# DRAINAGE REPORT

ALLEN & MAJOR
ASSOCIATES, INC.

## 200-400 Quannapowitt Parkway
## Wakefield, MA

8/3/21

COMMONWEALTH OF MASSACHUSETTS
TIMOTHY J. WILLIAMS
CIVIL
No. 43119
REGISTERED PROFESSIONAL ENGINEER


**APPLICANT**:
CCF Quannapowitt Property Company, LLC
185 Dartmouth Street
Boston, MA 02116

**PREPARED BY**:
Allen & Major Associates, Inc.
100 Commerce Way, Suite 5
Woburn, Massachusetts 01801

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**ISSUED:**
March 16, 2021

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August 3, 2021

**A&M PROJECT NO.:**
1623-11

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# SECTION 1.0 -
## DRAINAGE REPORT

## Introduction

The purpose of this drainage report is to provide an overview of the proposed stormwater management system for the proposed development of 200-400 Quannapowitt Parkway, Wakefield, MA, (the site). The report will show by means of narrative, calculations and exhibits that there is no increase in the peak rate of runoff from the Site at all of the study points for each of the required (2-, 10- and 100-year) design storm events.

The proposed mixed-use redevelopment includes razing the existing building, and constructing three detached multi-story buildings with approximately 485 multifamily units and retail space. Other improvements to the site include renovation and reconstruction of all surface parking, landscaping, and underground utilities servicing the redevelopment. The stormwater management system (SMS) will be enhanced to maximize treatment and infiltration of stormwater on site.

The SMS incorporates structural and non-structural Best Management Practices (BMPs) to provide stormwater quality treatment and conveyance. The SMS includes deep-sump hooded catch basins, drain manholes, underground piping, underground infiltration chambers, bioretention cells, surface infiltration basins vegetated filter strip with stone diaphragm, roof drains, and an Operation & Maintenance Plan.

## Site Categorization for Stormwater Regulations

According to the Massachusetts Stormwater Handbook the proposed site improvements at 200 Quannapowitt Parkway are considered "redevelopment" due to the reduction in impervious area. Under proposed conditions, the project will increase the amount of green (pervious) surfaces by approximately 41,000 s.f. (0.95 acres). 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. See the discussion of Stormwater Management Standards that follows.

There is work proposed within MA DEP jurisdictional areas. Therefore, approval under the Massachusetts Wetlands Protection Act is required and a Notice of Intent (NOI) filing has been prepared and submitted as part of this project.

## Site Location and Access

The site is located entirely within the Town of Wakefield, Massachusetts and is situated between Interstate-95 to the west and Lake Quannapowitt to the east. Access to

Quannapowitt Parkway is provided off Lowell Street to the north and North Ave to the south.

**Existing Site Conditions**

The majority of the existing building is currently vacant and previously used as office space with a small percentage dedicated to a data center. The Site is generally flat, varying 0-5 feet in elevation, with a low point around the perimeter of the property and a high point at the center in the general location of the existing building. The Site is surrounded by wetlands as shown on the accompanying plans. These wetlands are fed primarily by surface runoff from the existing roof and parking lot. The majority of this runoff flows unmitigated with no treatment prior to discharge at the resource areas. These wetlands are also connected to Lake Quannapowitt by two underground culverts located at the southern and eastern corners of the property.

All runoff from the Site was analyzed at three study points. Study Point #1 is a summation of all runoff towards the existing culvert to the south connecting to the lake. Study Point #2 is a summation of all site runoff from the site into the lake. Study Point #3 is a summation of all runoff towards the existing culvert to the east connecting to the lake. All Site runoff eventually discharges to Lake Quannapowitt through the two culverts described above, direct entry from roof leaders, or overland flow from the grassed area bordering the lake. Copies of the Watershed plans (Existing and Proposed), providing the boundaries and contributing areas are provided in the back pocket of this report.

**Existing Soil Conditions**

The on-site soils were identified using the USDA Natural Resources Conservation Services (NRCS) Soil Survey for Middlesex County. The site is primarily Soil Type 656 – Udorthents-Urban Land Complex. Urban Land consists of areas where the soil has been altered or obscured by buildings or paved areas. These structures cover 75 percent or more of the surface area. A copy of the soil mapping is included in the Appendix of this report.

Haley & Aldrich (H&A) performed some preliminary subsurface explorations on the property and described their findings in a Memorandum titled "Due Diligence Geotechnical Investigation". It's estimated that a 2-6' surficial layer of fill exists across the site. The fill consists primarily of reworked natural granular soils placed during previous site development. The memorandum went on to describe the groundwater conditions as follows:

"Groundwater observation wells were not installed as part of this investigation. Previous explorations on adjacent parcels, as well as water levels in the adjacent Lake Quannapowitt, suggest that groundwater is likely present about 3 to 5 feet below

existing site grades. This is consistent with where groundwater levels were interpreted in the recent CPT explorations. The Lake is dam controlled and reported to be maintained at approximately El. 79."

H&A went on to perform additional sub-surface investigations by digging eight (8) test pits throughout areas designated for stormwater management. These test pits were consistent with earlier findings showing fill across the site describing the soils as sandy/silty loam. Mottling was not apparent in any of the pits however water was observed between 2.7' and 7' below grade after an extended period of time. It is important to note that two-days prior to the test pit excavations, the surrounding area experienced above average rainfall with depths up to 1-inch recorded in the Boston area.

The Town Engineer witnessed several of the eight (8) test pits and has recommended TP-6 be used to establish the groundwater elevation 81.0' across the site for design purposes. The test pit logs prepared by H&A are provided in the appendix of this report.

**FEMA Floodplain/Environmental Due Diligence**

The Site borders and has a hydraulic connection to FEMA *Zone "AE"* elevation 83.0. *Zone "AE" areas* are areas of 1% annual chance (or 100-year) flood area. The official Flood Insurance Rate Map (FIRM) for the site is dated June 4, 2010 and shown on FEMA panel 25017C0314E. A copy of the FEMA FIRM is included in the appendix of this report.

**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 10.00-24. The HydroCAD program was used to generate the 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 Wakefield requirements and standard engineering practices. The peak rate of runoff has been estimated for each watershed during the 2, 10, and 100-year storm events.

The stormwater runoff model demonstrates that the overall peak rates of runoff into Lake Quannapowitt will not be increased under proposed conditions during all storm events. The following table provides a summary of the estimated peak rates of runoff for each of the design storm events. The HydroCAD worksheets are included in Section 3 and 4 of this report.

| **STUDY POINT #1** (Lake Quannapowitt) | | | |
|---|---|---|---|
| | 2-Year | 10-Year | 100-Year |
| Existing Flow (CFS) | 10.28 | 20.29 | 33.45 |
| Proposed Flow (CFS) | 2.13 | 10.02 | 24.25 |
| **Decrease (CFS)** | **8.15 (79%)** | **10.27 (51%)** | **9.20 (28%)** |
| Existing Volume (CF) | 88,974 | 173,080 | 307,440 |
| Proposed Volume (CF) | 47,968 | 128,688 | 260,071 |
| **Decrease (CF)** | **41,006 (46%)** | **44,392 (26%)** | **47,369 (15%)** |

**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
- Vegetated Filter Strip & Stone Diaphragm
- Subsurface Structures
- Bioretention Areas
- Surface Infiltration Basin
- Wet Basin

- Specific Maintenance Schedule

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 straw bale and/or silt fence 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 proposed site improvements are classified as a "redevelopment" under the MA DEP Stormwater Management Standards based upon a reduction in impervious area. Consequently, compliance with Standard #3 is required only to the maximum extent practicable. This reduction is achieved with the installation of landscape areas.
Existing impervious area = 9.77 ± acres
Proposed impervious area = 8.82 ± acres
Change in impervious area = -0.95 ± acres

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 redevelopment is captured and treated using the BMPs listed above.

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 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 proposed redevelopment is considered a source of higher potential pollutant loads due to 1,000 or more expected vehicle trips per day. The SMS will be designed to treat 1" water quality volume.

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 considered a redevelopment under the MA DEP Stormwater Management Standards as there is a decrease in the amount of total 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 Erosion and Sedimentation Control Plan is included in the Permit Drawings. 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. The applicant will submit the Illicit Discharge Compliance Statement prior to the discharge of stormwater runoff to the post-construction stormwater best management practices and prior to the issuance of a Certificate of Compliance.

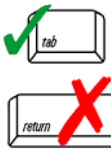
See the next page for the MassDEP Stormwater Checklist.

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

# Checklist for Stormwater Report

## A. Introduction

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




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

The Stormwater Report must include:

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

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

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

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

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

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

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

# Checklist for Stormwater Report

## B. Stormwater Checklist and Certification

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

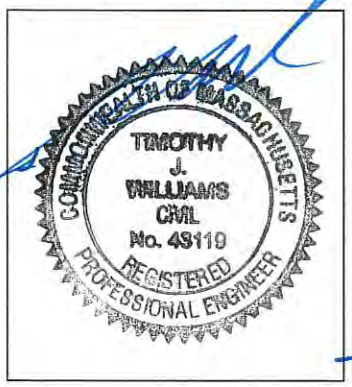
*Note:* Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that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

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

## Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature




3/16/21

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 existing development at 200 Quannapowitt Parkway, Wakefield, MA.

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 Cabot, Cabot & Forbes (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 Public Works Engineering Division 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 shall notify 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.

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: | CCF Quannapowitt Property Company, LLC<br>185 Dartmouth Street<br>Boston, MA 02116<br>Phone: 617-603-4000 |

Emergency Contact Information:

| | |
|---|---|
| Allen & Major Associates, Inc.<br>(Site Civil Engineer) | Phone: (781) 935-6889 |
| Wakefield Department of Public Works | Phone: 781-246-6301 |
| Wakefield Conservation Commission | Phone: 781-224-5015 |
| Wakefield Fire Department<br>(non-emergency line) | Phone: 781-246-6435 |
| 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 of Wakefield at least three (3) days prior to start of demolition and/or construction activities.
3. Install Erosion Control measures as shown on the Plans prepared by A&M. The Town of Wakefield shall review the installation of straw bales and silt fencing 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, straw bales, and silt fence at the locations shown on the Erosion Control 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 and straw bales around 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 of Wakefield.
11. Sediment accumulation up-gradient of the straw bales, silt fence, and stone check dams 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 damns 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 – On-Site:

The stormwater collection system is a series of inlets located at low points within the limits of the paved area. All of the proposed on-site catch basins incorporate a deep sump and hooded outlet. The catch basins are connected by a closed gravity pipe network routed to an isolator row within the underground detention chambers.

Roof runoff discharges directly to the underground chambers, bioretention area, or surface infiltration basin. All remaining runoff along the perimeter of the site and within the parkway, sheet flows through vegetated filter strips equipped with a stone diaphragm before entering the constructed wet basins. The wet basins then discharge treated stormwater to the wetlands and/or drainage channel.

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:
  Precast structure equipped with grated inlet and 4’ sump to allow sediment to settle out.
- Isolator Row:
  Single row of underground chambers wrapped in geotextile to filter out sediment. Equipped with overflow into remaining chambers.
- Vegetated Filter Strip:
  Uniformly graded vegetated surfaces that receive runoff from adjacent impervious surfaces via sheet flow.

Treatment BMPs:

- Exfiltrating Bioretention Area:

Shallow depressions filled with sandy soil topped with a thick layer of mulch and planted with dense native vegetation. Equipped with overflow and underdrain.

- Wet Basin/Pond:

  Wet Basins us a permanent pool of water as the primary mechanism to treat stormwater. The pool allows sediments to settle and removes soluble pollutants.

Infiltration BMPs:

- Subsurface Structures:
  Underground chambers surrounded by stone used to store large volumes of stormwater and allow for infiltration into the groundwater.
- Infiltration Basin:
  Stormwater runoff impoundments that are constructed over permeable soils.

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.

**OPERATION AND MAINTENANCE PLAN SCHEDULE** **Date: August 3, 2021**

ALLEN & MAJOR ASSOCIATES, INC.

**Project: 200 Quannapowitt Parkway**
**Project Address: 200 Quannapowitt Parkway Wakefield, MA**

**Responsible for O&M Plan: Cabot, Cabot & Forbes**
**Address: 185 Dartmouth Street Boston, MA**

*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** | 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 | | |
| | **VEGETATED FILTER STRIPS** | Inspect every six months during the first year and annually thereafter. Mow and remove sediment as needed. | Inspect the vegetation for signs of erosion, bare spots, and overall health. Regularly mow the grass. Remove sediment from the toe of slope or level spreader and reseed bare spots. | $250 | | |
| TREATMENT BMPs | **WET BASIN** | Remove trash monthly. Remove sediment from basin as necessary and at least once every 10 years. | slopes and emergency embankment at least tv | $2,000 | | |
| | **BIORETENTION AREA & RAIN GARDEN** | Remove trash monthly. Remove and replace dead vegetation, prune and mulch annually. | Inspect & remove trash, Mulch, Remove dead vegetation, Replace dead vegetation, Prune, Replace entire media & all vegetation. | $3,000 | | |
| INFILTRATION BMPs | **INFILTRATION BASIN** | Inspect after every major storm during first 3 months of operation and twice a year thereafter. Clean pretreatment devices twice a year and after every major storm. | Inspect to ensure proper functioning. Mow the buffer area, side slopes, and basin bottom if grassed floor; rake if stone bottom; remove trash and debris; remove grass clippings and accumulated organic matter. Inspect and clean pretreatment devices. | $1,500 | | |
| | **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. | $500 | | |
| 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. | $100 | | |
| | **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 | $2,000 | | |

# 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.

Construction Period Best Management Practices for Mosquito Control

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..

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

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.

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.

[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 23, 2019

**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**

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# Isolator™ Row O&M Manual

StormTech® Chamber System for Stormwater Management

# 1.0 The Isolator™ Row

## 1.1 INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patent pending technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

*Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.*

## 1.2 THE ISOLATOR™ ROW

The Isolator Row is a row of StormTech chambers, either SC-740 or SC-310 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

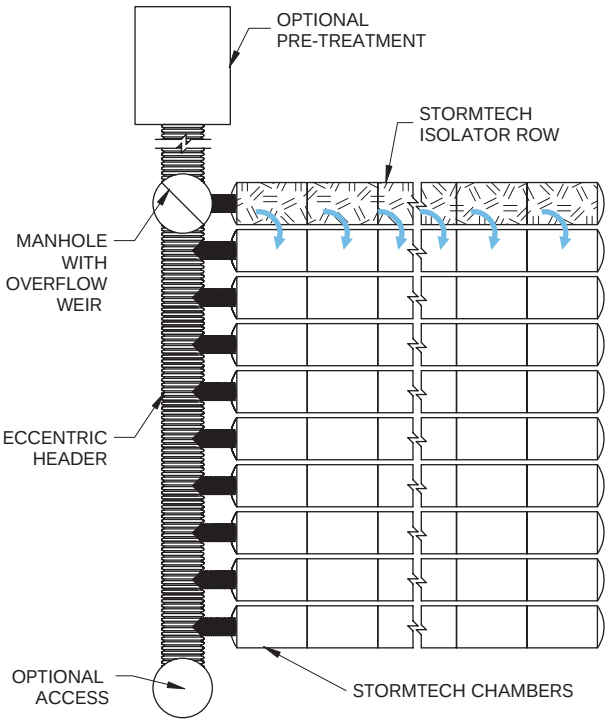
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means 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.*

**StormTech Isolator Row with Overflow Spillway**
(not to scale)



# 2.0 Isolator Row Inspection/Maintenance

## 2.1 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 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 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, clean-out should be performed.

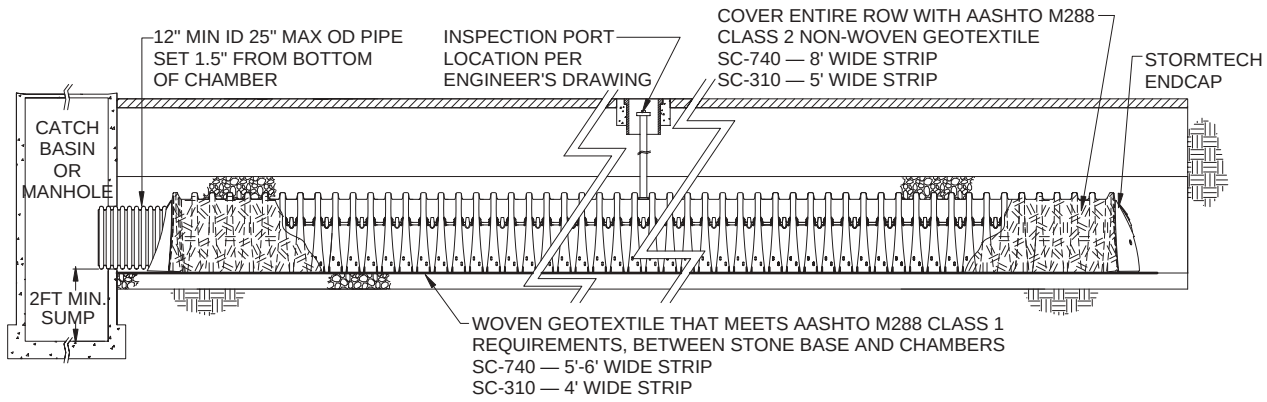
## 2.2 MAINTENANCE

The Isolator Row 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 entries.

*Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)*

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row 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. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

**StormTech Isolator Row** (not to scale)



# 3.0 Isolator Row Step By Step Maintenance Procedures

**Step 1)** Inspect Isolator Row 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 Rows

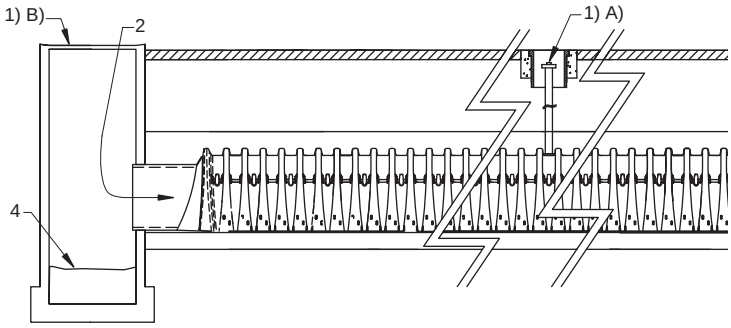
i. Remove cover from manhole at upstream end of Isolator Row

ii. Using a flashlight, inspect down Isolator Row 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.

**StormTech Isolator Row** (not to scale)




**Step 2)** Clean out Isolator Row using the JetVac process

A) A fixed culvert 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) | | | |
| 3/15/01 | 6.3 ft. | none | | New installation. Fixed point is CI frame at grade | djm |
| 9/24/01 | | 6.2 | 0.1 ft. | Some grit felt | sm |
| 6/20/03 | | 5.8 | 0.5 ft. | Mucky feel, debris visible in manhole and in Isolator row, maintenance due | rv |
| 7/7/03 | 6.3 ft. | | 0 | System jetted and vacuumed | djm |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StormTech products are covered by one or more of the following patents: U.S. Patents: 5,401,459; 5,511,903; 5,716,163; 5,588,778; 5,839,844; Canadian Patents: 2,158,418 Other U.S. and Foreign Patents PendingPrinted in U.S.A.

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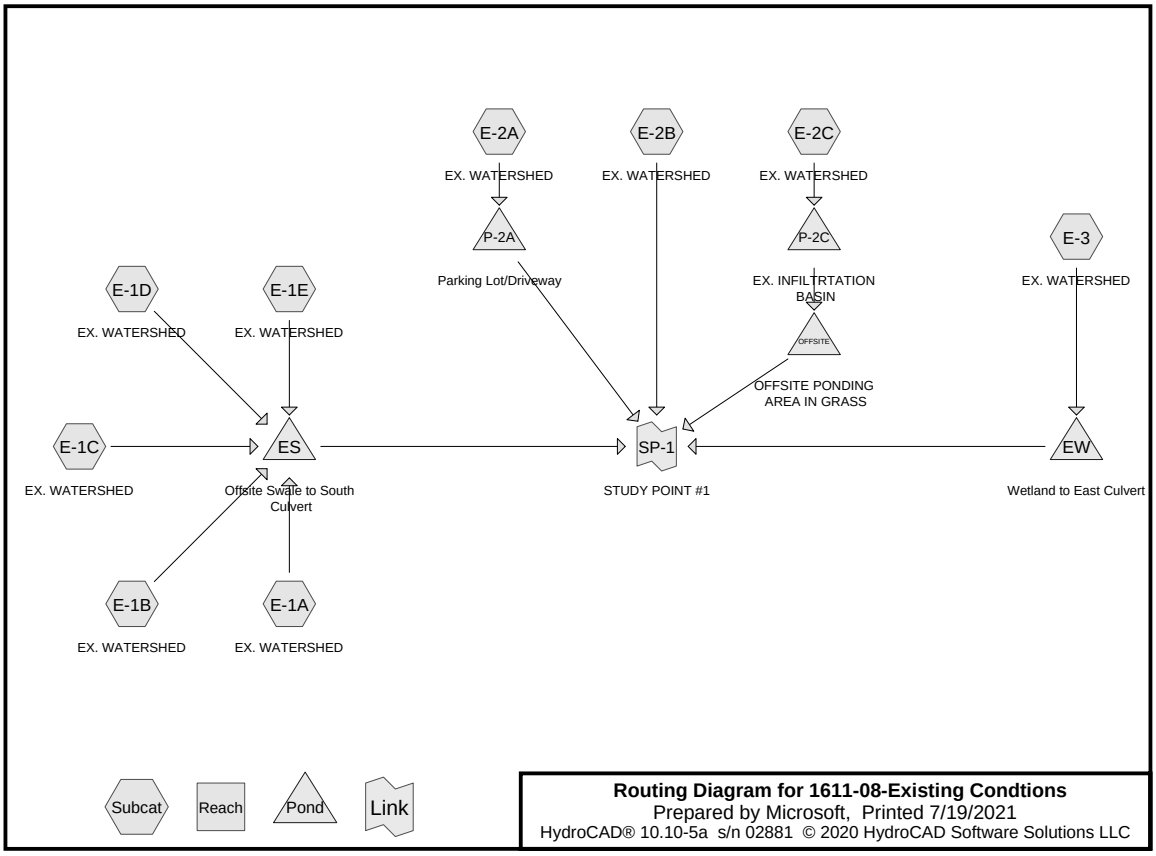
# SECTION 3.0 -
## EXISTING DRAINAGE ANALYSIS






## 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 | 3.10 | 2 |
| 2 | 10-Year | Type III 24-hr | | Default | 24.00 | 1 | 4.50 | 2 |
| 3 | 100-Year | Type III 24-hr | | Default | 24.00 | 1 | 6.50 | 2 |

**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 | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 31,336 | 0 | 0 | 31,336 | <50% Grass cover, Poor | E-1A, E-1B, E-1C, E-1D, E-1E, E-2A, E-2B, E-2C |
| 0 | 0 | 137,725 | 0 | 0 | 137,725 | >75% Grass cover, Good | E-1A, E-1B, E-1C, E-1D, E-1E, E-2B, E-2C, E-3 |
| 0 | 0 | 15,843 | 0 | 0 | 15,843 | Gravel surface | E-1E |
| 0 | 0 | 0 | 0 | 425,412 | 425,412 | Impervious | E-1A, E-1B, E-1C, E-1D, E-1E, E-2A, E-2B, E-2C, E-3 |
| 0 | 0 | 150,817 | 237,023 | 0 | 387,840 | Woods, Good | E-3 |
| 0 | 0 | 0 | 46,239 | 0 | 46,239 | Woods/grass comb., Good | E-1A, E-1B, E-1C, E-1D |
| **0** | **0** | **335,721** | **283,262** | **425,412** | **1,044,395** | **TOTAL AREA** | |



**Summary for Subcatchment E-1A: EX. WATERSHED**

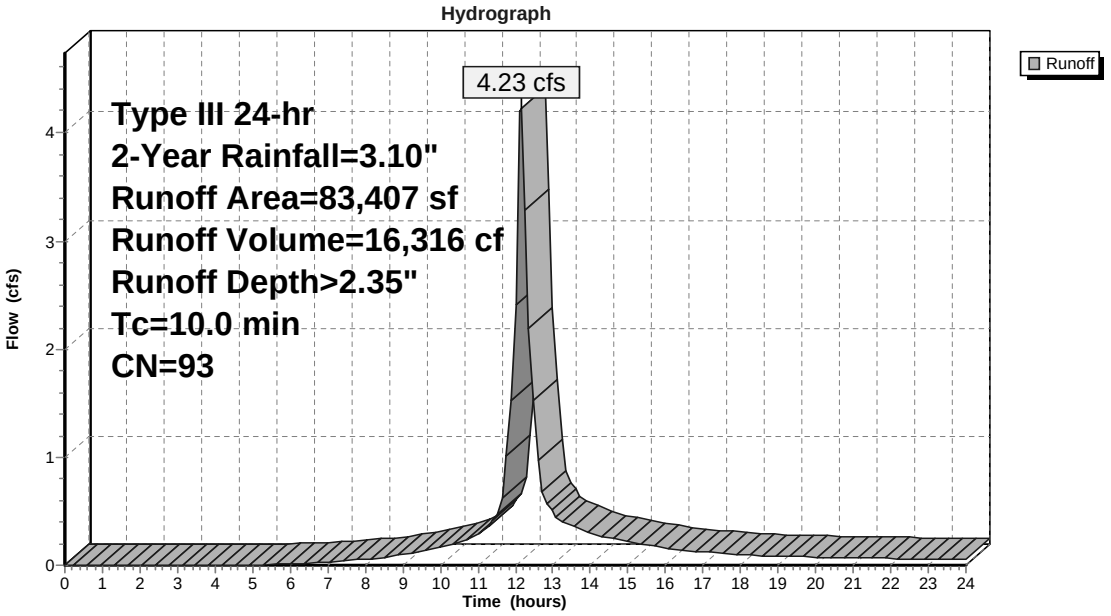
Runoff = 4.23 cfs @ 12.14 hrs, Volume= 16,316 cf, Depth> 2.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 6,343 | 86 | <50% Grass cover, Poor, HSG C |
| | 8,692 | 74 | >75% Grass cover, Good, HSG C |
| | 5,285 | 79 | Woods/grass comb., Good, HSG D |
| * | 63,087 | 98 | Impervious |
| | 83,407 | 93 | Weighted Average |
| | 20,320 | | 24.36% Pervious Area |
| | 63,087 | | 75.64% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-1A: EX. WATERSHED**






**Summary for Subcatchment E-1B: EX. WATERSHED**

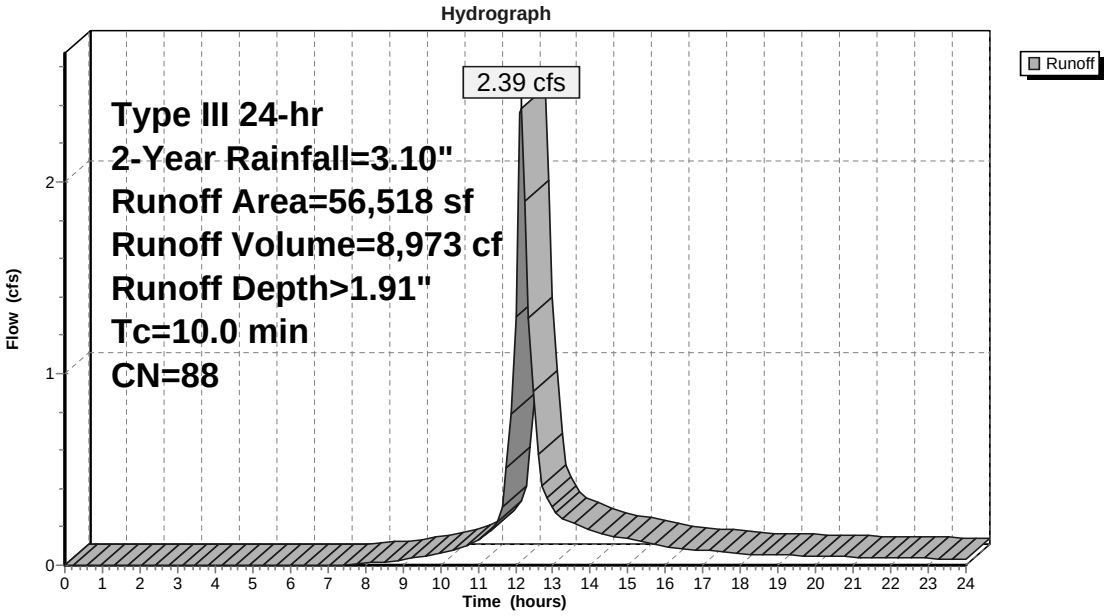
Runoff = 2.39 cfs @ 12.14 hrs, Volume= 8,973 cf, Depth> 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 3,722 | 86 | <50% Grass cover, Poor, HSG C |
| | 8,826 | 74 | >75% Grass cover, Good, HSG C |
| | 14,964 | 79 | Woods/grass comb., Good, HSG D |
| * | 29,006 | 98 | Impervious |
| | 56,518 | 88 | Weighted Average |
| | 27,512 | | 48.68% Pervious Area |
| | 29,006 | | 51.32% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-1B: EX. WATERSHED**






**Summary for Subcatchment E-1C: EX. WATERSHED**

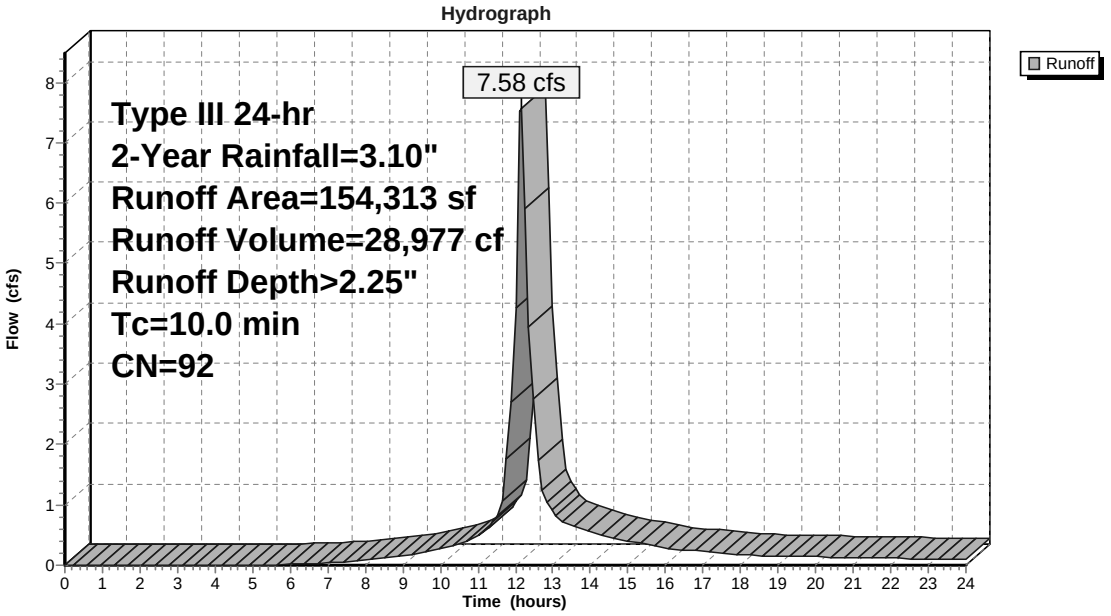
Runoff = 7.58 cfs @ 12.14 hrs, Volume= 28,977 cf, Depth> 2.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 3,840 | 86 | <50% Grass cover, Poor, HSG C |
| | 20,360 | 74 | >75% Grass cover, Good, HSG C |
| | 23,421 | 79 | Woods/grass comb., Good, HSG D |
| * | 106,692 | 98 | Impervious |
| | 154,313 | 92 | Weighted Average |
| | 47,621 | | 30.86% Pervious Area |
| | 106,692 | | 69.14% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-1C: EX. WATERSHED**






**Summary for Subcatchment E-1D: EX. WATERSHED**

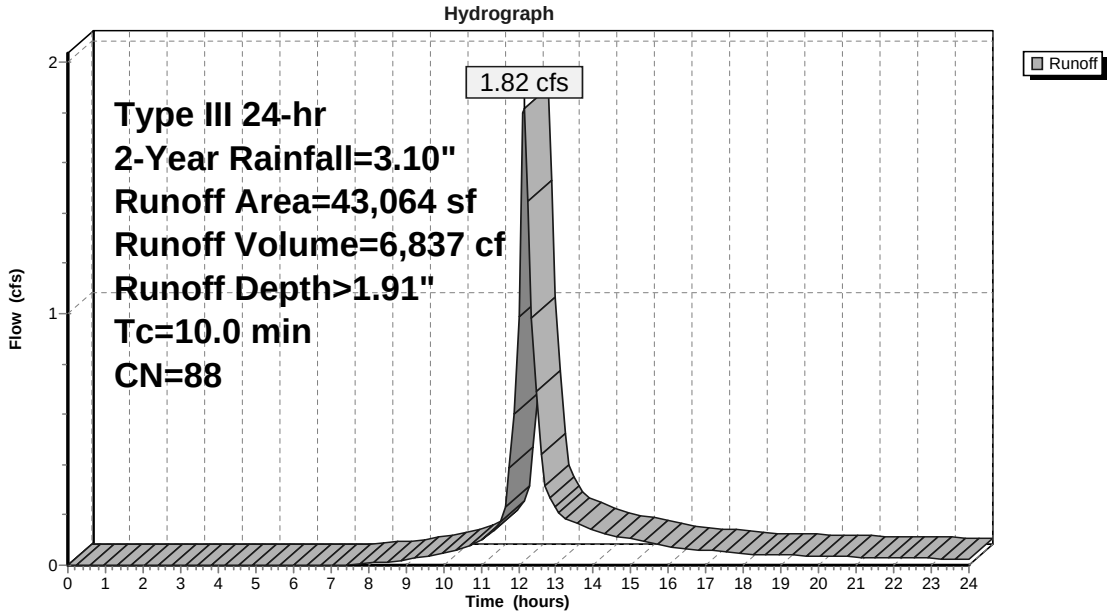
Runoff = 1.82 cfs @ 12.14 hrs, Volume= 6,837 cf, Depth> 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 5,705 | 86 | <50% Grass cover, Poor, HSG C |
| | 12,809 | 74 | >75% Grass cover, Good, HSG C |
| | 2,569 | 79 | Woods/grass comb., Good, HSG D |
| * | 21,981 | 98 | Impervious |
| | 43,064 | 88 | Weighted Average |
| | 21,083 | | 48.96% Pervious Area |
| | 21,981 | | 51.04% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-1D: EX. WATERSHED**






**Summary for Subcatchment E-1E: EX. WATERSHED**

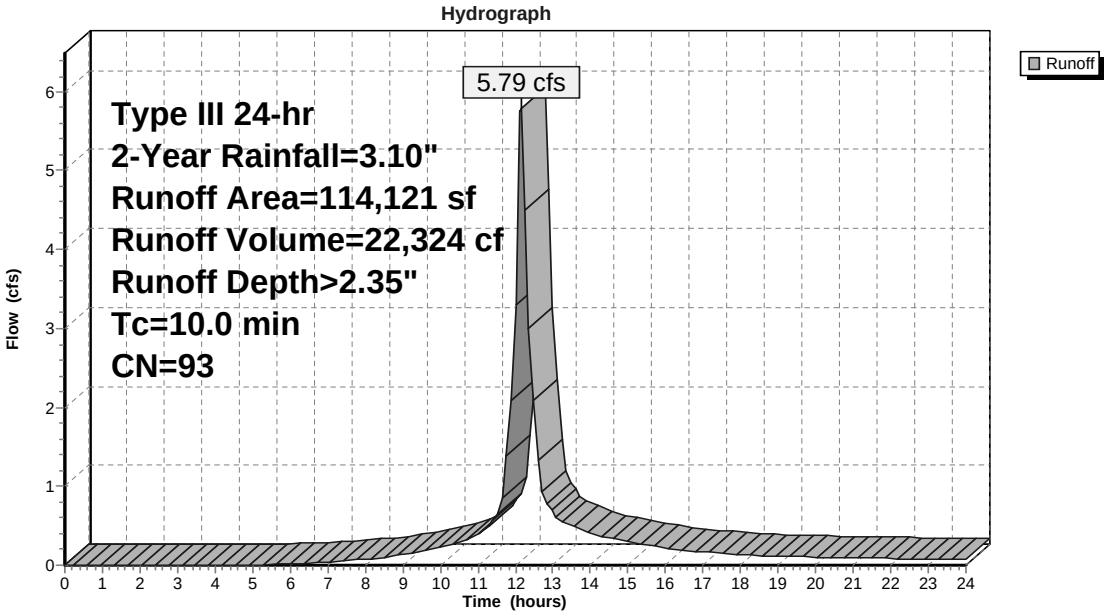
Runoff = 5.79 cfs @ 12.14 hrs, Volume= 22,324 cf, Depth> 2.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 6,384 | 86 | <50% Grass cover, Poor, HSG C |
| | 17,883 | 74 | >75% Grass cover, Good, HSG C |
| | 15,843 | 96 | Gravel surface, HSG C |
| * | 74,011 | 98 | Impervious |
| | 114,121 | 93 | Weighted Average |
| | 40,110 | | 35.15% Pervious Area |
| | 74,011 | | 64.85% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-1E: EX. WATERSHED**






**Summary for Subcatchment E-2A: EX. WATERSHED**

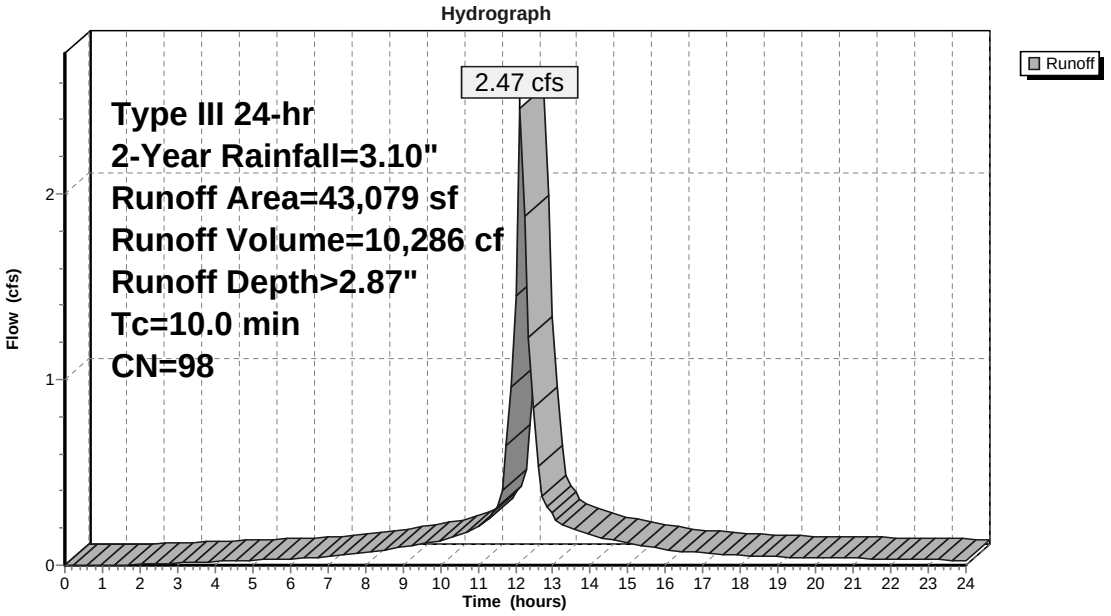
Runoff = 2.47 cfs @ 12.14 hrs, Volume= 10,286 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 1,483 | 86 | <50% Grass cover, Poor, HSG C |
| * | 41,596 | 98 | Impervious |
| | 43,079 | 98 | Weighted Average |
| | 1,483 | | 3.44% Pervious Area |
| | 41,596 | | 96.56% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-2A: EX. WATERSHED**






**Summary for Subcatchment E-2B: EX. WATERSHED**

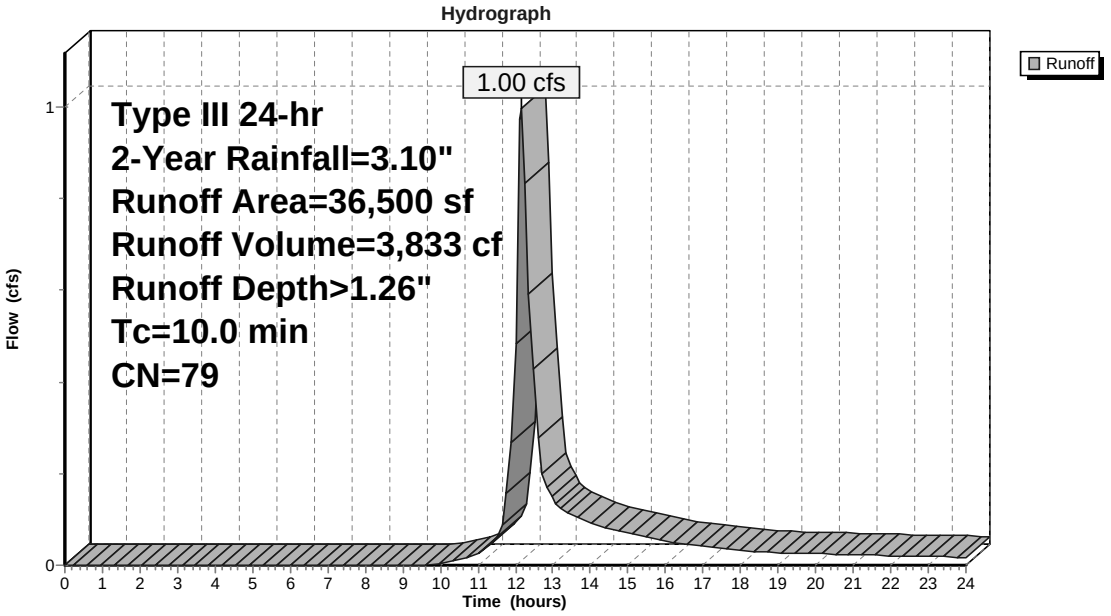
Runoff = 1.00 cfs @ 12.15 hrs, Volume= 3,833 cf, Depth> 1.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 1,043 | 86 | <50% Grass cover, Poor, HSG C |
| | 28,476 | 74 | >75% Grass cover, Good, HSG C |
| * | 6,981 | 98 | Impervious |
| | 36,500 | 79 | Weighted Average |
| | 29,519 | | 80.87% Pervious Area |
| | 6,981 | | 19.13% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-2B: EX. WATERSHED**






**Summary for Subcatchment E-2C: EX. WATERSHED**

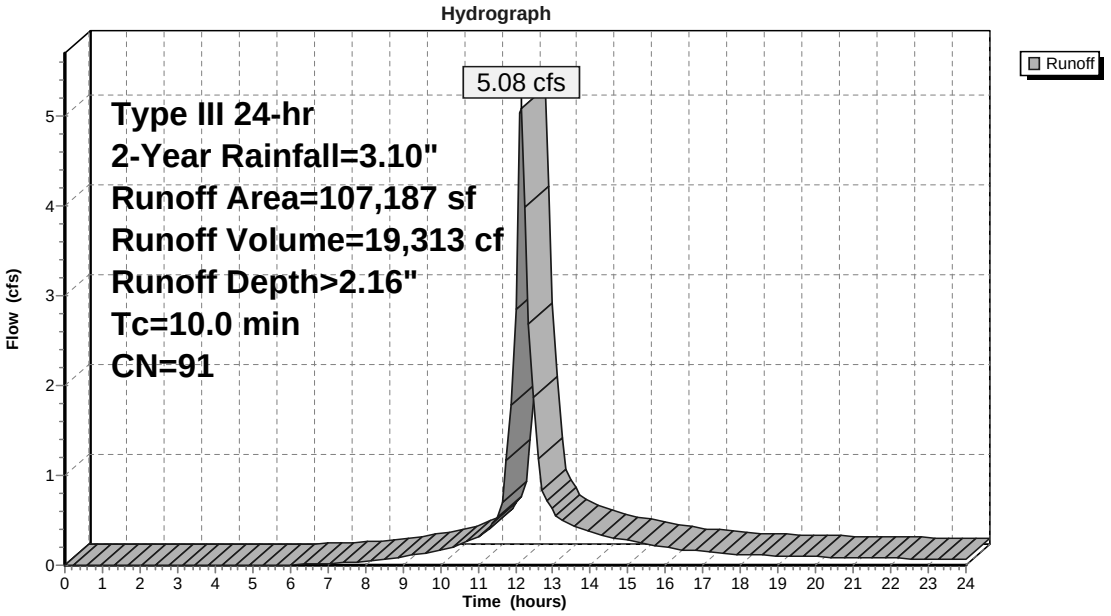
Runoff = 5.08 cfs @ 12.14 hrs, Volume= 19,313 cf, Depth> 2.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 2,816 | 86 | <50% Grass cover, Poor, HSG C |
| | 31,699 | 74 | >75% Grass cover, Good, HSG C |
| * | 72,672 | 98 | Impervious |
| | 107,187 | 91 | Weighted Average |
| | 34,515 | | 32.20% Pervious Area |
| | 72,672 | | 67.80% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-2C: EX. WATERSHED**






**Summary for Subcatchment E-3: EX. WATERSHED**

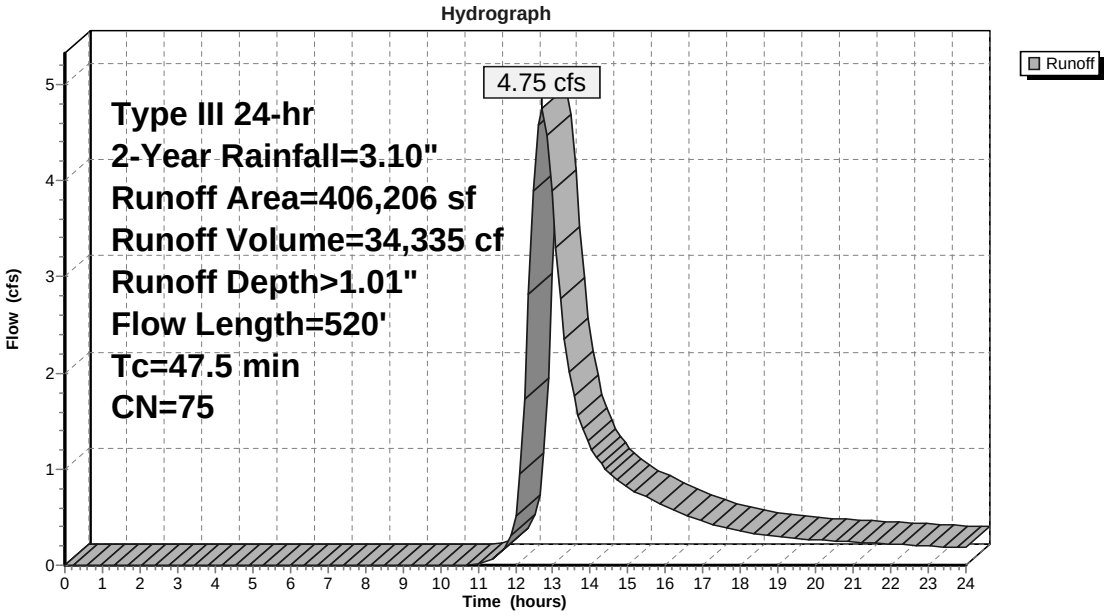
Runoff = 4.75 cfs @ 12.70 hrs, Volume= 34,335 cf, Depth> 1.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 237,023 | 77 | Woods, Good, HSG D |
| * | 9,386 | 98 | Impervious |
| | 150,817 | 70 | Woods, Good, HSG C |
| | 8,980 | 74 | >75% Grass cover, Good, HSG C |
| | 406,206 | 75 | Weighted Average |
| | 396,820 | | 97.69% Pervious Area |
| | 9,386 | | 2.31% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 28.3 | 100 | 0.0100 | 0.06 | | **Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.3 | 40 | 0.0100 | 0.50 | | **Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps |
| 17.9 | 380 | 0.0050 | 0.35 | | **Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps |
| 47.5 | 520 | Total | | | |

**Subcatchment E-3: EX. WATERSHED**






**Summary for Pond ES: Offsite Swale to South Culvert**

Inflow Area = 451,423 sf, 65.30% Impervious, Inflow Depth > 2.22" for 2-Year event
Inflow = 21.80 cfs @ 12.14 hrs, Volume= 83,425 cf
Outflow = 4.94 cfs @ 12.63 hrs, Volume= 57,943 cf, Atten= 77%, Lag= 29.3 min
Primary = 4.94 cfs @ 12.63 hrs, Volume= 57,943 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 80.60' @ 12.63 hrs Surf.Area= 47,284 sf Storage= 43,832 cf

Plug-Flow detention time= 210.0 min calculated for 57,943 cf (69% of inflow)
Center-of-Mass det. time= 117.8 min ( 920.7 - 802.9 )

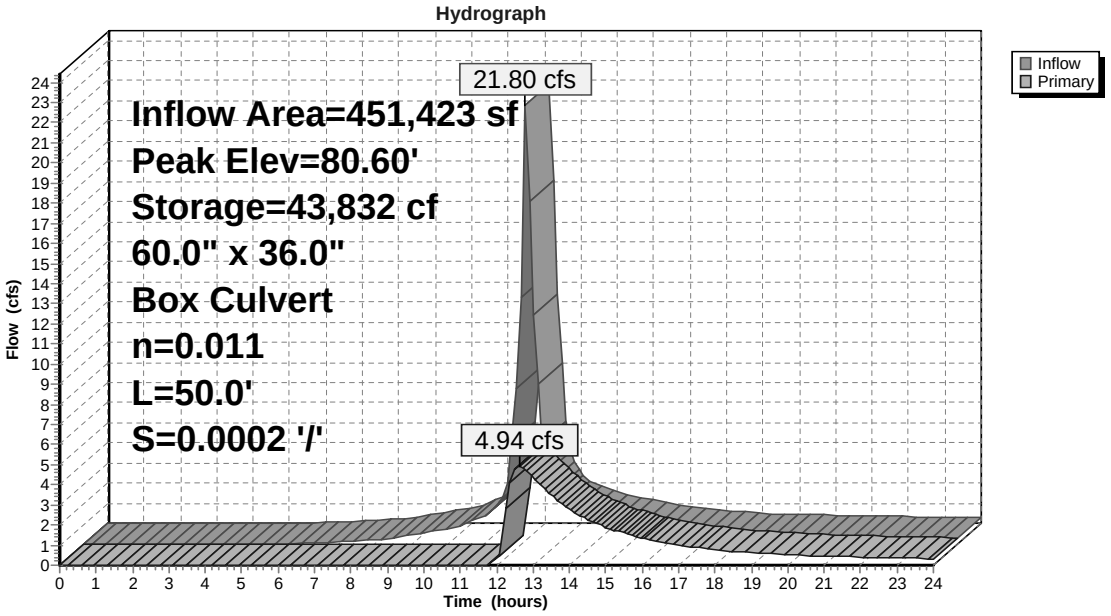
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 79.00' | 136,108 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 79.00 | 17,000 | 1,200.0 | 0 | 0 | 17,000 |
| 80.00 | 27,000 | 4,000.0 | 21,808 | 21,808 | 1,175,651 |
| 81.00 | 63,900 | 4,200.0 | 44,146 | 65,954 | 1,306,222 |
| 82.00 | 76,600 | 4,250.0 | 70,154 | 136,108 | 1,340,108 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.00' | **60.0" W x 36.0" H Box Culvert** L= 50.0' Box, headwall w/3 square edges, Ke= 0.500<br>Inlet / Outlet Invert= 80.00' / 79.99' S= 0.0002 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 15.00 sf |

**Primary OutFlow** Max=4.92 cfs @ 12.63 hrs HW=80.60' TW=0.00' (Dynamic Tailwater)
**1=Culvert** (Barrel Controls 4.92 cfs @ 2.19 fps)

**Pond ES: Offsite Swale to South Culvert**






**Summary for Pond EW: Wetland to East Culvert**

Inflow Area = 406,206 sf, 2.31% Impervious, Inflow Depth > 1.01" for 2-Year event
Inflow = 4.75 cfs @ 12.70 hrs, Volume= 34,335 cf
Outflow = 0.09 cfs @ 24.00 hrs, Volume= 1,828 cf, Atten= 98%, Lag= 677.7 min
Primary = 0.09 cfs @ 24.00 hrs, Volume= 1,828 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 80.46' @ 24.00 hrs Surf.Area= 90,563 sf Storage= 32,487 cf

Plug-Flow detention time= 510.8 min calculated for 1,828 cf (5% of inflow)
Center-of-Mass det. time= 342.9 min ( 1,235.2 - 892.2 )

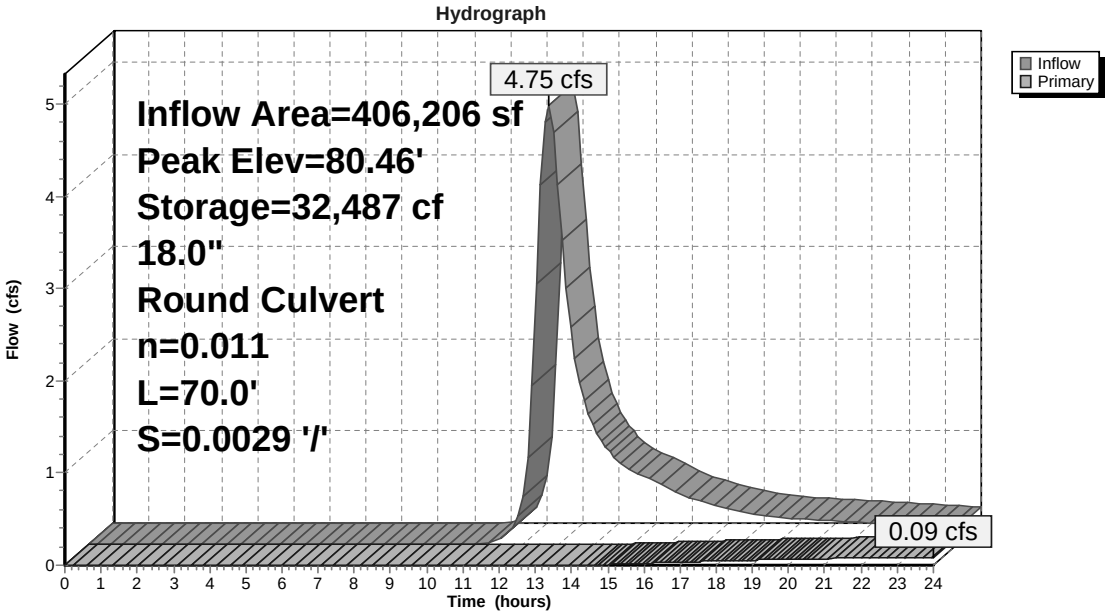
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 290,435 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 52,000 | 1,200.0 | 0 | 0 | 52,000 |
| 81.00 | 149,000 | 2,600.0 | 96,341 | 96,341 | 475,356 |
| 82.00 | 243,000 | 4,300.0 | 194,094 | 290,435 | 1,408,807 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.30' | **18.0" Round Culvert** L= 70.0' RCP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 80.30' / 80.10' S= 0.0029 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.09 cfs @ 24.00 hrs HW=80.46' TW=0.00' (Dynamic Tailwater)
**1=Culvert** (Barrel Controls 0.09 cfs @ 1.31 fps)

**Pond EW: Wetland to East Culvert**






**Summary for Pond OFFSITE: OFFSITE PONDING AREA IN GRASS**

Inflow Area = 107,187 sf, 67.80% Impervious, Inflow Depth > 1.71" for 2-Year event
Inflow = 4.66 cfs @ 12.19 hrs, Volume= 15,286 cf
Outflow = 4.62 cfs @ 12.23 hrs, Volume= 15,085 cf, Atten= 1%, Lag= 2.2 min
Primary = 4.62 cfs @ 12.23 hrs, Volume= 15,085 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 82.72' @ 12.23 hrs Surf.Area= 4,908 sf Storage= 1,597 cf

Plug-Flow detention time= 19.3 min calculated for 15,010 cf (98% of inflow)
Center-of-Mass det. time= 12.0 min ( 825.8 - 813.7 )

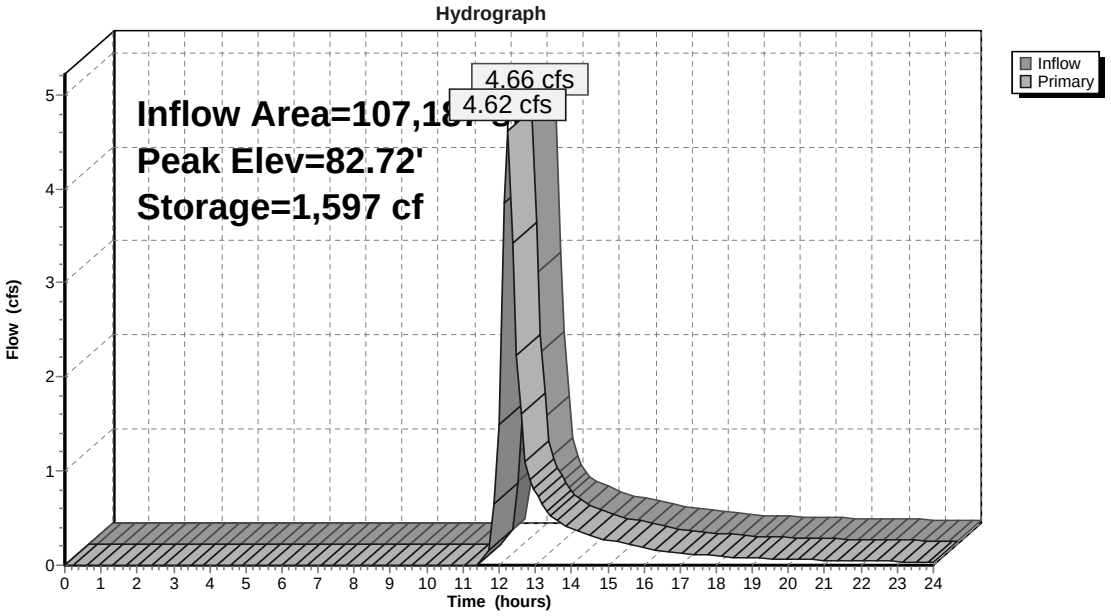
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.10' | 3,254 cf | **OFFSITE PONDING AREA (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 82.10 | 230 | 0 | 0 |
| 83.00 | 7,000 | 3,254 | 3,254 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.27' | **8.0" Round (3) 8" HDPE X 3.00 w/ 2.0" inside fill** L= 21.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 82.10' / 81.40' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.28 sf |
| #2 | Primary | 82.60' | **30.0' long x 10.0' breadth WEIR FLOW OVER WALKING PATH**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64 |

**Primary OutFlow** Max=4.52 cfs @ 12.23 hrs HW=82.72' TW=0.00' (Dynamic Tailwater)
**1=(3) 8" HDPE** (Inlet Controls 1.44 cfs @ 1.77 fps)
**2=WEIR FLOW OVER WALKING PATH** (Weir Controls 3.09 cfs @ 0.86 fps)

**Pond OFFSITE: OFFSITE PONDING AREA IN GRASS**






## Summary for Pond P-2A: Parking Lot/Driveway

Inflow Area = 43,079 sf, 96.56% Impervious, Inflow Depth > 2.87" for 2-Year event
Inflow = 2.47 cfs @ 12.14 hrs, Volume= 10,286 cf
Outflow = 2.37 cfs @ 12.14 hrs, Volume= 10,284 cf, Atten= 4%, Lag= 0.4 min
Primary = 2.37 cfs @ 12.14 hrs, Volume= 10,284 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 84.03' @ 12.14 hrs Surf.Area= 504 sf Storage= 52 cf

Plug-Flow detention time= 0.6 min calculated for 10,284 cf (100% of inflow)
Center-of-Mass det. time= 0.5 min ( 760.6 - 760.2 )

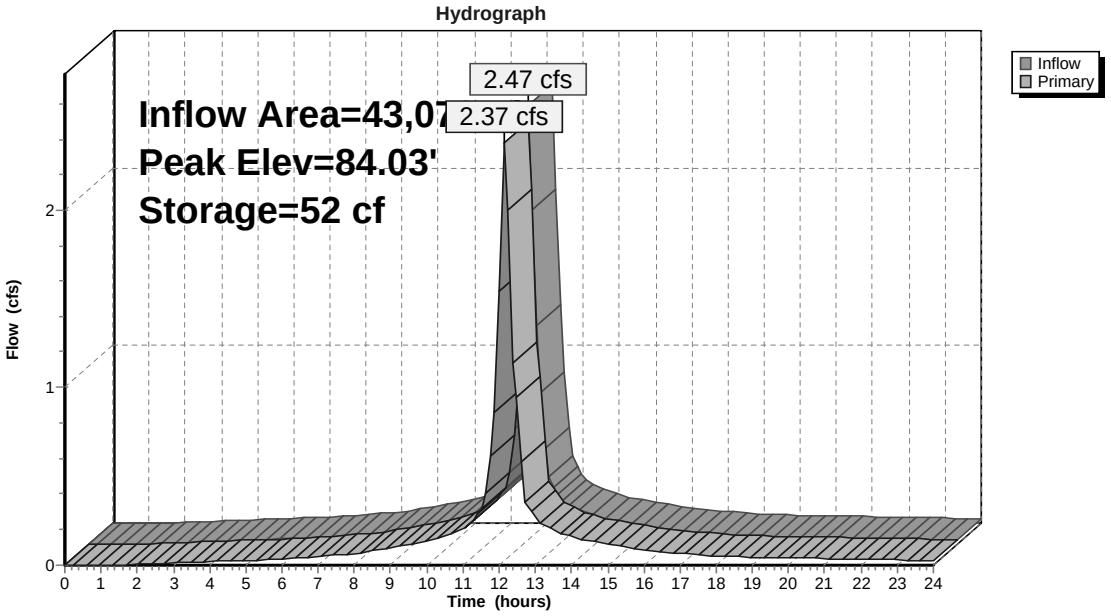
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.38' | 14 cf | **4.00'D x 1.10'H Ex.CB** |
| #2 | 83.45' | 1,680 cf | **Parking/Driveway (Prismatic)**Listed below (Recalc) |
| | | 1,694 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 83.45 | 4 | 0 | 0 |
| 84.00 | 103 | 29 | 29 |
| 84.50 | 6,500 | 1,651 | 1,680 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.46' | **6.0" Round 6"PVC w/ 1.0" inside fill** L= 170.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 82.38' / 81.00' S= 0.0081 '/' Cc= 0.900<br>n= 0.010 PVC, smooth interior, Flow Area= 0.17 sf |
| #2 | Primary | 84.00' | **120.0' long x 50.0' breadth Weir Flow Over Curb Towards Lake**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=2.28 cfs @ 12.14 hrs HW=84.03' TW=0.00' (Dynamic Tailwater)
**1=6"PVC** (Barrel Controls 0.68 cfs @ 3.88 fps)
**2=Weir Flow Over Curb Towards Lake** (Weir Controls 1.60 cfs @ 0.46 fps)

**Pond P-2A: Parking Lot/Driveway**






**Summary for Pond P-2C: EX. INFILTRTATION BASIN**

Inflow Area = 107,187 sf, 67.80% Impervious, Inflow Depth > 2.16" for 2-Year event
Inflow = 5.08 cfs @ 12.14 hrs, Volume= 19,313 cf
Outflow = 4.70 cfs @ 12.19 hrs, Volume= 17,179 cf, Atten= 7%, Lag= 2.9 min
Discarded = 0.04 cfs @ 12.19 hrs, Volume= 1,894 cf
Primary = 4.66 cfs @ 12.19 hrs, Volume= 15,286 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 83.41' @ 12.19 hrs Surf.Area= 6,622 sf Storage= 2,769 cf
Flood Elev= 83.30' Surf.Area= 5,645 sf Storage= 2,114 cf

Plug-Flow detention time= 77.5 min calculated for 17,094 cf (89% of inflow)
Center-of-Mass det. time= 27.3 min ( 833.9 - 806.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.50' | 8,308 cf | **EX. INFILTRATION BASIN (Prismatic)**Listed below (Recalc) |

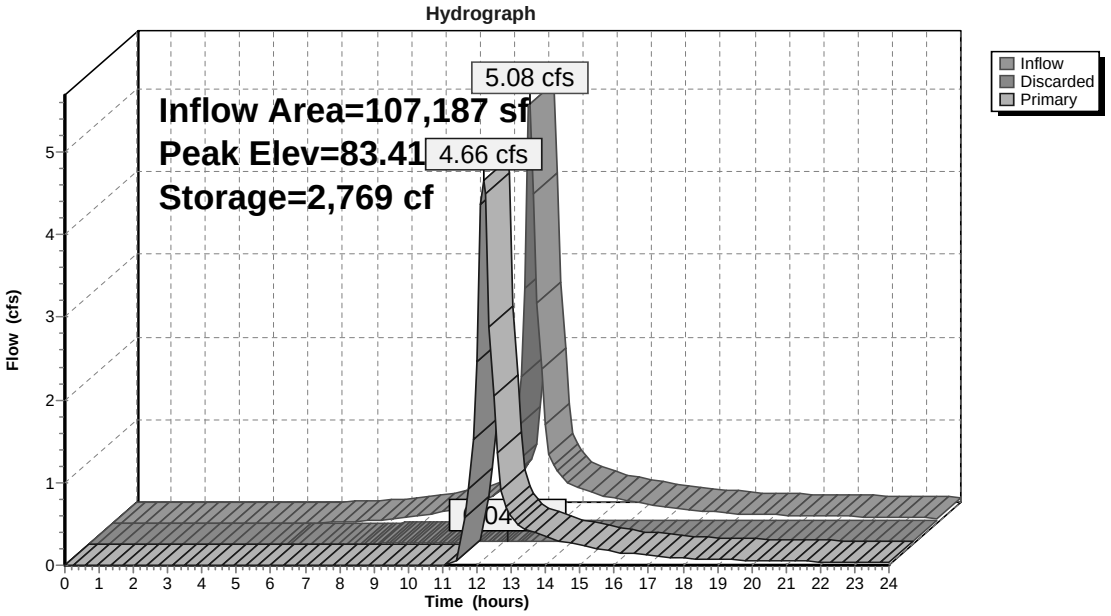
| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 82.50 | 430 | 0 | 0 |
| 83.00 | 2,900 | 833 | 833 |
| 84.00 | 12,050 | 7,475 | 8,308 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 83.30' | **50.0' long x 60.0' breadth GRASS/LAWN AREA**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Discarded | 82.50' | **0.270 in/hr Exfiltration over Surface area** |

**Discarded OutFlow** Max=0.04 cfs @ 12.19 hrs HW=83.40' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.04 cfs)

**Primary OutFlow** Max=4.44 cfs @ 12.19 hrs HW=83.40' TW=82.71' (Dynamic Tailwater)
↑**1=GRASS/LAWN AREA** (Weir Controls 4.44 cfs @ 0.86 fps)

