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Stormwater Management Report
South Hadley Electric Light Department Headquarters

65 Old Lyman Road, South Hadley, Massachusetts

Prepared For:

South Hadley Electric Light Department

South Hadley, Massachusetts

March 2, 2026

DANIEL F.
DELANY
CIVIL
NO. 43477

3/2/26

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1 Executive Summary

The South Hadley Electric Light Department (SHELD) proposes to construct a new Headquarters located on Old Lyman Road in South Hadley, Massachusetts. The site is bound by the existing Big Y to the west, Old Lyman Road to the east and private properties to the south. The project location is depicted in Figure 1.

The site currently consists of driveways and paved parking lots associated with Big Y, grassed and wooded areas and a wetland located on the southeastern portion of the site. Proposed site improvements include development of the new main office, warehouse, and garage space, driveways, parking lots, stormwater infrastructure, utilities, landscaping and other site amenities.

The proposed stormwater management system has been designed in accordance with the guidelines outlined within the Massachusetts Department of Environmental Protection (DEP) Stormwater Handbook and the Town of South Hadley Stormwater Management regulations. Stormwater management practices have been implemented to mitigate increases in peak runoff rates and provide stormwater treatment. The existing site conditions, proposed site conditions, and the proposed stormwater management system are described in detail in this report.

The design drawings include controls to protect wetland resource areas and properties adjacent to the development from erosion and sedimentation impacts caused by construction site runoff. The plan incorporates both non-structural and structural controls, such as inspections, waste management, good housekeeping and maintenance, perimeter sediment barriers, dust suppression, and a construction entrance. A Stormwater Pollution Prevention Plan (SWPPP) will be prepared as required under the Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES) General Permit for Discharge from Construction Activities prior to the start of construction. Additional information related to erosion and sediment controls is included in this report. To ensure the long-term success of the stormwater management system, post-construction operation and maintenance practices will be required in accordance with the Long-Term Operation and Maintenance Plan that has been developed for the site and included in *Appendix I.*

2 Project Description

2.1 Existing Conditions

The project is located west of Old Lyman Road and east of the existing Big Y located on Willimansett Street in South Hadley, Massachusetts. The project is located within the Business C (BC) Zoning District according to the Town of South Hadley's Zoning Bylaws. The site is approximately 9.38 acres and is identified as parcel No. 14-67 by the Town of South Hadley Assessor.

Wetland resource areas were delineated by LandTech on May 22, 2024, and June 4, 2024. One bordering vegetated wetland was identified, and an inland bank associated with a pond is contained within the wetland, both are located in the southeast portion of the site.

According to the MassMapper Natural Heritage (NHESP) Atlas, 15th edition, the project site is not located within the limits of mapped NHESP Priority Habitats of Rare Species, Estimated Habitats of Rare Wildlife, or Area of Critical Environmental Concern (ACEC) as shown on the Resource Map included as *Figure 2.*

The site is characterized by Natural Resources Conservation Service (NRCS) as "Merrimac fine sandy loam, 0 to 3 percent slopes", "Windsor loamy sand, 0 to 3 percent slopes", and "Windsor loamy sand, 3 to 8 slopes".

According to NRCS, all site soils are classified as Hydrologic Soil Group (HSG) A. The NRCS soil report is included in *Appendix B.*

According to Federal Emergency Management (FEMA) mapping, the site does not lay within any flood zones based on the FEMA Flood Insurance rate Maps (FIRM) Panel Numbers 250170 0010 A, dated August 15, 1979.

In January of 2025, O'Reilly, Talbot & Okun (OTO) performed a series of borings and test pits on the site. The boring and test pit logs show the site contain fine to medium sand with traces of silt. This is consistent with the NRCS classification. Test pits also show groundwater ranging from 7.5 to 9 feet from existing grade. A copy of the OTO Preliminary Geotechnical Engineering Recommendations can be found in *Appendix C*. OTO's test pits were not witnessed as required per Volume 3, Chapter 1, Soil Evaluation, of the Stormwater Management regulations. Fuss & O'Neill is currently working with the Board of Health to schedule a time for them to review the completion of additional test pits. Once the test pits have been completed, test pit logs will be provided to the Planning Board.

The site is mostly wooded with small trees and brush, with some grass and sandy areas. The site does not contain any stormwater management systems. Stormwater currently sheet flows to the wetland areas, Big Y parking lot, or the adjacent properties.

2.2 Proposed Conditions

The proposed project consists of the construction of the new main office, warehouse, and garage space adjacent to the existing Big Y located on Willimansett Street in South Hadley, Massachusetts. In addition, the project proposes the construction of associated parking areas, driveways, sidewalks, stormwater infrastructure, utilities, landscaping, and other site amenities.

The proposed project does not propose to change the existing stormwater patterns. The Stormwater Management system is comprised of a stormwater collection system and stormwater infiltration basins. The stormwater system has been designed to provide reduction in peak stormwater discharge and stormwater treatment. The following BMPs are proposed for the project.

- A series of deep sump hooded catch basins.

- **Infiltration Basin B1** is located east of the proposed building and associated driveway and west of Old Lyman Street. The system provides treatment and recharge for the employee parking lot, area between the garage and the covered storage, the warehouse roof, and the northern and eastern driveways and surrounding grassed areas. Runoff from the basin discharges to design point Discharge Point (DP) 1.

- **Infiltration Basin B2** is located south of the proposed southern driveway area. The system provides treatment and recharge to the visitor parking, office building, garage building, covered storage, and driveways located east and south of the proposed buildings along with surrounding grassed areas. Runoff from the basin discharges to design point DP1.

The proposed BMPs have been sized to accommodate the 100-year design storm without overtopping. Outlet control structures in each infiltration system will manage the discharges from the site.

3 Hydrologic Analysis

The hydrologic analyses for existing and proposed conditions were completed using a computer software package, HydroCAD, to determine peak runoff flow rates and total runoff volumes for the watershed models. The model is based on the NRCS Technical Release 20 and Technical Release 55 (TR-55) and is subject to cumulative rainfall/volume dependent routing calculations. Hydrographs are prepared for each element of the watershed and routed through the dynamic-storage-indication method to produce various time-based results. Precipitation depths and intensities were taken from NOAA Point Precipitation Frequency Estimates (National Oceanic and Atmospheric Administration) for a 24-hour storm event.

Three design points were developed for the project and used as the limits of analysis as described below:

- Design Point 1 (denoted as Link DP1 in the hydrologic analyses) is a wetland area in the southeastern portion of the site
- Design Point 2 (denoted as Link DP2) is the adjacent properties located southwest of the site.
- Design Point 3 (denoted as Link DP3) is the existing Big Y parking lot and its associated stormwater management system.

The Pre-Development Hydrologic Analysis is included as *Appendix D* and the Post-Development Hydrologic Analysis is included as *Appendix E*.

Tabulations of the weighted curve numbers based on cover types and HSG for each sub-watershed are included in *Appendices C* and *D*. The following is a description of how each cover type was modeled:

- Vegetated areas were modeled as “50-75% Grass cover, Fair, HSG A” or “>75% Grass cover, Good, HSG A" depending on location.
- Impervious areas (e.g., sidewalks, asphalt pavement, concrete pads, etc.) were modeled as “Paved parking, HSG A”
- Gravel areas were modeled as “Gravel roads, HSG A”
- Dirt areas were modeled as “Dirt roads, HSG A”
- Wooded areas were modeled as “Woods, Good, HSG A”
- Building roofs were modeled as “Roofs, HSG A”

Based on the soil textural classification of the test pits conducted by OTO, an infiltration rate of 8.27 inch/hour was used for a Sand Texture Class, in accordance with Table 2.3.3 of the Stormwater Handbook.

3.1 Existing Watershed Summary

The majority of the stormwater runoff on site is conveyed from the existing property located north of the site via a culvert, the existing central wooded and grassed areas, and the via sheet flow and shallow concentrated flow to wetland area, design point DP1. Stormwater runoff from the southwestern existing parking lot and wooded areas flows to the adjacent properties, Design Point DP2. Stormwater runoff from the developed western portions of the site and grassed areas flow via sheet flow to the existing Big Y parking lot toward Design Point DP3.

Subcatchment areas are depicted on the Pre-Development Watershed Map included as Figure 4Proposed Watershed Summary

3.2 Proposed Watershed Summary

As a result of the proposed development, overall drainage patterns do not change. The boundary of the post-development analysis is the same as the pre-development conditions. However, the subcatchments have been further delineated to support the proposed site grading and size the BMPs. A majority of the proposed development will be conveyed via the proposed stormwater management system to DP 1. The remaining site areas will sheet flow to either DP2 or DP3. The post-development subcatchments are depicted on the Post-Development Watershed Map included as *Figure 5*.

3.3 Hydrologic Analysis Results

The proposed BMPs attenuate peak flows from the site, effectively reducing the site's runoff rates compared to pre-redevelopment condition. The pre- and post-development peak flow rates for the three design points are included in the tables below.

2 Year Design Storm				
Design Point	**Existing Flow (CFS)**	**Proposed Flow (CFS)**	**Net Change (CFS)**	**Net Change (%)**
(1L)	0.55	0.00	-0.55	-100%
(2L)	0.01	0.01	0.00	0%
(3L)	1.30	1.26	-0.04	-3%
Total	**1.86**	**1.27**	**-0.59**	**-32%**

10 Year Design Storm				
Design Point	**Existing Flow (CFS)**	**Proposed Flow (CFS)**	**Net Change (CFS)**	**Net Change (%)**
(1L)	2.38	0.24	-2.14	-90%
(2L)	0.24	0.21	-0.03	-13%
(3L)	2.38	2.30	-0.08	-3%
Total	**5.00**	**2.75**	**-2.25**	**-45%**

25 Year Design Storm				
Design Point	**Existing Flow (CFS)**	**Proposed Flow (CFS)**	**Net Change (CFS)**	**Net Change (%)**
(1L)	3.79	1.69	-2.12	-56%
(2L)	0.63	0.56	-0.07	-11%
(3L)	3.20	2.99	-0.21	-7%
Total	**7.62**	**5.22**	**-2.40**	**-31%**

100 Year Design Storm				
Design Point	**Existing Flow (CFS)**	**Proposed Flow (CFS)**	**Net Change (CFS)**	**Net Change (%)**
(1L)	6.36	5.99	-0.08	-0.01
(2L)	1.48	1.36	-0.12	-0.08
(3L)	4.66	4.24	-0.42	-0.09
Total	**12.50**	**11.88**	**-0.62**	**-0.05**

4 Soil Erosion and Sedimentation Design

Soil erosion and sedimentation control details and narratives for construction periods are provided on the site plans. Soil erosion and sedimentation control details and procedures are consistent with the “Massachusetts Erosion and Sediment Control Guideline for Urban and Suburban Areas.”

Construction period erosion and sedimentation controls will include a construction entrance, compost filter socks, silt fence, catch basin inlet protection, erosion control blankets, and water for dust control. Additional erosion and sediment controls will be utilized as required. Perimeter sediment controls will be placed down-gradient of disturbed areas. Water will be applied to exposed soils to provide dust control as needed.

Soil disturbance, stabilization measures, stockpile locations, construction waste management procedures, and hazardous materials storage procedures shall be recorded and maintained as part of the Stormwater Pollution Prevention Plan (SWPPP). This is prepared as required under the EPA NPDES General Permit for Discharge from Construction Activities.

Waste materials generated from construction activities will include excavated soil, trees, brush, stumps, and pavement. All excavation debris and other waste will be transported to an approved disposal facility. If required, materials may be temporarily stockpiled within designated staging areas. Details and procedures are provided on the site plans and are included in the SWPPP.

Construction materials, including site and building materials, will be present on-site during various stages of construction. All materials will be temporarily stored within designated staging or lay-down areas and will be transported to the site as needed. Construction vehicle fueling will take place on site. Staging areas will be located within the limit of work, and drip lines of existing trees to remain.

5 Construction Sequence

A detailed construction sequence is included in the site plans. This construction sequence is subject to change based on construction methods, weather, or due to other unforeseen circumstances. Any changes to the sequence of construction shall be addressed in the SWPPP, which shall be updated during construction to address site conditions.

6 Massachusetts Stormwater Handbook Standards

The following is a description of how the proposed project conforms with the stormwater management standards (Standards) outlined in the Massachusetts Stormwater Handbook. The Stormwater Management Checklist is included in Appendix F.

Standard 1: No Untreated Discharge or Erosion to Wetlands
No concentrated and untreated flows are proposed into wetlands and/or waterways of the Commonwealth. Stormwater outlet sizing calculations are included in *Appendix E*.

Standard 2: Peak Rate Attenuation
Post-development discharge rates from the 2-, 10-, 25-, and 100-year storm events will not increase as a result of the development compared to the pre-redevelopment condition. This will be achieved through the storage provided by the infiltration basins. Peak flow results are provided in Section 3.3. of this report.

Standard 3: Stormwater Recharge
The infiltration stormwater basins will allow infiltration and promote groundwater recharge. The proposed BMPs have been designed to provide storage in excess of the recharge volume required by this standard and drawdown within 72 hours. Stormwater recharge calculations are included in the BMP Sizing Calculations *Appendix G.*

Soils on site provide a rapid infiltration rate, 8.27 inches per hour. The project has been designed to provide 44-percent pretreatment through deep sump hooded catch basins and the sediment forebay. Pre-treatment Total Suspended Solid (TSS) removal calculations are included in *Appendix H.*

Standard 4: Water Quality
The infiltration basins will provide water quality treatment through infiltration. The proposed BMPs provide storage in excess of the water quality volume required by this standard. Water quality calculations are included in the BMP Sizing Calculations in *Appendix G.* In addition, deep sump hooded catch basin will provide additional TSS removal. TSS calculations are included in *Appendix H.*

Standard 5: Land Uses with Higher Potential Pollutant Loads
The project does not contain any area of higher pollutant loads as defined by the Massachusetts Stormwater Handbook.

Standard 6: Critical Areas
The site is not located within Zone II or Interim Wellhead Protection Areas, or other Critical Areas, which include Shellfish Growing Areas, Bathing Beaches, Outstanding Resource Waters, Special Resource Waters, and Cold-Water Fisheries.

Standard 7: Redevelopment
The proposed project is not considered a Redevelopment project per the Massachusetts Stormwater Handbook.

Standard 8: Construction Pollution Prevention and Erosion and Sediment Controls
General erosion and sedimentation controls will be implemented and maintained in accordance with local, state, and federal requirements until construction is complete and disturbed areas have been stabilized. The extent and schedule for the commencement or cessation of construction activities, grading, and soil stabilization measures

will be recorded and maintained as part of the SWPPP prior to the start of construction. The SWPPP has been developed in accordance with the EPA NPDES General Permit for Discharge from Construction Activities.

Standard 9: Long-Term Operation and Maintenance Plan
A Long-Term Operation and Maintenance Plan has been prepared and is included in *Appendix I.*

Standard 10: Illicit Discharges to Drainage System
This project does not contain illicit discharges to Stormwater Management Systems as defined in the Massachusetts Stormwater Handbook. An Illicit Discharge Compliance Statement is included in *Appendix J*. A signed copy will be provided prior to construction.

7 Town of South Hadley Stormwater Management

The following is a description of how the proposed project conforms with the requirements of the South Hadley Stormwater Management regulations.

Per Section 200-19 A, stormwater Infiltration Basins are proposed for the project to provide infiltration, flow attenuation, and pollutant removal.

Per Section 200-19 B and C, the infiltration practices have been designed to retain the one-inch volume of rainfall runoff from impervious surfaces on-site. Thus, minimizing pollutants in the stormwater runoff prior to discharge to the wetlands or adjacent properties. Water quality calculations are provided in *Appendix G.*

Per Section 200-19 D, both infiltration basins have been designed with an emergency overflow system.

Per Section 200-19 E, the infiltration basins have been designed to attenuate peak flows and include rip rap protection at the outlets to ensure there is no increase in flooding or stream channel erosion downstream.

Per Section 200-19 F and Section 200-20 D, the project proposes the traditional collect and coney system. Unfortunately, existing and proposed topography does not allow enough pitch for the use of swales to collect and convey stormwater. In addition to the size of the development.

Per Section 200-20 A(6), infiltration basins have been designed with a minimum of 4 feet of vertical separation from seasonal high groundwater elevations.

