performed when the soil is somewhat drier for a greater overall effect.

    Depending on the intensity of use, it can be expected that all landscaped lawn areas will need aeration to reduce compaction at least once per year. The first operation should occur in late May following the spring season. Methods of reducing compaction will vary based on the nature of the compaction. Compaction on newly established landscaped areas is generally limited to the top 2-3" and can be alleviated using hollow core or thin tine aeration methods.

The spring aeration should consist of two passes at opposite directions with 1/4" hollow core tines penetrating 3-5" into the soil profile. Aeration should occur when the soil is moist but not saturated. The soil cores should be shattered in place and dragged or swept back into the turf to control thatch. If desired the cores may also be removed and the area top-dressed with sand or sandy loam. If the area drains on average too slowly, the topdressing should contain a higher percentage of sand. If it is draining on average too quickly, the top dressing should contain a higher percentage of soil and organic matter.

- Landscape Maintenance Program Practices:
  - Lawn
    1. Mow a minimum of once a week in spring, to a height of 2" to 2 1/2" high. Mowing should be frequent enough so that no more than 1/3 of grass blade is removed at each mowing. The top growth supports the roots; the shorter the grass is cute, the less the roots will grow. Short cutting also dries out the soil and encourages weeds to germinate.
    2. Mow approximately once every two weeks from July 1st to August 15th depending on lawn growth.
    3. Mow on a ten-day cycle in fall, when growth is stimulated by cooler nights and increased moisture.
    4. Do not remove grass clippings after mowing.
    5. Keep mower blades sharp to prevent ragged cuts on grass leaves, which cause a brownish appearance and increase the chance for disease to enter a leaf.
  - Shrubs
    1. Mulch not more than 3" depth with shredded pine or fir bark.
    2. Hand prune annually, immediately after blooming, to remove 1/3 of the above-ground biomass (older stems). Stem removals are to occur within 6" of the ground to open up shrub and maintain two-year wood (the blooming wood).
    3. Hand-prune evergreen shrubs only as needed to remove dead and damaged wood and to maintain the naturalistic form of the shrub. Never mechanically shear evergreen shrubs.
  - Trees
    1. Provide aftercare of new tree plantings for the first three years.

    2. Do not fertilize trees, it artificially stimulates them (unless tree health warrants).
    3. Water once a week for the first year; twice a month for the second; once a month for the third year.
    4. Prune trees on a four-year cycle.
  - Invasive Species
    1. Inform the Conservation Commission Agent prior to the removal of invasive species proposed either through hand work or through chemical removal.

- Storage and Use of Herbicides and Pesticides

Integrated Pest Management is the combination of all methods (of pest control) which may prevent, reduce, suppress, eliminate, or repel an insect population. The main requirements necessary to support any pest population are food, shelter and water, and any upset of the balance of these will assist in controlling a pest population. Scientific pest management is the knowledgeable use of all pest control methods (sanitation, mechanical, chemical) to benefit mankind's health, welfare, comfort, property and food. A Pest Management Professional (PMP) should be retained who is licensed with the Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, Department of Agricultural Resources.

The site manager will be provided with approved bulletin before entering into or renewing an agreement to apply pesticides for the control of indoor household or structural pests, refer to 333 CMR 13.08.

Before beginning each application, the applicator must post a Department approved notice on all of the entrances to the treated room or area. The applicator must leave such notices posted after the application. The notice will be posted at conspicuous point(s) of access to the area treated. The location and number of signs will be determined by the configuration of the area to be treated based on the applicator's best judgment. It is intended to give sufficient notice so that no one comes into an area being treated unaware that the applicator is working and pesticides are being applied. However, if the contracting entity does not want the signs posted, he/she may sign a Department approved waiver indicating this.

The applicator or employer will provide to any person upon their request the following information on previously conducted applications:

1. Name and phone number of pest control company;
2. Date and time of the application;
3. Name and license number of the applicator;
4. Target pests; and
5. Name and EPA Registration Number of pesticide products applied.

- Pet Waste Management
  The owner's landscape crew (or designee) shall remove any obvious pet waste that has been left behind by pet owners within the development. The pet waste shall be disposed of in accordance with local and state regulations.
- Operations and Management of Septic Systems
  There are no proposed septic systems within the limits of the project.
- Management of Deicing Chemicals and Snow
  Snow will be stockpiled on site until the accumulated snow becomes a hazard to the daily operations of the site. It will be the responsibility of the snow removal contractor to properly dispose of transported snow according to MassDEP, Bureau of Resource Protection – Snow Disposal Guideline #BRPG01-01, governing the proper disposal of snow. It will be the responsibility of the snow removal contractor to follow these guidelines and all applicable laws and regulations

  The owner's maintenance staff (or its designee) will be responsible for the clearing of the sidewalk and building entrances. The owner may be required to use a de-icing agent such as potassium chloride to maintain a safe walking surface. If used, the de-icing agent for the walkways and building entrances will be kept within the storage rooms located within the building. If used, de-icing agents will not be stored outside. The owner's maintenance staff will limit the application of sand.

Long-Term Maintenance Plan – Facilities Description
A maintenance log will be kept (i.e. report) summarizing inspections, maintenance, and any corrective actions taken. The log will include the date on which each inspection or maintenance task was performed, a description of the inspection findings or maintenance completed, and the name of the inspector or maintenance personnel performing the task. If a maintenance task requires the clean-out of any sediments or debris, the location where the sediment and debris was disposed after removal will be indicated. The log will be made accessible to department staff and a copy provided to the department upon request.

The following is a description of the Stormwater Management System for the project site.

Stormwater Collection System:

The stormwater collection system on site is composed of a series of catch basins, proprietary water quality devices, drainage conveyance pipe, Stormtech MC-3500 infiltration system, Stormtech SC-740 infiltration system, bioretention system, and outlet control structure. All the proposed on-site catch basins incorporate a deep sump and hooded outlet. The proposed catch basins and proprietary water quality devices are connected by a closed gravity pipe network that routes stormwater to the MC-3500 infiltration system for treatment prior to discharge.

Structural Pretreatment BMPs: Regular maintenance of these BMPs is especially critical because they typically receive the highest concentration of suspended solids during the first flush of a storm event.

- Deep Sump Catch Basin:
  There are various catch basins located throughout the project site, both existing and proposed. Each catch basin unit shall be inspected four times per year. These units should be cleaned at each inspection or when the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.

- Proprietary water quality devices:
  Inspect all hydrodynamic separators with the same frequency as catch basins. Remove sediment when the isolated sump has reached 75% of its capacity. Refer to the manufacturer's Maintenance Guide for additional information.

- Rain Guardian - Turret:
  The Rain Guardian Turret is a concrete curb-inlet device that discharges to the bioretention system. It is recommended that the Rain Guardian - Turret be inspected at least twice per year. If observed, remove trash and debris at each inspection. Replace the grate if damaged.
- Outlet Control Structure:
  The outlet control structure shall be inspected periodically, at least annually; remove debris and sediment when encountered. Review that the structure's internal weir is functioning properly following any major storm events.
- Outfall Structure (Headwall) & Rip-Rap Aprons:

  The outfall shall be inspected annually. Remove debris, sediment, and woody vegetation when encountered. Repair erosion and scouring by replacing rip-rap and/or regrading. Regrade outfall to be level if channelization occurs.

Infiltration BMPs:

- Subsurface Structure – Stormtech MC-3500 and SC-740 Chamber Systems:
  Inspect the catch basins that inlet to the subsurface infiltration system as recommended to ensure no trash or debris is entering the system. JetVac maintenance is recommended if sediment within the isolator row has been collected to an average depth of 3".

Other Maintenance Activity:

- Mosquito Control:
  Both above ground and underground stormwater BMPs have the potential to serve as mosquito breeding areas. Good design, proper operation and maintenance, and treatment with larvicides can minimize this potential. See the supplemental information for Mosquito Control in Stormwater Management Practices, and the Operation and Maintenance Plan Schedule for inspection schedule.

- Street Sweeping:
  Clear accumulations of winter sand in parking lots and along roadways at least once a year, preferably in the spring. Accumulations on pavement may be removed by pavement sweeping. Accumulations of sand along road shoulders may be removed by grading excess sand to the pavement edge and removing it manually or by a front-end loader.

Inspection and Maintenance Frequency and Corrective Measures
In accordance with MA DEP Stormwater Handbook: Volume 2, Chapter 2; the previously described BMPs will be inspected and the identified deficiencies will be corrected. Clean-out must include the removal and legal disposal of any accumulated sediments, trash, and debris. In any and all cases, operations, inspections, and maintenance activities shall utilize best practical measures to avoid and minimize impacts to wetland resource areas outside the footprint of the SMS.

Supplemental Information
- Operation & Maintenance Plan Schedule
- Massachusetts Stormwater Handbook, Chapter 5, Miscellaneous Stormwater Topics, Mosquito Control in Stormwater Management Practices
- Massachusetts DEP – Snow Disposal Guidance
- Isolator® Row Plus O&M Manual
- CDS Guide, Operation, Design, Performance and Maintenance
- Operation & Maintenance Figure

OPERATION AND MAINTENANCE PLAN SCHEDULE **Date:**

ALLEN & MAJOR ASSOCIATES, INC.

Project: 6 Forge Parkway
Project Address: 6 Forge Parkway, Franklin, MA

Responsible for O&M Plan: Donegal LLC
Address: PO Box 4430, Manchester, NH 03108
Phone: (603) 623-8811

All information within table is derived from Massachussetts Stormwater Handbook: Volume 2, Chapter 2

BMP CATEGORY	BMP OR MAINTENANCE ACTIVITY	SCHEDULE/ FREQUENCY	NOTES	ESTIMATED ANNUAL MAINTENANCE COST	INSPECTION PERFORMED	
					DATE:	BY:
STRUCTURAL PRETREATMENT BMPs	DEEP SUMP CATCH BASIN & PROPRIETARY WATER QUALITY DEVICES	Four times per year (quarterly).	Inspect and clean catch basin units whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.	$1,000		
	RAIN GUARDIANS & OUTLET STRUCTURES	Periodic cleaning of Structures as needed.	Clear trash and debris as necessary.	$500		
	OUTFALL STRUCTURE (HEADWALL) & RIP-RAP APRON	Annual inspection	Remove sediment and debris. Remove woody vegetaion. Repair erosion and scouring. Replace rip-rap. Regrade outfall to be level if channelization occurs.	$500		
INFILTRATION BMPs	SUBSURFACE STRUCTURES	Inspect structure inlets at least twice a year. Remove debris that may clog the system as needed.	Because subsurface structures are installed underground, they are extremely difficult to maintain. Remove any debris that might clog the system.	$1,000		
OTHER MAINTENANCE ACTIVITY	MISQUITO CONTROL	Inspect BMPs as needed to ensure the system's drainage time is less than the maximum 72 hour period.	Massachusetts stormwater handbook requires all stormwater practices that are designed to drain do so within 72 hours to reduce the number of mosquitos that mature to adults since the aquatic stage of a mosquito is 7-10 days.	$200		
	SNOW STORAGE	Clear and remove snow to approved storage locations as necessary to ensure systems are working properly and are protected from meltwater pollutants.	Carefully select snow disposal sites before winter. Avoid dumping removed snow over catch basins, or in detention ponds, sediment forebays, rivers, wetlands, and flood plains. It is also prohibited to dump snow in the bioretention basins or gravel swales.	$500		
	STREET SWEEPING	Clear accumulations of winter sand in parking lots and along roadways at least once a year, preferably in the spring.	Sweep, power broom or vacuum paved areas. Submit information that confirms that all street sweepings have been completed in accordance with state and local requirements	$1,500		

Chapter 5
Miscellaneous Stormwater Topics

Mosquito Control in Stormwater Management Practices

Both aboveground and underground stormwater BMPs have the potential to serve as mosquito breeding areas. Good design, proper operation and maintenance and treatment with larvicides can minimize this potential.

EPA recommends that stormwater treatment practices dewater within 3 days (72 hours) to reduce the number of mosquitoes that mature to adults, since the aquatic stage of many mosquito species is 7 to 10 days. Massachusetts has had a 72-hour dewatering rule in its Stormwater Management Standards since 1996. The 2008 technical specifications for BMPs set forth in Volume 2, Chapter 2 of the Massachusetts Stormwater Handbook also concur with this practice by requiring that all stormwater practices designed to drain do so within 72 hours.

Some stormwater practices are designed to include permanent wet pools. These practices – if maintained properly – can limit mosquito breeding by providing habitat for mosquito predators. Additional measures that can be taken to reduce mosquito populations include increasing water circulation, attracting mosquito predators by adding suitable habitat, and applying larvicides.

The Massachusetts State Reclamation and Mosquito Control Board (SRMCB), through the Massachusetts Mosquito Control Districts, can undertake further mosquito control actions specifically for the purpose of mosquito control pursuant to Massachusetts General Law Chapter 252. The Mosquito Control Board, http://www.mass.gov/agr/mosquito/, describes mosquito control methods and is in the process of developing guidance documents that describe Best Management Practices for mosquito control projects.

The SRMCB and Mosquito Control Districts are not responsible for operating and maintaining stormwater BMPs to reduce mosquito populations. The owners of property that construct the stormwater BMPs or municipalities that "accept" them through local subdivision approval are responsible for their maintenance.[1] The SRMCB is composed of officials from MassDEP, Department of Agricultural Resources, and Department of Conservation and Recreation. The nine (9) Mosquito Control Districts overseen by the SRMCB are located throughout Massachusetts, covering 176 municipalities.

<u>Construction Period Best Management Practices for Mosquito Control</u>

To minimize mosquito breeding during construction, it is essential that the following actions be taken to minimize the creation of standing pools by taking the following actions:

- ***Minimize Land Disturbance:*** Minimizing land disturbance reduces the likelihood of mosquito breeding by reducing silt in runoff that will cause construction period controls to clog and retain standing pools of water for more than 72 hours.
- ***Catch Basin inlets:*** Inspect and refresh filter fabric, hay bales, filter socks or stone dams on a regular basis to ensure that any stormwater ponded at the inlet drains within 8 hours after precipitation stops. Shorter periods may be necessary to avoid hydroplaning in roads

[1] MassDEP and MassHighway understand that the numerous stormwater BMPs along state highways pose a unique challenge. To address this challenge, the 2004 MassHighway Stormwater Handbook will provide additional information on appropriate operation and maintenance practices for mosquito control when the Handbook is revised to reflect the 2008 changes to the Stormwater Management Standards..

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caused by water ponded at the catch basin inlet. Treat catch basin sumps with larvicides such as *Bacillus sphaericus* (*Bs*) using a licensed pesticide applicator.

- ***Check Dams:*** If temporary check dams are used during the construction period to lag peak rate of runoff or pond runoff for exfiltration, inspect and repair the check dams on a regular basis to ensure that any stormwater ponded behind the check dam drains within 72 hours.
- ***Design construction period sediment traps*** to dewater within 72 hours after precipitation. Because these traps are subject to high silt loads and tend to clog, treat them with the larvicide *Bs* after it rains from June through October, until the first frost occurs.
- ***Construction period open conveyances:*** When temporary manmade ditches are used for channelizing construction period runoff, inspect them on a regular basis to remove any accumulated sediment to restore flow capacity to the temporary ditch.
- ***Revegetating Disturbed Surfaces:*** Revegetating disturbed surfaces reduces sediment in runoff that will cause construction period controls to clog and retain standing pools of water for greater than 72 hours.
- ***Sediment fences/hay bale barriers:*** When inspections find standing pools of water beyond the 24-hour period after a storm, take action to restore barrier to its normal function.

<u>Post-Construction Stormwater Treatment Practices</u>

- Mosquito control begins with the environmentally sensitive site design. Environmentally sensitive site design that minimizes impervious surfaces reduces the amount of stormwater runoff. Disconnecting runoff using the LID Site Design credits outlined in the Massachusetts Stormwater Handbook reduces the amount of stormwater that must be conveyed to a treatment practice. Utilizing green roofs minimizes runoff from smaller storms. Storage media must be designed to dewater within 72 hours after precipitation.
- Mosquito control continues with the selection of structural stormwater BMPs that are unlikely to become breeding grounds for mosquitoes, such as:
  - ***Bioretention Areas/Rain Gardens/Sand Filter:*** These practices tend not to result in mosquito breeding. If any level spreaders, weirs or sediment forebays are used as part of the design, inspect them and correct them as necessary to prevent standing pools of water for more than 72 hours.
  - ***Infiltration Trenches:*** This practice tends not to result in mosquito breeding. If any level spreaders, weirs, or sediment forebays are used as part of the design, inspect them and correct them as necessary to prevent standing pools of water for more than 72 hours.
- Another mosquito control strategy is to select BMPs that can become habitats for mosquito predators, such as:
  - ***Constructed Stormwater Wetlands:*** Habitat features can be incorporated in constructed stormwater wetlands to attract dragonflies, amphibians, turtles, birds, bats, and other natural predators of mosquitoes.
  - ***Wet Basins:*** Wet basins can be designed to incorporate fish habitat features, such as deep pools. Introduce fish in consultation with Massachusetts Division of Fisheries and Wildlife. Vegetation within wet basins designed as fish habitat must be properly managed to ensure that vegetation does not overtake the habitat. Proper design to ensure that no low circulation or "dead" zones are created may reduce the potential for mosquito breeding. Introducing bubblers may increase water circulation in the wet basin.

Effective mosquito controls require proponents to design structural BMPs to prevent ponding and facilitate maintenance and, if necessary, the application of larvicides. Examples of such design practices include the following:

- ***Basins:*** Provide perimeter access around wet basins, extended dry detention basins and dry detention basins for both larviciding and routine maintenance. Control vegetation to ensure that access pathways stay open.
- ***BMPs without a permanent pool of water:*** All structural BMPs that do not rely on a permanent pool of water must drain and completely dewater within 72 hours after precipitation. This includes dry detention basins, extended dry detention basins, infiltration basins, and dry water quality swales. Use underdrains at extended dry detention basins to drain the small pools that form due to accumulation of silts. Wallace indicates that extended dry extended detention basins may breed more mosquitoes than wet basins. It is, therefore, imperative to design outlets from extended dry detention basins to completely dewater within the 72-hour period.
- ***Energy Dissipators and Flow Spreaders:*** Currier and Moeller, 2000 indicate that shallow recesses in energy dissipators and flow spreaders trap water where mosquitoes breed. Set the riprap in grout to reduce the shallow recesses and minimize mosquito breeding.
- ***Outlet control structures:*** Debris trapped in small orifices or on trash racks of outlet control structures such as multiple stage outlet risers may clog the orifices or the trash rack, causing a standing pool of water. Optimize the orifice size or trash rack mesh size to provide required peak rate attenuation/water quality detention/retention time while minimizing clogging.
- ***Rain Barrels and Cisterns:*** Seal lids to reduce the likelihood of mosquitoes laying eggs in standing water. Install mosquito netting over inlets. The cistern system should be designed to ensure that all collected water is drained into it within 72 hours.
- ***Subsurface Structures, Deep Sump Catch Basins, Oil Grit Separators, and Leaching Catch Basins:*** Seal all manhole covers to reduce likelihood of mosquitoes laying eggs in standing water. Install mosquito netting over the outlet (CALTRANS 2004).

The Operation and Maintenance Plan should provide for mosquito prevention and control.

- ***Check dams:*** Inspect permanent check dams on the schedule set forth in the O&M Plan. Inspect check dams 72 hours after storms for standing water ponding behind the dam. Take corrective action if standing water is found.
- ***Cisterns:*** Apply *Bs* larvicide in the cistern if any evidence of mosquitoes is found. The Operation and Maintenance Plan shall specify how often larvicides should be applied to waters in the cistern.
- ***Water quality swales:*** Remove and properly dispose of any accumulated sediment as scheduled in the Operation and Maintenance Plan.
- ***Larvicide Treatment:*** The Operation and Maintenance Plan must include measures to minimize mosquito breeding, including larviciding.
- The party identified in the Operation and Maintenance Plan as responsible for maintenance shall see that larvicides are applied as necessary to the following stormwater treatment practices: catch basins, oil/grit separators, wet basins, wet water quality swales, dry extended detention basins, infiltration basins, and constructed stormwater wetlands. The Operation and Maintenance Plan must ensure that all larvicides are applied by a licensed pesticide applicator and in compliance with all pesticide label requirements.
- The Operation and Maintenance Plan should identify the appropriate larvicide and the time and method of application. For example, *Bacillus sphaericus (Bs*), the preferred

larvicide for stormwater BMPs, should be hand-broadcast.[2] Alternatively, Altosid, a Methopren product, may be used. Because some practices are designed to dewater between storms, such as dry extended detention and infiltration basins, the Operation and Maintenance Plan should provide that larviciding must be conducted during or immediately after wet weather, when the detention or infiltration basin has a standing pool of water, unless a product is used that can withstand extended dry periods.

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[2] *Bacillus thuringienis israelensis* or *Bti* is usually applied by helicopter to wetlands and floodplains

Roads and Stormwater BMPs

In general, the stormwater BMPs used for land development projects can also be used for new roadways and roadway improvement projects. However, for improvement of existing roads, there are often constraints that limit the choice of BMP. These constraints derive from the linear configuration of the road, the limited area within the existing right-of-way, the structural and safety requirements attendant to good roadway design, and the long-term maintainability of the roadway drainage systems. The MassHighway Handbook provides strategies for dealing with the constraints associated with providing stormwater BMPs for roadway redevelopment projects.

Roadway design can minimize impacts caused by stormwater. Reducing roadway width reduces the total and peak volume of runoff. Designing a road with country drainage (no road shoulders or curbs) disconnects roadway runoff. Disconnection of roadway runoff is eligible for the Low Impact Site Design Credit provided the drainage is disconnected in accordance with specifications outlined in Volume 3.

Like other parties, municipalities that work within wetlands jurisdictional areas and adjacent buffer zones must design and implement structural stormwater best management practices in accordance with the Stormwater Management Standards and the Stormwater Management Handbook. In addition, in municipalities and areas where state agencies operate stormwater systems, the DPWs (or other town or state agencies) must meet the "good housekeeping" requirement of the municipality's or agency's MS4 permit.

MassHighway has taken stormwater management one step further by working with MassDEP to develop the MassHighway Storm Water Handbook for Highways and Bridges. The purpose of the MassHighway Handbook is to provide guidance for persons involved in the design, permitting, review and implementation of state highway projects, especially those involving existing roadways where physical constraints often limit the stormwater management options available. These constraints, like those common to redevelopment sites, may make it difficult to comply precisely with the requirements of the Stormwater Management Standards and the Massachusetts Stormwater Handbook.[3] In response to these constraints, MassDEP and MHD developed specific design, permitting, review and implementation practices that meet the unique challenges of providing environmental protection for existing state roads. The information in the MassHighway Handbook may also aid in the planning and design of projects to build new highways and to add lanes to existing highways, since they may face similar difficulties in meeting the requirements of the Stormwater Management Standards.

Although it is very useful, the MassHighway Handbook does not allow MassHighway projects to proceed without individual review and approval by the issuing authority when subject to the Wetlands Protection Act Regulations, 310 CMR 10.00, or the 401 Water Quality Certification Regulations, 314 CMR 9.00. For example, MassHighway must provide a Conservation Commission with a project-specific Operation and Maintenance Plan in accordance with Standard 9 that documents how the project's post-construction BMPs will be operated and maintained.[4]

[3] The 2004 MassHighway Handbook outlines standardized methods for dealing with these constraints as they apply to highway redevelopment projects. MassDEP and MassHighway intend to work together to provide guidance for add a lane projects when the 2004 Handbook is revised to reflect the 2008 changes to the Stormwater Management Standards.

[4] The general permit for municipal separate storm sewer systems (the MS4 Permit) requires MassHighway to develop and implement procedures for the proper operation and maintenance of stormwater BMPs. To avoid duplication of effort, MassHighway may be able rely on the same procedures to fulfill the operation and maintenance requirements of Standard 9 and the MS 4 Permit.

Some municipalities have asked if the MassHighway Handbook governs municipal road projects. The answer is no.[5] The MassHighway Handbook was developed in response to the unique problems and challenges arising out of the management of the state highway system. Like other project proponents, cities and towns planning road or other projects in areas subject to jurisdiction under the Wetlands Protection Act must design and implement LID, non-structural and structural best management practices in accordance with the Stormwater Management Standards and the Massachusetts Stormwater Handbook.

[5] Although the MassHighway Handbook does not govern municipal road projects, cities and towns may find some of the information presented in the Handbook useful.

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Massachusetts Department of Environmental Protection
Bureau of Water Resources
Snow Disposal Guidance

Effective Date: December 11, 2020

Applicability: Applies to all federal, state, regional and local agencies, as well as to private businesses.

Supersedes: Bureau of Resource Protection (BRP) Snow Disposal Guideline No. BRPG97-1 issued December 12, 1997 and BRPG01-01 issued March 8, 2001; Bureau of Water Resources (BWR) snow disposal guidance issued December 21, 2015 and December 12, 2018.

Approved by: Kathleen Baskin, Assistant Commissioner, Bureau of Water Resources

PURPOSE: To provide guidelines to all government agencies and private businesses regarding snow disposal site selection, site preparation and maintenance, and emergency snow disposal options that are protective of wetlands, drinking water, and water bodies, and are acceptable to the Massachusetts Department of Environmental Protection (MassDEP), Bureau of Water Resources.

APPLICABILITY: These Guidelines are issued by MassDEP's Bureau of Water Resources on behalf of all Bureau Programs (including Drinking Water Supply, Wetlands and Waterways, Wastewater Management, and Watershed Planning and Permitting). They apply to all federal agencies, state agencies, state authorities, municipal agencies and private businesses disposing of snow in the Commonwealth of Massachusetts.

INTRODUCTION

Finding a place to dispose of collected snow poses a challenge to municipalities and businesses as they clear roads, parking lots, bridges, and sidewalks. While MassDEP is aware of the threats to public safety caused by snow, collected snow that is contaminated with road salt, sand, litter, and automotive pollutants such as oil also threatens public health and the environment.

As snow melts, road salt, sand, litter, and other pollutants are transported into surface water or through the soil where they may eventually reach the groundwater. Road salt and other pollutants can contaminate water supplies and are toxic to aquatic life at certain levels. Sand washed into

waterbodies can create sand bars or fill in wetlands and ponds, impacting aquatic life, causing flooding, and affecting our use of these resources.

There are several steps that communities can take to minimize the impacts of snow disposal on public health and the environment. These steps will help communities avoid the costs of a contaminated water supply, degraded waterbodies, and flooding. Everything that occurs on the land has the potential to impact the Commonwealth's water resources. Given the authority of local government over the use of the land, municipal officials and staff have a critically important role to play in protecting our water resources.

The purpose of these guidelines is to help federal agencies, state agencies, state authorities, municipalities and businesses select, prepare, and maintain appropriate snow disposal sites before the snow begins to accumulate through the winter. Following these guidelines and obtaining the necessary approvals may also help municipalities in cases when seeking reimbursement for snow disposal costs from the Federal Emergency Management Agency is possible.

RECOMMENDED GUIDELINES

These snow disposal guidelines address: (1) site selection; (2) site preparation and maintenance; and (3) emergency snow disposal.

1. SITE SELECTION

The key to selecting effective snow disposal sites is to locate them adjacent to or on pervious surfaces in upland areas or upland locations on impervious surfaces away from water resources and drinking water wells. At these locations, the snow meltwater can filter into the soil, leaving behind sand and debris which can be removed in the spring. The following conditions should be followed:

- Within water supply Zone A and Zone II, avoid storage or disposal of snow and ice containing deicing chemicals that has been collected from streets located outside these zones. Municipalities may have a water supply protection land use control that prohibits the disposal of snow and ice containing deicing chemicals from outside the Zone A and Zone II, subject to the Massachusetts Drinking Water Regulations at 310 CMR 22.20C and 310 CMR 22.21(2).
- Avoid storage or disposal of snow or ice in Interim Wellhead Protection Areas (IWPA) of public water supply wells, and within 75 feet of a private well, where road salt may contaminate water supplies.
- Avoid dumping snow into any waterbody, including rivers, the ocean, reservoirs, ponds, or wetlands. In addition to water quality impacts and flooding, snow disposed of in open water can cause navigational hazards when it freezes into ice blocks.
- Avoid dumping snow on MassDEP-designated high and medium-yield aquifers where it may contaminate groundwater.
- Avoid dumping snow in sanitary landfills and gravel pits. Snow meltwater will create more contaminated leachate in landfills posing a greater risk to groundwater, and in gravel pits, there is little opportunity for pollutants to be filtered out of the meltwater because groundwater is close to the land surface.

- Avoid disposing of snow on top of storm drain catch basins or in stormwater drainage systems including detention basins, swales or ditches. Snow combined with sand and debris may block a stormwater drainage system, causing localized flooding. A high volume of sand, sediment, and litter released from melting snow also may be quickly transported through the system into surface water.

Recommended Site Selection Procedures

It is important that the municipal Department of Public Works or Highway Department, Conservation Commission, and Board of Health work together to select appropriate snow disposal sites. The following steps should be taken:

- Estimate how much snow disposal capacity may be needed for the season so that an adequate number of disposal sites can be selected and prepared.
- Identify sites that could potentially be used for snow disposal, such as municipal open space (e.g., parking lots or parks).
- Select sites located in upland locations that are not likely to impact sensitive environmental resources first.
- If more storage space is still needed, prioritize the sites with the least environmental impact (using the site selection criteria, and local or MassGIS maps as a guide).

Snow Disposal Mapping Assistance

MassDEP has an online mapping tool to assist in identifying possible locations to potentially dispose of snow. MassDEP encourages municipalities to use this tool to identify possible snow disposal options. The tool identifies wetland resource areas, public drinking water supplies and other sensitive locations where snow should not be disposed. The tool may be accessed through the Internet at the following web address:
https://maps.env.state.ma.us/dep/arcgis/js/templates/PSF/.

2. SITE PREPARATION AND MAINTENANCE

In addition to carefully selecting disposal sites before the winter begins, it is important to prepare and maintain these sites to maximize their effectiveness. The following maintenance measures should be undertaken for all snow disposal sites:

- A silt fence or equivalent barrier should be placed securely on the downgradient side of the snow disposal site.
- Wherever possible maintain a 50-foot vegetated buffer between the disposal site and adjacent waterbodies to filter pollutants from the meltwater.
- Clear debris from the site prior to using the site for snow disposal.
- Clear debris from the site and properly dispose of it at the end of the snow season, and no later than May 15.

3. SNOW DISPOSAL APPROVALS

Proper snow disposal may be undertaken through one of the following approval procedures:

- Routine snow disposal – Minimal, if any, administrative review is required in these cases when upland and pervious snow disposal locations or upland locations on impervious surfaces that have functioning and maintained stormwater management systems have been identified, mapped, and used for snow disposal following ordinary snowfalls. Use of upland and pervious snow disposal sites avoids wetland resource areas and allows snow meltwater to recharge groundwater and will help filter pollutants, sand, and other debris. This process will address the majority of snow removal efforts until an entity exhausts all available upland snow disposal sites. The location and mapping of snow disposal sites will help facilitate each entity's routine snow management efforts.
- Emergency Certifications – If an entity demonstrates that there is no remaining capacity at upland snow disposal locations, local conservation commissions may issue an Emergency Certification under the Massachusetts Wetlands Protection regulations to authorize snow disposal in buffer zones to wetlands, certain open water areas, and certain wetland resource areas (i.e. within flood plains). Emergency Certifications can only be issued at the request of a public agency or by order of a public agency for the protection of the health or safety of citizens, and are limited to those activities necessary to abate the emergency. See 310 CMR 10.06(1)-(4). Use the following guidelines in these emergency situations:
  - Dispose of snow in open water with adequate flow and mixing to prevent ice dams from forming.
  - Do not dispose of snow in salt marshes, vegetated wetlands, certified vernal pools, shellfish beds, mudflats, drinking water reservoirs and their tributaries, Zone IIs or IWPAs of public water supply wells, Outstanding Resource Waters, or Areas of Critical Environmental Concern.
  - Do not dispose of snow where trucks may cause shoreline damage or erosion.
  - Consult with the municipal Conservation Commission to ensure that snow disposal in open water complies with local ordinances and bylaws.
- Severe Weather Emergency Declarations – In the event of a large-scale severe weather event, MassDEP may issue a broader Emergency Declaration under the Wetlands Protection Act which allows federal agencies, state agencies, state authorities, municipalities, and businesses greater flexibility in snow disposal practices. Emergency Declarations typically authorize greater snow disposal options while protecting especially sensitive resources such as public drinking water supplies, vernal pools, land containing shellfish, FEMA designated floodways, coastal dunes, and salt marsh. In the event of severe winter storm emergencies, the snow disposal site maps created by municipalities will enable MassDEP and the Massachusetts Emergency Management Agency (MEMA) in helping communities identify appropriate snow disposal locations.

  If upland disposal sites have been exhausted, the Emergency Declaration issued by MassDEP allows for snow disposal near water bodies. In these situations, a buffer of at least 50 feet, preferably vegetated, should still be maintained between the site and the waterbody. Furthermore, it is essential that the other guidelines for preparing and maintaining snow disposal sites be followed to minimize the threat to adjacent waterbodies.

Under extraordinary conditions, when all land-based snow disposal options are exhausted, the Emergency Declaration issued by MassDEP may allow disposal of snow in certain waterbodies under certain conditions. ***A federal agency, state agency, state authority, municipality or business seeking to dispose of snow in a waterbody should take the following steps***:

- Call the emergency contact phone number [(888) 304-1133)] and notify the MEMA of the municipality's intent.
- MEMA will ask for some information about where the requested disposal will take place.
- MEMA will confirm that the disposal is consistent with MassDEP's Severe Weather Emergency Declaration and these guidelines and is therefore approved.

During declared statewide snow emergency events, MassDEP's website will also highlight the emergency contact phone number [(888) 304-1133)] for authorizations and inquiries. For further non-emergency information about this Guidance you may contact your MassDEP Regional Office Service Center:

Northeast Regional Office, Wilmington, 978-694-3246
Southeast Regional Office, Lakeville, 508-946-2714
Central Regional Office, Worcester, 508-792-7650
Western Regional Office, Springfield, 413-755-2114

Isolator® Row Plus
O&M Manual

ADS StormTech™

The Isolator® Row Plus

Introduction

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row Plus is a technique to inexpensively enhance Total Suspended Solids (TSS), Total Phosphorus (TP), Total Petroluem Hydrocarbons (TPH) and Total Nitrogen (TN) removal with easy access for inspection and maintenance.

The Isolator Row Plus

The Isolator Row Plus is a row of StormTech chambers, either SC-160, SC-310, SC-310-3, SC-740, DC-780, MC-3500, MC-4500 or MC-7200 models, are lined with filter fabric and connected to a closely located manhole for easy access. The fabric lined chambers provide for sediment settling and filtration as stormwater rises in the Isolator Row Plus and passes through the filter fabric. The open bottom chambers allow stormwater to flow both vertically out of the chambers. Sediments are captured in the Isolator Row Plus protecting the adjacent stone and chambers storage areas from sediment accumulation.

ADS Isolator Row and Plus fabric are placed between the stone and the Isolator Row Plus chambers. The woven geotextile provides a media for stormwater filtration, a durable surface for maintenance, prevents scour of the underlying stone and remains intact during high pressure jetting.

The Isolator Row Plus is designed to capture the "first flush" runoff and offers the versatility to be sized on a volume basis or a flow-rate basis. An upstream manhole provides access to the Isolator Row Plus and includes a high/low concept such that stormwater flow rates or volumes that exceed the capacity of the Isolator Row Plus bypass through a manifold to the other chambers. This is achieved with an elevated bypass manifold or a high-flow weir. This creates a differential between the Isolator Row Plus row of chambers and the manifold to the rest of the system, thus allowing for settlement time in the Isolator Row Plus. After Stormwater flows through the Isolator Row Plus and into the rest of the chamber system it is either exfiltrated into the soils below or passed at a controlled rate through an outlet manifold and outlet control structure.

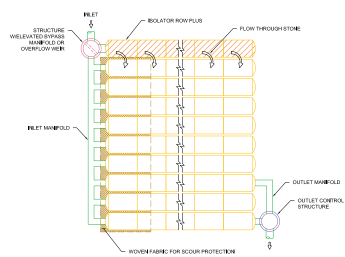
The Isolator Row Plus Flamp™ is a flared end ramp apparatus attached to the inlet pipe on the inside of the chamber end cap. The FLAMP provides a smooth transition from pipe invert to fabric bottom. It is configured to improve chamber function performance by enhancing outflow of solid debris that would otherwise collect at the chamber's end, or more difficult to remove and require confined space entry into the chamber area. It also serves to improve the fluid and solid flow into the access pipe during maintenance and cleaning and to guide cleaning and inspection equipment back into the inlet pipe when complete.