**Pond P-2C: EX. INFILTRTATION BASIN**



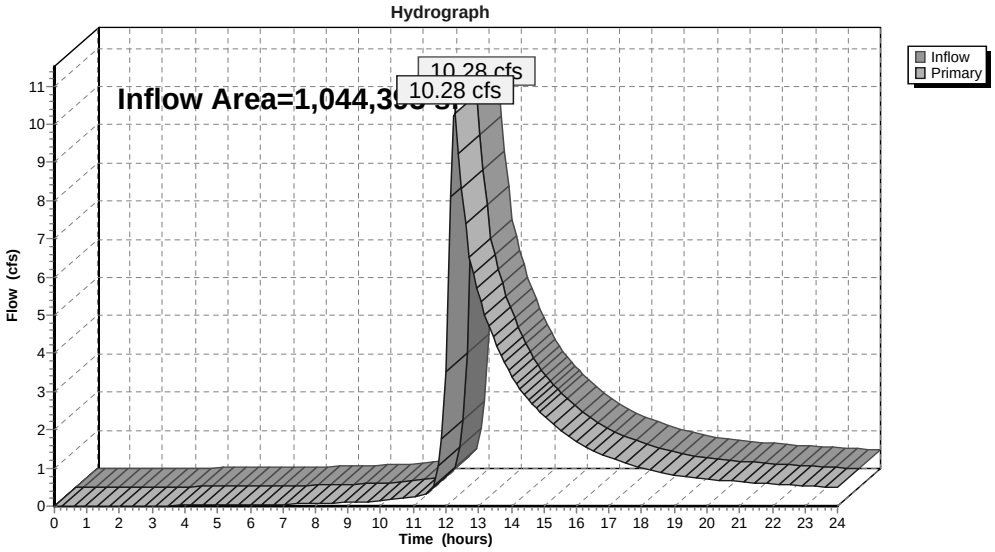



**Summary for Link SP-1: STUDY POINT #1**

Inflow Area = 1,044,395 sf, 40.73% Impervious, Inflow Depth > 1.02" for 2-Year event
Inflow = 10.28 cfs @ 12.26 hrs, Volume= 88,974 cf
Primary = 10.28 cfs @ 12.26 hrs, Volume= 88,974 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs

**Link SP-1: STUDY POINT #1**



### Summary for Subcatchment E-1A: EX. WATERSHED

Runoff = 6.53 cfs @ 12.14 hrs, Volume= 25,746 cf, Depth> 3.70"

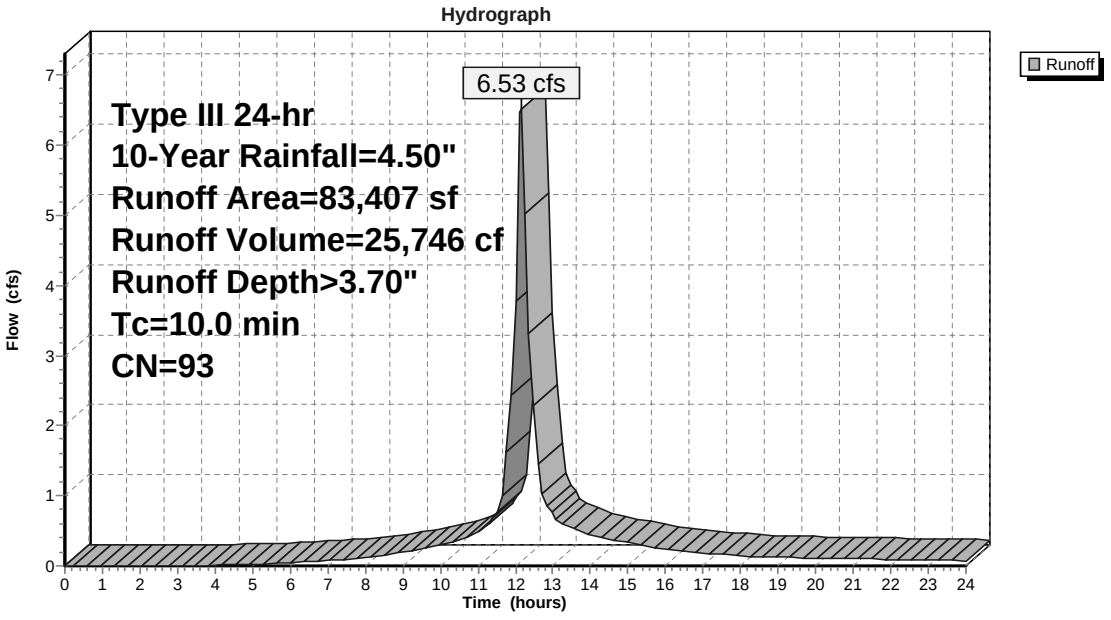
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 6,343 | 86 | <50% Grass cover, Poor, HSG C |
| | 8,692 | 74 | >75% Grass cover, Good, HSG C |
| | 5,285 | 79 | Woods/grass comb., Good, HSG D |
| * | 63,087 | 98 | Impervious |
| | 83,407 | 93 | Weighted Average |
| | 20,320 | | 24.36% Pervious Area |
| | 63,087 | | 75.64% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment E-1A: EX. WATERSHED



### Summary for Subcatchment E-1B: EX. WATERSHED

Runoff = 3.95 cfs @ 12.14 hrs, Volume= 15,037 cf, Depth> 3.19"

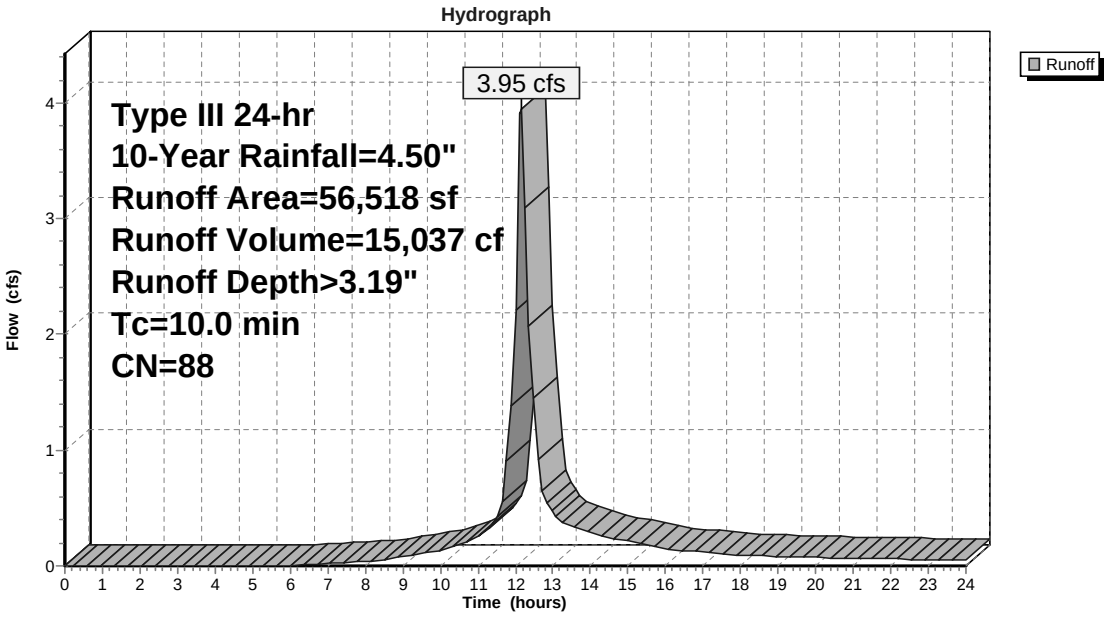
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 3,722 | 86 | <50% Grass cover, Poor, HSG C |
| | 8,826 | 74 | >75% Grass cover, Good, HSG C |
| | 14,964 | 79 | Woods/grass comb., Good, HSG D |
| * | 29,006 | 98 | Impervious |
| | 56,518 | 88 | Weighted Average |
| | 27,512 | | 48.68% Pervious Area |
| | 29,006 | | 51.32% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment E-1B: EX. WATERSHED



### Summary for Subcatchment E-1C: EX. WATERSHED

Runoff = 11.84 cfs @ 12.14 hrs, Volume= 46,274 cf, Depth> 3.60"

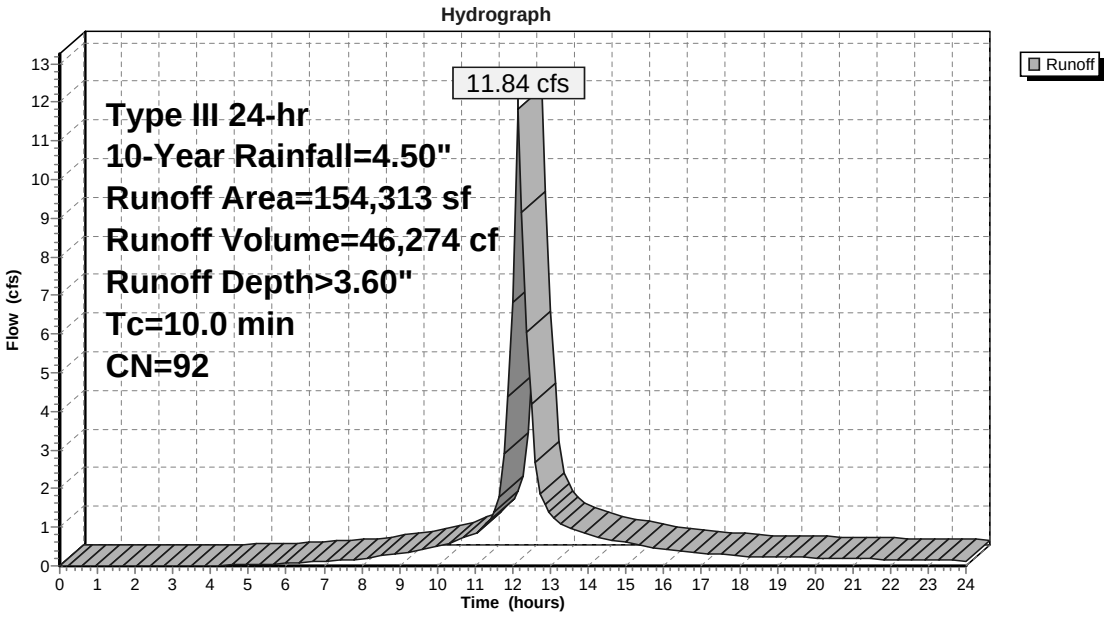
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 3,840 | 86 | <50% Grass cover, Poor, HSG C |
| | 20,360 | 74 | >75% Grass cover, Good, HSG C |
| | 23,421 | 79 | Woods/grass comb., Good, HSG D |
| * | 106,692 | 98 | Impervious |
| | 154,313 | 92 | Weighted Average |
| | 47,621 | | 30.86% Pervious Area |
| | 106,692 | | 69.14% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment E-1C: EX. WATERSHED



### Summary for Subcatchment E-1D: EX. WATERSHED

Runoff = 3.01 cfs @ 12.14 hrs, Volume= 11,458 cf, Depth> 3.19"

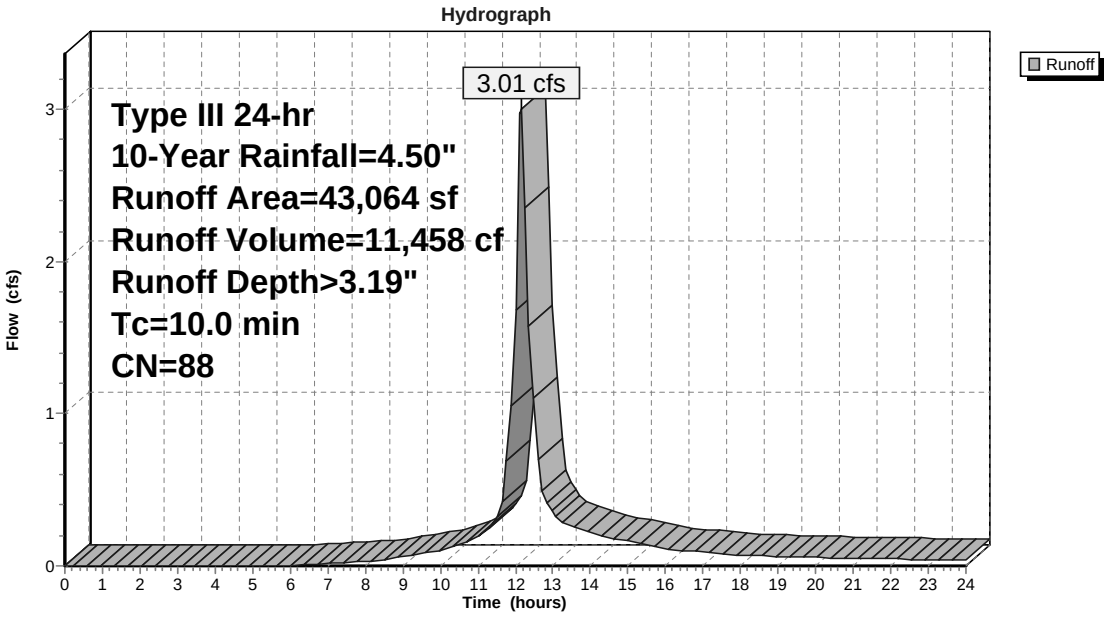
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 5,705 | 86 | <50% Grass cover, Poor, HSG C |
| | 12,809 | 74 | >75% Grass cover, Good, HSG C |
| | 2,569 | 79 | Woods/grass comb., Good, HSG D |
| * | 21,981 | 98 | Impervious |
| | 43,064 | 88 | Weighted Average |
| | 21,083 | | 48.96% Pervious Area |
| | 21,981 | | 51.04% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment E-1D: EX. WATERSHED



### Summary for Subcatchment E-1E: EX. WATERSHED

Runoff = 8.93 cfs @ 12.14 hrs, Volume= 35,227 cf, Depth> 3.70"

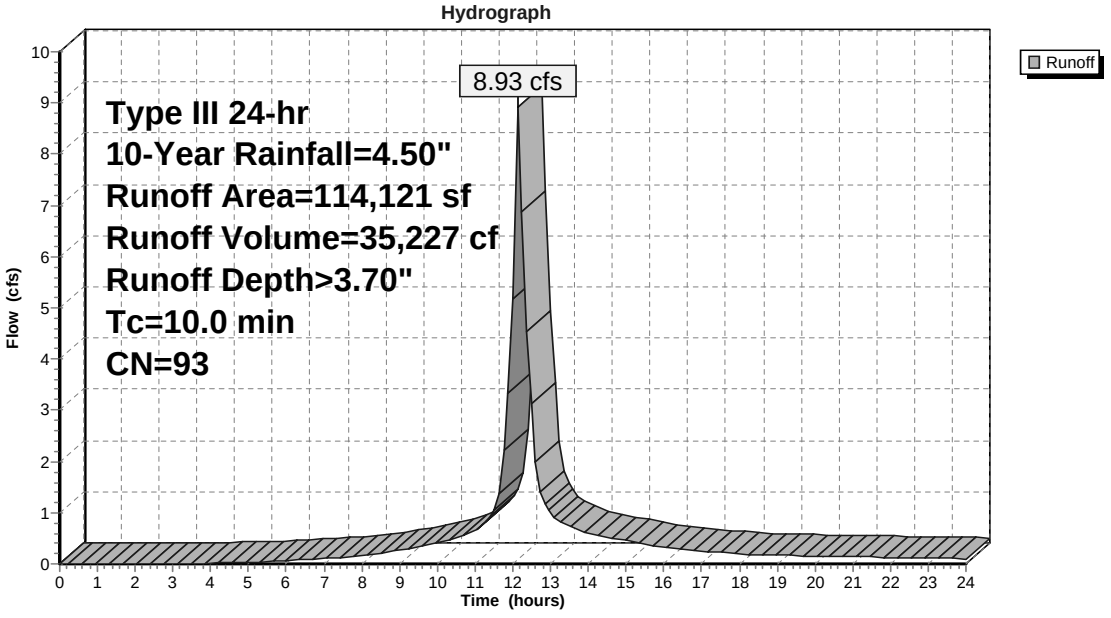
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 6,384 | 86 | <50% Grass cover, Poor, HSG C |
| | 17,883 | 74 | >75% Grass cover, Good, HSG C |
| | 15,843 | 96 | Gravel surface, HSG C |
| * | 74,011 | 98 | Impervious |
| | 114,121 | 93 | Weighted Average |
| | 40,110 | | 35.15% Pervious Area |
| | 74,011 | | 64.85% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment E-1E: EX. WATERSHED



### Summary for Subcatchment E-2A: EX. WATERSHED

Runoff = 3.61 cfs @ 12.14 hrs, Volume= 15,294 cf, Depth> 4.26"

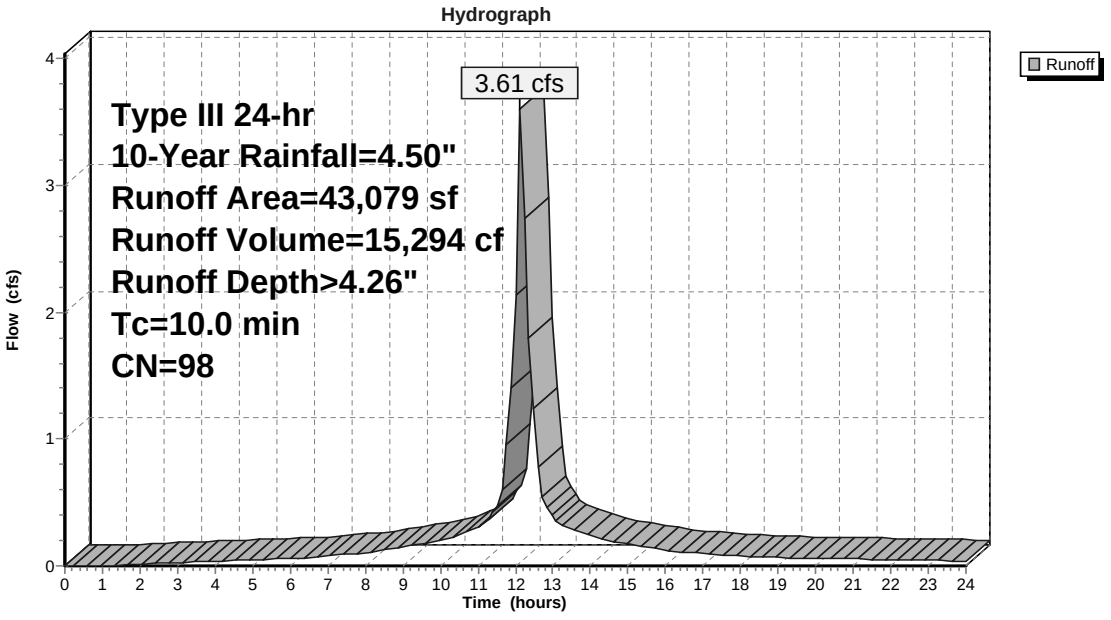
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 1,483 | 86 | <50% Grass cover, Poor, HSG C |
| * | 41,596 | 98 | Impervious |
| | 43,079 | 98 | Weighted Average |
| | 1,483 | | 3.44% Pervious Area |
| | 41,596 | | 96.56% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment E-2A: EX. WATERSHED



### Summary for Subcatchment E-2B: EX. WATERSHED

Runoff = 1.92 cfs @ 12.15 hrs, Volume= 7,219 cf, Depth> 2.37"

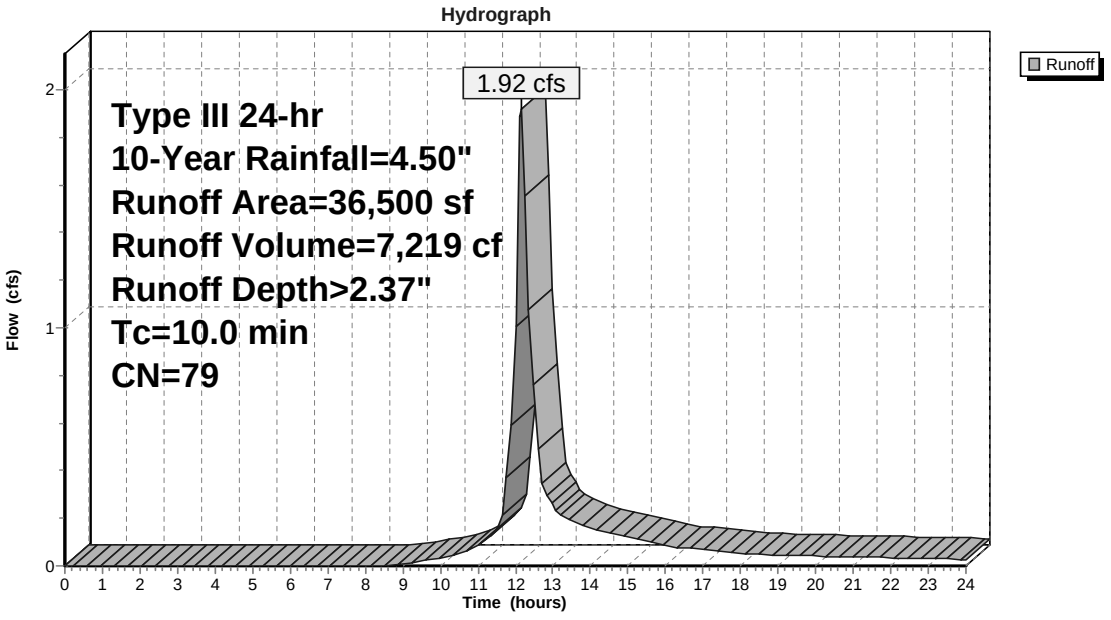
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 1,043 | 86 | <50% Grass cover, Poor, HSG C |
| | 28,476 | 74 | >75% Grass cover, Good, HSG C |
| * | 6,981 | 98 | Impervious |
| | 36,500 | 79 | Weighted Average |
| | 29,519 | | 80.87% Pervious Area |
| | 6,981 | | 19.13% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment E-2B: EX. WATERSHED



### Summary for Subcatchment E-2C: EX. WATERSHED

Runoff = 8.05 cfs @ 12.14 hrs, Volume= 31,214 cf, Depth> 3.49"

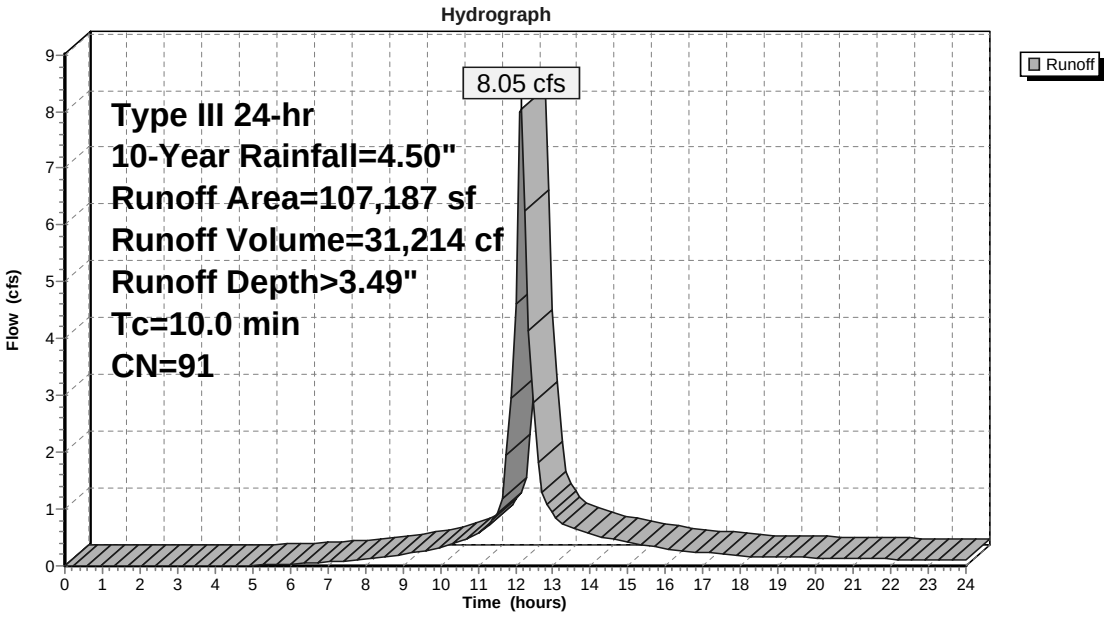
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 2,816 | 86 | <50% Grass cover, Poor, HSG C |
| | 31,699 | 74 | >75% Grass cover, Good, HSG C |
| * | 72,672 | 98 | Impervious |
| | 107,187 | 91 | Weighted Average |
| | 34,515 | | 32.20% Pervious Area |
| | 72,672 | | 67.80% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment E-2C: EX. WATERSHED



### Summary for Subcatchment E-3: EX. WATERSHED

Runoff = 9.92 cfs @ 12.67 hrs, Volume= 68,685 cf, Depth> 2.03"

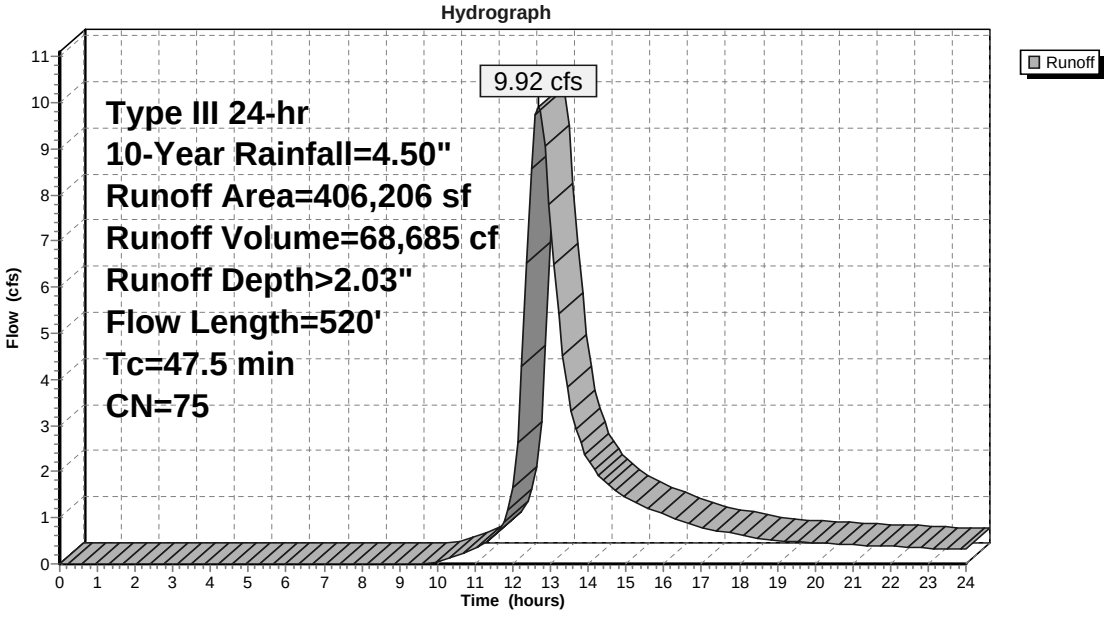
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 237,023 | 77 | Woods, Good, HSG D |
| * | 9,386 | 98 | Impervious |
| | 150,817 | 70 | Woods, Good, HSG C |
| | 8,980 | 74 | >75% Grass cover, Good, HSG C |
| | 406,206 | 75 | Weighted Average |
| | 396,820 | | 97.69% Pervious Area |
| | 9,386 | | 2.31% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 28.3 | 100 | 0.0100 | 0.06 | | **Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.3 | 40 | 0.0100 | 0.50 | | **Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps |
| 17.9 | 380 | 0.0050 | 0.35 | | **Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps |
| 47.5 | 520 | Total | | | |



### Subcatchment E-3: EX. WATERSHED



## Summary for Pond ES: Offsite Swale to South Culvert

Inflow Area = 451,423 sf, 65.30% Impervious, Inflow Depth > 3.56" for 10-Year event
Inflow = 34.25 cfs @ 12.14 hrs, Volume= 133,744 cf
Outflow = 10.77 cfs @ 12.52 hrs, Volume= 107,368 cf, Atten= 69%, Lag= 23.0 min
Primary = 10.77 cfs @ 12.52 hrs, Volume= 107,368 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 80.97' @ 12.52 hrs Surf.Area= 62,747 sf Storage= 64,313 cf

Plug-Flow detention time= 172.8 min calculated for 107,368 cf (80% of inflow)
Center-of-Mass det. time= 99.5 min ( 889.6 - 790.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 79.00' | 136,108 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

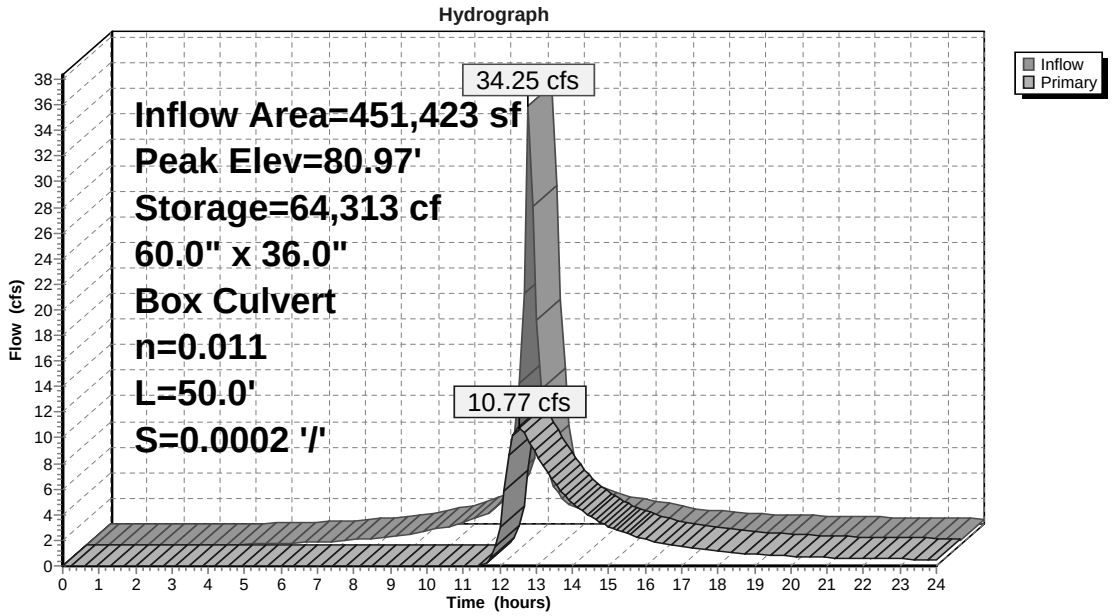
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 79.00 | 17,000 | 1,200.0 | 0 | 0 | 17,000 |
| 80.00 | 27,000 | 4,000.0 | 21,808 | 21,808 | 1,175,651 |
| 81.00 | 63,900 | 4,200.0 | 44,146 | 65,954 | 1,306,222 |
| 82.00 | 76,600 | 4,250.0 | 70,154 | 136,108 | 1,340,108 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.00' | **60.0" W x 36.0" H Box Culvert** L= 50.0' Box, headwall w/3 square edges, Ke= 0.500<br>Inlet / Outlet Invert= 80.00' / 79.99' S= 0.0002 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 15.00 sf |

**Primary OutFlow** Max=10.70 cfs @ 12.52 hrs HW=80.97' TW=0.00' (Dynamic Tailwater)
**1=Culvert** (Barrel Controls 10.70 cfs @ 2.94 fps)



## Pond ES: Offsite Swale to South Culvert



### Summary for Pond EW: Wetland to East Culvert

Inflow Area = 406,206 sf, 2.31% Impervious, Inflow Depth > 2.03" for 10-Year event
Inflow = 9.92 cfs @ 12.67 hrs, Volume= 68,685 cf
Outflow = 0.48 cfs @ 19.58 hrs, Volume= 16,473 cf, Atten= 95%, Lag= 414.6 min
Primary = 0.48 cfs @ 19.58 hrs, Volume= 16,473 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 80.67' @ 19.58 hrs Surf.Area= 111,464 sf Storage= 53,503 cf

Plug-Flow detention time= 412.7 min calculated for 16,473 cf (24% of inflow)
Center-of-Mass det. time= 273.5 min ( 1,145.8 - 872.3 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 290,435 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

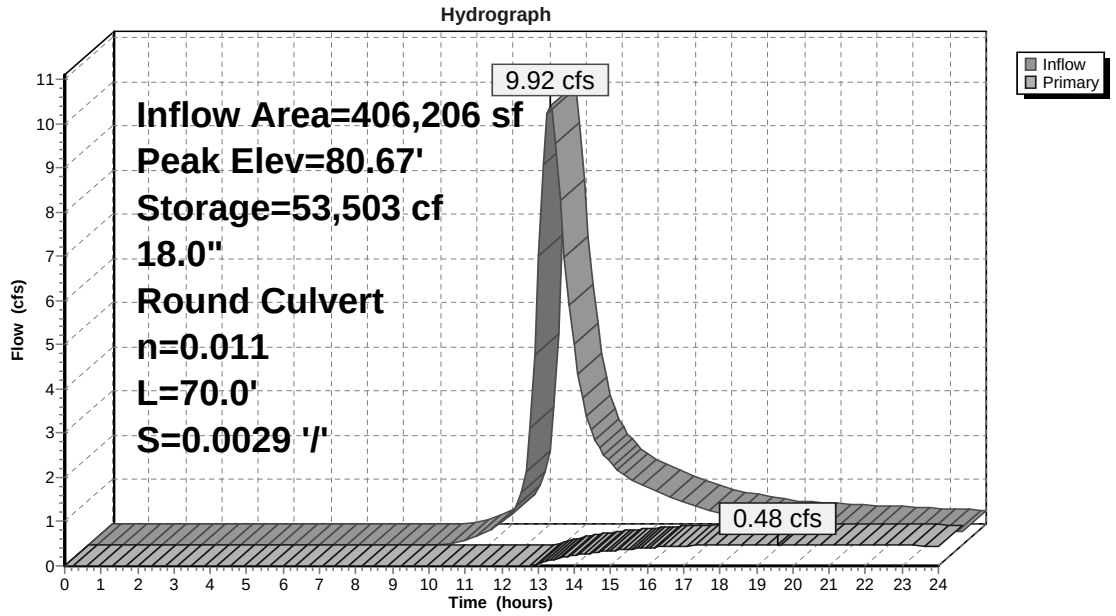
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 52,000 | 1,200.0 | 0 | 0 | 52,000 |
| 81.00 | 149,000 | 2,600.0 | 96,341 | 96,341 | 475,356 |
| 82.00 | 243,000 | 4,300.0 | 194,094 | 290,435 | 1,408,807 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.30' | **18.0" Round Culvert** L= 70.0' RCP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 80.30' / 80.10' S= 0.0029 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.48 cfs @ 19.58 hrs HW=80.67' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 0.48 cfs @ 2.13 fps)



### Pond EW: Wetland to East Culvert



## Summary for Pond OFFSITE: OFFSITE PONDING AREA IN GRASS

Inflow Area = 107,187 sf, 67.80% Impervious, Inflow Depth > 3.02" for 10-Year event
Inflow = 7.44 cfs @ 12.18 hrs, Volume= 26,967 cf
Outflow = 7.40 cfs @ 12.22 hrs, Volume= 26,727 cf, Atten= 1%, Lag= 2.5 min
Primary = 7.40 cfs @ 12.22 hrs, Volume= 26,727 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 82.78' @ 12.22 hrs Surf.Area= 5,350 sf Storage= 1,899 cf

Plug-Flow detention time= 15.7 min calculated for 26,727 cf (99% of inflow)
Center-of-Mass det. time= 10.3 min ( 815.4 - 805.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.10' | 3,254 cf | **OFFSITE PONDING AREA (Prismatic)** Listed below (Recalc) |

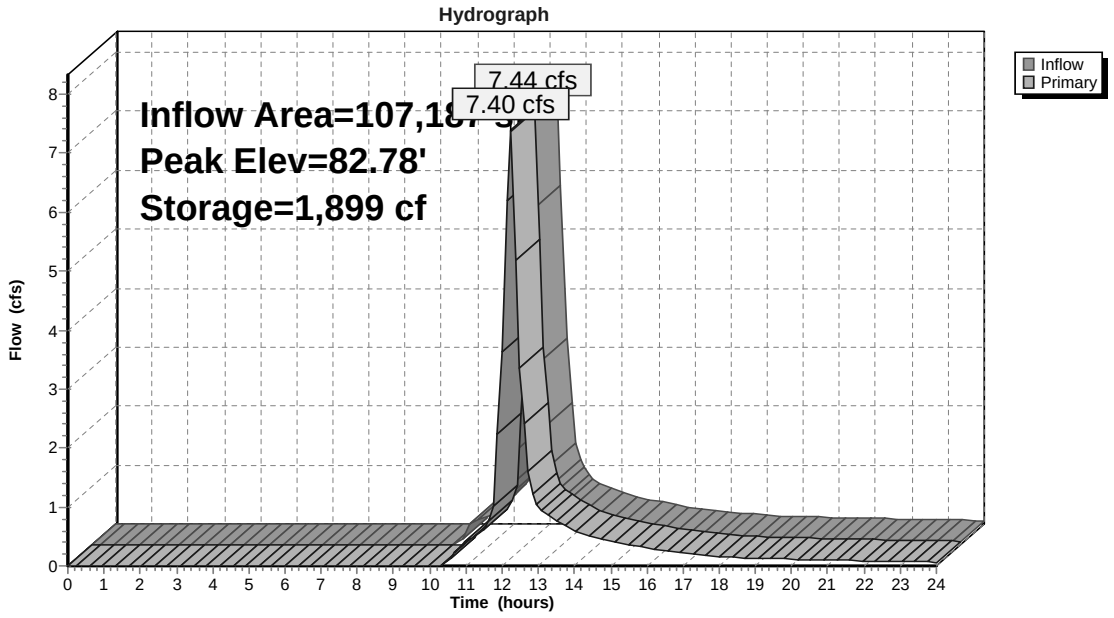
| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 82.10 | 230 | 0 | 0 |
| 83.00 | 7,000 | 3,254 | 3,254 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.27' | **8.0" Round (3) 8" HDPE X 3.00 w/ 2.0" inside fill** L= 21.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 82.10' / 81.40' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.28 sf |
| #2 | Primary | 82.60' | **30.0' long x 10.0' breadth WEIR FLOW OVER WALKING PATH**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64 |

**Primary OutFlow** Max=7.19 cfs @ 12.22 hrs HW=82.78' TW=0.00' (Dynamic Tailwater)
└─**1=(3) 8" HDPE** (Inlet Controls 1.65 cfs @ 1.96 fps)
└─**2=WEIR FLOW OVER WALKING PATH** (Weir Controls 5.53 cfs @ 1.05 fps)



## Pond OFFSITE: OFFSITE PONDING AREA IN GRASS



### Summary for Pond P-2A: Parking Lot/Driveway

Inflow Area = 43,079 sf, 96.56% Impervious, Inflow Depth > 4.26" for 10-Year event
Inflow = 3.61 cfs @ 12.14 hrs, Volume= 15,294 cf
Outflow = 3.69 cfs @ 12.14 hrs, Volume= 15,292 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.69 cfs @ 12.14 hrs, Volume= 15,292 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 84.04' @ 12.14 hrs Surf.Area= 684 sf Storage= 60 cf

Plug-Flow detention time= 0.5 min calculated for 15,216 cf (99% of inflow)
Center-of-Mass det. time= 0.4 min ( 753.3 - 752.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.38' | 14 cf | **4.00'D x 1.10'H Ex.CB** |
| #2 | 83.45' | 1,680 cf | **Parking/Driveway (Prismatic)**Listed below (Recalc) |
| | | 1,694 cf | Total Available Storage |

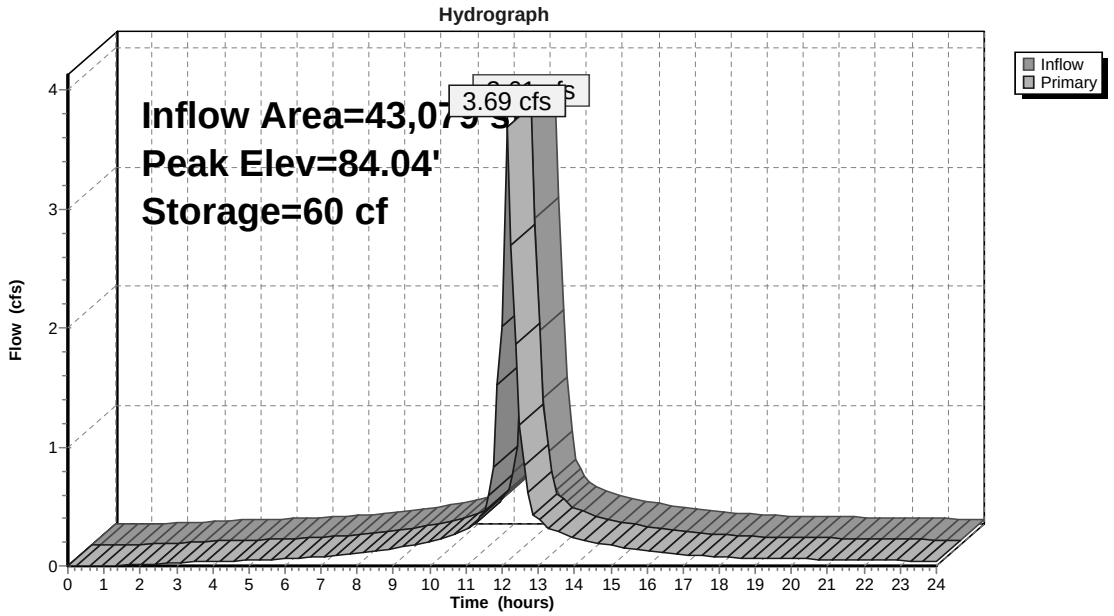
| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 83.45 | 4 | 0 | 0 |
| 84.00 | 103 | 29 | 29 |
| 84.50 | 6,500 | 1,651 | 1,680 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.46' | **6.0" Round 6"PVC w/ 1.0" inside fill** L= 170.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 82.38' / 81.00' S= 0.0081 '/' Cc= 0.900<br>n= 0.010 PVC, smooth interior, Flow Area= 0.17 sf |
| #2 | Primary | 84.00' | **120.0' long x 50.0' breadth Weir Flow Over Curb Towards Lake**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=3.53 cfs @ 12.14 hrs HW=84.04' TW=0.00' (Dynamic Tailwater)
└**1=6"PVC** (Barrel Controls 0.68 cfs @ 3.89 fps)
└**2=Weir Flow Over Curb Towards Lake** (Weir Controls 2.85 cfs @ 0.55 fps)



### Pond P-2A: Parking Lot/Driveway



### Summary for Pond P-2C: EX. INFILTRTATION BASIN

Inflow Area = 107,187 sf, 67.80% Impervious, Inflow Depth > 3.49" for 10-Year event
Inflow = 8.05 cfs @ 12.14 hrs, Volume= 31,214 cf
Outflow = 7.48 cfs @ 12.18 hrs, Volume= 29,067 cf, Atten= 7%, Lag= 2.4 min
Discarded = 0.04 cfs @ 12.18 hrs, Volume= 2,100 cf
Primary = 7.44 cfs @ 12.18 hrs, Volume= 26,967 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 83.45' @ 12.18 hrs Surf.Area= 6,981 sf Storage= 3,036 cf
Flood Elev= 83.30' Surf.Area= 5,645 sf Storage= 2,114 cf

Plug-Flow detention time= 58.6 min calculated for 29,067 cf (93% of inflow)
Center-of-Mass det. time= 22.3 min ( 815.7 - 793.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.50' | 8,308 cf | **EX. INFILTRATION BASIN (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 82.50 | 430 | 0 | 0 |
| 83.00 | 2,900 | 833 | 833 |
| 84.00 | 12,050 | 7,475 | 8,308 |

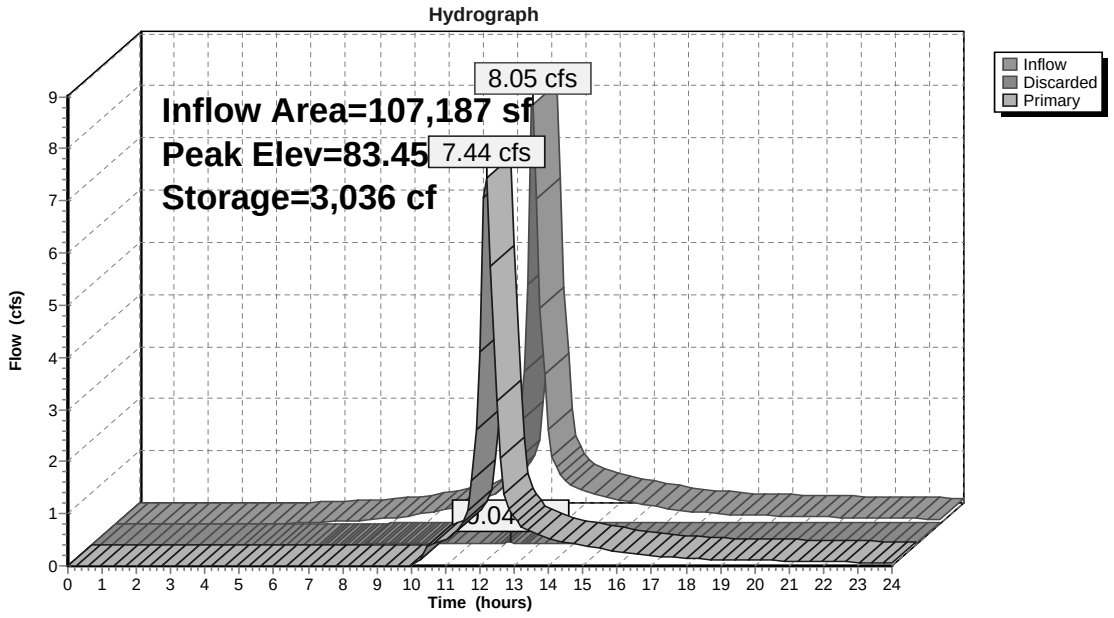
| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 83.30' | **50.0' long x 60.0' breadth GRASS/LAWN AREA**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Discarded | 82.50' | **0.270 in/hr Exfiltration over Surface area** |

**Discarded OutFlow** Max=0.04 cfs @ 12.18 hrs HW=83.44' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.04 cfs)

**Primary OutFlow** Max=7.07 cfs @ 12.18 hrs HW=83.44' TW=82.77' (Dynamic Tailwater)
└**1=GRASS/LAWN AREA** (Weir Controls 7.07 cfs @ 1.01 fps)



### Pond P-2C: EX. INFILTRTATION BASIN

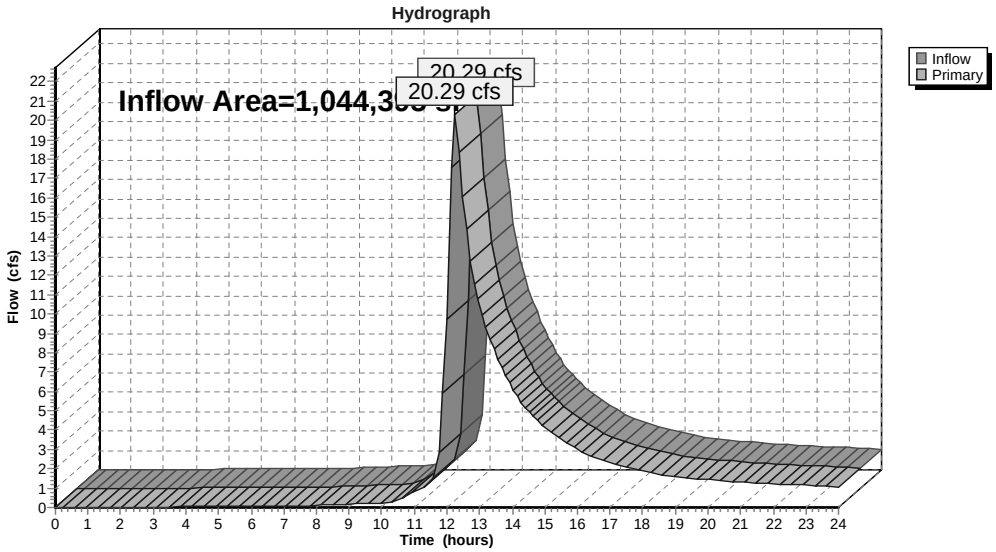


### Summary for Link SP-1: STUDY POINT #1

Inflow Area = 1,044,395 sf, 40.73% Impervious, Inflow Depth > 1.99" for 10-Year event
Inflow = 20.29 cfs @ 12.25 hrs, Volume= 173,080 cf
Primary = 20.29 cfs @ 12.25 hrs, Volume= 173,080 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs

**Link SP-1: STUDY POINT #1**






### Summary for Subcatchment E-1A: EX. WATERSHED

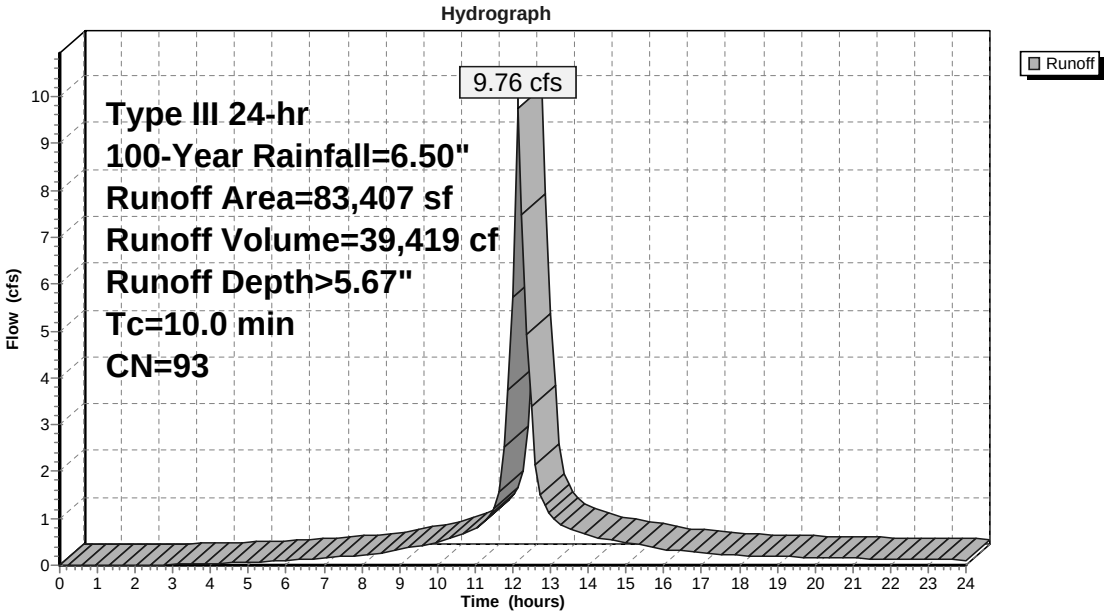
Runoff = 9.76 cfs @ 12.14 hrs, Volume= 39,419 cf, Depth> 5.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 6,343 | 86 | <50% Grass cover, Poor, HSG C |
| | 8,692 | 74 | >75% Grass cover, Good, HSG C |
| | 5,285 | 79 | Woods/grass comb., Good, HSG D |
| * | 63,087 | 98 | Impervious |
| | 83,407 | 93 | Weighted Average |
| | 20,320 | | 24.36% Pervious Area |
| | 63,087 | | 75.64% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-1A: EX. WATERSHED**






**Summary for Subcatchment E-1B: EX. WATERSHED**

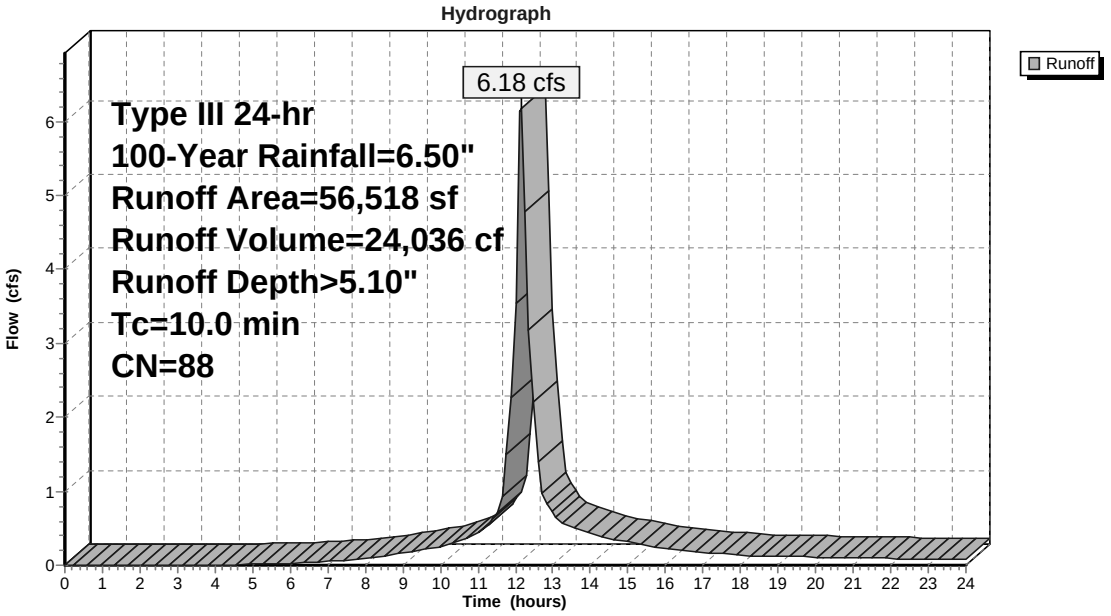
Runoff = 6.18 cfs @ 12.14 hrs, Volume= 24,036 cf, Depth> 5.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 3,722 | 86 | <50% Grass cover, Poor, HSG C |
| | 8,826 | 74 | >75% Grass cover, Good, HSG C |
| | 14,964 | 79 | Woods/grass comb., Good, HSG D |
| * | 29,006 | 98 | Impervious |
| | 56,518 | 88 | Weighted Average |
| | 27,512 | | 48.68% Pervious Area |
| | 29,006 | | 51.32% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-1B: EX. WATERSHED**






**Summary for Subcatchment E-1C: EX. WATERSHED**

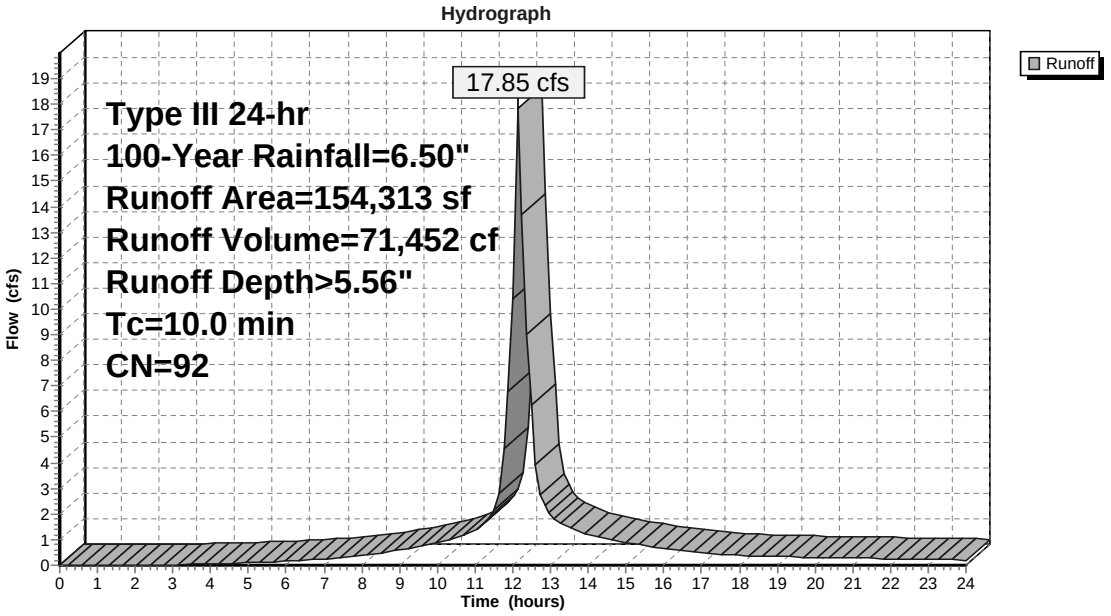
Runoff = 17.85 cfs @ 12.14 hrs, Volume= 71,452 cf, Depth> 5.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 3,840 | 86 | <50% Grass cover, Poor, HSG C |
| | 20,360 | 74 | >75% Grass cover, Good, HSG C |
| | 23,421 | 79 | Woods/grass comb., Good, HSG D |
| * | 106,692 | 98 | Impervious |
| | 154,313 | 92 | Weighted Average |
| | 47,621 | | 30.86% Pervious Area |
| | 106,692 | | 69.14% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-1C: EX. WATERSHED**






**Summary for Subcatchment E-1D: EX. WATERSHED**

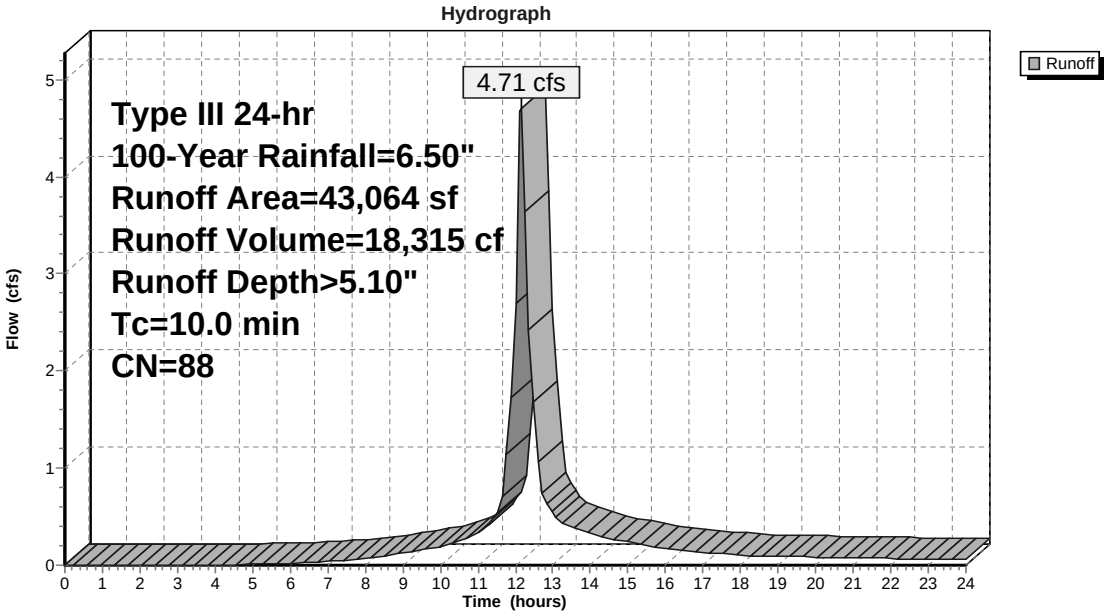
Runoff = 4.71 cfs @ 12.14 hrs, Volume= 18,315 cf, Depth> 5.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 5,705 | 86 | <50% Grass cover, Poor, HSG C |
| | 12,809 | 74 | >75% Grass cover, Good, HSG C |
| | 2,569 | 79 | Woods/grass comb., Good, HSG D |
| * | 21,981 | 98 | Impervious |
| | 43,064 | 88 | Weighted Average |
| | 21,083 | | 48.96% Pervious Area |
| | 21,981 | | 51.04% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-1D: EX. WATERSHED**






**Summary for Subcatchment E-1E: EX. WATERSHED**

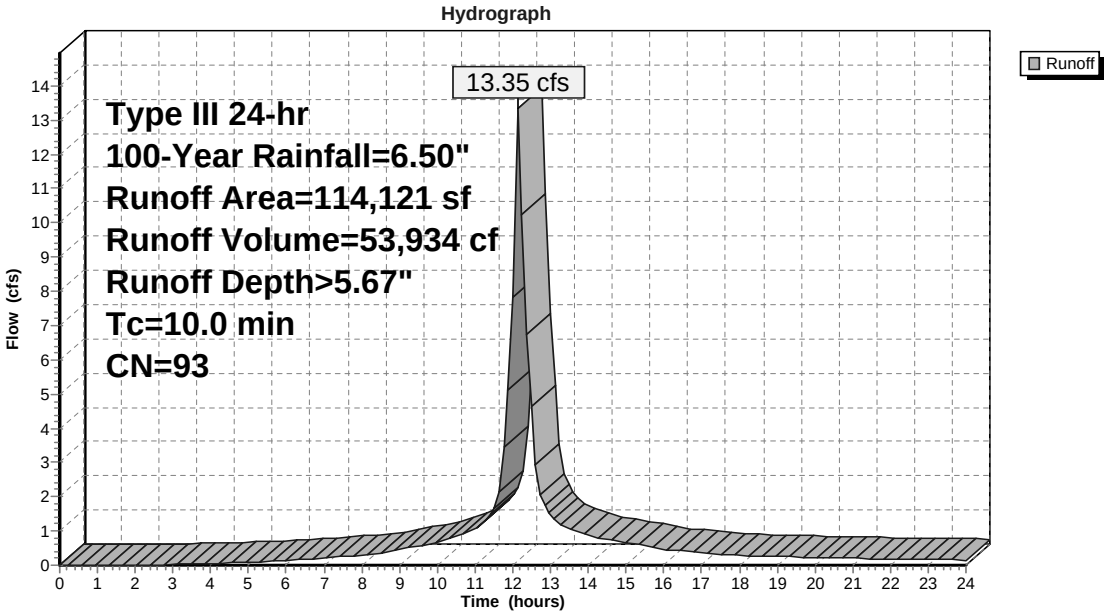
Runoff = 13.35 cfs @ 12.14 hrs, Volume= 53,934 cf, Depth> 5.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 6,384 | 86 | <50% Grass cover, Poor, HSG C |
| | 17,883 | 74 | >75% Grass cover, Good, HSG C |
| | 15,843 | 96 | Gravel surface, HSG C |
| * | 74,011 | 98 | Impervious |
| | 114,121 | 93 | Weighted Average |
| | 40,110 | | 35.15% Pervious Area |
| | 74,011 | | 64.85% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-1E: EX. WATERSHED**






**Summary for Subcatchment E-2A: EX. WATERSHED**

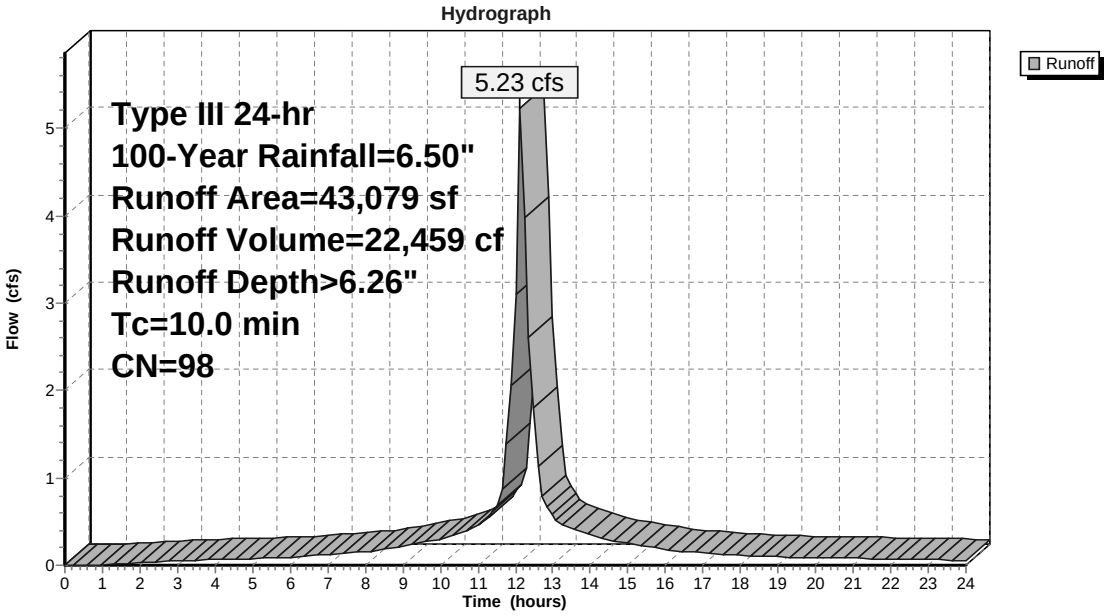
Runoff = 5.23 cfs @ 12.14 hrs, Volume= 22,459 cf, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 1,483 | 86 | <50% Grass cover, Poor, HSG C |
| * | 41,596 | 98 | Impervious |
| | 43,079 | 98 | Weighted Average |
| | 1,483 | | 3.44% Pervious Area |
| | 41,596 | | 96.56% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-2A: EX. WATERSHED**






**Summary for Subcatchment E-2B: EX. WATERSHED**

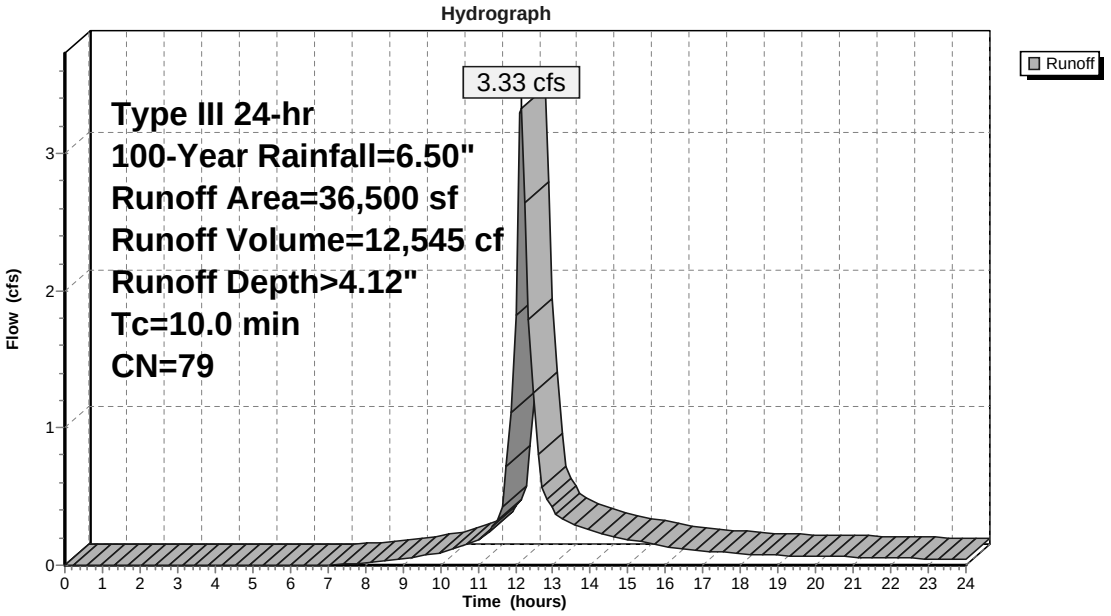
Runoff = 3.33 cfs @ 12.14 hrs, Volume= 12,545 cf, Depth> 4.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 1,043 | 86 | <50% Grass cover, Poor, HSG C |
| | 28,476 | 74 | >75% Grass cover, Good, HSG C |
| * | 6,981 | 98 | Impervious |
| | 36,500 | 79 | Weighted Average |
| | 29,519 | | 80.87% Pervious Area |
| | 6,981 | | 19.13% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-2B: EX. WATERSHED**