Per Section 200-20 H, parking lots are treated with deep sump hooded catch basins to provide removal of oil and sediment prior to discharge to the infiltration basins.

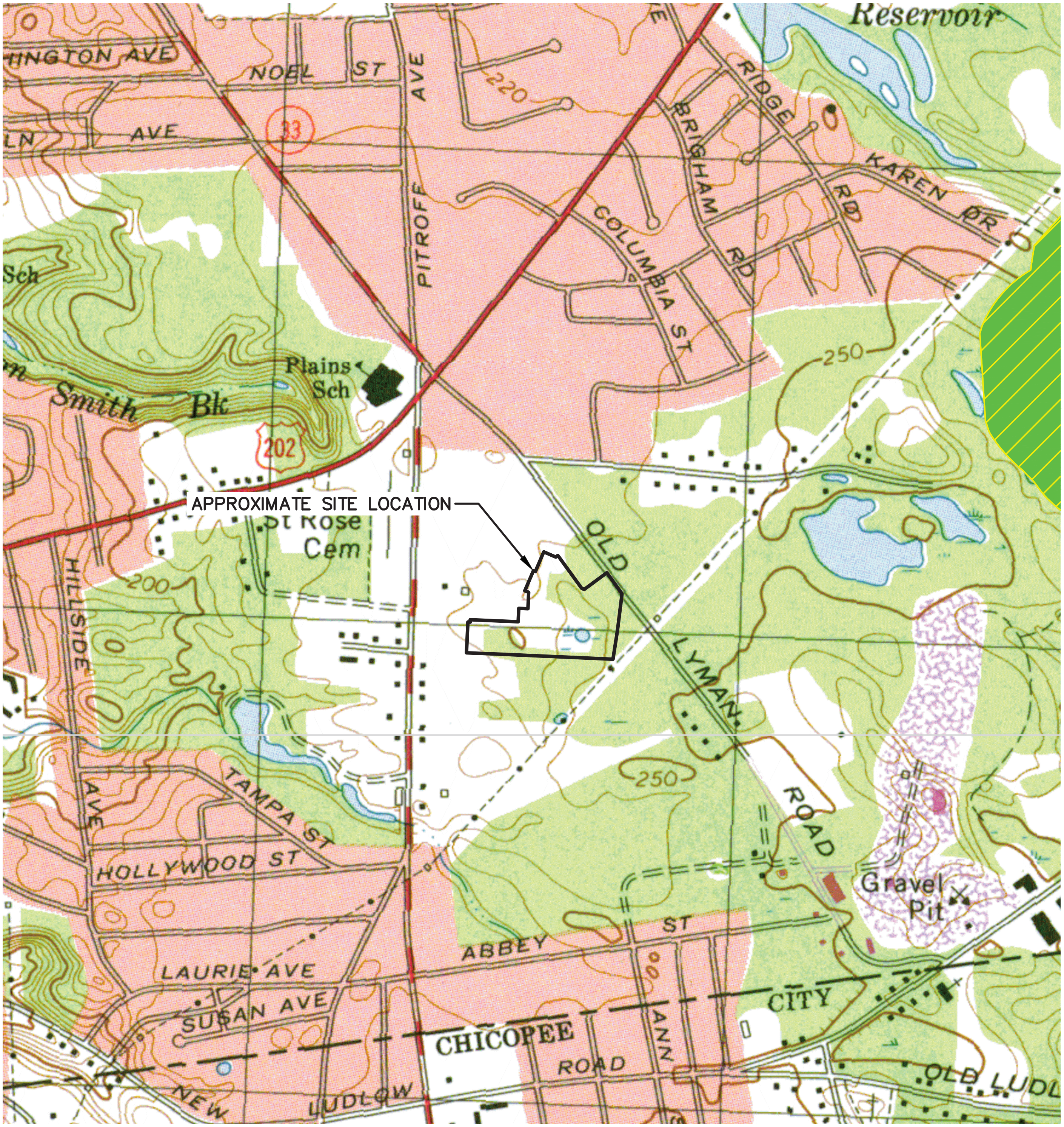
8 Summary

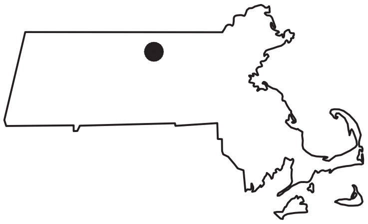
This Stormwater Management Report describes proposed work and stormwater management associated with the construction of the new South Hadley Electric Light District Headquarters located on Old Lyman Road, South Hadley, Massachusetts. The stormwater management system, which includes infiltration basins, will provide water quality treatment, groundwater recharge, and peak flow attenuation. Peak run-off rates and volumes from the site will decrease when compared to pre-development conditions during the 2-, 10-, 25-, and 100-year storm events.

The proposed design addresses the applicable standards set forth in the MassDEP Stormwater Management Guidelines and the Town of South Hadley Stormwater Management regulations as described above in this report. Soil erosion and sediment control measures have been incorporated into the design, and a site-specific SWPPP will be developed to mitigate the impacts of the proposed land disturbance and construction. Based on the conditions summarized above, the proposed site improvements will have no adverse effect on the abutters, on-site resource areas, or the receiving drainage systems.

Figure 1

Site Location Map





MAP REFERENCE
THIS MAP WAS PREPARED FROM THE FOLLOWING USGS TOPOGRAHIC QUADRANGLE IMAGES: q113882, q113886. QUADRANGLE IMAGES WERE PREPARED FROM MASS GIS DATA RECEIVED FROM OLIVER GIS ON 02/19/2026. ORIGINAL MAP UNITS IN METERS.

SCALE:
HORZ.: 1" = 1000'
VERT.: -
DATUM:
HORZ.: -
VERT.: -
0 500' 1000'
GRAPHIC SCALE

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SHELD

SITE LOCATION MAP

SHELD HEADQUARTERS

SOUTH HADLEY
MASSACHUSETTS

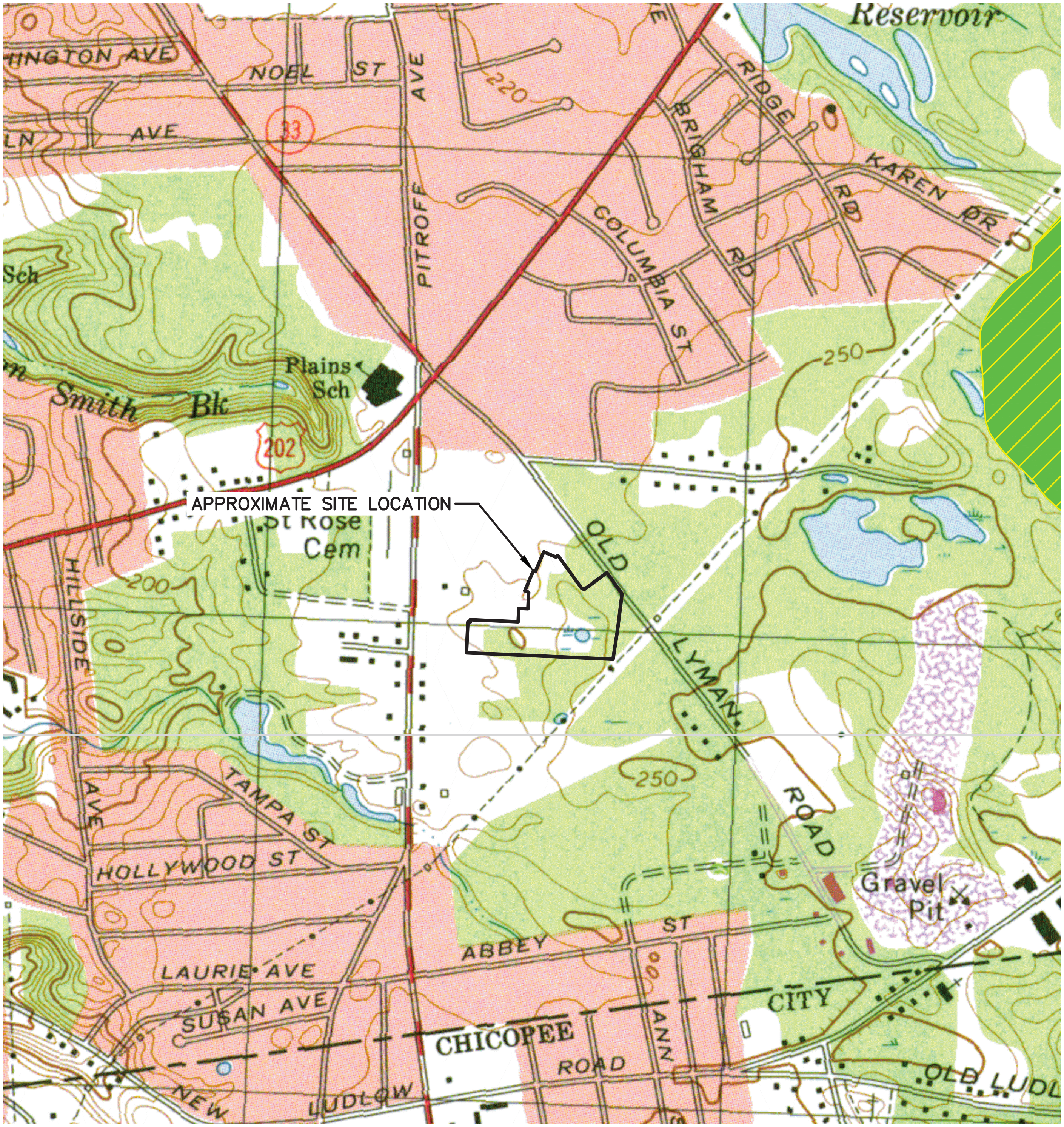
PROJ. No.: 20250806A10
DATE: 03/02/2026

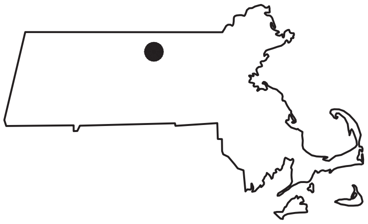
FIG.01

File: J:\DWG\P2025\0806\A10\Civil\Figures\20250806A10_LOC01.dwg Layout: FIG.01 Plotted: 2026-02-25 3:29 PM Saved: 2026-02-25 3:28 PM User: Amina.Nefic
PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO.STB
MS VIEW:
LAYER STATE:

Figure 2

Resource Map





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QUADRANGLE IMAGES WERE PREPARED FROM MASS GIS
DATA RECEIVED FROM OLIVER GIS ON 02/19/2026.
ORIGINAL MAP UNITS IN METERS.

🟩	NHESP ESTIMATED HABITATS OF RARE WILDLIFE
▨	NHESP PRIORITY HABITATS OF RARE SPECIES
▨	AREAS OF CRITICAL ENVIRONMENTAL CONCERN

SCALE:
HORZ.: 1" = 1000'
VERT.: -
DATUM:
HORZ.: -
VERT.: -
0 500' 1000'
GRAPHIC SCALE

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SHELD

RESOURCE MAP

SHELD HEADQUARTERS

SOUTH HADLEY MASSACHUSETTS

PROJ. No.: 20250806A10
DATE: 03/02/2026

FIG.01

Figure 3

Flood-Insurance Rate Map

ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION (FT. NGVD)	DESCRIPTION OF LOCATION
RM1	78.15	Monel rivet on the southeast end of the top step of the southwest entrance to the South Hadley Town Hall, on the north side of Main Street, 300 feet southeast of the intersection of Bridge Street. (TBM No. 3119) Established by Harry R. Feldman, Inc.
RM2	168.99	Standard tablet stamped C5 1933 169, in top of 9 x 9 x 38 inches stone post set flush with ground, 1.6 miles north of South Hadley Falls, 20 feet north and 55 feet east of intersection of Lathrop and Brainerd Streets, 1 foot south of fence. Established by Harry R. Feldman, Inc.
RM3	257.45	Standard tablet stamped C40 1933 257 in South Hadley Center, at Mount Holyoke College, at west entrance of Dwight Memorial Hall, on north end of second step. Established by Harry R. Feldman, Inc.

KEY TO MAP

500-Year Flood Boundary	ZONE B
100-Year Flood Boundary	
Zone Designations* With Date of Identification e.g., 12/2/74	ZONE A1 DATE / ZONE A5 DATE
100-Year Flood Boundary	
500-Year Flood Boundary	ZONE B
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7×
River Mile	• M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

For adjoining map panels, see separately printed Index To Map Panels.

INITIAL IDENTIFICATION:
MARCH 22, 1974

FLOOD HAZARD BOUNDARY MAP REVISIONS:

FLOOD INSURANCE RATE MAP EFFECTIVE:
AUGUST 15, 1979

FLOOD INSURANCE RATE MAP REVISIONS:

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program, at (800) 638-6620, or (800) 424-8872.

N

APPROXIMATE SCALE

800 0 800 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

TOWN OF
SOUTH HADLEY,
MASSACHUSETTS
HAMPSHIRE COUNTY

PANEL 10 OF 10
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
250170 0010 A

EFFECTIVE DATE:
AUGUST 15, 1979

U.S. DEPARTMENT OF HOUSING
AND URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION

Figure 4

Pre-Development Watershed Map

SHELD

PRE-DEVELOPMENT WATERSHED MAP

SHELD HEADQUARTERS

SOUTH HADLEY

MASSACHUSETTS

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SCALE:
HORZ.: 1" = 80'
VERT.: -
DATUM:
HORZ.: -
VERT.: -

0 40' 80'
GRAPHIC SCALE

PROJ. No.: 20250806.A10
DATE: 03/02/2026

FIG.04

File: J:\DWG\P2025\0806\A10\Civil\Figures\20250806A10_DRNG01.dwg Layout: FIG.04 Plotted: 2026-02-27 2:03 PM Saved: 2026-02-27 1:50 PM User: Amina.Nefic
MS VIEW: LAYER STATE: PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO.STB

Figure 5

Post-Development Watershed Map

SHELD

POST-DEVELOPMENT WATERSHED MAP

SHELD HEADQUARTERS

SOUTH HADLEY

MASSACHUSETTS

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SCALE:
HORZ.: 1" = 80'
VERT.: -
DATUM:
HORZ.: -
VERT.: -

0 40' 80'
GRAPHIC SCALE

PROJ. No.: 20250806.A10
DATE: 03/02/2026

FIG.05

File: J:\DWG\P2025\0806\A10\Civil\Figures\20250806A10_DRNG01.dwg Layout: FIG.05 Plotted: 2026-02-27 2:05 PM Saved: 2026-02-27 1:50 PM User: Amina.Nefic
PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO.STB
MS VIEW:
LAYER STATE:

Appendix A

Site Plans (Separately Bound)

Appendix B

NRCS Soil Report

Soil Map—Hampshire County, Massachusetts, Central Part

Map Scale: 1:5,630 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N 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:
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: Hampshire County, Massachusetts, Central Part
Survey Area Data: Version 20, Sep 5, 2025

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

Date(s) aerial images were photographed: Oct 15, 2020—Oct 31, 2020

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
31A	Walpole sandy loam, 0 to 3 percent slopes	3.7	3.0%
254A	Merrimac fine sandy loam, 0 to 3 percent slopes	4.1	3.4%
255A	Windsor loamy sand, 0 to 3 percent slopes	89.5	74.1%
255B	Windsor loamy sand, 3 to 8 percent slopes	21.5	17.8%
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	1.9	1.6%
750C	Windsor-Scitico-Amostown complex, 0 to 15 percent slopes	0.2	0.1%
Totals for Area of Interest		**120.8**	**100.0%**

Appendix C

Soil Investigations (Separately Bound)

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

J0381-63-01
February 14, 2025

SHELD
Attn: Sean Fitzgerald, General Manager
85 Main Street
South Hadley, Massachusetts 01075

Re: Preliminary Geotechnical Engineering Recommendations
Proposed SHELD Facility
64 Willimansett Street/Old Lyman Road
South Hadley, Massachusetts

Dear Mr. Fitzgerald:

O'Reilly, Talbot & Okun Associates, Inc. (OTO) is pleased to provide this preliminary report presenting our geotechnical engineering recommendations for the proposed South Hadley Electric Light Department (SHELD) facility to be constructed off Old Lyman Road in South Hadley, Massachusetts. A Site Locus is provided as Figure 1. A Site Plan is provided as Figure 2.

