STORMWATER MANAGEMENT REPORT

Dr Lords and Scargo Lake Town Landing Boat Ramps

Dennis, MA

January 2024

Cape Cod Boat Ramp Stormwater Retrofit Project
Partner: Association to Preserve Cape Cod
Owner/Operator: Town of Dennis

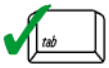
Horsley Witten Group

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

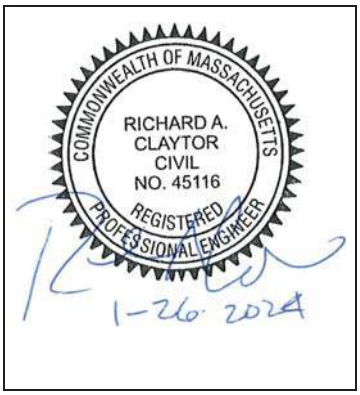
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☒ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☒ Grass Channel
- ☐ Green Roof
- ☒ Other (describe): Underground Infiltration Chambers; Porous Pavement

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.

STORMWATER MANAGEMENT REPORT

DR LORDS AND SCARGO LAKE TOWN LANDING BOAT RAMPS
CAPE COD BOAT RAMP STORMWATER RETROFIT PROJECT
DENNIS, MA

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EXECUTIVE SUMMARY

The purpose of this report is to describe existing and proposed site drainage conditions at the Dr Lords and the Scargo Lake Town Landing Boat Ramps, as well as measures to prevent stormwater pollution during and after construction. This project is part of a regional effort led by the Association to Preserve Cape Cod (APCC) to improve water quality at public boat ramps on Cape Cod by implementing green stormwater infrastructure (GSI) retrofits. The main goal for this site is to better manage and treat stormwater runoff from the parking lots and boat ramp access roads prior to entering Scargo Lake. The project also aims to provide public outreach on the benefits of GSI and overarching watershed issues using interpretive signage.

The project includes the following structural and non-structural stormwater control measures (SCMs) at the two sites:

- Sediment Forebays and Oil/Grit Separators for Pretreatment
- Bioretention and Wet Bioretention Areas for Treatment
- Permeable Pavement for Treatment
- Underground Infiltration Chambers for Managing Large Storm Events

Since the proposed stormwater management system is a retrofit project undertaken solely to improve water quality at the site, it falls under the redevelopment category in accordance with the Massachusetts Stormwater Management Standards (MASMS 2008), as described in Massachusetts Stormwater Handbook, Volume 1 Chapter 1. As a redevelopment project, the design is required to meet the MASMS standards to the maximum extent practicable (MEP).

As shown in **Table 1,** the proposed project meets or exceeds each standard**,** except the water quality standard at both sites and the recharge standard at Dr Lords due to high groundwater and lack of space, all of which are met to the MEP. While each of the proposed treatment SCMs are designed to capture and treat as much runoff as possible from their contributing drainage areas, small portions of each site could not be captured due to site constraints. However, through the integration of porous pavement and underground infiltration chambers, the proposed design greatly reduces peak runoff flow rates and volumes for the 2-, 10-, 25-, and 100-year storms. Overall, this project will significantly improve conditions at the Dr Lords and Scargo Lake Town Landing Boat Ramps and reduce on-going impacts to Scargo Lake and downstream resources.

Table 1. Project MASMS Compliance Summary

	Minimum Standard	Type	Dr Lords Compliance	Town Landing Compliance	Report Reference(s)
1	**New Stormwater Conveyances**	Narrative	Yes	Yes	Section 3.2
2	**Water Quantity**	Calculation	Yes	Yes	Section 4.3/ Table 6/Appendix B
3	**Recharge**	Calculation	MEP	Yes	Section 4.2/ Table 5 /Appendix B
4	**Water Quality**	Calculation	MEP	Yes	Section 4.1/ Table 3 and Table 4 /Appendix B
5	**Land Uses with Higher Potential Pollutant Loading**	Narrative	NA	NA	Section 2.0

	Minimum Standard	Type	Dr Lords Compliance	Town Landing Compliance	Report Reference(s)
6	**Critical Areas**	Narrative	Yes	Yes	Section 4.1
7	**Redevelopment**	Narrative	Yes	Yes	Section 4.0
8	**Erosion Control**	Narrative	Yes	Yes	Section 4.4/Appendix F
9	**Operation and Maintenance**	Narrative	Yes	Yes	Section 4.5/Appendix E
10	**Illicit Discharges**	Narrative	Yes	Yes	Section 4.6

1.0 INTRODUCTION

This report provides a summary of the stormwater management systems proposed for the Dr Lords and Scargo Lake Town Landing Boat Ramps in Dennis, MA, which are Town-operated boat ramps (**Figure 1**). The Dennis Department of Public Works is proposing this project in collaboration with the Association to Preserve Cape Cod (APCC) as a part of a regional effort (Cape Cod Boat Ramp Stormwater Retrofit Project) to improve water quality at public boat ramps across Cape Cod. The proposed project has been designed to retrofit existing impervious areas for water quality improvements while also managing runoff from larger storms and improving overall site conditions. This report describes the existing and proposed site conditions and the practices to be implemented to reduce stormwater discharges and pollutants during and after construction. As required for retrofit projects, the stormwater systems for the project have been designed to conform to the requirements of the Massachusetts Stormwater Standards (MASMS) to the maximum extent practicable (MEP).

1.1 Background

Freshwater ponds and coastal embayments across Cape Cod are significantly degraded by nutrient and bacteria impairment. Land uses, including stormwater runoff and fertilizer use, contribute on average 20% of the controllable nitrogen load within our coastal watersheds (Cape Cod Commission 208 Plan, 2015) and bacterial contamination, including cyanobacteria, regularly causes closures of beaches. In APCC's report (APCC's 2022 State of the Waters), 90% of the coastal embayments and 39% of the freshwater ponds assessed received unacceptable water quality scores. These high nutrient loads are of concern for the environment, our coastal economy, and public health as they negatively impact habitat for fish and shellfish and can result in unsafe conditions for swimming, fishing and boating. Public boats ramps are a common source of pollution in areas of high recreational use. As such, these locations have been targeted by APCC's regional project.

As part of an EPA Southeast New England Program (SNEP) Watershed Grant, APCC and partners first identified 20 public boat ramps across 10 Cape Cod towns in need of improved stormwater management. Concept designs for each of these twenty sites were ranked based on various criteria including potential pollutant removal (i.e., load and drainage area), water quality status of the associated waterbody, construction cost and feasibility, and additional human use and resource benefits (restored shellfish and anadromous fish habitat, proximity to environmental justice communities, improved climate resiliency, opportunity for public education, etc.). With additional funding from a CZM FY23 Coastal Habitat and Water Quality Grant and private foundation funding, 25% and 75% designs

were developed for seven high-ranking priority sites, including these two boat ramps at Scargo Lake, which have a direct connection to a coastal estuary (Sesuit Harbor) via a surface water stream (Sesuit Creek).

1.2 Project Goals

The purpose of this project is to improve water quality in Scargo Lake and downstream waters, including the downstream marsh, by reducing or eliminating pollutant loads from stormwater runoff at the public boat ramps using green stormwater infrastructure (GSI) stormwater control measures (SCMs). Specifically, the project aims to maximize pollutant removal (% bacteria, nitrogen and phosphorus) and water quality volume treated. Over time, we hope this work leads to improvements in water quality in the Lake and downstream embayments, specifically related to bacteria contamination; reduction in nutrients and associated algal blooms and improvements to the Sesuit Creek herring run.

1.3 Design Methodology

The design was completed by the following tasks:

- Preliminary field assessment of the sites and contributing drainage areas to identify usage, physical and environmental constraints and opportunities, and long-term operation and maintenance concerns
- Determination of drainage areas and land coverage within the project areas
- Selection of structural and non-structural SCMs best suited to site conditions and project goals
- Structural SCM sizing and performance estimates (described further below)
- Hydrologic/Hydraulic Modeling (described further below)
- Grading and layout of site plans
- Erosion control plan development
- Operation and maintenance (O&M) plan development

SCM Performance Estimates

The proposed SCMs were selected and sized to maximize pollutant load removals. Since the waterbodies these sites drains to have water quality impairments and are subject to TMDLs, the SCMs were chosen to maximize not only total suspended solids (TSS) removal, but total phosphorus (TP), total nitrogen (TN), and bacteria load reductions as well. MASMS was used as a reference for TSS removal estimates, but the more recently developed pollutant load removal curves (USEPA 2021 & Paradigm Environmental 2019) were used for TP, TN, and bacteria.[1]

Hydrologic/Hydraulic Modeling

[1] It is important to note that these curves have a crosswalk to help users determine which specific curve to reference: for wet bioretention, the appropriate curve is the Wet Pond; for the underground infiltration chambers, the appropriate curve is the Infiltration Trench (Soil infiltration rate = 8.27 in.hr); for the porous pavement (with an underdrain), the appropriate curve is Sand Filter; and for the bioretention (with underdrain), the appropriate curve is the Bio-filtration Performance Curve.

Existing and proposed conditions for the project area were modeled using HydroCAD software, which combines USDA Soil Conservation Service hydrology and hydraulic techniques (commonly known as SCS TR-55 and TR-20) to generate hydrographs. Conditions were evaluated for the water quality event (storm that produces 1 inch of runoff, or a roughly 1.2-inch rain event) as well as larger storm events, including the 2-, 10-, 25- and 100-year 24-hour Type III storm events. The rainfall depths used for each storm event are the NOAA+ values (NOAA Atlas 14 90% Upper Confidence value multiplied by 0.9) (NOAA NWS, 2017). Rainfall values are included in **Appendix A**.

2.0 Existing Conditions

The Dr Lords Boat Ramp is a very popular water access point on the eastern side of Scargo Lake. There is a public beach with a Town-operated lifeguard during the summer months, and a place to launch car-top boats (e.g., kayaks, canoes, and paddleboards). The public also enjoys recreating along the shores of Scargo Lake at several access points from the parking lot.

The site includes a large parking area, a drive aisle that also provides access to two private properties, and associated amenities such as a portable toilet and various signage (**Figure 2**). Utilities on site include overhead electric wires. The parking area drive aisle has parking only on one side, including 24 parking spaces and one handicap-accessible space. The existing pavement at the site is aging, with visible cracks and spalling, particularly along the edges of the drive aisle where stormwater flows down to the edge of the Lake. There is no existing stormwater management infrastructure.

The Scargo Lake Town Landing Boat Ramp is a public water access point located on the northwestern side of Scargo Lake. The site includes a wide access drive and informal parallel parking along both sides of the road, sufficient for approximately three to four vehicle parking spaces and three to four vehicles with trailers spaces (**Figure 7**). The grade down to the water is steep, and the landing access drive is finished with compacted crushed stone. Because of this, several erosion gullies are present, and sedimentation is evident along both sides and at the bottom.

The land uses at both boat ramp sites are not classified as a land use with higher potential pollutant loads (LUHPPL) and thus, are not subject to MASMS **Standard 5**.

2.1 Receiving Water and Watershed

Both boat ramps discharge stormwater into Scargo Lake, a freshwater pond at the headwaters of Sesuit Creek (**Figures 4 and 9**). The Lake provides freshwater spawning habitat for the Sesuit Creek herring run, and the Dr Lords boat ramp is adjacent to a public beach. The most recent Massachusetts DEP 303(d) – 2018/2020 Integrated list of Waters lists Scargo Lake (MA96-279) as not having any uses assessed. APCC's State of the Waters Report lists Scargo Lake as unacceptable for phosphorus.

Scargo Lake is located in the Sesuit Creek/Sesuit Harbor Watershed. The full list of impairments for this portion of the watershed is listed below, and a map showing these resources is included in **Figure 4/Figure 9**:

- Sesuit Creek (MA96-130) Dennis, Sesuit Harbor Watershed – Impairment not caused by a pollutant – no TMDL required; Category 4c (TMDL not required) of the 2018/2020 Integrated List of Waters.
- Sesuit Creek (MA96-13) Dennis, Sesuit Harbor Watershed – Impaired for fecal coliform; Category 4a (TMDL completed) of the 2018/2020 Integrated List of Waters.

2.2 Drainage Area

The Dr Lords boat ramp's existing contributing drainage area is approximately 5.2 acres. This area is mostly undisturbed forest, with less than half an acre of impervious cover. The impervious cover consists of a few buildings, Studio Way, Dr Lords Road, and the boat ramp parking lot. The existing site is a single drainage area that drains toward SP1 (Scargo Lake).

Scargo Lake Landing's existing contributing drainage area is 0.18 acres, mostly compacted gravel and deteriorated pavement, with vegetation around the perimeter. The existing site is one drainage area from the entrance at the roadway to the water's edge, also draining to SP1 (Scargo Lake).

For both sites, see the existing conditions drainage area maps and a detailed breakdown of land cover in **Appendix A,** as well as the existing HydroCAD model reports in **Appendix B.**

2.3 Resource Areas

HW wetland biologists delineated several resource areas at the Dr Lords site in December 2022. A full description of these resource areas is included in **Appendix C**, and their locations and associated buffers are shown on the plans in **Appendix G**. The wetland resource areas include Bordering Vegetated Wetland (BVW); Bank (locally Inland Bank); and the 50-foot No Disturb and 100-foot Buffer Zones to BVW and Bank (Inland Bank). Additional resource areas present adjacent to the site include Land Under Waterbodies and Waterways (LUW) and Banks of or Land Under the Ocean, Ponds, Streams, Rivers, Lakes, or Creeks that Underlie an Anadromous/Catadromous Fish Run ("Fish Run"). While much of the vegetation at the site is native woodlands, there was one invasive species observed (Asiatic bittersweet) to the northeast of the parking lot.

In addition, HW wetland biologists delineated several resource areas at the Scargo Lake Landing site in June 2023. A full description of these resource areas is included in **Appendix C**, and their locations and associated buffers are shown on the plans in **Appendix G**. The wetland resource areas include Bank (locally Inland Bank); and the 50-foot No Disturb and 100-foot Buffer Zones to Bank (Inland Bank). Additional resource areas present adjacent to the Site include Land Under Waterbodies and Waterways (LUW) and Banks of or Land Under the Ocean, Ponds, Streams, Rivers, Lakes, or Creeks that Underlie an Anadromous/Catadromous Fish Run ("Fish Run"). There was several invasive species present at or near the site, which include gray willow, Norway maple, sycamore maple, tree-of-heaven, Asiatic bittersweet, purple loosestrife, multiflora rose, and privet.

According to the most recent version of the *Massachusetts Natural Heritage Atlas* (15th Edition, August 1, 2021), portions of both sites lie within areas of *Priority Habitat of Rare Species* (PH 280) as designated by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) (**Figures 3 and 8**).

Both sites are located within a FEMA Flood Hazard Zone (Other Areas of Flood Hazard, Zone X), as shown in the wetland memo (**Appendix C**). Since the sites discharge near a public beach area and anadromous fish run, they are considered a critical area and subject to MASMS **Standard 6**.

2.4 Soils

Soils data from the Natural Resources Conservation Service (NRCS) indicate that the soils within the drainage area to the Dr Lords and Scargo Lake Landing sites are entirely composed of Eastchop Loamy Fine Sand, 0-3% and 3-8% slopes. This soil unit consists of loose, sandy glaciofluvial outwash deposits. The distribution of hydrologic soil groups (HSGs) of those soils within the contributing drainage areas for the Dr Lords and Scargo Lake Landing sites are shown in **Figure 5.** Test pits were conducted at each site to evaluate subsurface conditions and estimated seasonal high groundwater (ESHGW) based on evidence of mottling or redox. All test pits were witnessed and logged by an HW Massachusetts Title 5 Approved Soil Evaluator. See **Table 2 for a summary of the results, Appendix D** for soil test pit logs, and **Appendix G** for the locations on the design plans.

Three test pits were conducted on the pavement at the Dr Lords site on January 19, 2023. They were located in the following areas: the north and south ends of the parking lot (2), and northeast of the drive near the ramp, as close to the water as possible (1).

Two test pits were conducted at the Scargo Lake Landing site on July 6, 2023. The first test pit was conducted approximately halfway down the landing drive on the east side; the second was conducted near the water on the east side of the property. During the test pits, heavy seepage was encountered from a peat layer in TP-2. It was difficult to understand the estimated groundwater elevation in this pit and there was no groundwater encountered at TP-1. On November 20, 2023, the Town installed a groundwater monitoring well in the location of TP-2 to better understand groundwater elevations, especially given the peat layer encountered. Groundwater elevations recorded between November 20, 2023 and December 21, 2023 are between 8.52 and 8.60 feet. These elevations are above the peat layer encountered (elev. 8.1 feet) and below the pond elevation of 9.75 feet recorded on August 18, 2023.

Table 2. Test Pit (TP) Results

Test Pit ID	Surface Elevation at TP (ft)	Pit Bottom Elevation (ft)	ESHGW Elevation (ft)	Soil Texture(s)	Notes
DR LORDS					
TP-1	12.7	8.5	10.1	Sand	
TP-2	13.6	7.8	11.2	Sand	
TP-3	12.2	6.5	10.7	Sand	Peat @ 35” depth
SCARGO LAKE TOWN LANDING					
TP-1	17.0	7.0	7.0	Sand	
TP-2	11.0	0.8	0.8	Sand	Heavy seepage from peat layer used as ESHGW

3.0 Proposed Conditions

The proposed project consists of the following stormwater and related site development improvements:

- Resurfaced parking lot and boat ramp access road to better direct runoff while maintaining current parking spaces and dimensions, and required drive aisle;
- GSI including bioretention areas and underground infiltration chambers;
- Oil/water separator to remove gasoline by-products prior to infiltration;
- Reduction in overall impervious cover and installation of porous pavement; and
- Protection of as many existing mature trees as possible.

The proposed GSI systems at the Dr Lords and Scargo Lake Town Landing sites are designed to meet the following major objectives:

- Capture, treat, and infiltrate to the maximum extent practicable the first one inch of runoff (Water Quality Volume (WQV)); and
- Reduce peak flows and runoff volumes from the site.

3.1 Drainage Areas

The Dr Lords boat ramp's contributing drainage area under proposed conditions is very similar to existing, with a total of approximately 5.20 acres. However, the proposed project is reducing impervious cover by both removing pavement (approximately 1,440 square feet) and by converting regular impervious pavement into porous pavement (approximately 9,130 square feet), dropping the total impervious cover across the site to 8%. The existing single drainage area was subdivided into three proposed drainage areas: DA1 (which contains existing woods and pavement that could not be captured in a SCM), DA1A (pervious pavement and gravel trench) and DA1B (which includes Studio Way and all areas that will drain to the proposed bioretention). The proposed SCMs were added as "ponds" in the HydroCAD model. As in existing conditions, the entire site will discharge runoff to Study Point 1 (SP1).

The Scargo Lake Town Landing total contributing drainage area under proposed conditions is little changed from existing, with an area of 0.18 acres. Impervious cover on the site will increase by about 300 square feet, with former gravel areas being converted to paved. The three subcatchments under proposed conditions are: DA1, the area between the proposed work and the water; DA2a, the bottom paved area and surface stormwater treatment; and DA2b, the entrance and central parking area. DA2b runoff is captured by trench drains and catch basins, directing runoff to an oil/grit separator and underground infiltration chambers. The single study point remains SP1, Scargo Lake.

See the proposed conditions drainage area maps and detailed breakdown of land covers in **Appendix A,** as well as the proposed HydroCAD model reports in **Appendix B.**

3.2 Structural Stormwater Control Measures (SCMs)

The proposed stormwater management includes a GSI approach to capture, detain, treat, and infiltrate runoff. The stormwater management systems were designed to meet **Standard 1**, so that no new

untreated stormwater runoff will be directed to any off-site areas or resource areas. Runoff from contributing impervious areas will be treated by the proposed practices.

At the Dr Lords site, there are two stormwater GSI practices proposed – porous pavement and a bioretention area. Pretreatment will be provided with sediment forebays, and overflows from large events flow out the "bubbler" outlet placed near the water's edge to reduce erosion. At the Scargo Lake Landing site, the GSI practices proposed are underground infiltration galleys and a wet bioretention area. These SCMs are described in more detail below.

Sediment Forebays

Porous sediment forebays are provided for pretreatment of the runoff from the paved surfaces to allow for sediment and other debris to settle out prior to conveyance into the bioretention areas. An oil/grit separator will provide pretreatment of the runoff prior to conveyance into the underground infiltration galleys.

Porous Pavement

Porous pavement is designed to capture, filter (in a sand layer), and/or infiltrate runoff while providing the stability of traditional pavement. The system consists of a porous layer over a layer of sand and crushed stone. For small storms, the runoff falling directly on the porous pavement will completely infiltrate the pavement. For larger, intense storms, rainfall rate can exceed the infiltration rate of the porous pavement surface. Once this occurs, runoff will flow across the surface to the low point/drainage structure. Porous pavement should be placed to minimize "run-on" from adjacent traditional impervious pavement, as this can lead to premature clogging.

Porous pavement is proposed in the parking area and driveway of the Dr Lords site, and the site is designed to prevent "run-on" to these areas. During those larger, intense storm events, runoff from the porous pavement in the parking lot will flow into the gravel trench and/or catch basins along the edge of the drive aisle.

Bioretention Areas (BIO)

A bioretention area (BIO) is a shallow depression used to treat stormwater runoff using a specific planting soil and plants to filter runoff. The method combines physical filtering and adsorption with bio-geochemical processes to remove pollutants. The system consists of an inflow component, a pretreatment element, a shallow ponding area planted with appropriate native plant species (tolerant to both wet and dry periods as well as other site conditions such as wind, salt, shade, etc.), and an overflow structure. Some BIOs located in areas with poor drainage or high groundwater are lined and/or have underdrains, while others located in sandy soils greater than 2 feet above ESHGW can just infiltrate the treated runoff.

At the Dr Lords site, one BIO is proposed at the north end of the parking area, with an overflow structure to the porous pavement underdrain. Since this BIO does not have 2-feet separation to ESHGW,

the BIO has an underdrain. The BIO will be planted with low-maintenance, native plants tolerant of the periods of inundation and dry conditions.

Wet Bioretention Area (WBIO)

A wet bioretention area is a shallow depression to treat stormwater runoff using a specific soil media and carefully chosen plant species that are tolerant of extended wet and dry periods. The method combines settling, physical filtering, and adsorption with bio-geochemical processes to remove pollutants. The system consists of an inflow component, a pretreatment element, a shallow ponding area planted with appropriate native plant species, and an overflow weir. A wet bioretention area is proposed near the lake at Scargo Lake Landing.

Underground Infiltration Chambers (UIC)

Underground infiltration chambers are structures embedded in washed gravel that detain, and infiltrate runoff collected from surrounding impervious areas. The proposed UIC at Scargo Lake Landing consists of twelve SC-740 chambers sized to hold the 25-year storm volume before excess drive/parking lot runoff will be directed to the Lake.

3.3 Non-structural SCMs

The non-structural SCMs proposed at the sites include pavement reduction at the Dr Lords site (~1,440 sf). Excess pavement was reduced slightly with the proposed design, reducing overall runoff volume.

At Scargo Lake Landing, the proposed pavement will help to stabilize the site and reduce a previous pollutant source (e.g., sediment). In addition, the proposed berm at the entrance to the Landing road will prevent run on from the state-owned Route 6A and reduce overall stormwater volume.

4.0 Stormwater Design Components

The proposed SCMs were designed to meet a variety of goals and regulatory requirements as discussed above. As a retrofit project for managing existing impervious cover, this design must specifically comply with the redevelopment standard (MASMS **Standard 7)** by meeting all standards to the maximum extent practicable. The project fully meets this standard, as described in detail below.

4.1 Water Quality

The main purpose of this retrofit project is to improve water quality. This section describes the treatment volumes and pollutant load reductions achieved by the proposed design and how they compare to the MASMS standards.

Treatment Volume

Per **Standard 4** of MASMS, the stormwater management system for a new development site discharging to a critical area must be sized to treat the first one inch of runoff from impervious area (IA) and remove

80% or more of the annual post-construction load of total suspended solids (TSS). As a retrofit (falls under **Standard 7** - Redevelopment), the project is only required to meet this to the MEP.

The proposed HydroCAD models results showing treatment of the water quality volume (WQV) are included in **Appendix B** and summarized below in **Table 3**.

For design purposes, we are assuming that there is no infiltration occurring on the Dr Lords site as a conservative approach, given the ESHGW on site. However, during times of lower groundwater levels, some infiltration will occur and as such, additional treatment of the stormwater will take place. In addition, while the porous pavement is considered not to be impervious cover, the porous pavement was modeled in HydroCAD as having an impervious curve number (98) in order to be able to quantify the runoff generated from the porous pavement surface.

Table 3. Compliance with Water Quality Volume Requirements

DA ID	SCM ID	IA (ac)	WQv Goal (ac-ft)	WQv Provided (ac-ft)**	% WQv Provided	Meets Requirement?	Notes
DR LORDS							
DA1	NA	0.18	0.015	0.000	0%	MEP	This area not captured for this retrofit project given space and land use.
DA1A	PP*	0.21	0.017	0.017	100%	Y	
DA1B	BIO	0.21	0.018	0.015	84%	MEP	
TOTAL SITE:		**0.60**	**0.050**	**0.032**	**64.1%**	**MEP**	**MEP for Retrofit Projects**
SCARGO LAKE TOWN LANDING							
DA1	N/A	0.003	0.000***	0	0%	MEP	Area beyond SCM capture point(s)
DA2a	WBIO	0.032	0.003	0.003	100%	Y	No infiltration – wet practice
DA2b	UIC	0.106	0.009	0.009	100%	Y	
TOTAL SITE:		**0.141**	**0.012**	**0.012**	**100%**	**Y**	

**Porous Pavement (PP), treated as IA for purposes of water quality calculations.*
***From HydroCAD results – see Appendix B for volume filtered for WQv Event*
****While there is a very small area of IA, due to rounding there is no WQV goal for this DA.*

Pollutant Load Reductions

The proposed SCMs meets the MASMS requirements for TSS removal and maximize removals of the other pollutants of concern to the MEP. Estimated TSS, phosphorus (TP), nitrogen (TN), and bacteria removals are provided in **Table 4**[2]. During times of lower groundwater levels, more infiltration will occur

[2]It is important to note that these curves have a crosswalk to help users determine which specific curve to reference: for wet bioretention, the appropriate curve is the Wet Pond; for the underground infiltration chambers, the appropriate curve is the Infiltration Trench (Soil infiltration rate = 8.27 in.hr); for the porous pavement (with an underdrain), the appropriate curve is Sand Filter; and for the bioretention (with underdrain), the appropriate curve is the Bio-filtration Performance Curve.

and as such, additional treatment of the stormwater will take place[3]. The proposed O&M Guides in **Appendix E** were developed to ensure that the stormwater systems continue to function as they were designed into the future to maintain these levels of pollutant removal.

Table 4. Compliance with Water Quality Pollutant Load Reduction Requirements

DA ID	SCM ID	IA (ac)	WQv Provided (ac-ft)**	Runoff Depth Treated (in)	TSS Removal (%)***	TP Removal (%)****	TN Removal (%)****	Bacteria Removal (%)*****	Meets Reqt?
DR LORDS									
DA1	NA	0.18	0.000	0.0	0%	0%	0%	0%	N
DA1A	PP*	0.21	0.017	1.0	80%	53%	32%	89%	Y
DA1B	BIO	0.21	0.015	0.8	90%	48%	31%	50%	Y
TOTAL SITE:		**0.60**	**0.032**	**0.4**	**60%**	**35%**	**22%**	**49%**	**MEP**
SCARGO LAKE TOWN LANDING									
DA1	N/A	0.003	0.000	0.00	0%	0%	0%	0%	N
DA2a	WBIO	0.032	0.003	1.11	85%	55%	33%	65%	**Y**
DA2b	UIC	0.106	0.009	1.02	89%	100%	100%	100%	Y
TOTAL SITE:		**0.141**	**0.012**	**1.02**	**86%**	**88%**	**83%**	**90%**	**Y**

**Porous Pavement (PP)*
***From HydroCAD results – see Appendix B for volume filtered for WQv Event*
****From MASMS*
*****From MS4 NPDES Permit Appendix F Attachment 3 (USEPA 2021)*
******From Paradigm Environmental (2019)*

In addition, since the sites are located in a critical area (near a public beach and anadromous fish run) and must meet MASMS **Standard 6**, pretreatment practices before infiltration should remove 44% TSS or more. At Scargo Lake Landing, the deep-sump catchbasins and the oil/water separator provide pretreatment prior to infiltration through the underground chambers, meeting **Standard 6**.

Long-term Pollution Prevention Plan

Source control is important to ensure long-term functionality of the proposed SCMs and protect downstream resources and habitat. A long-term pollution prevention plan for both sites is provided as a part of the O&M Guide in **Appendix E**.

[3] For example, the porous pavement would expect to have additional pollutant removal as the runoff can infiltrate, with pollutant removal efficiencies matching more closely to the Infiltration Trench curve (not the Sand Filter curve used to estimate pollutant removal with assuming conservatively high groundwater levels).

4.2 Recharge

Infiltrating treated runoff into the underlying native sands is another objective of this project wherever possible. For new development projects, the MASMS requires a specific annual "recharge" volume (Rev) based on the HSG of the soil covered by new impervious surfaces, with a higher volume required for sandy soils (HSG A) and lower for silty, clayey soils (HSG D). This project is only required to provide infiltrate or recharge to the maximum extent practicable as a redevelopment project, as there is already pavement at the site.

At the Dr Lords site, infiltration is generally not feasible because much of the site has a shallow depth to groundwater much of the year (**Table 5**). However, while not accounted for here, the porous pavement and bioretention system at this site will infiltrate during periods of lower groundwater/lake elevations. In addition, removing impervious area (1,440 SF) and replanting with native vegetation will also improve recharge. In these ways, the proposed project at the Dr Lords site will improve existing conditions with regards to recharge.

At the Scargo Lake Landing site, two SCMs are being proposed, but only one (UIC) provides infiltration (**Table 5**). The UICs have been sized to capture and recharge the Rev and provides additional storage and capacity for the 25-year storm; while the wet bioretention system, which will be constructed very close to the water's edge, is not being designed to infiltrate, and no recharge is provided. However, the proposed project in total at Scargo Lake Landing does fully meet the recharge criteria.

Table 5. Compliance with Recharge Requirements

DA ID	SCM ID	IA (ac)	Soil HSG	Required Recharge Depth (in)	Rev Goal (ac-ft)	Rev Provided (ac-ft)*	% Rev Provided	Draw-down Time (hrs)**	Meets Reqt?	
DR LORDS										
DA1	NA	0.18	A	0.6	0.009	0.000	0%	N/A	N	No space
DA1A	PP	0.21	A	0.6	0.010	0.000	0%	N/A	N	Assumed no infiltration due to high GW
DA1B	BIO	0.21	A	0.6	0.011	0.000	0%	N/A	N	No infiltration
TOTAL SITE:		**0.41**			**0.021**	**0.000**	**0%**		**MEP**	**Due to site constraints**
SCARGO LAKE LANDING										
DA1	N/A	0.003	A	0.6	0.000	0.000	0%	N/A	N	
DA2a	WBIO	0.032	A	0.6	0.002	0.000	0%	N/A	N	No infiltration
DA2b	UIC	0.106	A	0.6	0.005	0.009	170%	10	Y	
TOTAL SITE:		**0.141**			**0.007**	**0.009**	**127%**		**Y**	

**From HydroCAD results – see Appendix B for volume "discarded" for WQv Event*

***From HydroCAD results – see Appendix B for hydrograph showing time from peak elevation to fully drained basins (WQv Event)*

4.3 Water Quantity

The main goal of this project is to improve water quality and habitat, but reducing water quantity impacts during large storm events was also prioritized. As such, porous pavement (at Dr Lords) and UICs (at Scargo Landing) are proposed to reduce peak flows and runoff volumes for the 2-, 10-, 25- and 100-year storms. The existing and proposed HydroCAD model results for these larger storm events are included in **Appendix B,** and the resulting peak flows and runoff volumes are summarized below in **Table 6** for both existing (EX) and proposed (PR) conditions. These results show that the proposed improvements will greatly reduce peak flows and runoff volumes for all evaluated storms, and thus, fully meet the requirements of **Standard 2** of the MASMS.

Table 6. Summary of Existing and Proposed Condition Peak Flow Rates and Runoff Volumes

Study Point		Peak Flow, cfs				Runoff Volume, acre-ft			
		2-yr	10-yr	25-yr	100-yr	2-yr	10-yr	25-yr	100-yr
DR LORDS									
SP1	EX	1.78	2.63	3.27	4.3	0.18	0.27	0.39	0.66
	PR	1.37	1.92	2.34	3.20	0.16	0.26	0.38	0.66
Reduction	**%**	**23%**	**27%**	**28%**	**26%**	***9%***	***6%***	***3%***	***0%***
SCARGO LAKE LANDING									
SP1	EX	0.37	0.68	0.92	1.32	0.026	0.047	0.064	0.093
	PR	0.01	0.11	0.25	0.49	0.002	0.008	0.013	0.026
Reduction	**%**	***97%***	***84%***	***73%***	***44%***	***92%***	***83%***	***77%***	***58%***

4.4 Erosion Control

Controlling erosion and sedimentation from the construction sites is important to meet the overall water quality goals of this retrofit project, as well as to meet MASMS **Standard 8**. Given both site's sizes (<1 acre of disturbance), a Stormwater Pollution Plan (SWPPP) is not required as part of the NPDES Construction General Permit. However, planning for effective erosion and sediment controls (ESCs) was important to this project's design, and so an ESC Plan is included in the design plans (**Appendix G**) for each site, along with a detailed sequence of construction activities and ESC notes. Visibility fence and/or silt socks are proposed at the limit of work to protect off-site areas and trees; silt socks are proposed along the downgradient edges of the area of disturbance. A construction entrance will be installed to minimize tracking onto Dr Lords Road. Areas for sediment traps/basins have been identified for when the pavement is removed from the parking lot, exposing a large area of soil. Disturbed areas will be stabilized as soon as possible to minimize erosion and sedimentation with pavement, seeding and/or erosion control blankets, if necessary. A Pollutant Controls During Construction guide is also included in **Appendix F** that discusses these controls in more detail. With these layered ESCs implemented throughout the sites, discharge of sediment-laden runoff during construction should be minimized to the maximum extent practicable.

The contractor will be required to establish these erosion controls prior to beginning any other project-related work. The ESC Plans will also establish the limit of work, beyond which the contractor will not be allowed to perform any work. It is the contractor's responsibility to monitor and correct erosion control practices throughout the duration of the project. Erosion control measures will not be removed until the project reaches completion as directed by the project engineer or landscape architect.

4.5 Operation and Maintenance

Ongoing maintenance is vital for long-term success at the sites. All SCMs were designed to be low-maintenance in nature. These SCMs will be operated and maintained appropriately during construction and post-construction as required on the construction drawings and O&M Guide per MASMS **Standard 9** (**Appendix E and G**).

4.6 Illicit Discharges

There will be no illicit discharges to the existing system by the proposed project per MASMS **Standard 10**. The Long-Term Pollution Prevention Plan in the O&M Guide (**Appendix E**) includes measures to prevent future illicit discharges.

5.0 REFERENCES

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FIGURES

Horsley Witten Group
Sustainable Environmental Solutions

Path: H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\GIS\Maps\ReportFigureMaps\DrLords\Locus.mxd

Date: 9/27/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

● Dr. Lords Boat Ramp

DR. LORDS Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Dennis, MA

Figure 1
Locus

Horsley Witten Group
Sustainable Environmental Solutions

Path: H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\GIS\Maps\ReportFigureMaps\DrLords\Aerial.mxd

Date: 9/26/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

Dr. Lords Boat Ramp
Town Parcels

DR. LORDS Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Dennis, MA

Figure 2
Aerial

Horsley Witten Group
Sustainable Environmental Solutions

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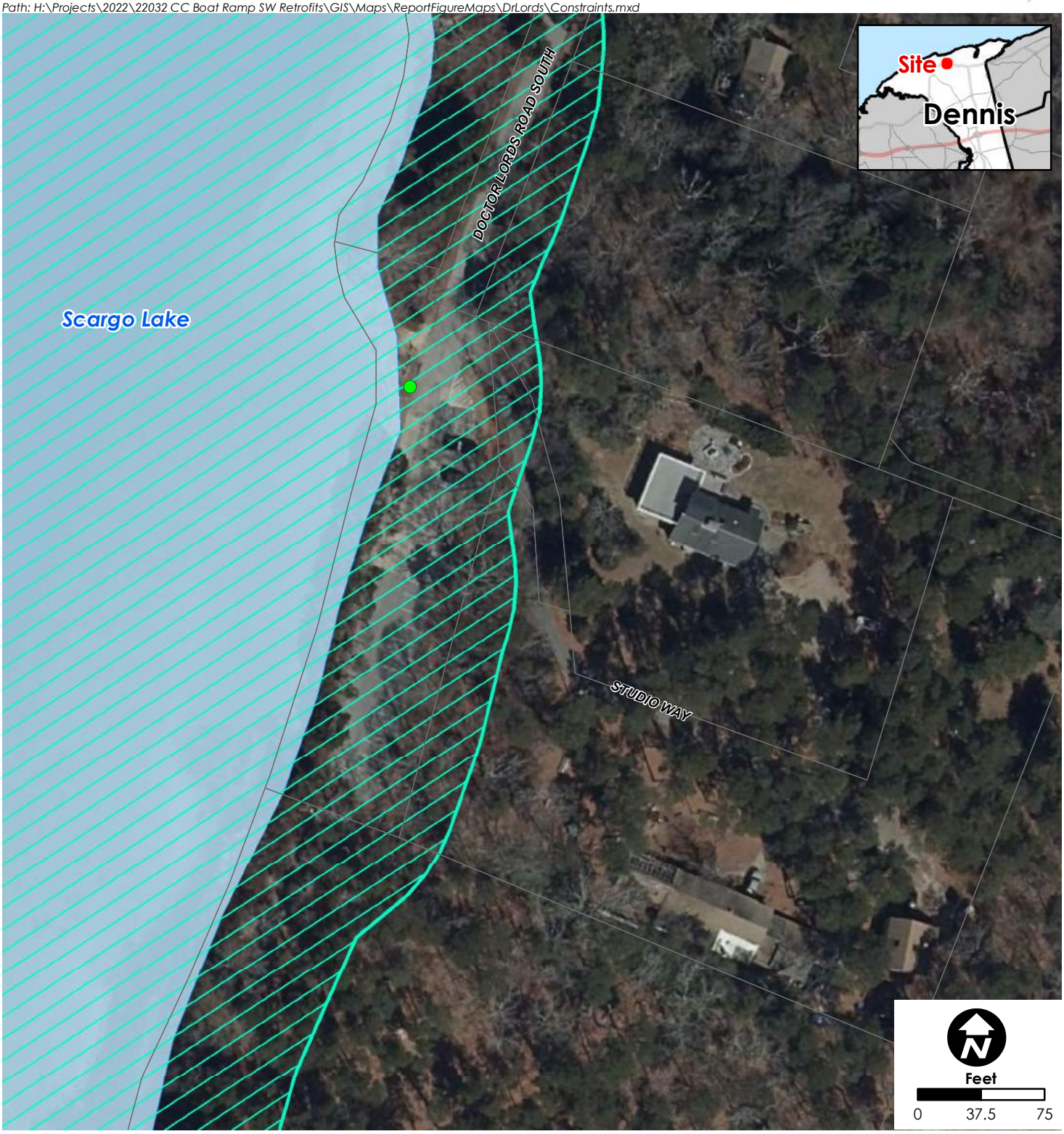

Date: 9/27/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

- Dr. Lords Boat Ramp
- Town Parcels
- NHESP Priority Habitats of Rare Species
- Shoreline
- Open Water

DR. LORDS Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Dennis, MA

Figure 3
Constraints

Horsley Witten Group
Sustainable Environmental Solutions

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Date: 9/27/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

Dr. Lords Boat Ramp

2018/2020 Integrated List Data

- 4C - Impairment not caused by a pollutant
- 5 - Impaired - TMDL required
- 3 - No uses assessed
- 4A - Impaired - TMDL is completed
- 4C - Impairment not caused by a pollutant
- 5 - Impaired - TMDL required

DR. LORDS Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Dennis, MA

Figure 4
Impaired Waters

Horsley Witten Group
Sustainable Environmental Solutions

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Date: 9/27/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

Dr. Lords Boat Ramp
Town Parcels

Hydrologic Soil Group
<Null>
A
B/D
C/D

DR. LORDS Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Dennis, MA

Figure 5
Soils

Horsley Witten Group
Sustainable Environmental Solutions

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Date: 12/6/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

● Scargo Lake Boat Ramp

SCARGO LAKE Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Dennis, MA

Figure 6
Locus

Horsley Witten Group
Sustainable Environmental Solutions

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Date: 12/6/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

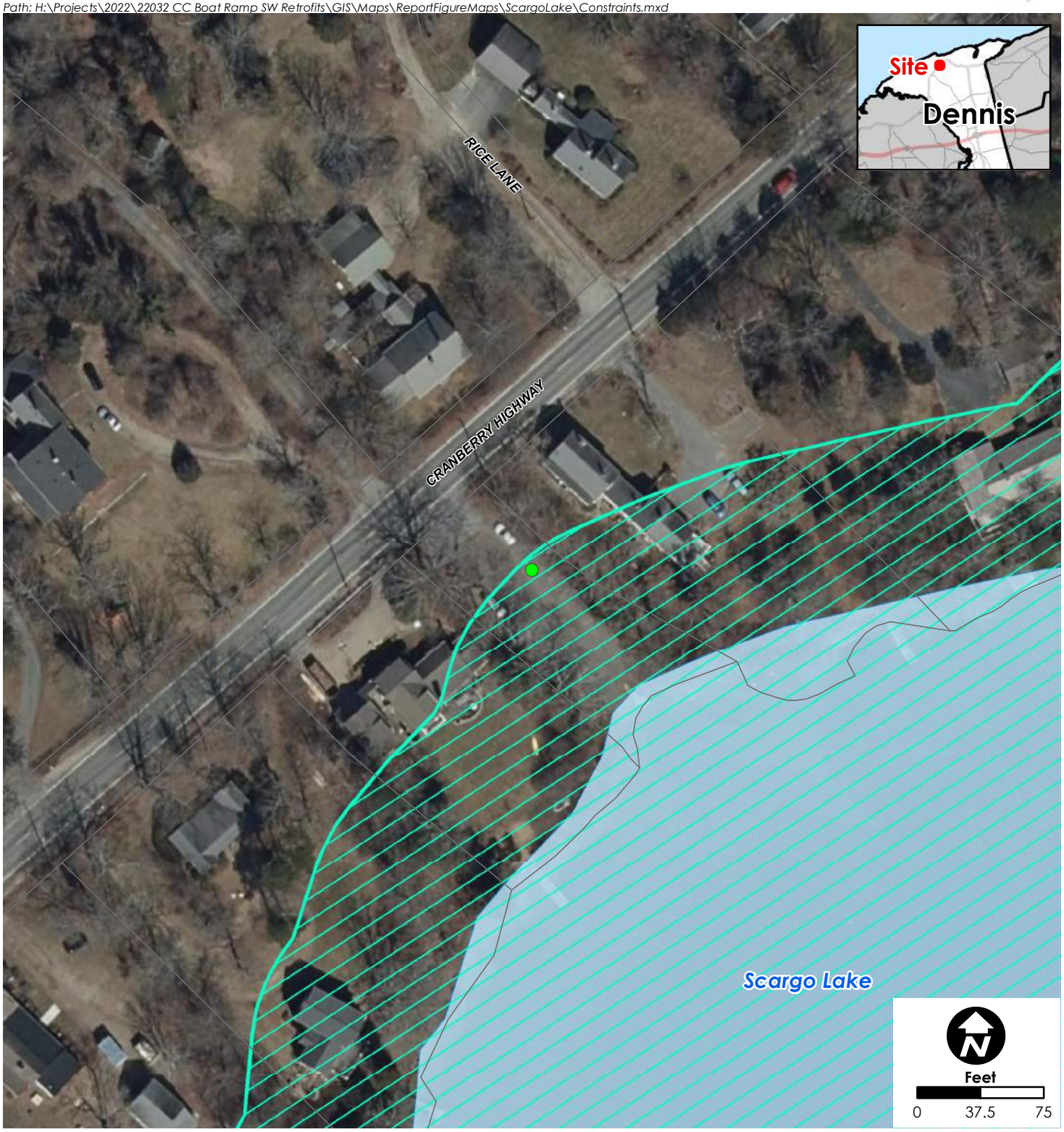
Scargo Lake Boat Ramp
Town Parcels

SCARGO LAKE Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Dennis, MA

Figure 7
Aerial

Horsley Witten Group
Sustainable Environmental Solutions

Path: H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\GIS\Maps\ReportFigureMaps\ScargoLake\Constraints.mxd



Date: 12/6/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

- Scargo Lake Boat Ramp
- Town Parcels
- NHESP Priority Habitats of Rare Species
- Shoreline
- Open Water

SCARGO LAKE Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Dennis, MA

Figure 8
Constraints

Horsley Witten Group
Sustainable Environmental Solutions

Path: H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\GIS\Maps\ReportFigureMaps\ScargoLake\Impaired Waters.mxd

Date: 12/6/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying

Scargo Lake Boat Ramp

2018/2020 Integrated List Data

- 4C - Impairment not caused by a pollutant
- 5 - Impaired - TMDL required
- 3 - No uses assessed
- 4A - Impaired - TMDL is completed
- 4C - Impairment not caused by a pollutant
- 5 - Impaired - TMDL required

SCARGO LAKE Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Dennis, MA

Figure 9
Impaired Waters

Horsley Witten Group
Sustainable Environmental Solutions

Path: H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\GIS\Maps\ReportFigureMaps\ScargoLake\Soils.mxd

Date: 12/6/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

Scargo Lake Boat Ramp
Town Parcels

Hydrologic Soil Group
<Null>
A
C

SCARGO LAKE Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Dennis, MA

Figure 10
Soils

APPENDIX A – Drainage Areas

- Existing and Proposed Drainage Areas Maps
- Land Coverage Summaries

Cape Cod Boat Ramps Dr Lords Dennis, MA	Calc'd by:	EWH
	Checked by:	GK
PRE-development Drainage Conditions	Date:	11/6/2023

DRAINAGE AREAS	
DA1	**EXISTING SITE**

NOAA 14+ 24-hr Type III (inches)	
WQv	1.21
1-yr	3.04
2-yr	3.59
5-yr	4.50
10-yr	5.27
25-yr	6.53
100-yr	8.57
500-yr	0.00

DA1	**EXISTING SITE**					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	20,210	0.464				
Permeable	0	0.000				
Roof	7,590	0.174				
Water	0	0.000				
Woods	188,790	4.334		**Impervious**		
Grass	9,720	0.223		Area, ft^2	Area, *ac*	Percent
TOTAL	226,310	5.195		27,800	0.638	12

ALL	***ALL PRE-DEVELOPMENT AREAS COMBINED***					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	20,210	0.464				
Permeable	0	0.000				
Roof	7,590	0.174				
Water	0	0.000				
Woods	188,790	4.334		**Impervious**		
Grass	9,720	0.223		Area, ft^2	Area, *ac*	Percent
TOTAL	226,310	5.195		27,800	0.638	12

Cape Cod Boat Ramps Dr Lords Dennis, MA	Calc'd by:	EWH
	Checked by:	GK
POST-development Drainage Conditions	Date:	12/8/2023

DRAINAGE AREAS	
DA1	WOODS/NOT CAPTURED
DA1A	PERMEABLE PAVEMENT
DA1B	TO BIO

NOAA 14+ 24-hr Type III (inches)	
WQv	1.21
1-yr	3.04
2-yr	3.59
5-yr	4.50
10-yr	5.27
25-yr	6.53
100-yr	8.57
500-yr	0.00

DA1	WOODS/NOT CAPTURED		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	2,960	0.068	
Permeable	580	0.013	
Roof	4,890	0.112	
Water	0	0.000	
Woods	81,620	1.874	
Grass	2,530	0.058	
TOTAL	92,580	2.125	

Impervious		
Area, ft^2	Area, *ac*	Percent
7,850	0.180	8

DA1A	PERMEABLE PAVEMENT		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	380	0.009	
Permeable	8,310	0.191	
Roof	0	0.000	
Water	370	0.008	
Woods	0	0.000	
Grass	0	0.000	
TOTAL	9,060	0.208	

Impervious		
Area, ft^2	Area, *ac*	Percent
9,060	0.208	100

DA1B	TO BIO		
Cover type	Area, ft^2	Area, *ac*	Note

Paved	6,300	0.145				
Permeable	240	0.006				
Roof	2,700	0.062				
Water	300	0.007				
Woods	105,840	2.430		**Impervious**		
Grass	9,290	0.213		Area, ft^2	Area, *ac*	Percent
TOTAL	124,670	2.862		9,300	0.213	7

ALL	***ALL POST-DEVELOPMENT AREAS COMBINED***					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	9,640	0.221				
Permeable	9,130	0.210				
Roof	7,590	0.174				
Water	670	0.015				
Woods	187,460	4.303		**Impervious**		
Grass	11,820	0.271		Area, ft^2	Area, *ac*	Percent
TOTAL	226,310	5.195		17,900	0.411	8

0 75

SCALE IN FEET

DRAINAGE AREA BOUNDARY

IMP. AREA
TOTAL AREA
(SQUARE FEET)

5,000
15,000

WOODS
WATER
ROOFTOP
GRASS
PAVEMENT

LEGEND

DA1 DRAINAGE AREA

SP1 STUDY POINT

SOIL BOUNDARY

TIME OF CONCENTRATION FLOW PATH

2' CONTOUR

SOIL TYPES

226B HSG C HINESBURG SANDY LOAM (HSG C)

264A HSG A EASTCHOP LOAMY FINE SAND (HSG A)

264B HSG A EASTCHOP LOAMY FINE SAND (HSG A)

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A Sandwich, MA 02563
horsleywittengroup.com

Date: NOVEMBER 2023 | Design By: EWH | Drawn By: EWH | Checked By: GK

Plan Set: DR LORDS & SCARGO LAKE LANDING
CAPE COD BOAT RAMP STORMWATER RETROFIT
PROJECT- PERMITTING PLANS
DENNIS, MASSACHUSETTS

Plan Title: EXISTING DRAINAGE MAP

Prepared For:
Town of Dennis
685 MA-134
South Dennis, MA
Phone:(508) 394-8300

Project Number: 22032A

Sheet Number: 1 of 2

0 75

SCALE IN FEET

LEGEND

DRAINAGE AREA BOUNDARY

IMP. AREA / TOTAL AREA (SQUARE FEET) — 5,000 / 15,000

WOODS
WATER
ROOFTOP
GRASS
PAVEMENT

DA1 DRAINAGE AREA

SP1 STUDY POINT

P1 POND

SOIL BOUNDARY

TIME OF CONCENTRATION FLOW PATH

2' CONTOUR

SOIL TYPES

226B HSG C	HINESBURG SANDY LOAM (HSG C)
264A HSG A	EASTCHOP LOAMY FINE SAND (HSG A)
264B HSG A	EASTCHOP LOAMY FINE SAND (HSG A)

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A Sandwich, MA 02563
horsleywittengroup.com

Date: NOVEMBER 2023 | Designed By: EWH | Drawn By: EWH | Checked By: GK

Plan Set: DR LORDS & SCARGO LAKE LANDING
CAPE COD BOAT RAMP STORMWATER RETROFIT
PROJECT- PERMITTING PLANS
DENNIS, MASSACHUSETTS

Plan Title: PROPOSED DRAINAGE MAP

Prepared For:
Town of Dennis
685 MA-134
South Dennis, MA
Phone:(508) 394-8300

Project Number: 22032A

Sheet Number: 2 of 2

SCARGO LANDING BOAT RAMP DENNIS, MASSACHUSETTS	Calc'd by:	MCL
	Checked by:	GK
Existing Drainage Conditions	Date:	12/5/2023

DRAINAGE AREAS	
DA1	**LANDING**

NOAA 14+ 24-hr Type III (inches)	
WQv	1.21
1-yr	3.04
2-yr	3.59
5-yr	4.50
10-yr	5.27
25-yr	6.53
100-yr	8.57
500-yr	11.43

DA1	**LANDING**		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	640	0.015	ncluding grave
Gravel	5,208	0.120	
Roof	0	0.000	
Water	0	0.000	
Woods	762	0.017	
Grass	1,285	0.029	
TOTAL	7,895	0.181	

Impervious		
Area, ft^2	Area, *ac*	Percent
5,848	0.134	74

ALL	***ALL EXISTING DRAINAGE AREAS COMBINED***					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	640	0.015				
Permeable	5,208	0.120				
Roof	0	0.000				
Water	0	0.000				
Woods	762	0.017		**Impervious**		
Grass	1,285	0.029		Area, ft^2	Area, *ac*	Percent
TOTAL	7,895	0.181		5,848	0.134	74

SCARGO LANDING BOAT RAMP DENNIS, MASSACHUSETTS	Calc'd by:	MCL
	Checked by:	GK
Proposed Drainage Conditions	Date:	12/5/2023

DRAINAGE AREAS	
DA1	**BEACH**
DA2a	**BOTTOM**
DA2b	**TOP**

NOAA 14+ 24-hr Type III (inches)	
WQv	1.21
1-yr	3.04
2-yr	3.59
5-yr	4.50
10-yr	5.27
25-yr	6.53
100-yr	8.57
500-yr	11.43

DA1	**BEACH**		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	130	0.003	
Gravel	0	0.000	
Roof	0	0.000	
Water	0	0.000	
Woods	101	0.002	
Grass	262	0.006	
TOTAL	493	0.011	

Impervious		
Area, ft^2	Area, *ac*	Percent
130	0.003	26

DA2a	**BOTTOM**		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	1,407	0.032	
Gravel	0	0.000	
Roof	0	0.000	
Water	63	0.001	
Woods	90	0.002	
Grass	589	0.014	
TOTAL	2,149	0.049	

Impervious		
Area, ft^2	Area, *ac*	Percent
1,407	0.032	65

DA2b	TOP					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	4,614	0.106				
Gravel	0	0.000				
Roof	0	0.000				
Water	0	0.000				
Woods	224	0.005		**Impervious**		
Grass	415	0.010		Area, ft^2	Area, *ac*	Percent
TOTAL	5,253	0.121		4,614	0.106	88

ALL	***ALL PROPOSED DRAINAGE AREAS COMBINED***					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	6,151	0.141				
Gravel	0	0.000				
Roof	0	0.000				
Water	63	0.001				
Woods	415	0.010		**Impervious**		
Grass	1,266	0.029		Area, ft^2	Area, *ac*	Percent
TOTAL	7,895	0.181		6,214	0.143	79

LEGEND

DRAINAGE AREA BOUNDARY
GRAVEL
IMP. AREA / **TOTAL AREA** (SQUARE FEET)
5,000 / **15,000**
WOODS
GRASS
PAVEMENT

DA1 DRAINAGE AREA
SP1 STUDY POINT
P1 POND

SOIL BOUNDARY
5' MAJOR CONTOUR
1' MINOR CONTOUR

SOIL TYPES

264A A	EASTCHOP LOAMY FINE SAND 0-3% SLOPE (HSG A)
264B A	EASTCHOP LOAMY FINE SAND 3-8% SLOPE (HSG A)

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A Sandwich, MA 02563
horsleywittengroup.com

Date: 12/4/23 | Design By: | Drawn By: MCL | Checked By: GK

Plan Set:
SCARGO LAKE
CAPE COD BOAT RAMP STORMWATER
RETROFIT PROJECT- 25% CONCEPT
DENNIS, MASSACHUSETTS

Plan Title:
EXISTING CONDITIONS DRAINAGE AREA MAP

Prepared For:
Town of Dennis
685 MA-134
South Dennis, MA
Phone: (508) 394-8300

Project Number: 22032B

Sheet Number: 1 of 2

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last modified: 12/04/23 printed: 12/04/23 by ml

LEGEND

DRAINAGE AREA BOUNDARY

IMP. AREA
TOTAL AREA
(SQUARE FEET)

5,000
15,000

WOODS
WATER
ROOFTOP
GRASS
PAVEMENT

DA1 DRAINAGE AREA

SP1 STUDY POINT

P1 POND

SOIL BOUNDARY

5' MAJOR CONTOUR

1' MINOR CONTOUR

SOIL TYPES

264A A	EASTCHOP LOAMY FINE SAND 0-3% SLOPE (HSG A)
264B A	EASTCHOP LOAMY FINE SAND 3-8% SLOPE (HSG A)

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Sustainable Environmental Solutions
90 Route 6A Sandwich, MA 02563
horsleywittengroup.com

Checked By: GK
Drawn By: MCL
Design By:
Date: 12/4/23

Plan Set:
SCARGO LAKE
CAPE COD BOAT RAMP STORMWATER
RETROFIT PROJECT- 25% CONCEPT
DENNIS, MASSACHUSETTS

Plan Title:
PROPOSED CONDITIONS DRAINAGE AREA MAP

Prepared For:
Town of Dennis
685 MA-134
South Dennis, MA
Phone: (508) 394-8300

Project Number:
22032B

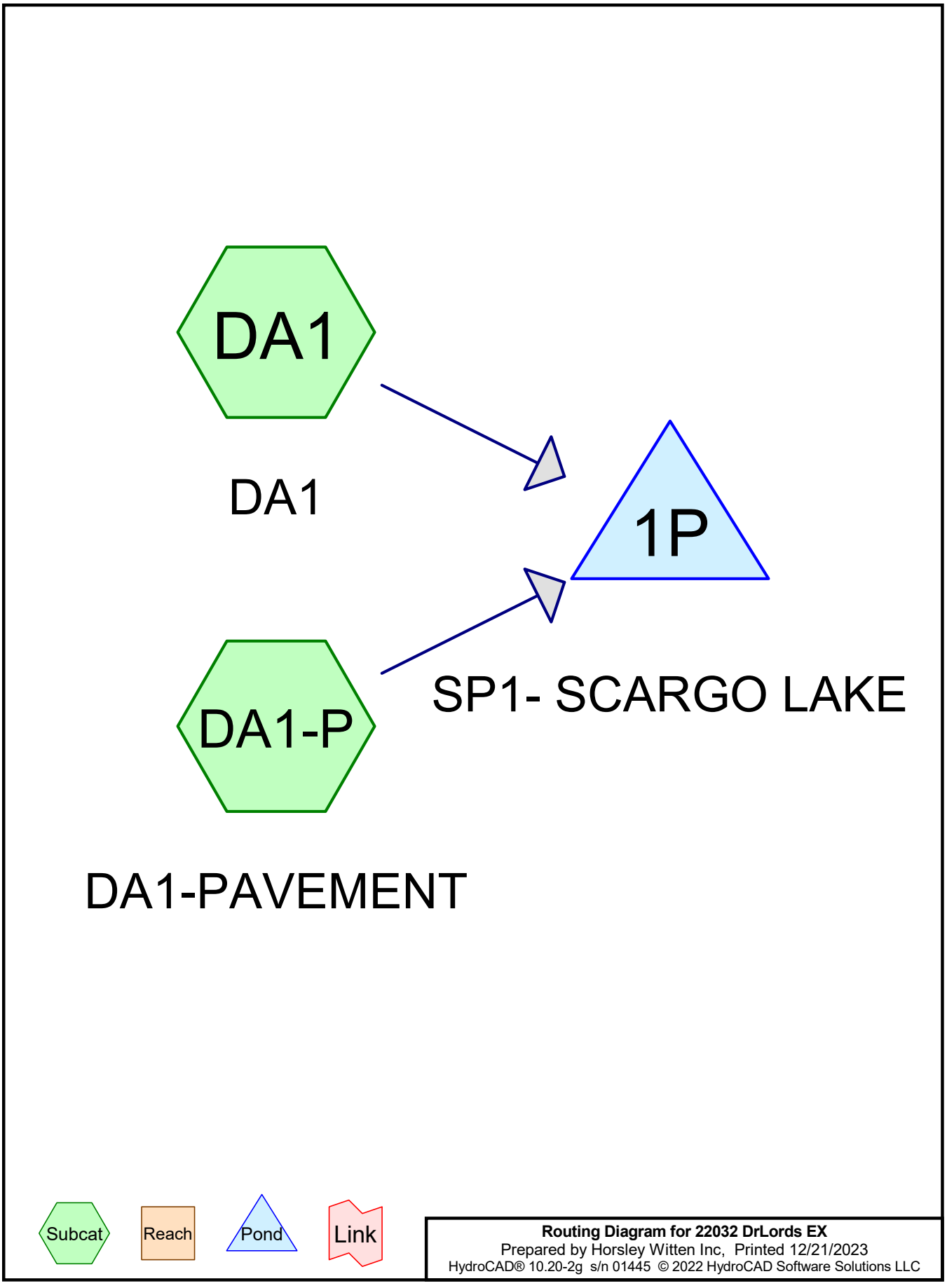
Sheet Number:
2 of 2

last modified: 12/21/23 printed: 12/21/23 by ml H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\Drawings\SCARGO LAKE LANDING\Misc\22032 SCARGO DR.dwg

APPENDIX B – Hydrologic/Hydraulic Model Results

HydroCAD® Results

- Existing
- Proposed



Routing Diagram for 22032 DrLords EX
Prepared by Horsley Witten Inc, Printed 12/21/2023

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2yr	Type III 24-hr		Default	24.00	1	3.59	2
2	10yr	Type III 24-hr		Default	24.00	1	5.27	2
3	25yr	Type III 24-hr		Default	24.00	1	6.53	2
4	100yr	Type III 24-hr		Default	24.00	1	8.57	2
5	WQv	Type III 24-hr		Default	24.00	1	1.21	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.223	39	>75% Grass cover, Good, HSG A (DA1)
0.464	98	Paved parking, HSG A (DA1-P)
0.174	98	Roofs, HSG A (DA1)
4.334	30	Woods, Good, HSG A (DA1)
5.195	**39**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
5.195	HSG A	DA1, DA1-P
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
5.195		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.223	0.000	0.000	0.000	0.000	0.223	>75% Grass cover, Good	DA1
0.464	0.000	0.000	0.000	0.000	0.464	Paved parking	DA1-P
0.174	0.000	0.000	0.000	0.000	0.174	Roofs	DA1
4.334	0.000	0.000	0.000	0.000	4.334	Woods, Good	DA1
5.195	**0.000**	**0.000**	**0.000**	**0.000**	**5.195**	**TOTAL AREA**	

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=206,100 sf 3.68% Impervious Runoff Depth=0.12"
Flow Length=583' Tc=32.1 min CN=30/98 Runoff=0.34 cfs 0.049 af

Subcatchment DA1-P: DA1-PAVEMENT Runoff Area=20,210 sf 100.00% Impervious Runoff Depth=3.36"
Tc=5.0 min CN=0/98 Runoff=1.63 cfs 0.130 af

Pond 1P: SP1- SCARGO LAKE Inflow=1.78 cfs 0.178 af
Primary=1.78 cfs 0.178 af

Total Runoff Area = 5.195 ac Runoff Volume = 0.178 af Average Runoff Depth = 0.41"
87.72% Pervious = 4.557 ac 12.28% Impervious = 0.638 ac

Summary for Subcatchment DA1: DA1

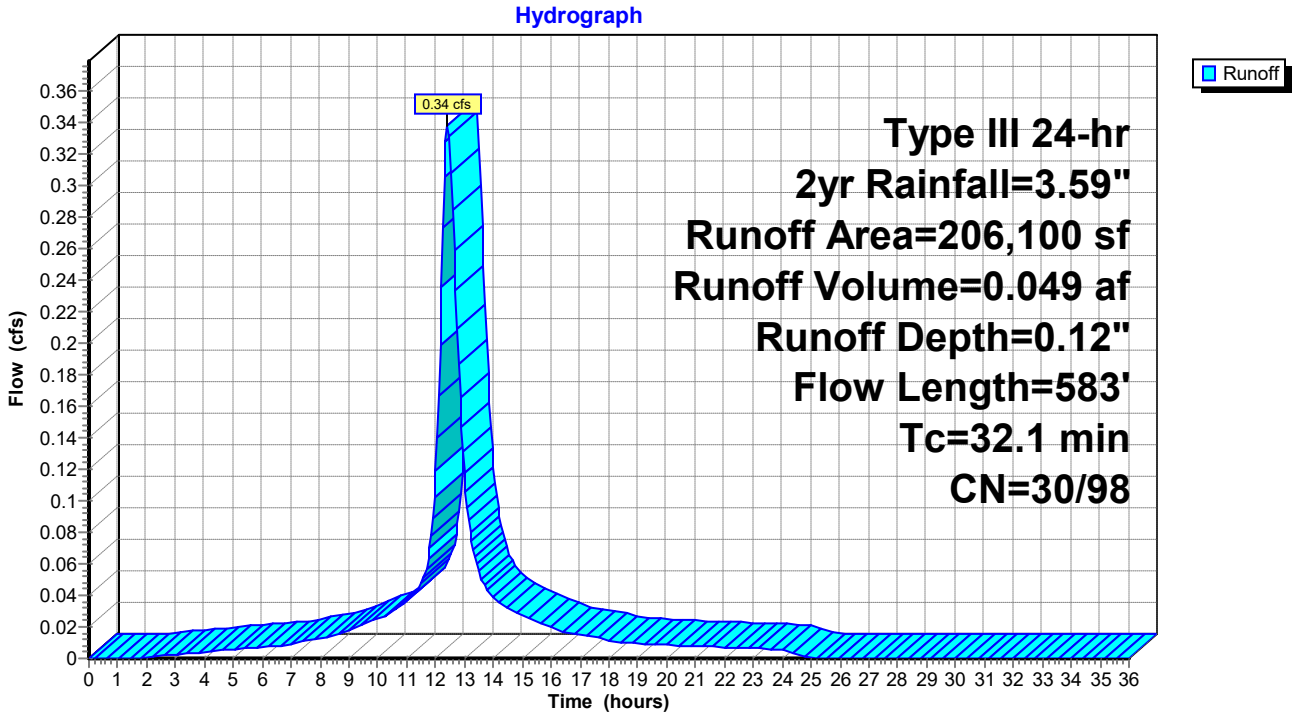
Runoff = 0.34 cfs @ 12.42 hrs, Volume= 0.049 af, Depth= 0.12"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2yr Rainfall=3.59"