**Summary for Subcatchment E-2C: EX. WATERSHED**

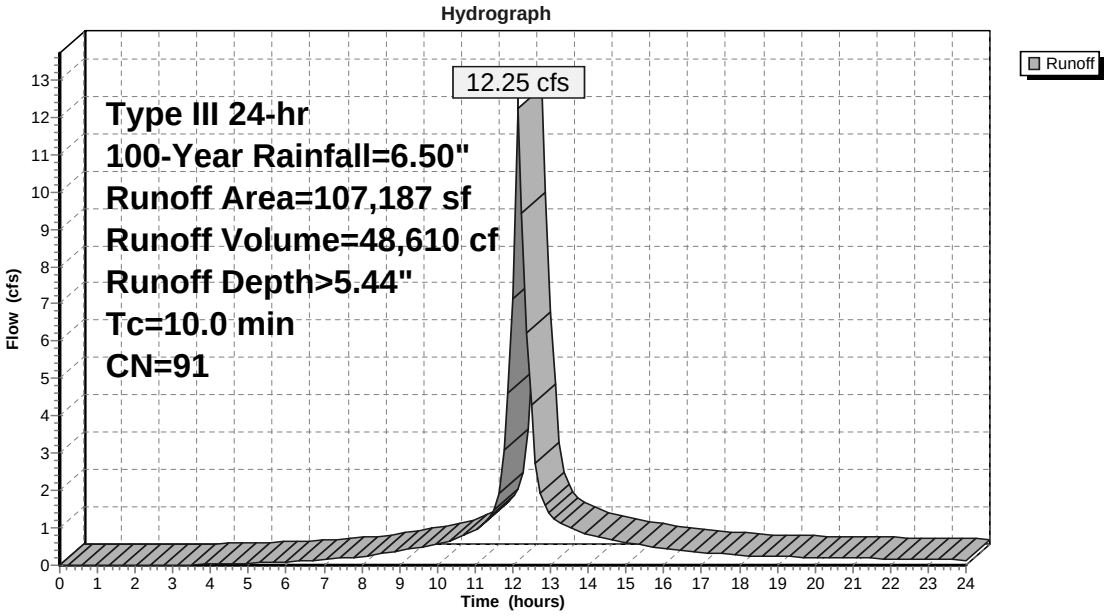
Runoff = 12.25 cfs @ 12.14 hrs, Volume= 48,610 cf, Depth> 5.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 2,816 | 86 | <50% Grass cover, Poor, HSG C |
| | 31,699 | 74 | >75% Grass cover, Good, HSG C |
| * | 72,672 | 98 | Impervious |
| | 107,187 | 91 | Weighted Average |
| | 34,515 | | 32.20% Pervious Area |
| | 72,672 | | 67.80% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment E-2C: EX. WATERSHED**






**Summary for Subcatchment E-3: EX. WATERSHED**

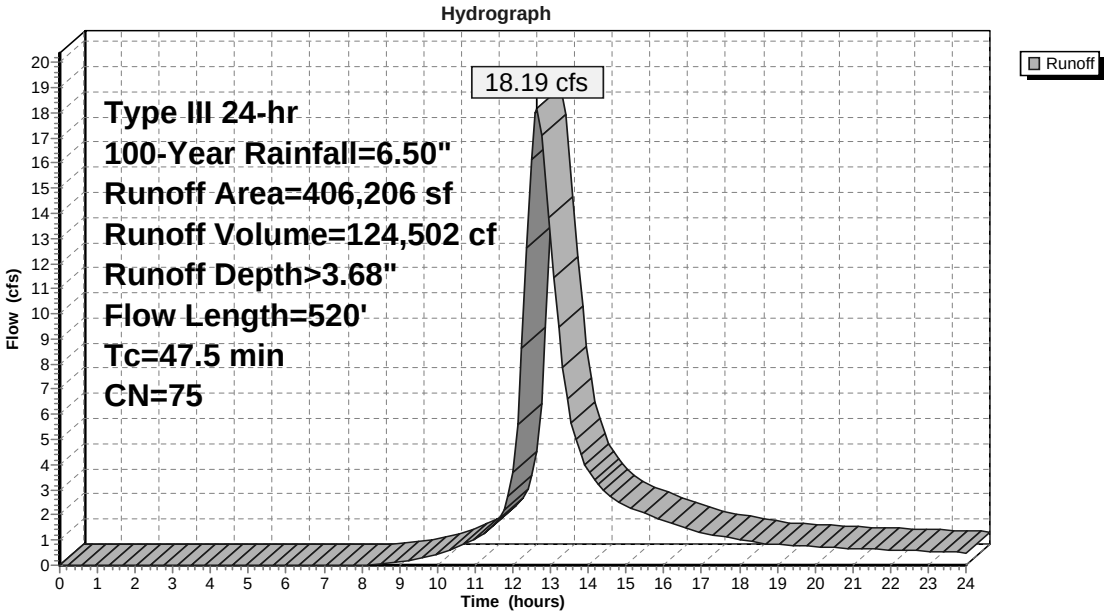
Runoff = 18.19 cfs @ 12.65 hrs, Volume= 124,502 cf, Depth> 3.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 237,023 | 77 | Woods, Good, HSG D |
| * | 9,386 | 98 | Impervious |
| | 150,817 | 70 | Woods, Good, HSG C |
| | 8,980 | 74 | >75% Grass cover, Good, HSG C |
| | 406,206 | 75 | Weighted Average |
| | 396,820 | | 97.69% Pervious Area |
| | 9,386 | | 2.31% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 28.3 | 100 | 0.0100 | 0.06 | | **Sheet Flow, A-B**<br>Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.3 | 40 | 0.0100 | 0.50 | | **Shallow Concentrated Flow, B-C**<br>Woodland Kv= 5.0 fps |
| 17.9 | 380 | 0.0050 | 0.35 | | **Shallow Concentrated Flow, C-D**<br>Woodland Kv= 5.0 fps |
| 47.5 | 520 | Total | | | |

**Subcatchment E-3: EX. WATERSHED**






**Summary for Pond ES: Offsite Swale to South Culvert**

Inflow Area = 451,423 sf, 65.30% Impervious, Inflow Depth > 5.51" for 100-Year event
Inflow = 51.85 cfs @ 12.14 hrs, Volume= 207,156 cf
Outflow = 18.20 cfs @ 12.49 hrs, Volume= 179,675 cf, Atten= 65%, Lag= 21.1 min
Primary = 18.20 cfs @ 12.49 hrs, Volume= 179,675 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 81.36' @ 12.49 hrs Surf.Area= 68,348 sf Storage= 89,800 cf

Plug-Flow detention time= 148.0 min calculated for 179,675 cf (87% of inflow)
Center-of-Mass det. time= 90.3 min ( 869.2 - 778.9 )

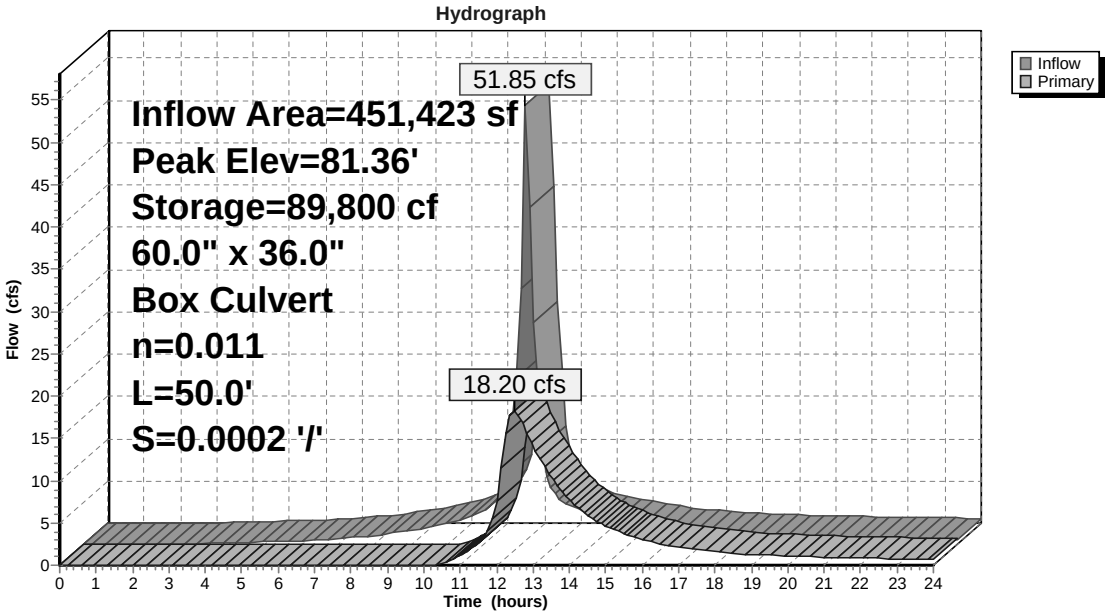
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 79.00' | 136,108 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 79.00 | 17,000 | 1,200.0 | 0 | 0 | 17,000 |
| 80.00 | 27,000 | 4,000.0 | 21,808 | 21,808 | 1,175,651 |
| 81.00 | 63,900 | 4,200.0 | 44,146 | 65,954 | 1,306,222 |
| 82.00 | 76,600 | 4,250.0 | 70,154 | 136,108 | 1,340,108 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.00' | **60.0" W x 36.0" H Box Culvert** L= 50.0' Box, headwall w/3 square edges, Ke= 0.500<br>Inlet / Outlet Invert= 80.00' / 79.99' S= 0.0002 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 15.00 sf |

**Primary OutFlow** Max=18.17 cfs @ 12.49 hrs HW=81.36' TW=0.00' (Dynamic Tailwater)
**1=Culvert** (Barrel Controls 18.17 cfs @ 3.57 fps)

**Pond ES: Offsite Swale to South Culvert**






**Summary for Pond EW: Wetland to East Culvert**

Inflow Area = 406,206 sf, 2.31% Impervious, Inflow Depth > 3.68" for 100-Year event
Inflow = 18.19 cfs @ 12.65 hrs, Volume= 124,502 cf
Outflow = 1.37 cfs @ 16.77 hrs, Volume= 48,919 cf, Atten= 92%, Lag= 246.8 min
Primary = 1.37 cfs @ 16.77 hrs, Volume= 48,919 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 80.94' @ 16.77 hrs Surf.Area= 141,746 sf Storage= 87,587 cf

Plug-Flow detention time= 373.6 min calculated for 48,919 cf (39% of inflow)
Center-of-Mass det. time= 251.2 min ( 1,106.9 - 855.7 )

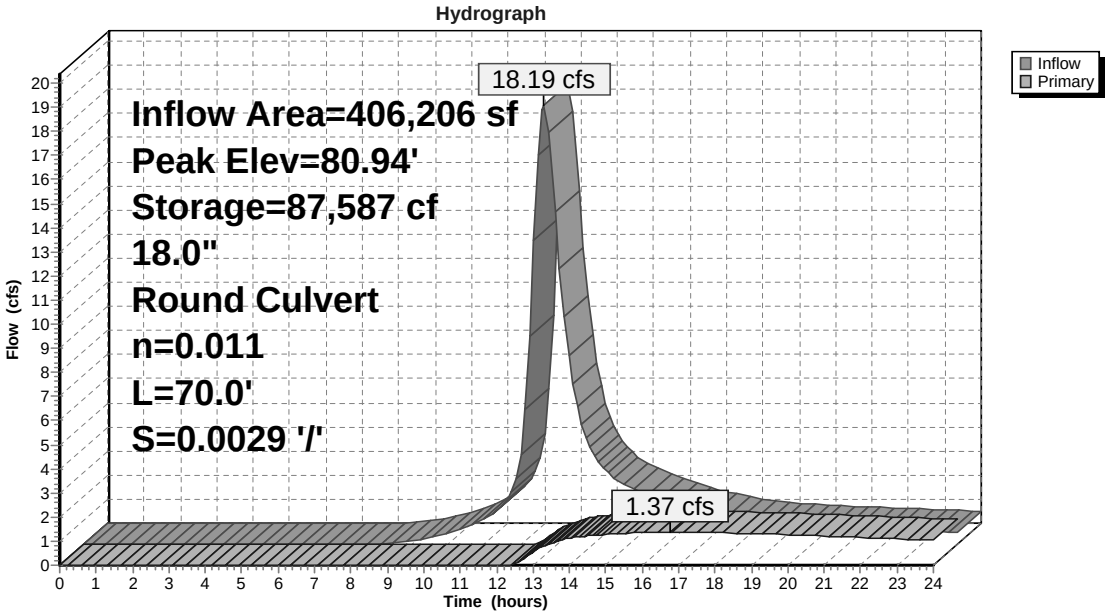
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 290,435 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 52,000 | 1,200.0 | 0 | 0 | 52,000 |
| 81.00 | 149,000 | 2,600.0 | 96,341 | 96,341 | 475,356 |
| 82.00 | 243,000 | 4,300.0 | 194,094 | 290,435 | 1,408,807 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.30' | **18.0" Round Culvert** L= 70.0' RCP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 80.30' / 80.10' S= 0.0029 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=1.37 cfs @ 16.77 hrs HW=80.94' TW=0.00' (Dynamic Tailwater)
**1=Culvert** (Barrel Controls 1.37 cfs @ 2.82 fps)

**Pond EW: Wetland to East Culvert**






## Summary for Pond OFFSITE: OFFSITE PONDING AREA IN GRASS

Inflow Area = 107,187 sf, 67.80% Impervious, Inflow Depth > 4.94" for 100-Year event
Inflow = 11.39 cfs @ 12.17 hrs, Volume= 44,132 cf
Outflow = 11.31 cfs @ 12.22 hrs, Volume= 43,845 cf, Atten= 1%, Lag= 2.5 min
Primary = 11.31 cfs @ 12.22 hrs, Volume= 43,845 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 82.85' @ 12.21 hrs Surf.Area= 5,876 sf Storage= 2,292 cf

Plug-Flow detention time= 13.2 min calculated for 43,845 cf (99% of inflow)
Center-of-Mass det. time= 9.2 min ( 803.5 - 794.4 )

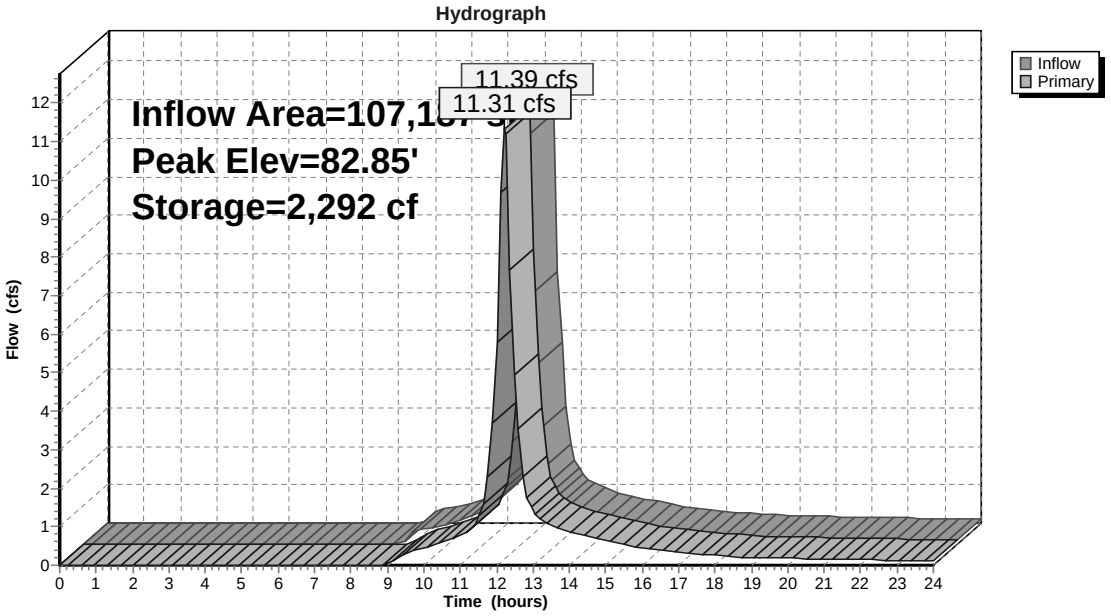
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.10' | 3,254 cf | **OFFSITE PONDING AREA (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 82.10 | 230 | 0 | 0 |
| 83.00 | 7,000 | 3,254 | 3,254 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.27' | **8.0" Round (3) 8" HDPE X 3.00 w/ 2.0" inside fill** L= 21.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 82.10' / 81.40' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.28 sf |
| #2 | Primary | 82.60' | **30.0' long x 10.0' breadth WEIR FLOW OVER WALKING PATH**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64 |

**Primary OutFlow** Max=10.90 cfs @ 12.22 hrs HW=82.84' TW=0.00' (Dynamic Tailwater)
**1=(3) 8" HDPE** (Inlet Controls 1.86 cfs @ 2.21 fps)
**2=WEIR FLOW OVER WALKING PATH** (Weir Controls 9.03 cfs @ 1.24 fps)

**Pond OFFSITE: OFFSITE PONDING AREA IN GRASS**






## Summary for Pond P-2A: Parking Lot/Driveway

Inflow Area = 43,079 sf, 96.56% Impervious, Inflow Depth > 6.26" for 100-Year event
Inflow = 5.23 cfs @ 12.14 hrs, Volume= 22,459 cf
Outflow = 5.16 cfs @ 12.14 hrs, Volume= 22,456 cf, Atten= 1%, Lag= 0.2 min
Primary = 5.16 cfs @ 12.14 hrs, Volume= 22,456 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 84.06' @ 12.14 hrs Surf.Area= 857 sf Storage= 71 cf

Plug-Flow detention time= 0.4 min calculated for 22,344 cf (99% of inflow)
Center-of-Mass det. time= 0.4 min ( 747.4 - 747.1 )

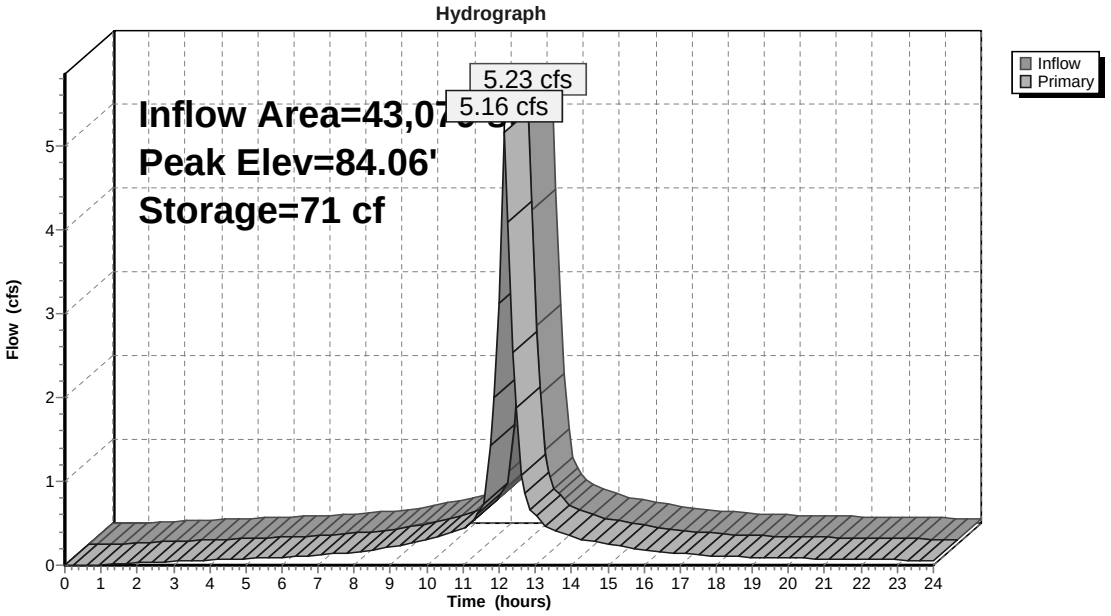
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.38' | 14 cf | **4.00'D x 1.10'H Ex.CB** |
| #2 | 83.45' | 1,680 cf | **Parking/Driveway (Prismatic)**Listed below (Recalc) |
| | | 1,694 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 83.45 | 4 | 0 | 0 |
| 84.00 | 103 | 29 | 29 |
| 84.50 | 6,500 | 1,651 | 1,680 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.46' | **6.0" Round 6"PVC w/ 1.0" inside fill** L= 170.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 82.38' / 81.00' S= 0.0081 '/' Cc= 0.900<br>n= 0.010 PVC, smooth interior, Flow Area= 0.17 sf |
| #2 | Primary | 84.00' | **120.0' long x 50.0' breadth Weir Flow Over Curb Towards Lake**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=4.95 cfs @ 12.14 hrs HW=84.06' TW=0.00' (Dynamic Tailwater)
**1=6"PVC** (Barrel Controls 0.68 cfs @ 3.90 fps)
**2=Weir Flow Over Curb Towards Lake** (Weir Controls 4.27 cfs @ 0.63 fps)

**Pond P-2A: Parking Lot/Driveway**






**Summary for Pond P-2C: EX. INFILTRTATION BASIN**

Inflow Area = 107,187 sf, 67.80% Impervious, Inflow Depth > 5.44" for 100-Year event
Inflow = 12.25 cfs @ 12.14 hrs, Volume= 48,610 cf
Outflow = 11.44 cfs @ 12.17 hrs, Volume= 46,449 cf, Atten= 7%, Lag= 2.2 min
Discarded = 0.05 cfs @ 12.17 hrs, Volume= 2,317 cf
Primary = 11.39 cfs @ 12.17 hrs, Volume= 44,132 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 83.49' @ 12.17 hrs Surf.Area= 7,419 sf Storage= 3,381 cf
Flood Elev= 83.30' Surf.Area= 5,645 sf Storage= 2,114 cf

Plug-Flow detention time= 42.9 min calculated for 46,218 cf (95% of inflow)
Center-of-Mass det. time= 18.4 min ( 800.1 - 781.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.50' | 8,308 cf | **EX. INFILTRATION BASIN (Prismatic)**Listed below (Recalc) |

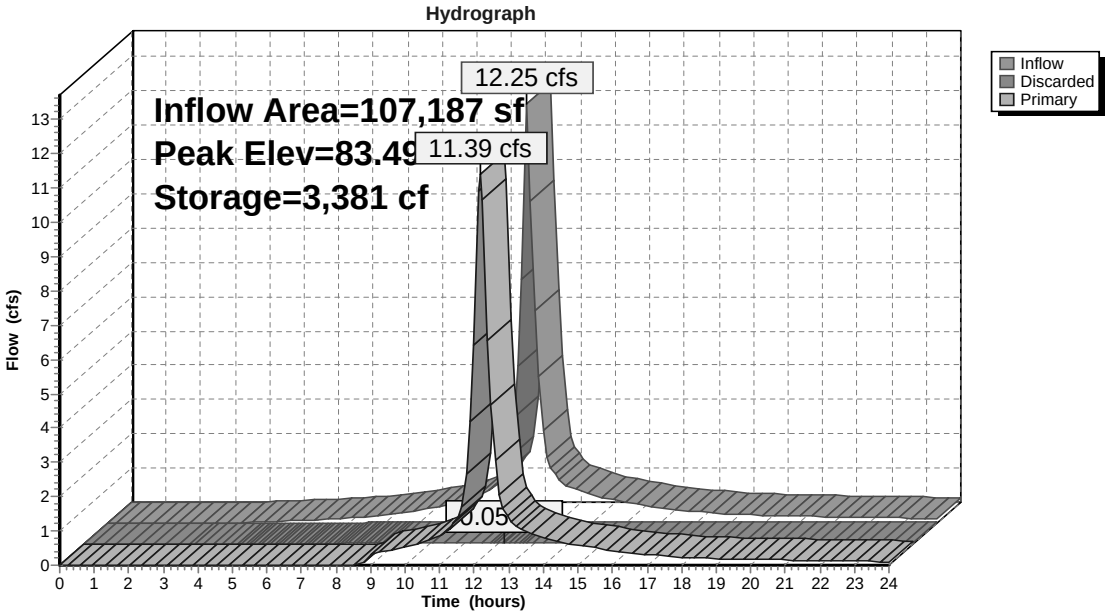
| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 82.50 | 430 | 0 | 0 |
| 83.00 | 2,900 | 833 | 833 |
| 84.00 | 12,050 | 7,475 | 8,308 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 83.30' | **50.0' long x 60.0' breadth GRASS/LAWN AREA**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Discarded | 82.50' | **0.270 in/hr Exfiltration over Surface area** |

**Discarded OutFlow** Max=0.05 cfs @ 12.17 hrs HW=83.49' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.05 cfs)

**Primary OutFlow** Max=10.80 cfs @ 12.17 hrs HW=83.49' TW=82.83' (Dynamic Tailwater)
↑**1=GRASS/LAWN AREA** (Weir Controls 10.80 cfs @ 1.16 fps)

**Pond P-2C: EX. INFILTRTATION BASIN**



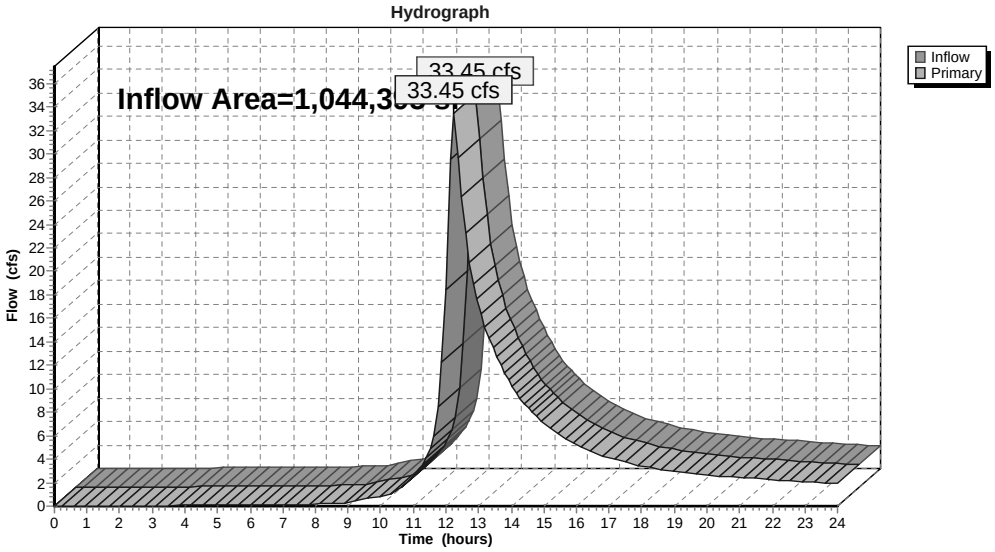



**Summary for Link SP-1: STUDY POINT #1**

Inflow Area = 1,044,395 sf, 40.73% Impervious, Inflow Depth > 3.53" for 100-Year event
Inflow = 33.45 cfs @ 12.24 hrs, Volume= 307,440 cf
Primary = 33.45 cfs @ 12.24 hrs, Volume= 307,440 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs

**Link SP-1: STUDY POINT #1**



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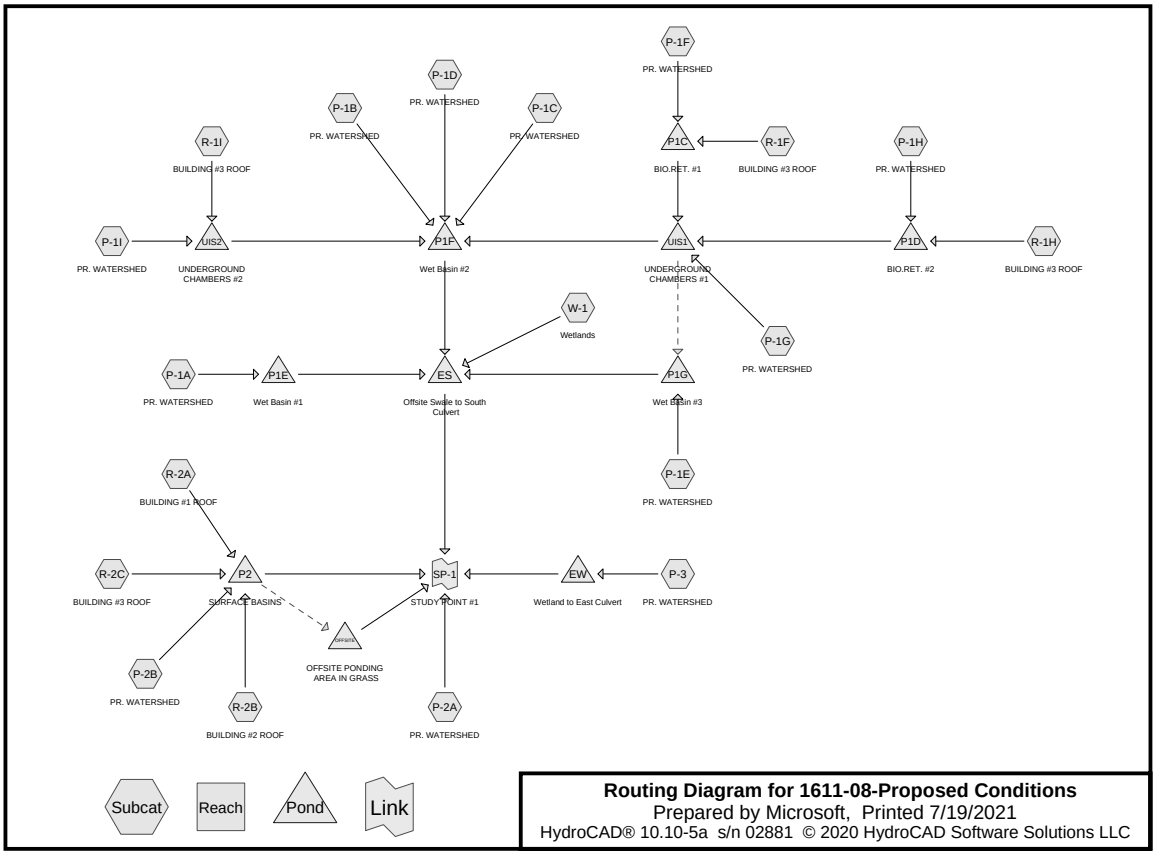
# SECTION 4.0 -
## PROPOSED DRAINAGE ANALYSIS






## 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 | 3.10 | 2 |
| 2 | 10-Year | Type III 24-hr | | Default | 24.00 | 1 | 4.50 | 2 |
| 3 | 100-Year | Type III 24-hr | | Default | 24.00 | 1 | 6.50 | 2 |

**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 | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 228,230 | 0 | 0 | 228,230 | >75% Grass cover, Good | P-1A, P-1B, P-1C, P-1D, P-1E, P-1F, P-1G, P-1H, P-1I, P-2A, P-2B |
| 0 | 0 | 0 | 0 | 202,099 | 202,099 | Impervious | P-1A, P-1B, P-1C, P-1D, P-1E, P-1F, P-1G, P-1H, P-1I, P-2A, P-2B, P-3 |
| 0 | 0 | 0 | 0 | 182,015 | 182,015 | Roof | R-1F, R-1H, R-1I, R-2A, R-2B, R-2C |
| 0 | 0 | 148,521 | 237,023 | 0 | 385,544 | Woods, Good | P-3 |
| 0 | 0 | 0 | 46,507 | 0 | 46,507 | Woods/grass comb., Good | W-1 |
| **0** | **0** | **376,751** | **283,530** | **384,114** | **1,044,395** | **TOTAL AREA** | |



**Summary for Subcatchment P-1A: PR. WATERSHED**

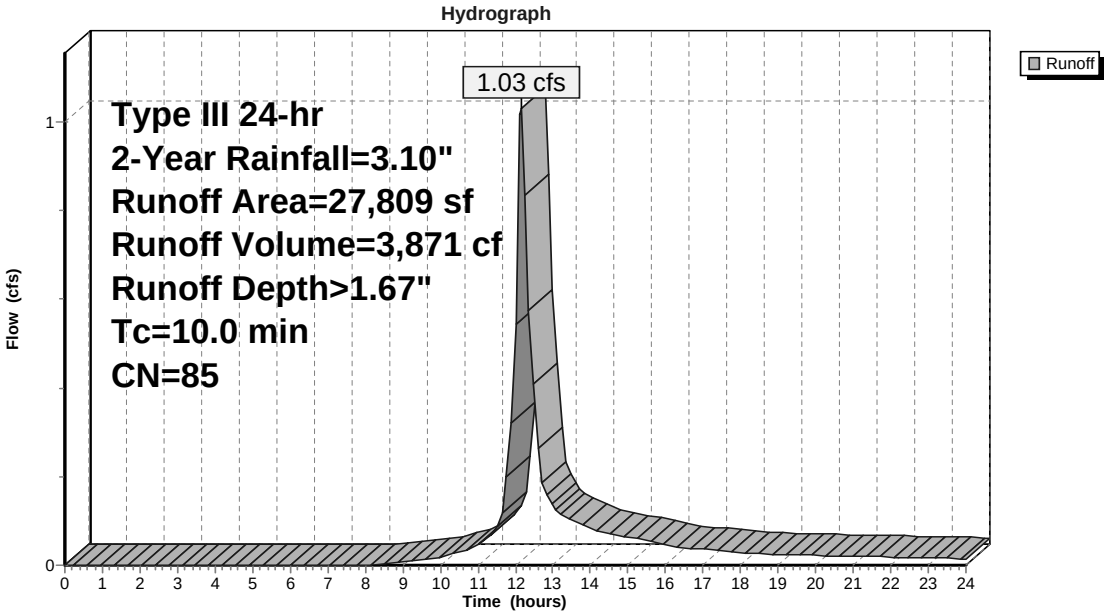
Runoff = 1.03 cfs @ 12.15 hrs, Volume= 3,871 cf, Depth> 1.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 14,724 | 74 | >75% Grass cover, Good, HSG C |
| * | 13,085 | 98 | Impervious |
| | 27,809 | 85 | Weighted Average |
| | 14,724 | | 52.95% Pervious Area |
| | 13,085 | | 47.05% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1A: PR. WATERSHED**






**Summary for Subcatchment P-1B: PR. WATERSHED**

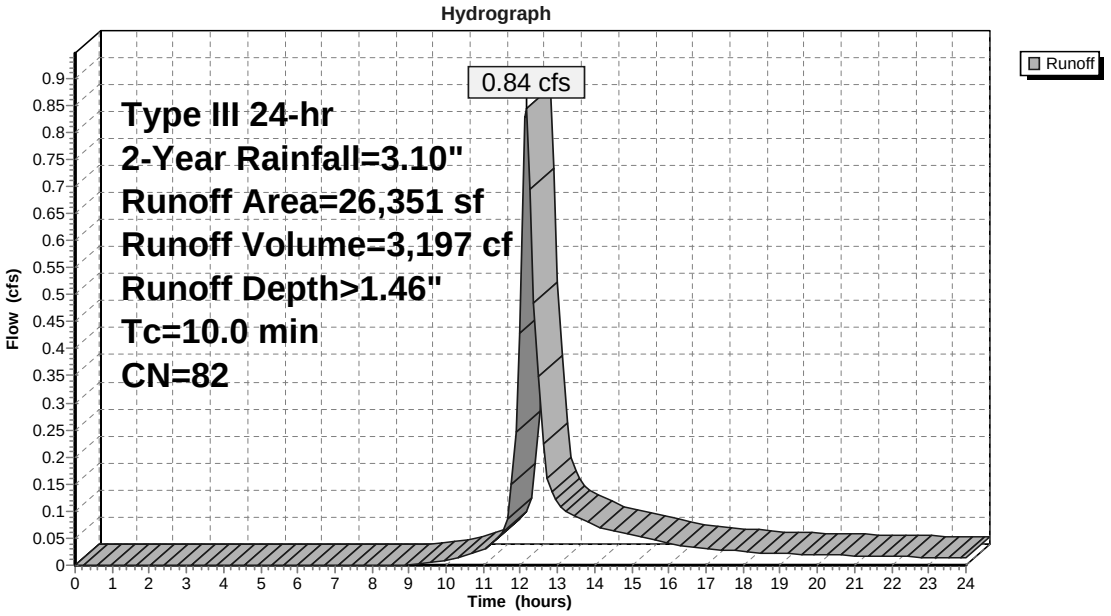
Runoff = 0.84 cfs @ 12.15 hrs, Volume= 3,197 cf, Depth> 1.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 17,448 | 74 | >75% Grass cover, Good, HSG C |
| * | 8,903 | 98 | Impervious |
| | 26,351 | 82 | Weighted Average |
| | 17,448 | | 66.21% Pervious Area |
| | 8,903 | | 33.79% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1B: PR. WATERSHED**






**Summary for Subcatchment P-1C: PR. WATERSHED**

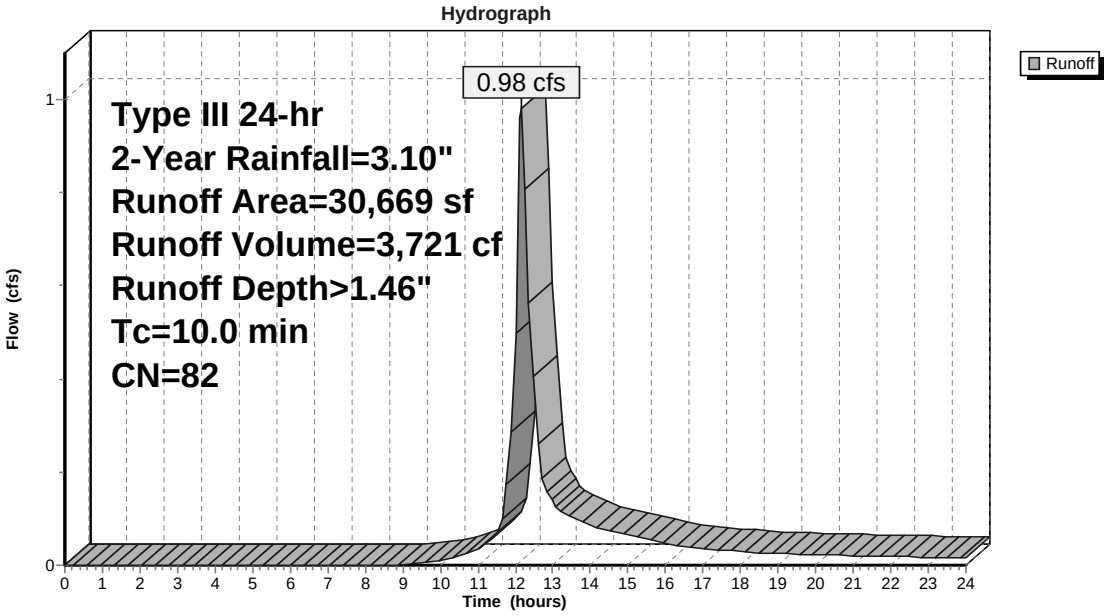
Runoff = 0.98 cfs @ 12.15 hrs, Volume= 3,721 cf, Depth> 1.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 20,040 | 74 | >75% Grass cover, Good, HSG C |
| * | 10,629 | 98 | Impervious |
| | 30,669 | 82 | Weighted Average |
| | 20,040 | | 65.34% Pervious Area |
| | 10,629 | | 34.66% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1C: PR. WATERSHED**






**Summary for Subcatchment P-1D: PR. WATERSHED**

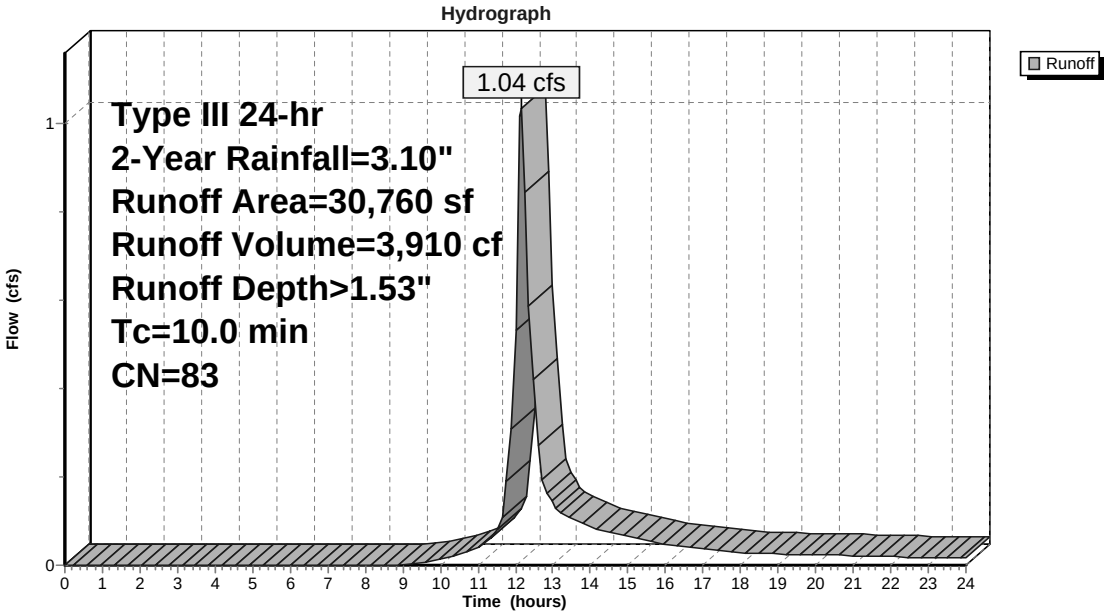
Runoff = 1.04 cfs @ 12.15 hrs, Volume= 3,910 cf, Depth> 1.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 19,029 | 74 | >75% Grass cover, Good, HSG C |
| * | 11,731 | 98 | Impervious |
| | 30,760 | 83 | Weighted Average |
| | 19,029 | | 61.86% Pervious Area |
| | 11,731 | | 38.14% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1D: PR. WATERSHED**






**Summary for Subcatchment P-1E: PR. WATERSHED**

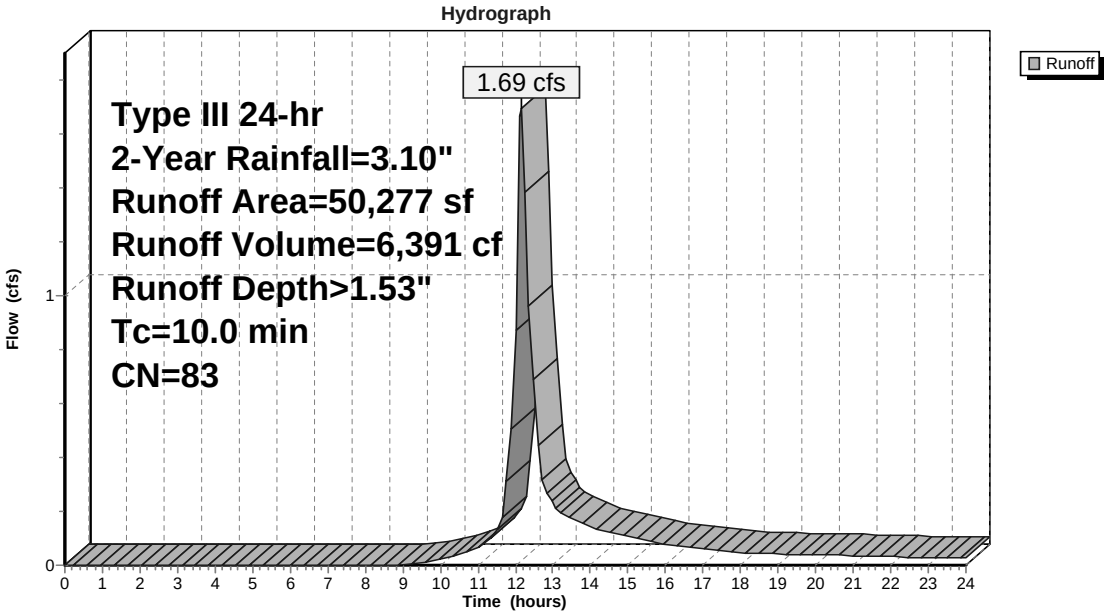
Runoff = 1.69 cfs @ 12.15 hrs, Volume= 6,391 cf, Depth> 1.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 31,091 | 74 | >75% Grass cover, Good, HSG C |
| * | 19,186 | 98 | Impervious |
| | 50,277 | 83 | Weighted Average |
| | 31,091 | | 61.84% Pervious Area |
| | 19,186 | | 38.16% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1E: PR. WATERSHED**






**Summary for Subcatchment P-1F: PR. WATERSHED**

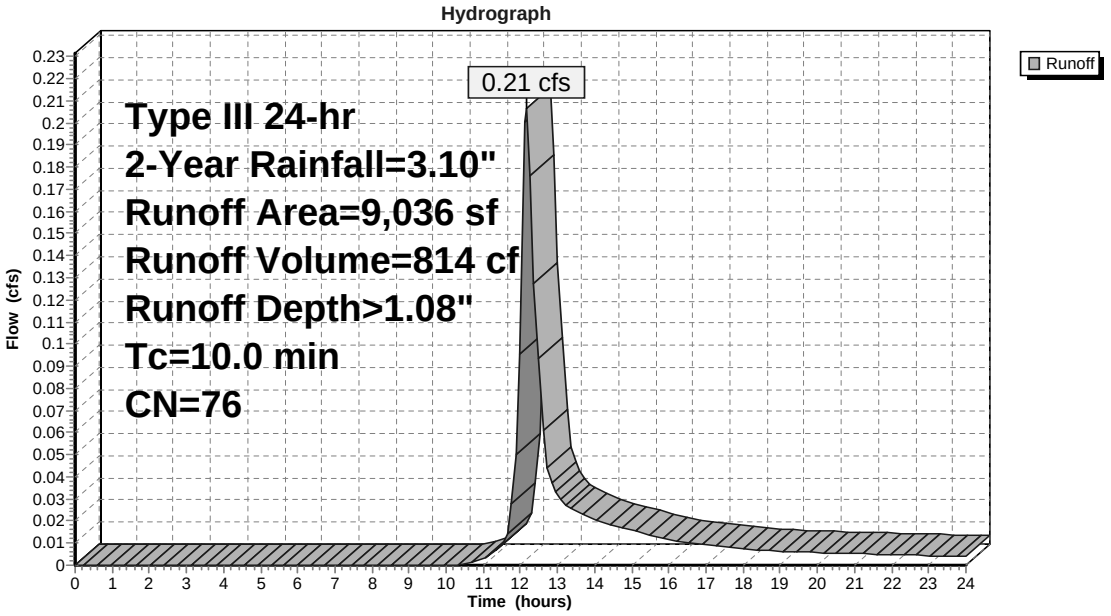
Runoff = 0.21 cfs @ 12.16 hrs, Volume= 814 cf, Depth> 1.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 8,156 | 74 | >75% Grass cover, Good, HSG C |
| * | 880 | 98 | Impervious |
| | 9,036 | 76 | Weighted Average |
| | 8,156 | | 90.26% Pervious Area |
| | 880 | | 9.74% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1F: PR. WATERSHED**






**Summary for Subcatchment P-1G: PR. WATERSHED**

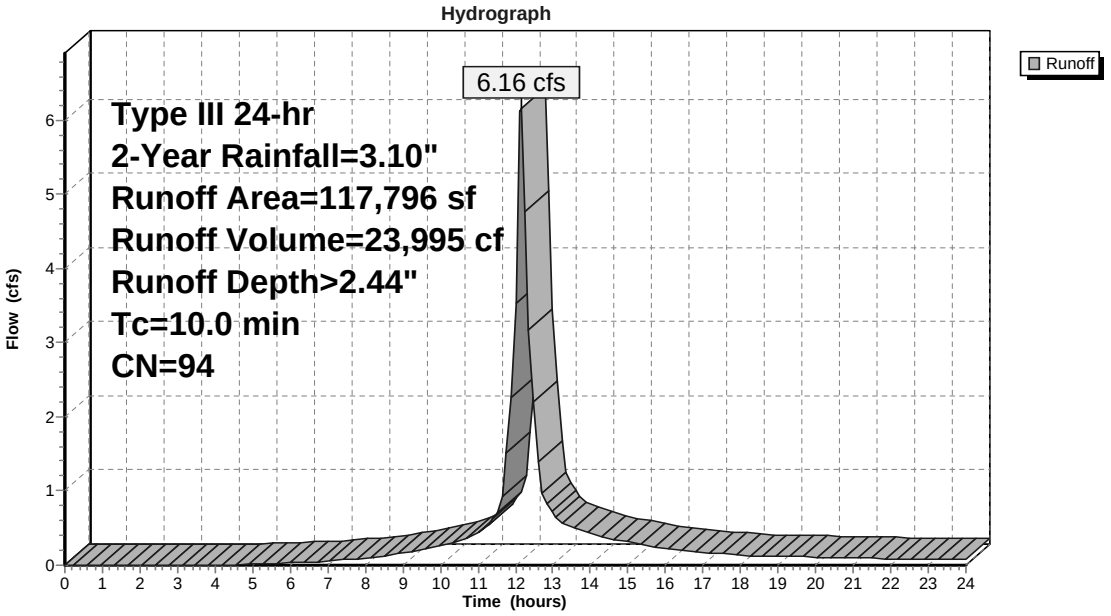
Runoff = 6.16 cfs @ 12.14 hrs, Volume= 23,995 cf, Depth> 2.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 21,862 | 74 | >75% Grass cover, Good, HSG C |
| * | 95,934 | 98 | Impervious |
| | 117,796 | 94 | Weighted Average |
| | 21,862 | | 18.56% Pervious Area |
| | 95,934 | | 81.44% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1G: PR. WATERSHED**






**Summary for Subcatchment P-1H: PR. WATERSHED**

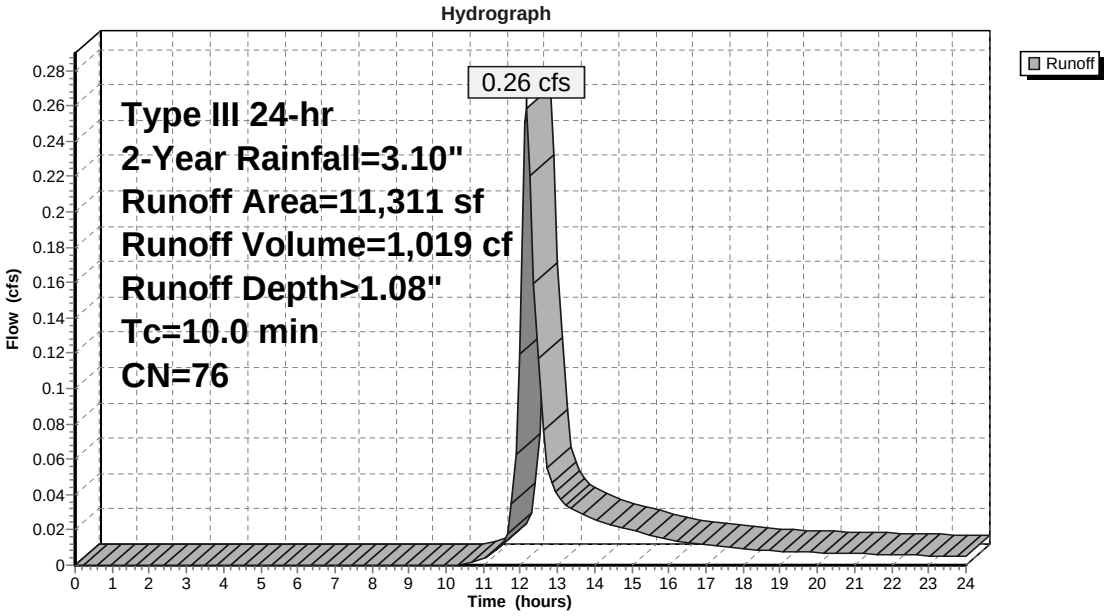
Runoff = 0.26 cfs @ 12.16 hrs, Volume= 1,019 cf, Depth> 1.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 10,351 | 74 | >75% Grass cover, Good, HSG C |
| * | 960 | 98 | Impervious |
| | 11,311 | 76 | Weighted Average |
| | 10,351 | | 91.51% Pervious Area |
| | 960 | | 8.49% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1H: PR. WATERSHED**






**Summary for Subcatchment P-1I: PR. WATERSHED**

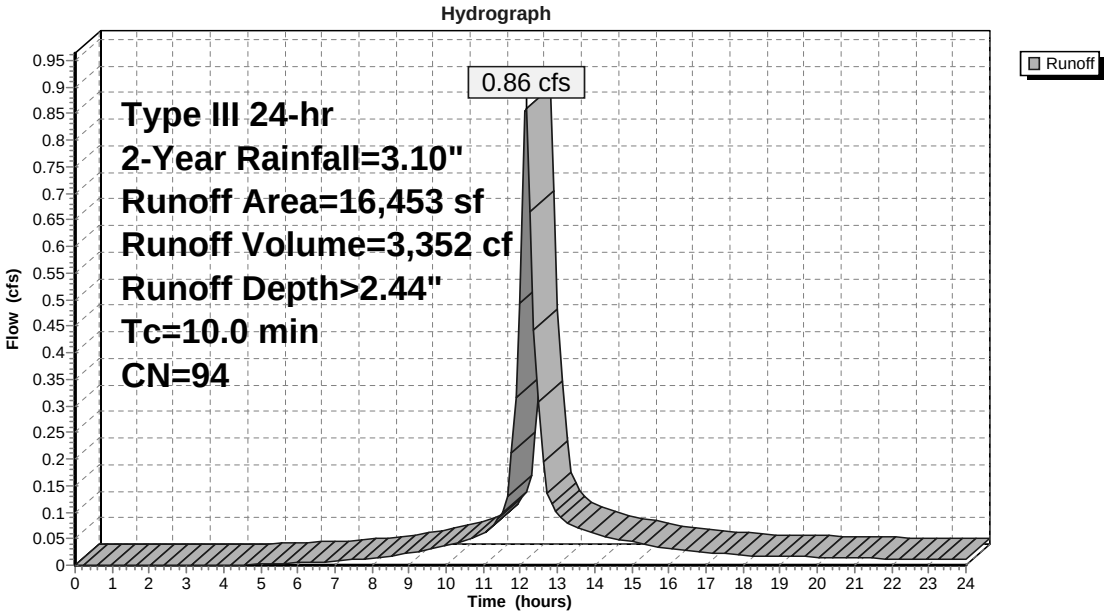
Runoff = 0.86 cfs @ 12.14 hrs, Volume= 3,352 cf, Depth> 2.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 2,946 | 74 | >75% Grass cover, Good, HSG C |
| * | 13,507 | 98 | Impervious |
| | 16,453 | 94 | Weighted Average |
| | 2,946 | | 17.91% Pervious Area |
| | 13,507 | | 82.09% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1I: PR. WATERSHED**






**Summary for Subcatchment P-2A: PR. WATERSHED**

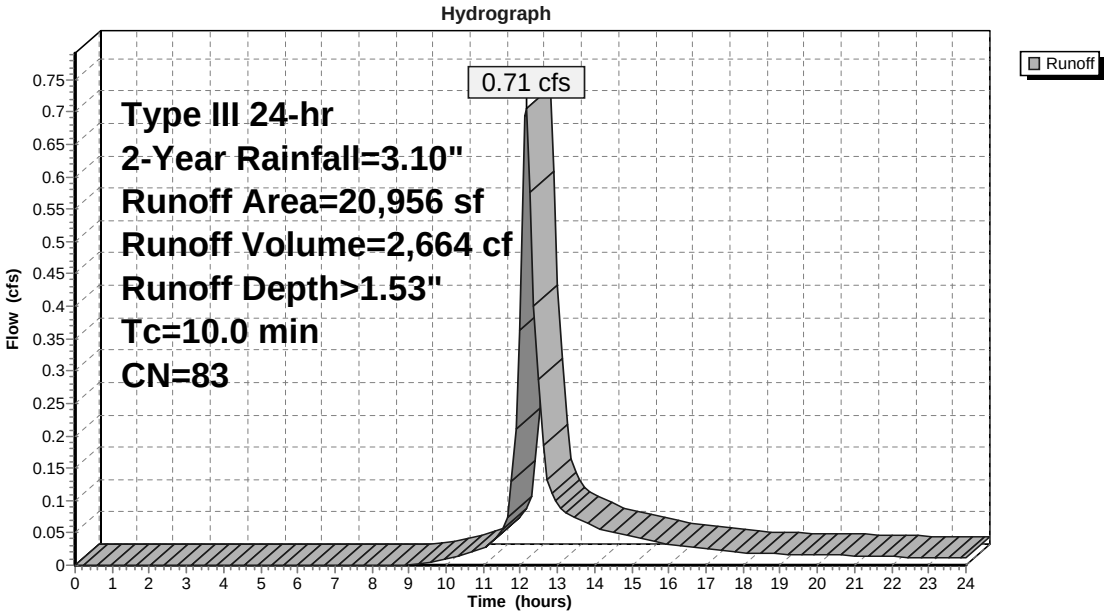
Runoff = 0.71 cfs @ 12.15 hrs, Volume= 2,664 cf, Depth> 1.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 12,753 | 74 | >75% Grass cover, Good, HSG C |
| * | 8,203 | 98 | Impervious |
| | 20,956 | 83 | Weighted Average |
| | 12,753 | | 60.86% Pervious Area |
| | 8,203 | | 39.14% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-2A: PR. WATERSHED**






**Summary for Subcatchment P-2B: PR. WATERSHED**

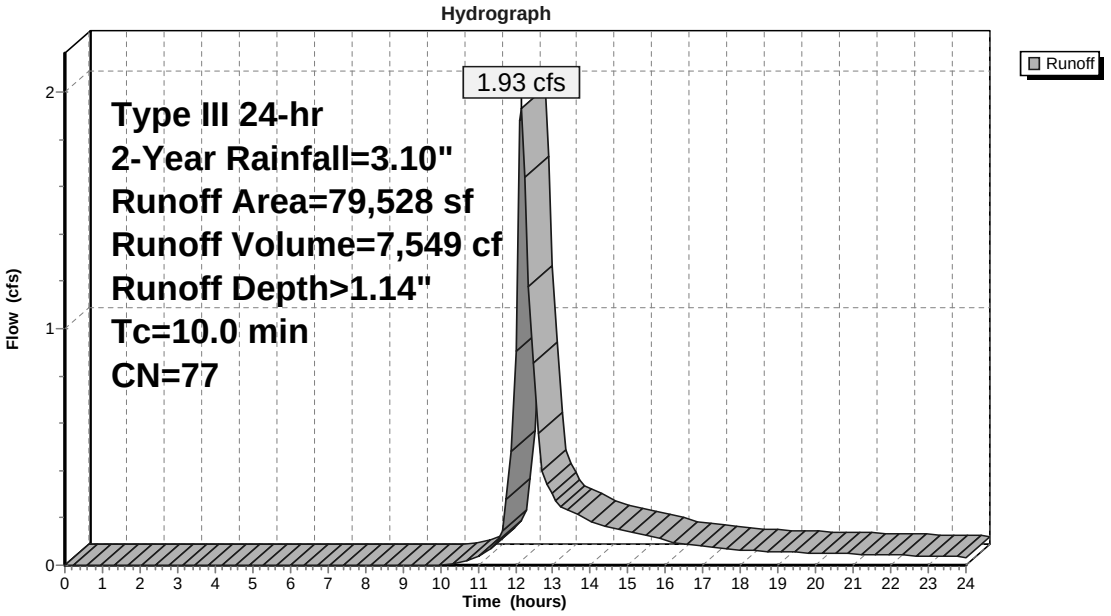
Runoff = 1.93 cfs @ 12.16 hrs, Volume= 7,549 cf, Depth> 1.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 69,830 | 74 | >75% Grass cover, Good, HSG C |
| * | 9,698 | 98 | Impervious |
| | 79,528 | 77 | Weighted Average |
| | 69,830 | | 87.81% Pervious Area |
| | 9,698 | | 12.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-2B: PR. WATERSHED**






**Summary for Subcatchment P-3: PR. WATERSHED**

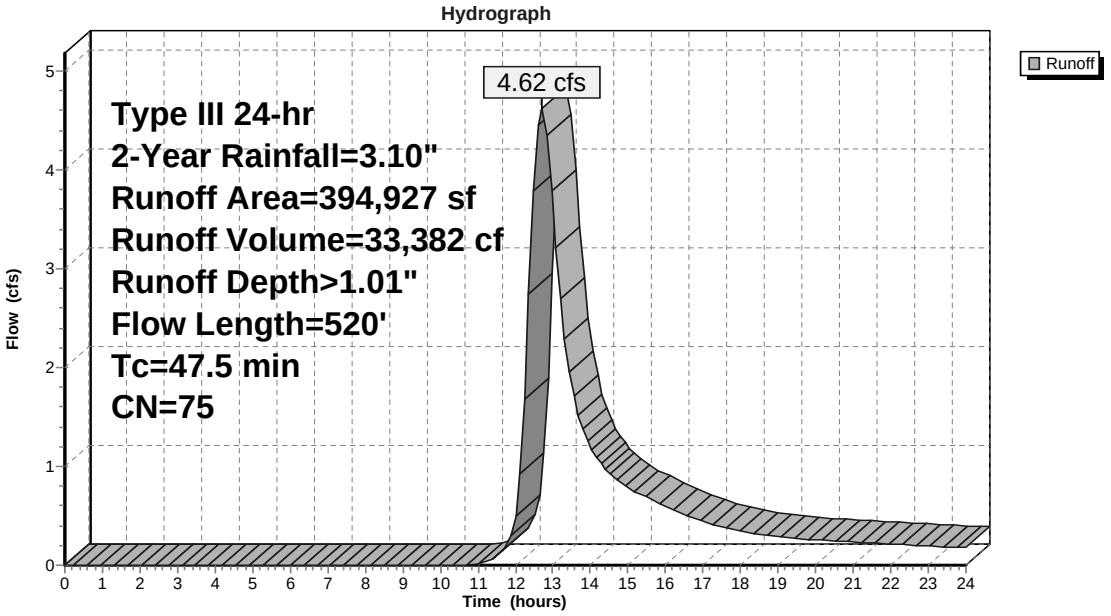
Runoff = 4.62 cfs @ 12.70 hrs, Volume= 33,382 cf, Depth> 1.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 237,023 | 77 | Woods, Good, HSG D |
| * | 9,383 | 98 | Impervious |
| | 148,521 | 70 | Woods, Good, HSG C |
| | 394,927 | 75 | Weighted Average |
| | 385,544 | | 97.62% Pervious Area |
| | 9,383 | | 2.38% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 28.3 | 100 | 0.0100 | 0.06 | | **Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.3 | 40 | 0.0100 | 0.50 | | **Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps |
| 17.9 | 380 | 0.0050 | 0.35 | | **Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps |
| 47.5 | 520 | Total | | | |

**Subcatchment P-3: PR. WATERSHED**






**Summary for Subcatchment R-1F: BUILDING #3 ROOF**

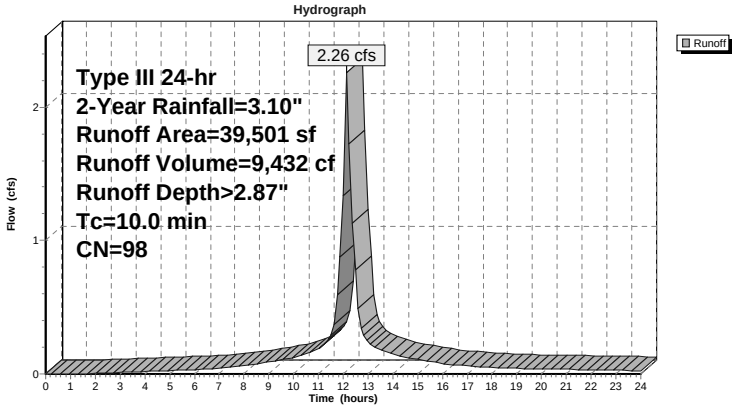
Runoff = 2.26 cfs @ 12.14 hrs, Volume= 9,432 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 39,501 | 98 | Roof |
| | 39,501 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment R-1F: BUILDING #3 ROOF**



### Summary for Subcatchment R-1H: BUILDING #3 ROOF

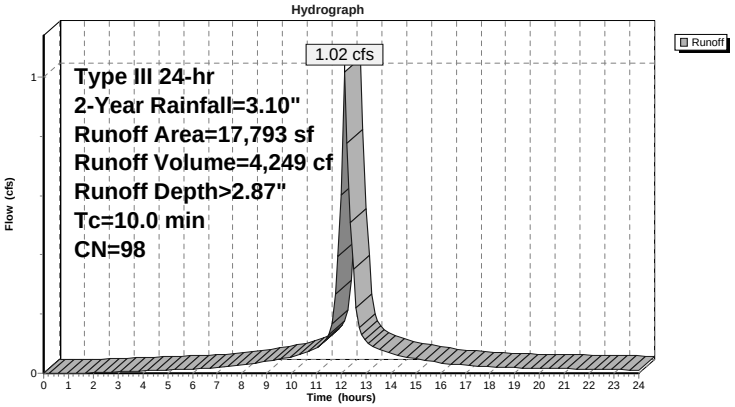
Runoff = 1.02 cfs @ 12.14 hrs, Volume= 4,249 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 17,793 | 98 | Roof |
| | 17,793 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-1H: BUILDING #3 ROOF






### Summary for Subcatchment R-1I: BUILDING #3 ROOF

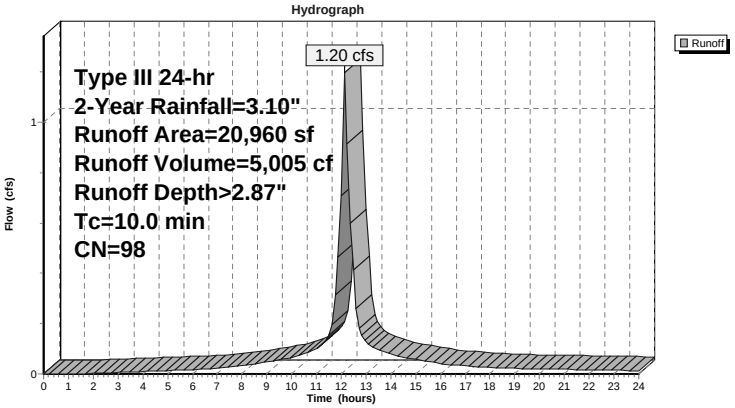
Runoff = 1.20 cfs @ 12.14 hrs, Volume= 5,005 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 20,960 | 98 | Roof |
| | 20,960 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-1I: BUILDING #3 ROOF



