STORMWATER MANAGEMENT REPORT

FOR: PLUM ISLAND LLC

SITE DEVELOPMENT

79 PARKER STREET

NEWBURYPORT, MA

TAX MAP 78 LOT No. 3

PREPARED BY:

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COMMONWEALTH OF MASSACHUSETTS
CHRISTOPHER M.
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CIVIL
No. 49181
REGISTERED
PROFESSIONAL ENGINEER

1-8-19

1.0 INTRODUCTION

1.1 Project Description

Plum Island LLC proposes to construct a multi-use development at 79 Parker Street. It is the Applicant's intention to develop office space, a function hall and a brewery. These improvements will require the renovation and expansion of the existing structure previously used for residential purposes and most recently, office space. In addition, an existing barn will be razed and replaced with a function hall mirroring the existing barn's architectural features. A new structure will be constructed to house a brewery.

Sidewalks, water and sewer services, and a stormwater management system will be constructed to support the development. Private utilities including gas, electric, telephone, and cable will also support the development. Access to the site will continue to be provided via Parker Street.

1.2 Existing Site Characteristics

The subject parcel is described as Tax Map 78, Lot No. 3 on the City of Newburyport, MA Assessor's Map and is bordered by Parker Street to the north. The parcel is approximately 3.98 acres in size. Elevations on the site range from 21.00' at the existing house to 4.00' in the brook. These elevations are based upon NAVD 1988.

A house and barn currently sit on the property. Access to the structures is through a circular gravel driveway with gravel parking behind the house. The remainder of the site consists of lawn and open meadow. Stormwater runoff from the site feeds an existing bordering vegetated wetland system located on both sides of the property. See the accompanying plan for a more detailed description of the existing site conditions and topography.

The lot consists of three soil groups: Maybid silt loam, 12A (Hydrologic Soil Group C/D); Scantic silt loam, 16A (Hydrologic Soil Group C/D); and Buxton silt loam, 228B (Hydrologic Soil Group D). See Appendix D for the NRCS soil map.

1.3 Proposed Site Features

The proposed development will service a multi-use development. 74 parking spaces are provided onsite as well as 38 overflow spaces located on the adjacent property, also owned by Plum Island LLC. The proposed work will include the installation of public and private utilities to support the development. The municipal water distribution system will be extended into the development and service all of the buildings. As well, the development will tie into the existing wastewater collection system to provide service to the buildings. Natural gas, electrical, telephone and cable service will also be provided.

The storm water management system for the proposed development will consist of overland flow into 2 separate constructed wetlands.

2.0 WATERSHED ANALYSIS AND METHODOLOGY

The stormwater runoff management system was analyzed using the storm events of the 2-year, 10-year and 100-year frequency. At the request of the Conservation Commission, rainfall data used in the storm event analyses are based on rainfall data provided by the Northeast Regional Climate Center, more commonly referred to as the Cornell Atlas Rainfall Data. The Cornell rainfall data is in general, approximately 20% higher than the standard SCS Type III storm event rainfall data. The analysis was performed using HydroCAD, version 10.00. Using USDA NRCS TR-20 and TR-55 methods of estimating runoff, the program uses the measured characteristics of the site and computes runoff produced by simulated rainfall events. The results are then used to design runoff control structures.

Existing drainage area boundaries were developed using an onsite topographic survey performed by Millennium Engineering, Inc. Proposed site development boundaries were developed from proposed grades and ground cover designed to minimize site storm water management structure requirements.

Hydrologic soil groups and curve numbers were estimated for existing and proposed developed conditions using available NRCS Soil Maps, current vegetation, and terrain.

3.0 DRAINAGE ANALYSIS

The purpose of the drainage analysis is two-fold. The first is to analyze and quantify the pre-development runoff flows through the site. The second purpose is to evaluate the impact of the proposed development on drainage patterns and flows, both within and outside the site, and to design a stormwater management system to adequately convey post-development runoff.

The design of the stormwater management system has the following goals:

1.) Minimize or eliminate erosion and sedimentation during construction as well as after development.

2.) To ensure that post-development flows do not have an adverse affect on downstream drainage structures and landowners.

3.) To design a stormwater and treatment system which will carry the surface runoff and satisfy goals one and two.

To determine the hydrological effect of the proposed development on the watershed, the existing conditions must first be analyzed.

4.0 WATERSHED DESCRIPTION: EXISTING CONDITIONS

Depending on the soil classification, type of ground cover present and the direction of the flow of runoff, the existing site is divided into watershed areas. Watershed area 100 consists of the majority of 79 Parker Street, including the majority of the house and parking area, as well as the abutting properties to the east and it feeds the brook that runs along the easterly property line. Area 200 consists of the westerly portion of 79 Parker Street, including the barn and a portion of the house, and it flows offsite to the west into the bordering vegetated wetland. See the attached plans (Watersheds and HydroCad Data, sheet 1 of 2) for the watershed area boundaries and the pre-development time of concentration flow paths.

4.1 WATERSHED ANALYSIS: EXISTING CONDITIONS

The existing conditions were modeled using the tabular hydrograph method with a Type III synthetic storm distribution for the 2, 10 and 100-year storm recurrence intervals. Runoff hydrographs were produced to estimate existing peak discharge.

Flows for the three storm simulations are as follows:

Existing (Pre-development) Peak Runoff Rates (c.f.s.)

Subcatchment	Size (Acres)	2 Yr Storm	10 Yr Storm	100 Yr Storm
100	8.21	13.3	24.7	51.9
200	1.28	2.0	3.8	8.3
		2 Yr	**10 Yr**	**100 Yr**
Brook		13.3	24.7	51.9
Wetlands		2.0	3.8	8.3

The pre-development drainage calculations can be found in Appendix C.

5.0 WATERSHED DESCRIPTION: POST-DEVELOPMENT CONDITIONS

To determine the post development runoff, new watersheds, runoff curve numbers and times of concentration were generated reflecting the changes in the topography and surface cover. The post-development watersheds are shown on the attached plans (Watersheds and HydroCad Data, sheet 2 of 2). Watershed area 1S consists of the front half of the proposed site, including the renovated office building and courtyard and it feeds constructed wetland #1 via overland flow. Area 2S consists of the rear half of the proposed site, including the proposed brewery building, and it feeds constructed wetland #2 via overland flow. Area 100 consists of the easterly undeveloped portion of 79 Parker Street, as well as the abutting properties to the east and it feeds the brook that runs along the easterly property line. Area

200 consists of the westerly portion of 79 Parker Street, including the proposed barn, and it flows offsite to the west into the bordering vegetated wetland.

5.1 WATERSHED ANALYSIS: POST-DEVELOPMENT CONDITIONS

The proposed developed conditions were modeled using the tabular hydrograph method with a Type III synthetic storm distribution for the 2, 10 and 100-year storm recurrence intervals. Runoff hydrographs were produced to estimate the post-development peak discharge.

Flows for the three storm simulations are as follows:

Post-Developed Peak Runoff Rates (c.f.s.)

Subcatchment	**Size (Acres)**	**2 Yr Storm**	**10 Yr Storm**	**100 Yr Storm**
1S	0.70	1.7	2.8	5.4
2S	0.99	2.6	4.2	7.9
100	6.71	11.3	20.7	42.9
200	1.08	1.9	3.6	7.6
		2 Yr	**10 Yr**	**100 Yr**
Brook		11.6	21.0	50.1
Wetlands		1.9	3.6	7.6

The post-development drainage calculations can be found in Appendix D.

6.0 STORMWATER STANDARDS CALCULATIONS

The Stormwater Management Plan developed for this project incorporates water quantity and quality controls that will protect surface and groundwater resources and adjacent properties from potential impacts due to increased impervious areas on the site. The following provides a brief discussion on how the proposed project will meet the ten established performance standards of the DEP Stormwater Management Policy.

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

No proposed site stormwater conveyance systems will discharge untreated stormwater directly to wetlands or surrounding areas. Stormwater runoff will discharge into the proposed constructed wetlands and Vortsentry VSHS36.

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

Stormwater runoff peak discharge rates from the proposed development are less than existing conditions for the 2-yr, 10-yr, and 100-yr 24-hour Type III storm events.

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

Site conditions make it very difficult to meet the recharge requirements. Poor soil conditions (C & D soils) exist on the site and the estimated seasonal high water table (ESHWT) ranges from approximately 11" to 24", which doesn't allow for the use of infiltration BMPs.

4. Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This Standard is met when:

a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;
b. Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and
c. Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

The Massachusetts DEP requires water quality calculations based on 1.0 inch of runoff for the total impervious area associated with the proposed development. The following calculation identifies the water quality volume required.

Total Impervious Area = 53,660 s.f.
53,660 s.f. * 0.5" / 12 (to convert to ft) = 2,236 c.f. of runoff to be treated for water quality.

Volume of Constructed Wetlands = 20,640 c.f.

The proposed development's drainage system must meet the MA Office of Coastal Zone management (CZM)/MA Department of Environmental Protection (DEP) Stormwater Management policy standard of removing 80% of the average annual load of Total Suspended Solids (TSS). The stormwater management system for this development will include the use of deep sump catch basins for pre-treatment, and a Contech CDS unit for treatment prior to discharge into the resource area. The following demonstrates that the proposed storm water management system for the development satisfies the requirement for treatment of 80% of total Suspended Solids:

Constructed Wetlands	80%
Vortsentry VSHS36	98%

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

This project does not qualify as a land use with higher potential pollutant loads.

6. Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "storm water discharge" as defined in 314 CMR 3.04(2)(a)1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of a public water supply.

This project does not fall within a critical area.

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

The proposed development is not considered a redevelopment project and does not meet the requirements of definition for this standard.

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

The proposed development design includes erosion and sediment controls to minimize the potential for sedimentation in down gradient resource areas. Reference is made to the project plans for additional information.

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

An O&M plan has been developed and is included in this report.

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

No illicit discharges exist on the site.

7.0 CONCLUSIONS

The results of this report indicate the proposed stormwater management system for the proposed development is capable of storing and treating the runoff for the 2-year, 10-year and 100-year storm events.

The peak flow rates in this analysis have been conservatively estimated for both the pre- and post-development conditions. Based on the results of the analyses described herein, the proposed development will not increase the runoff rate leaving the site. The proposed storm water management facilities shown on the Site Plan will produce no adverse storm water runoff impacts under the storms analyzed.

8.0 APPENDIX A – STORMWATER REPORT CHECKLIST

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

Checklist for Stormwater Report

A. Introduction

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

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

The Stormwater Report must include:

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

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

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

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

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

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

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

COMMONWEALTH OF MASSACHUSETTS
CHRISTOPHER M.
YORK
CIVIL
No. 49181
REGISTERED
PROFESSIONAL ENGINEER

1-8-19

Signature and Date

Checklist

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

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist (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 (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 (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 (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 (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.

9.0 APPENDIX B – LONG-TERM POLLUTION PREVENTION PLAN AND OPERATION & MAINTENANCE PLAN

LONG-TERM POLLUTION PREVENTION PLAN

AND

OPERATION & MAINTENANCE PLAN

For

PLUM ISLAND LLC
79 PARKER STREET
NEWBURYPORT, MA 01950

PROPOSED SITE DEVELOPMENT AT 79 PARKER STREET

PREPARED BY:

MILLENNIUM ENGINEERING, INC.
62 ELM STREET
SALISBURY, MA 01952
(978) 463–8980

JANUARY 8, 2019

This long-term Stormwater Management System Operations and Maintenance (O&M) Plan, filed with the City of Newburyport, shall be implemented for 79 Parker Street to ensure that the stormwater management system functions as designed. The Owner holds the primary responsibility for overseeing and implementing the O&M Plan and assigning a Property Manager who will be responsible for the proper operation and maintenance of the stormwater structures. In case of transfer of property ownership, future property owners shall be notified of the presence of the stormwater management system and the requirements for proper implementation of the O&M Plan. Included in the manual is a Stormwater Management O&M Plan identifying the key components of the stormwater system and a log for tracking inspections and maintenance.

The stormwater management system protects and enhances the stormwater runoff water quality through the removal of sediment and pollutants, and source control significantly reduces the amount of pollutants entering the system. Preventive maintenance of the system will include a comprehensive source reduction program of regular vacuuming and litter removal, and prohibitions on the use of pesticides.

The purpose of the Stormwater Operations and Maintenance (O&M) plan is to ensure inspection of the system, removal of accumulated sediments, oils, and debris, and implementation of corrective action and record keeping activities.

The ongoing responsibility is the Owner, its successors and assigns. Adequate maintenance is defined in this document as good working condition.

Contact information is provided below:

Responsibility for Operations and Maintenance
David Cowie
28 Plum Island Boulevard
Newbury, MA 01951
(978) 815-0150

Illicit Discharge Compliance Statement

I, ________________________________,verify that all illicit discharges to the stormwater management system are prohibited and no illicit discharges exist on the site.

<u>EROSION AND SEDIMENT CONTROL BMPs</u>

Minimize Disturbed Area and Protect Natural Features and Soil

<u>Topsoil</u>

Topsoil stripped from the immediate construction area can be temporarily stockpiled on site providing that the perimeter of the stockpiles are properly staked with silt fence at the toe of slope. The stockpiles shall be in areas that will not interfere with construction and at least 15 feet away from areas of concentrated flows or pavement. The area shall be inspected weekly for erosion and immediately after storm events. Areas on or around the stockpile that have eroded shall be stabilized immediately with erosion controls.

Stabilize Soils

<u>Temporary Stabilization</u>

- All vegetated areas which do not exhibit a minimum of 85% vegetative growth by Oct. 15th, or which are disturbed after Oct. 15th, shall be stabilized by seeding and installing erosion control blankets on slopes greater than 3:1, and seeding and placing 3 to 4 tons of mulch per acre, secured with anchored netting, elsewhere. The placement of erosion control blankets or mulch and netting shall not occur over accumulated snow or on frozen ground and shall be completed in advance of thaw or spring melt events.
- All ditches or swales which do not exhibit a minimum of 85% vegetative growth by Oct. 15th, or which are disturbed after Oct. 15th, shall be stabilized with stone or erosion control blankets appropriate for the design flow conditions.
- After November 15th, incomplete road surfaces, where work has stopped for the winter season, shall be protected with a minimum of 3 inches of crushed gravel.

Protect Slopes

Geotextile erosion control blankets shall be used to provide stabilization for slopes exceeding 3:1. Prepare soil before installing erosion control blanket, including any necessary application of lime, fertilizer, and seed. Begin at the top of the slope by anchoring the blanket in a 6" deep x 6" wide trench with approximately 12" extended beyond the upslope portion of the trench. Anchor the blanket with a row of staples/stakes approximately 12" apart in the bottom of the trench. Backfill and compact the trench after stapling. Apply seed to compacted soil and fold remaining 12" portion of back over seed and compacted soil. Secure over compacted soil with a row of staples/stakes spaced approximately 12" apart across the width of the blanket. Roll erosion control blanket either down or horizontally across the slope. Blanket will unroll with appropriate side against the soil surface. All blankets must be securely fastened to soil surface by placing staples/stakes in appropriate locations as shown in the staple pattern guide. When using the dot system, staples/stakes should be placed through each of the colored dots corresponding to the appropriate staple pattern. The edges of parallel blankets must be stapled with approximately 2"-5" overlap. Consecutive blankets spliced down the slope must be placed end over end (shingle style) with an approximate 3" overlap. Staple through overlapped area, approximately 12" apart across entire blanket's width. In loose soil conditions, the use of staple or stake lengths greater than 6" may be necessary to properly anchor the blanket.

Establish Perimeter Controls and Sediment Barriers

Silt fence shall be installed along the edge of wetlands. The silt fence shall be installed before construction begins. Wooden posts shall be doubled and coupled at filter cloth seams. Filter cloth shall be fastened securely to support netting with ties spaced every 24" at top, midsection, and bottom. When two sections of filter cloth adjoin each other, they shall be overlapped by 6 inches, folded and stapled. Woodchips shall be installed at downslope side of silt fence and shall remain after silt fence is removed. Silt fence shall be removed upon completion of the project and stabilization of all soil.