The Isolator Row Plus may be part of a treatment train system. The treatment train design and pretreatment device selection by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, StormTech recommend using the Isolator Row Plus to minimize maintenance requirements and maintenance costs.

Note: *See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row Plus.*

Looking down the Isolator Row PLUS from the manhole opening, ADS PLUS Fabric is shown between the chamber and stone base.

StormTech Isolator Row PLUS with Overflow Structure (not to scale)



Isolator Row Plus Inspection/Maintenance

Inspection

The frequency of inspection and maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row Plus should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

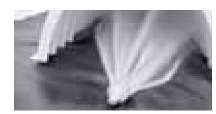
The Isolator Row Plus incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row Plus, clean-out should be performed.

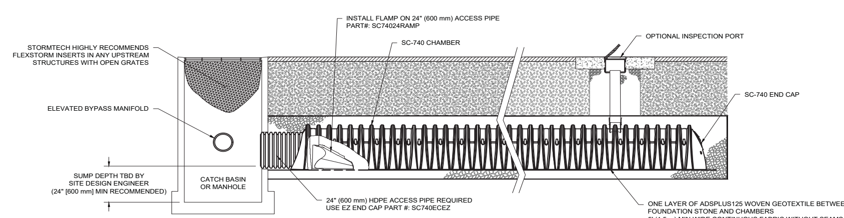
Maintenance

The Isolator Row Plus was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entry.

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row Plus while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" are best. StormTech recommends a maximum nozzle pressure of 2000 psi be utilized during cleaning. JetVac reels can vary in length. For ease of maintenance, ADS recommends Isolator Row Plus lengths up to 200' (61 m). **The JetVac process shall only be performed on StormTech Isolator Row Plus that have ADS Plus Fabric (as specified by StormTech) over their angular base stone.**



StormTech Isolator Row PLUS (*not to scale*)



Isolator Row Plus Step By Step Maintenance Procedures

Step 1

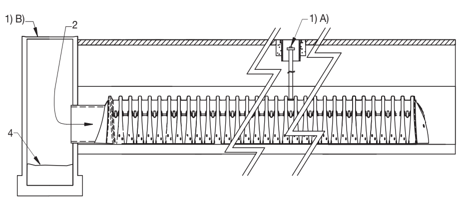
Inspect Isolator Row Plus for sediment.
- A) Inspection ports (if present)
  - i. Remove lid from floor box frame
  - ii. Remove cap from inspection riser
  - iii. Using a flashlight and stadia rod,measure depth of sediment and record results on maintenance log.
  - iv. If sediment is at or above 3 inch depth, proceed to Step 2. If not, proceed to Step 3.
- B) All Isolator Row Plus
  - i. Remove cover from manhole at upstream end of Isolator Row Plus
  - ii. Using a flashlight, inspect down Isolator Row Plus through outlet pipe
    1. Mirrors on poles or cameras may be used to avoid a confined space entry
    2. Follow OSHA regulations for confined space entry if entering manhole
  - iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches), proceed to Step 2. If not, proceed to Step 3.

Step 2

Clean out Isolator Row Plus using the JetVac process.
- A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable
- B) Apply multiple passes of JetVac until backflush water is clean
- C) Vacuum manhole sump as required

Step 3
Replace all caps, lids and covers, record observations and actions.

Step 4
Inspect & clean catch basins and manholes upstream of the StormTech system.



Sample Maintenance Log

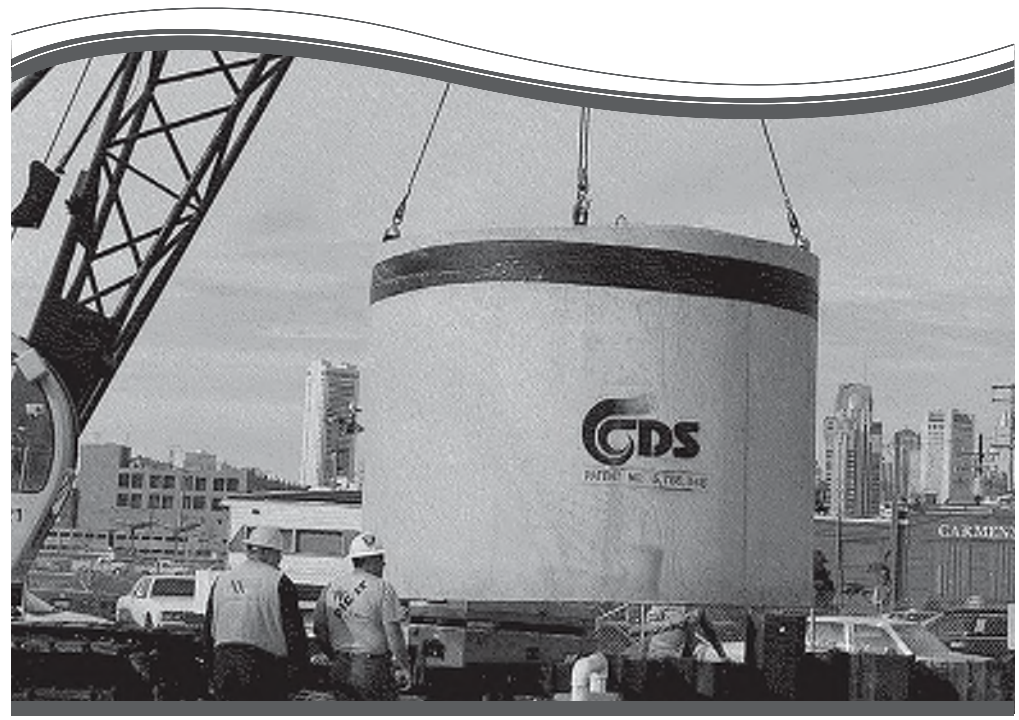
Date	Stadia Rod Readings		Sediment Depth (1)–(2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/11	6.3 ft	none		New installation. Fixed point is CI frame at grade	DJM
9/24/11		6.2	0.1 ft	Some grit felt	SM
6/20/13		5.8	0.5 ft	Mucky feel, debris visible in manhole and in Isolator Row PLUS, maintenance due	NV
7/7/13	6.3 ft		0	System jetted and vacuumed	DJM

adspipe.com
800-821-6710

ADS StormTech

CONTECH ENGINEERED SOLUTIONS

CDS Guide
Operation, Design, Performance and Maintenance



CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

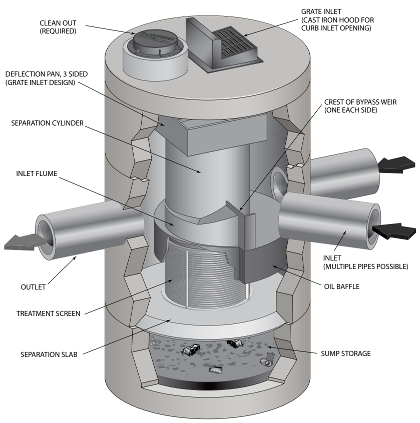
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

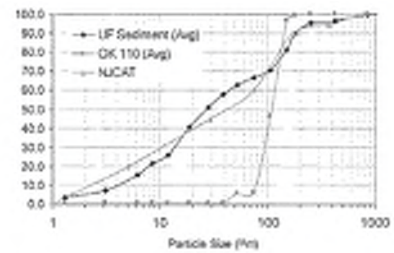


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

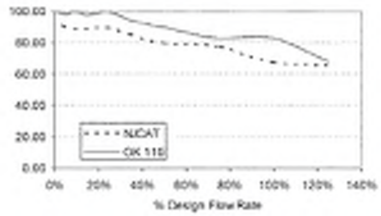


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μm).

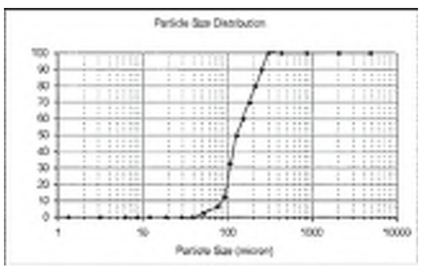


Figure 3. WASDOE PSD

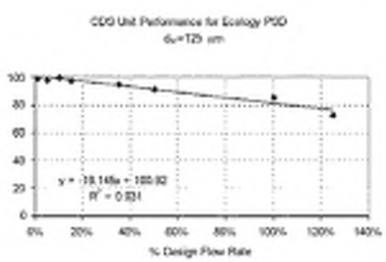


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

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

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified

during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

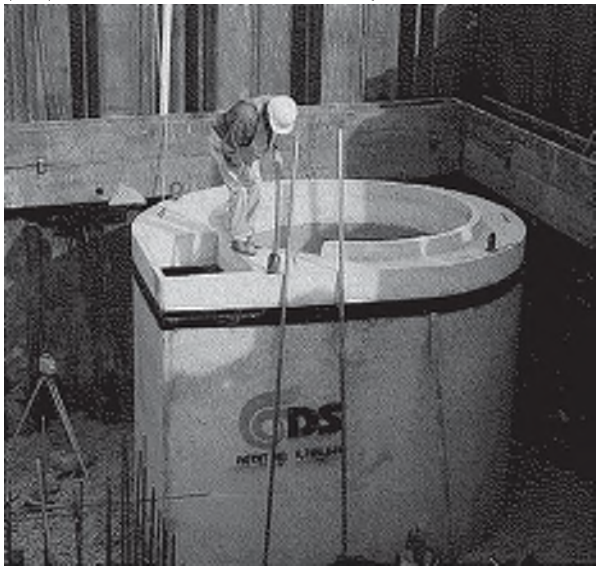
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y^3	m^3
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

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



CDS Inspection & Maintenance Log

CDS Model: ______________________ Location: ______________________

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

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

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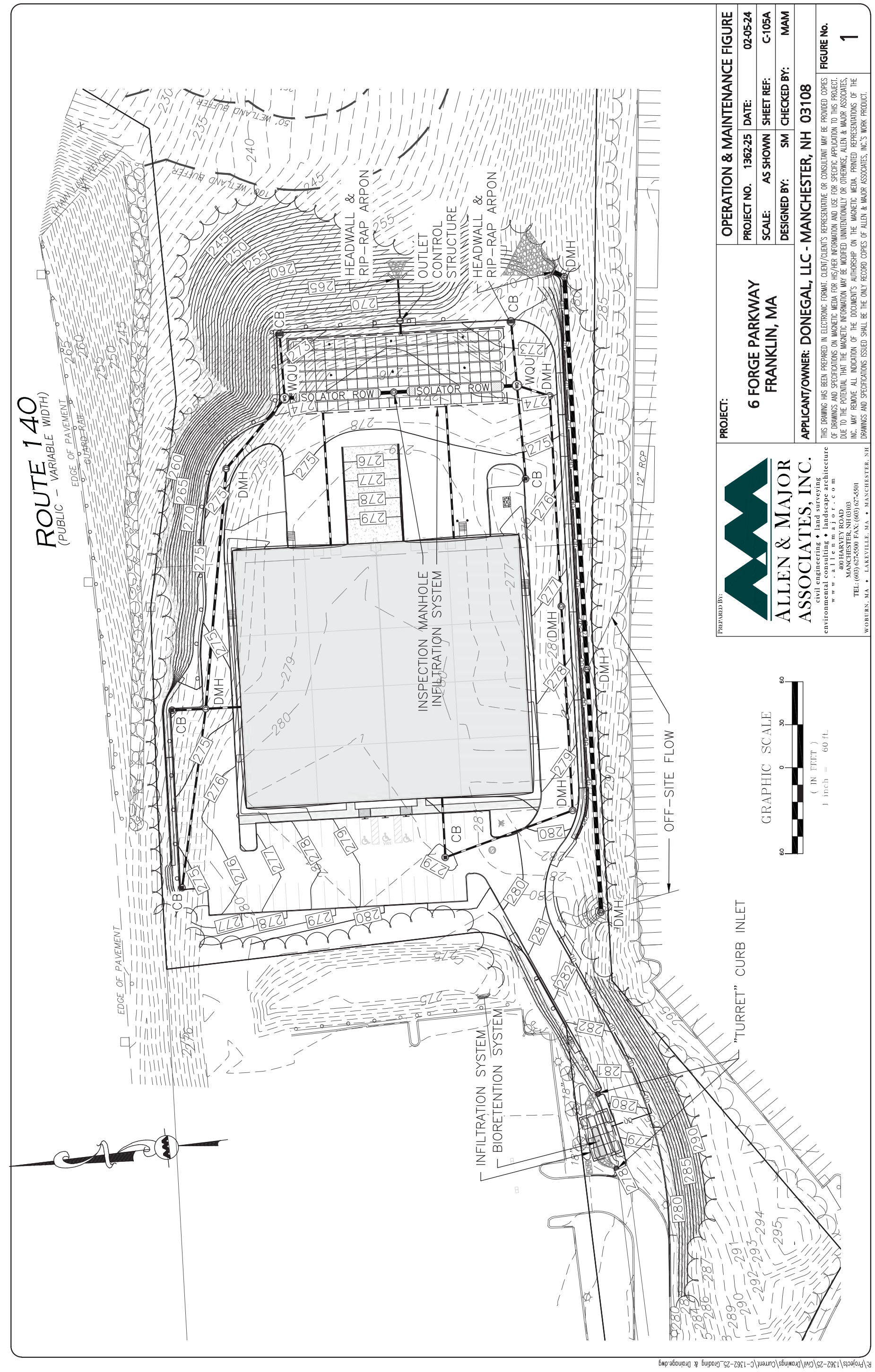
cds_manual 3/17 PDF

RECYCLED PAPER



USGS Site Locus Map

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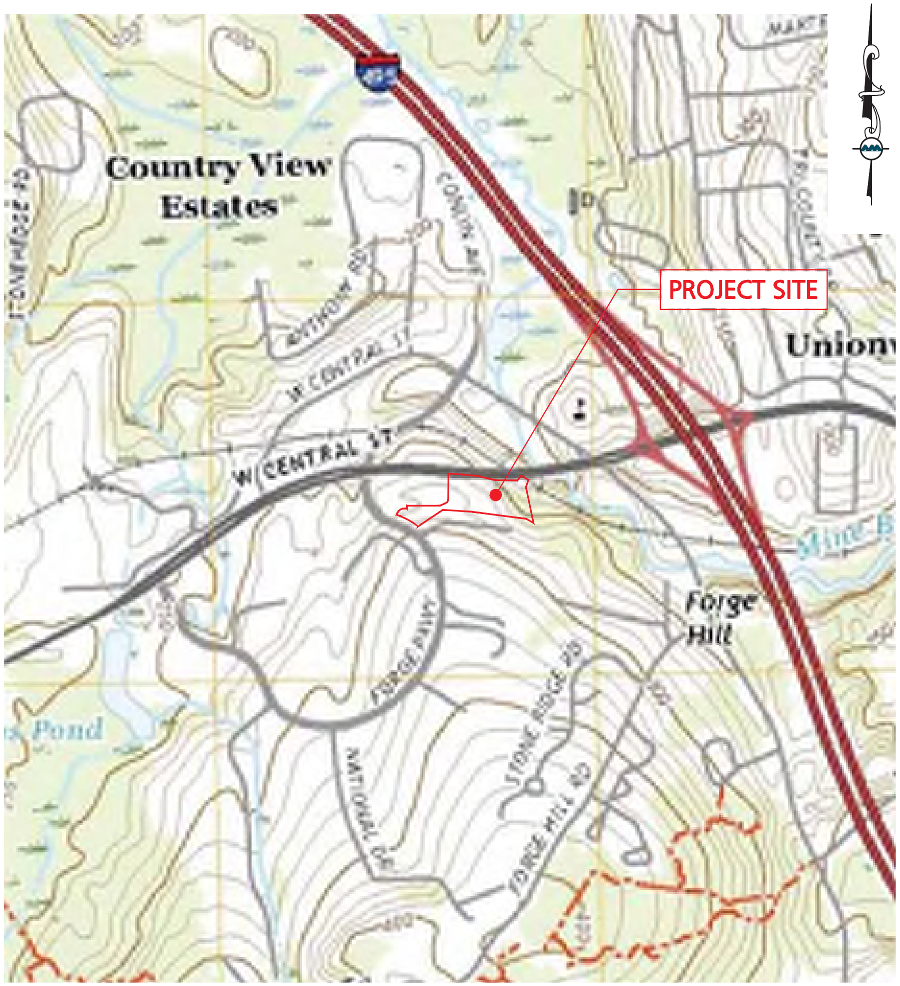
SECTION 3.0 -
EXHIBITS

Aerial Photo



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FRANKLIN, MA

USGS SITE LOCUS MAP

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SCALE:	1"=1000'	DWG. NAME:	EXHIBITS
DESIGNED BY:	SM	CHECKED BY:	MAM

SHEET No.
EX-1

MASSDEP Wetlands Map

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AERIAL PHOTO

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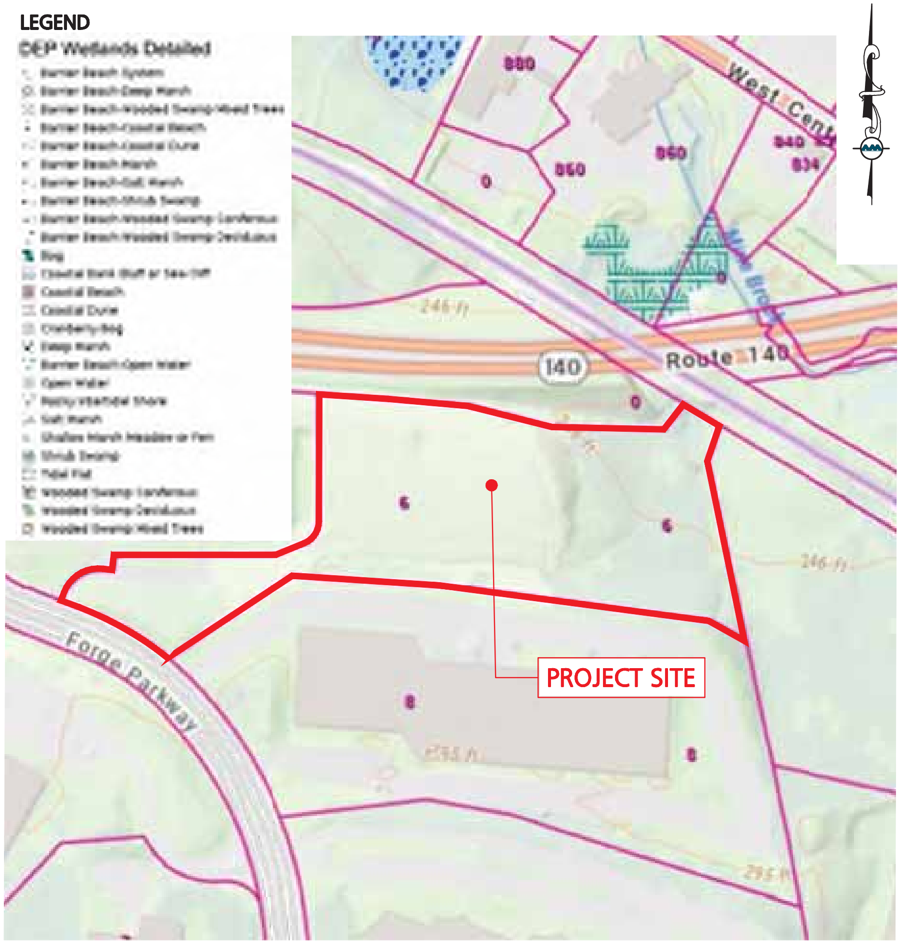
SHEET No.
EX-2

FEMA Flood Insurance Rate Map



MA MAPPER DEP WETLANDS

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WETLANDS MAP

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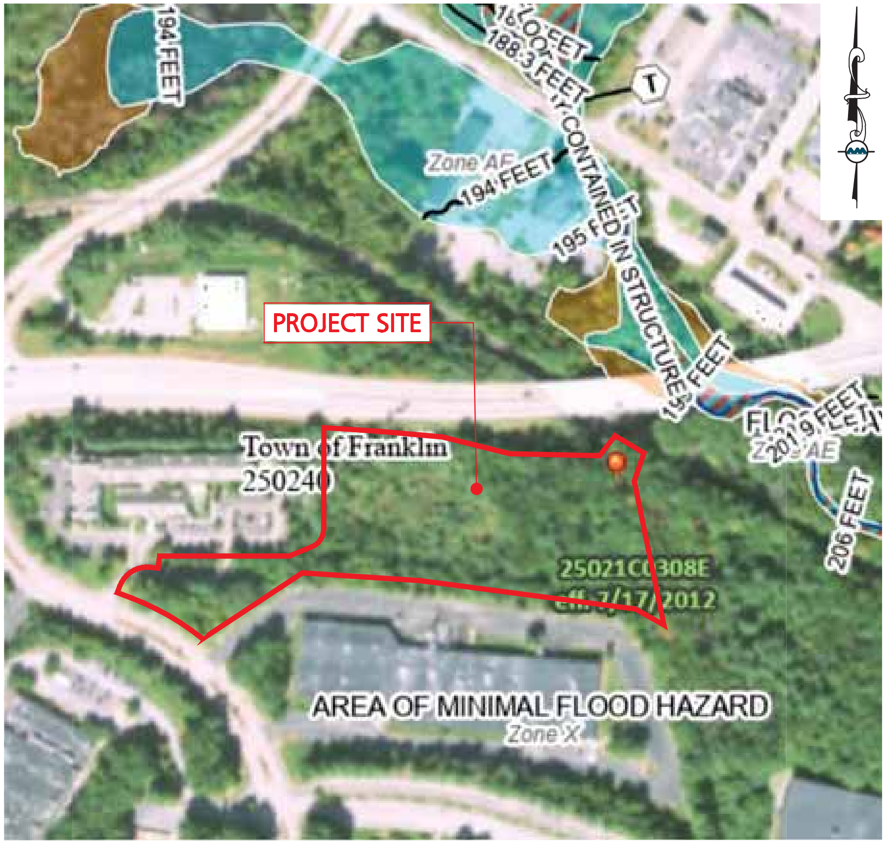
SHEET No.
EX-3



FEMA FLOOD INSURANCE RATE MAP
NORFOLK COUNTY, MASSACHUSETTS
MAP NUMBER 25021C0308E
EFFECTIVE DATE: JULY 17, 2012

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FEMA FIRM MAP

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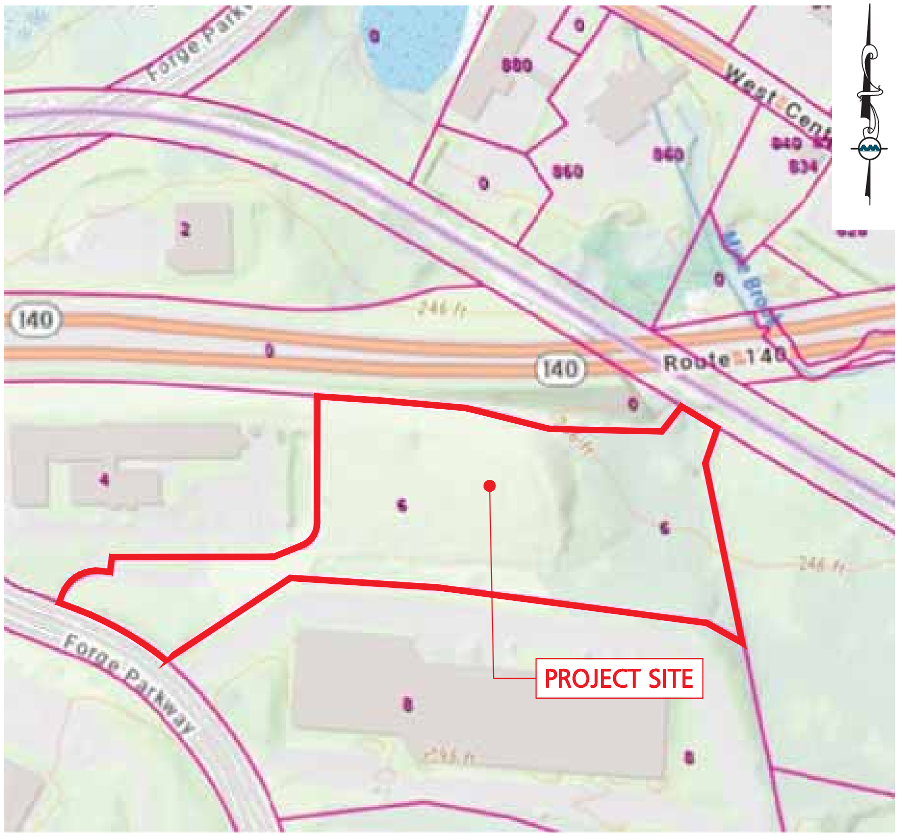
SHEET No.
EX-4

NHESP Map



LEGEND

NHESP Priority Habitats of Rare Species

NHESP Estimated Habitats of Rare Wildlife

MA MAPPER PRIORITY & ESTIMATED HABITATS

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PRIORITY & ESTIMATED HABITATS

PROJECT NO. 1362-25	DATE: 10-12-2023
SCALE: 1"=200'	DWG. NAME: EXHIBITS
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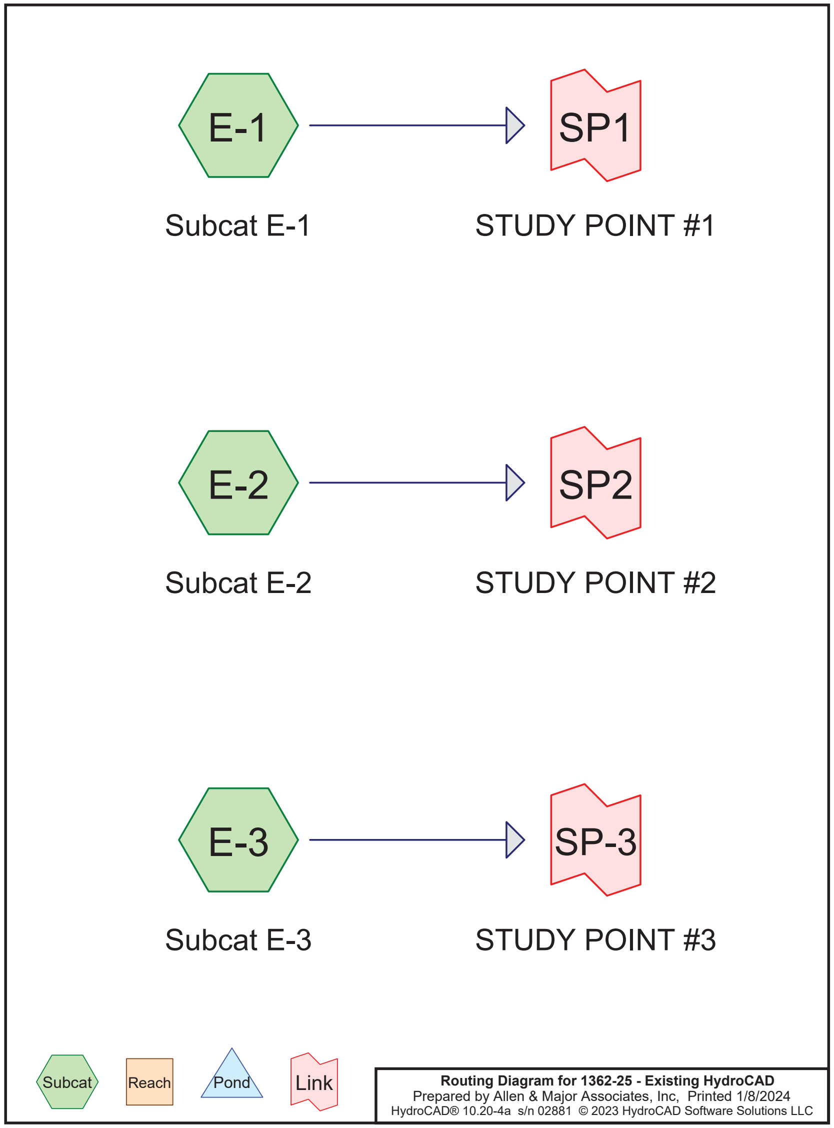
SHEET No.
EX-5

SECTION 4.0 - EXISTING DRAINAGE ANALYSIS

Existing HydroCAD



Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-year	Type III 24-hr		Default	24.00	1	3.27	2
2	10-year	Type III 24-hr		Default	24.00	1	4.90	2
3	25-year	Type III 24-hr		Default	24.00	1	6.17	2
4	100-year	Type III 24-hr		Default	24.00	1	8.78	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
9,732	39	>75% Grass cover, Good, HSG A (E-1, E-3)
3,913	61	>75% Grass cover, Good, HSG B (E-3)
66,407	30	Brush, Good, HSG A (E-1, E-2, E-3)
17,484	48	Brush, Good, HSG B (E-3)
2,413	98	Paved parking, HSG A (E-1)
50,654	30	Woods, Good, HSG A (E-1, E-2, E-3)
107,999	55	Woods, Good, HSG B (E-3)
258,601	**43**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
129,206	HSG A	E-1, E-2, E-3
129,395	HSG B	E-3
0	HSG C	
0	HSG D	
0	Other	
258,601		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Sub Nun
9,732	3,913	0	0	0	13,645	>75% Grass cover, Good	
66,407	17,484	0	0	0	83,891	Brush, Good	
2,413	0	0	0	0	2,413	Paved parking	
50,654	107,999	0	0	0	158,653	Woods, Good	
129,206	**129,395**	**0**	**0**	**0**	**258,601**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E-1: Subcat E-1 Runoff Area=40,603 sf 5.94% Impervious Runoff Depth=0.18"
Flow Length=155' Tc=6.4 min CN=WQ Runoff=0.17 cfs 611 cf

Subcatchment E-2: Subcat E-2 Runoff Area=13,338 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=196' Tc=16.8 min CN=WQ Runoff=0.00 cfs 0 cf

Subcatchment E-3: Subcat E-3 Runoff Area=204,661 sf 0.00% Impervious Runoff Depth=0.16"
Flow Length=486' Tc=7.7 min CN=WQ Runoff=0.31 cfs 2,750 cf

Link SP-3: STUDY POINT #3 Inflow=0.31 cfs 2,750 cf
Primary=0.31 cfs 2,750 cf

Link SP1: STUDY POINT #1 Inflow=0.17 cfs 611 cf
Primary=0.17 cfs 611 cf

Link SP2: STUDY POINT #2 Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Total Runoff Area = 258,601 sf Runoff Volume = 3,362 cf Average Runoff Depth = 0.16"
99.07% Pervious = 256,188 sf 0.93% Impervious = 2,413 sf

Summary for Subcatchment E-1: Subcat E-1

Runoff = 0.17 cfs @ 12.09 hrs, Volume= 611 cf, Depth= 0.18"
Routed to Link SP1 : STUDY POINT #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
6,146	39	>75% Grass cover, Good, HSG A
6,901	30	Brush, Good, HSG A
2,413	98	Paved parking, HSG A
25,143	30	Woods, Good, HSG A
40,603		Weighted Average
38,190	31	94.06% Pervious Area
2,413	98	5.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	50	0.1200	0.14		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.2	38	0.3200	2.83		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
0.3	67	0.0300	3.52		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
6.4	155	Total			

Summary for Subcatchment E-2: Subcat E-2

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Link SP2 : STUDY POINT #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
10,164	30	Brush, Good, HSG A
3,174	30	Woods, Good, HSG A
13,338		Weighted Average
13,338	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.4	50	0.0040	0.05		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.28"
1.4	146	0.0620	1.74		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
16.8	196	Total			

Summary for Subcatchment E-3: Subcat E-3

Runoff = 0.31 cfs @ 12.34 hrs, Volume= 2,750 cf, Depth= 0.16"
Routed to Link SP-3 : STUDY POINT #3

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
3,587	39	>75% Grass cover, Good, HSG A
3,913	61	>75% Grass cover, Good, HSG B
49,342	30	Brush, Good, HSG A
17,484	48	Brush, Good, HSG B
22,337	30	Woods, Good, HSG A
107,999	55	Woods, Good, HSG B
204,661		Weighted Average
204,661	45	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0407	0.22		**Sheet Flow, A-B** Range n= 0.130 P2= 3.28"
4.0	436	0.1290	1.80		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
7.7	486	Total			

Summary for Link SP-3: STUDY POINT #3

Inflow Area = 204,661 sf, 0.00% Impervious, Inflow Depth = 0.16" for 2-year event
Inflow = 0.31 cfs @ 12.34 hrs, Volume= 2,750 cf
Primary = 0.31 cfs @ 12.34 hrs, Volume= 2,750 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP1: STUDY POINT #1

Inflow Area = 40,603 sf, 5.94% Impervious, Inflow Depth = 0.18" for 2-year event
Inflow = 0.17 cfs @ 12.09 hrs, Volume= 611 cf
Primary = 0.17 cfs @ 12.09 hrs, Volume= 611 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP2: STUDY POINT #2

Inflow Area = 13,338 sf, 0.00% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E-1: Subcat E-1 Runoff Area=40,603 sf 5.94% Impervious Runoff Depth=0.31"
Flow Length=155' Tc=6.4 min CN=WQ Runoff=0.26 cfs 1,036 cf

Subcatchment E-2: Subcat E-2 Runoff Area=13,338 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=196' Tc=16.8 min CN=WQ Runoff=0.00 cfs 3 cf

Subcatchment E-3: Subcat E-3 Runoff Area=204,661 sf 0.00% Impervious Runoff Depth=0.57"
Flow Length=486' Tc=7.7 min CN=WQ Runoff=2.22 cfs 9,672 cf

Link SP-3: STUDY POINT #3 Inflow=2.22 cfs 9,672 cf
Primary=2.22 cfs 9,672 cf

Link SP1: STUDY POINT #1 Inflow=0.26 cfs 1,036 cf
Primary=0.26 cfs 1,036 cf

Link SP2: STUDY POINT #2 Inflow=0.00 cfs 3 cf
Primary=0.00 cfs 3 cf

Total Runoff Area = 258,601 sf Runoff Volume = 10,711 cf Average Runoff Depth = 0.50"
99.07% Pervious = 256,188 sf 0.93% Impervious = 2,413 sf

Summary for Subcatchment E-1: Subcat E-1

Runoff = 0.26 cfs @ 12.09 hrs, Volume= 1,036 cf, Depth= 0.31"
Routed to Link SP1 : STUDY POINT #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
6,146	39	>75% Grass cover, Good, HSG A
6,901	30	Brush, Good, HSG A
2,413	98	Paved parking, HSG A
25,143	30	Woods, Good, HSG A
40,603		Weighted Average
38,190	31	94.06% Pervious Area
2,413	98	5.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	50	0.1200	0.14		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.2	38	0.3200	2.83		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
0.3	67	0.0300	3.52		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
6.4	155	Total			

Summary for Subcatchment E-2: Subcat E-2

Runoff = 0.00 cfs @ 24.02 hrs, Volume= 3 cf, Depth= 0.00"
Routed to Link SP2 : STUDY POINT #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
10,164	30	Brush, Good, HSG A
3,174	30	Woods, Good, HSG A
13,338		Weighted Average
13,338	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.4	50	0.0040	0.05		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.28"
1.4	146	0.0620	1.74		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
16.8	196	Total			

Summary for Subcatchment E-3: Subcat E-3

Runoff = 2.22 cfs @ 12.13 hrs, Volume= 9,672 cf, Depth= 0.57"
Routed to Link SP-3 : STUDY POINT #3

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
3,587	39	>75% Grass cover, Good, HSG A
3,913	61	>75% Grass cover, Good, HSG B
49,342	30	Brush, Good, HSG A
17,484	48	Brush, Good, HSG B
22,337	30	Woods, Good, HSG A
107,999	55	Woods, Good, HSG B
204,661		Weighted Average
204,661	45	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0407	0.22		**Sheet Flow, A-B** Range n= 0.130 P2= 3.28"
4.0	436	0.1290	1.80		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
7.7	486	Total			

Summary for Link SP-3: STUDY POINT #3

Inflow Area = 204,661 sf, 0.00% Impervious, Inflow Depth = 0.57" for 10-year event
Inflow = 2.22 cfs @ 12.13 hrs, Volume= 9,672 cf
Primary = 2.22 cfs @ 12.13 hrs, Volume= 9,672 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP1: STUDY POINT #1