### Summary for Subcatchment R-2A: BUILDING #1 ROOF

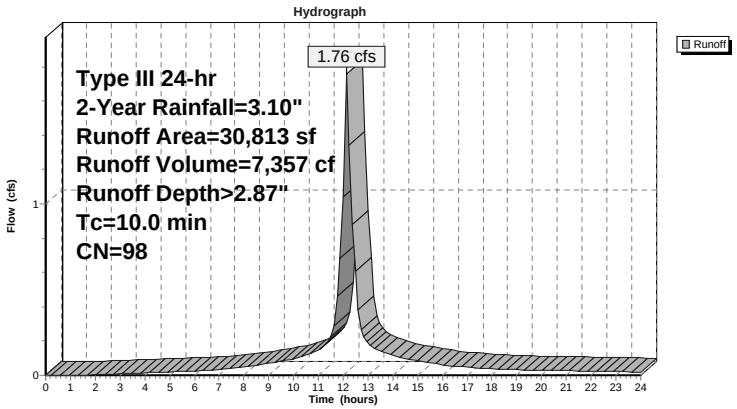
Runoff = 1.76 cfs @ 12.14 hrs, Volume= 7,357 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 30,813 | 98 | Roof |
| | 30,813 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-2A: BUILDING #1 ROOF






### Summary for Subcatchment R-2B: BUILDING #2 ROOF

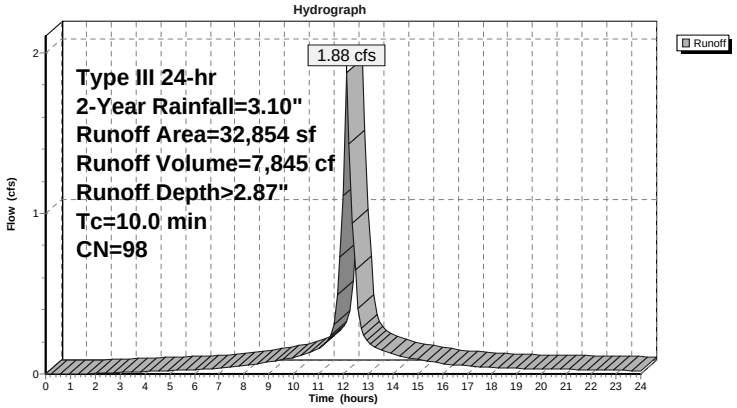
Runoff = 1.88 cfs @ 12.14 hrs, Volume= 7,845 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 32,854 | 98 | Roof |
| | 32,854 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-2B: BUILDING #2 ROOF



### Summary for Subcatchment R-2C: BUILDING #3 ROOF

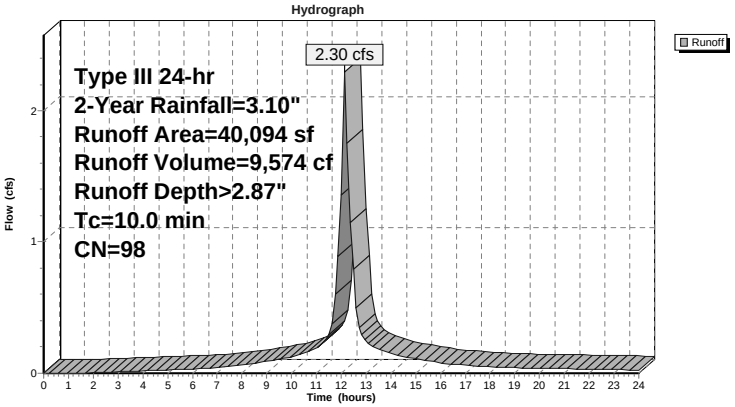
Runoff = 2.30 cfs @ 12.14 hrs, Volume= 9,574 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 40,094 | 98 | Roof |
| | 40,094 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-2C: BUILDING #3 ROOF






### Summary for Subcatchment W-1: Wetlands

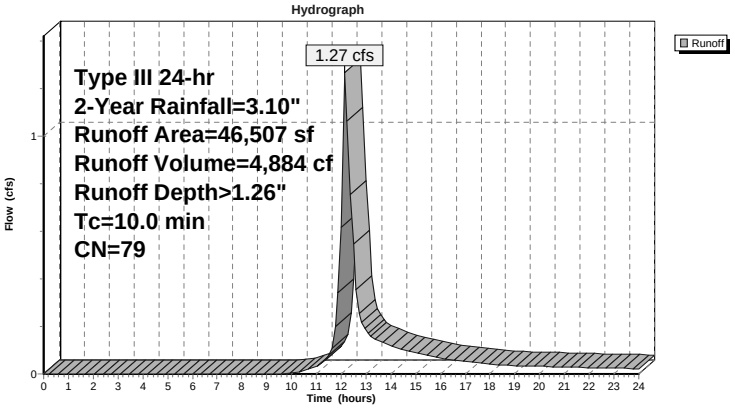
Runoff = 1.27 cfs @ 12.15 hrs, Volume= 4,884 cf, Depth> 1.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (sf) | CN | Description |
|---|---|---|
| 46,507 | 79 | Woods/grass comb., Good, HSG D |
| 46,507 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment W-1: Wetlands



## Summary for Pond ES: Offsite Swale to South Culvert

Inflow Area = 445,223 sf, 56.84% Impervious, Inflow Depth > 1.52" for 2-Year event
Inflow = 9.40 cfs @ 12.42 hrs, Volume= 56,337 cf
Outflow = 1.42 cfs @ 14.47 hrs, Volume= 30,847 cf, Atten= 85%, Lag= 122.9 min
Primary = 1.42 cfs @ 14.47 hrs, Volume= 30,847 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 80.29' @ 14.47 hrs Surf.Area= 35,977 sf Storage= 30,804 cf

Plug-Flow detention time= 277.8 min calculated for 30,847 cf (55% of inflow)
Center-of-Mass det. time= 157.2 min ( 1,030.3 - 873.2 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 79.00' | 136,108 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

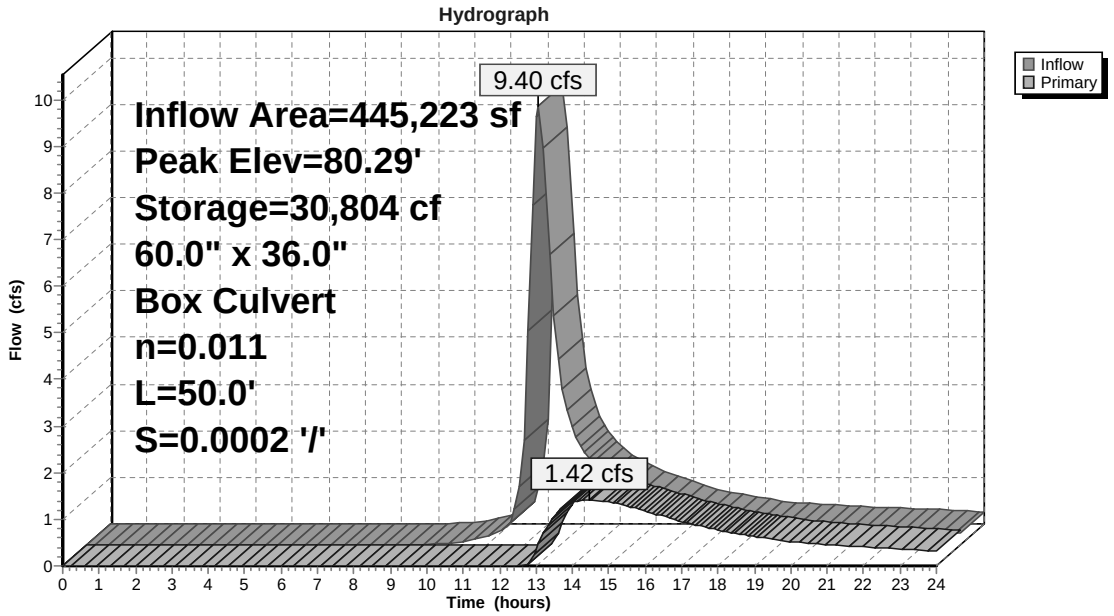
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 79.00 | 17,000 | 1,200.0 | 0 | 0 | 17,000 |
| 80.00 | 27,000 | 4,000.0 | 21,808 | 21,808 | 1,175,651 |
| 81.00 | 63,900 | 4,200.0 | 44,146 | 65,954 | 1,306,222 |
| 82.00 | 76,600 | 4,250.0 | 70,154 | 136,108 | 1,340,108 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.00' | **60.0" W x 36.0" H Box Culvert** L= 50.0' Box, headwall w/3 square edges, Ke= 0.500<br>Inlet / Outlet Invert= 80.00' / 79.99' S= 0.0002 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 15.00 sf |

**Primary OutFlow** Max=1.41 cfs @ 14.47 hrs HW=80.29' TW=0.00' (Dynamic Tailwater)
**1=Culvert** (Barrel Controls 1.41 cfs @ 1.32 fps)



## Pond ES: Offsite Swale to South Culvert



### Summary for Pond EW: Wetland to East Culvert

Inflow Area = 394,927 sf, 2.38% Impervious, Inflow Depth > 1.01" for 2-Year event
Inflow = 4.62 cfs @ 12.70 hrs, Volume= 33,382 cf
Outflow = 0.08 cfs @ 24.00 hrs, Volume= 1,592 cf, Atten= 98%, Lag= 677.7 min
Primary = 0.08 cfs @ 24.00 hrs, Volume= 1,592 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 80.45' @ 24.00 hrs Surf.Area= 89,808 sf Storage= 31,769 cf

Plug-Flow detention time= 517.2 min calculated for 1,592 cf (5% of inflow)
Center-of-Mass det. time= 347.8 min ( 1,240.0 - 892.2 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 290,435 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

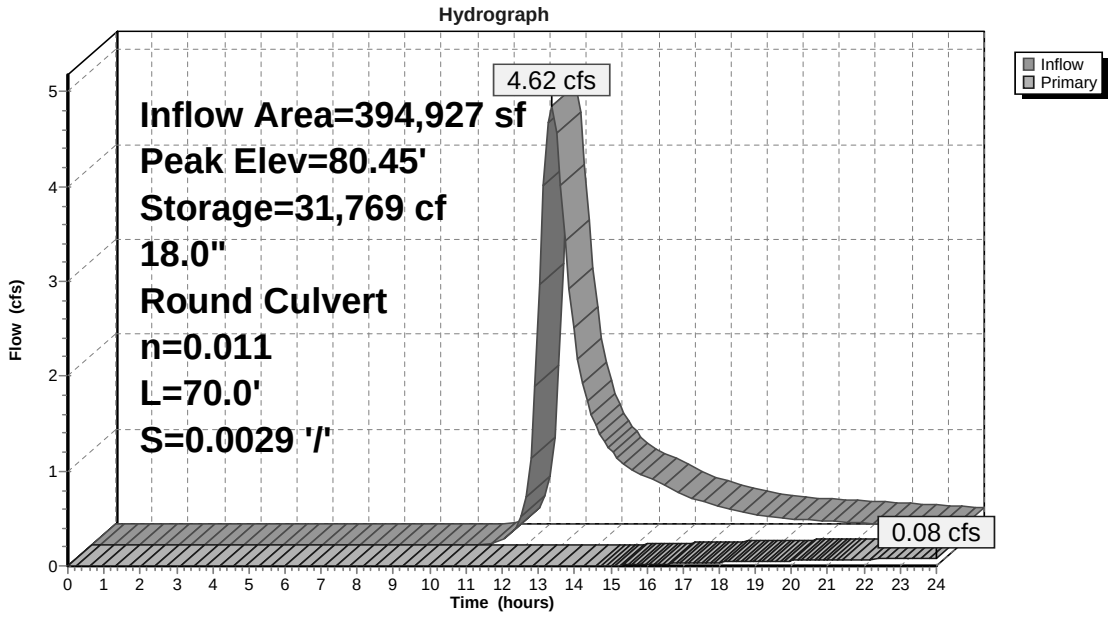
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 52,000 | 1,200.0 | 0 | 0 | 52,000 |
| 81.00 | 149,000 | 2,600.0 | 96,341 | 96,341 | 475,356 |
| 82.00 | 243,000 | 4,300.0 | 194,094 | 290,435 | 1,408,807 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.30' | **18.0" Round Culvert** L= 70.0' RCP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 80.30' / 80.10' S= 0.0029 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.08 cfs @ 24.00 hrs HW=80.45' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 0.08 cfs @ 1.27 fps)



### Pond EW: Wetland to East Culvert



### Summary for Pond OFFSITE: OFFSITE PONDING AREA IN GRASS

Inflow = 0.70 cfs @ 12.98 hrs, Volume= 9,440 cf
Outflow = 0.61 cfs @ 13.38 hrs, Volume= 9,181 cf, Atten= 12%, Lag= 24.0 min
Primary = 0.61 cfs @ 13.38 hrs, Volume= 9,181 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 82.52' @ 13.38 hrs Surf.Area= 3,373 sf Storage= 753 cf

Plug-Flow detention time= 28.8 min calculated for 9,135 cf (97% of inflow)
Center-of-Mass det. time= 16.2 min ( 982.9 - 966.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.10' | 3,254 cf | **OFFSITE PONDING AREA (Prismatic)** Listed below (Recalc) |

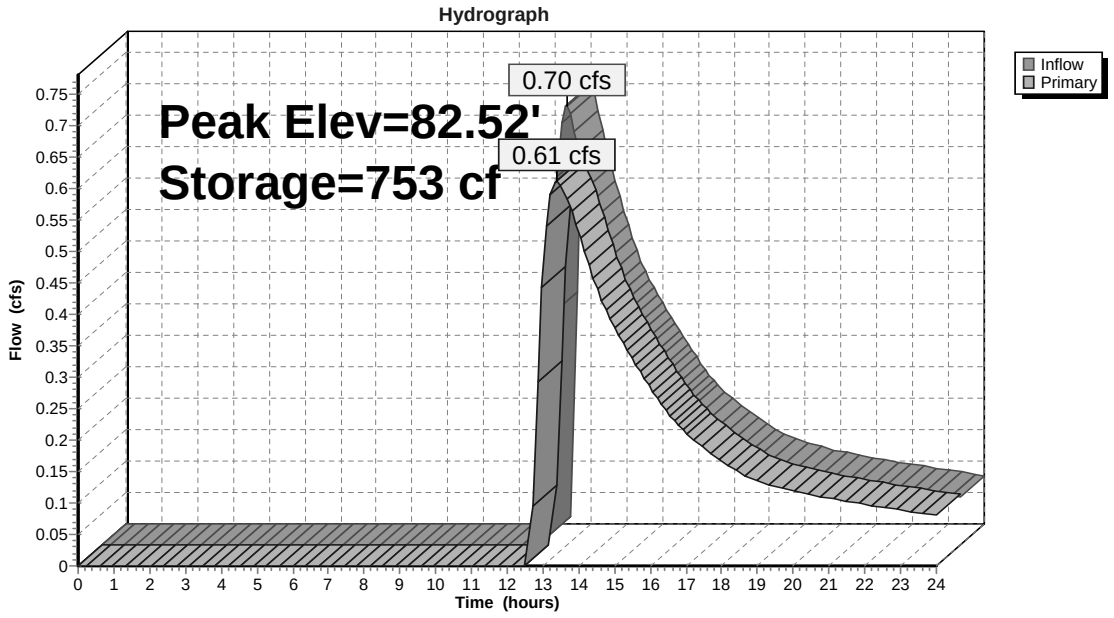
| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 82.10 | 230 | 0 | 0 |
| 83.00 | 7,000 | 3,254 | 3,254 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.27' | **8.0" Round (3) 8" HDPE X 3.00 w/ 2.0" inside fill** L= 21.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 82.10' / 81.40' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.28 sf |
| #2 | Primary | 82.60' | **30.0' long x 10.0' breadth WEIR FLOW OVER WALKING PATH**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64 |

**Primary OutFlow** Max=0.61 cfs @ 13.38 hrs HW=82.52' TW=0.00' (Dynamic Tailwater)
└─**1=(3) 8" HDPE** (Inlet Controls 0.61 cfs @ 1.26 fps)
└─**2=WEIR FLOW OVER WALKING PATH** ( Controls 0.00 cfs)



### Pond OFFSITE: OFFSITE PONDING AREA IN GRASS



### Summary for Pond P1C: BIO.RET. #1

Inflow Area = 48,537 sf, 83.20% Impervious, Inflow Depth > 2.53" for 2-Year event
Inflow = 2.47 cfs @ 12.14 hrs, Volume= 10,246 cf
Outflow = 1.84 cfs @ 12.16 hrs, Volume= 7,694 cf, Atten= 26%, Lag= 1.4 min
Primary = 1.84 cfs @ 12.16 hrs, Volume= 7,694 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 86.68' @ 12.29 hrs Surf.Area= 5,373 sf Storage= 3,463 cf
Flood Elev= 86.50' Surf.Area= 5,219 sf Storage= 2,505 cf

Plug-Flow detention time= 159.4 min calculated for 7,656 cf (75% of inflow)
Center-of-Mass det. time= 76.3 min ( 844.5 - 768.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 86.00' | 8,156 cf | **BIORETENTION #1 (Irregular)** Listed below (Recalc) |

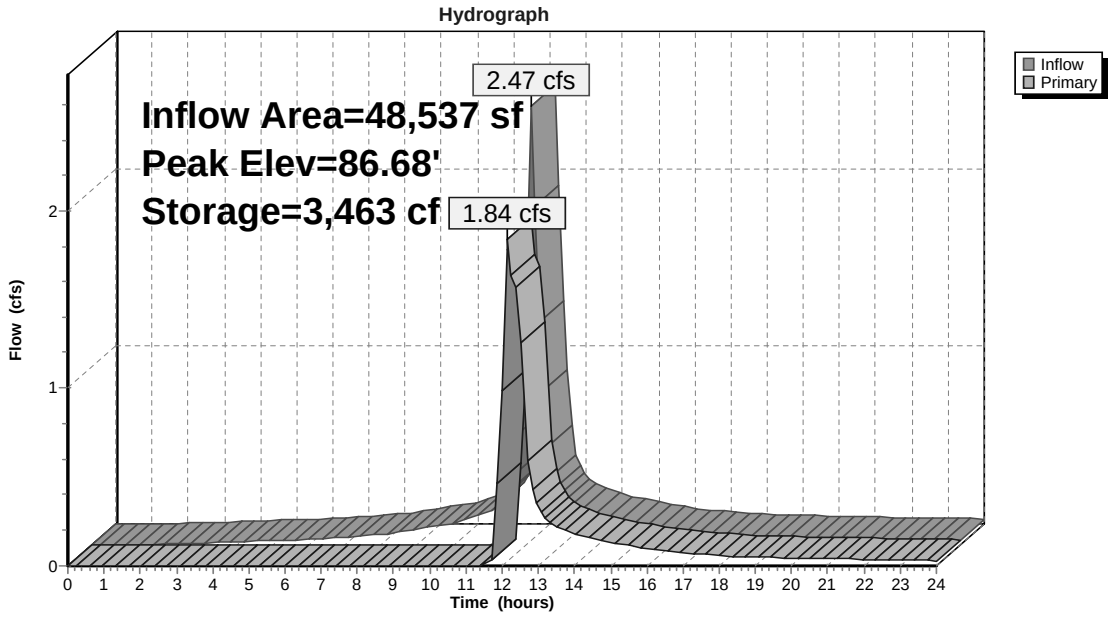
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 86.00 | 4,804 | 272.0 | 0 | 0 | 4,804 |
| 86.50 | 5,219 | 282.0 | 2,505 | 2,505 | 5,266 |
| 87.00 | 5,649 | 291.0 | 2,716 | 5,221 | 5,701 |
| 87.50 | 6,093 | 301.0 | 2,935 | 8,156 | 6,195 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 83.97' | **6.0" Round (2) 6" HDPE X 2.00** L= 56.0' CPP, mitered to conform to fill, Ke= 0.700<br>Inlet / Outlet Invert= 83.97' / 83.83' S= 0.0025 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf |
| #2 | Device 1 | 86.50' | **8.0" Horiz. (5) 8" OVERFLOW X 5.00** C= 0.600 Limited to weir flow at low heads |

**Primary OutFlow** Max=1.81 cfs @ 12.16 hrs HW=86.65' TW=84.84' (Dynamic Tailwater)
↑└─**1=(2) 6" HDPE** (Outlet Controls 1.81 cfs @ 4.62 fps)
↑└─**2=(5) 8" OVERFLOW** (Passes 1.81 cfs of 2.04 cfs potential flow)



### Pond P1C: BIO.RET. #1



## Summary for Pond P1D: BIO.RET. #2

Inflow Area = 29,104 sf, 64.43% Impervious, Inflow Depth > 2.17" for 2-Year event
Inflow = 1.28 cfs @ 12.14 hrs, Volume= 5,268 cf
Outflow = 1.14 cfs @ 12.22 hrs, Volume= 4,103 cf, Atten= 10%, Lag= 4.7 min
Primary = 1.14 cfs @ 12.22 hrs, Volume= 4,103 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 86.62' @ 12.22 hrs Surf.Area= 2,800 sf Storage= 1,473 cf
Flood Elev= 86.50' Surf.Area= 2,628 sf Storage= 1,146 cf

Plug-Flow detention time= 146.2 min calculated for 4,082 cf (77% of inflow)
Center-of-Mass det. time= 66.7 min ( 846.2 - 779.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 86.00' | 1,686 cf | **BIORETENTION (Irregular)** Listed below (Recalc) |
| #2 | 86.00' | 2,826 cf | **BIORETENTION (Irregular)** Listed below (Recalc) |
| | | 4,512 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 86.00 | 688 | 169.0 | 0 | 0 | 688 |
| 87.00 | 1,281 | 203.0 | 969 | 969 | 1,712 |
| 87.50 | 1,592 | 212.0 | 717 | 1,686 | 2,026 |

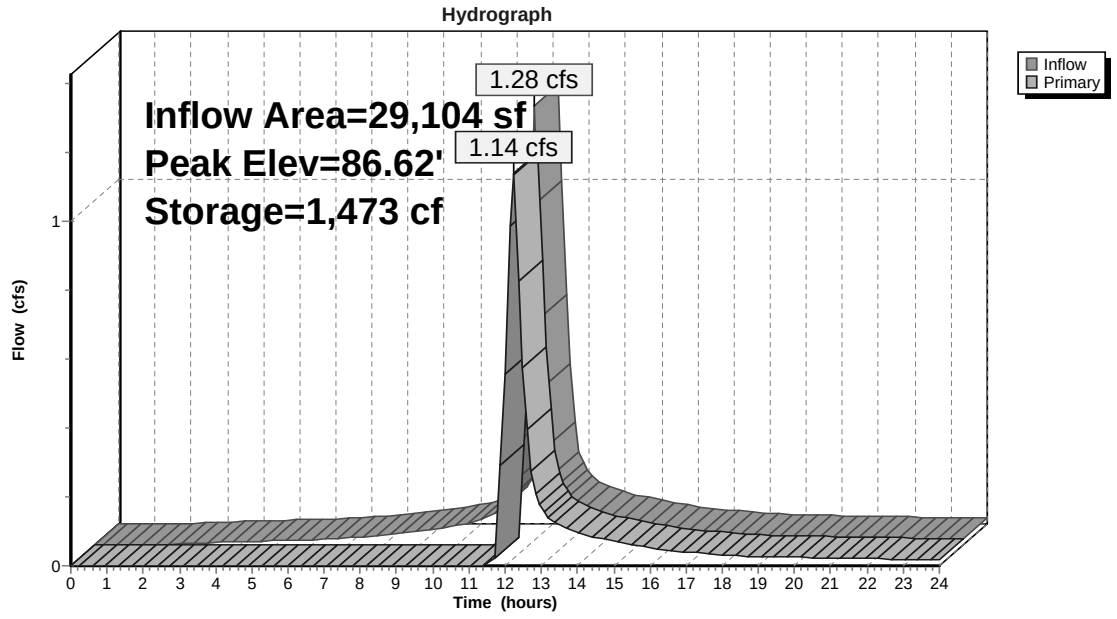
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 86.00 | 1,285 | 193.0 | 0 | 0 | 1,285 |
| 87.00 | 2,098 | 271.0 | 1,675 | 1,675 | 4,174 |
| 87.50 | 2,512 | 280.0 | 1,151 | 2,826 | 4,592 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 83.97' | **6.0" Round (2) 6" HDPE X 2.00** L= 54.0' CPP, mitered to conform to fill, Ke= 0.700<br>Inlet / Outlet Invert= 83.97' / 83.83' S= 0.0026 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf |
| #2 | Device 1 | 86.50' | **8.0" Horiz. (4) 8" OVERFLOW X 4.00** C= 0.600 Limited to weir flow at low heads |



**Primary OutFlow** Max=1.11 cfs @ 12.22 hrs HW=86.62' TW=85.09' (Dynamic Tailwater)
↑1=(2) 6" HDPE (Passes 1.11 cfs of 1.68 cfs potential flow)
↑2=(4) 8" OVERFLOW (Weir Controls 1.11 cfs @ 1.12 fps)

### Pond P1D: BIO.RET. #2



## Summary for Pond P1E: Wet Basin #1

Inflow Area = 27,809 sf, 47.05% Impervious, Inflow Depth > 1.67" for 2-Year event
Inflow = 1.03 cfs @ 12.15 hrs, Volume= 3,871 cf
Outflow = 0.92 cfs @ 12.23 hrs, Volume= 3,853 cf, Atten= 10%, Lag= 5.1 min
Primary = 0.92 cfs @ 12.23 hrs, Volume= 3,853 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Starting Elev= 81.50' Surf.Area= 3,408 sf Storage= 3,980 cf
Peak Elev= 81.58' @ 12.23 hrs Surf.Area= 3,495 sf Storage= 4,267 cf (287 cf above start)
Flood Elev= 81.50' Surf.Area= 3,408 sf Storage= 3,980 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 7.3 min ( 837.7 - 830.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 7,924 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

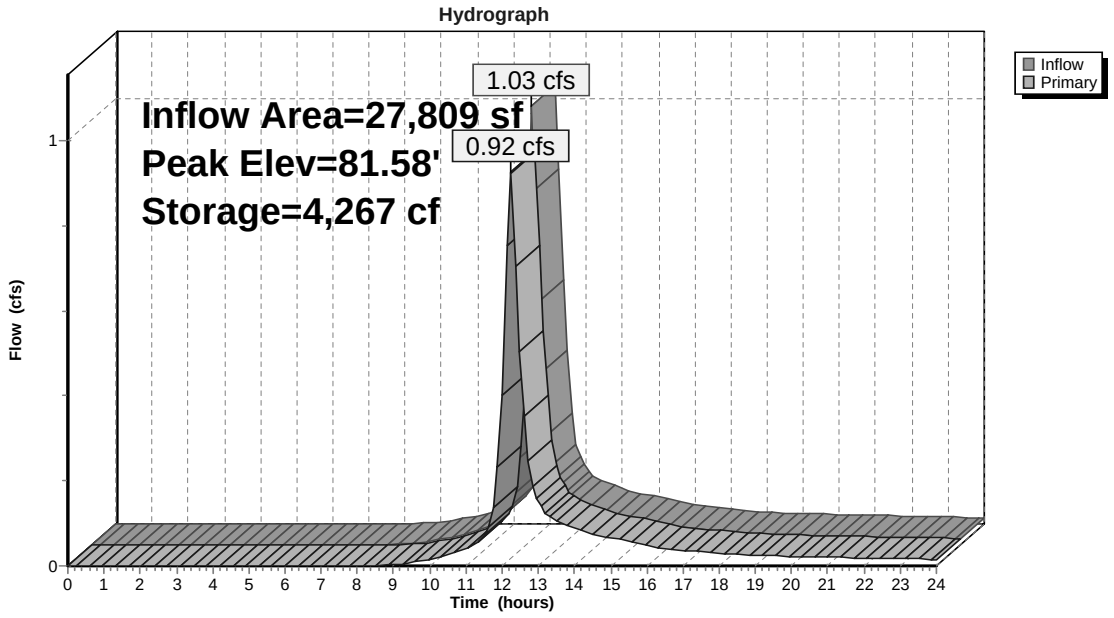
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 1,930 | 299.0 | 0 | 0 | 1,930 |
| 81.00 | 2,909 | 337.0 | 2,403 | 2,403 | 3,879 |
| 82.00 | 3,947 | 355.0 | 3,415 | 5,818 | 4,929 |
| 82.50 | 4,486 | 364.0 | 2,107 | 7,924 | 5,475 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 81.50' | **15.0' long x 12.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64 |

**Primary OutFlow** Max=0.91 cfs @ 12.23 hrs HW=81.58' TW=79.35' (Dynamic Tailwater)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 0.91 cfs @ 0.74 fps)



## Pond P1E: Wet Basin #1



## Summary for Pond P1F: Wet Basin #2

Inflow Area = 320,630 sf, 68.86% Impervious, Inflow Depth > 1.18" for 2-Year event
Inflow = 6.16 cfs @ 12.35 hrs, Volume= 31,507 cf
Outflow = 5.86 cfs @ 12.43 hrs, Volume= 31,337 cf, Atten= 5%, Lag= 4.6 min
Primary = 5.86 cfs @ 12.43 hrs, Volume= 31,337 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Starting Elev= 81.50' Surf.Area= 10,650 sf Storage= 10,212 cf
Peak Elev= 81.68' @ 12.43 hrs Surf.Area= 11,858 sf Storage= 12,277 cf (2,065 cf above start)
Flood Elev= 81.50' Surf.Area= 10,650 sf Storage= 10,212 cf

Plug-Flow detention time= 177.1 min calculated for 21,021 cf (67% of inflow)
Center-of-Mass det. time= 7.2 min ( 873.7 - 866.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 24,130 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

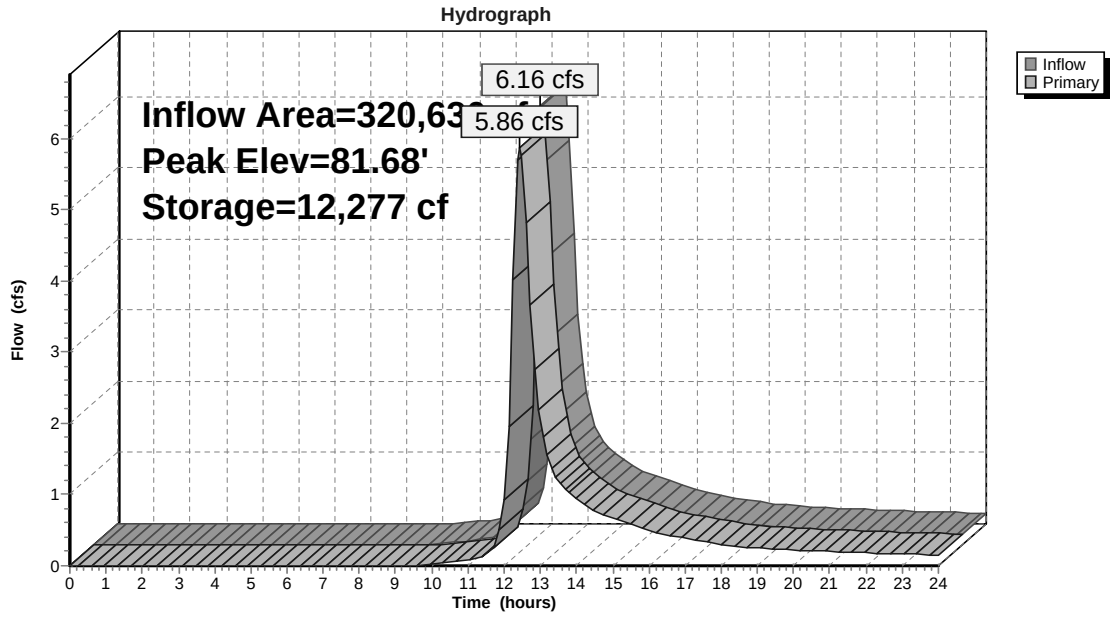
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 3,826 | 408.0 | 0 | 0 | 3,826 |
| 81.00 | 7,690 | 1,455.0 | 5,647 | 5,647 | 159,050 |
| 82.00 | 14,091 | 2,271.0 | 10,730 | 16,377 | 401,005 |
| 82.50 | 16,964 | 2,177.0 | 7,753 | 24,130 | 434,296 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 81.50' | **15.0' long x 7.0' breadth Broad-Crested Rectangular Weir**<br>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<br>Coef. (English) 2.40 2.52 2.70 2.68 2.68 2.67 2.66 2.65 2.65 2.65 2.66 2.65 2.66 2.68 2.70 2.73 2.78 |
| #2 | Primary | 81.50' | **15.0' long x 12.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64 |



**Primary OutFlow** Max=5.74 cfs @ 12.43 hrs HW=81.68' TW=79.62' (Dynamic Tailwater)
**1=Broad-Crested Rectangular Weir** (Weir Controls 2.77 cfs @ 1.02 fps)
**2=Broad-Crested Rectangular Weir** (Weir Controls 2.97 cfs @ 1.09 fps)

### Pond P1F: Wet Basin #2



## Summary for Pond P1G: Wet Basin #3

Inflow Area = 50,277 sf, 38.16% Impervious, Inflow Depth > 3.94" for 2-Year event
Inflow = 3.20 cfs @ 12.29 hrs, Volume= 16,524 cf
Outflow = 2.38 cfs @ 12.53 hrs, Volume= 16,262 cf, Atten= 25%, Lag= 14.3 min
Primary = 2.38 cfs @ 12.53 hrs, Volume= 16,262 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Starting Elev= 81.50' Surf.Area= 7,082 sf Storage= 6,991 cf
Peak Elev= 81.83' @ 12.53 hrs Surf.Area= 8,409 sf Storage= 9,579 cf (2,588 cf above start)
Flood Elev= 81.50' Surf.Area= 7,082 sf Storage= 6,991 cf

Plug-Flow detention time= 244.0 min calculated for 9,271 cf (56% of inflow)
Center-of-Mass det. time= 20.5 min ( 887.4 - 866.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 16,095 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

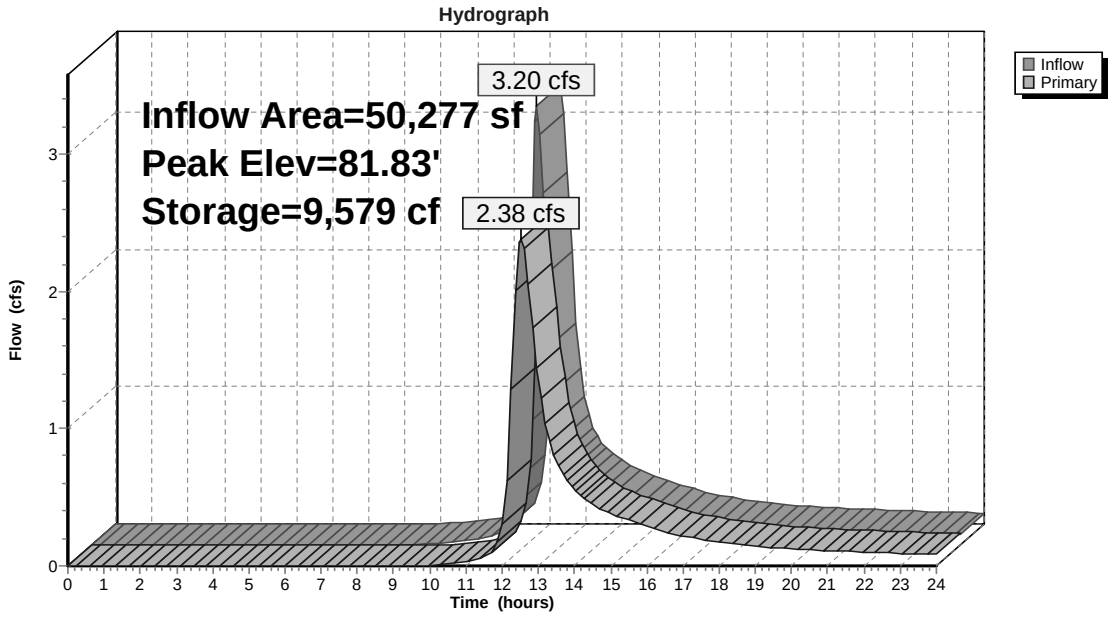
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 2,647 | 420.0 | 0 | 0 | 2,647 |
| 81.00 | 5,312 | 1,188.0 | 3,903 | 3,903 | 100,924 |
| 82.00 | 9,107 | 1,389.0 | 7,125 | 11,028 | 142,163 |
| 82.50 | 11,198 | 1,400.0 | 5,067 | 16,095 | 144,702 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 81.50' | **5.0' long x 6.0' breadth Broad-Crested Rectangular Weir**<br>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<br>Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83 |

**Primary OutFlow** Max=2.34 cfs @ 12.53 hrs HW=81.83' TW=79.76' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Weir Controls 2.34 cfs @ 1.41 fps)



## Pond P1G: Wet Basin #3



## Summary for Pond P2: SURFACE BASINS

Inflow Area = 183,289 sf, 61.90% Impervious, Inflow Depth > 2.12" for 2-Year event
Inflow = 7.86 cfs @ 12.14 hrs, Volume= 32,325 cf
Outflow = 0.97 cfs @ 12.98 hrs, Volume= 13,123 cf, Atten= 88%, Lag= 50.6 min
Primary = 0.27 cfs @ 12.98 hrs, Volume= 3,684 cf
Secondary = 0.70 cfs @ 12.98 hrs, Volume= 9,440 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 84.57' @ 12.98 hrs Surf.Area= 23,007 sf Storage= 20,490 cf
Flood Elev= 84.50' Surf.Area= 22,488 sf Storage= 18,822 cf

Plug-Flow detention time= 325.9 min calculated for 13,123 cf (41% of inflow)
Center-of-Mass det. time= 183.9 min ( 966.6 - 782.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 83.50' | 44,950 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 83.50 | 15,229 | 2,415.0 | 0 | 0 | 15,229 |
| 84.00 | 18,845 | 2,424.0 | 8,502 | 8,502 | 18,900 |
| 84.50 | 22,488 | 2,434.0 | 10,320 | 18,822 | 22,952 |
| 85.00 | 26,145 | 2,443.0 | 12,147 | 30,969 | 26,651 |
| 85.50 | 29,817 | 2,452.0 | 13,980 | 44,950 | 30,365 |

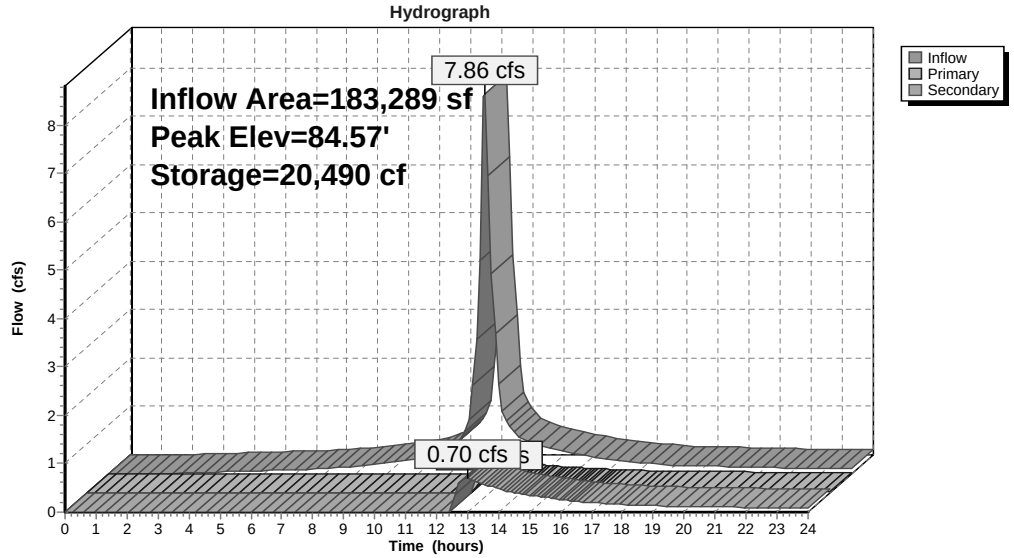
| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.40' | **6.0" Round (2) 6" PVC X 2.00** L= 140.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 82.40' / 81.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.010 PVC, smooth interior, Flow Area= 0.20 sf |
| #2 | Device 1 | 84.50' | **8.0" Horiz. (2) 8" OVERFLOW X 2.00** C= 0.600 Limited to weir flow at low heads |
| #3 | Secondary | 84.50' | **15.0' long x 5.0' breadth RIP-RAP OVERFLOW**<br>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<br>Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88 |



**Primary OutFlow** Max=0.27 cfs @ 12.98 hrs HW=84.57' TW=0.00' (Dynamic Tailwater)
└─**1=(2) 6" PVC** (Passes 0.27 cfs of 1.95 cfs potential flow)
└─**2=(2) 8" OVERFLOW** (Weir Controls 0.27 cfs @ 0.88 fps)

**Secondary OutFlow** Max=0.69 cfs @ 12.98 hrs HW=84.57' TW=82.48' (Dynamic Tailwater)
└─**3=RIP-RAP OVERFLOW** (Weir Controls 0.69 cfs @ 0.63 fps)

## Pond P2: SURFACE BASINS



## Summary for Pond UIS1: UNDERGROUND CHAMBERS #1

Inflow Area = 195,437 sf, 79.34% Impervious, Inflow Depth > 2.20" for 2-Year event
Inflow = 9.03 cfs @ 12.15 hrs, Volume= 35,792 cf
Outflow = 5.87 cfs @ 12.38 hrs, Volume= 26,250 cf, Atten= 35%, Lag= 13.9 min
Primary = 3.84 cfs @ 12.38 hrs, Volume= 16,117 cf
Secondary = 2.04 cfs @ 12.38 hrs, Volume= 10,133 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 85.32' @ 12.38 hrs Surf.Area= 10,861 sf Storage= 13,440 cf
Flood Elev= 84.36' Surf.Area= 10,861 sf Storage= 8,753 cf

Plug-Flow detention time= 156.4 min calculated for 26,250 cf (73% of inflow)
Center-of-Mass det. time= 69.7 min ( 878.6 - 809.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1B | 83.00' | 5,546 cf | **8.17'W x 928.80'L x 2.33'H Field B**<br>17,699 cf Overall - 3,833 cf Embedded = 13,866 cf x 40.0% Voids |
| #2B | 83.50' | 3,833 cf | **ADS_StormTech SC-310 +Cap** x 260 Inside #1<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>260 Chambers in 2 Rows |
| #3C | 83.00' | 1,094 cf | **14.83'W x 102.88'L x 2.33'H Field C**<br>3,561 cf Overall - 826 cf Embedded = 2,735 cf x 40.0% Voids |
| #4C | 83.50' | 826 cf | **ADS_StormTech SC-310 +Cap** x 56 Inside #3<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>56 Chambers in 4 Rows |
| #5D | 83.00' | 1,244 cf | **14.83'W x 117.12'L x 2.33'H Field D**<br>4,054 cf Overall - 943 cf Embedded = 3,110 cf x 40.0% Voids |
| #6D | 83.50' | 943 cf | **ADS_StormTech SC-310 +Cap** x 64 Inside #5<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>64 Chambers in 4 Rows |
| #7 | 83.50' | 50 cf | **4.00'D x 4.00'H DMH** |
| | | 13,537 cf | Total Available Storage |



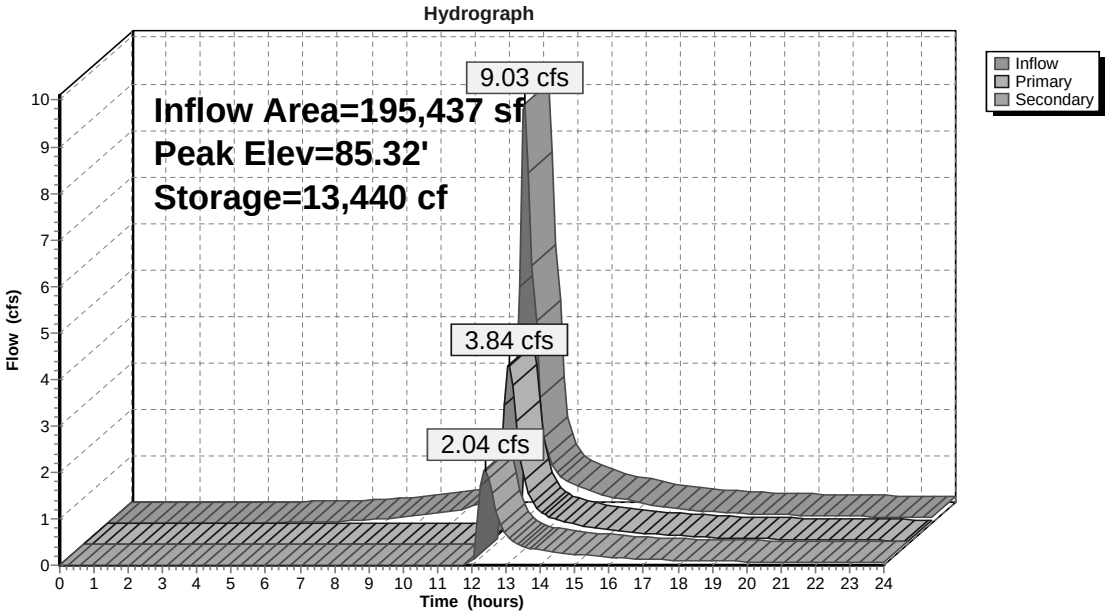
Storage Group B created with Chamber Wizard
Storage Group C created with Chamber Wizard
Storage Group D created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 84.36' | **24.0" Round 24" HDPE AT DMH12** L= 27.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 84.36' / 84.09' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 3.14 sf |
| #2 | Secondary | 84.36' | **12.0" Round 12" HDPE AT DMH8** L= 26.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 84.36' / 84.10' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=3.75 cfs @ 12.38 hrs HW=85.30' TW=81.68' (Dynamic Tailwater)
↑**1=24" HDPE AT DMH12** (Barrel Controls 3.75 cfs @ 3.77 fps)

**Secondary OutFlow** Max=2.00 cfs @ 12.38 hrs HW=85.30' TW=81.81' (Dynamic Tailwater)
↑**2=12" HDPE AT DMH8** (Inlet Controls 2.00 cfs @ 2.61 fps)

**Pond UIS1: UNDERGROUND CHAMBERS #1**






**Summary for Pond UIS2: UNDERGROUND CHAMBERS #2**

Inflow Area = 37,413 sf, 92.13% Impervious, Inflow Depth > 2.68" for 2-Year event
Inflow = 2.06 cfs @ 12.14 hrs, Volume= 8,356 cf
Outflow = 0.80 cfs @ 12.48 hrs, Volume= 4,560 cf, Atten= 61%, Lag= 20.3 min
Primary = 0.80 cfs @ 12.48 hrs, Volume= 4,560 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 84.82' @ 12.47 hrs Surf.Area= 4,282 sf Storage= 4,606 cf
Flood Elev= 84.36' Surf.Area= 4,282 sf Storage= 3,589 cf

Plug-Flow detention time= 242.1 min calculated for 4,560 cf (55% of inflow)
Center-of-Mass det. time= 130.5 min ( 903.1 - 772.6 )

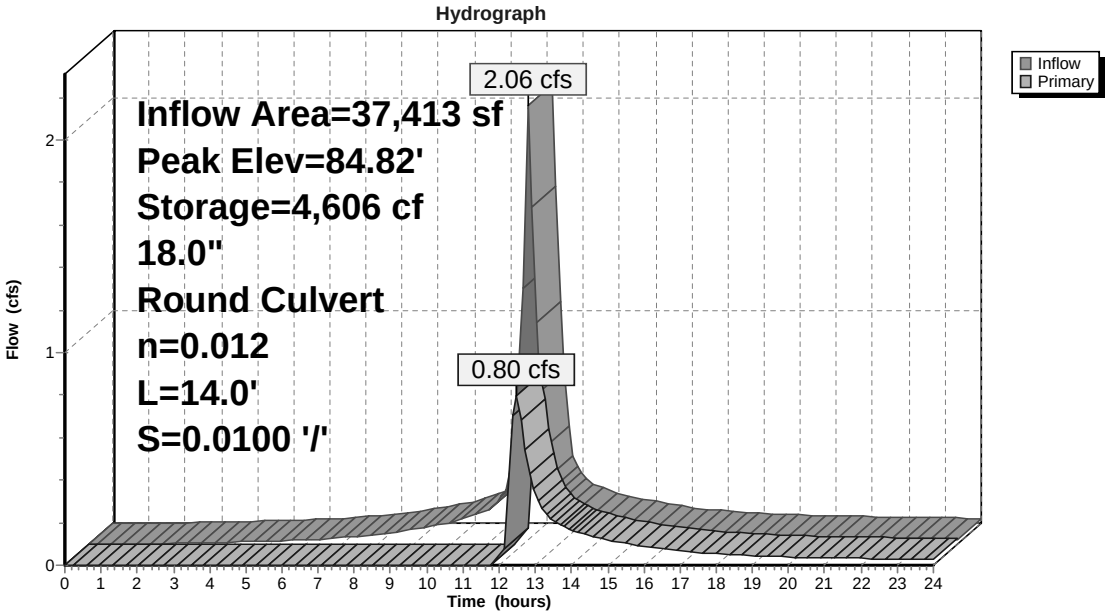
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 83.00' | 2,994 cf | **48.17'W x 88.64'L x 2.33'H Field A**<br>9,962 cf Overall - 2,477 cf Embedded = 7,486 cf x 40.0% Voids |
| #2A | 83.50' | 2,477 cf | **ADS_StormTech SC-310 +Cap** x 168 Inside #1<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>168 Chambers in 14 Rows |
| #3 | 83.50' | 50 cf | **4.00'D x 4.00'H DMH** |
| | | 5,521 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 84.36' | **18.0" Round 18" HDPE AT DMH3** L= 14.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 84.36' / 84.22' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.79 cfs @ 12.48 hrs HW=84.82' TW=81.68' (Dynamic Tailwater)
↑**1=18" HDPE AT DMH3** (Barrel Controls 0.79 cfs @ 2.61 fps)

**Pond UIS2: UNDERGROUND CHAMBERS #2**



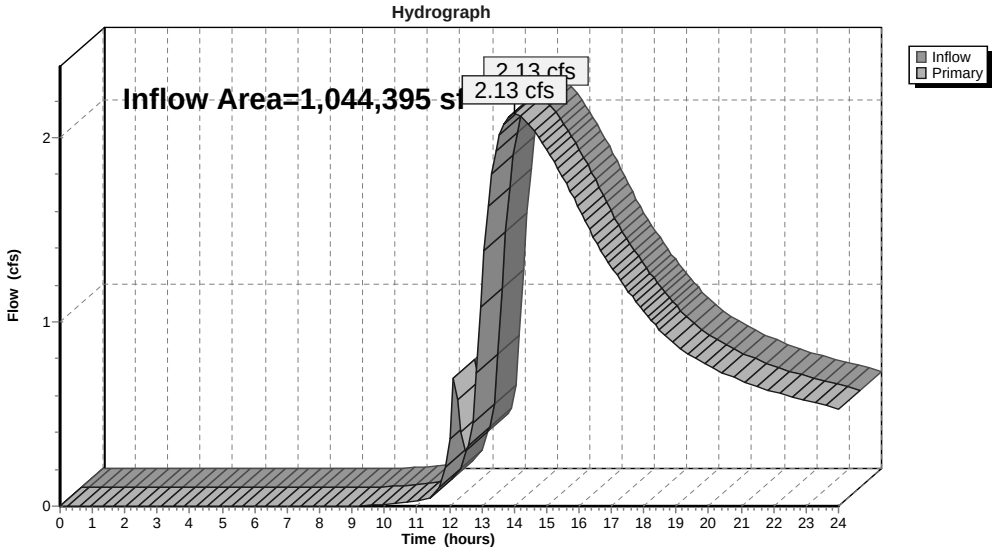



**Summary for Link SP-1: STUDY POINT #1**

Inflow Area = 1,044,395 sf, 36.78% Impervious, Inflow Depth > 0.55" for 2-Year event
Inflow = 2.13 cfs @ 14.02 hrs, Volume= 47,968 cf
Primary = 2.13 cfs @ 14.02 hrs, Volume= 47,968 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs

**Link SP-1: STUDY POINT #1**



### Summary for Subcatchment P-1A: PR. WATERSHED

Runoff = 1.79 cfs @ 12.14 hrs, Volume= 6,734 cf, Depth> 2.91"

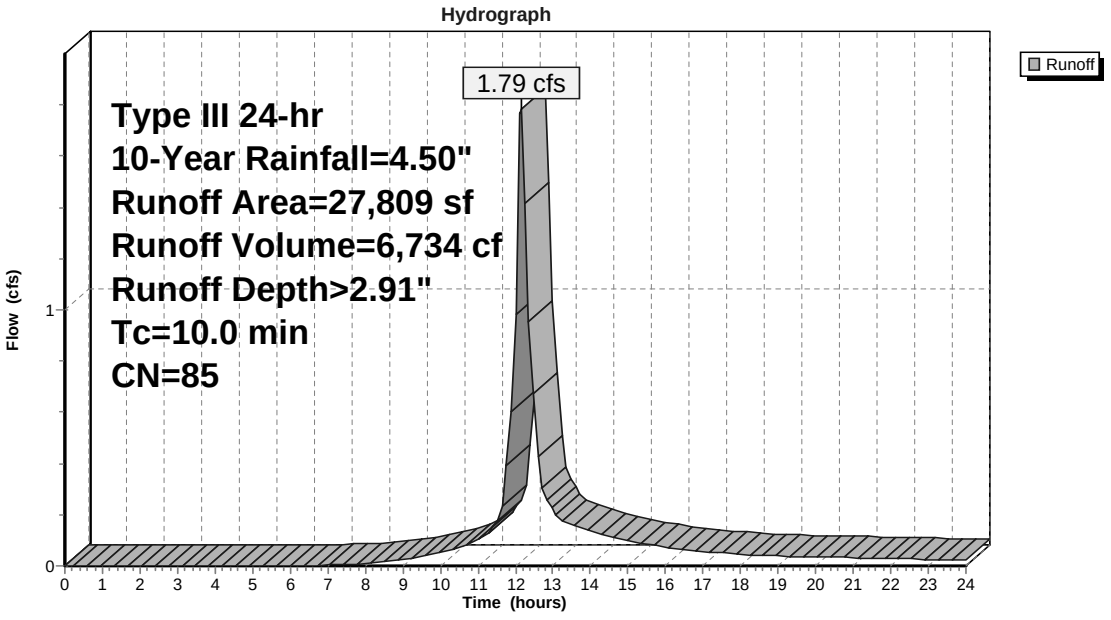
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 14,724 | 74 | >75% Grass cover, Good, HSG C |
| * | 13,085 | 98 | Impervious |
| | 27,809 | 85 | Weighted Average |
| | 14,724 | | 52.95% Pervious Area |
| | 13,085 | | 47.05% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment P-1A: PR. WATERSHED



### Summary for Subcatchment P-1B: PR. WATERSHED

Runoff = 1.54 cfs @ 12.14 hrs, Volume= 5,782 cf, Depth> 2.63"

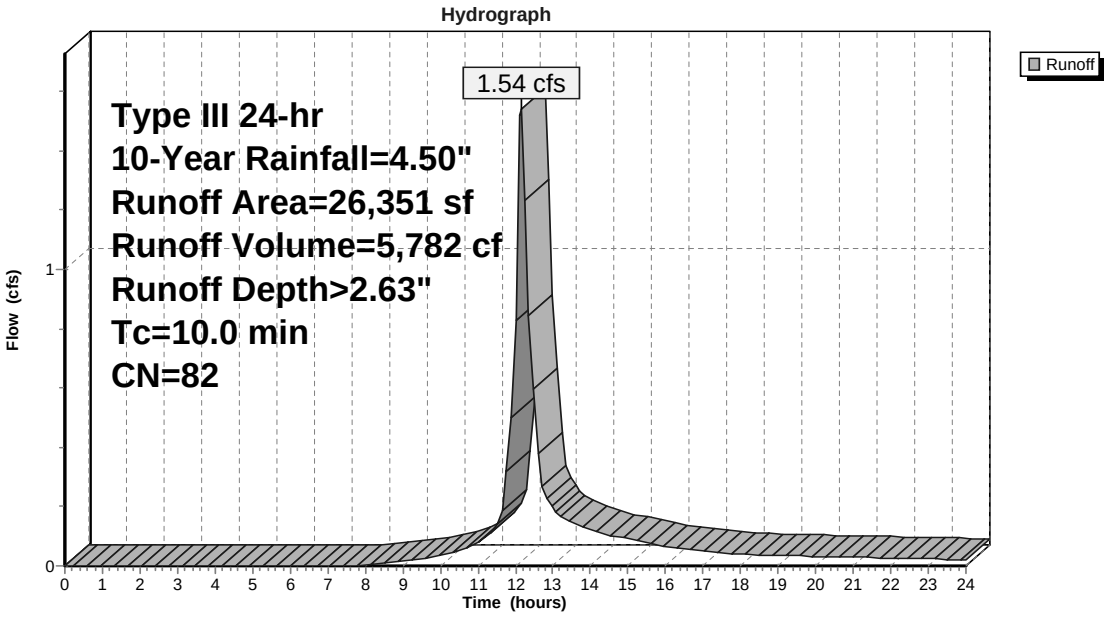
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 17,448 | 74 | >75% Grass cover, Good, HSG C |
| * | 8,903 | 98 | Impervious |
| | 26,351 | 82 | Weighted Average |
| | 17,448 | | 66.21% Pervious Area |
| | 8,903 | | 33.79% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment P-1B: PR. WATERSHED



### Summary for Subcatchment P-1C: PR. WATERSHED

Runoff = 1.79 cfs @ 12.14 hrs, Volume= 6,729 cf, Depth> 2.63"

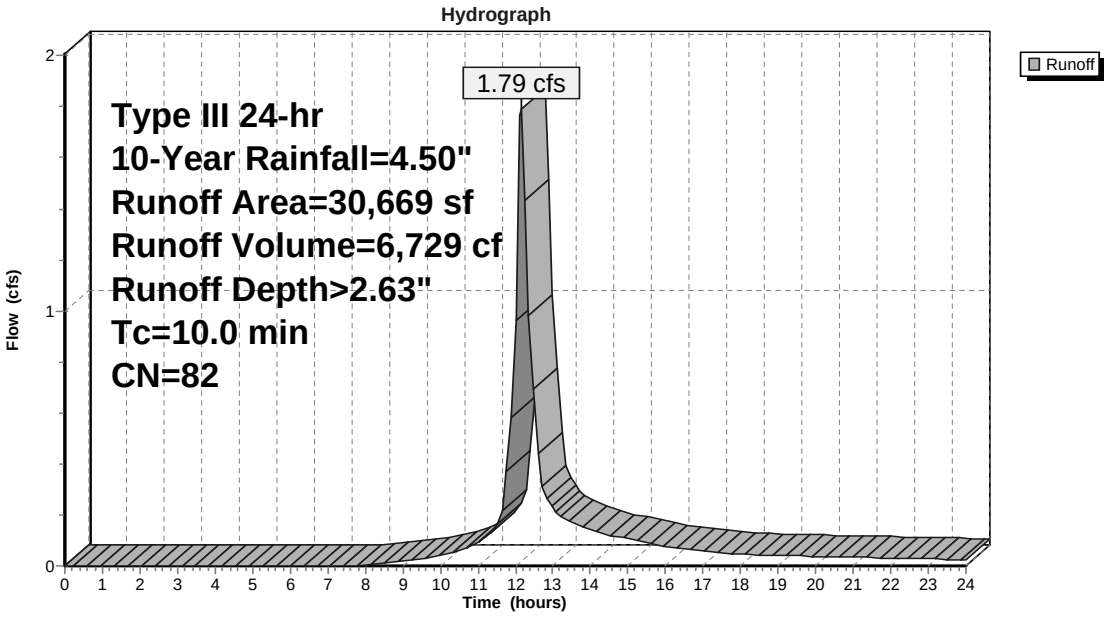
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 20,040 | 74 | >75% Grass cover, Good, HSG C |
| * | 10,629 | 98 | Impervious |
| | 30,669 | 82 | Weighted Average |
| | 20,040 | | 65.34% Pervious Area |
| | 10,629 | | 34.66% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment P-1C: PR. WATERSHED



### Summary for Subcatchment P-1D: PR. WATERSHED

Runoff = 1.86 cfs @ 12.14 hrs, Volume= 6,978 cf, Depth> 2.72"

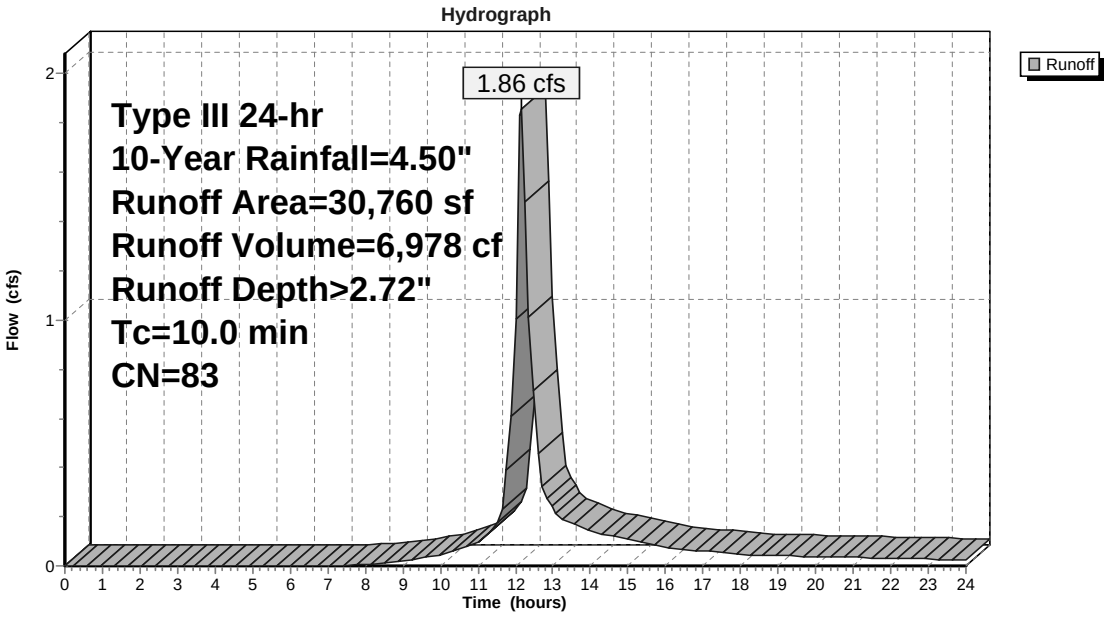
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 19,029 | 74 | >75% Grass cover, Good, HSG C |
| * | 11,731 | 98 | Impervious |
| | 30,760 | 83 | Weighted Average |
| | 19,029 | | 61.86% Pervious Area |
| | 11,731 | | 38.14% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment P-1D: PR. WATERSHED



### Summary for Subcatchment P-1E: PR. WATERSHED

Runoff = 3.03 cfs @ 12.14 hrs, Volume= 11,406 cf, Depth> 2.72"

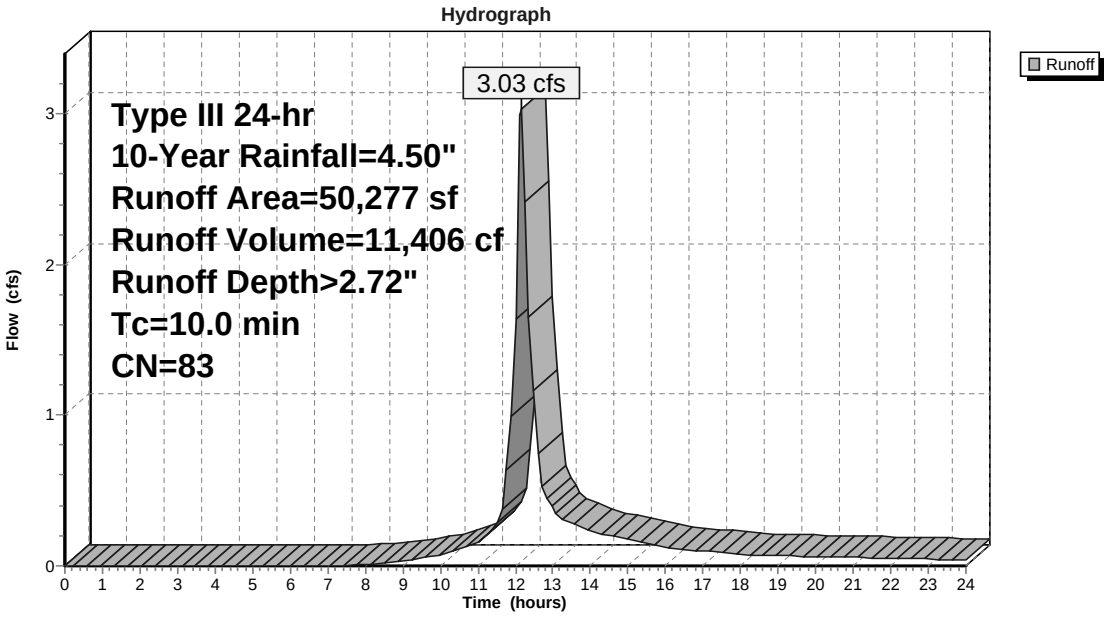
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 31,091 | 74 | >75% Grass cover, Good, HSG C |
| * | 19,186 | 98 | Impervious |
| | 50,277 | 83 | Weighted Average |
| | 31,091 | | 61.84% Pervious Area |
| | 19,186 | | 38.16% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment P-1E: PR. WATERSHED



### Summary for Subcatchment P-1F: PR. WATERSHED

Runoff = 0.42 cfs @ 12.15 hrs, Volume= 1,602 cf, Depth> 2.13"

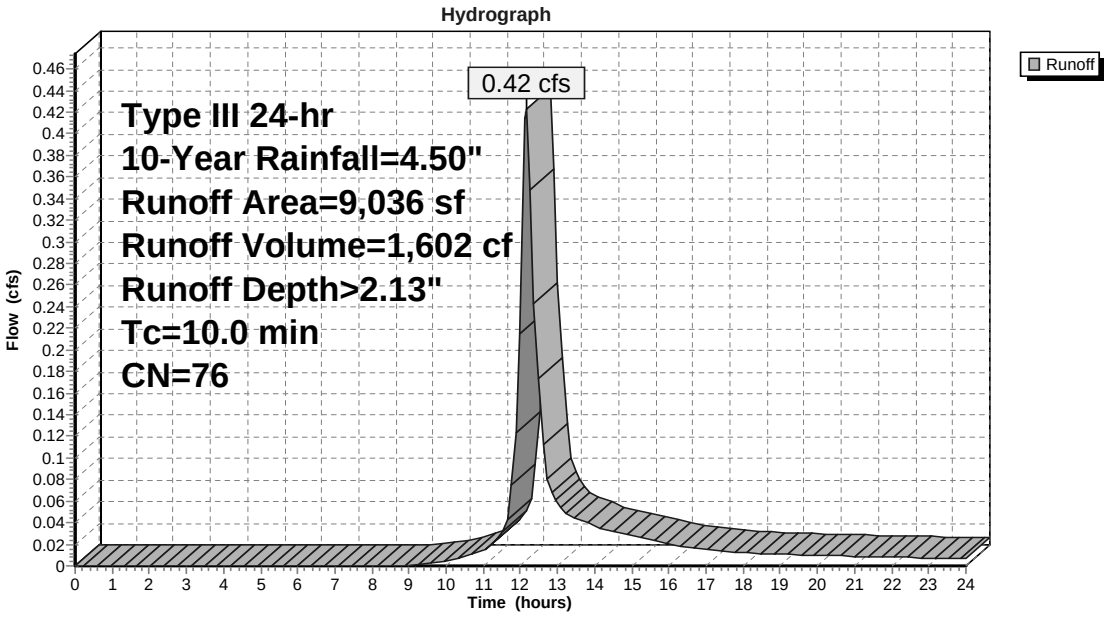
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 8,156 | 74 | >75% Grass cover, Good, HSG C |
| * | 880 | 98 | Impervious |
| | 9,036 | 76 | Weighted Average |
| | 8,156 | | 90.26% Pervious Area |
| | 880 | | 9.74% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment P-1F: PR. WATERSHED