Maintenance:
1. Silt fence shall be inspected immediately after each rainfall and at least daily during prolonged rainfall. Any repairs that are required shall be made immediately.
2. If the fabric on the silt fence shall decompose or become ineffective during the expected life of the fence, the fabric shall be replaced promptly.
3. Sediment deposits shall be inspected after every storm event. The deposits shall be removed when they reach approximately one-half the height of the barrier.
4. Sediment deposits that are removed or left in place after the fabric has been removed shall be graded to conform with the existing topography and vegetated.

Establish Stabilized Construction Entrance

A stabilized construction entrance shall be installed before construction begins on the site. The stone anti-tracking pad shall remain in place until the subgrade of pavement is installed.

1. Stone shall be 1-2" stone, reclaimed stone, or recycled concrete equivalent.
2. The length of the stabilized entrance shall not be less than 50'.
3. The thickness of the stone for the stabilized entrance shall not be less than 6".
4. Geotextile filter cloth shall be placed over the entire area prior to placing the stone.
5. All surface water that is flowing to or diverted toward the construction entrance shall be piped beneath the entrance. If piping is impractical, a berm with 5:1 slopes that can be crossed by vehicles may be substituted for the pipe.
6. The entrance shall be maintained in a condition that will prevent tracking or flowing of sediment onto public rights-of-way. This may require periodic top-dressing with additional stone as conditions demand and repair and/or cleanout of any measures used to trap sediment. All sediment spilled, washed, or tracked onto public rights-of-way must be removed promptly.
7. Wheels shall be cleaned to remove mud prior to entrance onto public rights-of way. When washing is required, it shall be done on an area stabilized with stone which drains into an approved sediment trapping device.

Catch Basin Inlet Protection

Inlet protection devices intercept and/or filter sediment before it can be transported from a site into the storm drain system and discharged into a lake, river, stream, wetland, or other waterbody. These devices also keep sediment from filling or clogging storm drain pipes, ditches, and downgradient sediment traps or ponds. A siltsack or approved equal shall be used for catch basin inlet protection. It should be inspected weekly. When the restraint cord is no longer visible, siltsack is full and shall be emptied.

POST-CONSTRUCTION BMPs

Dust Control/Sweeping

Street sweeping is an effective source control and will be implemented on a regular basis. Sweeping efforts shall be conducted biannually, including the period immediately following winter snowmelt when road sand and other accumulated sediment are washed off. The Owner shall be responsible for street sweeping operations.

Snow and Snow Melt Management

Proper management of snow and snow melt, snow removal and storage, use of deicing compounds, and other practices can minimize major runoff and pollutant loading impacts. Snow will be stored at various spots along the parking lot. The Owner shall be responsible for snow management.

Sediment Forebay

Sediment forebays are included in the stormwater management plan as pretreatment for the proposed constructed wetlands. The forebays will be portioned from the basins by use of a stone filter berm. The forebay shall be inspected monthly during construction and cleaned upon completion of the project and thereafter four times per year by a landscaping contractor hired by the owner. Sediments removed during cleaning shall be disposed of at an approved DEP landfill.

Constructed Wetlands

Constructed wetlands are included in the stormwater management plan design for the proposed development. The applicant of the project, through his contractor, will incorporate this sediment control feature into the project during construction activities. Upon completion of the development, the Owner shall be responsible for proper maintenance and upkeep of the wetlands. To ensure proper performance and system longevity, the following maintenance schedule is recommended:

a.) Sediment and debris removal: Wetlands should be inspected twice a year by a certified wetland scientist, during both growing and non-growing seasons, in the first 3 years after construction. Observations during the inspections should include:

i.) Types and distribution of dominant wetland plants in the wetland;

ii.) The presence and distribution of planted wetland species versus the presence and distribution of natural wetland species and any signs that natural species are overtaking planted species;

iii.) Accumulation of sediment in the forebay and micropool. Any sediment and debris should be removed manually before the vegetation is adversely impacted;

Wetland protection: Efforts should be made, through snow and snow melt management, local bylaws and public education, to protect the wetland from damages of snow removal and off street parking.

Vortsentry System

A Vortsentry VSHS36 is incorporated into the site design for treatment before discharging offsite. At a minimum, the unit shall be inspected twice per year (spring and fall). The unit should be vacuum cleaned when the level of sediment has reached 75% of capacity in the isolated sump. Sediments and debris shall be disposed of at an approved DEP landfill. The property owner shall be responsible for the Vortsentry cleaning operations.

<u>FINAL STABILIZATION</u>

<u>Permanent Seeding</u>

Loam and hydroseed any disturbed surfaces after the final design grades have been achieved. A minimum of 6" of loam shall be installed. Seed mix shall be a maximum of 10% rye grass and a minimum of 90% permanent bluegrass and/or fescue. Lime shall be applied at a rate of 2 tons/acre.

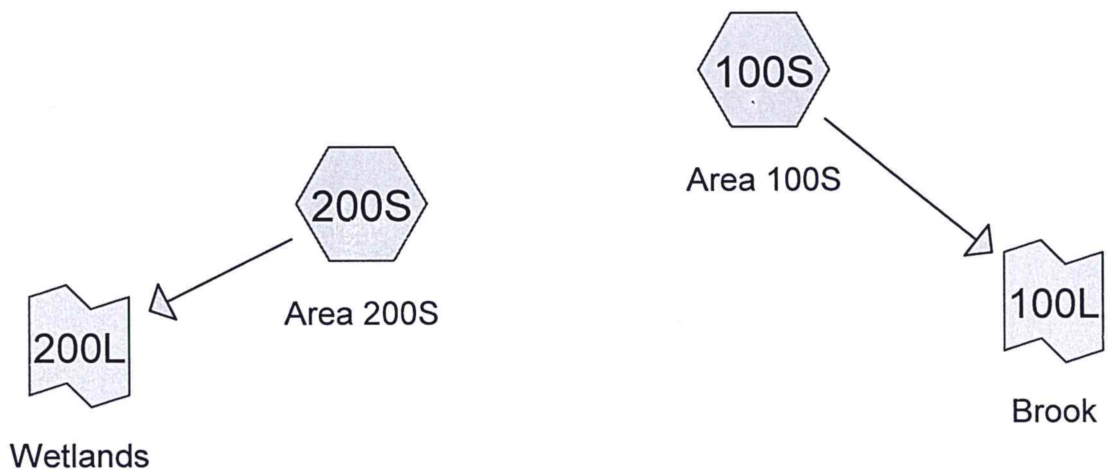
Construction debris, trash and temporary BMPs (including silt fences, material storage areas, and inlet protection) will also be removed and any areas disturbed during removal will be seeded immediately.

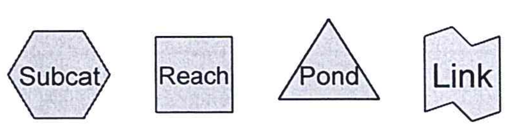
INSPECTION & MAINTENANCE LOG

The owner, heirs, successors or assigns, is responsible to perform the maintenance obligations or hire a Professional Engineer to review the site on an annual basis for maintenance of the stormwater system. Records of all maintenance companies hired throughout the year shall be submitted with the following form.

Activity	*Date*	*Inspected By*	*Findings*
Street Sweeping (2x per year)			
Forebay Sediment Removal Incl. rip rap and pipe (4x per year)			
Constructed Wetland Cleaning (2x per year min.)			
Culvert Outfall (2x per year)			
Vortsentry VSHS36 (2x per year)			
Roof Drain Cleanouts (2x per year)			
Vegetation and Landscaping (2x per year)			

10.0 APPENDIX C – PRE-DEVELOPMENT DRAINAGE CALCULATIONS





Routing Diagram for M173238-Existing
Prepared by Millennium Engineering, Inc., Printed 1/4/2019

Summary for Subcatchment 100S: Area 100S

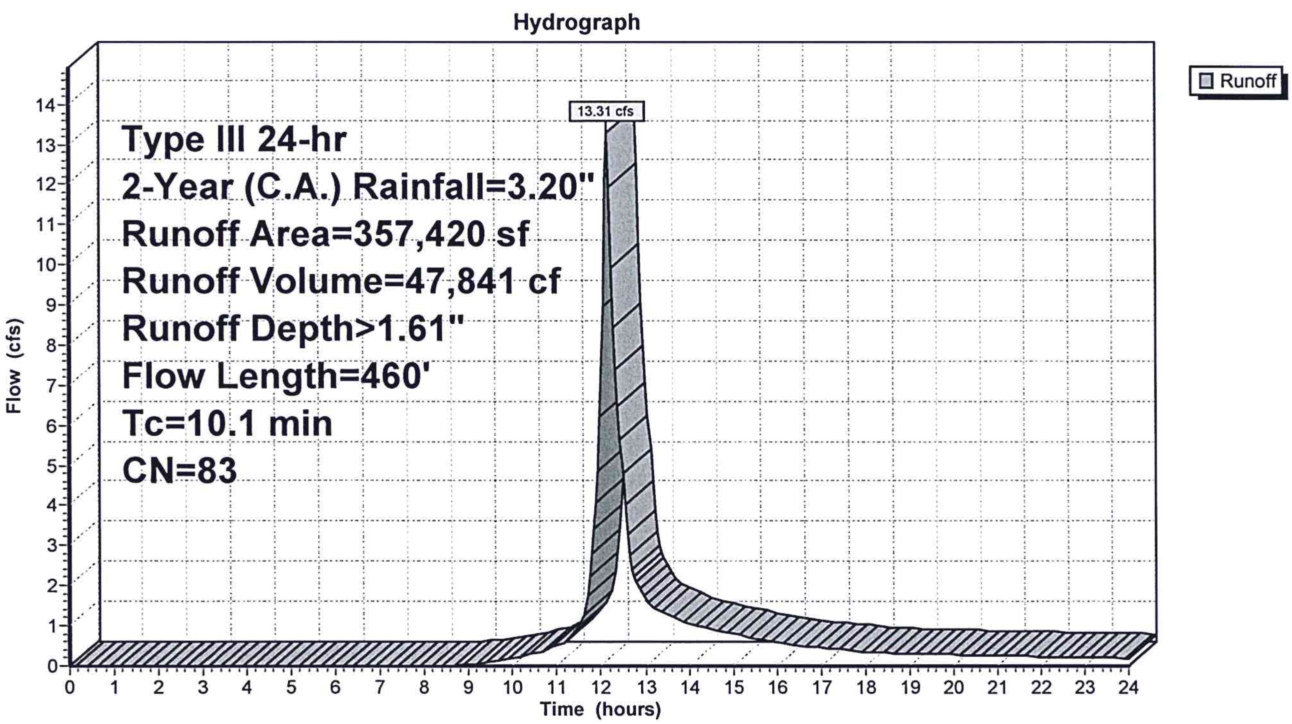
Runoff = 13.31 cfs @ 12.15 hrs, Volume= 47,841 cf, Depth> 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year (C.A.) Rainfall=3.20"

Area (sf)	CN	Description
5,435	98	Roofs
36,320	98	Paved roads w/curbs & sewers
37,415	91	Gravel roads, HSG D
278,250	80	Pasture/grassland/range, Good, HSG D
357,420	83	Weighted Average
315,665		88.32% Pervious Area
41,755		11.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
5.8	410	0.0280	1.17		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.1	460	Total			

Subcatchment 100S: Area 100S

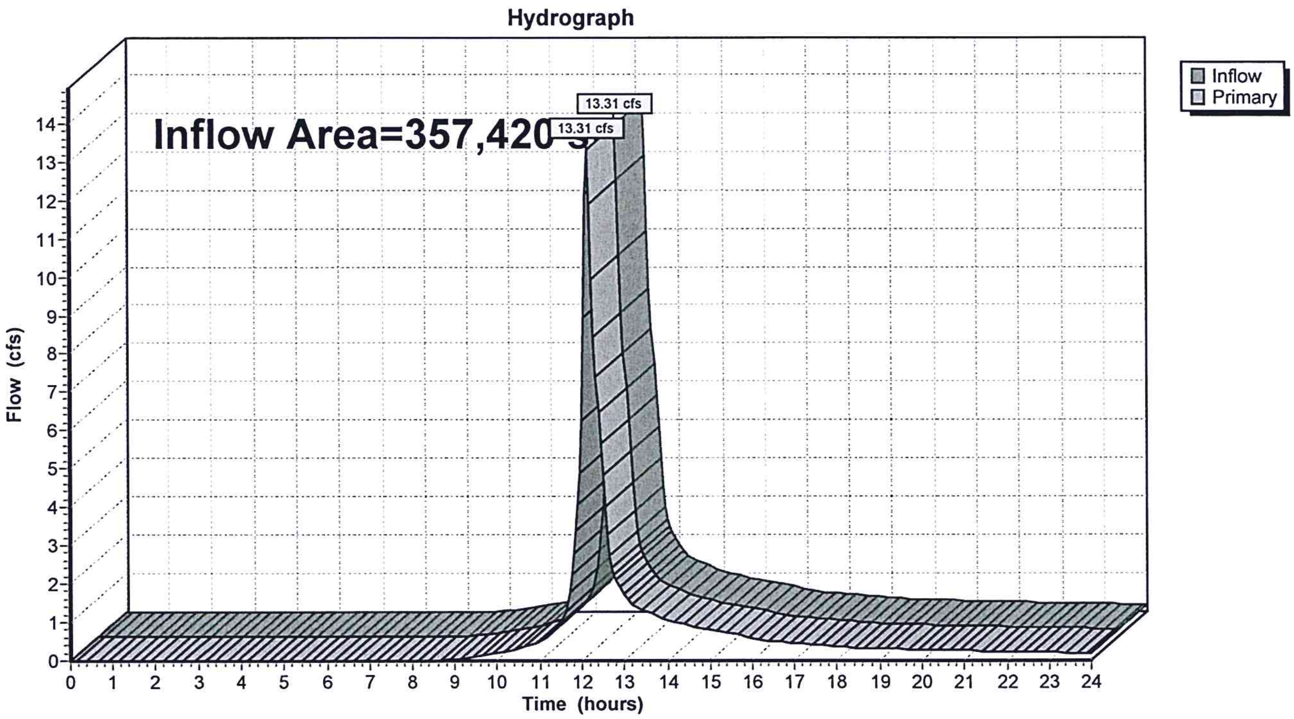


Summary for Link 100L: Brook

Inflow Area =	357,420 sf,	11.68% Impervious,	Inflow Depth > 1.61"	for 2-Year (C.A.) event
Inflow =	13.31 cfs @	12.15 hrs, Volume=	47,841 cf	
Primary =	13.31 cfs @	12.15 hrs, Volume=	47,841 cf,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 100L: Brook



Summary for Subcatchment 200S: Area 200S

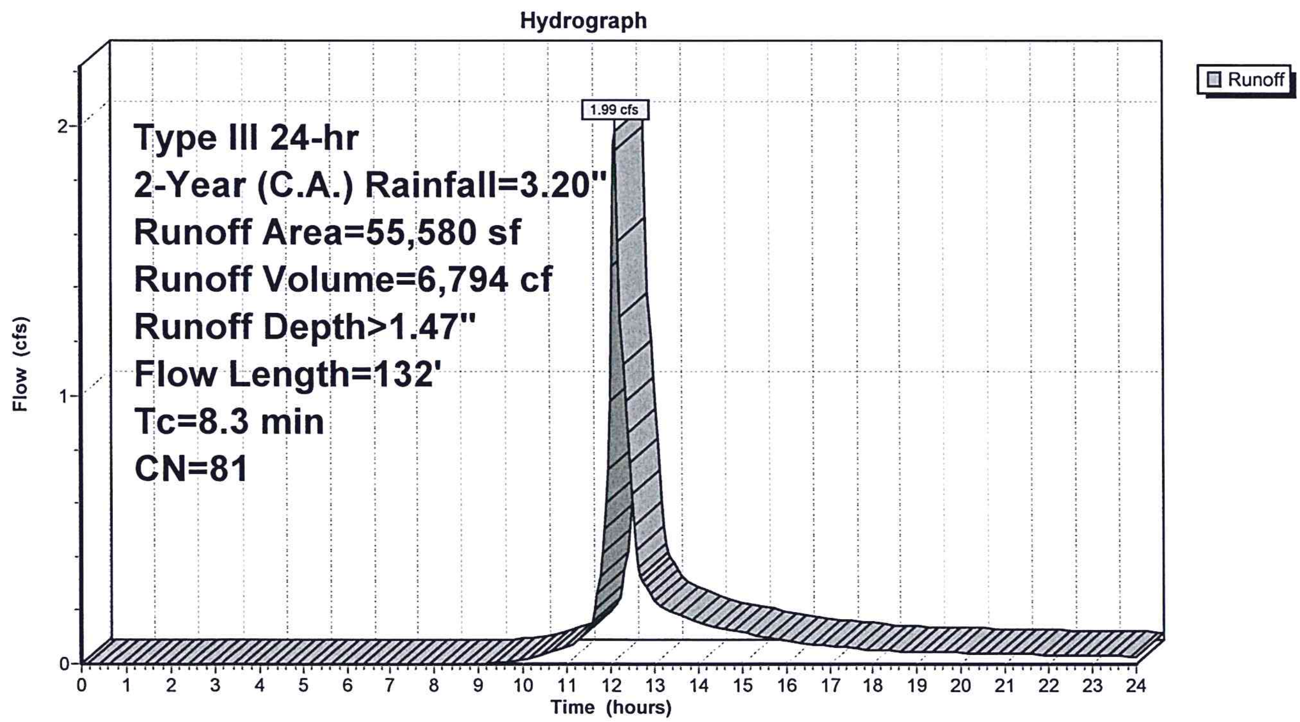
Runoff = 1.99 cfs @ 12.12 hrs, Volume= 6,794 cf, Depth> 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year (C.A.) Rainfall=3.20"