Area (sf)	CN	Description
7,590	98	Roofs, HSG A
188,790	30	Woods, Good, HSG A
9,720	39	>75% Grass cover, Good, HSG A
206,100	33	Weighted Average
198,510	30	96.32% Pervious Area
7,590	98	3.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.8	100	0.0100	0.06		**Sheet Flow, A TO B** Woods: Light underbrush n= 0.400 P2= 3.59"
4.2	179	0.0200	0.71		**Shallow Concentrated Flow, B TO C** Woodland Kv= 5.0 fps
0.8	244	0.0600	4.97		**Shallow Concentrated Flow, C TO D** Paved Kv= 20.3 fps
0.3	60	0.0400	3.00		**Shallow Concentrated Flow, D TO E** Grassed Waterway Kv= 15.0 fps
32.1	583	Total			

Subcatchment DA1: DA1



Summary for Subcatchment DA1-P: DA1-PAVEMENT

[49] Hint: Tc<2dt may require smaller dt

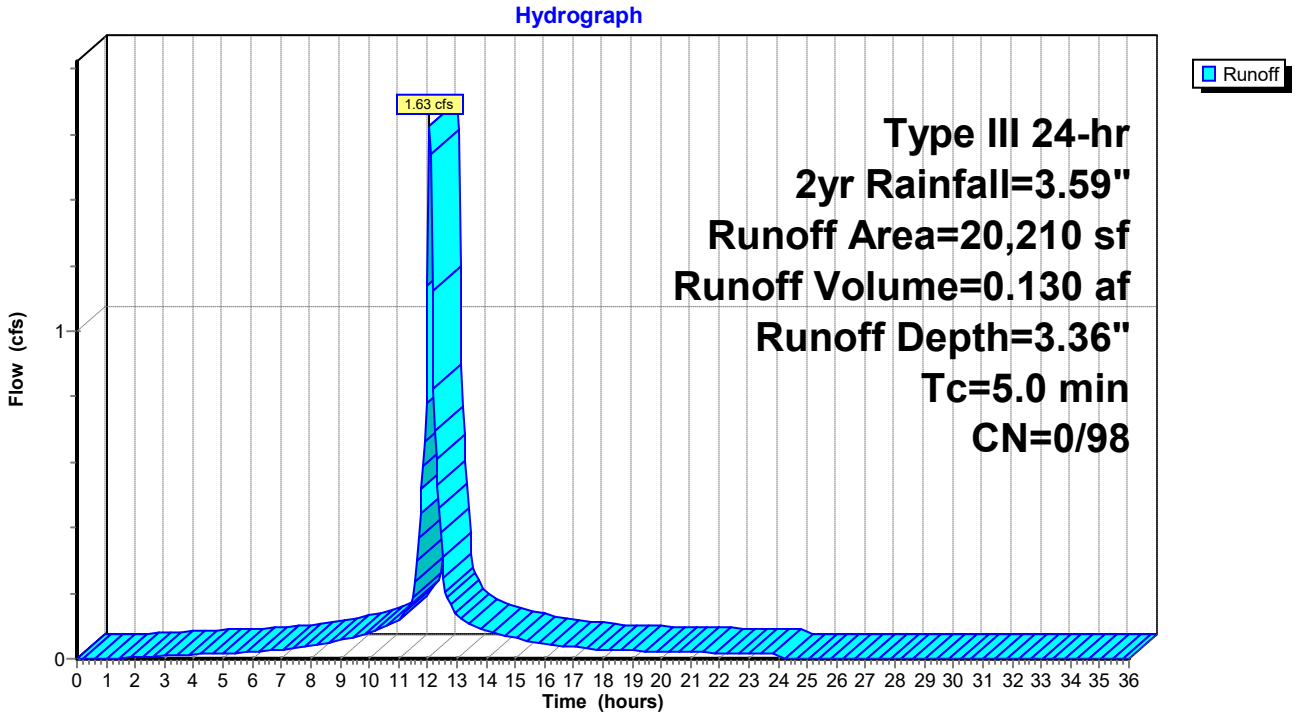
Runoff = 1.63 cfs @ 12.07 hrs, Volume= 0.130 af, Depth= 3.36"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2yr Rainfall=3.59"

Area (sf)	CN	Description
20,210	98	Paved parking, HSG A
20,210	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1-P: DA1-PAVEMENT



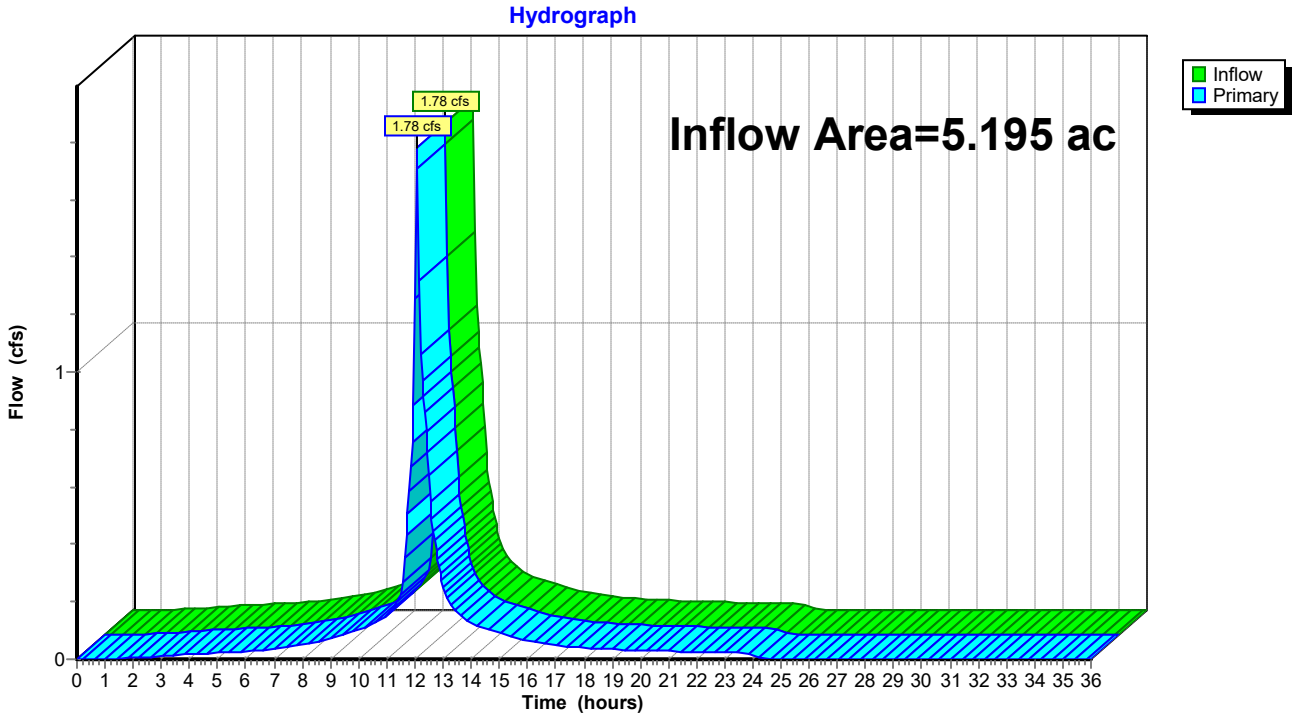
Summary for Pond 1P: SP1- SCARGO LAKE

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.195 ac, 12.28% Impervious, Inflow Depth = 0.41" for 2yr event
Inflow = 1.78 cfs @ 12.07 hrs, Volume= 0.178 af
Primary = 1.78 cfs @ 12.07 hrs, Volume= 0.178 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Pond 1P: SP1- SCARGO LAKE



Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=206,100 sf 3.68% Impervious Runoff Depth=0.20"
Flow Length=583' Tc=32.1 min CN=30/98 Runoff=0.50 cfs 0.079 af

Subcatchment DA1-P: DA1-PAVEMENT Runoff Area=20,210 sf 100.00% Impervious Runoff Depth=5.03"
Tc=5.0 min CN=0/98 Runoff=2.41 cfs 0.195 af

Pond 1P: SP1- SCARGO LAKE Inflow=2.63 cfs 0.273 af
Primary=2.63 cfs 0.273 af

Total Runoff Area = 5.195 ac Runoff Volume = 0.273 af Average Runoff Depth = 0.63"
87.72% Pervious = 4.557 ac 12.28% Impervious = 0.638 ac

Summary for Subcatchment DA1: DA1

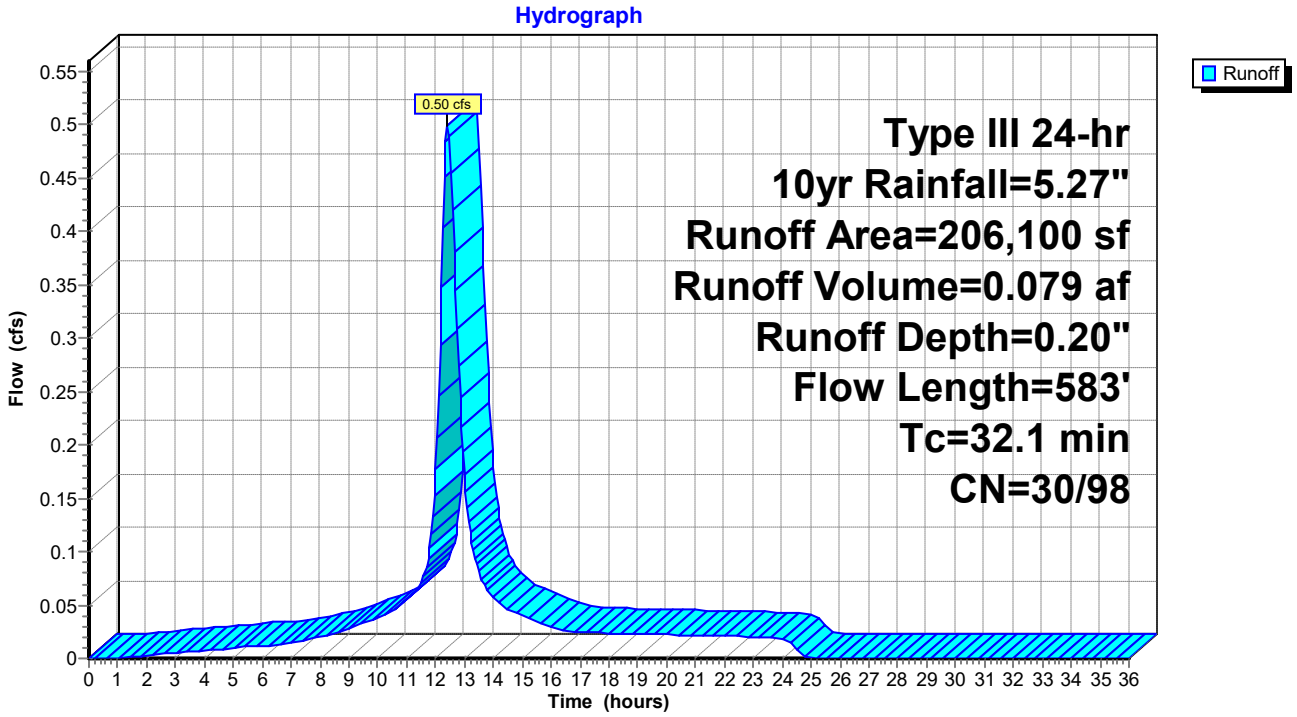
Runoff = 0.50 cfs @ 12.42 hrs, Volume= 0.079 af, Depth= 0.20"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10yr Rainfall=5.27"

Area (sf)	CN	Description
7,590	98	Roofs, HSG A
188,790	30	Woods, Good, HSG A
9,720	39	>75% Grass cover, Good, HSG A
206,100	33	Weighted Average
198,510	30	96.32% Pervious Area
7,590	98	3.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.8	100	0.0100	0.06		**Sheet Flow, A TO B** Woods: Light underbrush n= 0.400 P2= 3.59"
4.2	179	0.0200	0.71		**Shallow Concentrated Flow, B TO C** Woodland Kv= 5.0 fps
0.8	244	0.0600	4.97		**Shallow Concentrated Flow, C TO D** Paved Kv= 20.3 fps
0.3	60	0.0400	3.00		**Shallow Concentrated Flow, D TO E** Grassed Waterway Kv= 15.0 fps
32.1	583	Total			

Subcatchment DA1: DA1



Summary for Subcatchment DA1-P: DA1-PAVEMENT

[49] Hint: Tc<2dt may require smaller dt

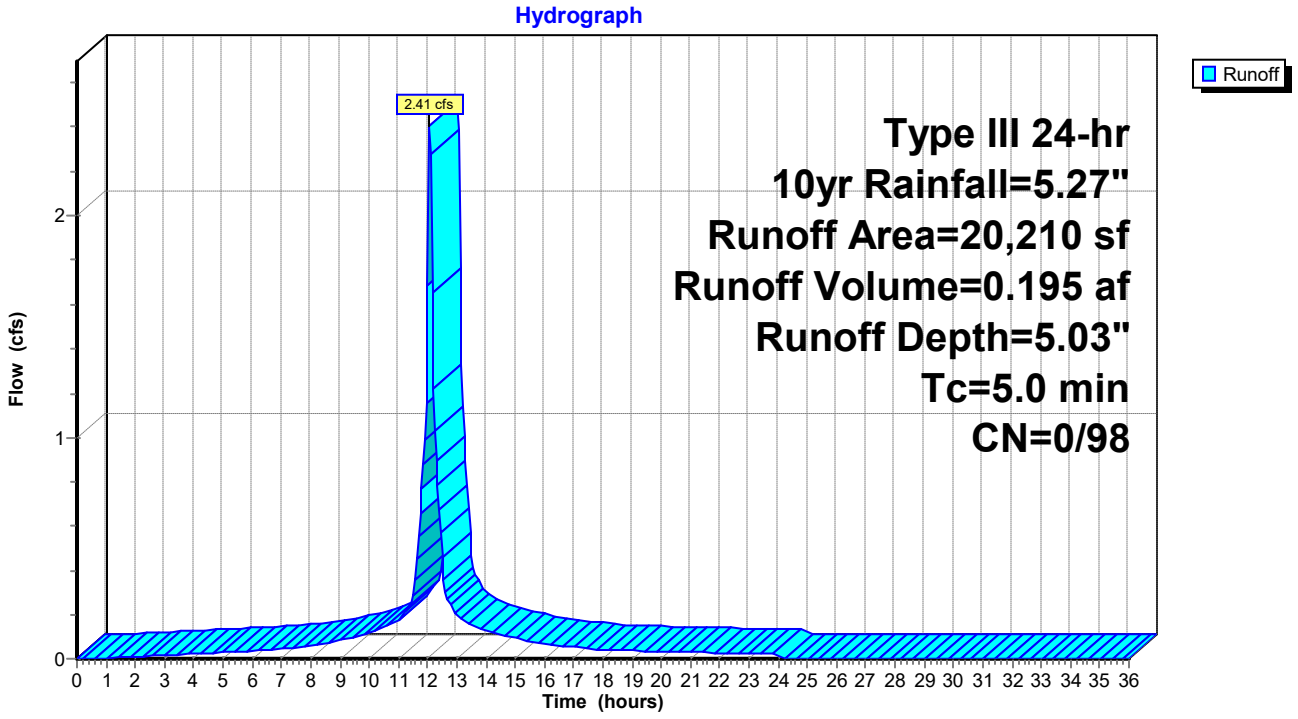
Runoff = 2.41 cfs @ 12.07 hrs, Volume= 0.195 af, Depth= 5.03"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10yr Rainfall=5.27"

Area (sf)	CN	Description
20,210	98	Paved parking, HSG A
20,210	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1-P: DA1-PAVEMENT



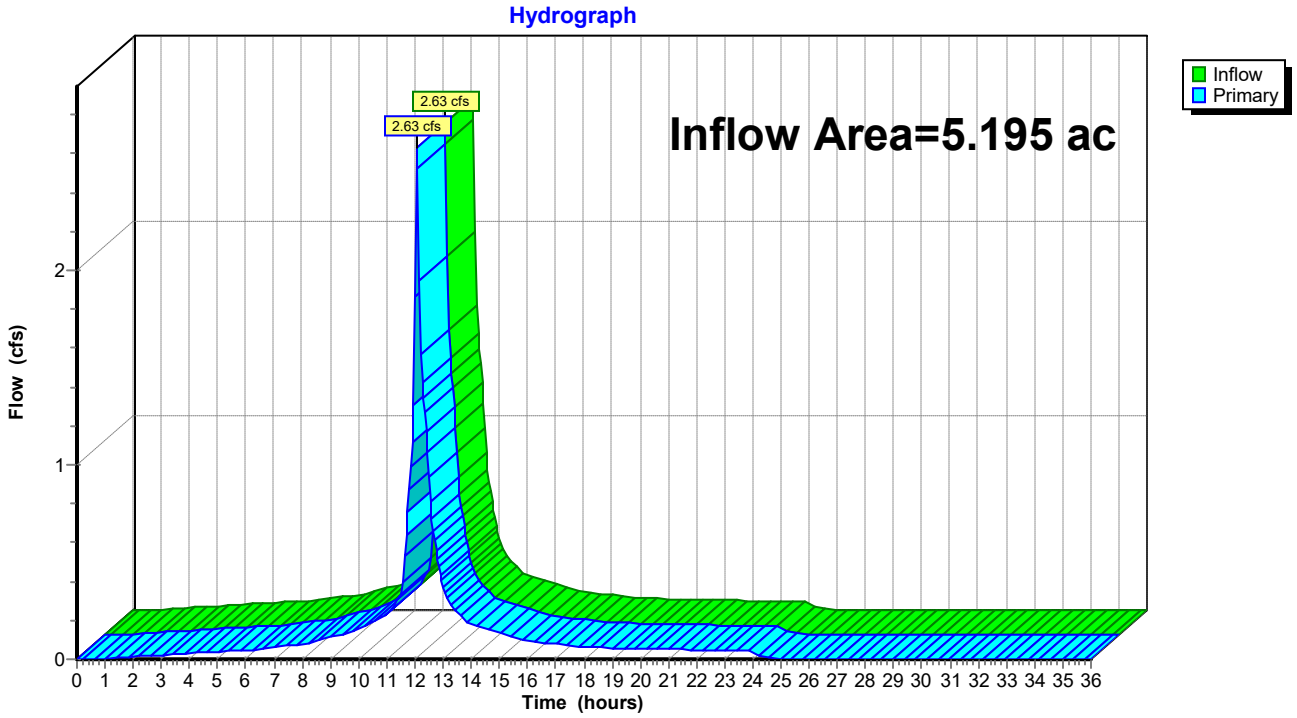
Summary for Pond 1P: SP1- SCARGO LAKE

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.195 ac, 12.28% Impervious, Inflow Depth = 0.63" for 10yr event
Inflow = 2.63 cfs @ 12.07 hrs, Volume= 0.273 af
Primary = 2.63 cfs @ 12.07 hrs, Volume= 0.273 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Pond 1P: SP1- SCARGO LAKE



Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=206,100 sf 3.68% Impervious Runoff Depth=0.36"
Flow Length=583' Tc=32.1 min CN=30/98 Runoff=0.62 cfs 0.144 af

Subcatchment DA1-P: DA1-PAVEMENT Runoff Area=20,210 sf 100.00% Impervious Runoff Depth=6.29"
Tc=5.0 min CN=0/98 Runoff=2.99 cfs 0.243 af

Pond 1P: SP1- SCARGO LAKE Inflow=3.27 cfs 0.387 af
Primary=3.27 cfs 0.387 af

Total Runoff Area = 5.195 ac Runoff Volume = 0.387 af Average Runoff Depth = 0.89"
87.72% Pervious = 4.557 ac 12.28% Impervious = 0.638 ac

Summary for Subcatchment DA1: DA1

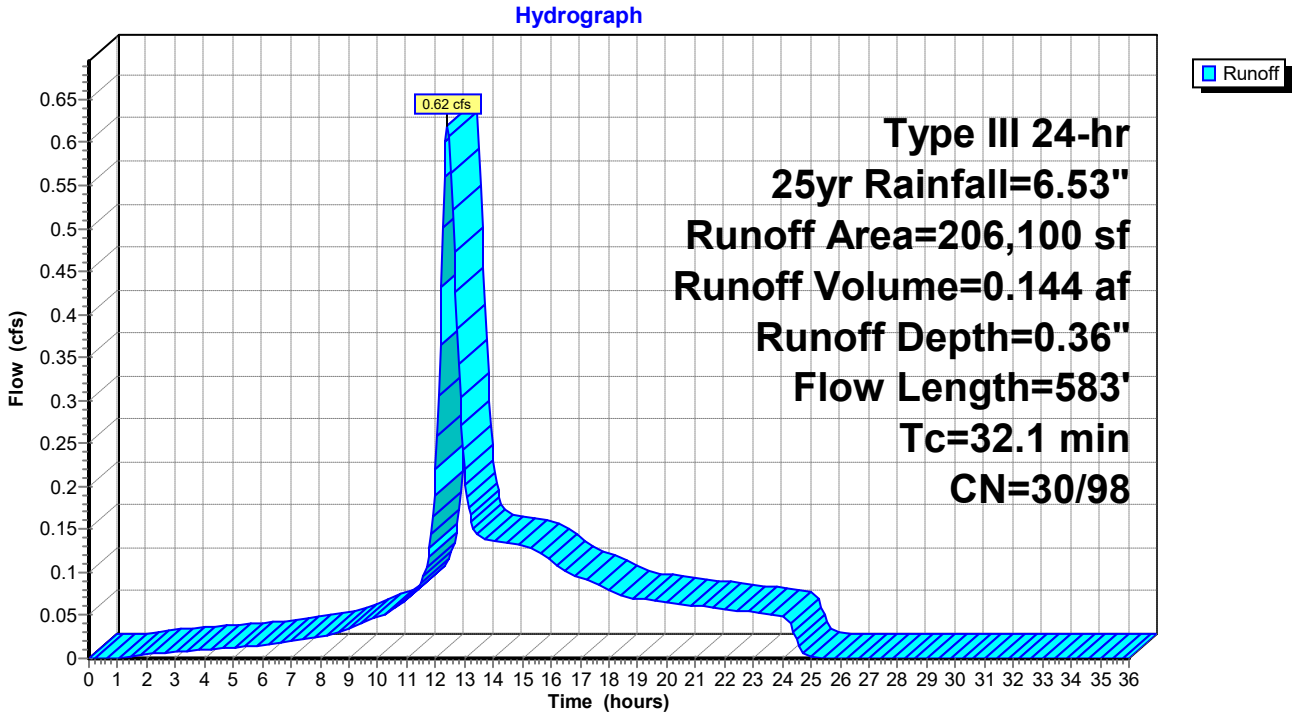
Runoff = 0.62 cfs @ 12.42 hrs, Volume= 0.144 af, Depth= 0.36"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=6.53"

Area (sf)	CN	Description
7,590	98	Roofs, HSG A
188,790	30	Woods, Good, HSG A
9,720	39	>75% Grass cover, Good, HSG A
206,100	33	Weighted Average
198,510	30	96.32% Pervious Area
7,590	98	3.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.8	100	0.0100	0.06		**Sheet Flow, A TO B** Woods: Light underbrush n= 0.400 P2= 3.59"
4.2	179	0.0200	0.71		**Shallow Concentrated Flow, B TO C** Woodland Kv= 5.0 fps
0.8	244	0.0600	4.97		**Shallow Concentrated Flow, C TO D** Paved Kv= 20.3 fps
0.3	60	0.0400	3.00		**Shallow Concentrated Flow, D TO E** Grassed Waterway Kv= 15.0 fps
32.1	583	Total			

Subcatchment DA1: DA1



Summary for Subcatchment DA1-P: DA1-PAVEMENT

[49] Hint: Tc<2dt may require smaller dt

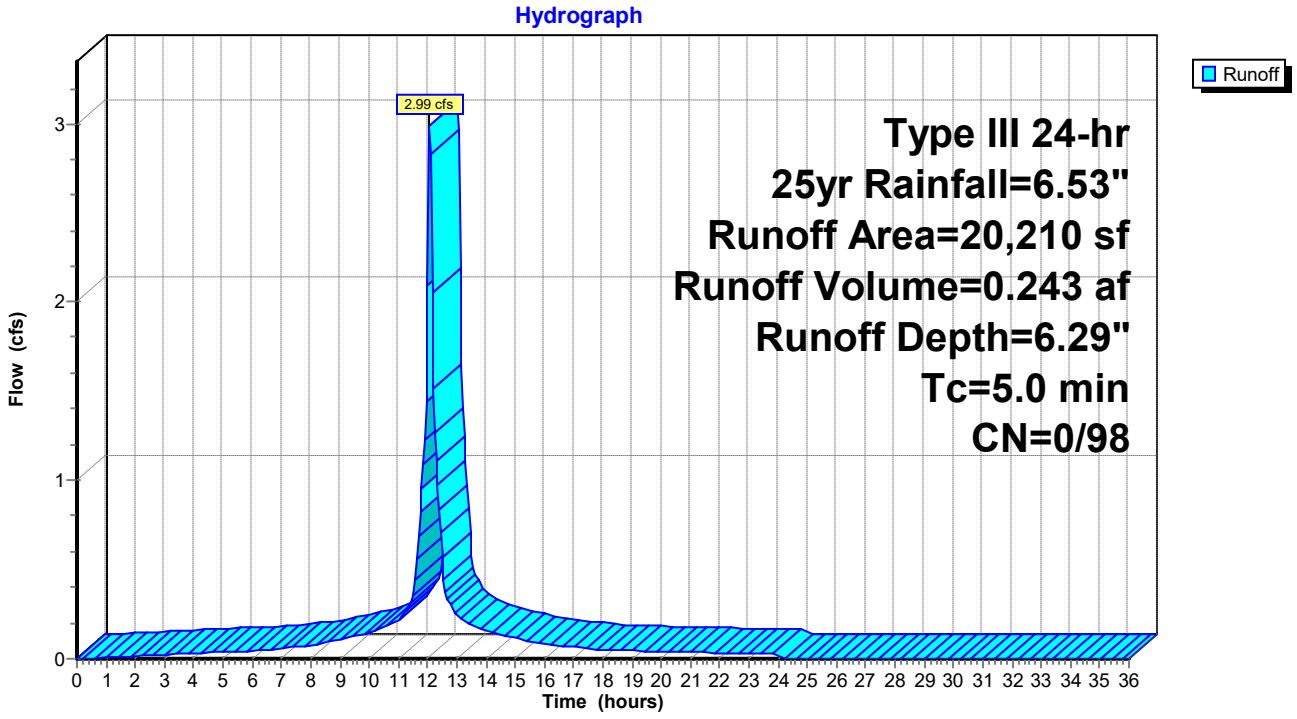
Runoff = 2.99 cfs @ 12.07 hrs, Volume= 0.243 af, Depth= 6.29"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=6.53"

Area (sf)	CN	Description
20,210	98	Paved parking, HSG A
20,210	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1-P: DA1-PAVEMENT



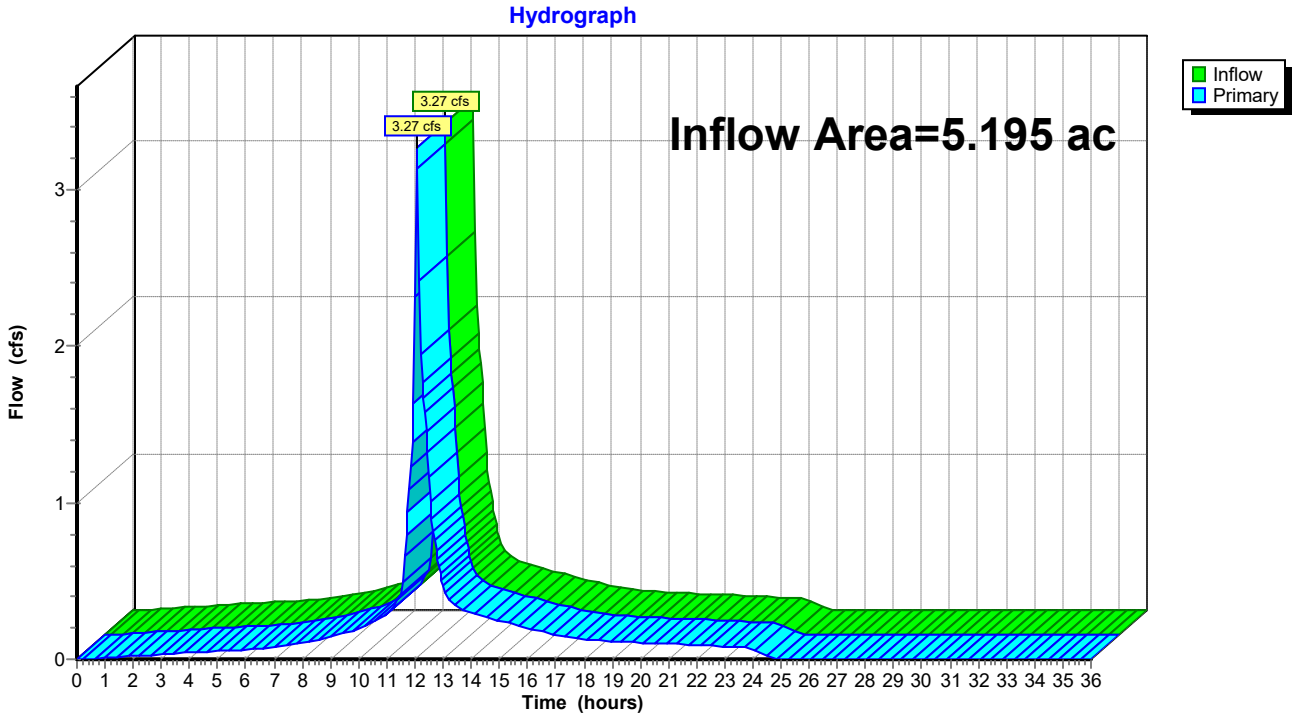
Summary for Pond 1P: SP1- SCARGO LAKE

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.195 ac, 12.28% Impervious, Inflow Depth = 0.89" for 25yr event
Inflow = 3.27 cfs @ 12.07 hrs, Volume= 0.387 af
Primary = 3.27 cfs @ 12.07 hrs, Volume= 0.387 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Pond 1P: SP1- SCARGO LAKE



Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=206,100 sf 3.68% Impervious Runoff Depth=0.85"
Flow Length=583' Tc=32.1 min CN=30/98 Runoff=1.21 cfs 0.333 af

Subcatchment DA1-P: DA1-PAVEMENT Runoff Area=20,210 sf 100.00% Impervious Runoff Depth=8.33"
Tc=5.0 min CN=0/98 Runoff=3.93 cfs 0.322 af

Pond 1P: SP1- SCARGO LAKE Inflow=4.30 cfs 0.655 af
Primary=4.30 cfs 0.655 af

Total Runoff Area = 5.195 ac Runoff Volume = 0.655 af Average Runoff Depth = 1.51"
87.72% Pervious = 4.557 ac 12.28% Impervious = 0.638 ac

Summary for Subcatchment DA1: DA1

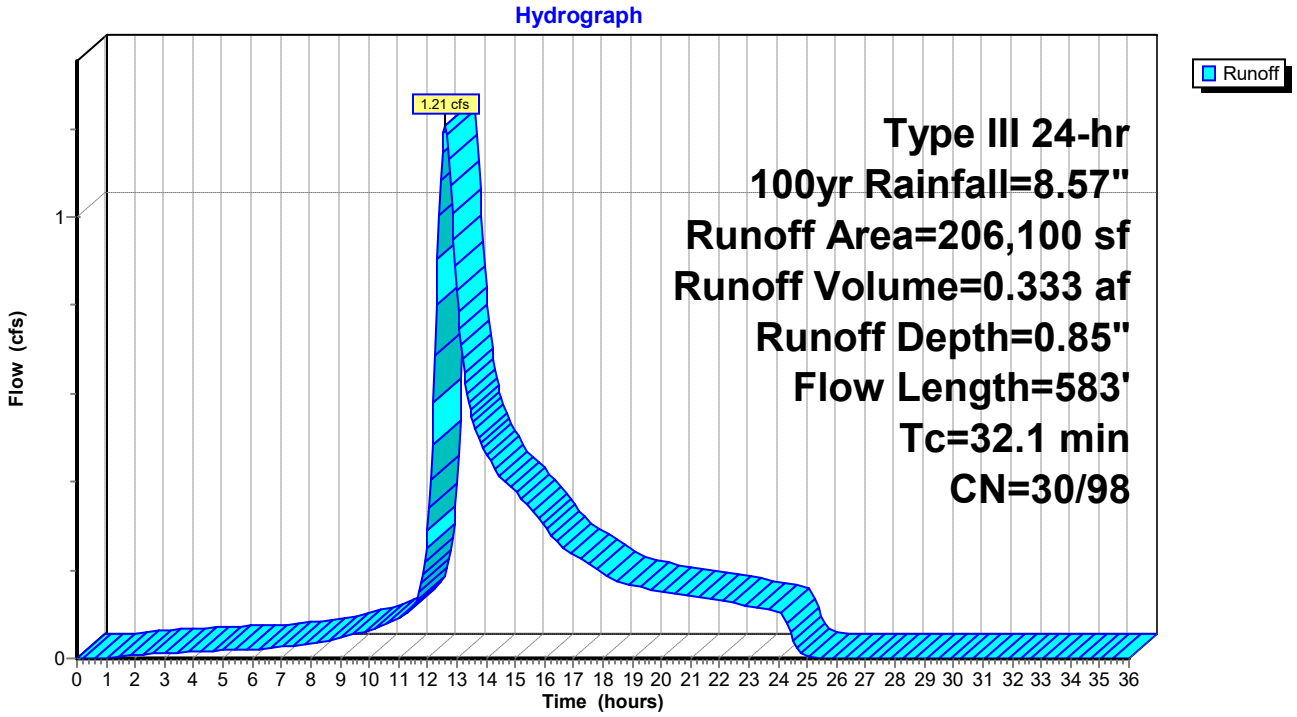
Runoff = 1.21 cfs @ 12.61 hrs, Volume= 0.333 af, Depth= 0.85"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr Rainfall=8.57"

Area (sf)	CN	Description
7,590	98	Roofs, HSG A
188,790	30	Woods, Good, HSG A
9,720	39	>75% Grass cover, Good, HSG A
206,100	33	Weighted Average
198,510	30	96.32% Pervious Area
7,590	98	3.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.8	100	0.0100	0.06		**Sheet Flow, A TO B** Woods: Light underbrush n= 0.400 P2= 3.59"
4.2	179	0.0200	0.71		**Shallow Concentrated Flow, B TO C** Woodland Kv= 5.0 fps
0.8	244	0.0600	4.97		**Shallow Concentrated Flow, C TO D** Paved Kv= 20.3 fps
0.3	60	0.0400	3.00		**Shallow Concentrated Flow, D TO E** Grassed Waterway Kv= 15.0 fps
32.1	583	Total			

Subcatchment DA1: DA1



Summary for Subcatchment DA1-P: DA1-PAVEMENT

[49] Hint: Tc<2dt may require smaller dt

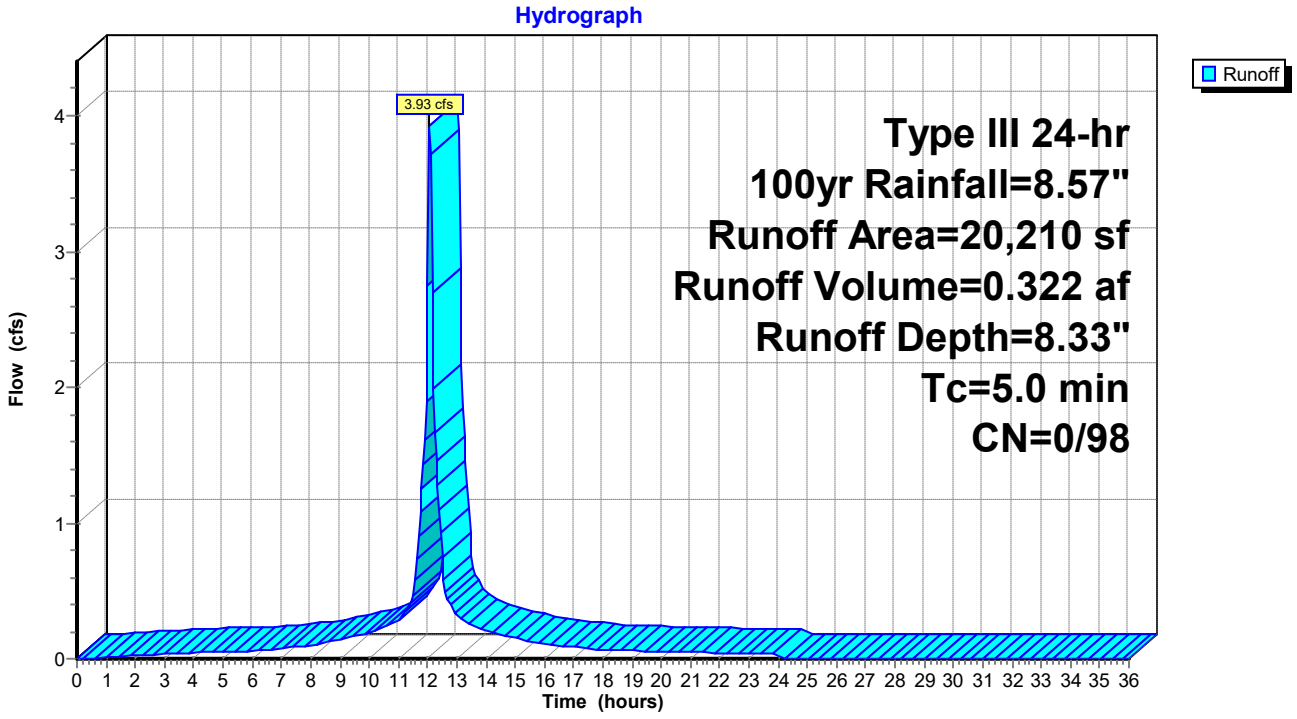
Runoff = 3.93 cfs @ 12.07 hrs, Volume= 0.322 af, Depth= 8.33"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr Rainfall=8.57"

Area (sf)	CN	Description
20,210	98	Paved parking, HSG A
20,210	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1-P: DA1-PAVEMENT



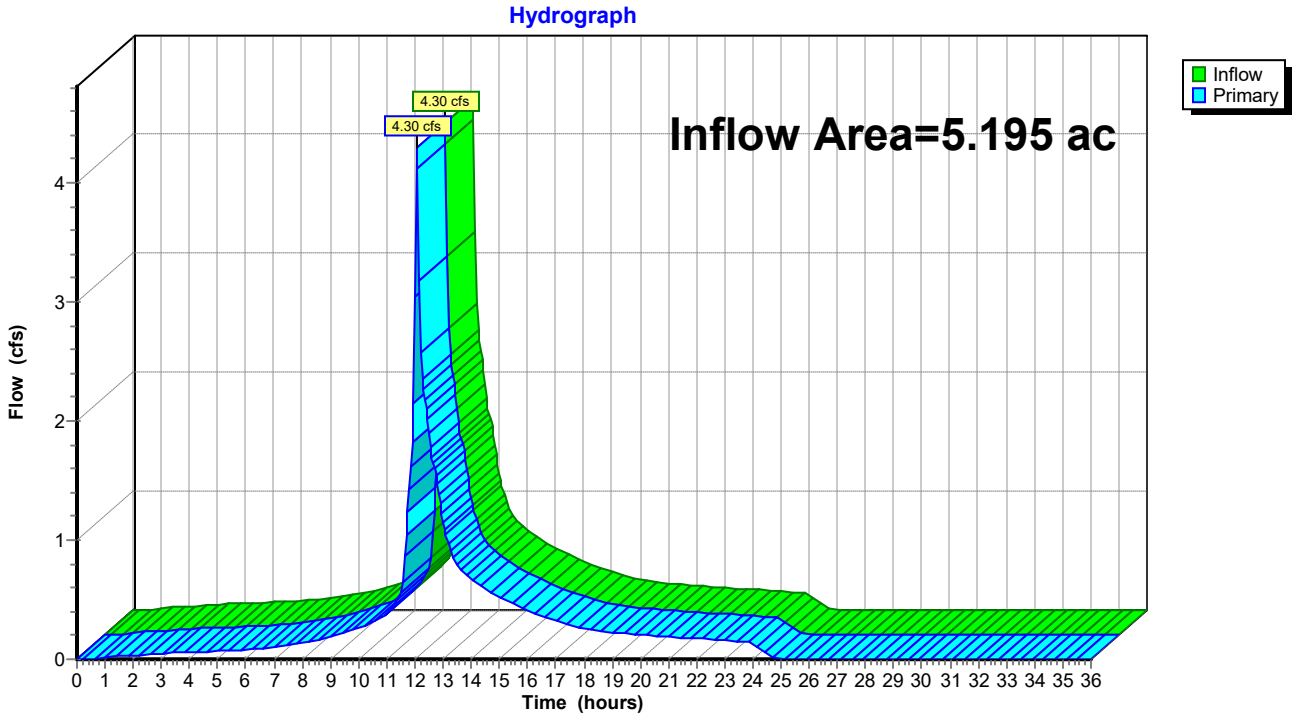
Summary for Pond 1P: SP1- SCARGO LAKE

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.195 ac, 12.28% Impervious, Inflow Depth = 1.51" for 100yr event
Inflow = 4.30 cfs @ 12.07 hrs, Volume= 0.655 af
Primary = 4.30 cfs @ 12.07 hrs, Volume= 0.655 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Pond 1P: SP1- SCARGO LAKE



Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=206,100 sf 3.68% Impervious Runoff Depth=0.04"
Flow Length=583' Tc=32.1 min CN=30/98 Runoff=0.11 cfs 0.014 af

Subcatchment DA1-P: DA1-PAVEMENT Runoff Area=20,210 sf 100.00% Impervious Runoff Depth=1.00"
Tc=5.0 min CN=0/98 Runoff=0.52 cfs 0.038 af

Pond 1P: SP1- SCARGO LAKE Inflow=0.56 cfs 0.053 af
Primary=0.56 cfs 0.053 af

Total Runoff Area = 5.195 ac Runoff Volume = 0.053 af Average Runoff Depth = 0.12"
87.72% Pervious = 4.557 ac 12.28% Impervious = 0.638 ac

Summary for Subcatchment DA1: DA1

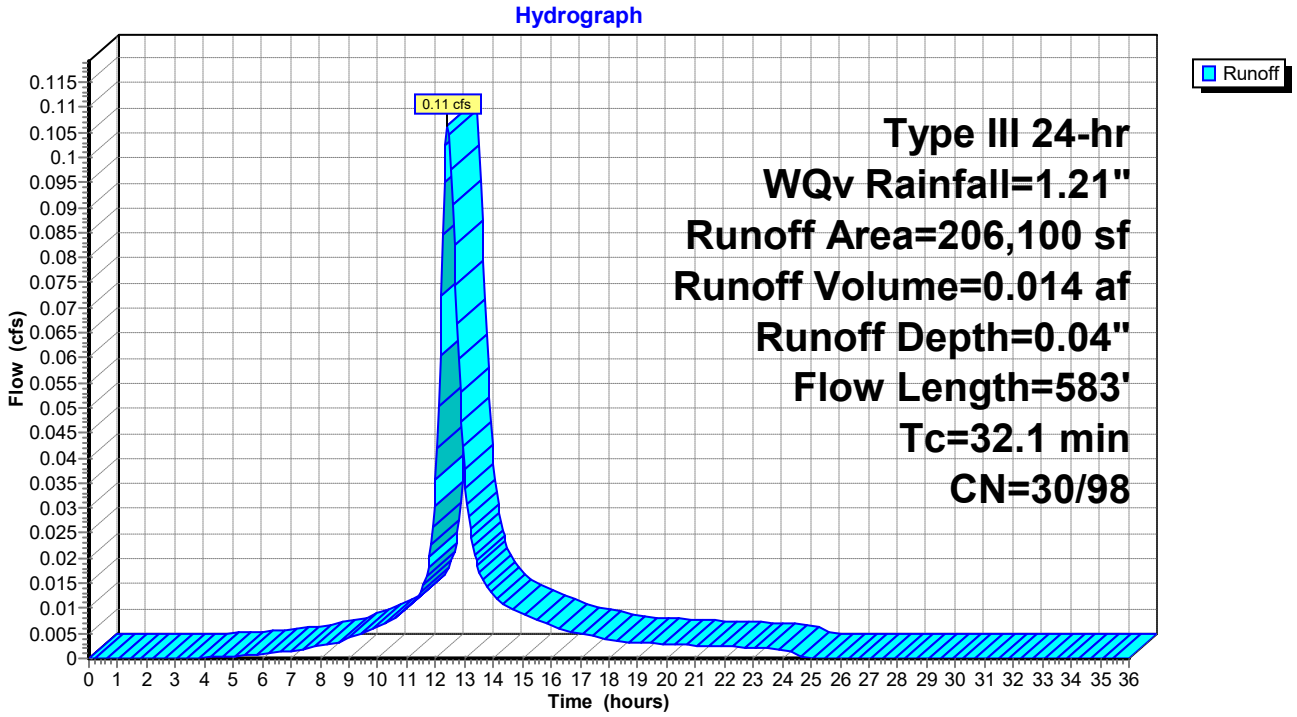
Runoff = 0.11 cfs @ 12.43 hrs, Volume= 0.014 af, Depth= 0.04"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.21"

Area (sf)	CN	Description
7,590	98	Roofs, HSG A
188,790	30	Woods, Good, HSG A
9,720	39	>75% Grass cover, Good, HSG A
206,100	33	Weighted Average
198,510	30	96.32% Pervious Area
7,590	98	3.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.8	100	0.0100	0.06		**Sheet Flow, A TO B** Woods: Light underbrush n= 0.400 P2= 3.59"
4.2	179	0.0200	0.71		**Shallow Concentrated Flow, B TO C** Woodland Kv= 5.0 fps
0.8	244	0.0600	4.97		**Shallow Concentrated Flow, C TO D** Paved Kv= 20.3 fps
0.3	60	0.0400	3.00		**Shallow Concentrated Flow, D TO E** Grassed Waterway Kv= 15.0 fps
32.1	583	Total			

Subcatchment DA1: DA1



Summary for Subcatchment DA1-P: DA1-PAVEMENT

[49] Hint: Tc<2dt may require smaller dt

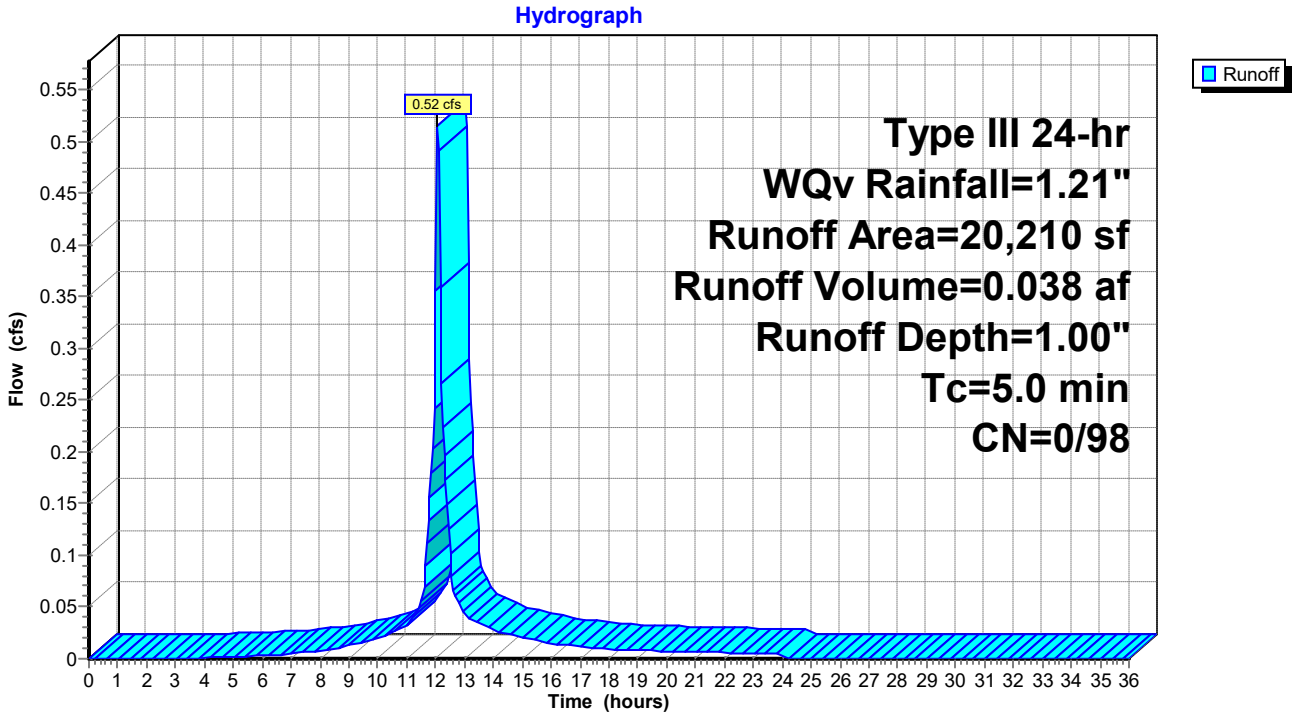
Runoff = 0.52 cfs @ 12.07 hrs, Volume= 0.038 af, Depth= 1.00"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.21"

Area (sf)	CN	Description
20,210	98	Paved parking, HSG A
20,210	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1-P: DA1-PAVEMENT



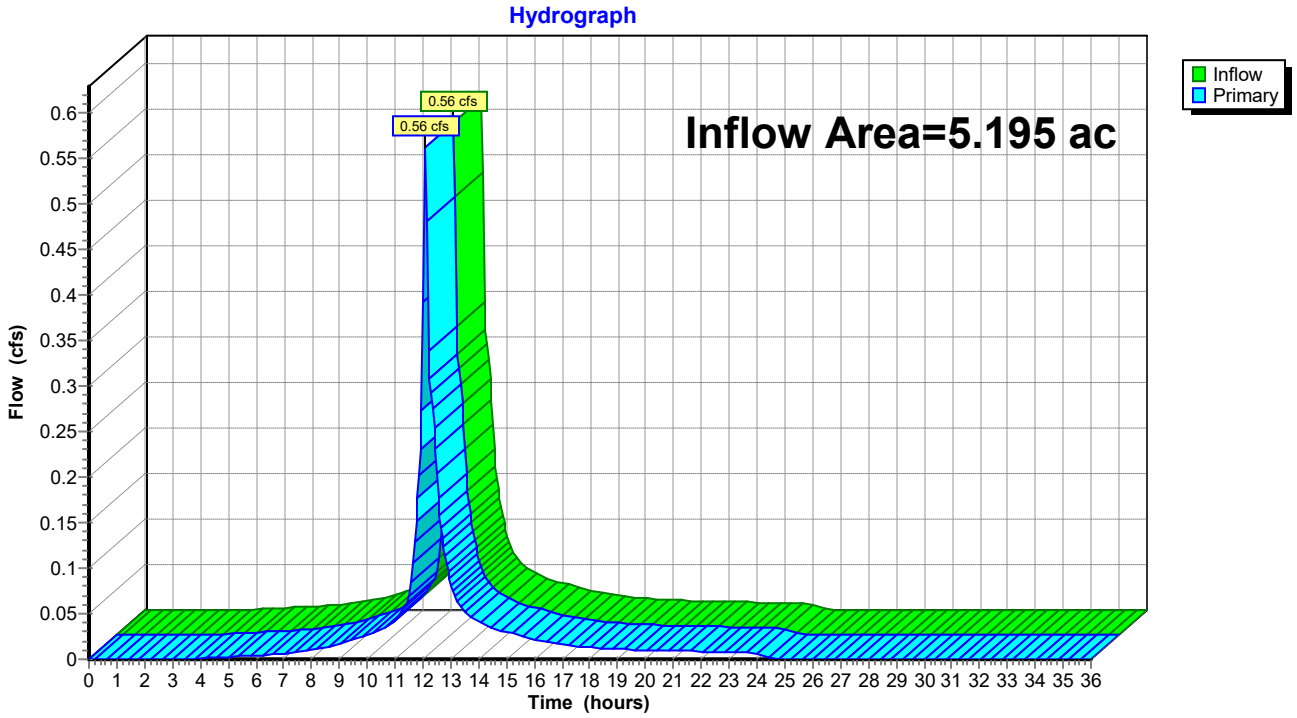
Summary for Pond 1P: SP1- SCARGO LAKE

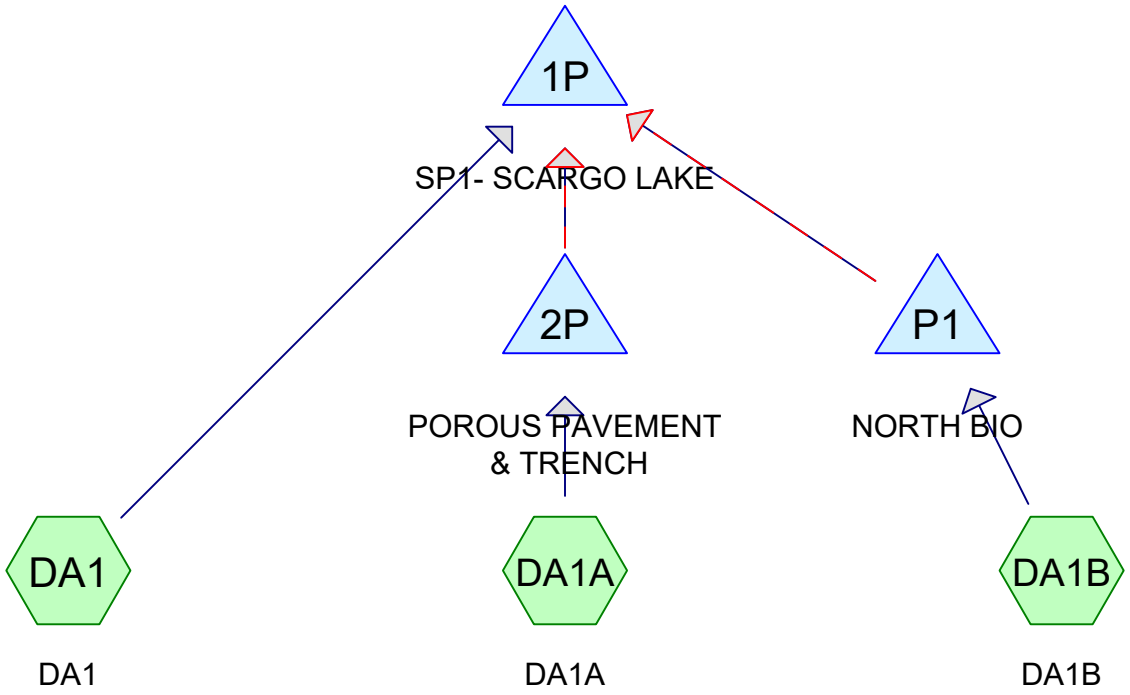
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.195 ac, 12.28% Impervious, Inflow Depth = 0.12" for WQv event
Inflow = 0.56 cfs @ 12.07 hrs, Volume= 0.053 af
Primary = 0.56 cfs @ 12.07 hrs, Volume= 0.053 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Pond 1P: SP1- SCARGO LAKE





Subcat Reach Pond Link

Routing Diagram for 22032 DrLords PR
Prepared by Horsley Witten Inc, Printed 12/21/2023

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2yr	Type III 24-hr		Default	24.00	1	3.59	2
2	10yr	Type III 24-hr		Default	24.00	1	5.27	2
3	25yr	Type III 24-hr		Default	24.00	1	6.53	2
4	100yr	Type III 24-hr		Default	24.00	1	8.57	2
5	WQv	Type III 24-hr		Default	24.00	1	1.21	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.271	39	>75% Grass cover, Good, HSG A (DA1, DA1B)
0.283	98	Paved parking, HSG A (DA1, DA1A, DA1B)
0.013	65	Permeable pavement, (RI SW manual, 9" subbase in HSG B) (DA1)
0.191	98	Permeable pavement, HSG A (DA1A)
0.006	98	Permeable pavement, HSG A (for WQV) (DA1B)
0.112	98	Roofs, HSG A (DA1)
0.015	98	Water Surface, HSG A (DA1A, DA1B)
4.303	30	Woods, Good, HSG A (DA1, DA1B)
5.195	**39**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
5.182	HSG A	DA1, DA1A, DA1B
0.013	HSG B	DA1
0.000	HSG C	
0.000	HSG D	
0.000	Other	
5.195		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover
0.271	0.000	0.000	0.000	0.000	0.271	>75% Grass cover, Good
0.283	0.000	0.000	0.000	0.000	0.283	Paved parking
0.196	0.000	0.000	0.000	0.000	0.196	Permeable pavement
0.000	0.013	0.000	0.000	0.000	0.013	Permeable pavement, (RI SW manual, 9" subbase in
0.112	0.000	0.000	0.000	0.000	0.112	Roofs
0.015	0.000	0.000	0.000	0.000	0.015	Water Surface
4.303	0.000	0.000	0.000	0.000	4.303	Woods, Good
5.182	**0.013**	**0.000**	**0.000**	**0.000**	**5.195**	**TOTAL AREA**

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	2P	10.10	10.00	10.0	0.0100	0.012	0.0	8.0	0.0
2	P1	11.00	10.95	10.0	0.0050	0.013	0.0	6.0	0.0

Time span=0.00-36.00 hrs, dt=0.03 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=92,580 sf 8.48% Impervious Runoff Depth=0.28"
Flow Length=385' Tc=30.4 min CN=31/98 Runoff=0.36 cfs 0.050 af

Subcatchment DA1A: DA1A Runoff Area=9,060 sf 100.00% Impervious Runoff Depth=3.36"
Tc=5.0 min CN=0/98 Runoff=0.75 cfs 0.058 af

Subcatchment DA1B: DA1B Runoff Area=124,670 sf 7.65% Impervious Runoff Depth=0.26"
Tc=5.0 min CN=31/98 Runoff=0.79 cfs 0.061 af

Pond 1P: SP1- SCARGO LAKE Inflow=1.37 cfs 0.160 af
Primary=1.37 cfs 0.160 af

Pond 2P: POROUS PAVEMENT & TRENCH Peak Elev=11.41' Storage=3,600 cf Inflow=0.75 cfs 0.058 af
Primary=0.45 cfs 0.052 af Secondary=0.00 cfs 0.000 af Outflow=0.45 cfs 0.052 af

Pond P1: NORTH BIO Peak Elev=12.36' Storage=686 cf Inflow=0.79 cfs 0.061 af
Primary=0.04 cfs 0.035 af Secondary=0.73 cfs 0.023 af Outflow=0.76 cfs 0.058 af

Total Runoff Area = 5.195 ac Runoff Volume = 0.170 af Average Runoff Depth = 0.39"
88.31% Pervious = 4.588 ac 11.69% Impervious = 0.607 ac

Summary for Subcatchment DA1: DA1

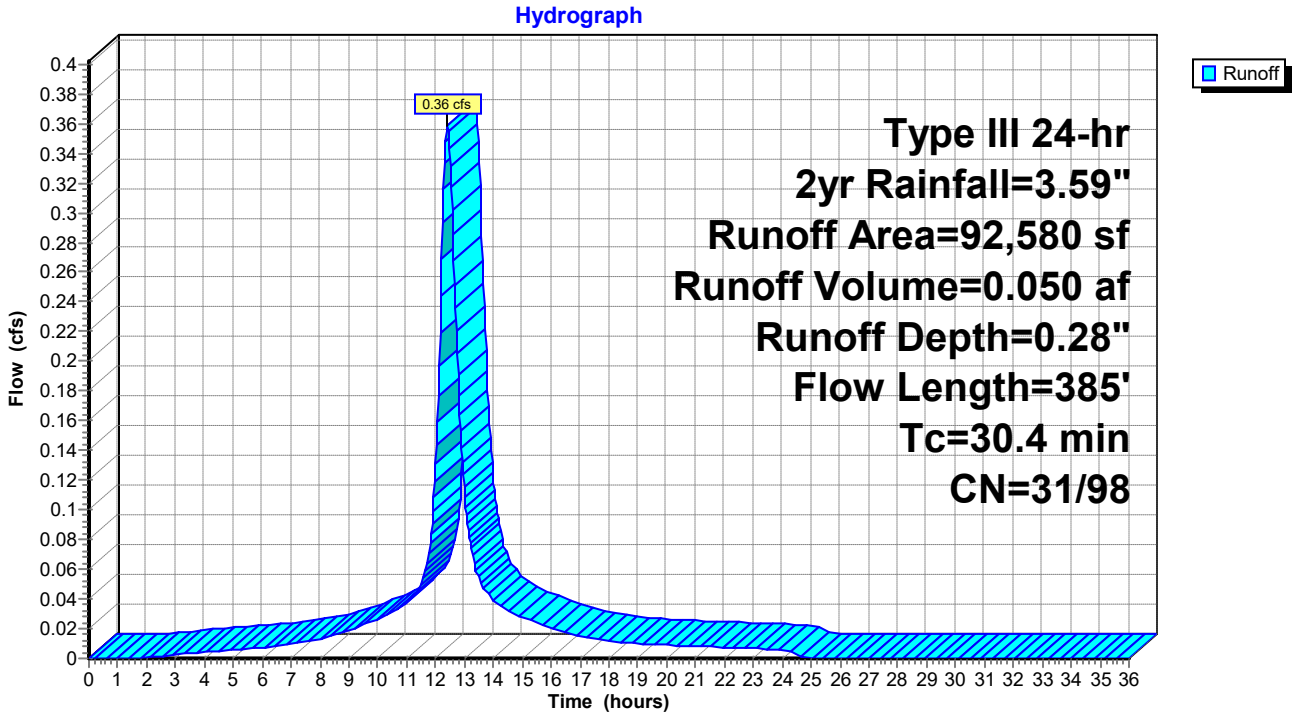
Runoff = 0.36 cfs @ 12.40 hrs, Volume= 0.050 af, Depth= 0.28"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2yr Rainfall=3.59"

	Area (sf)	CN	Description
	2,960	98	Paved parking, HSG A
*	580	65	Permeable pavement, (RI SW manual, 9" subbase in HSG B)
	4,890	98	Roofs, HSG A
	81,620	30	Woods, Good, HSG A
	2,530	39	>75% Grass cover, Good, HSG A
	92,580	36	Weighted Average
	84,730	31	91.52% Pervious Area
	7,850	98	8.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.8	100	0.0100	0.06		**Sheet Flow, A TO B** Woods: Light underbrush n= 0.400 P2= 3.59"
3.5	260	0.0600	1.22		**Shallow Concentrated Flow, B TO C** Woodland Kv= 5.0 fps
0.1	25	0.0600	4.97		**Shallow Concentrated Flow, C TO D** Kv= 20.3 fps
30.4	385	Total			