Inflow Area = 40,603 sf, 5.94% Impervious, Inflow Depth = 0.31" for 10-year event
Inflow = 0.26 cfs @ 12.09 hrs, Volume= 1,036 cf
Primary = 0.26 cfs @ 12.09 hrs, Volume= 1,036 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP2: STUDY POINT #2

Inflow Area = 13,338 sf, 0.00% Impervious, Inflow Depth = 0.00" for 10-year event
Inflow = 0.00 cfs @ 24.02 hrs, Volume= 3 cf
Primary = 0.00 cfs @ 24.02 hrs, Volume= 3 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E-1: Subcat E-1 Runoff Area=40,603 sf 5.94% Impervious Runoff Depth=0.50"
Flow Length=155' Tc=6.4 min CN=WQ Runoff=0.34 cfs 1,689 cf

Subcatchment E-2: Subcat E-2 Runoff Area=13,338 sf 0.00% Impervious Runoff Depth=0.09"
Flow Length=196' Tc=16.8 min CN=WQ Runoff=0.00 cfs 101 cf

Subcatchment E-3: Subcat E-3 Runoff Area=204,661 sf 0.00% Impervious Runoff Depth=1.03"
Flow Length=486' Tc=7.7 min CN=WQ Runoff=4.53 cfs 17,505 cf

Link SP-3: STUDY POINT #3 Inflow=4.53 cfs 17,505 cf
Primary=4.53 cfs 17,505 cf

Link SP1: STUDY POINT #1 Inflow=0.34 cfs 1,689 cf
Primary=0.34 cfs 1,689 cf

Link SP2: STUDY POINT #2 Inflow=0.00 cfs 101 cf
Primary=0.00 cfs 101 cf

Total Runoff Area = 258,601 sf Runoff Volume = 19,295 cf Average Runoff Depth = 0.90"
99.07% Pervious = 256,188 sf 0.93% Impervious = 2,413 sf

Summary for Subcatchment E-1: Subcat E-1

Runoff = 0.34 cfs @ 12.09 hrs, Volume= 1,689 cf, Depth= 0.50"
Routed to Link SP1 : STUDY POINT #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
6,146	39	>75% Grass cover, Good, HSG A
6,901	30	Brush, Good, HSG A
2,413	98	Paved parking, HSG A
25,143	30	Woods, Good, HSG A
40,603		Weighted Average
38,190	31	94.06% Pervious Area
2,413	98	5.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	50	0.1200	0.14		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.2	38	0.3200	2.83		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
0.3	67	0.0300	3.52		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
6.4	155	Total			

Summary for Subcatchment E-2: Subcat E-2

Runoff = 0.00 cfs @ 15.44 hrs, Volume= 101 cf, Depth= 0.09"
Routed to Link SP2 : STUDY POINT #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
10,164	30	Brush, Good, HSG A
3,174	30	Woods, Good, HSG A
13,338		Weighted Average
13,338	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.4	50	0.0040	0.05		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.28"
1.4	146	0.0620	1.74		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
16.8	196	Total			

Summary for Subcatchment E-3: Subcat E-3

Runoff = 4.53 cfs @ 12.12 hrs, Volume= 17,505 cf, Depth= 1.03"
Routed to Link SP-3 : STUDY POINT #3

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
3,587	39	>75% Grass cover, Good, HSG A
3,913	61	>75% Grass cover, Good, HSG B
49,342	30	Brush, Good, HSG A
17,484	48	Brush, Good, HSG B
22,337	30	Woods, Good, HSG A
107,999	55	Woods, Good, HSG B
204,661		Weighted Average
204,661	45	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0407	0.22		**Sheet Flow, A-B** Range n= 0.130 P2= 3.28"
4.0	436	0.1290	1.80		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
7.7	486	Total			

Summary for Link SP-3: STUDY POINT #3

Inflow Area = 204,661 sf, 0.00% Impervious, Inflow Depth = 1.03" for 25-year event
Inflow = 4.53 cfs @ 12.12 hrs, Volume= 17,505 cf
Primary = 4.53 cfs @ 12.12 hrs, Volume= 17,505 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP1: STUDY POINT #1

Inflow Area = 40,603 sf, 5.94% Impervious, Inflow Depth = 0.50" for 25-year event
Inflow = 0.34 cfs @ 12.09 hrs, Volume= 1,689 cf
Primary = 0.34 cfs @ 12.09 hrs, Volume= 1,689 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP2: STUDY POINT #2

Inflow Area = 13,338 sf, 0.00% Impervious, Inflow Depth = 0.09" for 25-year event
Inflow = 0.00 cfs @ 15.44 hrs, Volume= 101 cf
Primary = 0.00 cfs @ 15.44 hrs, Volume= 101 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E-1: Subcat E-1 Runoff Area=40,603 sf 5.94% Impervious Runoff Depth=1.22"
Flow Length=155' Tc=6.4 min CN=WQ Runoff=0.67 cfs 4,132 cf

Subcatchment E-2: Subcat E-2 Runoff Area=13,338 sf 0.00% Impervious Runoff Depth=0.62"
Flow Length=196' Tc=16.8 min CN=WQ Runoff=0.06 cfs 685 cf

Subcatchment E-3: Subcat E-3 Runoff Area=204,661 sf 0.00% Impervious Runoff Depth=2.29"
Flow Length=486' Tc=7.7 min CN=WQ Runoff=10.44 cfs 39,072 cf

Link SP-3: STUDY POINT #3 Inflow=10.44 cfs 39,072 cf
Primary=10.44 cfs 39,072 cf

Link SP1: STUDY POINT #1 Inflow=0.67 cfs 4,132 cf
Primary=0.67 cfs 4,132 cf

Link SP2: STUDY POINT #2 Inflow=0.06 cfs 685 cf
Primary=0.06 cfs 685 cf

Total Runoff Area = 258,601 sf Runoff Volume = 43,888 cf Average Runoff Depth = 2.04"
99.07% Pervious = 256,188 sf 0.93% Impervious = 2,413 sf

Summary for Subcatchment E-1: Subcat E-1

Runoff = 0.67 cfs @ 12.11 hrs, Volume= 4,132 cf, Depth= 1.22"
Routed to Link SP1 : STUDY POINT #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
6,146	39	>75% Grass cover, Good, HSG A
6,901	30	Brush, Good, HSG A
2,413	98	Paved parking, HSG A
25,143	30	Woods, Good, HSG A
40,603		Weighted Average
38,190	31	94.06% Pervious Area
2,413	98	5.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	50	0.1200	0.14		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.2	38	0.3200	2.83		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
0.3	67	0.0300	3.52		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
6.4	155	Total			

Summary for Subcatchment E-2: Subcat E-2

Runoff = 0.06 cfs @ 12.52 hrs, Volume= 685 cf, Depth= 0.62"
Routed to Link SP2 : STUDY POINT #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
10,164	30	Brush, Good, HSG A
3,174	30	Woods, Good, HSG A
13,338		Weighted Average
13,338	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.4	50	0.0040	0.05		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.28"
1.4	146	0.0620	1.74		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
16.8	196	Total			

Summary for Subcatchment E-3: Subcat E-3

Runoff = 10.44 cfs @ 12.12 hrs, Volume= 39,072 cf, Depth= 2.29"
Routed to Link SP-3 : STUDY POINT #3

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
3,587	39	>75% Grass cover, Good, HSG A
3,913	61	>75% Grass cover, Good, HSG B
49,342	30	Brush, Good, HSG A
17,484	48	Brush, Good, HSG B
22,337	30	Woods, Good, HSG A
107,999	55	Woods, Good, HSG B
204,661		Weighted Average
204,661	45	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0407	0.22		**Sheet Flow, A-B** Range n= 0.130 P2= 3.28"
4.0	436	0.1290	1.80		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
7.7	486	Total			

Summary for Link SP-3: STUDY POINT #3

Inflow Area = 204,661 sf, 0.00% Impervious, Inflow Depth = 2.29" for 100-year event
Inflow = 10.44 cfs @ 12.12 hrs, Volume= 39,072 cf
Primary = 10.44 cfs @ 12.12 hrs, Volume= 39,072 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP1: STUDY POINT #1

Inflow Area = 40,603 sf, 5.94% Impervious, Inflow Depth = 1.22" for 100-year event
Inflow = 0.67 cfs @ 12.11 hrs, Volume= 4,132 cf
Primary = 0.67 cfs @ 12.11 hrs, Volume= 4,132 cf, Atten= 0%, Lag= 0.0 min

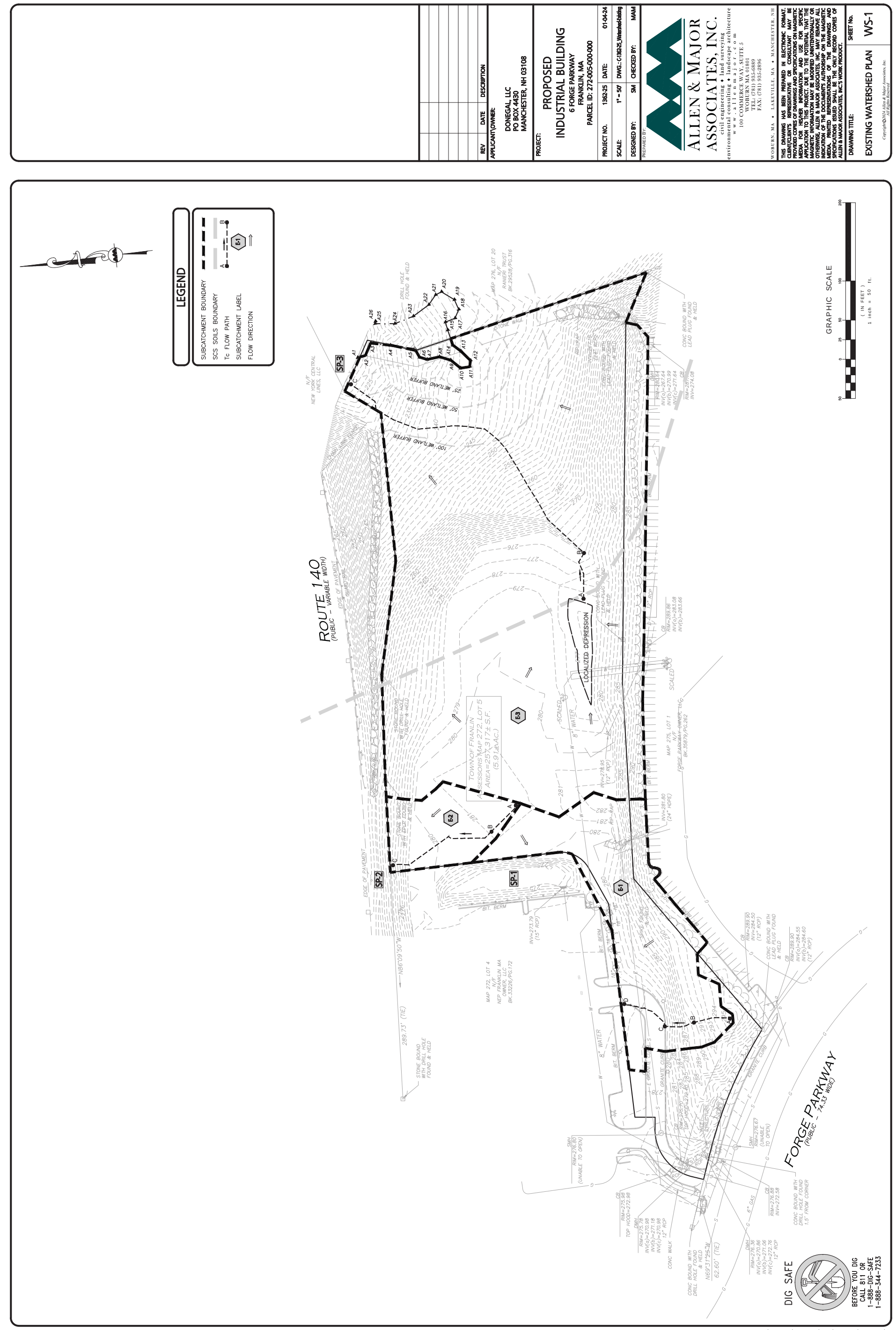
Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP2: STUDY POINT #2

Inflow Area = 13,338 sf, 0.00% Impervious, Inflow Depth = 0.62" for 100-year event
Inflow = 0.06 cfs @ 12.52 hrs, Volume= 685 cf
Primary = 0.06 cfs @ 12.52 hrs, Volume= 685 cf, Atten= 0%, Lag= 0.0 min

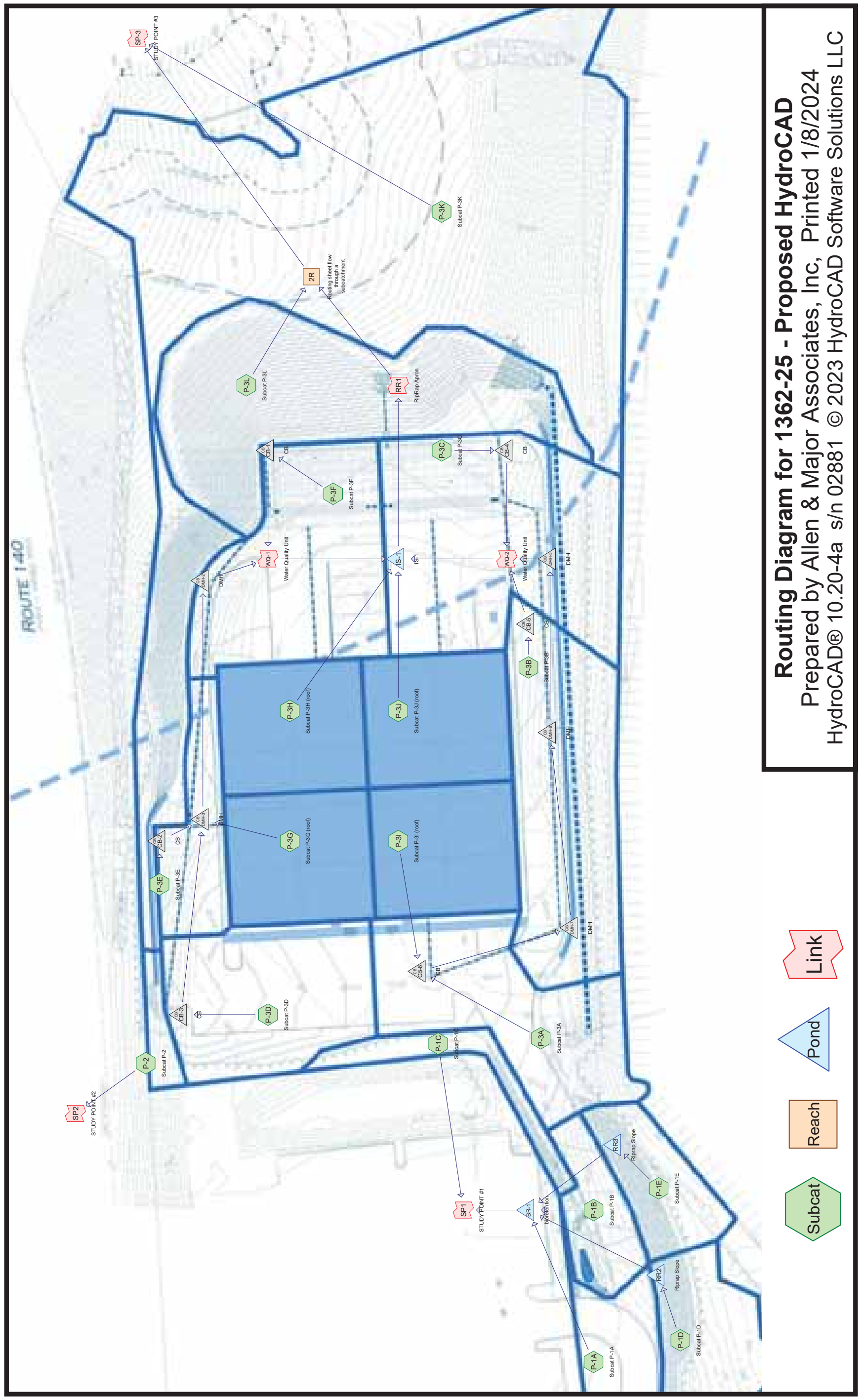
Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

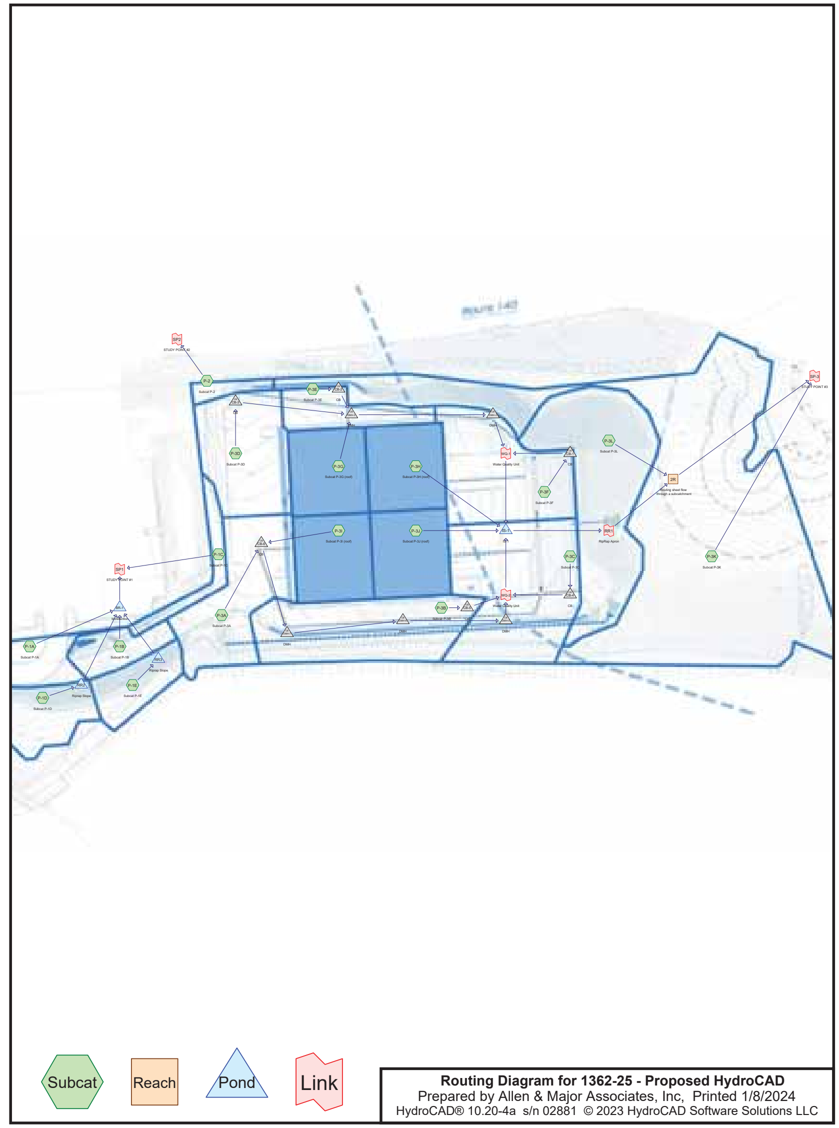
Existing Watershed Plan



SECTION 5.0 -
PROPOSED DRAINAGE ANALYSIS

Proposed HydroCAD


Routing Diagram for 1362-25 - Proposed HydroCAD
Prepared by Allen & Major Associates, Inc, Printed 1/8/2024
HydroCAD® 10.20-4a s/n 02881 © 2023 HydroCAD Software Solutions LLC
ROUTE 140
Subcat
Reach
Pond
Link


Subcat
Reach
Pond
Link
Routing Diagram for 1362-25 - Proposed HydroCAD
Prepared by Allen & Major Associates, Inc, Printed 1/8/2024
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Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-year	Type III 24-hr		Default	24.00	1	3.27	2
2	10-year	Type III 24-hr		Default	24.00	1	4.90	2
3	25-year	Type III 24-hr		Default	24.00	1	6.17	2
4	100-year	Type III 24-hr		Default	24.00	1	8.78	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
43,448	39	>75% Grass cover, Good, HSG A (P-1A, P-1B, P-1C, P-1D, P-1E, P-2, P-3A, P-3B, P-3C, P-3D, P-3E, P-3K)
38,144	61	>75% Grass cover, Good, HSG B (P-3C, P-3E, P-3F, P-3K, P-3L)
38,274	98	Paved parking, HSG A (P-1A, P-1B, P-3A, P-3B, P-3C, P-3D, P-3E, P-3F)
25,761	98	Paved parking, HSG B (P-3C, P-3E, P-3F)
35,032	98	Roofs, HSG A (P-3G, P-3H, P-3I, P-3J)
968	98	Roofs, HSG B (P-3H)
12,453	30	Woods, Good, HSG A (P-1C, P-1D, P-1E, P-2, P-3A, P-3B, P-3C, P-3D, P-3K)
64,521	55	Woods, Good, HSG B (P-3C, P-3K)
258,601	**69**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
129,206	HSG A	P-1A, P-1B, P-1C, P-1D, P-1E, P-2, P-3A, P-3B, P-3C, P-3D, P-3E, P-3F, P-3G, P-3H, P-3I, P-3J, P-3K
129,395	HSG B	P-3C, P-3E, P-3F, P-3H, P-3K, P-3L
0	HSG C	
0	HSG D	
0	Other	
258,601		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Sub Nun
43,448	38,144	0	0	0	81,592	>75% Grass cover, Good	
38,274	25,761	0	0	0	64,035	Paved parking	
35,032	968	0	0	0	36,000	Roofs	
12,453	64,521	0	0	0	76,974	Woods, Good	
129,206	**129,395**	**0**	**0**	**0**	**258,601**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)	Node Name
1	CB-1	269.22	268.77	45.0	0.0100	0.013	0.0	12.0	0.0	
2	CB-2	270.46	270.23	23.0	0.0100	0.013	0.0	12.0	0.0	
3	CB-3	271.40	270.23	126.0	0.0093	0.013	0.0	12.0	0.0	
4	CB-4	269.24	268.80	44.0	0.0100	0.013	0.0	12.0	0.0	
5	CB-5	271.36	269.55	65.0	0.0278	0.013	0.0	12.0	0.0	
6	CB-6	274.74	273.79	95.0	0.0100	0.013	0.0	12.0	0.0	
7	DMH-2	268.42	267.87	64.0	0.0086	0.013	0.0	15.0	0.0	
8	DMH-3	269.98	268.52	168.0	0.0087	0.013	0.0	15.0	0.0	
9	DMH-5	267.34	266.88	23.0	0.0200	0.013	0.0	12.0	0.0	
10	DMH-6	272.17	269.87	147.0	0.0156	0.013	0.0	12.0	0.0	
11	DMH-7	273.70	272.27	143.0	0.0100	0.013	0.0	12.0	0.0	
12	IS-1	266.47	265.92	29.0	0.0190	0.013	0.0	10.0	0.0	

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment P-1A: Subcat P-1A Runoff Area=5,859 sf 54.96% Impervious Runoff Depth=1.67"
Flow Length=67' Slope=0.0300 '/' Tc=6.0 min CN=WQ Runoff=0.23 cfs 815 cf

Subcatchment P-1B: Subcat P-1B Runoff Area=4,722 sf 61.71% Impervious Runoff Depth=1.87"
Flow Length=34' Slope=0.0300 '/' Tc=6.0 min CN=WQ Runoff=0.21 cfs 738 cf

Subcatchment P-1C: Subcat P-1C Runoff Area=3,424 sf 0.00% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=WQ Runoff=0.00 cfs 0 cf

Subcatchment P-1D: Subcat P-1D Runoff Area=7,513 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=68' Slope=0.1673 '/' Tc=6.0 min CN=WQ Runoff=0.00 cfs 0 cf

Subcatchment P-1E: Subcat P-1E Runoff Area=5,707 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=62' Tc=6.0 min CN=WQ Runoff=0.00 cfs 1 cf

Subcatchment P-2: Subcat P-2 Runoff Area=1,587 sf 0.00% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=WQ Runoff=0.00 cfs 0 cf

Subcatchment P-3A: Subcat P-3A Runoff Area=15,170 sf 55.11% Impervious Runoff Depth=1.67"
Flow Length=153' Tc=6.2 min CN=WQ Runoff=0.61 cfs 2,117 cf

Subcatchment P-3B: Subcat P-3B Runoff Area=17,711 sf 37.69% Impervious Runoff Depth=1.15"
Flow Length=301' Tc=7.5 min CN=WQ Runoff=0.46 cfs 1,690 cf

Subcatchment P-3C: Subcat P-3C Runoff Area=22,442 sf 65.03% Impervious Runoff Depth=2.01"
Flow Length=158' Slope=0.0200 '/' Tc=6.0 min CN=WQ Runoff=1.08 cfs 3,756 cf

Subcatchment P-3D: Subcat P-3D Runoff Area=13,831 sf 67.53% Impervious Runoff Depth=2.05"
Flow Length=135' Slope=0.0360 '/' Tc=6.0 min CN=WQ Runoff=0.68 cfs 2,365 cf

Subcatchment P-3E: Subcat P-3E Runoff Area=6,117 sf 82.83% Impervious Runoff Depth=2.53"
Tc=6.0 min CN=WQ Runoff=0.37 cfs 1,287 cf

Subcatchment P-3F: Subcat P-3F Runoff Area=16,643 sf 83.29% Impervious Runoff Depth=2.61"
Tc=6.0 min CN=WQ Runoff=1.03 cfs 3,618 cf

Subcatchment P-3G: Subcat P-3G (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=3.04"
Tc=7.0 min CN=98 Runoff=0.63 cfs 2,278 cf

Subcatchment P-3H: Subcat P-3H (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=3.04"
Tc=7.0 min CN=WQ Runoff=0.63 cfs 2,278 cf

Subcatchment P-3I: Subcat P-3I (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=3.04"
Tc=7.0 min CN=98 Runoff=0.63 cfs 2,278 cf

Subcatchment P-3J: Subcat P-3J (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=3.04"
Tc=7.0 min CN=98 Runoff=0.63 cfs 2,278 cf

Subcatchment P-3K: Subcat P-3K Runoff Area=77,492 sf 0.00% Impervious Runoff Depth=0.28"
Flow Length=409' Tc=11.3 min CN=WQ Runoff=0.22 cfs 1,829 cf

Subcatchment P-3L: Subcat P-3L Runoff Area=24,381 sf 0.00% Impervious Runoff Depth=0.47"
Flow Length=81' Slope=0.4000 '/' Tc=6.0 min CN=61 Runoff=0.20 cfs 961 cf

Reach 2R: Routing sheet flow through a Avg. Flow Depth=0.01' Max Vel=0.03 fps Inflow=0.20 cfs 961 cf
n=0.800 L=280.0' S=0.1590 '/' Capacity=113.05 cfs Outflow=0.03 cfs 961 cf

Pond BR-1: bioretention Peak Elev=272.81' Storage=541 cf Inflow=0.45 cfs 1,553 cf
Discarded=0.04 cfs 1,553 cf Primary=0.00 cfs 0 cf Outflow=0.04 cfs 1,553 cf

Pond CB-1: CB Peak Elev=269.76' Inflow=1.03 cfs 3,618 cf
12.0" Round Culvert n=0.013 L=45.0' S=0.0100 '/' Outflow=1.03 cfs 3,618 cf

Pond CB-2: CB Peak Elev=270.82' Inflow=0.37 cfs 1,287 cf
12.0" Round Culvert n=0.013 L=23.0' S=0.0100 '/' Outflow=0.37 cfs 1,287 cf

Pond CB-3: CB Peak Elev=271.82' Inflow=0.68 cfs 2,365 cf
12.0" Round Culvert n=0.013 L=126.0' S=0.0093 '/' Outflow=0.68 cfs 2,365 cf

Pond CB-4: CB Peak Elev=269.80' Inflow=1.08 cfs 3,756 cf
12.0" Round Culvert n=0.013 L=44.0' S=0.0100 '/' Outflow=1.08 cfs 3,756 cf

Pond CB-5: CB Peak Elev=271.70' Inflow=0.46 cfs 1,690 cf
12.0" Round Culvert n=0.013 L=65.0' S=0.0278 '/' Outflow=0.46 cfs 1,690 cf

Pond CB-6: CB Peak Elev=275.33' Inflow=1.24 cfs 4,395 cf
12.0" Round Culvert n=0.013 L=95.0' S=0.0100 '/' Outflow=1.24 cfs 4,395 cf

Pond DMH-2: DMH Peak Elev=269.08' Inflow=1.68 cfs 5,930 cf
15.0" Round Culvert n=0.013 L=64.0' S=0.0086 '/' Outflow=1.68 cfs 5,930 cf

Pond DMH-3: DMH Peak Elev=270.62' Inflow=1.68 cfs 5,930 cf
15.0" Round Culvert n=0.013 L=168.0' S=0.0087 '/' Outflow=1.68 cfs 5,930 cf

Pond DMH-5: DMH Peak Elev=267.92' Inflow=1.24 cfs 4,395 cf
12.0" Round Culvert n=0.013 L=23.0' S=0.0200 '/' Outflow=1.24 cfs 4,395 cf

Pond DMH-6: DMH Peak Elev=272.75' Inflow=1.24 cfs 4,395 cf
12.0" Round Culvert n=0.013 L=147.0' S=0.0156 '/' Outflow=1.24 cfs 4,395 cf

Pond DMH-7: DMH Peak Elev=274.28' Inflow=1.24 cfs 4,395 cf
12.0" Round Culvert n=0.013 L=143.0' S=0.0100 '/' Outflow=1.24 cfs 4,395 cf

Pond IS-1: IS-1 Peak Elev=267.60' Storage=9,621 cf Inflow=6.74 cfs 23,945 cf
Discarded=0.44 cfs 23,945 cf Primary=0.00 cfs 0 cf Outflow=0.44 cfs 23,945 cf

Pond RR2: Riprap Slope Peak Elev=280.00' Storage=0 cf Inflow=0.00 cfs 0 cf
Discarded=0.00 cfs 0 cf Primary=0.00 cfs 0 cf Outflow=0.00 cfs 0 cf

Pond RR3: Riprap Slope Peak Elev=280.00' Storage=0 cf Inflow=0.00 cfs 1 cf
Discarded=0.00 cfs 1 cf Primary=0.00 cfs 0 cf Outflow=0.00 cfs 1 cf

Link RR1: RipRap Apron Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Link SP-3: STUDY POINT #3 Inflow=0.24 cfs 2,790 cf
Primary=0.24 cfs 2,790 cf

Link SP1: STUDY POINT #1 Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Link SP2: STUDY POINT #2 Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Link WQ-1: Water Quality Unit Inflow=2.71 cfs 9,548 cf
Primary=2.71 cfs 9,548 cf

Link WQ-2: Water Quality Unit Inflow=2.77 cfs 9,841 cf
Primary=2.77 cfs 9,841 cf

Total Runoff Area = 258,601 sf Runoff Volume = 28,289 cf Average Runoff Depth = 1.31"
61.32% Pervious = 158,566 sf 38.68% Impervious = 100,035 sf

Summary for Subcatchment P-1A: Subcat P-1A

Runoff = 0.23 cfs @ 12.08 hrs, Volume= 815 cf, Depth= 1.67"
Routed to Pond BR-1 : bioretention

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
2,639	39	>75% Grass cover, Good, HSG A
3,220	98	Paved parking, HSG A
5,859		Weighted Average
2,639	39	45.04% Pervious Area
3,220	98	54.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	67	0.0300	1.51		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.28"
0.7	67	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1B: Subcat P-1B

Runoff = 0.21 cfs @ 12.08 hrs, Volume= 738 cf, Depth= 1.87"
Routed to Pond BR-1 : bioretention

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
1,808	39	>75% Grass cover, Good, HSG A
2,914	98	Paved parking, HSG A
4,722		Weighted Average
1,808	39	38.29% Pervious Area
2,914	98	61.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	34	0.0300	1.32		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
0.4	34	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1C: Subcat P-1C

Runoff = 0.00 cfs @ 24.01 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Link SP1 : STUDY POINT #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
2,411	39	>75% Grass cover, Good, HSG A
1,014	30	Woods, Good, HSG A
3,424		Weighted Average
3,424	36	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-1D: Subcat P-1D

Runoff = 0.00 cfs @ 24.01 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Pond RR2 : Riprap Slope

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
2,966	39	>75% Grass cover, Good, HSG A
4,547	30	Woods, Good, HSG A
7,513		Weighted Average
7,513	34	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1673	0.16		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.1	18	0.1673	2.05		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
5.3	68	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1E: Subcat P-1E

Runoff = 0.00 cfs @ 24.01 hrs, Volume= 1 cf, Depth= 0.00"
Routed to Pond RR3 : Riprap Slope

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
4,885	39	>75% Grass cover, Good, HSG A
823	30	Woods, Good, HSG A
5,707		Weighted Average
5,707	38	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	21	0.1200	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
0.3	41	0.0992	2.20		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.3	62	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-2: Subcat P-2

Runoff = 0.00 cfs @ 24.01 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Link SP2 : STUDY POINT #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
683	39	>75% Grass cover, Good, HSG A
904	30	Woods, Good, HSG A
1,587		Weighted Average
1,587	34	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3A: Subcat P-3A

Runoff = 0.61 cfs @ 12.09 hrs, Volume= 2,117 cf, Depth= 1.67"
Routed to Pond CB-6 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
5,532	39	>75% Grass cover, Good, HSG A
8,361	98	Paved parking, HSG A
1,278	30	Woods, Good, HSG A
15,170		Weighted Average
6,810	37	44.89% Pervious Area
8,361	98	55.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	47	0.1200	0.14		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.5	106	0.0300	3.52		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
6.2	153	Total			

Summary for Subcatchment P-3B: Subcat P-3B

Runoff = 0.46 cfs @ 12.10 hrs, Volume= 1,690 cf, Depth= 1.15"
Routed to Pond CB-5 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
9,350	39	>75% Grass cover, Good, HSG A
6,675	98	Paved parking, HSG A
1,685	30	Woods, Good, HSG A
17,711		Weighted Average
11,035	38	62.31% Pervious Area
6,675	98	37.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	47	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
1.8	254	0.0140	2.40		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
7.5	301	Total			

Summary for Subcatchment P-3C: Subcat P-3C

Runoff = 1.08 cfs @ 12.08 hrs, Volume= 3,756 cf, Depth= 2.01"
Routed to Pond CB-4 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
5,057	39	>75% Grass cover, Good, HSG A
1,547	61	>75% Grass cover, Good, HSG B
2,587	98	Paved parking, HSG A
12,008	98	Paved parking, HSG B
1,229	30	Woods, Good, HSG A
14	55	Woods, Good, HSG B
22,442		Weighted Average
7,847	42	34.97% Pervious Area
14,595	98	65.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	158	0.0200	1.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
1.7	158	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-3D: Subcat P-3D

Runoff = 0.68 cfs @ 12.08 hrs, Volume= 2,365 cf, Depth= 2.05"
Routed to Pond CB-3 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
3,872	39	>75% Grass cover, Good, HSG A
9,341	98	Paved parking, HSG A
619	30	Woods, Good, HSG A
13,831		Weighted Average
4,491	38	32.47% Pervious Area
9,341	98	67.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0360	1.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
0.4	85	0.0360	3.85		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
0.9	135	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-3E: Subcat P-3E

Runoff = 0.37 cfs @ 12.08 hrs, Volume= 1,287 cf, Depth= 2.53"
Routed to Pond CB-2 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
925	39	>75% Grass cover, Good, HSG A
125	61	>75% Grass cover, Good, HSG B
4,721	98	Paved parking, HSG A
346	98	Paved parking, HSG B
6,117		Weighted Average
1,050	42	17.17% Pervious Area
5,067	98	82.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3F: Subcat P-3F

Runoff = 1.03 cfs @ 12.08 hrs, Volume= 3,618 cf, Depth= 2.61"
Routed to Pond CB-1 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
2,781	61	>75% Grass cover, Good, HSG B
455	98	Paved parking, HSG A
13,407	98	Paved parking, HSG B
16,643		Weighted Average
2,781	61	16.71% Pervious Area
13,862	98	83.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3G: Subcat P-3G (roof)

Runoff = 0.63 cfs @ 12.10 hrs, Volume= 2,278 cf, Depth= 3.04"
Routed to Pond DMH-3 : DMH

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3H: Subcat P-3H (roof)

Runoff = 0.63 cfs @ 12.10 hrs, Volume= 2,278 cf, Depth= 3.04"
Routed to Pond IS-1 : IS-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
8,032	98	Roofs, HSG A
968	98	Roofs, HSG B
9,000		Weighted Average
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3I: Subcat P-3I (roof)

Runoff = 0.63 cfs @ 12.10 hrs, Volume= 2,278 cf, Depth= 3.04"
Routed to Pond CB-6 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3J: Subcat P-3J (roof)

Runoff = 0.63 cfs @ 12.10 hrs, Volume= 2,278 cf, Depth= 3.04"
Routed to Pond IS-1 : IS-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3K: Subcat P-3K

Runoff = 0.22 cfs @ 12.39 hrs, Volume= 1,829 cf, Depth= 0.28"
Routed to Link SP-3 : STUDY POINT #3

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
3,321	39	>75% Grass cover, Good, HSG A
9,309	61	>75% Grass cover, Good, HSG B
355	30	Woods, Good, HSG A
64,507	55	Woods, Good, HSG B
77,492		Weighted Average
77,492	55	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	50	0.2500	0.11		**Sheet Flow, A-B** Woods: Dense underbrush n= 0.800 P2= 3.28"
3.6	359	0.1100	1.66		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.3	409	Total			

Summary for Subcatchment P-3L: Subcat P-3L

Runoff = 0.20 cfs @ 12.12 hrs, Volume= 961 cf, Depth= 0.47"
Routed to Reach 2R : Routing sheet flow through a subcatchment

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.27"

Area (sf)	CN	Description
24,381	61	>75% Grass cover, Good, HSG B
24,381	61	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	81	0.4000	0.25		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
5.4	81	Total, Increased to minimum Tc = 6.0 min			

Summary for Reach 2R: Routing sheet flow through a subcatchment

A subcatchment performs runoff calculations, including the associated Tc anc CN determinations. It does not have any facility for routing an inflow hydrograph from another source. However, a reach may be used to perform this type of specialized routing.