Area (sf)	CN	Description
365	98	Paved roads w/curbs & sewers, HSG D
2,035	98	Roofs
1,430	91	Gravel roads, HSG D
51,750	80	Pasture/grassland/range, Good, HSG D
55,580	81	Weighted Average
53,180		95.68% Pervious Area
2,400		4.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	50	0.0280	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
1.0	82	0.0420	1.43		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.3	132	Total			

Subcatchment 200S: Area 200S

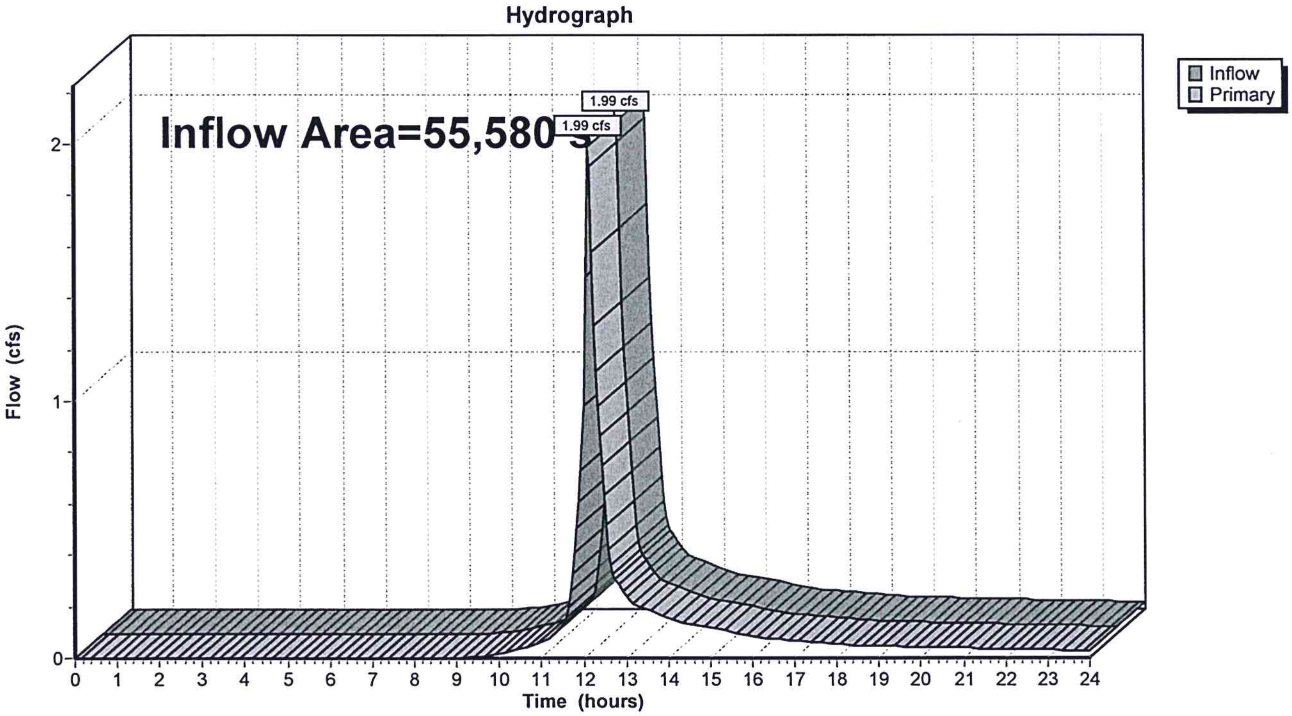


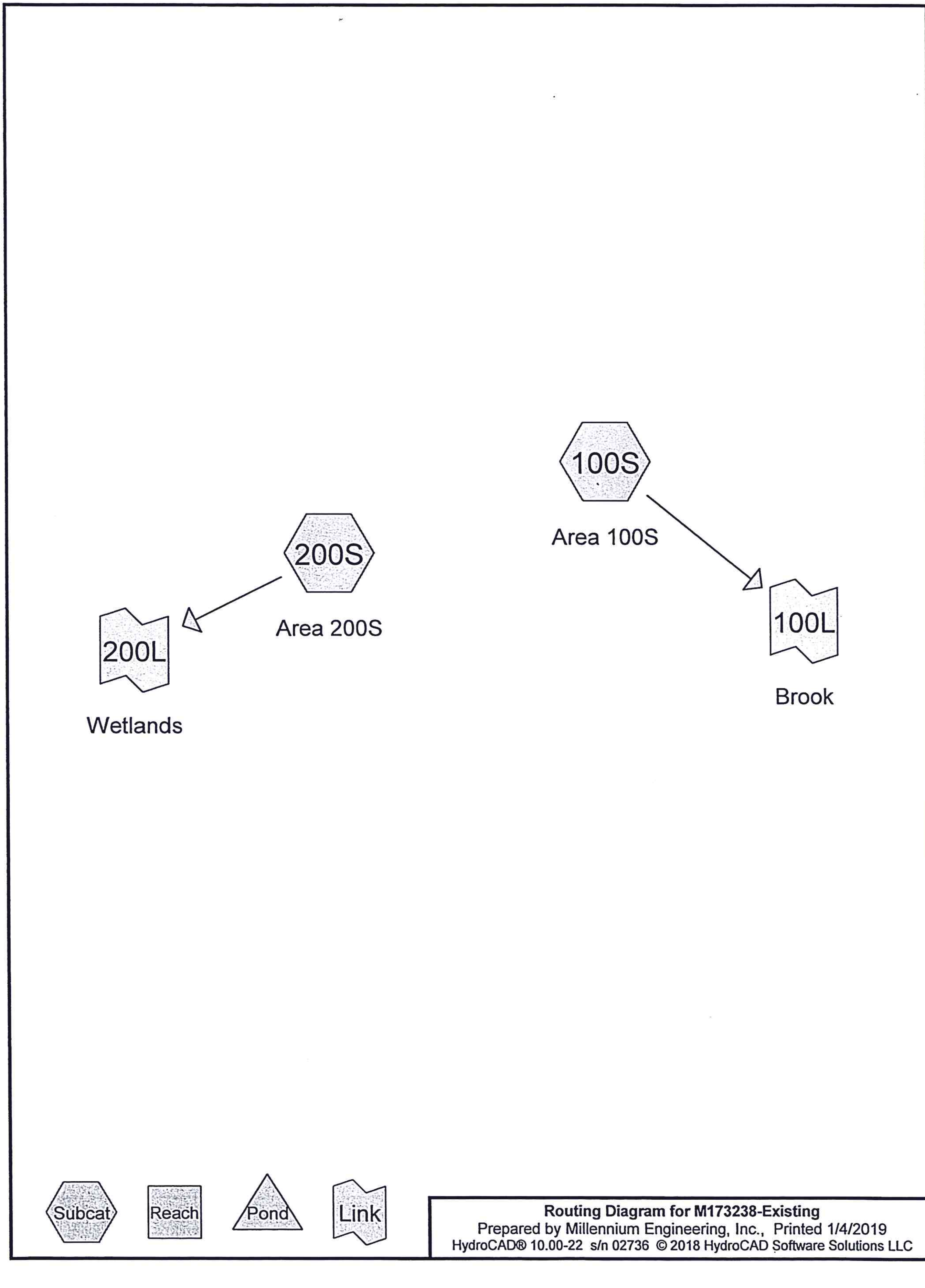
Summary for Link 200L: Wetlands

Inflow Area =	55,580 sf,	4.32% Impervious,	Inflow Depth > 1.47"	for 2-Year (C.A.) event	
Inflow =	1.99 cfs @	12.12 hrs,	Volume=	6,794 cf	
Primary =	1.99 cfs @	12.12 hrs,	Volume=	6,794 cf,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 200L: Wetlands





Routing Diagram for M173238-Existing
Prepared by Millennium Engineering, Inc., Printed 1/4/2019

Summary for Subcatchment 100S: Area 100S

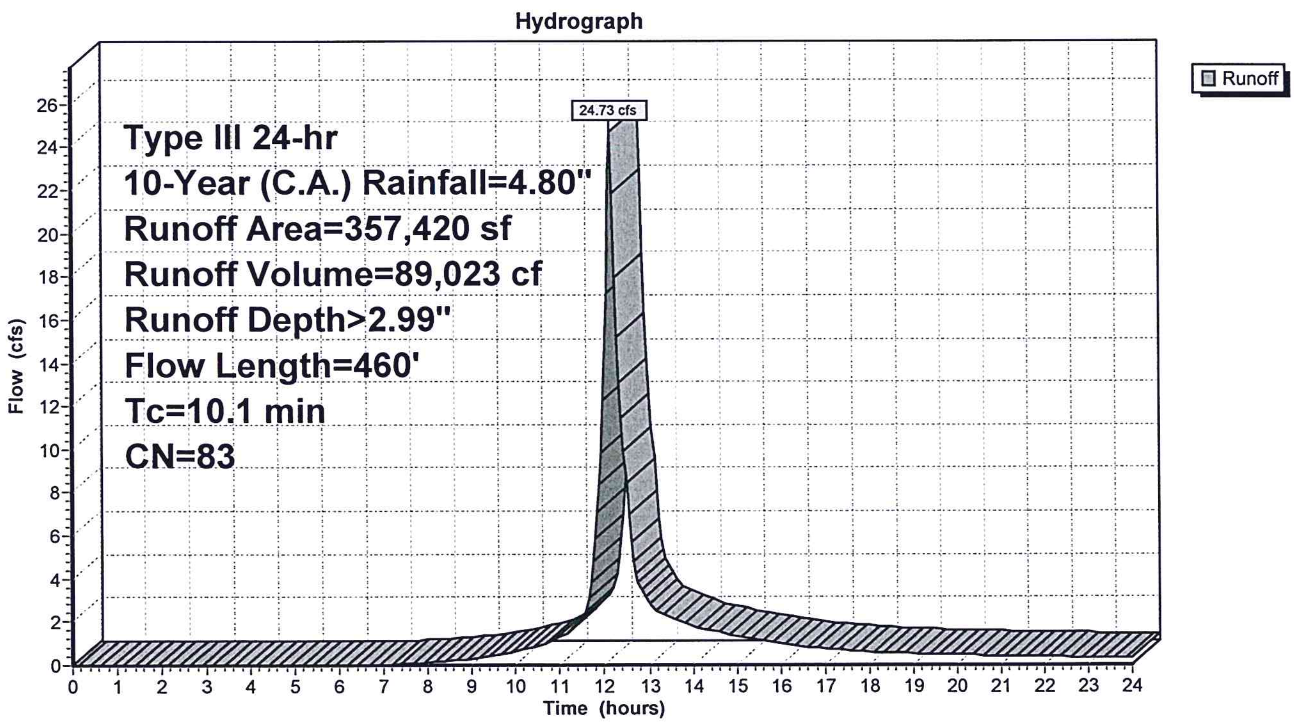
Runoff = 24.73 cfs @ 12.14 hrs, Volume= 89,023 cf, Depth> 2.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year (C.A.) Rainfall=4.80"

Area (sf)	CN	Description
5,435	98	Roofs
36,320	98	Paved roads w/curbs & sewers
37,415	91	Gravel roads, HSG D
278,250	80	Pasture/grassland/range, Good, HSG D
357,420	83	Weighted Average
315,665		88.32% Pervious Area
41,755		11.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
5.8	410	0.0280	1.17		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.1	460	Total			

Subcatchment 100S: Area 100S

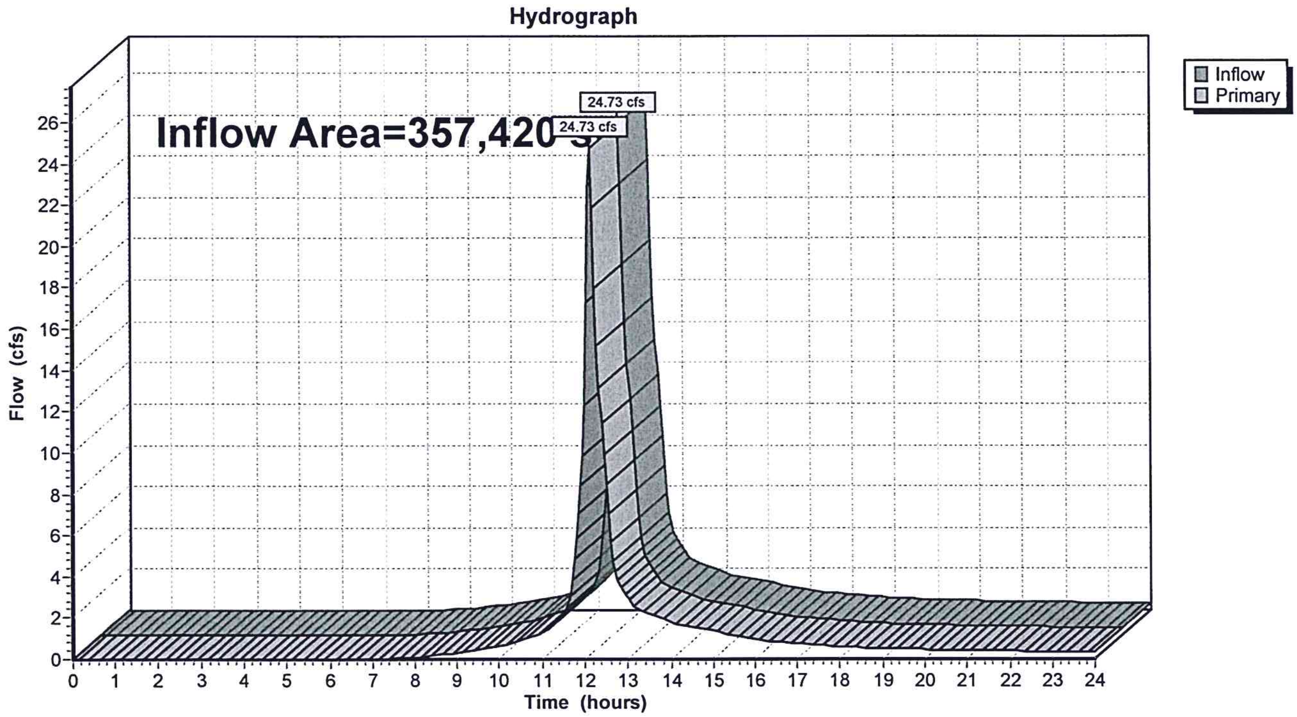


Summary for Link 100L: Brook

Inflow Area = 357,420 sf, 11.68% Impervious, Inflow Depth > 2.99" for 10-Year (C.A.) event
Inflow = 24.73 cfs @ 12.14 hrs, Volume= 89,023 cf
Primary = 24.73 cfs @ 12.14 hrs, Volume= 89,023 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 100L: Brook