Our preliminary geotechnical recommendations are based upon subsurface conditions observed in six soil borings, two cone penetration test (CPT) soundings, and six test pits. Our services consisted of the full-time observation of the soil borings and test pits; coordination of the CPT soundings; field and laboratory testing; review of the logs, soil samples, and test data; engineering analyses; and preparation of this report. This report is subject to the Limitations attached as Appendix A.

Subsurface conditions are favorable for the proposed construction. Site soils generally consist of approximately 40 feet of loose to medium dense, fine or fine to medium sand over fine grained soils, followed by glacial till. At this time, it appears that the proposed buildings can be supported on traditional spread footings bearing upon densified native soils or engineered fill. Groundwater is present at an approximate depth of between 5 and 15 feet below the ground surface, based upon current topography. However, the groundwater table may be higher during wet periods or immediately after rain events. Therefore, dewatering may be necessary to construct footings and install utilities, depending on final Site layout and elevations.

We understand that final grading concepts are in progress. The topography in portions of the Site varies by several feet. Therefore, we anticipate that significant earthwork will be required to level the Site and establish building and pavement subgrades, and that it is the developer's intent to re-use on-Site soils as engineered fill to the extent possible. The uniform sands are susceptible to disturbance, tend to dry out quickly, and may be difficult to compact. A preliminary discussion of the suitability of Site soils for re-use is discussed in the report.

This report should be reviewed and updated as necessary once final structure, layout, and grading designs are completed.

We appreciated the opportunity to be of service on this project. If you have any questions, please do not hesitate to contact the undersigned.

Sincerely yours,
O'Reilly, Talbot & Okun Associates, Inc.

Ashley L Sullivan

Pierre J. Carriere, EIT	Ashley L. Sullivan, P.E.
Project Engineer	Principal

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Figure 1: Site Locus

Figure 2: Site Plan

Sheet 1: General Compaction Guidelines

Appendix A: Limitations

Appendix B: ConeTec Report (January 20, 2025)

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1.0 PROJECT DESCRIPTION

The Site is located off Old Lyman Road in South Hadley, Massachusetts, on the parcel known as 64 Willimansett Street (Hampshire County Registry of Deeds, Book 12464, Page 112). The Site is currently undeveloped and is mostly covered by small trees and brush, with some open grass-covered or sandy areas. Wetlands are located in the southern portion of the property. The project area is bounded to the north by an existing access road, followed by commercial properties; to the east by Old Lyman Road and residential properties; to the south by wooded land; and to the west by the Big Y World Class Market building and parking lot. The location of the Site is shown on Figure 1.

The proposed project includes the construction of a new SHELD facility to consist of the following:

- An office building (footprint of approximately 12,000 square feet);
- A warehouse building (footprint of approximately 10,000 square feet);
- A garage building (footprint of approximately 12,000 square feet);
- A covered storage area (footprint of approximately 7,500 square feet);
- Paved areas including access roads and both staff and public parking;
- Stormwater basins in the north, east, and southwest portions of the Site; and
- Miscellaneous improvements including a fuel dispensing and storage area, generator mechanical yard, and open storage areas.

We understand that the facility is categorized as a Category IV structure(s).

We anticipate that the proposed buildings will be single-story, slab-on-grade structures. Framing materials and building loads are not known at this time. However, we expect that maximum column loads will be on the order of 100 kips or less, and strip footing loads will be on the order of 5 kips or less. The footprints of the proposed structures are shown on Figure 2.

We understand that final grading concepts are in progress. The Site was previously mined for sand, and topography in portions of the Site varies by several feet. Therefore, significant earthwork will be required to level the Site and establish building and pavement subgrades. We anticipate that fills needed to establish final grades will be generated from the excavations of soil piles and cuts to construct of the proposed infiltration basins. This report should be reviewed and updated as necessary once final structure, layout, and grading designs are completed. A preliminary discussion of the suitability of Site soils for reuse as engineered fill is discussed in Section 5.7.

2.0 SUBSURFACE EXPLORATIONS AND TESTING

Subsurface investigations consisted of six geotechnical soil borings, two cone penetration test (CPT) soundings, and six test pits. Soil boring, CPT, and test pit locations are shown on Figure 2.

An O'Reilly, Talbot & Okun Associates, Inc. (OTO) representative observed and logged each of the soil borings and test pits and coordinated CPT testing. Soil samples were described according to a modified version of the Burmister Soil Classification System. The CPT data were used to estimate soil behavior type, which is analogous to soil classification based upon published correlations[1,2,3,4], and to measure the seismic shear wave velocity of the Site soils. Explorations were backfilled with Site soils upon completion.

2.1 Cone Penetration Tests

Two cone penetration test (CPT) soundings (SCPT25-01 and SCPT25-02) were performed by ConeTec, Inc. of West Berlin, New Jersey on January 8, 2024 using a C03-030 CPT Track Rig. A cone penetrometer is a cylindrical element with a conical tip that is pushed into the ground at a fixed rate while the resistance at the tip and friction along the sides of the penetrometer are measured on a continuous basis using electronic load cells. Soil properties such as density, friction angle, and strength can be approximated based upon the tip resistance, skin friction, and ratios calculated using these measurements.

The electronic CPT probe used for this project was a seismic piezocone (SCPTu) probe, equipped with a geophone to measure seismic shear wave velocity (S) and a pressure transducer to measure pore water pressure (u). The response of the Site soils under earthquake loadings can be estimated based upon seismic shear wave velocity measurements. A detailed discussion of the piezocone and shear wave velocity tests is presented in the attached ConeTec data report attached as Appendix B.

The CPT soundings were performed in the eastern and western portions of the Site. Since CPT measurements of tip resistance and skin friction are collected on a nearly continuous basis, detailed profiles of soil type and geotechnical properties (such as density, friction angle, and strength) were developed. The data from the CPT soundings indicated soil types and properties consistent with published correlations for the Standard Penetration Tests (SPT) performed in the soil borings.

Shear wave measurements were obtained at approximate three-foot intervals in soundings SCPT25-01 and SCPT25-02. These soundings were each terminated within a dense soil layer, likely glacial till, at a depth of approximately 100 feet.

2.2 Shear Wave Velocity Measurements

Sixty (60) seismic shear wave velocity (Vs) measurements (total) were obtained in CPT soundings SCPT25-01 and SCPT25-02 at approximate three-foot intervals, to provide a profile of shear wave velocity with depth at the Site. Shear wave velocity measurements are presented in the attached ConeTec data report. The approximate harmonic averages were 778 and 784 feet per second (fps), respectively, with velocities ranging from 569 to 979 fps for the two probes.

Shear wave velocity measurements were used to determine the Seismic Site Classification for the structural design of the building. The Site Classification was determined to be Class D based upon these measurements.

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[1] Robertson, P.K., Campanella, R.G., Gillespie D and Rice, A., 1986, "Seismic CPT to Measure In-Situ Shear Wave Velocity", Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8: 791-803.

[2] Robertson, P.K., 1990, "Soil Classification Using the Cone Penetration Test", Canadian Geotechnical Journal, Volume 27: 151-158.

[3] "Guide to Cone Penetration Testing for Geotechnical Engineering", by Robertson and Cabal, Gregg Drilling and Testing Inc. 6th Edition, December 2014.

[4] Robertson, P.K., 2009, "Interpretation of cone penetration tests – a unified approach", Canadian Geotechnical Journal, Volume 46: 1337-1355.

2.3 Soil Borings

Soil borings B-1 through B-6 were performed by Seaboard Drilling of Chicopee, Massachusetts. The borings were performed with a Diedrich D-50 track mounted drill rig, and advanced using hollow stem auger drilling techniques. Borings were performed in accessible areas within the footprint of the proposed office, warehouse, and garage buildings. Boring locations are shown on Figure 2. Borings B-1 through B-5 were terminated at a depth of 22 feet. Boring B-6 was extended to a depth of 42 feet.

Soil samples were collected from the borings on a semi-continuous basis from the ground surface to a depth of nine feet below ground surface, at a depth of ten feet, and every five feet thereafter. Samples were collected using a two-inch diameter split spoon sampler, driven 24 inches with a 140-pound hammer falling 30 inches (American Society for Testing and Materials Test Method D1586 “Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils”). The number of blows required to drive the sampler each six inches was recorded. The standard penetration resistance, or N-value, is the number of blows required to drive the sampler the middle 12 inches. Soil properties, such as strength and density, are related to the N-value. The field N-values are corrected to a standard 60% hammer efficiency, known as the N_{60}-value, to account for differing sampler type, borehole diameter, depth, and hammer type/efficiency. The N-values presented on the boring logs are field values and are not corrected values. However, the corrected N_{60} values were determined and were used in our engineering calculations and analysis. Boring logs are attached as Appendix C.

The headspace of each soil sample collected from the borings was screened using a MiniRAE Lite Photo-Ionization Detector (PID). PID screening provides an assessment of volatile organic content of the samples. PID readings are provided on the boring logs.

2.4 Test Pits

Six test pits (designated T-1 through T-6) were performed by Seaboard Drilling of Riverside, Rhode Island using a Komatsu PC40MR mini excavator equipped with an approximately 0.3 cubic yard bucket. The test pits were performed to observe the nature of soils and any signs of seasonal high groundwater, as well as to determine the presence of over-sized material (cobbles and boulders). An OTO field engineer observed and logged each test pit. Test pit locations are shown on Figure 2. Test pit logs and photographs are attached as Appendix D.

2.5 In-Situ Hydraulic Conductivity Testing

Four in-situ hydraulic conductivity (or permeability) tests were performed immediately adjacent to test pits performed in the area of proposed stormwater basins. The hydraulic conductivity tests were performed with a Guelph permeameter, which uses a constant head testing methodology. The Guelph permeameter allows the rate of water recharge into an unsaturated soil to be measured while a constant water head is maintained.

The permeability test is performed by augering a shallow hole into the soil at the base of a test pit. The Guelph apparatus is then inserted, water is added to the apparatus, and the change in the rate of water flow from a reservoir over time is recorded. These data are then used to calculate the coefficient of permeability or hydraulic conductivity. The results of in-situ permeability testing are discussed in Section 3.3.

2.1 Laboratory Analyses

Select soil samples collected from test pits were analyzed for grain size distribution by Allied Testing Laboratories of Springfield, Massachusetts. These tests were performed to evaluate the suitability of on-Site soils for use as engineered fill. The following samples were analyzed: T-4 (2'-6.5'), T-5 (0'-5'), T-5 (5'-9'), and T-6 (2.5'-4.5'). Results are discussed in Section 3.4 and 5.7.1. Laboratory data sheets are attached as Appendix E.

3.0 SUBSURFACE CONDITIONS

Subsurface conditions were interpreted based upon samples collected from the soil borings and test pits and supplemented with data from the CPT soundings. Conditions generally consisted of a surface layer of topsoil (where present), underlain by native sandy and fine-grained soils. Soil conditions are favorable for the proposed construction.

The Site is geologically situated near the eastern shore of former Lake Hitchcock, which was a large post-glacial lake that formerly covered much of the Connecticut River Valley. The lake was present from the final retreat of the continental glaciers (which once covered all of New England) until about 14,000 years ago, when the natural dam that formed the southern edge of the lake in Connecticut was eroded and the lake drained. Sediments consisting of thin interbedded layers of clay, silt, and sand (collectively known as varved clay) were deposited at the bottom of the lake. Published geologic maps[5] indicate that the lake bottom deposits at the Site are up to 50 feet thick.

3.1 Soil Conditions

Topsoil: Where present, up to 14 inches of topsoil was encountered at the ground surface. The topsoil consisted of brown to dark brown, fine or fine to medium sand with little silt and trace amounts of organics (roots). We note that testing for nutrient content, pH, or organic content was not part of this study. We recommend this testing be performed to evaluate the suitability of existing Site topsoil for reuse.

Granular Soils: Sandy soils were encountered at the ground surface or immediately beneath the topsoil in each boring. The upper (near-surface) portion of this soil layer consisted of loose to medium dense, fine sand with little to trace amounts of medium sand and silt. The proportion of medium sand generally increased at between 5 and 10 feet beneath the ground surface and varied thereafter. Each of the test pits was terminated in the upper sandy soils at a depth of between 9 and 11 feet. We note that portions of the near-surface soils may consist of reworked Site soils or imported material similar in composition to the native soils.

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[5] Langer, W.H. (1979). "Map Showing Distribution and Thickness of the Principal Fine-Grained Deposits, Connecticut Valley Urban Area, Central New England", *Miscellaneous Investigations* Series, USGS Map No. 1-1074-C, Sheet 1 of 2.

Based upon the borings, the silt content of the granular soils increased at depths of approximately 16 to 22 feet. Borings B-1 through B-5 were terminated in silty sand at a depth of 22 feet below the ground surface.

Native Fine-Grained Soils: The fines (silt and clay) content continues to increase with depth, based upon boring B-6 and the CPT probes. Fine-grained soils that likely contain significantly less sand are present below a depth of 40 feet. This fine-grained soil layer extended to the maximum depth explored (approximately 100 feet) in CPT probes SCPT25-01 and SCPT25-02. Boring B-1 was terminated near the top of the fine-grained soil layer, at 42 feet below the ground surface.

Given the observed soil conditions, we do not anticipate that the fine grained soil layer will impact the proposed construction.

Results of PID Screening: The headspace of each sample collected from the soil borings was screened using a photoionization detector (PID). PID screening provides an assessment of the total organic vapor (TOV) content of the samples. The PID readings were generally below 2.0 parts per million (ppm) by volume, which are consistent with background values. PID readings of between 8 and 16 ppm were observed in the upper 2 to 4 feet in borings B-1 and B-2. However, no significant odors or staining were observed. PID readings are presented on the boring logs.

3.2 Groundwater Conditions

We note that groundwater appears to be relatively shallow at the Site (approximately 5 to 15 feet below the existing ground surface), based upon observations in the test pits and piezocone measurements from the CPT probes. A trace amount of redoximorphic features (i.e., rust mottling) was observed as shallow as 2 feet below the ground surface, and more significant mottling was encountered at depths of 3.5 to 8 feet. Recommendations for water control during construction are provided in Section 5.3.

3.3 In-Situ Hydraulic Conductivity Testing

In-situ hydraulic conductivity (or permeability) tests were performed immediately adjacent to three of the test pits (T-2, T-3, and T-5) to aid in design of the stormwater management systems. The hydraulic conductivity tests were performed with a Guelph permeameter, in a shallow hole augered at the base of a test pit. Results are presented in Table 1.

Table 1
Hydraulic Conductivity Test Results

Test Pit	Test Depth (ft)	Soil Conditions	K Value (feet/day)
T-2	3.0	Fine sand, little medium sand, trace silt	23
T-3	3.0	Fine sand, trace medium sand, trace silt	26
	7.5	Fine sand, little medium sand, trace silt	36
T-5	5.5	Fine to medium sand, trace silt, trace coarse sand	76

The relative proportions of fine sand, medium sand, and silt appear to vary; therefore, we recommend that a relatively lower permeability value, on the order of 20 to 30 feet per day, be assumed for the design of stormwater management systems.

3.4 Grain Size Distribution Analyses

Four soil samples were submitted to Allied Testing Laboratories, Inc. of Springfield, Massachusetts for grain size distribution analysis. The samples were collected from test pits T-4, T-5, and T-6. The results were used to evaluate the suitability of the near-surface granular soils for reuse as engineered fill. Grain size distribution requirements are provided in Table 4. Laboratory testing results are discussed below and in Section 5.6. Laboratory data sheets are attached as Appendix E.

The near surface samples were generally classified as fine or fine to medium sand with trace amounts of silt. Two of the samples contained trace amounts of coarse sand and fine gravel. Additional information regarding the uniformity of on-Site soils and their use as engineered fill is presented in Section 5.7.

4.0 SIGNIFICANT GEOTECHNICAL ISSUES

The significant geotechnical issues for the proposed construction addressed in this report include the following: foundation type and bearing capacity; settlement; seismic design considerations; pavement subgrades; and the suitability of on-Site materials for use as engineered fill.