Subcatchment DA1: DA1



Summary for Subcatchment DA1A: DA1A

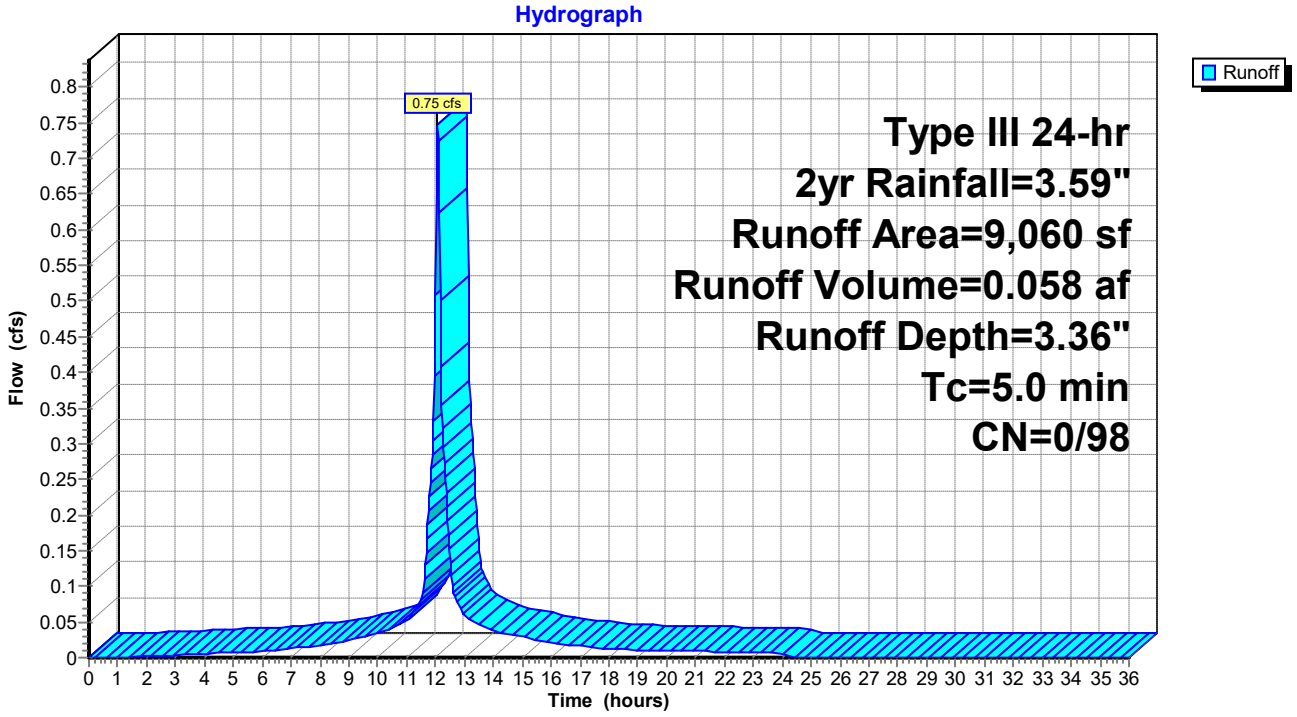
Runoff = 0.75 cfs @ 12.07 hrs, Volume= 0.058 af, Depth= 3.36"
Routed to Pond 2P : POROUS PAVEMENT & TRENCH

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2yr Rainfall=3.59"

	Area (sf)	CN	Description
	380	98	Paved parking, HSG A
*	8,310	98	Permeable pavement, HSG A
	0	98	Roofs, HSG A
	370	98	Water Surface, HSG A
	0	30	Woods, Good, HSG A
	0	39	>75% Grass cover, Good, HSG A
	9,060	98	Weighted Average
	9,060	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1A: DA1A



Summary for Subcatchment DA1B: DA1B

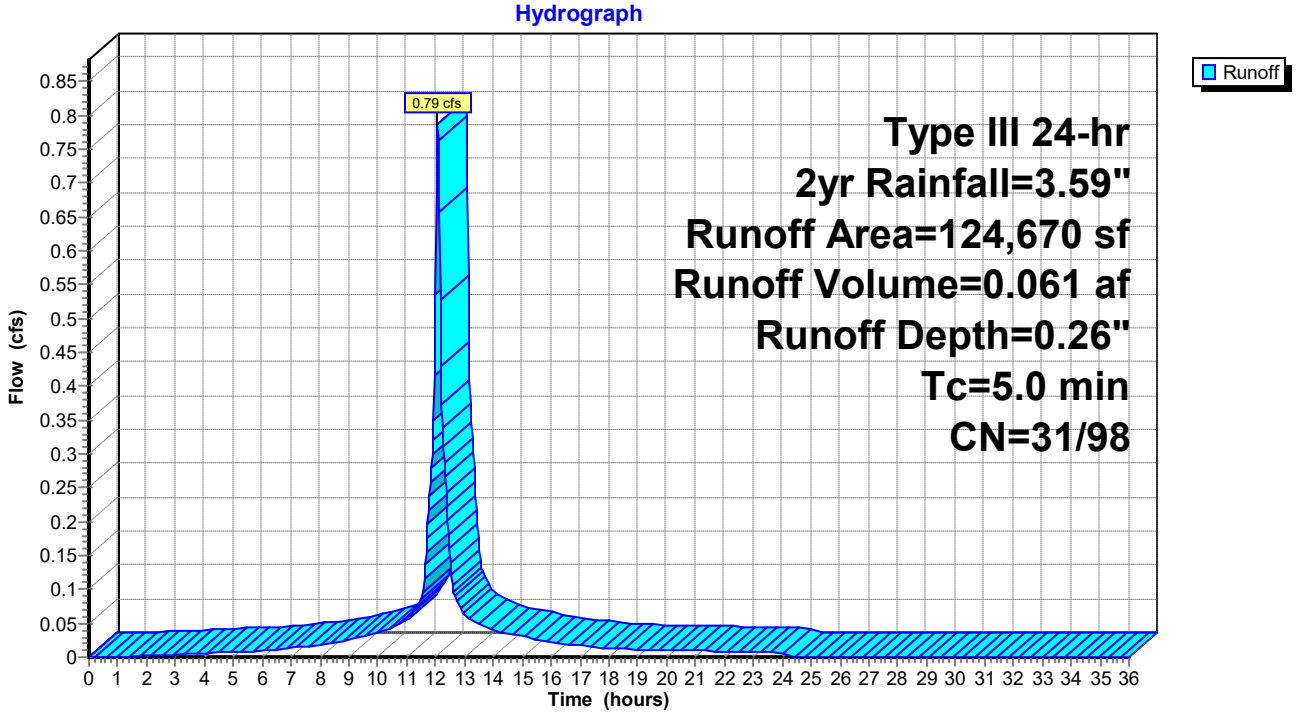
Runoff = 0.79 cfs @ 12.07 hrs, Volume= 0.061 af, Depth= 0.26"
Routed to Pond P1 : NORTH BIO

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2yr Rainfall=3.59"

Area (sf)	CN	Description
6,300	98	Paved parking, HSG A
240	98	Permeable pavement, HSG A (for WQV)
2,700	98	Paved parking, HSG A
300	98	Water Surface, HSG A
105,840	30	Woods, Good, HSG A
9,290	39	>75% Grass cover, Good, HSG A
124,670	36	Weighted Average
115,130	31	92.35% Pervious Area
9,540	98	7.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1B: DA1B



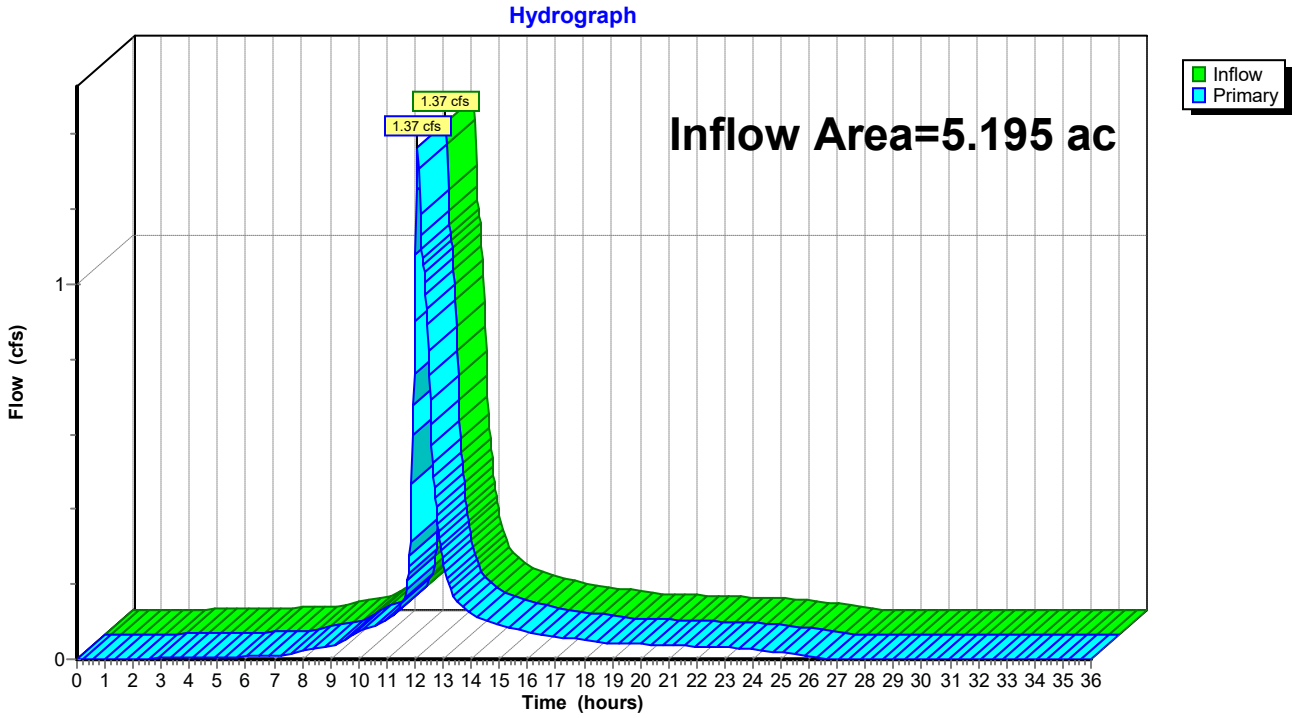
Summary for Pond 1P: SP1- SCARGO LAKE

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.195 ac, 11.69% Impervious, Inflow Depth = 0.37" for 2yr event
Inflow = 1.37 cfs @ 12.10 hrs, Volume= 0.160 af
Primary = 1.37 cfs @ 12.10 hrs, Volume= 0.160 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Pond 1P: SP1- SCARGO LAKE



Summary for Pond 2P: POROUS PAVEMENT & TRENCH

Inflow Area = 0.208 ac,100.00% Impervious, Inflow Depth = 3.36" for 2yr event
Inflow = 0.75 cfs @ 12.07 hrs, Volume= 0.058 af
Outflow = 0.45 cfs @ 12.17 hrs, Volume= 0.052 af, Atten= 40%, Lag= 5.9 min
Primary = 0.45 cfs @ 12.17 hrs, Volume= 0.052 af
Routed to Pond 1P : SP1- SCARGO LAKE
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond 1P : SP1- SCARGO LAKE

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Starting Elev= 11.20' Surf.Area= 8,310 sf Storage= 3,017 cf
Peak Elev= 11.41' @ 12.17 hrs Surf.Area= 8,310 sf Storage= 3,600 cf (584 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 55.7 min (808.8 - 753.1)

Volume	Invert	Avail.Storage	Storage Description
#1	10.10'	9,824 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

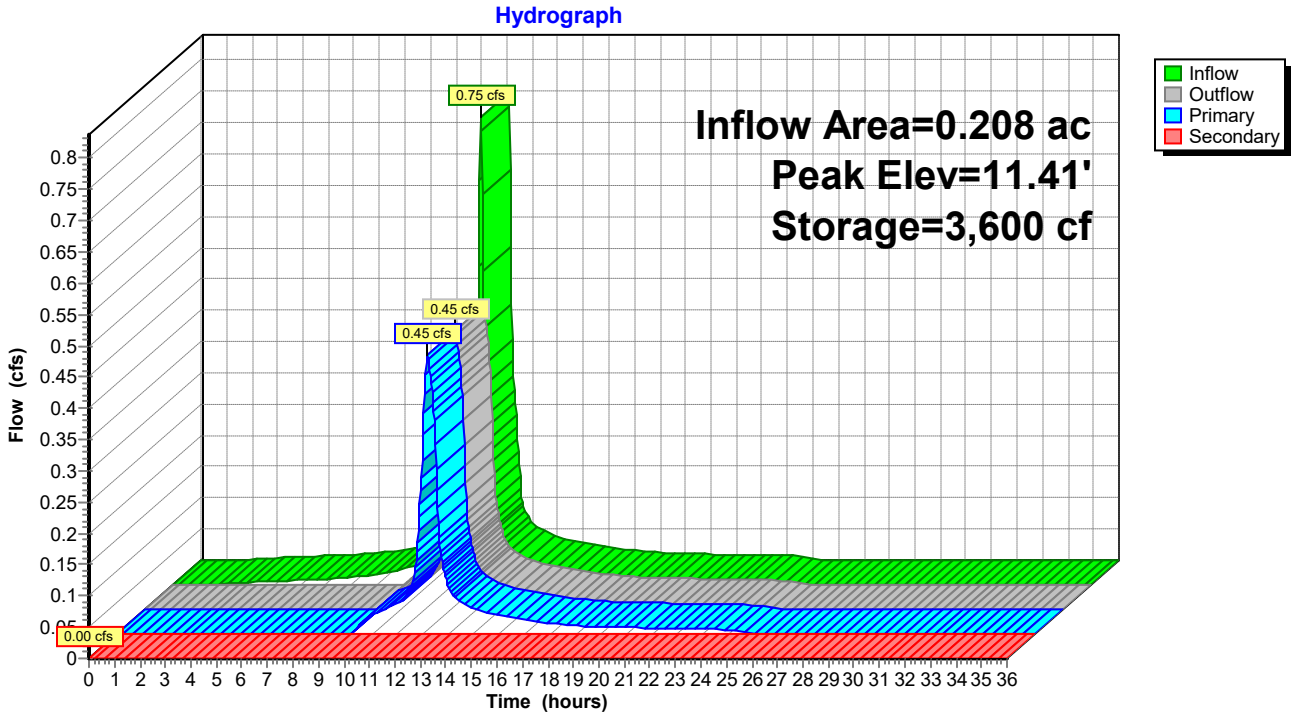
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.10	8,310	0.0	0	0
10.20	8,310	33.0	274	274
12.65	8,310	33.0	6,719	6,993
12.70	8,310	100.0	415	7,408
12.80	10,000	100.0	916	8,324
12.85	50,000	100.0	1,500	9,824

Device	Routing	Invert	Outlet Devices
#1	Primary	11.30'	**24.0" Horiz. Bubbler** C= 0.600 Limited to weir flow at low heads
#2	Device 1	10.10'	**8.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.10' / 10.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Secondary	12.80'	**150.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.45 cfs @ 12.17 hrs HW=11.41' (Free Discharge)
└**1=Bubbler** (Passes 0.45 cfs of 0.78 cfs potential flow)
└**2=Culvert** (Inlet Controls 0.45 cfs @ 1.28 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.20' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: POROUS PAVEMENT & TRENCH



Summary for Pond P1: NORTH BIO

Inflow Area = 2.862 ac, 7.65% Impervious, Inflow Depth = 0.26" for 2yr event
Inflow = 0.79 cfs @ 12.07 hrs, Volume= 0.061 af
Outflow = 0.76 cfs @ 12.09 hrs, Volume= 0.058 af, Atten= 3%, Lag= 1.2 min
Primary = 0.04 cfs @ 12.09 hrs, Volume= 0.035 af
Routed to Pond 1P : SP1- SCARGO LAKE
Secondary = 0.73 cfs @ 12.09 hrs, Volume= 0.023 af
Routed to Pond 1P : SP1- SCARGO LAKE

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 12.36' @ 12.09 hrs Surf.Area= 690 sf Storage= 686 cf

Plug-Flow detention time= 172.8 min calculated for 0.058 af (94% of inflow)
Center-of-Mass det. time= 139.6 min (892.7 - 753.1)

Volume	Invert	Avail.Storage	Storage Description
#1	10.40'	972 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

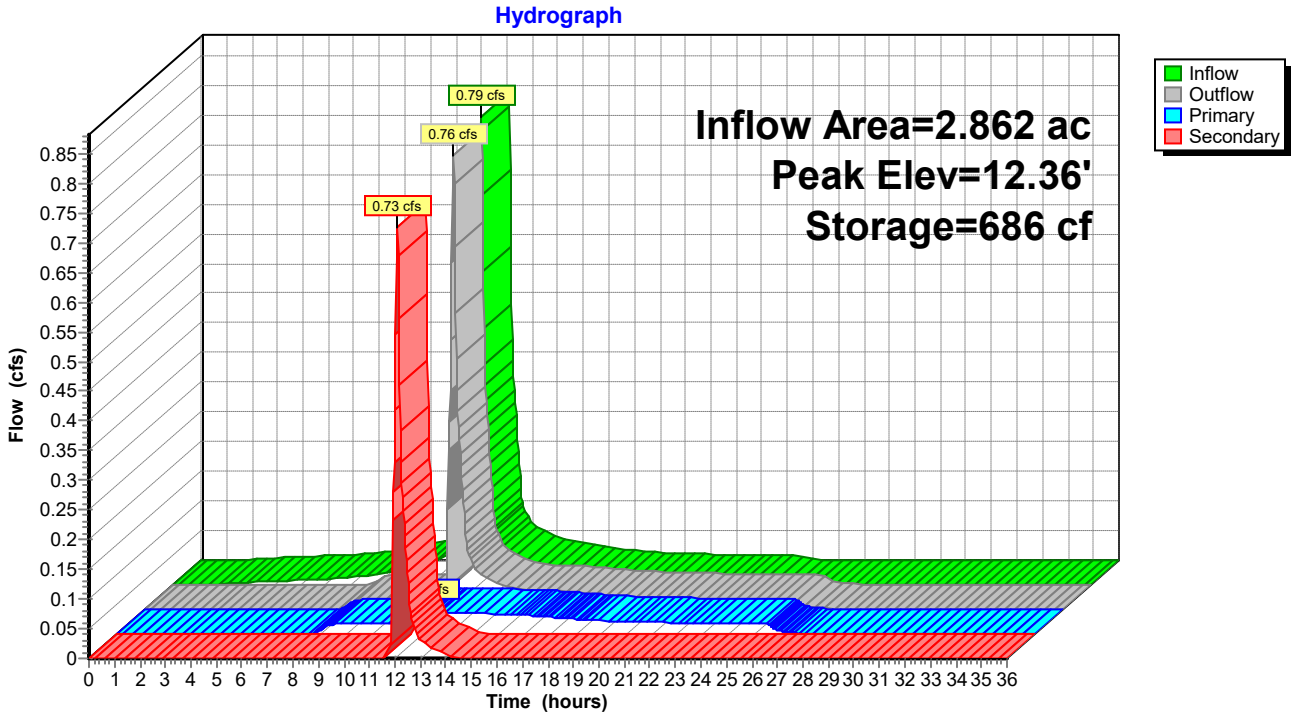
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.40	300	0.0	0	0
10.50	300	33.0	10	10
11.50	300	100.0	300	310
12.00	415	100.0	179	489
12.50	800	100.0	304	792
12.70	1,000	100.0	180	972

Device	Routing	Invert	Outlet Devices
#1	Secondary	12.25'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	11.00'	**6.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 11.00' / 10.95' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#3	Device 2	10.40'	**2.410 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.04 cfs @ 12.09 hrs HW=12.36' (Free Discharge)
2=Culvert (Passes 0.04 cfs of 0.79 cfs potential flow)
3=Exfiltration (Exfiltration Controls 0.04 cfs)

Secondary OutFlow Max=0.72 cfs @ 12.09 hrs HW=12.36' (Free Discharge)
1=Orifice/Grate (Weir Controls 0.72 cfs @ 1.07 fps)

Pond P1: NORTH BIO



Time span=0.00-36.00 hrs, dt=0.03 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=92,580 sf 8.48% Impervious Runoff Depth=0.45"
Flow Length=385' Tc=30.4 min CN=31/98 Runoff=0.53 cfs 0.080 af

Subcatchment DA1A: DA1A Runoff Area=9,060 sf 100.00% Impervious Runoff Depth=5.03"
Tc=5.0 min CN=0/98 Runoff=1.10 cfs 0.087 af

Subcatchment DA1B: DA1B Runoff Area=124,670 sf 7.65% Impervious Runoff Depth=0.41"
Tc=5.0 min CN=31/98 Runoff=1.16 cfs 0.098 af

Pond 1P: SP1- SCARGO LAKE Inflow=1.92 cfs 0.256 af
Primary=1.92 cfs 0.256 af

Pond 2P: POROUS PAVEMENT & TRENCH Peak Elev=11.49' Storage=3,800 cf Inflow=1.10 cfs 0.087 af
Primary=0.57 cfs 0.081 af Secondary=0.00 cfs 0.000 af Outflow=0.57 cfs 0.081 af

Pond P1: NORTH BIO Peak Elev=12.39' Storage=710 cf Inflow=1.16 cfs 0.098 af
Primary=0.04 cfs 0.049 af Secondary=1.09 cfs 0.046 af Outflow=1.13 cfs 0.095 af

Total Runoff Area = 5.195 ac Runoff Volume = 0.266 af Average Runoff Depth = 0.61"
88.31% Pervious = 4.588 ac 11.69% Impervious = 0.607 ac

Summary for Subcatchment DA1: DA1

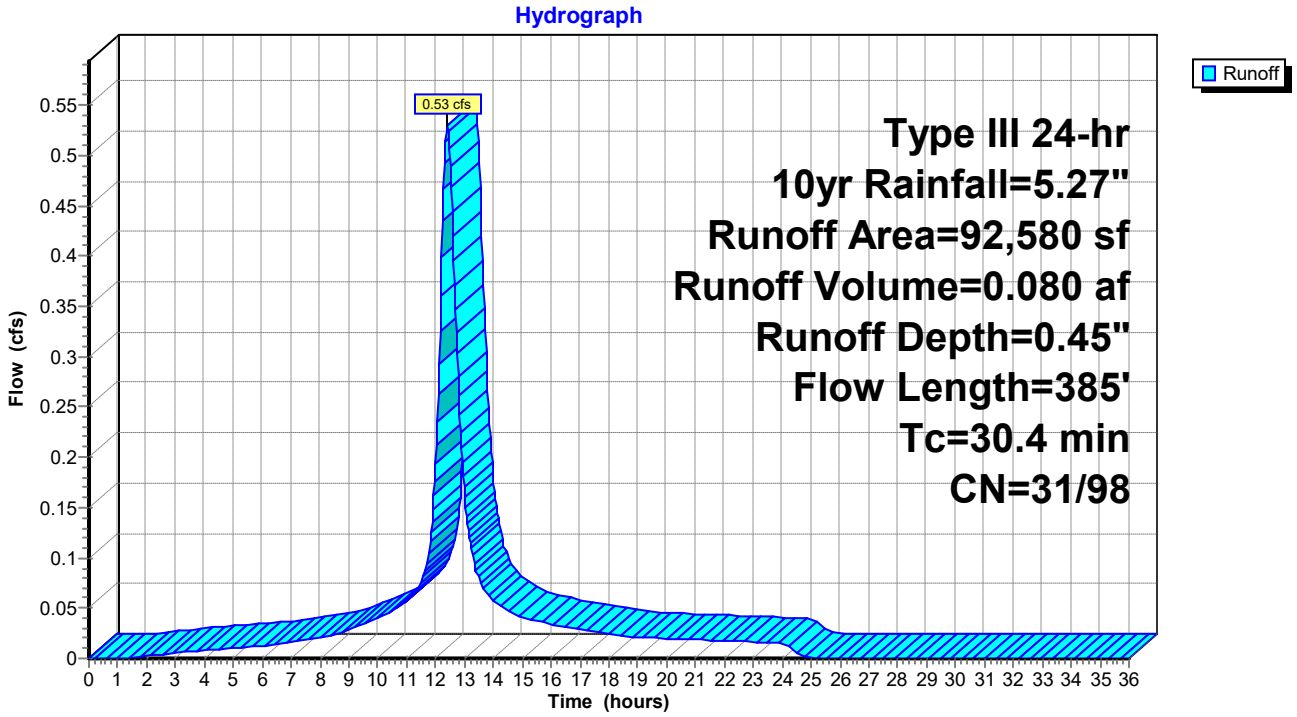
Runoff = 0.53 cfs @ 12.40 hrs, Volume= 0.080 af, Depth= 0.45"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10yr Rainfall=5.27"

	Area (sf)	CN	Description
	2,960	98	Paved parking, HSG A
*	580	65	Permeable pavement, (RI SW manual, 9" subbase in HSG B)
	4,890	98	Roofs, HSG A
	81,620	30	Woods, Good, HSG A
	2,530	39	>75% Grass cover, Good, HSG A
	92,580	36	Weighted Average
	84,730	31	91.52% Pervious Area
	7,850	98	8.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.8	100	0.0100	0.06		**Sheet Flow, A TO B** Woods: Light underbrush n= 0.400 P2= 3.59"
3.5	260	0.0600	1.22		**Shallow Concentrated Flow, B TO C** Woodland Kv= 5.0 fps
0.1	25	0.0600	4.97		**Shallow Concentrated Flow, C TO D** Kv= 20.3 fps
30.4	385	Total			

Subcatchment DA1: DA1



Summary for Subcatchment DA1A: DA1A

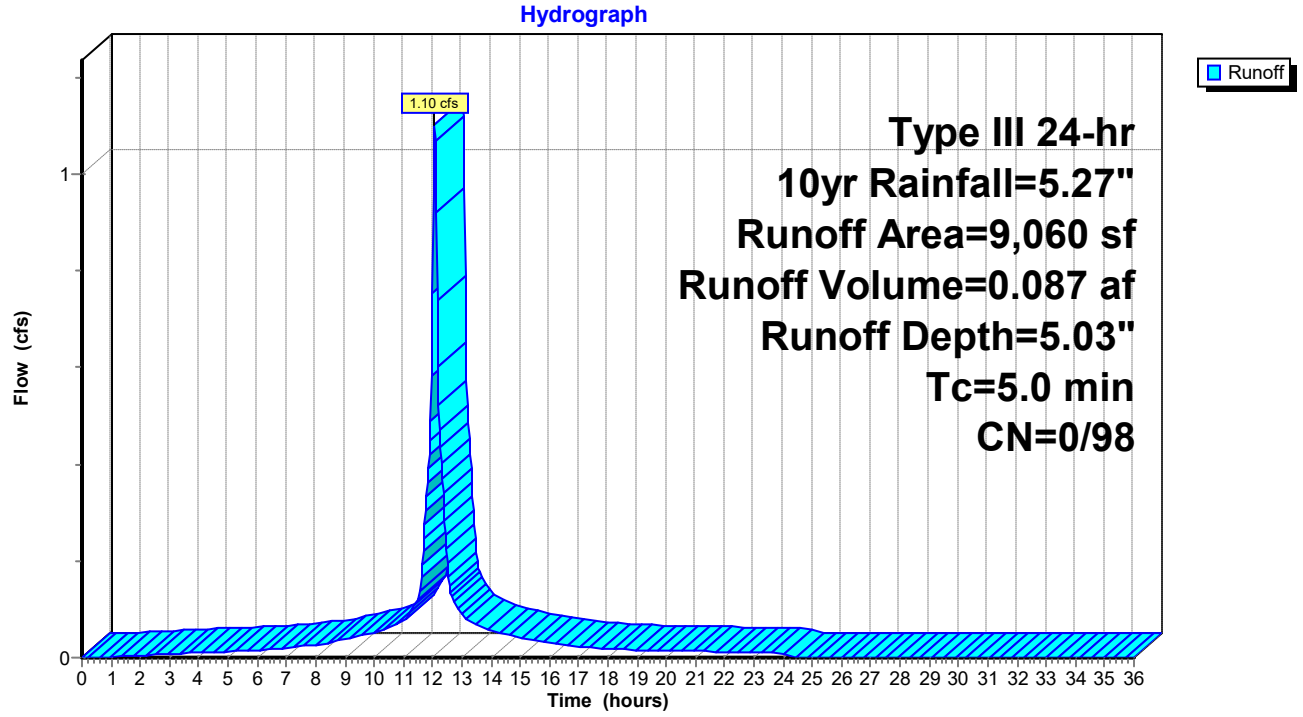
Runoff = 1.10 cfs @ 12.07 hrs, Volume= 0.087 af, Depth= 5.03"
Routed to Pond 2P : POROUS PAVEMENT & TRENCH

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10yr Rainfall=5.27"

	Area (sf)	CN	Description
	380	98	Paved parking, HSG A
*	8,310	98	Permeable pavement, HSG A
	0	98	Roofs, HSG A
	370	98	Water Surface, HSG A
	0	30	Woods, Good, HSG A
	0	39	>75% Grass cover, Good, HSG A
	9,060	98	Weighted Average
	9,060	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1A: DA1A



Summary for Subcatchment DA1B: DA1B

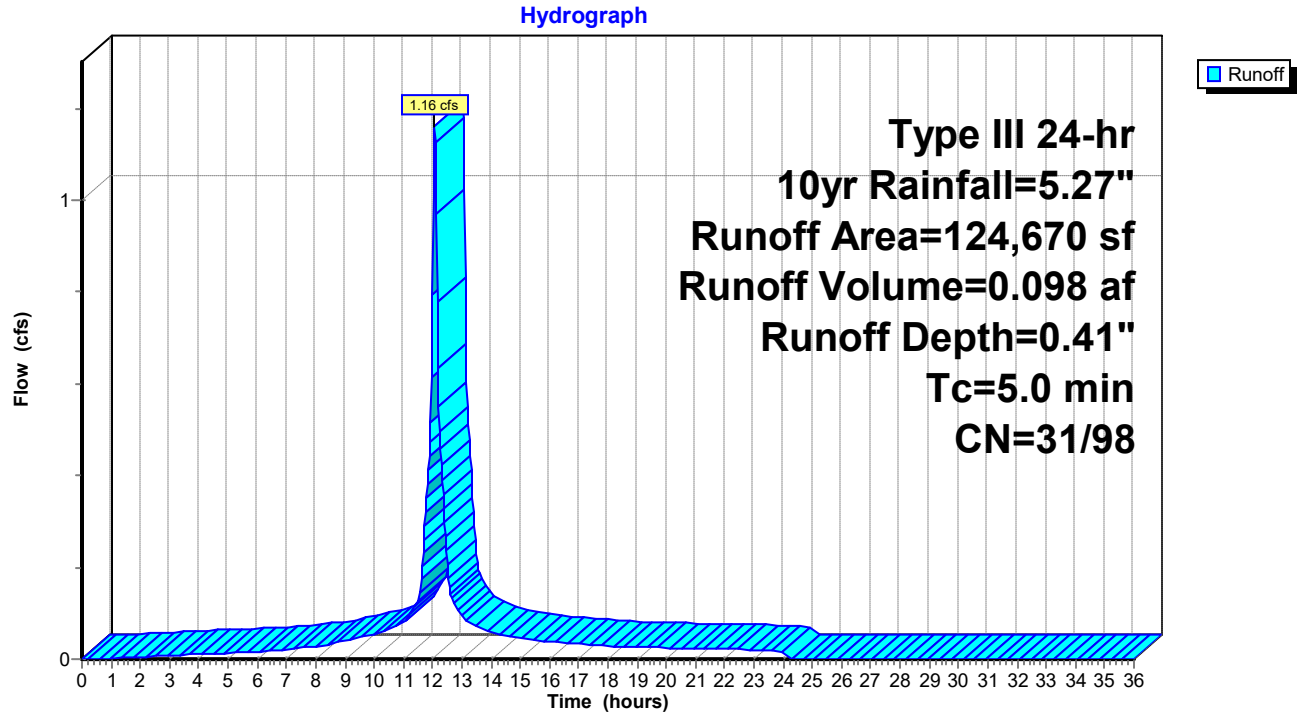
Runoff = 1.16 cfs @ 12.07 hrs, Volume= 0.098 af, Depth= 0.41"
Routed to Pond P1 : NORTH BIO

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10yr Rainfall=5.27"

Area (sf)	CN	Description
6,300	98	Paved parking, HSG A
240	98	Permeable pavement, HSG A (for WQV)
2,700	98	Paved parking, HSG A
300	98	Water Surface, HSG A
105,840	30	Woods, Good, HSG A
9,290	39	>75% Grass cover, Good, HSG A
124,670	36	Weighted Average
115,130	31	92.35% Pervious Area
9,540	98	7.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1B: DA1B



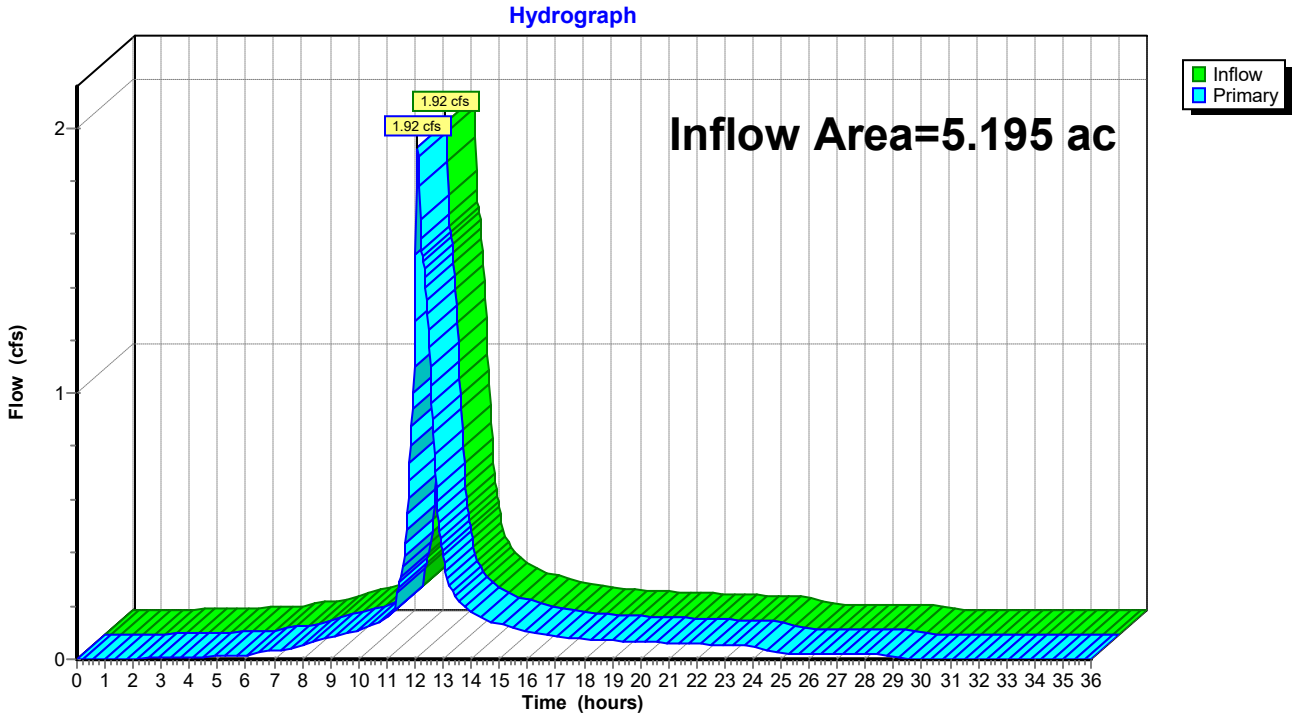
Summary for Pond 1P: SP1- SCARGO LAKE

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.195 ac, 11.69% Impervious, Inflow Depth = 0.59" for 10yr event
Inflow = 1.92 cfs @ 12.10 hrs, Volume= 0.256 af
Primary = 1.92 cfs @ 12.10 hrs, Volume= 0.256 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Pond 1P: SP1- SCARGO LAKE



Summary for Pond 2P: POROUS PAVEMENT & TRENCH

Inflow Area = 0.208 ac,100.00% Impervious, Inflow Depth = 5.03" for 10yr event
Inflow = 1.10 cfs @ 12.07 hrs, Volume= 0.087 af
Outflow = 0.57 cfs @ 12.19 hrs, Volume= 0.081 af, Atten= 48%, Lag= 7.3 min
Primary = 0.57 cfs @ 12.19 hrs, Volume= 0.081 af
Routed to Pond 1P : SP1- SCARGO LAKE
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond 1P : SP1- SCARGO LAKE

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Starting Elev= 11.20' Surf.Area= 8,310 sf Storage= 3,017 cf
Peak Elev= 11.49' @ 12.19 hrs Surf.Area= 8,310 sf Storage= 3,800 cf (784 cf above start)

Plug-Flow detention time= 745.9 min calculated for 0.012 af (13% of inflow)
Center-of-Mass det. time= 47.3 min (793.6 - 746.2)

Volume	Invert	Avail.Storage	Storage Description
#1	10.10'	9,824 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

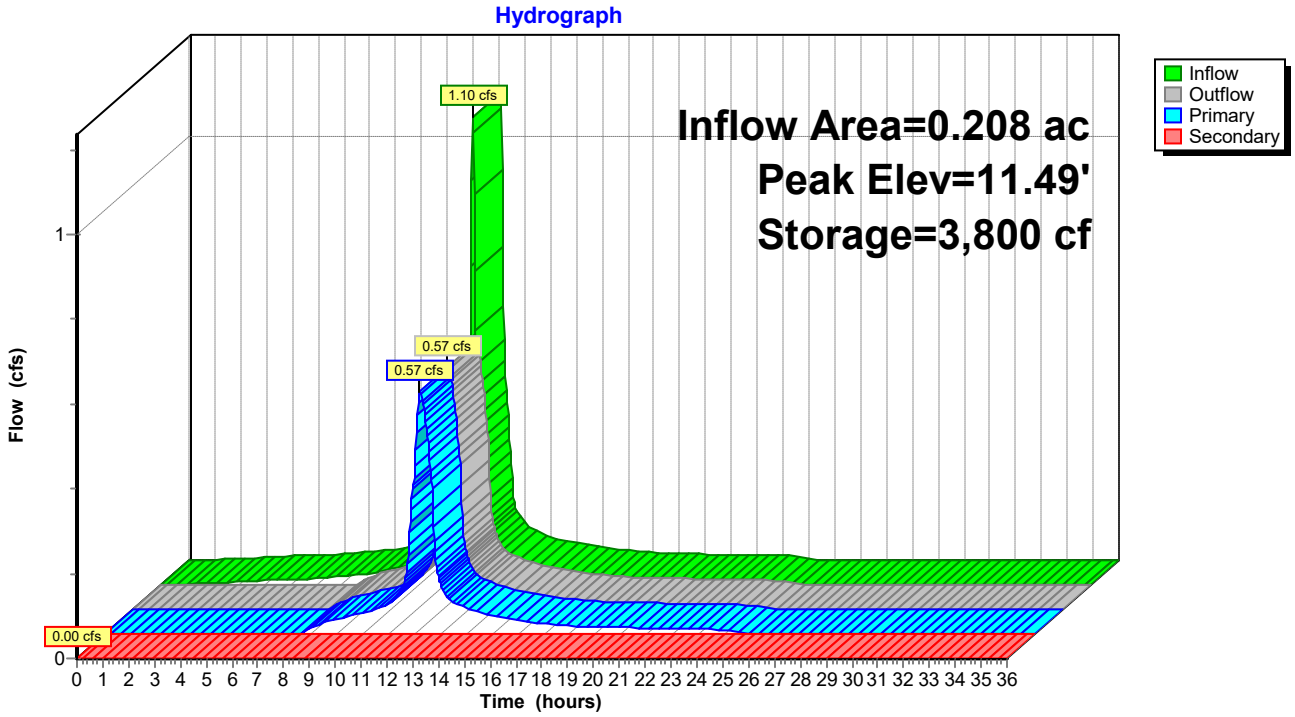
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.10	8,310	0.0	0	0
10.20	8,310	33.0	274	274
12.65	8,310	33.0	6,719	6,993
12.70	8,310	100.0	415	7,408
12.80	10,000	100.0	916	8,324
12.85	50,000	100.0	1,500	9,824

Device	Routing	Invert	Outlet Devices
#1	Primary	11.30'	**24.0" Horiz. Bubbler** C= 0.600 Limited to weir flow at low heads
#2	Device 1	10.10'	**8.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.10' / 10.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Secondary	12.80'	**150.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.57 cfs @ 12.19 hrs HW=11.49' (Free Discharge)
└**1=Bubbler** (Passes 0.57 cfs of 1.64 cfs potential flow)
└**2=Culvert** (Inlet Controls 0.57 cfs @ 1.64 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.20' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: POROUS PAVEMENT & TRENCH



Summary for Pond P1: NORTH BIO

Inflow Area = 2.862 ac, 7.65% Impervious, Inflow Depth = 0.41" for 10yr event
Inflow = 1.16 cfs @ 12.07 hrs, Volume= 0.098 af
Outflow = 1.13 cfs @ 12.09 hrs, Volume= 0.095 af, Atten= 2%, Lag= 1.1 min
Primary = 0.04 cfs @ 12.09 hrs, Volume= 0.049 af
Routed to Pond 1P : SP1- SCARGO LAKE
Secondary = 1.09 cfs @ 12.09 hrs, Volume= 0.046 af
Routed to Pond 1P : SP1- SCARGO LAKE

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 12.39' @ 12.09 hrs Surf.Area= 716 sf Storage= 710 cf

Plug-Flow detention time= 145.8 min calculated for 0.094 af (96% of inflow)
Center-of-Mass det. time= 122.9 min (897.8 - 774.9)

Volume	Invert	Avail.Storage	Storage Description
#1	10.40'	972 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

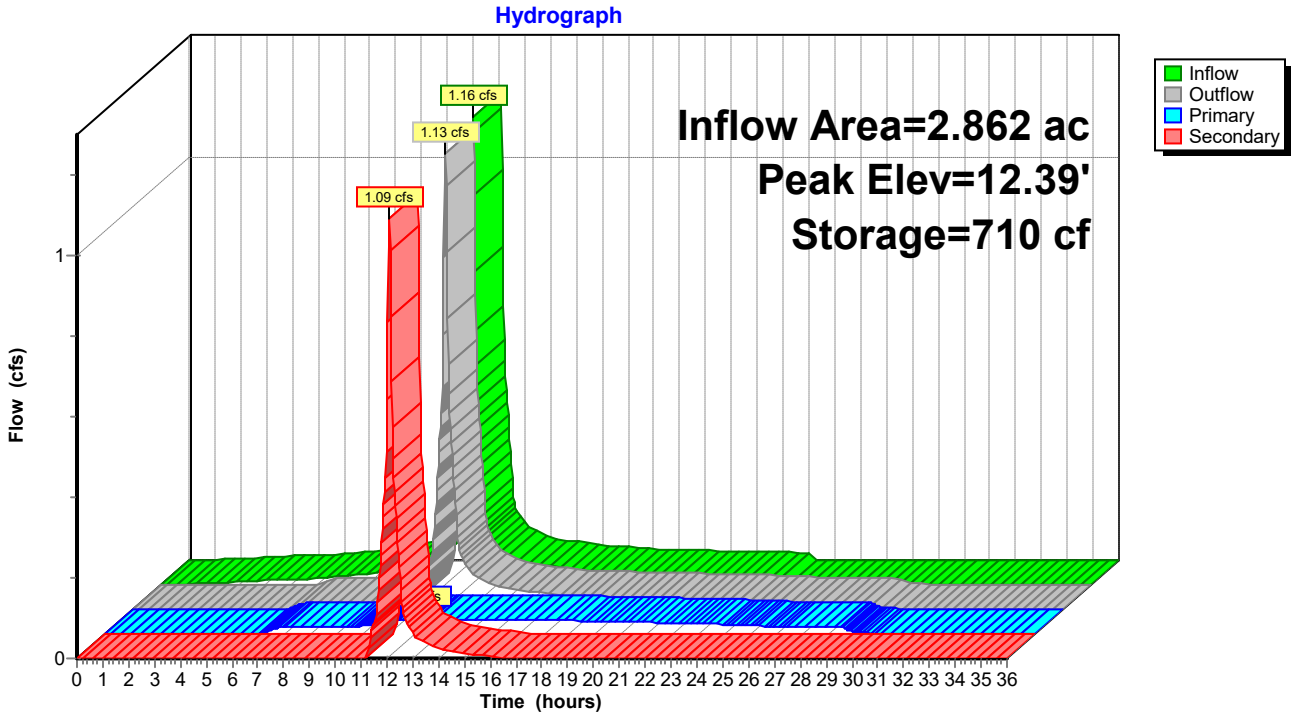
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.40	300	0.0	0	0
10.50	300	33.0	10	10
11.50	300	100.0	300	310
12.00	415	100.0	179	489
12.50	800	100.0	304	792
12.70	1,000	100.0	180	972

Device	Routing	Invert	Outlet Devices
#1	Secondary	12.25'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	11.00'	**6.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 11.00' / 10.95' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#3	Device 2	10.40'	**2.410 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.04 cfs @ 12.09 hrs HW=12.39' (Free Discharge)
↑—**2=Culvert** (Passes 0.04 cfs of 0.80 cfs potential flow)
↑—**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Secondary OutFlow Max=1.09 cfs @ 12.09 hrs HW=12.39' (Free Discharge)
↑—**1=Orifice/Grate** (Weir Controls 1.09 cfs @ 1.23 fps)

Pond P1: NORTH BIO



Time span=0.00-36.00 hrs, dt=0.03 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=92,580 sf 8.48% Impervious Runoff Depth=0.70"
Flow Length=385' Tc=30.4 min CN=31/98 Runoff=0.66 cfs 0.123 af

Subcatchment DA1A: DA1A Runoff Area=9,060 sf 100.00% Impervious Runoff Depth=6.29"
Tc=5.0 min CN=0/98 Runoff=1.37 cfs 0.109 af

Subcatchment DA1B: DA1B Runoff Area=124,670 sf 7.65% Impervious Runoff Depth=0.65"
Tc=5.0 min CN=31/98 Runoff=1.44 cfs 0.154 af

Pond 1P: SP1- SCARGO LAKE Inflow=2.34 cfs 0.376 af
Primary=2.34 cfs 0.376 af

Pond 2P: POROUS PAVEMENT & TRENCH Peak Elev=11.55' Storage=3,970 cf Inflow=1.37 cfs 0.109 af
Primary=0.66 cfs 0.103 af Secondary=0.00 cfs 0.000 af Outflow=0.66 cfs 0.103 af

Pond P1: NORTH BIO Peak Elev=12.41' Storage=727 cf Inflow=1.44 cfs 0.154 af
Primary=0.04 cfs 0.057 af Secondary=1.37 cfs 0.093 af Outflow=1.41 cfs 0.150 af

Total Runoff Area = 5.195 ac Runoff Volume = 0.386 af Average Runoff Depth = 0.89"
88.31% Pervious = 4.588 ac 11.69% Impervious = 0.607 ac

Summary for Subcatchment DA1: DA1

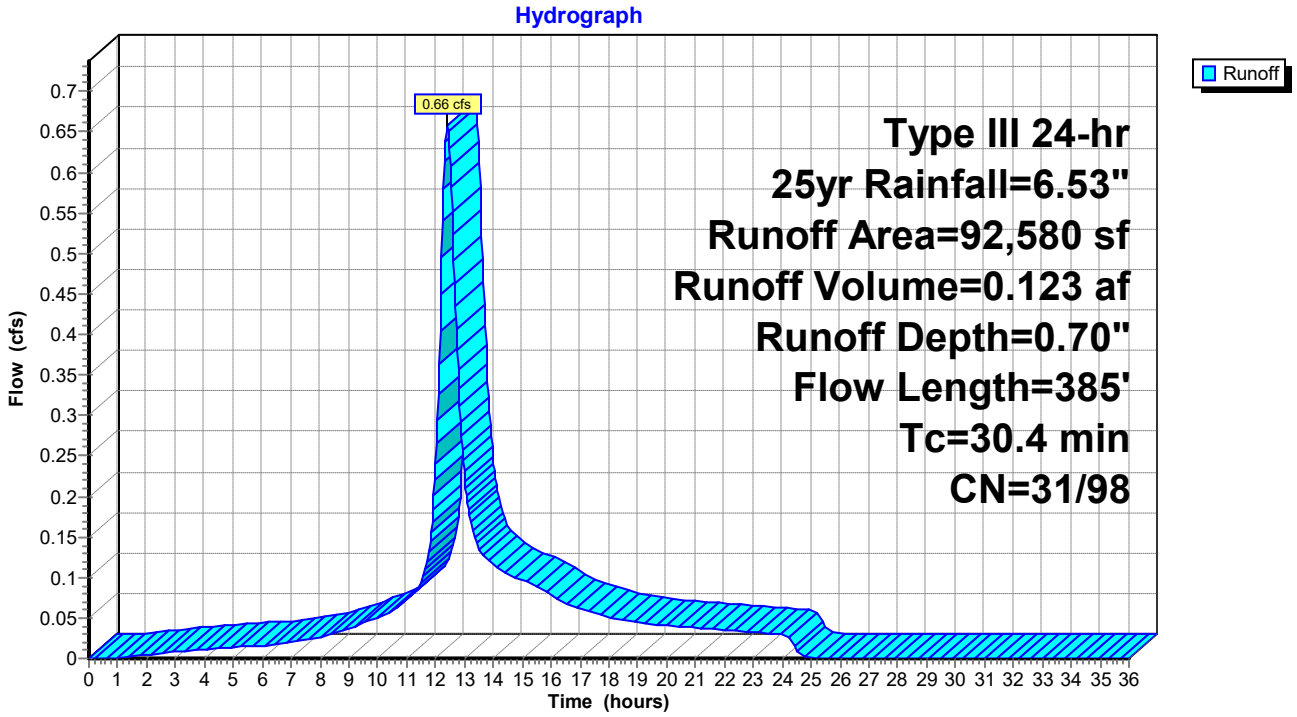
Runoff = 0.66 cfs @ 12.40 hrs, Volume= 0.123 af, Depth= 0.70"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25yr Rainfall=6.53"

	Area (sf)	CN	Description
	2,960	98	Paved parking, HSG A
*	580	65	Permeable pavement, (RI SW manual, 9" subbase in HSG B)
	4,890	98	Roofs, HSG A
	81,620	30	Woods, Good, HSG A
	2,530	39	>75% Grass cover, Good, HSG A
	92,580	36	Weighted Average
	84,730	31	91.52% Pervious Area
	7,850	98	8.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.8	100	0.0100	0.06		**Sheet Flow, A TO B** Woods: Light underbrush n= 0.400 P2= 3.59"
3.5	260	0.0600	1.22		**Shallow Concentrated Flow, B TO C** Woodland Kv= 5.0 fps
0.1	25	0.0600	4.97		**Shallow Concentrated Flow, C TO D** Kv= 20.3 fps
30.4	385	Total			

Subcatchment DA1: DA1



Summary for Subcatchment DA1A: DA1A

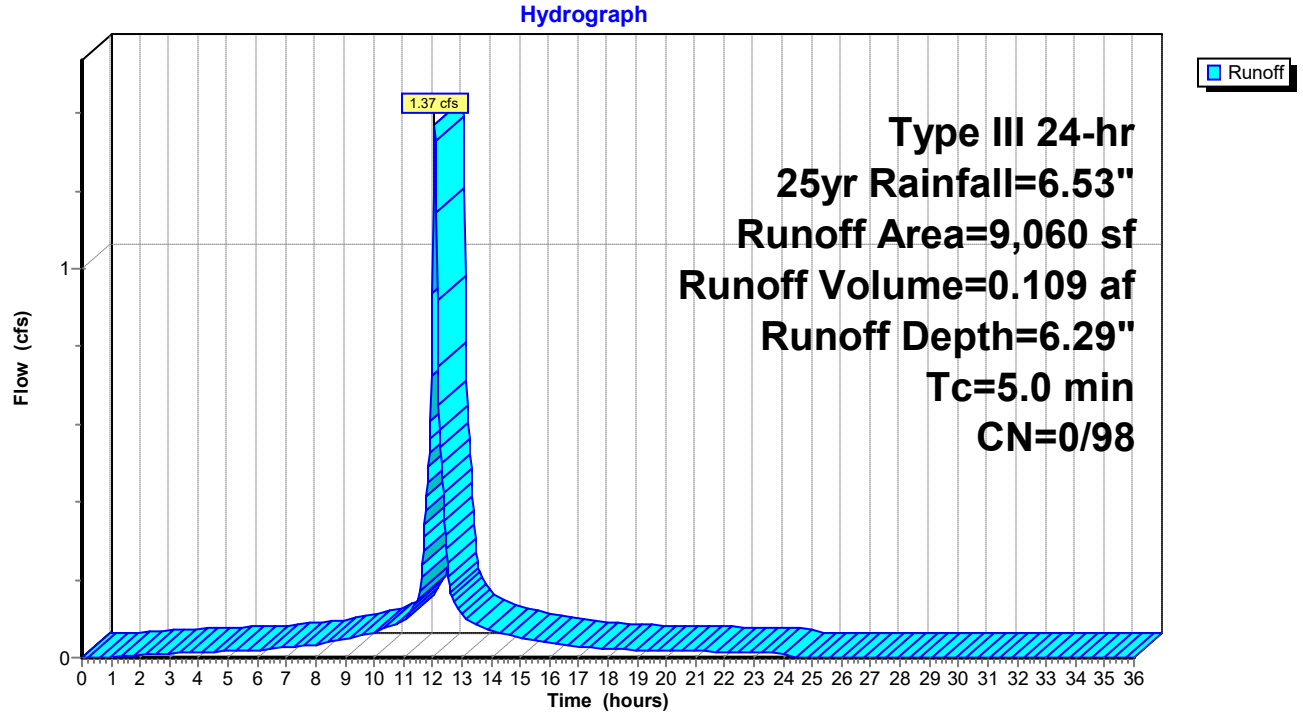
Runoff = 1.37 cfs @ 12.07 hrs, Volume= 0.109 af, Depth= 6.29"
Routed to Pond 2P : POROUS PAVEMENT & TRENCH

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25yr Rainfall=6.53"

	Area (sf)	CN	Description
	380	98	Paved parking, HSG A
*	8,310	98	Permeable pavement, HSG A
	0	98	Roofs, HSG A
	370	98	Water Surface, HSG A
	0	30	Woods, Good, HSG A
	0	39	>75% Grass cover, Good, HSG A
	9,060	98	Weighted Average
	9,060	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1A: DA1A



Summary for Subcatchment DA1B: DA1B

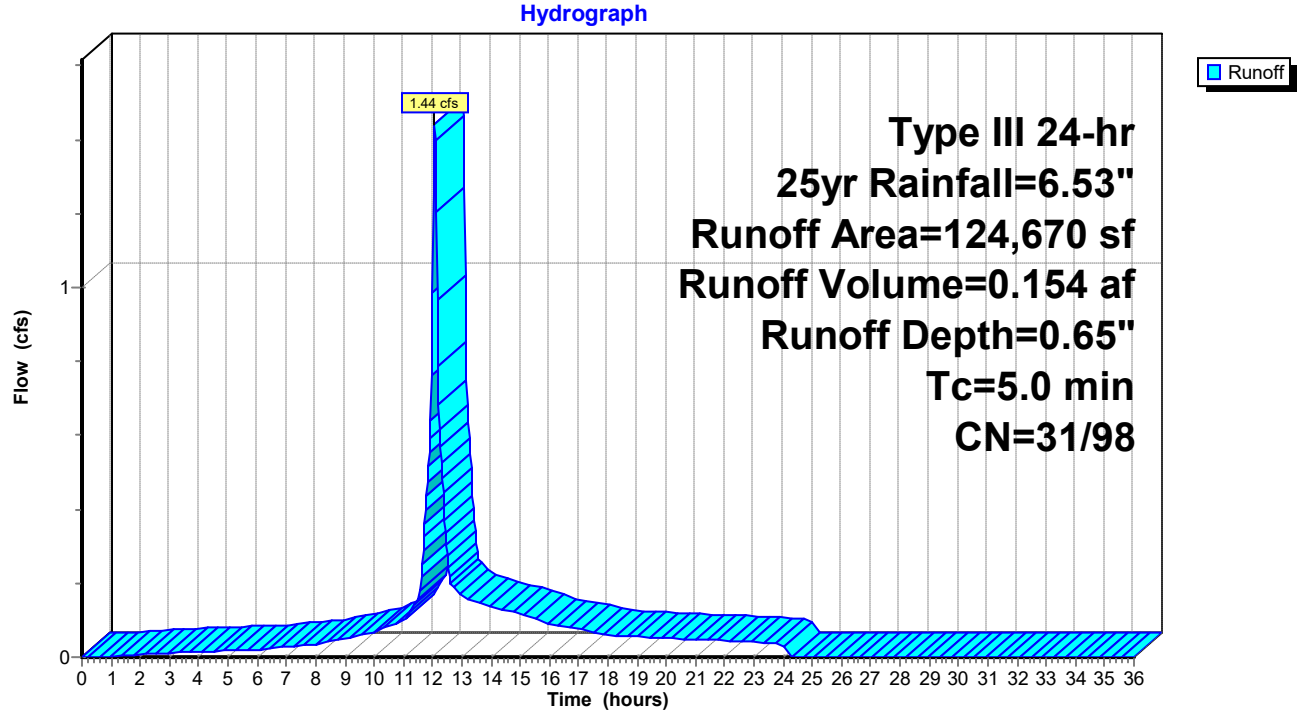
Runoff = 1.44 cfs @ 12.07 hrs, Volume= 0.154 af, Depth= 0.65"
Routed to Pond P1 : NORTH BIO

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25yr Rainfall=6.53"

Area (sf)	CN	Description
6,300	98	Paved parking, HSG A
240	98	Permeable pavement, HSG A (for WQV)
2,700	98	Paved parking, HSG A
300	98	Water Surface, HSG A
105,840	30	Woods, Good, HSG A
9,290	39	>75% Grass cover, Good, HSG A
124,670	36	Weighted Average
115,130	31	92.35% Pervious Area
9,540	98	7.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1B: DA1B



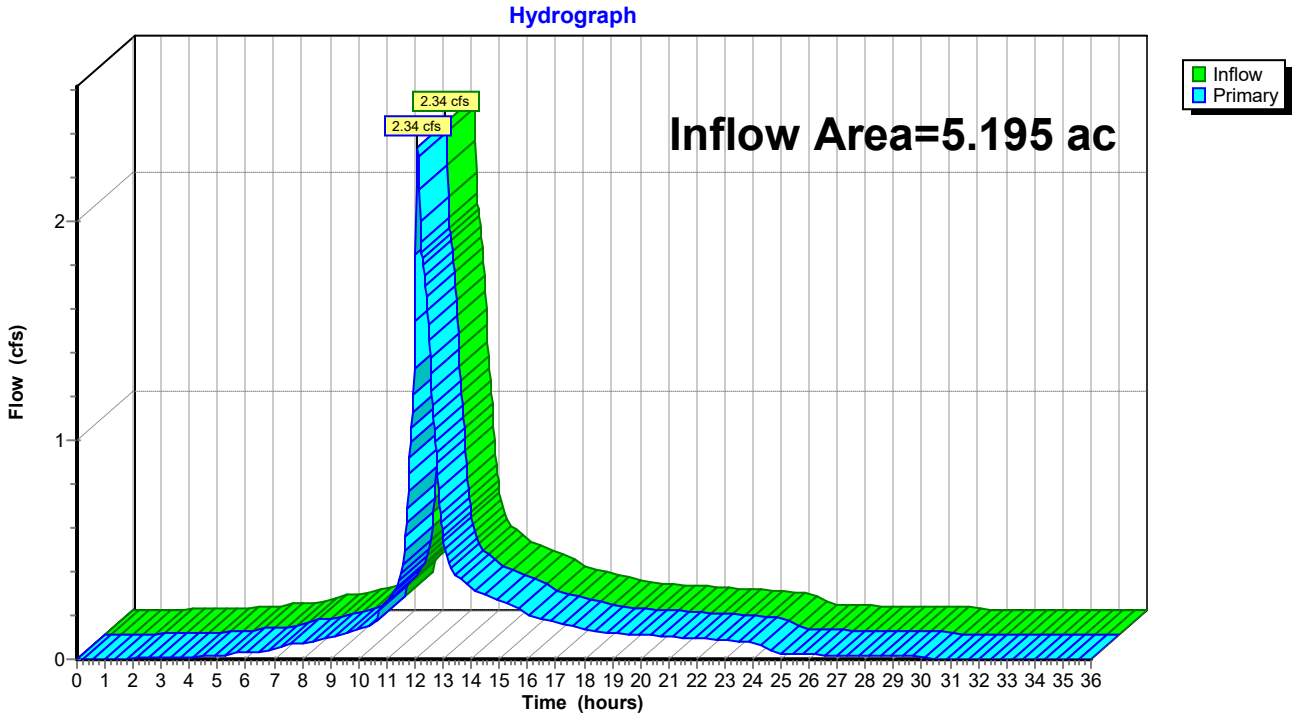
Summary for Pond 1P: SP1- SCARGO LAKE

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.195 ac, 11.69% Impervious, Inflow Depth = 0.87" for 25yr event
Inflow = 2.34 cfs @ 12.10 hrs, Volume= 0.376 af
Primary = 2.34 cfs @ 12.10 hrs, Volume= 0.376 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Pond 1P: SP1- SCARGO LAKE



Summary for Pond 2P: POROUS PAVEMENT & TRENCH

Inflow Area = 0.208 ac,100.00% Impervious, Inflow Depth = 6.29" for 25yr event
Inflow = 1.37 cfs @ 12.07 hrs, Volume= 0.109 af
Outflow = 0.66 cfs @ 12.21 hrs, Volume= 0.103 af, Atten= 52%, Lag= 8.3 min
Primary = 0.66 cfs @ 12.21 hrs, Volume= 0.103 af
Routed to Pond 1P : SP1- SCARGO LAKE
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond 1P : SP1- SCARGO LAKE

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Starting Elev= 11.20' Surf.Area= 8,310 sf Storage= 3,017 cf
Peak Elev= 11.55' @ 12.21 hrs Surf.Area= 8,310 sf Storage= 3,970 cf (953 cf above start)

Plug-Flow detention time= 435.3 min calculated for 0.033 af (31% of inflow)
Center-of-Mass det. time= 43.3 min (786.3 - 743.0)

Volume	Invert	Avail.Storage	Storage Description
#1	10.10'	9,824 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

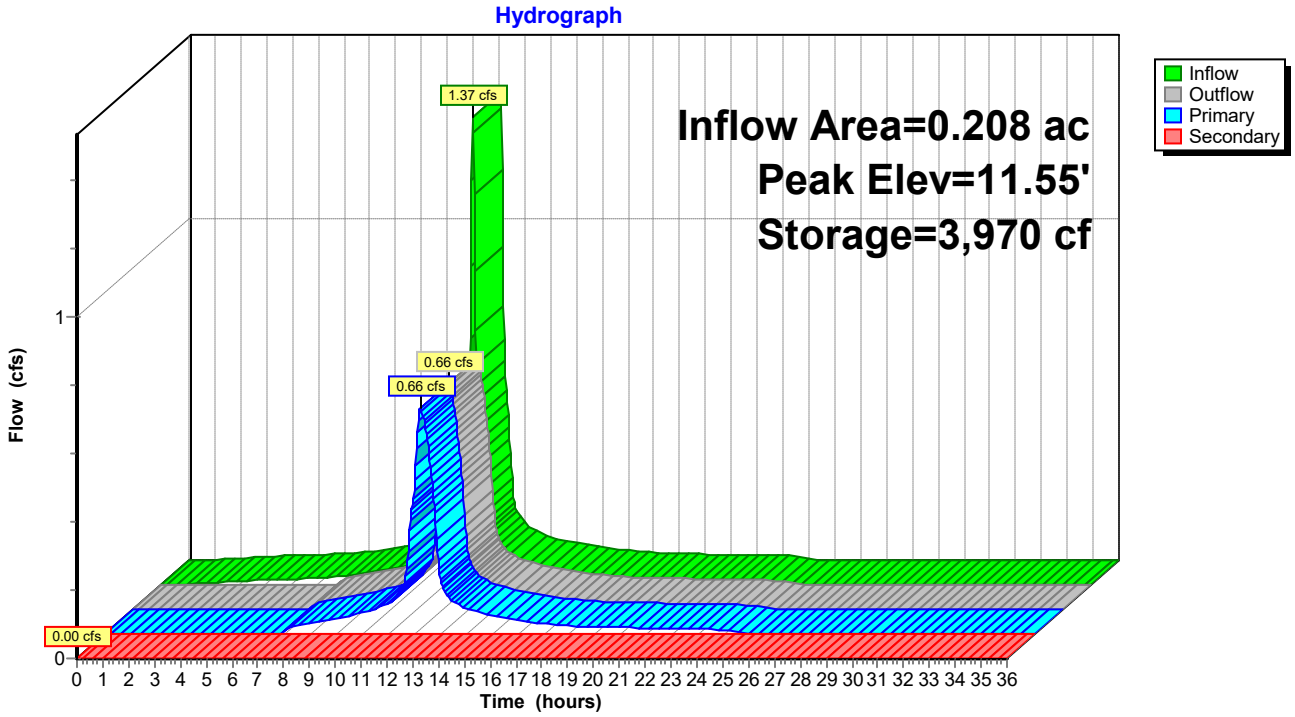
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.10	8,310	0.0	0	0
10.20	8,310	33.0	274	274
12.65	8,310	33.0	6,719	6,993
12.70	8,310	100.0	415	7,408
12.80	10,000	100.0	916	8,324
12.85	50,000	100.0	1,500	9,824