Summary for Subcatchment 200S: Area 200S

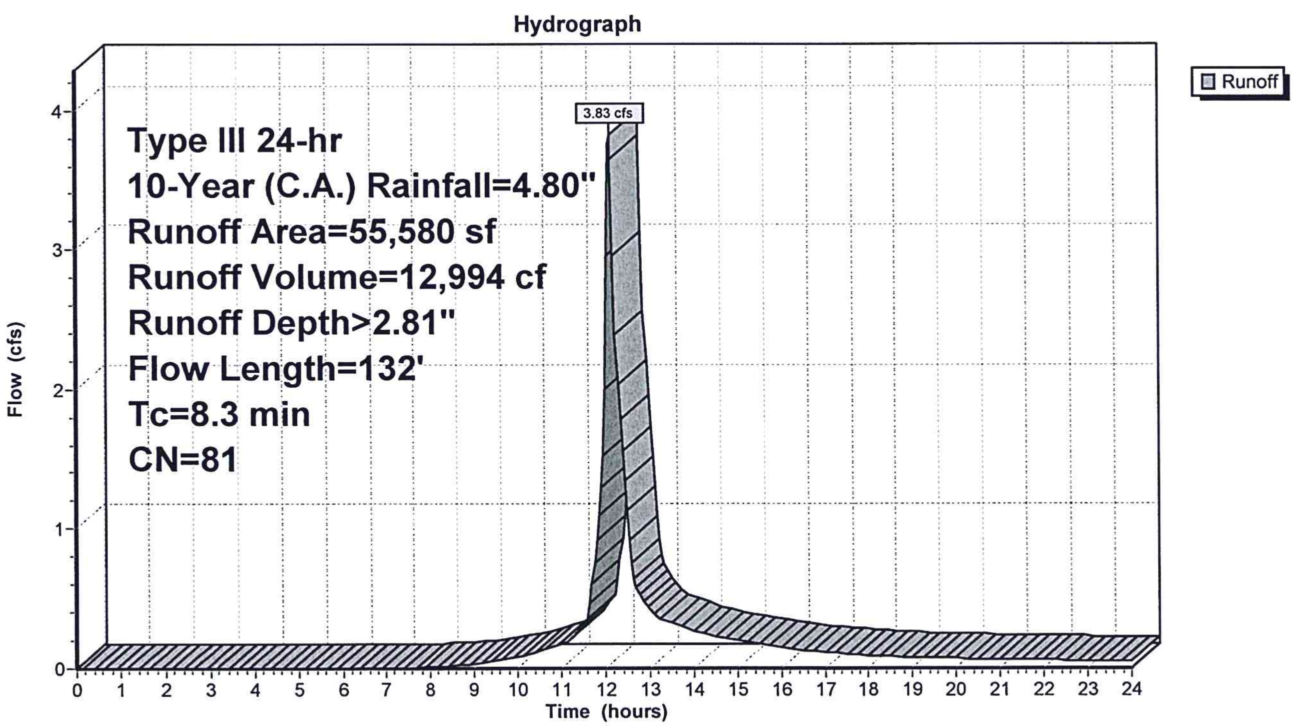
Runoff = 3.83 cfs @ 12.12 hrs, Volume= 12,994 cf, Depth> 2.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year (C.A.) Rainfall=4.80"

Area (sf)	CN	Description
365	98	Paved roads w/curbs & sewers, HSG D
2,035	98	Roofs
1,430	91	Gravel roads, HSG D
51,750	80	Pasture/grassland/range, Good, HSG D
55,580	81	Weighted Average
53,180		95.68% Pervious Area
2,400		4.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	50	0.0280	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
1.0	82	0.0420	1.43		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.3	132	Total			

Subcatchment 200S: Area 200S

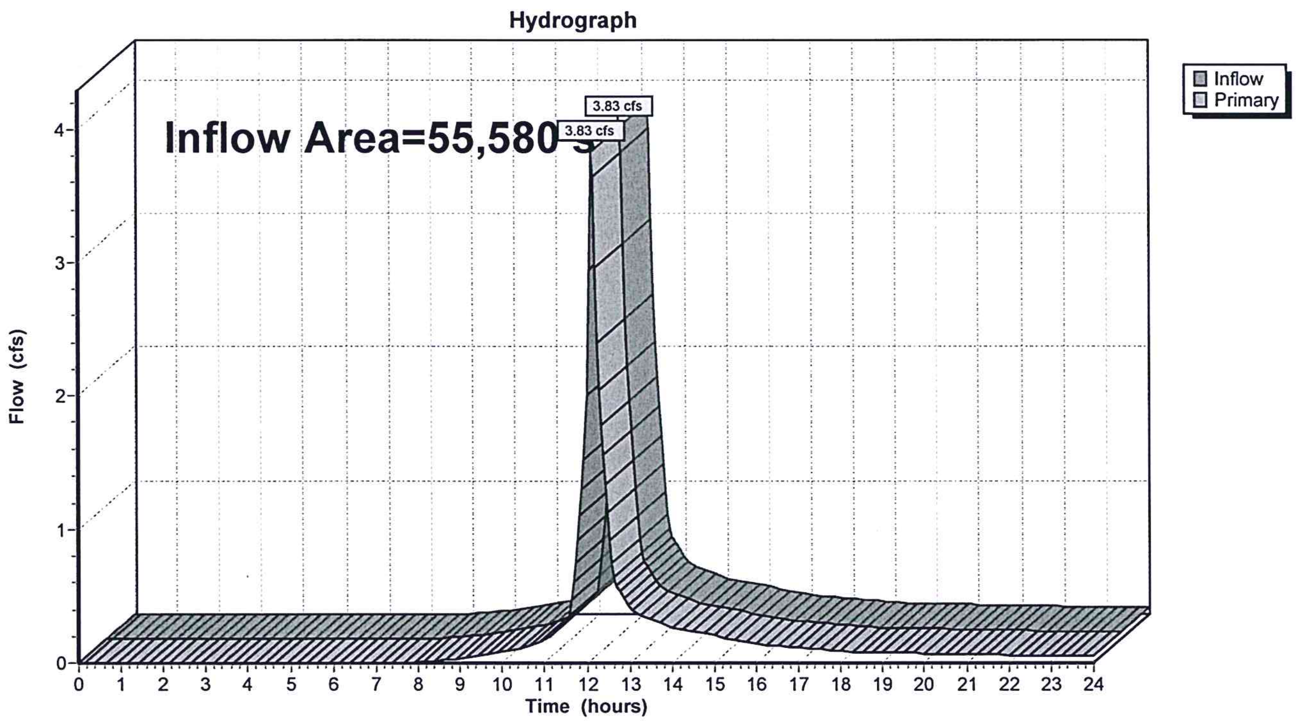


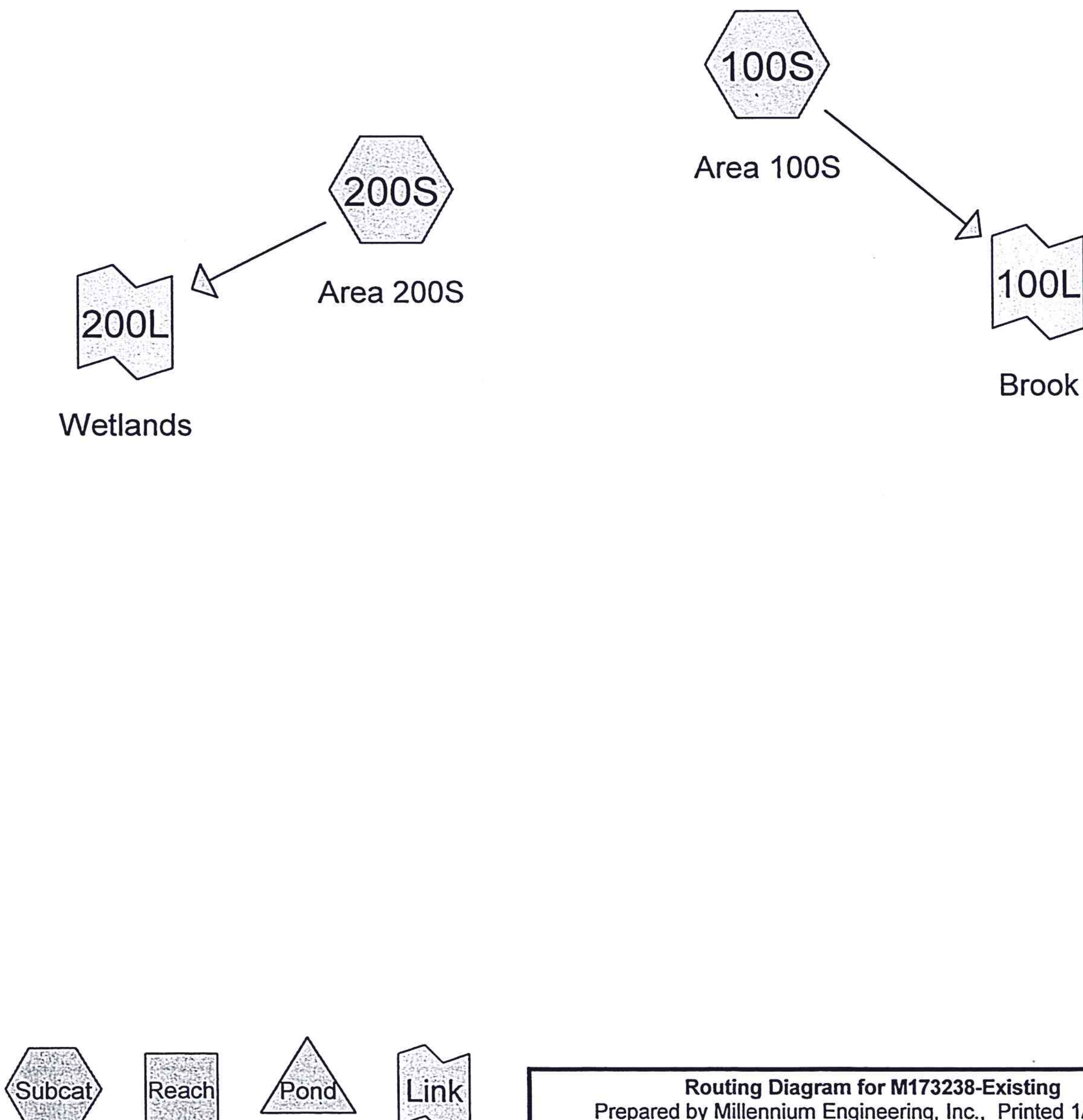
Summary for Link 200L: Wetlands

Inflow Area = 55,580 sf, 4.32% Impervious, Inflow Depth > 2.81" for 10-Year (C.A.) event
Inflow = 3.83 cfs @ 12.12 hrs, Volume= 12,994 cf
Primary = 3.83 cfs @ 12.12 hrs, Volume= 12,994 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 200L: Wetlands





Routing Diagram for M173238-Existing
Prepared by Millennium Engineering, Inc., Printed 1/4/2019

Summary for Subcatchment 100S: Area 100S

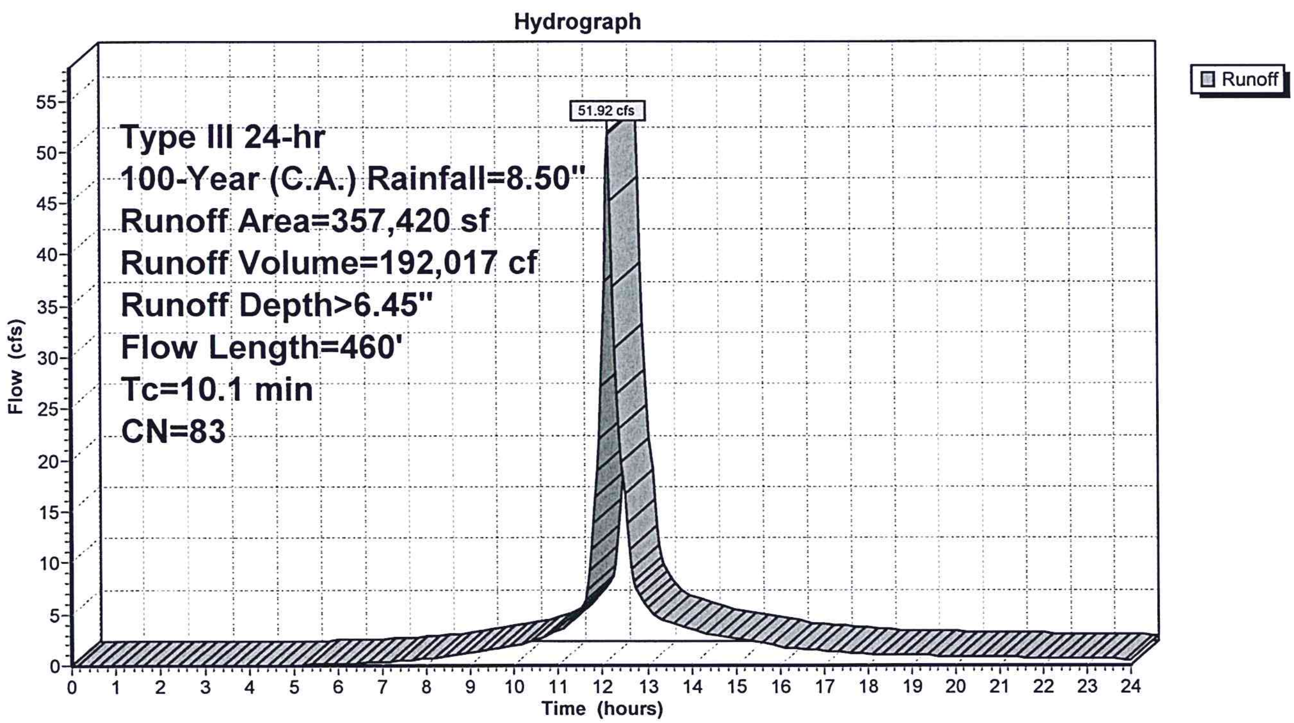
Runoff = 51.92 cfs @ 12.14 hrs, Volume= 192,017 cf, Depth> 6.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year (C.A.) Rainfall=8.50"

Area (sf)	CN	Description
5,435	98	Roofs
36,320	98	Paved roads w/curbs & sewers
37,415	91	Gravel roads, HSG D
278,250	80	Pasture/grassland/range, Good, HSG D
357,420	83	Weighted Average
315,665		88.32% Pervious Area
41,755		11.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
5.8	410	0.0280	1.17		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.1	460	Total			