5.0 DESIGN RECOMMENDATIONS

The following recommendations are provided for the construction assumed in this report and refer to the 10th Edition of the Massachusetts State Building Code (MSBC), which includes amendments to the 2021 International Building Code (IBC) and became effective on October 11, 2024. The 9th Edition of the Building Code will apply concurrently with the

10th Edition until June 30, 2025.[6] For seismic parameters, both 9th and 10th Edition values are provided.

5.1 Preliminary Foundation Recommendations

The new building can be supported on normal spread footings bearing on densified native sandy soils and/or compacted Sand and Gravel or Crushed Stone fill.

The native near surface soils at the Site consist of a relatively clean (i.e., containing only minimal amounts of fine-grained soils) and uniform fine to medium sand, which will tend to dry out quickly and become loose and disturbed under normal construction traffic. In addition, their in-situ moisture content is often well below optimum. Additional information regarding on-Site soil properties and their re-use is provided in Section 5.7. Therefore, in areas where footings extend into native soils, we recommend that the contractor over-excavate footing subgrades by 6 inches and place 6 inches of compacted Sand and Gravel or Crushed Stone fill to protect foundation subgrades and provide a firm working surface. We note that it may be necessary to apply water and compact native subgrades immediately prior to placement of engineered fills. The Sand and Gravel or Crushed Stone fill beneath the footings should meet the grain size distribution characteristics outlined in Table 4.

Any non-engineered fill, debris, organics, topsoil, asphalt, or other deleterious materials should be removed from beneath the building footprint. Excavations resulting from the removal of unsuitable materials should be backfilled with compacted Sand and Gravel or Crushed Stone fill.

The proposed building can be founded on normal spread footing foundations bearing on densified native soils or compacted engineered fill. Provided the recommendations presented in this section are followed, we recommend that a maximum allowable bearing pressure of 3,000 pounds per square foot be used for the design of the proposed structures. We recommend that the entire building footprint be thoroughly proof compacted prior to construction.

Exterior footings should be embedded a minimum of 48 inches below the lowest adjacent grade for frost protection. Interior footings should bear at least two feet below the surrounding floor slab. Strip footings, beneath the load bearing walls, should be at least 18 inches wide. All other applicable requirements of the Massachusetts State Building Code (MSBC) should be followed.

Footings should not be placed on frozen soils. Footing excavations should be free of loose or disturbed materials. If boulders or cobbles larger than four inches in diameter are encountered in footing subgrades, they should be removed from within one foot of the

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[6] Tenth edition of the MA State Building Code 780 | Mass.gov Building permit applications for projects utilizing the 9*th* Edition need to be filed on or before June 30, 2025. Applications received on or after July 1, 2025, that are based on the 9*th* Edition will not be accepted and will not be granted a building permit. Breaking ground on a jobsite does not need to begin immediately when obtaining a permit. However, if breaking ground does not commence within 180 days of a permit being issued, the permit may expire unless extended.

bottom of the footing and replaced with compacted Sand and Gravel or Crushed Stone fill. The footing subgrades should be densified immediately prior to placement of footing concrete with at least three passes with a vibrating plate compactor. If loose materials are present in the excavations, they shall be compacted to form a firm, dense bearing surface.

5.2 Settlement

We anticipate that the new buildings will be constructed near existing grade. We estimate that settlement of footings and slabs bearing on densified native soils or compacted engineered fill should be small and largely elastic in nature. Maximum settlements should be less than 1 inch and should occur relatively quickly after load application (during construction).

5.3 Concrete Slabs

We recommend that concrete slabs bear on at least 12 inches of compacted Sand and Gravel fill or Crushed Stone to provide uniform support and a capillary moisture break. The subgrade should also be free of large boulders or cobbles. The engineered fill beneath the concrete slabs should meet the grain size distribution characteristics outlined in Table 4.

The subgrade within the footprint of the proposed buildings should be stripped of topsoil and any non-engineered fill. Prior to the placement of any engineered fill, we recommend that the building footprint be thoroughly densified to treat any loose areas present. If non-engineered fill, soft, or disturbed areas are present, these materials should be removed and recompacted or replaced with compacted Sand and Gravel or Crushed Stone. Fill supporting slabs should be placed in accordance with the recommendations presented on Sheet 1.

For preliminary design, slabs may be designed using a standardized (based on a one square foot test plate) vertical subgrade modulus of 150 tons per cubic foot, provided the slab sits upon compacted structural fill. This subgrade modulus should be corrected for mat/slab size. This value should be re-evaluated during final design, when slab elevations are known.

5.4 Groundwater and Surface Water Control

Saturated soils were observed at a depth of between 5 and 15 feet below the existing ground surface. The difference in depth to groundwater appears to be due to elevation changes at the surface. The groundwater depth/elevation should be reviewed once final grading and slab elevations are known. Groundwater may be present at shallower depths during periods of wet weather. If groundwater is encountered during excavations for footings and utilities, it should be possible to dewater these excavations by trenching or using sump pumps.

We recommend that the building include perimeter drainage to control groundwater and surface water infiltration. The perimeter drainage system can consist of perforated PVC pipe, installed in a Crushed Stone trench and wrapped in a non-woven geotextile fabric. The perimeter drain should be designed to allow water to flow away from the foundation via gravity. Clean-outs should also be provided in the perimeter drainage system to allow for future maintenance.

5.5 Seismic Considerations

Earthquake loadings must be considered under requirements in Section 1613 and 1806 of the 10th Edition (October 2024) of the Massachusetts State Building Code (MSBC). The 10th Edition of the MSBC is based upon the International Building Code 2021 (IBC) with Massachusetts amendments. Note that the IBC refers to ASCE-7, *Minimum Design Loads for Buildings and Other Structures*.

5.5.1 Site Class and Earthquake Design Factors

Section 1613 of the IBC covers lateral forces imposed on structures from earthquake shaking and requires that every structure be designed and constructed to resist the effects of earthquake motions in accordance with ASCE-7. Lateral forces are dependent on the type and properties of soils present beneath the Site, along with the geographic location.

The maximum considered earthquake spectral response acceleration at short periods (S_s) and at 1-sec (S_1) were determined per Table 1604.11 for South Hadley, Massachusetts, and are presented in Table 2.

Soil properties are represented through Site Classification. Procedures for the Site-specific determination of Site Classification are provided in Chapter 20 of ASCE-7. At this Site, we evaluated Site Classification using seismic shear wave velocity (V_s) measurements obtained in the CPT soundings. Based upon these measurements, the Site Class was determined to be Class D. Furthermore, the Site coefficients F_a and F_v were determined according to Tables of the IBC (2021), using both the S_s and S_1 values and the Site Class. Seismic design values are provided in Table 2.

Table 2
Seismic Design Parameters

Parameter	Value 9th Ed. MSBC	Value 10th Ed. MSBC
S_s	0.171	0.167
S_1	0.066	0.056
Site Class	D	D
F_a	1.6	1.6
F_v	2.4	2.4

5.5.2 Liquefaction

Section 1806.4 relates to the liquefaction potential of the underlying soils. The liquefaction potential was evaluated for saturated Site soils using methods recommended by Youd and Idriss[7]. It is unlikely that significant amounts of liquefaction-induced settlement would occur under the design earthquake.

5.6 Exterior Slabs and Pavements

This section provides recommendations for exterior entryways, slabs, and sidewalks, as well as flexible pavements.

5.6.1 Concrete Slabs

Exterior concrete slabs, such as those at entryways and sidewalks adjacent to the building should be designed to mitigate differential frost movement between adjacent slabs, doorways, and pavements. To address this concern, we recommend that concrete slabs at entryways be underlain by four feet of non-frost susceptible Sand and Gravel fill. Where exterior slabs butt against hard surfaces, we recommend that for the area beyond the edges of the slab, the bottom of Sand and Gravel fill should transition gradually upward at a slope of 3H:1V or flatter (zone of influence).

We recommend that concrete sidewalks that are outside the zone of influence of the building and entryways, as well as areas where differential frost movement would not cause a tripping hazard, bear on at least 12 inches of imported, compacted Sand and Gravel to provide uniform support and a capillary moisture break. Fill should be placed in accordance with the recommendations for compaction provided on Sheet 1. Subgrades should also be free of large boulders. We recommend that the entire subgrade of the sidewalk be proof compacted with a heavy vibrating roller to treat any loose areas. The Sand and Gravel fill beneath the concrete slabs and sidewalks should meet the grain size distribution characteristics described in Table 4.

5.6.2 Flexible Pavement Design

We expect that the proposed project will involve the construction of parking areas and roadways for use by light passenger vehicles and/or heavy vehicles. The recommended pavement design sections are presented in Table 3. We recommend that pavement subgrades be thoroughly proof compacted to treat any loose areas present.

The native near surface soils at the Site consist of a relatively uniform fine sand with generally trace amounts of silt. The poorly graded (uniform) Site soils will tend to dry out quickly and will become loose and disturbed under normal construction traffic when dry. These soils will tend to dry out and significant water may need to be applied to keep the moisture content near optimum. In addition, the team may consider supplementing these soils with coarser material. Additional information is provided in Section 5.7.1.

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[7] Youd, T.L. and Idriss, I.M. (2001). “Liquefaction Resistance of Soils: Summary Report from the 1996 NCEEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils”, *Journal of Geotechnical and Geoenvironmental Engineering*, April 2001, pp. 297-313.

Table 3
Recommended Pavement Design Sections

Layer	Thickness
Asphalt Finish Course	1.5 inches
Asphalt Binder Course	1.5 inches
Gravel Base Course	12 inches

The project civil engineer should review and revise the Asphalt Finish Course and Binder Course thicknesses as appropriate for the anticipated traffic loads. Table 4 presents recommendations for gradation requirements for the Gravel Base Course material. Please note that the Gravel Base Course specification is Mass Highway M1.03.1, Processed Gravel for Subbase.

5.7 Earthwork Considerations

We anticipate that earthwork for this project will include the following: cuts and fills to level the Site; excavations for footings; placement of compacted engineered fill beneath the building, floor slab, and pavements (as needed); and the treatment of the existing soils to address any localized loose areas that may be present.

5.7.1 Engineered Fill Recommendations

Four engineered fill types are recommended:

- Sand and Gravel for use immediately below footings, slabs, and sidewalks,
- Crushed Stone in drainage systems (as needed), and as an alternative to Sand and Gravel,
- Gravel Base Course for use beneath pavements, and
- Granular Fill for use as miscellaneous fill and to form the building pad at depths greater than 12 inches beneath floor slabs and footings.

Grain size distribution requirements are presented in Table 4.

Table 4
Grain Size Distribution Requirements

Size	Sand and Gravel	Gravel Base Course	Granular Fill	Crushed Stone
	Percent Finer by Weight			
3 inch	100	100	100	---
1 ½ inch	---	70-100	---	---
1 inch	---	---	---	100
¾ inch	---	50-85	---	90-100
½ inch	50-85	---	---	10-50
⅜ inch	---	---	---	0-20
No. 4	40-75	30-60	---	0-5
No. 8	---	---	---	---
No. 10	---	---	30-90	---
No. 40	10-35	---	10-70	---
No. 200	0-10	0-10	0-15	---

Please note that the Sand and Gravel specification is approximately that for Mass Highway M1.03.0, Type B Gravel Borrow.

Based upon the subsurface explorations and laboratory testing performed, the near-surface soils generally consist of a uniform fine sand. Therefore, it does not appear that significant amounts of near surface soils meet requirements for use as engineered fill beneath structures or immediately below pavements (within 2 feet). However, these soils may be placed as backfill in landscaped areas or in deep fill areas below pavements.

We note that the in-Situ moisture content of the near surface Site soils is likely to be several percent less (drier) than the optimal moisture content during dry periods. Therefore, it may be necessary to apply significant amounts of water for dust control and during compaction to facilitate proper compaction and keep them in a dense, compacted condition if they are exposed. In our experience, the in-situ moisture content of near surface granular soils could be five or more percent drier than the optimum moisture content during dry periods.

We recommend engineered fills that re-use Site soils be placed and compacted as a continuous operation so that they do not dry out between fill lifts. Compacted fills can be protected by placing a layer of well graded, compacted Sand and Gravel over surfaces that will be exposed for an extended period.

In addition to wetting the soils, the design team may consider methods such as supplementing existing Site soils with natural aggregates, the modification of construction sequencing or methods, or the use of geotextile stabilization fabrics. We note that it is common to supplement a uniform, poorly graded soil with gravel or crushed aggregate to create an improved material.

5.7.2 Compaction Recommendations

Fill, debris, and topsoil (if encountered) should be removed from beneath the building footprint and should not be reused as fill beneath structures. To avoid point loads, any cobbles or boulders larger than four inches in diameter encountered at the subgrade should also be removed.

Prior to the placement of any engineered fill, we recommend that the entire building footprint be thoroughly proof compacted. Proof compaction should be accomplished by a minimum of six passes with a 6,000-pound vibratory roller. To facilitate compaction, the moisture content of the on-Site material should be maintained at or near the optimum moisture content as determined by ASTM D1557.

Compacted fill should be placed in lifts ranging in thickness between 6 and 12 inches depending on the size and type of equipment. Recommended degrees of compaction and compaction means and methods are presented on Sheet 1.

Compaction within five feet of foundation walls should be performed using a hand-operated roller or vibratory plate compactor. If the new walls are to be backfilled on both sides, placement and compaction of engineered fill should proceed on both sides of the wall so that the difference in top of fill on either side does not exceed two feet.

5.7.3 Construction Dewatering

If necessary, it should be possible to dewater construction excavations by trenching or using sump pumps. The contractor should establish and maintain proper drainage of soils during construction (e.g., preventing excess stormwater from entering excavations).

5.7.4 Sloping and Earth Support

Soil adjacent to excavations may become unstable when excavations extend deeper than four feet. Any groundwater or surface water runoff encountered during the excavations will need to be controlled via trenching and sumps to keep the excavation stable and dry. Shoring or sloping may be necessary to protect personnel and to provide stability. The soils encountered at the Site are estimated to be Type C soils for slope stability purposes. The maximum allowable slope for excavations of Class C soils is 1.5H:1V (34°). Protective systems for any excavation exceeding 20 feet in depth must be designed by a registered professional engineer. All excavations should conform to current OSHA requirements.

In areas where sloping is not feasible, excavations may require temporary earth support systems during construction. Based upon the current design, we do not anticipate that such systems will be needed to construct the building. If necessary, the design and engineering of the temporary earth support systems should be the responsibility of the contractor. Prior to construction, we recommend that the contractor evaluate the need for temporary earth support systems.