Device	Routing	Invert	Outlet Devices
#1	Primary	11.30'	**24.0" Horiz. Bubbler** C= 0.600 Limited to weir flow at low heads
#2	Device 1	10.10'	**8.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.10' / 10.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Secondary	12.80'	**150.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.66 cfs @ 12.21 hrs HW=11.55' (Free Discharge)
└**1=Bubbler** (Passes 0.66 cfs of 2.53 cfs potential flow)
└**2=Culvert** (Inlet Controls 0.66 cfs @ 1.89 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.20' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: POROUS PAVEMENT & TRENCH



Summary for Pond P1: NORTH BIO

Inflow Area = 2.862 ac, 7.65% Impervious, Inflow Depth = 0.65" for 25yr event
Inflow = 1.44 cfs @ 12.07 hrs, Volume= 0.154 af
Outflow = 1.41 cfs @ 12.09 hrs, Volume= 0.150 af, Atten= 2%, Lag= 1.1 min
Primary = 0.04 cfs @ 12.09 hrs, Volume= 0.057 af
Routed to Pond 1P : SP1- SCARGO LAKE
Secondary = 1.37 cfs @ 12.09 hrs, Volume= 0.093 af
Routed to Pond 1P : SP1- SCARGO LAKE

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 12.41' @ 12.09 hrs Surf.Area= 734 sf Storage= 727 cf

Plug-Flow detention time= 106.2 min calculated for 0.150 af (98% of inflow)
Center-of-Mass det. time= 91.8 min (911.2 - 819.4)

Volume	Invert	Avail.Storage	Storage Description
#1	10.40'	972 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

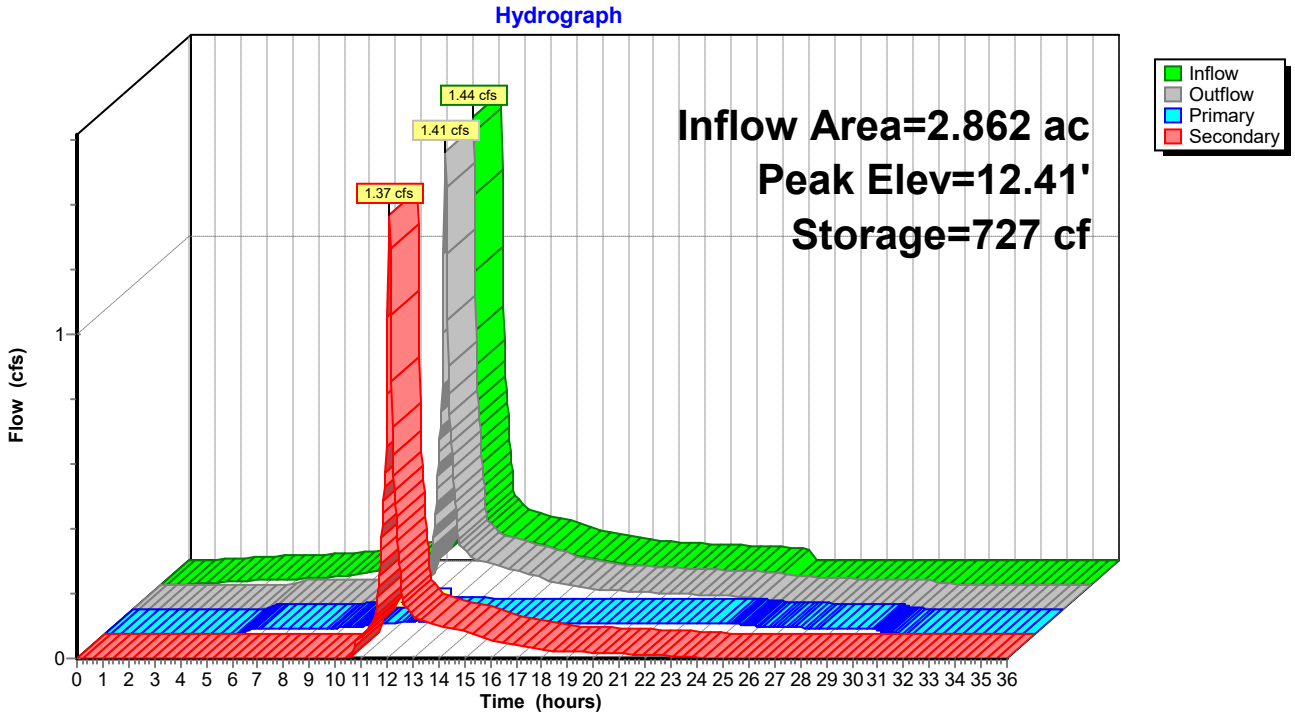
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.40	300	0.0	0	0
10.50	300	33.0	10	10
11.50	300	100.0	300	310
12.00	415	100.0	179	489
12.50	800	100.0	304	792
12.70	1,000	100.0	180	972

Device	Routing	Invert	Outlet Devices
#1	Secondary	12.25'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	11.00'	**6.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 11.00' / 10.95' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#3	Device 2	10.40'	**2.410 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.04 cfs @ 12.09 hrs HW=12.41' (Free Discharge)
↑**2=Culvert** (Passes 0.04 cfs of 0.81 cfs potential flow)
↑**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Secondary OutFlow Max=1.36 cfs @ 12.09 hrs HW=12.41' (Free Discharge)
↑**1=Orifice/Grate** (Weir Controls 1.36 cfs @ 1.32 fps)

Pond P1: NORTH BIO



Time span=0.00-36.00 hrs, dt=0.03 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=92,580 sf 8.48% Impervious Runoff Depth=1.29"
Flow Length=385' Tc=30.4 min CN=31/98 Runoff=1.07 cfs 0.229 af

Subcatchment DA1A: DA1A Runoff Area=9,060 sf 100.00% Impervious Runoff Depth=8.33"
Tc=5.0 min CN=0/98 Runoff=1.80 cfs 0.144 af

Subcatchment DA1B: DA1B Runoff Area=124,670 sf 7.65% Impervious Runoff Depth=1.23"
Tc=5.0 min CN=31/98 Runoff=2.01 cfs 0.294 af

Pond 1P: SP1- SCARGO LAKE Inflow=3.20 cfs 0.657 af
Primary=3.20 cfs 0.657 af

Pond 2P: POROUS PAVEMENT & TRENCH Peak Elev=11.66' Storage=4,271 cf Inflow=1.80 cfs 0.144 af
Primary=0.79 cfs 0.138 af Secondary=0.00 cfs 0.000 af Outflow=0.79 cfs 0.138 af

Pond P1: NORTH BIO Peak Elev=12.46' Storage=759 cf Inflow=2.01 cfs 0.294 af
Primary=0.04 cfs 0.061 af Secondary=1.94 cfs 0.229 af Outflow=1.98 cfs 0.290 af

Total Runoff Area = 5.195 ac Runoff Volume = 0.667 af Average Runoff Depth = 1.54"
88.31% Pervious = 4.588 ac 11.69% Impervious = 0.607 ac

Summary for Subcatchment DA1: DA1

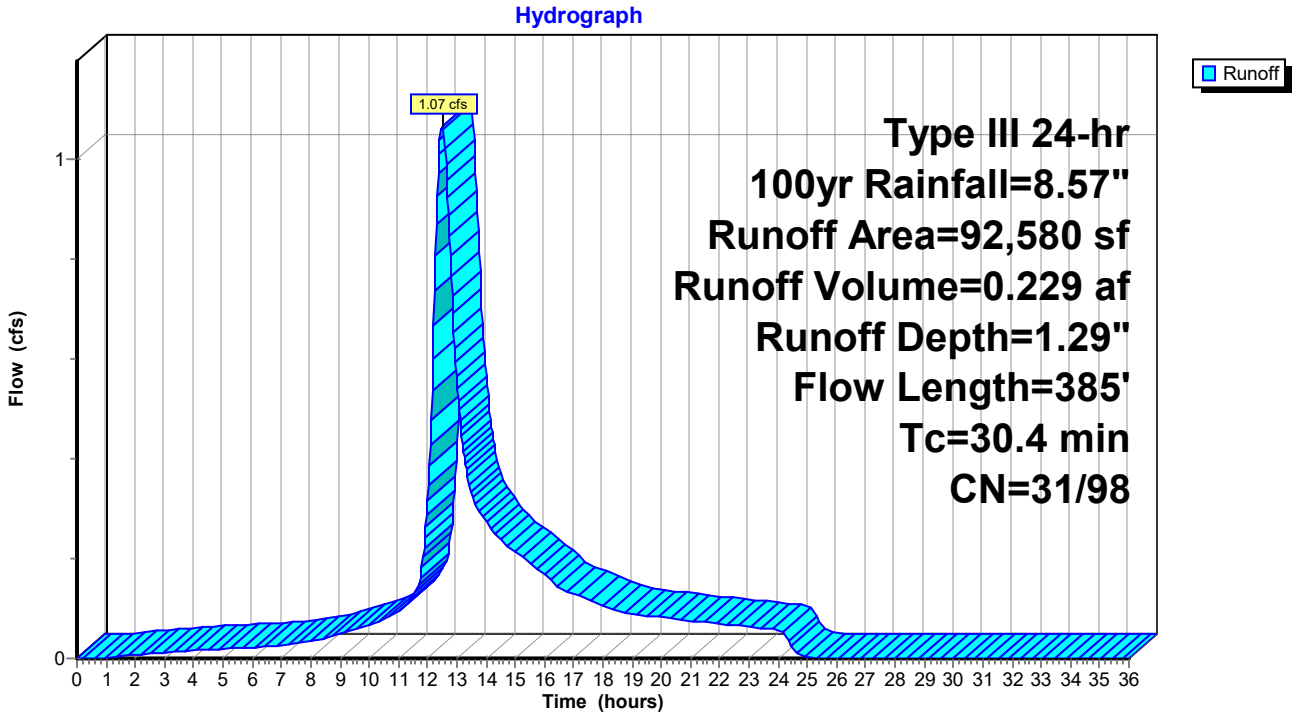
Runoff = 1.07 cfs @ 12.49 hrs, Volume= 0.229 af, Depth= 1.29"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100yr Rainfall=8.57"

	Area (sf)	CN	Description
	2,960	98	Paved parking, HSG A
*	580	65	Permeable pavement, (RI SW manual, 9" subbase in HSG B)
	4,890	98	Roofs, HSG A
	81,620	30	Woods, Good, HSG A
	2,530	39	>75% Grass cover, Good, HSG A
	92,580	36	Weighted Average
	84,730	31	91.52% Pervious Area
	7,850	98	8.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.8	100	0.0100	0.06		**Sheet Flow, A TO B** Woods: Light underbrush n= 0.400 P2= 3.59"
3.5	260	0.0600	1.22		**Shallow Concentrated Flow, B TO C** Woodland Kv= 5.0 fps
0.1	25	0.0600	4.97		**Shallow Concentrated Flow, C TO D** Kv= 20.3 fps
30.4	385	Total			

Subcatchment DA1: DA1



Summary for Subcatchment DA1A: DA1A

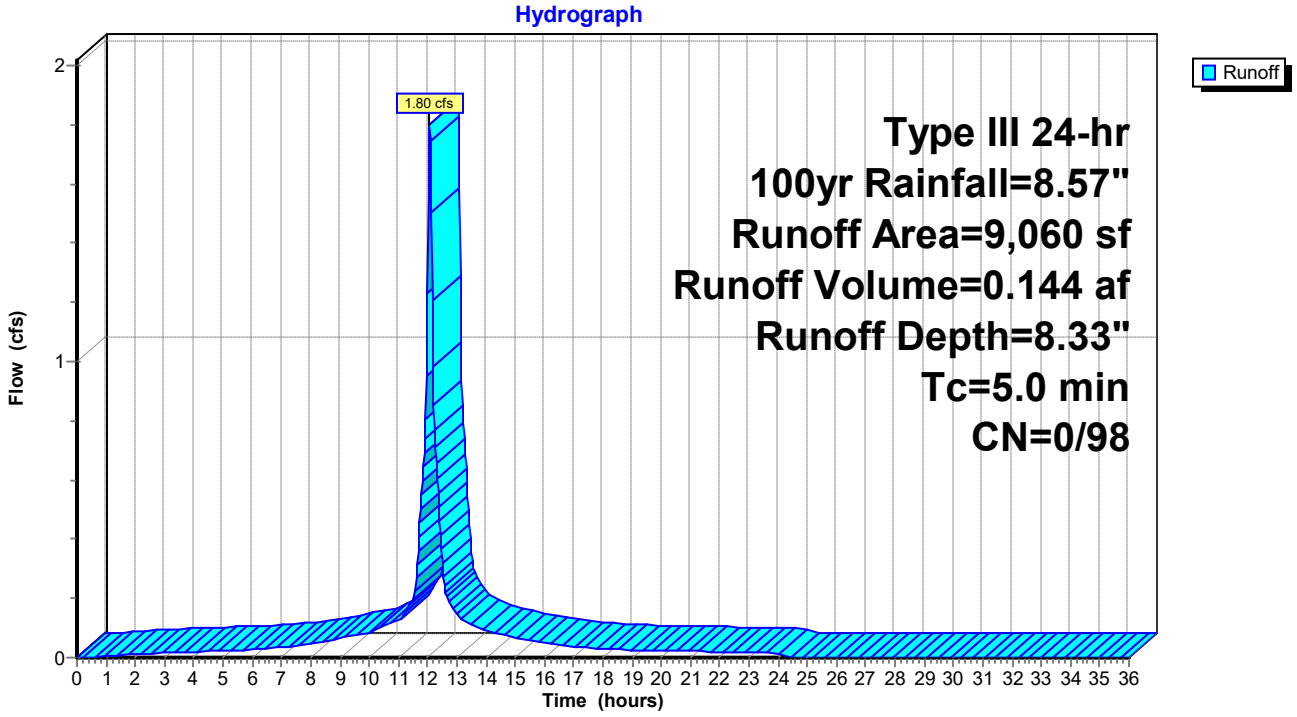
Runoff = 1.80 cfs @ 12.07 hrs, Volume= 0.144 af, Depth= 8.33"
Routed to Pond 2P : POROUS PAVEMENT & TRENCH

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100yr Rainfall=8.57"

	Area (sf)	CN	Description
	380	98	Paved parking, HSG A
*	8,310	98	Permeable pavement, HSG A
	0	98	Roofs, HSG A
	370	98	Water Surface, HSG A
	0	30	Woods, Good, HSG A
	0	39	>75% Grass cover, Good, HSG A
	9,060	98	Weighted Average
	9,060	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1A: DA1A



Summary for Subcatchment DA1B: DA1B

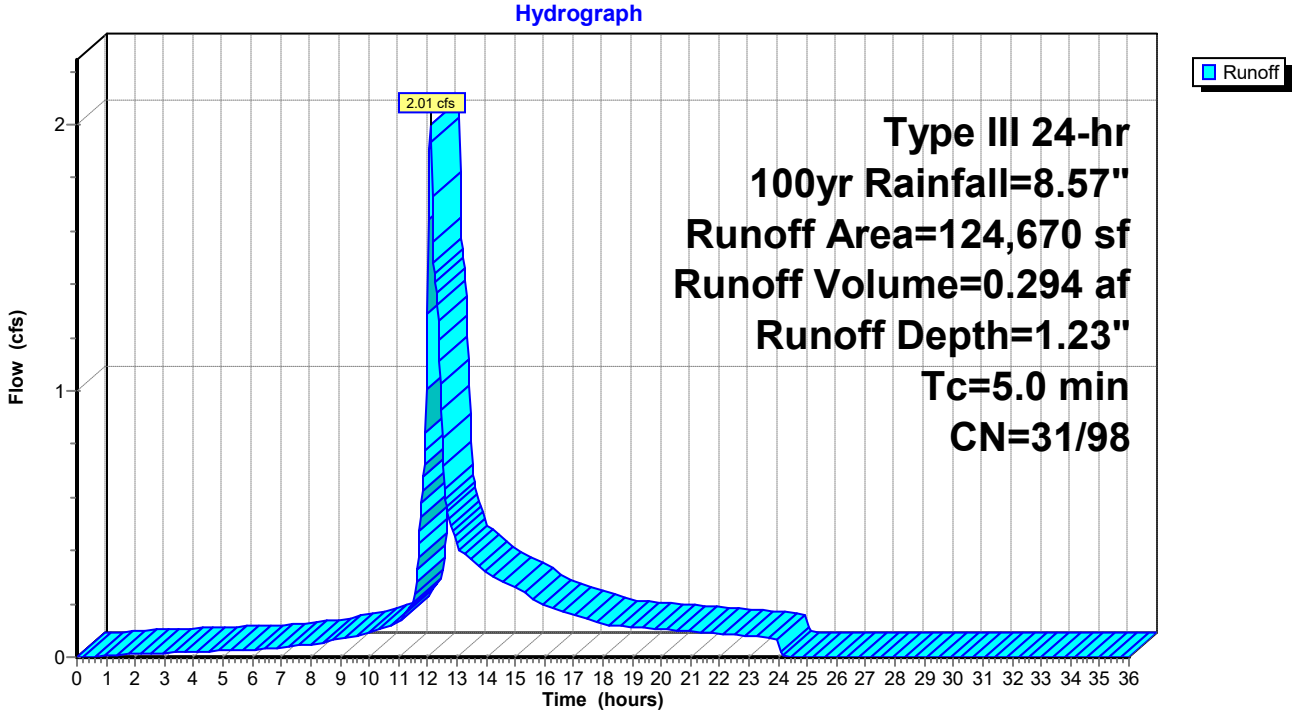
Runoff = 2.01 cfs @ 12.09 hrs, Volume= 0.294 af, Depth= 1.23"
Routed to Pond P1 : NORTH BIO

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100yr Rainfall=8.57"

Area (sf)	CN	Description
6,300	98	Paved parking, HSG A
240	98	Permeable pavement, HSG A (for WQV)
2,700	98	Paved parking, HSG A
300	98	Water Surface, HSG A
105,840	30	Woods, Good, HSG A
9,290	39	>75% Grass cover, Good, HSG A
124,670	36	Weighted Average
115,130	31	92.35% Pervious Area
9,540	98	7.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1B: DA1B



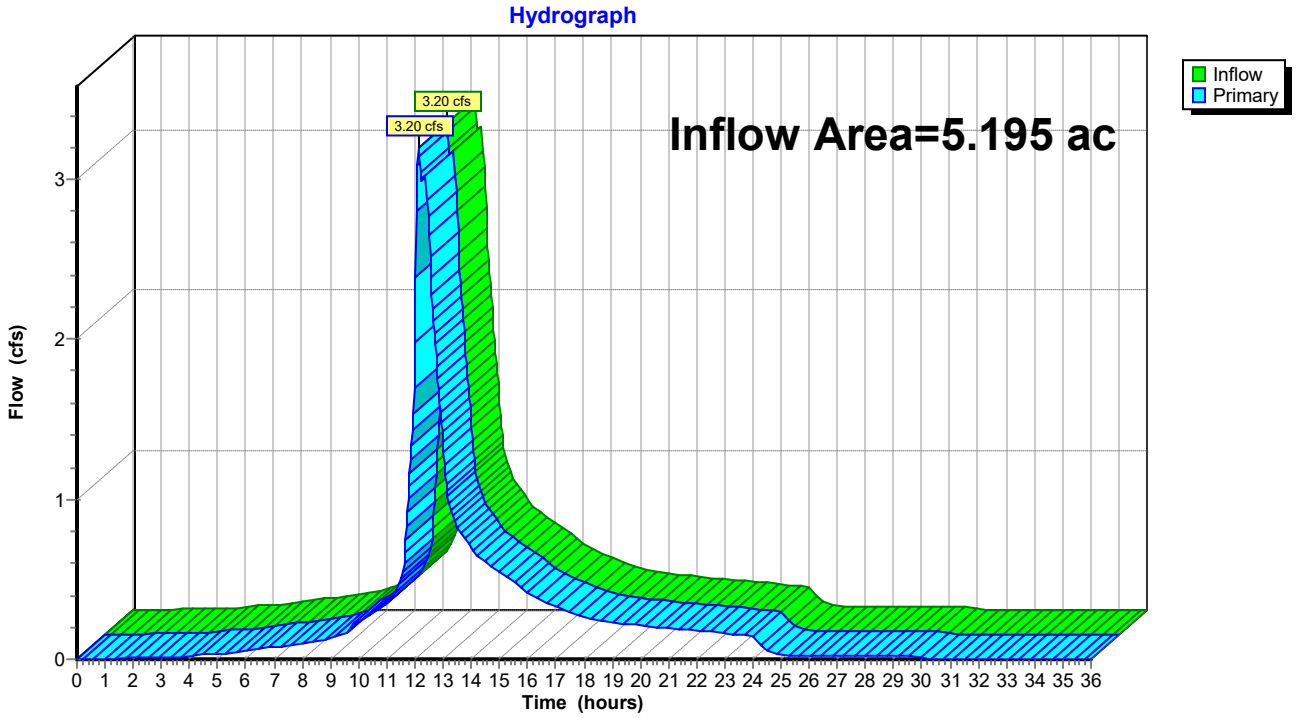
Summary for Pond 1P: SP1- SCARGO LAKE

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.195 ac, 11.69% Impervious, Inflow Depth = 1.52" for 100yr event
Inflow = 3.20 cfs @ 12.13 hrs, Volume= 0.657 af
Primary = 3.20 cfs @ 12.13 hrs, Volume= 0.657 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Pond 1P: SP1- SCARGO LAKE



Summary for Pond 2P: POROUS PAVEMENT & TRENCH

Inflow Area = 0.208 ac,100.00% Impervious, Inflow Depth = 8.33" for 100yr event
Inflow = 1.80 cfs @ 12.07 hrs, Volume= 0.144 af
Outflow = 0.79 cfs @ 12.23 hrs, Volume= 0.138 af, Atten= 56%, Lag= 9.7 min
Primary = 0.79 cfs @ 12.23 hrs, Volume= 0.138 af
Routed to Pond 1P : SP1- SCARGO LAKE
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond 1P : SP1- SCARGO LAKE

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Starting Elev= 11.20' Surf.Area= 8,310 sf Storage= 3,017 cf
Peak Elev= 11.66' @ 12.23 hrs Surf.Area= 8,310 sf Storage= 4,271 cf (1,255 cf above start)

Plug-Flow detention time= 299.8 min calculated for 0.069 af (48% of inflow)
Center-of-Mass det. time= 38.8 min (778.3 - 739.4)

Volume	Invert	Avail.Storage	Storage Description
#1	10.10'	9,824 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

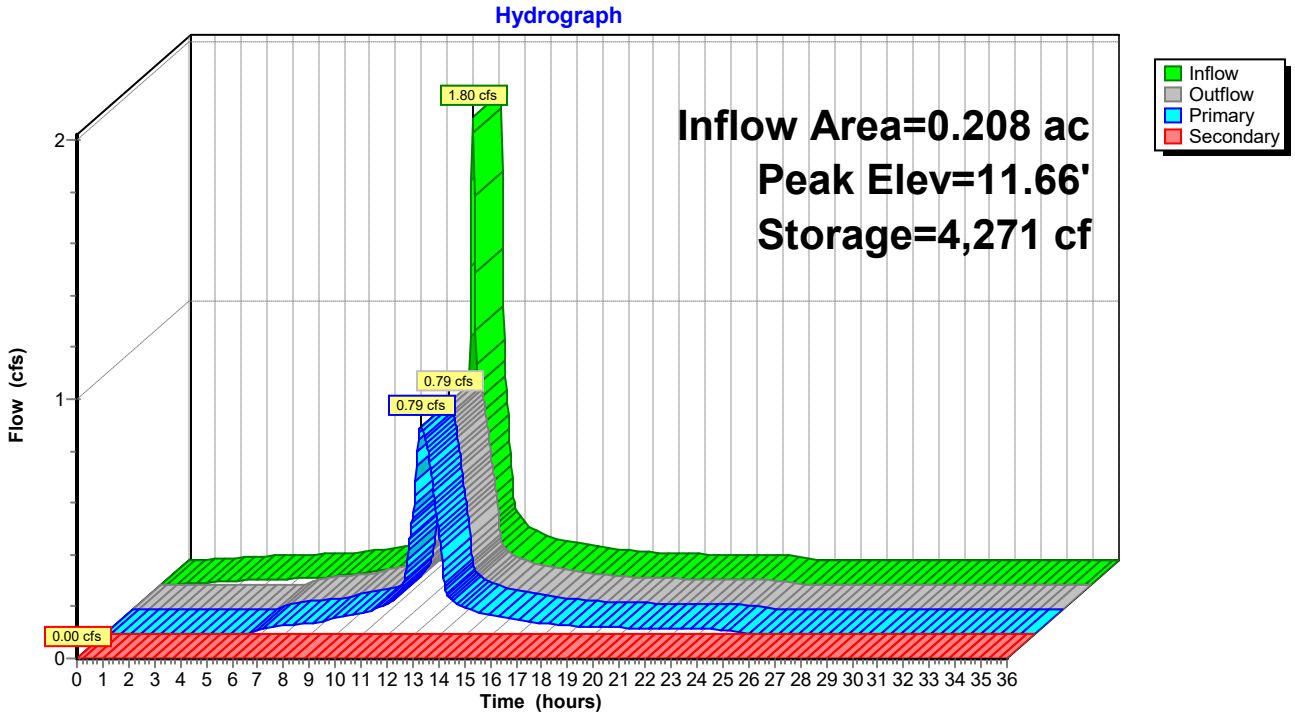
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.10	8,310	0.0	0	0
10.20	8,310	33.0	274	274
12.65	8,310	33.0	6,719	6,993
12.70	8,310	100.0	415	7,408
12.80	10,000	100.0	916	8,324
12.85	50,000	100.0	1,500	9,824

Device	Routing	Invert	Outlet Devices
#1	Primary	11.30'	**24.0" Horiz. Bubbler** C= 0.600 Limited to weir flow at low heads
#2	Device 1	10.10'	**8.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.10' / 10.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Secondary	12.80'	**150.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.79 cfs @ 12.23 hrs HW=11.66' (Free Discharge)
└**1=Bubbler** (Passes 0.79 cfs of 4.39 cfs potential flow)
└**2=Culvert** (Inlet Controls 0.79 cfs @ 2.27 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.20' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: POROUS PAVEMENT & TRENCH



Summary for Pond P1: NORTH BIO

Inflow Area = 2.862 ac, 7.65% Impervious, Inflow Depth = 1.23" for 100yr event
Inflow = 2.01 cfs @ 12.09 hrs, Volume= 0.294 af
Outflow = 1.98 cfs @ 12.11 hrs, Volume= 0.290 af, Atten= 1%, Lag= 0.9 min
Primary = 0.04 cfs @ 12.11 hrs, Volume= 0.061 af
Routed to Pond 1P : SP1- SCARGO LAKE
Secondary = 1.94 cfs @ 12.11 hrs, Volume= 0.229 af
Routed to Pond 1P : SP1- SCARGO LAKE

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 12.46' @ 12.11 hrs Surf.Area= 767 sf Storage= 759 cf

Plug-Flow detention time= 59.3 min calculated for 0.290 af (99% of inflow)
Center-of-Mass det. time= 51.9 min (896.6 - 844.8)

Volume	Invert	Avail.Storage	Storage Description
#1	10.40'	972 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

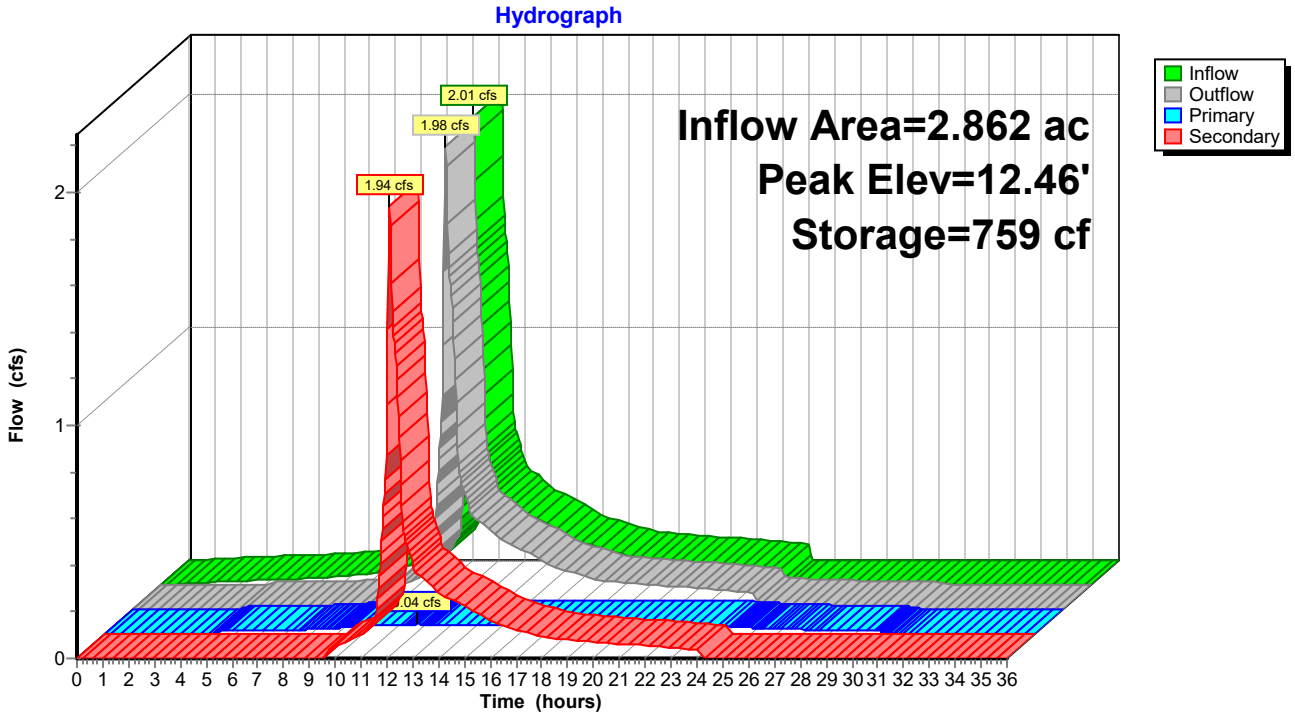
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.40	300	0.0	0	0
10.50	300	33.0	10	10
11.50	300	100.0	300	310
12.00	415	100.0	179	489
12.50	800	100.0	304	792
12.70	1,000	100.0	180	972

Device	Routing	Invert	Outlet Devices
#1	Secondary	12.25'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	11.00'	**6.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 11.00' / 10.95' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#3	Device 2	10.40'	**2.410 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.04 cfs @ 12.11 hrs HW=12.46' (Free Discharge)
↑└**2=Culvert** (Passes 0.04 cfs of 0.82 cfs potential flow)
↑└**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Secondary OutFlow Max=1.92 cfs @ 12.11 hrs HW=12.46' (Free Discharge)
↑└**1=Orifice/Grate** (Weir Controls 1.92 cfs @ 1.48 fps)

Pond P1: NORTH BIO



Time span=0.00-36.00 hrs, dt=0.03 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=92,580 sf 8.48% Impervious Runoff Depth=0.08"
Flow Length=385' Tc=30.4 min CN=31/98 Runoff=0.11 cfs 0.015 af

Subcatchment DA1A: DA1A Runoff Area=9,060 sf 100.00% Impervious Runoff Depth=1.00"
Tc=5.0 min CN=0/98 Runoff=0.24 cfs 0.017 af

Subcatchment DA1B: DA1B Runoff Area=124,670 sf 7.65% Impervious Runoff Depth=0.08"
Tc=5.0 min CN=31/98 Runoff=0.25 cfs 0.018 af

Pond 1P: SP1- SCARGO LAKE Inflow=0.23 cfs 0.040 af
Primary=0.23 cfs 0.040 af

Pond 2P: POROUS PAVEMENT & TRENCH Peak Elev=11.33' Storage=3,369 cf Inflow=0.24 cfs 0.017 af
Primary=0.11 cfs 0.011 af Secondary=0.00 cfs 0.000 af Outflow=0.11 cfs 0.011 af

Pond P1: NORTH BIO Peak Elev=11.93' Storage=461 cf Inflow=0.25 cfs 0.018 af
Primary=0.02 cfs 0.014 af Secondary=0.00 cfs 0.000 af Outflow=0.02 cfs 0.014 af

Total Runoff Area = 5.195 ac Runoff Volume = 0.050 af Average Runoff Depth = 0.12"
88.31% Pervious = 4.588 ac 11.69% Impervious = 0.607 ac

Summary for Subcatchment DA1: DA1

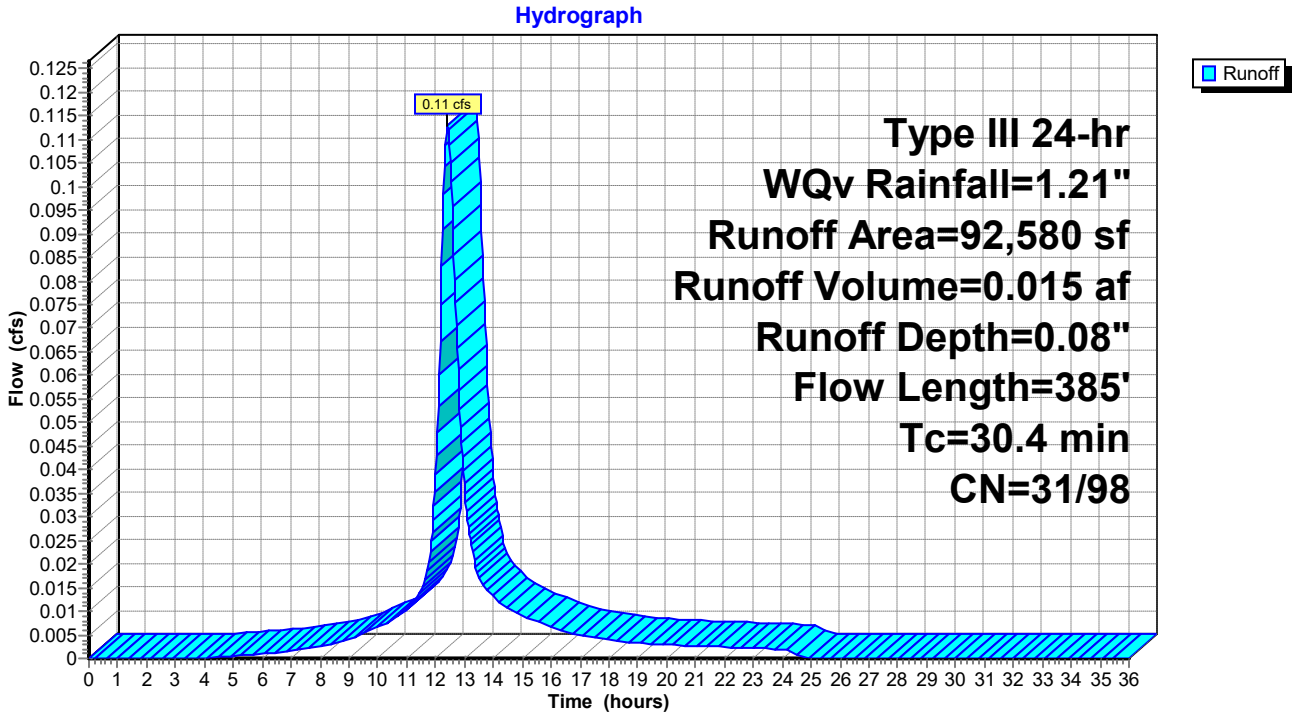
Runoff = 0.11 cfs @ 12.40 hrs, Volume= 0.015 af, Depth= 0.08"
Routed to Pond 1P : SP1- SCARGO LAKE

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr WQv Rainfall=1.21"

	Area (sf)	CN	Description
	2,960	98	Paved parking, HSG A
*	580	65	Permeable pavement, (RI SW manual, 9" subbase in HSG B)
	4,890	98	Roofs, HSG A
	81,620	30	Woods, Good, HSG A
	2,530	39	>75% Grass cover, Good, HSG A
	92,580	36	Weighted Average
	84,730	31	91.52% Pervious Area
	7,850	98	8.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.8	100	0.0100	0.06		**Sheet Flow, A TO B** Woods: Light underbrush n= 0.400 P2= 3.59"
3.5	260	0.0600	1.22		**Shallow Concentrated Flow, B TO C** Woodland Kv= 5.0 fps
0.1	25	0.0600	4.97		**Shallow Concentrated Flow, C TO D** Kv= 20.3 fps
30.4	385	Total			

Subcatchment DA1: DA1



Summary for Subcatchment DA1A: DA1A

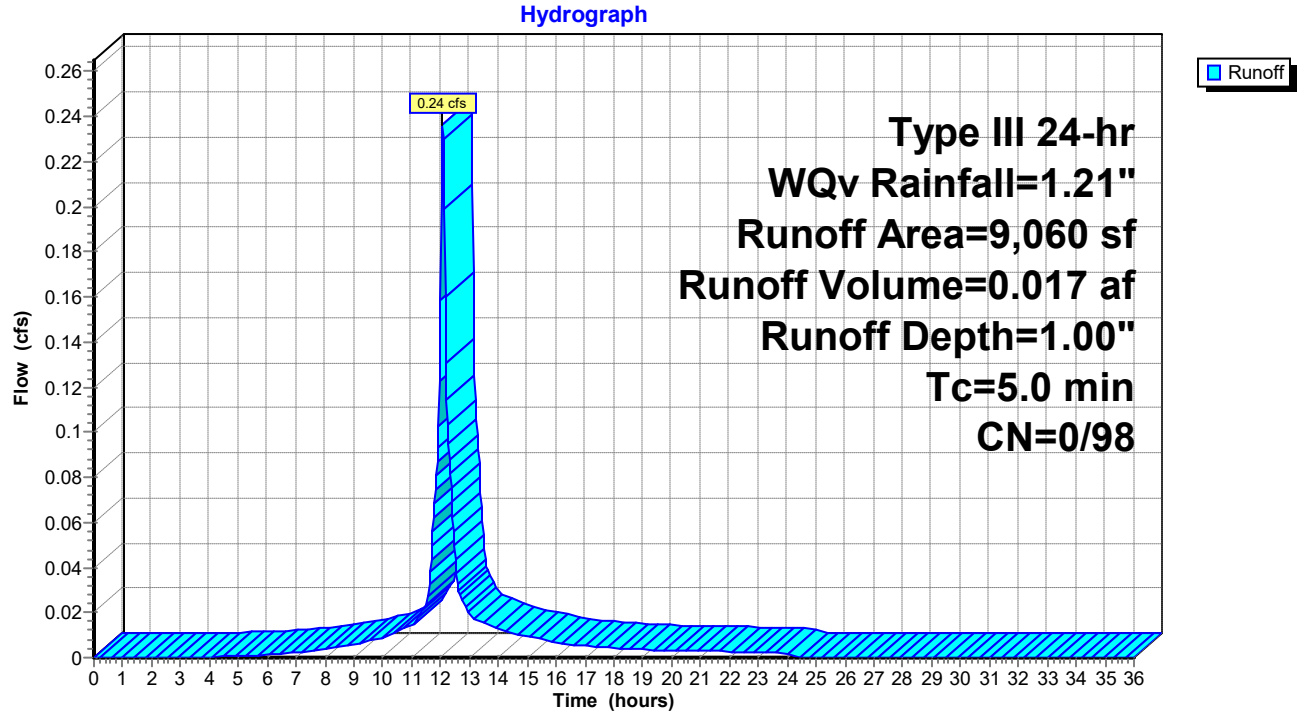
Runoff = 0.24 cfs @ 12.07 hrs, Volume= 0.017 af, Depth= 1.00"
Routed to Pond 2P : POROUS PAVEMENT & TRENCH

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr WQv Rainfall=1.21"

	Area (sf)	CN	Description
	380	98	Paved parking, HSG A
*	8,310	98	Permeable pavement, HSG A
	0	98	Roofs, HSG A
	370	98	Water Surface, HSG A
	0	30	Woods, Good, HSG A
	0	39	>75% Grass cover, Good, HSG A
	9,060	98	Weighted Average
	9,060	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1A: DA1A



Summary for Subcatchment DA1B: DA1B

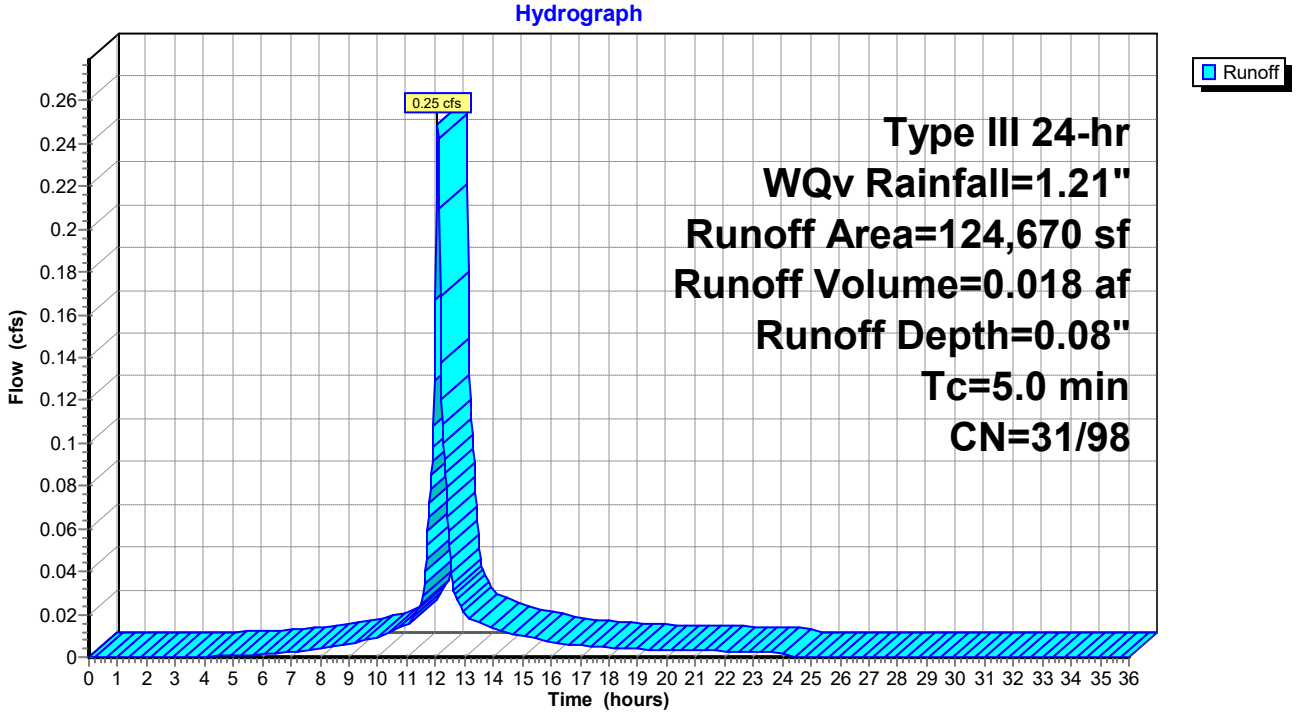
Runoff = 0.25 cfs @ 12.07 hrs, Volume= 0.018 af, Depth= 0.08"
Routed to Pond P1 : NORTH BIO

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr WQv Rainfall=1.21"

Area (sf)	CN	Description
6,300	98	Paved parking, HSG A
240	98	Permeable pavement, HSG A (for WQV)
2,700	98	Paved parking, HSG A
300	98	Water Surface, HSG A
105,840	30	Woods, Good, HSG A
9,290	39	>75% Grass cover, Good, HSG A
124,670	36	Weighted Average
115,130	31	92.35% Pervious Area
9,540	98	7.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 min**

Subcatchment DA1B: DA1B



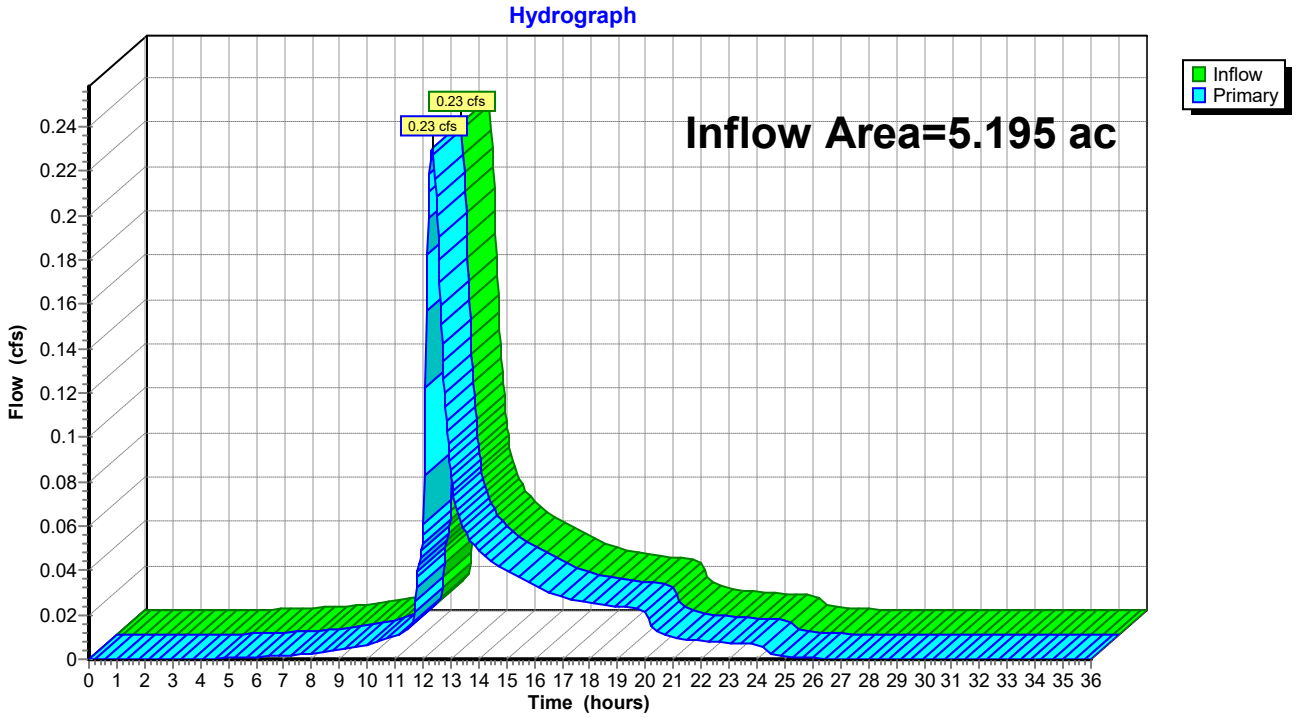
Summary for Pond 1P: SP1- SCARGO LAKE

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.195 ac, 11.69% Impervious, Inflow Depth = 0.09" for WQv event
Inflow = 0.23 cfs @ 12.33 hrs, Volume= 0.040 af
Primary = 0.23 cfs @ 12.33 hrs, Volume= 0.040 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Pond 1P: SP1- SCARGO LAKE



Summary for Pond 2P: POROUS PAVEMENT & TRENCH

Inflow Area = 0.208 ac,100.00% Impervious, Inflow Depth = 1.00" for WQv event
Inflow = 0.24 cfs @ 12.07 hrs, Volume= 0.017 af
Outflow = 0.11 cfs @ 12.23 hrs, Volume= 0.011 af, Atten= 55%, Lag= 9.4 min
Primary = 0.11 cfs @ 12.23 hrs, Volume= 0.011 af
Routed to Pond 1P : SP1- SCARGO LAKE
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond 1P : SP1- SCARGO LAKE

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Starting Elev= 11.20' Surf.Area= 8,310 sf Storage= 3,017 cf
Peak Elev= 11.33' @ 12.23 hrs Surf.Area= 8,310 sf Storage= 3,369 cf (353 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 97.2 min (878.0 - 780.8)

Volume	Invert	Avail.Storage	Storage Description
#1	10.10'	9,824 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

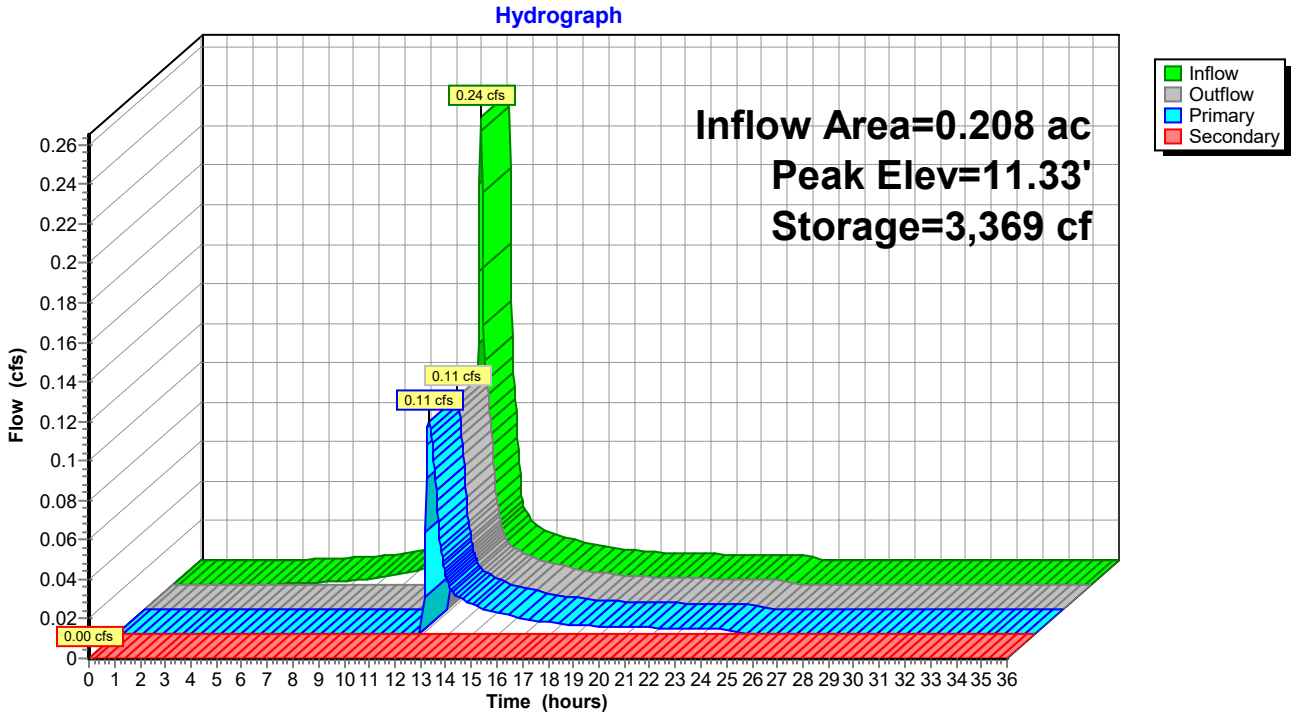
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.10	8,310	0.0	0	0
10.20	8,310	33.0	274	274
12.65	8,310	33.0	6,719	6,993
12.70	8,310	100.0	415	7,408
12.80	10,000	100.0	916	8,324
12.85	50,000	100.0	1,500	9,824

Device	Routing	Invert	Outlet Devices
#1	Primary	11.30'	**24.0" Horiz. Bubbler** C= 0.600 Limited to weir flow at low heads
#2	Device 1	10.10'	**8.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.10' / 10.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Secondary	12.80'	**150.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.10 cfs @ 12.23 hrs HW=11.33' (Free Discharge)
└**1=Bubbler** (Weir Controls 0.10 cfs @ 0.55 fps)
└**2=Culvert** (Passes 0.10 cfs of 0.22 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.20' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: POROUS PAVEMENT & TRENCH



Summary for Pond P1: NORTH BIO

Inflow Area = 2.862 ac, 7.65% Impervious, Inflow Depth = 0.08" for WQv event
Inflow = 0.25 cfs @ 12.07 hrs, Volume= 0.018 af
Outflow = 0.02 cfs @ 12.93 hrs, Volume= 0.014 af, Atten= 91%, Lag= 51.5 min
Primary = 0.02 cfs @ 12.93 hrs, Volume= 0.014 af
Routed to Pond 1P : SP1- SCARGO LAKE
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond 1P : SP1- SCARGO LAKE

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 11.93' @ 12.93 hrs Surf.Area= 399 sf Storage= 461 cf

Plug-Flow detention time= 276.2 min calculated for 0.014 af (80% of inflow)
Center-of-Mass det. time= 201.3 min (982.1 - 780.8)

Volume	Invert	Avail.Storage	Storage Description
#1	10.40'	972 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

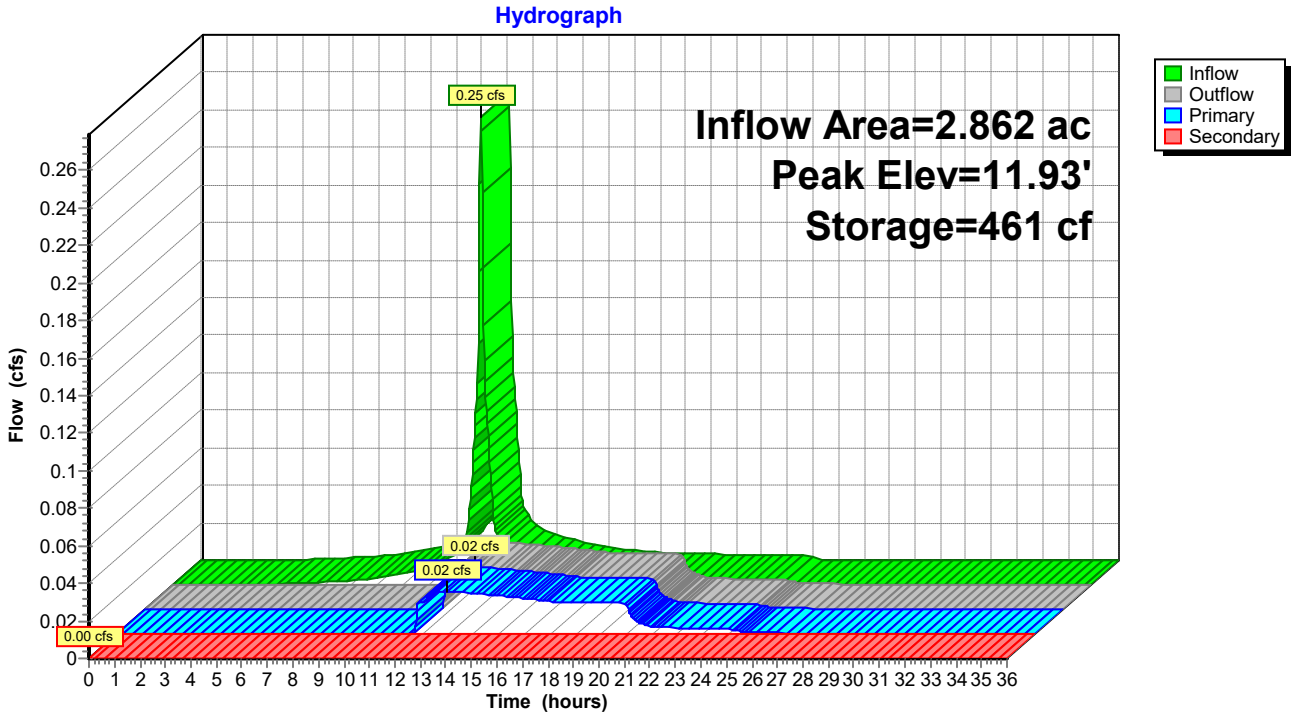
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.40	300	0.0	0	0
10.50	300	33.0	10	10
11.50	300	100.0	300	310
12.00	415	100.0	179	489
12.50	800	100.0	304	792
12.70	1,000	100.0	180	972

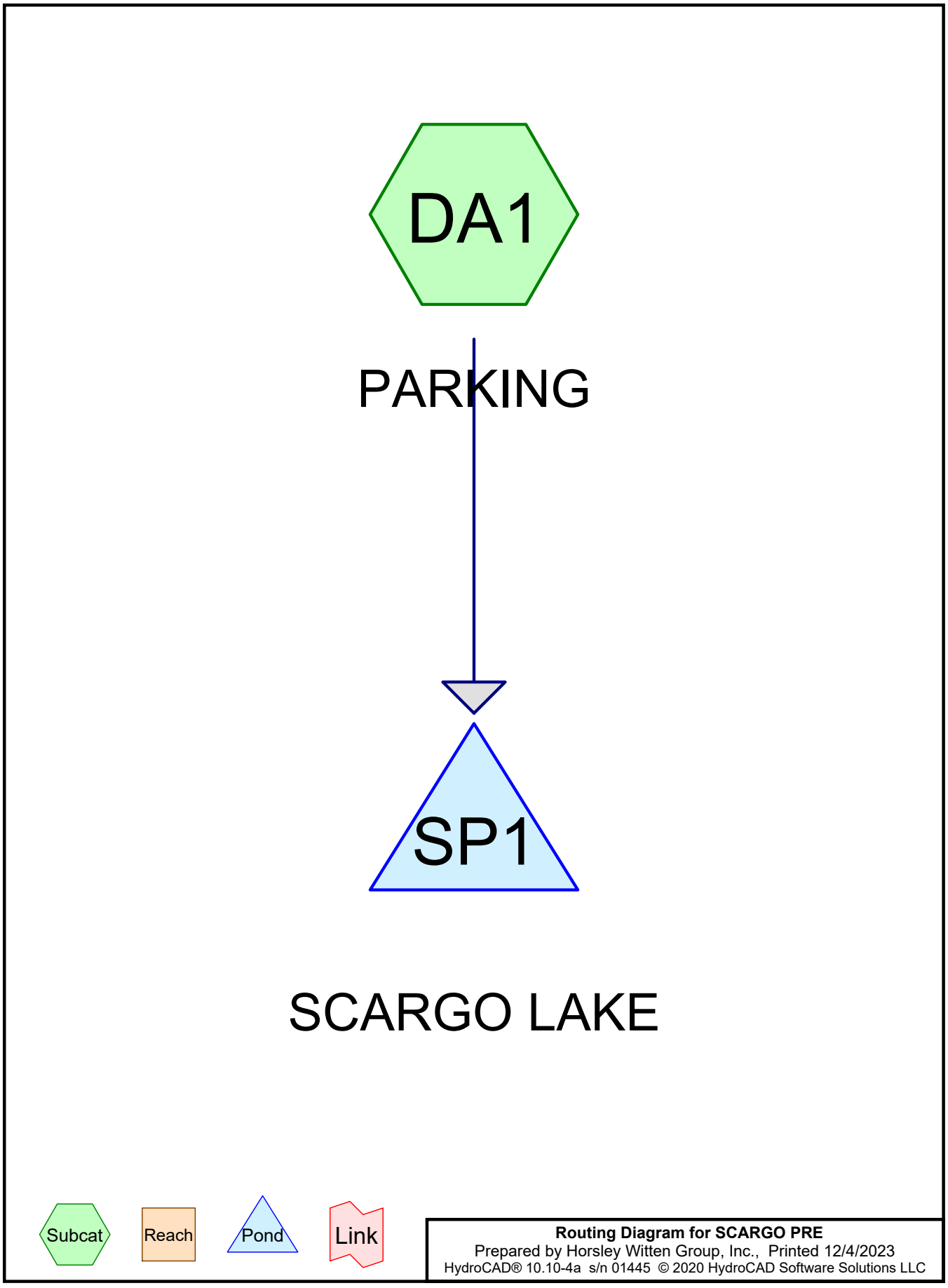
Device	Routing	Invert	Outlet Devices
#1	Secondary	12.25'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	11.00'	**6.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 11.00' / 10.95' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#3	Device 2	10.40'	**2.410 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.02 cfs @ 12.93 hrs HW=11.93' (Free Discharge)
↑—**2=Culvert** (Passes 0.02 cfs of 0.62 cfs potential flow)
↑—**3=Exfiltration** (Exfiltration Controls 0.02 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=10.40' (Free Discharge)
↑—**1=Orifice/Grate** (Controls 0.00 cfs)

Pond P1: NORTH BIO





Routing Diagram for SCARGO PRE
Prepared by Horsley Witten Group, Inc., Printed 12/4/2023

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2 YR	Type III 24-hr		Default	24.00	1	3.59	2
2	10 YR	Type III 24-hr		Default	24.00	1	5.27	2
3	25 YR	Type III 24-hr		Default	24.00	1	6.53	2
4	100 YR	Type III 24-hr		Default	24.00	1	8.57	2
5	WQv	Type III 24-hr		Default	24.00	1	1.21	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.029	39	>75% Grass cover, Good, HSG A (DA1)
0.120	96	Gravel surface, HSG A (DA1)
0.015	98	Unconnected pavement, HSG A (DA1)
0.017	30	Woods, Good, HSG A (DA1)
0.181	**81**	**TOTAL AREA**

Time span=0.00-48.00 hrs, dt=0.02 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: PARKING Runoff Area=7,895 sf 8.11% Impervious Runoff Depth=1.69"
Tc=5.0 min UI Adjusted CN=80 Runoff=0.37 cfs 0.026 af

Pond SP1: SCARGO LAKE Inflow=0.37 cfs 0.026 af
Primary=0.37 cfs 0.026 af

Total Runoff Area = 0.181 ac Runoff Volume = 0.026 af Average Runoff Depth = 1.69"
91.89% Pervious = 0.167 ac 8.11% Impervious = 0.015 ac

Summary for Subcatchment DA1: PARKING

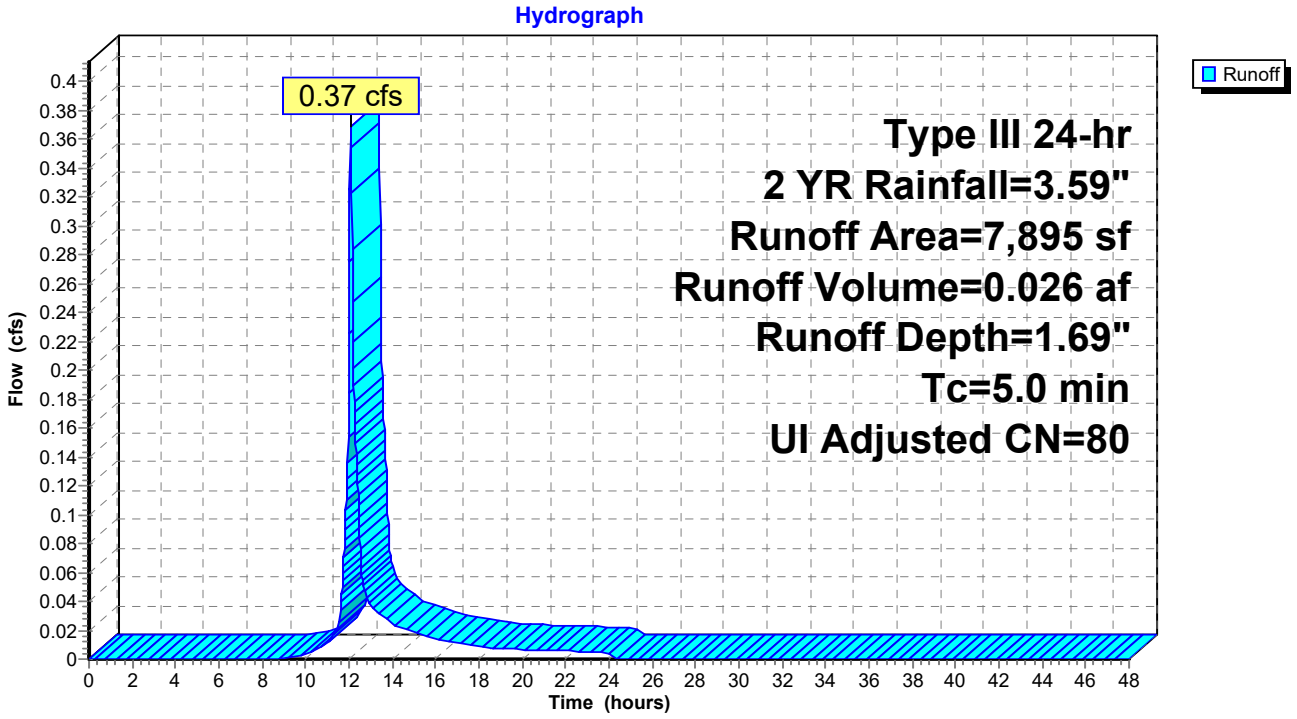
Runoff = 0.37 cfs @ 12.08 hrs, Volume= 0.026 af, Depth= 1.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 2 YR Rainfall=3.59"

Area (sf)	CN	Adj	Description
640	98		Unconnected pavement, HSG A
5,208	96		Gravel surface, HSG A
762	30		Woods, Good, HSG A
1,285	39		>75% Grass cover, Good, HSG A
7,895	81	80	Weighted Average, UI Adjusted
7,255	79	79	91.89% Pervious Area
640	98	98	8.11% Impervious Area
640			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA1: PARKING