Subcatchment 100S: Area 100S

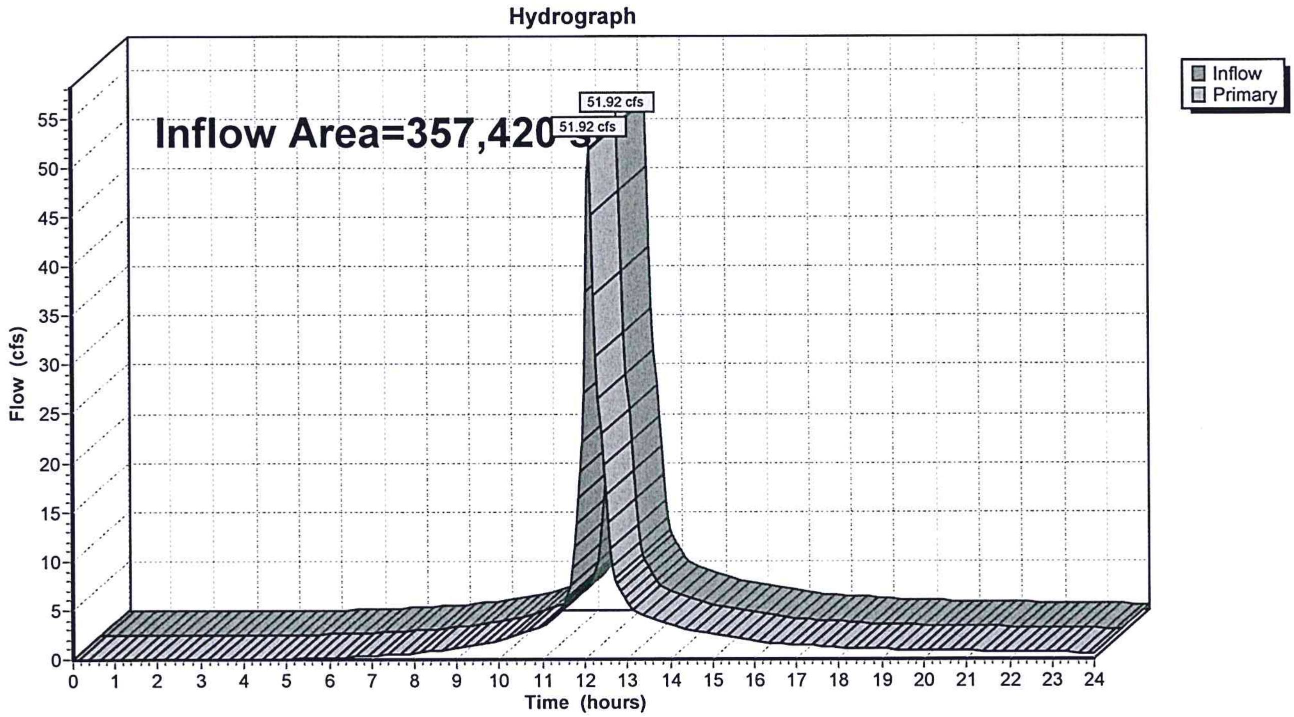


Summary for Link 100L: Brook

Inflow Area =	357,420 sf,	11.68% Impervious,	Inflow Depth > 6.45"	for 100-Year (C.A.) event
Inflow =	51.92 cfs @	12.14 hrs,	Volume=	192,017 cf
Primary =	51.92 cfs @	12.14 hrs,	Volume=	192,017 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 100L: Brook



Summary for Subcatchment 200S: Area 200S

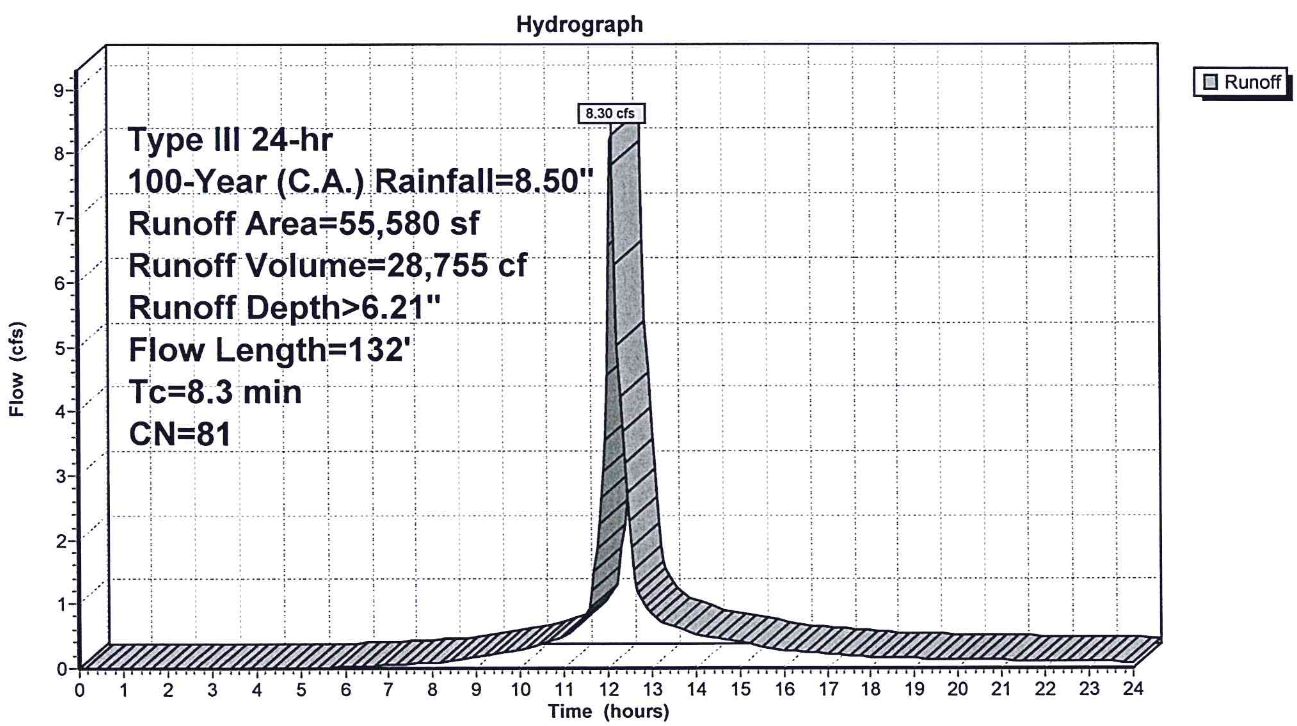
Runoff = 8.30 cfs @ 12.12 hrs, Volume= 28,755 cf, Depth> 6.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year (C.A.) Rainfall=8.50"

Area (sf)	CN	Description
365	98	Paved roads w/curbs & sewers, HSG D
2,035	98	Roofs
1,430	91	Gravel roads, HSG D
51,750	80	Pasture/grassland/range, Good, HSG D
55,580	81	Weighted Average
53,180		95.68% Pervious Area
2,400		4.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	50	0.0280	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
1.0	82	0.0420	1.43		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.3	132	Total			

Subcatchment 200S: Area 200S

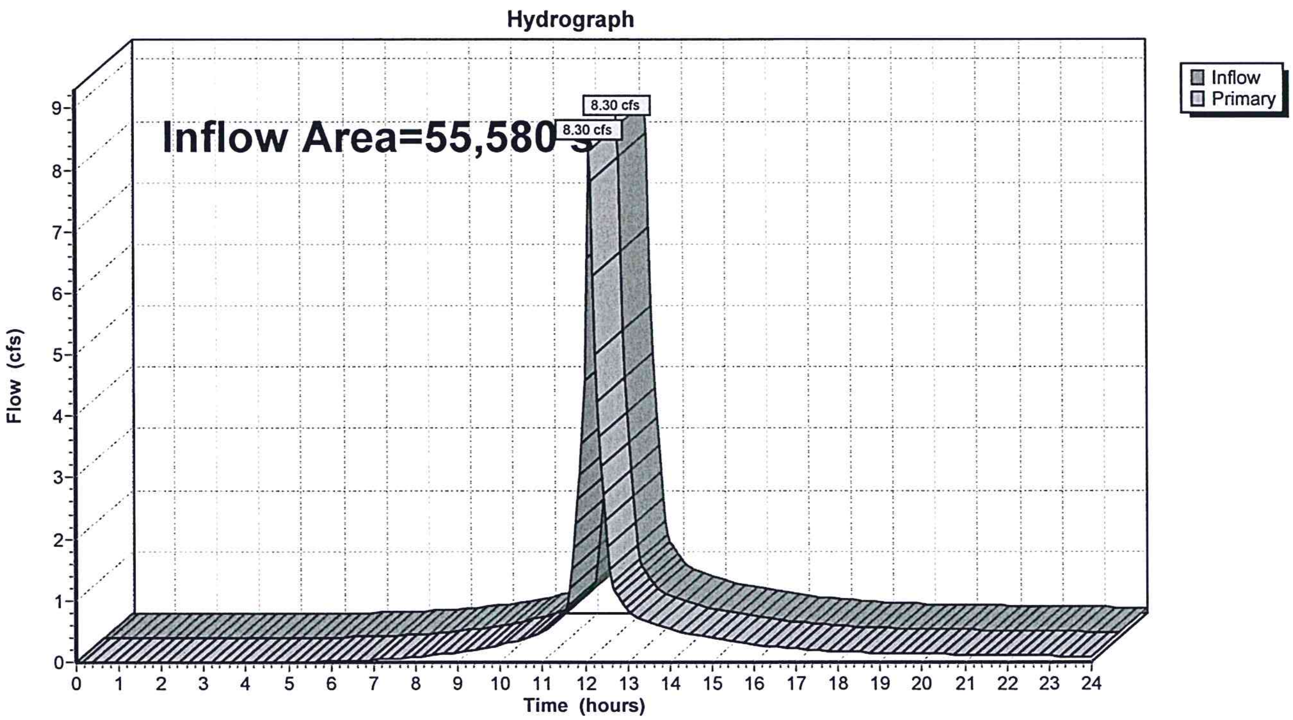


Summary for Link 200L: Wetlands

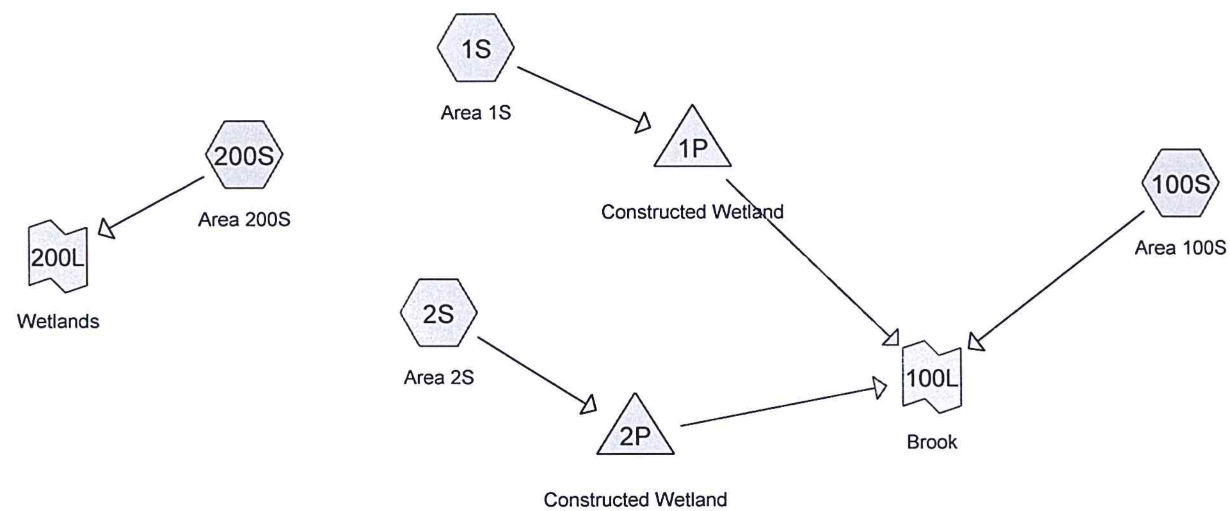
Inflow Area = 55,580 sf, 4.32% Impervious, Inflow Depth > 6.21" for 100-Year (C.A.) event
Inflow = 8.30 cfs @ 12.12 hrs, Volume= 28,755 cf
Primary = 8.30 cfs @ 12.12 hrs, Volume= 28,755 cf, Atten= 0%, Lag= 0.0 min

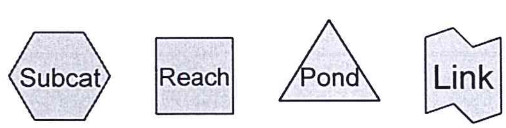
Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 200L: Wetlands



11.0 APPENDIX D – POST-DEVELOPMENT DRAINAGE CALCULATIONS





Routing Diagram for M173238-Proposed
Prepared by Millennium Engineering, Inc., Printed 1/4/2019
HydroCAD® 10.00-22 s/n 02736 © 2018 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Area 1S

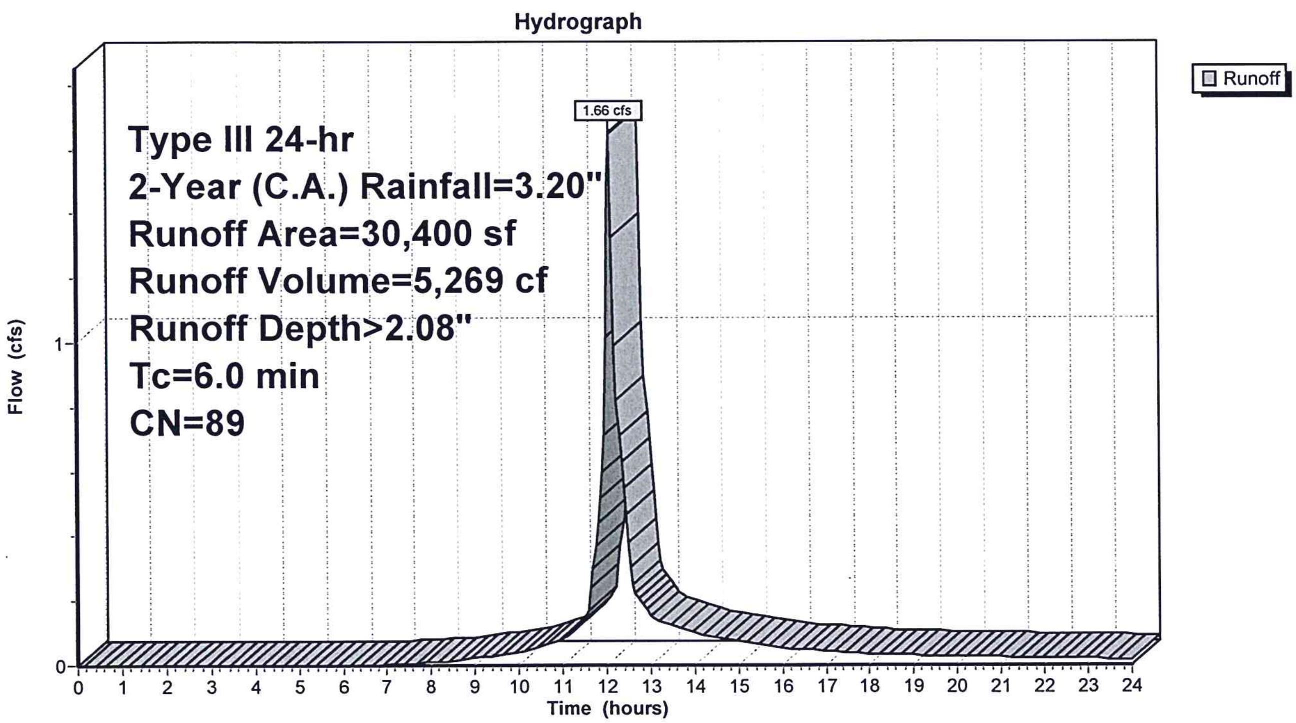
Runoff = 1.66 cfs @ 12.09 hrs, Volume= 5,269 cf, Depth> 2.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year (C.A.) Rainfall=3.20"

Area (sf)	CN	Description
3,840	98	Roofs
9,000	98	Paved roads w/curbs & sewers
2,640	98	Sidewalks
14,920	80	>75% Grass cover, Good, HSG D
30,400	89	Weighted Average
14,920		49.08% Pervious Area
15,480		50.92% Impervious Area

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

Subcatchment 1S: Area 1S



Summary for Pond 1P: Constructed Wetland

Inflow Area = 30,400 sf, 50.92% Impervious, Inflow Depth > 2.08" for 2-Year (C.A.) event
Inflow = 1.66 cfs @ 12.09 hrs, Volume= 5,269 cf
Outflow = 0.11 cfs @ 13.77 hrs, Volume= 4,611 cf, Atten= 93%, Lag= 100.9 min
Primary = 0.11 cfs @ 13.77 hrs, Volume= 4,611 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 10.22' @ 13.77 hrs Surf.Area= 3,484 sf Storage= 2,696 cf
Flood Elev= 12.00' Surf.Area= 5,050 sf Storage= 10,185 cf

Plug-Flow detention time= 266.7 min calculated for 4,601 cf (87% of inflow)
Center-of-Mass det. time= 210.4 min (1,021.0 - 810.6)

Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	10,185 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