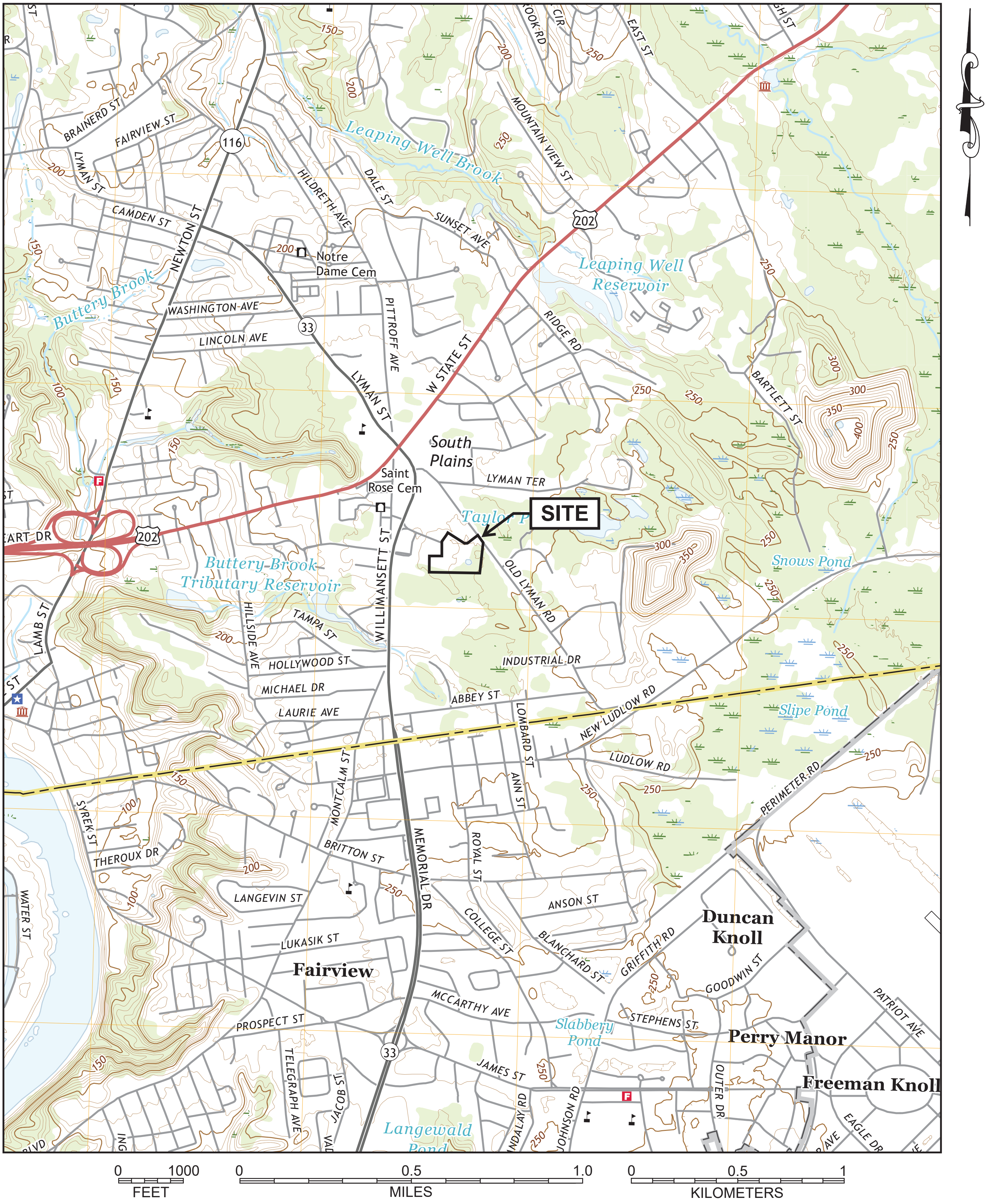
6.0 FINAL DESIGN AND CONSTRUCTION PHASE SERVICES

It is recommended that O'Reilly, Talbot & Okun Associates, Inc. (OTO) be retained during final design stages to review the recommendations provided in this report since only concept designs were available.

We recommend that OTO be retained during the construction design phase to prepare and/or review appropriate specification sections and drawings and meet with the Construction Manager and Owner's Project Manager to finalize construction plans.

During construction phases, we recommend that OTO be retained to provide engineering support, review submittals related to geotechnical aspects of the project, and to document subgrade conditions and preparation. Earthwork observation during construction should occur during excavations and subgrade preparation for the new structures.

FIGURES



1:24,000 SCALE NORTH AMERICAN VERTICAL DATUM OF 1988 10 FOOT CONTOUR INTERVAL

O:\J0300\381 Caolo Bieniek Assoc Inc\63-01 Old Lyman Rd South Hadley - Geotech\Report and Figures\Figure 1 - Site Locus (24k scale).pdf

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES
293 Bridge Street, Suite 500 Springfield, MA 01103 413.788.6222
www.OTO-ENV.com

PROPOSED SHELD FACILITY

64 WILLIMANSETT STREET
SOUTH HADLEY, MASSACHUSETTS

SITE LOCUS

Topographic Map Quadrants:
SPRINGFIELD NORTH, MA

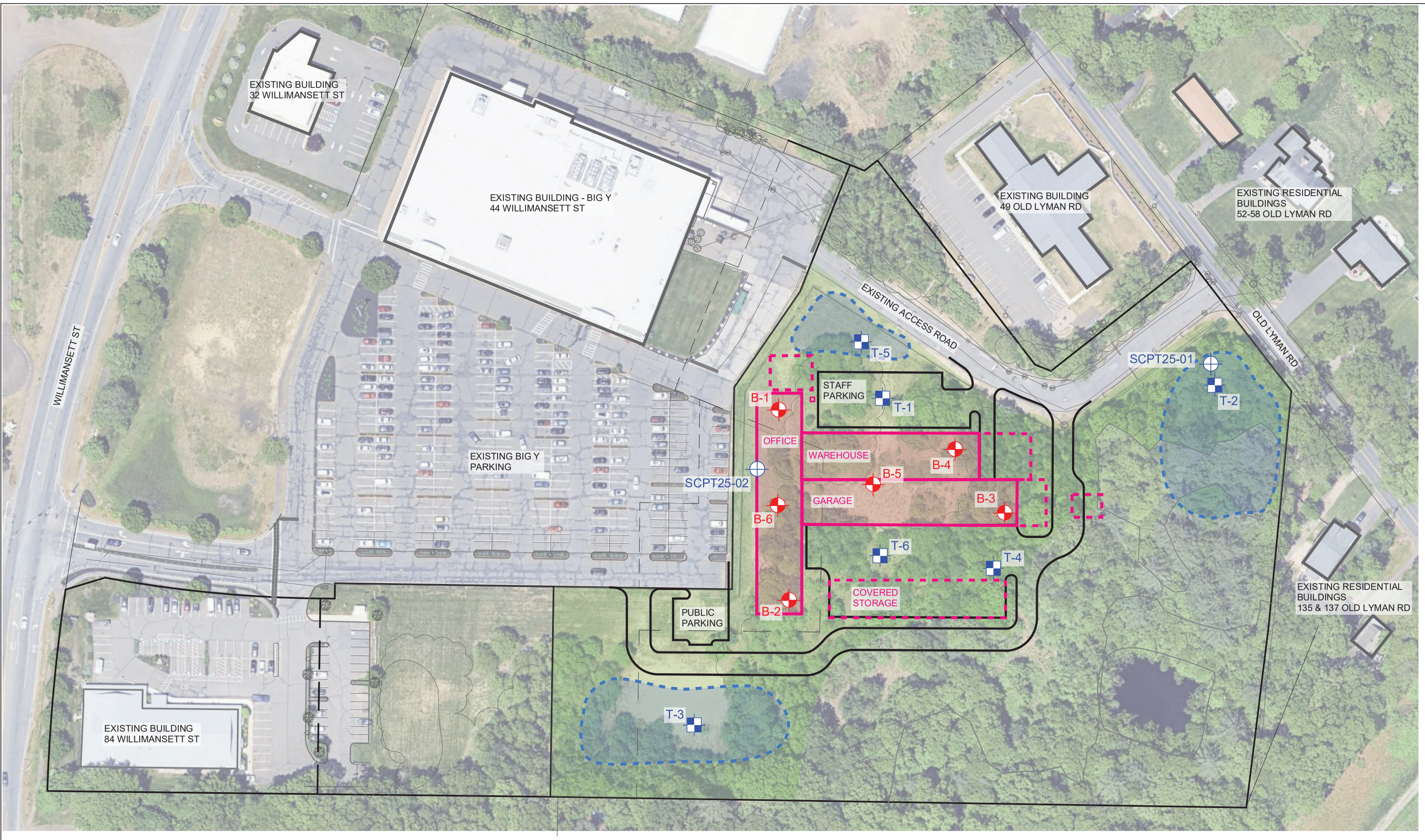
Map Version: 2021

Current As Of: 2021

Date: FEBRUARY 2025

PROJECT No.
J0381-63-01

FIGURE No.
1



NOTES:

1. BASE PLAN PROVIDED TO OTO IN ELECTRONIC FORMAT; ORIGINAL DRAWING TITLED "LOT LINE RECONFIGURATION PLAN" (SHEET ANR-6), BY F.A. HESKETH & ASSOCIATES, DATED 05/04/2022.
2. PROPOSED SITE LAYOUT PROVIDED TO OTO IN ELECTRONIC FORMAT; ORIGINAL DRAWING TITLED "CONCEPTUAL SITE PLAN - 3D BORING LOCATION PLAN" (SHEET CONCEPT 3D-R1), BY CAOLO & BIENIEK ASSOCIATES, DATED 12/16/2024.
3. BASE IMAGERY FROM GOOGLE EARTH, RETRIEVED 12/03/2024.
4. APPROXIMATE SAMPLE LOCATIONS ARE SHOWN ACCORDING TO TAPED MEASUREMENS TAKEN FROM EXISTING SITE FEATURES OR BASED UPON MOBILE GPS APPLICATIONS.
5. ALL DATA IS TO BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHODS USED IN THE DEVELOPMENT OF THIS PLAN

LEGEND:

⊕	PROPOSED SOIL BORING LOCATION, TO BE PERFORMED BY SEABOARD DRILLING AND OBSERVED BY OTO
⊕	APPROXIMATE LOCATION OF CPT SOUNDING, PERFORMED BY CONETEC ON JANUARY 8, 2025
▨	APPROXIMATE LOCATION OF TEST PIT PERFORMED BY SEABOARD DRILLING ON JANUARY 8, 2025, OBSERVED BY OTO
🟥	PROPOSED BUILDING
⬚	PROPOSED OPEN STRUCTURE OR MISC./FUTURE SITE IMPROVEMENT
🟦	PROPOSED STORMWATER BASIN

SCALE IN FEET
1" = 120'
0' 60' 120' 240'

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES
293 Bridge Street, Suite 500 Springfield, MA 01103 413.788.6222
www.OTO-ENV.com

DESIGNED BY: PJC
DRAWN BY: PJC
CHECKED BY: ALS
DATE: 02/04/2024
REV. DATE:

PROPOSED SHELD FACILITY
64 WILLIMANSETT STREET
SOUTH HADLEY, MASSACHUSETTS

SITE PLAN

PROJECT NO.
J0381-63-01

FIGURE NO.
2

SHEETS

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

Table 1-1
Degree of Compaction Recommendations

Location	Minimum Compaction
Below Structures (Foundations and Slabs)	95%
Below Pavements/Sidewalks/Exterior Slabs	95%
Against Basement Walls/Retaining Walls	92%
Utility Trenches	95%
General Landscaped Areas	90%

Notes.

1. Percentage of the maximum dry density as determined by Modified Proctor ASTM D1557, Method C.
2. When location falls into two or more categories, the engineer should be notified to determine appropriate compaction efforts and/or methods.
3. Crushed stone should be compacted in lifts of 12 inches to form a dense matrix using either traditional compaction methods (vibratory plate and/or roller) or tamping with an excavator bucket in deep excavations. It is generally not necessary to perform laboratory or field density testing on crushed stone.

Table 1-2
General Guidelines for Compaction Means and Methods

Compaction Method	Maximum Stone Size (Inches Diameter)	Maximum Lift Thickness (Inches)		Minimum Number of Passes	
		Below Structures & Pavement	Non-Critical Areas	Below Structures & Pavement	Non-Critical Areas
Hand-operated Vibratory Plate and confined spaces	3	6	8	6	4
Hand-operated vibratory drum roller (less than 1000 pounds)	3	6	8	6	4
Hand-operated vibratory drum roller (at least 1,000 pounds)	6	8	10	6	4
Light vibratory drum roller (minimum 3000 pounds)	6	10	14	6	4
Heavy vibratory drum roller (minimum 6000 pounds)	6	12	18	6	4

Note: The contractor should reduce or stop drum vibration if pumping of the subgrade is observed.

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES
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www.OTO-ENV.com

PROPOSED SHELD FACILITY

64 WILLIMANSETT STREET
SOUTH HADLEY, MASSACHUSETTS

GENERAL COMPACTION GUIDELINES

DESIGNED BY: ALS
DRAWN BY: DAH
CHECKED BY: MJT
DATE: 02/04/2025
REV. DATE:

PROJECT No.
J0381-63-01

SHEET No.
1

APPENDIX A

LIMITATIONS

LIMITATIONS

1. The observations presented in this report were made under the conditions described herein. The conclusions presented in this report were based solely upon the services described in the report and not on scientific tasks or procedures beyond the scope of the project or the time and budgetary constraints imposed by the client. The work described in this report was carried out in accordance with the Statement of Terms and Conditions attached to our proposal.

2. The analysis and recommendations submitted in this report are based in part upon the data obtained from widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it may be necessary to reevaluate the recommendations of this report.

3. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the boring logs.

4. In the event that any changes in the nature, design or location of the proposed structures are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by O'Reilly, Talbot & Okun Associates Inc. It is recommended that we be retained to provide a general review of final plans and specifications.

5. Our report was prepared for the exclusive benefit of our client. Reliance upon the report and its conclusions is not made to third parties or future property owners.

APPENDIX B

CONETEC REPORT
JANUARY 20, 2025

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

PRESENTATION OF SITE INVESTIGATION RESULTS

Old Lyman Road - South Hadley, MA

Prepared for:
O'Reilly, Talbot & Okun Engineering Associates

ConeTec Job No:	**25-53-28903**
Project Start Date:	2025-01-08
Project End Date:	2025-01-08
Release Date:	2025-01-20

Report prepared by:
ConeTec, Inc.

436 Commerce Lane, Unit C, West Berlin, NJ 08091
Tel: (856) 767-8600

ConeTecNJ@conetec.com
www.conetec.com
www.conetecdataservices.com

ABOUT THIS REPORT

The attached report presents the findings of the site investigation program.

At the request of: O'Reilly, Talbot & Okun Engineering Associates.

Conducted by: ConeTec, Inc.

Please be advised that this report, along with all associated data, is subject to the Third-Party Disclaimer and the Client Disclaimer contained in the 'Limitations' section of this report. For further reference, please consult the list of attached documents following the main body of the report.

PROJECT	
Client Name	O'Reilly, Talbot & Okun Engineering Associates
Project Name	Old Lyman Road - South Hadley, MA
Test Types	SCPTu
ConeTec Project Number	25-53-28903
Additional Comments	None

CONTENTS

The following are included in the body of the report:

- Site Map
- Limitations and Closure
- Project Information
- Test Summaries and Plots
- Supporting Documents and Materials

SITE MAP

All locations are approximate unless otherwise stated in the body of the report.

ConeTec Job Number: 25-53-28903

Client: O’Reilly, Talbot & Okun Engineering Associates

Project: Old Lyman Road - South Hadley, MA

Date: 2025-01-20

LIMITATIONS

Third-Party Disclaimer

‘Report’ refers to this document titled: Old Lyman Road - South Hadley, MA

The Report was prepared by ConeTec for: O’Reilly, Talbot & Okun Engineering Associates

The Report is confidential and may not be distributed to or relied upon by any third parties without the express written consent of ConeTec. Third parties who gain access to the Report do not acquire any rights by virtue of such access. Any use which a third party makes of the Report, or any reliance on or decisions made based on it, are the responsibility of such third parties. ConeTec accepts no responsibility for loss, damage and/or expense, if any, suffered by any third parties as a result of decisions made, or actions taken or not taken, which are in any way based on, or related to, the Report or any portion(s) thereof.

Client Disclaimer

ConeTec was retained by: O’Reilly, Talbot & Okun Engineering Associates

‘Report’ refers to this document titled: Old Lyman Road - South Hadley, MA

ConeTec was retained to collect and provide the raw data (‘Data’) which is included in the Report.

ConeTec has collected and reported the Data in accordance with current industry standards. No other warranties, either expressed or implied, with respect to the Data is made by ConeTec. To fully understand the Data included in the Report, reference must be made to the supporting documents and other sources referenced in the Report in their entirety. Other than the Data, the contents of the Report, including any Interpretations, should not be relied upon in any fashion without independent verification. ConeTec is in no way responsible for any loss, damage or expense resulting from the use of, and/or reliance on, such material by any party.

Closure

Thank you for the opportunity to contribute to this project. The equipment utilized, as well as the field procedures followed, fully complied with currently accepted best practice standards.