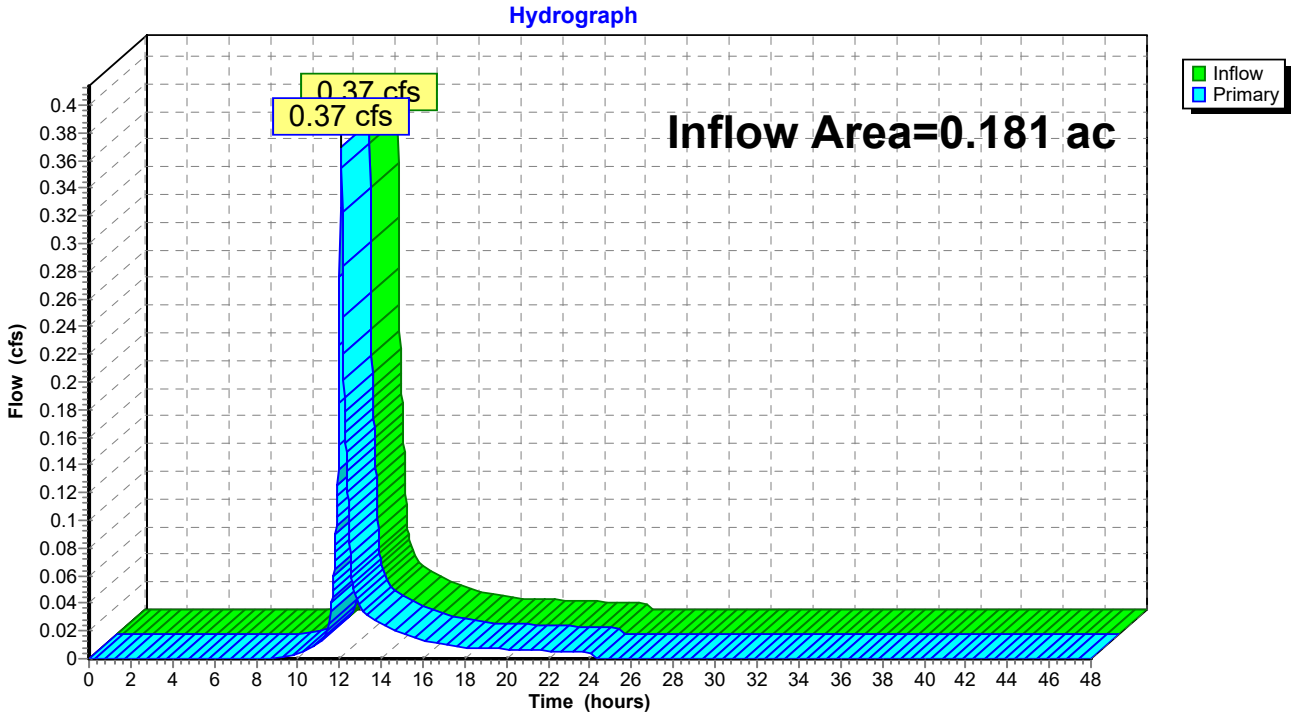


Summary for Pond SP1: SCARGO LAKE

Inflow Area = 0.181 ac, 8.11% Impervious, Inflow Depth = 1.69" for 2 YR event
Inflow = 0.37 cfs @ 12.08 hrs, Volume= 0.026 af
Primary = 0.37 cfs @ 12.08 hrs, Volume= 0.026 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: SCARGO LAKE



Time span=0.00-48.00 hrs, dt=0.02 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: PARKING Runoff Area=7,895 sf 8.11% Impervious Runoff Depth=3.11"
Tc=5.0 min UI Adjusted CN=80 Runoff=0.68 cfs 0.047 af

Pond SP1: SCARGO LAKE Inflow=0.68 cfs 0.047 af
Primary=0.68 cfs 0.047 af

Total Runoff Area = 0.181 ac Runoff Volume = 0.047 af Average Runoff Depth = 3.11"
91.89% Pervious = 0.167 ac 8.11% Impervious = 0.015 ac

Summary for Subcatchment DA1: PARKING

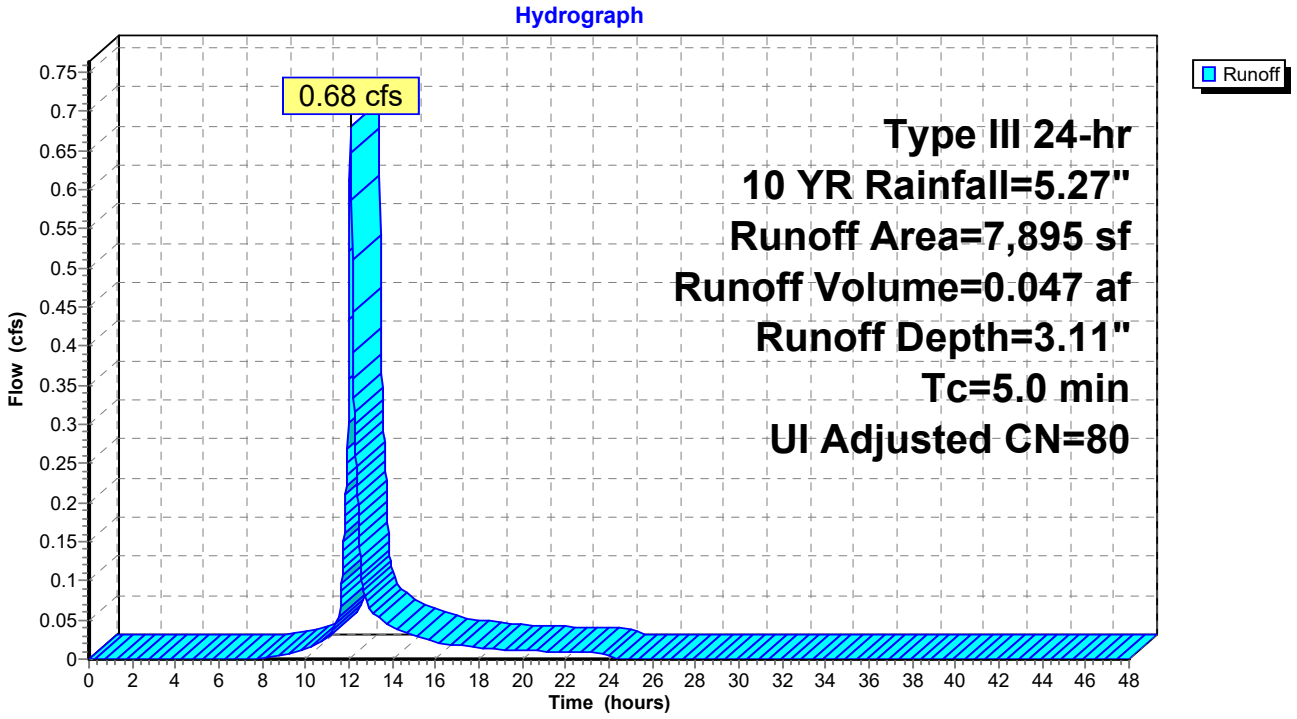
Runoff = 0.68 cfs @ 12.08 hrs, Volume= 0.047 af, Depth= 3.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 10 YR Rainfall=5.27"

Area (sf)	CN	Adj	Description
640	98		Unconnected pavement, HSG A
5,208	96		Gravel surface, HSG A
762	30		Woods, Good, HSG A
1,285	39		>75% Grass cover, Good, HSG A
7,895	81	80	Weighted Average, UI Adjusted
7,255	79	79	91.89% Pervious Area
640	98	98	8.11% Impervious Area
640			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA1: PARKING

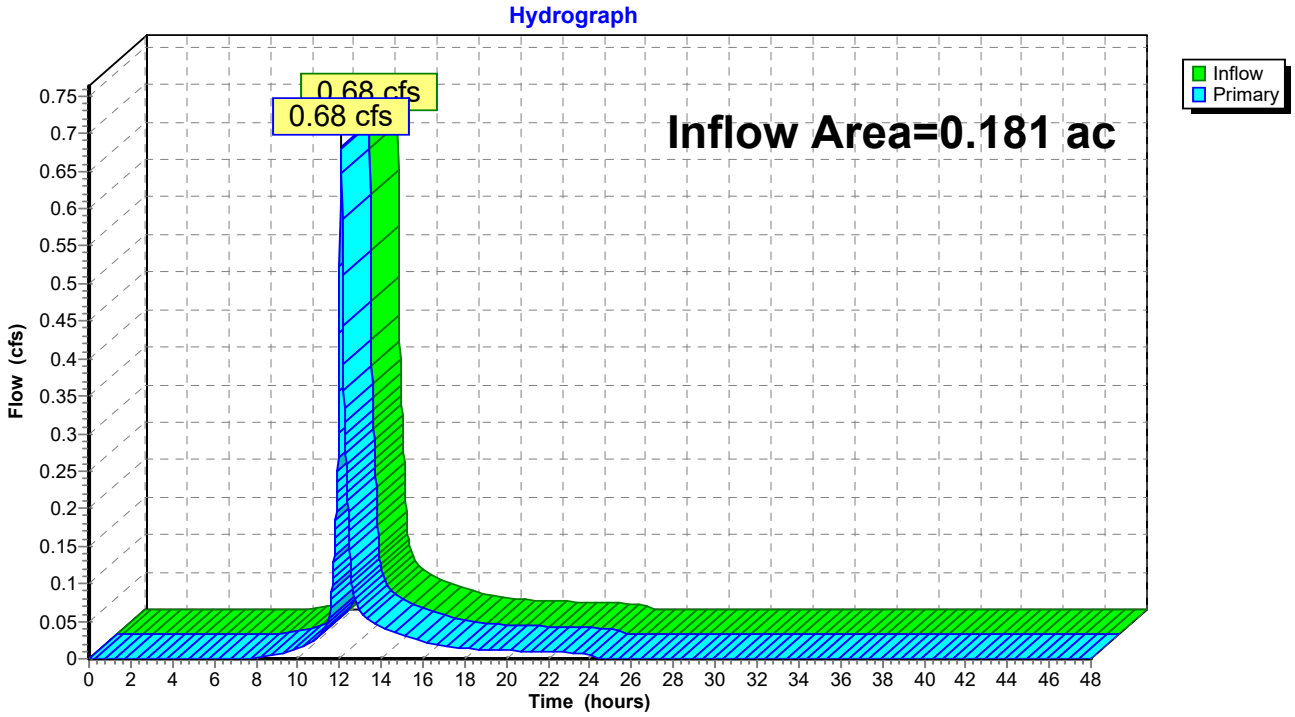


Summary for Pond SP1: SCARGO LAKE

Inflow Area = 0.181 ac, 8.11% Impervious, Inflow Depth = 3.11" for 10 YR event
Inflow = 0.68 cfs @ 12.08 hrs, Volume= 0.047 af
Primary = 0.68 cfs @ 12.08 hrs, Volume= 0.047 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: SCARGO LAKE



Time span=0.00-48.00 hrs, dt=0.02 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: PARKING Runoff Area=7,895 sf 8.11% Impervious Runoff Depth=4.24"
Tc=5.0 min UI Adjusted CN=80 Runoff=0.92 cfs 0.064 af

Pond SP1: SCARGO LAKE Inflow=0.92 cfs 0.064 af
Primary=0.92 cfs 0.064 af

Total Runoff Area = 0.181 ac Runoff Volume = 0.064 af Average Runoff Depth = 4.24"
91.89% Pervious = 0.167 ac 8.11% Impervious = 0.015 ac

Summary for Subcatchment DA1: PARKING

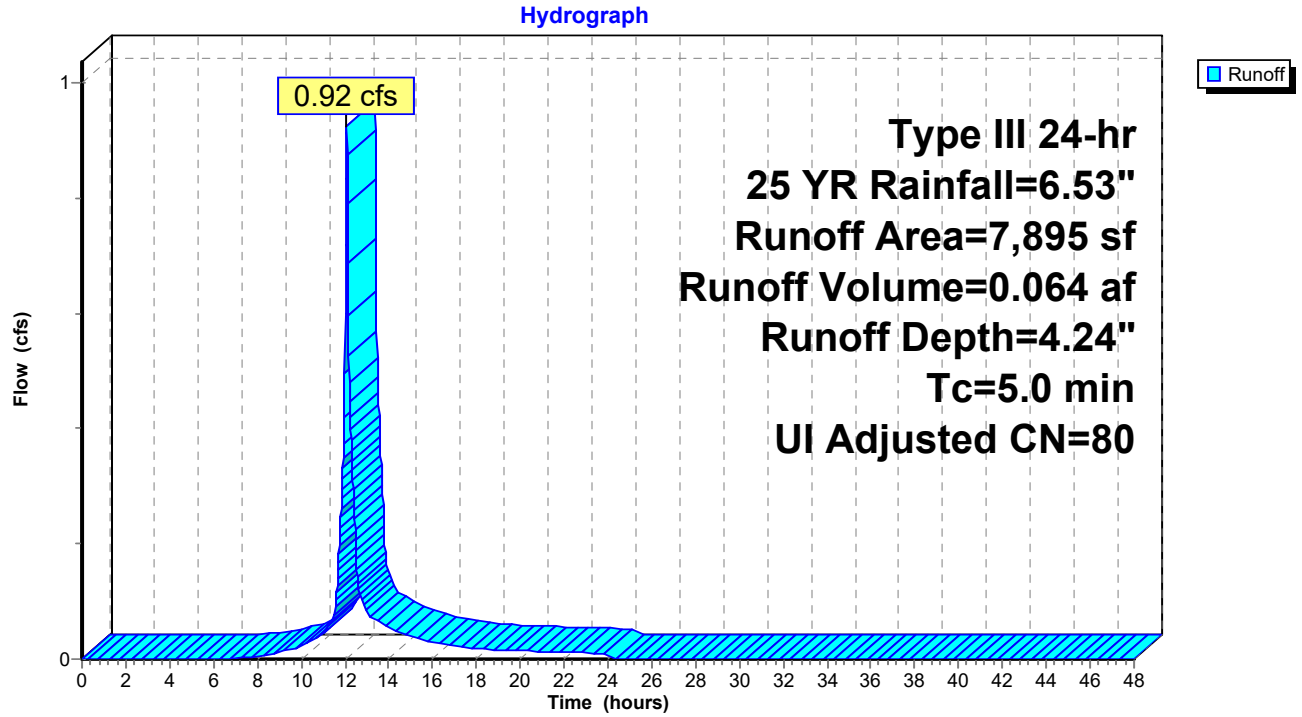
Runoff = 0.92 cfs @ 12.07 hrs, Volume= 0.064 af, Depth= 4.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 25 YR Rainfall=6.53"

Area (sf)	CN	Adj	Description
640	98		Unconnected pavement, HSG A
5,208	96		Gravel surface, HSG A
762	30		Woods, Good, HSG A
1,285	39		>75% Grass cover, Good, HSG A
7,895	81	80	Weighted Average, UI Adjusted
7,255	79	79	91.89% Pervious Area
640	98	98	8.11% Impervious Area
640			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA1: PARKING

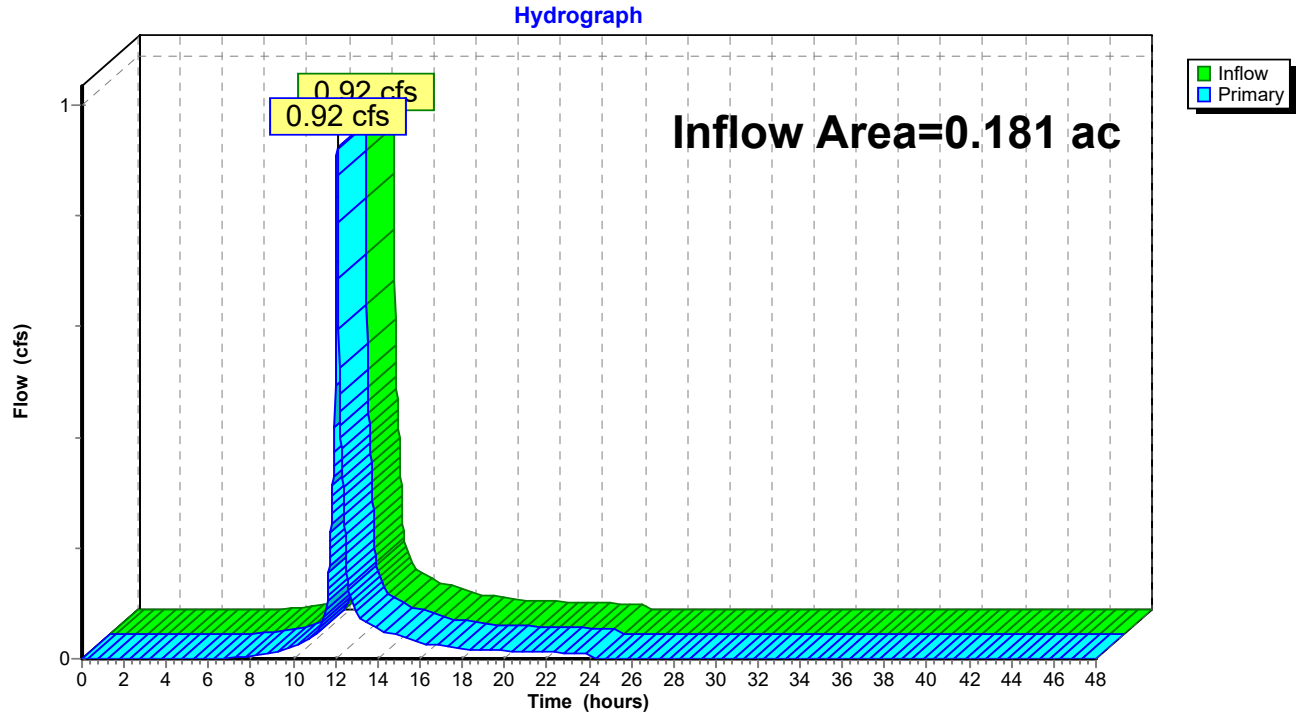


Summary for Pond SP1: SCARGO LAKE

Inflow Area = 0.181 ac, 8.11% Impervious, Inflow Depth = 4.24" for 25 YR event
Inflow = 0.92 cfs @ 12.07 hrs, Volume= 0.064 af
Primary = 0.92 cfs @ 12.07 hrs, Volume= 0.064 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: SCARGO LAKE



Time span=0.00-48.00 hrs, dt=0.02 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: PARKING Runoff Area=7,895 sf 8.11% Impervious Runoff Depth=6.13"
Tc=5.0 min UI Adjusted CN=80 Runoff=1.32 cfs 0.093 af

Pond SP1: SCARGO LAKE Inflow=1.32 cfs 0.093 af
Primary=1.32 cfs 0.093 af

Total Runoff Area = 0.181 ac Runoff Volume = 0.093 af Average Runoff Depth = 6.13"
91.89% Pervious = 0.167 ac 8.11% Impervious = 0.015 ac

Summary for Subcatchment DA1: PARKING

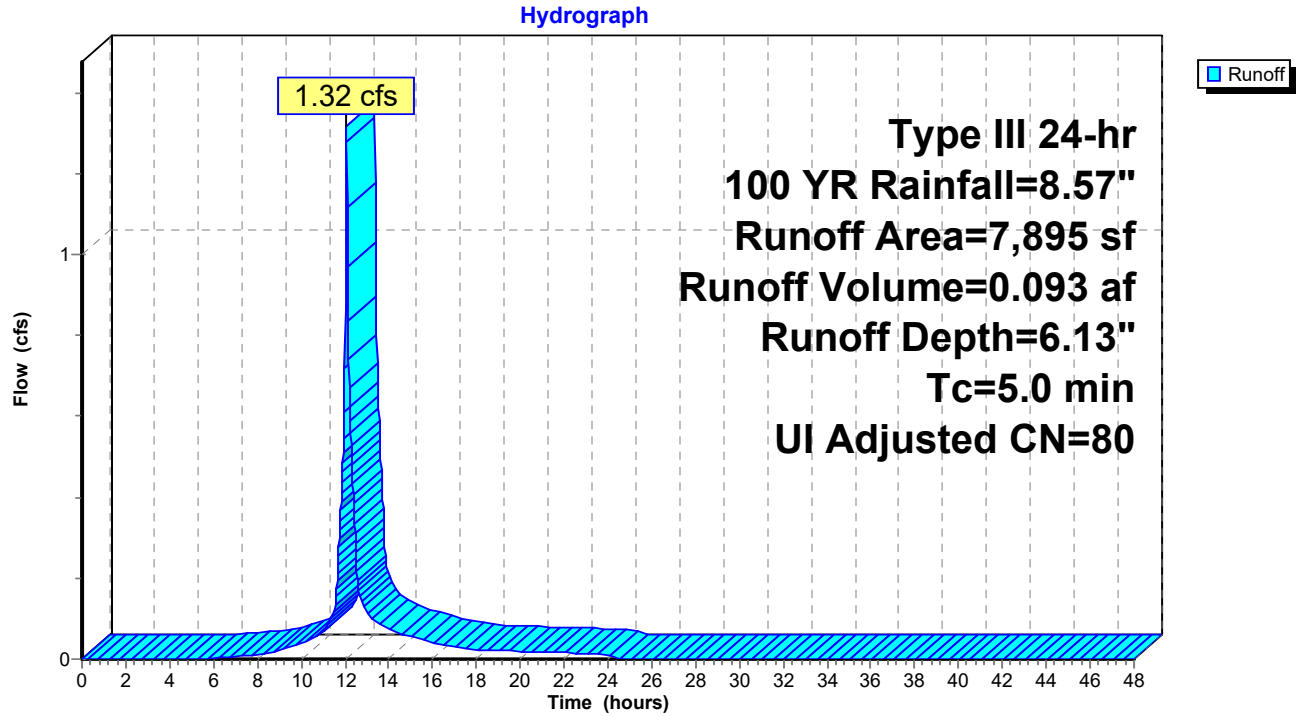
Runoff = 1.32 cfs @ 12.07 hrs, Volume= 0.093 af, Depth= 6.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 100 YR Rainfall=8.57"

Area (sf)	CN	Adj	Description
640	98		Unconnected pavement, HSG A
5,208	96		Gravel surface, HSG A
762	30		Woods, Good, HSG A
1,285	39		>75% Grass cover, Good, HSG A
7,895	81	80	Weighted Average, UI Adjusted
7,255	79	79	91.89% Pervious Area
640	98	98	8.11% Impervious Area
640			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA1: PARKING

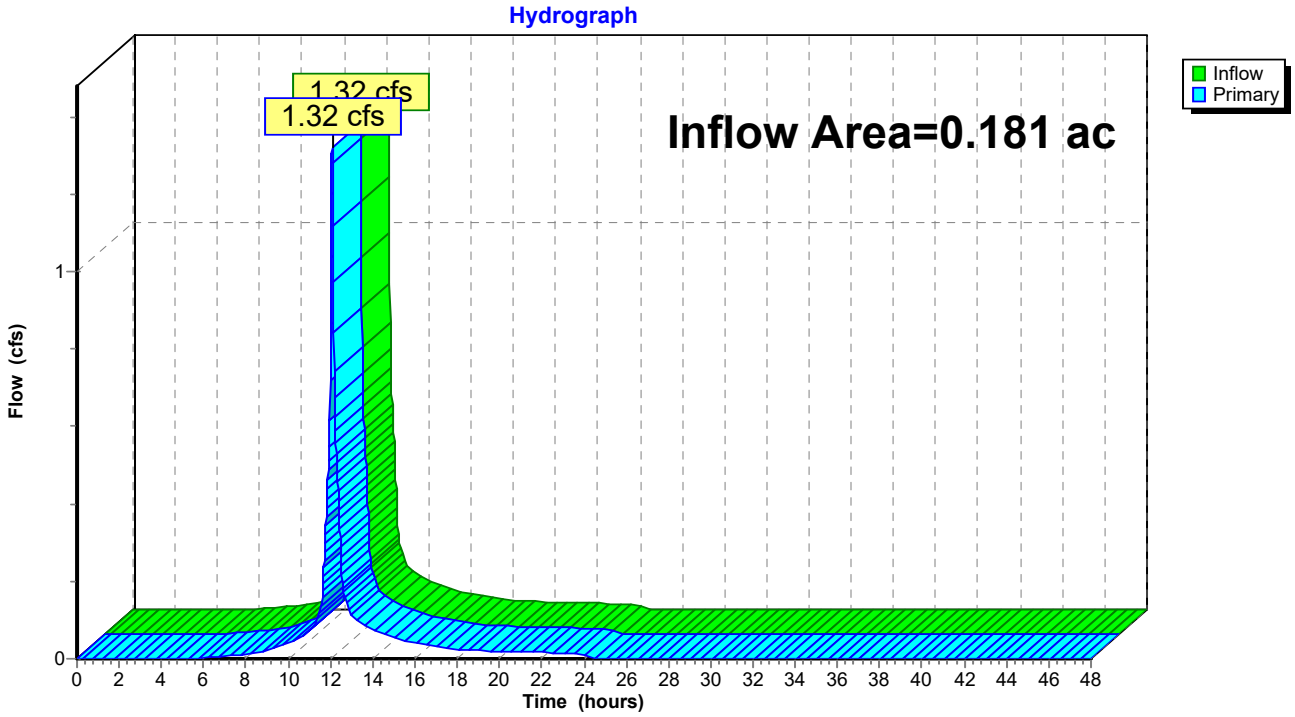


Summary for Pond SP1: SCARGO LAKE

Inflow Area = 0.181 ac, 8.11% Impervious, Inflow Depth = 6.13" for 100 YR event
Inflow = 1.32 cfs @ 12.07 hrs, Volume= 0.093 af
Primary = 1.32 cfs @ 12.07 hrs, Volume= 0.093 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: SCARGO LAKE



Time span=0.00-48.00 hrs, dt=0.02 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: PARKING Runoff Area=7,895 sf 8.11% Impervious Runoff Depth=0.15"
Tc=5.0 min UI Adjusted CN=80 Runoff=0.02 cfs 0.002 af

Pond SP1: SCARGO LAKE Inflow=0.02 cfs 0.002 af
Primary=0.02 cfs 0.002 af

Total Runoff Area = 0.181 ac Runoff Volume = 0.002 af Average Runoff Depth = 0.15"
91.89% Pervious = 0.167 ac 8.11% Impervious = 0.015 ac

Summary for Subcatchment DA1: PARKING

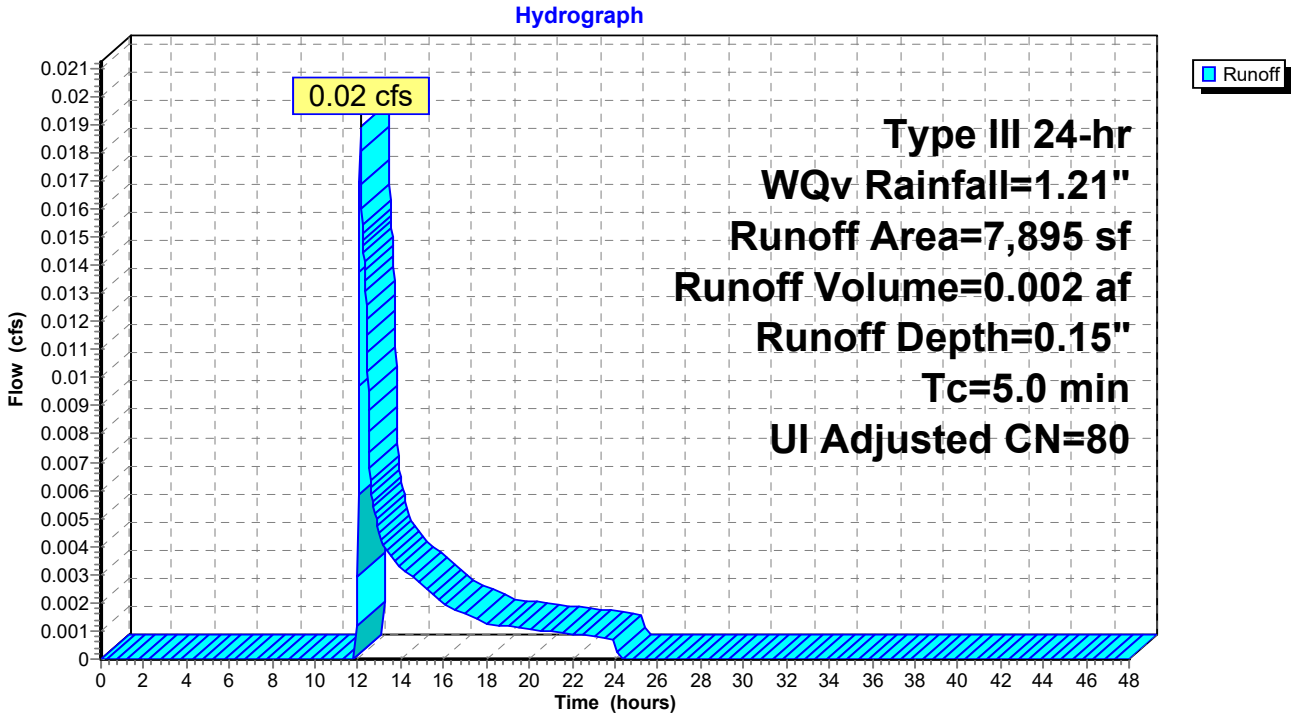
Runoff = 0.02 cfs @ 12.11 hrs, Volume= 0.002 af, Depth= 0.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr WQv Rainfall=1.21"

Area (sf)	CN	Adj	Description
640	98		Unconnected pavement, HSG A
5,208	96		Gravel surface, HSG A
762	30		Woods, Good, HSG A
1,285	39		>75% Grass cover, Good, HSG A
7,895	81	80	Weighted Average, UI Adjusted
7,255	79	79	91.89% Pervious Area
640	98	98	8.11% Impervious Area
640			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA1: PARKING

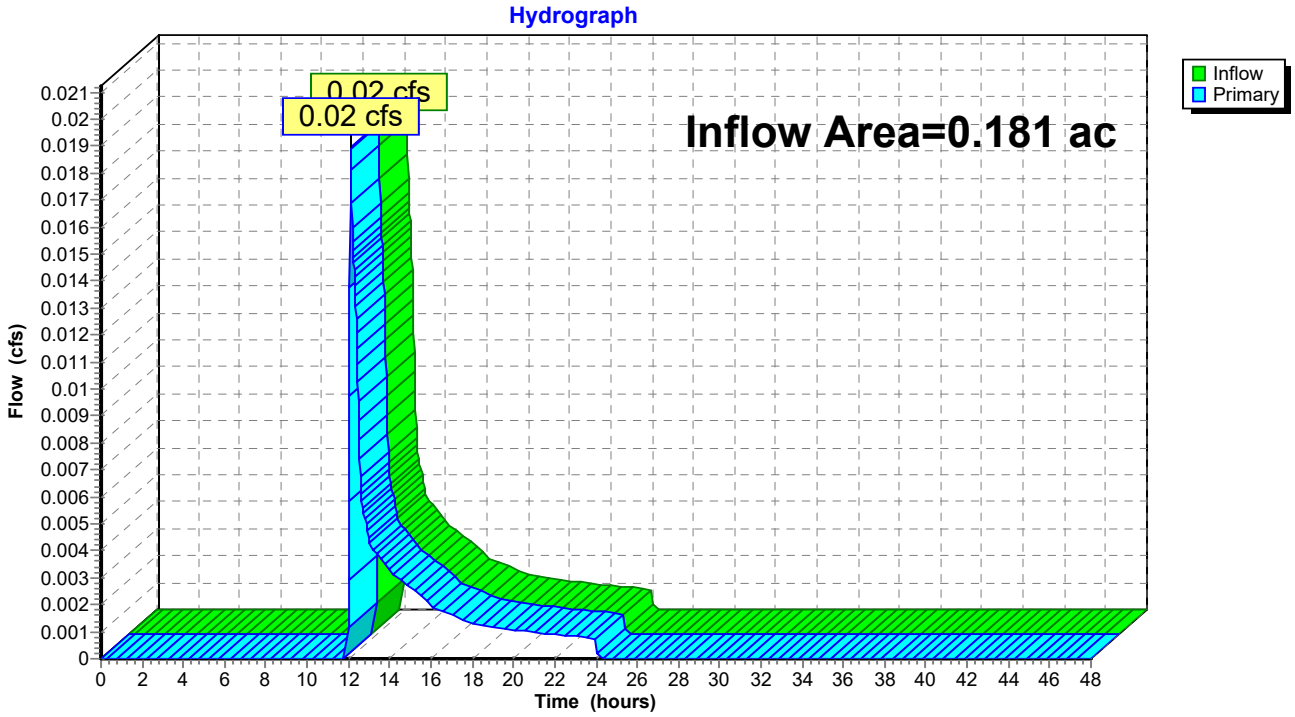


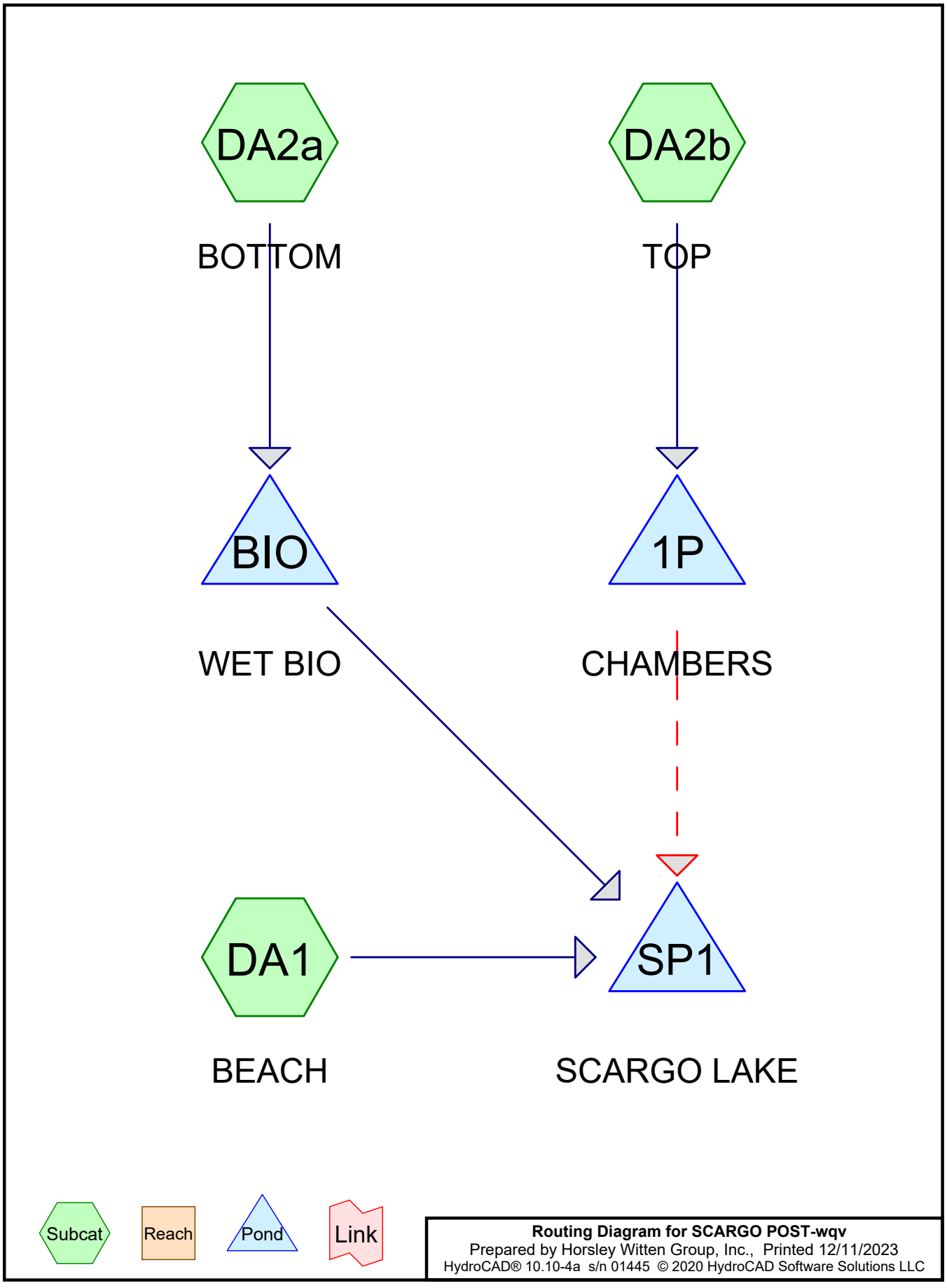
Summary for Pond SP1: SCARGO LAKE

Inflow Area = 0.181 ac, 8.11% Impervious, Inflow Depth = 0.15" for WQv event
Inflow = 0.02 cfs @ 12.11 hrs, Volume= 0.002 af
Primary = 0.02 cfs @ 12.11 hrs, Volume= 0.002 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: SCARGO LAKE





Routing Diagram for SCARGO POST-wqv
Prepared by Horsley Witten Group, Inc., Printed 12/11/2023

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	WQv	Type III 24-hr		Default	24.00	1	1.21	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.141	98	Unconnected pavement, HSG A (DA1, DA2a, DA2b)
0.141	**98**	**TOTAL AREA**

Time span=0.00-48.00 hrs, dt=0.02 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment DA1: BEACH Runoff Area=130 sf Runoff Depth=1.00"
Tc=5.0 min CN=98 Runoff=0.00 cfs 0.000 af

Subcatchment DA2a: BOTTOM Runoff Area=1,407 sf Runoff Depth=1.00"
Tc=5.0 min CN=98 Runoff=0.04 cfs 0.003 af

Subcatchment DA2b: TOP Runoff Area=4,614 sf Runoff Depth=1.00"
Tc=5.0 min CN=98 Runoff=0.12 cfs 0.009 af

Pond 1P: CHAMBERS Peak Elev=10.07' Storage=12 cf Inflow=0.12 cfs 0.009 af
Discarded=0.10 cfs 0.009 af Secondary=0.00 cfs 0.000 af Outflow=0.10 cfs 0.009 af

Pond BIO: WET BIO Peak Elev=10.32' Storage=117 cf Inflow=0.04 cfs 0.003 af
Outflow=0.00 cfs 0.000 af

Pond SP1: SCARGO LAKE Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Total Runoff Area = 0.141 ac Runoff Volume = 0.012 af Average Runoff Depth = 1.00"

Summary for Subcatchment DA1: BEACH

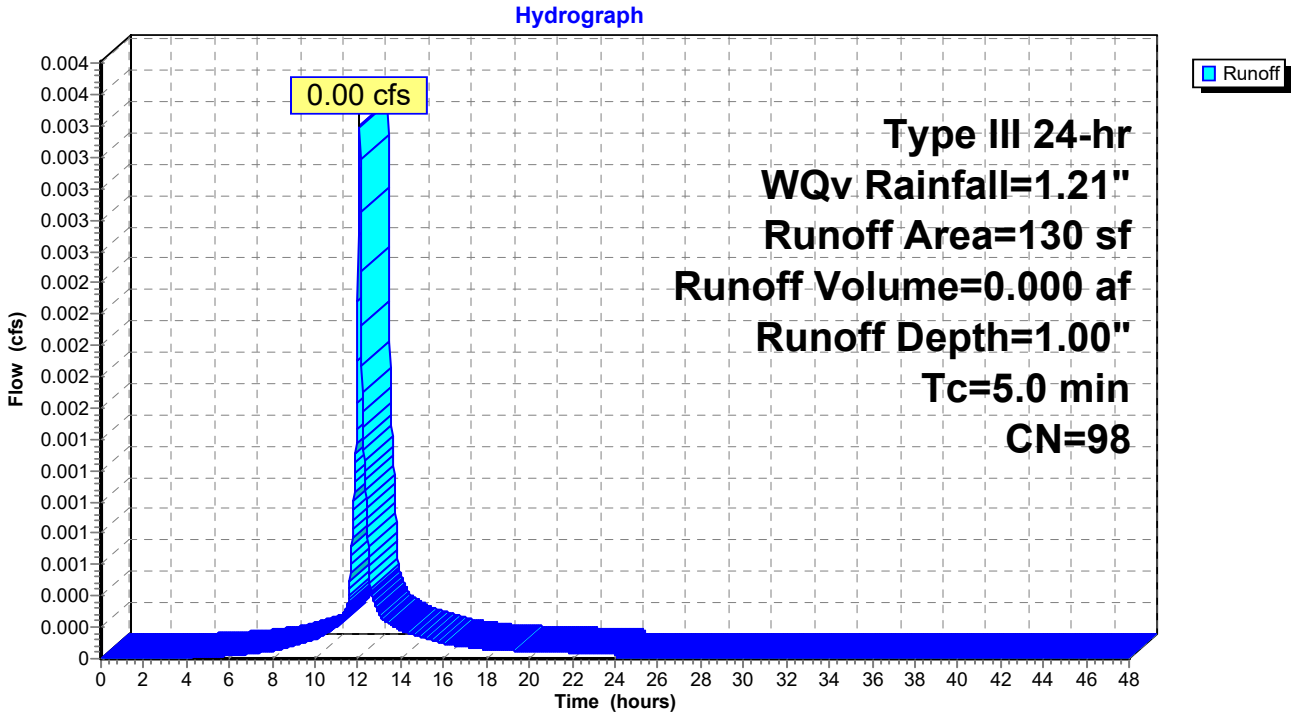
Runoff = 0.00 cfs @ 12.07 hrs, Volume= 0.000 af, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr WQv Rainfall=1.21"

Area (sf)	CN	Description
130	98	Unconnected pavement, HSG A

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA1: BEACH



Summary for Subcatchment DA2a: BOTTOM

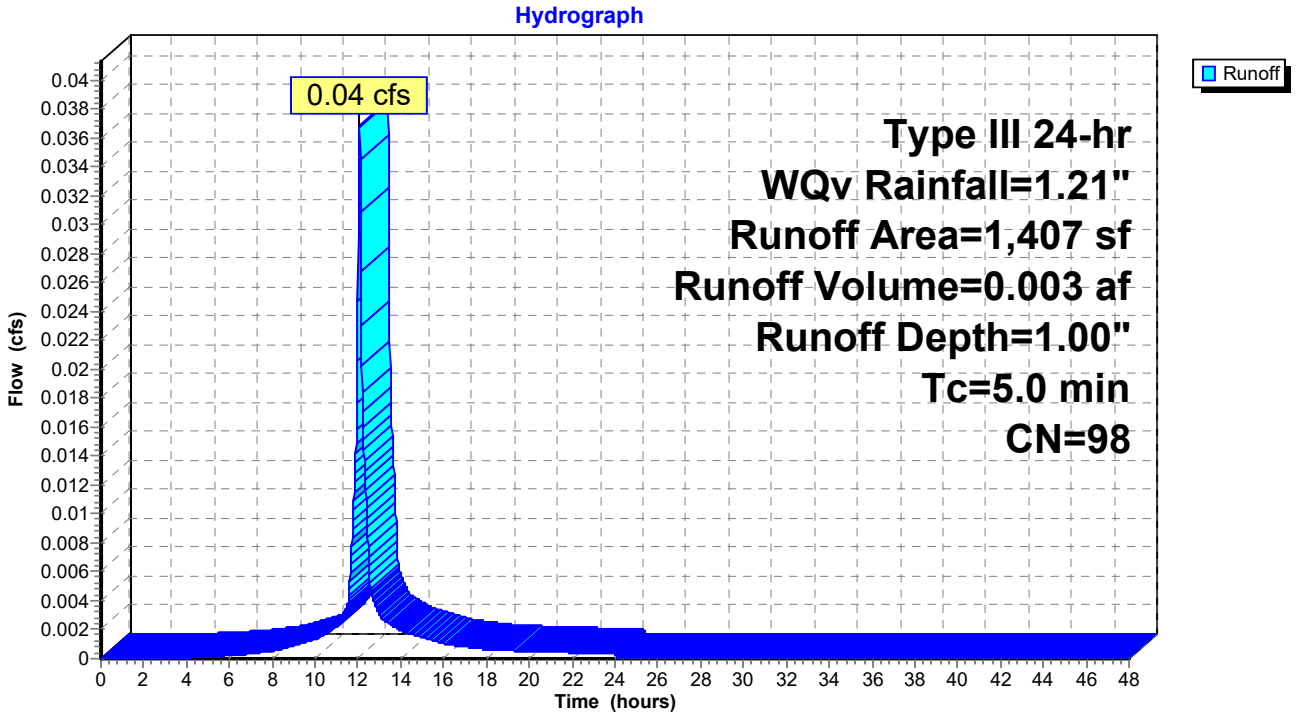
Runoff = 0.04 cfs @ 12.07 hrs, Volume= 0.003 af, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr WQv Rainfall=1.21"

Area (sf)	CN	Description
1,407	98	Unconnected pavement, HSG A

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA2a: BOTTOM



Summary for Subcatchment DA2b: TOP

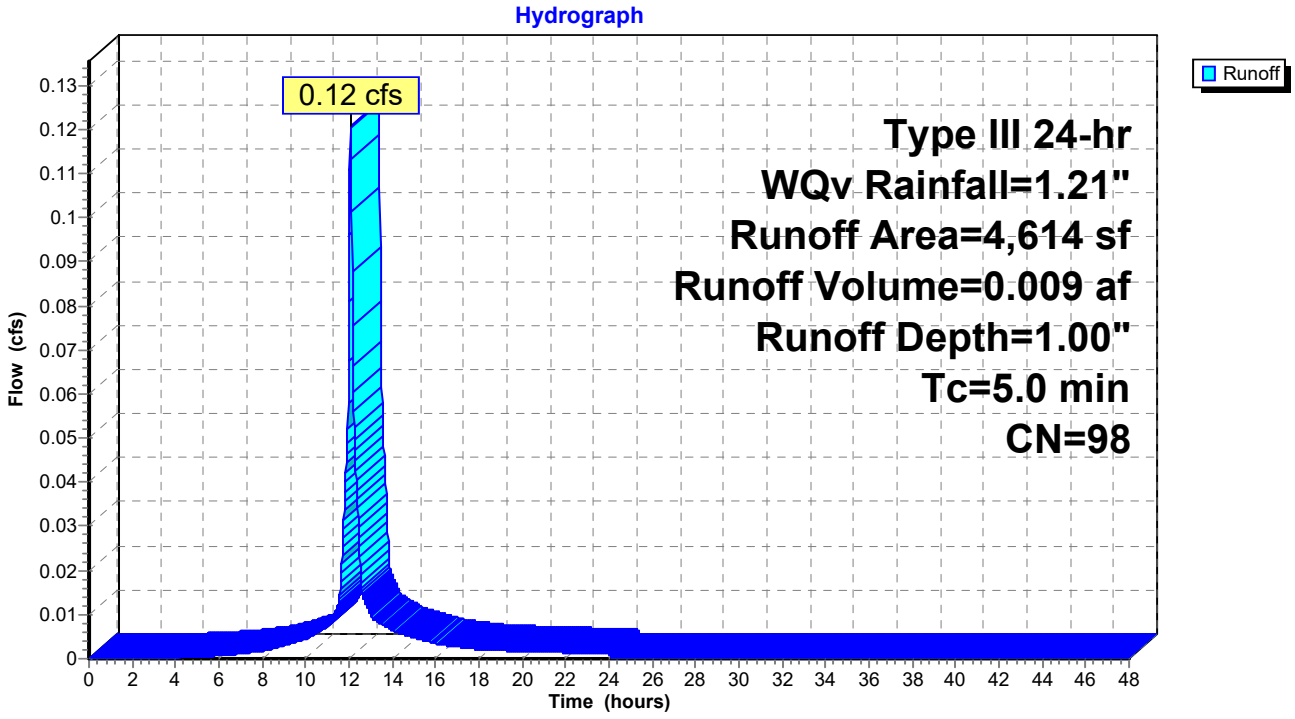
Runoff = 0.12 cfs @ 12.07 hrs, Volume= 0.009 af, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr WQv Rainfall=1.21"

Area (sf)	CN	Description
4,614	98	Unconnected pavement, HSG A

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA2b: TOP



Summary for Pond 1P: CHAMBERS

Inflow Area = 0.106 ac, Inflow Depth = 1.00" for WQv event
Inflow = 0.12 cfs @ 12.07 hrs, Volume= 0.009 af
Outflow = 0.10 cfs @ 12.06 hrs, Volume= 0.009 af, Atten= 20%, Lag= 0.0 min
Discarded = 0.10 cfs @ 12.06 hrs, Volume= 0.009 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 10.07' @ 12.13 hrs Surf.Area= 506 sf Storage= 12 cf

Plug-Flow detention time= 1.2 min calculated for 0.009 af (100% of inflow)
Center-of-Mass det. time= 1.2 min (782.1 - 780.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	10.00'	490 cf	**15.75'W x 32.10'L x 4.00'H Field A** 2,022 cf Overall - 551 cf Embedded = 1,471 cf x 33.3% Voids
#2A	11.00'	551 cf	**ADS_StormTech SC-740 +Cap** x 12 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 12 Chambers in 3 Rows
		1,041 cf	Total Available Storage

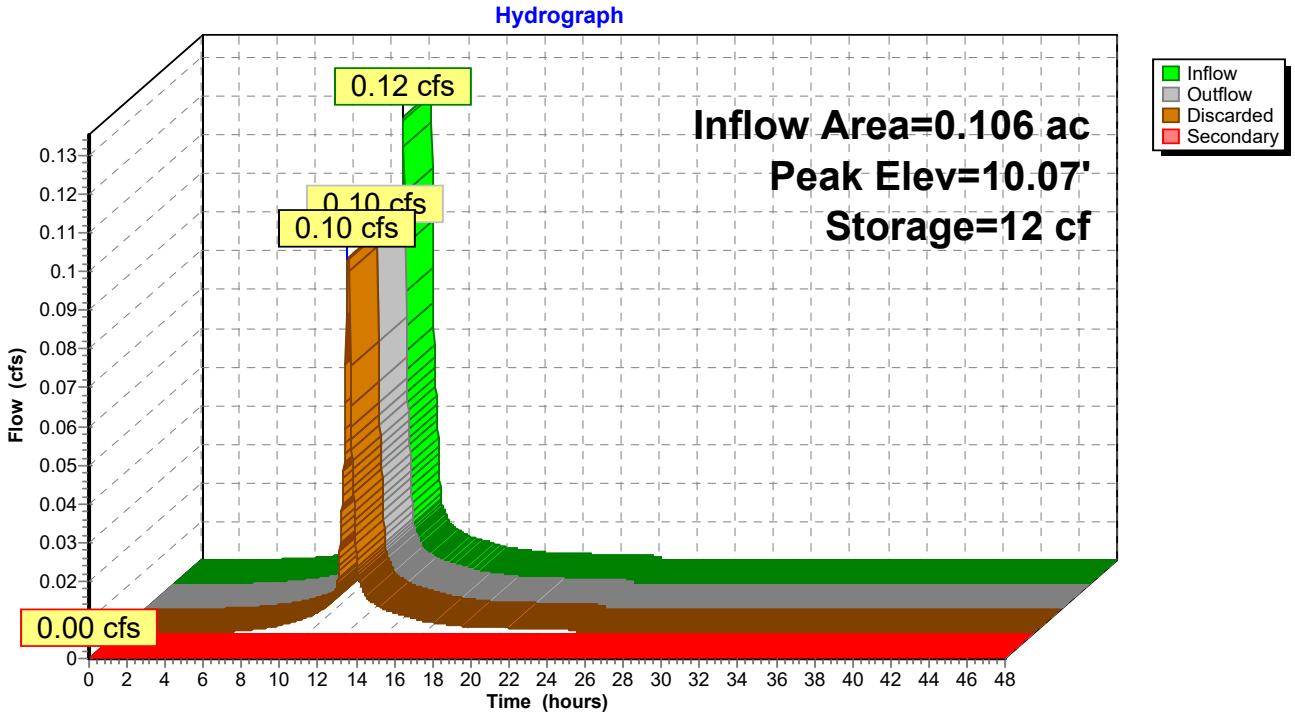
Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	10.00'	**8.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Secondary	13.50'	**24.0" x 24.0" Horiz. DCB104** X 2 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.10 cfs @ 12.06 hrs HW=10.05' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.10 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=10.00' (Free Discharge)
↑**2=DCB104** (Controls 0.00 cfs)

Pond 1P: CHAMBERS



Summary for Pond BIO: WET BIO

Inflow Area = 0.032 ac, Inflow Depth = 1.00" for WQv event
Inflow = 0.04 cfs @ 12.07 hrs, Volume= 0.003 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 10.32' @ 24.30 hrs Surf.Area= 169 sf Storage= 117 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

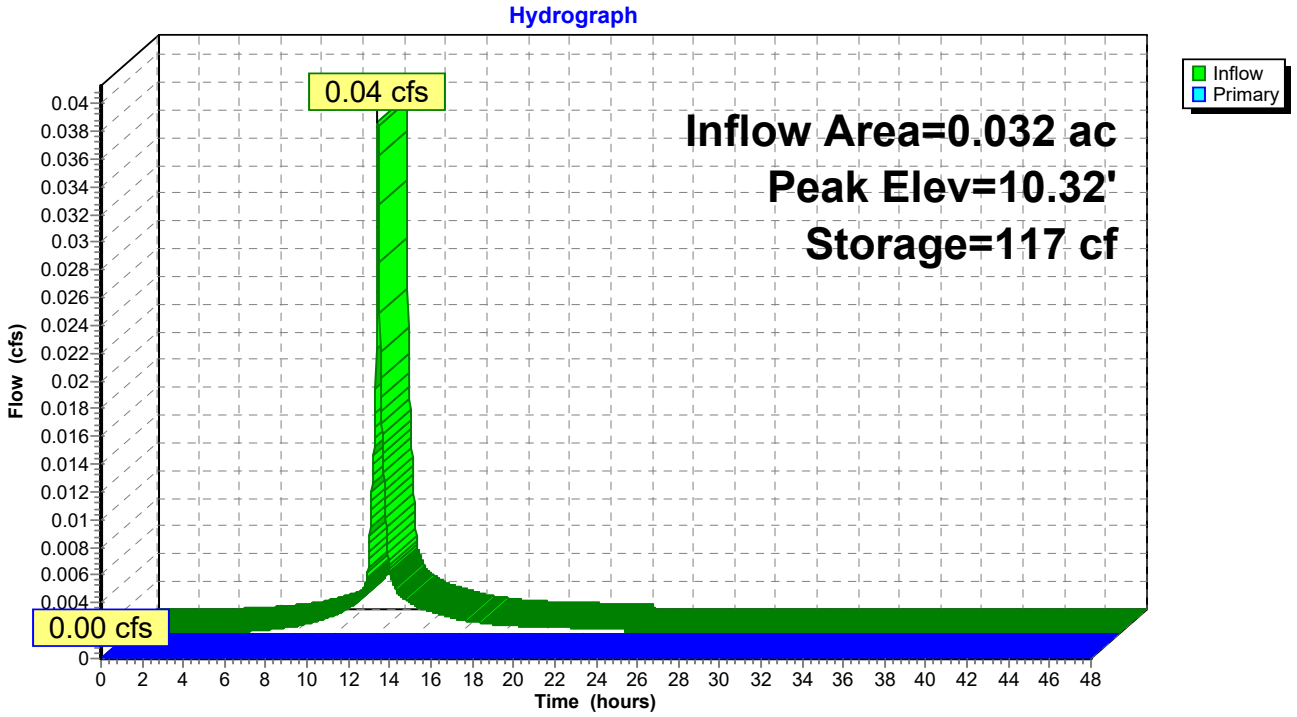
Volume	Invert	Avail.Storage	Storage Description
#1	8.75'	418 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.75	5	0	0
9.00	20	3	3
10.00	115	68	71
11.00	280	198	268
11.25	500	98	366
11.26	10,000	52	418

Device	Routing	Invert	Outlet Devices
#1	Primary	10.75'	**7.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=8.75' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond BIO: WET BIO

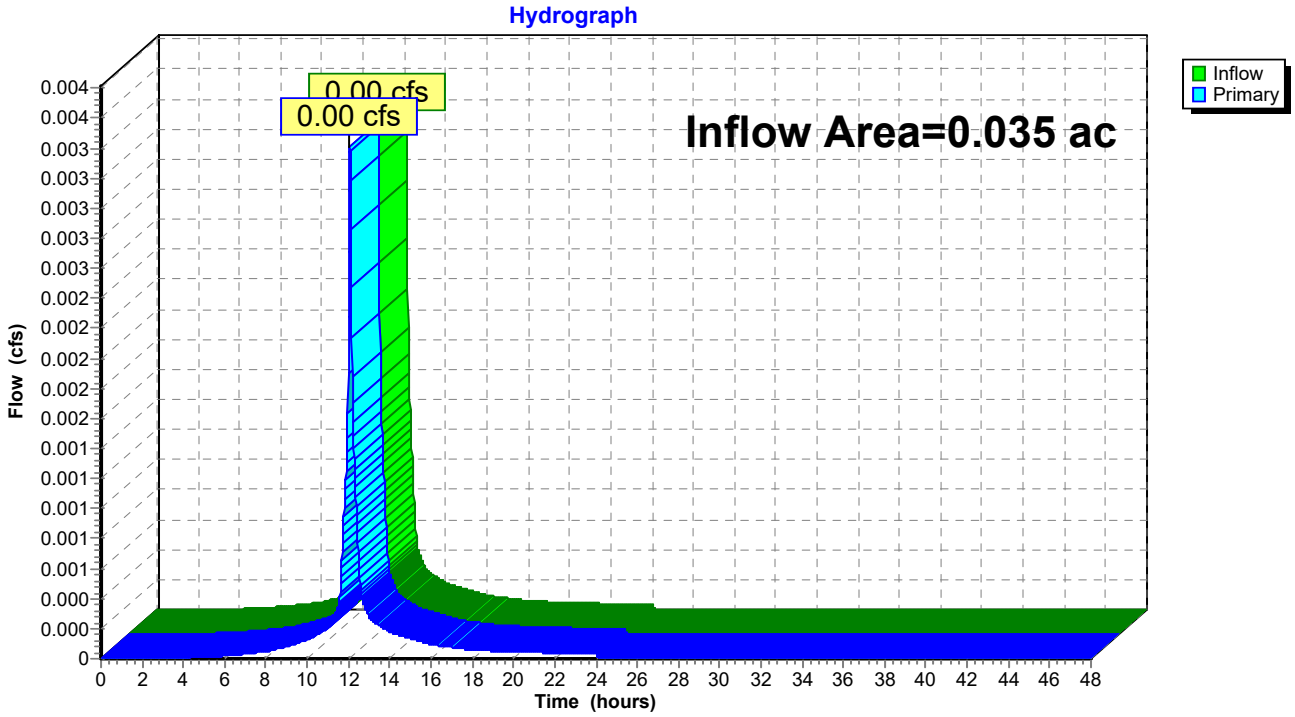


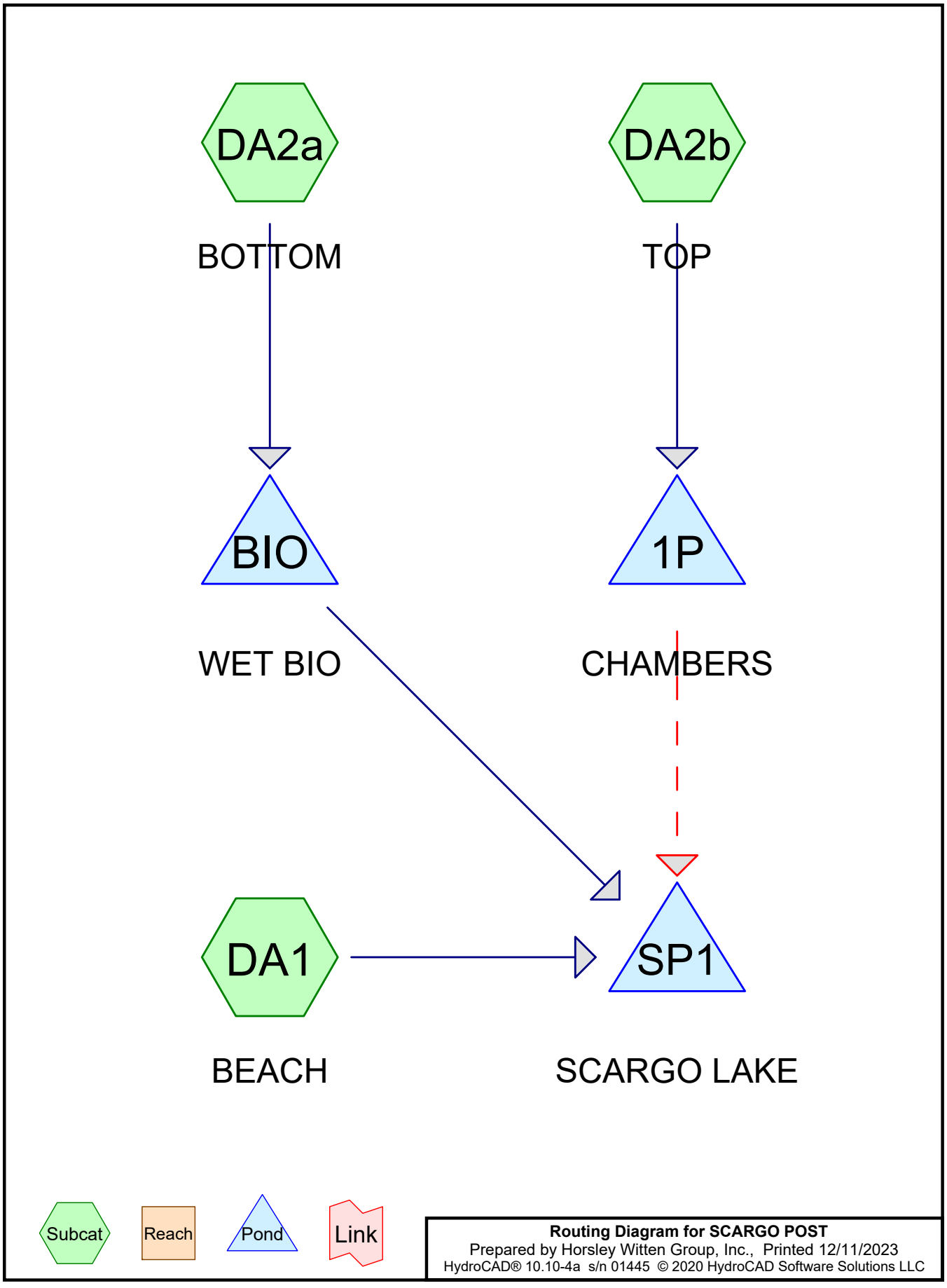
Summary for Pond SP1: SCARGO LAKE

Inflow Area = 0.035 ac, Inflow Depth = 0.08" for WQv event
Inflow = 0.00 cfs @ 12.07 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 12.07 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: SCARGO LAKE





Routing Diagram for SCARGO POST
Prepared by Horsley Witten Group, Inc., Printed 12/11/2023

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2 YR	Type III 24-hr		Default	24.00	1	3.59	2
2	10 YR	Type III 24-hr		Default	24.00	1	5.27	2
3	25 YR	Type III 24-hr		Default	24.00	1	6.53	2
4	100 YR	Type III 24-hr		Default	24.00	1	8.57	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.029	39	>75% Grass cover, Good, HSG A (DA1, DA2a, DA2b)
0.141	98	Unconnected pavement, HSG A (DA1, DA2a, DA2b)
0.001	98	Water Surface, HSG A (DA2a)
0.010	30	Woods, Good, HSG A (DA1, DA2a, DA2b)
0.181	**85**	**TOTAL AREA**

Time span=0.00-48.00 hrs, dt=0.02 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment DA1: BEACH Runoff Area=493 sf Runoff Depth=0.09"
Tc=5.0 min UI Adjusted CN=45 Runoff=0.00 cfs 0.000 af

Subcatchment DA2a: BOTTOM Runoff Area=2,149 sf Runoff Depth=1.63"
Tc=5.0 min CN=79 Runoff=0.10 cfs 0.007 af

Subcatchment DA2b: TOP Runoff Area=5,253 sf Runoff Depth=2.57"
Tc=5.0 min CN=90 Runoff=0.37 cfs 0.026 af

Pond 1P: CHAMBERS Peak Elev=11.13' Storage=217 cf Inflow=0.37 cfs 0.026 af
Discarded=0.10 cfs 0.026 af Secondary=0.00 cfs 0.000 af Outflow=0.10 cfs 0.026 af

Pond BIO: WET BIO Peak Elev=10.75' Storage=204 cf Inflow=0.10 cfs 0.007 af
Outflow=0.01 cfs 0.002 af

Pond SP1: SCARGO LAKE Inflow=0.01 cfs 0.002 af
Primary=0.01 cfs 0.002 af

Total Runoff Area = 0.181 ac Runoff Volume = 0.033 af Average Runoff Depth = 2.16"