### Summary for Subcatchment P-1G: PR. WATERSHED

Runoff = 9.38 cfs @ 12.14 hrs, Volume= 37,417 cf, Depth> 3.81"

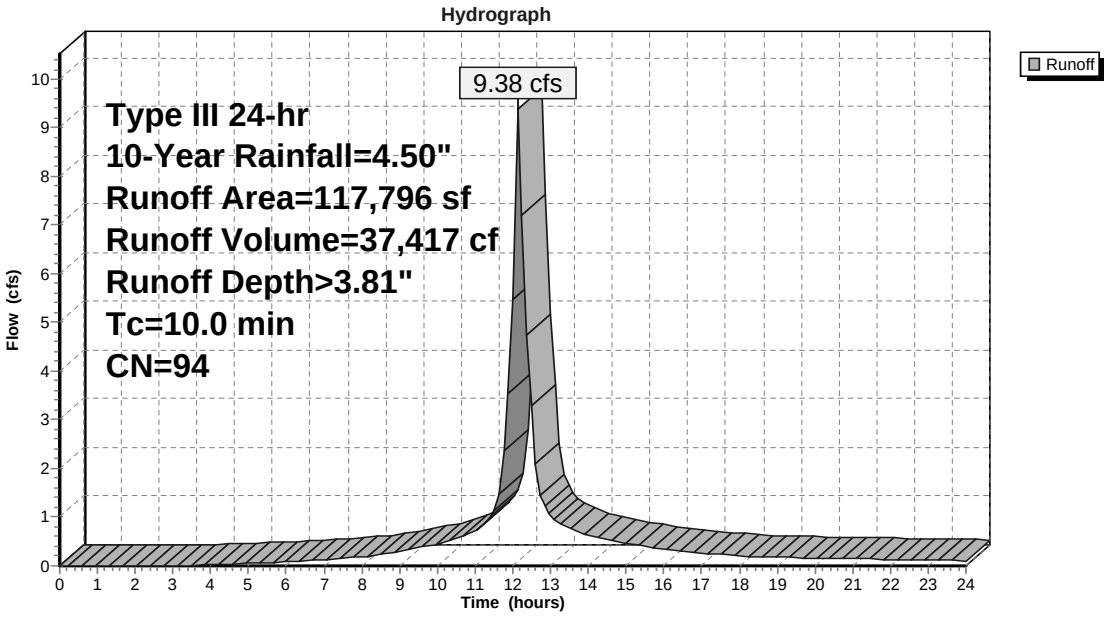
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 21,862 | 74 | >75% Grass cover, Good, HSG C |
| * | 95,934 | 98 | Impervious |
| | 117,796 | 94 | Weighted Average |
| | 21,862 | | 18.56% Pervious Area |
| | 95,934 | | 81.44% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment P-1G: PR. WATERSHED



### Summary for Subcatchment P-1H: PR. WATERSHED

Runoff = 0.53 cfs @ 12.15 hrs, Volume= 2,005 cf, Depth> 2.13"

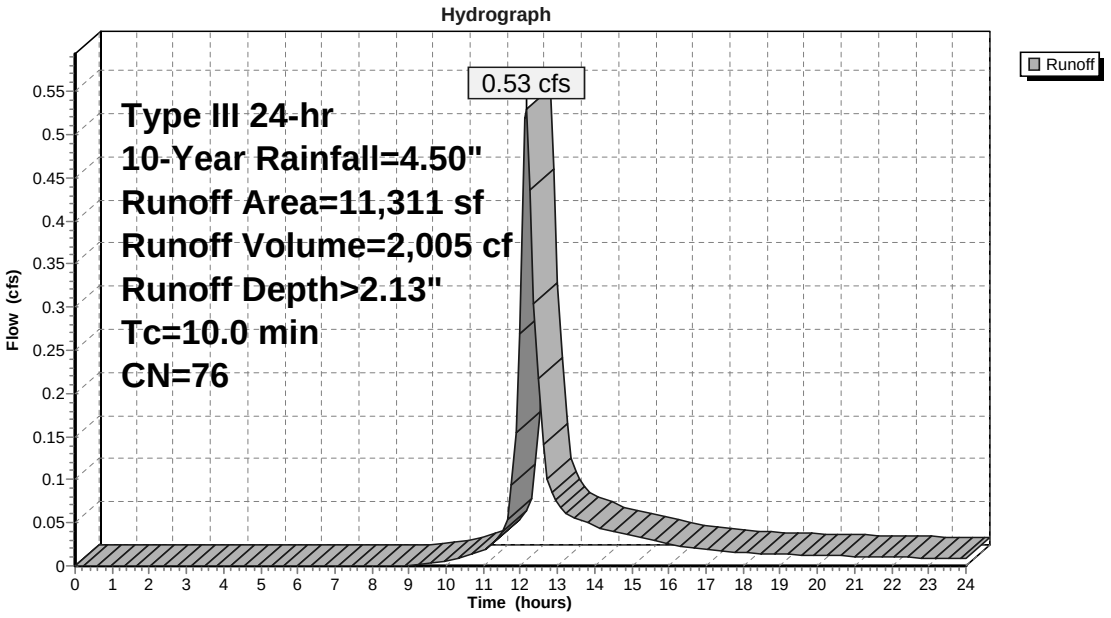
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 10,351 | 74 | >75% Grass cover, Good, HSG C |
| * | 960 | 98 | Impervious |
| | 11,311 | 76 | Weighted Average |
| | 10,351 | | 91.51% Pervious Area |
| | 960 | | 8.49% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment P-1H: PR. WATERSHED



### Summary for Subcatchment P-1I: PR. WATERSHED

Runoff = 1.31 cfs @ 12.14 hrs, Volume= 5,226 cf, Depth> 3.81"

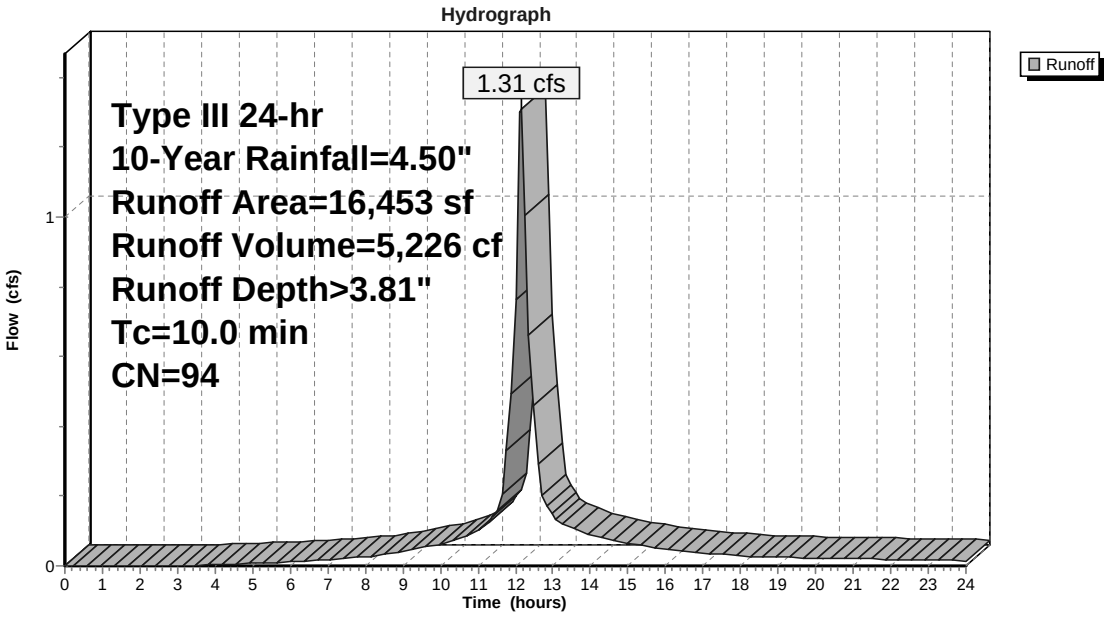
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 2,946 | 74 | >75% Grass cover, Good, HSG C |
| * | 13,507 | 98 | Impervious |
| | 16,453 | 94 | Weighted Average |
| | 2,946 | | 17.91% Pervious Area |
| | 13,507 | | 82.09% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment P-1I: PR. WATERSHED



### Summary for Subcatchment P-2A: PR. WATERSHED

Runoff = 1.26 cfs @ 12.14 hrs, Volume= 4,754 cf, Depth> 2.72"

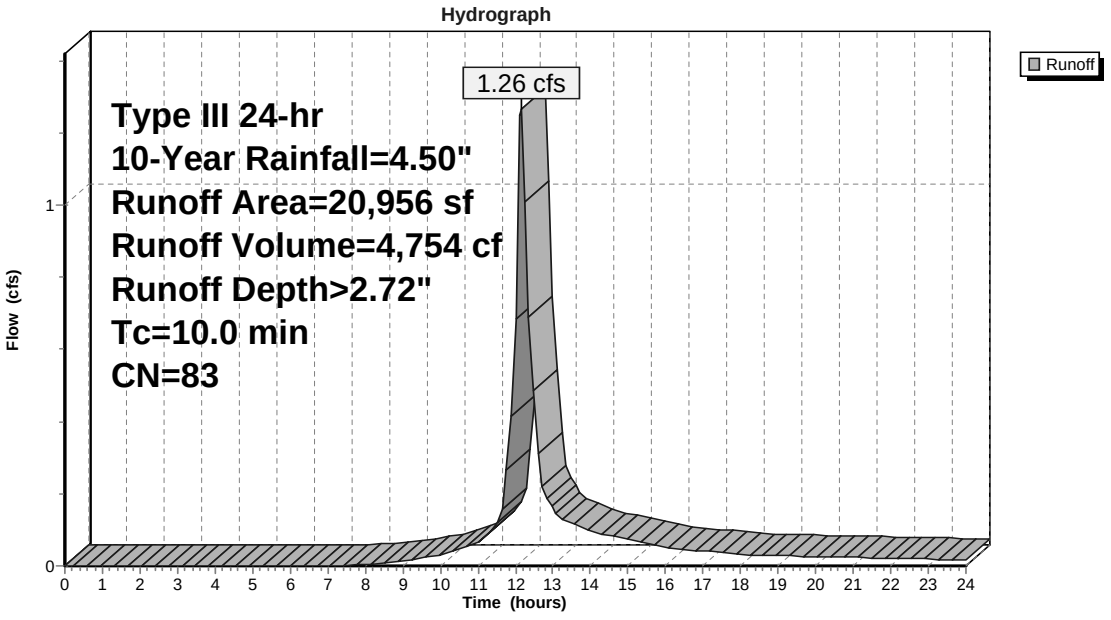
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 12,753 | 74 | >75% Grass cover, Good, HSG C |
| * | 8,203 | 98 | Impervious |
| | 20,956 | 83 | Weighted Average |
| | 12,753 | | 60.86% Pervious Area |
| | 8,203 | | 39.14% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment P-2A: PR. WATERSHED



### Summary for Subcatchment P-2B: PR. WATERSHED

Runoff = 3.88 cfs @ 12.15 hrs, Volume= 14,631 cf, Depth> 2.21"

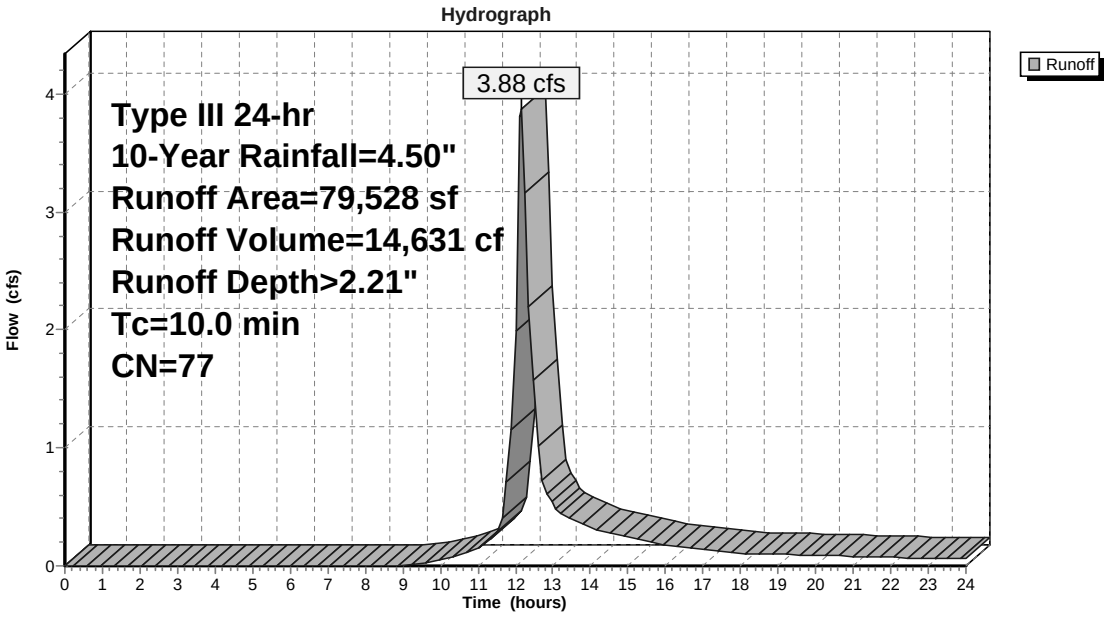
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 69,830 | 74 | >75% Grass cover, Good, HSG C |
| * | 9,698 | 98 | Impervious |
| | 79,528 | 77 | Weighted Average |
| | 69,830 | | 87.81% Pervious Area |
| | 9,698 | | 12.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |



### Subcatchment P-2B: PR. WATERSHED



### Summary for Subcatchment P-3: PR. WATERSHED

Runoff = 9.64 cfs @ 12.67 hrs, Volume= 66,778 cf, Depth> 2.03"

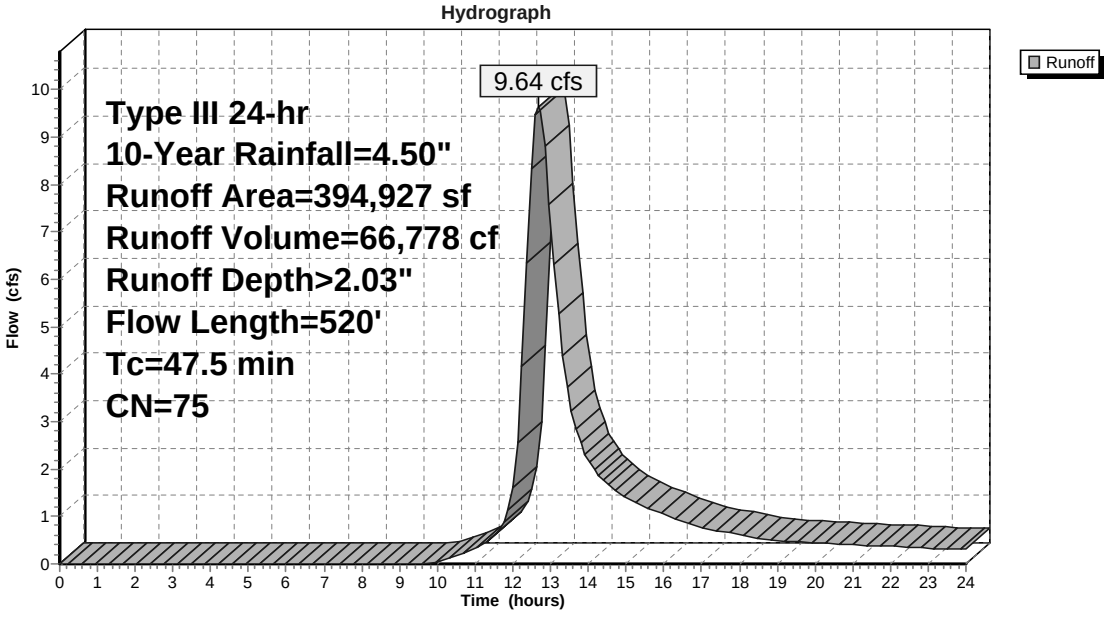
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 237,023 | 77 | Woods, Good, HSG D |
| * | 9,383 | 98 | Impervious |
| | 148,521 | 70 | Woods, Good, HSG C |
| | 394,927 | 75 | Weighted Average |
| | 385,544 | | 97.62% Pervious Area |
| | 9,383 | | 2.38% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 28.3 | 100 | 0.0100 | 0.06 | | **Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.3 | 40 | 0.0100 | 0.50 | | **Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps |
| 17.9 | 380 | 0.0050 | 0.35 | | **Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps |
| 47.5 | 520 | Total | | | |



### Subcatchment P-3: PR. WATERSHED



### Summary for Subcatchment R-1F: BUILDING #3 ROOF

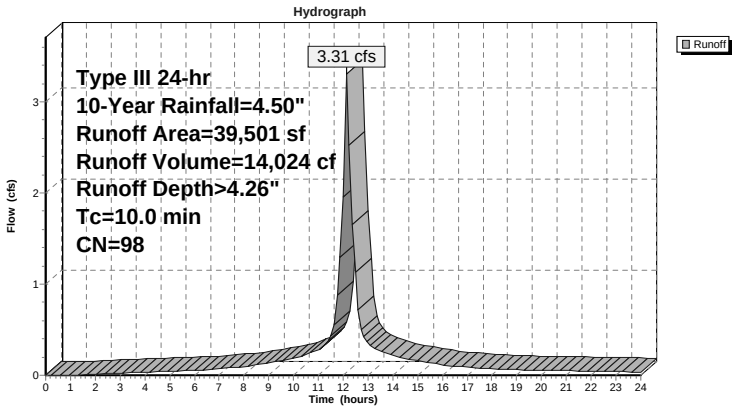
Runoff = 3.31 cfs @ 12.14 hrs, Volume= 14,024 cf, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 39,501 | 98 | Roof |
| | 39,501 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-1F: BUILDING #3 ROOF






### Summary for Subcatchment R-1H: BUILDING #3 ROOF

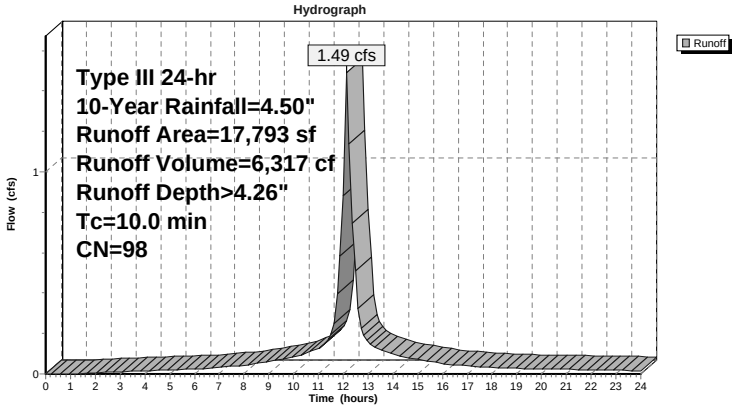
Runoff = 1.49 cfs @ 12.14 hrs, Volume= 6,317 cf, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 17,793 | 98 | Roof |
| | 17,793 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-1H: BUILDING #3 ROOF



### Summary for Subcatchment R-1I: BUILDING #3 ROOF

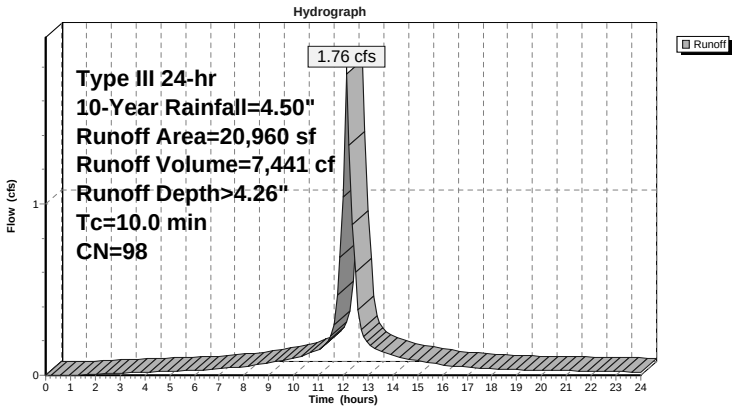
Runoff = 1.76 cfs @ 12.14 hrs, Volume= 7,441 cf, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 20,960 | 98 | Roof |
| | 20,960 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-1I: BUILDING #3 ROOF






### Summary for Subcatchment R-2A: BUILDING #1 ROOF

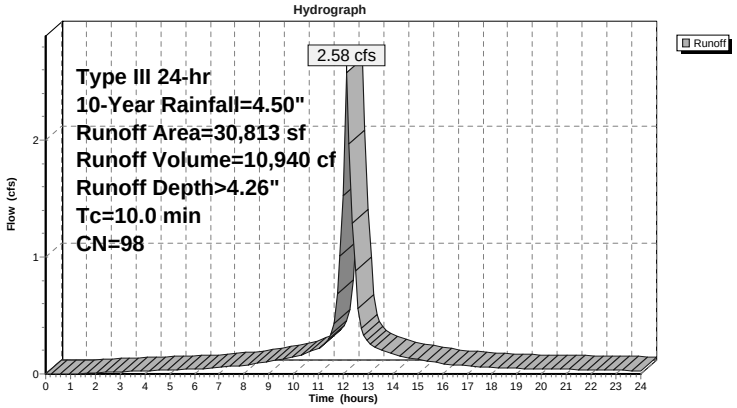
Runoff = 2.58 cfs @ 12.14 hrs, Volume= 10,940 cf, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 30,813 | 98 | Roof |
| | 30,813 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-2A: BUILDING #1 ROOF



### Summary for Subcatchment R-2B: BUILDING #2 ROOF

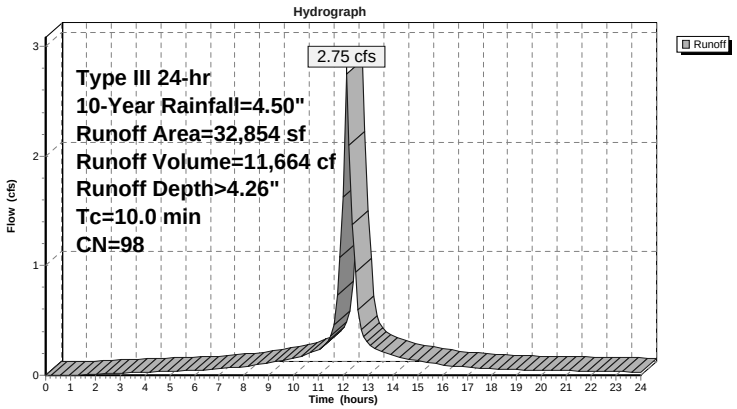
Runoff = 2.75 cfs @ 12.14 hrs, Volume= 11,664 cf, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 32,854 | 98 | Roof |
| | 32,854 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-2B: BUILDING #2 ROOF






### Summary for Subcatchment R-2C: BUILDING #3 ROOF

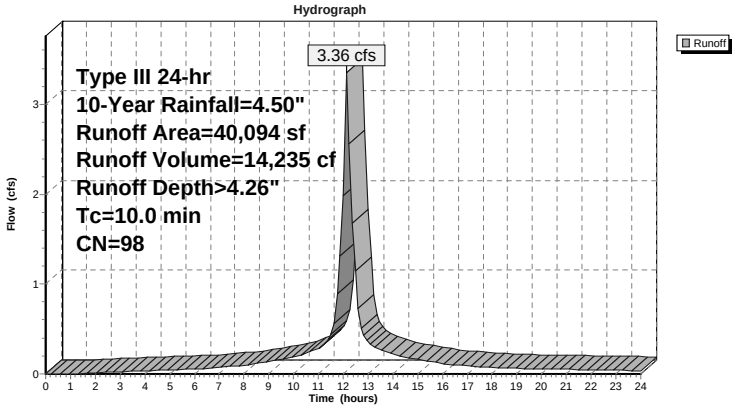
Runoff = 3.36 cfs @ 12.14 hrs, Volume= 14,235 cf, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 40,094 | 98 | Roof |
| | 40,094 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-2C: BUILDING #3 ROOF



### Summary for Subcatchment W-1: Wetlands

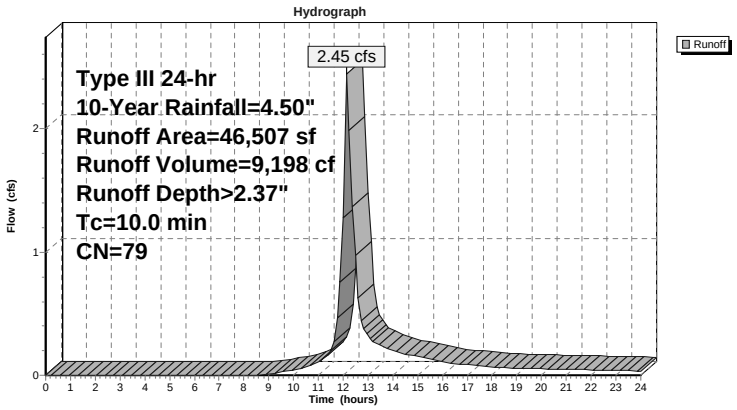
Runoff = 2.45 cfs @ 12.15 hrs, Volume= 9,198 cf, Depth> 2.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 46,507 | 79 | Woods/grass comb., Good, HSG D |
| 46,507 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment W-1: Wetlands






### Summary for Pond ES: Offsite Swale to South Culvert

Inflow Area = 445,223 sf, 56.84% Impervious, Inflow Depth > 2.78" for 10-Year event
Inflow = 22.48 cfs @ 12.25 hrs, Volume= 102,999 cf
Outflow = 5.58 cfs @ 13.09 hrs, Volume= 76,586 cf, Atten= 75%, Lag= 50.3 min
Primary = 5.58 cfs @ 13.09 hrs, Volume= 76,586 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 80.65' @ 13.09 hrs Surf.Area= 49,078 sf Storage= 46,058 cf

Plug-Flow detention time= 181.2 min calculated for 76,205 cf (74% of inflow)
Center-of-Mass det. time= 96.8 min ( 943.2 - 846.4 )

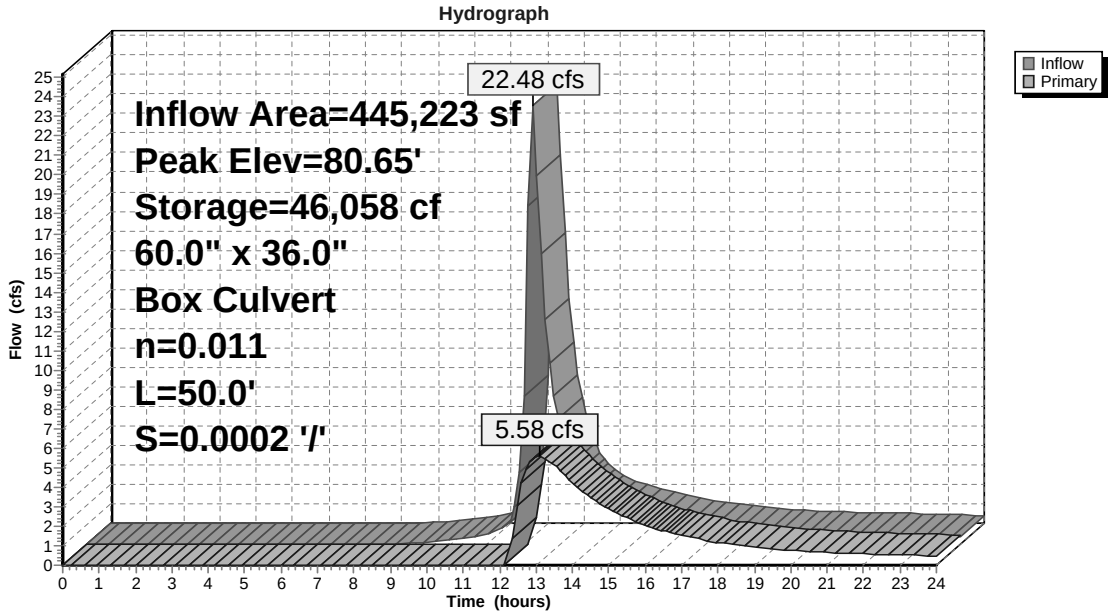
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 79.00' | 136,108 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 79.00 | 17,000 | 1,200.0 | 0 | 0 | 17,000 |
| 80.00 | 27,000 | 4,000.0 | 21,808 | 21,808 | 1,175,651 |
| 81.00 | 63,900 | 4,200.0 | 44,146 | 65,954 | 1,306,222 |
| 82.00 | 76,600 | 4,250.0 | 70,154 | 136,108 | 1,340,108 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.00' | **60.0" W x 36.0" H Box Culvert** L= 50.0' Box, headwall w/3 square edges, Ke= 0.500<br>Inlet / Outlet Invert= 80.00' / 79.99' S= 0.0002 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 15.00 sf |

**Primary OutFlow** Max=5.58 cfs @ 13.09 hrs HW=80.65' TW=0.00' (Dynamic Tailwater)
**1=Culvert** (Barrel Controls 5.58 cfs @ 2.30 fps)

**Pond ES: Offsite Swale to South Culvert**






**Summary for Pond EW: Wetland to East Culvert**

Inflow Area = 394,927 sf, 2.38% Impervious, Inflow Depth > 2.03" for 10-Year event
Inflow = 9.64 cfs @ 12.67 hrs, Volume= 66,778 cf
Outflow = 0.45 cfs @ 19.85 hrs, Volume= 15,504 cf, Atten= 95%, Lag= 430.8 min
Primary = 0.45 cfs @ 19.85 hrs, Volume= 15,504 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 80.66' @ 19.85 hrs Surf.Area= 110,383 sf Storage= 52,364 cf

Plug-Flow detention time= 414.1 min calculated for 15,427 cf (23% of inflow)
Center-of-Mass det. time= 275.5 min ( 1,147.8 - 872.3 )

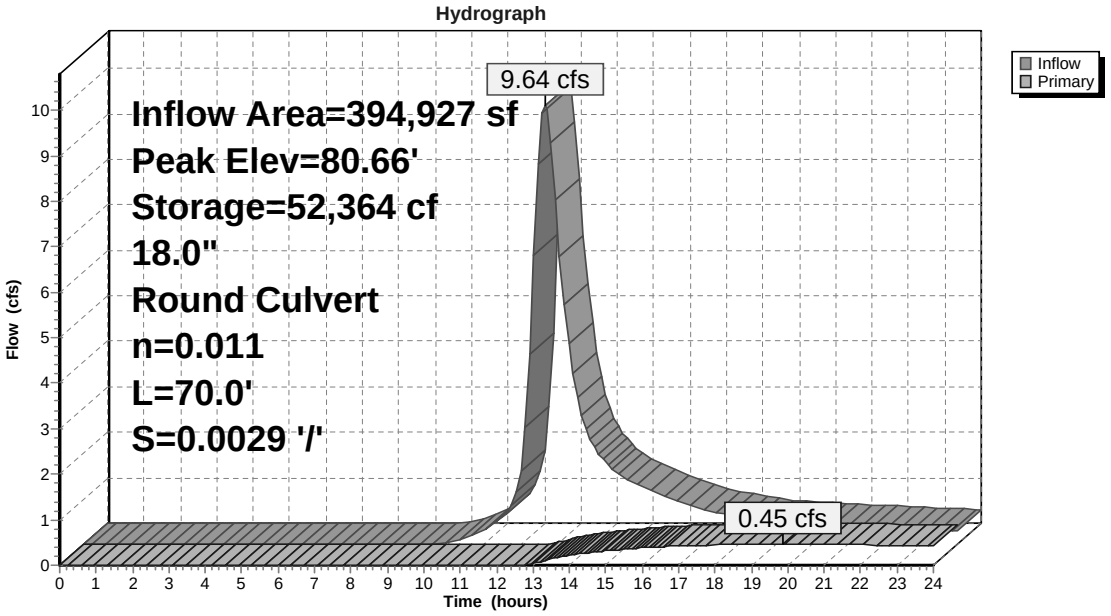
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 290,435 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 52,000 | 1,200.0 | 0 | 0 | 52,000 |
| 81.00 | 149,000 | 2,600.0 | 96,341 | 96,341 | 475,356 |
| 82.00 | 243,000 | 4,300.0 | 194,094 | 290,435 | 1,408,807 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.30' | **18.0" Round Culvert** L= 70.0' RCP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 80.30' / 80.10' S= 0.0029 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.45 cfs @ 19.85 hrs HW=80.66' TW=0.00' (Dynamic Tailwater)
**1=Culvert** (Barrel Controls 0.45 cfs @ 2.10 fps)

**Pond EW: Wetland to East Culvert**






**Summary for Pond OFFSITE: OFFSITE PONDING AREA IN GRASS**

| | | | | | |
|---|---|---|---|---|---|
| Inflow | = | 4.72 cfs @ | 12.40 hrs, | Volume= | 23,168 cf |
| Outflow | = | 4.66 cfs @ | 12.47 hrs, | Volume= | 22,866 cf, Atten= 1%, Lag= 4.5 min |
| Primary | = | 4.66 cfs @ | 12.47 hrs, | Volume= | 22,866 cf |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 82.72' @ 12.47 hrs Surf.Area= 4,914 sf Storage= 1,602 cf

Plug-Flow detention time= 17.5 min calculated for 22,866 cf (99% of inflow)
Center-of-Mass det. time= 10.4 min ( 895.1 - 884.7 )

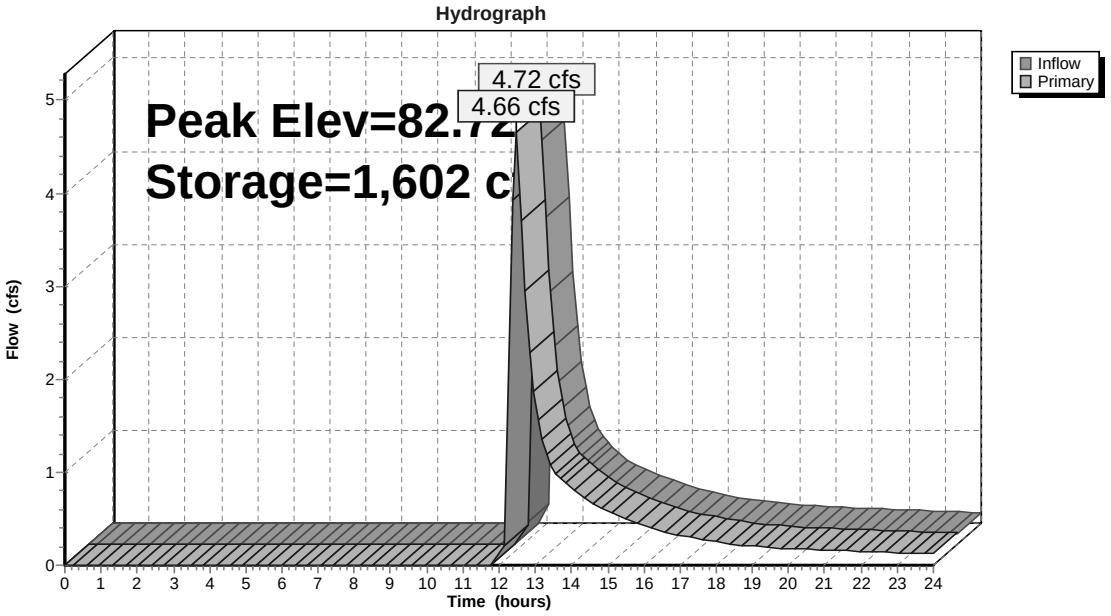
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.10' | 3,254 cf | **OFFSITE PONDING AREA (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 82.10 | 230 | 0 | 0 |
| 83.00 | 7,000 | 3,254 | 3,254 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.27' | **8.0" Round (3) 8" HDPE X 3.00 w/ 2.0" inside fill** L= 21.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 82.10' / 81.40' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.28 sf |
| #2 | Primary | 82.60' | **30.0' long x 10.0' breadth WEIR FLOW OVER WALKING PATH**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64 |

**Primary OutFlow** Max=4.60 cfs @ 12.47 hrs HW=82.72' TW=0.00' (Dynamic Tailwater)
**1=(3) 8" HDPE** (Inlet Controls 1.44 cfs @ 1.78 fps)
**2=WEIR FLOW OVER WALKING PATH** (Weir Controls 3.16 cfs @ 0.87 fps)

**Pond OFFSITE: OFFSITE PONDING AREA IN GRASS**






**Summary for Pond P1C: BIO.RET. #1**

Inflow Area = 48,537 sf, 83.20% Impervious, Inflow Depth > 3.86" for 10-Year event
Inflow = 3.73 cfs @ 12.14 hrs, Volume= 15,626 cf
Outflow = 1.74 cfs @ 12.75 hrs, Volume= 13,060 cf, Atten= 53%, Lag= 36.6 min
Primary = 1.74 cfs @ 12.75 hrs, Volume= 13,060 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 86.99' @ 12.41 hrs Surf.Area= 5,639 sf Storage= 5,155 cf
Flood Elev= 86.50' Surf.Area= 5,219 sf Storage= 2,505 cf

Plug-Flow detention time= 135.4 min calculated for 13,060 cf (84% of inflow)
Center-of-Mass det. time= 67.8 min ( 829.7 - 761.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 86.00' | 8,156 cf | **BIORETENTION #1 (Irregular)**Listed below (Recalc) |

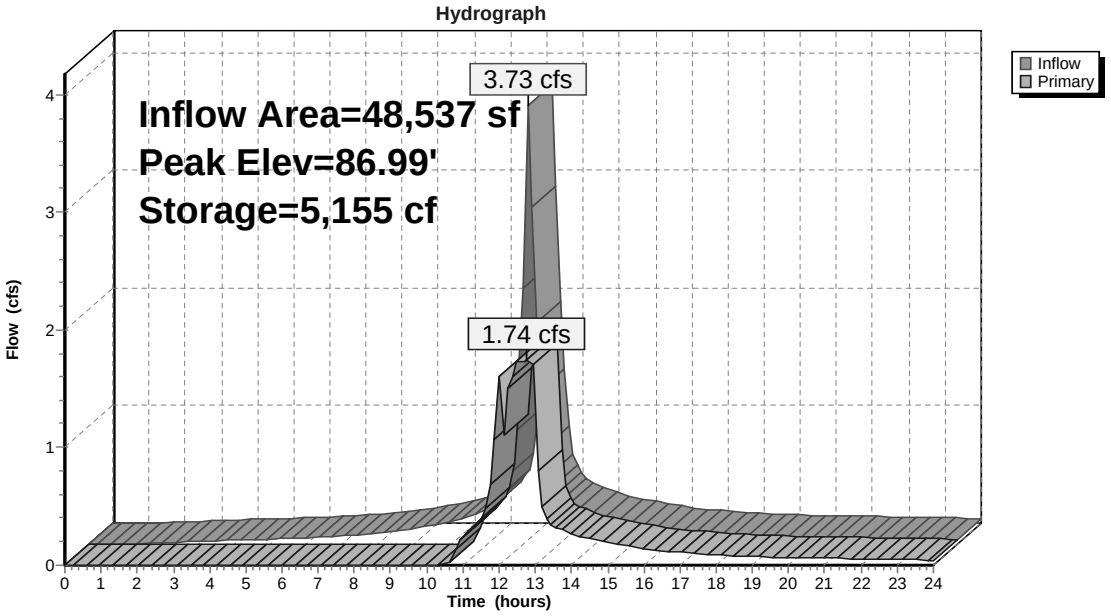
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 86.00 | 4,804 | 272.0 | 0 | 0 | 4,804 |
| 86.50 | 5,219 | 282.0 | 2,505 | 2,505 | 5,266 |
| 87.00 | 5,649 | 291.0 | 2,716 | 5,221 | 5,701 |
| 87.50 | 6,093 | 301.0 | 2,935 | 8,156 | 6,195 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 83.97' | **6.0" Round (2) 6" HDPE X 2.00** L= 56.0' CPP, mitered to conform to fill, Ke= 0.700<br>Inlet / Outlet Invert= 83.97' / 83.83' S= 0.0025 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf |
| #2 | Device 1 | 86.50' | **8.0" Horiz. (5) 8" OVERFLOW X 5.00** C= 0.600 Limited to weir flow at low heads |

**Primary OutFlow** Max=1.74 cfs @ 12.75 hrs HW=86.82' TW=85.16' (Dynamic Tailwater)
↑**1=(2) 6" HDPE** (Outlet Controls 1.74 cfs @ 4.42 fps)
↑**2=(5) 8" OVERFLOW** (Passes 1.74 cfs of 4.79 cfs potential flow)

**Pond P1C: BIO.RET. #1**

**Hydrograph**






**Summary for Pond P1D: BIO.RET. #2**

Inflow Area = 29,104 sf, 64.43% Impervious, Inflow Depth > 3.43" for 10-Year event
Inflow = 2.02 cfs @ 12.14 hrs, Volume= 8,322 cf
Outflow = 1.66 cfs @ 12.43 hrs, Volume= 7,151 cf, Atten= 18%, Lag= 17.5 min
Primary = 1.66 cfs @ 12.43 hrs, Volume= 7,151 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 86.78' @ 12.27 hrs Surf.Area= 3,030 sf Storage= 1,926 cf
Flood Elev= 86.50' Surf.Area= 2,628 sf Storage= 1,146 cf

Plug-Flow detention time= 113.7 min calculated for 7,115 cf (86% of inflow)
Center-of-Mass det. time= 53.8 min ( 827.8 - 774.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 86.00' | 1,686 cf | **BIORETENTION (Irregular)**Listed below (Recalc) |
| #2 | 86.00' | 2,826 cf | **BIORETENTION (Irregular)**Listed below (Recalc) |
| | | 4,512 cf | Total Available Storage |

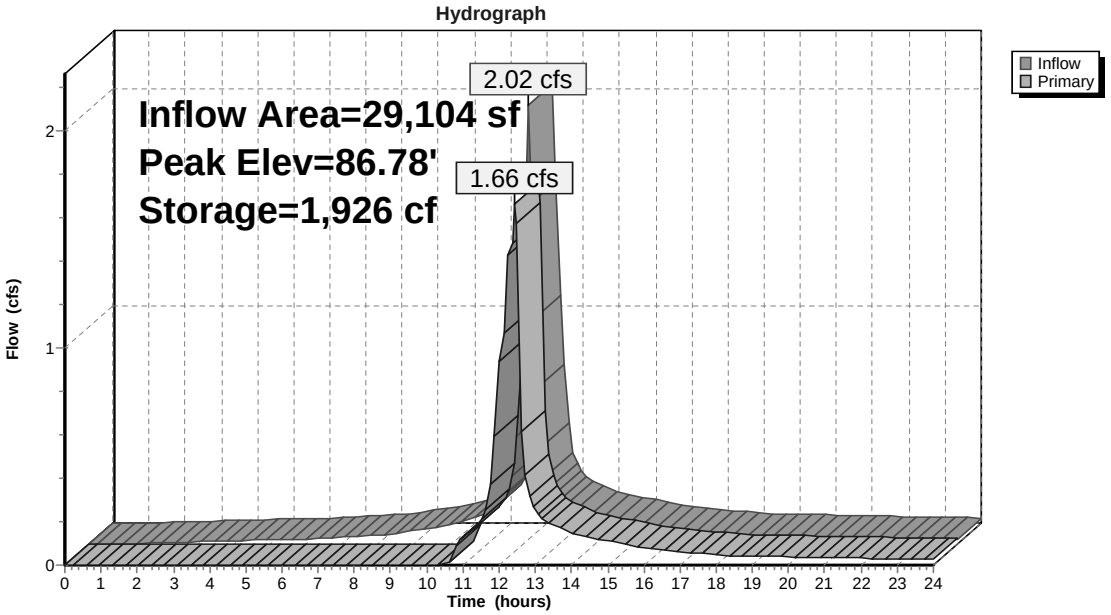
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 86.00 | 688 | 169.0 | 0 | 0 | 688 |
| 87.00 | 1,281 | 203.0 | 969 | 969 | 1,712 |
| 87.50 | 1,592 | 212.0 | 717 | 1,686 | 2,026 |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 86.00 | 1,285 | 193.0 | 0 | 0 | 1,285 |
| 87.00 | 2,098 | 271.0 | 1,675 | 1,675 | 4,174 |
| 87.50 | 2,512 | 280.0 | 1,151 | 2,826 | 4,592 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 83.97' | **6.0" Round (2) 6" HDPE X 2.00** L= 54.0' CPP, mitered to conform to fill, Ke= 0.700<br>Inlet / Outlet Invert= 83.97' / 83.83' S= 0.0026 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf |
| #2 | Device 1 | 86.50' | **8.0" Horiz. (4) 8" OVERFLOW X 4.00** C= 0.600 Limited to weir flow at low heads |

**Primary OutFlow** Max=1.53 cfs @ 12.43 hrs HW=86.69' TW=85.44' (Dynamic Tailwater)
└**1=(2) 6" HDPE** (Outlet Controls 1.53 cfs @ 3.89 fps)
└**2=(4) 8" OVERFLOW** (Passes 1.53 cfs of 2.36 cfs potential flow)

**Pond P1D: BIO.RET. #2**






**Summary for Pond P1E: Wet Basin #1**

Inflow Area = 27,809 sf, 47.05% Impervious, Inflow Depth > 2.91" for 10-Year event
Inflow = 1.79 cfs @ 12.14 hrs, Volume= 6,734 cf
Outflow = 1.62 cfs @ 12.22 hrs, Volume= 6,710 cf, Atten= 9%, Lag= 4.5 min
Primary = 1.62 cfs @ 12.22 hrs, Volume= 6,710 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Starting Elev= 81.50' Surf.Area= 3,408 sf Storage= 3,980 cf
Peak Elev= 81.62' @ 12.22 hrs Surf.Area= 3,535 sf Storage= 4,400 cf (419 cf above start)
Flood Elev= 81.50' Surf.Area= 3,408 sf Storage= 3,980 cf

Plug-Flow detention time= 279.8 min calculated for 2,716 cf (40% of inflow)
Center-of-Mass det. time= 6.4 min ( 821.0 - 814.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 7,924 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

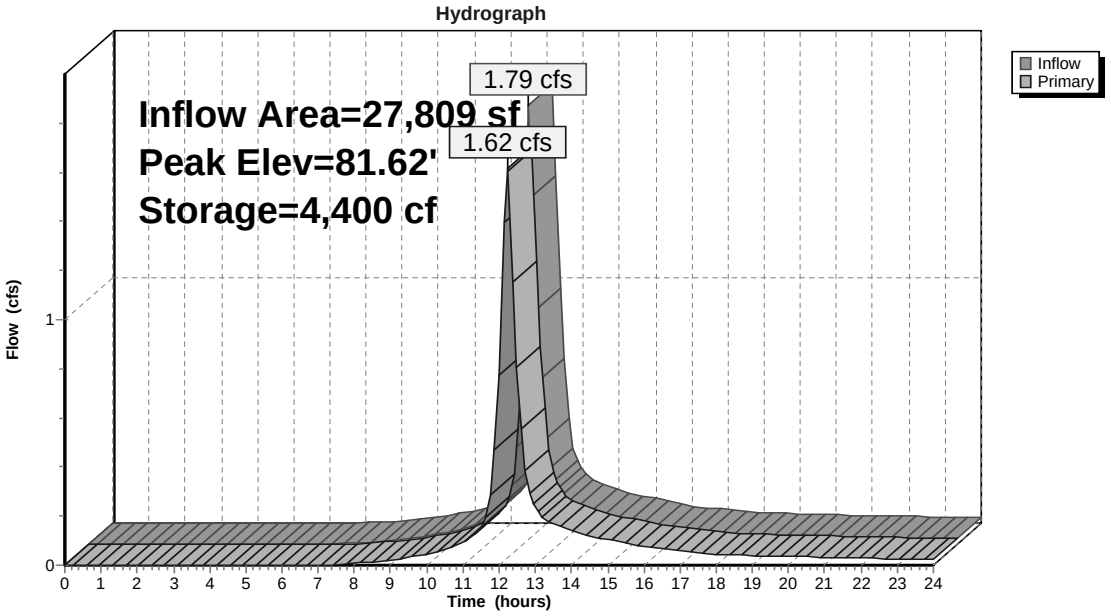
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 1,930 | 299.0 | 0 | 0 | 1,930 |
| 81.00 | 2,909 | 337.0 | 2,403 | 2,403 | 3,879 |
| 82.00 | 3,947 | 355.0 | 3,415 | 5,818 | 4,929 |
| 82.50 | 4,486 | 364.0 | 2,107 | 7,924 | 5,475 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 81.50' | **15.0' long x 12.0' breadth Broad-Crested Rectangular Weir** |
| | | | Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 |
| | | | Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64 |

**Primary OutFlow** Max=1.57 cfs @ 12.22 hrs HW=81.62' TW=79.95' (Dynamic Tailwater)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 1.57 cfs @ 0.88 fps)

**Pond P1E: Wet Basin #1**

**Hydrograph**






**Summary for Pond P1F: Wet Basin #2**

Inflow Area = 320,630 sf, 68.86% Impervious, Inflow Depth > 2.21" for 10-Year event
Inflow = 16.07 cfs @ 12.16 hrs, Volume= 59,141 cf
Outflow = 14.63 cfs @ 12.25 hrs, Volume= 58,920 cf, Atten= 9%, Lag= 5.6 min
Primary = 14.63 cfs @ 12.25 hrs, Volume= 58,920 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Starting Elev= 81.50' Surf.Area= 10,650 sf Storage= 10,212 cf
Peak Elev= 81.83' @ 12.25 hrs Surf.Area= 12,886 sf Storage= 14,121 cf (3,910 cf above start)
Flood Elev= 81.50' Surf.Area= 10,650 sf Storage= 10,212 cf

Plug-Flow detention time= 104.1 min calculated for 48,708 cf (82% of inflow)
Center-of-Mass det. time= 6.0 min ( 843.1 - 837.2 )

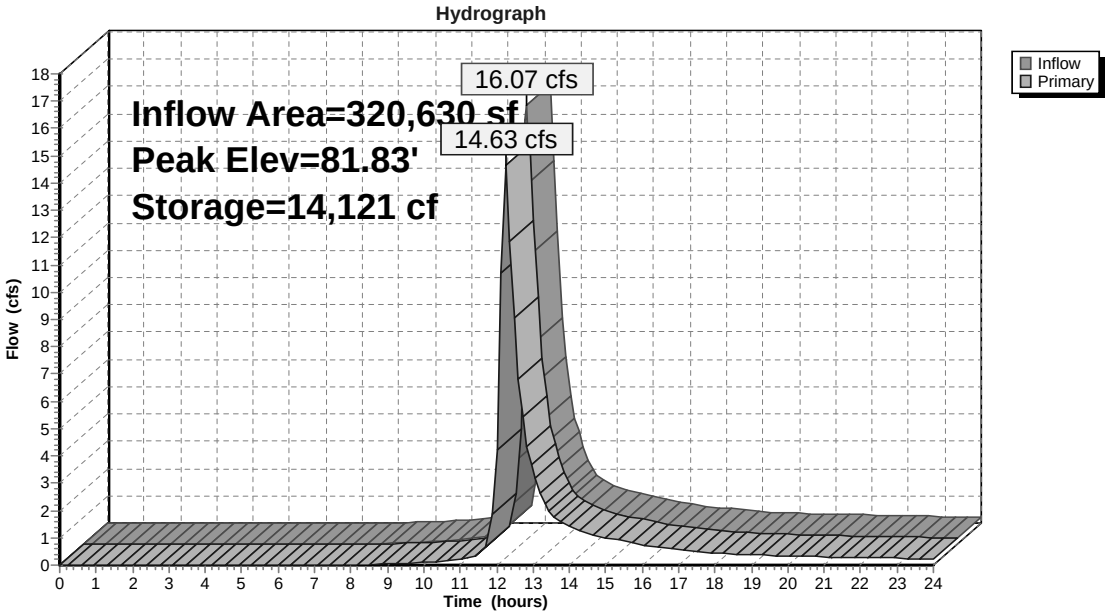
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 24,130 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 3,826 | 408.0 | 0 | 0 | 3,826 |
| 81.00 | 7,690 | 1,455.0 | 5,647 | 5,647 | 159,050 |
| 82.00 | 14,091 | 2,271.0 | 10,730 | 16,377 | 401,005 |
| 82.50 | 16,964 | 2,177.0 | 7,753 | 24,130 | 434,296 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 81.50' | **15.0' long x 7.0' breadth Broad-Crested Rectangular Weir**<br>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<br>Coef. (English) 2.40 2.52 2.70 2.68 2.68 2.67 2.66 2.65 2.65 2.65 2.66 2.65 2.66 2.68 2.70 2.73 2.78 |
| #2 | Primary | 81.50' | **15.0' long x 12.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64 |

**Primary OutFlow** Max=14.35 cfs @ 12.25 hrs HW=81.83' TW=80.04' (Dynamic Tailwater)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 7.00 cfs @ 1.42 fps)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 7.35 cfs @ 1.49 fps)

**Pond P1F: Wet Basin #2**






**Summary for Pond P1G: Wet Basin #3**

Inflow Area = 50,277 sf, 38.16% Impervious, Inflow Depth > 6.81" for 10-Year event
Inflow = 6.25 cfs @ 12.15 hrs, Volume= 28,512 cf
Outflow = 4.49 cfs @ 12.34 hrs, Volume= 28,171 cf, Atten= 28%, Lag= 11.7 min
Primary = 4.49 cfs @ 12.34 hrs, Volume= 28,171 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Starting Elev= 81.50' Surf.Area= 7,082 sf Storage= 6,991 cf
Peak Elev= 81.99' @ 12.34 hrs Surf.Area= 9,075 sf Storage= 10,961 cf (3,970 cf above start)
Flood Elev= 81.50' Surf.Area= 7,082 sf Storage= 6,991 cf

Plug-Flow detention time= 152.7 min calculated for 21,075 cf (74% of inflow)
Center-of-Mass det. time= 17.7 min ( 863.9 - 846.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 16,095 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

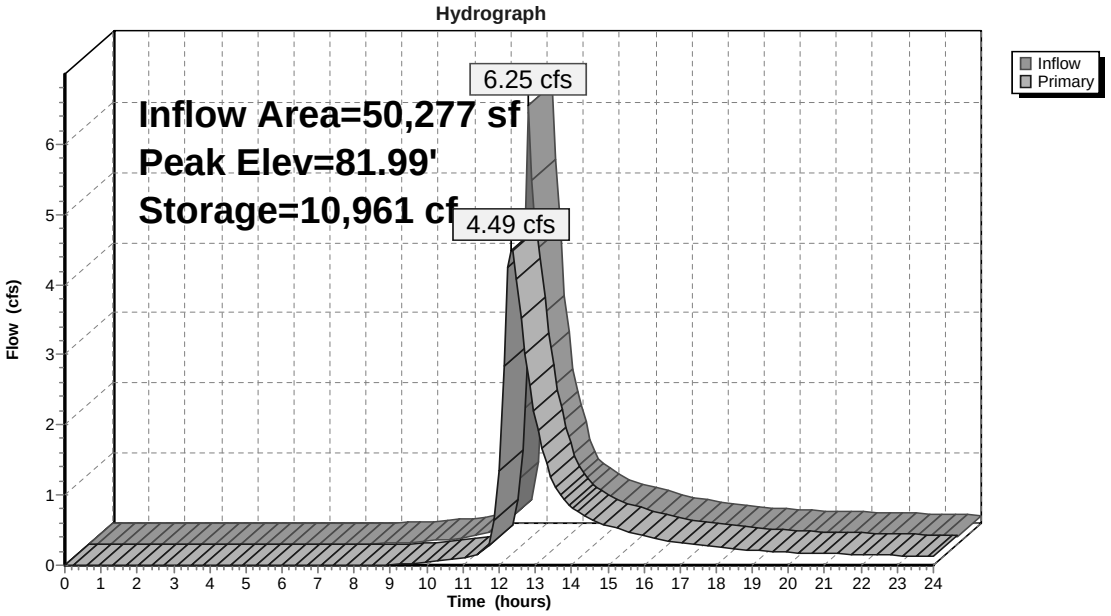
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 2,647 | 420.0 | 0 | 0 | 2,647 |
| 81.00 | 5,312 | 1,188.0 | 3,903 | 3,903 | 100,924 |
| 82.00 | 9,107 | 1,389.0 | 7,125 | 11,028 | 142,163 |
| 82.50 | 11,198 | 1,400.0 | 5,067 | 16,095 | 144,702 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 81.50' | **5.0' long x 6.0' 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) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83 |

**Primary OutFlow** Max=4.45 cfs @ 12.34 hrs HW=81.99' TW=80.25' (Dynamic Tailwater)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 4.45 cfs @ 1.82 fps)

**Pond P1G: Wet Basin #3**

**Hydrograph**






**Summary for Pond P2: SURFACE BASINS**

Inflow Area = 183,289 sf, 61.90% Impervious, Inflow Depth > 3.37" for 10-Year event
Inflow = 12.56 cfs @ 12.14 hrs, Volume= 51,469 cf
Outflow = 6.45 cfs @ 12.40 hrs, Volume= 32,145 cf, Atten= 49%, Lag= 15.6 min
Primary = 1.74 cfs @ 12.41 hrs, Volume= 8,978 cf
Secondary = 4.72 cfs @ 12.40 hrs, Volume= 23,168 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 84.76' @ 12.40 hrs Surf.Area= 24,349 sf Storage= 24,889 cf
Flood Elev= 84.50' Surf.Area= 22,488 sf Storage= 18,822 cf

Plug-Flow detention time= 214.1 min calculated for 32,145 cf (62% of inflow)
Center-of-Mass det. time= 108.0 min ( 885.0 - 777.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 83.50' | 44,950 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

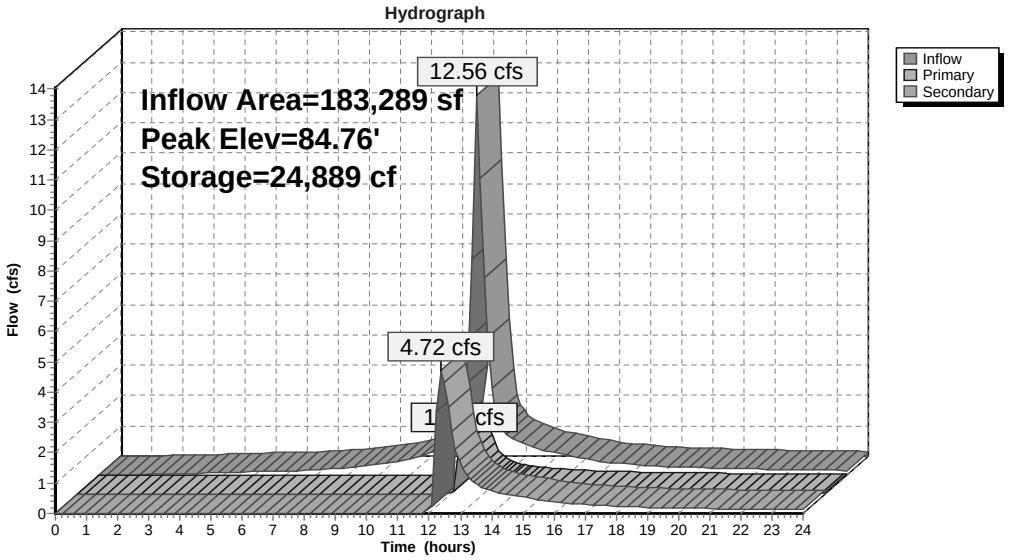
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 83.50 | 15,229 | 2,415.0 | 0 | 0 | 15,229 |
| 84.00 | 18,845 | 2,424.0 | 8,502 | 8,502 | 18,900 |
| 84.50 | 22,488 | 2,434.0 | 10,320 | 18,822 | 22,952 |
| 85.00 | 26,145 | 2,443.0 | 12,147 | 30,969 | 26,651 |
| 85.50 | 29,817 | 2,452.0 | 13,980 | 44,950 | 30,365 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.40' | **6.0" Round (2) 6" PVC X 2.00** L= 140.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 82.40' / 81.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.010 PVC, smooth interior, Flow Area= 0.20 sf |
| #2 | Device 1 | 84.50' | **8.0" Horiz. (2) 8" OVERFLOW X 2.00** C= 0.600 Limited to weir flow at low heads |
| #3 | Secondary | 84.50' | **15.0' long x 5.0' breadth RIP-RAP OVERFLOW**<br>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<br>Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88 |

**Primary OutFlow** Max=1.69 cfs @ 12.41 hrs HW=84.75' TW=0.00' (Dynamic Tailwater)
└─**1=(2) 6" PVC** (Passes 1.69 cfs of 2.00 cfs potential flow)
└─**2=(2) 8" OVERFLOW** (Orifice Controls 1.69 cfs @ 2.42 fps)

**Secondary OutFlow** Max=4.55 cfs @ 12.40 hrs HW=84.75' TW=82.71' (Dynamic Tailwater)
└─**3=RIP-RAP OVERFLOW** (Weir Controls 4.55 cfs @ 1.20 fps)

**Pond P2: SURFACE BASINS**






**Summary for Pond UIS1: UNDERGROUND CHAMBERS #1**

Inflow Area = 195,437 sf, 79.34% Impervious, Inflow Depth > 3.54" for 10-Year event
Inflow = 11.61 cfs @ 12.15 hrs, Volume= 57,628 cf
Outflow = 12.34 cfs @ 12.15 hrs, Volume= 47,928 cf, Atten= 0%, Lag= 0.2 min
Primary = 9.12 cfs @ 12.15 hrs, Volume= 30,821 cf
Secondary = 3.22 cfs @ 12.15 hrs, Volume= 17,107 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 86.00' @ 12.15 hrs Surf.Area= 10,861 sf Storage= 13,518 cf
Flood Elev= 84.36' Surf.Area= 10,861 sf Storage= 8,753 cf

Plug-Flow detention time= 115.7 min calculated for 47,689 cf (83% of inflow)
Center-of-Mass det. time= 51.5 min ( 848.4 - 796.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1B | 83.00' | 5,546 cf | **8.17'W x 928.80'L x 2.33'H Field B**<br>17,699 cf Overall - 3,833 cf Embedded = 13,866 cf x 40.0% Voids |
| #2B | 83.50' | 3,833 cf | **ADS_StormTech SC-310 +Cap** x 260 Inside #1<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>260 Chambers in 2 Rows |
| #3C | 83.00' | 1,094 cf | **14.83'W x 102.88'L x 2.33'H Field C**<br>3,561 cf Overall - 826 cf Embedded = 2,735 cf x 40.0% Voids |
| #4C | 83.50' | 826 cf | **ADS_StormTech SC-310 +Cap** x 56 Inside #3<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>56 Chambers in 4 Rows |
| #5D | 83.00' | 1,244 cf | **14.83'W x 117.12'L x 2.33'H Field D**<br>4,054 cf Overall - 943 cf Embedded = 3,110 cf x 40.0% Voids |
| #6D | 83.50' | 943 cf | **ADS_StormTech SC-310 +Cap** x 64 Inside #5<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>64 Chambers in 4 Rows |
| #7 | 83.50' | 50 cf | **4.00'D x 4.00'H DMH** |
| | | 13,537 cf | Total Available Storage |

Storage Group B created with Chamber Wizard
Storage Group C created with Chamber Wizard
Storage Group D created with Chamber Wizard

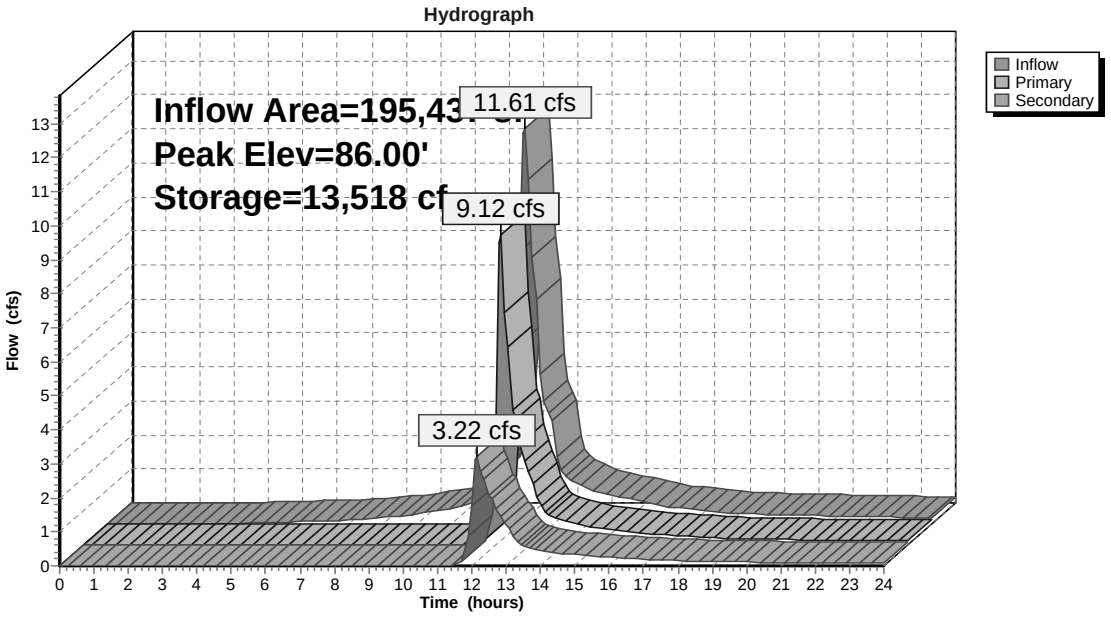
| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 84.36' | **24.0" Round 24" HDPE AT DMH12** L= 27.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 84.36' / 84.09' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 3.14 sf |
| #2 | Secondary | 84.36' | **12.0" Round 12" HDPE AT DMH8** L= 26.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 84.36' / 84.10' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=8.41 cfs @ 12.15 hrs HW=85.91' TW=81.79' (Dynamic Tailwater)
└**1=24" HDPE AT DMH12** (Barrel Controls 8.41 cfs @ 4.43 fps)

**Secondary OutFlow** Max=3.04 cfs @ 12.15 hrs HW=85.90' TW=81.90' (Dynamic Tailwater)
└**2=12" HDPE AT DMH8** (Inlet Controls 3.04 cfs @ 3.87 fps)