Report prepared by: Jenna Griggs
Anthony Rasmussen, Mike Coia

PROJECT INFORMATION

Rig Utilized

Description	Deployment System	Test Type
C03-030 CPT Track Rig	Twin mounted cylinders	SCPTu

Coordinates

Test Type	Number of Locations	GPS Collection Method	EPSG Number
SCPTu	2	Consumer Grade GPS	32618 (WGS84 / UTM Zone 18 North)

Piezocones Used for this Project

Cone Description	Cone Number	Cross Sectional Area (cm^2)	Sleeve Area (cm^2)	Tip Capacity (bar)	Sleeve Capacity (bar)	Pore Pressure Capacity (bar)
EC990:T1000F10U35	990	15	225	1000	10	35

Cone Penetration Test (CPTu)

Depth reference	Depths are referenced to the existing ground surface at the time of each test.
Tip and sleeve data offset	0.1 Meters. This has been accounted for in the CPT data files.
Additional Comments	None

Calculated Geotechnical Parameters	
Additional information	The Normalized Soil Behavior Type Chart based on Q_{tn} (SBT Q_{tn}) (Robertson, 2009) was used to classify the soil for this project. A detailed set of calculated CPTu parameters have been generated and are provided in Excel format files in the release folder. The CPTu parameter calculations are based on values of corrected tip resistance (q_t) sleeve friction (f_s) and pore pressure (u_2). Effective stresses are calculated based on unit weights that have been assigned to the individual soil behavior type zones and the assumed equilibrium pore pressure profile. Soils were classified as either drained or undrained based on the Q_{tn} Normalized Soil Behavior Type Chart (Robertson, 2009). Calculations for both drained and undrained parameters were included for materials that classified as silt mixtures (zone 4). For calculating undrained shear strength based on pore pressure ($S_u(N_{\Delta u})$) and undrained shear strength based on cone tip resistance ($S_u(N_{kt})$), an $N_{\Delta u}$ value of 6 and an N_{kt} value of 15 were selected.

REPORT APPENDICES

The appendices listed below are included in the report:

- **Cone Penetration Test (CPTu) Summary and Standard CPTu Plots**
- **Advanced Cone Penetration Test Plots with Ic, Su(Nkt), Phi, and N1(60)Ic**
- **Soil Behavior Type (SBT) Scatter Plots**
- **Pore Pressure Dissipation Test (PPD) Summary and PPD Plots**
- **Seismic Cone Penetration Test (SCPTu) Tabular Results**
- **SCPTu Test Plots**
- **SCPTu Velocity Wave Traces**
- **Supporting Documents and Materials**

Cone Penetration Test (CPTu) Summary and Standard CPTu Plots

Job No: 25-53-28903
Client: OTO Engineering Associates
Project: Old Lyman Road - South Hadley, MA
Start Date: 8-Jan-2025
End Date: 8-Jan-2025

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Rig	Cone	Cone Area (cm^2)	Assumed Phreatic Surface[1] (ft)	Final Depth (ft)	Shear Wave Velocity Tests	Northing[2] (m)	Easting[2] (m)
SCPT25-01	25-53-28903_SP01	8-Jan-2025	TC-30	990:T1000F10U35	15	7.9	101.54	31	4677314	700742
SCPT25-02	25-53-28903_SP02	8-Jan-2025	TC-30	990:T1000F10U35	15	11.7	93.26	29	4677279	700591
Totals	2 Soundings						194.80 ft	60 Tests		

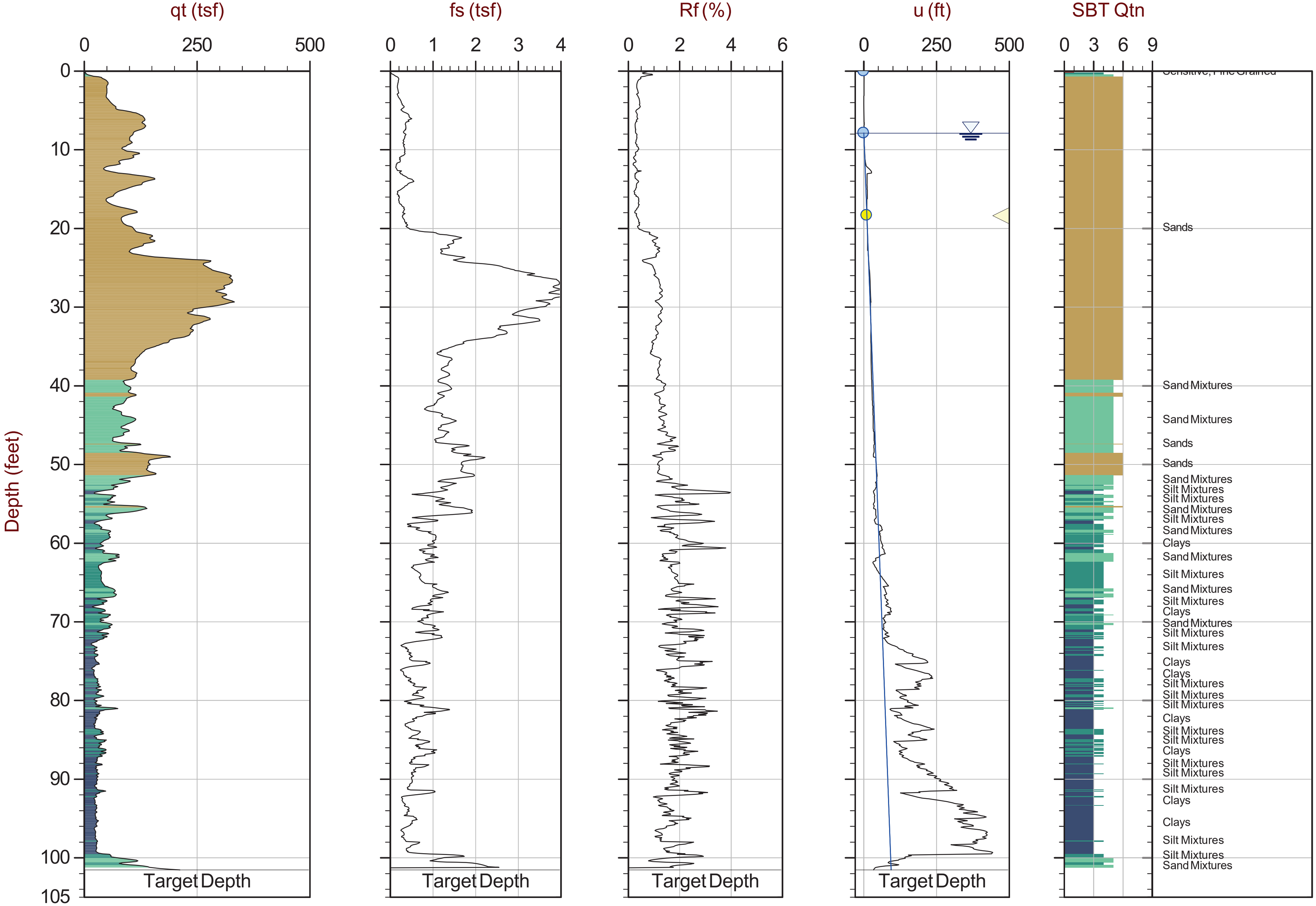
1. The assumed phreatic surface was based off the shallowest pore pressure dissipation test performed within the sounding. Hydrostatic conditions were assumed for the calculated parameters.
2. The coordinates were collected using a consumer grade GPS. EPSG number: 32618 (WGS84 / UTM Zone 18 North).

CONETEC

OTO Engineering Associates

Job No: 25-53-28903
Date: 2025-01-08 09:54
Site: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-01
Cone: 990:T1000F10U35 Area=15 cm²



Max Depth: 30.950 m / 101.54 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-53-28903_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 18 N: 4677314m E: 700742m

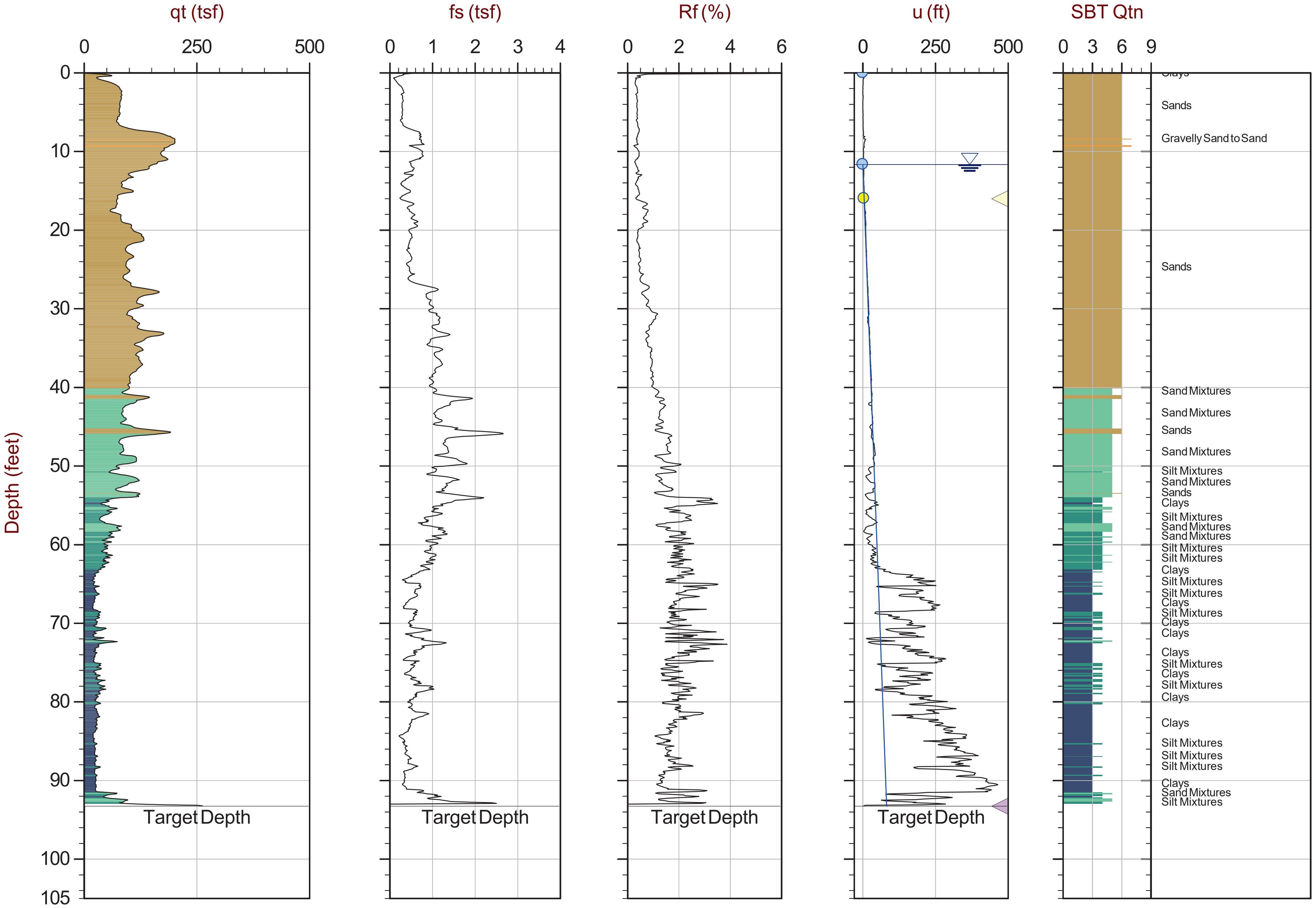
Overplot Item: —— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved ◁ PPD, Ueq assumed

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

OTO Engineering Associates

Job No: 25-53-28903
Date: 2025-01-08 13:34
Site: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-02
Cone: 990:T1000F10U35 Area=15 cm²



Max Depth: 28.425 m / 93.26 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-53-28903_SP02.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 18 N: 4677279m E: 700591m

Overplot Item: —— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved ◁ PPD, Ueq assumed

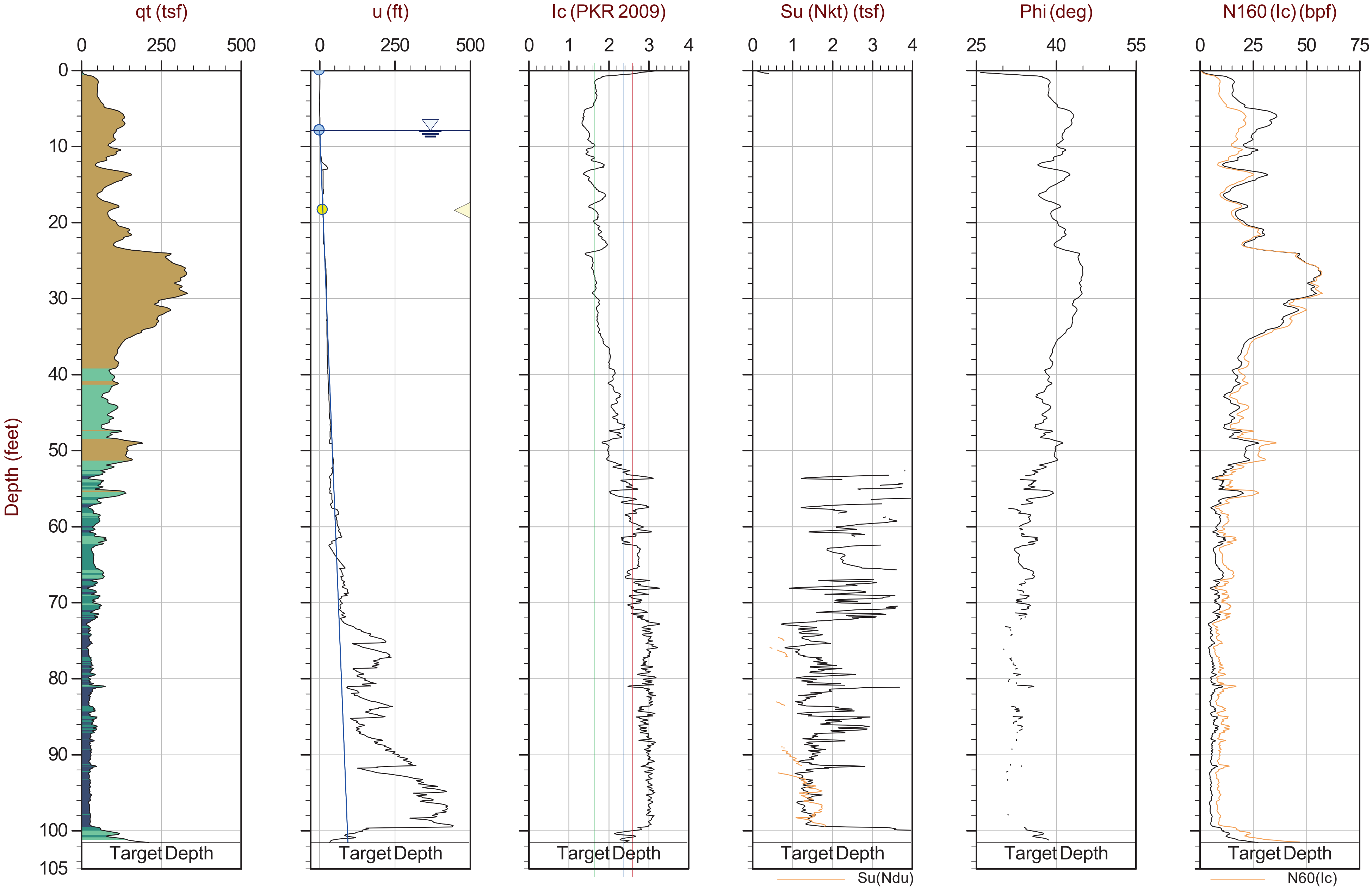
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Advanced Cone Penetration Test Plots with Ic, Su(Nkt), Phi, and N1(60)Ic

OTO Engineering Associates

Job No: 25-53-28903
Date: 2025-01-08 09:54
Site: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-01
Cone: 990:T1000F10U35 Area=15 cm²



Max Depth: 30.950 m / 101.54 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-53-28903_SP01.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 6.0