Summary for Subcatchment DA1: BEACH

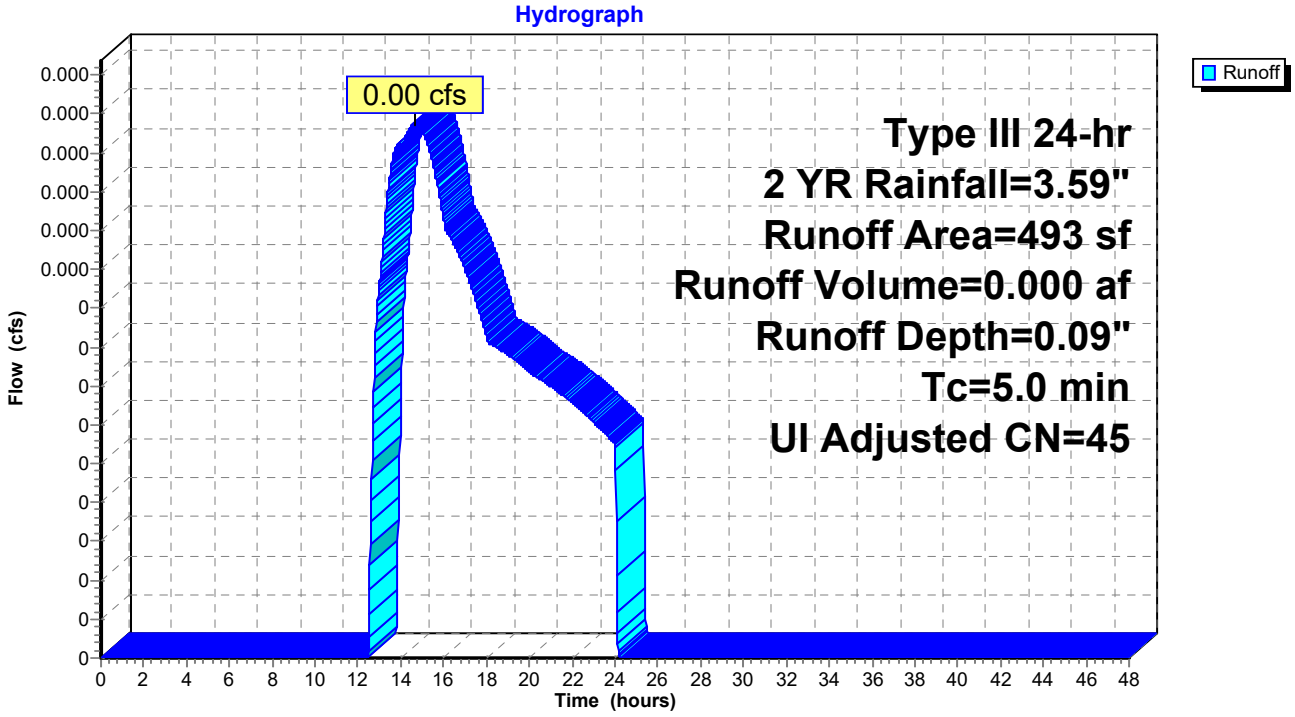
Runoff = 0.00 cfs @ 14.68 hrs, Volume= 0.000 af, Depth= 0.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 2 YR Rainfall=3.59"

Area (sf)	CN	Adj	Description
130	98		Unconnected pavement, HSG A
101	30		Woods, Good, HSG A
262	39		>75% Grass cover, Good, HSG A
493	53	45	Weighted Average, UI Adjusted

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA1: BEACH



Summary for Subcatchment DA2a: BOTTOM

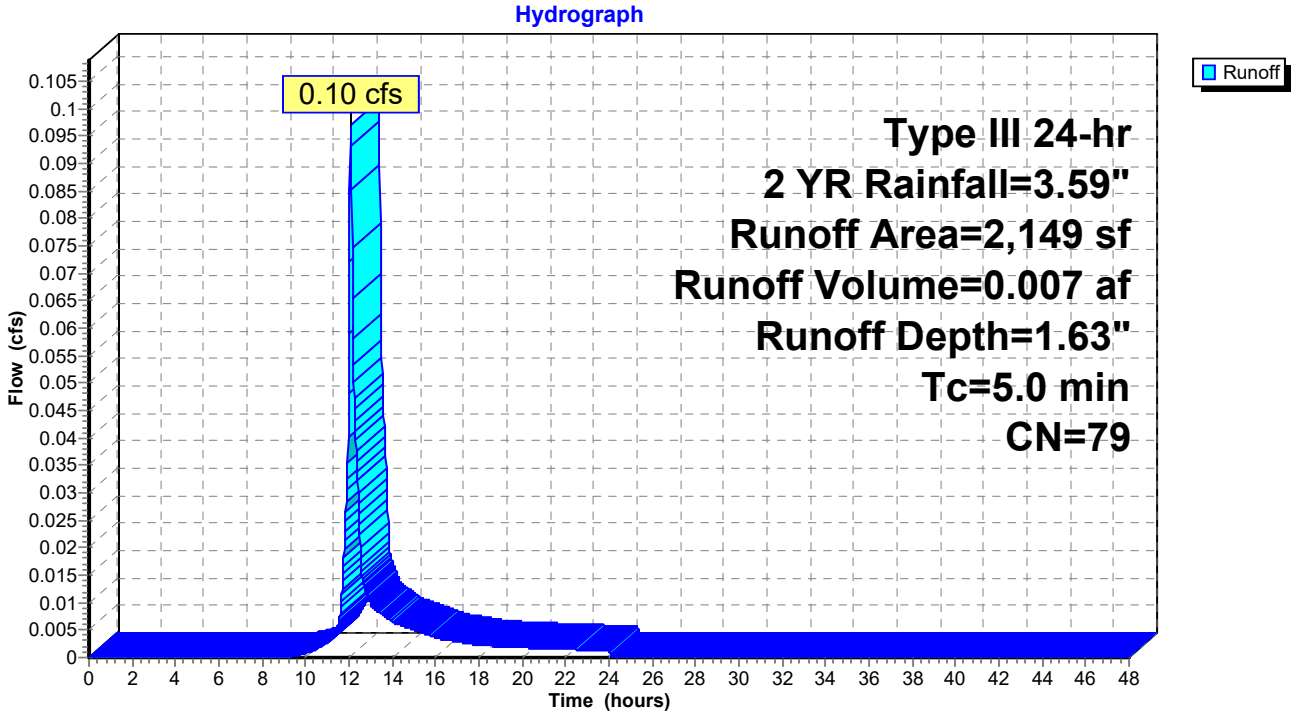
Runoff = 0.10 cfs @ 12.08 hrs, Volume= 0.007 af, Depth= 1.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 2 YR Rainfall=3.59"

Area (sf)	CN	Description
1,407	98	Unconnected pavement, HSG A
90	30	Woods, Good, HSG A
589	39	>75% Grass cover, Good, HSG A
63	98	Water Surface, HSG A
2,149	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA2a: BOTTOM



Summary for Subcatchment DA2b: TOP

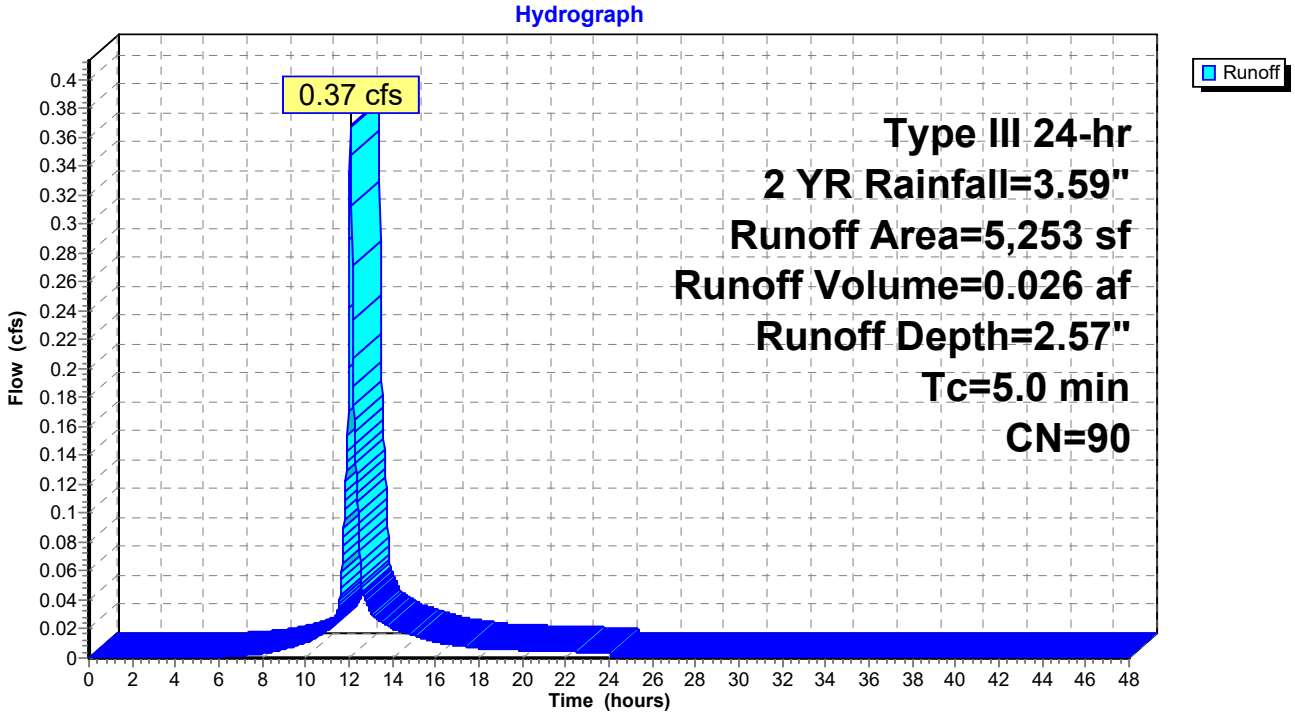
Runoff = 0.37 cfs @ 12.07 hrs, Volume= 0.026 af, Depth= 2.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 2 YR Rainfall=3.59"

Area (sf)	CN	Description
4,614	98	Unconnected pavement, HSG A
224	30	Woods, Good, HSG A
415	39	>75% Grass cover, Good, HSG A
5,253	90	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA2b: TOP



Summary for Pond 1P: CHAMBERS

Inflow Area = 0.121 ac, Inflow Depth = 2.57" for 2 YR event
Inflow = 0.37 cfs @ 12.07 hrs, Volume= 0.026 af
Outflow = 0.10 cfs @ 11.82 hrs, Volume= 0.026 af, Atten= 74%, Lag= 0.0 min
Discarded = 0.10 cfs @ 11.82 hrs, Volume= 0.026 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 11.13' @ 12.43 hrs Surf.Area= 506 sf Storage= 217 cf

Plug-Flow detention time= 11.4 min calculated for 0.026 af (100% of inflow)
Center-of-Mass det. time= 11.4 min (811.2 - 799.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	10.00'	490 cf	**15.75'W x 32.10'L x 4.00'H Field A** 2,022 cf Overall - 551 cf Embedded = 1,471 cf x 33.3% Voids
#2A	11.00'	551 cf	**ADS_StormTech SC-740 +Cap** x 12 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 12 Chambers in 3 Rows
		1,041 cf	Total Available Storage

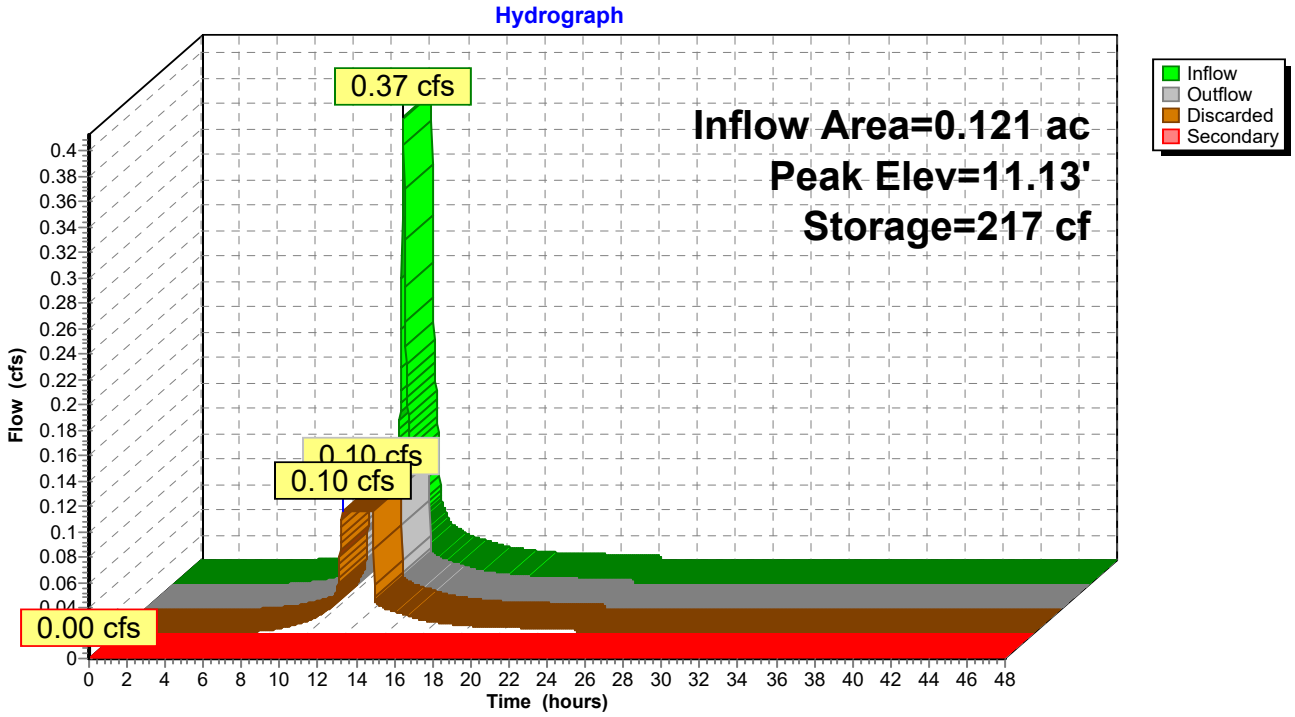
Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	10.00'	**8.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Secondary	13.50'	**24.0" x 24.0" Horiz. DCB104** X 2 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.10 cfs @ 11.82 hrs HW=10.04' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.10 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=10.00' (Free Discharge)
↑**2=DCB104** (Controls 0.00 cfs)

Pond 1P: CHAMBERS



Summary for Pond BIO: WET BIO

Inflow Area = 0.049 ac, Inflow Depth = 1.63" for 2 YR event
Inflow = 0.10 cfs @ 12.08 hrs, Volume= 0.007 af
Outflow = 0.01 cfs @ 14.38 hrs, Volume= 0.002 af, Atten= 94%, Lag= 138.1 min
Primary = 0.01 cfs @ 14.38 hrs, Volume= 0.002 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 10.75' @ 14.38 hrs Surf.Area= 239 sf Storage= 204 cf

Plug-Flow detention time= 362.7 min calculated for 0.002 af (31% of inflow)
Center-of-Mass det. time= 230.5 min (1,069.7 - 839.2)

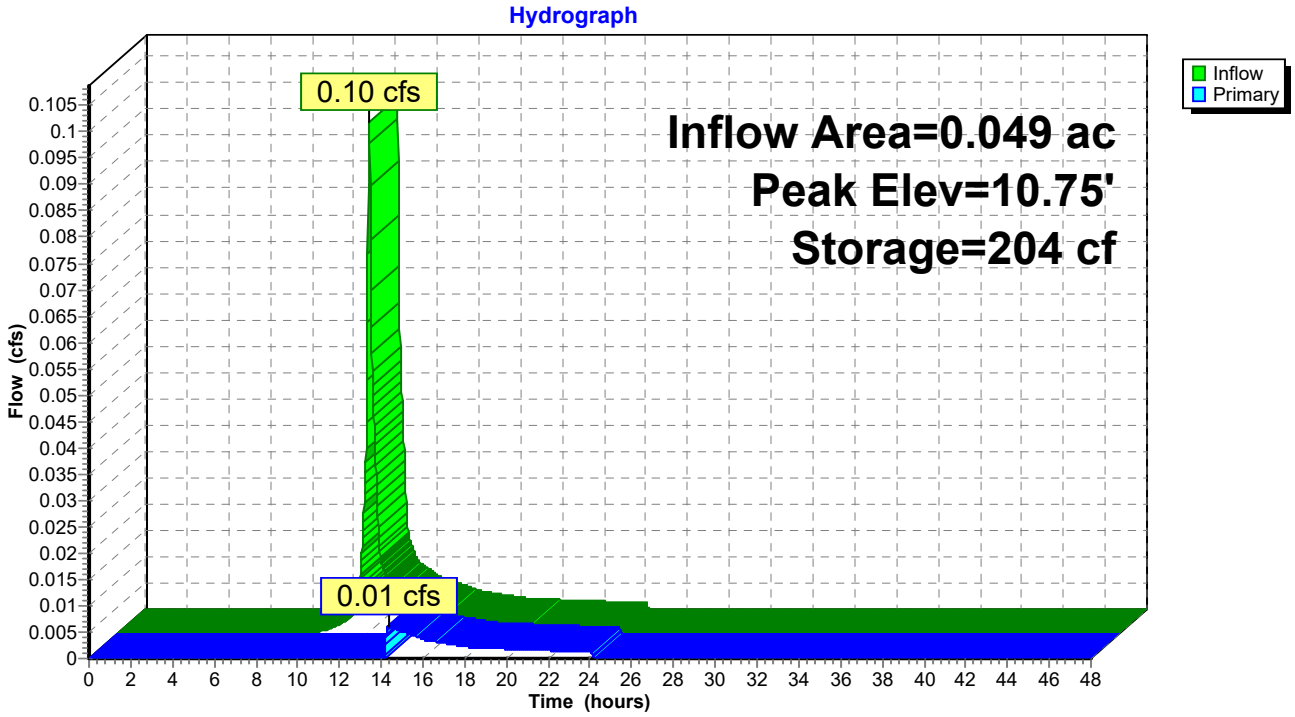
Volume	Invert	Avail.Storage	Storage Description
#1	8.75'	418 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.75	5	0	0
9.00	20	3	3
10.00	115	68	71
11.00	280	198	268
11.25	500	98	366
11.26	10,000	52	418

Device	Routing	Invert	Outlet Devices
#1	Primary	10.75'	**7.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 14.38 hrs HW=10.75' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.00 cfs @ 0.15 fps)

Pond BIO: WET BIO

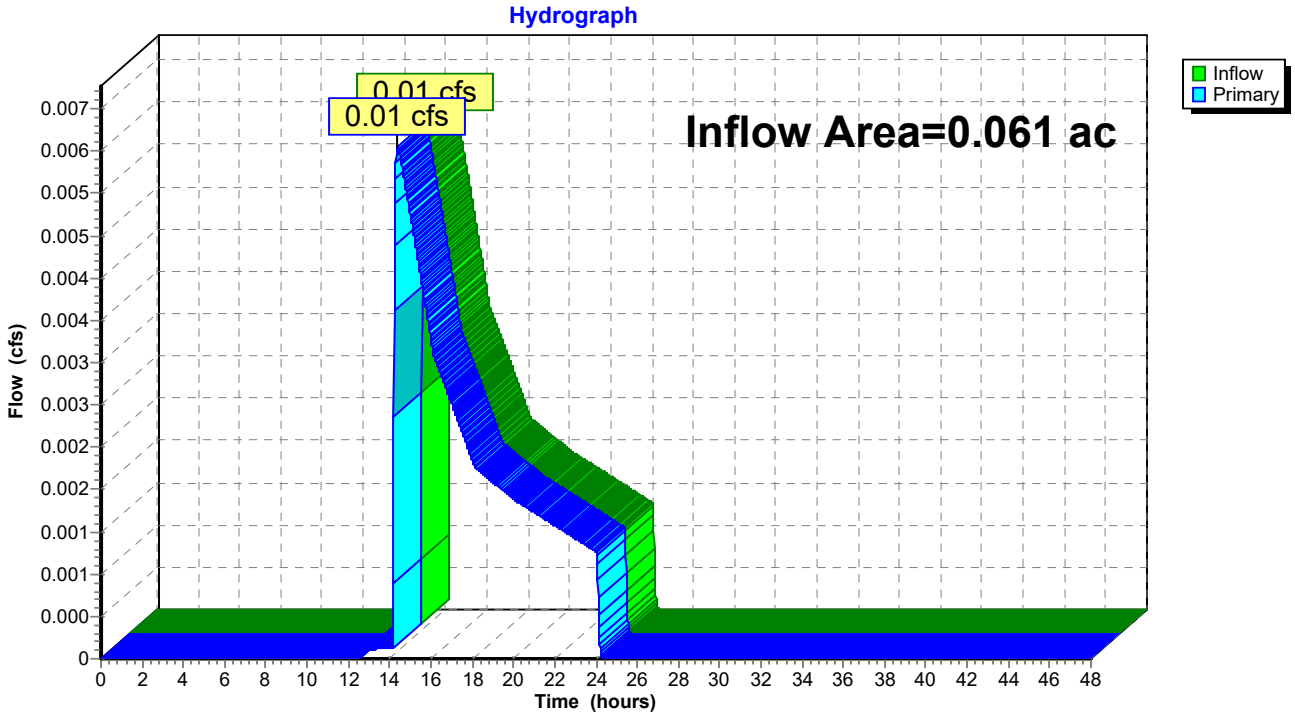


Summary for Pond SP1: SCARGO LAKE

Inflow Area = 0.061 ac, Inflow Depth = 0.42" for 2 YR event
Inflow = 0.01 cfs @ 14.38 hrs, Volume= 0.002 af
Primary = 0.01 cfs @ 14.38 hrs, Volume= 0.002 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: SCARGO LAKE



Time span=0.00-48.00 hrs, dt=0.02 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment DA1: BEACH Runoff Area=493 sf Runoff Depth=0.51"
Tc=5.0 min UI Adjusted CN=45 Runoff=0.00 cfs 0.000 af

Subcatchment DA2a: BOTTOM Runoff Area=2,149 sf Runoff Depth=3.03"
Tc=5.0 min CN=79 Runoff=0.18 cfs 0.012 af

Subcatchment DA2b: TOP Runoff Area=5,253 sf Runoff Depth=4.18"
Tc=5.0 min CN=90 Runoff=0.59 cfs 0.042 af

Pond 1P: CHAMBERS Peak Elev=11.90' Storage=499 cf Inflow=0.59 cfs 0.042 af
Discarded=0.10 cfs 0.042 af Secondary=0.00 cfs 0.000 af Outflow=0.10 cfs 0.042 af

Pond BIO: WET BIO Peak Elev=10.78' Storage=212 cf Inflow=0.18 cfs 0.012 af
Outflow=0.11 cfs 0.008 af

Pond SP1: SCARGO LAKE Inflow=0.11 cfs 0.008 af
Primary=0.11 cfs 0.008 af

Total Runoff Area = 0.181 ac Runoff Volume = 0.055 af Average Runoff Depth = 3.64"

Summary for Subcatchment DA1: BEACH

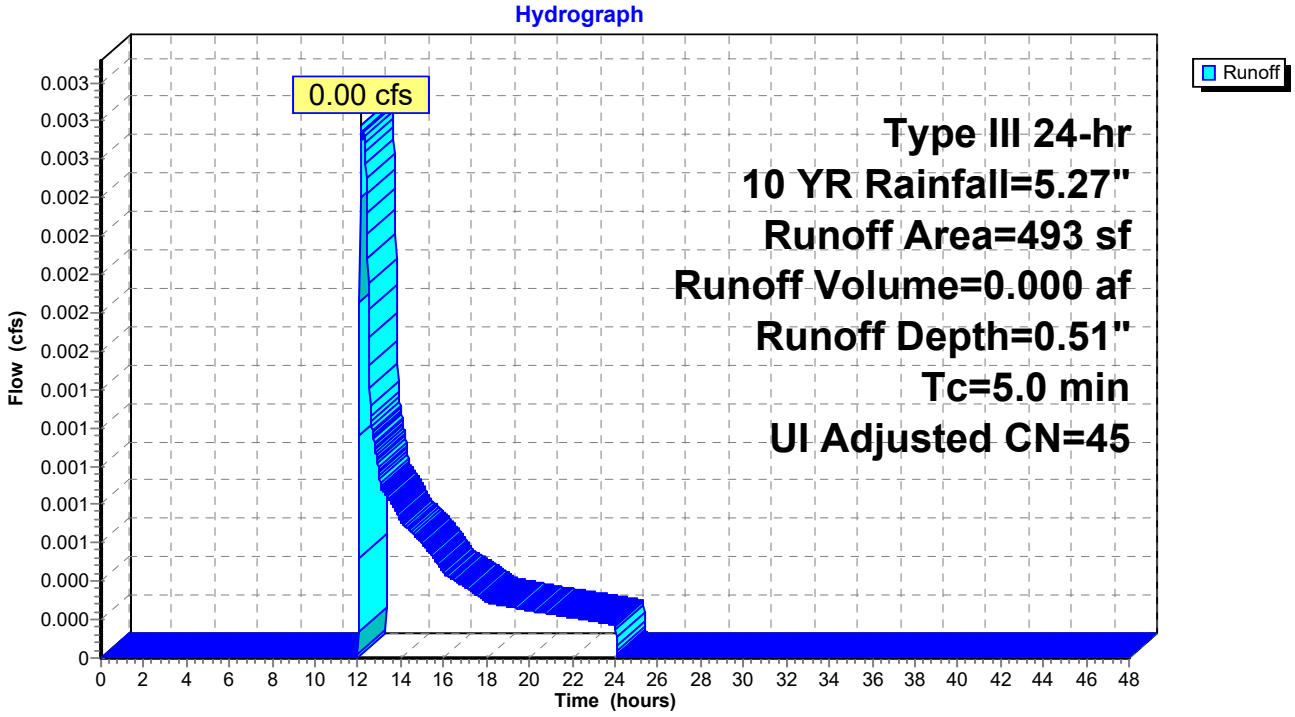
Runoff = 0.00 cfs @ 12.14 hrs, Volume= 0.000 af, Depth= 0.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 10 YR Rainfall=5.27"

Area (sf)	CN	Adj	Description
130	98		Unconnected pavement, HSG A
101	30		Woods, Good, HSG A
262	39		>75% Grass cover, Good, HSG A
493	53	45	Weighted Average, UI Adjusted

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA1: BEACH



Summary for Subcatchment DA2a: BOTTOM

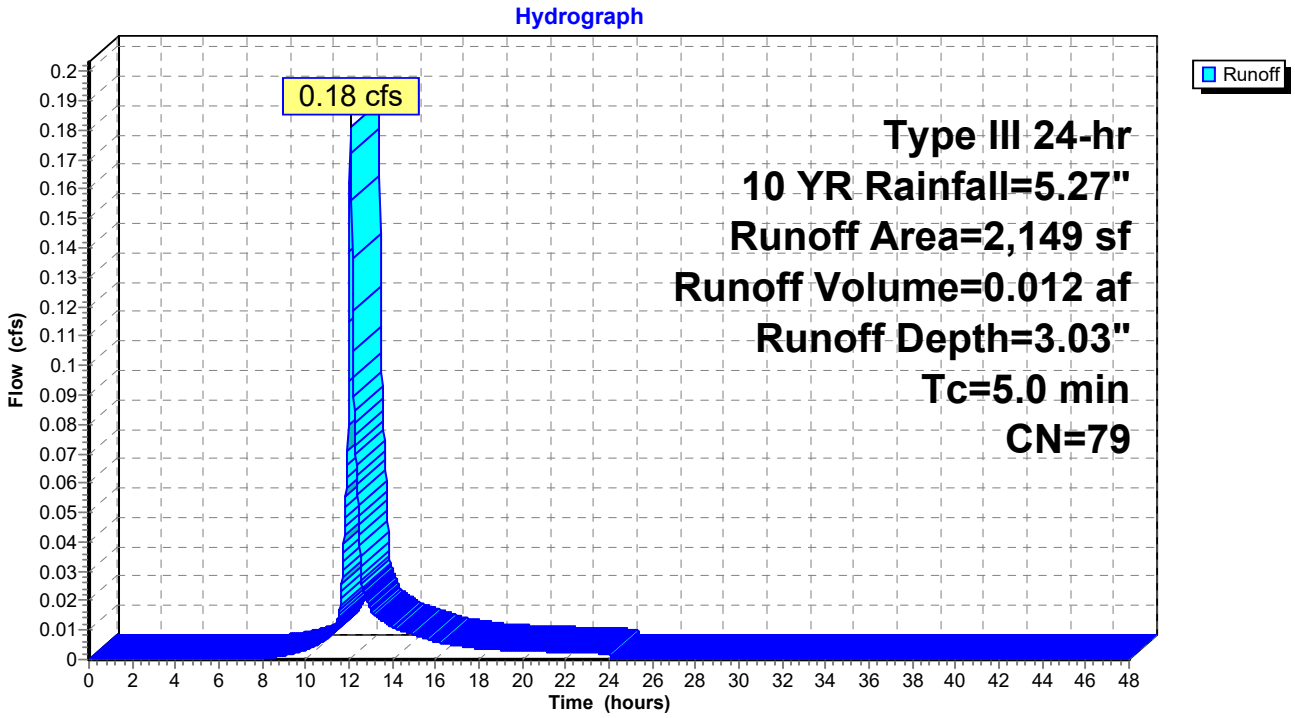
Runoff = 0.18 cfs @ 12.08 hrs, Volume= 0.012 af, Depth= 3.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 10 YR Rainfall=5.27"

Area (sf)	CN	Description
1,407	98	Unconnected pavement, HSG A
90	30	Woods, Good, HSG A
589	39	>75% Grass cover, Good, HSG A
63	98	Water Surface, HSG A
2,149	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA2a: BOTTOM



Summary for Subcatchment DA2b: TOP

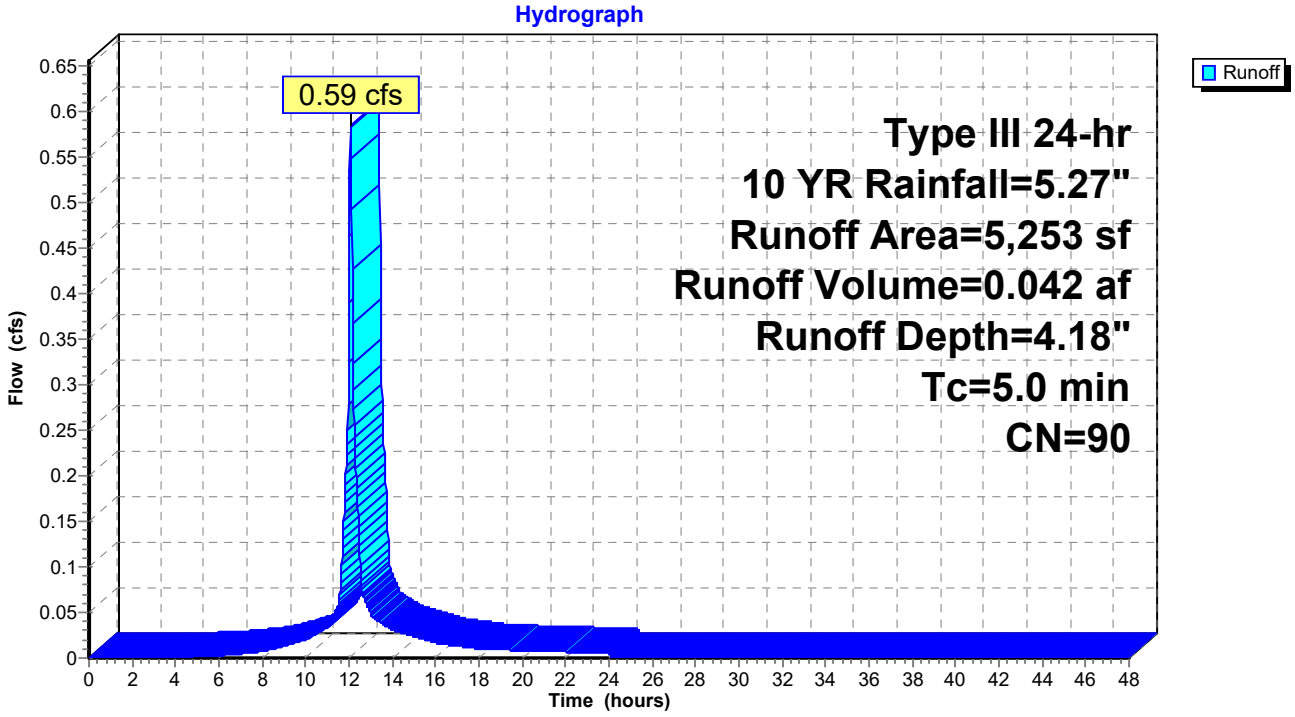
Runoff = 0.59 cfs @ 12.07 hrs, Volume= 0.042 af, Depth= 4.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 10 YR Rainfall=5.27"

Area (sf)	CN	Description
4,614	98	Unconnected pavement, HSG A
224	30	Woods, Good, HSG A
415	39	>75% Grass cover, Good, HSG A
5,253	90	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA2b: TOP



Summary for Pond 1P: CHAMBERS

Inflow Area = 0.121 ac, Inflow Depth = 4.18" for 10 YR event
Inflow = 0.59 cfs @ 12.07 hrs, Volume= 0.042 af
Outflow = 0.10 cfs @ 11.68 hrs, Volume= 0.042 af, Atten= 83%, Lag= 0.0 min
Discarded = 0.10 cfs @ 11.68 hrs, Volume= 0.042 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 11.90' @ 12.53 hrs Surf.Area= 506 sf Storage= 499 cf

Plug-Flow detention time= 30.0 min calculated for 0.042 af (100% of inflow)
Center-of-Mass det. time= 30.0 min (816.3 - 786.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	10.00'	490 cf	**15.75'W x 32.10'L x 4.00'H Field A** 2,022 cf Overall - 551 cf Embedded = 1,471 cf x 33.3% Voids
#2A	11.00'	551 cf	**ADS_StormTech SC-740 +Cap** x 12 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 12 Chambers in 3 Rows
		1,041 cf	Total Available Storage

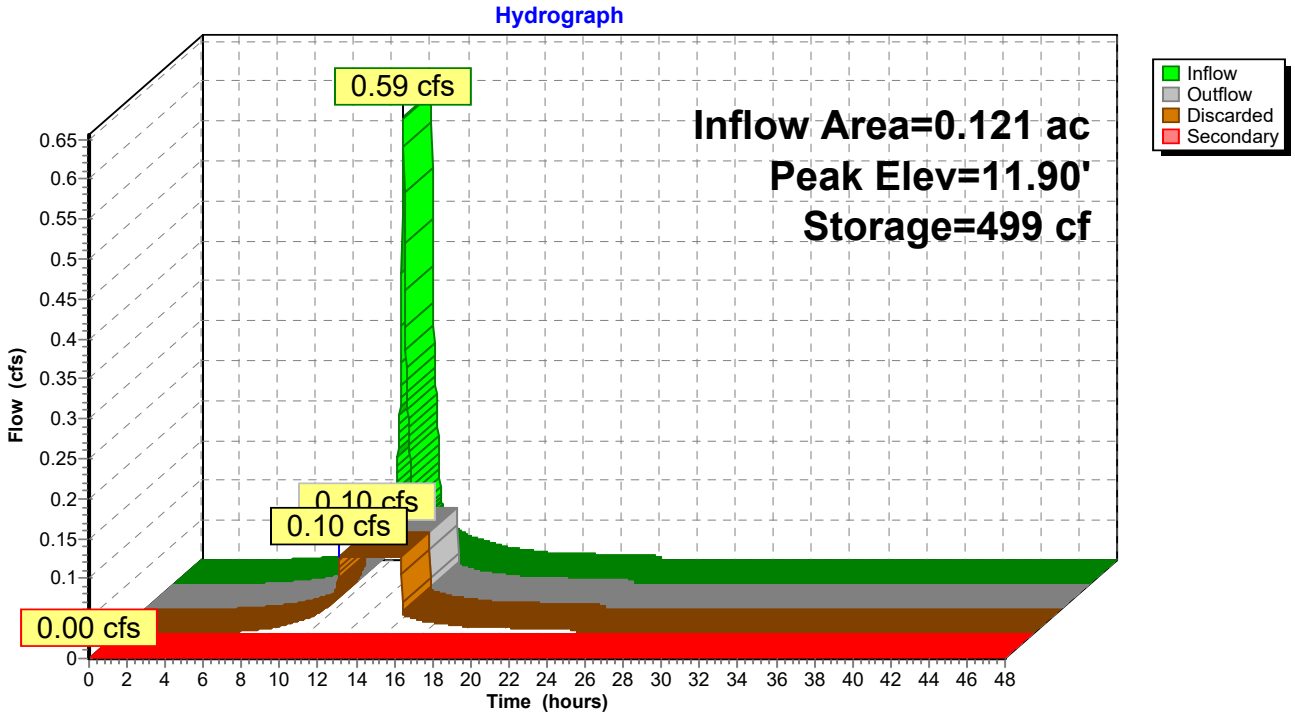
Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	10.00'	**8.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Secondary	13.50'	**24.0" x 24.0" Horiz. DCB104** X 2 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.10 cfs @ 11.68 hrs HW=10.04' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.10 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=10.00' (Free Discharge)
↑**2=DCB104** (Controls 0.00 cfs)

Pond 1P: CHAMBERS



Summary for Pond BIO: WET BIO

Inflow Area = 0.049 ac, Inflow Depth = 3.03" for 10 YR event
Inflow = 0.18 cfs @ 12.08 hrs, Volume= 0.012 af
Outflow = 0.11 cfs @ 12.19 hrs, Volume= 0.008 af, Atten= 42%, Lag= 6.7 min
Primary = 0.11 cfs @ 12.19 hrs, Volume= 0.008 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 10.78' @ 12.19 hrs Surf.Area= 244 sf Storage= 212 cf

Plug-Flow detention time= 181.5 min calculated for 0.008 af (63% of inflow)
Center-of-Mass det. time= 76.5 min (897.8 - 821.3)

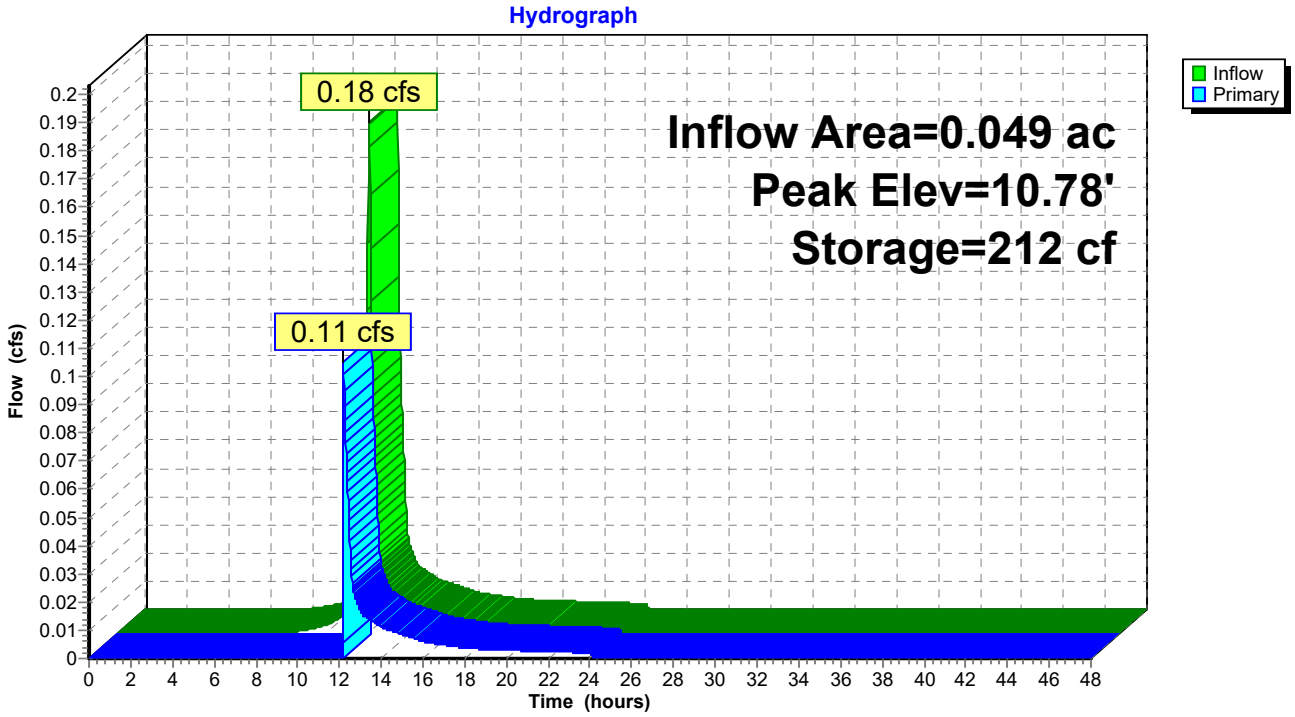
Volume	Invert	Avail.Storage	Storage Description
#1	8.75'	418 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.75	5	0	0
9.00	20	3	3
10.00	115	68	71
11.00	280	198	268
11.25	500	98	366
11.26	10,000	52	418

Device	Routing	Invert	Outlet Devices
#1	Primary	10.75'	**7.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=0.10 cfs @ 12.19 hrs HW=10.78' (Free Discharge)
↑**1=Broad-Crested Rectangular Weir** (Weir Controls 0.10 cfs @ 0.44 fps)

Pond BIO: WET BIO

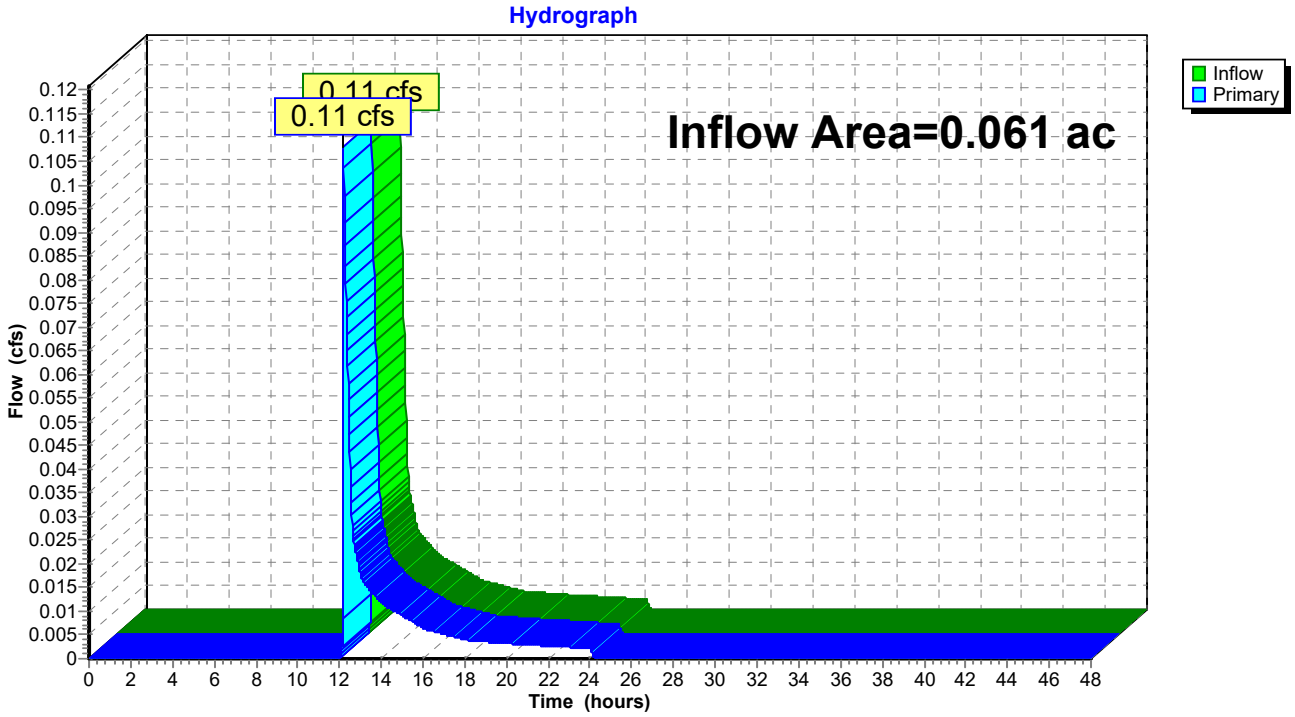


Summary for Pond SP1: SCARGO LAKE

Inflow Area = 0.061 ac, Inflow Depth = 1.64" for 10 YR event
Inflow = 0.11 cfs @ 12.19 hrs, Volume= 0.008 af
Primary = 0.11 cfs @ 12.19 hrs, Volume= 0.008 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: SCARGO LAKE



Time span=0.00-48.00 hrs, dt=0.02 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment DA1: BEACH Runoff Area=493 sf Runoff Depth=0.99"
Tc=5.0 min UI Adjusted CN=45 Runoff=0.01 cfs 0.001 af

Subcatchment DA2a: BOTTOM Runoff Area=2,149 sf Runoff Depth=4.15"
Tc=5.0 min CN=79 Runoff=0.25 cfs 0.017 af

Subcatchment DA2b: TOP Runoff Area=5,253 sf Runoff Depth=5.41"
Tc=5.0 min CN=90 Runoff=0.75 cfs 0.054 af

Pond 1P: CHAMBERS Peak Elev=12.57' Storage=726 cf Inflow=0.75 cfs 0.054 af
Discarded=0.10 cfs 0.054 af Secondary=0.00 cfs 0.000 af Outflow=0.10 cfs 0.054 af

Pond BIO: WET BIO Peak Elev=10.81' Storage=218 cf Inflow=0.25 cfs 0.017 af
Outflow=0.24 cfs 0.012 af

Pond SP1: SCARGO LAKE Inflow=0.25 cfs 0.013 af
Primary=0.25 cfs 0.013 af

Total Runoff Area = 0.181 ac Runoff Volume = 0.072 af Average Runoff Depth = 4.79"

Summary for Subcatchment DA1: BEACH

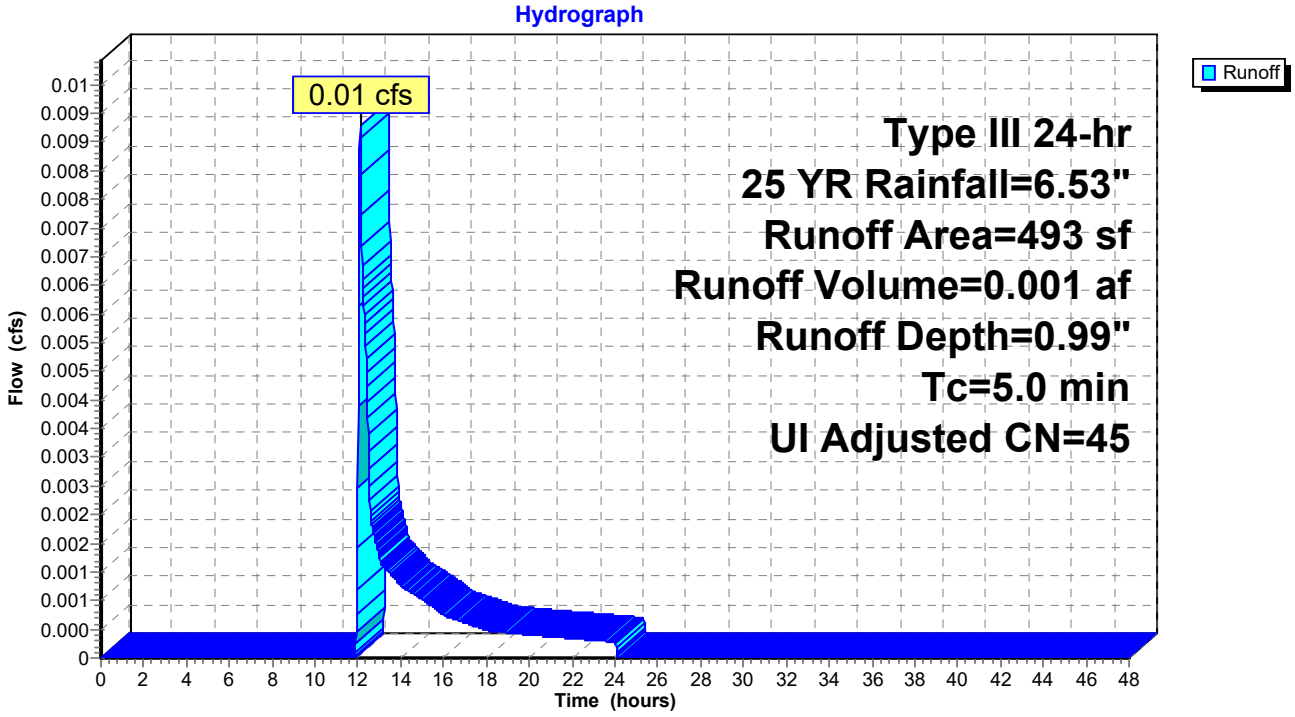
Runoff = 0.01 cfs @ 12.10 hrs, Volume= 0.001 af, Depth= 0.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 25 YR Rainfall=6.53"

Area (sf)	CN	Adj	Description
130	98		Unconnected pavement, HSG A
101	30		Woods, Good, HSG A
262	39		>75% Grass cover, Good, HSG A
493	53	45	Weighted Average, UI Adjusted

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA1: BEACH



Summary for Subcatchment DA2a: BOTTOM

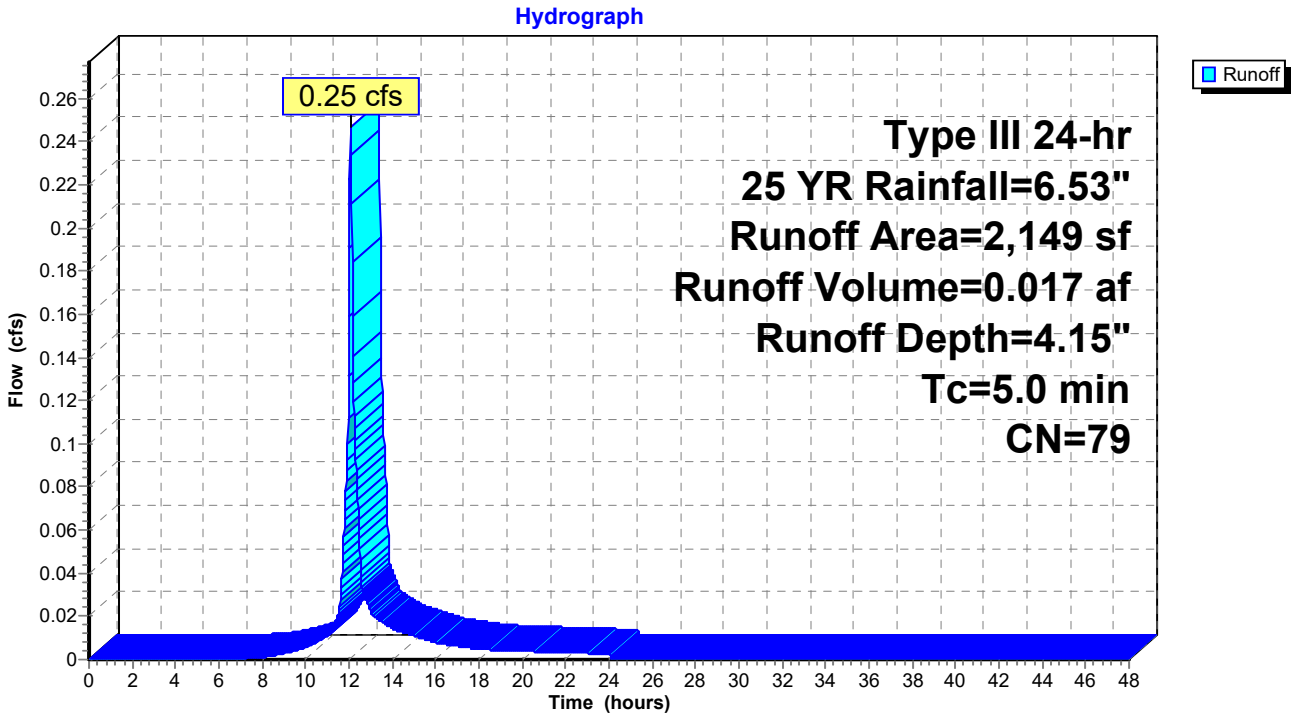
Runoff = 0.25 cfs @ 12.07 hrs, Volume= 0.017 af, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 25 YR Rainfall=6.53"

Area (sf)	CN	Description
1,407	98	Unconnected pavement, HSG A
90	30	Woods, Good, HSG A
589	39	>75% Grass cover, Good, HSG A
63	98	Water Surface, HSG A
2,149	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA2a: BOTTOM



Summary for Subcatchment DA2b: TOP

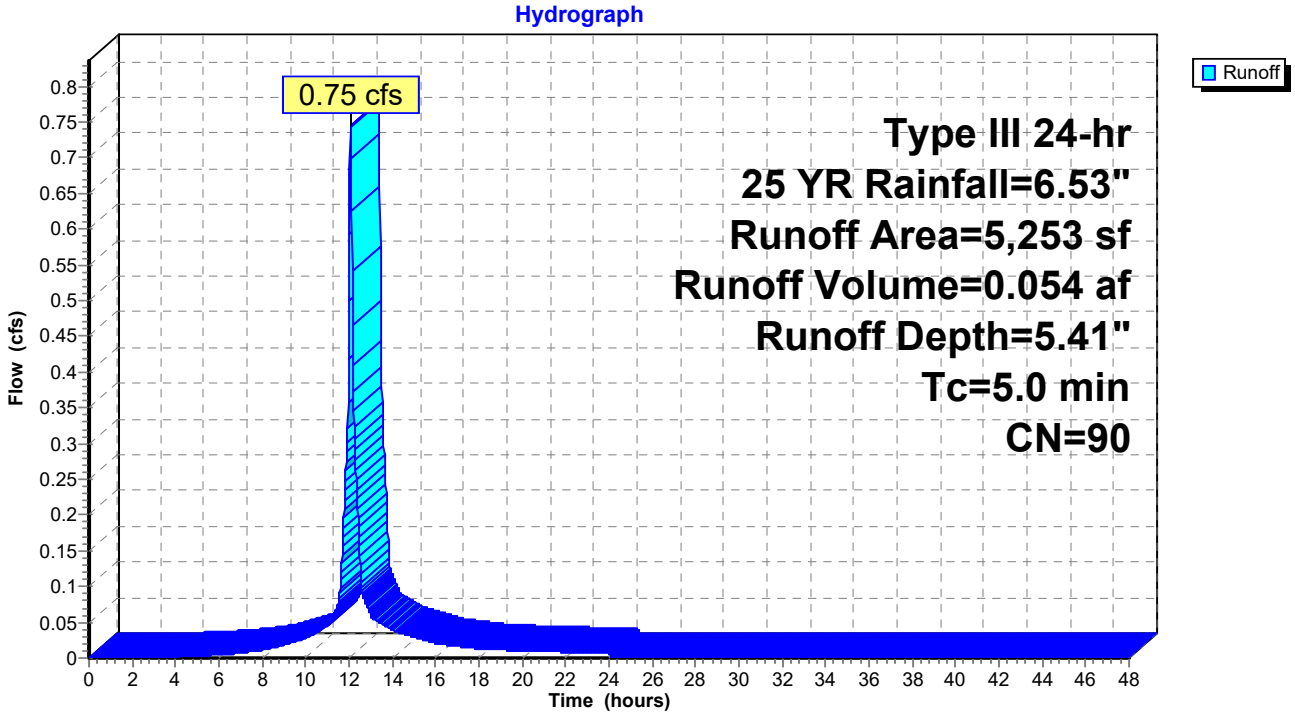
Runoff = 0.75 cfs @ 12.07 hrs, Volume= 0.054 af, Depth= 5.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 25 YR Rainfall=6.53"

Area (sf)	CN	Description
4,614	98	Unconnected pavement, HSG A
224	30	Woods, Good, HSG A
415	39	>75% Grass cover, Good, HSG A
5,253	90	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA2b: TOP



Summary for Pond 1P: CHAMBERS

Inflow Area = 0.121 ac, Inflow Depth = 5.41" for 25 YR event
Inflow = 0.75 cfs @ 12.07 hrs, Volume= 0.054 af
Outflow = 0.10 cfs @ 11.62 hrs, Volume= 0.054 af, Atten= 87%, Lag= 0.0 min
Discarded = 0.10 cfs @ 11.62 hrs, Volume= 0.054 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 12.57' @ 12.59 hrs Surf.Area= 506 sf Storage= 726 cf

Plug-Flow detention time= 47.6 min calculated for 0.054 af (100% of inflow)
Center-of-Mass det. time= 47.5 min (827.1 - 779.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	10.00'	490 cf	**15.75'W x 32.10'L x 4.00'H Field A** 2,022 cf Overall - 551 cf Embedded = 1,471 cf x 33.3% Voids
#2A	11.00'	551 cf	**ADS_StormTech SC-740 +Cap** x 12 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 12 Chambers in 3 Rows
		1,041 cf	Total Available Storage

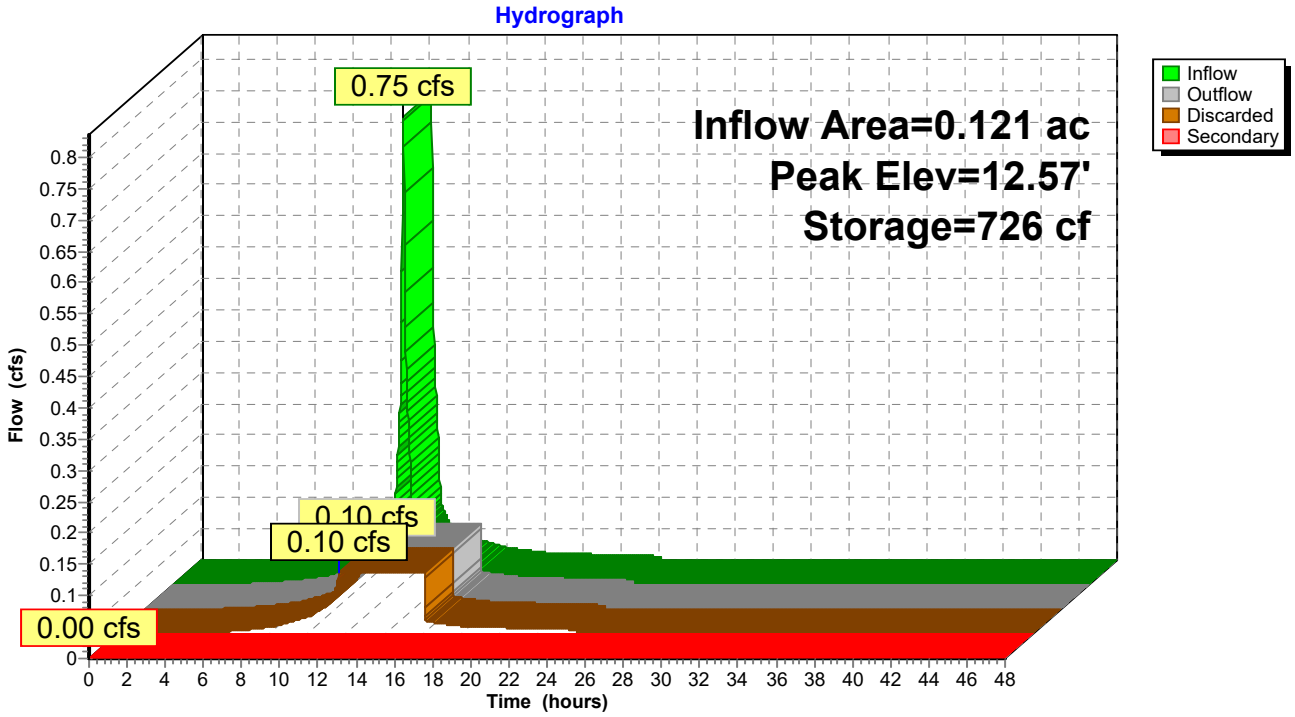
Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	10.00'	**8.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Secondary	13.50'	**24.0" x 24.0" Horiz. DCB104** X 2 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.10 cfs @ 11.62 hrs HW=10.04' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.10 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=10.00' (Free Discharge)
↑**2=DCB104** (Controls 0.00 cfs)

Pond 1P: CHAMBERS



Summary for Pond BIO: WET BIO

Inflow Area = 0.049 ac, Inflow Depth = 4.15" for 25 YR event
Inflow = 0.25 cfs @ 12.07 hrs, Volume= 0.017 af
Outflow = 0.24 cfs @ 12.09 hrs, Volume= 0.012 af, Atten= 1%, Lag= 0.8 min
Primary = 0.24 cfs @ 12.09 hrs, Volume= 0.012 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 10.81' @ 12.09 hrs Surf.Area= 249 sf Storage= 218 cf

Plug-Flow detention time= 143.9 min calculated for 0.012 af (73% of inflow)
Center-of-Mass det. time= 53.6 min (866.0 - 812.3)

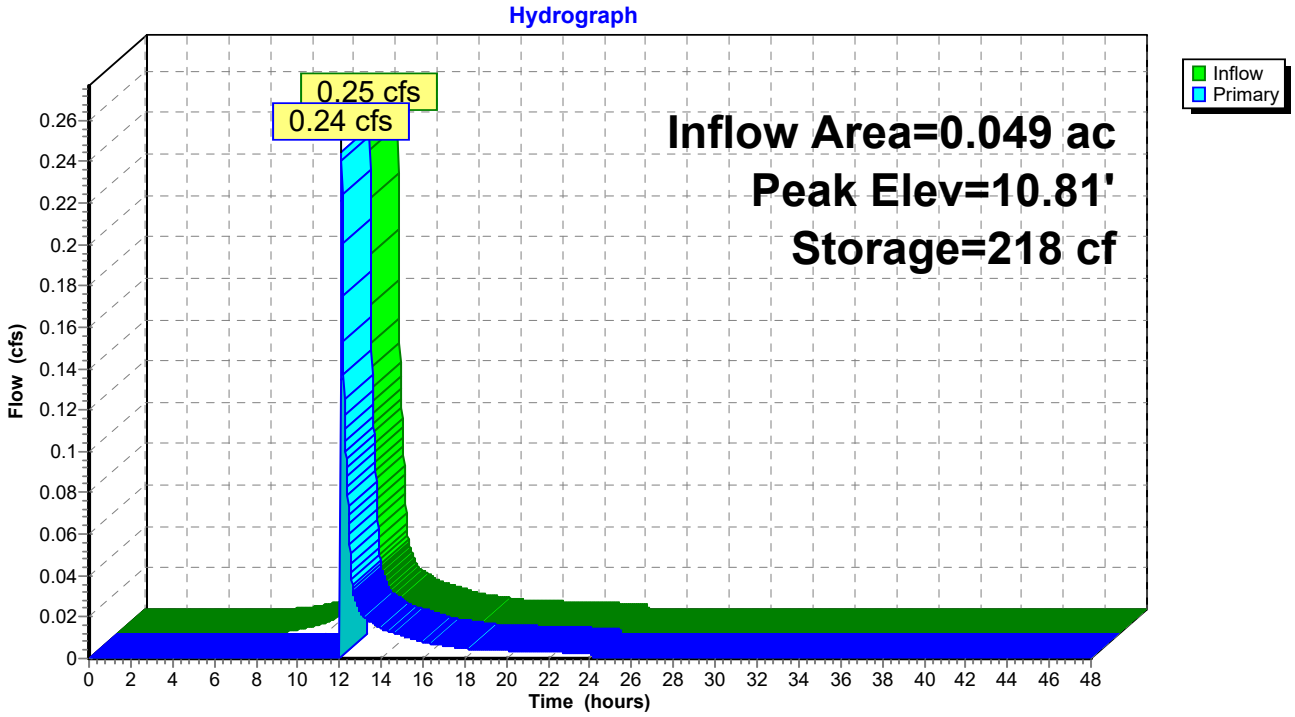
Volume	Invert	Avail.Storage	Storage Description
#1	8.75'	418 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.75	5	0	0
9.00	20	3	3
10.00	115	68	71
11.00	280	198	268
11.25	500	98	366
11.26	10,000	52	418

Device	Routing	Invert	Outlet Devices
#1	Primary	10.75'	**7.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=0.24 cfs @ 12.09 hrs HW=10.81' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 0.24 cfs @ 0.58 fps)