**Pond UIS1: UNDERGROUND CHAMBERS #1**



### Summary for Pond UIS2: UNDERGROUND CHAMBERS #2

Inflow Area = 37,413 sf, 92.13% Impervious, Inflow Depth > 4.06" for 10-Year event
Inflow = 3.07 cfs @ 12.14 hrs, Volume= 12,668 cf
Outflow = 2.37 cfs @ 12.27 hrs, Volume= 8,832 cf, Atten= 23%, Lag= 7.9 min
Primary = 2.37 cfs @ 12.27 hrs, Volume= 8,832 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 85.22' @ 12.27 hrs Surf.Area= 4,282 sf Storage= 5,302 cf
Flood Elev= 84.36' Surf.Area= 4,282 sf Storage= 3,589 cf

Plug-Flow detention time= 184.2 min calculated for 8,788 cf (69% of inflow)
Center-of-Mass det. time= 94.4 min ( 858.3 - 763.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 83.00' | 2,994 cf | **48.17'W x 88.64'L x 2.33'H Field A**<br>9,962 cf Overall - 2,477 cf Embedded = 7,486 cf x 40.0% Voids |
| #2A | 83.50' | 2,477 cf | **ADS_StormTech SC-310 +Cap** x 168 Inside #1<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>168 Chambers in 14 Rows |
| #3 | 83.50' | 50 cf | **4.00'D x 4.00'H DMH** |
| | | 5,521 cf | Total Available Storage |

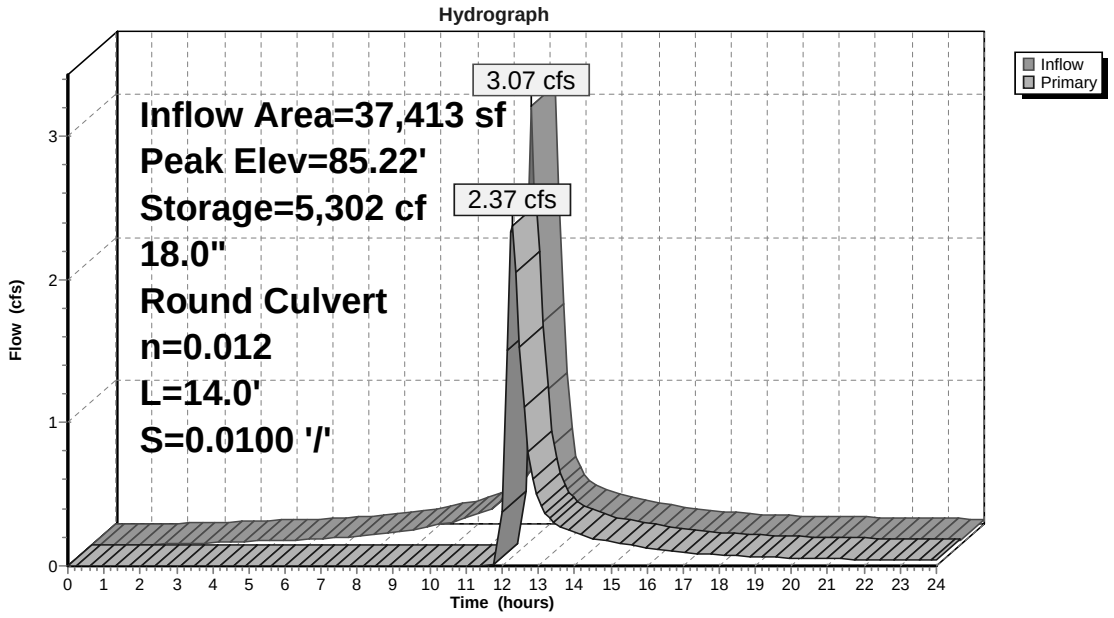
Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 84.36' | **18.0" Round 18" HDPE AT DMH3** L= 14.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 84.36' / 84.22' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=2.27 cfs @ 12.27 hrs HW=85.20' TW=81.82' (Dynamic Tailwater)
↑**1=18" HDPE AT DMH3** (Barrel Controls 2.27 cfs @ 3.23 fps)



### Pond UIS2: UNDERGROUND CHAMBERS #2

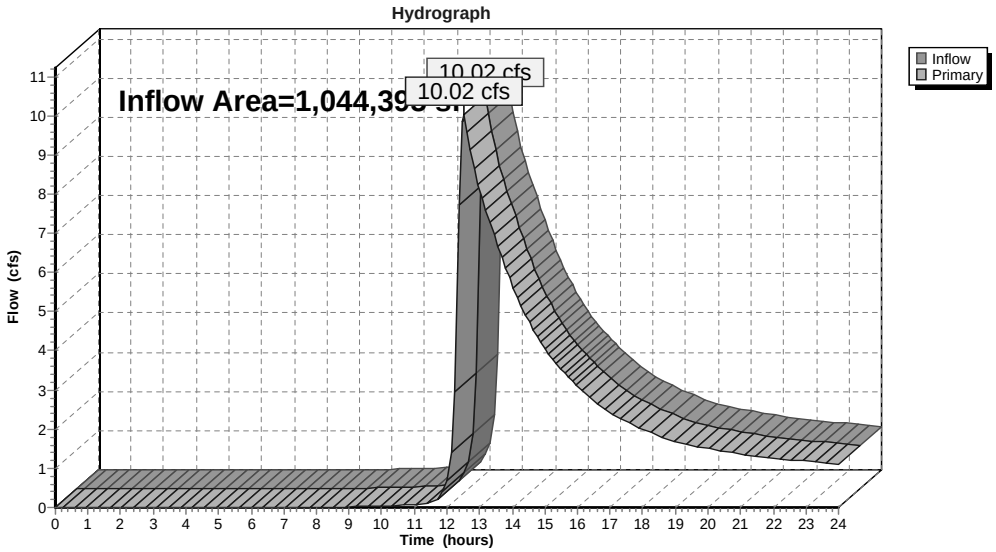


### Summary for Link SP-1: STUDY POINT #1

Inflow Area = 1,044,395 sf, 36.78% Impervious, Inflow Depth > 1.48" for 10-Year event
Inflow = 10.02 cfs @ 12.53 hrs, Volume= 128,688 cf
Primary = 10.02 cfs @ 12.53 hrs, Volume= 128,688 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs

### Link SP-1: STUDY POINT #1






### Summary for Subcatchment P-1A: PR. WATERSHED

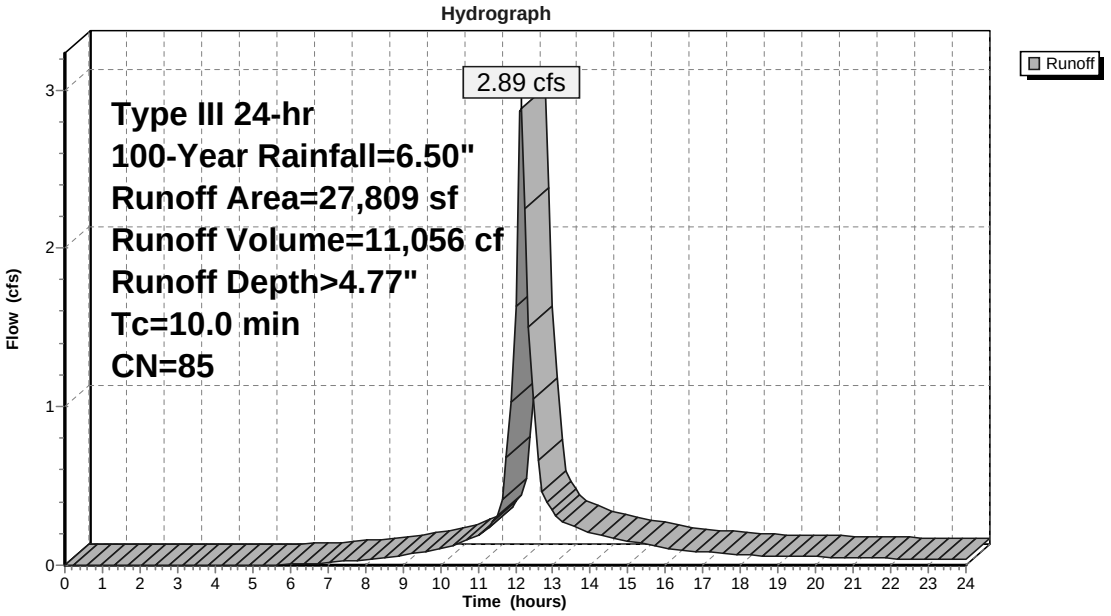
Runoff = 2.89 cfs @ 12.14 hrs, Volume= 11,056 cf, Depth> 4.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 14,724 | 74 | >75% Grass cover, Good, HSG C |
| * | 13,085 | 98 | Impervious |
| | 27,809 | 85 | Weighted Average |
| | 14,724 | | 52.95% Pervious Area |
| | 13,085 | | 47.05% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1A: PR. WATERSHED**






**Summary for Subcatchment P-1B: PR. WATERSHED**

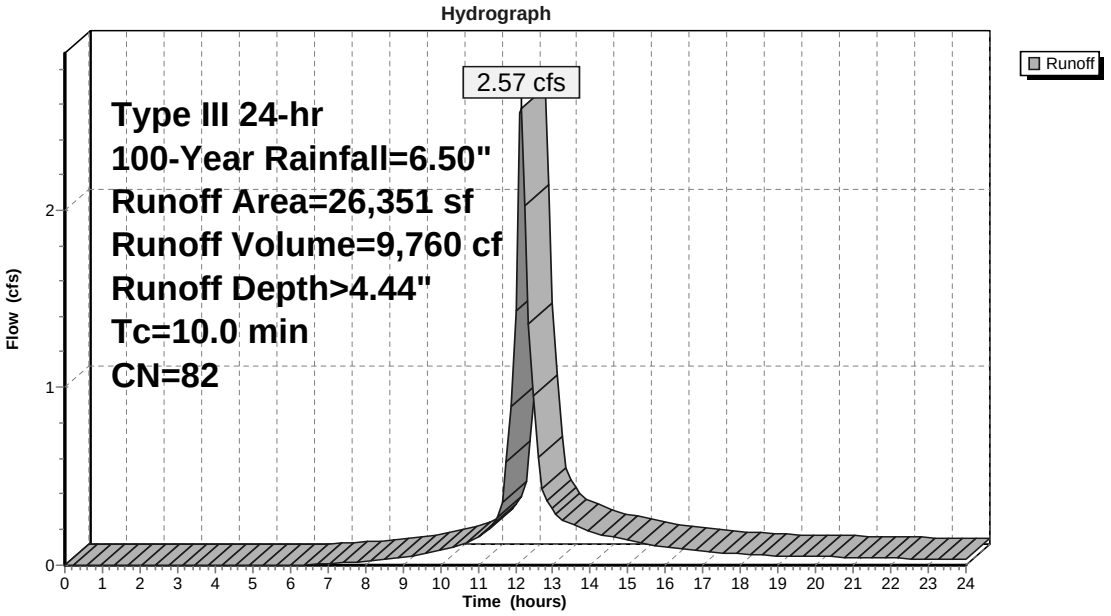
Runoff = 2.57 cfs @ 12.14 hrs, Volume= 9,760 cf, Depth> 4.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 17,448 | 74 | >75% Grass cover, Good, HSG C |
| * | 8,903 | 98 | Impervious |
| | 26,351 | 82 | Weighted Average |
| | 17,448 | | 66.21% Pervious Area |
| | 8,903 | | 33.79% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1B: PR. WATERSHED**






**Summary for Subcatchment P-1C: PR. WATERSHED**

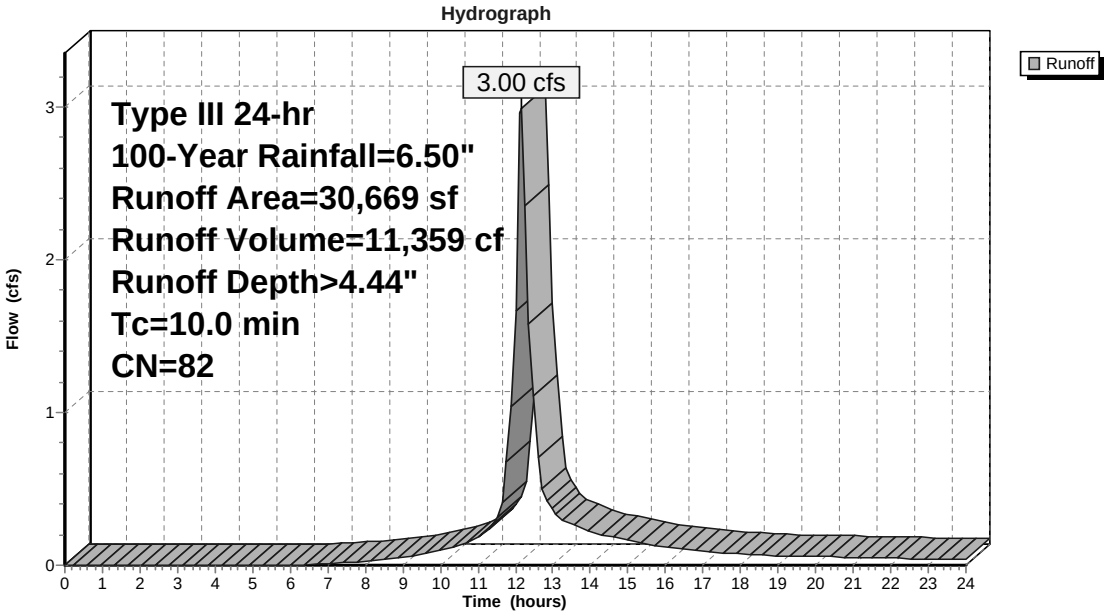
Runoff = 3.00 cfs @ 12.14 hrs, Volume= 11,359 cf, Depth> 4.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 20,040 | 74 | >75% Grass cover, Good, HSG C |
| * | 10,629 | 98 | Impervious |
| | 30,669 | 82 | Weighted Average |
| | 20,040 | | 65.34% Pervious Area |
| | 10,629 | | 34.66% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1C: PR. WATERSHED**






**Summary for Subcatchment P-1D: PR. WATERSHED**

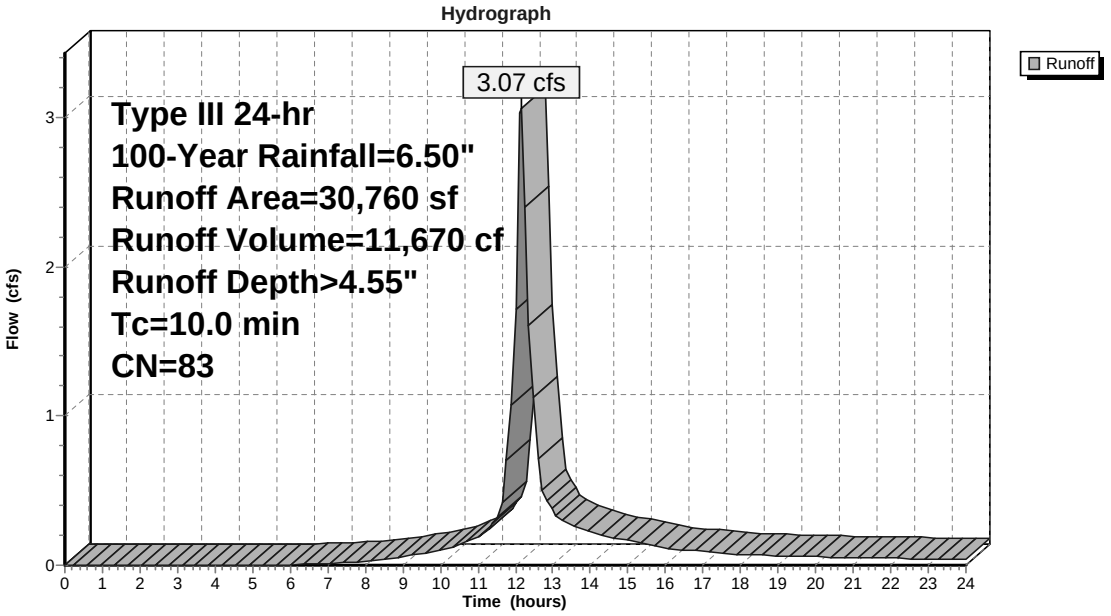
Runoff = 3.07 cfs @ 12.14 hrs, Volume= 11,670 cf, Depth> 4.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 19,029 | 74 | >75% Grass cover, Good, HSG C |
| * | 11,731 | 98 | Impervious |
| | 30,760 | 83 | Weighted Average |
| | 19,029 | | 61.86% Pervious Area |
| | 11,731 | | 38.14% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1D: PR. WATERSHED**






**Summary for Subcatchment P-1E: PR. WATERSHED**

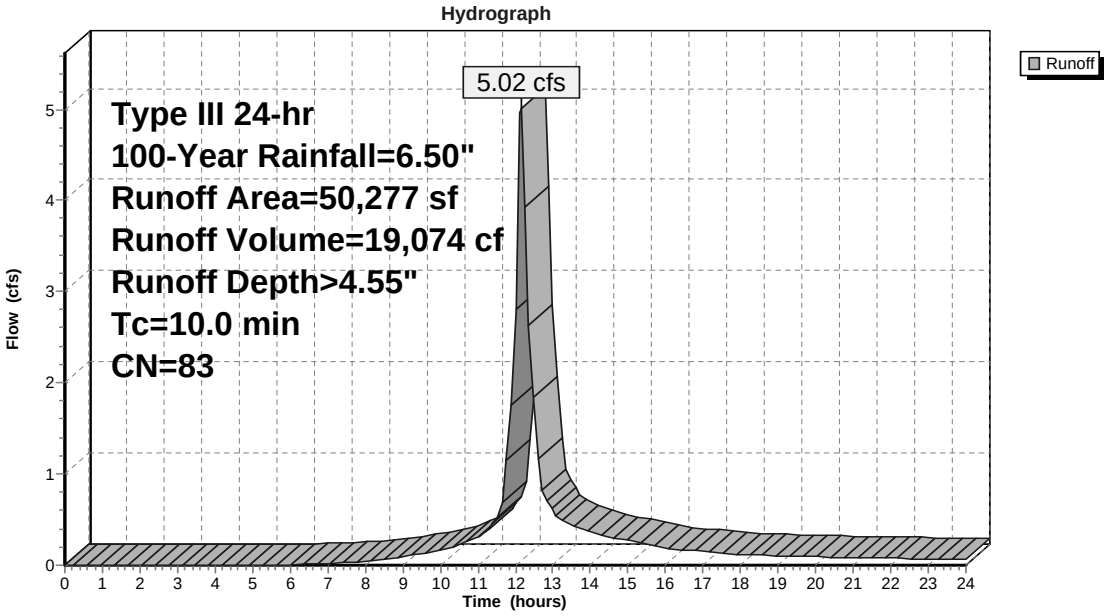
Runoff = 5.02 cfs @ 12.14 hrs, Volume= 19,074 cf, Depth> 4.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 31,091 | 74 | >75% Grass cover, Good, HSG C |
| * | 19,186 | 98 | Impervious |
| | 50,277 | 83 | Weighted Average |
| | 31,091 | | 61.84% Pervious Area |
| | 19,186 | | 38.16% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1E: PR. WATERSHED**






**Summary for Subcatchment P-1F: PR. WATERSHED**

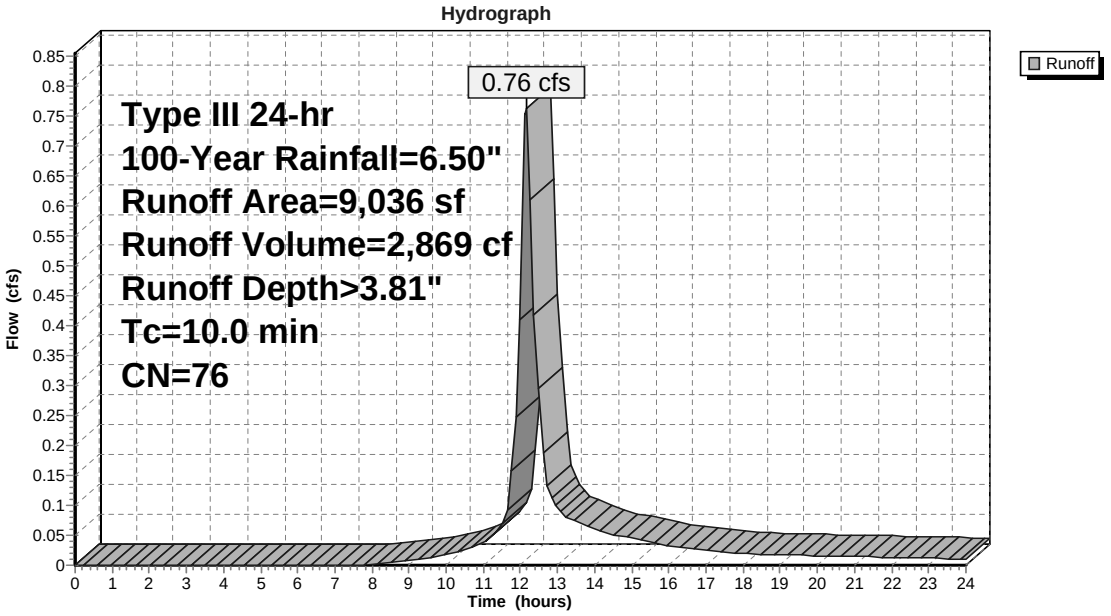
Runoff = 0.76 cfs @ 12.14 hrs, Volume= 2,869 cf, Depth> 3.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 8,156 | 74 | >75% Grass cover, Good, HSG C |
| * | 880 | 98 | Impervious |
| | 9,036 | 76 | Weighted Average |
| | 8,156 | | 90.26% Pervious Area |
| | 880 | | 9.74% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1F: PR. WATERSHED**






**Summary for Subcatchment P-1G: PR. WATERSHED**

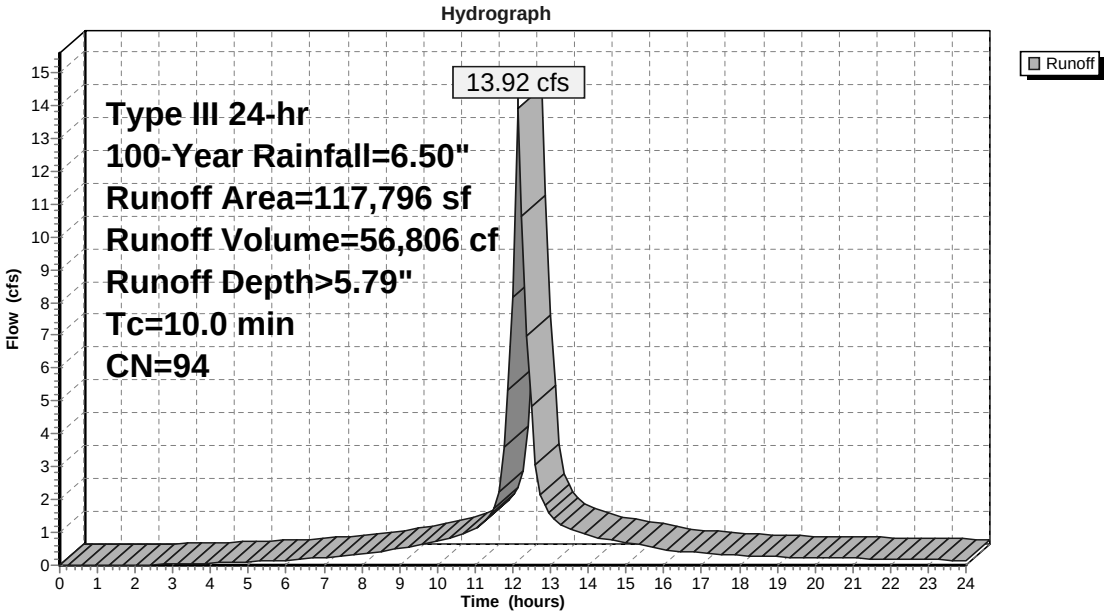
Runoff = 13.92 cfs @ 12.14 hrs, Volume= 56,806 cf, Depth> 5.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 21,862 | 74 | >75% Grass cover, Good, HSG C |
| * | 95,934 | 98 | Impervious |
| | 117,796 | 94 | Weighted Average |
| | 21,862 | | 18.56% Pervious Area |
| | 95,934 | | 81.44% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1G: PR. WATERSHED**






**Summary for Subcatchment P-1H: PR. WATERSHED**

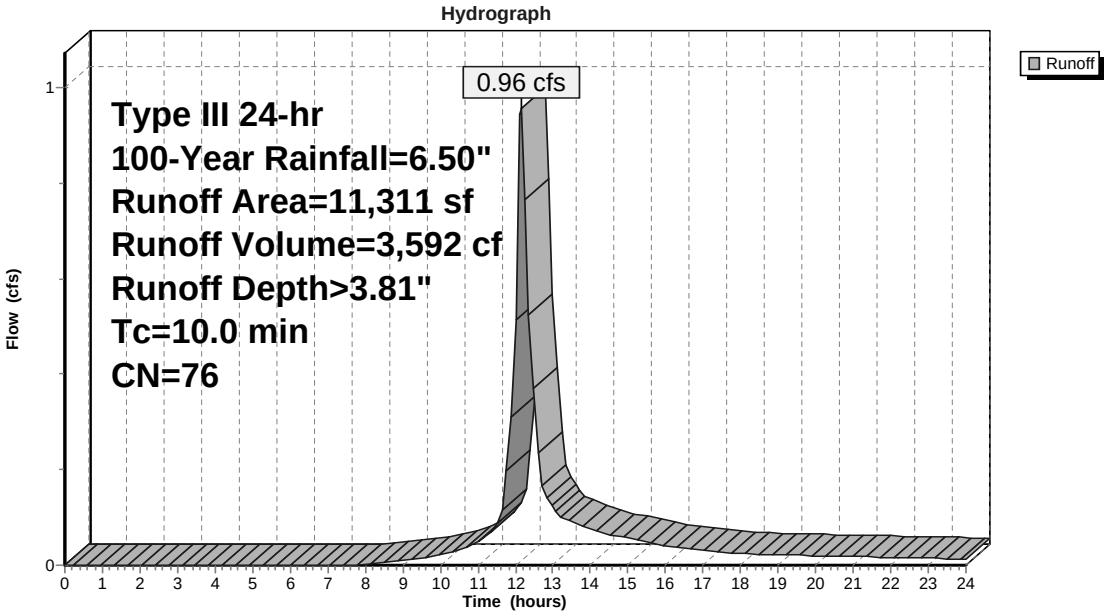
Runoff = 0.96 cfs @ 12.14 hrs, Volume= 3,592 cf, Depth> 3.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 10,351 | 74 | >75% Grass cover, Good, HSG C |
| * | 960 | 98 | Impervious |
| | 11,311 | 76 | Weighted Average |
| | 10,351 | | 91.51% Pervious Area |
| | 960 | | 8.49% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1H: PR. WATERSHED**






**Summary for Subcatchment P-1I: PR. WATERSHED**

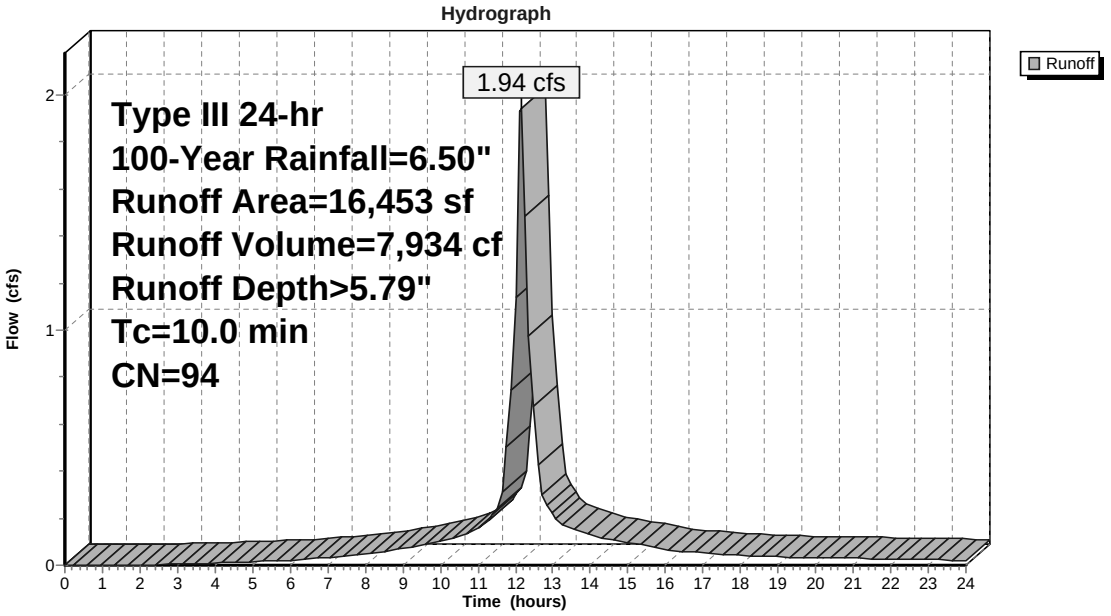
Runoff = 1.94 cfs @ 12.14 hrs, Volume= 7,934 cf, Depth> 5.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 2,946 | 74 | >75% Grass cover, Good, HSG C |
| * | 13,507 | 98 | Impervious |
| | 16,453 | 94 | Weighted Average |
| | 2,946 | | 17.91% Pervious Area |
| | 13,507 | | 82.09% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-1I: PR. WATERSHED**






**Summary for Subcatchment P-2A: PR. WATERSHED**

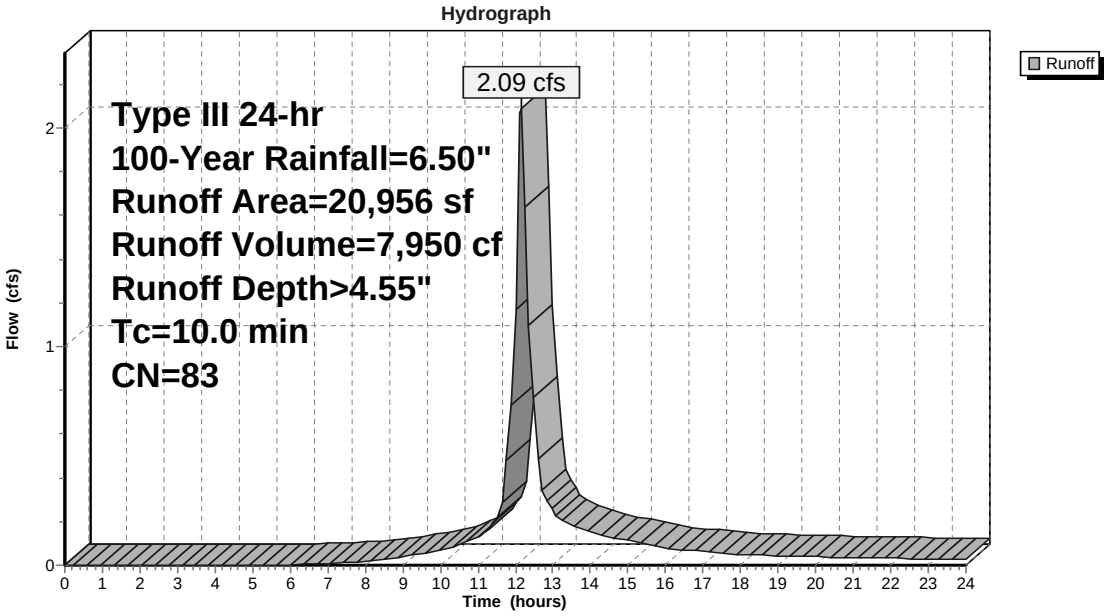
Runoff = 2.09 cfs @ 12.14 hrs, Volume= 7,950 cf, Depth> 4.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 12,753 | 74 | >75% Grass cover, Good, HSG C |
| * | 8,203 | 98 | Impervious |
| | 20,956 | 83 | Weighted Average |
| | 12,753 | | 60.86% Pervious Area |
| | 8,203 | | 39.14% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-2A: PR. WATERSHED**






**Summary for Subcatchment P-2B: PR. WATERSHED**

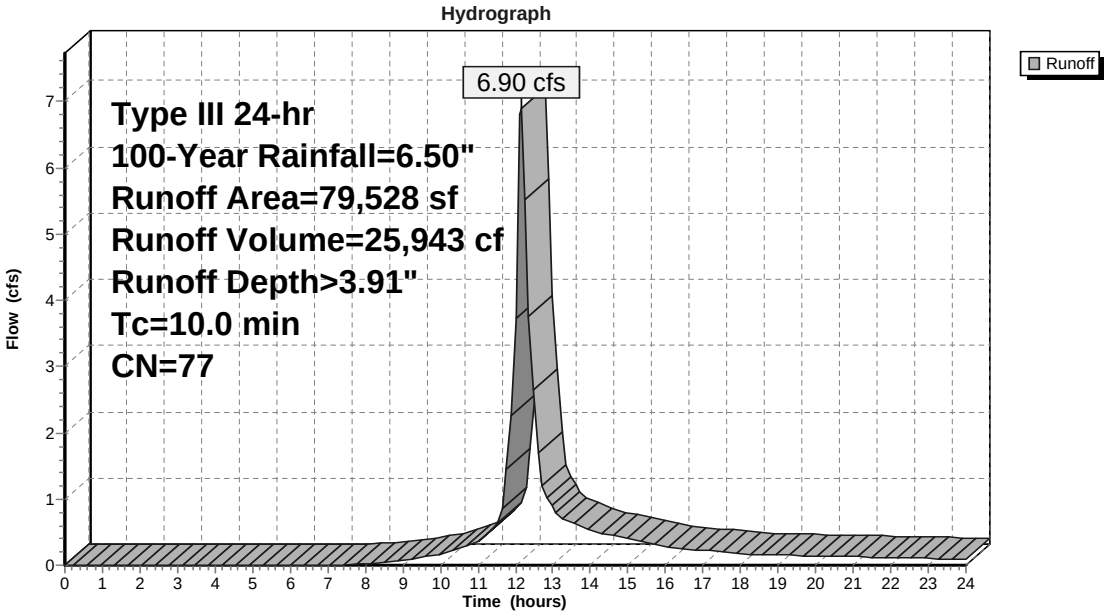
Runoff = 6.90 cfs @ 12.14 hrs, Volume= 25,943 cf, Depth> 3.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 69,830 | 74 | >75% Grass cover, Good, HSG C |
| * | 9,698 | 98 | Impervious |
| | 79,528 | 77 | Weighted Average |
| | 69,830 | | 87.81% Pervious Area |
| | 9,698 | | 12.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment P-2B: PR. WATERSHED**






**Summary for Subcatchment P-3: PR. WATERSHED**

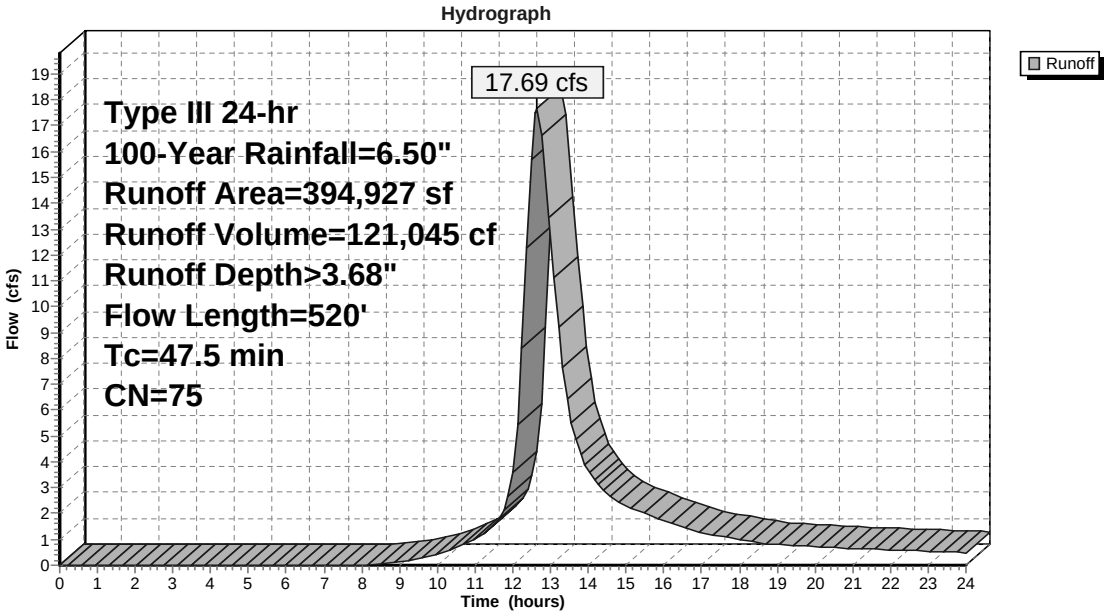
Runoff = 17.69 cfs @ 12.65 hrs, Volume= 121,045 cf, Depth> 3.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 237,023 | 77 | Woods, Good, HSG D |
| * | 9,383 | 98 | Impervious |
| | 148,521 | 70 | Woods, Good, HSG C |
| | 394,927 | 75 | Weighted Average |
| | 385,544 | | 97.62% Pervious Area |
| | 9,383 | | 2.38% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 28.3 | 100 | 0.0100 | 0.06 | | **Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.3 | 40 | 0.0100 | 0.50 | | **Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps |
| 17.9 | 380 | 0.0050 | 0.35 | | **Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps |
| 47.5 | 520 | Total | | | |

**Subcatchment P-3: PR. WATERSHED**






**Summary for Subcatchment R-1F: BUILDING #3 ROOF**

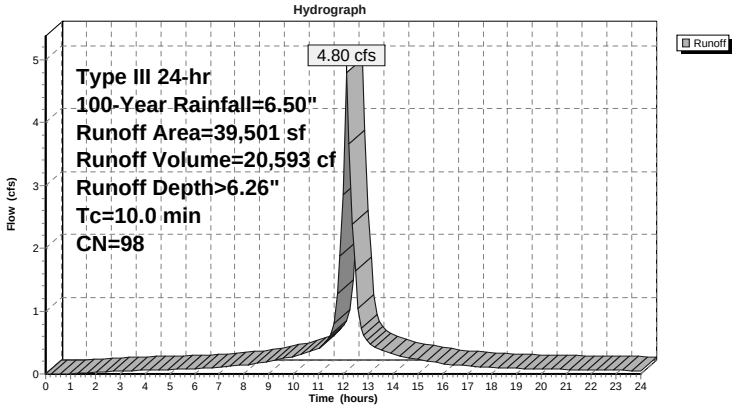
Runoff = 4.80 cfs @ 12.14 hrs, Volume= 20,593 cf, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 39,501 | 98 | Roof |
| | 39,501 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

**Subcatchment R-1F: BUILDING #3 ROOF**



### Summary for Subcatchment R-1H: BUILDING #3 ROOF

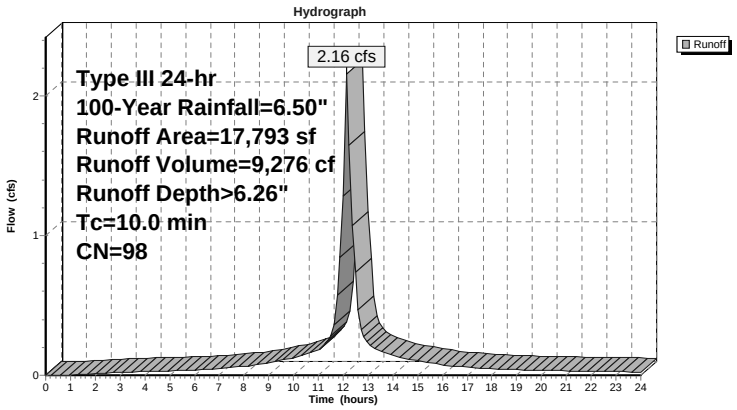
Runoff = 2.16 cfs @ 12.14 hrs, Volume= 9,276 cf, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 17,793 | 98 | Roof |
| | 17,793 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-1H: BUILDING #3 ROOF






### Summary for Subcatchment R-1I: BUILDING #3 ROOF

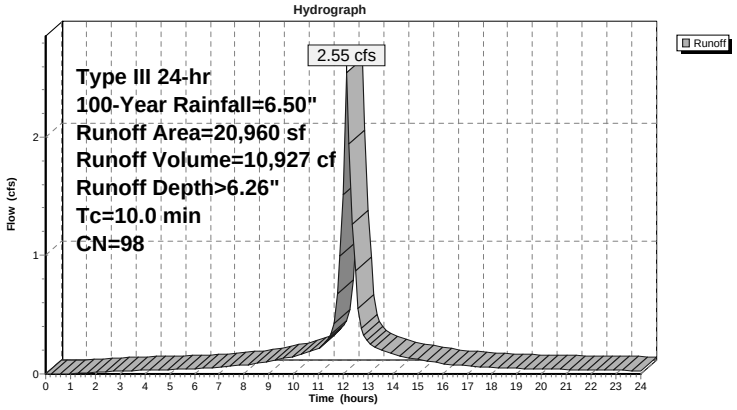
Runoff = 2.55 cfs @ 12.14 hrs, Volume= 10,927 cf, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 20,960 | 98 | Roof |
| | 20,960 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-1I: BUILDING #3 ROOF



### Summary for Subcatchment R-2A: BUILDING #1 ROOF

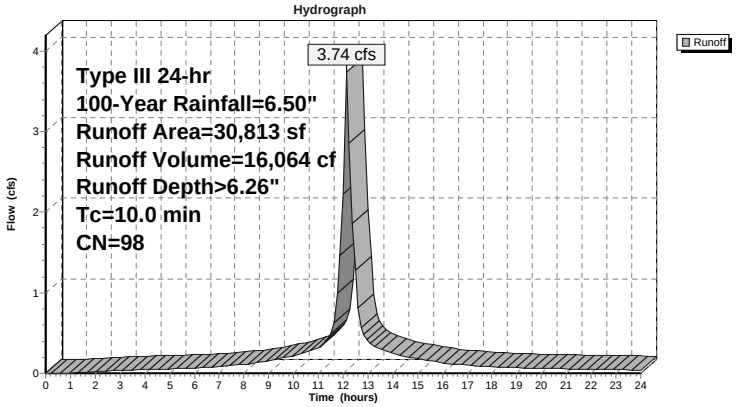
Runoff = 3.74 cfs @ 12.14 hrs, Volume= 16,064 cf, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 30,813 | 98 | Roof |
| | 30,813 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-2A: BUILDING #1 ROOF






### Summary for Subcatchment R-2B: BUILDING #2 ROOF

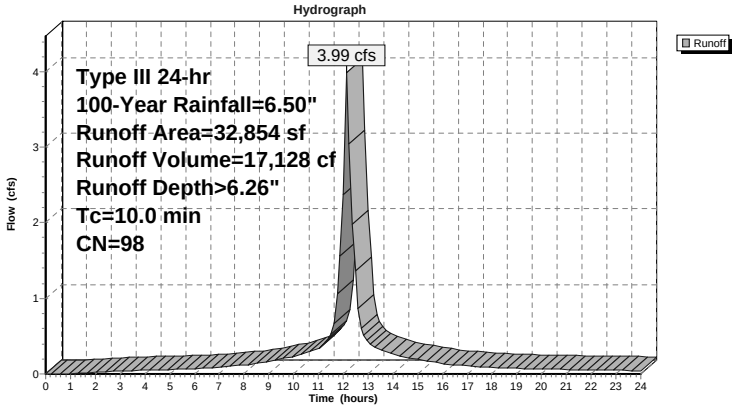
Runoff = 3.99 cfs @ 12.14 hrs, Volume= 17,128 cf, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 32,854 | 98 | Roof |
| | 32,854 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-2B: BUILDING #2 ROOF



### Summary for Subcatchment R-2C: BUILDING #3 ROOF

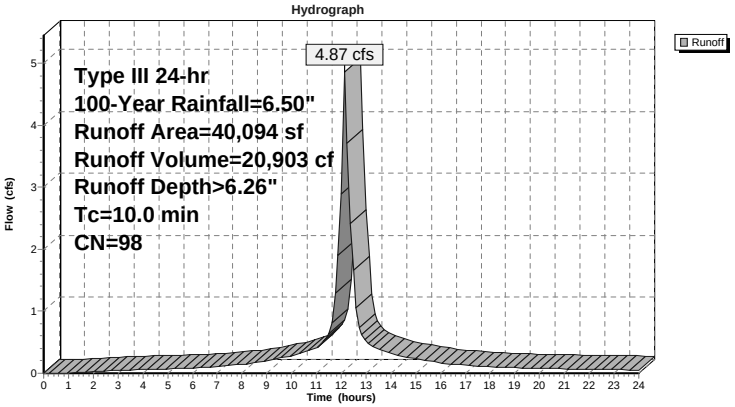
Runoff = 4.87 cfs @ 12.14 hrs, Volume= 20,903 cf, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 40,094 | 98 | Roof |
| | 40,094 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment R-2C: BUILDING #3 ROOF






### Summary for Subcatchment W-1: Wetlands

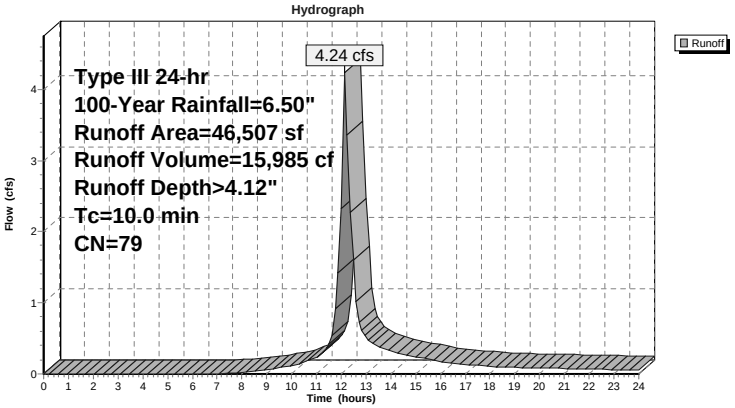
Runoff = 4.24 cfs @ 12.14 hrs, Volume= 15,985 cf, Depth> 4.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 46,507 | 79 | Woods/grass comb., Good, HSG D |
| | 46,507 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, MIN. TC** |

### Subcatchment W-1: Wetlands



## Summary for Pond ES: Offsite Swale to South Culvert

Inflow Area = 445,223 sf, 56.84% Impervious, Inflow Depth > 4.65" for 100-Year event
Inflow = 36.05 cfs @ 12.22 hrs, Volume= 172,620 cf
Outflow = 12.25 cfs @ 12.75 hrs, Volume= 145,070 cf, Atten= 66%, Lag= 31.5 min
Primary = 12.25 cfs @ 12.75 hrs, Volume= 145,070 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 81.06' @ 12.75 hrs Surf.Area= 64,593 sf Storage= 69,615 cf

Plug-Flow detention time= 142.9 min calculated for 145,070 cf (84% of inflow)
Center-of-Mass det. time= 79.2 min ( 907.4 - 828.2 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 79.00' | 136,108 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

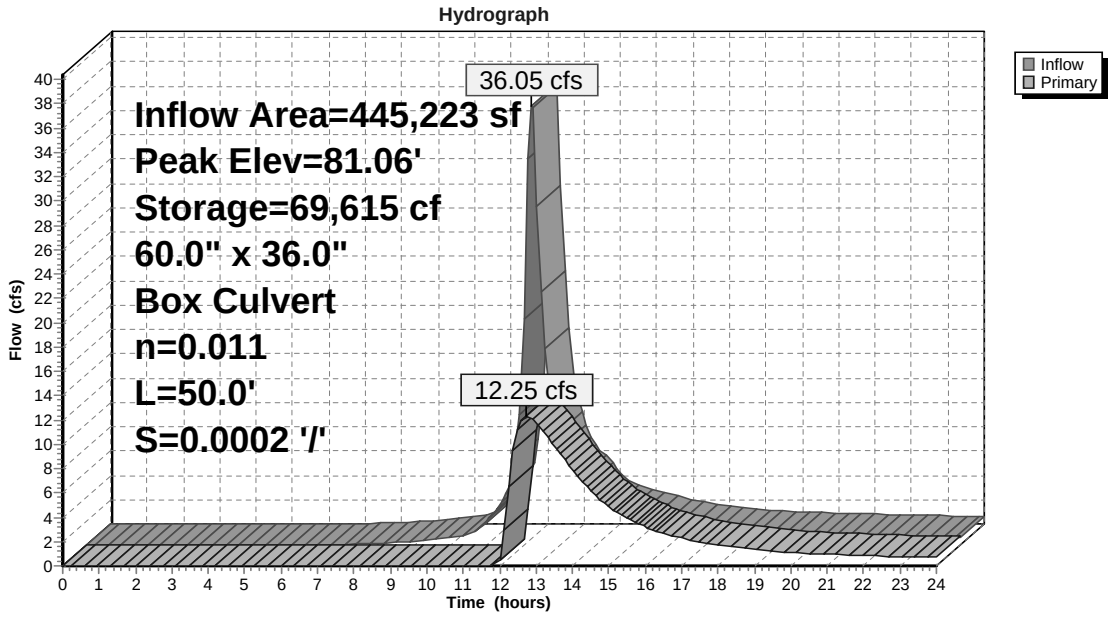
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 79.00 | 17,000 | 1,200.0 | 0 | 0 | 17,000 |
| 80.00 | 27,000 | 4,000.0 | 21,808 | 21,808 | 1,175,651 |
| 81.00 | 63,900 | 4,200.0 | 44,146 | 65,954 | 1,306,222 |
| 82.00 | 76,600 | 4,250.0 | 70,154 | 136,108 | 1,340,108 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.00' | **60.0" W x 36.0" H Box Culvert** L= 50.0' Box, headwall w/3 square edges, Ke= 0.500<br>Inlet / Outlet Invert= 80.00' / 79.99' S= 0.0002 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 15.00 sf |

**Primary OutFlow** Max=12.22 cfs @ 12.75 hrs HW=81.06' TW=0.00' (Dynamic Tailwater)
**1=Culvert** (Barrel Controls 12.22 cfs @ 3.09 fps)



## Pond ES: Offsite Swale to South Culvert



### Summary for Pond EW: Wetland to East Culvert

Inflow Area = 394,927 sf, 2.38% Impervious, Inflow Depth > 3.68" for 100-Year event
Inflow = 17.69 cfs @ 12.65 hrs, Volume= 121,045 cf
Outflow = 1.31 cfs @ 16.82 hrs, Volume= 46,847 cf, Atten= 93%, Lag= 250.2 min
Primary = 1.31 cfs @ 16.82 hrs, Volume= 46,847 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 80.92' @ 16.82 hrs Surf.Area= 139,993 sf Storage= 85,504 cf

Plug-Flow detention time= 375.1 min calculated for 46,847 cf (39% of inflow)
Center-of-Mass det. time= 252.2 min ( 1,107.9 - 855.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 290,435 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

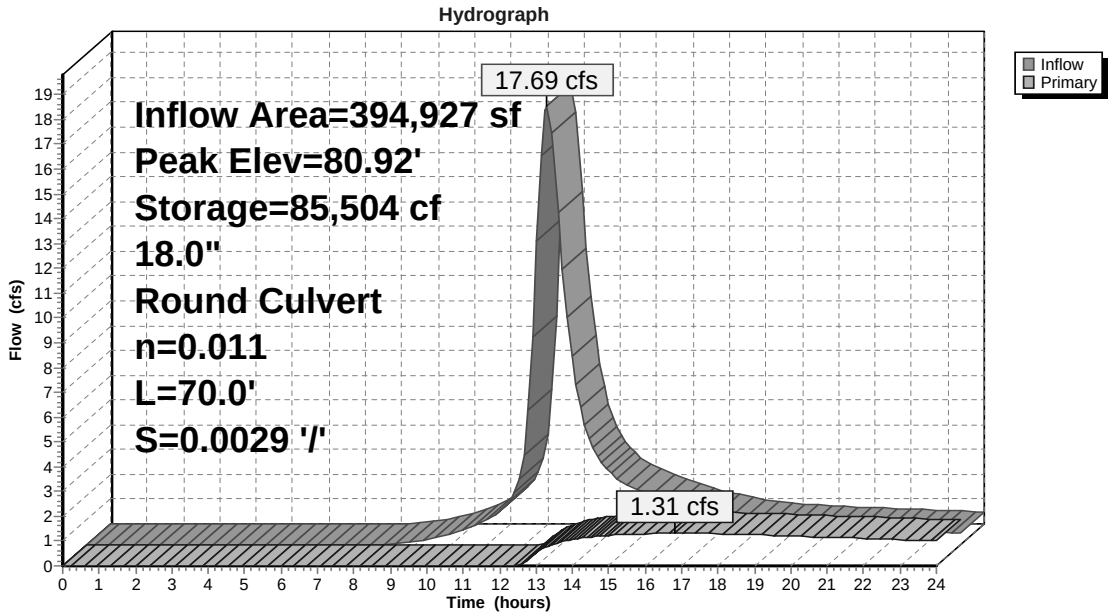
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 52,000 | 1,200.0 | 0 | 0 | 52,000 |
| 81.00 | 149,000 | 2,600.0 | 96,341 | 96,341 | 475,356 |
| 82.00 | 243,000 | 4,300.0 | 194,094 | 290,435 | 1,408,807 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 80.30' | **18.0" Round Culvert** L= 70.0' RCP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 80.30' / 80.10' S= 0.0029 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=1.31 cfs @ 16.82 hrs HW=80.92' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 1.31 cfs @ 2.79 fps)



### Pond EW: Wetland to East Culvert



### Summary for Pond OFFSITE: OFFSITE PONDING AREA IN GRASS

Inflow = 11.81 cfs @ 12.28 hrs, Volume= 45,974 cf
Outflow = 11.55 cfs @ 12.33 hrs, Volume= 45,616 cf, Atten= 2%, Lag= 2.8 min
Primary = 11.55 cfs @ 12.33 hrs, Volume= 45,616 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 82.85' @ 12.33 hrs Surf.Area= 5,905 sf Storage= 2,314 cf

Plug-Flow detention time= 11.5 min calculated for 45,389 cf (99% of inflow)
Center-of-Mass det. time= 7.0 min ( 853.6 - 846.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 82.10' | 3,254 cf | **OFFSITE PONDING AREA (Prismatic)** Listed below (Recalc) |

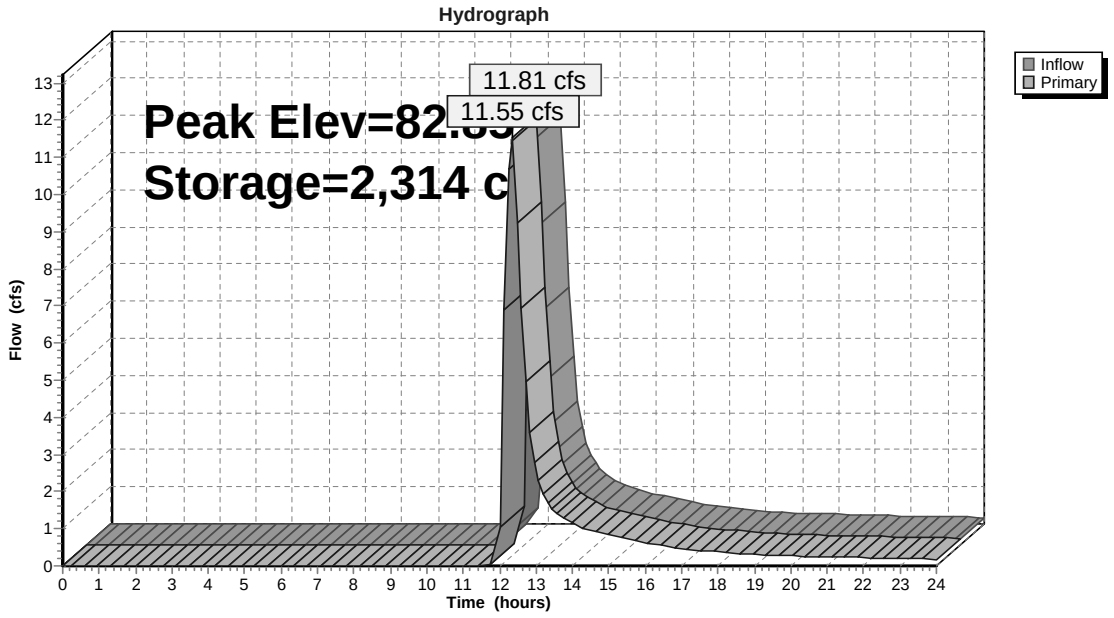
| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 82.10 | 230 | 0 | 0 |
| 83.00 | 7,000 | 3,254 | 3,254 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.27' | **8.0" Round (3) 8" HDPE X 3.00 w/ 2.0" inside fill** L= 21.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 82.10' / 81.40' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.28 sf |
| #2 | Primary | 82.60' | **30.0' long x 10.0' breadth WEIR FLOW OVER WALKING PATH**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64 |

**Primary OutFlow** Max=11.27 cfs @ 12.33 hrs HW=82.85' TW=0.00' (Dynamic Tailwater)
└─**1=(3) 8" HDPE** (Inlet Controls 1.88 cfs @ 2.23 fps)
└─**2=WEIR FLOW OVER WALKING PATH** (Weir Controls 9.39 cfs @ 1.25 fps)



### Pond OFFSITE: OFFSITE PONDING AREA IN GRASS



### Summary for Pond P1C: BIO.RET. #1

Inflow Area = 48,537 sf, 83.20% Impervious, Inflow Depth > 5.80" for 100-Year event
Inflow = 5.56 cfs @ 12.14 hrs, Volume= 23,463 cf
Outflow = 1.97 cfs @ 12.63 hrs, Volume= 20,879 cf, Atten= 65%, Lag= 29.5 min
Primary = 1.97 cfs @ 12.63 hrs, Volume= 20,879 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 87.45' @ 12.50 hrs Surf.Area= 6,051 sf Storage= 7,873 cf
Flood Elev= 86.50' Surf.Area= 5,219 sf Storage= 2,505 cf

Plug-Flow detention time= 114.8 min calculated for 20,775 cf (89% of inflow)
Center-of-Mass det. time= 64.2 min ( 820.6 - 756.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 86.00' | 8,156 cf | **BIORETENTION #1 (Irregular)** Listed below (Recalc) |

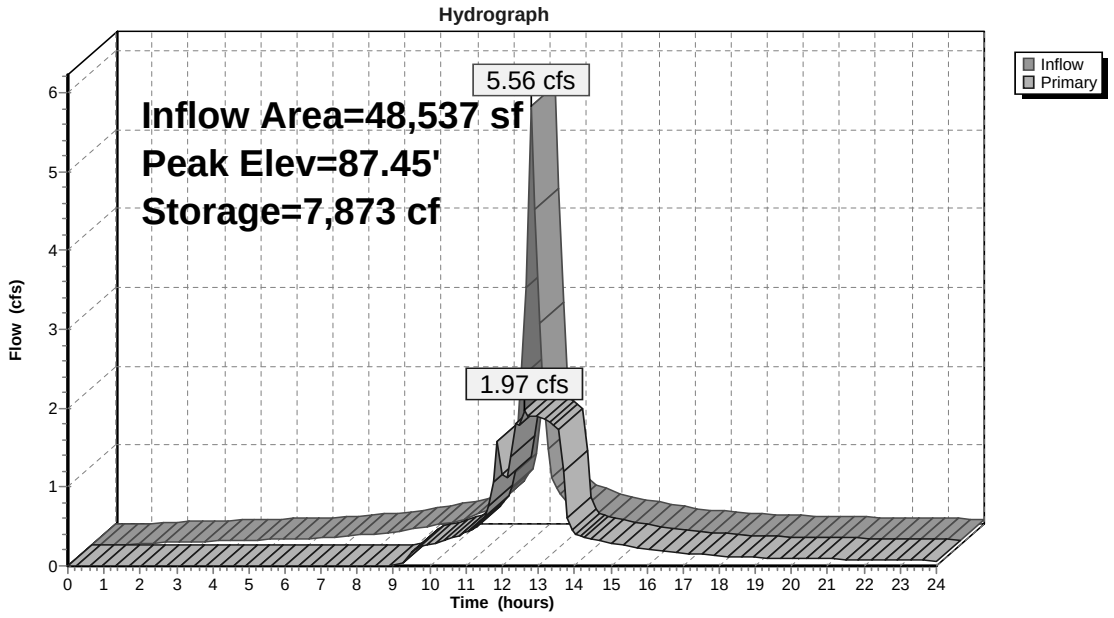
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 86.00 | 4,804 | 272.0 | 0 | 0 | 4,804 |
| 86.50 | 5,219 | 282.0 | 2,505 | 2,505 | 5,266 |
| 87.00 | 5,649 | 291.0 | 2,716 | 5,221 | 5,701 |
| 87.50 | 6,093 | 301.0 | 2,935 | 8,156 | 6,195 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 83.97' | **6.0" Round (2) 6" HDPE X 2.00** L= 56.0' CPP, mitered to conform to fill, Ke= 0.700<br>Inlet / Outlet Invert= 83.97' / 83.83' S= 0.0025 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf |
| #2 | Device 1 | 86.50' | **8.0" Horiz. (5) 8" OVERFLOW X 5.00** C= 0.600 Limited to weir flow at low heads |

**Primary OutFlow** Max=1.94 cfs @ 12.63 hrs HW=87.42' TW=85.33' (Dynamic Tailwater)
↑└**1=(2) 6" HDPE** (Outlet Controls 1.94 cfs @ 4.95 fps)
↑└**2=(5) 8" OVERFLOW** (Passes 1.94 cfs of 8.04 cfs potential flow)



### Pond P1C: BIO.RET. #1



## Summary for Pond P1D: BIO.RET. #2

Inflow Area = 29,104 sf, 64.43% Impervious, Inflow Depth > 5.31" for 100-Year event
Inflow = 3.12 cfs @ 12.14 hrs, Volume= 12,868 cf
Outflow = 1.78 cfs @ 12.61 hrs, Volume= 11,690 cf, Atten= 43%, Lag= 28.3 min
Primary = 1.78 cfs @ 12.61 hrs, Volume= 11,690 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 87.14' @ 12.38 hrs Surf.Area= 3,581 sf Storage= 3,148 cf
Flood Elev= 86.50' Surf.Area= 2,628 sf Storage= 1,146 cf

Plug-Flow detention time= 90.6 min calculated for 11,632 cf (90% of inflow)
Center-of-Mass det. time= 46.4 min ( 814.8 - 768.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 86.00' | 1,686 cf | **BIORETENTION (Irregular)** Listed below (Recalc) |
| #2 | 86.00' | 2,826 cf | **BIORETENTION (Irregular)** Listed below (Recalc) |
| | | 4,512 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 86.00 | 688 | 169.0 | 0 | 0 | 688 |
| 87.00 | 1,281 | 203.0 | 969 | 969 | 1,712 |
| 87.50 | 1,592 | 212.0 | 717 | 1,686 | 2,026 |

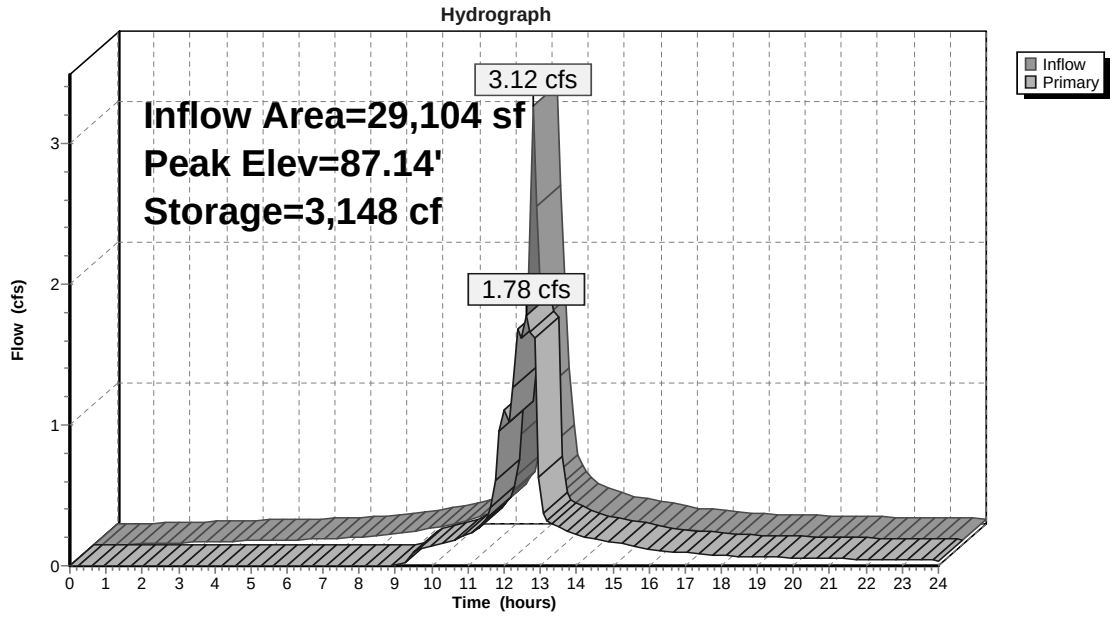
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 86.00 | 1,285 | 193.0 | 0 | 0 | 1,285 |
| 87.00 | 2,098 | 271.0 | 1,675 | 1,675 | 4,174 |
| 87.50 | 2,512 | 280.0 | 1,151 | 2,826 | 4,592 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 83.97' | **6.0" Round (2) 6" HDPE X 2.00** L= 54.0' CPP, mitered to conform to fill, Ke= 0.700<br>Inlet / Outlet Invert= 83.97' / 83.83' S= 0.0026 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf |
| #2 | Device 1 | 86.50' | **8.0" Horiz. (4) 8" OVERFLOW X 4.00** C= 0.600 Limited to weir flow at low heads |



**Primary OutFlow** Max=1.76 cfs @ 12.61 hrs HW=87.00' TW=85.32' (Dynamic Tailwater)
↑└1=(2) 6" HDPE (Outlet Controls 1.76 cfs @ 4.49 fps)
↑└2=(4) 8" OVERFLOW (Passes 1.76 cfs of 4.74 cfs potential flow)

## Pond P1D: BIO.RET. #2



## Summary for Pond P1E: Wet Basin #1

Inflow Area = 27,809 sf, 47.05% Impervious, Inflow Depth > 4.77" for 100-Year event
Inflow = 2.89 cfs @ 12.14 hrs, Volume= 11,056 cf
Outflow = 2.63 cfs @ 12.21 hrs, Volume= 11,024 cf, Atten= 9%, Lag= 4.0 min
Primary = 2.63 cfs @ 12.21 hrs, Volume= 11,024 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Starting Elev= 81.50' Surf.Area= 3,408 sf Storage= 3,980 cf
Peak Elev= 81.67' @ 12.21 hrs Surf.Area= 3,584 sf Storage= 4,565 cf (584 cf above start)
Flood Elev= 81.50' Surf.Area= 3,408 sf Storage= 3,980 cf

Plug-Flow detention time= 178.4 min calculated for 7,044 cf (64% of inflow)
Center-of-Mass det. time= 5.6 min ( 806.4 - 800.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 7,924 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