This reach demonstrates a procedure for performing a sheet-flow routing through a subcatchment area. In this case, the "reach" is defined as a wide channel with very low side slopes. The Manning's value of 0.15 is selected from the table of sheet flow roughness coefficients, which are much higher than normal Manning's values, in order to allow for the greater frictional losses of shallow flow. This value is comparable to the Manning's value for "very weedy reaches".

This example assumes that sheet flow occurs evenly over the entire 100' channel width, and that the flow depth is therefore very small. If the flow is concentrated or forms channels, the description and Manning's value must be adjusted accordingly.

Inflow Area = 152,297 sf, 61.66% Impervious, Inflow Depth = 0.08" for 2-year event
Inflow = 0.20 cfs @ 12.12 hrs, Volume= 961 cf
Outflow = 0.03 cfs @ 13.63 hrs, Volume= 961 cf, Atten= 83%, Lag= 90.9 min
Routed to Link SP-3 : STUDY POINT #3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.03 fps, Min. Travel Time= 136.6 min
Avg. Velocity = 0.03 fps, Avg. Travel Time= 136.6 min

Peak Storage= 279 cf @ 13.63 hrs
Average Depth at Peak Storage= 0.01' , Surface Width= 101.98'
Bank-Full Depth= 1.00' Flow Area= 200.0 sf, Capacity= 113.05 cfs

100.00' x 1.00' deep channel, n= 0.800 Sheet flow: Woods+dense brush
Side Slope Z-value= 100.0 '/' Top Width= 300.00'
Length= 280.0' Slope= 0.1590 '/'
Inlet Invert= 265.92', Outlet Invert= 221.40'

‡

Summary for Pond BR-1: bioretention

Inflow Area = 23,802 sf, 25.77% Impervious, Inflow Depth = 0.78" for 2-year event
Inflow = 0.45 cfs @ 12.08 hrs, Volume= 1,553 cf
Outflow = 0.04 cfs @ 11.68 hrs, Volume= 1,553 cf, Atten= 91%, Lag= 0.0 min
Discarded = 0.04 cfs @ 11.68 hrs, Volume= 1,553 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Link SP1 : STUDY POINT #1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 272.81' @ 12.94 hrs Surf.Area= 658 sf Storage= 541 cf
Flood Elev= 278.00' Surf.Area= 1,416 sf Storage= 1,824 cf

Plug-Flow detention time= 93.6 min calculated for 1,553 cf (100% of inflow)
Center-of-Mass det. time= 93.6 min (849.7 - 756.1)

Volume	Invert	Avail.Storage	Storage Description
#1	277.00'	1,211 cf	**surface storage (Irregular)** Listed below (Recalc)
#2	275.00'	78 cf	**media storage (Irregular)** Listed below (Recalc) 260 cf Overall x 30.0% Voids
#3A	271.50'	627 cf	**20.50'W x 32.10'L x 3.50'H Field A** 2,303 cf Overall - 735 cf Embedded = 1,568 cf x 40.0% Voids
#4A	272.00'	735 cf	**ADS_StormTech SC-740 +Cap** x 16 Inside #3 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 16 Chambers in 4 Rows
		2,651 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
277.00	184	71.0	0	0	184
278.00	628	136.5	384	384	1,271
279.00	1,043	158.1	827	1,211	1,798

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
275.00	130	53.0	0	0	130
277.00	130	53.0	260	260	236

Device	Routing	Invert	Outlet Devices
#0	Primary	279.00'	**Automatic Storage Overflow** (Discharged without head)
#1	Discarded	271.50'	**0.04 cfs Exfiltration at all elevations** Phase-In= 0.01'
#2	Primary	277.80'	**9.0' long x 4.0' 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) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=0.04 cfs @ 11.68 hrs HW=271.58' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=271.50' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond CB-1: CB

Inflow Area = 16,643 sf, 83.29% Impervious, Inflow Depth = 2.61" for 2-year event
Inflow = 1.03 cfs @ 12.08 hrs, Volume= 3,618 cf
Outflow = 1.03 cfs @ 12.08 hrs, Volume= 3,618 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.03 cfs @ 12.08 hrs, Volume= 3,618 cf
Routed to Link WQ-1 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 269.76' @ 12.08 hrs
Flood Elev= 272.52'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.22'	**12.0" Round Culvert** L= 45.0' Ke= 0.500 Inlet / Outlet Invert= 269.22' / 268.77' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.03 cfs @ 12.08 hrs HW=269.76' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.03 cfs @ 3.43 fps)

Summary for Pond CB-2: CB

Inflow Area = 6,117 sf, 82.83% Impervious, Inflow Depth = 2.53" for 2-year event
Inflow = 0.37 cfs @ 12.08 hrs, Volume= 1,287 cf
Outflow = 0.37 cfs @ 12.08 hrs, Volume= 1,287 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.37 cfs @ 12.08 hrs, Volume= 1,287 cf
Routed to Pond DMH-3 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 270.82' @ 12.09 hrs
Flood Elev= 273.92'

Device	Routing	Invert	Outlet Devices
#1	Primary	270.46'	**12.0" Round Culvert** L= 23.0' Ke= 0.500 Inlet / Outlet Invert= 270.46' / 270.23' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.36 cfs @ 12.08 hrs HW=270.82' TW=270.62' (Dynamic Tailwater)
1=Culvert (Outlet Controls 0.36 cfs @ 2.14 fps)

Summary for Pond CB-3: CB

Inflow Area = 13,831 sf, 67.53% Impervious, Inflow Depth = 2.05" for 2-year event
Inflow = 0.68 cfs @ 12.08 hrs, Volume= 2,365 cf
Outflow = 0.68 cfs @ 12.08 hrs, Volume= 2,365 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.68 cfs @ 12.08 hrs, Volume= 2,365 cf
Routed to Pond DMH-3 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 271.82' @ 12.09 hrs
Flood Elev= 274.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	271.40'	**12.0" Round Culvert** L= 126.0' Ke= 0.500 Inlet / Outlet Invert= 271.40' / 270.23' S= 0.0093 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.68 cfs @ 12.08 hrs HW=271.82' TW=270.62' (Dynamic Tailwater)
1=Culvert (Outlet Controls 0.68 cfs @ 3.18 fps)

Summary for Pond CB-4: CB

Inflow Area = 22,442 sf, 65.03% Impervious, Inflow Depth = 2.01" for 2-year event
Inflow = 1.08 cfs @ 12.08 hrs, Volume= 3,756 cf
Outflow = 1.08 cfs @ 12.08 hrs, Volume= 3,756 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.08 cfs @ 12.08 hrs, Volume= 3,756 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Peak Elev= 269.80' @ 12.08 hrs
Flood Elev= 272.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.24'	**12.0" Round Culvert** L= 44.0' Ke= 0.500 Inlet / Outlet Invert= 269.24' / 268.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.07 cfs @ 12.08 hrs HW=269.80' TW=0.00' (Dynamic Tailwater)
1=Culvert (Barrel Controls 1.07 cfs @ 3.45 fps)

Summary for Pond CB-5: CB

Inflow Area = 17,711 sf, 37.69% Impervious, Inflow Depth = 1.15" for 2-year event
Inflow = 0.46 cfs @ 12.10 hrs, Volume= 1,690 cf
Outflow = 0.46 cfs @ 12.10 hrs, Volume= 1,690 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.46 cfs @ 12.10 hrs, Volume= 1,690 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 271.70' @ 12.10 hrs
Flood Elev= 275.46'

Device	Routing	Invert	Outlet Devices
#1	Primary	271.36'	**12.0" Round Culvert** L= 65.0' Ke= 0.500 Inlet / Outlet Invert= 271.36' / 269.55' S= 0.0278 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.46 cfs @ 12.10 hrs HW=271.70' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.46 cfs @ 1.98 fps)

Summary for Pond CB-6: CB

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 2.18" for 2-year event
Inflow = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf
Outflow = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf
Routed to Pond DMH-7 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 275.33' @ 12.09 hrs
Flood Elev= 278.85'

Device	Routing	Invert	Outlet Devices
#1	Primary	274.74'	**12.0" Round Culvert** L= 95.0' Ke= 0.500 Inlet / Outlet Invert= 274.74' / 273.79' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.24 cfs @ 12.09 hrs HW=275.33' TW=274.28' (Dynamic Tailwater)
1=Culvert (Outlet Controls 1.24 cfs @ 3.72 fps)

Summary for Pond DMH-2: DMH

Inflow Area = 28,949 sf, 80.86% Impervious, Inflow Depth = 2.46" for 2-year event
Inflow = 1.68 cfs @ 12.09 hrs, Volume= 5,930 cf
Outflow = 1.68 cfs @ 12.09 hrs, Volume= 5,930 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.68 cfs @ 12.09 hrs, Volume= 5,930 cf
Routed to Link WQ-1 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 269.08' @ 12.09 hrs
Flood Elev= 274.78'

Device	Routing	Invert	Outlet Devices
#1	Primary	268.42'	**15.0" Round Culvert** L= 64.0' Ke= 0.500 Inlet / Outlet Invert= 268.42' / 267.87' S= 0.0086 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=1.68 cfs @ 12.09 hrs HW=269.08' TW=0.00' (Dynamic Tailwater)
1=Culvert (Barrel Controls 1.68 cfs @ 3.71 fps)

Summary for Pond DMH-3: DMH

Inflow Area = 28,949 sf, 80.86% Impervious, Inflow Depth = 2.46" for 2-year event
Inflow = 1.68 cfs @ 12.09 hrs, Volume= 5,930 cf
Outflow = 1.68 cfs @ 12.09 hrs, Volume= 5,930 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.68 cfs @ 12.09 hrs, Volume= 5,930 cf
Routed to Pond DMH-2 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 270.62' @ 12.09 hrs
Flood Elev= 274.41'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.98'	**15.0" Round Culvert** L= 168.0' Ke= 0.500 Inlet / Outlet Invert= 269.98' / 268.52' S= 0.0087 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=1.68 cfs @ 12.09 hrs HW=270.62' TW=269.08' (Dynamic Tailwater)
1=Culvert (Outlet Controls 1.68 cfs @ 3.89 fps)

Summary for Pond DMH-5: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 2.18" for 2-year event
Inflow = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf
Outflow = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Peak Elev= 267.92' @ 12.09 hrs
Flood Elev= 274.16'

Device	Routing	Invert	Outlet Devices
#1	Primary	267.34'	**12.0" Round Culvert** L= 23.0' Ke= 0.500 Inlet / Outlet Invert= 267.34' / 266.88' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.24 cfs @ 12.09 hrs HW=267.92' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 1.24 cfs @ 2.60 fps)

Summary for Pond DMH-6: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 2.18" for 2-year event
Inflow = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf
Outflow = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf
Routed to Pond DMH-5 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 272.75' @ 12.09 hrs
Flood Elev= 277.33'

Device	Routing	Invert	Outlet Devices
#1	Primary	272.17'	**12.0" Round Culvert** L= 147.0' Ke= 0.500 Inlet / Outlet Invert= 272.17' / 269.87' S= 0.0156 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.24 cfs @ 12.09 hrs HW=272.75' TW=267.92' (Dynamic Tailwater)
1=Culvert (Inlet Controls 1.24 cfs @ 2.60 fps)

Summary for Pond DMH-7: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 2.18" for 2-year event
Inflow = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf
Outflow = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.24 cfs @ 12.09 hrs, Volume= 4,395 cf
Routed to Pond DMH-6 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 274.28' @ 12.09 hrs
Flood Elev= 279.73'

Device	Routing	Invert	Outlet Devices
#1	Primary	273.70'	**12.0" Round Culvert** L= 143.0' Ke= 0.500 Inlet / Outlet Invert= 273.70' / 272.27' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.24 cfs @ 12.09 hrs HW=274.28' TW=272.75' (Dynamic Tailwater)
1=Culvert (Inlet Controls 1.24 cfs @ 2.60 fps)

Summary for Pond IS-1: IS-1

GEO-TP-5 indicates silty sand to a depth of 14' below grade with no refusal. The infiltration rate for loamy sand is 2.41 inches per hour (Rawls Rates)

Redox was encountered at 9' below grade or elevation 263.5

Inflow Area = 127,915 sf, 73.41% Impervious, Inflow Depth = 2.25" for 2-year event
Inflow = 6.74 cfs @ 12.09 hrs, Volume= 23,945 cf
Outflow = 0.44 cfs @ 11.44 hrs, Volume= 23,945 cf, Atten= 93%, Lag= 0.0 min
Discarded = 0.44 cfs @ 11.44 hrs, Volume= 23,945 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Link RR1 : RipRap Apron

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 267.60' @ 13.59 hrs Surf.Area= 7,868 sf Storage= 9,621 cf
Flood Elev= 271.25' Surf.Area= 7,868 sf Storage= 26,670 cf

Plug-Flow detention time= 169.7 min calculated for 23,942 cf (100% of inflow)
Center-of-Mass det. time= 169.7 min (927.4 - 757.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	265.75'	11,068 cf	**52.42'W x 150.10'L x 5.50'H Field A** 43,273 cf Overall - 15,602 cf Embedded = 27,671 cf x 40.0% Voids
#2A	266.50'	15,602 cf	**ADS_StormTech MC-3500 d +Cap** x 140 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 140 Chambers in 7 Rows Cap Storage= 14.9 cf x 2 x 7 rows = 208.6 cf
		26,670 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	265.75'	**0.44 cfs Exfiltration at all elevations** Phase-In= 0.01'
#2	Primary	266.47'	**10.0" Round Culvert** L= 29.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 266.47' / 265.92' S= 0.0190 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#3	Device 2	267.90'	**4.0' long x 6.26' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.44 cfs @ 11.44 hrs HW=265.84' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.44 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=265.75' TW=0.00' (Dynamic Tailwater)
└─**2=Culvert** (Controls 0.00 cfs)
  └─**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond RR2: Riprap Slope

Inflow Area = 7,513 sf, 0.00% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 24.01 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 24.01 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 24.01 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 19.97 hrs, Volume= 0 cf
Routed to Pond BR-1 : bioretention

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 280.00' @ 0.00 hrs Surf.Area= 111 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (1,356.0 - 1,356.0)

Volume	Invert	Avail.Storage	Storage Description
#1	280.00'	328 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 821 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
280.00	111	0	0
281.00	111	111	111
282.00	111	111	222
283.00	103	107	329
284.00	75	89	418
285.00	73	74	492
286.00	70	72	564
287.00	68	69	633
288.00	66	67	700
289.00	62	64	764
290.00	52	57	821

Device	Routing	Invert	Outlet Devices
#1	Discarded	280.00'	**0.37 cfs Exfiltration at all elevations**
#2	Primary	280.00'	**111.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.00 cfs @ 24.01 hrs HW=280.00' (Free Discharge)
└─**1=Exfiltration** (Passes 0.00 cfs of 0.37 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 19.97 hrs HW=280.00' TW=271.50' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond RR3: Riprap Slope

Inflow Area = 5,707 sf, 0.00% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 24.01 hrs, Volume= 1 cf
Outflow = 0.00 cfs @ 24.01 hrs, Volume= 1 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 24.01 hrs, Volume= 1 cf
Primary = 0.00 cfs @ 19.97 hrs, Volume= 0 cf
Routed to Pond BR-1 : bioretention

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 280.00' @ 0.00 hrs Surf.Area= 116 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (1,356.0 - 1,356.0)

Volume	Invert	Avail.Storage	Storage Description
#1	280.00'	464 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 1,160 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
280.00	116	0	0
281.00	116	116	116
282.00	116	116	232
283.00	116	116	348
284.00	116	116	464
285.00	116	116	580
286.00	116	116	696
287.00	116	116	812
288.00	116	116	928
289.00	116	116	1,044
290.00	116	116	1,160

Device	Routing	Invert	Outlet Devices
#1	Discarded	280.00'	**0.37 cfs Exfiltration at all elevations**
#2	Primary	280.00'	**111.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.00 cfs @ 24.01 hrs HW=280.00' (Free Discharge)
└─**1=Exfiltration** (Passes 0.00 cfs of 0.37 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 19.97 hrs HW=280.00' TW=271.50' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link RR1: RipRap Apron

Inflow Area = 127,915 sf, 73.41% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Routed to Reach 2R : Routing sheet flow through a subcatchment

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP-3: STUDY POINT #3

Inflow Area = 229,788 sf, 40.86% Impervious, Inflow Depth = 0.15" for 2-year event
Inflow = 0.24 cfs @ 12.39 hrs, Volume= 2,790 cf
Primary = 0.24 cfs @ 12.39 hrs, Volume= 2,790 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP1: STUDY POINT #1

Inflow Area = 27,226 sf, 22.53% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 24.01 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 24.01 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP2: STUDY POINT #2

Inflow Area = 1,587 sf, 0.00% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 24.01 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 24.01 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link WQ-1: Water Quality Unit

Inflow Area = 45,592 sf, 81.75% Impervious, Inflow Depth = 2.51" for 2-year event
Inflow = 2.71 cfs @ 12.09 hrs, Volume= 9,548 cf
Primary = 2.71 cfs @ 12.09 hrs, Volume= 9,548 cf, Atten= 0%, Lag= 0.0 min
Routed to Pond IS-1 : IS-1

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link WQ-2: Water Quality Unit

Inflow Area = 64,323 sf, 60.06% Impervious, Inflow Depth = 1.84" for 2-year event
Inflow = 2.77 cfs @ 12.09 hrs, Volume= 9,841 cf
Primary = 2.77 cfs @ 12.09 hrs, Volume= 9,841 cf, Atten= 0%, Lag= 0.0 min
Routed to Pond IS-1 : IS-1

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment P-1A: Subcat P-1A Runoff Area=5,859 sf 54.96% Impervious Runoff Depth=2.64"
Flow Length=67' Slope=0.0300 '/' Tc=6.0 min CN=WQ Runoff=0.35 cfs 1,291 cf

Subcatchment P-1B: Subcat P-1B Runoff Area=4,722 sf 61.71% Impervious Runoff Depth=2.95"
Flow Length=34' Slope=0.0300 '/' Tc=6.0 min CN=WQ Runoff=0.32 cfs 1,160 cf

Subcatchment P-1C: Subcat P-1C Runoff Area=3,424 sf 0.00% Impervious Runoff Depth=0.13"
Tc=6.0 min CN=WQ Runoff=0.00 cfs 36 cf

Subcatchment P-1D: Subcat P-1D Runoff Area=7,513 sf 0.00% Impervious Runoff Depth=0.07"
Flow Length=68' Slope=0.1673 '/' Tc=6.0 min CN=WQ Runoff=0.00 cfs 45 cf

Subcatchment P-1E: Subcat P-1E Runoff Area=5,707 sf 0.00% Impervious Runoff Depth=0.15"
Flow Length=62' Tc=6.0 min CN=WQ Runoff=0.00 cfs 74 cf

Subcatchment P-2: Subcat P-2 Runoff Area=1,587 sf 0.00% Impervious Runoff Depth=0.08"
Tc=6.0 min CN=WQ Runoff=0.00 cfs 10 cf

Subcatchment P-3A: Subcat P-3A Runoff Area=15,170 sf 55.11% Impervious Runoff Depth=2.64"
Flow Length=153' Tc=6.2 min CN=WQ Runoff=0.91 cfs 3,332 cf

Subcatchment P-3B: Subcat P-3B Runoff Area=17,711 sf 37.69% Impervious Runoff Depth=1.85"
Flow Length=301' Tc=7.5 min CN=WQ Runoff=0.70 cfs 2,735 cf

Subcatchment P-3C: Subcat P-3C Runoff Area=22,442 sf 65.03% Impervious Runoff Depth=3.16"
Flow Length=158' Slope=0.0200 '/' Tc=6.0 min CN=WQ Runoff=1.65 cfs 5,918 cf

Subcatchment P-3D: Subcat P-3D Runoff Area=13,831 sf 67.53% Impervious Runoff Depth=3.20"
Flow Length=135' Slope=0.0360 '/' Tc=6.0 min CN=WQ Runoff=1.03 cfs 3,688 cf

Subcatchment P-3E: Subcat P-3E Runoff Area=6,117 sf 82.83% Impervious Runoff Depth=3.92"
Tc=6.0 min CN=WQ Runoff=0.56 cfs 1,997 cf

Subcatchment P-3F: Subcat P-3F Runoff Area=16,643 sf 83.29% Impervious Runoff Depth=4.10"
Tc=6.0 min CN=WQ Runoff=1.61 cfs 5,690 cf

Subcatchment P-3G: Subcat P-3G (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=4.66"
Tc=7.0 min CN=98 Runoff=0.96 cfs 3,497 cf

Subcatchment P-3H: Subcat P-3H (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=4.66"
Tc=7.0 min CN=WQ Runoff=0.96 cfs 3,497 cf

Subcatchment P-3I: Subcat P-3I (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=4.66"
Tc=7.0 min CN=98 Runoff=0.96 cfs 3,497 cf

Subcatchment P-3J: Subcat P-3J (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=4.66"
Tc=7.0 min CN=98 Runoff=0.96 cfs 3,497 cf

Subcatchment P-3K: Subcat P-3K Runoff Area=77,492 sf 0.00% Impervious Runoff Depth=0.94"
Flow Length=409' Tc=11.3 min CN=WQ Runoff=1.29 cfs 6,068 cf

Subcatchment P-3L: Subcat P-3L Runoff Area=24,381 sf 0.00% Impervious Runoff Depth=1.31"
Flow Length=81' Slope=0.4000 '/' Tc=6.0 min CN=61 Runoff=0.78 cfs 2,661 cf

Reach 2R: Routing sheet flow through a Avg. Flow Depth=0.09' Max Vel=0.14 fps Inflow=2.66 cfs 8,988 cf
n=0.800 L=280.0' S=0.1590 '/' Capacity=113.05 cfs Outflow=1.45 cfs 8,988 cf

Pond BR-1: bioretention Peak Elev=273.80' Storage=993 cf Inflow=0.67 cfs 2,451 cf
Discarded=0.04 cfs 2,451 cf Primary=0.00 cfs 0 cf Outflow=0.04 cfs 2,451 cf

Pond CB-1: CB Peak Elev=269.93' Inflow=1.61 cfs 5,690 cf
12.0" Round Culvert n=0.013 L=45.0' S=0.0100 '/' Outflow=1.61 cfs 5,690 cf

Pond CB-2: CB Peak Elev=270.96' Inflow=0.56 cfs 1,997 cf
12.0" Round Culvert n=0.013 L=23.0' S=0.0100 '/' Outflow=0.56 cfs 1,997 cf

Pond CB-3: CB Peak Elev=271.94' Inflow=1.03 cfs 3,688 cf
12.0" Round Culvert n=0.013 L=126.0' S=0.0093 '/' Outflow=1.03 cfs 3,688 cf

Pond CB-4: CB Peak Elev=269.97' Inflow=1.65 cfs 5,918 cf
12.0" Round Culvert n=0.013 L=44.0' S=0.0100 '/' Outflow=1.65 cfs 5,918 cf

Pond CB-5: CB Peak Elev=271.78' Inflow=0.70 cfs 2,735 cf
12.0" Round Culvert n=0.013 L=65.0' S=0.0278 '/' Outflow=0.70 cfs 2,735 cf

Pond CB-6: CB Peak Elev=275.50' Inflow=1.87 cfs 6,830 cf
12.0" Round Culvert n=0.013 L=95.0' S=0.0100 '/' Outflow=1.87 cfs 6,830 cf

Pond DMH-2: DMH Peak Elev=269.27' Inflow=2.54 cfs 9,182 cf
15.0" Round Culvert n=0.013 L=64.0' S=0.0086 '/' Outflow=2.54 cfs 9,182 cf

Pond DMH-3: DMH Peak Elev=270.80' Inflow=2.54 cfs 9,182 cf
15.0" Round Culvert n=0.013 L=168.0' S=0.0087 '/' Outflow=2.54 cfs 9,182 cf

Pond DMH-5: DMH Peak Elev=268.09' Inflow=1.87 cfs 6,830 cf
12.0" Round Culvert n=0.013 L=23.0' S=0.0200 '/' Outflow=1.87 cfs 6,830 cf

Pond DMH-6: DMH Peak Elev=272.92' Inflow=1.87 cfs 6,830 cf
12.0" Round Culvert n=0.013 L=147.0' S=0.0156 '/' Outflow=1.87 cfs 6,830 cf

Pond DMH-7: DMH Peak Elev=274.45' Inflow=1.87 cfs 6,830 cf
12.0" Round Culvert n=0.013 L=143.0' S=0.0100 '/' Outflow=1.87 cfs 6,830 cf

Pond IS-1: IS-1 Peak Elev=268.22' Storage=13,486 cf Inflow=10.27 cfs 37,351 cf
Discarded=0.44 cfs 31,023 cf Primary=2.36 cfs 6,328 cf Outflow=2.80 cfs 37,351 cf

Pond RR2: Riprap Slope Peak Elev=280.00' Storage=0 cf Inflow=0.00 cfs 45 cf
Discarded=0.00 cfs 45 cf Primary=0.00 cfs 0 cf Outflow=0.00 cfs 45 cf

Pond RR3: Riprap Slope Peak Elev=280.00' Storage=0 cf Inflow=0.00 cfs 74 cf
Discarded=0.00 cfs 74 cf Primary=0.00 cfs 0 cf Outflow=0.00 cfs 74 cf

Link RR1: RipRap Apron Inflow=2.36 cfs 6,328 cf
Primary=2.36 cfs 6,328 cf

Link SP-3: STUDY POINT #3 Inflow=1.86 cfs 15,057 cf
Primary=1.86 cfs 15,057 cf

Link SP1: STUDY POINT #1 Inflow=0.00 cfs 36 cf
Primary=0.00 cfs 36 cf

Link SP2: STUDY POINT #2 Inflow=0.00 cfs 10 cf
Primary=0.00 cfs 10 cf

Link WQ-1: Water Quality Unit Inflow=4.15 cfs 14,873 cf
Primary=4.15 cfs 14,873 cf

Link WQ-2: Water Quality Unit Inflow=4.21 cfs 15,483 cf
Primary=4.21 cfs 15,483 cf

Total Runoff Area = 258,601 sf Runoff Volume = 48,696 cf Average Runoff Depth = 2.26"
61.32% Pervious = 158,566 sf 38.68% Impervious = 100,035 sf

Summary for Subcatchment P-1A: Subcat P-1A

Runoff = 0.35 cfs @ 12.08 hrs, Volume= 1,291 cf, Depth= 2.64"
Routed to Pond BR-1 : bioretention

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
2,639	39	>75% Grass cover, Good, HSG A
3,220	98	Paved parking, HSG A
5,859		Weighted Average
2,639	39	45.04% Pervious Area
3,220	98	54.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	67	0.0300	1.51		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.28"
0.7	67	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1B: Subcat P-1B

Runoff = 0.32 cfs @ 12.08 hrs, Volume= 1,160 cf, Depth= 2.95"
Routed to Pond BR-1 : bioretention

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
1,808	39	>75% Grass cover, Good, HSG A
2,914	98	Paved parking, HSG A
4,722		Weighted Average
1,808	39	38.29% Pervious Area
2,914	98	61.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	34	0.0300	1.32		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
0.4	34	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1C: Subcat P-1C

Runoff = 0.00 cfs @ 12.50 hrs, Volume= 36 cf, Depth= 0.13"
Routed to Link SP1 : STUDY POINT #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
2,411	39	>75% Grass cover, Good, HSG A
1,014	30	Woods, Good, HSG A
3,424		Weighted Average
3,424	36	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-1D: Subcat P-1D

Runoff = 0.00 cfs @ 12.50 hrs, Volume= 45 cf, Depth= 0.07"
Routed to Pond RR2 : Riprap Slope

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
2,966	39	>75% Grass cover, Good, HSG A
4,547	30	Woods, Good, HSG A
7,513		Weighted Average
7,513	34	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1673	0.16		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.1	18	0.1673	2.05		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
5.3	68	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1E: Subcat P-1E

Runoff = 0.00 cfs @ 12.50 hrs, Volume= 74 cf, Depth= 0.15"
Routed to Pond RR3 : Riprap Slope

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
4,885	39	>75% Grass cover, Good, HSG A
823	30	Woods, Good, HSG A
5,707		Weighted Average
5,707	38	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	21	0.1200	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
0.3	41	0.0992	2.20		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.3	62	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-2: Subcat P-2

Runoff = 0.00 cfs @ 12.50 hrs, Volume= 10 cf, Depth= 0.08"
Routed to Link SP2 : STUDY POINT #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
683	39	>75% Grass cover, Good, HSG A
904	30	Woods, Good, HSG A
1,587		Weighted Average
1,587	34	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3A: Subcat P-3A

Runoff = 0.91 cfs @ 12.09 hrs, Volume= 3,332 cf, Depth= 2.64"
Routed to Pond CB-6 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
5,532	39	>75% Grass cover, Good, HSG A
8,361	98	Paved parking, HSG A
1,278	30	Woods, Good, HSG A
15,170		Weighted Average
6,810	37	44.89% Pervious Area
8,361	98	55.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	47	0.1200	0.14		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.5	106	0.0300	3.52		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
6.2	153	Total			

Summary for Subcatchment P-3B: Subcat P-3B

Runoff = 0.70 cfs @ 12.10 hrs, Volume= 2,735 cf, Depth= 1.85"
Routed to Pond CB-5 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
9,350	39	>75% Grass cover, Good, HSG A
6,675	98	Paved parking, HSG A
1,685	30	Woods, Good, HSG A
17,711		Weighted Average
11,035	38	62.31% Pervious Area
6,675	98	37.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	47	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
1.8	254	0.0140	2.40		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
7.5	301	Total			

Summary for Subcatchment P-3C: Subcat P-3C

Runoff = 1.65 cfs @ 12.08 hrs, Volume= 5,918 cf, Depth= 3.16"
Routed to Pond CB-4 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
5,057	39	>75% Grass cover, Good, HSG A
1,547	61	>75% Grass cover, Good, HSG B
2,587	98	Paved parking, HSG A
12,008	98	Paved parking, HSG B
1,229	30	Woods, Good, HSG A
14	55	Woods, Good, HSG B
22,442		Weighted Average
7,847	42	34.97% Pervious Area
14,595	98	65.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	158	0.0200	1.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
1.7	158	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-3D: Subcat P-3D

Runoff = 1.03 cfs @ 12.08 hrs, Volume= 3,688 cf, Depth= 3.20"
Routed to Pond CB-3 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
3,872	39	>75% Grass cover, Good, HSG A
9,341	98	Paved parking, HSG A
619	30	Woods, Good, HSG A
13,831		Weighted Average
4,491	38	32.47% Pervious Area
9,341	98	67.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0360	1.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
0.4	85	0.0360	3.85		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
0.9	135	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-3E: Subcat P-3E

Runoff = 0.56 cfs @ 12.08 hrs, Volume= 1,997 cf, Depth= 3.92"
Routed to Pond CB-2 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
925	39	>75% Grass cover, Good, HSG A
125	61	>75% Grass cover, Good, HSG B
4,721	98	Paved parking, HSG A
346	98	Paved parking, HSG B
6,117		Weighted Average
1,050	42	17.17% Pervious Area
5,067	98	82.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3F: Subcat P-3F

Runoff = 1.61 cfs @ 12.08 hrs, Volume= 5,690 cf, Depth= 4.10"
Routed to Pond CB-1 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
2,781	61	>75% Grass cover, Good, HSG B
455	98	Paved parking, HSG A
13,407	98	Paved parking, HSG B
16,643		Weighted Average
2,781	61	16.71% Pervious Area
13,862	98	83.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3G: Subcat P-3G (roof)

Runoff = 0.96 cfs @ 12.10 hrs, Volume= 3,497 cf, Depth= 4.66"
Routed to Pond DMH-3 : DMH

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3H: Subcat P-3H (roof)

Runoff = 0.96 cfs @ 12.10 hrs, Volume= 3,497 cf, Depth= 4.66"
Routed to Pond IS-1 : IS-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
8,032	98	Roofs, HSG A
968	98	Roofs, HSG B
9,000		Weighted Average
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3I: Subcat P-3I (roof)

Runoff = 0.96 cfs @ 12.10 hrs, Volume= 3,497 cf, Depth= 4.66"
Routed to Pond CB-6 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3J: Subcat P-3J (roof)

Runoff = 0.96 cfs @ 12.10 hrs, Volume= 3,497 cf, Depth= 4.66"
Routed to Pond IS-1 : IS-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3K: Subcat P-3K

Runoff = 1.29 cfs @ 12.19 hrs, Volume= 6,068 cf, Depth= 0.94"
Routed to Link SP-3 : STUDY POINT #3

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
3,321	39	>75% Grass cover, Good, HSG A
9,309	61	>75% Grass cover, Good, HSG B
355	30	Woods, Good, HSG A
64,507	55	Woods, Good, HSG B
77,492		Weighted Average
77,492	55	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	50	0.2500	0.11		**Sheet Flow, A-B** Woods: Dense underbrush n= 0.800 P2= 3.28"
3.6	359	0.1100	1.66		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.3	409	Total			

Summary for Subcatchment P-3L: Subcat P-3L

Runoff = 0.78 cfs @ 12.10 hrs, Volume= 2,661 cf, Depth= 1.31"
Routed to Reach 2R : Routing sheet flow through a subcatchment

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.90"

Area (sf)	CN	Description
24,381	61	>75% Grass cover, Good, HSG B
24,381	61	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	81	0.4000	0.25		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
5.4	81	Total, Increased to minimum Tc = 6.0 min			

Summary for Reach 2R: Routing sheet flow through a subcatchment

A subcatchment performs runoff calculations, including the associated Tc anc CN determinations. It does not have any facility for routing an inflow hydrograph from another source. However, a reach may be used to perform this type of specialized routing.

This reach demonstrates a procedure for performing a sheet-flow routing through a subcatchment area. In this case, the "reach" is defined as a wide channel with very low side slopes. The Manning's value of 0.15 is selected from the table of sheet flow roughness coefficients, which are much higher than normal Manning's values, in order to allow for the greater frictional losses of shallow flow. This value is comparable to the Manning's value for "very weedy reaches".

This example assumes that sheet flow occurs evenly over the entire 100' channel width, and that the flow depth is therefore very small. If the flow is concentrated or forms channels, the description and Manning's value must be adjusted accordingly.