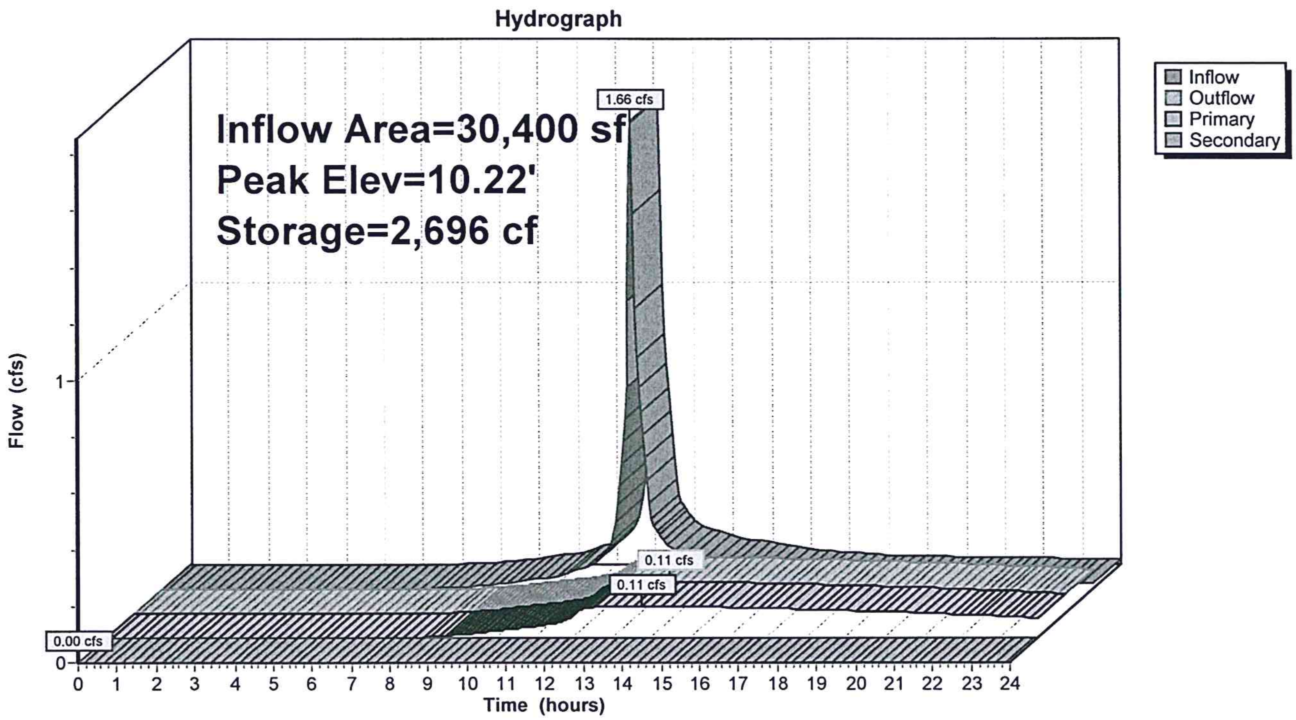
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
9.00	570	0	0
10.00	3,325	1,948	1,948
11.00	4,050	3,688	5,635
12.00	5,050	4,550	10,185

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**12.0" Round Culvert** L= 50.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 9.00' / 8.50' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	9.00'	**2.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	11.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	11.50'	**15.0' long x 9.0' 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) 2.46 2.55 2.70 2.69 2.68 2.68 2.67 2.64 2.64 2.64 2.65 2.64 2.65 2.65 2.66 2.67 2.69

Primary OutFlow Max=0.11 cfs @ 13.77 hrs HW=10.22' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.11 cfs of 2.83 cfs potential flow)
 ├─**2=Orifice/Grate** (Orifice Controls 0.11 cfs @ 5.13 fps)
 └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=9.00' TW=0.00' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Constructed Wetland



Summary for Subcatchment 2S: Area 2S

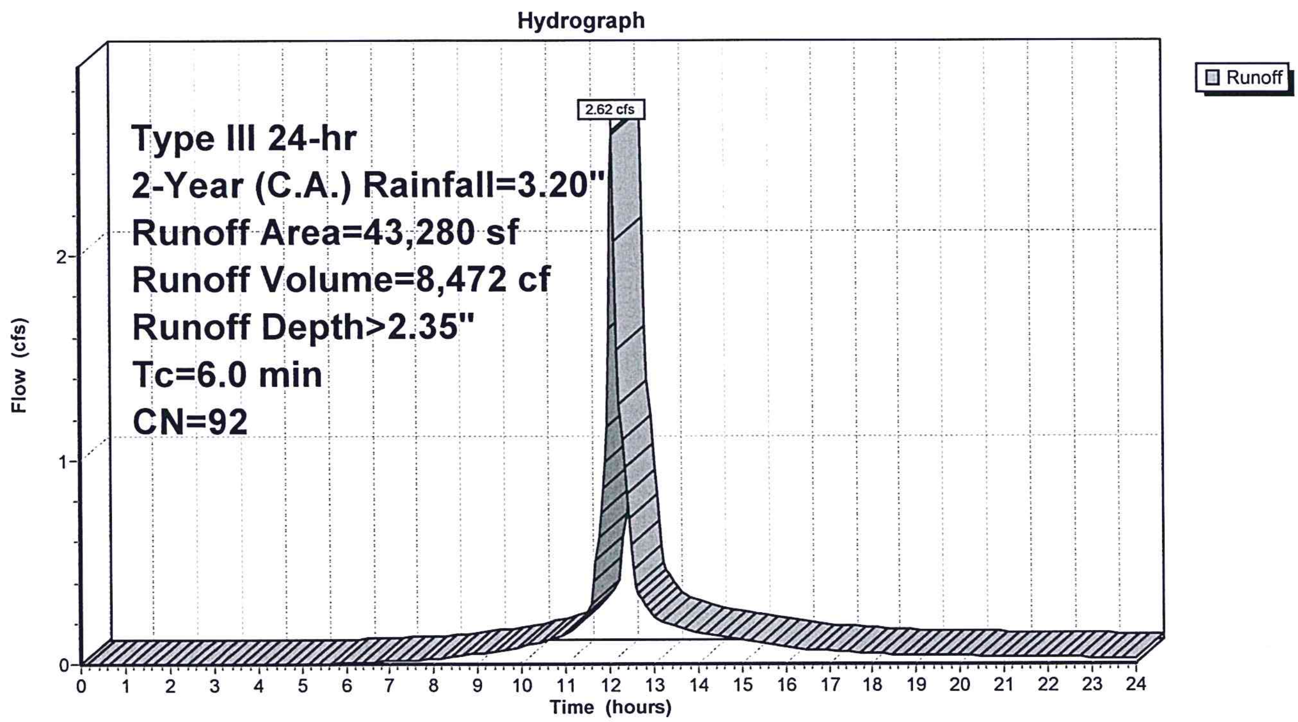
Runoff = 2.62 cfs @ 12.09 hrs, Volume= 8,472 cf, Depth> 2.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year (C.A.) Rainfall=3.20"

Area (sf)	CN	Description
13,300	98	Roofs
14,760	98	Paved roads w/curbs & sewers
820	98	Sidewalks
14,400	80	>75% Grass cover, Good, HSG D
43,280	92	Weighted Average
14,400		33.27% Pervious Area
28,880		66.73% Impervious Area

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

Subcatchment 2S: Area 2S



Summary for Pond 2P: Constructed Wetland

Inflow Area = 43,280 sf, 66.73% Impervious, Inflow Depth > 2.35" for 2-Year (C.A.) event
Inflow = 2.62 cfs @ 12.09 hrs, Volume= 8,472 cf
Outflow = 0.14 cfs @ 14.40 hrs, Volume= 6,106 cf, Atten= 95%, Lag= 138.9 min
Primary = 0.14 cfs @ 14.40 hrs, Volume= 6,106 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 12.75' @ 14.40 hrs Surf.Area= 3,958 sf Storage= 4,764 cf
Flood Elev= 14.00' Surf.Area= 5,225 sf Storage= 10,455 cf

Plug-Flow detention time= 309.8 min calculated for 6,106 cf (72% of inflow)
Center-of-Mass det. time= 220.6 min (1,017.9 - 797.3)

Volume	Invert	Avail.Storage	Storage Description
#1	11.00'	10,455 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

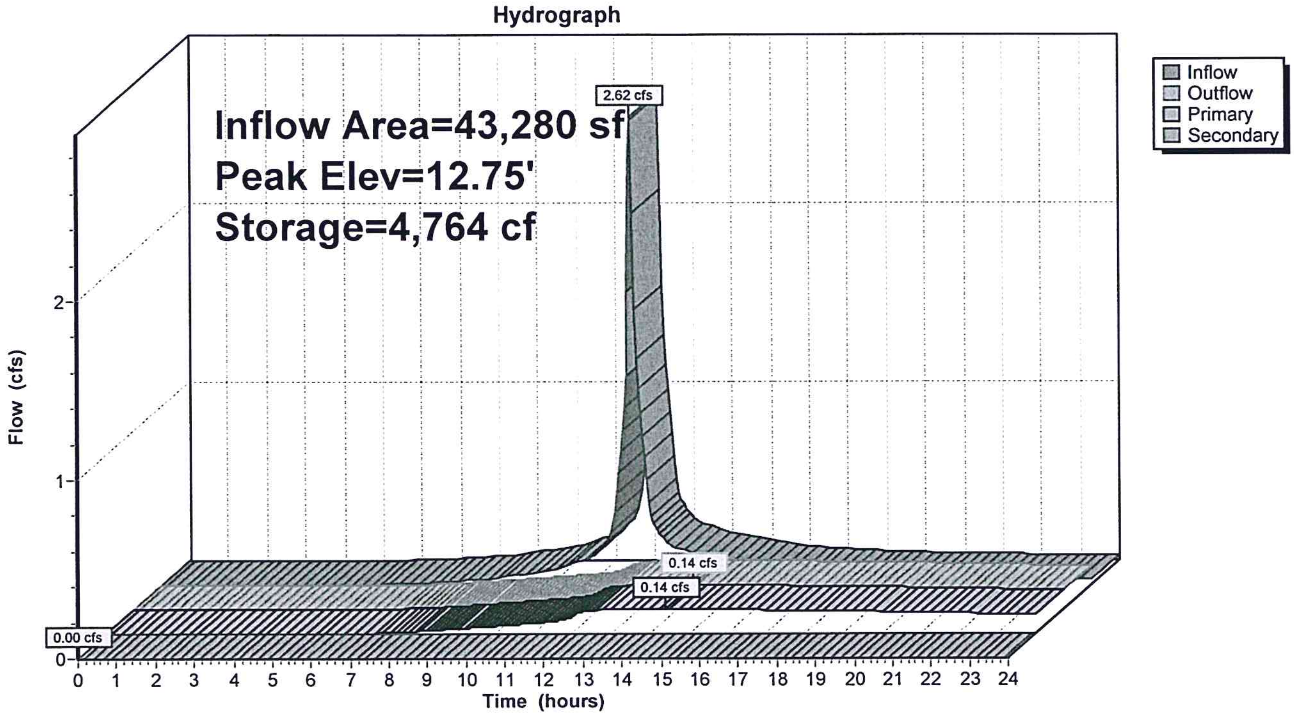
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
11.00	635	0	0
12.00	3,375	2,005	2,005
13.00	4,150	3,763	5,768
14.00	5,225	4,688	10,455

Device	Routing	Invert	Outlet Devices
#1	Primary	11.00'	**12.0" Round Culvert** L= 40.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 11.00' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	11.00'	**2.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	13.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	13.50'	**15.0' long x 9.0' 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) 2.46 2.55 2.70 2.69 2.68 2.68 2.67 2.64 2.64 2.64 2.65 2.64 2.65 2.65 2.66 2.67 2.69

Primary OutFlow Max=0.14 cfs @ 14.40 hrs HW=12.75' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.14 cfs of 3.73 cfs potential flow)
  ↑—**2=Orifice/Grate** (Orifice Controls 0.14 cfs @ 6.22 fps)
  └—**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.00' TW=0.00' (Dynamic Tailwater)
↑—**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: Constructed Wetland



Summary for Subcatchment 100S: Area 100S

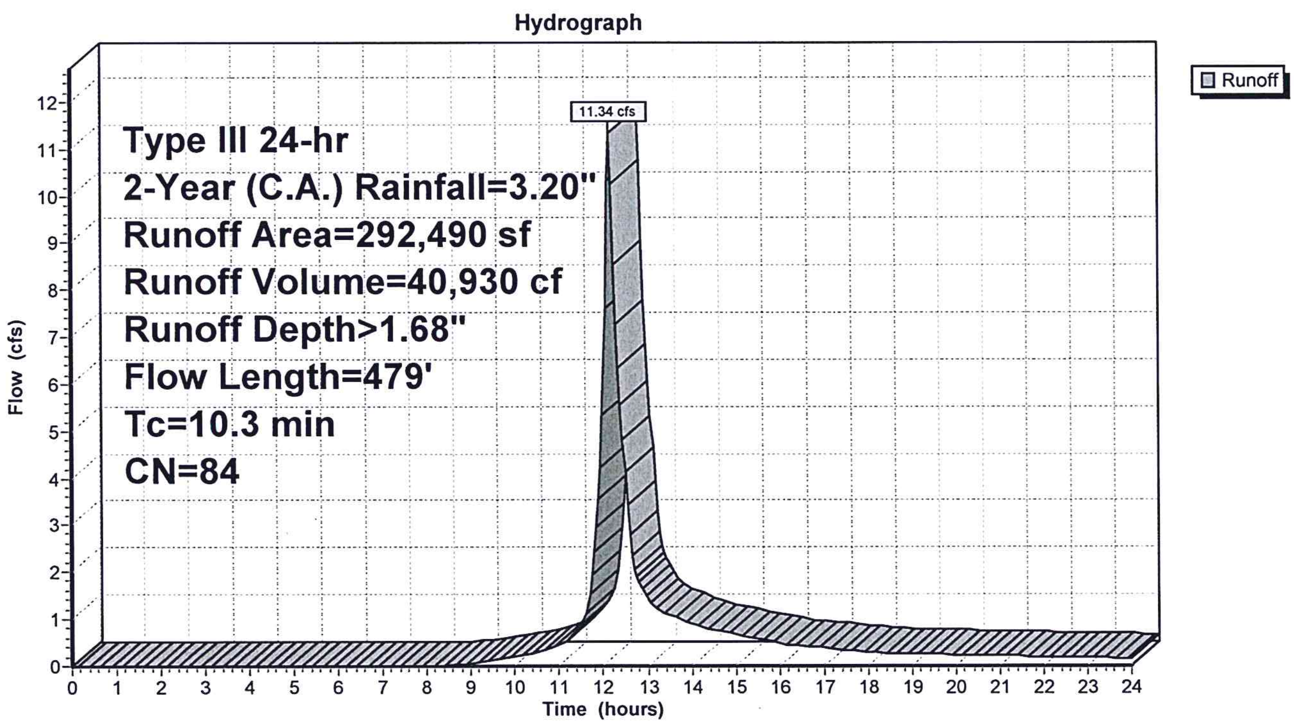
Runoff = 11.34 cfs @ 12.15 hrs, Volume= 40,930 cf, Depth> 1.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year (C.A.) Rainfall=3.20"

Area (sf)	CN	Description
3,135	98	Roofs
41,600	98	Paved roads w/curbs & sewers
41,585	91	Gravel roads, HSG D
206,170	80	Pasture/grassland/range, Good, HSG D
292,490	84	Weighted Average
247,755		84.71% Pervious Area
44,735		15.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	50	0.0500	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
6.3	429	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.3	479	Total			