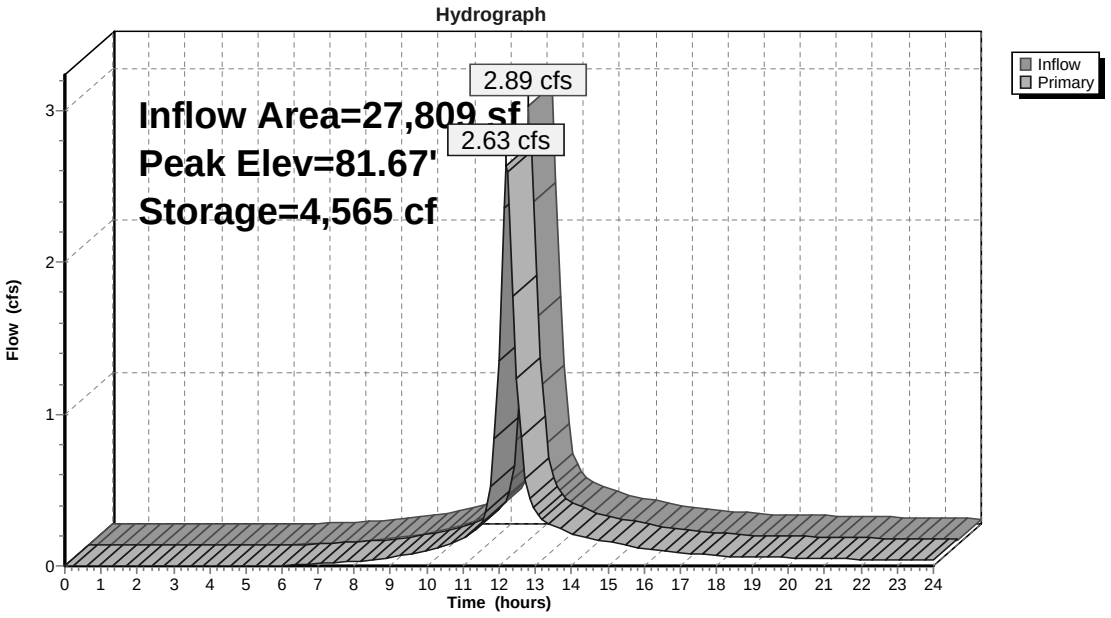
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 1,930 | 299.0 | 0 | 0 | 1,930 |
| 81.00 | 2,909 | 337.0 | 2,403 | 2,403 | 3,879 |
| 82.00 | 3,947 | 355.0 | 3,415 | 5,818 | 4,929 |
| 82.50 | 4,486 | 364.0 | 2,107 | 7,924 | 5,475 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 81.50' | **15.0' long x 12.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64 |

**Primary OutFlow** Max=2.52 cfs @ 12.21 hrs HW=81.66' TW=80.64' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 2.52 cfs @ 1.04 fps)



## Pond P1E: Wet Basin #1



## Summary for Pond P1F: Wet Basin #2

Inflow Area = 320,630 sf, 68.86% Impervious, Inflow Depth > 3.74" for 100-Year event
Inflow = 23.91 cfs @ 12.17 hrs, Volume= 100,048 cf
Outflow = 23.21 cfs @ 12.22 hrs, Volume= 99,762 cf, Atten= 3%, Lag= 3.4 min
Primary = 23.21 cfs @ 12.22 hrs, Volume= 99,762 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Starting Elev= 81.50' Surf.Area= 10,650 sf Storage= 10,212 cf
Peak Elev= 81.95' @ 12.22 hrs Surf.Area= 13,696 sf Storage= 15,626 cf (5,414 cf above start)
Flood Elev= 81.50' Surf.Area= 10,650 sf Storage= 10,212 cf

Plug-Flow detention time= 72.7 min calculated for 89,551 cf (90% of inflow)
Center-of-Mass det. time= 5.3 min ( 824.4 - 819.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 24,130 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

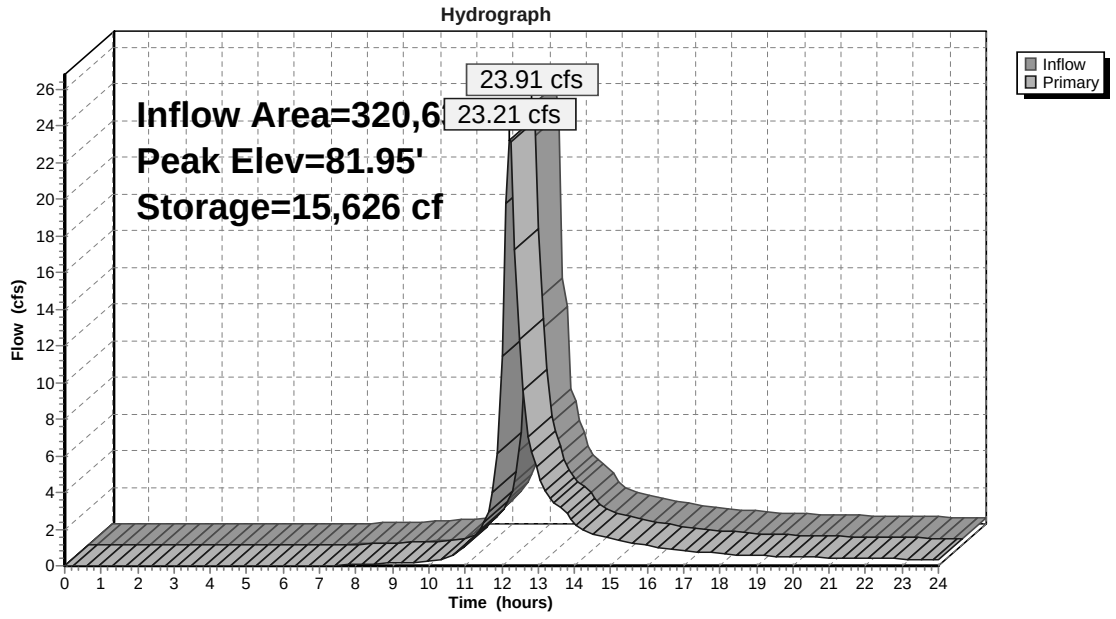
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 3,826 | 408.0 | 0 | 0 | 3,826 |
| 81.00 | 7,690 | 1,455.0 | 5,647 | 5,647 | 159,050 |
| 82.00 | 14,091 | 2,271.0 | 10,730 | 16,377 | 401,005 |
| 82.50 | 16,964 | 2,177.0 | 7,753 | 24,130 | 434,296 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 81.50' | **15.0' long x 7.0' breadth Broad-Crested Rectangular Weir**<br>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<br>Coef. (English) 2.40 2.52 2.70 2.68 2.68 2.67 2.66 2.65 2.65 2.65 2.66 2.65 2.66 2.68 2.70 2.73 2.78 |
| #2 | Primary | 81.50' | **15.0' long x 12.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64 |



**Primary OutFlow** Max=22.64 cfs @ 12.22 hrs HW=81.94' TW=80.67' (Dynamic Tailwater)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 11.15 cfs @ 1.69 fps)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 11.50 cfs @ 1.75 fps)

### Pond P1F: Wet Basin #2



### Summary for Pond P1G: Wet Basin #3

Inflow Area = 50,277 sf, 38.16% Impervious, Inflow Depth > 11.05" for 100-Year event
Inflow = 8.56 cfs @ 12.14 hrs, Volume= 46,289 cf
Outflow = 6.92 cfs @ 12.28 hrs, Volume= 45,849 cf, Atten= 19%, Lag= 8.3 min
Primary = 6.92 cfs @ 12.28 hrs, Volume= 45,849 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Starting Elev= 81.50' Surf.Area= 7,082 sf Storage= 6,991 cf
Peak Elev= 82.14' @ 12.28 hrs Surf.Area= 9,673 sf Storage= 12,348 cf (5,357 cf above start)
Flood Elev= 81.50' Surf.Area= 7,082 sf Storage= 6,991 cf

Plug-Flow detention time= 111.4 min calculated for 38,664 cf (84% of inflow)
Center-of-Mass det. time= 16.0 min ( 845.9 - 829.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 80.00' | 16,095 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

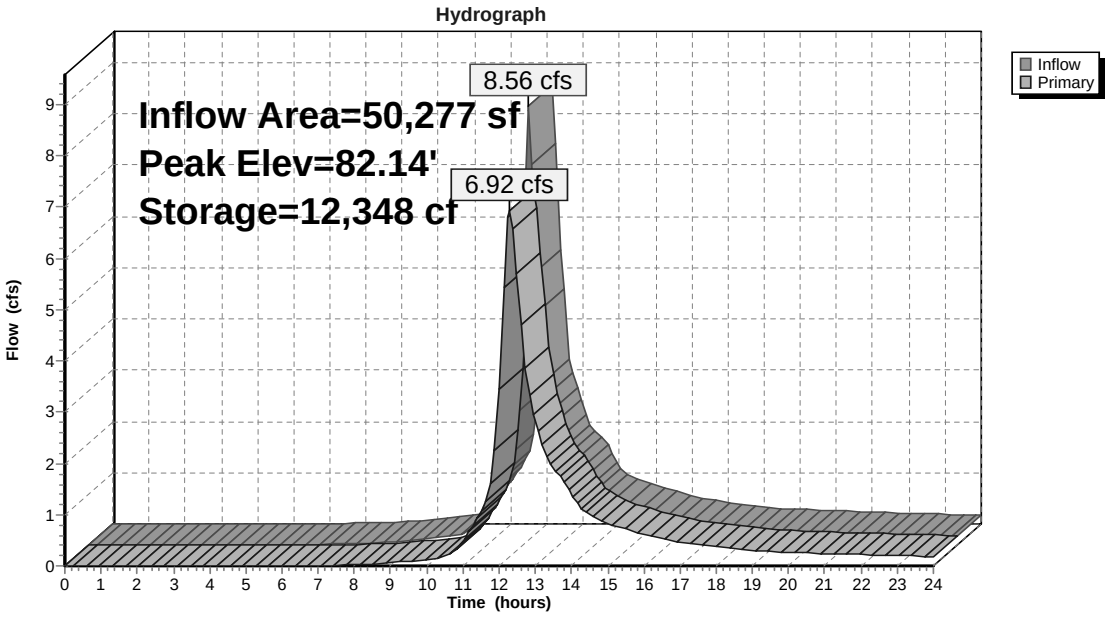
| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 80.00 | 2,647 | 420.0 | 0 | 0 | 2,647 |
| 81.00 | 5,312 | 1,188.0 | 3,903 | 3,903 | 100,924 |
| 82.00 | 9,107 | 1,389.0 | 7,125 | 11,028 | 142,163 |
| 82.50 | 11,198 | 1,400.0 | 5,067 | 16,095 | 144,702 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 81.50' | **5.0' long x 6.0' breadth Broad-Crested Rectangular Weir**<br>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<br>Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83 |

**Primary OutFlow** Max=6.74 cfs @ 12.28 hrs HW=82.13' TW=80.78' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Weir Controls 6.74 cfs @ 2.14 fps)



### Pond P1G: Wet Basin #3



## Summary for Pond P2: SURFACE BASINS

Inflow Area = 183,289 sf, 61.90% Impervious, Inflow Depth > 5.24" for 100-Year event
Inflow = 19.50 cfs @ 12.14 hrs, Volume= 80,038 cf
Outflow = 13.88 cfs @ 12.28 hrs, Volume= 60,562 cf, Atten= 29%, Lag= 8.8 min
Primary = 2.06 cfs @ 12.24 hrs, Volume= 14,588 cf
Secondary = 11.81 cfs @ 12.28 hrs, Volume= 45,974 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 84.96' @ 12.29 hrs Surf.Area= 25,820 sf Storage= 29,853 cf
Flood Elev= 84.50' Surf.Area= 22,488 sf Storage= 18,822 cf

Plug-Flow detention time= 164.2 min calculated for 60,261 cf (75% of inflow)
Center-of-Mass det. time= 81.4 min ( 852.5 - 771.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 83.50' | 44,950 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 83.50 | 15,229 | 2,415.0 | 0 | 0 | 15,229 |
| 84.00 | 18,845 | 2,424.0 | 8,502 | 8,502 | 18,900 |
| 84.50 | 22,488 | 2,434.0 | 10,320 | 18,822 | 22,952 |
| 85.00 | 26,145 | 2,443.0 | 12,147 | 30,969 | 26,651 |
| 85.50 | 29,817 | 2,452.0 | 13,980 | 44,950 | 30,365 |

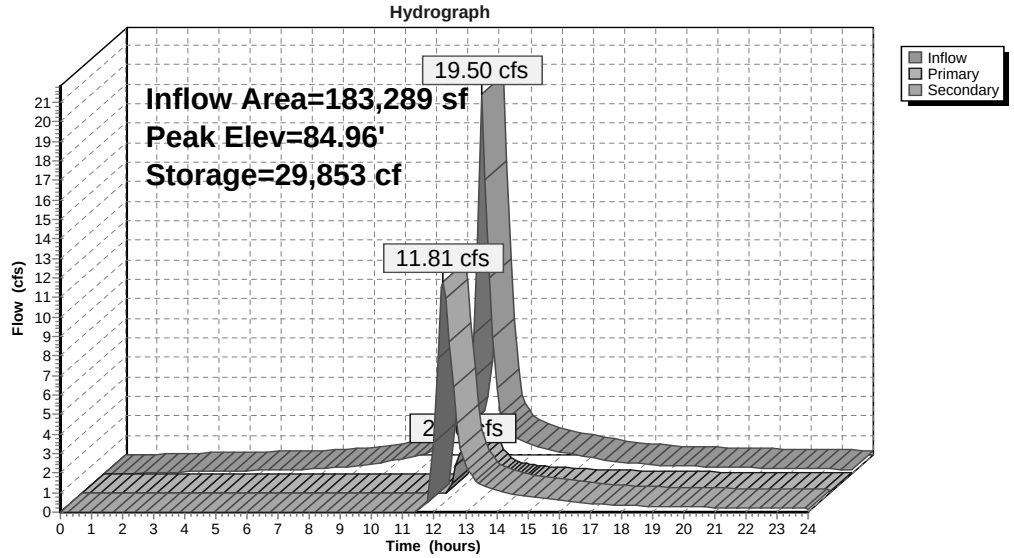
| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 82.40' | **6.0" Round (2) 6" PVC X 2.00** L= 140.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 82.40' / 81.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.010 PVC, smooth interior, Flow Area= 0.20 sf |
| #2 | Device 1 | 84.50' | **8.0" Horiz. (2) 8" OVERFLOW X 2.00** C= 0.600 Limited to weir flow at low heads |
| #3 | Secondary | 84.50' | **15.0' long x 5.0' breadth RIP-RAP OVERFLOW**<br>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<br>Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88 |



**Primary OutFlow** Max=2.06 cfs @ 12.24 hrs HW=84.95' TW=0.00' (Dynamic Tailwater)
└─**1=(2) 6" PVC** (Barrel Controls 2.06 cfs @ 5.25 fps)
└─**2=(2) 8" OVERFLOW** (Passes 2.06 cfs of 2.25 cfs potential flow)

**Secondary OutFlow** Max=11.32 cfs @ 12.28 hrs HW=84.94' TW=82.84' (Dynamic Tailwater)
└─**3=RIP-RAP OVERFLOW** (Weir Controls 11.32 cfs @ 1.70 fps)

## Pond P2: SURFACE BASINS



## Summary for Pond UIS1: UNDERGROUND CHAMBERS #1

Inflow Area = 195,437 sf, 79.34% Impervious, Inflow Depth > 5.49" for 100-Year event
Inflow = 16.10 cfs @ 12.14 hrs, Volume= 89,375 cf
Outflow = 15.07 cfs @ 12.17 hrs, Volume= 79,495 cf, Atten= 6%, Lag= 1.8 min
Primary = 11.51 cfs @ 12.17 hrs, Volume= 52,280 cf
Secondary = 3.56 cfs @ 12.17 hrs, Volume= 27,215 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 86.28' @ 12.17 hrs Surf.Area= 10,861 sf Storage= 13,521 cf
Flood Elev= 84.36' Surf.Area= 10,861 sf Storage= 8,753 cf

Plug-Flow detention time= 93.0 min calculated for 79,495 cf (89% of inflow)
Center-of-Mass det. time= 42.8 min ( 830.2 - 787.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1B | 83.00' | 5,546 cf | **8.17'W x 928.80'L x 2.33'H Field B**<br>17,699 cf Overall - 3,833 cf Embedded = 13,866 cf x 40.0% Voids |
| #2B | 83.50' | 3,833 cf | **ADS_StormTech SC-310 +Cap** x 260 Inside #1<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>260 Chambers in 2 Rows |
| #3C | 83.00' | 1,094 cf | **14.83'W x 102.88'L x 2.33'H Field C**<br>3,561 cf Overall - 826 cf Embedded = 2,735 cf x 40.0% Voids |
| #4C | 83.50' | 826 cf | **ADS_StormTech SC-310 +Cap** x 56 Inside #3<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>56 Chambers in 4 Rows |
| #5D | 83.00' | 1,244 cf | **14.83'W x 117.12'L x 2.33'H Field D**<br>4,054 cf Overall - 943 cf Embedded = 3,110 cf x 40.0% Voids |
| #6D | 83.50' | 943 cf | **ADS_StormTech SC-310 +Cap** x 64 Inside #5<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>64 Chambers in 4 Rows |
| #7 | 83.50' | 50 cf | **4.00'D x 4.00'H DMH** |
| | | 13,537 cf | Total Available Storage |



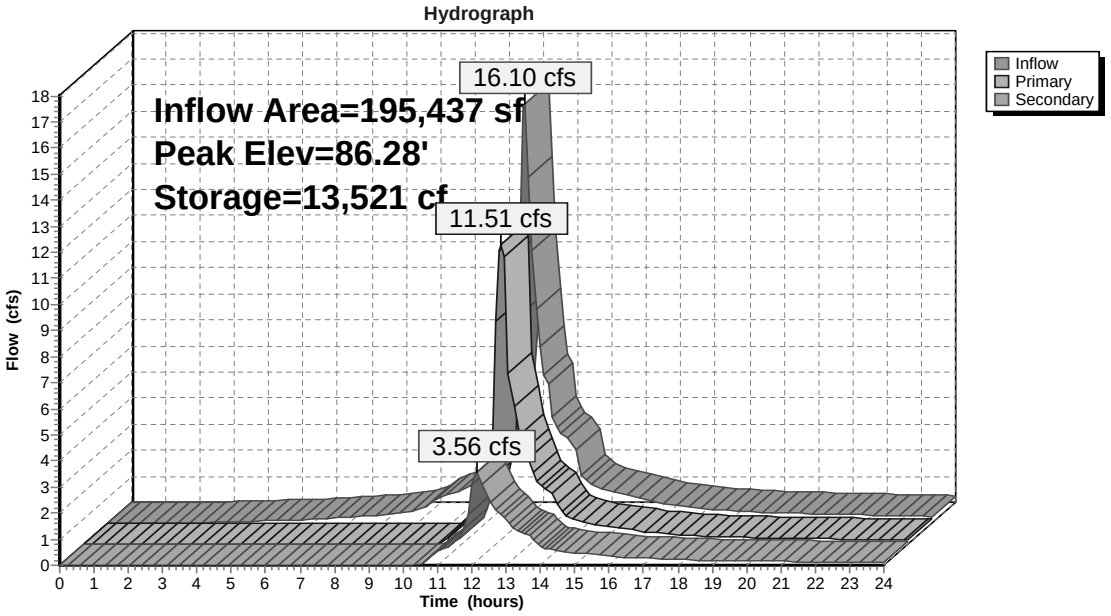
Storage Group B created with Chamber Wizard
Storage Group C created with Chamber Wizard
Storage Group D created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 84.36' | **24.0" Round 24" HDPE AT DMH12** L= 27.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 84.36' / 84.09' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 3.14 sf |
| #2 | Secondary | 84.36' | **12.0" Round 12" HDPE AT DMH8** L= 26.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 84.36' / 84.10' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=11.15 cfs @ 12.17 hrs HW=86.23' TW=81.92' (Dynamic Tailwater)
↑**1=24" HDPE AT DMH12** (Barrel Controls 11.15 cfs @ 4.73 fps)

**Secondary OutFlow** Max=3.50 cfs @ 12.17 hrs HW=86.23' TW=82.09' (Dynamic Tailwater)
↑**2=12" HDPE AT DMH8** (Inlet Controls 3.50 cfs @ 4.46 fps)

**Pond UIS1: UNDERGROUND CHAMBERS #1**






**Summary for Pond UIS2: UNDERGROUND CHAMBERS #2**

Inflow Area = 37,413 sf, 92.13% Impervious, Inflow Depth > 6.05" for 100-Year event
Inflow = 4.49 cfs @ 12.14 hrs, Volume= 18,862 cf
Outflow = 4.51 cfs @ 12.22 hrs, Volume= 14,979 cf, Atten= 0%, Lag= 5.0 min
Primary = 4.51 cfs @ 12.22 hrs, Volume= 14,979 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs / 2
Peak Elev= 85.64' @ 12.22 hrs Surf.Area= 4,282 sf Storage= 5,498 cf
Flood Elev= 84.36' Surf.Area= 4,282 sf Storage= 3,589 cf

Plug-Flow detention time= 151.5 min calculated for 14,905 cf (79% of inflow)
Center-of-Mass det. time= 77.4 min ( 833.9 - 756.5 )

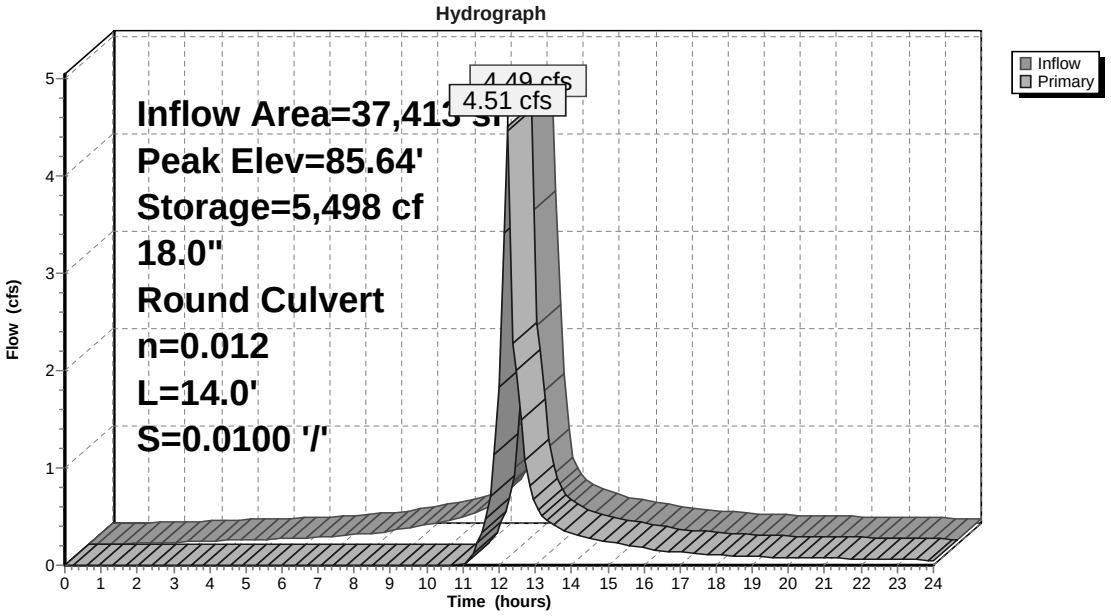
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 83.00' | 2,994 cf | **48.17'W x 88.64'L x 2.33'H Field A**<br>9,962 cf Overall - 2,477 cf Embedded = 7,486 cf x 40.0% Voids |
| #2A | 83.50' | 2,477 cf | **ADS_StormTech SC-310 +Cap** x 168 Inside #1<br>Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf<br>Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap<br>168 Chambers in 14 Rows |
| #3 | 83.50' | 50 cf | **4.00'D x 4.00'H DMH** |
| | | 5,521 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 84.36' | **18.0" Round 18" HDPE AT DMH3** L= 14.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 84.36' / 84.22' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=4.27 cfs @ 12.22 hrs HW=85.60' TW=81.94' (Dynamic Tailwater)
↑**1=18" HDPE AT DMH3** (Barrel Controls 4.27 cfs @ 3.72 fps)

**Pond UIS2: UNDERGROUND CHAMBERS #2**



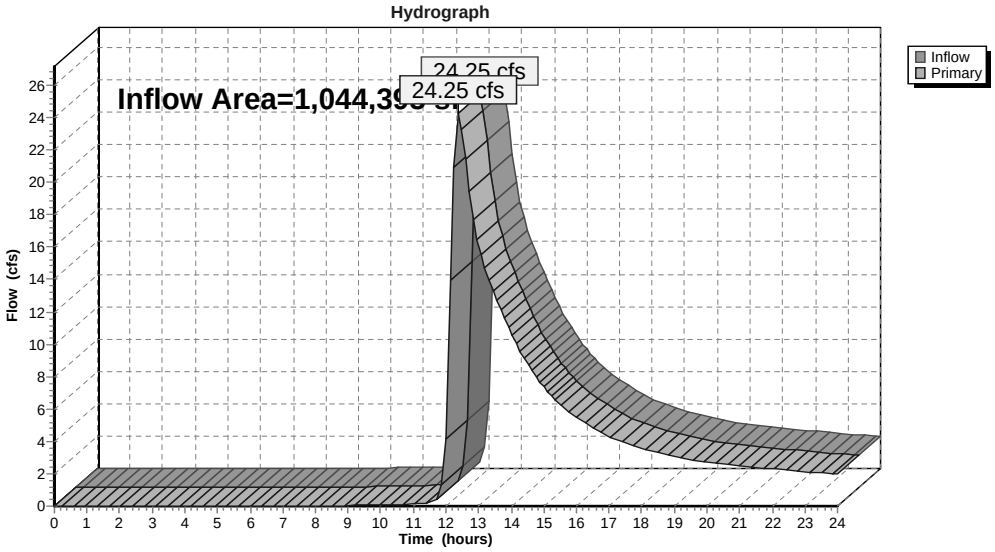



**Summary for Link SP-1: STUDY POINT #1**

Inflow Area = 1,044,395 sf, 36.78% Impervious, Inflow Depth > 2.99" for 100-Year event
Inflow = 24.25 cfs @ 12.39 hrs, Volume= 260,071 cf
Primary = 24.25 cfs @ 12.39 hrs, Volume= 260,071 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.12 hrs

**Link SP-1: STUDY POINT #1**



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# SECTION 5.0 -
## APPENDIX

| | |
|---|---|
| **Title** | ***MA DEP Standard Calculations*** |
| **Project** | *200 Quannapowitt* |
| **Location** | 200 Quannapowitt Pkwy Wakefield, MA |
| **Date** | March 16, 2021 |
| **Revised** | August 3, 2021 |

Computation Sheet

| | |
|---|---|
| By | NCD |
| Chk'd | TJW |
| Apprv'd | TJW |

**Stormwater Recharge/Water Quality Volume Table**

$Rv = F*A_{IMP}$

$A_{WQ} = D_{WQ}*A_{IMP}$

$Rv$ = *Required Recharge Volume, expressed in ft$^3$, cubic yards or acre-feet*

$F$ = *Target Depth Factor associated with each Hydraulic Soil Group*

$A_{WQ}$ = *Required Water Quality Treatment Volume, expressed in ft$^3$*

$D_{WQ}$ = *Water Quality Depth*

$A_{IMP}$ = *Impervious Area (pavement & rooftop area on site)*

| Watershed | Area (Sq. Ft.) | Landscaped | Impervious Area (Square Feet) | | | Recharge Required | | | Water Quality Volume Required | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | HSG B (F=0.35) | HSG C (F=0.25) | HSG D (F=0.10) | *F Avg. (Inches)* | *Impervious Area (Feet)* | *Rv (ft$^3$)* | $D_{WQ}$ *(Inch)* | $A_{WQ}$ |
| P-1A | 27,809 | 14,724 | 0 | 13,085 | 0 | 0.25 | 13,085 | 273 | 1.0 | 1,090 |
| P-1B | 26,351 | 17,448 | 0 | 8,903 | 0 | 0.25 | 8,903 | 185 | 1.0 | 742 |
| P-1C | 30,669 | 20,040 | 0 | 10,629 | 0 | 0.25 | 10,629 | 221 | 1.0 | 886 |
| P-1D | 30,760 | 19,029 | 0 | 11,731 | 0 | 0.25 | 11,731 | 244 | 1.0 | 978 |
| P-1E | 50,277 | 31,091 | 0 | 19,186 | 0 | 0.25 | 19,186 | 400 | 1.0 | 1,599 |
| W-1 | 46,507 | 46,507 | 0 | 0 | 0 | 0.00 | 0 | 0 | 1.0 | 0 |
| P-1F | 9,036 | 8,156 | 0 | 880 | 0 | 0.25 | 880 | 18 | 1.0 | 73 |
| P-1G | 117,796 | 21,862 | 0 | 95,934 | 0 | 0.25 | 95,934 | 1,999 | 1.0 | 7,995 |
| P-1H | 11,311 | 10,351 | 0 | 960 | 0 | 0.25 | 960 | 20 | 1.0 | 80 |
| P-1I | 16,453 | 2,946 | 0 | 13,507 | 0 | 0.25 | 13,507 | 281 | 1.0 | 1,126 |
| R-1F | 39,501 | 0 | 0 | 39,501 | 0 | 0.25 | 39,501 | 823 | 1.0 | 3,292 |
| R-1H | 17,793 | 0 | 0 | 17,793 | 0 | 0.25 | 17,793 | 371 | 1.0 | 1,483 |
| R-1I | 20,960 | 0 | 0 | 20,960 | 0 | 0.25 | 20,960 | 437 | 1.0 | 1,747 |
| P-2A | 20,956 | 20,956 | 0 | 0 | 0 | 0.00 | 0 | 0 | 1.0 | 0 |
| P-2B | 79,528 | 69,830 | 0 | 9,698 | 0 | 0.25 | 9,698 | 202 | 1.0 | 808 |
| R-2A | 30,813 | 0 | 0 | 30,813 | 0 | 0.25 | 30,813 | 642 | 1.0 | 2,568 |
| R-2B | 32,854 | 0 | 0 | 32,854 | 0 | 0.25 | 32,854 | 684 | 1.0 | 2,738 |
| R-2C | 40,094 | 0 | 0 | 40,094 | 0 | 0.25 | 40,094 | 835 | 1.0 | 3,341 |
| P-3 | 394,927 | 385,544 | 0 | 9,383 | 0 | 0.25 | 9,383 | 195 | 1.0 | 782 |
| **Total** | **1,044,395** | **668,484** | **0** | **375,911** | **0** | | **375,911** | **7,831** | | **31,326** |

| | | | | |
|---|---|---|---|---|
| | | | Computation Sheet | |
| **Title** | ***MA DEP Standard Calculations*** | | By | NCD |
| **Project** | *200 Quannapowitt* | | Chk'd | TJW |
| **Location** | 200 Quannapowitt Pkwy Wakefield, MA | | Apprv'd | TJW |
| **Date** | March 16, 2021 | | | |

**Stormwater Recharge Summary**

| | ***Required (cf)*** | ***Provided (cf)*** | |
|---|---|---|---|
| ***ARv =*** | ***273*** | ***0*** | ***Wet Basin #1 (Below Outlet Inv.=81.50) [P-1A]*** |
| ***ARv =*** | ***651*** | ***0*** | ***Wet Basin #2 (Below Outlet Inv.=81.50) [P-1B, P-1C, P-1D]*** |
| ***ARv =*** | ***400*** | ***0*** | ***Wet Basin #3 (Below Outlet Inv.=81.50) [P-1E]*** |
| ***ARv =*** | ***1,999*** | ***8,078*** | ***Infiltration Chambers #1 (Below Outlet Inv.=84.00) [P-1G]*** |
| ***ARv =*** | ***843*** | ***3,539*** | ***Infiltration Chambers#2 (Below Outlet Inv.=84.00) [P-1I, R-1I]*** |
| ***ARv =*** | ***841*** | ***2,505*** | ***Bioretention #1(Below Outlet Inv.=86.50) [P-1F, R-1F]*** |
| ***ARv =*** | ***391*** | ***1,146*** | ***Bioretention #2 (Below Outlet Inv.=86.50) [P-1H, R-1H]*** |
| ***ARv =*** | ***2,364*** | ***18,822*** | ***Surface Infiltration Basin (Below Outlet Inv.=84.50) [P-2B, R-2A, R-2B, R-2C]*** |
| ***ARv =*** | ***7,761*** | ***34,090*** | ***Total*** |
| ***Capture Area Adjustment * =*** | ***9,716*** | | |

| ***Capture Area Adjustment** | |
|---|---|
| Total Impervious Area | 375,911 |
| Site Impervious area draining to Recharge BMPs | 302,994 |
| Ratio | 1.24 |
| Adjusted ARv | 9,716 |

**Water Quality Summary**

| | ***Required (cf)*** | ***Provided (cf)*** | |
|---|---|---|---|
| ***$A_{WQ}$ =*** | ***1,090*** | ***3,980*** | ***Wet Basin #1 (Below Outlet Inv.=81.50) [P-1A]*** |
| ***$A_{WQ}$ =*** | ***2,605*** | ***10,212*** | ***Wet Basin #2 (Below Outlet Inv.=81.50) [P-1B, P-1C, P-1D]*** |
| ***$A_{WQ}$ =*** | ***1,599*** | ***6,991*** | ***Wet Basin #3 (Below Outlet Inv.=81.50) [P-1E]*** |
| ***$A_{WQ}$ =*** | ***7,995*** | ***8,078*** | ***Infiltration Chambers #1 (Below Outlet Inv.=84.00) [P-1G]*** |
| ***$A_{WQ}$ =*** | ***2,872*** | ***3,539*** | ***Infiltration Chambers #2 (Below Outlet Inv.=84.00) [P-1I, R-1I]*** |
| ***$A_{WQ}$ =*** | ***3,365*** | ***2,505*** | ***Bioretention #1(Below Outlet Inv.=86.50) [P-1F, R-1F]*** |
| ***$A_{WQ}$ =*** | ***1,563*** | ***1,146*** | ***Bioretention #2 (Below Outlet Inv.=86.50) [P-1H, R-1H]*** |
| ***$A_{WQ}$ =*** | ***9,455*** | ***18,822*** | ***Surface Infiltration Basin (Below Outlet Inv.=84.50) [P-2B, R-2A, R-2B, R-2C]*** |
| ***$A_{WQ}$ =*** | ***30,544*** | ***55,273*** | ***Total*** |
| ***Capture Area Adjustment * =*** | ***32,128*** | | |

| ***Capture Area Adjustment** | |
|---|---|
| Total Impervious Area | 375,911 |
| Site Impervious area draining to Treatment BMPs | 366,528 |
| Ratio | 1.03 |
| Adjusted Awq | 32,128 |

| | | | Computation Sheet | |
|---|---|---|---|---|
| **Title** | ***MA DEP Standard Calculations*** | | By | NCD |
| **Project** | *200 Quannapowitt* | | Chk'd | TJW |
| **Location** | 200 Quannapowitt Pkwy Wakefield, MA | | Apprv'd | TJW |
| **Date** | March 16, 2021 | | | |

**Draindown Within 72 Hours**

**Time$_{drawdown}$**=(Rv) (1/Design Infiltration Rate in inches per hour) (Conversion for inches to feet) (1/bottom area in feet)

| **Infiltration Chambers #1 (HSG C - Silty Loam)** | |
|---|---|
| Infiltration Rate (in/Hr)= | 0.27 |
| Bottom Area (ft$^2$) = | 10,861 |
| Infiltration Volume (ft$^3$) = | 8,078 |
| **Time$_{drawdown}$ (Hours)**= | 33.06 |

| **Infiltration Chambers #2 (HSG C - Silty Loam)** | |
|---|---|
| Infiltration Rate (in/Hr)= | 0.27 |
| Bottom Area (ft$^2$) = | 4,282 |
| Infiltration Volume (ft$^3$) = | 3,539 |
| **Time$_{drawdown}$ (Hours)**= | 36.73 |

| **Bioretention #1 (HSG C - Silty Loam)** | |
|---|---|
| Infiltration Rate (in/Hr)= | 0.27 |
| Bottom Area (ft$^2$) = | 4,804 |
| Infiltration Volume (ft$^3$) = | 2,505 |
| **Time$_{drawdown}$ (Hours)**= | 23.18 |

| **Bioretention #2 (HSG C - Silty Loam)** | |
|---|---|
| Infiltration Rate (in/Hr)= | 0.27 |
| Bottom Area (ft$^2$) = | 1,972 |
| Infiltration Volume (ft$^3$) = | 1,146 |
| **Time$_{drawdown}$ (Hours)**= | 25.83 |

| **Surface Infiltration Basin (HSG C - Silty Loam)** | |
|---|---|
| Infiltration Rate (in/Hr)= | 0.27 |
| Bottom Area (ft$^2$) = | 15,229 |
| Infiltration Volume (ft$^3$) = | 18,822 |
| **Time$_{drawdown}$ (Hours)**= | 54.93 |

Computation Sheet

| | |
|---|---|
| **Title** | ***EPA Total Phosphorous & Total Nitrogen Standard Calculations*** |
| **Project** | *200 Quannapowitt* |
| **Location** | 200 Quannapowitt Pkwy Wakefield, MA |
| **Date** | August 3, 2021 |
| **Revised** | |

By NCD
Chk'd TJW
Apprv'd TJW

**Determining Nitrogen & Phosphorous Loads**

***Load = (IA x LER) + (PA x LER)***

***IA*** *= Impervious Area, expressed in acres*

***PA*** *= Pervious Area, expressed in acres*

***LER*** *= Load Export Rate, expressed in lb/acre/yr (Table 3-1 & 3-2)*

***Exising Loads***

| Watershed | Land Use Category | Cover Type | Area (s.f.) | Area (Acre) | PLER (lb/acre/yr) | NLER (lb/acre/yr) | BMP Phosphorous Load Reduction | Phosphorous Load (lb/yr) | BMP Nitrogen Load Reduction | Nitrogen Load (lb/yr) | Total Nutrient Load (lb/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| E-1A | COM | Impervious | 63,087 | 1.45 | 1.78 | 15.00 | 0% | 2.58 | 0% | 21.72 | 24.30 |
| E-1A | FOR | Pervious | 5,285 | 0.12 | 0.13 | 0.50 | 0% | 0.02 | 0% | 0.06 | 0.08 |
| E-1A | DevPERV (HSGC) | Pervious | 15,035 | 0.35 | 0.21 | 2.40 | 0% | 0.07 | 0% | 0.83 | 0.90 |
| E-1B | COM | Impervious | 29,006 | 0.67 | 1.78 | 15.00 | 0% | 1.19 | 0% | 9.99 | 11.17 |
| E-1B | FOR | Pervious | 14,964 | 0.34 | 0.13 | 0.50 | 0% | 0.04 | 0% | 0.17 | 0.22 |
| E-1B | DevPERV (HSGC) | Pervious | 12,548 | 0.29 | 0.21 | 2.40 | 0% | 0.06 | 0% | 0.69 | 0.75 |
| E-1C | COM | Impervious | 106,692 | 2.45 | 1.78 | 15.00 | 0% | 4.36 | 0% | 36.74 | 41.10 |
| E-1C | FOR | Pervious | 23,421 | 0.54 | 0.13 | 0.50 | 0% | 0.07 | 0% | 0.27 | 0.34 |
| E-1C | DevPERV (HSGC) | Pervious | 24,200 | 0.56 | 0.21 | 2.40 | 0% | 0.12 | 0% | 1.33 | 1.45 |
| E-1D | COM | Impervious | 21,981 | 0.50 | 1.78 | 15.00 | 0% | 0.90 | 0% | 7.57 | 8.47 |
| E-1D | FOR | Pervious | 2,569 | 0.06 | 0.13 | 0.50 | 0% | 0.01 | 0% | 0.03 | 0.04 |
| E-1D | DevPERV (HSGC) | Pervious | 18,514 | 0.43 | 0.21 | 2.40 | 0% | 0.09 | 0% | 1.02 | 1.11 |
| E-1E | COM | Impervious | 74,011 | 1.70 | 1.78 | 15.00 | 0% | 3.02 | 0% | 25.49 | 28.51 |
| E-1E | DevPERV (HSGC) | Pervious | 40,110 | 0.92 | 0.21 | 2.40 | 0% | 0.19 | 0% | 2.21 | 2.40 |
| E-2A | COM | Impervious | 41,596 | 0.95 | 1.78 | 15.00 | 0% | 1.70 | 0% | 14.32 | 16.02 |
| E-2A | DevPERV (HSGC) | Pervious | 1,483 | 0.03 | 0.21 | 2.40 | 0% | 0.01 | 0% | 0.08 | 0.09 |
| E-2B | COM | Impervious | 6,981 | 0.16 | 1.78 | 15.00 | 0% | 0.29 | 0% | 2.40 | 2.69 |
| E-2B | DevPERV (HSGC) | Pervious | 29,519 | 0.68 | 0.21 | 2.40 | 0% | 0.14 | 0% | 1.63 | 1.77 |
| E-2C | COM | Impervious | 72,672 | 1.67 | 1.78 | 15.00 | 25% | 2.23 | 16% | 21.02 | 23.25 |
| E-2C | DevPERV (HSGC) | Pervious | 34,515 | 0.79 | 0.21 | 2.40 | 25% | 0.12 | 16% | 1.60 | 1.72 |
| E-3 | COM | Impervious | 9,386 | 0.22 | 1.78 | 15.00 | 0% | 0.38 | 0% | 3.23 | 3.62 |
| E-3 | FOR | Pervious | 387,840 | 8.90 | 0.13 | 0.50 | 0% | 1.16 | 0% | 4.45 | 5.61 |
| E-3 | DevPERV (HSGC) | Pervious | 8,980 | 0.21 | 0.21 | 2.40 | 0% | 0.04 | 0% | 0.49 | 0.54 |
| **Total** | | | **1,044,395** | **23.98** | | | | **18.79** | | **157.35** | **176.14** |

***Proposed Loads***

| Watershed | Land Use Category | Cover Type | Area (s.f.) | Area (Acre) | PLER (lb/acre/yr) | NLER (lb/acre/yr) | BMP Phosphorous Load Reduction | Phosphorous Load (lb/yr) | BMP Nitrogen Load Reduction | Nitrogen Load (lb/yr) | Total Nutrient Load (lb/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| P-1A | MFR | Impervious | 13,085 | 0.30 | 2.32 | 14.10 | 53% | 0.33 | 32% | 2.88 | 3.21 |
| P-1A | DevPERV (HSGC) | Pervious | 14,724 | 0.34 | 0.21 | 2.40 | 53% | 0.03 | 32% | 0.55 | 0.59 |
| P-1B | MFR | Impervious | 8,903 | 0.20 | 2.32 | 14.10 | 53% | 0.22 | 32% | 1.96 | 2.18 |
| P-1B | DevPERV (HSGC) | Pervious | 17,448 | 0.40 | 0.21 | 2.40 | 53% | 0.04 | 32% | 0.65 | 0.69 |
| P-1C | MFR | Impervious | 10,629 | 0.24 | 2.32 | 14.10 | 53% | 0.27 | 32% | 2.34 | 2.61 |
| P-1C | DevPERV (HSGC) | Pervious | 20,040 | 0.46 | 0.21 | 2.40 | 53% | 0.05 | 32% | 0.75 | 0.80 |
| P-1D | MFR | Impervious | 11,731 | 0.27 | 2.32 | 14.10 | 53% | 0.29 | 32% | 2.58 | 2.88 |
| P-1D | DevPERV (HSGC) | Pervious | 19,029 | 0.44 | 0.21 | 2.40 | 53% | 0.04 | 32% | 0.71 | 0.76 |
| W-1 | FOR | Pervious | 46,507 | 1.07 | 0.13 | 0.50 | 0% | 0.14 | 0% | 0.53 | 0.67 |
| P-1E | MFR | Impervious | 19,186 | 0.44 | 2.32 | 14.10 | 53% | 0.48 | 32% | 4.22 | 4.70 |
| P-1E | DevPERV (HSGC) | Pervious | 31,091 | 0.71 | 0.21 | 2.40 | 53% | 0.07 | 32% | 1.16 | 1.24 |
| P1F | MFR | Impervious | 880 | 0.02 | 2.32 | 14.10 | 85% | 0.01 | 93% | 0.02 | 0.03 |
| P-1F | DevPERV (HSGC) | Pervious | 8,156 | 0.19 | 0.21 | 2.40 | 85% | 0.01 | 93% | 0.03 | 0.04 |
| P-1G | MFR | Impervious | 95,934 | 2.20 | 2.32 | 14.10 | 92% | 0.41 | 98% | 0.62 | 1.03 |
| P-1G | DevPERV (HSGC) | Pervious | 21,862 | 0.50 | 0.21 | 2.40 | 92% | 0.01 | 98% | 0.02 | 0.03 |
| P-1H | MFR | Impervious | 960 | 0.02 | 2.32 | 14.10 | 85% | 0.01 | 93% | 0.02 | 0.03 |
| P-1H | DevPERV (HSGC) | Pervious | 10,351 | 0.24 | 0.21 | 2.40 | 85% | 0.01 | 93% | 0.04 | 0.05 |
| P-1I | MFR | Impervious | 13,507 | 0.31 | 2.32 | 14.10 | 92% | 0.06 | 98% | 0.09 | 0.14 |
| P-1I | DevPERV (HSGC) | Pervious | 2,946 | 0.07 | 0.21 | 2.40 | 92% | 0.00 | 98% | 0.00 | 0.00 |
| R-1F | MFR | Impervious | 39,501 | 0.91 | 2.32 | 14.10 | 85% | 0.32 | 93% | 0.90 | 1.21 |
| R-1H | MFR | Impervious | 17,793 | 0.41 | 2.32 | 14.10 | 85% | 0.14 | 93% | 0.40 | 0.55 |
| R-1I | MFR | Impervious | 20,960 | 0.48 | 2.32 | 14.10 | 92% | 0.09 | 98% | 0.14 | 0.22 |
| P-2A | DevPERV (HSGC) | Pervious | 20,956 | 0.48 | 0.21 | 2.40 | 0% | 0.10 | 0% | 1.15 | 1.26 |
| P-2B | MFR | Impervious | 9,698 | 0.22 | 2.32 | 14.10 | 99% | 0.01 | 100% | 0.00 | 0.01 |
| P-2B | DevPERV (HSGC) | Pervious | 69,830 | 1.60 | 0.21 | 2.40 | 99% | 0.00 | 100% | 0.00 | 0.00 |
| R-2A | MFR | Impervious | 30,813 | 0.71 | 2.32 | 14.10 | 98% | 0.03 | 99% | 0.10 | 0.13 |
| R-2B | MFR | Impervious | 32,854 | 0.75 | 2.32 | 14.10 | 98% | 0.03 | 99% | 0.11 | 0.14 |
| R-2C | MFR | Impervious | 40,094 | 0.92 | 2.32 | 14.10 | 98% | 0.04 | 99% | 0.13 | 0.17 |
| P-3 | MFR | Impervious | 9,383 | 0.22 | 2.32 | 14.10 | 0% | 0.50 | 0% | 3.04 | 3.54 |
| P-3 | FOR | Pervious | 385,544 | 8.85 | 0.13 | 0.50 | 0% | 1.15 | 0% | 4.43 | 5.58 |
| **Total** | | | **1,044,395** | **23.98** | | | | **4.88** | | **29.59** | **34.47** |

Computation Sheet

| | |
|---|---|
| **Title** | ***EPA Total Phosphorous & Total Nitrogen Standard Calculations*** |
| **Project** | *200 Quannapowitt* |
| **Location** | 200 Quannapowitt Pkwy Wakefield, MA |
| **Date** | August 3, 2021 |

By NCD
Chk'd TJW
Apprv'd TJW

***Nutrient Loading Reduction***

| | |
|---|---|
| Existing Load | 176.14 |
| Proposed Load | 34.47 |
| Reduction | 80% |

***Required Volume = (IA*Rainfall Depth) + (PA*Rainfall Depth) * (3,630 cf/acre-in)***

| ***Required BMP Storage Volumes*** | | | **BMP Design Capacity (in)** | | | |
|---|---|---|---|---|---|---|
| **BMP** | **Contributing Pervious (Acre)** | **Contributing Impervious (Acre)** | **Pervious Cover (Table 3-4)** | **Impervious Cover (Performance Tables)** | **Required Volume (c.f.)** | **Provided Volume Below Outlet (c.f.)** |
| Wet Basin #1 | 0.34 | 0.30 | 0.69 | 2.00 | 3,027 | 3,980 |
| Wet Basin #2 | 1.30 | 0.72 | 0.69 | 2.00 | 8,460 | 10,212 |
| Wet Basin #3 | 0.71 | 0.66 | 0.69 | 2.00 | 6,549 | 6,991 |
| Bioretention Area #1 | 0.19 | 0.93 | 0.06 | 0.60 | 2,060 | 2,505 |
| Bioretention Area #2 | 0.24 | 0.43 | 0.06 | 0.60 | 989 | 1,146 |
| Infiltration Chamber #1 | 0.50 | 2.20 | 0.12 | 1.00 | 8,213 | 8,753 |
| Infiltration Chamber #2 | 0.07 | 0.79 | 0.12 | 1.00 | 2,902 | 3,589 |
| Infiltration Basin | 1.60 | 2.60 | 0.69 | 1.50 | 18,198 | 18,822 |

**Table 3-1: Average annual distinct phosphorus (P) load export rates for use in estimating P load reduction credits in the MA MS4 Permit**

| Phosphorus Source Category by Land Use | Land Surface Cover | P Load Export Rate, lbs./acre/year | P Load Export Rate, kg/ha/yr. |
|---|---|---|---|
| Commercial (COM) and Industrial (IND) | Directly connected impervious | 1.78 | 2.0 |
| | Pervious | See* DevPERV | See* DevPERV |
| Multi-Family (MFR) and High-Density Residential (HDR) | Directly connected impervious | 2.32 | 2.6 |
| | Pervious | See* DevPERV | See* DevPERV |
| Medium -Density Residential (MDR) | Directly connected impervious | 1.96 | 2.2 |
| | Pervious | See* DevPERV | See* DevPERV |
| Low Density Residential (LDR) - "Rural" | Directly connected impervious | 1.52 | 1.7 |
| | Pervious | See* DevPERV | See* DevPERV |
| Highway (HWY) | Directly connected impervious | 1.34 | 1.5 |
| | Pervious | See* DevPERV | See* DevPERV |
| Forest (FOR) | Directly connected impervious | 1.52 | 1.7 |
| | Pervious | 0.13 | 0.13 |
| Open Land (OPEN) | Directly connected impervious | 1.52 | 1.7 |
| | Pervious | See* DevPERV | See* DevPERV |
| Agriculture (AG) | Directly connected impervious | 1.52 | 1.7 |
| | Pervious | 0.45 | 0.5 |
| *Developed Land Pervious (DevPERV) – HSG A | Pervious | 0.03 | 0.03 |
| *Developed Land Pervious (DevPERV) – HSG B | Pervious | 0.12 | 0.13 |
| *Developed Land Pervious (DevPERV) – HSG C | Pervious | 0.21 | 0.24 |
| *Developed Land Pervious (DevPERV) – HSG C/D | Pervious | 0.29 | 0.33 |
| *Developed Land Pervious (DevPERV) – HSG D | Pervious | 0.37 | 0.41 |

**Table 3-2: Average annual distinct nitrogen (N) load export rates for use in estimating N load reduction credits in the MA MS4 Permit**

| Nitrogen Source Category by Land Use | Land Surface Cover | N Load Export Rate, lbs./acre/year | N Load Export Rate, kg/ha/yr. |
|---|---|---|---|
| Commercial (COM) and Industrial (IND) | Directly connected impervious | 15.0 | 16.9 |
| | Pervious | See* DevPERV | See* DevPERV |
| All Residential | Directly connected impervious | 14.1 | 15.8 |
| | Pervious | See* DevPERV | See* DevPERV |
| Highway (HWY) | Directly connected impervious | 10.5 | 11.8 |
| | Pervious | See* DevPERV | See* DevPERV |
| Forest (FOR) | Directly connected impervious | 11.3 | 12.7 |
| | Pervious | 0.5 | 0.6 |
| Open Land (OPEN) | Directly connected impervious | 11.3 | 12.7 |
| | Pervious | See* DevPERV | See* DevPERV |
| Agriculture (AG) | Directly connected impervious | 11.3 | 12.7 |
| | Pervious | 2.6 | 2.9 |
| *Developed Land Pervious (DevPERV) – HSG A | Pervious | 0.3 | 0.3 |
| *Developed Land Pervious (DevPERV) – HSG B | Pervious | 1.2 | 1.3 |
| *Developed Land Pervious (DevPERV) – HSG C | Pervious | 2.4 | 2.7 |
| *Developed Land Pervious (DevPERV) – HSG C/D | Pervious | 3.1 | 3.5 |
| *Developed Land Pervious (DevPERV) – HSG D | Pervious | 3.6 | 4.1 |

**Table 3- 4: Developed Land Pervious Area Runoff Depths based on Precipitation depth and Hydrological Soil Groups (HSGs)**

| Developed Land Pervious Area Runoff Depths based on Precipitation depth and Hydrological Soil Groups | | | | | |
|---|---|---|---|---|---|
| | Runoff Depth, inches | | | | |
| Rainfall Depth, Inches | Pervious HSG A | Pervious HSG B | Pervious HSG C | Pervious HSG C/D | Pervious HSG D |
| 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.20 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 |
| 0.40 | 0.00 | 0.00 | 0.03 | 0.05 | 0.06 |
| 0.50 | 0.00 | 0.01 | 0.05 | 0.07 | 0.09 |
| 0.60 | 0.01 | 0.02 | 0.06 | 0.09 | 0.11 |
| 0.80 | 0.02 | 0.03 | 0.09 | 0.13 | 0.16 |
| 1.00 | 0.03 | 0.04 | 0.12 | 0.17 | 0.21 |
| 1.20 | 0.04 | 0.05 | 0.14 | 0.27 | 0.39 |
| 1.50 | 0.08 | 0.11 | 0.39 | 0.55 | 0.72 |
| 2.00 | 0.14 | 0.22 | 0.69 | 0.89 | 1.08 |

Notes: Runoff depths derived from combination of volumetric runoff coefficients from Table 5 of *Small Storm Hydrology and Why it is Important for the Design of Stormwater Control Practices*, (Pitt, 1999), and using the Stormwater Management Model (SWMM) in continuous model mode for hourly precipitation data for Boston, MA, 1998-2002.

| | |
|---|---|
| **Title** | ***EPA Total Phosphorous & Total Nitrogen Standard Calculations*** |
| **Project** | *200 Quannapowitt* |
| **Location** | 200 Quannapowitt Pkwy Wakefield, MA |
| **Date** | August 3, 2021 |

Computation Sheet

| | |
|---|---|
| By | NCD |
| Chk'd | TJW |
| Apprv'd | TJW |

Table 3- 7: Infiltration Trench (IR = 0.27 in/hr) BMP Performance Table

Infiltration Trench (IR = 0.27 in/hr) BMP Performance Table: Long-Term Phosphorus & Nitrogen Load Reduction

| BMP Capacity: Depth of Runoff from Impervious Area (inches) | 0.1 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 1.5 | 2.0 |
|---|---|---|---|---|---|---|---|---|
| Runoff Volume Reduction | 17.6% | 32.5% | 55.0% | 70.0% | 79.3% | 85.2% | 93.3% | 96.3% |
| Cumulative Phosphorus Load Reduction | 20% | 37% | 63% | 78% | 86% | 92% | 97% | 99% |
| Cumulative Nitrogen Load Reduction | 57% | 74% | 88% | 94% | 97% | 98% | 99% | 100% |

Figure 3- 7: BMP Performance Curve: Infiltration Trench (infiltration rate = 0.27 in/hr)

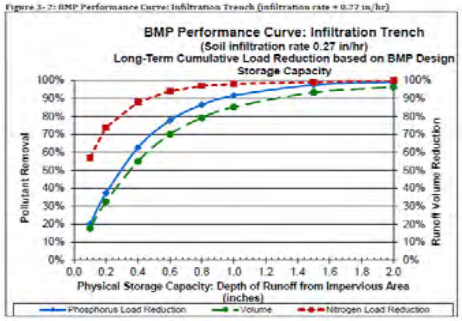



Table 3- 13: Infiltration Basin (0.27 in/hr) BMP Performance Table

Surface Infiltration (0.27 in/hr) BMP Performance Table: Long-Term Phosphorus & Nitrogen Load Reduction

| BMP Capacity: Depth of Runoff from Impervious Area (inches) | 0.1 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 1.5 | 2.0 |
|---|---|---|---|---|---|---|---|---|
| Runoff Volume Reduction | 16% | 30% | 51% | 66% | 76% | 82% | 91% | 95% |
| Cumulative Phosphorus Load Reduction | 37% | 54% | 74% | 85% | 90% | 93% | 98% | 99% |
| Cumulative Nitrogen Load Reduction | 54% | 71% | 87% | 93% | 97% | 98% | 99% | 100% |

Figure 3- 8: BMP Performance Curve: Surface Infiltration (infiltration rate = 0.27 in/hr)

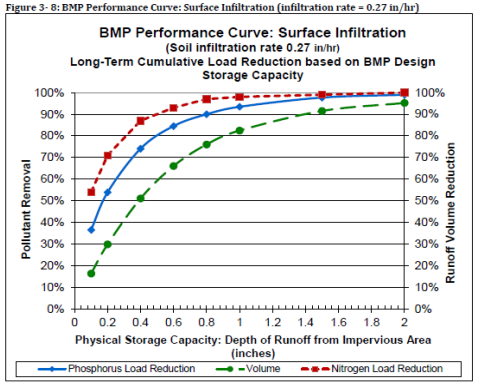
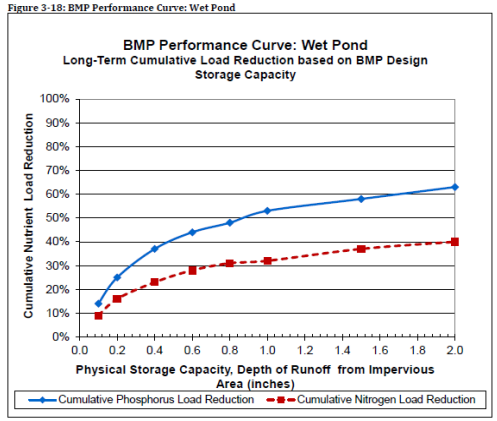



Table 3- 23: Wet Pond BMP Performance Table

Wet Pond BMP Performance Table: Long-Term Phosphorus Load Reduction

| BMP Capacity: Depth of Runoff from Impervious Area (inches) | 0.1 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 1.5 | 2.0 |
|---|---|---|---|---|---|---|---|---|
| Cumulative Phosphorus Load Reduction | 14% | 25% | 37% | 44% | 48% | 53% | 58% | 63% |
| Cumulative Nitrogen Load Reduction | 9% | 16% | 23% | 28% | 31% | 32% | 37% | 40% |

Figure 3-18: BMP Performance Curve: Wet Pond



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

*Version 1, Automated: Mar. 4, 2008*

Location: 200 Quannapowitt Parkway Wakefield, MA

## TSS Removal Calculation Worksheet

| B<br>BMP[1] | C<br>TSS Removal Rate[1] | D<br>Starting TSS Load* | E<br>Amount Removed (C*D) | F<br>Remaining Load (D-E) |
|---|---|---|---|---|
| **Street Sweeping - 5%** | **0.05** | **1.00** | **0.05** | **0.95** |
| **Deep Sump and Hooded Catch Basin** | **0.25** | **0.95** | **0.24** | **0.71** |
| **Subsurface Infiltration Structure** | **0.80** | **0.71** | **0.57** | **0.14** |
| | **0.00** | **0.14** | **0.00** | **0.14** |
| | **0.00** | **0.14** | **0.00** | **0.14** |

**Total TSS Removal =** **86%**

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

Project: **200 Quannapowitt**
Prepared By: **NCD**
Date: **16-Mar-21**

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

# SC-310 CHAMBER

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for private (commercial) and public applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.

**STORMTECH SC-310 CHAMBER**
(not to scale)

**Nominal Chamber Specifications**

**Size (L x W x H)**
85.4" x 34.0" x 16.0"
2,170 mm x 864 mm x 406 mm

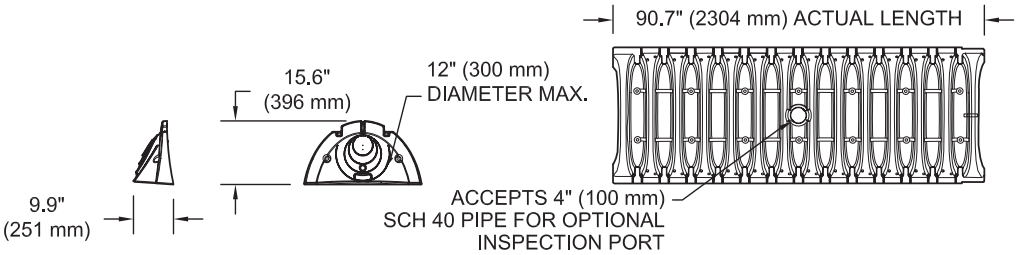
**Chamber Storage**
14.7 ft³ (0.42 m³)

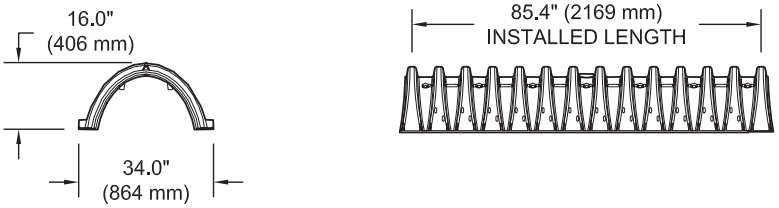
**Min. Installed Storage***
31.0 ft³ (0.88 m³)

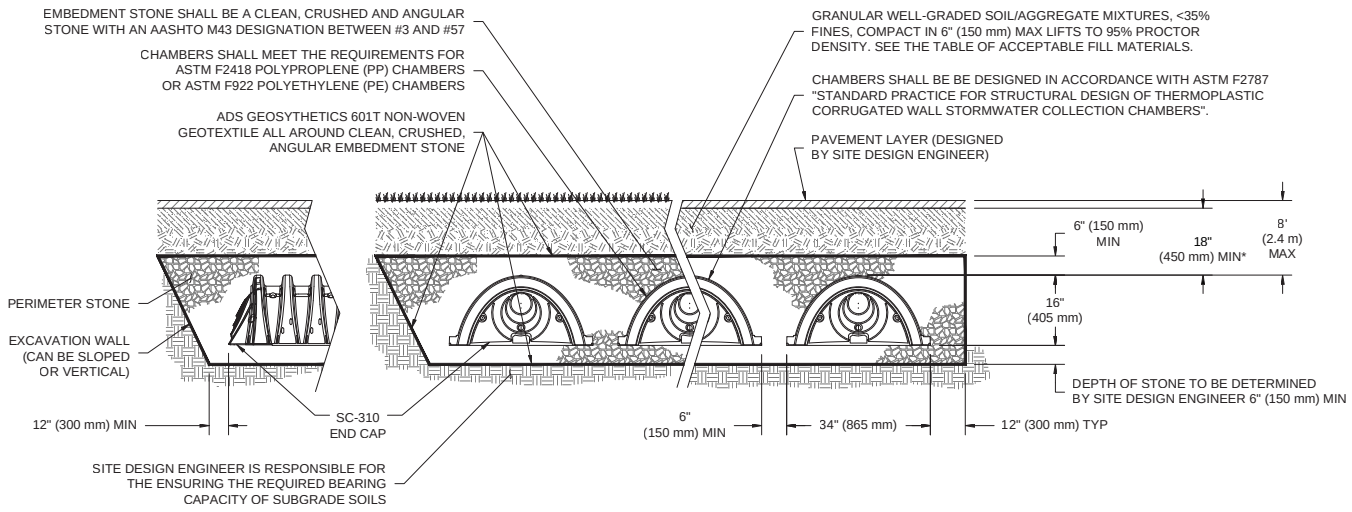
**Weight**
37.0 lbs (16.8 kg)

**Shipping**
41 chambers/pallet
108 end caps/pallet
18 pallets/truck

*Assumes 6" (150 mm) stone above and below chambers and 40% stone porosity.




*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 24" (600 mm).

# SC-310 CUMULATIVE STORAGE VOLUMES PER CHAMBER

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under Chambers.

| Depth of Water in System Inches (mm) | | Cumulative Chamber Storage ft³ (m³) | Total System Cumulative Storage ft³ (m³) |
|---|---|---|---|
| 28 (711) | | 14.70 (0.416) | 31.00 (0.878) |
| 27 (686) | | 14.70 (0.416) | 30.21 (0.855) |
| 26 (680) | Stone | 14.70 (0.416) | 29.42 (0.833) |
| 25 (610) | Cover | 14.70 (0.416) | 28.63 (0.811) |
| 24 (609) | | 14.70 (0.416) | 27.84 (0.788) |
| 23 (584) | | 14.70 (0.416) | 27.05 (0.766) |
| 22 (559) | | 14.70 (0.416) | 26.26 (0.748) |
| 21 (533) | | 14.64 (0.415) | 25.43 (0.720) |
| 20 (508) | | 14.49 (0.410) | 24.54 (0.695) |
| 19 (483) | | 14.22 (0.403) | 23.58 (0.668) |
| 18 (457) | | 13.68 (0.387) | 22.47 (0.636) |
| 17 (432) | | 12.99 (0.368) | 21.25 (0.602) |
| 16 (406) | | 12.17 (0.345) | 19.97 (0.566) |
| 15 (381) | | 11.25 (0.319) | 18.62 (0.528) |
| 14 (356) | | 10.23 (0.290) | 17.22 (0.488) |
| 13 (330) | | 9.15 (0.260) | 15.78 (0.447) |
| 12 (305) | | 7.99 (0.227) | 14.29 (0.425) |
| 11 (279) | | 6.78 (0.192) | 12.77 (0.362) |
| 10 (254) | | 5.51 (0.156) | 11.22 (0.318) |
| 9 (229) | | 4.19 (0.119) | 9.64 (0.278) |
| 8 (203) | | 2.83 (0.081) | 8.03 (0.227) |
| 7 (178) | | 1.43 (0.041) | 6.40 (0.181) |
| 6 (152) | | 0 | 4.74 (0.134) |
| 5 (127) | | 0 | 3.95 (0.112) |
| 4(102) | Stone Foundation | 0 | 3.16 (0.090) |
| 3 (76) | | 0 | 2.37 (0.067) |
| 2 (51) | | 0 | 1.58 (0.046) |
| 1 (25) | | 0 | 0.79 (0.022) |

**Note:** Add 0.79 ft³ (0.022 m³) of storage for each additional inch. (25 mm) of stone foundation.

## STORAGE VOLUME PER CHAMBER FT³ (M³)

| | Bare Chamber Storage ft³ (m³) | Chamber and Stone Foundation Depth in. (mm) | | |
|---|---|---|---|---|
| | | 6 (150) | 12 (300) | 18 (450) |
| StormTech SC-310 | 14.7 (0.4) | 31.0 (0.9) | 35.7 (1.0) | 40.4 (1.1) |

**Note:** Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% stone porosity.

## AMOUNT OF STONE PER CHAMBER

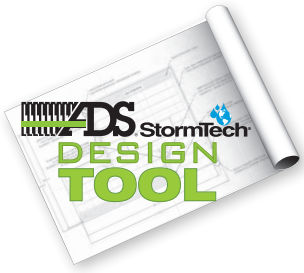
| ENGLISH TONS (yds³) | Stone Foundation Depth | | |
|---|---|---|---|
| | 6" | 12" | 18" |
| StormTech SC-310 | 2.1 (1.5 yd³) | 2.7 (1.9 yd³) | 3.4 (2.4 yd³) |
| **METRIC KILOGRAMS (m³)** | **150 mm** | **300 mm** | **450 mm** |
| StormTech SC-310 | 1830 (1.1 m³) | 2490 (1.5 m³) | 2990 (1.8 m³) |

**Note:** Assumes 6" (150 mm) of stone above, and between chambers.

## VOLUME EXCAVATION PER CHAMBER YD³ (M³)

| | Stone Foundation Depth | | |
|---|---|---|---|
| | 6" (150 mm) | 12" (300 mm) | 18" (450 mm) |
| StormTech SC-310 | 2.9 (2.2) | 3.4 (2.6) | 3.8 (2.9) |

**Note:** Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. The volume of excavation will vary as the depth of the cover increases.