Inflow Area = 152,297 sf, 61.66% Impervious, Inflow Depth = 0.71" for 10-year event
Inflow = 2.66 cfs @ 12.43 hrs, Volume= 8,988 cf
Outflow = 1.45 cfs @ 12.73 hrs, Volume= 8,988 cf, Atten= 46%, Lag= 18.2 min
Routed to Link SP-3 : STUDY POINT #3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.14 fps, Min. Travel Time= 32.5 min
Avg. Velocity = 0.04 fps, Avg. Travel Time= 111.2 min

Peak Storage= 2,825 cf @ 12.73 hrs
Average Depth at Peak Storage= 0.09' , Surface Width= 118.47'
Bank-Full Depth= 1.00' Flow Area= 200.0 sf, Capacity= 113.05 cfs

100.00' x 1.00' deep channel, n= 0.800 Sheet flow: Woods+dense brush
Side Slope Z-value= 100.0 '/' Top Width= 300.00'
Length= 280.0' Slope= 0.1590 '/'
Inlet Invert= 265.92', Outlet Invert= 221.40'

‡

Summary for Pond BR-1: bioretention

Inflow Area = 23,802 sf, 25.77% Impervious, Inflow Depth = 1.24" for 10-year event
Inflow = 0.67 cfs @ 12.08 hrs, Volume= 2,451 cf
Outflow = 0.04 cfs @ 11.23 hrs, Volume= 2,451 cf, Atten= 94%, Lag= 0.0 min
Discarded = 0.04 cfs @ 11.23 hrs, Volume= 2,451 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Link SP1 : STUDY POINT #1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 273.80' @ 13.89 hrs Surf.Area= 658 sf Storage= 993 cf
Flood Elev= 278.00' Surf.Area= 1,416 sf Storage= 1,824 cf

Plug-Flow detention time= 197.4 min calculated for 2,450 cf (100% of inflow)
Center-of-Mass det. time= 197.4 min (953.1 - 755.7)

Volume	Invert	Avail.Storage	Storage Description
#1	277.00'	1,211 cf	**surface storage (Irregular)**Listed below (Recalc)
#2	275.00'	78 cf	**media storage (Irregular)**Listed below (Recalc) 260 cf Overall x 30.0% Voids
#3A	271.50'	627 cf	**20.50'W x 32.10'L x 3.50'H Field A** 2,303 cf Overall - 735 cf Embedded = 1,568 cf x 40.0% Voids
#4A	272.00'	735 cf	**ADS_StormTech SC-740 +Cap** x 16 Inside #3 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 16 Chambers in 4 Rows
		2,651 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
277.00	184	71.0	0	0	184
278.00	628	136.5	384	384	1,271
279.00	1,043	158.1	827	1,211	1,798

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
275.00	130	53.0	0	0	130
277.00	130	53.0	260	260	236

Device	Routing	Invert	Outlet Devices
#0	Primary	279.00'	**Automatic Storage Overflow** (Discharged without head)
#1	Discarded	271.50'	**0.04 cfs Exfiltration at all elevations** Phase-In= 0.01'
#2	Primary	277.80'	**9.0' long x 4.0' 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) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=0.04 cfs @ 11.23 hrs HW=271.58' (Free Discharge)
↑1=Exfiltration (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=271.50' TW=0.00' (Dynamic Tailwater)
↑2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Pond CB-1: CB

Inflow Area = 16,643 sf, 83.29% Impervious, Inflow Depth = 4.10" for 10-year event
Inflow = 1.61 cfs @ 12.08 hrs, Volume= 5,690 cf
Outflow = 1.61 cfs @ 12.08 hrs, Volume= 5,690 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.61 cfs @ 12.08 hrs, Volume= 5,690 cf
Routed to Link WQ-1 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 269.93' @ 12.08 hrs
Flood Elev= 272.52'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.22'	**12.0" Round Culvert** L= 45.0' Ke= 0.500 Inlet / Outlet Invert= 269.22' / 268.77' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.61 cfs @ 12.08 hrs HW=269.93' TW=0.00' (Dynamic Tailwater)
↑1=Culvert (Barrel Controls 1.61 cfs @ 3.77 fps)

Summary for Pond CB-2: CB

Inflow Area = 6,117 sf, 82.83% Impervious, Inflow Depth = 3.92" for 10-year event
Inflow = 0.56 cfs @ 12.08 hrs, Volume= 1,997 cf
Outflow = 0.56 cfs @ 12.08 hrs, Volume= 1,997 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.56 cfs @ 12.08 hrs, Volume= 1,997 cf
Routed to Pond DMH-3 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 270.96' @ 12.09 hrs
Flood Elev= 273.92'

Device	Routing	Invert	Outlet Devices
#1	Primary	270.46'	**12.0" Round Culvert** L= 23.0' Ke= 0.500 Inlet / Outlet Invert= 270.46' / 270.23' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.55 cfs @ 12.08 hrs HW=270.96' TW=270.79' (Dynamic Tailwater)
↑1=Culvert (Outlet Controls 0.55 cfs @ 2.06 fps)

Summary for Pond CB-3: CB

Inflow Area = 13,831 sf, 67.53% Impervious, Inflow Depth = 3.20" for 10-year event
Inflow = 1.03 cfs @ 12.08 hrs, Volume= 3,688 cf
Outflow = 1.03 cfs @ 12.08 hrs, Volume= 3,688 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.03 cfs @ 12.08 hrs, Volume= 3,688 cf
Routed to Pond DMH-3 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 271.94' @ 12.09 hrs
Flood Elev= 274.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	271.40'	**12.0" Round Culvert** L= 126.0' Ke= 0.500 Inlet / Outlet Invert= 271.40' / 270.23' S= 0.0093 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.02 cfs @ 12.08 hrs HW=271.94' TW=270.79' (Dynamic Tailwater)
↑1=Culvert (Outlet Controls 1.02 cfs @ 3.42 fps)

Summary for Pond CB-4: CB

Inflow Area = 22,442 sf, 65.03% Impervious, Inflow Depth = 3.16" for 10-year event
Inflow = 1.65 cfs @ 12.08 hrs, Volume= 5,918 cf
Outflow = 1.65 cfs @ 12.08 hrs, Volume= 5,918 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.65 cfs @ 12.08 hrs, Volume= 5,918 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Peak Elev= 269.97' @ 12.08 hrs
Flood Elev= 272.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.24'	**12.0" Round Culvert** L= 44.0' Ke= 0.500 Inlet / Outlet Invert= 269.24' / 268.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.65 cfs @ 12.08 hrs HW=269.96' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.65 cfs @ 3.79 fps)

Summary for Pond CB-5: CB

Inflow Area = 17,711 sf, 37.69% Impervious, Inflow Depth = 1.85" for 10-year event
Inflow = 0.70 cfs @ 12.10 hrs, Volume= 2,735 cf
Outflow = 0.70 cfs @ 12.10 hrs, Volume= 2,735 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.70 cfs @ 12.10 hrs, Volume= 2,735 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 271.78' @ 12.10 hrs
Flood Elev= 275.46'

Device	Routing	Invert	Outlet Devices
#1	Primary	271.36'	**12.0" Round Culvert** L= 65.0' Ke= 0.500 Inlet / Outlet Invert= 271.36' / 269.55' S= 0.0278 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.70 cfs @ 12.10 hrs HW=271.78' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.70 cfs @ 2.21 fps)

Summary for Pond CB-6: CB

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 3.39" for 10-year event
Inflow = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf
Outflow = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf
Routed to Pond DMH-7 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 275.50' @ 12.09 hrs
Flood Elev= 278.85'

Device	Routing	Invert	Outlet Devices
#1	Primary	274.74'	**12.0" Round Culvert** L= 95.0' Ke= 0.500 Inlet / Outlet Invert= 274.74' / 273.79' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.86 cfs @ 12.09 hrs HW=275.50' TW=274.45' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.86 cfs @ 4.02 fps)

Summary for Pond DMH-2: DMH

Inflow Area = 28,949 sf, 80.86% Impervious, Inflow Depth = 3.81" for 10-year event
Inflow = 2.54 cfs @ 12.09 hrs, Volume= 9,182 cf
Outflow = 2.54 cfs @ 12.09 hrs, Volume= 9,182 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.54 cfs @ 12.09 hrs, Volume= 9,182 cf
Routed to Link WQ-1 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 269.27' @ 12.09 hrs
Flood Elev= 274.78'

Device	Routing	Invert	Outlet Devices
#1	Primary	268.42'	**15.0" Round Culvert** L= 64.0' Ke= 0.500 Inlet / Outlet Invert= 268.42' / 267.87' S= 0.0086 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=2.54 cfs @ 12.09 hrs HW=269.27' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.54 cfs @ 4.06 fps)

Summary for Pond DMH-3: DMH

Inflow Area = 28,949 sf, 80.86% Impervious, Inflow Depth = 3.81" for 10-year event
Inflow = 2.54 cfs @ 12.09 hrs, Volume= 9,182 cf
Outflow = 2.54 cfs @ 12.09 hrs, Volume= 9,182 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.54 cfs @ 12.09 hrs, Volume= 9,182 cf
Routed to Pond DMH-2 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 270.80' @ 12.09 hrs
Flood Elev= 274.41'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.98'	**15.0" Round Culvert** L= 168.0' Ke= 0.500 Inlet / Outlet Invert= 269.98' / 268.52' S= 0.0087 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=2.53 cfs @ 12.09 hrs HW=270.80' TW=269.27' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 2.53 cfs @ 4.24 fps)

Summary for Pond DMH-5: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 3.39" for 10-year event
Inflow = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf
Outflow = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Peak Elev= 268.09' @ 12.09 hrs
Flood Elev= 274.16'

Device	Routing	Invert	Outlet Devices
#1	Primary	267.34'	**12.0" Round Culvert** L= 23.0' Ke= 0.500 Inlet / Outlet Invert= 267.34' / 266.88' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.87 cfs @ 12.09 hrs HW=268.09' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.87 cfs @ 2.95 fps)

Summary for Pond DMH-6: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 3.39" for 10-year event
Inflow = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf
Outflow = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf
Routed to Pond DMH-5 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 272.92' @ 12.09 hrs
Flood Elev= 277.33'

Device	Routing	Invert	Outlet Devices
#1	Primary	272.17'	**12.0" Round Culvert** L= 147.0' Ke= 0.500 Inlet / Outlet Invert= 272.17' / 269.87' S= 0.0156 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.87 cfs @ 12.09 hrs HW=272.92' TW=268.09' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.87 cfs @ 2.95 fps)

Summary for Pond DMH-7: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 3.39" for 10-year event
Inflow = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf
Outflow = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.87 cfs @ 12.09 hrs, Volume= 6,830 cf
Routed to Pond DMH-6 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 274.45' @ 12.09 hrs
Flood Elev= 279.73'

Device	Routing	Invert	Outlet Devices
#1	Primary	273.70'	**12.0" Round Culvert** L= 143.0' Ke= 0.500 Inlet / Outlet Invert= 273.70' / 272.27' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.87 cfs @ 12.09 hrs HW=274.45' TW=272.92' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.87 cfs @ 2.95 fps)

Summary for Pond IS-1: IS-1

GEO-TP-5 indicates silty sand to a depth of 14' below grade with no refusal. The infiltration rate for loamy sand is 2.41 inches per hour (Rawls Rates)

Redox was encountered at 9' below grade or elevation 263.5

Inflow Area = 127,915 sf, 73.41% Impervious, Inflow Depth = 3.50" for 10-year event
Inflow = 10.27 cfs @ 12.09 hrs, Volume= 37,351 cf
Outflow = 2.80 cfs @ 12.44 hrs, Volume= 37,351 cf, Atten= 73%, Lag= 21.2 min
Discarded = 0.44 cfs @ 10.52 hrs, Volume= 31,023 cf
Primary = 2.36 cfs @ 12.44 hrs, Volume= 6,328 cf
Routed to Link RR1 : RipRap Apron

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 268.22' @ 12.44 hrs Surf.Area= 7,868 sf Storage= 13,486 cf
Flood Elev= 271.25' Surf.Area= 7,868 sf Storage= 26,670 cf

Plug-Flow detention time= 186.6 min calculated for 37,345 cf (100% of inflow)
Center-of-Mass det. time= 186.6 min (939.8 - 753.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	265.75'	11,068 cf	**52.42'W x 150.10'L x 5.50'H Field A** 43,273 cf Overall - 15,602 cf Embedded = 27,671 cf x 40.0% Voids
#2A	266.50'	15,602 cf	**ADS_StormTech MC-3500 d +Cap** x 140 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 140 Chambers in 7 Rows Cap Storage= 14.9 cf x 2 x 7 rows = 208.6 cf
		26,670 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	265.75'	**0.44 cfs Exfiltration at all elevations** Phase-In= 0.01'
#2	Primary	266.47'	**10.0" Round Culvert** L= 29.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 266.47' / 265.92' S= 0.0190 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#3	Device 2	267.90'	**4.0' long x 6.26' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.44 cfs @ 10.52 hrs HW=265.83' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.44 cfs)

Primary OutFlow Max=2.36 cfs @ 12.44 hrs HW=268.22' TW=0.00' (Dynamic Tailwater)
└─**2=Culvert** (Passes 2.36 cfs of 2.40 cfs potential flow)
  └─**3=Sharp-Crested Rectangular Weir** (Weir Controls 2.36 cfs @ 1.86 fps)

Summary for Pond RR2: Riprap Slope

Inflow Area = 7,513 sf, 0.00% Impervious, Inflow Depth = 0.07" for 10-year event
Inflow = 0.00 cfs @ 12.50 hrs, Volume= 45 cf
Outflow = 0.00 cfs @ 12.50 hrs, Volume= 45 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 12.50 hrs, Volume= 45 cf
Primary = 0.00 cfs @ 24.30 hrs, Volume= 0 cf
Routed to Pond BR-1 : bioretention

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 280.00' @ 0.00 hrs Surf.Area= 111 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (1,024.0 - 1,024.0)

Volume	Invert	Avail.Storage	Storage Description
#1	280.00'	328 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 821 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
280.00	111	0	0
281.00	111	111	111
282.00	111	111	222
283.00	103	107	329
284.00	75	89	418
285.00	73	74	492
286.00	70	72	564
287.00	68	69	633
288.00	66	67	700
289.00	62	64	764
290.00	52	57	821

Device	Routing	Invert	Outlet Devices
#1	Discarded	280.00'	**0.37 cfs Exfiltration at all elevations**
#2	Primary	280.00'	**111.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.00 cfs @ 12.50 hrs HW=280.00' (Free Discharge)
↑—**1=Exfiltration** (Passes 0.00 cfs of 0.37 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 24.30 hrs HW=280.00' TW=271.67' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond RR3: Riprap Slope

Inflow Area = 5,707 sf, 0.00% Impervious, Inflow Depth = 0.15" for 10-year event
Inflow = 0.00 cfs @ 12.50 hrs, Volume= 74 cf
Outflow = 0.00 cfs @ 12.50 hrs, Volume= 74 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 12.50 hrs, Volume= 74 cf
Primary = 0.00 cfs @ 24.34 hrs, Volume= 0 cf
Routed to Pond BR-1 : bioretention

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 280.00' @ 0.00 hrs Surf.Area= 116 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (1,018.4 - 1,018.4)

Volume	Invert	Avail.Storage	Storage Description
#1	280.00'	464 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 1,160 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
280.00	116	0	0
281.00	116	116	116
282.00	116	116	232
283.00	116	116	348
284.00	116	116	464
285.00	116	116	580
286.00	116	116	696
287.00	116	116	812
288.00	116	116	928
289.00	116	116	1,044
290.00	116	116	1,160

Device	Routing	Invert	Outlet Devices
#1	Discarded	280.00'	**0.37 cfs Exfiltration at all elevations**
#2	Primary	280.00'	**111.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.00 cfs @ 12.50 hrs HW=280.00' (Free Discharge)
↑—**1=Exfiltration** (Passes 0.00 cfs of 0.37 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 24.34 hrs HW=280.00' TW=271.65' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link RR1: RipRap Apron

Inflow Area = 127,915 sf, 73.41% Impervious, Inflow Depth = 0.59" for 10-year event
Inflow = 2.36 cfs @ 12.44 hrs, Volume= 6,328 cf
Primary = 2.36 cfs @ 12.44 hrs, Volume= 6,328 cf, Atten= 0%, Lag= 0.0 min
Routed to Reach 2R : Routing sheet flow through a subcatchment

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP-3: STUDY POINT #3

Inflow Area = 229,788 sf, 40.86% Impervious, Inflow Depth = 0.79" for 10-year event
Inflow = 1.86 cfs @ 12.59 hrs, Volume= 15,057 cf
Primary = 1.86 cfs @ 12.59 hrs, Volume= 15,057 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP1: STUDY POINT #1

Inflow Area = 27,226 sf, 22.53% Impervious, Inflow Depth = 0.02" for 10-year event
Inflow = 0.00 cfs @ 12.50 hrs, Volume= 36 cf
Primary = 0.00 cfs @ 12.50 hrs, Volume= 36 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP2: STUDY POINT #2

Inflow Area = 1,587 sf, 0.00% Impervious, Inflow Depth = 0.08" for 10-year event
Inflow = 0.00 cfs @ 12.50 hrs, Volume= 10 cf
Primary = 0.00 cfs @ 12.50 hrs, Volume= 10 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link WQ-1: Water Quality Unit

Inflow Area = 45,592 sf, 81.75% Impervious, Inflow Depth = 3.91" for 10-year event
Inflow = 4.15 cfs @ 12.09 hrs, Volume= 14,873 cf
Primary = 4.15 cfs @ 12.09 hrs, Volume= 14,873 cf, Atten= 0%, Lag= 0.0 min
Routed to Pond IS-1 : IS-1

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link WQ-2: Water Quality Unit

Inflow Area = 64,323 sf, 60.06% Impervious, Inflow Depth = 2.89" for 10-year event
Inflow = 4.21 cfs @ 12.09 hrs, Volume= 15,483 cf
Primary = 4.21 cfs @ 12.09 hrs, Volume= 15,483 cf, Atten= 0%, Lag= 0.0 min
Routed to Pond IS-1 : IS-1

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment P-1A: Subcat P-1A Runoff Area=5,859 sf 54.96% Impervious Runoff Depth=3.48"
Flow Length=67' Slope=0.0300 '/' Tc=6.0 min CN=WQ Runoff=0.45 cfs 1,701 cf

Subcatchment P-1B: Subcat P-1B Runoff Area=4,722 sf 61.71% Impervious Runoff Depth=3.85"
Flow Length=34' Slope=0.0300 '/' Tc=6.0 min CN=WQ Runoff=0.41 cfs 1,515 cf

Subcatchment P-1C: Subcat P-1C Runoff Area=3,424 sf 0.00% Impervious Runoff Depth=0.38"
Tc=6.0 min CN=WQ Runoff=0.01 cfs 107 cf

Subcatchment P-1D: Subcat P-1D Runoff Area=7,513 sf 0.00% Impervious Runoff Depth=0.25"
Flow Length=68' Slope=0.1673 '/' Tc=6.0 min CN=WQ Runoff=0.01 cfs 157 cf

Subcatchment P-1E: Subcat P-1E Runoff Area=5,707 sf 0.00% Impervious Runoff Depth=0.44"
Flow Length=62' Tc=6.0 min CN=WQ Runoff=0.02 cfs 208 cf

Subcatchment P-2: Subcat P-2 Runoff Area=1,587 sf 0.00% Impervious Runoff Depth=0.26"
Tc=6.0 min CN=WQ Runoff=0.00 cfs 35 cf

Subcatchment P-3A: Subcat P-3A Runoff Area=15,170 sf 55.11% Impervious Runoff Depth=3.46"
Flow Length=153' Tc=6.2 min CN=WQ Runoff=1.16 cfs 4,371 cf

Subcatchment P-3B: Subcat P-3B Runoff Area=17,711 sf 37.69% Impervious Runoff Depth=2.51"
Flow Length=301' Tc=7.5 min CN=WQ Runoff=0.89 cfs 3,698 cf

Subcatchment P-3C: Subcat P-3C Runoff Area=22,442 sf 65.03% Impervious Runoff Depth=4.12"
Flow Length=158' Slope=0.0200 '/' Tc=6.0 min CN=WQ Runoff=2.12 cfs 7,708 cf

Subcatchment P-3D: Subcat P-3D Runoff Area=13,831 sf 67.53% Impervious Runoff Depth=4.15"
Flow Length=135' Slope=0.0360 '/' Tc=6.0 min CN=WQ Runoff=1.30 cfs 4,782 cf

Subcatchment P-3E: Subcat P-3E Runoff Area=6,117 sf 82.83% Impervious Runoff Depth=5.03"
Tc=6.0 min CN=WQ Runoff=0.71 cfs 2,565 cf

Subcatchment P-3F: Subcat P-3F Runoff Area=16,643 sf 83.29% Impervious Runoff Depth=5.29"
Tc=6.0 min CN=WQ Runoff=2.08 cfs 7,344 cf

Subcatchment P-3G: Subcat P-3G (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=5.93"
Tc=7.0 min CN=98 Runoff=1.21 cfs 4,449 cf

Subcatchment P-3H: Subcat P-3H (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=5.93"
Tc=7.0 min CN=WQ Runoff=1.21 cfs 4,449 cf

Subcatchment P-3I: Subcat P-3I (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=5.93"
Tc=7.0 min CN=98 Runoff=1.21 cfs 4,449 cf

Subcatchment P-3J: Subcat P-3J (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=5.93"
Tc=7.0 min CN=98 Runoff=1.21 cfs 4,449 cf

Subcatchment P-3K: Subcat P-3K Runoff Area=77,492 sf 0.00% Impervious Runoff Depth=1.62"
Flow Length=409' Tc=11.3 min CN=WQ Runoff=2.52 cfs 10,474 cf

Subcatchment P-3L: Subcat P-3L Runoff Area=24,381 sf 0.00% Impervious Runoff Depth=2.12"
Flow Length=81' Slope=0.4000 '/' Tc=6.0 min CN=61 Runoff=1.33 cfs 4,308 cf

Reach 2R: Routing sheet flow through Avg. Flow Depth=0.14' Max Vel=0.18 fps Inflow=3.63 cfs 18,437 cf
n=0.800 L=280.0' S=0.1590 '/' Capacity=113.05 cfs Outflow=2.79 cfs 18,437 cf

Pond BR-1: bioretention Peak Elev=277.12' Storage=1,466 cf Inflow=0.86 cfs 3,216 cf
Discarded=0.04 cfs 3,216 cf Primary=0.00 cfs 0 cf Outflow=0.04 cfs 3,216 cf

Pond CB-1: CB Peak Elev=270.06' Inflow=2.08 cfs 7,344 cf
12.0" Round Culvert n=0.013 L=45.0' S=0.0100 '/' Outflow=2.08 cfs 7,344 cf

Pond CB-2: CB Peak Elev=271.07' Inflow=0.71 cfs 2,565 cf
12.0" Round Culvert n=0.013 L=23.0' S=0.0100 '/' Outflow=0.71 cfs 2,565 cf

Pond CB-3: CB Peak Elev=272.03' Inflow=1.30 cfs 4,782 cf
12.0" Round Culvert n=0.013 L=126.0' S=0.0093 '/' Outflow=1.30 cfs 4,782 cf

Pond CB-4: CB Peak Elev=270.09' Inflow=2.12 cfs 7,708 cf
12.0" Round Culvert n=0.013 L=44.0' S=0.0100 '/' Outflow=2.12 cfs 7,708 cf

Pond CB-5: CB Peak Elev=271.84' Inflow=0.89 cfs 3,698 cf
12.0" Round Culvert n=0.013 L=65.0' S=0.0278 '/' Outflow=0.89 cfs 3,698 cf

Pond CB-6: CB Peak Elev=275.64' Inflow=2.36 cfs 8,820 cf
12.0" Round Culvert n=0.013 L=95.0' S=0.0100 '/' Outflow=2.36 cfs 8,820 cf

Pond DMH-2: DMH Peak Elev=269.40' Inflow=3.21 cfs 11,795 cf
15.0" Round Culvert n=0.013 L=64.0' S=0.0086 '/' Outflow=3.21 cfs 11,795 cf

Pond DMH-3: DMH Peak Elev=270.93' Inflow=3.21 cfs 11,795 cf
15.0" Round Culvert n=0.013 L=168.0' S=0.0087 '/' Outflow=3.21 cfs 11,795 cf

Pond DMH-5: DMH Peak Elev=268.23' Inflow=2.36 cfs 8,820 cf
12.0" Round Culvert n=0.013 L=23.0' S=0.0200 '/' Outflow=2.36 cfs 8,820 cf

Pond DMH-6: DMH Peak Elev=273.06' Inflow=2.36 cfs 8,820 cf
12.0" Round Culvert n=0.013 L=147.0' S=0.0156 '/' Outflow=2.36 cfs 8,820 cf

Pond DMH-7: DMH Peak Elev=274.59' Inflow=2.36 cfs 8,820 cf
12.0" Round Culvert n=0.013 L=143.0' S=0.0100 '/' Outflow=2.36 cfs 8,820 cf

Pond IS-1: IS-1 Peak Elev=268.84' Storage=17,079 cf Inflow=13.05 cfs 48,262 cf
Discarded=0.44 cfs 34,132 cf Primary=2.89 cfs 14,130 cf Outflow=3.33 cfs 48,262 cf

Pond RR2: Riprap Slope Peak Elev=280.00' Storage=0 cf Inflow=0.01 cfs 157 cf
Discarded=0.01 cfs 157 cf Primary=0.00 cfs 0 cf Outflow=0.01 cfs 157 cf

Pond RR3: Riprap Slope Peak Elev=280.00' Storage=0 cf Inflow=0.02 cfs 208 cf
Discarded=0.02 cfs 208 cf Primary=0.00 cfs 0 cf Outflow=0.02 cfs 208 cf

Link RR1: RipRap Apron Inflow=2.89 cfs 14,130 cf
Primary=2.89 cfs 14,130 cf

Link SP-3: STUDY POINT #3 Inflow=3.54 cfs 28,911 cf
Primary=3.54 cfs 28,911 cf

Link SP1: STUDY POINT #1 Inflow=0.01 cfs 107 cf
Primary=0.01 cfs 107 cf

Link SP2: STUDY POINT #2 Inflow=0.00 cfs 35 cf
Primary=0.00 cfs 35 cf

Link WQ-1: Water Quality Unit Inflow=5.29 cfs 19,139 cf
Primary=5.29 cfs 19,139 cf

Link WQ-2: Water Quality Unit Inflow=5.35 cfs 20,226 cf
Primary=5.35 cfs 20,226 cf

Total Runoff Area = 258,601 sf Runoff Volume = 66,766 cf Average Runoff Depth = 3.10"
61.32% Pervious = 158,566 sf 38.68% Impervious = 100,035 sf

Summary for Subcatchment P-1A: Subcat P-1A

Runoff = 0.45 cfs @ 12.08 hrs, Volume= 1,701 cf, Depth= 3.48"
Routed to Pond BR-1 : bioretention

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
2,639	39	>75% Grass cover, Good, HSG A
3,220	98	Paved parking, HSG A
5,859		Weighted Average
2,639	39	45.04% Pervious Area
3,220	98	54.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	67	0.0300	1.51		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.28"
0.7	67	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1B: Subcat P-1B

Runoff = 0.41 cfs @ 12.08 hrs, Volume= 1,515 cf, Depth= 3.85"
Routed to Pond BR-1 : bioretention

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
1,808	39	>75% Grass cover, Good, HSG A
2,914	98	Paved parking, HSG A
4,722		Weighted Average
1,808	39	38.29% Pervious Area
2,914	98	61.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	34	0.0300	1.32		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
0.4	34	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1C: Subcat P-1C

Runoff = 0.01 cfs @ 12.33 hrs, Volume= 107 cf, Depth= 0.38"
Routed to Link SP1 : STUDY POINT #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
2,411	39	>75% Grass cover, Good, HSG A
1,014	30	Woods, Good, HSG A
3,424		Weighted Average
3,424	36	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-1D: Subcat P-1D

Runoff = 0.01 cfs @ 12.33 hrs, Volume= 157 cf, Depth= 0.25"
Routed to Pond RR2 : Riprap Slope

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
2,966	39	>75% Grass cover, Good, HSG A
4,547	30	Woods, Good, HSG A
7,513		Weighted Average
7,513	34	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1673	0.16		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.1	18	0.1673	2.05		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
5.3	68	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1E: Subcat P-1E

Runoff = 0.02 cfs @ 12.33 hrs, Volume= 208 cf, Depth= 0.44"
Routed to Pond RR3 : Riprap Slope

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
4,885	39	>75% Grass cover, Good, HSG A
823	30	Woods, Good, HSG A
5,707		Weighted Average
5,707	38	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	21	0.1200	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
0.3	41	0.0992	2.20		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.3	62	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-2: Subcat P-2

Runoff = 0.00 cfs @ 12.33 hrs, Volume= 35 cf, Depth= 0.26"
Routed to Link SP2 : STUDY POINT #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
683	39	>75% Grass cover, Good, HSG A
904	30	Woods, Good, HSG A
1,587		Weighted Average
1,587	34	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3A: Subcat P-3A

Runoff = 1.16 cfs @ 12.09 hrs, Volume= 4,371 cf, Depth= 3.46"
Routed to Pond CB-6 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
5,532	39	>75% Grass cover, Good, HSG A
8,361	98	Paved parking, HSG A
1,278	30	Woods, Good, HSG A
15,170		Weighted Average
6,810	37	44.89% Pervious Area
8,361	98	55.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	47	0.1200	0.14		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.5	106	0.0300	3.52		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
6.2	153	Total			

Summary for Subcatchment P-3B: Subcat P-3B

Runoff = 0.89 cfs @ 12.11 hrs, Volume= 3,698 cf, Depth= 2.51"
Routed to Pond CB-5 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
9,350	39	>75% Grass cover, Good, HSG A
6,675	98	Paved parking, HSG A
1,685	30	Woods, Good, HSG A
17,711		Weighted Average
11,035	38	62.31% Pervious Area
6,675	98	37.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	47	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
1.8	254	0.0140	2.40		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
7.5	301	Total			

Summary for Subcatchment P-3C: Subcat P-3C

Runoff = 2.12 cfs @ 12.08 hrs, Volume= 7,708 cf, Depth= 4.12"
Routed to Pond CB-4 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
5,057	39	>75% Grass cover, Good, HSG A
1,547	61	>75% Grass cover, Good, HSG B
2,587	98	Paved parking, HSG A
12,008	98	Paved parking, HSG B
1,229	30	Woods, Good, HSG A
14	55	Woods, Good, HSG B
22,442		Weighted Average
7,847	42	34.97% Pervious Area
14,595	98	65.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	158	0.0200	1.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
1.7	158	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-3D: Subcat P-3D

Runoff = 1.30 cfs @ 12.08 hrs, Volume= 4,782 cf, Depth= 4.15"
Routed to Pond CB-3 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
3,872	39	>75% Grass cover, Good, HSG A
9,341	98	Paved parking, HSG A
619	30	Woods, Good, HSG A
13,831		Weighted Average
4,491	38	32.47% Pervious Area
9,341	98	67.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0360	1.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
0.4	85	0.0360	3.85		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
0.9	135	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-3E: Subcat P-3E

Runoff = 0.71 cfs @ 12.08 hrs, Volume= 2,565 cf, Depth= 5.03"
Routed to Pond CB-2 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
925	39	>75% Grass cover, Good, HSG A
125	61	>75% Grass cover, Good, HSG B
4,721	98	Paved parking, HSG A
346	98	Paved parking, HSG B
6,117		Weighted Average
1,050	42	17.17% Pervious Area
5,067	98	82.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3F: Subcat P-3F

Runoff = 2.08 cfs @ 12.08 hrs, Volume= 7,344 cf, Depth= 5.29"
Routed to Pond CB-1 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
2,781	61	>75% Grass cover, Good, HSG B
455	98	Paved parking, HSG A
13,407	98	Paved parking, HSG B
16,643		Weighted Average
2,781	61	16.71% Pervious Area
13,862	98	83.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3G: Subcat P-3G (roof)

Runoff = 1.21 cfs @ 12.10 hrs, Volume= 4,449 cf, Depth= 5.93"
Routed to Pond DMH-3 : DMH

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3H: Subcat P-3H (roof)

Runoff = 1.21 cfs @ 12.10 hrs, Volume= 4,449 cf, Depth= 5.93"
Routed to Pond IS-1 : IS-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
8,032	98	Roofs, HSG A
968	98	Roofs, HSG B
9,000		Weighted Average
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3I: Subcat P-3I (roof)

Runoff = 1.21 cfs @ 12.10 hrs, Volume= 4,449 cf, Depth= 5.93"
Routed to Pond CB-6 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3J: Subcat P-3J (roof)

Runoff = 1.21 cfs @ 12.10 hrs, Volume= 4,449 cf, Depth= 5.93"
Routed to Pond IS-1 : IS-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3K: Subcat P-3K

Runoff = 2.52 cfs @ 12.17 hrs, Volume= 10,474 cf, Depth= 1.62"
Routed to Link SP-3 : STUDY POINT #3

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
3,321	39	>75% Grass cover, Good, HSG A
9,309	61	>75% Grass cover, Good, HSG B
355	30	Woods, Good, HSG A
64,507	55	Woods, Good, HSG B
77,492		Weighted Average
77,492	55	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	50	0.2500	0.11		**Sheet Flow, A-B** Woods: Dense underbrush n= 0.800 P2= 3.28"
3.6	359	0.1100	1.66		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.3	409	Total			

Summary for Subcatchment P-3L: Subcat P-3L

Runoff = 1.33 cfs @ 12.09 hrs, Volume= 4,308 cf, Depth= 2.12"
Routed to Reach 2R : Routing sheet flow through a subcatchment

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.17"

Area (sf)	CN	Description
24,381	61	>75% Grass cover, Good, HSG B
24,381	61	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	81	0.4000	0.25		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
5.4	81	Total, Increased to minimum Tc = 6.0 min			

Summary for Reach 2R: Routing sheet flow through a subcatchment

A subcatchment performs runoff calculations, including the associated Tc anc CN determinations. It does not have any facility for routing an inflow hydrograph from another source. However, a reach may be used to perform this type of specialized routing.

This reach demonstrates a procedure for performing a sheet-flow routing through a subcatchment area. In this case, the "reach" is defined as a wide channel with very low side slopes. The Manning's value of 0.15 is selected from the table of sheet flow roughness coefficients, which are much higher than normal Manning's values, in order to allow for the greater frictional losses of shallow flow. This value is comparable to the Manning's value for "very weedy reaches".

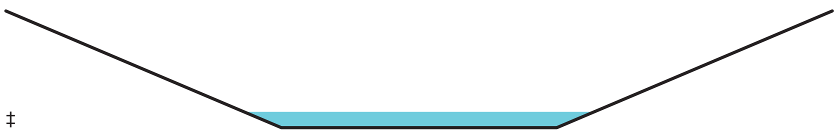
This example assumes that sheet flow occurs evenly over the entire 100' channel width, and that the flow depth is therefore very small. If the flow is concentrated or forms channels, the description and Manning's value must be adjusted accordingly.