Subcatchment 100S: Area 100S

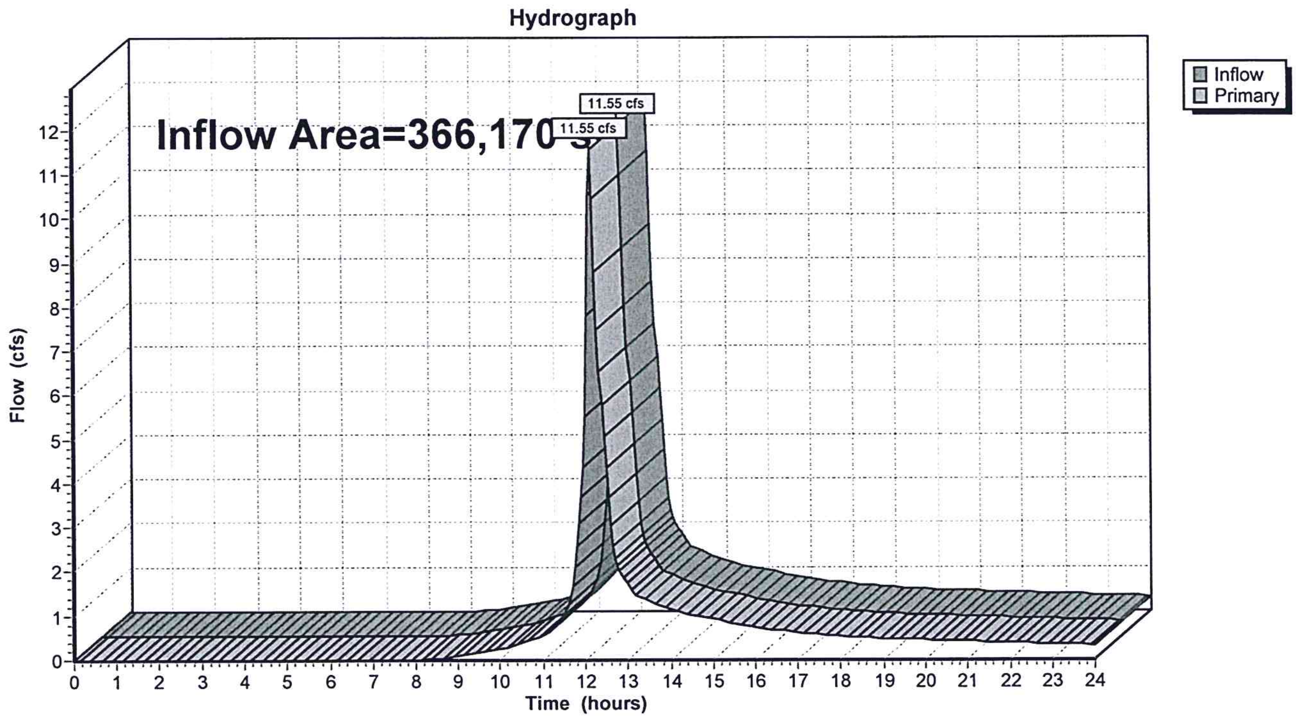


Summary for Link 100L: Brook

Inflow Area =	366,170 sf,	24.33% Impervious,	Inflow Depth > 1.69"	for 2-Year (C.A.) event
Inflow =	11.55 cfs @ 12.15 hrs,	Volume=	51,647 cf	
Primary =	11.55 cfs @ 12.15 hrs,	Volume=	51,647 cf,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 100L: Brook



Summary for Subcatchment 200S: Area 200S

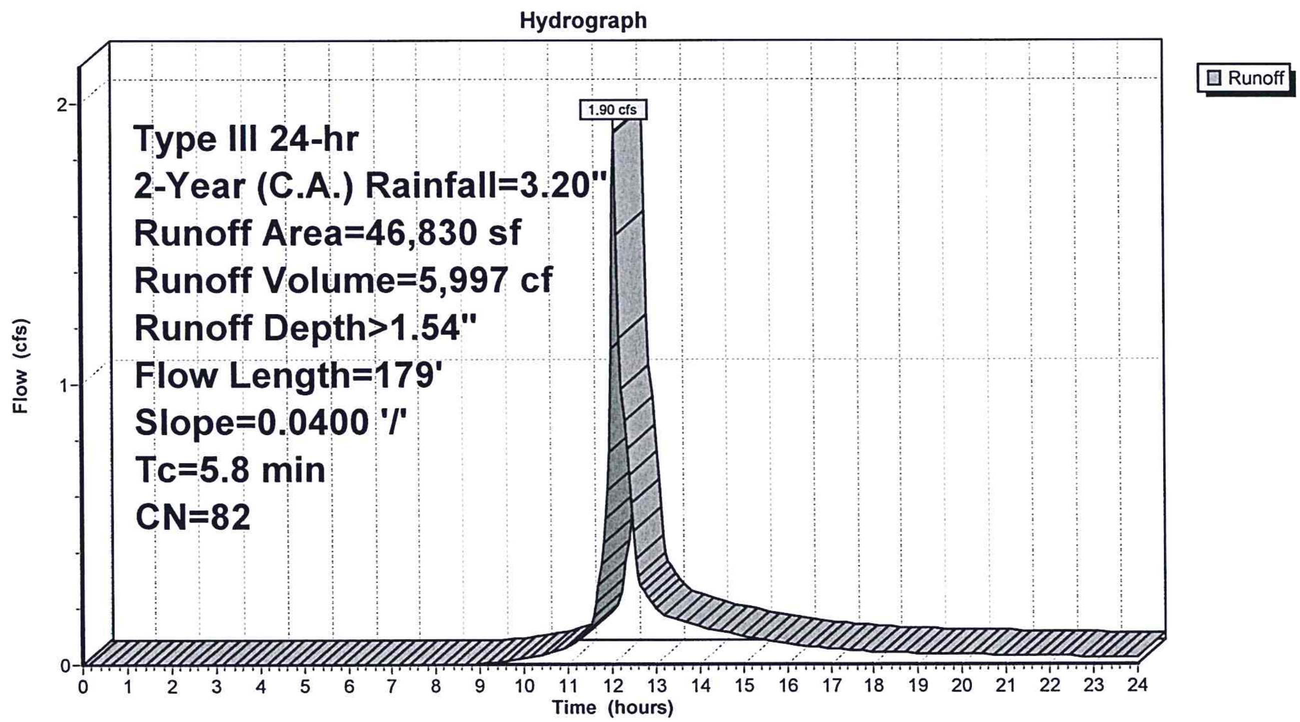
Runoff = 1.90 cfs @ 12.09 hrs, Volume= 5,997 cf, Depth> 1.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year (C.A.) Rainfall=3.20"

	Area (sf)	CN	Description
	920	98	Paved roads w/curbs & sewers, HSG D
	2,330	98	Roofs
*	770	98	Sidewalks
	3,810	91	Gravel roads, HSG D
	39,000	80	Pasture/grassland/range, Good, HSG D
	46,830	82	Weighted Average
	42,810		91.42% Pervious Area
	4,020		8.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.5	129	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.8	179	Total			

Subcatchment 200S: Area 200S

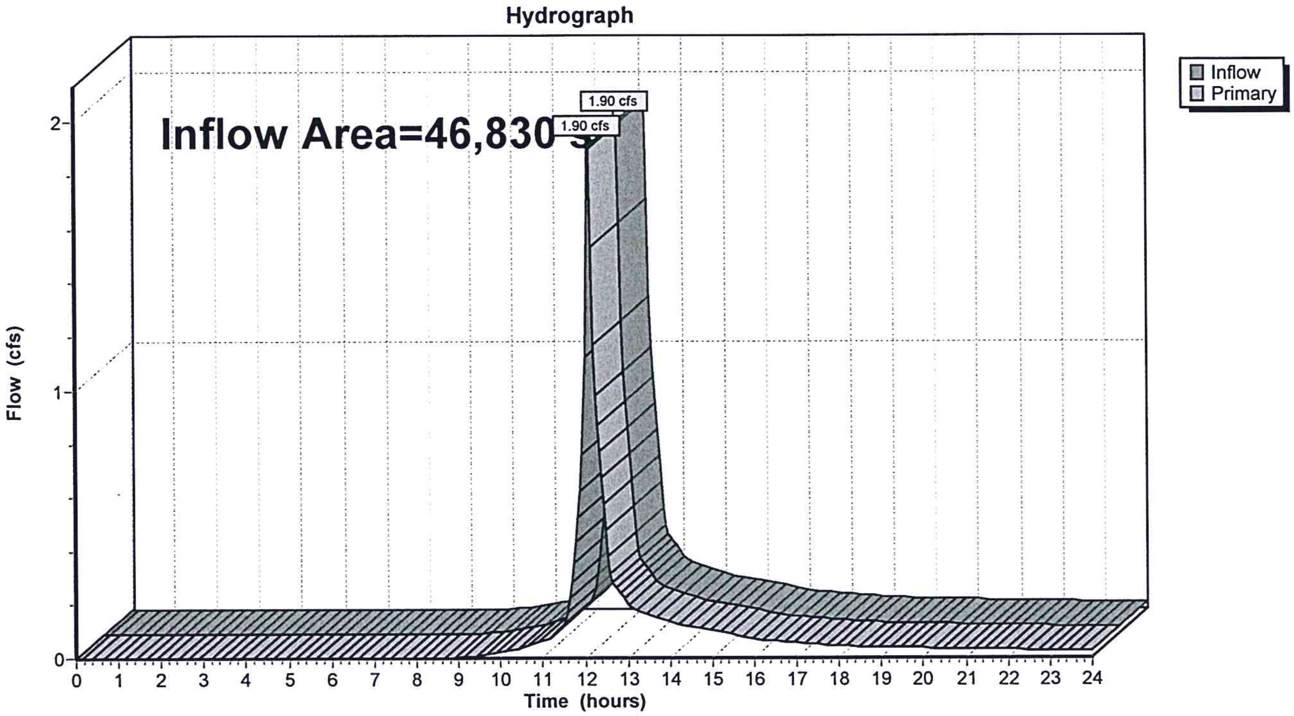


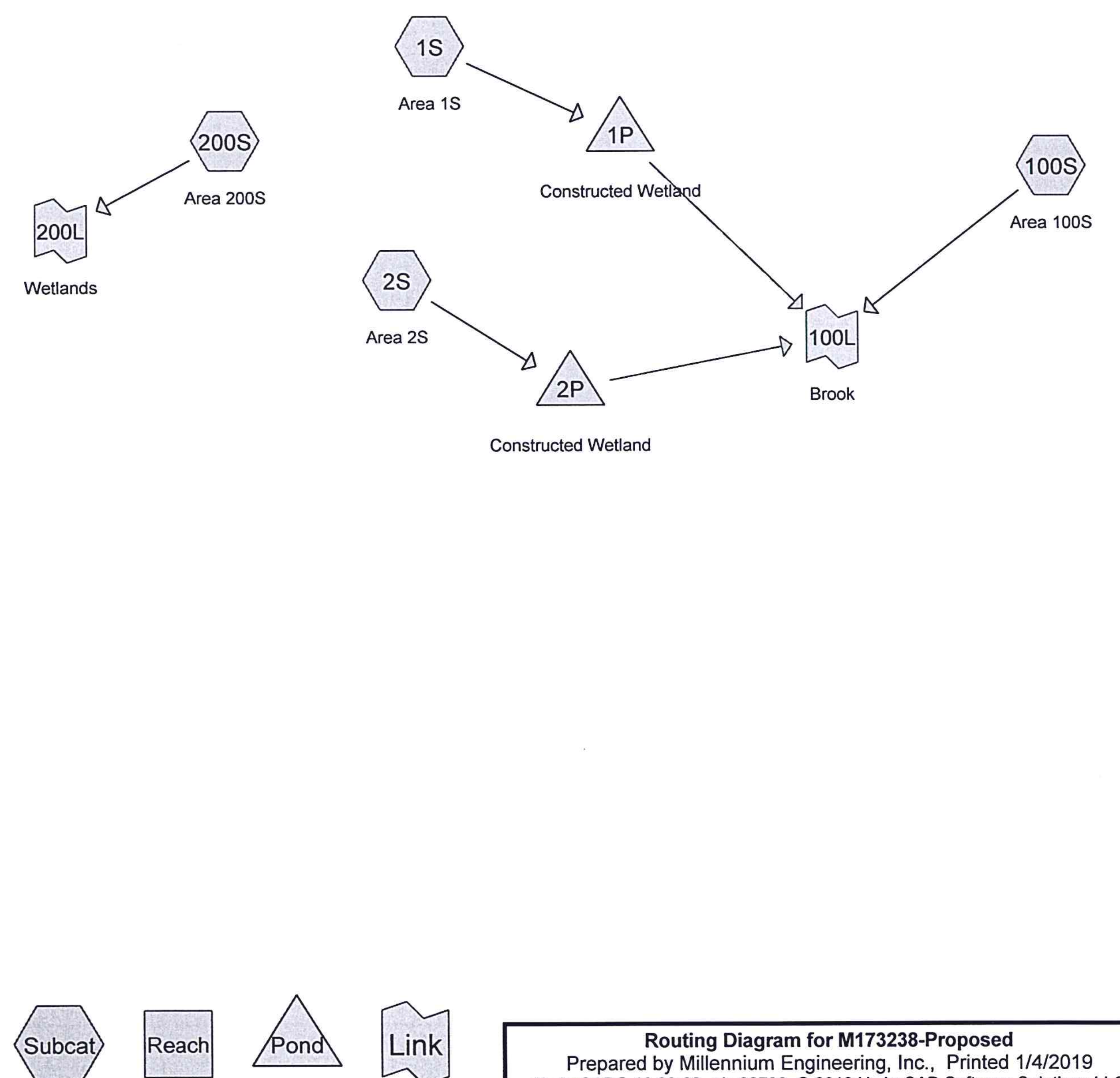
Summary for Link 200L: Wetlands

Inflow Area = 46,830 sf, 8.58% Impervious, Inflow Depth > 1.54" for 2-Year (C.A.) event
Inflow = 1.90 cfs @ 12.09 hrs, Volume= 5,997 cf
Primary = 1.90 cfs @ 12.09 hrs, Volume= 5,997 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 200L: Wetlands





Routing Diagram for M173238-Proposed
Prepared by Millennium Engineering, Inc., Printed 1/4/2019
HydroCAD® 10.00-22 s/n 02736 © 2018 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Area 1S

Runoff = 2.79 cfs @ 12.09 hrs, Volume= 9,064 cf, Depth> 3.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year (C.A.) Rainfall=4.80"

Area (sf)	CN	Description
3,840	98	Roofs
9,000	98	Paved roads w/curbs & sewers
2,640	98	Sidewalks
14,920	80	>75% Grass cover, Good, HSG D
30,400	89	Weighted Average
14,920		49.08% Pervious Area
15,480		50.92% Impervious Area

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

Summary for Subcatchment 2S: Area 2S

Runoff = 4.22 cfs @ 12.09 hrs, Volume= 14,035 cf, Depth> 3.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year (C.A.) Rainfall=4.80"

Area (sf)	CN	Description
13,300	98	Roofs
14,760	98	Paved roads w/curbs & sewers
820	98	Sidewalks
14,400	80	>75% Grass cover, Good, HSG D
43,280	92	Weighted Average
14,400		33.27% Pervious Area
28,880		66.73% Impervious Area

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

Summary for Subcatchment 100S: Area 100S

Runoff = 20.72 cfs @ 12.15 hrs, Volume= 75,145 cf, Depth> 3.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year (C.A.) Rainfall=4.80"

Area (sf)	CN	Description
3,135	98	Roofs
41,600	98	Paved roads w/curbs & sewers
41,585	91	Gravel roads, HSG D
206,170	80	Pasture/grassland/range, Good, HSG D
292,490	84	Weighted Average
247,755		84.71% Pervious Area
44,735		15.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	50	0.0500	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
6.3	429	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.3	479	Total			

Summary for Subcatchment 200S: Area 200S

Runoff = 3.59 cfs @ 12.09 hrs, Volume= 11,311 cf, Depth> 2.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year (C.A.) Rainfall=4.80"

	Area (sf)	CN	Description
	920	98	Paved roads w/curbs & sewers, HSG D
	2,330	98	Roofs
*	770	98	Sidewalks
	3,810	91	Gravel roads, HSG D
	39,000	80	Pasture/grassland/range, Good, HSG D
	46,830	82	Weighted Average
	42,810		91.42% Pervious Area
	4,020		8.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.5	129	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.8	179	Total			

Summary for Pond 1P: Constructed Wetland

Inflow Area = 30,400 sf, 50.92% Impervious, Inflow Depth > 3.58" for 10-Year (C.A.) event
Inflow = 2.79 cfs @ 12.09 hrs, Volume= 9,064 cf
Outflow = 0.14 cfs @ 14.49 hrs, Volume= 6,396 cf, Atten= 95%, Lag= 144.3 min
Primary = 0.14 cfs @ 14.49 hrs, Volume= 6,396 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 10.88' @ 14.49 hrs Surf.Area= 3,960 sf Storage= 5,137 cf
Flood Elev= 12.00' Surf.Area= 5,050 sf Storage= 10,185 cf