Pond BIO: WET BIO

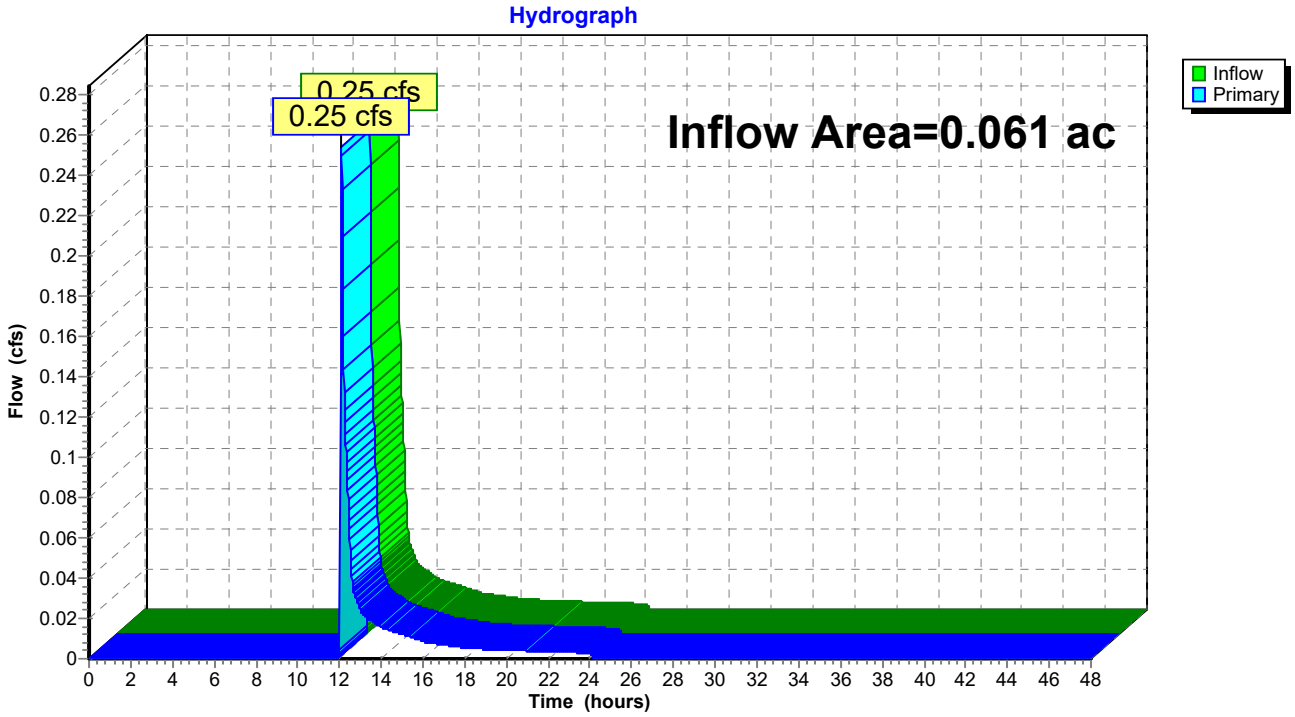


Summary for Pond SP1: SCARGO LAKE

Inflow Area = 0.061 ac, Inflow Depth = 2.64" for 25 YR event
Inflow = 0.25 cfs @ 12.09 hrs, Volume= 0.013 af
Primary = 0.25 cfs @ 12.09 hrs, Volume= 0.013 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: SCARGO LAKE



Time span=0.00-48.00 hrs, dt=0.02 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment DA1: BEACH Runoff Area=493 sf Runoff Depth=2.00"
Tc=5.0 min UI Adjusted CN=45 Runoff=0.02 cfs 0.002 af

Subcatchment DA2a: BOTTOM Runoff Area=2,149 sf Runoff Depth=6.04"
Tc=5.0 min CN=79 Runoff=0.35 cfs 0.025 af

Subcatchment DA2b: TOP Runoff Area=5,253 sf Runoff Depth=7.42"
Tc=5.0 min CN=90 Runoff=1.00 cfs 0.075 af

Pond 1P: CHAMBERS Peak Elev=13.53' Storage=962 cf Inflow=1.00 cfs 0.075 af
Discarded=0.10 cfs 0.071 af Secondary=0.35 cfs 0.004 af Outflow=0.44 cfs 0.075 af

Pond BIO: WET BIO Peak Elev=10.83' Storage=222 cf Inflow=0.35 cfs 0.025 af
Outflow=0.35 cfs 0.020 af

Pond SP1: SCARGO LAKE Inflow=0.49 cfs 0.026 af
Primary=0.49 cfs 0.026 af

Total Runoff Area = 0.181 ac Runoff Volume = 0.101 af Average Runoff Depth = 6.71"

Summary for Subcatchment DA1: BEACH

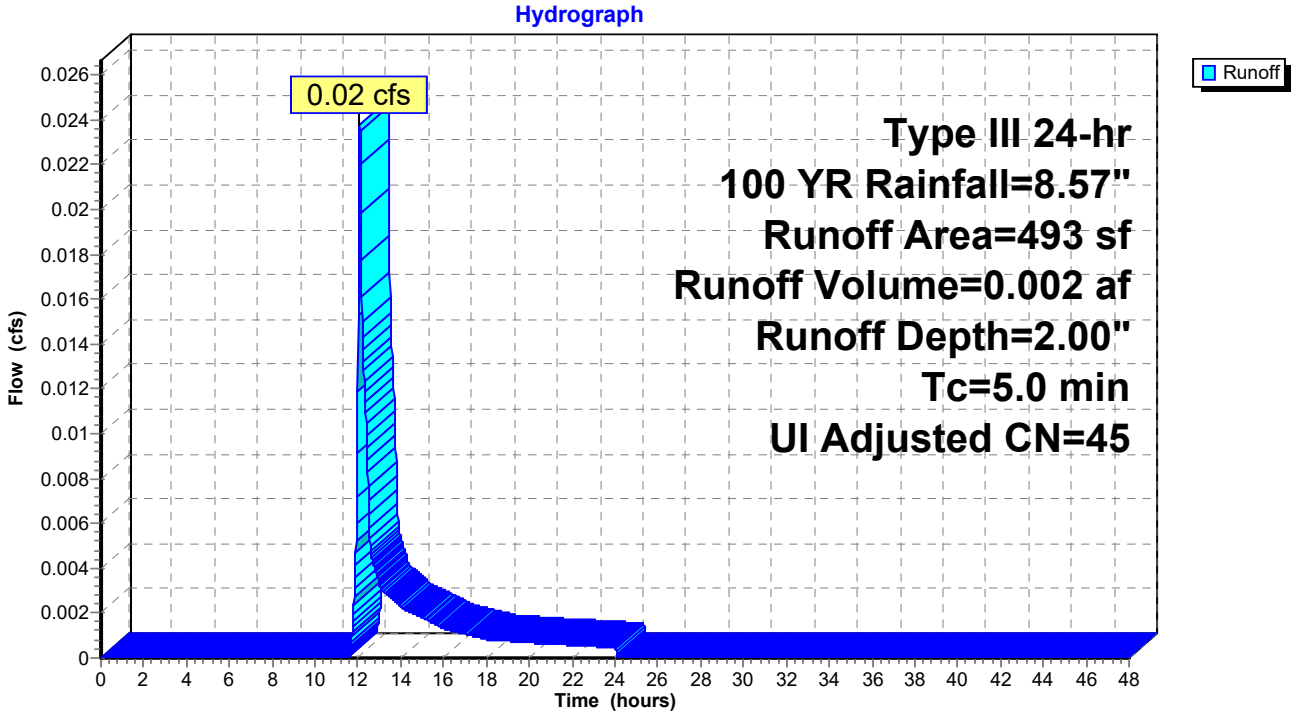
Runoff = 0.02 cfs @ 12.09 hrs, Volume= 0.002 af, Depth= 2.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 100 YR Rainfall=8.57"

Area (sf)	CN	Adj	Description
130	98		Unconnected pavement, HSG A
101	30		Woods, Good, HSG A
262	39		>75% Grass cover, Good, HSG A
493	53	45	Weighted Average, UI Adjusted

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA1: BEACH



Summary for Subcatchment DA2a: BOTTOM

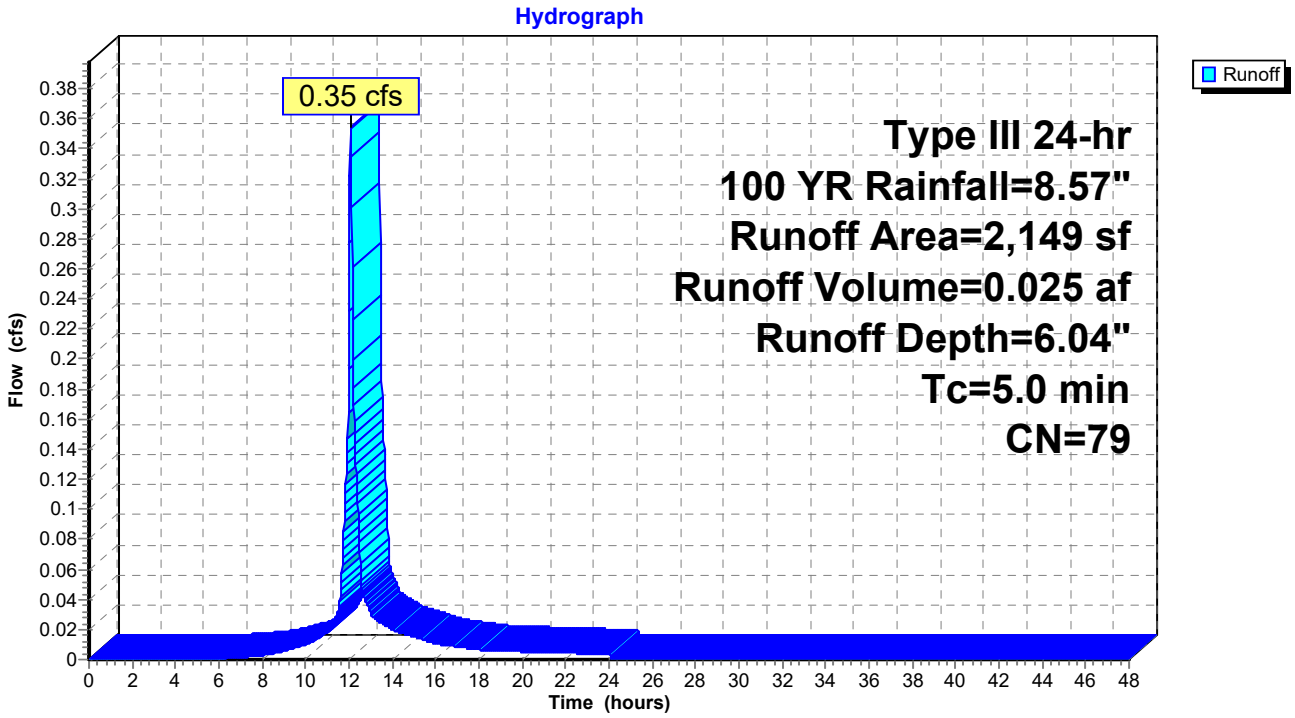
Runoff = 0.35 cfs @ 12.07 hrs, Volume= 0.025 af, Depth= 6.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 100 YR Rainfall=8.57"

Area (sf)	CN	Description
1,407	98	Unconnected pavement, HSG A
90	30	Woods, Good, HSG A
589	39	>75% Grass cover, Good, HSG A
63	98	Water Surface, HSG A
2,149	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA2a: BOTTOM



Summary for Subcatchment DA2b: TOP

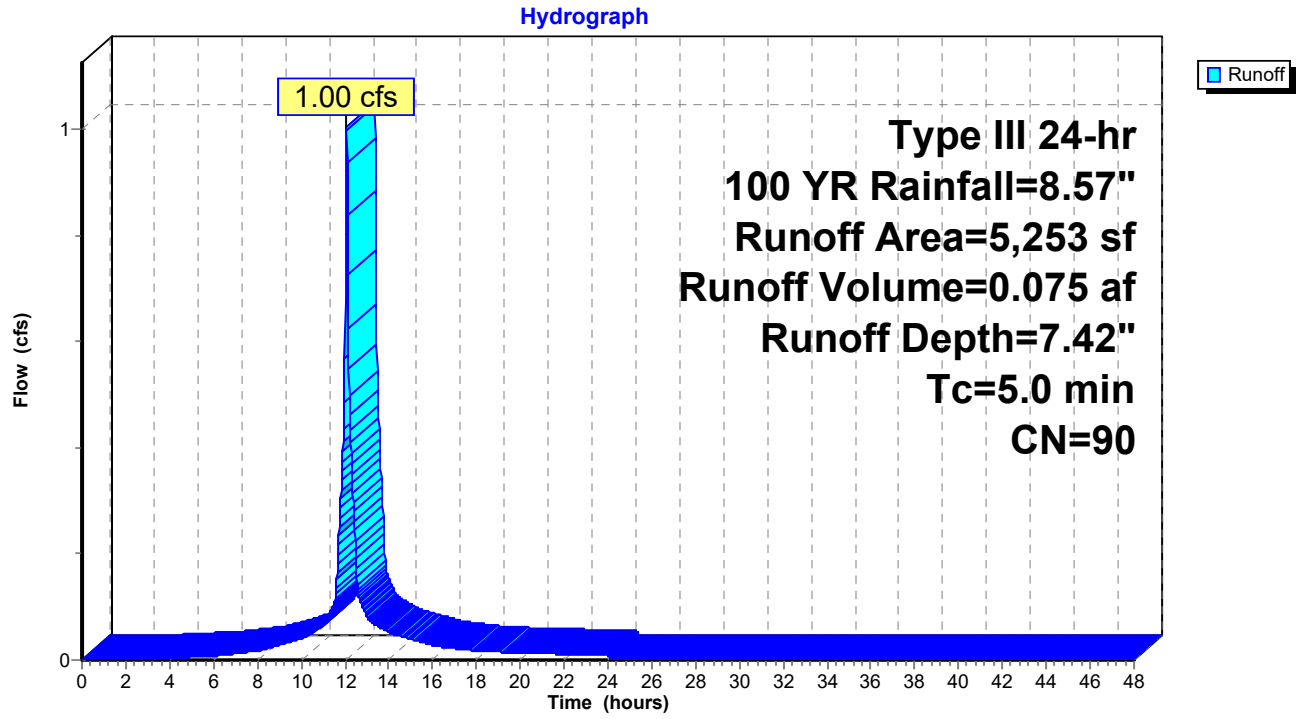
Runoff = 1.00 cfs @ 12.07 hrs, Volume= 0.075 af, Depth= 7.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr 100 YR Rainfall=8.57"

Area (sf)	CN	Description
4,614	98	Unconnected pavement, HSG A
224	30	Woods, Good, HSG A
415	39	>75% Grass cover, Good, HSG A
5,253	90	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Subcatchment DA2b: TOP



Summary for Pond 1P: CHAMBERS

Inflow Area = 0.121 ac, Inflow Depth = 7.42" for 100 YR event
Inflow = 1.00 cfs @ 12.07 hrs, Volume= 0.075 af
Outflow = 0.44 cfs @ 12.32 hrs, Volume= 0.075 af, Atten= 56%, Lag= 15.2 min
Discarded = 0.10 cfs @ 11.44 hrs, Volume= 0.071 af
Secondary = 0.35 cfs @ 12.32 hrs, Volume= 0.004 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 13.53' @ 12.32 hrs Surf.Area= 506 sf Storage= 962 cf

Plug-Flow detention time= 64.4 min calculated for 0.075 af (100% of inflow)
Center-of-Mass det. time= 64.3 min (835.9 - 771.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	10.00'	490 cf	**15.75'W x 32.10'L x 4.00'H Field A** 2,022 cf Overall - 551 cf Embedded = 1,471 cf x 33.3% Voids
#2A	11.00'	551 cf	**ADS_StormTech SC-740 +Cap** x 12 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 12 Chambers in 3 Rows
		1,041 cf	Total Available Storage

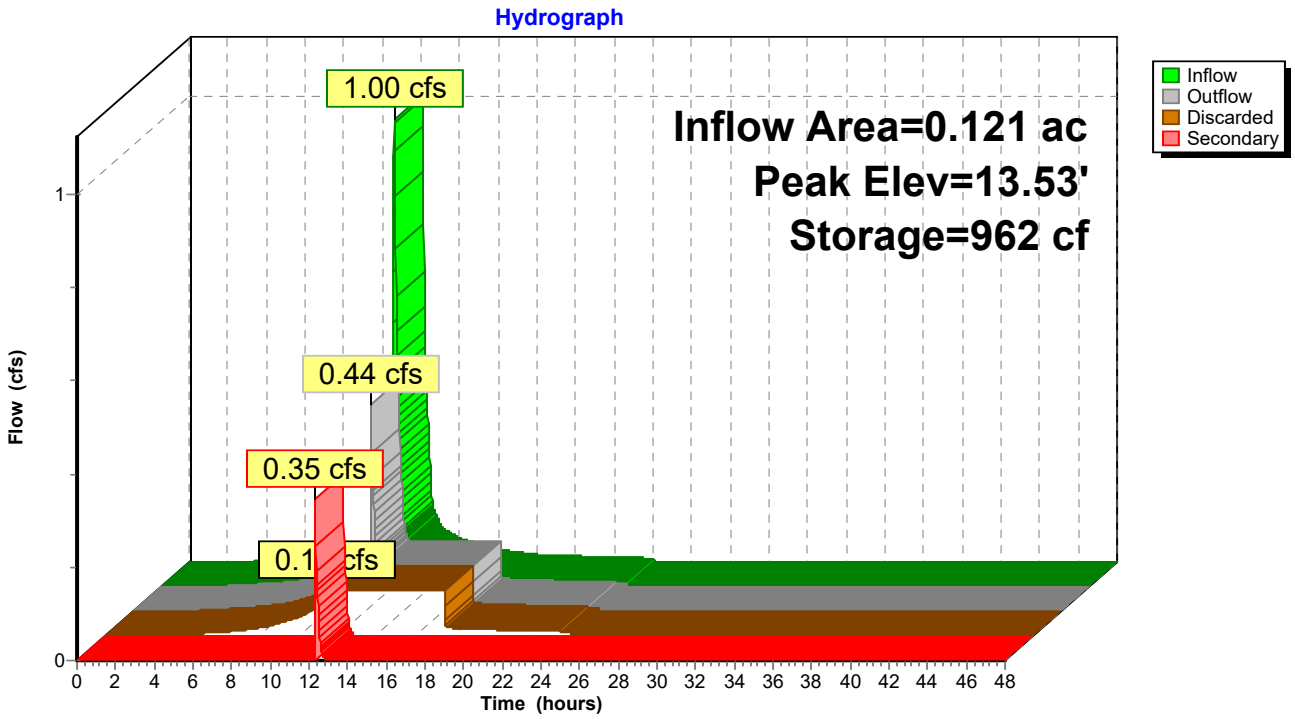
Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	10.00'	**8.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Secondary	13.50'	**24.0" x 24.0" Horiz. DCB104** X 2 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.10 cfs @ 11.44 hrs HW=10.04' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.10 cfs)

Secondary OutFlow Max=0.28 cfs @ 12.32 hrs HW=13.53' (Free Discharge)
↑**2=DCB104** (Weir Controls 0.28 cfs @ 0.57 fps)

Pond 1P: CHAMBERS



Summary for Pond BIO: WET BIO

Inflow Area = 0.049 ac, Inflow Depth = 6.04" for 100 YR event
Inflow = 0.35 cfs @ 12.07 hrs, Volume= 0.025 af
Outflow = 0.35 cfs @ 12.08 hrs, Volume= 0.020 af, Atten= 1%, Lag= 0.6 min
Primary = 0.35 cfs @ 12.08 hrs, Volume= 0.020 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 10.83' @ 12.08 hrs Surf.Area= 251 sf Storage= 222 cf

Plug-Flow detention time= 113.9 min calculated for 0.020 af (81% of inflow)
Center-of-Mass det. time= 40.6 min (842.4 - 801.7)

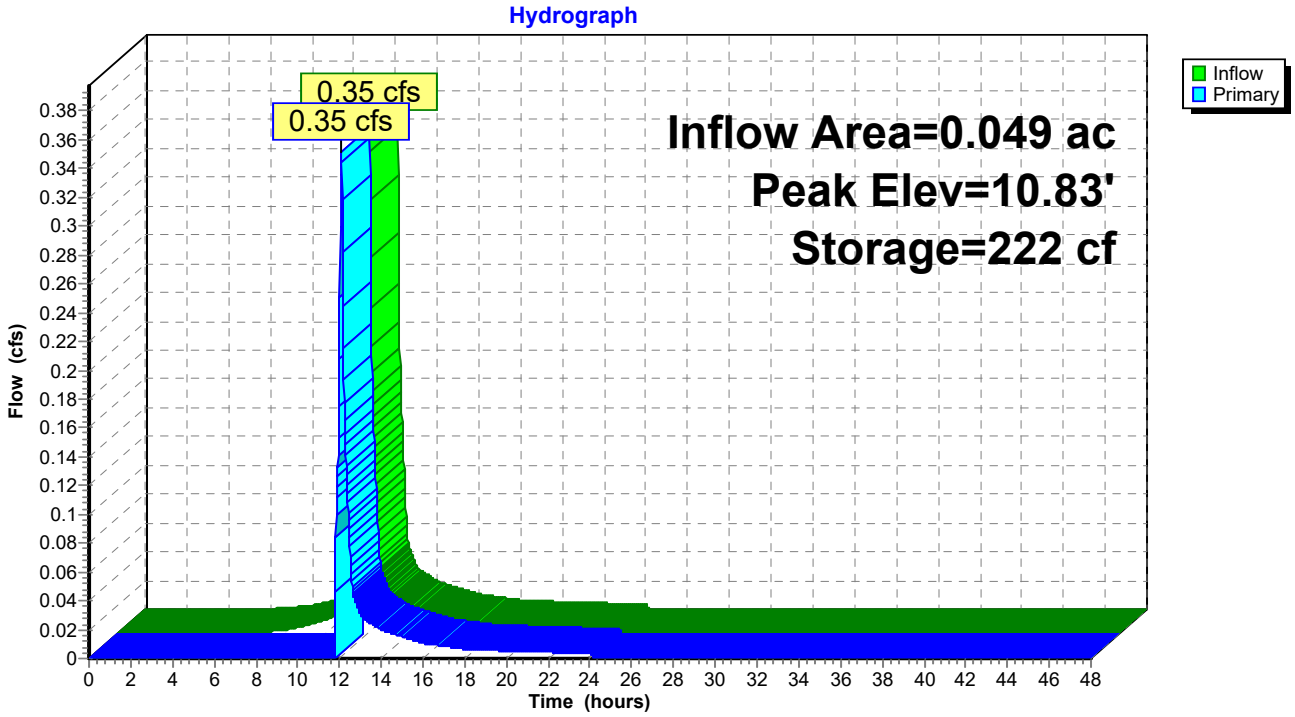
Volume	Invert	Avail.Storage	Storage Description
#1	8.75'	418 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.75	5	0	0
9.00	20	3	3
10.00	115	68	71
11.00	280	198	268
11.25	500	98	366
11.26	10,000	52	418

Device	Routing	Invert	Outlet Devices
#1	Primary	10.75'	**7.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=0.35 cfs @ 12.08 hrs HW=10.83' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 0.35 cfs @ 0.65 fps)

Pond BIO: WET BIO

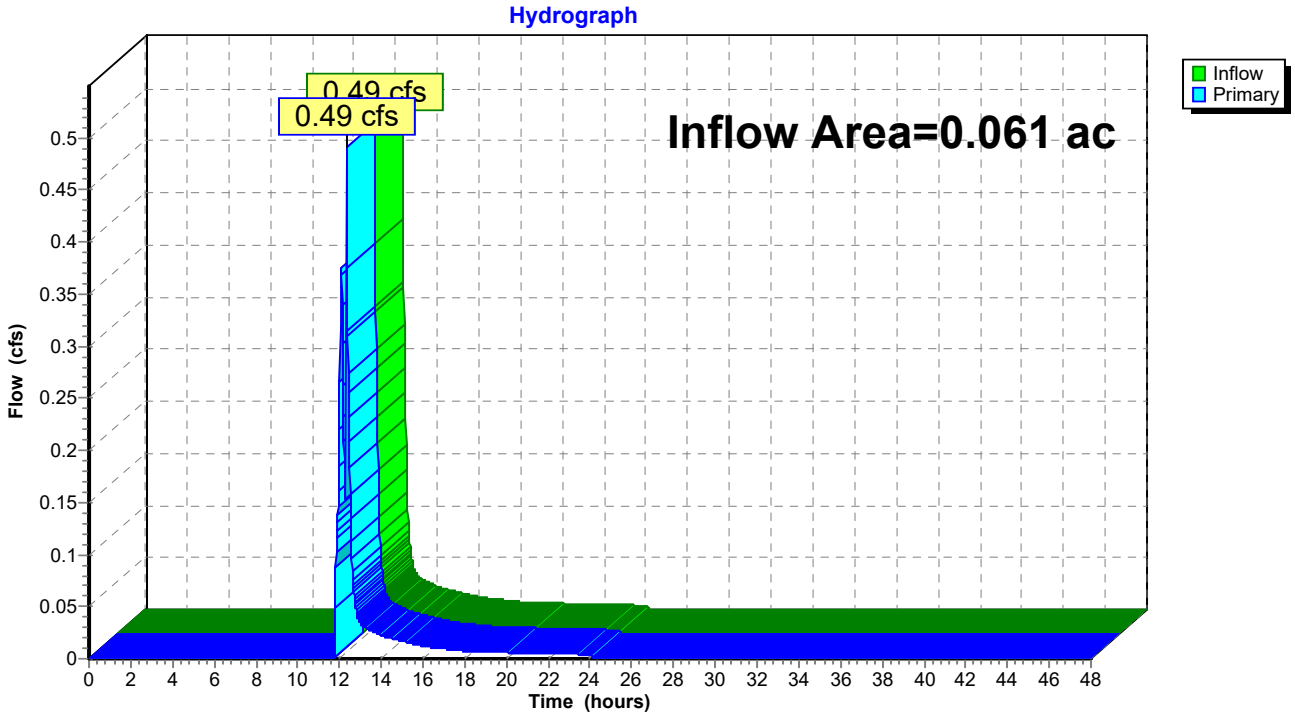


Summary for Pond SP1: SCARGO LAKE

Inflow Area = 0.061 ac, Inflow Depth = 5.09" for 100 YR event
Inflow = 0.49 cfs @ 12.32 hrs, Volume= 0.026 af
Primary = 0.49 cfs @ 12.32 hrs, Volume= 0.026 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: SCARGO LAKE



APPENDIX C – Wetland Resources Summary Memo

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Unit 1 • Sandwich, MA 02563
508-833-6600 • horsleywitten.com

MEMORANDUM

To: Jordan Mora, APCC

From: Ben Wollman, Wetland Scientist

Date: January 19, 2023

Re: Wetland Resources – Dr. Lord's Landing Boat Ramp Site, Dennis, MA

HW has prepared the following memo and site figures to document the wetland resource areas at the referenced site and to provide regulatory context for future work.

General Site Description

The site is located along the northeast side of Scargo Lake in Dennis, Massachusetts, and is focused on improvements to the parking lot to Scargo Beach.

FEMA Designation

According to the FEMA National Flood Hazard Map (Community Panel No. 25001C0581J, effective July 16, 2014), portions of the site are located within Other Areas of Flood Hazard, Zone X (0.2% annual chance of flooding) (**Figure 1**).

Figure 1. Excerpt from Federal Emergency Management Agency (FEMA) FIRMette for the subject site.

State-listed Rare Species Habitat and Open Space

According to the most recent version of the *Massachusetts Natural Heritage Atlas* (15th Edition, August 1, 2021), the site lies within a designated *Priority Habitat of Rare Species* (PH 430) area but does not contain any areas of *Estimated Habitat of Rare Wildlife or Certified Vernal Pools* (**Figure 2**).

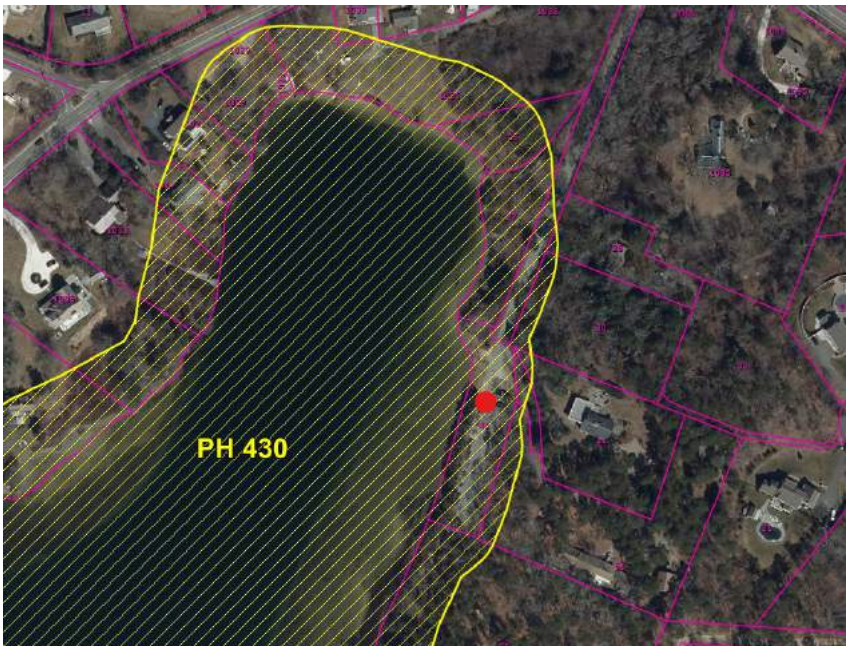


Figure 2. Rare species habitat (Source: MassMapper 2022).

Wetland Resource Areas

The site supports freshwater wetland resource areas, as defined under the Massachusetts *Wetlands Protection Act* (M.G.L. Ch. 131 § 40) and the Town of Dennis Wetlands Protection By-law (Chapter 187) and their respective regulations. Horsley Witten Group, Inc. (HW) wetland biologists identified and delineated these resource areas during a site visit on December 28, 2022. Jurisdictional areas identified on or adjacent to the site include Bordering Vegetated Wetland (BVW); Bank (locally Inland Bank); and the 50-foot No Disturb and 100-foot Buffer Zones to BVW and Bank (Inland Bank). Additional resource areas present adjacent to the site include Land Under Waterbodies and Waterways (LUW) and Banks of or Land Under the Ocean, Ponds, Streams, Rivers, Lakes, or Creeks that Underlie an Anadromous/Catadromous Fish Run ("Fish Run").

HW followed wetland resource area identification and on-site delineation procedure guidelines described in the Massachusetts Department of Environmental Protection (MassDEP) handbook, entitled *Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act* (March, 1995), Massachusetts Wetlands Protection Act (M.G.L. Ch. 131 § 40), and its implementing Regulations (310 CMR 10.00), and the Town of Dennis *Wetlands Protection By-law* (Chapter 187) and associated Town of Dennis Conservation Commission Rules and Regulations.

Prior to conducting field delineations, HW reviewed existing source data, including USGS Geological Survey 7.5 minute topographic maps, Massachusetts Department of Environmental Protection (MassDEP) wetlands source data available through the Massachusetts Geographic Information System (MassGIS), USDA Natural Resources Conservation Service (NRCS) soils survey, U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps, and other source data to identify the presence of jurisdictional wetlands and waters of the United States within the site. This information was used to compile base mapping to assist in the understanding of the hydrologic variables, soils conditions, and vegetation communities (where applicable).

A brief description of the regulatory definitions and the observed resources areas is provided below.

Bank (Inland Bank)

Bank is defined at 310 CMR 10.54(2)(a) as "…*the portion of land surface which normally abuts and confines a water body. It occurs between a water body and a vegetated bordering wetland and adjacent floodplain, or, in the absence of these, it occurs between a water body and an upland. A Bank may be partially or totally vegetated, or it may be comprised of exposed soil, gravel or stone. The upper boundary of a Bank is first observable break in the slope or the mean annual flood level, whichever is lower. The lower boundary of a Bank is the mean annual low flow level"* [310 CMR 10.54(2)(c)]. The Town of Dennis Conservation Commission Rules and Regulations define Inland Bank similarly.

Bank (Inland Bank) is present around the perimeter of Scargo Lake and borders the BVW and upland areas adjacent to the Scargo Lake Beach parking lot (**Photos 1 & 2**). The lower portion of the Bank exists as a gentle, unvegetated slope rising from the edge of the lake, comprised of a mix of sand and gravel material. The Bank then contains a short, steep rise in elevation before flattening back out to meet a vegetated strip of forest, scrub/shrub, or grassy upland between the Bank and parking lot. The upper portion of the Bank is predominantly vegetated with a mix of native shrubs and trees, with some sections limited to grasses or bare soils where foot traffic/public recreational access is frequent. Commonly observed vegetation along the upper portions of the Bank includes red maple (*Acer rubrum*), eastern red cedar (*Juniperus virginiana*), bayberry (*Morella caroliniana*), highbush blueberry (*Vaccinium corymbosum*), maleberry (*Lyonia ligustrina*), alder (*Alnus sp.*), and prairie cordgrass (*Spartina pectinate*). Common upland species observed landward of the Bank and adjacent to the parking lot include eastern red cedar, black oak (*Quercus velutina*), black cherry (*Prunus serotina*), pitch pine (*Pinus rigida*), bayberry, switchgrass (*Panicum virgatum*), and round-leaf greenbrier (*Smilax rotundifolia*). The landward edge of the Bank is defined by mean annual flood level. HW used a combination of observed variables to determine the mean annual flood level (Top of Bank), including water line markings and moss rings along the base of the existing woody vegetation, wrack lines, changes in vegetative cover, and breaks in slope.

HW delineated the landward boundary of the Bank with a series of consecutively numbered blue/white-striped flagging stations labeled BANK 1 – BANK 16.

Photo 1. Bank present adjacent to the southern end of the parking lot.

Photo 2. Bank present adjacent to the northern end of the parking lot.

Bordering Vegetated Wetland

Bordering Vegetated Wetland (BVW) is defined at 310 CMR 10.55(2)(a) as:

> "*freshwater wetlands that border on creeks, rivers, streams, ponds and lakes. The types of freshwater wetlands are wet meadows, marshes, swamps and bogs. Bordering Vegetated Wetlands are areas where the soils are saturated and/or inundated such that they support a predominance of wetland indicator plants. The boundary of Bordering Vegetated Wetland is defined at 310 CMR 10.55 (2)(c) as the line within which 50% or more of the vegetational community consists of wetland indicator plants and saturated or inundated conditions exist.*" The Town of Dennis Conservation Commission Rules and Regulations define Bordering Vegetated Wetland similarly.

The site supports a BVW area along the edge of Scargo Lake adjacent to the southern end of the parking area (**Photo 3**). The BVW is characterized as a shallow emergent marsh community closer to the edge of Scargo Lake, and transitions to become more of a shrub/scrub swamp community as it extends further from the lake toward the upland. The landward boundary of the wetland is defined by a short, steep rising slope along the eastern edge where the vegetation transitions to a predominance of upland species. Commonly observed vegetation comprising the wetland community includes swamp loosestrife (*Decodon verticillatus*), sweetgale (*Myrica gale*), swamp rose (*Rosa palustris*), swamp milkweed (*Asclepias incarnata*), maleberry, and sweet-pepperbush.

HW delineated the landward boundary of the BVW with a series of consecutively numbered pink flagging stations labeled BVW 1 – BVW 6.

Photo 3. Looking north from within the BVW area located near the southwest corner of the parking lot.

Invasive Species

Invasive plants (as defined by the Massachusetts Invasive Plant Advisory Group) were present at or near the site, primarily in the area adjacent to the northeast of the parking lot, but the only species observed to be present is Asiatic bittersweet (*Celastrus orbiculatus*). The Massachusetts Invasive Plant Advisory Group identifies invasive plant species as “non-native species that have spread into native or minimally managed plant systems in Massachusetts,” and which “cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems.” For future planning purposes, the Town may wish to develop a management plan for reducing or eliminating these plants at this site to allow for the establishment of naturally vegetated protective buffers to the wetland resource areas.

If you have any questions regarding our findings, or if HW may be of further assistance, please do not hesitate to contact me directly at bwollman@horsleywitten.com or at (508) 833-6600.

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Unit 1 • Sandwich, MA 02563
508-833-6600 • horsleywitten.com

MEMORANDUM

To: Jordan Mora, APCC

From: Ben Wollman, Wetland Scientist

Date: July 11, 2023

Re: Wetland Resources – Scargo Lake Landing Boat Ramp Site, Dennis, MA

HW has prepared the following memo and site figures to document the wetland resource areas at the referenced site and to provide regulatory context for future work.

General Site Description

The Site is located along the northwest side of Scargo Lake in Dennis, Massachusetts, just south of Route 6A, and consists of a gravel access/boat ramp that extends from Route 6A down to the edge of Scargo Lake. The Site is bordered by residential properties to the northeast and southwest.

FEMA Designation

According to the FEMA National Flood Hazard Map (Community Panel No. 25001C0581J, effective July 16, 2014), portions of the Site are located within Other Areas of Flood Hazard, Zone X (0.2% annual chance of flooding) (**Figure 1**).

Figure 1. Excerpt from Federal Emergency Management Agency (FEMA) FIRMette for the Site.

State-listed Rare Species Habitat and Open Space

According to the most recent version of the *Massachusetts Natural Heritage Atlas* (15th Edition, August 1, 2021), the Site lies within a designated *Priority Habitat of Rare Species* (PH 430) area but does not contain any areas of *Estimated Habitat of Rare Wildlife or Certified Vernal Pools* (**Figure 2**).

Figure 2. Rare species habitat (Source: MassMapper 2022).

Wetland Resource Areas

The Site supports freshwater wetland resource areas, as defined under the Massachusetts *Wetlands Protection Act* (M.G.L. Ch. 131 § 40) and the Town of Dennis Wetlands Protection By-law (Chapter 187) and their respective regulations. Horsley Witten Group, Inc. (HW) wetland biologists identified and delineated these resource areas during a site visit on June 22, 2023. Jurisdictional areas identified on or adjacent to the Site include Bank (locally Inland Bank); and the 50-foot No Disturb and 100-foot Buffer Zones to Bank (Inland Bank). Additional resource areas present adjacent to the Site include Land Under Waterbodies and Waterways (LUW) and Banks of or Land Under the Ocean, Ponds, Streams, Rivers, Lakes, or Creeks that Underlie an Anadromous/Catadromous Fish Run ("Fish Run").

HW followed wetland resource area identification and on-site delineation procedure guidelines described in the Massachusetts Department of Environmental Protection (MassDEP) handbook, entitled *Massachusetts Handbook for Delineation of Bordering Vegetated Wetlands* (September, 2022), Massachusetts Wetlands Protection Act (M.G.L. Ch. 131 § 40), and its implementing Regulations (310 CMR 10.00), and the Town of Dennis *Wetlands Protection By-law* (Chapter 187) and associated Town of Dennis Conservation Commission Rules and Regulations.

Prior to conducting field delineations, HW reviewed existing source data, including USGS Geological Survey 7.5 minute topographic maps, Massachusetts Department of Environmental

Protection (MassDEP) wetlands source data available through the Massachusetts Geographic Information System (MassGIS), USDA Natural Resources Conservation Service (NRCS) soils survey, U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps, and other source data to identify the presence of jurisdictional wetlands and waters of the United States within the Site. This information was used to compile base mapping to assist in the understanding of the hydrologic variables, soils conditions, and vegetation communities (where applicable).

A brief description of the regulatory definitions and the observed resources areas is provided below.

Bank (Inland Bank)

Bank is defined at 310 CMR 10.54(2)(a) as "…*the portion of land surface which normally abuts and confines a water body. It occurs between a water body and a vegetated bordering wetland and adjacent floodplain, or, in the absence of these, it occurs between a water body and an upland. A Bank may be partially or totally vegetated, or it may be comprised of exposed soil, gravel or stone. The upper boundary of a Bank is first observable break in the slope or the mean annual flood level, whichever is lower. The lower boundary of a Bank is the mean annual low flow level"* [310 CMR 10.54(2)(c)]. The Town of Dennis Conservation Commission Rules and Regulations define Inland Bank similarly.

Bank (Inland Bank) is present around the perimeter of Scargo Lake at the Site (**Photos 1 & 2**). The lower portion of the Bank exists as a gentle, unvegetated slope rising from the edge of the lake, comprised of a mix of sand and gravel material. The Bank continues to rise to the northwest (toward Route 6A) and is comprised of a mix of gravel and patches of short grass and other herbaceous vegetation where the boat ramp is maintained for vehicle and boat access. Beyond the upper boundary of the Bank, the slope rises more steeply up the gravel boat ramp access and adjacent residential properties. The vegetation on the upper portion of the Bank on the adjacent residential properties is a mix of native and non-native trees, shrubs, and herbaceous species. Commonly observed vegetation along the upper portions of the Bank includes red maple (*Acer rubrum*), gray willow (*Salix cinerea*), shrub honeysuckle (*Lonicera sp.*), multiflora rose (*Rosa multiflora*), arrowwood viburnum *(Viburnum dentatum*), alder (*Alnus sp.*), Virginia rose (*Rosa virginiana*), Asian bittersweet (*Celastrus orbiculatus*), grape (*Vitis sp.*), rough-stem goldenrod (*Solidago rugosa*), velvet grass (*Holcus lanatus*), path rush (*Juncus tenuis)*, sensitive fern (*Onoclea sensibilis*), fox sedge (*Carex vulpinoidea*), white clover (*Trifolium repens*), Deer-tongue (*Dichanthelium clandestinum*), soft rush (*Juncus effusus*), orange jewelweed (*Impatiens capensis*), and switchgrass (*Panicum virgatum*). Additionally, smaller patches and thin strips of swamp-loosestrife (*Decodon verticillatus*), buttonbush (*Cephalanthus occidentalis*), marsh St. John's-wort (*Triadenum virginicum*), and purple loosestrife (*Lythrum salicaria*) were observed along the lower sections of the bank on the properties adjacent to the Site.

Common upland species observed landward of the Bank and adjacent to the boat ramp access include Norway maple (*Acer platinoides*), tree-of-heaven (*Ailanthus altissima*), eastern red cedar, black oak (*Quercus velutina*), sycamore maple (*Acer pseudoplatanus*), privet (*Ligustrum sp.*), brambles (*Rubus sp.*), Virginia creeper (*Parthenocissus quinquefolia*), climbing spindle-tree (*Euonymus fortunei*), English Ivy (*Hedera helix*), round-leaf greenbrier (*Smilax rotundifolia*), and

spiderwort (*Tradescantia sp.*). The landward edge of the Bank is defined by mean annual flood level. HW used a combination of observed variables to determine the mean annual flood level (Top of Bank), including water line markings and moss rings along the base of the existing woody vegetation, wrack lines, changes in vegetative cover, and breaks in slope.

HW delineated the landward boundary of the Bank with a series of consecutively numbered blue flagging stations labeled BANK 1 – BANK 5.

Photo 1. Bank present to the north of the boat ramp area.

Photo 2. Bank present at and to the south of the boat ramp area.

Invasive Species

Invasive or Likely Invasive plants (as defined by the Massachusetts Invasive Plant Advisory Group) were present at or near the Site, which include gray willow, Norway maple, sycamore maple, tree-of-heaven, Asiatic bittersweet, purple loosestrife, multiflora rose, and privet. The Massachusetts Invasive Plant Advisory Group identifies invasive plant species as “non-native species that have spread into native or minimally managed plant systems in Massachusetts,” and which “cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems.” For future planning purposes, the Town may wish to develop a management plan for reducing or eliminating these plants at this Site to allow for the establishment of naturally vegetated protective buffers to the wetland resource areas.

If you have any questions regarding our findings, or if HW may be of further assistance, please do not hesitate to contact me directly at bwollman@horsleywitten.com or at (508) 833-6600.

APPENDIX D – Soil Test Pit Logs

Commonwealth of Massachusetts

City/Town of Dennis

DR LORDS BOAT RAMP

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review

Deep Observation Hole Number: 1 (Hole #) | 1/19/23 (Date) | 830 (Time) | 40F Cloudy (Weather) | 41°44'43.4"N (Latitude) | 70°10'45.9"W (Longitude)

1. Land Use: Parking lot (e.g. woodland, agricultural field, vacant lot, etc.) | Scrub oak & pine (Vegetation) | No (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | <5% (Slope (%))

Description of Location: North end of parking lot, near abutter driveway

2. Soil Parent Material: Sandy glaciofluvial deposits | Outwash plains (Landform) | Footslope (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body 50 feet | Drainage Way feet | Wetlands feet | Property Line 10 feet | Drinking Water Well feet | Other feet

4. Unsuitable Materials Present: ☑ Yes ☐ No If Yes: ☐ Disturbed Soil ☑ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☑ Yes ☐ No If Yes: 48" Depth weeping from pit | N/A Depth standing water in hole

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			
0-2	Pavement	-	-	-	-	-	-	-	-	-	
2-28	HTM	MS	10 YR 5/6	-	-	-	-	-	SG	VFR	
28-31	Ab	MS	10 YR 3/1	-	-	-	-	-	SG	VFR	
31-43	Bw	MS	10 YR 5/6	31	7.5 YR 5/6	40	-	-	SG	VFR	
43-50	C	CS	10 YR 5/3	-	-	-	-	-	SG	VFR	

Additional Notes: Seeping @ 48"

Commonwealth of Massachusetts

City/Town of Dennis

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review

Deep Observation Hole Number: 2 (Hole #) | 1/19/23 (Date) | 9:30 (Time) | 40F Cloudy (Weather) | 41°44'41.2"N (Latitude) | 70°10'46.5"W (Longitude)

1. Land Use: Parking lot (e.g. woodland, agricultural field, vacant lot, etc.) | Scrub oak & pine (Vegetation) | No (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | <5% (Slope (%))

Description of Location: North end of parking lot, near abutter driveway

2. Soil Parent Material: Sandy glaciofluvial deposits | Outwash plains (Landform) | Footslope (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body 50 feet | Drainage Way feet | Wetlands feet | Property Line 20 feet | Drinking Water Well feet | Other feet

4. Unsuitable Materials Present: ☑ Yes ☐ No If Yes: ☐ Disturbed Soil ☑ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☑ Yes ☐ No If Yes: 66 Depth weeping from pit | N/A Depth standing water in hole

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			
0-2	Pavement	-	-	-	-	-	-	-	-	-	
2-6	HTM	MS	10 YR 3/6	-	-	-	-	-	SG	VFR	
6-13	HTM	FS	10 YR 4/4	-	-	-	-	-	SG	VFR	
13-15	Ab	FS	10 UR 5/2	-	-	-	-	-	SG	VFR	
15-48	C1	VFS	10 YR 4/4	28	5 YR 4/6	20	-	-	SG	VFR	
48-70	C2	FS	2.5 YR 5/3	-	-	-	-	-	SG	VFR	

Additional Notes: Seeping @ 66"

Commonwealth of Massachusetts

City/Town of Dennis

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review

Deep Observation Hole Number: 3 (Hole #) | 1/19/23 (Date) | 10:15 (Time) | 40F Cloudy (Weather) | 41°44'42.5"N (Latitude) | 70°10'46.2"W (Longitude)

1. Land Use: Parking lot (e.g. woodland, agricultural field, vacant lot, etc.) | Scrub oak & pine (Vegetation) | No (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | <5% (Slope (%))

Description of Location: North end of parking lot, near abutter driveway

2. Soil Parent Material: Sandy glaciofluvial deposits | Outwash plains (Landform) | Footslope (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body 50 feet | Drainage Way feet | Wetlands feet | Property Line 50 feet | Drinking Water Well feet | Other feet

4. Unsuitable Materials Present: ☑ Yes ☐ No If Yes: ☐ Disturbed Soil ☑ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☑ Yes ☐ No If Yes: 54 Depth weeping from pit | N/A Depth standing water in hole

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			
0-10	Pavement	-	-	-	-	-	-	-	-	-	
10-12	HTM	VFS	10 YR 5/8	-	-	-	-	-	SG	VFR	
12-36	HTM	VFS	10 YR 5/4	-	-	-	-	-	SG	VFR	
35-54	Peat	Organic	10 YR 2/2	-	-	-	-	-	SG	VFR	
54-62	C1	MS	10 YR 5/2				-	-	SG	VFR	
62-68	C2	VFSL	GLEY 1 5/10 Y	-	-	-	-	-	SG	VFR	

Additional Notes: Seeping @ 54"

Commonwealth of Massachusetts

City/Town of Dennis

SCARGO LAKE TOWN LANDING

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review

Deep Observation Hole Number: 1 (Hole #) | 7/6/23 (Date) | 1030 (Time) | 75F Sun (Weather) | 41°44'39.06"N (Latitude) | 70°11'05.04"W (Longitude)

1. Land Use: Parking area (e.g. woodland, agricultural field, vacant lot, etc.) | Deciduous trees, grass (Vegetation) | Few (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | 8% (Slope (%))

Description of Location: Middle of parking area, east side

2. Soil Parent Material: Sandy, loose glaciofluvial deposits | Outwash plains (Landform) | Summit (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From:

Open Water Body	50 feet	Drainage Way	feet	Wetlands	50 feet		
Property Line	10 feet	Drinking Water Well	feet	Other	feet		

4. Unsuitable Materials Present: ☐ Yes ☐ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☑ No If Yes: _____ Depth weeping from pit N/A Depth standing water in hole

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			
0-2	Fill	-	-	-	-	-	-	-	-	-	
2-8	A	LS	10 YR 3/3	-	-	-	-	-	SG	VFR	
8-45	C1	MS	10 YR 6/8	-	-	-	-	-	SG	VFR	
45-120	C2	MS	10 YR 5/6	-	-	-	-	-	SG	VFR	

Additional Notes: Soil below 108" is moist

Commonwealth of Massachusetts

City/Town of Dennis

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review

Deep Observation Hole Number: 2 (Hole #) | 7/6/23 (Date) | 1100 (Time) | 78F Sun (Weather) | 41°44'38.59"N (Latitude) | 70°11'05.00"W (Longitude)

1. Land Use: Parking area (e.g. woodland, agricultural field, vacant lot, etc.) | Deciduous trees, grass (Vegetation) | Few (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | 3% (Slope (%))

Description of Location: East side near beach

2. Soil Parent Material: Sandy, loose glaciofluvial deposits | Outwash plains (Landform) | Summit (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body 10 feet | Property Line 10 feet | Drainage Way feet | Drinking Water Well feet | Wetlands 10 feet | Other feet

4. Unsuitable Materials Present: ☐ Yes ☐ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☑ No If Yes: Depth weeping from pit | N/A Depth standing water in hole

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			
0-11	Fill	LS	10 YR 2/1	-	-	-	-	-	-	-	
11-24	Fill	MS	10 YR 5/3	-	-	-	-	-	SG	VFR	
24-35	Fill	CS	10 YR 7/1	-	-	-	-	-	SG	VFR	
35-45	O	PEAT	10 YR 2/1	-	-	-	-	-	-	-	
45-88	C1	MS	7.5 YR 2.5/1	-	-	-	-	-	SG	VFR	
88-122	C2	CS	10 YR 3/3	-	-	-	-	-	SG	VFR	

Additional Notes: Heavy seepage from peat layer, C1 and C2 dry

APPENDIX E – Operation and Maintenance Guide

Stormwater Operations & Maintenance Guide

Dr Lords Boat Ramp & Scargo Lake Landing

Table of Contents

APPENDICES

1. INTRODUCTION

This document provides a general description of, and outlines the operation and maintenance requirements for the Dr Lords Boat Ramp Stormwater Retrofit project at Dr Lords Road, and the Scargo Lake Landing Stormwater Retrofit project, both in Dennis, MA. The responsible parties are required to inspect and maintain all measures as outlined in this maintenance guide throughout the year. Site maintenance is divided into three categories as outlined below.

1. Green Stormwater Infrastructure
    - Structural Components
    - Structural Maintenance Schedule
    - Planting
    - Landscape Maintenance Schedule
    - Weed Guide
2. General Site Maintenance
    - Trash & Debris
    - Pet Waste
    - Pavement Sweeping
    - Contributing Drainage Areas
    - Snow Removal
    - De-icing
3. Long-Term Pollution Prevention Measures

2. RESPONSIBLE PARTIES AND BUDGET

The estimated average annual O&M budget for the proposed system is shown below:

- **Bioretention Area (1):** **$500**
- **Wet Bioretention Area (1):** **$500**
- **Underground Infiltration Chambers (1):** **$750**
- **Porous Pavement & Gravel Infiltration Swale:** **$2,000**

ANNUAL TOTAL **$3,750**

Owner and operator contact information is provided below:

Owner: **Town of Dennis**
Contact: **Engineering Department**
Tom Andrade and Chris Wickson
120 Theophilus F. Smith Road
South Dennis, MA 02660
508-760-6166

Owner - Signature:_____ Date:_____

3. GREEN STORMWATER INFRASTRUCTURE

3.1. How Does Green Infrastructure Work?

Green Stormwater Infrastructure (GSI) is a nature-based approach to stormwater treatment and management. These stormwater practices or "treatment areas" are designed to mimic nature and use the natural filtration properties of soil and plants to remove pollutants from stormwater runoff prior to discharging to the municipal drainage system or waterbodies.

GSI relies on the following basic steps to function properly. Structural components of the practices facilitate the functioning of the steps. If one of these steps, or components, does not work properly, the entire system can be compromised and the GSI practice itself could be contributing to maintenance problems. This can lead to landscape nuisances, more frequent maintenance and costly repairs/improvement. The steps are:

1. ***Collect*** (Inlets)
2. ***Move Water*** (Conveyance) if needed, can come after capturing sediment
3. ***Capture Sediment*** (Pretreatment)
4. ***Treat and Manage*** (Filter, Infiltrate or Store)
5. ***Overflow*** (Structures and Spillways)

3.2. What is required for Maintenance?

As these are nature-based systems that rely on plant upkeep, the maintenance for GSI typically falls under landscape and general site maintenance services. Proper operation and maintenance (O&M) are vital to its long-term viability. Regularly scheduled maintenance can prevent system failures due to sediment build-up, damage, or deterioration. The maintenance requirements, outlined in this guide, are critical to ensure proper treatment, maintain storage capacity and preserve the visual integrity.

General maintenance includes the following:

1. Removing sediment from the pretreatment practices used to capture sediment.
2. Maintaining the proper drainage function and pollutant removal capacity of the systems.
3. Maintaining healthy and native, trees, plants, and vegetative cover as well as the removal of unwanted weeds and invasive species.

It is recommended that all practices be maintained regularly as part of the routine landscape maintenance or at a minimum four times per year and after major rain events:

- **Early Spring**: during spring cleanup
- **Summer:** during lawn mowing and other routine site maintenance
- **Early Fall:** when leaves begin to fall
- **Late Fall/Early Winter:** after all the leaves have fallen during leaf removal
- **After major storm events**: 2" of rain or greater.

The following sections describe the general function and landscape maintenance of each practice on the site. Included in the appendices is a specific Inspection Report for each practice type (**Appendix A**) along with a plan showing the location of the items to be inspected and maintained (**Appendix B**).

3.3. What practices are used at this site?

The following practices are present at these sites:

a. Bioretention/Wet Bioretention Area: A bioretention area is a stormwater management practice to manage and treat stormwater runoff using a conditioned planting soil bed or "filter" media and plants to filter runoff captured in a shallow depression. The method combines physical filtering and adsorption with bio-geochemical processes to remove pollutants.
b. Underground Infiltration Chambers/Galleys: High-density polypropylene or precast concrete structures, bedded and surrounded with clean washed stone, installed under paved or landscaped surfaces. Stormwater runoff is pretreated and directed to these systems to detain and infiltrate water over time, while excess flows beyond the design capacity are directed to a stabilized overflow point. It is important that sediment – especially fine particles – do not enter this system, as it greatly reduces the function and can be very difficult to remove once introduced.

c. Porous Pavement: Porous pavement is designed to capture and infiltrate runoff, but also help stabilize the site during periods of tidal inundation. The areas of porous pavement have been placed to ensure they do not collect runoff from the traditional impervious pavement, as this can clog the pervious pavement. Regular maintenance is critical to the success of this practice.

The maintenance for the green infrastructure is divided into two categories:

a. The **Structural Components** that make up the basic steps of a functioning system.

b. The **Plantings** that are the landscape and filtration element.

Each category is further described in the sections below.

4. STRUCTURAL COMPONENTS: BIORETENTION/WET BIORETENTION AREAS

Structural Components

1. ***Collect***: Stormwater runoff is directed to paved flume inlets(s) where stormwater enters the bioretention area.

2. ***Capture Sediment***: Sand and debris settle out within sediment forebays.

3. ***Move Water:*** The stormwater discharges directly to the bioretention area via a check dam weir.

4. ***Treat and Manage***: Stormwater overtops the forebay check dam and flows through the planted bioretention area. Plants slow the water down, and the soil media and plant roots filter the runoff, removing nutrients and bacteria. The treated water then infiltrates into the soil below or overflows as described below.

5. ***Overflow***: During larger rain events, the water level will rise and overflow either into the outlet structure or back out the paved flume.

MAINTENANCE SCHEDULE: BIORETENTION/WET BIORETENTION AREAS

A site inspection of the wet bioretention components shall be conducted at least twice a year in the Spring and Fall, and after major storm events (2" of rain or greater). Debris and trash should be removed monthly from April to November and sediment removal should occur during the two site inspections and during the monthly debris and trash inspections as needed. See the calendar below and the Inspection Report in **Appendix A** for more information.

Wet Bioretention General Maintenance Schedule												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Task	**Frequency & Time of the Year**											
Site Inspection				**X**							**X**	
Debris & Trash Removal				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Sediment Removal				**X**	x	x	x	x	x	x	**X**	

should **also** be completed after major storm events

X required inspection

x as needed

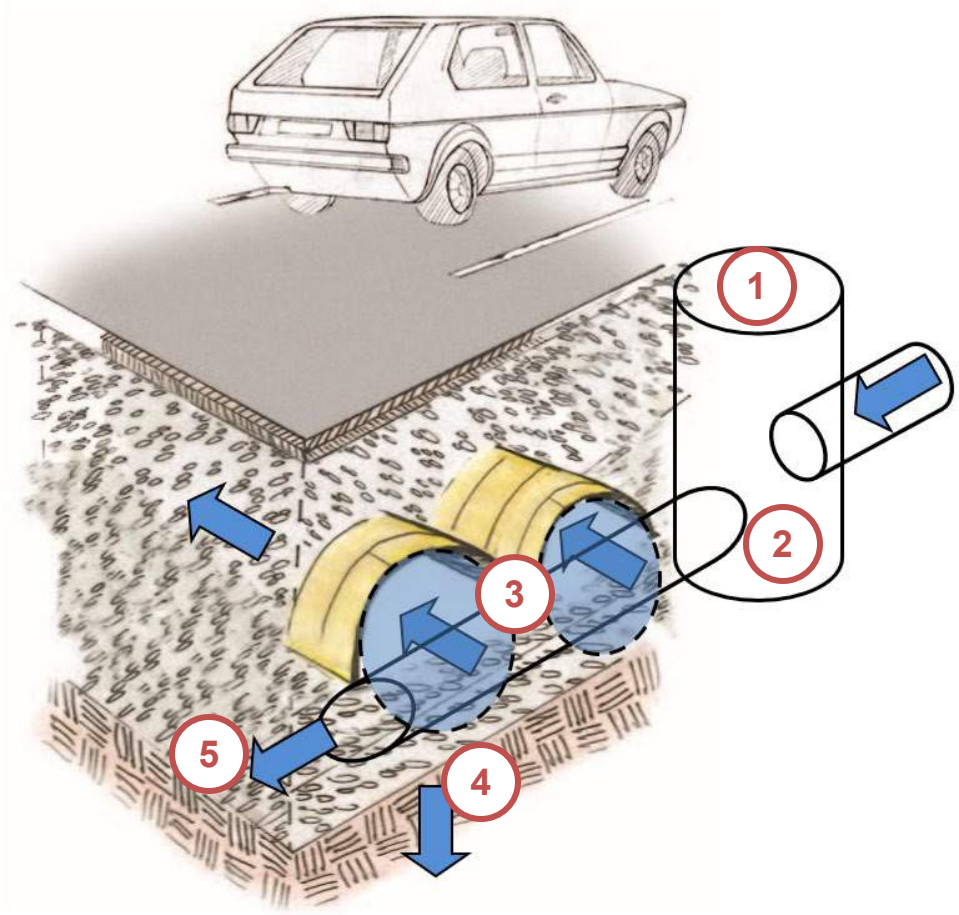
- When removing trash and debris during monthly inspections look for:
  - If sediment is > 3" in paver lined sediment forebays. Ensure sediment does not cause blockage of inlet weirs. If it is, remove sediment.
  - If standing water does not drain after 48 hours. See Inspection Report for action items.

- After rain event look for:
  - If standing water does not drain after 48 hours. See Inspection Report for action items.

Use a shovel to clear stone and sediment from the inlets.

See Plantings section for information on plantings maintenance of the wet bioretention area. Use the plantings maintenance calendar to combine maintenance efforts.

5. STRUCTURAL COMPONENTS: UNDERGROUND INFILTRATION CHAMBERS



Structural Components

1. ***Collect***: Stormwater runoff is directed to catch basins, trench drains and oil/grit separator.
2. ***Capture Sediment***: Sand and debris settle out within deep sump manhole.
3. ***Move Water:*** The stormwater is piped from collection and capture structures to the underground high-density polypropylene galley system.
4. ***Treat and Manage***: Stormwater runoff up to the 25-year storm is detained and slowly infiltrated into the native subsoil providing groundwater recharge.
5. ***Overflow***: During rain events larger than the 25-year storm, runoff will continue down toward the lake as occurs under existing conditions.

MAINTENANCE SCHEDULE: UNDERGROUND INFILTRATION CHAMBERS

A site inspection of the underground infiltration system components shall be conducted at least twice a year in the Spring and Fall, and after major storm events (2" of rain or greater). Debris and trash should be removed from trench drains, catch basins, and manholes monthly from April to November and sediment removal should occur during the two site inspections and during the monthly debris and trash inspections as needed. See the calendar below and the Inspection Report in **Appendix A** for more information. The StormTech Owner's Manual is provided in **Appendix C**.

Underground Infiltration Chambers General Maintenance Schedule												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Task	**Frequency & Time of the Year**											
Site Inspection				**X**							**X**	
Debris & Trash Removal				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Sediment Removal				**X**	x	x	x	x	x	x	**X**	

should **also** be completed after major storm events

X required inspection

x as needed

- When removing trash and debris during monthly inspections look for:
  - Sediment accumulation or clogging in the trench drains
- After rain event look for:
  - Standing water that does not drain after 48 hours. See Inspection Report for action items.

Remove debris and sediment from trench drains and catch basins.

6. STRUCTURAL COMPONENTS: POROUS PAVEMENT

A Pervious Pavers
B Edging *(Per Manufacturer)*
C Bedding Course
D Filter Fabric *(Sidewalls Only)*
E Gravel Reservoir
F Approved Subsoil

Structural Components

1. ***Collect***: Stormwater runoff is absorbed directly into the pervious surface when it rains.
2. ***Capture Sediment***: Porous pavements are designed for minimal run-on from permeable surfaces (like lawn areas) and no runoff from impervious pavement, so sediment should be minimal. Sediment will filter into the porous pavement and will eventually clog.
3. ***Move Water:*** The stormwater filters through the surface material and choker courses.
4. ***Treat and Manage***: The stormwater is treated as it flows through the filter course into the underlying native soils.
5. ***Overflow***: During larger rain events, once the porous pavement and gravel below are saturated, additional runoff will flow downgradient to the wet bioretention and then down to the boat ramp and out to the pond.

MAINTENANCE SCHEDULE: POROUS PAVEMENT

A site inspection of the porous pavement shall be conducted at least twice a year in the Spring and Fall, and after major storm events (2" of rain or greater). See the calendar below.

Pervious Pavement and Pavers General Maintenance Schedule												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Task	**Frequency & Time of the Year**											
Site Inspection				**X**				**X**				
Debris & Trash Removal				**X**	x	x	x	x	x	x	**X**	
Sediment Removal	x	x	x	**X**	x	x	x	x	x	x	**X**	x

should **also** be completed after major storm events

X required inspection

x as needed

Frequent cleaning and maintenance is critical to prevent clogging of porous surfaces. To keep the surface clean, sweep the porous pavement using vacuum sweepers at least twice a year.

No sanding or de-icing is permitted. Full porous pavement replacement will be conducted every 10-20 years or as determined necessary due to field conditions.

7. PLANTINGS

7.1. Plantings

The planting design for the sites consists of three landscape maintenance areas. The “mow” area which consists of turf, the “no mow” areas (two wet bioretention areas), and the natural buffer. The plantings maintenance checklist is included in **Appendix A**, and the full planting plan is available in **Appendix D**.