Inflow Area = 152,297 sf, 61.66% Impervious, Inflow Depth = 1.45" for 25-year event
Inflow = 3.63 cfs @ 12.13 hrs, Volume= 18,437 cf
Outflow = 2.79 cfs @ 12.90 hrs, Volume= 18,437 cf, Atten= 23%, Lag= 46.0 min
Routed to Link SP-3 : STUDY POINT #3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.18 fps, Min. Travel Time= 25.7 min
Avg. Velocity = 0.05 fps, Avg. Travel Time= 101.5 min

Peak Storage= 4,303 cf @ 12.90 hrs
Average Depth at Peak Storage= 0.14' , Surface Width= 127.07'
Bank-Full Depth= 1.00' Flow Area= 200.0 sf, Capacity= 113.05 cfs

100.00' x 1.00' deep channel, n= 0.800 Sheet flow: Woods+dense brush
Side Slope Z-value= 100.0 '/' Top Width= 300.00'
Length= 280.0' Slope= 0.1590 '/'
Inlet Invert= 265.92', Outlet Invert= 221.40'



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Summary for Pond BR-1: bioretention

Inflow Area = 23,802 sf, 25.77% Impervious, Inflow Depth = 1.62" for 25-year event
Inflow = 0.86 cfs @ 12.08 hrs, Volume= 3,216 cf
Outflow = 0.04 cfs @ 10.67 hrs, Volume= 3,216 cf, Atten= 95%, Lag= 0.0 min
Discarded = 0.04 cfs @ 10.67 hrs, Volume= 3,216 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Link SP1 : STUDY POINT #1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 277.12' @ 14.93 hrs Surf.Area= 1,013 sf Storage= 1,466 cf
Flood Elev= 278.00' Surf.Area= 1,416 sf Storage= 1,824 cf

Plug-Flow detention time= 307.0 min calculated for 3,215 cf (100% of inflow)
Center-of-Mass det. time= 307.0 min (1,063.7 - 756.7)

Volume	Invert	Avail.Storage	Storage Description
#1	277.00'	1,211 cf	**surface storage (Irregular)**Listed below (Recalc)
#2	275.00'	78 cf	**media storage (Irregular)**Listed below (Recalc) 260 cf Overall x 30.0% Voids
#3A	271.50'	627 cf	**20.50'W x 32.10'L x 3.50'H Field A** 2,303 cf Overall - 735 cf Embedded = 1,568 cf x 40.0% Voids
#4A	272.00'	735 cf	**ADS_StormTech SC-740 +Cap** x 16 Inside #3 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 16 Chambers in 4 Rows
		2,651 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
277.00	184	71.0	0	0	184
278.00	628	136.5	384	384	1,271
279.00	1,043	158.1	827	1,211	1,798

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
275.00	130	53.0	0	0	130
277.00	130	53.0	260	260	236

Device	Routing	Invert	Outlet Devices
#0	Primary	279.00'	**Automatic Storage Overflow** (Discharged without head)
#1	Discarded	271.50'	**0.04 cfs Exfiltration at all elevations** Phase-In= 0.01'
#2	Primary	277.80'	**9.0' long x 4.0' 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) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=0.04 cfs @ 10.67 hrs HW=271.58' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=271.50' TW=0.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond CB-1: CB

Inflow Area = 16,643 sf, 83.29% Impervious, Inflow Depth = 5.29" for 25-year event
Inflow = 2.08 cfs @ 12.08 hrs, Volume= 7,344 cf
Outflow = 2.08 cfs @ 12.08 hrs, Volume= 7,344 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.08 cfs @ 12.08 hrs, Volume= 7,344 cf
Routed to Link WQ-1 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 270.06' @ 12.08 hrs
Flood Elev= 272.52'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.22'	**12.0" Round Culvert** L= 45.0' Ke= 0.500 Inlet / Outlet Invert= 269.22' / 268.77' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.07 cfs @ 12.08 hrs HW=270.06' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 2.07 cfs @ 3.97 fps)

Summary for Pond CB-2: CB

Inflow Area = 6,117 sf, 82.83% Impervious, Inflow Depth = 5.03" for 25-year event
Inflow = 0.71 cfs @ 12.08 hrs, Volume= 2,565 cf
Outflow = 0.71 cfs @ 12.08 hrs, Volume= 2,565 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.71 cfs @ 12.08 hrs, Volume= 2,565 cf
Routed to Pond DMH-3 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 271.07' @ 12.09 hrs
Flood Elev= 273.92'

Device	Routing	Invert	Outlet Devices
#1	Primary	270.46'	**12.0" Round Culvert** L= 23.0' Ke= 0.500 Inlet / Outlet Invert= 270.46' / 270.23' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.68 cfs @ 12.08 hrs HW=271.07' TW=270.93' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 0.68 cfs @ 1.97 fps)

Summary for Pond CB-3: CB

Inflow Area = 13,831 sf, 67.53% Impervious, Inflow Depth = 4.15" for 25-year event
Inflow = 1.30 cfs @ 12.08 hrs, Volume= 4,782 cf
Outflow = 1.30 cfs @ 12.08 hrs, Volume= 4,782 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.30 cfs @ 12.08 hrs, Volume= 4,782 cf
Routed to Pond DMH-3 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 272.03' @ 12.09 hrs
Flood Elev= 274.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	271.40'	**12.0" Round Culvert** L= 126.0' Ke= 0.500 Inlet / Outlet Invert= 271.40' / 270.23' S= 0.0093 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.29 cfs @ 12.08 hrs HW=272.03' TW=270.93' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.29 cfs @ 3.54 fps)

Summary for Pond CB-4: CB

Inflow Area = 22,442 sf, 65.03% Impervious, Inflow Depth = 4.12" for 25-year event
Inflow = 2.12 cfs @ 12.08 hrs, Volume= 7,708 cf
Outflow = 2.12 cfs @ 12.08 hrs, Volume= 7,708 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.12 cfs @ 12.08 hrs, Volume= 7,708 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Peak Elev= 270.09' @ 12.08 hrs
Flood Elev= 272.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.24'	**12.0" Round Culvert** L= 44.0' Ke= 0.500 Inlet / Outlet Invert= 269.24' / 268.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.11 cfs @ 12.08 hrs HW=270.09' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.11 cfs @ 3.98 fps)

Summary for Pond CB-5: CB

Inflow Area = 17,711 sf, 37.69% Impervious, Inflow Depth = 2.51" for 25-year event
Inflow = 0.89 cfs @ 12.11 hrs, Volume= 3,698 cf
Outflow = 0.89 cfs @ 12.11 hrs, Volume= 3,698 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.89 cfs @ 12.11 hrs, Volume= 3,698 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 271.84' @ 12.11 hrs
Flood Elev= 275.46'

Device	Routing	Invert	Outlet Devices
#1	Primary	271.36'	**12.0" Round Culvert** L= 65.0' Ke= 0.500 Inlet / Outlet Invert= 271.36' / 269.55' S= 0.0278 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.89 cfs @ 12.11 hrs HW=271.84' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.89 cfs @ 2.37 fps)

Summary for Pond CB-6: CB

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 4.38" for 25-year event
Inflow = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf
Outflow = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf
Routed to Pond DMH-7 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 275.64' @ 12.09 hrs
Flood Elev= 278.85'

Device	Routing	Invert	Outlet Devices
#1	Primary	274.74'	**12.0" Round Culvert** L= 95.0' Ke= 0.500 Inlet / Outlet Invert= 274.74' / 273.79' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.36 cfs @ 12.09 hrs HW=275.64' TW=274.59' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 2.36 cfs @ 4.17 fps)

Summary for Pond DMH-2: DMH

Inflow Area = 28,949 sf, 80.86% Impervious, Inflow Depth = 4.89" for 25-year event
Inflow = 3.21 cfs @ 12.09 hrs, Volume= 11,795 cf
Outflow = 3.21 cfs @ 12.09 hrs, Volume= 11,795 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.21 cfs @ 12.09 hrs, Volume= 11,795 cf
Routed to Link WQ-1 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 269.40' @ 12.09 hrs
Flood Elev= 274.78'

Device	Routing	Invert	Outlet Devices
#1	Primary	268.42'	**15.0" Round Culvert** L= 64.0' Ke= 0.500 Inlet / Outlet Invert= 268.42' / 267.87' S= 0.0086 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=3.21 cfs @ 12.09 hrs HW=269.40' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 3.21 cfs @ 4.27 fps)

Summary for Pond DMH-3: DMH

Inflow Area = 28,949 sf, 80.86% Impervious, Inflow Depth = 4.89" for 25-year event
Inflow = 3.21 cfs @ 12.09 hrs, Volume= 11,795 cf
Outflow = 3.21 cfs @ 12.09 hrs, Volume= 11,795 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.21 cfs @ 12.09 hrs, Volume= 11,795 cf
Routed to Pond DMH-2 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 270.93' @ 12.09 hrs
Flood Elev= 274.41'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.98'	**15.0" Round Culvert** L= 168.0' Ke= 0.500 Inlet / Outlet Invert= 269.98' / 268.52' S= 0.0087 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=3.20 cfs @ 12.09 hrs HW=270.93' TW=269.40' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 3.20 cfs @ 4.43 fps)

Summary for Pond DMH-5: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 4.38" for 25-year event
Inflow = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf
Outflow = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Peak Elev= 268.23' @ 12.09 hrs
Flood Elev= 274.16'

Device	Routing	Invert	Outlet Devices
#1	Primary	267.34'	**12.0" Round Culvert** L= 23.0' Ke= 0.500 Inlet / Outlet Invert= 267.34' / 266.88' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.36 cfs @ 12.09 hrs HW=268.23' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 2.36 cfs @ 3.21 fps)

Summary for Pond DMH-6: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 4.38" for 25-year event
Inflow = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf
Outflow = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf
Routed to Pond DMH-5 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 273.06' @ 12.09 hrs
Flood Elev= 277.33'

Device	Routing	Invert	Outlet Devices
#1	Primary	272.17'	**12.0" Round Culvert** L= 147.0' Ke= 0.500 Inlet / Outlet Invert= 272.17' / 269.87' S= 0.0156 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.36 cfs @ 12.09 hrs HW=273.06' TW=268.23' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 2.36 cfs @ 3.21 fps)

Summary for Pond DMH-7: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 4.38" for 25-year event
Inflow = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf
Outflow = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.36 cfs @ 12.09 hrs, Volume= 8,820 cf
Routed to Pond DMH-6 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 274.59' @ 12.09 hrs
Flood Elev= 279.73'

Device	Routing	Invert	Outlet Devices
#1	Primary	273.70'	**12.0" Round Culvert** L= 143.0' Ke= 0.500 Inlet / Outlet Invert= 273.70' / 272.27' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.36 cfs @ 12.09 hrs HW=274.59' TW=273.06' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 2.36 cfs @ 3.21 fps)

Summary for Pond IS-1: IS-1

GEO-TP-5 indicates silty sand to a depth of 14' below grade with no refusal. The infiltration rate for loamy sand is 2.41 inches per hour (Rawls Rates)

Redox was encountered at 9' below grade or elevation 263.5

Inflow Area = 127,915 sf, 73.41% Impervious, Inflow Depth = 4.53" for 25-year event
Inflow = 13.05 cfs @ 12.09 hrs, Volume= 48,262 cf
Outflow = 3.33 cfs @ 12.47 hrs, Volume= 48,262 cf, Atten= 74%, Lag= 22.7 min
Discarded = 0.44 cfs @ 9.73 hrs, Volume= 34,132 cf
Primary = 2.89 cfs @ 12.47 hrs, Volume= 14,130 cf
Routed to Link RR1 : RipRap Apron

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 268.84' @ 12.47 hrs Surf.Area= 7,868 sf Storage= 17,079 cf
Flood Elev= 271.25' Surf.Area= 7,868 sf Storage= 26,670 cf

Plug-Flow detention time= 169.1 min calculated for 48,255 cf (100% of inflow)
Center-of-Mass det. time= 169.1 min (920.8 - 751.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	265.75'	11,068 cf	**52.42'W x 150.10'L x 5.50'H Field A** 43,273 cf Overall - 15,602 cf Embedded = 27,671 cf x 40.0% Voids
#2A	266.50'	15,602 cf	**ADS_StormTech MC-3500 d +Cap** x 140 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 140 Chambers in 7 Rows Cap Storage= 14.9 cf x 2 x 7 rows = 208.6 cf
		26,670 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	265.75'	**0.44 cfs Exfiltration at all elevations** Phase-In= 0.01'
#2	Primary	266.47'	**10.0" Round Culvert** L= 29.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 266.47' / 265.92' S= 0.0190 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#3	Device 2	267.90'	**4.0' long x 6.26' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.44 cfs @ 9.73 hrs HW=265.83' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.44 cfs)

Primary OutFlow Max=2.89 cfs @ 12.47 hrs HW=268.84' TW=0.00' (Dynamic Tailwater)
└─**2=Culvert** (Inlet Controls 2.89 cfs @ 5.31 fps)
  └─**3=Sharp-Crested Rectangular Weir** (Passes 2.89 cfs of 11.28 cfs potential flow)

Summary for Pond RR2: Riprap Slope

Inflow Area = 7,513 sf, 0.00% Impervious, Inflow Depth = 0.25" for 25-year event
Inflow = 0.01 cfs @ 12.33 hrs, Volume= 157 cf
Outflow = 0.01 cfs @ 12.33 hrs, Volume= 157 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.01 cfs @ 12.33 hrs, Volume= 157 cf
Primary = 0.00 cfs @ 24.32 hrs, Volume= 0 cf
Routed to Pond BR-1 : bioretention

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 280.00' @ 0.00 hrs Surf.Area= 111 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (985.9 - 985.9)

Volume	Invert	Avail.Storage	Storage Description
#1	280.00'	328 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 821 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
280.00	111	0	0
281.00	111	111	111
282.00	111	111	222
283.00	103	107	329
284.00	75	89	418
285.00	73	74	492
286.00	70	72	564
287.00	68	69	633
288.00	66	67	700
289.00	62	64	764
290.00	52	57	821

Device	Routing	Invert	Outlet Devices
#1	Discarded	280.00'	**0.37 cfs Exfiltration at all elevations**
#2	Primary	280.00'	**111.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.00 cfs @ 12.33 hrs HW=280.00' (Free Discharge)
└─**1=Exfiltration** (Passes 0.00 cfs of 0.37 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 24.32 hrs HW=280.00' TW=273.10' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond RR3: Riprap Slope

Inflow Area = 5,707 sf, 0.00% Impervious, Inflow Depth = 0.44" for 25-year event
Inflow = 0.02 cfs @ 12.33 hrs, Volume= 208 cf
Outflow = 0.02 cfs @ 12.33 hrs, Volume= 208 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.02 cfs @ 12.33 hrs, Volume= 208 cf
Primary = 0.00 cfs @ 24.34 hrs, Volume= 0 cf
Routed to Pond BR-1 : bioretention

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 280.00' @ 0.00 hrs Surf.Area= 116 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (958.0 - 958.0)

Volume	Invert	Avail.Storage	Storage Description
#1	280.00'	464 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 1,160 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
280.00	116	0	0
281.00	116	116	116
282.00	116	116	232
283.00	116	116	348
284.00	116	116	464
285.00	116	116	580
286.00	116	116	696
287.00	116	116	812
288.00	116	116	928
289.00	116	116	1,044
290.00	116	116	1,160

Device	Routing	Invert	Outlet Devices
#1	Discarded	280.00'	**0.37 cfs Exfiltration at all elevations**
#2	Primary	280.00'	**111.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.00 cfs @ 12.33 hrs HW=280.00' (Free Discharge)
└─**1=Exfiltration** (Passes 0.00 cfs of 0.37 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 24.34 hrs HW=280.00' TW=273.10' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link RR1: RipRap Apron

Inflow Area = 127,915 sf, 73.41% Impervious, Inflow Depth = 1.33" for 25-year event
Inflow = 2.89 cfs @ 12.47 hrs, Volume= 14,130 cf
Primary = 2.89 cfs @ 12.47 hrs, Volume= 14,130 cf, Atten= 0%, Lag= 0.0 min
Routed to Reach 2R : Routing sheet flow through a subcatchment

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP-3: STUDY POINT #3

Inflow Area = 229,788 sf, 40.86% Impervious, Inflow Depth = 1.51" for 25-year event
Inflow = 3.54 cfs @ 12.47 hrs, Volume= 28,911 cf
Primary = 3.54 cfs @ 12.47 hrs, Volume= 28,911 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP1: STUDY POINT #1

Inflow Area = 27,226 sf, 22.53% Impervious, Inflow Depth = 0.05" for 25-year event
Inflow = 0.01 cfs @ 12.33 hrs, Volume= 107 cf
Primary = 0.01 cfs @ 12.33 hrs, Volume= 107 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP2: STUDY POINT #2

Inflow Area = 1,587 sf, 0.00% Impervious, Inflow Depth = 0.26" for 25-year event
Inflow = 0.00 cfs @ 12.33 hrs, Volume= 35 cf
Primary = 0.00 cfs @ 12.33 hrs, Volume= 35 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link WQ-1: Water Quality Unit

Inflow Area = 45,592 sf, 81.75% Impervious, Inflow Depth = 5.04" for 25-year event
Inflow = 5.29 cfs @ 12.09 hrs, Volume= 19,139 cf
Primary = 5.29 cfs @ 12.09 hrs, Volume= 19,139 cf, Atten= 0%, Lag= 0.0 min
Routed to Pond IS-1 : IS-1

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link WQ-2: Water Quality Unit

Inflow Area = 64,323 sf, 60.06% Impervious, Inflow Depth = 3.77" for 25-year event
Inflow = 5.35 cfs @ 12.09 hrs, Volume= 20,226 cf
Primary = 5.35 cfs @ 12.09 hrs, Volume= 20,226 cf, Atten= 0%, Lag= 0.0 min
Routed to Pond IS-1 : IS-1

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment P-1A: Subcat P-1A Runoff Area=5,859 sf 54.96% Impervious Runoff Depth=5.37"
Flow Length=67' Slope=0.0300 '/' Tc=6.0 min CN=WQ Runoff=0.71 cfs 2,622 cf

Subcatchment P-1B: Subcat P-1B Runoff Area=4,722 sf 61.71% Impervious Runoff Depth=5.84"
Flow Length=34' Slope=0.0300 '/' Tc=6.0 min CN=WQ Runoff=0.63 cfs 2,300 cf

Subcatchment P-1C: Subcat P-1C Runoff Area=3,424 sf 0.00% Impervious Runoff Depth=1.24"
Tc=6.0 min CN=WQ Runoff=0.07 cfs 353 cf

Subcatchment P-1D: Subcat P-1D Runoff Area=7,513 sf 0.00% Impervious Runoff Depth=0.97"
Flow Length=68' Slope=0.1673 '/' Tc=6.0 min CN=WQ Runoff=0.09 cfs 604 cf

Subcatchment P-1E: Subcat P-1E Runoff Area=5,707 sf 0.00% Impervious Runoff Depth=1.37"
Flow Length=62' Tc=6.0 min CN=WQ Runoff=0.15 cfs 653 cf

Subcatchment P-2: Subcat P-2 Runoff Area=1,587 sf 0.00% Impervious Runoff Depth=1.00"
Tc=6.0 min CN=WQ Runoff=0.02 cfs 132 cf

Subcatchment P-3A: Subcat P-3A Runoff Area=15,170 sf 55.11% Impervious Runoff Depth=5.31"
Flow Length=153' Tc=6.2 min CN=WQ Runoff=1.80 cfs 6,707 cf

Subcatchment P-3B: Subcat P-3B Runoff Area=17,711 sf 37.69% Impervious Runoff Depth=4.07"
Flow Length=301' Tc=7.5 min CN=WQ Runoff=1.51 cfs 6,006 cf

Subcatchment P-3C: Subcat P-3C Runoff Area=22,442 sf 65.03% Impervious Runoff Depth=6.21"
Flow Length=158' Slope=0.0200 '/' Tc=6.0 min CN=WQ Runoff=3.20 cfs 11,608 cf

Subcatchment P-3D: Subcat P-3D Runoff Area=13,831 sf 67.53% Impervious Runoff Depth=6.21"
Flow Length=135' Slope=0.0360 '/' Tc=6.0 min CN=WQ Runoff=1.96 cfs 7,163 cf

Subcatchment P-3E: Subcat P-3E Runoff Area=6,117 sf 82.83% Impervious Runoff Depth=7.38"
Tc=6.0 min CN=WQ Runoff=1.04 cfs 3,764 cf

Subcatchment P-3F: Subcat P-3F Runoff Area=16,643 sf 83.29% Impervious Runoff Depth=7.79"
Tc=6.0 min CN=WQ Runoff=3.04 cfs 10,804 cf

Subcatchment P-3G: Subcat P-3G (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=8.54"
Tc=7.0 min CN=98 Runoff=1.72 cfs 6,405 cf

Subcatchment P-3H: Subcat P-3H (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=8.54"
Tc=7.0 min CN=WQ Runoff=1.72 cfs 6,405 cf

Subcatchment P-3I: Subcat P-3I (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=8.54"
Tc=7.0 min CN=98 Runoff=1.72 cfs 6,405 cf

Subcatchment P-3J: Subcat P-3J (roof) Runoff Area=9,000 sf 100.00% Impervious Runoff Depth=8.54"
Tc=7.0 min CN=98 Runoff=1.72 cfs 6,405 cf

Subcatchment P-3K: Subcat P-3K Runoff Area=77,492 sf 0.00% Impervious Runoff Depth=3.33"
Flow Length=409' Tc=11.3 min CN=WQ Runoff=5.62 cfs 21,475 cf

Subcatchment P-3L: Subcat P-3L Runoff Area=24,381 sf 0.00% Impervious Runoff Depth=4.05"
Flow Length=81' Slope=0.4000 '/' Tc=6.0 min CN=61 Runoff=2.64 cfs 8,228 cf

Reach 2R: Routing sheet flow through Avg. Flow Depth=0.18' Max Vel=0.21 fps Inflow=5.81 cfs 40,678 cf
n=0.800 L=280.0' S=0.1590 '/' Capacity=113.05 cfs Outflow=4.57 cfs 40,678 cf

Pond BR-1: bioretention Peak Elev=277.88' Storage=1,754 cf Inflow=1.34 cfs 4,921 cf
Discarded=0.04 cfs 3,927 cf Primary=0.51 cfs 995 cf Outflow=0.55 cfs 4,921 cf

Pond CB-1: CB Peak Elev=270.37' Inflow=3.04 cfs 10,804 cf
12.0" Round Culvert n=0.013 L=45.0' S=0.0100 '/' Outflow=3.04 cfs 10,804 cf

Pond CB-2: CB Peak Elev=271.36' Inflow=1.04 cfs 3,764 cf
12.0" Round Culvert n=0.013 L=23.0' S=0.0100 '/' Outflow=1.04 cfs 3,764 cf

Pond CB-3: CB Peak Elev=272.25' Inflow=1.96 cfs 7,163 cf
12.0" Round Culvert n=0.013 L=126.0' S=0.0093 '/' Outflow=1.96 cfs 7,163 cf

Pond CB-4: CB Peak Elev=270.46' Inflow=3.20 cfs 11,608 cf
12.0" Round Culvert n=0.013 L=44.0' S=0.0100 '/' Outflow=3.20 cfs 11,608 cf

Pond CB-5: CB Peak Elev=272.02' Inflow=1.51 cfs 6,006 cf
12.0" Round Culvert n=0.013 L=65.0' S=0.0278 '/' Outflow=1.51 cfs 6,006 cf

Pond CB-6: CB Peak Elev=276.77' Inflow=3.52 cfs 13,112 cf
12.0" Round Culvert n=0.013 L=95.0' S=0.0100 '/' Outflow=3.52 cfs 13,112 cf

Pond DMH-2: DMH Peak Elev=269.72' Inflow=4.71 cfs 17,332 cf
15.0" Round Culvert n=0.013 L=64.0' S=0.0086 '/' Outflow=4.71 cfs 17,332 cf

Pond DMH-3: DMH Peak Elev=271.25' Inflow=4.71 cfs 17,332 cf
15.0" Round Culvert n=0.013 L=168.0' S=0.0087 '/' Outflow=4.71 cfs 17,332 cf

Pond DMH-5: DMH Peak Elev=268.71' Inflow=3.52 cfs 13,112 cf
12.0" Round Culvert n=0.013 L=23.0' S=0.0200 '/' Outflow=3.52 cfs 13,112 cf

Pond DMH-6: DMH Peak Elev=273.54' Inflow=3.52 cfs 13,112 cf
12.0" Round Culvert n=0.013 L=147.0' S=0.0156 '/' Outflow=3.52 cfs 13,112 cf

Pond DMH-7: DMH Peak Elev=275.39' Inflow=3.52 cfs 13,112 cf
12.0" Round Culvert n=0.013 L=143.0' S=0.0100 '/' Outflow=3.52 cfs 13,112 cf

Pond IS-1: IS-1 Peak Elev=271.18' Storage=26,441 cf Inflow=19.37 cfs 71,671 cf
Discarded=0.44 cfs 39,221 cf Primary=4.29 cfs 32,450 cf Outflow=4.73 cfs 71,671 cf

Pond RR2: Riprap Slope Peak Elev=280.00' Storage=0 cf Inflow=0.09 cfs 604 cf
Discarded=0.09 cfs 604 cf Primary=0.00 cfs 0 cf Outflow=0.09 cfs 604 cf

Pond RR3: Riprap Slope Peak Elev=280.00' Storage=0 cf Inflow=0.15 cfs 653 cf
Discarded=0.15 cfs 653 cf Primary=0.00 cfs 0 cf Outflow=0.15 cfs 653 cf

Link RR1: RipRap Apron Inflow=4.29 cfs 32,450 cf
Primary=4.29 cfs 32,450 cf

Link SP-3: STUDY POINT #3 Inflow=8.15 cfs 62,152 cf
Primary=8.15 cfs 62,152 cf

Link SP1: STUDY POINT #1 Inflow=0.56 cfs 1,348 cf
Primary=0.56 cfs 1,348 cf

Link SP2: STUDY POINT #2 Inflow=0.02 cfs 132 cf
Primary=0.02 cfs 132 cf

Link WQ-1: Water Quality Unit Inflow=7.75 cfs 28,135 cf
Primary=7.75 cfs 28,135 cf

Link WQ-2: Water Quality Unit Inflow=8.19 cfs 30,726 cf
Primary=8.19 cfs 30,726 cf

Total Runoff Area = 258,601 sf Runoff Volume = 108,038 cf Average Runoff Depth = 5.01"
61.32% Pervious = 158,566 sf 38.68% Impervious = 100,035 sf

Summary for Subcatchment P-1A: Subcat P-1A

Runoff = 0.71 cfs @ 12.09 hrs, Volume= 2,622 cf, Depth= 5.37"
Routed to Pond BR-1 : bioretention

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
2,639	39	>75% Grass cover, Good, HSG A
3,220	98	Paved parking, HSG A
5,859		Weighted Average
2,639	39	45.04% Pervious Area
3,220	98	54.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	67	0.0300	1.51		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.28"
0.7	67	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1B: Subcat P-1B

Runoff = 0.63 cfs @ 12.09 hrs, Volume= 2,300 cf, Depth= 5.84"
Routed to Pond BR-1 : bioretention

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
1,808	39	>75% Grass cover, Good, HSG A
2,914	98	Paved parking, HSG A
4,722		Weighted Average
1,808	39	38.29% Pervious Area
2,914	98	61.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	34	0.0300	1.32		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
0.4	34	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1C: Subcat P-1C

Runoff = 0.07 cfs @ 12.12 hrs, Volume= 353 cf, Depth= 1.24"
Routed to Link SP1 : STUDY POINT #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
2,411	39	>75% Grass cover, Good, HSG A
1,014	30	Woods, Good, HSG A
3,424		Weighted Average
3,424	36	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-1D: Subcat P-1D

Runoff = 0.09 cfs @ 12.13 hrs, Volume= 604 cf, Depth= 0.97"
Routed to Pond RR2 : Riprap Slope

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
2,966	39	>75% Grass cover, Good, HSG A
4,547	30	Woods, Good, HSG A
7,513		Weighted Average
7,513	34	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1673	0.16		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.1	18	0.1673	2.05		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
5.3	68	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-1E: Subcat P-1E

Runoff = 0.15 cfs @ 12.11 hrs, Volume= 653 cf, Depth= 1.37"
Routed to Pond RR3 : Riprap Slope

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
4,885	39	>75% Grass cover, Good, HSG A
823	30	Woods, Good, HSG A
5,707		Weighted Average
5,707	38	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	21	0.1200	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
0.3	41	0.0992	2.20		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.3	62	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-2: Subcat P-2

Runoff = 0.02 cfs @ 12.13 hrs, Volume= 132 cf, Depth= 1.00"
Routed to Link SP2 : STUDY POINT #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
683	39	>75% Grass cover, Good, HSG A
904	30	Woods, Good, HSG A
1,587		Weighted Average
1,587	34	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3A: Subcat P-3A

Runoff = 1.80 cfs @ 12.09 hrs, Volume= 6,707 cf, Depth= 5.31"
Routed to Pond CB-6 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
5,532	39	>75% Grass cover, Good, HSG A
8,361	98	Paved parking, HSG A
1,278	30	Woods, Good, HSG A
15,170		Weighted Average
6,810	37	44.89% Pervious Area
8,361	98	55.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	47	0.1200	0.14		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.28"
0.5	106	0.0300	3.52		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
6.2	153	Total			

Summary for Subcatchment P-3B: Subcat P-3B

Runoff = 1.51 cfs @ 12.11 hrs, Volume= 6,006 cf, Depth= 4.07"
Routed to Pond CB-5 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
9,350	39	>75% Grass cover, Good, HSG A
6,675	98	Paved parking, HSG A
1,685	30	Woods, Good, HSG A
17,711		Weighted Average
11,035	38	62.31% Pervious Area
6,675	98	37.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	47	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
1.8	254	0.0140	2.40		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
7.5	301	Total			

Summary for Subcatchment P-3C: Subcat P-3C

Runoff = 3.20 cfs @ 12.09 hrs, Volume= 11,608 cf, Depth= 6.21"
Routed to Pond CB-4 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
5,057	39	>75% Grass cover, Good, HSG A
1,547	61	>75% Grass cover, Good, HSG B
2,587	98	Paved parking, HSG A
12,008	98	Paved parking, HSG B
1,229	30	Woods, Good, HSG A
14	55	Woods, Good, HSG B
22,442		Weighted Average
7,847	42	34.97% Pervious Area
14,595	98	65.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	158	0.0200	1.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
1.7	158	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-3D: Subcat P-3D

Runoff = 1.96 cfs @ 12.09 hrs, Volume= 7,163 cf, Depth= 6.21"
Routed to Pond CB-3 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
3,872	39	>75% Grass cover, Good, HSG A
9,341	98	Paved parking, HSG A
619	30	Woods, Good, HSG A
13,831		Weighted Average
4,491	38	32.47% Pervious Area
9,341	98	67.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0360	1.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.28"
0.4	85	0.0360	3.85		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
0.9	135	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment P-3E: Subcat P-3E

Runoff = 1.04 cfs @ 12.08 hrs, Volume= 3,764 cf, Depth= 7.38"
Routed to Pond CB-2 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
925	39	>75% Grass cover, Good, HSG A
125	61	>75% Grass cover, Good, HSG B
4,721	98	Paved parking, HSG A
346	98	Paved parking, HSG B
6,117		Weighted Average
1,050	42	17.17% Pervious Area
5,067	98	82.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3F: Subcat P-3F

Runoff = 3.04 cfs @ 12.08 hrs, Volume= 10,804 cf, Depth= 7.79"
Routed to Pond CB-1 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
2,781	61	>75% Grass cover, Good, HSG B
455	98	Paved parking, HSG A
13,407	98	Paved parking, HSG B
16,643		Weighted Average
2,781	61	16.71% Pervious Area
13,862	98	83.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3G: Subcat P-3G (roof)

Runoff = 1.72 cfs @ 12.10 hrs, Volume= 6,405 cf, Depth= 8.54"
Routed to Pond DMH-3 : DMH

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3H: Subcat P-3H (roof)

Runoff = 1.72 cfs @ 12.10 hrs, Volume= 6,405 cf, Depth= 8.54"
Routed to Pond IS-1 : IS-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
8,032	98	Roofs, HSG A
968	98	Roofs, HSG B
9,000		Weighted Average
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3I: Subcat P-3I (roof)

Runoff = 1.72 cfs @ 12.10 hrs, Volume= 6,405 cf, Depth= 8.54"
Routed to Pond CB-6 : CB

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3J: Subcat P-3J (roof)

Runoff = 1.72 cfs @ 12.10 hrs, Volume= 6,405 cf, Depth= 8.54"
Routed to Pond IS-1 : IS-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
9,000	98	Roofs, HSG A
9,000	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, TR-55 MIN**

Summary for Subcatchment P-3K: Subcat P-3K

Runoff = 5.62 cfs @ 12.16 hrs, Volume= 21,475 cf, Depth= 3.33"
Routed to Link SP-3 : STUDY POINT #3

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
3,321	39	>75% Grass cover, Good, HSG A
9,309	61	>75% Grass cover, Good, HSG B
355	30	Woods, Good, HSG A
64,507	55	Woods, Good, HSG B
77,492		Weighted Average
77,492	55	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	50	0.2500	0.11		**Sheet Flow, A-B** Woods: Dense underbrush n= 0.800 P2= 3.28"
3.6	359	0.1100	1.66		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.3	409	Total			

Summary for Subcatchment P-3L: Subcat P-3L

Runoff = 2.64 cfs @ 12.09 hrs, Volume= 8,228 cf, Depth= 4.05"
Routed to Reach 2R : Routing sheet flow through a subcatchment

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.78"

Area (sf)	CN	Description
24,381	61	>75% Grass cover, Good, HSG B
24,381	61	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	81	0.4000	0.25		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.28"
5.4	81	Total, Increased to minimum Tc = 6.0 min			

Summary for Reach 2R: Routing sheet flow through a subcatchment

A subcatchment performs runoff calculations, including the associated Tc anc CN determinations. It does not have any facility for routing an inflow hydrograph from another source. However, a reach may be used to perform this type of specialized routing.

This reach demonstrates a procedure for performing a sheet-flow routing through a subcatchment area. In this case, the "reach" is defined as a wide channel with very low side slopes. The Manning's value of 0.15 is selected from the table of sheet flow roughness coefficients, which are much higher than normal Manning's values, in order to allow for the greater frictional losses of shallow flow. This value is comparable to the Manning's value for "very weedy reaches".

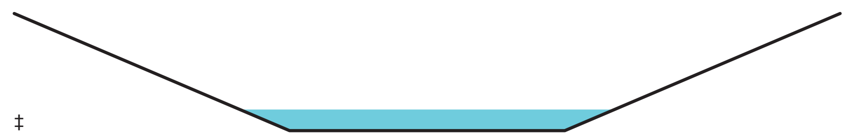
This example assumes that sheet flow occurs evenly over the entire 100' channel width, and that the flow depth is therefore very small. If the flow is concentrated or forms channels, the description and Manning's value must be adjusted accordingly.