Plug-Flow detention time= 310.6 min calculated for 6,382 cf (70% of inflow)
Center-of-Mass det. time= 220.1 min (1,015.4 - 795.3)

Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	10,185 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
9.00	570	0	0
10.00	3,325	1,948	1,948
11.00	4,050	3,688	5,635
12.00	5,050	4,550	10,185

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**12.0" Round Culvert** L= 50.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 9.00' / 8.50' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	9.00'	**2.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	11.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	11.50'	**15.0' long x 9.0' 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) 2.46 2.55 2.70 2.69 2.68 2.68 2.67 2.64 2.64 2.64 2.65 2.64 2.65 2.65 2.66 2.67 2.69

Primary OutFlow Max=0.14 cfs @ 14.49 hrs HW=10.88' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.14 cfs of 3.91 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.14 cfs @ 6.45 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=9.00' TW=0.00' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 2P: Constructed Wetland

Inflow Area = 43,280 sf, 66.73% Impervious, Inflow Depth > 3.89" for 10-Year (C.A.) event
Inflow = 4.22 cfs @ 12.09 hrs, Volume= 14,035 cf
Outflow = 0.32 cfs @ 13.27 hrs, Volume= 8,598 cf, Atten= 92%, Lag= 71.0 min
Primary = 0.23 cfs @ 13.27 hrs, Volume= 8,212 cf
Secondary = 0.09 cfs @ 13.27 hrs, Volume= 386 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 13.52' @ 13.27 hrs Surf.Area= 4,707 sf Storage= 8,062 cf
Flood Elev= 14.00' Surf.Area= 5,225 sf Storage= 10,455 cf

Plug-Flow detention time= 307.0 min calculated for 8,598 cf (61% of inflow)
Center-of-Mass det. time= 205.5 min (989.0 - 783.5)

Volume	Invert	Avail.Storage	Storage Description
#1	11.00'	10,455 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
11.00	635	0	0
12.00	3,375	2,005	2,005
13.00	4,150	3,763	5,768
14.00	5,225	4,688	10,455

Device	Routing	Invert	Outlet Devices
#1	Primary	11.00'	**12.0" Round Culvert** L= 40.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 11.00' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	11.00'	**2.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	13.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	13.50'	**15.0' long x 9.0' 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) 2.46 2.55 2.70 2.69 2.68 2.68 2.67 2.64 2.64 2.64 2.65 2.64 2.65 2.65 2.66 2.67 2.69

Primary OutFlow Max=0.23 cfs @ 13.27 hrs HW=13.52' TW=0.00' (Dynamic Tailwater)
1=Culvert (Passes 0.23 cfs of 4.74 cfs potential flow)
2=Orifice/Grate (Orifice Controls 0.16 cfs @ 7.51 fps)
3=Orifice/Grate (Weir Controls 0.06 cfs @ 0.44 fps)

Secondary OutFlow Max=0.09 cfs @ 13.27 hrs HW=13.52' TW=0.00' (Dynamic Tailwater)
4=Broad-Crested Rectangular Weir (Weir Controls 0.09 cfs @ 0.33 fps)

Summary for Link 100L: Brook

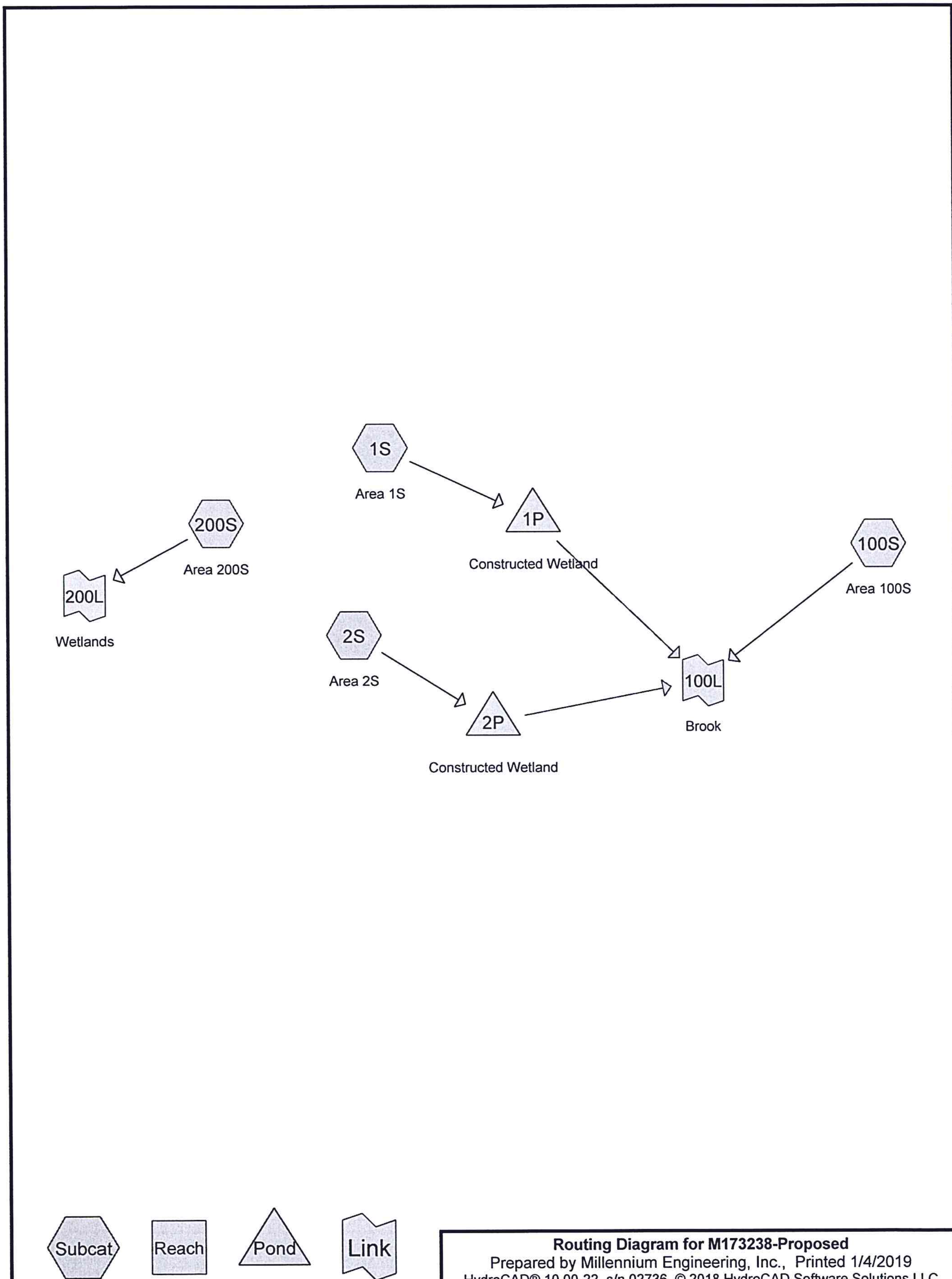
Inflow Area = 366,170 sf, 24.33% Impervious, Inflow Depth > 2.95" for 10-Year (C.A.) event
Inflow = 20.98 cfs @ 12.15 hrs, Volume= 90,138 cf
Primary = 20.98 cfs @ 12.15 hrs, Volume= 90,138 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link 200L: Wetlands

Inflow Area = 46,830 sf, 8.58% Impervious, Inflow Depth > 2.90" for 10-Year (C.A.) event
Inflow = 3.59 cfs @ 12.09 hrs, Volume= 11,311 cf
Primary = 3.59 cfs @ 12.09 hrs, Volume= 11,311 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Routing Diagram for M173238-Proposed
Prepared by Millennium Engineering, Inc., Printed 1/4/2019

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Area 1S Runoff Area=30,400 sf 50.92% Impervious Runoff Depth>7.17"
Tc=6.0 min CN=89 Runoff=5.38 cfs 18,172 cf

Subcatchment 2S: Area 2S Runoff Area=43,280 sf 66.73% Impervious Runoff Depth>7.53"
Tc=6.0 min CN=92 Runoff=7.86 cfs 27,172 cf

Subcatchment 100S: Area 100S Runoff Area=292,490 sf 15.29% Impervious Runoff Depth>6.57"
Flow Length=479' Tc=10.3 min CN=84 Runoff=42.88 cfs 160,060 cf

Subcatchment 200S: Area 200S Runoff Area=46,830 sf 8.58% Impervious Runoff Depth>6.33"
Flow Length=179' Slope=0.0400 '/' Tc=5.8 min CN=82 Runoff=7.64 cfs 24,707 cf

Pond 1P: Constructed Wetland Peak Elev=11.60' Storage=8,253 cf Inflow=5.38 cfs 18,172 cf
Primary=1.01 cfs 10,071 cf Secondary=1.20 cfs 2,380 cf Outflow=2.21 cfs 12,451 cf

Pond 2P: Constructed Wetland Peak Elev=13.73' Storage=9,080 cf Inflow=7.86 cfs 27,172 cf
Primary=3.04 cfs 13,811 cf Secondary=4.07 cfs 6,641 cf Outflow=7.11 cfs 20,452 cf

Link 100L: Brook Inflow=50.09 cfs 192,963 cf
Primary=50.09 cfs 192,963 cf

Link 200L: Wetlands Inflow=7.64 cfs 24,707 cf
Primary=7.64 cfs 24,707 cf

Total Runoff Area = 413,000 sf Runoff Volume = 230,111 cf Average Runoff Depth = 6.69"
77.45% Pervious = 319,885 sf 22.55% Impervious = 93,115 sf

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
29,320	80	>75% Grass cover, Good, HSG D (1S, 2S)
45,395	91	Gravel roads, HSG D (100S, 200S)
245,170	80	Pasture/grassland/range, Good, HSG D (100S, 200S)
65,360	98	Paved roads w/curbs & sewers (1S, 2S, 100S)
920	98	Paved roads w/curbs & sewers, HSG D (200S)
22,605	98	Roofs (1S, 2S, 100S, 200S)
4,230	98	Sidewalks (1S, 2S, 200S)
413,000	**85**	**TOTAL AREA**

12.0 APPENDIX E – NRCS SOIL MAP

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Essex County, Massachusetts, Northern Part

79 Parker Street

August 31, 2016

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map


70° 53' 13" W
70° 52' 54" W
42° 48' 3" N
42° 47' 54" N
345700
345740
345780
345820
345860
345900
345940
345980
346020
346060
346100
4740410
4740370
4740330
4740290
4740250
4740210
4740170
Parker St
Parker
16A
12A
228B
16A
228B
N
Map Scale: 1:1,900 if printed on A landscape (11" x 8.5") sheet.
Meters
0 25 50 100 150
Feet
0 50 100 200 300
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 11, Sep 28, 2015

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

Date(s) aerial images were photographed: Mar 30, 2011—Apr 8, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Essex County, Massachusetts, Northern Part (MA605)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
12A	Maybid silt loam, 0 to 3 percent slopes	1.3	11.2%
16A	Scantic silt loam, 0 to 3 percent slopes	6.1	53.6%
228B	Buxton silt loam, 3 to 8 percent slopes	4.0	35.2%
Totals for Area of Interest		**11.4**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Essex County, Massachusetts, Northern Part

12A—Maybid silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: vjhj
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Maybid

Setting

Landform: Depressions, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Soft silty and clayey glaciolacustrine deposits and/or firm silty marine deposits

Typical profile

H1 - 0 to 7 inches: silt loam
H2 - 7 to 19 inches: silty clay
H3 - 19 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Scantic

Percent of map unit: 12 percent
Landform: Depressions
Hydric soil rating: Yes

Swansea

Percent of map unit: 3 percent
Landform: Bogs
Hydric soil rating: Yes

16A—Scantic silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: vjrl
Elevation: 10 to 900 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Scantic

Setting

Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Soft fine-silty glaciolacustrine deposits and/or soft fine-silty glaciomarine deposits over hard fine-silty glaciolacustrine deposits and/or hard fine-silty glaciomarine deposits

Typical profile

H1 - 0 to 11 inches: silt loam
H2 - 11 to 26 inches: silty clay loam
H3 - 26 to 60 inches: clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Maybid

Percent of map unit: 10 percent
Landform: Depressions
Hydric soil rating: Yes

Buxton

Percent of map unit: 5 percent
Hydric soil rating: No

228B—Buxton silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: vj37
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Buxton

Setting

Landform: Valleys, valleys
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Soft fine-loamy glaciolacustrine deposits derived from mica schist over hard fine-loamy glaciolacustrine deposits derived from mica schist

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 30 inches: silt loam
H3 - 30 to 60 inches: silty clay

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)

Depth to water table: About 12 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.7 inches)

Interpretive groups

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

Minor Components

Suffield

Percent of map unit: 15 percent
Hydric soil rating: No

Scantic

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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

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

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

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

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

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

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

Map—Hydrologic Soil Group

Map Scale: 1:1,900 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 11, Sep 28, 2015

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

Date(s) aerial images were photographed: Mar 30, 2011—Apr 8, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Essex County, Massachusetts, Northern Part (MA605)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
12A	Maybid silt loam, 0 to 3 percent slopes	C/D	1.3	11.2%
16A	Scantic silt loam, 0 to 3 percent slopes	C/D	6.1	53.6%
228B	Buxton silt loam, 3 to 8 percent slopes	D	4.0	35.2%
Totals for Area of Interest			**11.4**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

13.0 APPENDIX F – PROPRIETARY BMP DOCUMENTATION

Project:	**Multi-Use Development**
Location:	**Newburyport, MA**
Prepared For:	**Millennium Engineering**

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Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1/2" of runoff from the contributing impervious surface.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Procedure: Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

Compute Q Rate using the following equation:

$$Q = (qu)\ (A)\ (WQV)$$

where:

Q = flow rate associated with first 1/2" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1/2" in this case)

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
WQ	0.28	0.0004297	6.0	0.100	0.50	752.00	0.16

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MULTI-USE DEVELOPMENT
NEWBURYPORT, MA

Area	0.28 ac	Unit Site Deignation	WQ
Weighted C	0.9	Rainfall Station #	67
t_c	6 min	Design Ratio[1]	0.0090
VSHS Model	HS36	VSHS Treatment Capacity	0.55 cfs

Rainfall Intensity[1] (in/hr)	Flow Rate (cfs)	Operating Rate[2] cfs/ft[3]	% Total Rainfall	Rel. Effcy (%)
0.08	0.02	0.00075	41.0%	40.2%
0.16	0.04	0.00149	23.9%	23.4%
0.24	0.06	0.00224	11.5%	11.3%
0.32	0.08	0.00299	7.4%	7.3%
0.40	0.10	0.00373	4.4%	4.4%
0.48	0.12	0.00448	2.9%	2.8%
0.56	0.14	0.00523	1.8%	1.7%
0.64	0.16	0.00598	1.2%	1.2%
0.72	0.18	0.00672	1.6%	1.6%
0.80	0.20	0.00747	0.8%	0.8%
1.00	0.25	0.00934	0.6%	0.6%
1.40	0.35	0.01307	1.4%	1.3%
1.80	0.45	0.01681	0.9%	0.8%
2.20	0.54	0.02054	0.5%	0.4%
0.00	0.00	0.00000	0.0%	0.0%
0.00	0.00	0.00000	0.0%	0.0%
0.00	0.00	0.00000	0.0%	0.0%
0.00	0.00	0.00000	0.0%	0.0%
0.00	0.00	0.00000	0.0%	0.0%
0.00	0.00	0.00000	0.0%	0.0%
0.00	0.00	0.00000	0.0%	0.0%
				97.7%
			% rain falling at >0"/hr =	0.0%
			Removal Efficiency Adjustment[4] =	0.0%
			Predicted Net Annual Load Removal Efficiency =	**97.7%**

1 - Design Ratio = (Total Drainage Area x Runoff Coefficient) / VortSentry HS Treatment Volume
= The Total Drainage Area and Runoff Coefficient are specified by the site engineer.

2 - Operating Rate (cfs/ft^3) = Rainfall Intensity ("/hr) x Design Ratio

3 - Based on 7 years of data from NCDC station #3276, Groveland, Essex County, MA

4 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

14.0 APPENDIX G - WATERSHED PLANS