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**and utilize the StormTech Design Tool**

**For more information on the StormTech SC-310 Chamber and other ADS products, please contact our Customer Service Representatives at 1-800-821-6710**

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StormTech®

Detention - Retention - Water Quality

Division of ADS

| STORMTECH ISOLATOR ROW SIZING CHART | | | | | |
|---|---|---|---|---|---|
| | **SC-310** | **SC-740** | **DC-780** | **MC-3500** | **MC-4500** |
| Chamber Area (Sq.Ft.) | 20 | 27.8 | 27.8 | 43.2 | 30.1 |
| Treated Flow Rate per chamber (CFS) | 0.11 | 0.15 | 0.15 | 0.24 | 0.17 |

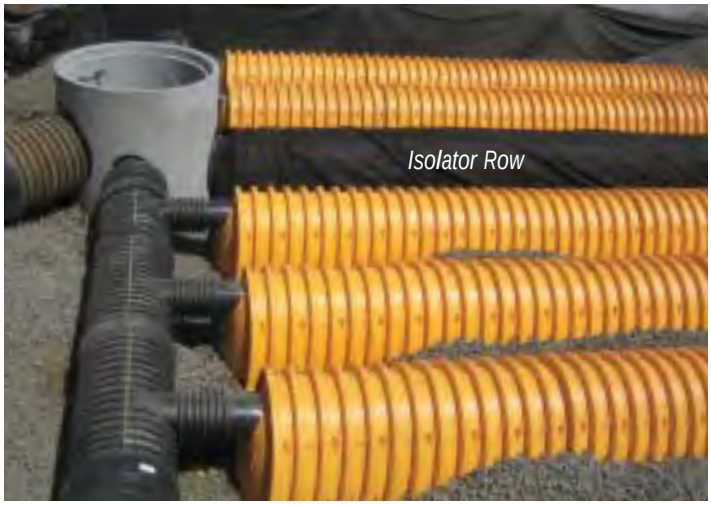
***NOTE:*** *Testing of the Isolator Row completed by Tennesse Tech has been verified by NJCAT and it has shown to have a TSS removal efficiency of 84% for SIL-CO-SIL 250*

NJCAT verified Treated Flow Rate (GPM / Sq.Ft.) 2.5

StormTech®
Detention • Retention • Recharge
Subsurface Stormwater Management℠

# Isolator Row™ Performance Test Results

as reported by Tennessee Technological University




StormTech chambers are the only chambers that meet stringent AASHTO safety factors for traffic load and deep burial applications.

Four SC-740 chambers in test apparatus at Tennessee Tech.

Uniform sediment distribution (US Silica OK-110 SG=2.65).

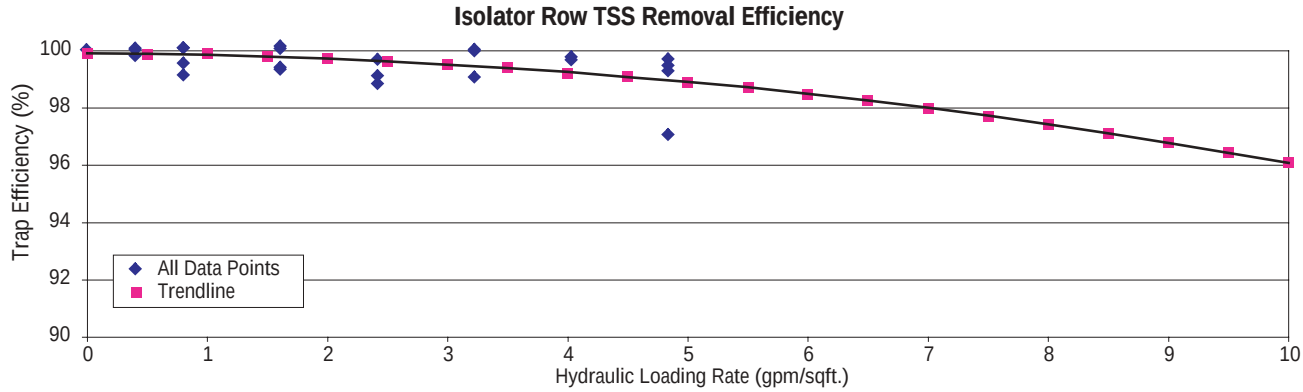
The Isolator Row is an innovative yet simple system that inexpensively removes total suspended solids (TSS) from storm water and provides easy access for inspection and maintenance. In the Isolator Row, StormTech chambers are completely enclosed by geotextile fabrics. Sediment is captured in the Isolator Row as storm water passes through the fabric to the stone and adjacent chambers.

The recent completion of TSS removal testing at Tennessee Tech provides design engineers and regulators solid data that can be used to estimate the maintenance free interval and establishes the Isolator Row as a best management practice (BMP) for TSS removal.

For additional information on the Isolator Row (patent pending), contact StormTech at (888) 892-2694.

**Performance Summary:**

- 97% Overall TSS Removal
- 80% TSS Captured in the Isolator Row
- Estimated Maintenance Interval – 3 years



# Another Success Story for the Isolator Row

## After One Year of Operation, Harvey Industries Inspected and Cleaned Their Isolator Row in Portland, Maine

150 StormTech SC-740 chambers were installed in April, 2003. On July 7, 2004, after one year in service, StormTech inspected the Isolator Row and observed maintenance procedures.

Vactor trucks are typically equipped with both jetting and vacuum equipment.


During maintenance, the jetting nozzle propels itself down the Isolator Row scouring up sediment and washing it down to the access manhole where it is vacuumed into the truck.


After four passes of the jetting nozzle at pressures up to 1900 psi, the bottom fabric was scoured clean.

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StormTech products are covered by one or more of the following patents: U.S. Patents: 5,401,459; 5,511,903; 5,716,163; 5,588,778; 5,839,844; Canadian Patents: 2,158,418 Other U.S. and Foreign Patents Pending

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## F-1. Rainfall Data for Massachusetts from *Rainfall Frequency Atlas of the United States* (TP-40)

- Users of this Handbook should note that current MA DEP written guidance (see DEP Waterlines newsletter -- Fall 2000) requires the use of TP-40 Rainfall Data for calculations under the Wetlands Protection Regulations and the Stormwater Management Policy. More stringent design storms may be used under a local bylaw or ordinance. However, DEP will continue to require the use of TP-40 in any case it reviews under the Wetlands Protection Act and Stormwater Management Policy.

*Adjusted Technical Paper 40 Design Storms for 24-hour Event by County*

| County Name | 1-yr 24-hr | 2-yr 24-hr | 5-yr 24-hr | 10-yr 24-hr | 25-yr 24-hr | 50-yr 24-hr | 100-yr 24-hr |
|---|---|---|---|---|---|---|---|
| Barnstable | 2.5 | 3.6 | 4.5 | 4.8 | 5.7 | 6.4 | 7.1 |
| Berkshire | 2.5 | 2.9 | 3.8 | 4.4 | 5.1 | 5.9 | 6.4 |
| Bristol | 2.5 | 3.4 | 4.3 | 4.8 | 5.6 | 6.3 | 7.0 |
| Dukes | 2.5 | 3.6 | 4.6 | 4.9 | 5.8 | 6.5 | 7.2 |
| Essex | 2.5 | 3.1 | 3.9 | 4.5 | 5.4 | 5.9 | 6.5 |
| Franklin | 2.5 | 2.9 | 3.8 | 4.3 | 5.1 | 5.8 | 6.2 |
| Hampden | 2.5 | 3.0 | 4.0 | 4.6 | 5.3 | 6.0 | 6.5 |
| Hampshire | 2.5 | 3.0 | 3.9 | 4.5 | 5.2 | 5.9 | 6.4 |
| Middlesex | 2.5 | 3.1 | 4.0 | 4.5 | 5.3 | 5.9 | 6.5 |
| Nantucket | 2.5 | 3.6 | 4.6 | 4.9 | 5.8 | 6.5 | 7.2 |
| Norfolk | 2.5 | 3.2 | 4.1 | 4.7 | 5.5 | 6.1 | 6.7 |
| Plymouth | 2.5 | 3.4 | 4.3 | 4.7 | 5.6 | 6.2 | 7.0 |
| Suffolk | 2.5 | 3.2 | 4.0 | 4.6 | 5.5 | 6.0 | 6.6 |
| Worcester | 2.5 | 3.0 | 4.0 | 4.5 | 5.3 | 5.9 | 6.5 |

VALUES OF THE ROUGHNESS COEFFICIENT $n$
(Boldface figures are values generally recommended in design)

| Type of channel and description | Minimum | Normal | Maximum |
|---|---|---|---|
| A. CLOSED CONDUITS FLOWING PARTLY FULL | | | |
| A-1. Metal | | | |
| *a.* Brass, smooth | 0.009 | **0.010** | 0.013 |
| *b.* Steel | | | |
| 1. Lockbar and welded | 0.010 | 0.012 | 0.014 |
| 2. Riveted and spiral | 0.013 | 0.016 | 0.017 |
| *c.* Cast iron | | | |
| 1. Coated | 0.010 | 0.013 | 0.014 |
| 2. Uncoated | 0.011 | 0.014 | 0.016 |
| *d.* Wrought iron | | | |
| 1. Black | 0.012 | **0.014** | 0.015 |
| 2. Galvanized | 0.013 | 0.016 | 0.017 |
| *e.* Corrugated metal | | | |
| 1. Subdrain | 0.017 | 0.019 | 0.021 |
| 2. Storm drain | 0.021 | **0.024** | 0.030 |
| A-2. Nonmetal | | | |
| *a.* Lucite | 0.008 | 0.009 | 0.010 |
| *b.* Glass | 0.009 | **0.010** | 0.013 |
| *c.* Cement | | | |
| 1. Neat, surface | 0.010 | 0.011 | 0.013 |
| 2. Mortar | 0.011 | 0.013 | 0.015 |
| *d.* Concrete | | | |
| 1. Culvert, straight and free of debris | 0.010 | 0.011 | 0.013 |
| 2. Culvert with bends, connections, and some debris | 0.011 | **0.013** | 0.014 |
| 3. Finished | 0.011 | 0.012 | 0.014 |
| 4. Sewer with manholes, inlet, etc., straight | 0.013 | 0.015 | 0.017 |
| 5. Unfinished, steel form | 0.012 | 0.013 | 0.014 |
| 6. Unfinished, smooth wood form | 0.012 | **0.014** | 0.016 |
| 7. Unfinished, rough wood form | 0.015 | 0.017 | 0.020 |
| *e.* Wood | | | |
| 1. Stave | 0.010 | 0.012 | 0.014 |
| 2. Laminated, treated | 0.015 | 0.017 | 0.020 |
| *f.* Clay | | | |
| 1. Common drainage tile | 0.011 | **0.013** | 0.017 |
| 2. Vitrified sewer | 0.011 | 0.014 | 0.017 |
| 3. Vitrified sewer with manholes, inlet, etc. | 0.013 | 0.015 | **0.017** |
| 4. Vitrified subdrain with open joint | 0.014 | **0.016** | **0.018** |
| *g.* Brickwork | | | |
| 1. Glazed | 0.011 | **0.013** | 0.015 |
| 2. Lined with cement mortar | 0.012 | 0.015 | 0.017 |
| *h.* Sanitary sewers coated with sewage slimes, with bends and connections | 0.012 | 0.013 | 0.016 |
| *i.* Paved invert, sewer, smooth bottom | 0.016 | 0.019 | 0.020 |
| *j.* Rubble masonry, cemented | 0.018 | 0.025 | 0.030 |

VALUES OF THE ROUGHNESS COEFFICIENT $n$ (*continued*)

| Type of channel and description | Minimum | Normal | Maximum |
|---|---|---|---|
| B. LINED OR BUILT-UP CHANNELS | | | |
| B-1. Metal | | | |
| *a.* Smooth steel surface | | | |
| 1. Unpainted | 0.011 | **0.012** | 0.014 |
| 2. Painted | 0.012 | 0.013 | 0.017 |
| *b.* Corrugated | 0.021 | 0.025 | 0.030 |
| B-2. Nonmetal | | | |
| *a.* Cement | | | |
| 1. Neat, surface | 0.010 | 0.011 | 0.013 |
| 2. Mortar | 0.011 | 0.013 | 0.015 |
| *b.* Wood | | | |
| 1. Planed, untreated | 0.010 | 0.012 | 0.014 |
| 2. Planed, creosoted | 0.011 | 0.012 | 0.015 |
| 3. Unplaned | 0.011 | 0.013 | 0.015 |
| 4. Plank with battens | 0.012 | 0.015 | 0.018 |
| 5. Lined with roofing paper | 0.010 | 0.014 | 0.017 |
| *c.* Concrete | | | |
| 1. Trowel finish | 0.011 | **0.013** | 0.015 |
| 2. Float finish | 0.013 | 0.015 | 0.016 |
| 3. Finished, with gravel on bottom | 0.015 | 0.017 | 0.020 |
| 4. Unfinished | 0.014 | 0.017 | 0.020 |
| 5. Gunite, good section | 0.016 | 0.019 | 0.023 |
| 6. Gunite, wavy section | 0.018 | 0.022 | 0.025 |
| 7. On good excavated rock | 0.017 | 0.020 | |
| 8. On irregular excavated rock | 0.022 | 0.027 | |
| *d.* Concrete bottom float finished with sides of | | | |
| 1. Dressed stone in mortar | 0.015 | 0.017 | 0.020 |
| 2. Random stone in mortar | 0.017 | 0.020 | 0.024 |
| 3. Cement rubble masonry, plastered | 0.016 | 0.020 | 0.024 |
| 4. Cement rubble masonry | 0.020 | 0.025 | 0.030 |
| 5. Dry rubble or riprap | 0.020 | 0.030 | 0.035 |
| *e.* Gravel bottom with sides of | | | |
| 1. Formed concrete | 0.017 | 0.020 | 0.025 |
| 2. Random stone in mortar | 0.020 | 0.023 | 0.026 |
| 3. Dry rubble or riprap | 0.023 | 0.033 | 0.036 |
| *f.* Brick | | | |
| 1. Glazed | 0.011 | **0.013** | 0.015 |
| 2. In cement mortar | 0.012 | **0.015** | 0.018 |
| *g.* Masonry | | | |
| 1. Cemented rubble | 0.017 | 0.025 | 0.030 |
| 2. Dry rubble | 0.023 | 0.032 | 0.035 |
| *h.* Dressed ashlar | 0.013 | 0.015 | 0.017 |
| *i.* Asphalt | | | |
| 1. Smooth | 0.013 | 0.013 | |
| 2. Rough | 0.016 | 0.016 | |
| *j.* Vegetal lining | 0.030 | ..... | 0.500 |

VALUES OF THE ROUGHNESS COEFFICIENT $n$ (*continued*)

| Type of channel and description | Minimum | Normal | Maximum |
|---|---|---|---|
| C. EXCAVATED OR DREDGED | | | |
| *a.* Earth, straight and uniform | | | |
| 1. Clean, recently completed | 0.016 | 0.018 | 0.020 |
| 2. Clean, after weathering | 0.018 | 0.022 | 0.025 |
| 3. Gravel, uniform section, clean | 0.022 | 0.025 | 0.030 |
| 4. With short grass, few weeds | 0.022 | 0.027 | 0.033 |
| *b.* Earth, winding and sluggish | | | |
| 1. No vegetation | 0.023 | 0.025 | 0.030 |
| 2. Grass, some weeds | 0.025 | 0.030 | 0.033 |
| 3. Dense weeds or aquatic plants in deep channels | 0.030 | 0.035 | 0.040 |
| 4. Earth bottom and rubble sides | 0.028 | 0.030 | 0.035 |
| 5. Stony bottom and weedy banks | 0.025 | 0.035 | 0.040 |
| 6. Cobble bottom and clean sides | 0.030 | 0.040 | 0.050 |
| *c.* Dragline-excavated or dredged | | | |
| 1. No vegetation | 0.025 | 0.028 | 0.033 |
| 2. Light brush on banks | 0.035 | 0.050 | 0.060 |
| *d.* Rock cuts | | | |
| 1. Smooth and uniform | 0.025 | 0.035 | 0.040 |
| 2. Jagged and irregular | 0.035 | 0.040 | 0.050 |
| *e.* Channels not maintained, weeds and brush uncut | | | |
| 1. Dense weeds, high as flow depth | 0.050 | 0.080 | 0.120 |
| 2. Clean bottom, brush on sides | 0.040 | 0.050 | 0.080 |
| 3. Same, highest stage of flow | 0.045 | 0.070 | 0.110 |
| 4. Dense brush, high stage | 0.080 | 0.100 | 0.140 |
| D. NATURAL STREAMS | | | |
| D-1. Minor streams (top width at flood stage <100 ft) | | | |
| *a.* Streams on plain | | | |
| 1. Clean, straight, full stage, no rifts or deep pools | 0.025 | 0.030 | 0.033 |
| 2. Same as above, but more stones and weeds | 0.030 | 0.035 | 0.040 |
| 3. Clean, winding, some pools and shoals | 0.033 | 0.040 | 0.045 |
| 4. Same as above, but some weeds and stones | 0.035 | 0.045 | 0.050 |
| 5. Same as above, lower stages, more ineffective slopes and sections | 0.040 | 0.048 | 0.055 |
| 6. Same as 4, but more stones | 0.045 | 0.050 | 0.060 |
| 7. Sluggish reaches, weedy, deep pools | 0.050 | 0.070 | 0.080 |
| 8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush | 0.075 | 0.100 | 0.150 |

VALUES OF THE ROUGHNESS COEFFICIENT $n$ (*continued*)

| Type of channel and description | Minimum | Normal | Maximum |
|---|---|---|---|
| *b.* Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages | | | |
| 1. Bottom: gravels, cobbles, and few boulders | 0.030 | 0.040 | 0.050 |
| 2. Bottom: cobbles with large boulders | 0.040 | 0.050 | 0.070 |
| D-2. Flood plains | | | |
| *a.* Pasture, no brush | | | |
| 1. Short grass | 0.025 | 0.030 | 0.035 |
| 2. High grass | 0.030 | 0.035 | 0.050 |
| *b.* Cultivated areas | | | |
| 1. No crop | 0.020 | 0.030 | 0.040 |
| 2. Mature row crops | 0.025 | 0.035 | 0.045 |
| 3. Mature field crops | 0.030 | 0.040 | 0.050 |
| *c.* Brush | | | |
| 1. Scattered brush, heavy weeds | 0.035 | 0.050 | 0.070 |
| 2. Light brush and trees, in winter | 0.035 | 0.050 | 0.060 |
| 3. Light brush and trees, in summer | 0.040 | 0.060 | 0.080 |
| 4. Medium to dense brush, in winter | 0.045 | 0.070 | 0.110 |
| 5. Medium to dense brush, in summer | 0.070 | 0.100 | 0.160 |
| *d.* Trees | | | |
| 1. Dense willows, summer, straight | 0.110 | 0.150 | 0.200 |
| 2. Cleared land with tree stumps, no sprouts | 0.030 | 0.040 | 0.050 |
| 3. Same as above, but with heavy growth of sprouts | 0.050 | 0.060 | 0.080 |
| 4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches | 0.080 | 0.100 | 0.120 |
| 5. Same as above, but with flood stage reaching branches | 0.100 | 0.120 | 0.160 |
| D-3. Major streams (top width at flood stage >100 ft). The $n$ value is less than that for minor streams of similar description, because banks offer less effective resistance. | | | |
| *a.* Regular section with no boulders or brush | 0.025 | ..... | 0.060 |
| *b.* Irregular and rough section | 0.035 | ..... | 0.100 |


Map Scale: 1:6,600 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 300 600 1200 1800

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: Middlesex County, Massachusetts
Survey Area Data: Version 18, Sep 7, 2018

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

Date(s) aerial images were photographed: Aug 10, 2014—Sep 19, 2014

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

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 1 | Water | 59.1 | 32.5% |
| 51A | Swansea muck, 0 to 1 percent slopes | 7.5 | 4.1% |
| 52A | Freetown muck, 0 to 1 percent slopes | 25.9 | 14.3% |
| 603 | Urban land, wet substratum | 1.0 | 0.5% |
| 626B | Merrimac-Urban land complex, 0 to 8 percent slopes | 12.7 | 7.0% |
| 629C | Canton-Charlton-Urban land complex, 3 to 15 percent slopes | 2.4 | 1.3% |
| 652 | Udorthents, refuse substratum | 6.4 | 3.5% |
| 656 | Udorthents-Urban land complex | 66.8 | 36.7% |
| **Totals for Area of Interest** | | **181.8** | **100.0%** |

# National Flood Hazard Layer FIRMette


## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

- **SPECIAL FLOOD HAZARD AREAS**
  - Without Base Flood Elevation (BFE) *Zone A, V, A99*
  - With BFE or Depth *Zone AE, AO, AH, VE, AR*
  - Regulatory Floodway
- **OTHER AREAS OF FLOOD HAZARD**
  - 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
  - Future Conditions 1% Annual Chance Flood Hazard *Zone X*
  - Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
  - Area with Flood Risk due to Levee *Zone D*
- **OTHER AREAS**
  - NO SCREEN Area of Minimal Flood Hazard *Zone X*
  - Effective LOMRs
  - Area of Undetermined Flood Hazard *Zone D*
- **GENERAL STRUCTURES**
  - Channel, Culvert, or Storm Sewer
  - Levee, Dike, or Floodwall
- **OTHER FEATURES**
  - 20.2 Cross Sections with 1% Annual Chance
  - 17.5 Water Surface Elevation
  - Coastal Transect
  - Base Flood Elevation Line (BFE)
  - Limit of Study
  - Jurisdiction Boundary
  - Coastal Transect Baseline
  - Profile Baseline
  - Hydrographic Feature
- **MAP PANELS**
  - Digital Data Available
  - No Digital Data Available
  - Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/2/2018 at 9:24:28 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

HALEY ALDRICH

# TEST PIT LOG

**Test Pit No.** TP-1

| | | | |
|---|---|---|---|
| **Project** | 200 QUANNAPOWITT PARKWAY REDEVELOPMENT | **File No.** | 134635-005 |
| **Location** | WAKEFIELD, MA | **H&A Rep** | S. Shay |
| **Client** | Cabot, Cabot, & Forbes | **Date** | 3 Jun 2021 |
| **Contractor** | EARTHWORK INDUSTRIES, INC. | **Weather** | Partly Cloudy 70's |
| **Equipment Used** | Doosan DX85R | | |

**Ground El.:** 83.0 est. **El. Datum:** NAVD88 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** Seepage 2' / Rapid infiltration at 7.2 ft

| Depth (ft) | Sample ID | Stratum Change Elev./ Depth (ft) | USCS Symbol | VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION) | Gravel % Coarse | Gravel % Fine | Sand % Coarse | Sand % Medium | Sand % Fine | % Fines | Field Tests: Dilatancy | Toughness | Plasticity | Strength |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | -ASPHALT- | | | | | | | | | | |
| | | 0.3 | SP- SM | Brown poorly graded SAND with silt (SP-SM), 2% oversized, mps 3.5 in., no structure, no odor, dry | 5 | 10 | 20 | 20 | 35 | 10 | | | | |
| | | | | -FILL- | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | |
| 4 | | 4.0 | SM | Gray silty SAND with gravel (SM), 10% oversized, mps 1.0 ft, appears to be placed layers of similar material in lifts 1.5 to 2.5 ft thick, no odor, moist | 10 | 10 | 15 | 10 | 35 | 20 | | | | |
| | | | | -FILL- | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| | | 7.6 | | Olive-gray poorly graded SAND (SP), no oversized, mps 1/16 in., single-grained structure, no odor, wet | | | | 20 | 80 | | | | | |
| 8 | | | | -GLACIOFLUVIAL DEPOSITS- | | | | | | | | | | |
| | | 8.5 | | BOTTOM OF EXPLORATION 8.5 FT | | | | | | | | | | |

**Obstructions:** None

**Remarks:** Standard test tip backfill, full asphalt restore.

**Field Tests**

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

**Standing Water in Completed Pit**

at depth 5.8 ft
measured after 0.25 hours elapsed

**Boulders**

| Diameter (in.) | Number | Approx. Vol. (cu.ft) |
|---|---|---|
| 12 to 24 | 2 | = 2 |
| over 24 | 1 | = |

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) 12 X 4.2
Pit Depth (ft) 8.5

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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HALEY ALDRICH

# TEST PIT LOG

**Test Pit No.** TP-2

| | |
|---|---|
| **Project** | 200 QUANNAPOWITT PARKWAY REDEVELOPMENT |
| **Location** | WAKEFIELD, MA |
| **Client** | Cabot, Cabot, & Forbes |
| **Contractor** | EARTHWORK INDUSTRIES, INC. |
| **Equipment Used** | Doosan DX85R |
| **File No.** | 134635-005 |
| **H&A Rep** | S. Shay |
| **Date** | 3 Jun 2021 |
| **Weather** | Partly Cloudy 70's |

**Ground El.:** 83.5 est. **El. Datum:** NAVD88 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** 7.0' / Rapidly

| Depth (ft) | Sample ID | Stratum Change Elev./ Depth (ft) | USCS Symbol | VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION) | Gravel % Coarse | Gravel % Fine | Sand % Coarse | Sand % Medium | Sand % Fine | % Fines | Field Tests Dilatancy | Toughness | Plasticity | Strength |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | -ASPHALT- | | | | | | | | | | |
| | | 0.3 | SP- SM | Brown poorly graded SAND with silt and gravel (SP-SM), 5% oversized, mps 9.0 in., no structure, no odor, dry | 10 | 10 | 15 | 15 | 40 | 10 | | | | |
| | | | | -FILL- | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | |
| | | 3.0 | SM | Yellow-brown silty SAND (SM), no oversized, mps 1/8 in., no structure, no odor, dry, appear to be placed | | | 5 | 5 | 60 | 30 | | | | |
| | | 3.3 | SP | Brown poorly graded SAND (SP), no oversized, mps 1.0 in., single-grained structure, no odor, moist | | 10 | 20 | 40 | 25 | 5 | | | | |
| 4 | | 4.0 | SM | Gray-brown silty SAND with gravel (SM), 15% oversized, mps 1.3 ft, no structure, no odor, moist | 10 | 10 | 10 | 10 | 35 | 25 | | | | |
| 6 | | | | | | | | | | | | | | |
| | | 7.0 | OL/ OH | Dark brown ORGANIC SOIL (OL/OH), no oversized, mps 0.5 in., no structure, organic odor, wet, appears to be disturbed 15% fibers | | | | | 10 | 90 | | | | |
| | | 7.4 | SP | Olive-gray poorly graded SAND (SP), no oversized, mps 1/16 in., single-grain structure, no odor, wet | | | | 20 | 80 | | | | | |
| | | | | -GLACIOFLUVIAL DEPOSITS- | | | | | | | | | | |
| 8 | | 8.0 | | BOTTOM OF EXPLORATION 8.0 FT | | | | | | | | | | |

**Obstructions:** None

**Remarks:** Standard test tip backfill, full asphalt restore.

**Field Tests**

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

**Standing Water in Completed Pit**

at depth 4.9 ft
measured after 2.0 hours elapsed

**Boulders**

| Diameter (in.) | Number | | Approx. Vol. (cu.ft) |
|---|---|---|---|
| 12 to 24 | 2 | = | 2.1 |
| over 24 | 0 | = | 0 |

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) 10 X 4
Pit Depth (ft) 8.0

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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HALEY ALDRICH

# TEST PIT LOG

**Test Pit No.** TP-3

**Project** 200 QUANNAPOWITT PARKWAY REDEVELOPMENT
**Location** WAKEFIELD, MA
**Client** Cabot, Cabot, & Forbes
**Contractor** EARTHWORK INDUSTRIES, INC.
**Equipment Used** Doosan DX85R

**File No.** 134635-005
**H&A Rep** S. Shay
**Date** 2 Jun 2021
**Weather** Partly Cloudy 70's

**Ground El.:** 84 est.
**El. Datum:** NAVD88
**Location:** See Plan
**Groundwater depths/entry rates (in./min.):** 7.0' / Rapidly

| Depth (ft) | Sample ID | Stratum Change Elev./ Depth (ft) | USCS Symbol | VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION) | Gravel % Coarse | Gravel % Fine | Sand % Coarse | Sand % Medium | Sand % Fine | % Fines | Field Tests Dilatancy | Toughness | Plasticity | Strength |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | -ASPHALT- | | | | | | | | | | |
| | | 0.2 | | -GRAVEL BINDER BASE- | | | | | | | | | | |
| | | 0.4 | SP- SM | Brown poorly graded SAND with silt and gravel (SP-SM), 5% oversized, mps 6.0 in., no structure, no odor, moist | 5 | 15 | 15 | 15 | 40 | 10 | | | | |
| | | | | -FILL- | | | | | | | | | | |
| 2 | | 2.0 | SP | Olive-brown poorly graded SAND with gravel (SP), 5-8% oversized, mps 10.0 in., no structure, no odor, moist | 5 | 10 | 10 | 40 | 30 | 5 | | | | |
| 4 | | 4.0 | SM | Gray silty SAND with gravel (SM), 5% oversized, mps 8.0 ft, no structure, no odor, moist | 5 | 10 | 10 | 15 | 40 | 20 | | | | |
| 6 | | | | -FILL- | | | | | | | | | | |
| | | | SM | Olive-gray silty SAND (SM), 2-4% oversized, mps 4.0 ft, no structure, slight organic odor, wet, trace fibers | | 10 | 10 | 35 | 30 | 15 | | | | |
| | | 6.7 | | -GLACIOFLUVIAL DEPOSITS- | | | | | | | | | | |
| | | 7.5 | | BOTTOM OF EXPLORATION 7.5 FT | | | | | | | | | | |

**Obstructions:** None

**Remarks:** Standard test tip backfill, full asphalt restore.

**Field Tests**

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

**Standing Water in Completed Pit**

at depth 7.0 ft
measured after 0.5 hours elapsed

**Boulders**

| Diameter (in.) | Number | | Approx. Vol. (cu.ft) |
|---|---|---|---|
| 12 to 24 | 2 | = | 2 |
| over 24 | 0 | = | 0 |

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) 12 X 4.5
Pit Depth (ft) 7.5

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

**Test Pit No.** TP-4

| | |
|---|---|
| **Project** | 200 QUANNAPOWITT PARKWAY REDEVELOPMENT |
| **Location** | WAKEFIELD, MA |
| **Client** | Cabot, Cabot, & Forbes |
| **Contractor** | EARTHWORK INDUSTRIES, INC. |
| **Equipment Used** | Doosan DX85R |
| **File No.** | 134635-005 |
| **H&A Rep** | S. Shay |
| **Date** | 2 Jun 2021 |
| **Weather** | Partly Cloudy 70's |

**Ground El.:** 85.5 est. **El. Datum:** NAVD88 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** Heavy seepage at 2 and 3 ft

| Depth (ft) | Sample ID | Stratum Change Elev./ Depth (ft) | USCS Symbol | VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION) | Gravel % Coarse | Gravel % Fine | Sand % Coarse | Sand % Medium | Sand % Fine | % Fines | Field Tests Dilatancy | Toughness | Plasticity | Strength |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | OL/ OH | Dark brown sandy ORGANIC SOIL (OL/OH), no oversized, mps 2.0 in., no structure, no odor, moist, heavy root material | | | | | 30 | 70 | | | | |
| 1 | | | | -TOPSOIL/FILL- | | | | | | | | | | |
| | | 1.2 | SM | Light brown silty SAND (SM), no oversize, mps 2.5 in., no structure, no odor, moist | 5 | 10 | 10 | 20 | 40 | 15 | | | | |
| | | 1.5 | SP- SM | -FILL- Mixed layer of discontinuous pockets of dark brown to brown poorly graded SAND and silty SAND (SP-SM) | 10 | 10 | 20 | 20 | 40 | | | | | |
| 2 | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | |
| | | 3.3 | SM | Olive-brown silty SAND (SM), no oversized, mps 2.0 ft, no structure, no odor, wet | 5 | 5 | 20 | 20 | 30 | 20 | | | | |
| 4 | | | | Note: Encounter 0.5 in. copper pipe across the floor of the test pit. | | | | | | | | | | |
| 5 | | 5.0 | | BOTTOM OF EXPLORATION 5.0 FT | | | | | | | | | | |

**Obstructions:** 0.5 in. copper pipe at 5 ft

**Remarks:** Standard test tip backfill, full asphalt restore.

**Field Tests**

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

**Standing Water in Completed Pit**

at depth 3.6 ft
measured after 0.5 hours elapsed

**Boulders**

| Diameter (in.) | Number | Approx. Vol. (cu.ft) |
|---|---|---|
| 12 to 24 | 1 | = 0.9 |
| over 24 | 0 | = 0 |

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) 12 X 4
Pit Depth (ft) 5.0

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

**Test Pit No.** TP-5

| | |
|---|---|
| **Project** | 200 QUANNAPOWITT PARKWAY REDEVELOPMENT |
| **Location** | WAKEFIELD, MA |
| **Client** | Cabot, Cabot, & Forbes |
| **Contractor** | EARTHWORK INDUSTRIES, INC. |
| **Equipment Used** | Doosan DX85R |
| **File No.** | 134635-005 |
| **H&A Rep** | S. Shay |
| **Date** | 2 Jun 2021 |
| **Weather** | Partly Cloudy 70's |

**Ground El.:** 84 est. **El. Datum:** NAVD88 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** 2.0' / Rapidly

| Depth (ft) | Sample ID | Stratum Change Elev./ Depth (ft) | USCS Symbol | VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION) | Gravel % Coarse | Gravel % Fine | Sand % Coarse | Sand % Medium | Sand % Fine | % Fines | Field Tests Dilatancy | Toughness | Plasticity | Strength |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | -ASPHALT- | | | | | | | | | | |
| | | 0.2 | SP- SM | Brown poorly graded SAND with silt and gravel (SP-SM), 10% oversized, mps 5.0 in., no structure, no odor, moist | 5 | 15 | 20 | 20 | 30 | 10 | | | | |
| 1 | | | | -FILL- | | | | | | | | | | |
| | | 1.5 | SP | Olive-brown poorly graded SAND with gravel (SP), no oversized, mps 2.0 in., no structure, no odor, moist | | 10 | 20 | 35 | 30 | 5 | | | | |
| | | 1.8 | OL/ OH | Dark brown sandy ORGANIC SOIL (OL/OH), no oversized, mps 2.5 in., no structure, slight organic odor, wet, 20-30% fibers, appears to be disturbed | | | | 5 | 30 | 65 | | | | |
| 2 | | 2.5 | SM | Gray-brown silty SAND with gravel (SM), 10% oversized, mps 9.0 in., no structure, no odor, wet | 5 | 15 | 10 | 15 | 30 | 25 | | | | |
| 3 | | | | | | | | | | | | | | |
| 4 | | | | -FILL- | | | | | | | | | | |
| 5 | | 5.0 | | BOTTOM OF EXPLORATION 5.0 FT | | | | | | | | | | |

**Obstructions:** None

**Remarks:** Standard test tip backfill, full asphalt restore.

**Field Tests**

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

**Standing Water in Completed Pit**

| | | |
|---|---|---|
| at depth | 4.3/3.6 | ft |
| measured after | 0.5/1.0 | hours elapsed |

**Boulders**

| Diameter (in.) | Number | | Approx. Vol. (cu.ft) |
|---|---|---|---|
| 12 to 24 | 0 | = | 0 |
| over 24 | 0 | = | 0 |

**Test Pit Dimensions (ft)**

Pit Length x Width (ft)
Pit Depth (ft) 5.0

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

**Test Pit No.** TP-6

| | |
|---|---|
| **Project** | 200 QUANNAPOWITT PARKWAY REDEVELOPMENT |
| **Location** | WAKEFIELD, MA |
| **Client** | Cabot, Cabot, & Forbes |
| **Contractor** | EARTHWORK INDUSTRIES, INC. |
| **Equipment Used** | Doosan DX85R |
| **File No.** | 134635-005 |
| **H&A Rep** | S. Shay |
| **Date** | 2 Jun 2021 |
| **Weather** | Partly Cloudy 70's |

**Ground El.:** 83.5 est. **El. Datum:** NAVD88 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** 2.5' / Rapidly

| Depth (ft) | Sample ID | Stratum Change Elev./ Depth (ft) | USCS Symbol | VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION) | Gravel % Coarse | Gravel % Fine | Sand % Coarse | Sand % Medium | Sand % Fine | % Fines | Field Tests Dilatancy | Toughness | Plasticity | Strength |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | OL/ OH | Dark brown sandy ORGANIC SOIL (OL/OH), no oversize, mps 1.0 in., no structure, no odor, wet, heavy root material | | | | | 30 | 70 | | | | |
| | | | | -TOPSOIL/FILL- | | | | | | | | | | |
| | | 0.8 | SP | Yellow-brown poorly graded SAND with silt and gravel (SP-SM), no oversized, mps 1/2 in., no structure, no odor, wet | | 5 | | 45 | 45 | 5 | | | | |
| 1 | | | | | | | | | | | | | | |
| | | 1.6 | SM | Olive-gray silty SAND with gravel (SM), 10% oversized, mps 3.0 in., no structure, no odor, wet | 10 | 10 | 10 | 15 | 25 | 30 | | | | |
| 2 | | 2.0 | SM | Dark brown silty SAND with gravel (SM), 2% oversized, mps 4.0 in., no structure, no odor, wet | 5 | 10 | 20 | 20 | 30 | 15 | | | | |
| | | 2.3 | SP- SM | -FILL- Olive-brown poorly graded SAND with silt and gravel (SP-SM), 15% oversized, mps 6.0 in., no structure, no odor, wet | 10 | 10 | 15 | 15 | 40 | 10 | | | | |
| 3 | | | | | | | | | | | | | | |
| 4 | | | | -GLACIOFLUVIAL DEPOSITS- | | | | | | | | | | |
| | | 4.5 | SM | Light gray-brown silty SAND (SM) | 5 | 5 | 10 | 15 | 45 | 20 | | | | |
| 5 | | | | | | | | | | | | | | |
| | | 5.5 | | BOTTOM OF EXPLORATION 5.5 FT | | | | | | | | | | |

**Obstructions:** None

**Remarks:** Standard test tip backfill, full asphalt restore.

**Field Tests**

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

**Standing Water in Completed Pit**

| | | |
|---|---|---|
| at depth | 3.5 | ft |
| measured after | 0.5 | hours elapsed |

**Boulders**

| Diameter (in.) | Number | Approx. Vol. (cu.ft) |
|---|---|---|
| 12 to 24 | 0 | = 0 |
| over 24 | 0 | = 0 |

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) 10 X 4
Pit Depth (ft) 5.5

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

**Test Pit No.** TP-7

| | |
|---|---|
| **Project** | 200 QUANNAPOWITT PARKWAY REDEVELOPMENT |
| **Location** | WAKEFIELD, MA |
| **Client** | Cabot, Cabot, & Forbes |
| **Contractor** | EARTHWORK INDUSTRIES, INC. |
| **Equipment Used** | Doosan DX85R |
| **File No.** | 134635-005 |
| **H&A Rep** | S. Shay |
| **Date** | 2 Jun 2021 |
| **Weather** | Partly Cloudy 70's |

**Ground El.:** 84 est. **El. Datum:** NAVD88 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** 3.0' / Rapidly

| Depth (ft) | Sample ID | Stratum Change Elev./ Depth (ft) | USCS Symbol | VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION) | Gravel % Coarse | Gravel % Fine | Sand % Coarse | Sand % Medium | Sand % Fine | % Fines | Field Tests: Dilatancy | Toughness | Plasticity | Strength |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | -ASPHALT- | | | | | | | | | | |
| | | 0.3 | SM | Brown silty SAND with gravel (SM), 20% oversized, mps 6.5 in., no structure, no odor, dry | 10 | 15 | 15 | 15 | 30 | 15 | | | | |
| 1 | | | | -FILL- | | | | | | | | | | |
| | | | SM | Gray silty SAND with gravel (SM), 10% oversized, mps 4.0 in., no structure, no odor, moist | 5 | 15 | 15 | 15 | 35 | 15 | | | | |
| 2 | | | | | | | | | | | | | | |
| | | | SM | Gray silty SAND with gravel (SM), 5% oversized, mps 1.0 in., no structure, no odor, moist | 5 | 10 | 15 | 15 | 35 | 20 | | | | |
| 3 | | | | | | | | | | | | | | |
| | | 3.2 | SP- SM | Olive-brown poorly graded SAND with silt (SP-SM), 2% oversized, mps 3.5 in., no structure, no odor, wet, possible re-worked material | 5 | 5 | 10 | 35 | 35 | 10 | | | | |
| 4 | | | | -FILL- | | | | | | | | | | |
| | | 4.2 | SP | Olive-brown poorly graded SAND (SP), no oversized, mps 1/2 in., weak stratification, no odor, wet | 5 | 5 | 15 | 35 | 35 | 5 | | | | |
| 5 | | | | GLACIOFLUVIAL DEPOSITS- | | | | | | | | | | |
| | | 5.5 | | BOTTOM OF EXPLORATION 5.5 FT | | | | | | | | | | |

**Obstructions:** None

**Remarks:** Standard test tip backfill, full asphalt restore.

**Field Tests**

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

**Standing Water in Completed Pit**

at depth 4.2/3.7 ft
measured after 1.0/2.0 hours elapsed

**Boulders**

| Diameter (in.) | Number | | Approx. Vol. (cu.ft) |
|---|---|---|---|
| 12 to 24 | 0 | = | 0 |
| over 24 | 0 | = | 0 |

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) 10 X 4
Pit Depth (ft) 5.5

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

**Test Pit No.** TP-8

**Project** 200 QUANNAPOWITT PARKWAY REDEVELOPMENT
**Location** WAKEFIELD, MA
**Client** Cabot, Cabot, & Forbes
**Contractor** EARTHWORK INDUSTRIES, INC.
**Equipment Used** Doosan DX85R

**File No.** 134635-005
**H&A Rep** S. Shay
**Date** 2 Jun 2021
**Weather** Partly Cloudy 70's

**Ground El.:** 83 est.
**El. Datum:** NAVD88
**Location:** See Plan
**Groundwater depths/entry rates (in./min.):** Rapidly at 3.5 ', fast seepage pockets 1.0, 1.5, and 2.7'

| Depth (ft) | Sample ID | Stratum Change Elev./ Depth (ft) | USCS Symbol | VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION) | Gravel % Coarse | Gravel % Fine | Sand % Coarse | Sand % Medium | Sand % Fine | % Fines | Field Tests Dilatancy | Toughness | Plasticity | Strength |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | -ASPHALT/GRAVEL BINDER BASE- | | | | | | | | | | |
| | | 0.3 | SP- SM | Brown poorly graded SAND with silt and gravel (SP-SM), 30% oversized, mps 6.0 in., no structure, no odor, moist to wet | 10 | 20 | 10 | 15 | 35 | 10 | | | | |
| 1 | | | | -FILL- | | | | | | | | | | |
| 2 | | 1.9 | SP | Olive-brown poorly graded SAND with gravel (SP), 20% oversized, mps 6.0 in., no structure, no odor, wet | 5 | 15 | 10 | 40 | 25 | 5 | | | | |
| 3 | | 2.9 | SM | Olive-gray silty SAND with gravel (SM), 2% oversized, mps 4.0 in., no structure, though difficult to fully characterize due to inflex of groundwater, no odor, wet | 5 | 10 | 10 | 15 | 40 | 20 | | | | |
| 4 | | | | -FILL- | | | | | | | | | | |
| 5 | | 5.0 | | BOTTOM OF EXPLORATION 5.0 FT | | | | | | | | | | |

**Obstructions:** None

**Remarks:** Standard test tip backfill, full asphalt restore.

**Field Tests**

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

**Standing Water in Completed Pit**

at depth 3.2/2.7 ft
measured after 0.5/1.0 hours elapsed

**Boulders**

| Diameter (in.) | Number | | Approx. Vol. (cu.ft) |
|---|---|---|---|
| 12 to 24 | 0 | = | 0 |
| over 24 | 0 | = | 0 |

**Test Pit Dimensions (ft)**

Pit Length x Width (ft)
Pit Depth (ft) 5.0

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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**Commonwealth of Massachusetts**
**City/Town of**

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

**Deep Observation Hole Number:** TP -1 (Hole #) 6/3/21 (Date)

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA) | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0 - 0.3 | Asphalt | | | | | | | | | | |
| 0.3 - 4.0 | Fill | Sandy loam | 10 YR 4/4 | | | | 20 | 10 | Structureless | Friable | |
| 4.0 - 7.6 | Fill | Sandy loam | 10 YR 4/1 | | | | 25 | 15 | Structureless | Friable | |
| 7.6 - 8.5 | C | Sand | 5Y 4/1 | | | | 0 | 0 | Structureless | loose | Saturated |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Additional Notes:
Rapid influx of water with organic odor at 7.2' during excavation

Standing water at 5.8' after 0.25 HR

Open pit viewed by W. Renault / Town Eng.

**Commonwealth of Massachusetts**
**City/Town of**

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

**Deep Observation Hole Number:** TP - 2 (Hole #) 6/3/21 (Date)

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0-0.3 | Asphalt | | | | | | | | | | |
| 0.3 - 3.0 | Fill | Sandy loam | 10 YR 5.4 | | | | 20 | 10 | | Friable | |
| 3.0 - 3.3 | Fill | Silt Loam | 2.5Y 5/4 | 3.0 | 7.54R 5/6 | 10 | 2 | 0 | | Very friable | Variagated<br>Not assoc. w/ SHW |
| 3.3 - 4.0 | Fill | Sandy loam | 2.5Y 4/2 | | | | 10 | 0 | | Friable | Dense |
| 4.0 - 7.0 | Fill | Sandy loam | 10 YR 4/3 | | | | 15 | 5 | | Friable | |
| 7.0 - 7.4 | Organic fill | Clay loam | 2.5Y 2.5/1 | | | | 0 | 0 | | Very friable | 40% organic |
| 7.4 - 8.0 | C | Sand | 2.5Y 5/2 | | | | 0 | 0 | single-grain | loose | saturated |

Additional Notes:

Rapid influx of water at 7.0' with organic odor during excavation ESHW not apparent

Standing water at 4.9' after 20'

Open pit viewed by W. Renault / Town Eng

**Commonwealth of Massachusetts**
**City/Town of**

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

**Deep Observation Hole Number:** TP-3 (Hole #) 6/2/21 (Date)

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0 - 0.2 | Asphalt | | | | | | | | | | |
| 0.2 - 0.4 | | | | | | | | | | | 0.2 - 0.4 coarse gravel binder base |
| 0.4 - 2.0 | Fill | Sandy loam | 10 YR 4/3 | | | | 30 | 5 | Structureless | Friable | |
| 2.0 - 4.0 | Fill | Sandy loam | 10 YR 5/4 | | | | 25 | 2 | Structureless | Friable | |
| 4.0 - 6.5 | Fill | Sandy loam | 5Y 4/2 | | | | 30 | 15 | Structureless | Friable | trace roots |
| 6.5 - 7.5 | ? | Sandy loam | 7.5 YR 3/3 | | | | 20 | 5 | massive | Friable | 10% saturated organic fibers |
| | | | | | | | | | | | |

Additional Notes:
Standing water at 7.0' after 0.5 HR ESHW not apparent Photo of open pit sent via text to W. Renault / Town Eng.

**Commonwealth of Massachusetts**
**City/Town of**

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

**Deep Observation Hole Number:** TP-4 (Hole #) 6/2/21 (Date)

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA) | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0 - 1.2 | (A) Topsoil / fill | Loam | 7.5 YR 2.5 /1 | | | | 15 | 4-5 | Structureless | Friable | |
| 1.2 - 1.5 | Fill | Sandy loam | 10YR 5/6 | | | | 10 | 0 | Structureless | very friable | |
| 1.5 - 3.3 | Fill | silt loam and sandy loam | 7.5 YR 2.5/1 and 10 YR 5/2 | | | | 20 | 10 | Structureless | Friable | Mixed |
| 3.3 - 5.0 | B | sandy loam | 2.5Y 5/2 | 4.5 - 5.0 | 7.5 YR 5/8 | 15 | 5 | 0 | Structureless | Friable | May be variagated coloring |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Additional Notes:
Standing water at 3.6 after 0.5 HR appears to be distinct mottles  Heavy seepage at 2.0 and 3.0'  Open pit viewed by W. Renault / town eng

**Commonwealth of Massachusetts**
**City/Town of**

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

**Deep Observation Hole Number:** TP-5 (Hole #) 6/2/21 (Date)

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0 - 0.2 | Asphalt | | | | | | | | | | |
| 0.2 - 1.5 | Fill | Sand | 10 YR 4/4 | | | | 15 | 5 | Structureless | Very friable | |
| | Fill | Sand | 2.5Y 4/4 | | | | 10 | 0 | Structureless | Very friable | similar as above except saturate |
| | Fill | Loam | 7.5 YR 3/1 | | | | 5 | 0 | Structureless | Friable | |
| | Fill | Silt loam | 5Y 4/2 | | | | 25 | 10 | Structureless | Friable | 2 boulders |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Additional Notes:
Water entering pit rapidly at 2.0' Standing water at 4.3' after 0.5HR / 3.6 after 1.0 HR Copper pipe at bottom of pit

Open pit viewed by W. Renault / Town Eng.

**Commonwealth of Massachusetts**
**City/Town of**

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

**Deep Observation Hole Number:** TP-6 (Hole #) 6/2/21 (Date)

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA) | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0 - 0.8 | O | Loam | 7.5 YR 2.5/1 | | | | 0 | 0 | Structureless | Loose | |
| 0.8 - 1.6 | Fill | Sandy loam | 10 YR 5/4 | | | | 10 | 0 | Structureless | Friable | |
| 1.6 - 2.0 | Fill | Silt loam | 7.5 YR 3/3 | | | | 2 | 0 | Structureless | very friable | disturbed |
| 2.0 - 2.3 | Fill | Sandy loam | 7.5 YR 3/1 | | | | 0 | 0 | Structureless | very friable | disturbed |
| 2.3 - 4.5 | C1 | Loamy sand | 10 YR 5/3 | | | | 12-15 | 2 | massive | friable | Saturated |
| 4.5 - 5.5 | C2 | Silt loam | 2.5 Y 5/1 | | | | 2 | 0 | massive | friable | |
| | | | | | | | | | | | |

Additional Notes:

Water entering pit at 2.5 rapidly / standing water at 3.5 after 0.5 HR

Open pit viewed by W. Renault / Town Eng

Unable to determine ESHW / mottling not apparent

**Commonwealth of Massachusetts**
**City/Town of**

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

**Deep Observation Hole Number:** TP-7 (Hole #) 6/2/21 (Date)

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0 - 0.3 | Asphalt | | | | | | | | | | |
| 0.3 - 1.3 | Fill | very gravelly sandy loam | 5 Y 4/2 | | | | 40 | 0 | Structureless | Friable | |
| 1.3 - 2.5 | Fill | sandy loam | 7.5 YR 4/4 | | | | 15 | 0 | Structureless | Friable | |
| 2.5 - 3.2 | Fill | silt loam | 2.5Y 5/3 | | | | 10 | 10 | Structureless | Friable | Angular Cobbles |
| 3.2 - 4.2 | Fill | sandy loam | 10 YR 4/3 | | | | 5 | 2 | Structureless | Friable | Re-worked Material |
| 4.2 - 5.5 | C | loamy sand | 2.5Y 4/3 | | | | 5 | 0 | massive | Friable | |
| | | | | | | | | | | | |

Additional Notes:
Standing water at 4.2' after 1.0 HR / 3.7' after 2.0 HR
Unable to determine ESHW / mottling not apparent

Open pit viewed by W. Renault / Town Eng

**Commonwealth of Massachusetts**
**City/Town of**

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

**Deep Observation Hole Number:** TP-8 (Hole #) 6/2/2021 (Date)

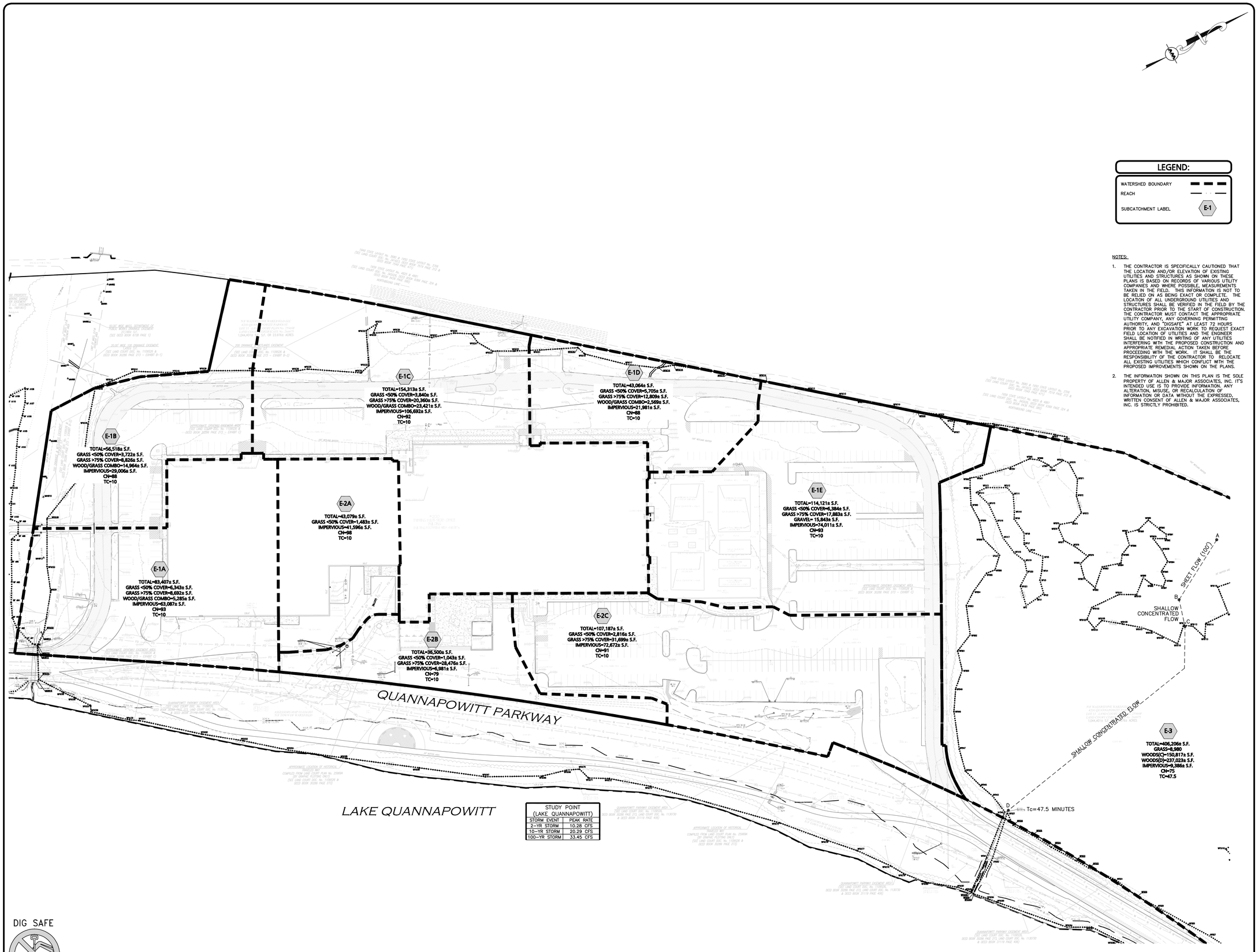
**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0-0.3 | Asphalt w/ gravel under base | | | | | | | | | | |
| 0.3-1.9 | Fill | Sandy loam | | | | | 40 | 20 | Structureless | Friable | |
| 1.9-2.9 | Fill | Sandy loam | | | | | 20 | 5 | Structureless | Friable | Trace roots* |
| 2.9-5.0 | Fill | Silt loam | 54 5/1 | | | | 5 | 2 | Structureless | Friable | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Additional Notes: Standing water at 3.2 after 0.5 HR/2.7 after 1.0 HR
Water seepage from various pockets in fill at 1.0, 1.5, and 2.7 ft
ES HW not apparent/ mottling at present
Upon pit viewed by W. Renault/Town Eng.

*Varigated 7.5 YR 1/1 discontinuous

# SECTION 6.0 –
# WATERSHED PLANS




| STUDY POINT (LAKE QUANNAPOWITT) | |
|---|---|
| STORM EVENT | PEAK RATE |
| 2-YR STORM | 10.28 CFS |
| 10-YR STORM | 20.29 CFS |
| 100-YR STORM | 33.45 CFS |

## LEGEND:

WATERSHED BOUNDARY

REACH

SUBCATCHMENT LABEL — E-1

NOTES:

1. THE CONTRACTOR IS SPECIFICALLY CAUTIONED THAT THE LOCATION AND/OR ELEVATION OF EXISTING UTILITIES AND STRUCTURES AS SHOWN ON THESE PLANS IS BASED ON RECORDS OF VARIOUS UTILITY COMPANIES AND WHERE POSSIBLE, MEASUREMENTS TAKEN IN THE FIELD. THIS INFORMATION IS NOT TO BE RELIED ON AS BEING EXACT OR COMPLETE. THE LOCATION OF ALL UNDERGROUND UTILITIES AND STRUCTURES SHALL BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO THE START OF CONSTRUCTION. THE CONTRACTOR MUST CONTACT THE APPROPRIATE UTILITY COMPANY, ANY GOVERNING PERMITTING AUTHORITY, AND "DIGSAFE" AT LEAST 72 HOURS PRIOR TO ANY EXCAVATION WORK TO REQUEST EXACT FIELD LOCATION OF UTILITIES AND THE ENGINEER SHALL BE NOTIFIED IN WRITING OF ANY UTILITIES INTERFERING WITH THE PROPOSED CONSTRUCTION AND APPROPRIATE REMEDIAL ACTION TAKEN BEFORE PROCEEDING WITH THE WORK. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO RELOCATE ALL EXISTING UTILITIES WHICH CONFLICT WITH THE PROPOSED IMPROVEMENTS SHOWN ON THE PLANS.
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GRAPHIC SCALE

50 0 25 50 100 200

( IN FEET )
1 inch = 50 ft.

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CALL 811 OR
1-888-DIG-SAFE
1-888-344-7233

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PROFESSIONAL ENGINEER FOR
ALLEN & MAJOR ASSOCIATES, INC.

| REV | DATE | DESCRIPTION |
|---|---|---|
| 1 | 3/31/2021 | Re-Issued to ZBA |

APPLICANT:
CCF QUANNAPOWITT PROPERTY COMPANY, LLC
185 DARTMOUTH STREET
BOSTON, MA 02116

PROJECT:
200-400 QUANNAPOWITT PARKWAY
WAKEFIELD, MA 01880

| | | | |
|---|---|---|---|
| PROJECT NO. | 1623-11 | DATE: | MARCH 16, 2021 |
| SCALE: | 1"=50' | DWG. NAME: | C-1623-11.dwg |
| DESIGNED BY: | NCD | CHECKED BY: | TJW |

PREPARED BY:

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civil engineering ◆ land surveying
environmental consulting ◆ landscape architecture
www.allenmajor.com
100 COMMERCE WAY
WOBURN MA 01888-0118
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SHEET No.
EWS

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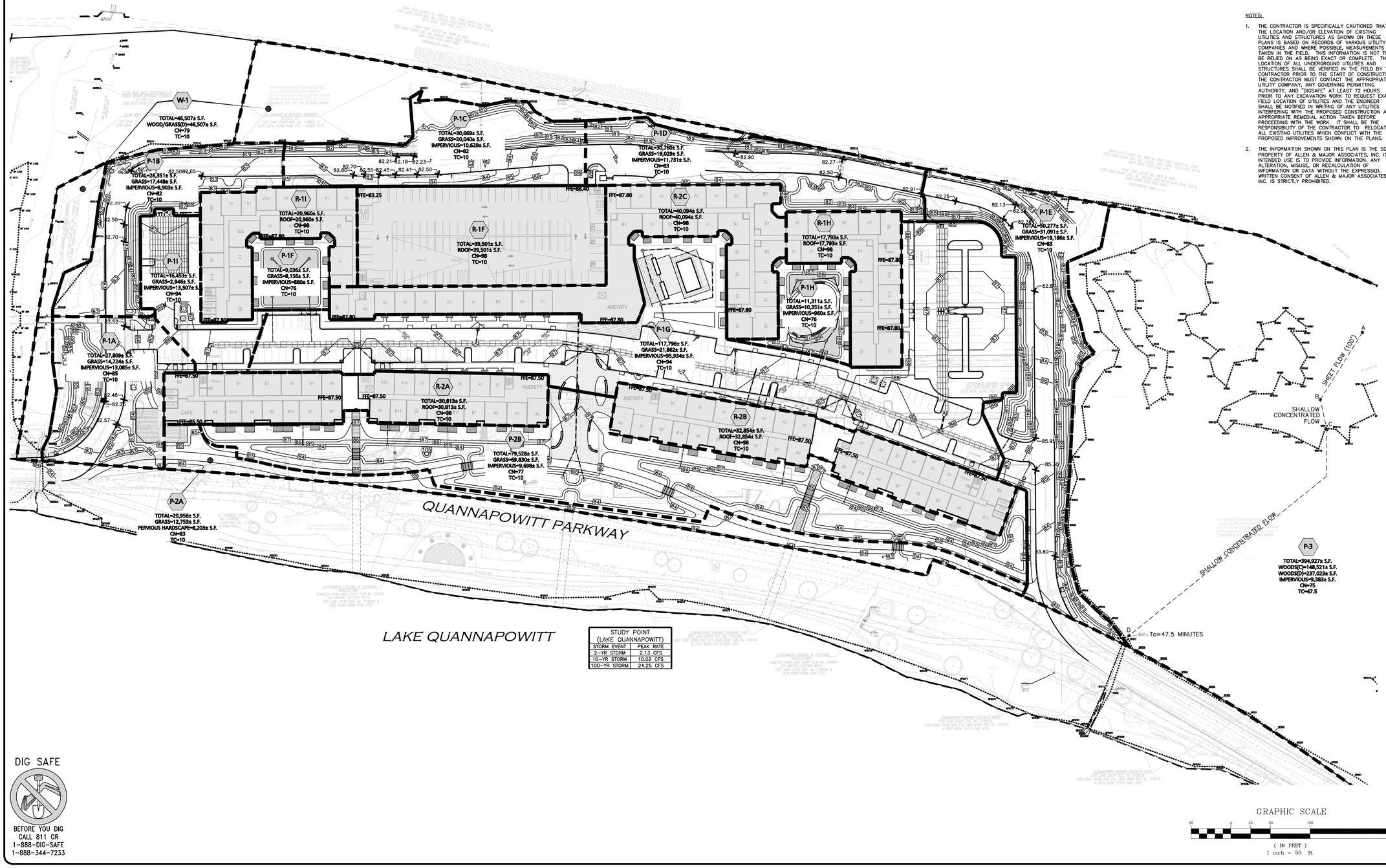


| STUDY POINT (LAKE QUANNAPOWITT) | |
|---|---|
| STORM EVENT | PEAK RATE |
| 2-YR STORM | 2.13 CFS |
| 10-YR STORM | 10.02 CFS |
| 100-YR STORM | 24.25 CFS |

GRAPHIC SCALE

50 0 25 50 100 200

( IN FEET )
1 inch = 50 ft.

## LEGEND:

WATERSHED BOUNDARY

REACH

SUBCATCHMENT LABEL P-1

NOTES:

1. THE CONTRACTOR IS SPECIFICALLY CAUTIONED THAT THE LOCATION AND/OR ELEVATION OF EXISTING UTILITIES AND STRUCTURES AS SHOWN ON THESE PLANS IS BASED ON RECORDS OF VARIOUS UTILITY COMPANIES AND WHERE POSSIBLE, MEASUREMENTS TAKEN IN THE FIELD. THIS INFORMATION IS NOT TO BE RELIED ON AS BEING EXACT OR COMPLETE. THE LOCATION OF ALL UNDERGROUND UTILITIES AND STRUCTURES SHALL BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO THE START OF CONSTRUCTION. THE CONTRACTOR MUST CONTACT THE APPROPRIATE UTILITY COMPANY, ANY GOVERNING PERMITTING AUTHORITY, AND "DIGSAFE" AT LEAST 72 HOURS PRIOR TO ANY EXCAVATION WORK TO REQUEST EXACT FIELD LOCATION OF UTILITIES AND THE ENGINEER SHALL BE NOTIFIED IN WRITING OF ANY UTILITIES INTERFERING WITH THE PROPOSED CONSTRUCTION AND APPROPRIATE REMEDIAL ACTION TAKEN BEFORE PROCEEDING WITH THE WORK. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO RELOCATE ALL EXISTING UTILITIES WHICH CONFLICT WITH THE PROPOSED IMPROVEMENTS SHOWN ON THE PLANS.
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N:\PROJECTS\1623-11\CIVIL\DRAWINGS\CURRENT\C-1623-11 - PWS.DWG

PROFESSIONAL ENGINEER FOR ALLEN & MAJOR ASSOCIATES, INC.

| REV | DATE | DESCRIPTION |
|---|---|---|
| 1 | 3/31/2021 | Re-Issued to ZBA |

APPLICANT:
CCF QUANNAPOWITT PROPERTY COMPANY, LLC
185 DARTMOUTH STREET
BOSTON, MA 02116

PROJECT:
200-400 QUANNAPOWITT PARKWAY
WAKEFIELD, MA 01880

| | | | |
|---|---|---|---|
| PROJECT NO. | 1623-11 | DATE: | MARCH 16, 2021 |
| SCALE: | 1"=50' | DWG. NAME: | C-1623-11.dwg |
| DESIGNED BY: | NCD | CHECKED BY: | TJW |

PREPARED BY:


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environmental consulting ◆ landscape architecture
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