Inflow Area = 152,297 sf, 61.66% Impervious, Inflow Depth = 3.21" for 100-year event
Inflow = 5.81 cfs @ 12.11 hrs, Volume= 40,678 cf
Outflow = 4.57 cfs @ 12.65 hrs, Volume= 40,678 cf, Atten= 21%, Lag= 32.2 min
Routed to Link SP-3 : STUDY POINT #3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.21 fps, Min. Travel Time= 21.7 min
Avg. Velocity = 0.05 fps, Avg. Travel Time= 87.7 min

Peak Storage= 5,953 cf @ 12.65 hrs
Average Depth at Peak Storage= 0.18' , Surface Width= 136.03'
Bank-Full Depth= 1.00' Flow Area= 200.0 sf, Capacity= 113.05 cfs

100.00' x 1.00' deep channel, n= 0.800 Sheet flow: Woods+dense brush
Side Slope Z-value= 100.0 '/' Top Width= 300.00'
Length= 280.0' Slope= 0.1590 '/'
Inlet Invert= 265.92', Outlet Invert= 221.40'



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Summary for Pond BR-1: bioretention

Inflow Area = 23,802 sf, 25.77% Impervious, Inflow Depth = 2.48" for 100-year event
Inflow = 1.34 cfs @ 12.09 hrs, Volume= 4,921 cf
Outflow = 0.55 cfs @ 12.31 hrs, Volume= 4,921 cf, Atten= 59%, Lag= 13.4 min
Discarded = 0.04 cfs @ 9.51 hrs, Volume= 3,927 cf
Primary = 0.51 cfs @ 12.31 hrs, Volume= 995 cf
Routed to Link SP1 : STUDY POINT #1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 277.88' @ 12.31 hrs Surf.Area= 1,350 sf Storage= 1,754 cf
Flood Elev= 278.00' Surf.Area= 1,416 sf Storage= 1,824 cf

Plug-Flow detention time= 303.2 min calculated for 4,921 cf (100% of inflow)
Center-of-Mass det. time= 303.3 min (1,061.6 - 758.3)

Volume	Invert	Avail.Storage	Storage Description
#1	277.00'	1,211 cf	**surface storage (Irregular)**Listed below (Recalc)
#2	275.00'	78 cf	**media storage (Irregular)**Listed below (Recalc) 260 cf Overall x 30.0% Voids
#3A	271.50'	627 cf	**20.50'W x 32.10'L x 3.50'H Field A** 2,303 cf Overall - 735 cf Embedded = 1,568 cf x 40.0% Voids
#4A	272.00'	735 cf	**ADS_StormTech SC-740 +Cap** x 16 Inside #3 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 16 Chambers in 4 Rows
		2,651 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
277.00	184	71.0	0	0	184
278.00	628	136.5	384	384	1,271
279.00	1,043	158.1	827	1,211	1,798

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
275.00	130	53.0	0	0	130
277.00	130	53.0	260	260	236

Device	Routing	Invert	Outlet Devices
#0	Primary	279.00'	**Automatic Storage Overflow** (Discharged without head)
#1	Discarded	271.50'	**0.04 cfs Exfiltration at all elevations** Phase-In= 0.01'
#2	Primary	277.80'	**9.0' long x 4.0' 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) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=0.04 cfs @ 9.51 hrs HW=271.58' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.51 cfs @ 12.31 hrs HW=277.88' TW=0.00' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Weir Controls 0.51 cfs @ 0.68 fps)

Summary for Pond CB-1: CB

Inflow Area = 16,643 sf, 83.29% Impervious, Inflow Depth = 7.79" for 100-year event
Inflow = 3.04 cfs @ 12.08 hrs, Volume= 10,804 cf
Outflow = 3.04 cfs @ 12.08 hrs, Volume= 10,804 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.04 cfs @ 12.08 hrs, Volume= 10,804 cf
Routed to Link WQ-1 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 270.37' @ 12.08 hrs
Flood Elev= 272.52'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.22'	**12.0" Round Culvert** L= 45.0' Ke= 0.500 Inlet / Outlet Invert= 269.22' / 268.77' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.04 cfs @ 12.08 hrs HW=270.37' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 3.04 cfs @ 3.87 fps)

Summary for Pond CB-2: CB

Inflow Area = 6,117 sf, 82.83% Impervious, Inflow Depth = 7.38" for 100-year event
Inflow = 1.04 cfs @ 12.08 hrs, Volume= 3,764 cf
Outflow = 1.04 cfs @ 12.08 hrs, Volume= 3,764 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.04 cfs @ 12.08 hrs, Volume= 3,764 cf
Routed to Pond DMH-3 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 271.36' @ 12.10 hrs
Flood Elev= 273.92'

Device	Routing	Invert	Outlet Devices
#1	Primary	270.46'	**12.0" Round Culvert** L= 23.0' Ke= 0.500 Inlet / Outlet Invert= 270.46' / 270.23' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.95 cfs @ 12.08 hrs HW=271.34' TW=271.25' (Dynamic Tailwater)
1=Culvert (Outlet Controls 0.95 cfs @ 1.72 fps)

Summary for Pond CB-3: CB

Inflow Area = 13,831 sf, 67.53% Impervious, Inflow Depth = 6.21" for 100-year event
Inflow = 1.96 cfs @ 12.09 hrs, Volume= 7,163 cf
Outflow = 1.96 cfs @ 12.09 hrs, Volume= 7,163 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.96 cfs @ 12.09 hrs, Volume= 7,163 cf
Routed to Pond DMH-3 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 272.25' @ 12.09 hrs
Flood Elev= 274.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	271.40'	**12.0" Round Culvert** L= 126.0' Ke= 0.500 Inlet / Outlet Invert= 271.40' / 270.23' S= 0.0093 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.94 cfs @ 12.09 hrs HW=272.25' TW=271.25' (Dynamic Tailwater)
1=Culvert (Outlet Controls 1.94 cfs @ 3.66 fps)

Summary for Pond CB-4: CB

Inflow Area = 22,442 sf, 65.03% Impervious, Inflow Depth = 6.21" for 100-year event
Inflow = 3.20 cfs @ 12.09 hrs, Volume= 11,608 cf
Outflow = 3.20 cfs @ 12.09 hrs, Volume= 11,608 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.20 cfs @ 12.09 hrs, Volume= 11,608 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Peak Elev= 270.46' @ 12.09 hrs
Flood Elev= 272.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.24'	**12.0" Round Culvert** L= 44.0' Ke= 0.500 Inlet / Outlet Invert= 269.24' / 268.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.19 cfs @ 12.09 hrs HW=270.45' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 3.19 cfs @ 4.07 fps)

Summary for Pond CB-5: CB

Inflow Area = 17,711 sf, 37.69% Impervious, Inflow Depth = 4.07" for 100-year event
Inflow = 1.51 cfs @ 12.11 hrs, Volume= 6,006 cf
Outflow = 1.51 cfs @ 12.11 hrs, Volume= 6,006 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.51 cfs @ 12.11 hrs, Volume= 6,006 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 272.02' @ 12.11 hrs
Flood Elev= 275.46'

Device	Routing	Invert	Outlet Devices
#1	Primary	271.36'	**12.0" Round Culvert** L= 65.0' Ke= 0.500 Inlet / Outlet Invert= 271.36' / 269.55' S= 0.0278 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.50 cfs @ 12.11 hrs HW=272.02' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.50 cfs @ 2.76 fps)

Summary for Pond CB-6: CB

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 6.51" for 100-year event
Inflow = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf
Outflow = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf
Routed to Pond DMH-7 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 276.77' @ 12.10 hrs
Flood Elev= 278.85'

Device	Routing	Invert	Outlet Devices
#1	Primary	274.74'	**12.0" Round Culvert** L= 95.0' Ke= 0.500 Inlet / Outlet Invert= 274.74' / 273.79' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.43 cfs @ 12.09 hrs HW=276.71' TW=275.38' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 3.43 cfs @ 4.37 fps)

Summary for Pond DMH-2: DMH

Inflow Area = 28,949 sf, 80.86% Impervious, Inflow Depth = 7.18" for 100-year event
Inflow = 4.71 cfs @ 12.09 hrs, Volume= 17,332 cf
Outflow = 4.71 cfs @ 12.09 hrs, Volume= 17,332 cf, Atten= 0%, Lag= 0.0 min
Primary = 4.71 cfs @ 12.09 hrs, Volume= 17,332 cf
Routed to Link WQ-1 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 269.72' @ 12.09 hrs
Flood Elev= 274.78'

Device	Routing	Invert	Outlet Devices
#1	Primary	268.42'	**15.0" Round Culvert** L= 64.0' Ke= 0.500 Inlet / Outlet Invert= 268.42' / 267.87' S= 0.0086 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=4.71 cfs @ 12.09 hrs HW=269.71' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 4.71 cfs @ 4.61 fps)

Summary for Pond DMH-3: DMH

Inflow Area = 28,949 sf, 80.86% Impervious, Inflow Depth = 7.18" for 100-year event
Inflow = 4.71 cfs @ 12.09 hrs, Volume= 17,332 cf
Outflow = 4.71 cfs @ 12.09 hrs, Volume= 17,332 cf, Atten= 0%, Lag= 0.0 min
Primary = 4.71 cfs @ 12.09 hrs, Volume= 17,332 cf
Routed to Pond DMH-2 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 271.25' @ 12.09 hrs
Flood Elev= 274.41'

Device	Routing	Invert	Outlet Devices
#1	Primary	269.98'	**15.0" Round Culvert** L= 168.0' Ke= 0.500 Inlet / Outlet Invert= 269.98' / 268.52' S= 0.0087 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=4.70 cfs @ 12.09 hrs HW=271.25' TW=269.71' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 4.70 cfs @ 4.67 fps)

Summary for Pond DMH-5: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 6.51" for 100-year event
Inflow = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf
Outflow = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf
Routed to Link WQ-2 : Water Quality Unit

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Peak Elev= 268.71' @ 12.09 hrs
Flood Elev= 274.16'

Device	Routing	Invert	Outlet Devices
#1	Primary	267.34'	**12.0" Round Culvert** L= 23.0' Ke= 0.500 Inlet / Outlet Invert= 267.34' / 266.88' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.51 cfs @ 12.09 hrs HW=268.70' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 3.51 cfs @ 4.47 fps)

Summary for Pond DMH-6: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 6.51" for 100-year event
Inflow = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf
Outflow = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf
Routed to Pond DMH-5 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 273.54' @ 12.09 hrs
Flood Elev= 277.33'

Device	Routing	Invert	Outlet Devices
#1	Primary	272.17'	**12.0" Round Culvert** L= 147.0' Ke= 0.500 Inlet / Outlet Invert= 272.17' / 269.87' S= 0.0156 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.51 cfs @ 12.09 hrs HW=273.53' TW=268.70' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 3.51 cfs @ 4.47 fps)

Summary for Pond DMH-7: DMH

Inflow Area = 24,170 sf, 71.83% Impervious, Inflow Depth = 6.51" for 100-year event
Inflow = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf
Outflow = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.52 cfs @ 12.09 hrs, Volume= 13,112 cf
Routed to Pond DMH-6 : DMH

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 275.39' @ 12.10 hrs
Flood Elev= 279.73'

Device	Routing	Invert	Outlet Devices
#1	Primary	273.70'	**12.0" Round Culvert** L= 143.0' Ke= 0.500 Inlet / Outlet Invert= 273.70' / 272.27' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.50 cfs @ 12.09 hrs HW=275.38' TW=273.53' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 3.50 cfs @ 4.46 fps)

Summary for Pond IS-1: IS-1

GEO-TP-5 indicates silty sand to a depth of 14' below grade with no refusal. The infiltration rate for loamy sand is 2.41 inches per hour (Rawls Rates)

Redox was encountered at 9' below grade or elevation 263.5

Inflow Area = 127,915 sf, 73.41% Impervious, Inflow Depth = 6.72" for 100-year event
Inflow = 19.37 cfs @ 12.09 hrs, Volume= 71,671 cf
Outflow = 4.73 cfs @ 12.48 hrs, Volume= 71,671 cf, Atten= 76%, Lag= 23.5 min
Discarded = 0.44 cfs @ 8.66 hrs, Volume= 39,221 cf
Primary = 4.29 cfs @ 12.48 hrs, Volume= 32,450 cf
Routed to Link RR1 : RipRap Apron

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 271.18' @ 12.48 hrs Surf.Area= 7,868 sf Storage= 26,441 cf
Flood Elev= 271.25' Surf.Area= 7,868 sf Storage= 26,670 cf

Plug-Flow detention time= 152.4 min calculated for 71,661 cf (100% of inflow)
Center-of-Mass det. time= 152.5 min (902.8 - 750.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	265.75'	11,068 cf	**52.42'W x 150.10'L x 5.50'H Field A** 43,273 cf Overall - 15,602 cf Embedded = 27,671 cf x 40.0% Voids
#2A	266.50'	15,602 cf	**ADS_StormTech MC-3500 d +Cap** x 140 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 140 Chambers in 7 Rows Cap Storage= 14.9 cf x 2 x 7 rows = 208.6 cf
		26,670 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	265.75'	**0.44 cfs Exfiltration at all elevations** Phase-In= 0.01'
#2	Primary	266.47'	**10.0" Round Culvert** L= 29.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 266.47' / 265.92' S= 0.0190 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#3	Device 2	267.90'	**4.0' long x 6.26' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.44 cfs @ 8.66 hrs HW=265.84' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.44 cfs)

Primary OutFlow Max=4.29 cfs @ 12.48 hrs HW=271.18' TW=0.00' (Dynamic Tailwater)
└─**2=Culvert** (Inlet Controls 4.29 cfs @ 7.87 fps)
  └─**3=Sharp-Crested Rectangular Weir** (Passes 4.29 cfs of 64.88 cfs potential flow)

Summary for Pond RR2: Riprap Slope

Inflow Area = 7,513 sf, 0.00% Impervious, Inflow Depth = 0.97" for 100-year event
Inflow = 0.09 cfs @ 12.13 hrs, Volume= 604 cf
Outflow = 0.09 cfs @ 12.13 hrs, Volume= 604 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.09 cfs @ 12.13 hrs, Volume= 604 cf
Primary = 0.00 cfs @ 24.34 hrs, Volume= 0 cf
Routed to Pond BR-1 : bioretention

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 280.00' @ 0.00 hrs Surf.Area= 111 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (925.5 - 925.5)

Volume	Invert	Avail.Storage	Storage Description
#1	280.00'	328 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 821 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
280.00	111	0	0
281.00	111	111	111
282.00	111	111	222
283.00	103	107	329
284.00	75	89	418
285.00	73	74	492
286.00	70	72	564
287.00	68	69	633
288.00	66	67	700
289.00	62	64	764
290.00	52	57	821

Device	Routing	Invert	Outlet Devices
#1	Discarded	280.00'	**0.37 cfs Exfiltration at all elevations**
#2	Primary	280.00'	**111.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.00 cfs @ 12.13 hrs HW=280.00' (Free Discharge)
└─**1=Exfiltration** (Passes 0.00 cfs of 0.37 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 24.34 hrs HW=280.00' TW=274.37' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond RR3: Riprap Slope

Inflow Area = 5,707 sf, 0.00% Impervious, Inflow Depth = 1.37" for 100-year event
Inflow = 0.15 cfs @ 12.11 hrs, Volume= 653 cf
Outflow = 0.15 cfs @ 12.11 hrs, Volume= 653 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.15 cfs @ 12.11 hrs, Volume= 653 cf
Primary = 0.00 cfs @ 11.79 hrs, Volume= 0 cf
Routed to Pond BR-1 : bioretention

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 280.00' @ 0.00 hrs Surf.Area= 116 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (905.3 - 905.3)

Volume	Invert	Avail.Storage	Storage Description
#1	280.00'	464 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 1,160 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
280.00	116	0	0
281.00	116	116	116
282.00	116	116	232
283.00	116	116	348
284.00	116	116	464
285.00	116	116	580
286.00	116	116	696
287.00	116	116	812
288.00	116	116	928
289.00	116	116	1,044
290.00	116	116	1,160

Device	Routing	Invert	Outlet Devices
#1	Discarded	280.00'	**0.37 cfs Exfiltration at all elevations**
#2	Primary	280.00'	**111.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.00 cfs @ 12.11 hrs HW=280.00' (Free Discharge)
└─**1=Exfiltration** (Passes 0.00 cfs of 0.37 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 11.79 hrs HW=280.00' TW=272.68' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Proposed Watershed Plan

Summary for Link RR1: RipRap Apron

Inflow Area = 127,915 sf, 73.41% Impervious, Inflow Depth = 3.04" for 100-year event
Inflow = 4.29 cfs @ 12.48 hrs, Volume= 32,450 cf
Primary = 4.29 cfs @ 12.48 hrs, Volume= 32,450 cf, Atten= 0%, Lag= 0.0 min
Routed to Reach 2R : Routing sheet flow through a subcatchment

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP-3: STUDY POINT #3

Inflow Area = 229,788 sf, 40.86% Impervious, Inflow Depth = 3.25" for 100-year event
Inflow = 8.15 cfs @ 12.19 hrs, Volume= 62,152 cf
Primary = 8.15 cfs @ 12.19 hrs, Volume= 62,152 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP1: STUDY POINT #1

Inflow Area = 27,226 sf, 22.53% Impervious, Inflow Depth = 0.59" for 100-year event
Inflow = 0.56 cfs @ 12.31 hrs, Volume= 1,348 cf
Primary = 0.56 cfs @ 12.31 hrs, Volume= 1,348 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link SP2: STUDY POINT #2

Inflow Area = 1,587 sf, 0.00% Impervious, Inflow Depth = 1.00" for 100-year event
Inflow = 0.02 cfs @ 12.13 hrs, Volume= 132 cf
Primary = 0.02 cfs @ 12.13 hrs, Volume= 132 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link WQ-1: Water Quality Unit

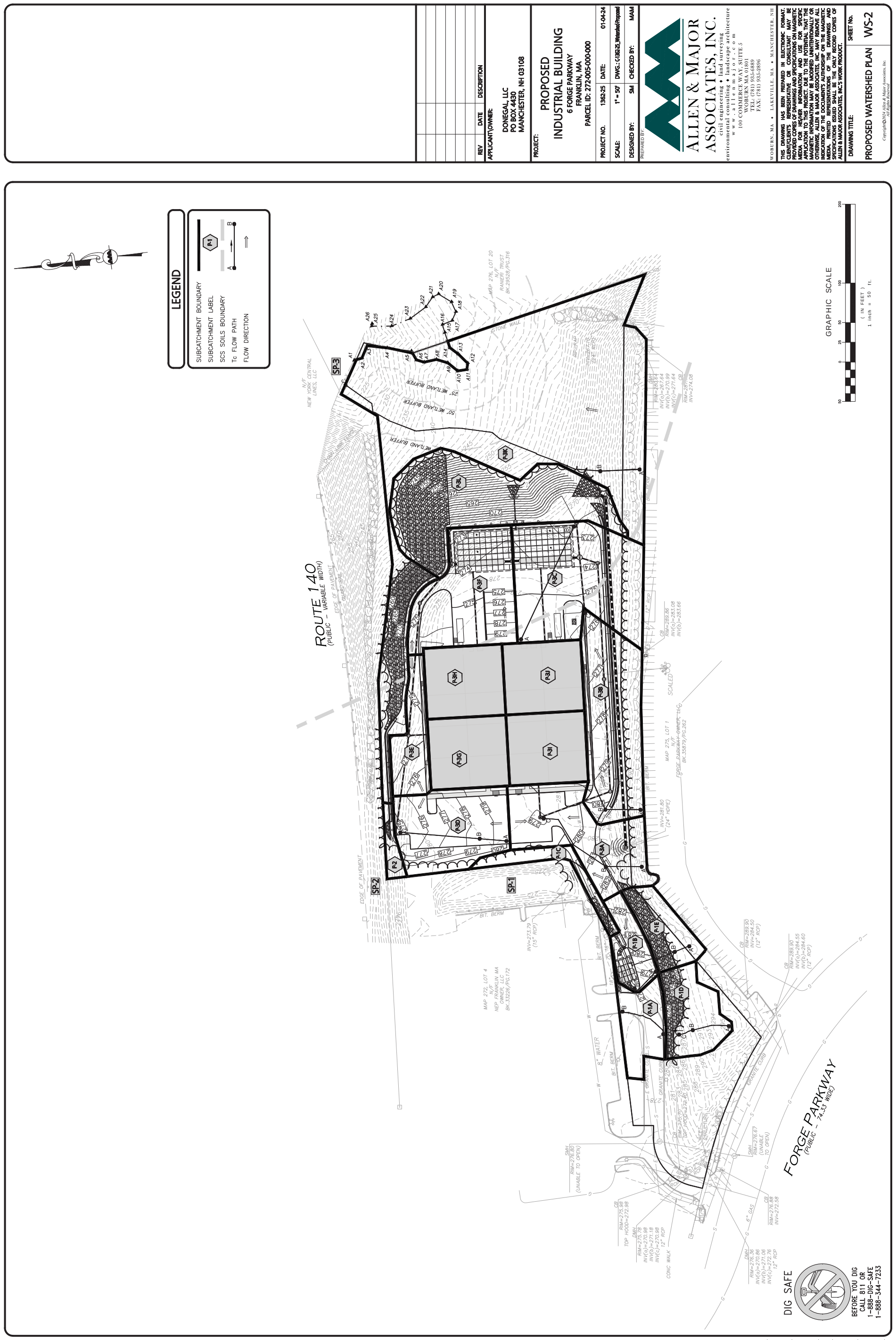
Inflow Area = 45,592 sf, 81.75% Impervious, Inflow Depth = 7.41" for 100-year event
Inflow = 7.75 cfs @ 12.09 hrs, Volume= 28,135 cf
Primary = 7.75 cfs @ 12.09 hrs, Volume= 28,135 cf, Atten= 0%, Lag= 0.0 min
Routed to Pond IS-1 : IS-1

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link WQ-2: Water Quality Unit

Inflow Area = 64,323 sf, 60.06% Impervious, Inflow Depth = 5.73" for 100-year event
Inflow = 8.19 cfs @ 12.09 hrs, Volume= 30,726 cf
Primary = 8.19 cfs @ 12.09 hrs, Volume= 30,726 cf, Atten= 0%, Lag= 0.0 min
Routed to Pond IS-1 : IS-1

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs



SECTION 6.0 -

APPENDIX

Illicit Discharge Compliance Statement

Illicit Discharge Compliance Statement

Responsibility:

The Owner is responsible for ultimate compliance with all provisions of the Massachusetts Stormwater Management Policy, the USEPA NPDES Construction General Permit and responsible for identifying and eliminating illicit discharges (as defined by the USEPA).

OWNER NAME: Donegal LLC

ADDRESS: PO Box 4430
Manchester, NH 03108

TEL. NUMBER: (603) 623-8811

Owner Signature

____

1/31/2024

____
Date

Engineer's Compliance Statement:

To the best of my knowledge, the attached plans, computations and specifications meet the requirements of Standard 10 of the Massachusetts Stormwater Handbook regarding illicit discharges to the stormwater management system and that no detectable illicit discharges exist on the site. All documents and attachments were prepared under my direction and qualified personnel properly gathered and evaluated the information submitted, to the best of my knowledge.

Included with this statement are site plans, drawn to scale, that identify the location of systems for conveying stormwater on the site and show that these systems do not allow the entry of any illicit discharges into the stormwater management system. The plans also show any systems for conveying wastewater and/or groundwater on the site and show that there are no connections between the stormwater and wastewater systems.

For a redevelopment project (if applicable), all actions taken to identify and remove illicit discharges, including without limitation, visual screening, dye or smoke testing, and the removal of any sources of illicit discharges to the stormwater management system are documented and included with this statement.

Rainfall Data

Extreme Precipitation Tables

Northeast Regional Climate Center

Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

Metadata for Point

Smoothing	Yes
State	Massachusetts
Location	Massachusetts, United States
Latitude	42.089 degrees North
Longitude	71.435 degrees West
Elevation	80 feet
Date/Time	Thu May 11 2023 14:01:37 GMT-0400 (Eastern Daylight Time)

Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2d
1yr	0.29	0.45	0.56	0.73	0.91	1.15	**1yr**	0.79	1.08	1.33	1.69	2.14	2.74	3.01	**1yr**	2.42	2.8
2yr	0.36	0.55	0.68	0.90	1.13	1.43	**2yr**	0.98	1.31	1.65	2.07	2.60	3.27	3.59	**2yr**	2.89	3.4
5yr	0.42	0.66	0.83	1.11	1.42	1.80	**5yr**	1.22	1.63	2.09	2.63	3.29	4.11	4.58	**5yr**	3.64	4.4
10yr	0.48	0.75	0.95	1.29	1.68	2.16	**10yr**	1.45	1.93	2.51	3.16	3.94	4.90	5.50	**10yr**	4.33	5.2
25yr	0.56	0.90	1.15	1.59	2.11	2.74	**25yr**	1.82	2.41	3.20	4.02	5.00	6.17	7.02	**25yr**	5.46	6.7
50yr	0.65	1.04	1.33	1.87	2.51	3.28	**50yr**	2.17	2.84	3.84	4.82	5.99	7.36	8.45	**50yr**	6.51	8.1
100yr	0.74	1.20	1.54	2.19	2.99	3.92	**100yr**	2.58	3.36	4.60	5.79	7.17	8.78	10.17	**100yr**	7.77	9.7
200yr	0.86	1.39	1.81	2.58	3.56	4.69	**200yr**	3.07	3.98	5.51	6.94	8.58	10.48	12.25	**200yr**	9.28	11.
500yr	1.03	1.69	2.21	3.21	4.49	5.97	**500yr**	3.88	4.98	7.03	8.84	10.90	13.26	15.68	**500yr**	11.74	15.

Lower Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2d

Manning's Number Tables

Manning's Roughness Coefficients ("n")

Conduit	Manning's Coefficients
Closed Conduits	
Asbestos-Cement Pipe	0.011 to 0.015
Brick	0.013 to 0.017
Cast Iron Pipe	
Cement-lined and seal-coated	0.011 to 0.015
Concrete (Monolithic)	
Smooth forms	0.012 to 0.014
Rough forms	0.015 to 0.017
Concrete Pipe	0.011 to 0.015
Corrugated-Metal Pipe (1/2 - STUL 34470 2 1/2-inch corrgtn.)	
Plain	0.022 to 0.026
Paved invert	0.018 to 0.022
Spun asphalt-lined	0.011 to 0.015
Plastic Pipe (Smooth)	0.011 to 0.015
Vitrified Clay	
Pipes	0.011 to 0.015
Liner channels	0.013 to 0.017
Open Channels	
Lined Channels	
Asphalt	0.013 to 0.017
Brick	0.012 to 0.018
Concrete	0.011 to 0.020
Rubble or riprap	0.020 to 0.035
Vegetal	0.030 to 0.040
Excavated or Dredged	
Earth, straight and uniform	0.020 to 0.030
Earth, winding, fairly uniform	0.025 to 0.040
Rock	0.030 to 0.045
Unmaintained	0.050 to 0.140
Natural Channels (minor streams, top width at flood state < 100 feet)	
Fairly regular section	0.030 to 0.070
Irregular section with pools	0.040 to 0.100

Source: Design and Construction of Sanitary and Storm Sewers, American Society of Civil Engineers and the Water Pollution Control Federation, 1969.

1

NRCS Soil Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Norfolk and Suffolk Counties, Massachusetts

May 11, 2023

Soil Map

Map Scale: 1:1,960 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

N

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

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

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

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

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

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

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

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

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 18, Sep 9, 2022

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes	7.8	52.9%
420C	Canton fine sandy loam, 8 to 15 percent slopes	7.0	47.1%
Totals for Area of Interest		**14.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the

development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Norfolk and Suffolk Counties, Massachusetts

103B—Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: vktd
Elevation: 0 to 480 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 120 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Charlton and similar soils: 40 percent
Hollis and similar soils: 25 percent
Rock outcrop: 20 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Charlton

Setting

Landform: Hills
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable coarse-loamy ablation till derived from granite

Typical profile

H1 - 0 to 6 inches: fine sandy loam
H2 - 6 to 36 inches: fine sandy loam
H3 - 36 to 60 inches: fine sandy loam

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Hollis

Setting

Landform: Hills
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Shallow, friable loamy ablation till derived from igneous rock

Typical profile

H1 - 0 to 3 inches: fine sandy loam
H2 - 3 to 14 inches: gravelly fine sandy loam
H3 - 14 to 18 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: High
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: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Parent material: Igneous and metamorphic rock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: Unranked

Minor Components

Canton

Percent of map unit: 7 percent
Hydric soil rating: No

Chatfield

Percent of map unit: 5 percent
Hydric soil rating: No

Scituate

Percent of map unit: 2 percent
Hydric soil rating: No

Whitman

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

420C—Canton fine sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2w817
Elevation: 0 to 1,330 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

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

Description of Canton

Setting

Landform: Hills, moraines, ridges
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy over sandy melt-out till derived from gneiss, granite, and/or schist

Typical profile

Ap - 0 to 7 inches: fine sandy loam
Bw1 - 7 to 15 inches: fine sandy loam
Bw2 - 15 to 26 inches: gravelly fine sandy loam
2C - 26 to 65 inches: gravelly loamy sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 19 to 39 inches to strongly contrasting textural stratification
Drainage class: Well drained
Runoff class: Low

Custom Soil Resource Report

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Montauk

Percent of map unit: 6 percent
Landform: Moraines, ground moraines, hills, drumlins
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Scituate

Percent of map unit: 6 percent
Landform: Hills, drumlins, ground moraines
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

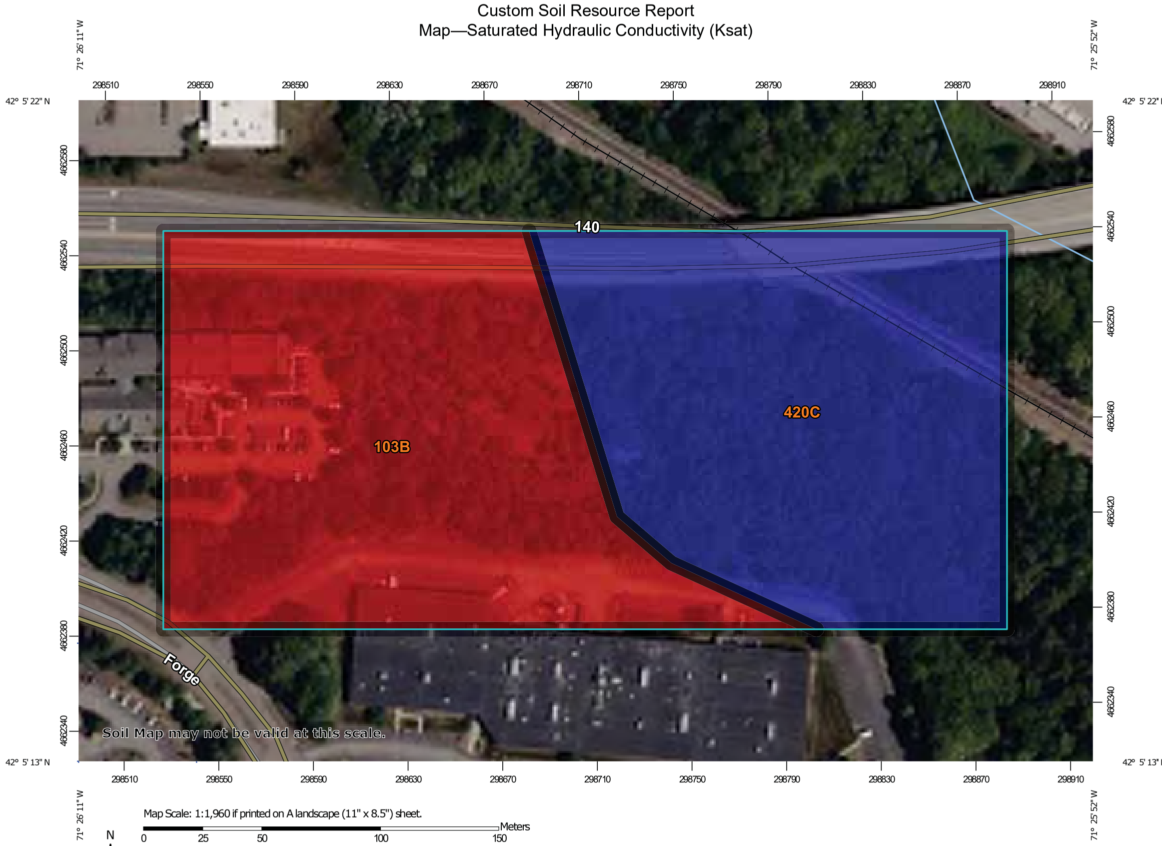
Newfields

Percent of map unit: 4 percent
Landform: Ground moraines, hills, moraines
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Charlton

Percent of map unit: 4 percent
Landform: Ridges, ground moraines, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Map—Saturated Hydraulic Conductivity (Ksat)



Map Scale: 1:1,960 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

N

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

MAP LEGEND

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

Soils

Soil Rating Polygons
- <= 23.2900
- > 23.2900 and <= 46.0000
- Not rated or not available

Soil Rating Lines
- <= 23.2900
- > 23.2900 and <= 46.0000
- Not rated or not available

Soil Rating Points
- <= 23.2900
- > 23.2900 and <= 46.0000
- 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 1:25,000.

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

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

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

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

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

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

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 18, Sep 9, 2022

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

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.

Table—Saturated Hydraulic Conductivity (Ksat)

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes	23.2900	7.8	52.9%
420C	Canton fine sandy loam, 8 to 15 percent slopes	46.0000	7.0	47.1%
Totals for Area of Interest			**14.8**	**100.0%**

Rating Options—Saturated Hydraulic Conductivity (Ksat)

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 100

Units of Measure: Inches

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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.

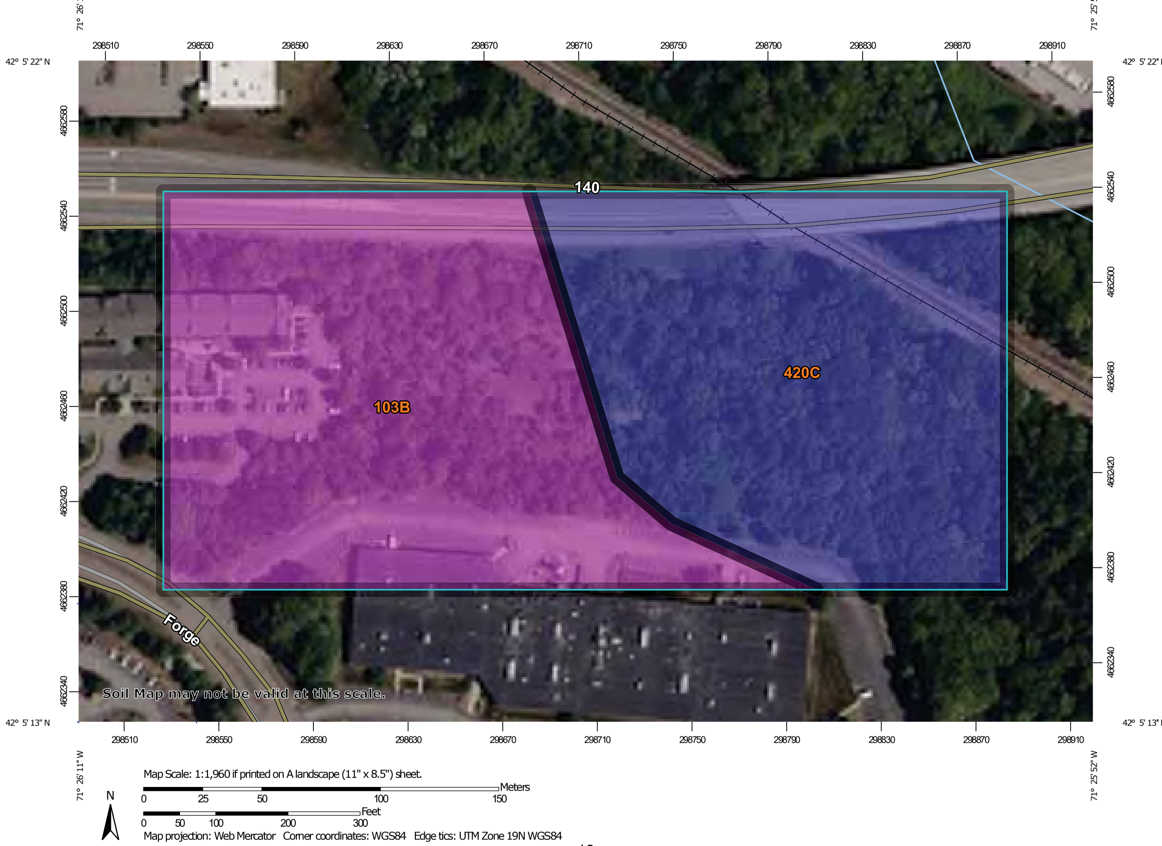
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Map—Hydrologic Soil Group



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 1:25,000.