“Mow” Areas

No “Mow” Area (Wet Bioretentions)

Natural Buffer

Figure 1. Dr Lords Boat Ramp Landscape Maintenance Areas

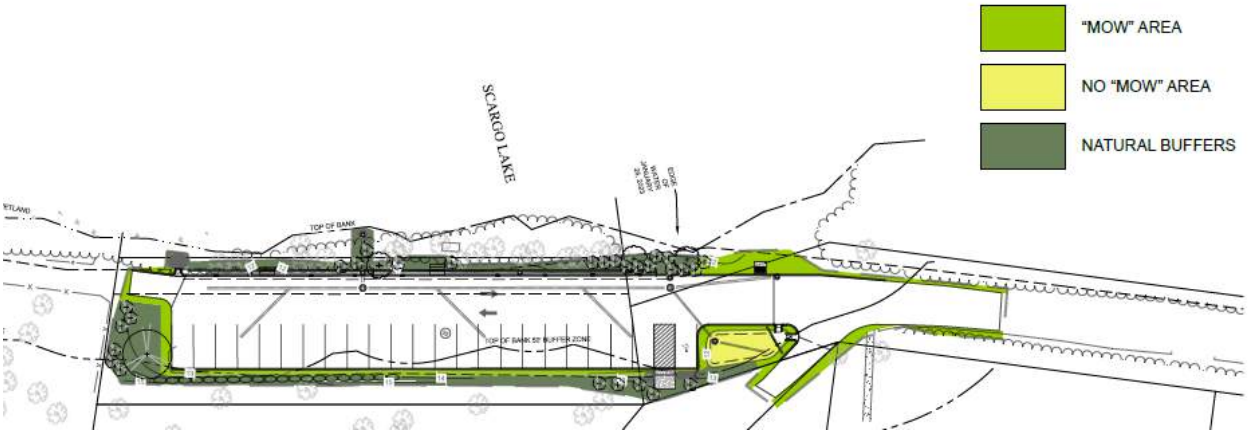
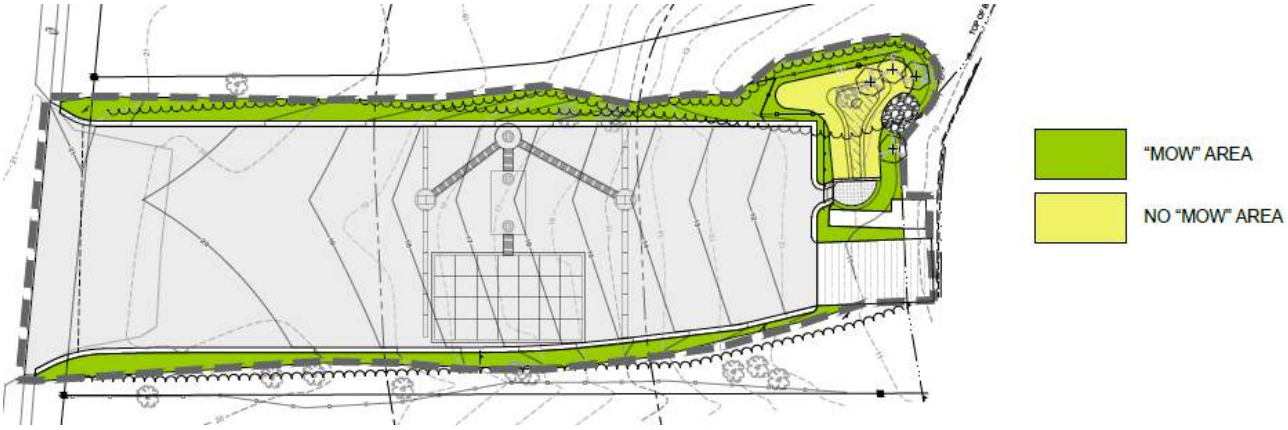


Figure 2. Scargo Lake Town Landing Landscape Maintenance Areas



PLANTINGS: "MOW" AREAS MAINTENANCE

There is an area of the site that is allowed to be maintained as "mowed" lawn as necessary. Landscape maintenance of "mowed" lawn areas includes the following:

Seeding

Loam and reseed bare spots with a seed mix that matches existing species.

Mowing/Weed Whacking

Cut only 1/3 of vegetation. Do not mow during drought periods or when excessively wet. Depending on height of grasses and the time of year, grass cuttings/stalks may need to be raked and removed from site.

Watering

Allowing the lawn areas to "brown" is desired. Water only during drought conditions or during reseeding establishment period.

Fertilizing

No fertilizer shall be used.

Weeding

Weeding should be limited to invasive and weedy species (see section 3.6 Weed Identification below and the Weed Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf). Non-chemical methods (hand pulling and hoeing) are required; chemical herbicides should be avoided. Properly remove and dispose of all invasive species off site as to prevent colonization elsewhere, this includes disposal on land beyond the project area.

Monitoring

During the establishment period, walk the mow areas monthly during the first year to look for invasive species, bare spots and identify potential pest or disease problems. Properly remove and dispose of all invasive species as to prevent colonization elsewhere, this includes disposal on land beyond the project area.

Debris & Trash

Remove and properly dispose litter from all areas prior to mowing.

PLANTINGS: NO "MOW" AREA MAINTENANCE (BIORETENTION/WET BIORETENTION AREAS)

By design, plants in wet bioretention areas are meant to flourish throughout the growing season leaving dry standing stalks during the dormant months. Plants do not require fertilizers or watering (except during drought or establishment period). This area is designated as "no mow." Frequent mowing would eliminate selected meadow species, may promote the growth of undesirable plants, and require additional maintenance and watering. It is recommended this area be cut back no more than one time per year and only as necessary. Remove and replace vegetation as necessary, using the appropriate species as shown on the Planting Plan. The best time to plant is in early to mid-fall or early to mid-spring. Specific maintenance activities of the "no mow" area include:

Seeding

Loam and reseed bare spots with the specified seed mix as shown on the Planting Plan.

Cutting Back

Recommend cutting with shears a maximum of once a year in early spring. Otherwise, allow areas to grow to their natural heights (12" to 36") to maintain a meadow appearance. Do NOT cut area lower than 6" – maintain sporadic wooden stakes on site at 6" height to provide visual cues during cutting. Depending on height of grasses and the time of year, grass cuttings/stalks may need to be raked and removed from site so as not to clog the wet bioretention. Use a leaf blower as needed to assist in clean-up.

Pruning

Prune trees and shrubs to remove deadwood and low hanging branches.

Watering

Water only during drought conditions or during reseeding establishment period.

Fertilizing

No fertilizer shall be used.

Weeding

Weeding should be limited to invasive and weedy species (see section on Weed Identification below and the Weed Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf). Non-chemical methods (hand pulling and hoeing) are required; chemical herbicides should be avoided. Properly remove and dispose off site all invasive species as to prevent colonization elsewhere; this includes disposal on land beyond the project area.

Monitoring

During the establishment period, walk the "no mow" areas monthly without the intent to cut, but to look for invasive species, bare spots and identify potential pest or disease problems.

Debris & Trash

Remove and properly dispose of litter from all areas.

PLANTINGS: NATURAL BUFFER AREAS MAINTENANCE

This area is intended to increase the natural buffer to the adjacent pond and is not to be disturbed. Maintenance of natural buffer areas includes the following:

Monitoring

Walk the buffers to look for potential invasive species and identify potential disease.

Weeding

Weeding should be limited to invasive and weedy species (see section 3.6 Weed Identification below and the Weed Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf). Non-chemical methods (hand pulling and hoeing) are required; chemical herbicides should be avoided. Properly remove and dispose of all invasive species as to prevent colonization elsewhere; this includes disposal on land beyond the project area.

Watering

Water only during drought conditions or during the plant establishment period.

Debris & Trash

Remove and properly dispose litter from all natural areas.

PLANTINGS: REPLACEMENTS

The plants that thrive in wet bioretention areas are typically quite drought tolerant due to the filter profile having a top layer of planting soil and sandy soil media below. They need to be able to withstand periods of inundation after storm events; however, when it doesn't rain, there will be less water held naturally in the sand than in other soil types for the plants to use, so they need to tolerate dry periods as well.

Specifying plants native to the area increases the ecosystem benefits by helping to support native wildlife like pollinators.

If replacements are needed, use the planting plan as a guide (see **Appendix D**). However, if all the plants of a certain species have not done well in the bioretention area or other locations on the site, do not replace with that same species. Rather, replant with one or more of the other species that has thrived under the conditions or have a plant professional choose a different species based on current photos of the site.

Site specific considerations for plants in bioretention areas should be:

- Freshwater species (preferably native)
- Tolerant of occasional fresh water inundation
- Size constraints:
    - taller perennials at the bottom of the bioretention
    - shorter perennials on the side slopes
- A mix of different types of plants that will create a resilient plant community: cold & warm season grasses, perennials, groundcovers in all areas.

PLANTINGS: MAINTENANCE SCHEDULE

By design, plants in the bioretention area are meant to help filter the stormwater as it passes through and flourish throughout the growing season. The plants do not require fertilizers or mulch, and, after establishment, only need water during periods of drought. Remove and replace vegetation as necessary, using the appropriate species as discussed in the no-mow section above. Weeding should occur quarterly during the growing season as well as monitoring for invasive species. An annual spring "clean up" includes cutting last season's growth of the perennials and pruning as needed. See the calendar below, the Plantings Maintenance Checklist in **Appendix A**, the Weed Identification section, and the Weed Identification Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf for more information.

Bioretention/Wet Bioretention Landscape Maintenance Schedule												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Task	**Frequency & Time of the Year**											
Cutting				**X**								
Mowing				x	**X**	x	x	x	x	x	x	
Weeding				**X**		**X**			**X**			
Monitoring				**X**		**X**			**X**			
Watering						x	x	x	x			
Seeding				x	x				x	x		
Plant Replacement				x	x				x	x		

"Mow" Areas
No "Mow" Areas (Bioretention Areas)
All areas

X required
x as needed

- Trash and debris are removed during monthly structural component inspections but can also be completed during landscape maintenance visits for weeding and monitoring.

Yellow Toadflax *(Linaris vulgaris)*

Redroot Pigweed- (*Amaranthus retroflexus)*

Smartweed *(Polygonum lapathifolium)*

Dandelion *(Taraxacum officinale)*

Fireweed *(Erechtites hieracifolia)*

Spotted Spurge (Euphorbia maculata)

Crabgrass *(Digitaria ischaemum)*

Crabgrass with seedheads

Ragweed (*Ambrosia artemisiifolia*)

Japanese Knotweed (Polygonum cuspidatum)

Ragweed (*Ambrosia artemisiifolia*)

Oriental Bittersweet (*Celastrus orbiculatus*)

Green Foxtail (Setaria viridis)

Norway Maple Tree Seedling (Acer platanoides)

Catalpa Tree Seedling (Catalpa speciosa)

Purple Loosestrife (*Lythrum salicaria*)

Field Bindweed (*Convolvulus arvensis*)

Black Swallow-wort (*Cynanchum louisea*)

8. GENERAL SITE MAINTENANCE

General site maintenance includes the following requirements:

Trash & Debris

Remove and properly dispose of all trash and debris.

Pet Waste

Visitors to the site are encouraged to pick up after their pets. Remove and properly dispose of all pet waste left behind. Pet waste should be picked up and disposed of properly to reduce bacteria and nutrient levels in stormwater.

Pavement Sweeping

Paved roadways should be mechanically swept, at a minimum of once per year in early spring, to remove accumulated sand and sediment debris. Porous pavement/pavers should be swept using a vacuum sweeper at least twice a year.

Snow Removal

Due to the potential for plant damage, snow piling and or removal is NOT recommended in the bioretention areas.

De-Icing

When de-icing compounds are necessary for areas draining to the green stormwater infrastructure, the least harmful chemicals should be used. Excessive salting should be avoided. Use of large amounts of sand should also be avoided, since it may obstruct the conveyance system. For the porous pavement areas, avoid sanding or excessive salting. Ice removal is NOT permitted in the bioretention areas.

9. LONG-TERM POLLUTION PREVENTION MEASURES

Long-term pollution prevention measures implemented at the site reduce pollutants in stormwater discharges. The following precautions will be employed on an on-going basis.

Spill Prevention & Control Measures

To minimize the risk of spills or other accidental exposure of materials and substances to stormwater runoff, the following material management is to be used when working on site.

- Any materials stored on-site will be stored in a neat, orderly manner in their appropriate containers.
- Products will be kept in their original containers with the original manufacturer's label.
- Substances will not be mixed with one another unless recommended by the manufacturer.
- Manufacturers' recommendations for proper use and disposal will be followed.
- The contractor's supervisor will be issued this Guide to ensure proper use and disposal of materials.

Materials or substances listed below may be present on-site for maintenance and care should be taken to avoid spills:

  - Petroleum Based Products

The following product-specific measures will be followed on-site:

- *Petroleum Products* - All on-site vehicles will be monitored for leaks and receive preventative maintenance to reduce the chance of leakage.
- *Grass Clipping, Leaf Litter and Plant Debris* – are to be removed from the property and not disposed on site.

APPENDIX A – Inspection Checklists

- Inspection Checklist for Dr Lords
  - Bioretention Area
  - Porous Pavement
  - Landscaping
- Inspection Checklist for Scargo Lake Town Landing
  - Wet Bioretention Area
  - Underground Infiltration Chambers
  - Landscaping

Operation and Maintenance Checklist
Dr Lords Boat Ramp

Date:

Time:

Inspector:

Maintenance Item	Description	Maintenance (Y/N)
1, 2 & 3. Catch Basins, Inlet Flumes, Grass Channel Sediment Forebays, and Check Dam Weirs		
Debris Cleanout	Remove all trash, leaf litter and debris from the catch basins, inlet flumes, grass channel and forebays.	
Sediment/Organic Debris Removal	Check for clogging and sediment accumulation that impacts inflow and outflow. Remove and properly dispose of when sediment is >3" in forebays. Remove/cut any vegetation that sprouts through voids in stone, pavement, or pavers.	
Erosion	Check for areas of erosion (gullies, animal burrowing, or overtopping), particularly near check dam weir and along grass swale. Repair as necessary and return to design grades.	
Actions to be taken:		
4. Bioretention Areas		
Debris Cleanout	Remove trash and debris from the surface.	
Erosion	Signs of erosion gullies, animal burrowing, or overtopping are observed. Repair as necessary.	
Sediment/Organic Debris Removal	Remove sediment accumulation and properly dispose when accumulation is greater than or equal to 3 inches.*	
Water Draining properly	If standing water is observed in bioretention areas for more than 48 hours after a storm event, rototill or aerate the bottom 6 inches to breakup any hard-packed sediment, and re-plant as needed. Check for leaf litter, debris, and sediment accumulation in overflow outlet structure that impacts inflow to chambers. If accumulation present, schedule cleaning.	
Actions to be taken:		

Operation and Maintenance Checklist
Dr Lords Boat Ramp

4. Porous Pavement		
Debris Removal	Remove trash from paved and perimeter areas. Sweep surface.	
Vacuum	Vacuum surface to clean pores of debris and sediment with a commercial vacuum system.	
Structure	Repair cracking or other structural issues as found during inspection.	
Actions to be taken:		
5. Overflow Structures: Overflow Structure, Bubbler and Plunge Pool		
Overflow Spillway	Look for areas of erosion in the overflow structures. Repair as necessary.	
Actions to be taken:		
General Site Maintenance		
Debris Removal	Remove trash from perimeter areas.	
Pet Waste Removal	Remove any pet waste from perimeter areas.	
Pavement Sweeping	Sweep road minimum once a year after spring thaw.	
Contributing drainage area	Confirm that contributing drainage area stabilized – stabilize as necessary.	
Portable Toilets	Ensure proper operation. Clean/repair as necessary.	
Snow Removal	Ensure snow piles do no block inlet structures and are not placed in the green stormwater infrastructure.	
De-Icing	Do not remove ice in the bioretention areas. If needed on road, use de-icing compounds with the least harmful chemicals. If needed on the porous pavement surfaces, use de-icing compounds with the least harmful chemicals. Avoid sanding the porous pavement or excessive salting.	
Actions to be taken:		

*Sediment shall be disposed of offsite in a pre-approved location.

Plantings Maintenance Checklist
Dr Lords Boat Ramp

Location:

Date:

Inspector:

Task	Description	Complete (Y/N)
Cutting	• Cut with shears once a year in the early spring. • Do not cut lower than 6". • Blow out leaves and cuttings for easy removal. • Remove cuttings so the bioretention area does not clog.	
Mowing	• Mow twice a year or more frequently as needed with a mulching mower or weed whacker depending on the frequency of cutting. • Bag clippings as needed and dispose of off site. • Maintain a cutting height of 3" or greater. • Leave the grass taller in the warmer months. • Trim edges when necessary.	
Weeding	• Weeding should be limited to invasive and exotic species, which can overwhelm the desired plant community.* • Non-chemical methods including hand pulling and hoeing are recommended. • Chemical herbicides are not allowed.	
Monitoring	• Look for potential invasive species and identify potential disease. Remove and dispose of all invasive species.* (see weeding)	
Watering	• During establishment or drought conditions, plants should be watered a minimum of once every seven to ten days.	
Seeding	• Loam and re-seed bare spots with the specified seed mix as shown on the Planting Plan.	
Plant Replacement	• Replace/replant diseases, unhealthy or dead plans to maintain a healthy plant community	
Fertilizing	NONE	
Mulch	NONE	
Actions to be taken:		

*Invasive species shall be disposed of offsite in a pre-approved location.

"Mowed" Areas
No "Mow" Areas (Bioretention Areas)
All areas

Operation and Maintenance Checklist
Scargo Lake Landing

Date:

Time:

Inspector:

Maintenance Item	Description	Maintenance (Y/N)
1, 2 & 3. Catch Basins, Trench Drains, Oil/grit Separators, Sediment Forebays, Check Dams		
Debris Cleanout	Remove all trash, leaf litter and debris from the catch basins, trench drains, and forebays.	
Sediment/Organic Debris Removal	Check for clogging and sediment accumulation that impacts inflow and outflow. Remove and properly dispose of when sediment is >3" in forebays. Remove/cut any vegetation that sprouts through voids in stone, pavement, or pavers. Open access manhole and remove any sediment and debris that has been trapped by the baffle – a vac truck may be used for this.	
Erosion	Check for areas of erosion (gullies, animal burrowing, or overtopping), particularly near check dam weirs and pavement interface with forebay. Repair as necessary and return to design grades.	
Actions to be taken:		
4. Wet Bioretention Area		
Debris Cleanout	Remove trash and debris from the surface.	
Erosion	Signs of erosion gullies, animal burrowing, or overtopping are observed. Repair as necessary.	
Sediment/Organic Debris Removal	Remove sediment accumulation and properly dispose when accumulation is greater than or equal to 3 inches.*	
Actions to be taken:		
4. Underground Infiltration Chambers		
Observation	Utilize observation port(s) to assess condition of gravel below chambers	
Vacuum	Employ vac truck or manually remove as much sediment as possible that has been deposited in the system	
Flush	Use a water jet/hose to flush the system, taking care not to cause scour at the inlet or erosion at the outlet	

Operation and Maintenance Checklist
Scargo Lake Landing

Maintenance Item	Description	Maintenance (Y/N)
Actions to be taken:		
5. Overflow Structures: Overflow Structures		
Overflow Spillway	Look for areas of erosion in the overflow structures (Bio). Repair as necessary.	
Actions to be taken:		
General Site Maintenance		
Debris Removal	Remove trash from perimeter areas.	
Pet Waste Removal	Remove any pet waste from perimeter areas.	
Pavement Sweeping	Sweep road minimum once a year after spring thaw.	
Contributing drainage area	Confirm that contributing drainage area stabilized – stabilize as necessary.	
Portable Toilets	Ensure proper operation. Clean/repair as necessary.	
Snow Removal	Ensure snow piles do no block inlet structures and are not placed in the green stormwater infrastructure.	
De-Icing	Do not remove ice in the bioretention areas. If needed on road, use de-icing compounds with the least harmful chemicals. Avoid excessive salting or large amounts of sand.	
Actions to be taken:		

*Sediment shall be disposed of offsite in a pre-approved location.

Plantings Maintenance Checklist
Scargo Lake Landing

Location:

Date:

Inspector:

Task	Description	Complete (Y/N)
Cutting	• Cut with shears once a year in the early spring. • Do not cut lower than 6". • Blow out leaves and cuttings for easy removal. • Remove cuttings so the bioretention area does not clog.	
Mowing	• Mow twice a year or more frequently as needed with a mulching mower or weed whacker depending on the frequency of cutting. • Bag clippings as needed and dispose of off site. • Maintain a cutting height of 3" or greater. • Leave the grass taller in the warmer months. • Trim edges when necessary.	
Weeding	• Weeding should be limited to invasive and exotic species, which can overwhelm the desired plant community.* • Non-chemical methods including hand pulling and hoeing are recommended. • Chemical herbicides are not allowed.	
Monitoring	• Look for potential invasive species and identify potential disease. Remove and dispose of all invasive species.* (see weeding)	
Watering	• During establishment or drought conditions, plants should be watered a minimum of once every seven to ten days.	
Seeding	• Loam and re-seed bare spots with the specified seed mix as shown on the Planting Plan.	
Plant Replacement	• Replace/replant diseases, unhealthy or dead plans to maintain a healthy plant community	
Fertilizing	NONE	
Mulch	NONE	
Actions to be taken:		

*Invasive species shall be disposed of offsite in a pre-approved location.

"Mowed" Areas
No "Mow" Areas (Bioretention Areas)
All areas

APPENDIX B – Overall SCM Locations

SOIL TEST PIT DATA

PERFORMED BY:M LEHMAN HORSLEY WITTEN GROUP, INC
DATE:JANUARY 19, 2023

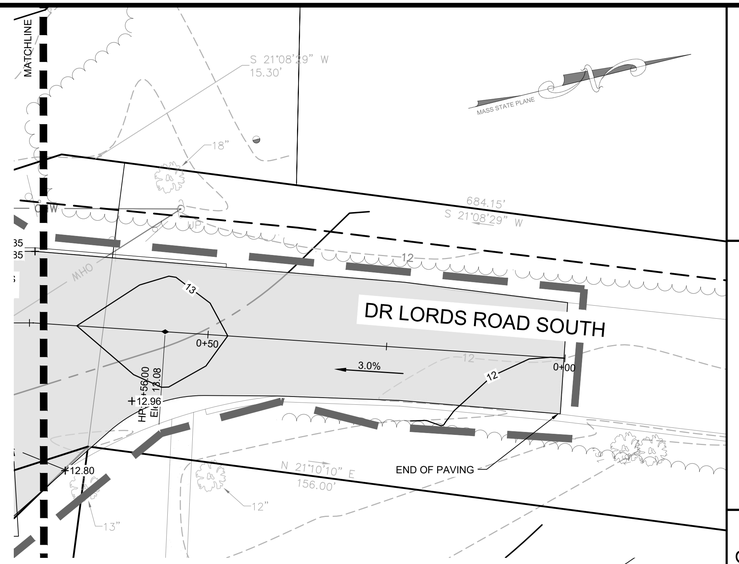
TP-1			TP-2			TP-3		
0"	PAVEMENT	12.7	0"	PAVEMENT	13.6	0"	PAVEMENT	12.2
2"	HTM 10YR 5/6 MEDIUM SAND	12.5	2"	FILL 10YR 3/6 MEDIUM SAND	13.4	10"	HTM 10YR 5/8 VERY FINE SAND	11.4
28"	Ab 10YR 3/1 MEDIUM SAND	10.3	6"	FILL 10YR 4/4 FINE SAND	13.1	12"	HTM 10YR 5/4 VERY FINE SAND	11.2
31"	Bw 10YR 5/6 MEDIUM SAND	10.1	13"	Ab 10YR 5/2 FINE SAND	12.5	36"	PEAT 10YR 2/2 ORGANIC MATTER	9.2
43"	C 10YR 5/3 COARSE SAND	9.1	15"	C1 10YR 4/4 VERY FINE SAND	12.3	54"	C1 10YR 5/2 MEDIUM SAND	7.7
50"		8.5	48"	C2 2.5YR 5/3 COARSE SAND	9.6	62"	C2 GLEY 1 5/10Y VERY FINE SANDY LOAM	7.0
	REDOX @ 31" SEEPING @ 48" ESHGW EL: 10.1		70"		7.8	68"		6.5
				REDOX @ 28" SEEPING @ 66" ESHGW EL: 11.2			NO REDOXIMORPHIC FEATURES OBSERVED SEEPING @ 54"	

LEGEND

- BIORETENTION AREA (1)
- POROUS PAVEMENT
- GRAVEL TRENCH
- GRASS SWALE
- CATCH BASIN/OVERFLOW STRUCTURE (7)
- MANHOLE (2)

***SEE STORMWATER O&M GUIDE FOR DESCRIPTION OF NUMBERS**

SCARGO LAKE



PERMITTING SET ONLY
NOT FOR CONSTRUCTION

GRAPHIC SCALE
10 0 5 10 20 40
(in feet)
1 INCH = 10 FEET

Revisions

Rev.	Date	By	Appr.	Description

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
www.horsleywitten.com
90 Route 6A
Sandwich, MA 02563
508-833-6600 voice
508-833-3150 fax

Checked By: GK
Drawn By: EHH
Designed By: EHH
Date: NOVEMBER 2023

Plan Set: DR LORDS & SCARGO LAKE LANDING
CAPE COD BOAT RAMP STORMWATER
RETROFIT PROJECT- PERMITTING PLANS
DENNIS, MASSACHUSETTS

Plan Title: DR LORDS SITE AND GRADING PLAN

Prepared For:
Town of Dennis
685 MA-134
South Dennis, MA
Phone: (508) 394-8300
Fax: —

Survey Provided By:
Horsley Witten Group, Inc.
90 Route 6A
Sandwich, MA 02563
Phone: (508) 833-6600
Fax: (508) 833-3150
Dated: January 26, 2023

Registration:

DRAFT
NOT FOR CONSTRUCTION

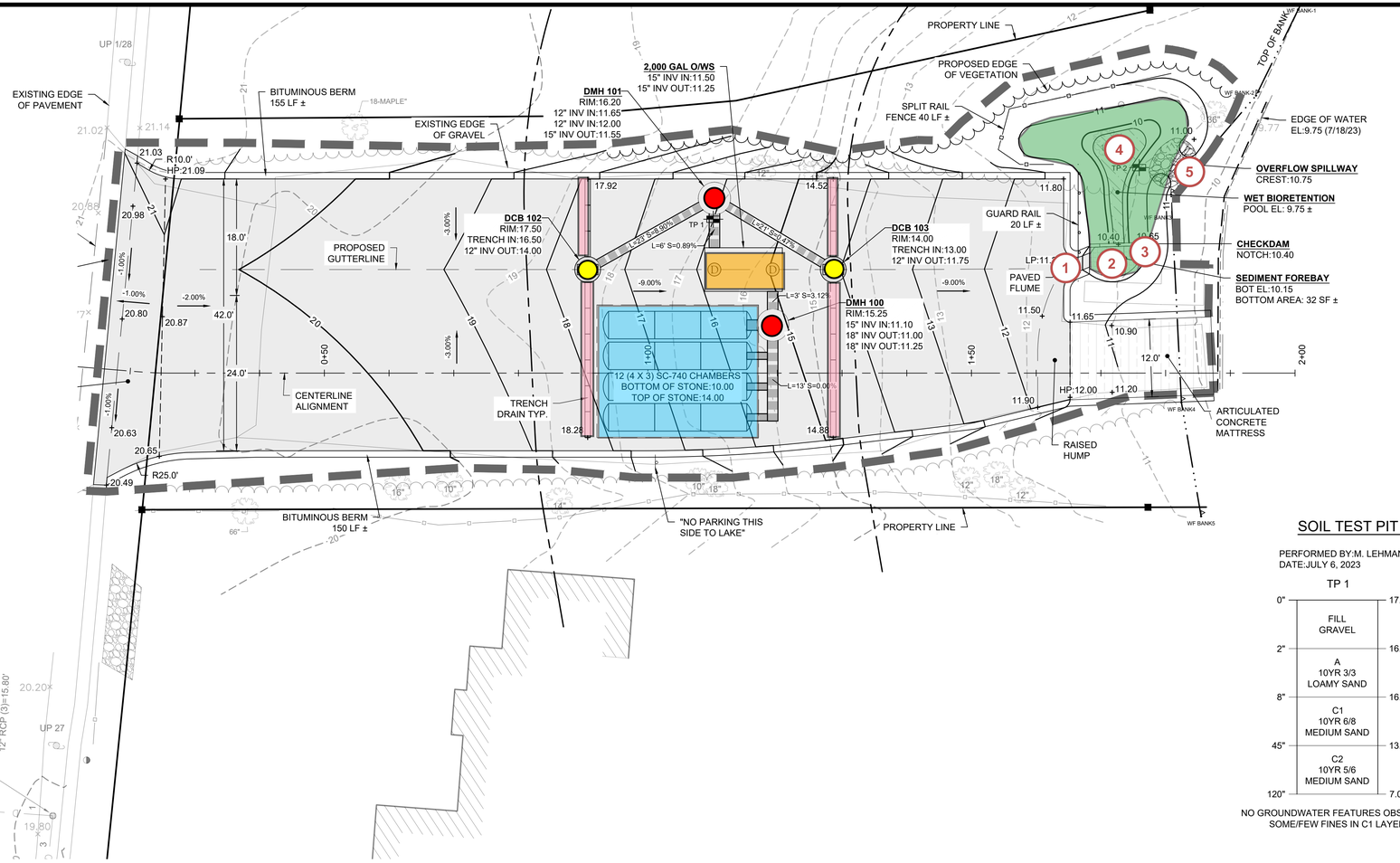
Project Number: 22032A
Sheet : 5 of 10
Sheet Number: C - 5

last modified: 11/21/23 printed: 11/21/23 by eh H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\Drawings\DR LORDS\22032 ST DR LORD.dwg

LEGEND

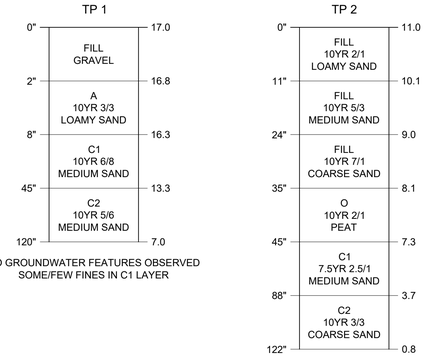
- WET BIORETENTION AREA (1)
- UNDERGROUND CHAMBERS (1)
- TRENCH DRAIN (4)
- OIL/GRIT SEPARATOR (1)
- CATCH BASIN (2)
- MANHOLE (2)

*SEE STORMWATER O&M GUIDE FOR DESCRIPTION OF NUMBERS



SOIL TEST PIT DATA

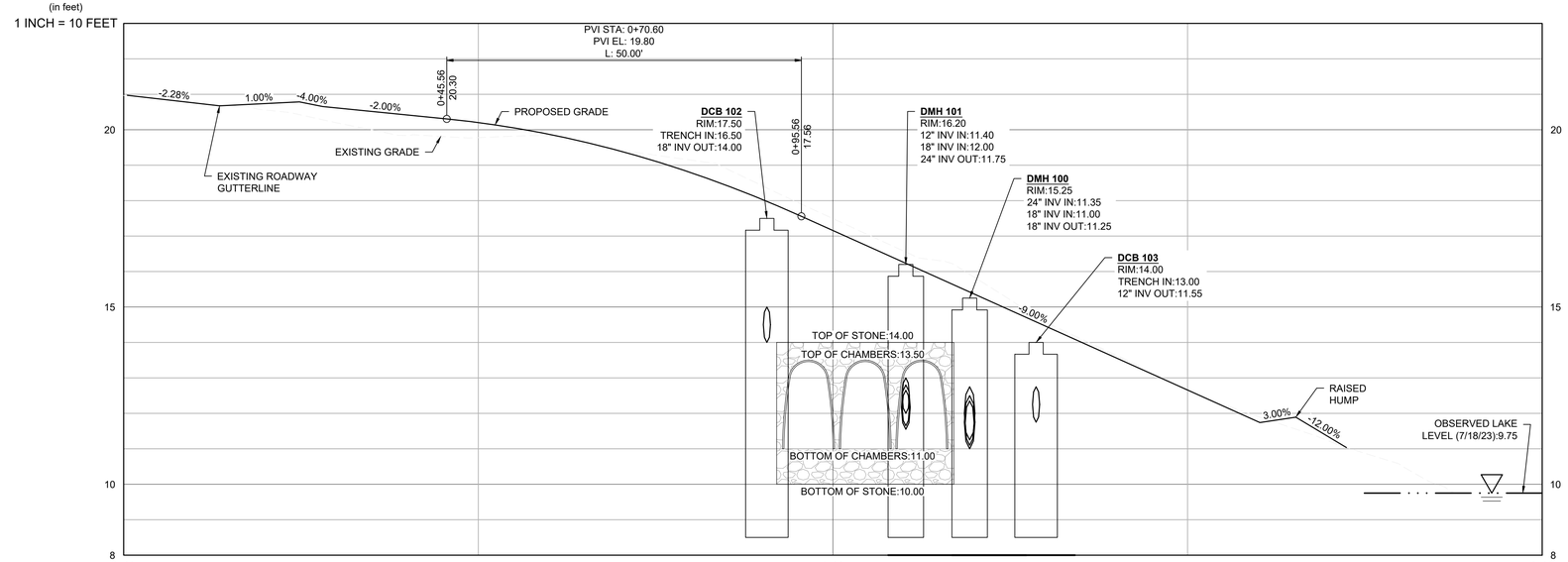
PERFORMED BY:M. LEHMAN HORSLEY WITTEN GROUP, INC
DATE:JULY 6, 2023

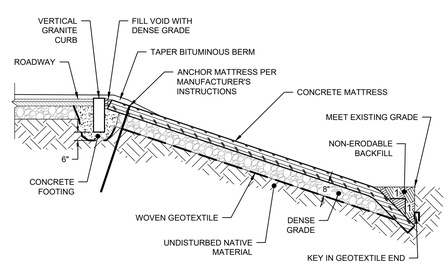


NO GROUNDWATER FEATURES OBSERVED
SOME/FEW FINES IN C1 LAYER

HEAVY SEEPAGE FROM PEAT LAYER
NO WATER IN BOTTOM OF HOLE

GRAPHIC SCALE
10 0 5 10 20 40
(in feet)
1 INCH = 10 FEET





ARTICULATED CONCRETE MATTRESS
NOT TO SCALE

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Sheet: 7 of 12
Sheet Number: C - 7

last modified: 01/17/24 printed: 01/19/24 by eh H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\Drawings\SCARGO LAKE LANDING\22032 SCARGO ST.dwg

APPENDIX C – StormTech Owners Manual

Isolator® Row Plus
O&M Manual

ADS StormTech™

The Isolator® Row Plus

Introduction

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

The Isolator Row Plus

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

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

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

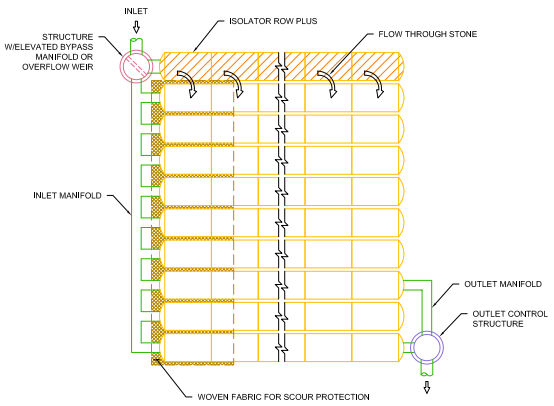
The Isolator Row Plus Flamp™ is a flared end ramp apparatus attached to the inlet pipe on the inside of the chamber end cap. The FLAMP provides a smooth transition from pipe invert to fabric bottom. It is configured to improve chamber function performance by enhancing outflow of solid debris that would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

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

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

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

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



Isolator Row Plus Inspection/Maintenance

Inspection

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

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

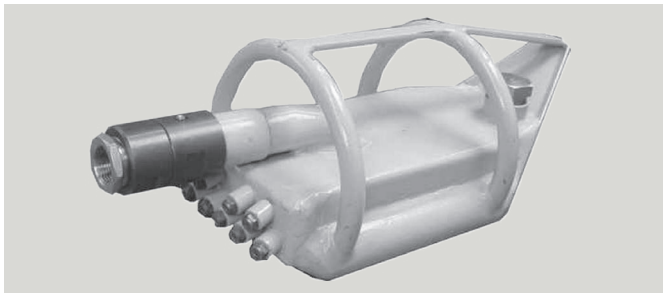
The Isolator Row Plus incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

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

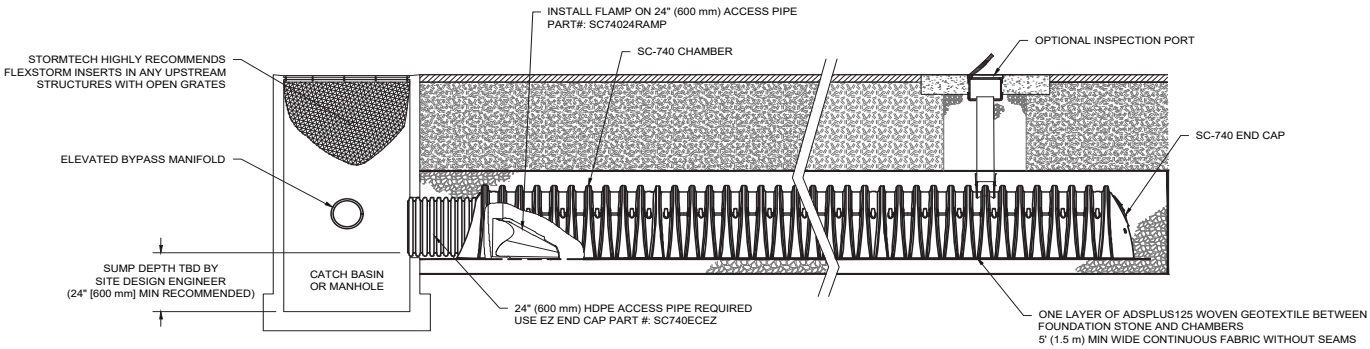
Maintenance

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

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



StormTech Isolator Row PLUS (*not to scale*)



Isolator Row Plus Step By Step Maintenance Procedures

Step 1

Inspect Isolator Row Plus for sediment.

A) Inspection ports (if present)
- i. Remove lid from floor box frame
- ii. Remove cap from inspection riser
- iii. Using a flashlight and stadia rod,measure depth of sediment and record results on maintenance log.
- iv. If sediment is at or above 3 inch depth, proceed to Step 2. If not, proceed to Step 3.

B) All Isolator Row Plus
- i. Remove cover from manhole at upstream end of Isolator Row Plus
- ii. Using a flashlight, inspect down Isolator Row Plus through outlet pipe
  1. Mirrors on poles or cameras may be used to avoid a confined space entry
  2. Follow OSHA regulations for confined space entry if entering manhole
- iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches), proceed to Step 2.
  If not, proceed to Step 3.

Step 2

Clean out Isolator Row Plus using the JetVac process.

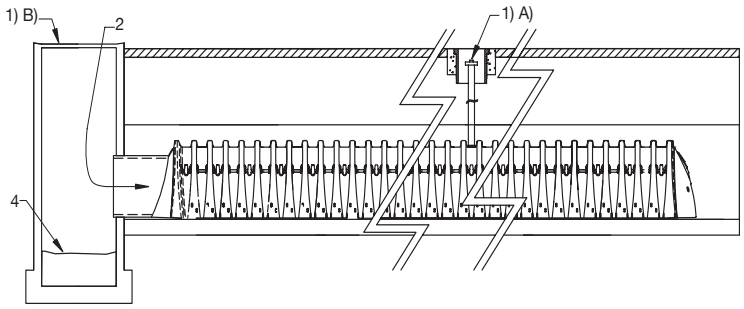
A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable
B) Apply multiple passes of JetVac until backflush water is clean
C) Vacuum manhole sump as required

Step 3

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

Step 4

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



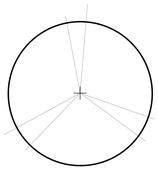
Sample Maintenance Log

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

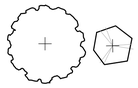
adspipe.com
800-821-6710

APPENDIX D –Planting Plan

KEY

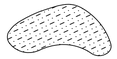


DECIDUOUS TREE

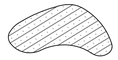


SHRUBS

SEED MIX #1



SEED MIX #2



SEED MIX #3

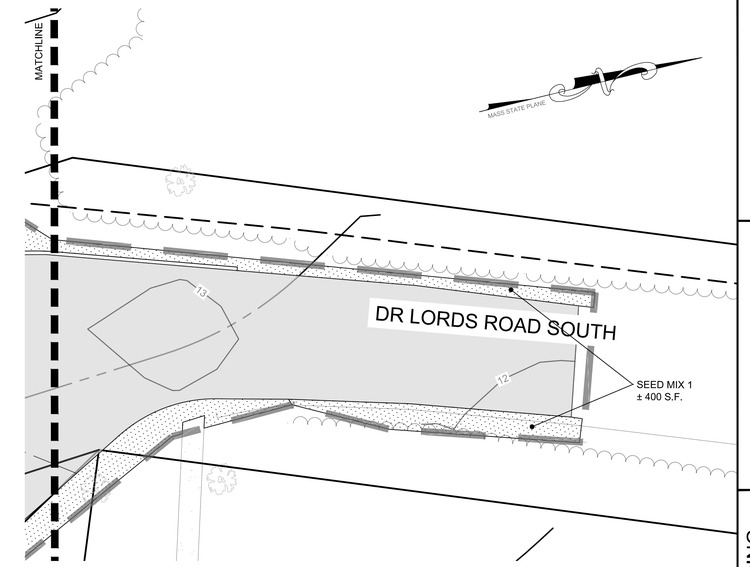
PLANTING LAYOUT NOTES

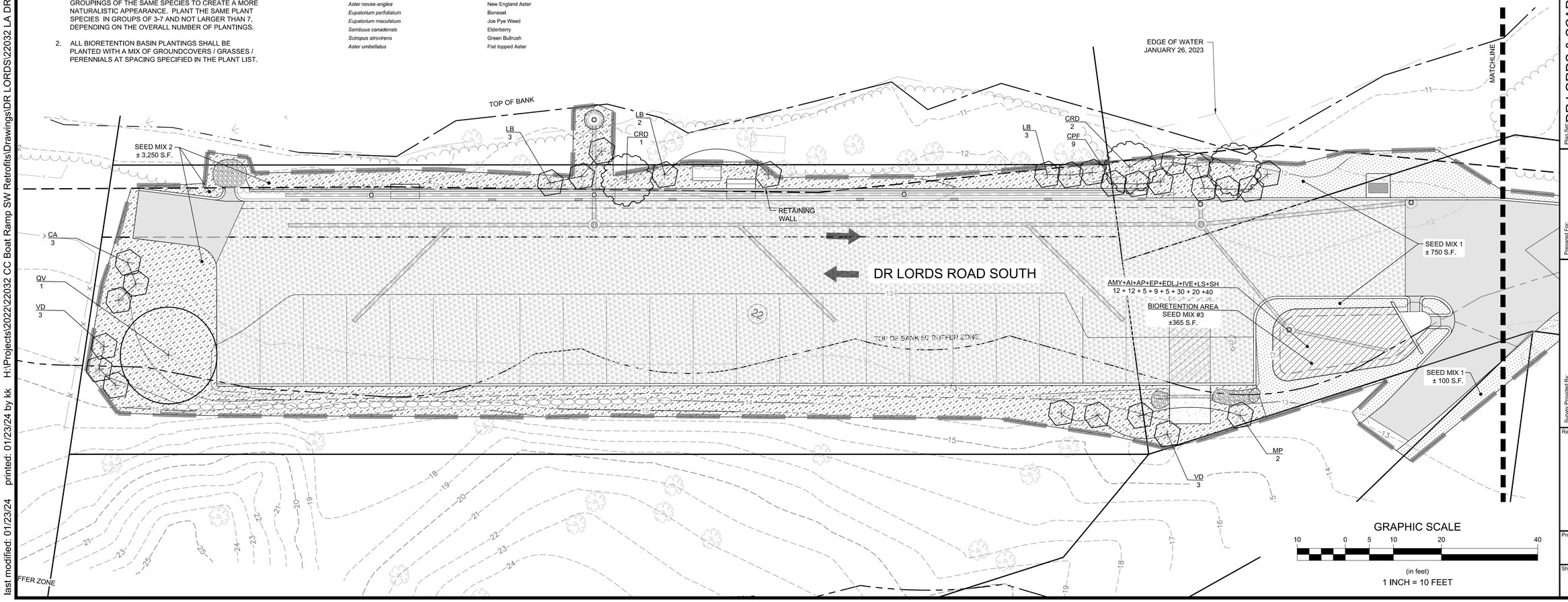
1. FOR AREAS WITH MIXED GROUNDCOVERS / GRASSES AND/OR PERENNIALS (SHOWN AS HATCHED AREAS ON PLANS), DO NOT PLANT IN A PATTERN OR WITH LARGE AREAS OF THE SAME SPECIES. RANDOMLY PLANT AS INDICATED ON THE PLANTING PLANS INTO SMALL GROUPINGS OF THE SAME SPECIES TO CREATE A MORE NATURALISTIC APPEARANCE. PLANT THE SAME PLANT SPECIES IN GROUPS OF 3-7 AND NOT LARGER THAN 7, DEPENDING ON THE OVERALL NUMBER OF PLANTINGS.

2. ALL BIORETENTION BASIN PLANTINGS SHALL BE PLANTED WITH A MIX OF GROUNDCOVERS / GRASSES / PERENNIALS AT SPACING SPECIFIED IN THE PLANT LIST.

Master Plant List

Key		Botanical Name	Common Name	Size	Spacing
		Trees			
QV	1	*Quercus velutina*	Black Oak	2-2.5" cal.	As Shown
		Shrubs			
CA	3	*Clethra alnifolia*	White Summer Sweet	#2	As Shown
CPF	9	*Comptonia peregrina*	Sweet Fern	4" pot	As Shown
CRD	3	*Cornus racemosa*	Gray Dogwood	#3	As Shown
LB	8	*Lindera benzoin*	Spice Bush	#2	As Shown
MP	2	*Myrica pensylvanica*	Northern Bayberry	#3	As Shown
VD	6	*Viburnum dentatum*	Arrowwood Viburnum	#5	As Shown
		Ground Cover/Grasses/Perennials			
AMY	12	*Achillea millefolium*	Yarrow	#1	18" O.C.
AI	12	*Asclepias incarnata*	Swamp Milkweed	#1	18" O.C.
AP	5	*Aster puniceus*	Purple Stemmed Aster	#1	24" O.C.
EP	9	*Echinacea purpurea* 'Ruby Star'	Ruby Star Purple Coneflower	#1	18" O.C.
EDLJ	5	*Eupatorium dubium* 'Little Joe'	Little Joe Pye Weed	#1	18" O.C.
IVE	30	*Iris versicolor*	Blue Flag	#1	18" O.C.
LS	20	*Liatris spicata*	Blazing Star	#1	24" O.C.
SH	40	*Sporobolus heterolepis*	Prairie Dropseed	#1	18" O.C.
		Seed Mixes			
1,250 SF		**SEED MIX 1: Harmony Seed Mix**			
		Deschampsia flexuosa	Coastal/Wavy Hair Grass		
		festuca ovina	Sheep Fescue		
		Festuca x glauca	Blue X Hard Fescue		
		Festuca glauca	Blue Fescue		
		Festuca ovina var. duriuscula	Hard Fescue		
3,250 SF		**SEED MIX 2: New England Wetland Plants Semi Shade Grasses and Forbs Seed Mix**			
		Elymus canadensis	Canada Wild Rye		
		Elymus virginicus	Virginia Wild Rye		
		Festucua rubra	Red Fescue		
		Chamaecrista fasciculata	Partridge Pea		
		Liatris spicata	Marsh Blazing Star		
		Onoclea sensibilis	Sensitive Fern		
		Aster prenanthoides	Zig Zag Aster		
		Eupatorium fistulosum	Hollow-stem Joe Pye Weed		
		Eupatorisum perfoliatum	Boneset		
		Eupatorum maculatum	Joe Pye Weed		
		Juncus tenuis	Path Rush		
365 SF		**SEED MIX 3: New England Wetland Plants Roadside Matrix Wet Meadow Seed Mix**			
		Elymus riparius	Riverbank Wild Rye		
		Elymus virginicus	Virginia Wild Rye		
		Festuca rubra	Red Fescue		
		Panicum virgatum	Switch Grass		
		Carex scopari	Blunt Broom Sedge		
		Cornus amomium	Silky Dogwood		
		Carex lurida	Lurid Sedge		
		Iris versicolor	Blue Flag Iris		
		Viburnum dentatum	Arrowood Viburnum		
		Aesclepias incarnata	Swamp Milkweed		
		Aster novae-angliea	New England Aster		
		Eupatorium perfoliatum	Boneset		
		Eupatorium maculatum	Joe Pye Weed		
		Sambuus canadensis	Elderberry		
		Scirpus atrovirens	Green Bullrush		
		Aster umbellatus	Flat topped Aster		





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508-833-6600 voice
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Drawn By: KA/ME
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Phone: (508) 833-6600
Fax: (508) 833-3150
Dated: January 26, 2023

Registration:

DRAFT
NOT FOR CONSTRUCTION

Project Number: 22032A

Sheet : 10 of 12

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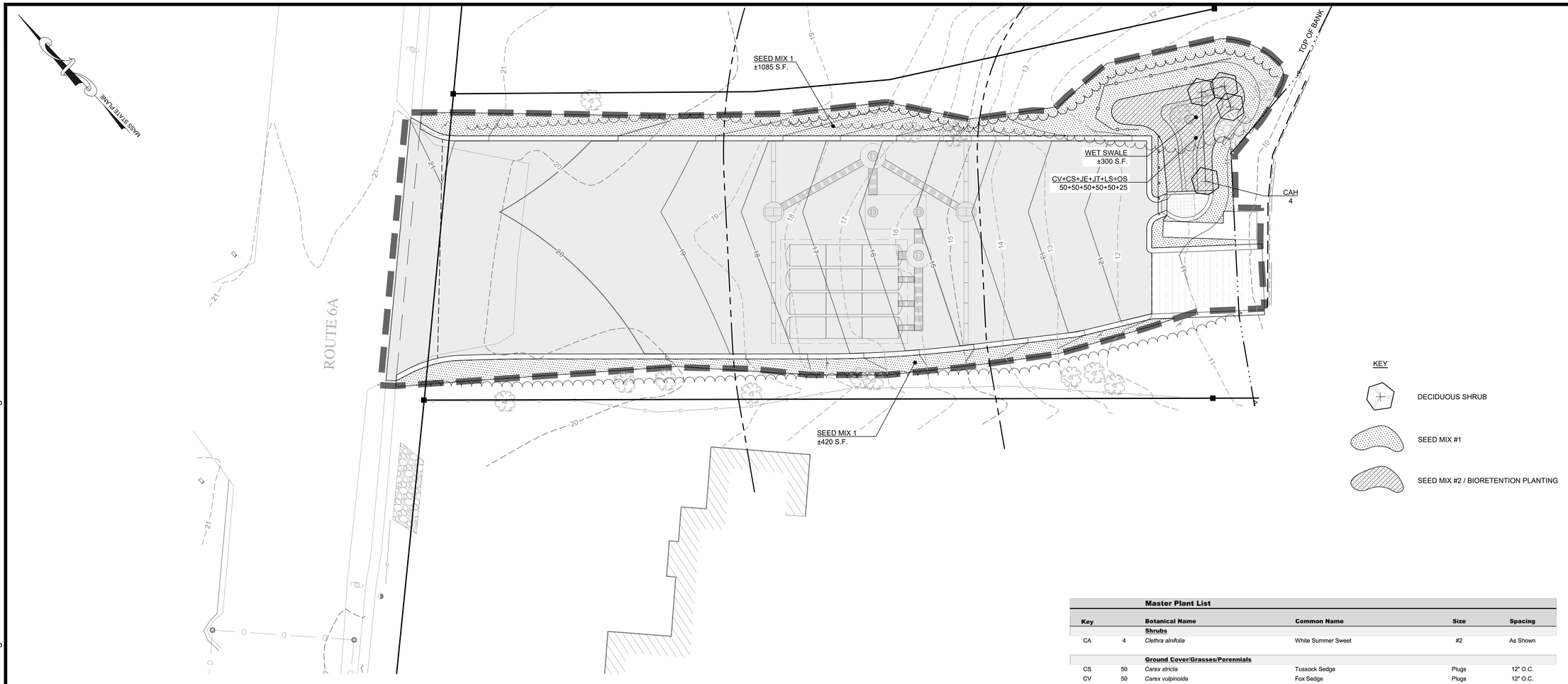

Master Plant List

Key		Botanical Name	Common Name	Size	Spacing
		Shrubs			
CA	4	*Clethra alnifolia*	White Summer Sweet	#2	As Shown
		Ground Cover/Grasses/Perennials			
CS	50	*Carex stricta*	Tussock Sedge	Plugs	12" O.C.
CV	50	*Carex vulpinoida*	Fox Sedge	Plugs	12" O.C.
JE	50	*Juncus effusus*	Soft Rush	Plugs	12" O.C.
JT	50	*Juncus tenuis*	Slender Rush	Plugs	12" O.C.
LS	50	*Lobelia siphilitica*	Blue Cardinal Flower	Plugs	12" O.C.
OS	25	*Onoclea sensibilis*	Sensitive Fern	#1	18" O.C.
		Seed Mixes			
1,505 SF		**SEED MIX 1: Lavoie Horticulture "Harmony Mix"**			
		Deschampsia flexuosa	Coastal/Wavy Hair Grass		
		Festuca ovina	Sheep Fescue		
		Festuca x glauca	Blue X Hard Fescue		
		Festuca glauca	Blue Fescue		
		Festuca ovina var. duriuscula	Hard Fescue		
300 SF		**SEED MIX 2: New England Wetland Erosion Control/Restoration Mix for Detention Basins & Moist Sites**			
		Elymus riparius	Riverbank Wild Rye		
		Schizachyrium scoparium	Little Bluestem		
		Festuca rubra	Red Fescue		
		Andropogon gerardii	Big Bluestem		
		Panicum virgatum	Switch Grass		
		Vernonia noveboracensis	New York Ironweed		
		Agrostis perennans	Upland Bentgrass		
		Bidens frondosa	Beggar Ticks		
		Eupatorium maculatum	Spotted Joe Pye Weed		
		Eupatorium perfoliatum	Boneset		
		Aster novae-angliae	New England Aster		
		Scirpus cyperinus	Wool Grass		
		Juncus effusus	Soft Rush		

PLANTING LAYOUT NOTES

1. FOR AREAS WITH MIXED PERENNIALS AND/OR GRASSES DO NOT PLANT IN A PATTERN OR WITH LARGE AREAS OF THE SAME SPECIES. RANDOMLY PLANT AS INDICATED ON THE PLANTING PLANS INTO SMALL GROUPINGS OF THE SAME SPECIES TO CREATE A MORE NATURALISTIC APPEARANCE. PLANT THE SAME PLANT SPECIES IN GROUPS OF 3-7 AND NOT LARGER THAN 7, DEPENDING ON THE OVERALL NUMBER OF PLANTINGS.

2. ALL BIORETENTION BASIN PLANTINGS SHALL BE PLANTED WITH A MIX OF GROUNDCOVERS / GRASSES / PERENNIALS 18" O.C. AND OVERSEEDED WITH WET EROSION CONTROL/BIORETENTION BASIN MIX FOR DETENTION BASINS SEED MIX

GRAPHIC SCALE

10 0 5 10 20 40

(in feet)

1 INCH = 10 FEET

Revisions

Rev.	Date	By	Appr.	Description
1	---	---	---	---
2	---	---	---	---
3	---	---	---	---
4	---	---	---	---
5	---	---	---	---
6	---	---	---	---
7	---	---	---	---
8	---	---	---	---

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
www.horsleywitten.com
90 Route 6A
Sandwich, MA 02563
508-833-6600 voice
508-833-3150 fax

Checked By: MEHLC | Drawn By: KAK | Designed By: KAK | Date: DECEMBER 2023

Plan Set: DR LORDS & SCARGO LAKE LANDING
CAPE COD BOAT RAMP STORMWATER
RETROFIT PROJECT- PERMITTING PLANS
DENNIS, MASSACHUSETTS

Plan Title: SCARGO PLANTING PLAN

Prepared For:
Town of Dennis
685 Mn.134
South Dennis, MA
Phone: (508) 394-8300
Fax: ----

Survey Provided By:
Horsley Witten Group, Inc.
90 Route 6A
Sandwich, MA 02563
Phone: (508) 833-6600
Fax: (508) 833-3150
Dated: January 26, 2023

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Project Number: 22032A | Sheet : 11 of 12

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last modified: 01/18/24 printed: 01/19/24 by eh H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\Drawings\SCARGO LAKE LANDING\22032 SCARGO LA.dwg

APPENDIX F – Pollutant Controls During Construction

POLLUTANT CONTROLS DURING CONSTRUCTION

1.1 Structural Practices

The following are the structural practices that will be implemented as part of the construction activity.

- Visibility Fence/Sediment Silt Sock Barrier will be installed prior to commencement of construction. The visibility fence will keep construction equipment within the limit of work, and the silt sock will be used on the downgradient portions of the limit of work to allow water to flow through it while keeping sediment on site. The Town will be informed upon their installation so that they may inspect these barriers prior to construction. Portions of these barriers will be replaced and/or repaired as necessary. Barriers will be installed parallel to land slope at the perimeter of the work site, as shown on the Plans. Details are provided in the Plans.

- Silt Sacks (or approved equivalent) will be installed at existing and proposed inlets and overflow structures to prevent sedimentation during construction. The silt sack will be emptied/replaced and disposed of off-site if damage is observed.

- Sediment Traps/Basins. The bioretention area(s) will be graded to within one foot of design elevations until site is fully stabilized to capture sediment during construction. Heavy equipment will not be allowed to operate on the surface location where the systems are planned because soil compaction can adversely impact their long-term performance. Light earth-moving equipment will be used for excavation and construction of the systems. All excavated materials from the area will be removed and disposed of in an approved location. All sediment traps/basins will be inspected at least once every seven calendar days and immediately after storm events by the Construction Manager.

- Stone Filter Berms will be installed following rough grading to direct runoff into sediment traps/basins. They will be inspected daily and repaired/replaced as necessary.

- Construction Entrance will be installed following pavement removal. All construction vehicles must use this access point to ensure sediment is not tracked off site.

- Slope Stabilization will occur immediately upon obtaining final grades as shown on the project site plans. Areas that fail to stabilize will be re-graded to final grade and stabilized as necessary. Amount of land disturbed will be minimized to reduce potential for erosion and sedimentation. Stabilization measures shall be initiated within 14 days following the end of construction at each portion of the site and as soon as practicable.

The entire stormwater management system including pipe, structures, bioretention areas, and underground infiltration chambers will be inspected upon completion of construction. Sediment will be removed from all elements of the stormwater management system. All control measures must be installed and maintained in accordance with manufacturer's specifications, good engineering practices,

and in accordance with this report (every seven calendar days and after storm events). If inspections show that a control has failed or been installed incorrectly, the Operator must replace or modify it within 24 hours.

1.2 Stabilization Practices

The amount of land disturbed during construction will be minimized to reduce the potential for erosion and sedimentation. Prompt surface stabilization will be provided to control erosion in areas where disturbances cannot be avoided during construction. Stabilization measures shall be initiated within 14 days following the end of construction at each portion of the site. Exceptions to this requirement are allowable when snow cover prevents the initiation of stabilization within 14 days, in which case such measures shall be undertaken as soon as possible.

Stabilization measures that will be, or may be, used during construction are described below:

- Temporary Seeding – Temporary seeding of disturbed surfaces with fast-growing grasses (annual rye) to provide greater resistance to stormwater runoff and/or wind erosion for areas where construction has temporarily ceased.
- Permanent Seeding – Permanent seeding of surfaces with vegetation, including but not limited to grass, trees, bushes, and shrubs, to stabilize the soil. Establishing a permanent and sustainable ground cover at a site stabilizes the soil while reducing the sediment content in runoff.
- Permanent Planting –establish all planting as required at the completion of the project.
- Erosion Control Blankets - install erosion control blankets along all slopes greater than 3:1.
- Mulching – materials, including but not limited to hay, grass, woodchips, straw, and gravel will be placed on the soil surface to cover and hold in place disturbed soils.

Temporary seeding or other soil stabilization measures will be provided where construction activities have ceased at the site. Topsoil stockpiles will be temporarily seeded or covered to prevent erosion and will be surrounded with silt fence or silt sock. When the site's final grade has been established, permanent vegetation will be planted on the disturbed areas. The vegetation will consist of grass, shrubs, bushes, and trees in the locations indicated on the plans.

1.3 Other Types of Controls

Additional controls/practices will be undertaken to reduce pollution in stormwater runoff flows which include, but are not limited to, control of off-site mud tracking from construction site, dust suppression, proper sanitary waste disposal, earthwork procedures timed and conducted in manners aimed to minimize erosion and sedimentation, snow removal plans, proper management of waste materials,

proper management of hazardous waste, proper material stockpiling, and spill prevention and control measures.

- Dust Suppression – Water sprays shall be used to control dust during extended dry periods during construction.

- Earthwork – The exposure of disturbed surfaces to stormwater and potential stormwater erosion will be minimized by well-organized earthwork procedures. Stabilization procedures shall be undertaken in accordance with this report. Grubbing during wet seasons will be avoided if feasible.

- Snow Removal Plan – Plowed snow collected from the roadway and parking areas will be deposited onto free draining, pervious surfaces, away from the sites drainage conveyance structures to maximize infiltration.

- Waste Materials – Dumpsters rented from a licensed solid waste management company will be used to store solid waste and debris that cannot be recycled, reused or salvaged. The dumpsters will meet all local and state solid waste management regulations. Dumpsters will be covered when refuse is not being directly deposited or withdrawn from them. Potentially hazardous wastes will be separated from normal wastes, including segregation of storage areas and proper labeling of containers. Removal of all waste from the site will be performed by licensed contractors in accordance with applicable regulatory requirements and disposed of at either local or regional approved facilities. Waste materials will not be buried on-site. All site personnel will be instructed regarding the correct procedures for waste disposal. Notices stating these procedures will be posted at the site. Solvents and flushing materials used during construction and pre-operational cleaning will be provided, handled, managed, and removed by the contractor for appropriate off-site disposal.

- Hazardous Waste Materials – Any disposal of hazardous materials will be completed using the required paperwork. Copies will be provided to the Engineer and to the city.

- Spill Prevention and Control Measures – To minimize the risk of spills or other accidental exposure of materials and substances to stormwater runoff, the following material management practices will be used throughout the project:

    - An effort will be made to store only enough products required to do the job.

    - All materials stored on-site will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure.

    - Products will be kept in their original containers with the original manufacturer's label.

    - Substances will not be mixed with one another unless recommended by the manufacturer.

- Whenever possible, the maximum amount of a product will be used before disposing of the container.
- Manufacturers' recommendations for proper use and disposal will be followed.
- The site superintendent will conduct daily inspections to ensure proper use and disposal of materials.

To reduce the risk associated with hazardous materials used on the site, the following practices will be used:

- Products will be kept in original containers unless they are not resealable.
- Original labels and material safety data sheets will be retained and kept on-site; they contain important product information.
- If surplus product must be disposed of, manufacturers' or local and state recommended methods for proper disposal will be followed.

- Materials List - Materials or substances listed below are expected to be present on-site during construction:

- Concrete	- Fertilizers
- Asphalt	- Petroleum Based Products
- Paints (enamel and latex)	- Cleaning Solvents
- Metal Studs	- Wood
- Concrete	- Tar
- Sealants	- Adhesives

The following product-specific practices will be followed on-site:

Petroleum Products - All on-site vehicles will be monitored for leaks and receive preventative maintenance to reduce the chance of leakage. Petroleum products will be stored in tightly sealed containers which area clearly labeled. Any asphalt substances used on-site will be applied according to the manufacturers' recommendations.

Paints – All containers will be tightly sealed and stored indoors when not required for use. Excess paint will not be discharged to the storm sewer system but will be properly disposed of according to the manufacturers' instructions or state and local regulations.

Concrete Trucks – Concrete trucks will not be allowed to wash out or discharge surplus concrete or drum wash water on the site.

In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup:

- Manufacturers' recommended methods for spill cleanup will be clearly posted, and site personnel will be made aware of the procedures and location of the information and cleanup supplies.

- Materials and equipment necessary for spill cleanup will be kept in the material storage area on-site. Equipment and materials will include, but not be limited to, brooms, dust pans, mops, rags, gloves, goggles, speedi-dry, sand, sawdust, and plastic and metal trash containers specifically for this purpose.

- All spills will be cleaned up immediately after discovery. Spills large enough to reach the storm water system will be reported to the National Response Center at 1-800-424-8802.

- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.

- Spills of toxic or hazardous material will be reported to the appropriate state or local government agency, regardless of the size.

- The site superintendent responsible for the day-to-day site operations will be the spill prevention and clean-up coordinator. He will designate at least three other site personnel who will receive spill prevention and cleanup training. These individuals will each become responsible for a particular phase of prevention and cleanup. The names of responsible spill personnel will be posted in the material storage area and in the on-site office trailer.

APPENDIX G – Site Plans