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 18 N: 4677314m E: 700742m

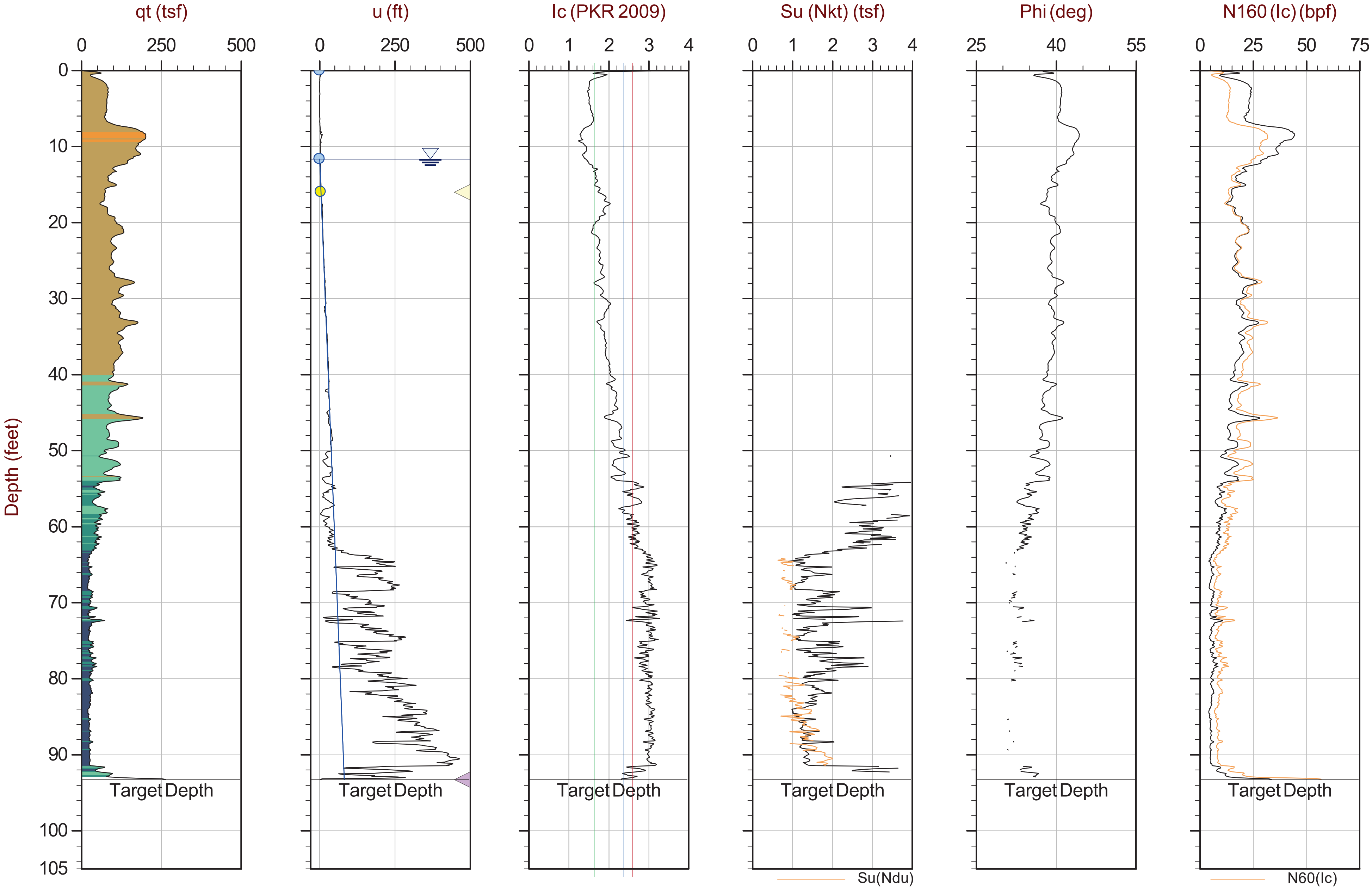
Overplot Item: —— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved ◁ PPD, Ueq assumed

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

OTO Engineering Associates

Job No: 25-53-28903
Date: 2025-01-08 13:34
Site: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-02
Cone: 990:T1000F10U35 Area=15 cm²



Max Depth: 28.425 m / 93.26 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-53-28903_SP02.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 6.0

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 18 N: 4677279m E: 700591m

Overplot Item: —— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved ◁ PPD, Ueq assumed

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

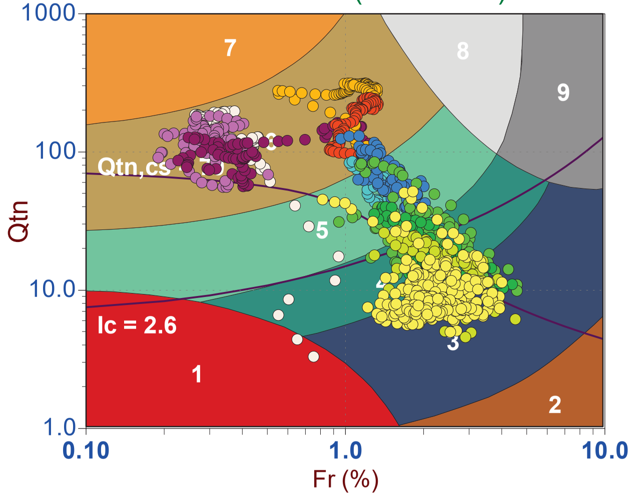
Soil Behavior Type (SBT) Scatter Plots

OTO Engineering Associates

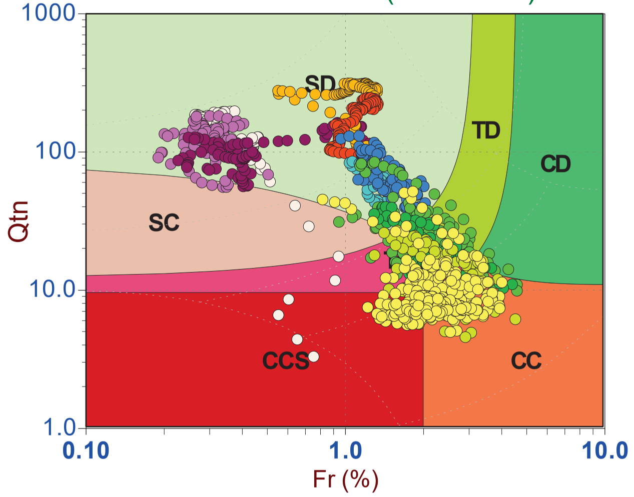
Job No: 25-53-28903
Date: 2025-01-08 09:54
Site: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-01
Cone: 990:T1000F10U35 Area=15 cm²

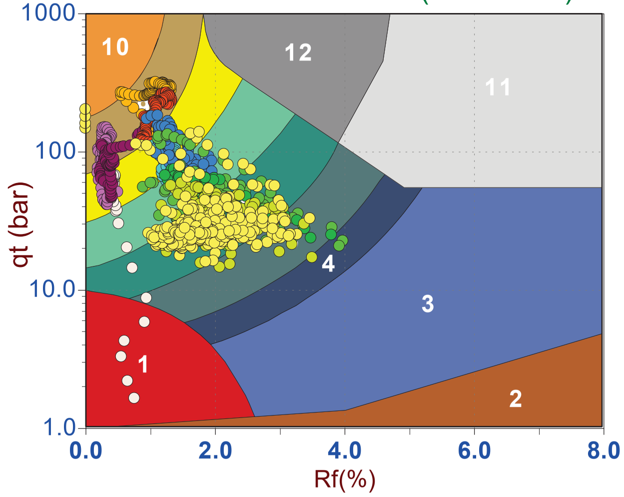
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges
- ● >0.0 to 7.5 ft
- ● >7.5 to 15.0 ft
- ● >15.0 to 22.5 ft
- ● >22.5 to 30.0 ft
- ● >30.0 to 37.5 ft
- ● >37.5 to 45.0 ft
- ● >45.0 to 52.5 ft
- ● >52.5 to 60.0 ft
- ● >60.0 to 67.5 ft
- ● >67.5 to 75.0 ft
- ● >75.0 ft

Legend
- 🟥 Sensitive, Fine Grained
- 🟫 Organic Soils
- 🟦 Clays
- 🟩 Silt Mixtures
- 🟩 Sand Mixtures
- 🟫 Sands
- 🟧 Gravelly Sand to Sand
- ⬜ Stiff Sand to Clayey Sand
- ⬛ Very Stiff Fine Grained

Legend
- 🟥 CCS (Cont. sensitive clay like)
- 🟧 CC (Cont. clay like)
- 🟥 TC (Cont. transitional)
- 🟫 SC (Cont. sand like)
- 🟩 CD (Dil. clay like)
- 🟩 TD (Dil. transitional)
- 🟩 SD (Dil. sand like)

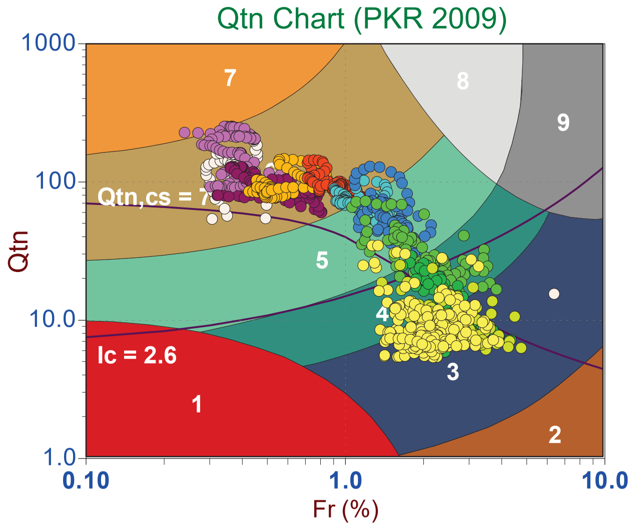
Legend
- 🟥 Sensitive Fines
- 🟫 Organic Soil
- 🟦 Clay
- 🟦 Silty Clay
- ⬛ Clayey Silt
- 🟩 Silt
- 🟩 Sandy Silt
- 🟨 Silty Sand/Sand
- 🟫 Sand
- 🟧 Gravelly Sand
- ⬜ Stiff Fine Grained
- ⬛ Cemented Sand

OTO Engineering Associates

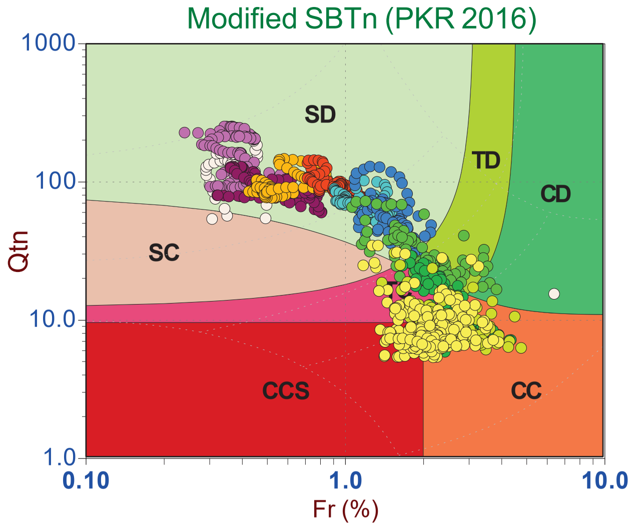
Job No: 25-53-28903
Date: 2025-01-08 13:34
Site: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-02
Cone: 990:T1000F10U35 Area=15 cm²

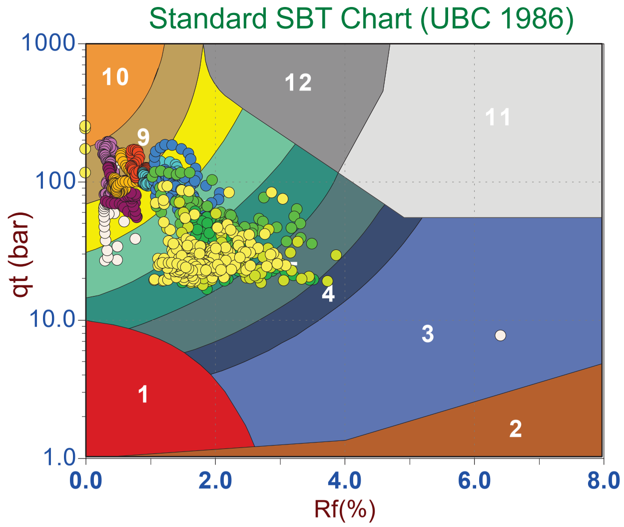
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges
- >0.0 to 7.5 ft
- >7.5 to 15.0 ft
- >15.0 to 22.5 ft
- >22.5 to 30.0 ft
- >30.0 to 37.5 ft
- >37.5 to 45.0 ft
- >45.0 to 52.5 ft
- >52.5 to 60.0 ft
- >60.0 to 67.5 ft
- >67.5 to 75.0 ft
- >75.0 ft

Legend
- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend
- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

Legend
- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

Pore Pressure Dissipation Test (PPD) Summary and PPD Plots

Job No:	25-53-28903
Client:	OTO Engineering Associates
Project:	Old Lyman Road - South Hadley, MA
Start Date:	8-Jan-2025
End Date:	8-Jan-2025

CPTu PORE PRESSURE DISSIPATION SUMMARY

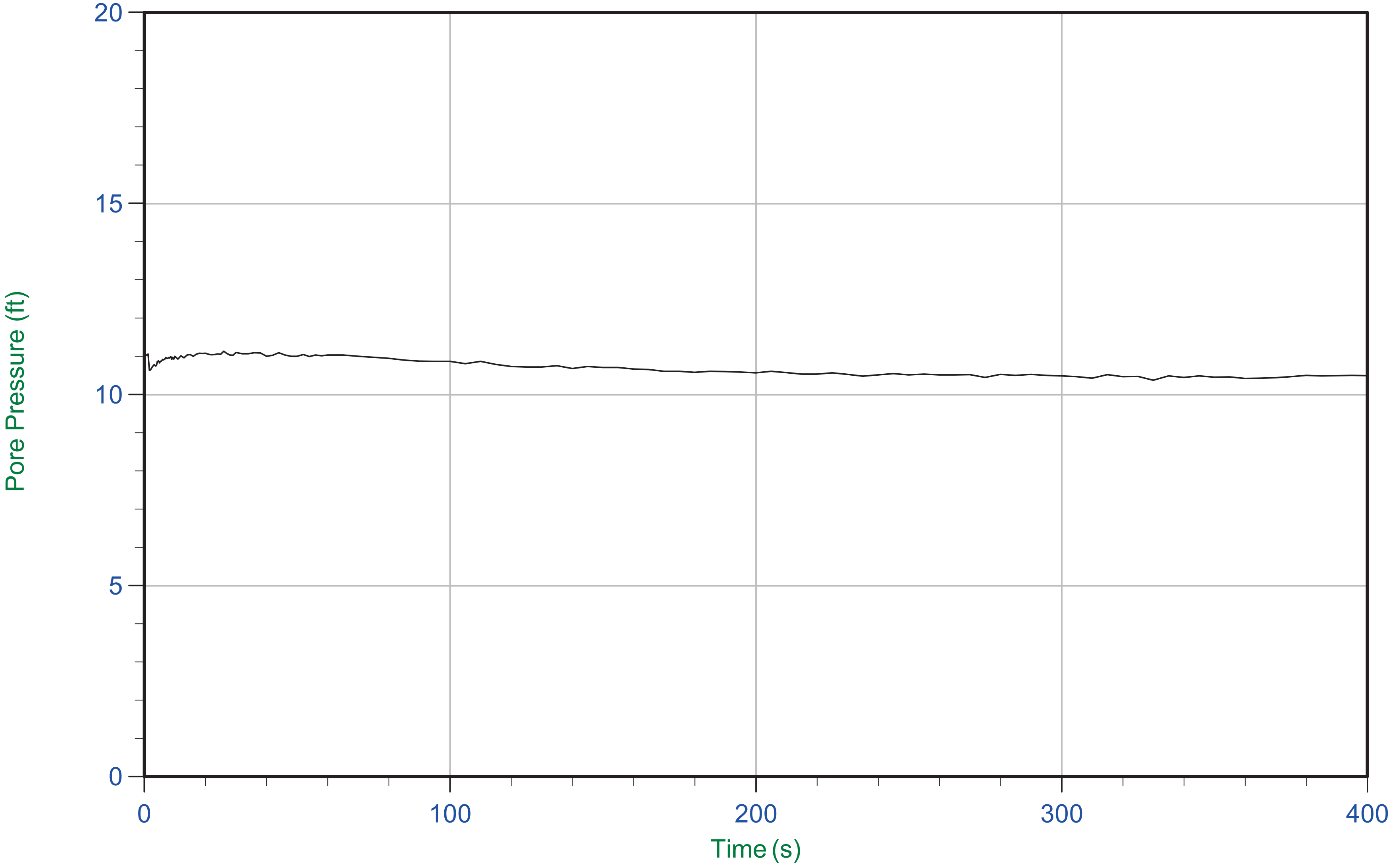
Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (ft)	Calculated Phreatic Surface (ft)
SCPT25-01	25-53-28903_SP01	15	400	18.37	10.5	7.9
SCPT25-02	25-53-28903_SP02	15	400	15.99	4.3	11.7
SCPT25-02	25-53-28903_SP02	15	200	93.26	Not Achieved	
Totals	3 Dissipations		17 min			