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

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

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

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

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

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

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 18, Sep 9, 2022

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

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.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes	A	7.8	52.9%
420C	Canton fine sandy loam, 8 to 15 percent slopes	B	7.0	47.1%
Totals for Area of Interest			**14.8**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Test Pit Logs

Log of Test Pit GEO-TP-1

Date Excavated	11/15/2023	Total Depth (ft)	9.5	Logged By HKC / Checked By HPC	Excavator Equipment Doosan DX-140 LC
Groundwater not observed	Caving not observed				
Surface Elevation (ft) / Vertical Datum	276.74	Easting (X) / Northing (Y)	673912.6 / 2857407.58	Coordinate System / Horizontal Datum	

Depth (feet)	Sample Name	Group Classification	Material Description	Moisture Content (%)	Fines Content (%)	Remarks
0–1	S-1	TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (topsoil)			
1–2	S-2	SP-SM	Brown fine to medium sand with silt, gravel and roots (moist)			
2–9.5	S-3	SM	Brown silty fine to medium sand with gravel and cobbles (moist) (glacial till) With orange redox features			

Test pit terminated at 9½ feet due to probable boulder

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

GeoEngineers USA

Project: 6 Forge Parkway Development
Project Location: Franklin, Massachusetts
Project Number: 27167-001-00

Figure A-7
Sheet 1 of 1

Log of Test Pit GEO-TP-2

Date Excavated	11/15/2023	Total Depth (ft)	17	Logged By HKC / Checked By HPC	Excavator Equipment Doosan DX-140 LC
Groundwater not observed	Caving not observed				
Surface Elevation (ft) / Vertical Datum	272.04	Easting (X) / Northing (Y)	674015.12 / 2857399.76	Coordinate System / Horizontal Datum	

Depth (feet)	Sample Name	Group Classification	Material Description	Moisture Content (%)	Fines Content (%)	Remarks
0–1.5		TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (topsoil)			
1.5–4		SM	Brown silty fine to medium sand with gravel and roots (fill)			
4–4.5		TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (buried topsoil)			
4.5–5		SP-SM	Brown fine to medium sand with silt, gravel and roots (moist)			
5–17	S-1	SM	Brown silty fine to medium sand with gravel and cobbles (moist) (glacial till)			

Test pit terminated at approximately 17 feet as target depth achieved

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

GeoEngineers USA

Project: 6 Forge Parkway Development
Project Location: Franklin, Massachusetts
Project Number: 27167-001-00

Figure A-8
Sheet 1 of 1

Date Excavated: 11/16/2023	Total Depth (ft): 6	Logged By: HKC; Checked By: HPC	Excavator; Equipment: Doosan DX-140 LC	Groundwater not observed; Caving not observed	
Surface Elevation (ft) / Vertical Datum: 257.94	Easting (X): 674262.57 / Northing (Y): 2857319.08	Coordinate System / Horizontal Datum			

Elevation (feet)	Depth (feet)	Testing Sample	Sample Name / Testing	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0			TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (topsoil)			
257	1			SM	Tan silty fine to medium sand with gravel and roots (fill)			
255	3			TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (buried topsoil)			
				SP-SM	Brown fine to medium sand with silt, gravel and roots (moist)			Multiple boulders observed from 4 to 6 feet
				SM	Tan silty fine to medium sand with gravel (moist) (glacial till)			
	5.5	▯	S-1					

Test pit terminated at approximately 6 feet due to probable boulder

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit GEO-TP-3

GeoEngineers USA

Project: 6 Forge Parkway Development
Project Location: Franklin, Massachusetts
Project Number: 27167-001-00

Figure A-9
Sheet 1 of 1

Date Excavated: 11/16/2023	Total Depth (ft): 15	Logged By: HKC; Checked By: HPC	Excavator; Equipment: Doosan DX-140 LC	Groundwater not observed; Caving not observed	
Surface Elevation (ft) / Vertical Datum: 278.56	Easting (X): 674194.57 / Northing (Y): 2857237.72	Coordinate System / Horizontal Datum			

Elevation (feet)	Depth (feet)	Testing Sample	Sample Name / Testing	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
278	0			TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (topsoil)			
				SP-SM	Brown fine to medium sand with silt, gravel and roots (moist)			
277				SM	Tan silty fine to medium sand with gravel (moist) (glacial till)			
274	4	▯	S-1					Approximately 1-foot-diameter cobbles observed
264	14.5	▯	S-2				21.4	

Test pit terminated at approximately 15 feet as target depth achieved

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit GEO-TP-4

GeoEngineers USA

Project: 6 Forge Parkway Development
Project Location: Franklin, Massachusetts
Project Number: 27167-001-00

Figure A-10
Sheet 1 of 1

Date:1/5/24 Path:P:\27\27167001\GINT\2716700100.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEIB_TESTPIT_1P_GEOTEC_%F

Log of Test Pit GEO-TP-5 (Figure A-11)

Date Excavated	11/16/2023	Total Depth (ft)	14	Logged By HKC Checked By HPC	Excavator Equipment Doosan DX-140 LC	Groundwater not observed Caving not observed	
Surface Elevation (ft) Vertical Datum	271.99	Easting (X) Northing (Y)	674251.6 2857149.77	Coordinate System Horizontal Datum			

Elevation (feet)	Depth (feet)	Testing Sample	Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0–1		S-1		TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (topsoil)			
	1–2		S-2		SP-SM	Orange brown fine to medium sand with silt, gravel and roots (moist) (fill)			
	2–2.5				TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (buried topsoil)			
	2.5–4				SP-SM	Orange brown fine to medium sand with silt, gravel and roots (moist)			
	4–14				SM	Tan silty fine to medium sand with gravel (moist) (glacial till)			
	9					With orange redox features			
	14		S-3						

Test pit terminated at approximately 14 feet as target depth achieved

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit GEO-TP-5

GeoEngineers USA

Project: 6 Forge Parkway Development
Project Location: Franklin, Massachusetts
Project Number: 27167-001-00

Figure A-11
Sheet 1 of 1

Log of Test Pit GEO-TP-5 (Figure A-12)

Date Excavated	11/16/2023	Total Depth (ft)	14	Logged By HKC Checked By HPC	Excavator Equipment Doosan DX-140 LC	See "Remarks" section for groundwater observed Caving not observed	
Surface Elevation (ft) Vertical Datum	280.41	Easting (X) Northing (Y)	674020.73 2857138.38	Coordinate System Horizontal Datum			

Elevation (feet)	Depth (feet)	Testing Sample	Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0–0.7				TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (topsoil)			
	0.7–2.7		S-1		SP-SM	Orange brown fine to medium sand with silt, gravel and roots (moist) (fill)			
	2.7–3.5				TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (buried topsoil)			
	3.5–6		S-2		SP-SM	Orange brown fine to medium sand with silt, gravel and roots (moist)			
	6–14				SM	Tan silty fine to medium sand with gravel and orange redox features (moist) (glacial till)			
	9								Groundwater seepage observed at approximately 9 feet
	14		S-3						

Test pit terminated at approximately 14 feet as target depth is achieved

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit GEO-TP-5

GeoEngineers USA

Project: 6 Forge Parkway Development
Project Location: Franklin, Massachusetts
Project Number: 27167-001-00

Figure A-12
Sheet 1 of 1

Date Excavated	11/16/2023	Total Depth (ft)	14	Logged By HKC Checked By HPC	Excavator Equipment Doosan DX-140 LC	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum	281	Easting (X) Northing (Y)	673884.13 2857278.5	Coordinate System Horizontal Datum		

Elevation (feet)	Depth (feet)	Testing Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0				TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (topsoil)			No distinct subsoil layer observed
280	1	▯	S-1		SM	Tan silty fine to medium sand with gravel (moist) (glacial till)			
276	5								Approximately 6-inches to 1-foot-diameter cobbles observed
267	14	▯	S-2			Test pit terminated at approximately 14 feet as target depth achieved			

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit GEO-TP-7

GeoEngineers USA

Project: 6 Forge Parkway Development
Project Location: Franklin, Massachusetts
Project Number: 27167-001-00

Figure A-13
Sheet 1 of 1

Date Excavated	11/16/2023	Total Depth (ft)	13	Logged By HKC Checked By HPC	Excavator Equipment Doosan DX-140 LC	See "Remarks" section for groundwater observed See "Remarks" section for caving observed
Surface Elevation (ft) Vertical Datum	Undetermined	Easting (X) Northing (Y)		Coordinate System Horizontal Datum		

Elevation (feet)	Depth (feet)	Testing Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0				TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (topsoil)			
	~0.7				SP-SM	Brown fine to medium sand with silt, gravel and roots (moist) (fill)			
	3				SM	Tan silty fine to medium sand with gravel (fill)			
	5				TS	Dark brown silty fine to medium sand with trace gravel and roots (moist) (buried topsoil)			
	~5.7				SP-SM	Brown fine to medium sand with silt, gravel and roots (moist)			
	~6				SM	Tan silty fine to medium sand with gravel (moist) (glacial till)			
	13					Test pit terminated at approximately 13 feet due to caving			Groundwater seepage and caving observed at approximately 13 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit GEO-TP-8

GeoEngineers USA

Project: 6 Forge Parkway Development
Project Location: Franklin, Massachusetts
Project Number: 27167-001-00

Figure A-14
Sheet 1 of 1

MA Groundwater Recharge Calculation

ALLEN & MAJOR ASSOCIATES, INC.

Project No.	1362-25	**Sheet**	**1 of 1**
Project Description	6 Forge Parkway		
	Franklin, MA		
Calculated By	SM	**Date**	01/03/24
Checked By	MAM	**Date**	01/03/24

Standard # 3: Groundwater Recharge

Proposed recharge system: Stormtech MC-3500 Chamber Infitration System

In accordance with *MADEP – Volume 2, Technical Guide for Compliance with Massachusetts Stormwater Management Standards, dated January 2008*

A soils require a Volume to recharge of	**0.60**	**inches**
B soils require a Volume to recharge of	**0.35**	**inches**
C soils require a Volume to recharge of	**0.25**	**inches**
D soils require a Volume to recharge of	**0.10**	**inches**

Impervious area within: A-soils =	70,893	sf
Impervious area within: B-soils =	26,729	sf
Impervious area within: C-soils =		sf
Impervious area within: D-soils =		sf

Weighted Groundwater Recharge Depth = **0.53** **in**

Total Site Volume required to be recharged =

97,622 sf x 1" / 12 x 0.53 in = **4,324 cf**

Site volume recharge provided by = volume within the infiltration system below the invert out. See the HydroCAD stage storage table within the Appendix of the Drainage Report

= **13,205** cf Total Volume Recharged > **4,324 cf** (OK)

Water Quality Volume Calculation

ALLEN & MAJOR ASSOCIATES, INC.

Project No.	1362-25	**Sheet**	1 of 1
Project Description	6 Forge Parkway		
	Franklin, MA		
Calculated By	SM	**Date**	01/03/24
Checked By	MAM	**Date**	01/03/24

Standard # 4: Water Quality

$V_{WQ} = (D_{WQ}/12 \text{ inches/foot}) * (A_{IMP})$

Where:

V_{WQ} = Required Water Quality Volume (in cubic feet)
D_{WQ} = Water Quality Depth: one-inch for discharges within a Zone II or Interim Wellhead Protection Area, to or near another critical area, runoff from a LUHPPL, or exfiltration to soils with infiltration rate greater than 2.4 inches/hour or greater: ½-inch for discharges near or to other areas.
A_{IMP} = Impervious Area (in square feet)

Proposed Development Impervious = Total Site Impervious - Existing Impervious

Total Site Impervious	=	100,035 sf
Existing Impervious	=	2,413 sf
Proposed Development Impervious	=	97,622 sf

D_{WQ} = 1.0 in
A_{IMP} = 97,622 sf

$V_{WQ} = (D_{WQ}/12 \text{ inches/foot}) * (A_{IMP})$

V_{WQ} = 0.083 ft x 97,622 sf = **8,135 cf** (Water Quality Treatment Volume Required)

The infiltration systems provide 13,205 cf of storage below the outlet inverts.

Infiltration System Drain Calculation

ALLEN & MAJOR ASSOCIATES, INC.

Project No.	1362-25	**Sheet**	1 of 2
Project Description	6 Forge Parkway		
	Franklin, MA		
Calculated By	SM	**Date**	01/03/24
Checked By	MAM	**Date**	01/03/24

Drawdown within 72 hours Analysis for Static Method

Infiltration System #1 - Stormtech MC-3500

Infiltration Rate: 2.41 inches/hour *(From table 2.3.3: Rawls, Brakensiek, Saxton, 1982)*

Volume Provide for Infiltration: 11,495 cf

Basin bottom area: 7,871 sf

$Time_{drawdown}$ = (Required Recharge Volume in cubic feet as determined by the Static Method)(1/Design Infiltration Rate in inches per hour)(conversion for inches to feet)(1/bottom area in feet)

$Time_{drawdown}$ = (11,495 cf) (1 / 2.41 in/hr) (12 in./ft.) (1 / 7,871 sf)

= 7.27 hours

TSS Removal Calculation

ALLEN & MAJOR ASSOCIATES, INC.

Project No.	1362-25	**Sheet**	2 of 2
Project Description	6 Forge Parkway		
	Franklin, MA		
Calculated By	SM	**Date**	01/03/24
Checked By	MAM	**Date**	01/03/24

Drawdown within 72 hours Analysis for Static Method

Infiltration System #2 - Stormtech SC-740

Infiltration Rate: 2.41 inches/hour *(From table 2.3.3: Rawls, Brakensiek, Saxton, 1982)*

Volume Provide for Infiltration: 1,710 cf

Basin bottom area: 658 sf

$Time_{drawdown}$ = (Required Recharge Volume in cubic feet as determined by the Static Method)(1/Design Infiltration Rate in inches per hour)(conversion for inches to feet)(1/bottom area in feet)

$Time_{drawdown}$ = (1,710 cf) (1 / 2.41 in/hr) (12 in./ft.) (1 / 658 sf)

= 12.94 hours

ALLEN & MAJOR ASSOCIATES, INC.

Project No.	1362-25	**Sheet**	1 of 2
Project Description	6 Forge Parkway		
	Franklin, MA		
Calculated By	SM	**Date**	01/12/24
Checked By	MAM	**Date**	01/12/24

The calculations below provide the TSS removal rate of the stormwater management system

Stormwater Management BMP	TSS Removal rate
Parking Lot Sweeping	5 %
Deep sump catch basins	25 %
CDS2015-4	82 %
Infiltration System #1 - Isolator Row	80 %

Average Annual Load	=	1.0	
Parking Lot Sweeping	=	5.0	% Removal Rate
		95.0	% TSS Load Remains
TSS Load Remaining	=	95.0	%
Deep sump catch basins	=	25.0	% Removal Rate
		71.3	% TSS Load Remains
TSS Load Remaining	=	71.3	%
CDS2015-4	=	82.0	% Removal Rate
		12.8	% TSS Load Remains
TSS Load Remaining	=	12.8	%
Infiltration System #1 - Isolator Row	=	80.0	% Removal Rate
		2.6	% TSS Load Remains

Percentage of TSS Remaining	-	Initial TSS Load	=	Final TSS Removal Rate
100	-	2.57	=	97.4 %

For this drainage area, this system as designed will remove an estimated 97.4 % of the annual TSS load and therefore will meet the TSS removal standard.

ALLEN & MAJOR ASSOCIATES, INC.

Project No.	1362-25	**Sheet**	2 of 2
Project Description	6 Forge Parkway		
	Franklin, MA		
Calculated By	SM	**Date**	01/12/24
Checked By	MAM	**Date**	01/12/24

The calculations below provide the TSS removal rate of the stormwater management system

Stormwater Management BMP	TSS Removal rate	
Parking Lot Sweeping	5 %	
Rain guardrian turret	0 %	insufficienct data
Bioretention System	80 %	
Infiltration System #2	80 %	

Average Annual Load	=	1.0	
Parking Lot Sweeping	=	5.0	% Removal Rate
		95.0	% TSS Load Remains
TSS Load Remaining	=	95.0	%
Rain guardrian turret	=	0.0	% Removal Rate
		95.0	% TSS Load Remains
TSS Load Remaining	=	95.0	%
Bioretention System	=	80.0	% Removal Rate
		19.0	% TSS Load Remains
TSS Load Remaining	=	19.0	%
Infiltration System #2	=	80.0	% Removal Rate
		3.8	% TSS Load Remains

Percentage of TSS Remaining	-	Initial TSS Load	=	Final TSS Removal Rate
100	-	3.80	=	96.2 %

For this drainage area, this system as designed will remove an estimated 96.2 % of the annual TSS load and therefore will meet the TSS removal standard.

Project: 6 Forge Parkway
Location: Franklin, MA
Prepared For: Allen & Major

Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Procedure: Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

Compute Q Rate using the following equation:

Q = (qu) (A) (WQV)

where:

Q = flow rate associated with first 1" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1" in this case)

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
WQ-1	0.86	0.0013359	6.0	0.100	1.00	774.00	1.03
WQ-2	0.89	0.0013844	6.0	0.100	1.00	774.00	1.07

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

6 FORGE PARKWAY
FRANKLIN, MA

Area	0.86 ac	Unit Site Designation	WQ-1
Weighted C	0.9	Rainfall Station #	68
t_c	6 min		
CDS Model	2015-4	CDS Treatment Capacity	1.4 cfs

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.02	0.02	9.0
0.04	9.5%	18.8%	0.03	0.03	9.1
0.06	8.7%	27.5%	0.05	0.05	8.3
0.08	10.1%	37.6%	0.06	0.06	9.5
0.10	7.2%	44.8%	0.08	0.08	6.7
0.12	6.0%	50.8%	0.09	0.09	5.6
0.14	6.3%	57.1%	0.11	0.11	5.8
0.16	5.6%	62.7%	0.12	0.12	5.1
0.18	4.7%	67.4%	0.14	0.14	4.2
0.20	3.6%	71.0%	0.15	0.15	3.2
0.25	8.2%	79.1%	0.19	0.19	7.2
0.50	14.9%	94.0%	0.38	0.38	11.7
0.75	3.2%	97.3%	0.58	0.58	2.2
1.00	1.2%	98.5%	0.77	0.77	0.7
1.50	0.7%	99.2%	1.15	1.15	0.3
2.00	0.8%	100.0%	1.54	1.40	0.2
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					88.8
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**82.4%**

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH ENGINEERED SOLUTIONS

Stage Storage Calculations

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

6 FORGE PARKWAY
FRANKLIN, MA

Area	**0.89 ac**	Unit Site Designation	**WQ-2**
Weighted C	**0.9**	Rainfall Station #	**68**
t_c	**6 min**		
CDS Model	**2015-4**	CDS Treatment Capacity	**1.4 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.02	0.02	9.0
0.04	9.5%	18.8%	0.03	0.03	9.1
0.06	8.7%	27.5%	0.05	0.05	8.3
0.08	10.1%	37.6%	0.06	0.06	9.5
0.10	7.2%	44.8%	0.08	0.08	6.7
0.12	6.0%	50.8%	0.10	0.10	5.6
0.14	6.3%	57.1%	0.11	0.11	5.8
0.16	5.6%	62.7%	0.13	0.13	5.1
0.18	4.7%	67.4%	0.14	0.14	4.2
0.20	3.6%	71.0%	0.16	0.16	3.2
0.25	8.2%	79.1%	0.20	0.20	7.1
0.50	14.9%	94.0%	0.40	0.40	11.6
0.75	3.2%	97.3%	0.60	0.60	2.2
1.00	1.2%	98.5%	0.80	0.80	0.7
1.50	0.7%	99.2%	1.20	1.20	0.3
2.00	0.8%	100.0%	1.59	1.40	0.2
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					88.6
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**82.1%**

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Stage-Area-Storage for Pond IS-1: IS-1

Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)
265.75	0	266.28	1,668	266.81	4,435
265.76	31	266.29	1,699	266.82	4,502
265.77	63	266.30	1,731	266.83	4,568
265.78	94	266.31	1,762	266.84	4,635
265.79	126	266.32	1,794	266.85	4,701
265.80	157	266.33	1,825	266.86	4,768
265.81	189	266.34	1,857	266.87	4,834
265.82	220	266.35	1,888	266.88	4,900
265.83	252	266.36	1,920	266.89	4,967
265.84	283	266.37	1,951	266.90	5,033
265.85	315	266.38	1,983	266.91	5,099
265.86	346	266.39	2,014	266.92	5,166
265.87	378	266.40	2,046	266.93	5,232
265.88	409	266.41	2,077	266.94	5,298
265.89	441	266.42	2,109	266.95	5,364
265.90	472	266.43	2,140	266.96	5,430
265.91	504	266.44	2,171	266.97	5,496
265.92	535	266.45	2,203	266.98	5,562
265.93	566	266.46	2,234	266.99	5,629
265.94	598	266.47	2,266	267.00	5,695
265.95	629	266.48	2,297	267.01	5,761
265.96	661	266.49	2,329	267.02	5,827
265.97	692	266.50	2,360	267.03	5,892
265.98	724	266.51	2,428	267.04	5,958
265.99	755	266.52	2,495	267.05	6,024
266.00	787	266.53	2,562	267.06	6,090
266.01	818	266.54	2,629	267.07	6,156
266.02	850	266.55	2,697	267.08	6,222
266.03	881	266.56	2,764	267.09	6,288
266.04	913	266.57	2,831	267.10	6,353
266.05	944	266.58	2,898	267.11	6,419
266.06	976	266.59	2,965	267.12	6,485
266.07	1,007	266.60	3,032	267.13	6,550
266.08	1,039	266.61	3,099	267.14	6,616
266.09	1,070	266.62	3,166	267.15	6,682
266.10	1,101	266.63	3,233	267.16	6,747
266.11	1,133	266.64	3,300	267.17	6,813
266.12	1,164	266.65	3,367	267.18	6,878
266.13	1,196	266.66	3,434	267.19	6,944
266.14	1,227	266.67	3,501	267.20	7,009
266.15	1,259	266.68	3,568	267.21	7,075
266.16	1,290	266.69	3,635	267.22	7,140
266.17	1,322	266.70	3,702	267.23	7,205
266.18	1,353	266.71	3,769	267.24	7,271
266.19	1,385	266.72	3,835	267.25	7,336
266.20	1,416	266.73	3,902	267.26	7,401
266.21	1,448	266.74	3,969	267.27	7,466
266.22	1,479	266.75	4,036	267.28	7,531
266.23	1,511	266.76	4,102	267.29	7,596
266.24	1,542	266.77	4,169	267.30	7,662
266.25	1,574	266.78	4,236	267.31	7,727
266.26	1,605	266.79	4,302	267.32	7,792
266.27	1,636	266.80	4,369	267.33	7,857

Stage-Area-Storage for Pond IS-1: IS-1 (continued)

Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)
267.34	7,922	267.87	11,307	268.40	14,553
267.35	7,986	267.88	11,370	268.41	14,613
267.36	8,051	267.89	11,433	268.42	14,672
267.37	8,116	267.90	11,495	268.43	14,732
267.38	8,181	267.91	11,558	268.44	14,791
267.39	8,246	267.92	11,620	268.45	14,850
267.40	8,310	267.93	11,683	268.46	14,910
267.41	8,375	267.94	11,745	268.47	14,969
267.42	8,440	267.95	11,807	268.48	15,028
267.43	8,504	267.96	11,870	268.49	15,087
267.44	8,569	267.97	11,932	268.50	15,146
267.45	8,634	267.98	11,994	268.51	15,205
267.46	8,698	267.99	12,056	268.52	15,264
267.47	8,762	268.00	12,118	268.53	15,322
267.48	8,827	268.01	12,180	268.54	15,381
267.49	8,891	268.02	12,242	268.55	15,440
267.50	8,956	268.03	12,304	268.56	15,498
267.51	9,020	268.04	12,366	268.57	15,557
267.52	9,084	268.05	12,427	268.58	15,615
267.53	9,148	268.06	12,489	268.59	15,673
267.54	9,213	268.07	12,551	268.60	15,732
267.55	9,277	268.08	12,612	268.61	15,790
267.56	9,341	268.09	12,674	268.62	15,848
267.57	9,405	268.10	12,736	268.63	15,906
267.58	9,469	268.11	12,797	268.64	15,964
267.59	9,533	268.12	12,858	268.65	16,022
267.60	9,597	268.13	12,920	268.66	16,079
267.61	9,661	268.14	12,981	268.67	16,137
267.62	9,725	268.15	13,042	268.68	16,195
267.63	9,789	268.16	13,103	268.69	16,252
267.64	9,852	268.17	13,165	268.70	16,310
267.65	9,916	268.18	13,226	268.71	16,367
267.66	9,980	268.19	13,287	268.72	16,424
267.67	10,043	268.20	13,348	268.73	16,481
267.68	10,107	268.21	13,408	268.74	16,538
267.69	10,171	268.22	13,469	268.75	16,595
267.70	10,234	268.23	13,530	268.76	16,652
267.71	10,298	268.24	13,591	268.77	16,709
267.72	10,361	268.25	13,651	268.78	16,766
267.73	10,425	268.26	13,712	268.79	16,823
267.74	10,488	268.27	13,772	268.80	16,879
267.75	10,551	268.28	13,833	268.81	16,936
267.76	10,615	268.29	13,893	268.82	16,992
267.77	10,678	268.30	13,953	268.83	17,048
267.78	10,741	268.31	14,014	268.84	17,104
267.79	10,804	268.32	14,074	268.85	17,161
267.80	10,867	268.33	14,134	268.86	17,217
267.81	10,930	268.34	14,194	268.87	17,273
267.82	10,993	268.35	14,254	268.88	17,328
267.83	11,056	268.36	14,314	268.89	17,384
267.84	11,119	268.37	14,374	268.90	17,440
267.85	11,182	268.38	14,434	268.91	17,495
267.86	11,245	268.39	14,493	268.92	17,551

Existing Offsite Pipe Evaluation

Stage-Area-Storage for Pond BR-1: bioretention

Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)
271.50	0	274.15	1,126	276.80	1,432
271.55	13	274.20	1,143	276.85	1,434
271.60	26	274.25	1,159	276.90	1,436
271.65	39	274.30	1,175	276.95	1,438
271.70	53	274.35	1,189	277.00	1,440
271.75	66	274.40	1,204	277.05	1,450
271.80	79	274.45	1,217	277.10	1,460
271.85	92	274.50	1,231	277.15	1,471
271.90	105	274.55	1,244	277.20	1,484
271.95	118	274.60	1,257	277.25	1,497
272.00	132	274.65	1,270	277.30	1,511
272.05	157	274.70	1,283	277.35	1,526
272.10	183	274.75	1,296	277.40	1,542
272.15	209	274.80	1,310	277.45	1,559
272.20	235	274.85	1,323	277.50	1,577
272.25	261	274.90	1,336	277.55	1,596
272.30	286	274.95	1,349	277.60	1,616
272.35	312	275.00	1,362	277.65	1,638
272.40	337	275.05	1,364	277.70	1,661
272.45	362	275.10	1,366	277.75	1,684
272.50	388	275.15	1,368	277.80	1,710
272.55	413	275.20	1,370	277.85	1,736
272.60	438	275.25	1,372	277.90	1,764
272.65	463	275.30	1,374	277.95	1,793
272.70	488	275.35	1,376	278.00	1,824
272.75	512	275.40	1,378	278.05	1,856
272.80	537	275.45	1,380	278.10	1,889
272.85	561	275.50	1,382	278.15	1,923
272.90	586	275.55	1,384	278.20	1,957
272.95	610	275.60	1,386	278.25	1,993
273.00	634	275.65	1,388	278.30	2,029
273.05	658	275.70	1,389	278.35	2,067
273.10	681	275.75	1,391	278.40	2,106
273.15	705	275.80	1,393	278.45	2,145
273.20	728	275.85	1,395	278.50	2,186
273.25	752	275.90	1,397	278.55	2,227
273.30	775	275.95	1,399	278.60	2,270
273.35	797	276.00	1,401	278.65	2,314
273.40	820	276.05	1,403	278.70	2,359
273.45	842	276.10	1,405	278.75	2,405
273.50	865	276.15	1,407	278.80	2,452
273.55	887	276.20	1,409	278.85	2,500
273.60	908	276.25	1,411	278.90	2,549
273.65	930	276.30	1,413	278.95	2,599
273.70	951	276.35	1,415	279.00	**2,651**
273.75	972	276.40	1,417		
273.80	992	276.45	1,419		
273.85	1,013	276.50	1,421		
273.90	1,033	276.55	1,423		
273.95	1,052	276.60	1,425		
274.00	1,071	276.65	1,427		
274.05	1,090	276.70	1,428		
274.10	1,108	276.75	1,430		

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Existing 24" HDPE

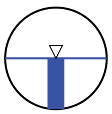
slope assumed based on 12" RCP

Inputs

Pipe diameter, d_0	24	in
Manning roughness, n	0.013	
Pressure slope (possibly ? equal to pipe slope), S_0	0.035	rise/run
Relative flow depth, y/d_0	0.5	fraction

Results

Flow depth, y	1.0000	ft
Flow area, a	1.5708	ft^2
Pipe area, a0	3.1416	ft^2
Relative area, a/a0	0.5000	fraction
Wetted perimeter, P_w	3.1416	ft
Hydraulic radius, R_h	0.5000	ft
Top width, T	2.0000	ft
Velocity, v	13.4708	ft/sec
Velocity head, h_v	2.8202	ft H2O
Froude number, F	2.68	
Average shear stress (tractive force), tau	1.0925	psf
Flow, Q (See notes)	21.1593	cfs
Full flow, Q0	42.3185	cfs
Ratio to full flow, Q/Q0	0.5000	fraction



Notes:

This is the flow and depth inside an *infinitely long* pipe.
Getting the flow into the pipe may require significantly higher headwater depth. Add at least 1.5 times the velocity head to get the headwater depth or see my 2-minute tutorial for standard culvert headwater calculations using HY-8.

Manning Formula Uniform Pipe Flow at Given Slope and Depth

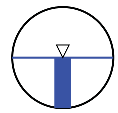
Existing12" RCP

Inputs

Pipe diameter, d_0	12	in
Manning roughness, n	0.012	
Pressure slope (possibly ? equal to pipe slope), S_0	0.035	rise/run
Relative flow depth, y/d_0	0.5	fraction

Results

Flow depth, y	0.5000	ft
Flow area, a	0.3927	ft^2
Pipe area, a0	0.7854	ft^2
Relative area, a/a0	0.5000	fraction
Wetted perimeter, P_w	1.5708	ft
Hydraulic radius, R_h	0.2500	ft
Top width, T	1.0000	ft
Velocity, v	9.1933	ft/sec
Velocity head, h_v	1.3135	ft H2O
Froude number, F	2.59	
Average shear stress (tractive force), tau	0.5463	psf
Flow, Q (See notes)	3.6101	cfs
Full flow, Q0	7.2201	cfs
Ratio to full flow, Q/Q0	0.5000	fraction



Notes:

This is the flow and depth inside an *infinitely long* pipe.
Getting the flow into the pipe may require significantly higher headwater depth. Add at least 1.5 times the velocity head to get the headwater depth or see my 2-minute tutorial for standard culvert headwater calculations using HY-8.

Rip Rap Design

Manning Formula Uniform Pipe Flow at Given Slope and Depth

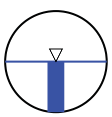
Proposed 30" HDPE

Inputs

Pipe diameter, d_0	30	in
Manning roughness, n	0.013	
Pressure slope (possibly ? equal to pipe slope), S_0	0.0163	rise/run
Relative flow depth, y/d_0	0.5	fraction

Results

Flow depth, y	1.2500	ft
Flow area, a	2.4544	ft^2
Pipe area, a0	4.9088	ft^2
Relative area, a/a0	0.5000	fraction
Wetted perimeter, P_w	3.9270	ft
Hydraulic radius, R_h	0.6250	ft
Top width, T	2.5000	ft
Velocity, v	10.6675	ft/sec
Velocity head, h_v	1.7686	ft H2O
Froude number, F	1.90	
Average shear stress (tractive force), tau	0.6360	psf
Flow, Q (See notes)	26.1811	cfs
Full flow, Q0	52.3621	cfs
Ratio to full flow, Q/Q0	0.5000	fraction



Notes:

This is the flow and depth inside an *infinitely long* pipe.
Getting the flow into the pipe may require significantly higher headwater depth. Add at least 1.5 times the velocity head to get the headwater depth or see my 2-minute tutorial for standard culvert headwater calculations using HY-8.

Engineers Note:
The capacity of the proposed 30" HDPE pipe exceeds the cumulative capacity of the two existing pipes and will therefore not result in negative impacts to the upstream infrastructure.

Existing 24" HDPE Capacity = 21.16 cfs
Existing 12" RCP Capacity = 3.61 cfs
Cumulative Flow Rate: 21.16 + 3.61 = 24.77 cfs
Proposed 30" HDPE Capacity = 26.18 cfs > 24.77 cfs

Outlet # HW-01

Q10 = 2.36 cfs T_w = 0.25 feet

D_o = 10 inches

Design Criteria

Apron Dimensions

The dimensions of the apron at the outlet of the pipe shall be determined as follows:

1.) The width of the apron at the outlet of the pipe or channel shall be 3 times the diameter of the pipe of width of the channel.

W= **2.5** feet

2.) The length of the apron shall be determined from the following formula when the tailwater depth at the outlet of the pipe or channel is less than one-half the diameter of the pipe or one-half the width of the channel:

USE THIS ONE ⇒ La=1.8*Q/ Do^3/2+ 7Do

La= **11.42** feet

Where:

La is the length of the apron

Q is the discharge from the pipe or channel

D_o is the diameter of pipe of width of channel

3.) When the depth of the tailwater at the outlet of the pipe or channel is equal to or greater than one-half the diameter of the pipe or the width of the channel. Then the following formula applies:

La=3.0*Qo/ Do^1.5 +7D_o

La= **15.14** feet

4.) Where there is no well defined channel downstream of the outlet, the width of the downstream end of the apron shall be determined as follows:

a. For minimum tailwater conditions where the tailwater depth is less than the elevation of the center of the pipe:

W=3*Do+La

USE THIS ONE ⇒ W= **13.92** feet

b. For maximum tailwater conditions where the tailwater depth is greater than the elevation of the center of the pipe:

W=3*Do+0.4*La

W= **8.56** feet

5.) Where there is a stable well-defined channel downstream of the apron, the bottom of the apron shall be equal to the width of the channel.

6.) The side of the apron in a well-defined channel shall be 2:1 (horizontal to vertical) or flatter. The height of the structural lining along the channel sides shall begin at the elevation equal to the top of conduit and taper down to the channel bottom through the length of the apron.

7.) The bottom grade of the apron shall be level (0% grade). No overfall is allowable at the end of the apron.

8.) The apron shall be located so that there are no bends in the horizontal alignment of the apron.

Rock Riprap

The following criteria shall be used to determine the dimensions of the rock riprap used for the apron:

1.) The median stone diameter shall be determined using the formula:

d_{50}=0.02*Q^4/3/(Tw*D_o)

d_{50}= **3.61** inches **USE 4** inches

d_{50} minimum 3 inches

Where:

d_{50} is the median stone diameter in feet

Tw is the tailwater depth above the invert of the pipe channel in feet

Q is the discharge from the pipe or channel in cubic feet per second

D_o is the diameter of the pipe or width of the channel in feet

2.) Fifty percent by weight of the riprap mixture shall be smaller the than median size stone designated as d_{50}. The largest stone size in the mixture shall be 1.5 times the d_{50} size.

3.) The quality and gradation of the rock, the thickness of the riprap lining, filter material and the quality of the stone shall meet the requirements in the Rock Riprap BMP. The minimum depth shall be 6 inches or 1.5 times the largest stone size in the mixture whichever is larger (d).

Thickness of the riprap

d = 1.5*(1.5*d_{50}(largest stone size))

d = **9** inches*

* must use a minimum of 6"

Rock Rip Rap Gradation

% of weight smaller than the given size	size of stone in inches		
100	**6.0**	to	**8.0**
85	**5.2**	to	**7.2**
50	**4.0**	to	**6.0**
15	**1.2**	to	**2.0**

Formulas Used (Reference NHDES Handbook, Pages 7-114, 7-115)

Outlet # HW-02

$Q_{(capacity)}$ 26.18 cfs T_w = 1.25 feet

D_o = 30 inches

Design Criteria

Apron Dimensions

The dimensions of the apron at the outlet of the pipe shall be determined as follows:

1.) The width of the apron at the outlet of the pipe or channel shall be 3 times the diameter of the pipe of width of the channel.

W= **7.5** feet

2.) The length of the apron shall be determined from the following formula when the tailwater depth at the outlet of the pipe or channel is less than one-half the diameter of the pipe or one-half the width of the channel:

USE THIS ONE

La=1.8*Q/ Do^3/2+ 7Do

La= **29.42** feet

Where:

La is the length of the apron

Q is the discharge from the pipe or channel

D_o is the diameter of pipe of width of channel

3.) When the depth of the tailwater at the outlet of the pipe or channel is equal to or greater than one-half the diameter of the pipe or the width of the channel. Then the following formula applies:

La=3.0*Qo/ Do^1.5 +7D_o

La= **37.37** feet

4.) Where there is no well defined channel downstream of the outlet, the width of the downstream end of the apron shall be determined as follows:

a. For minimum tailwater conditions where the tailwater depth is less than the elevation of the center of the pipe:

USE THIS ONE

W=3*Do+La

W= **36.92** feet

b. For maximum tailwater conditions where the tailwater depth is greater than the elevation of the center of the pipe:

W=3*Do+0.4*La

W= **22.45** feet

5.) Where there is a stable well-defined channel downstream of the apron, the bottom of the apron shall be equal to the width of the channel.

6.) The side of the apron in a well-defined channel shall be 2:1 (horizontal to vertical) or flatter. The height of the structural lining along the channel sides shall begin at the elevation equal to the top of conduit and taper down to the channel bottom through the length of the apron.

7.) The bottom grade of the apron shall be level (0% grade). No overfall is allowable at the end of the apron.

8.) The apron shall be located so that there are no bends in the horizontal alignment of the apron.

Rock Riprap

The following criteria shall be used to determine the dimensions of the rock riprap used for the apron:

1.) The median stone diameter shall be determined using the formula:

d_{50}=0.02*Q^4/3/(Tw*D_o)

d_{50}= **5.91** inches **USE 6** inches

d_{50} minimum 3 inches

Where:

d_{50} is the median stone diameter in feet

Tw is the tailwater depth above the invert of the pipe channel in feet

Q is the discharge from the pipe or channel in cubic feet per second

D_o is the diameter of the pipe or width of the channel in feet

2.) Fifty percent by weight of the riprap mixture shall be smaller the than median size stone designated as d_{50}. The largest stone size in the mixture shall be 1.5 times the d_{50} size.

3.) The quality and gradation of the rock, the thickness of the riprap lining, filter material and the quality of the stone shall meet the requirements in the Rock Riprap BMP. The minimum depth shall be 6 inches or 1.5 times the largest stone size in the mixture whichever is larger (d).

Thickness of the riprap

d = 1.5*(1.5*d_{50}(largest stone size))

d = **14** inches*

* must use a minimum of 6"

Rock Rip Rap Gradation

% of weight smaller than the given size	size of stone in inches		
100	**9.0**	to	**12.0**
85	**7.8**	to	**10.8**
50	**6.0**	to	**9.0**
15	**1.8**	to	**3.0**

Formulas Used (Reference NHDES Handbook, Pages 7-114, 7-115)

SECTION 7.0

SITE DEVELOPMENT PLANS

(See Attached Plans)