CONETEC

OTO Engineering Associates

Job No: 25-53-28903
Date: 2025-01-08 09:54
Site: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-01
Cone: 990:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-53-28903_SP01.PPF2
Depth: 5.600 m / 18.372 ft
Duration: 400.0 s

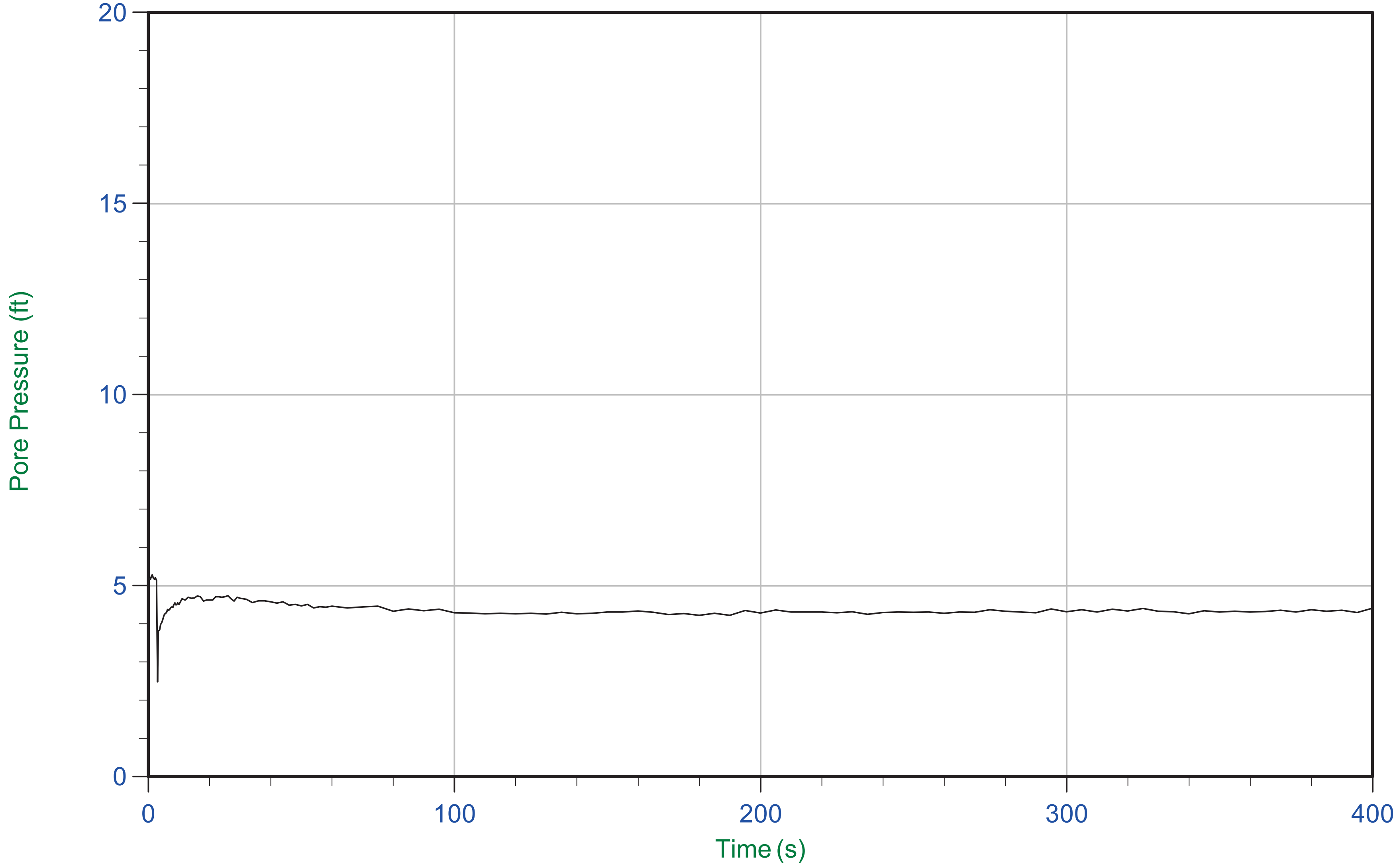
u Min: 10.4 ft
u Max: 11.1 ft
u Final: 10.5 ft

WT: 2.4 m / 7.9 ft
Ueq: 10.5 ft

OTO Engineering Associates

Job No: 25-53-28903
Date: 2025-01-08 13:34
Site: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-02
Cone: 990:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-53-28903_SP02.PPF2
Depth: 4.875 m / 15.994 ft
Duration: 400.0 s

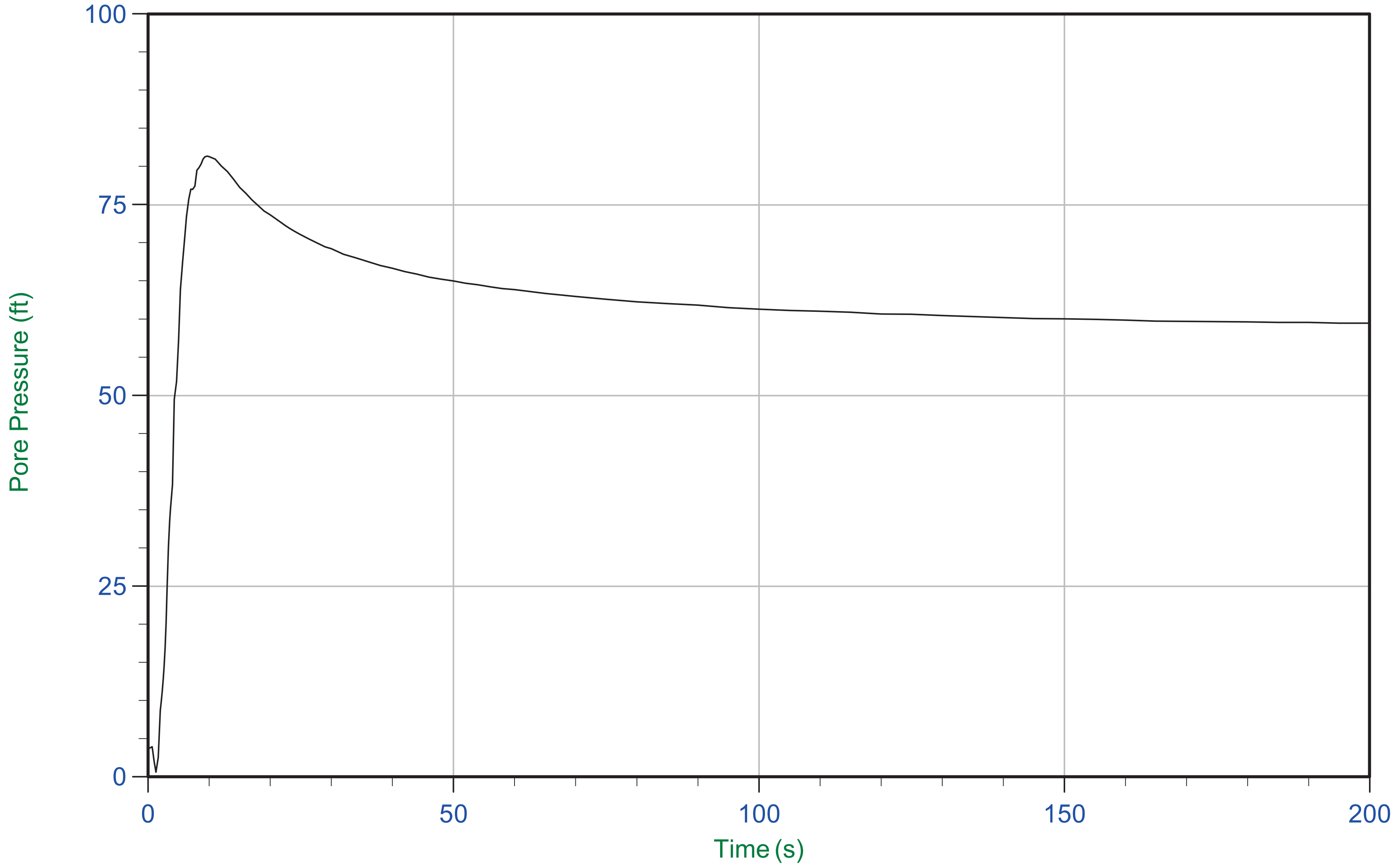
u Min: 2.5 ft
u Max: 5.3 ft
u Final: 4.4 ft

WT: 3.6 m / 11.7 ft
Ueq: 4.3 ft

OTO Engineering Associates

Job No: 25-53-28903
Date: 2025-01-08 13:34
Site: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-02
Cone: 990:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-53-28903_SP02.PPF2
Depth: 28.425 m / 93.257 ft
Duration: 200.0 s

u Min: 0.6 ft
u Max: 81.4 ft
u Final: 59.5 ft

Seismic Cone Penetration Test (SCPTu) Tabular Results

Job No: 25-53-28903
Client: OTO Engineering Associates
Project: Old Lyman Road - South Hadley, MA
Sounding ID: SCPT25-01
Date: 08-Jan-2025

Seismic Source: Beam
Seismic Offset (ft): 0.49
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
3.12	2.46	2.51			
6.40	5.74	5.76	3.25	5.16	631
9.58	8.92	8.94	3.18	5.58	569
12.96	12.30	12.31	3.38	5.21	647
16.24	15.58	15.59	3.28	5.05	649
19.52	18.86	18.87	3.28	5.05	650
22.80	22.15	22.15	3.28	4.47	734
26.08	25.43	25.43	3.28	3.40	967
29.36	28.71	28.71	3.28	3.39	969
32.58	31.92	31.93	3.22	3.52	914
35.93	35.27	35.27	3.35	4.10	815
39.21	38.55	38.55	3.28	4.46	736
42.49	41.83	41.83	3.28	4.46	736
45.77	45.11	45.11	3.28	4.46	736
49.05	48.39	48.40	3.28	4.36	753
52.33	51.67	51.68	3.28	4.00	821
55.61	54.95	54.96	3.28	4.28	767
58.79	58.14	58.14	3.18	4.24	750
62.17	61.52	61.52	3.38	4.08	829
65.45	64.80	64.80	3.28	4.10	800
68.73	68.08	68.08	3.28	4.05	811
72.01	71.36	71.36	3.28	4.13	794
75.30	74.64	74.64	3.28	4.19	784
78.58	77.92	77.92	3.28	4.08	805
81.86	81.20	81.20	3.28	3.94	833
85.14	84.48	84.48	3.28	3.98	825
88.42	87.76	87.76	3.28	3.89	843
91.70	91.04	91.04	3.28	3.79	866
94.98	94.32	94.33	3.28	3.74	878
98.26	97.61	97.61	3.28	3.79	866
101.54	100.89	100.89	3.28	3.52	933

Job No: 25-53-28903
Client: OTO Engineering Associates
Project: Old Lyman Road - South Hadley, MA
Sounding ID: SCPT25-02
Date: 08-Jan-2025

Seismic Source: Beam
Seismic Offset (ft): 0.49
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

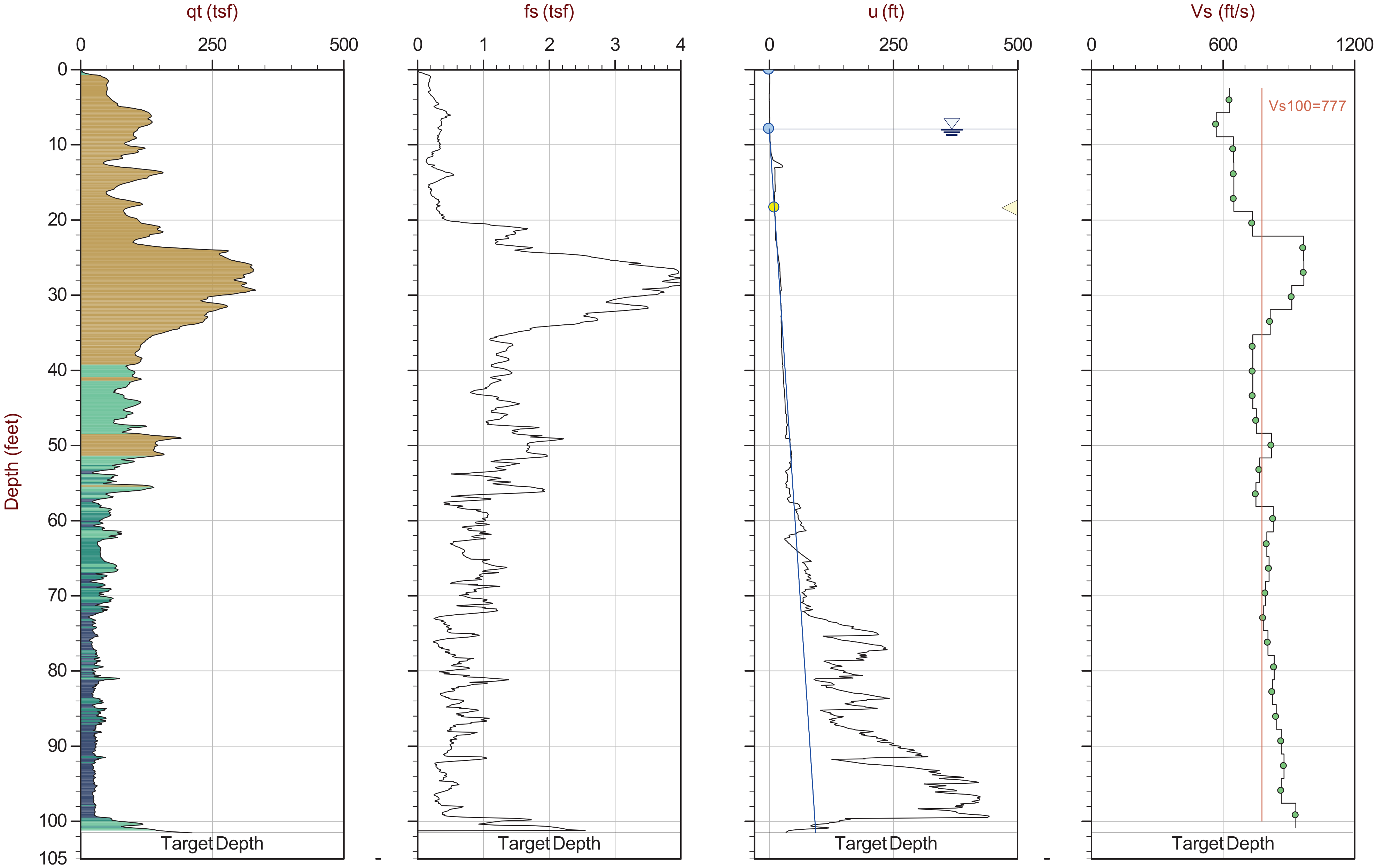
Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
2.89	2.23	2.28			
6.17	5.51	5.53	3.25	5.07	641
9.45	8.79	8.81	3.27	4.59	714
12.73	12.07	12.08	3.28	4.27	767
16.01	15.35	15.36	3.28	4.64	707
19.29	18.64	18.64	3.28	4.79	685
22.57	21.92	21.92	3.28	4.53	724
25.85	25.20	25.20	3.28	4.64	708
29.13	28.48	28.48	3.28	4.10	800
32.32	31.66	31.66	3.18	3.63	877
35.70	35.04	35.04	3.38	3.74	904
38.98	38.32	38.32	3.28	3.97	827
42.26	41.60	41.60	3.28	4.32	760
45.54	44.88	44.89	3.28	4.17	787
48.82	48.16	48.17	3.28	4.29	765
52.10	51.44	51.45	3.28	4.20	781
55.38	54.72	54.73	3.28	4.17	787
58.66	58.01	58.01	3.28	4.25	771
61.94	61.29	61.29	3.28	4.04	813
65.22	64.57	64.57	3.28	4.17	786
68.50	67.85	67.85	3.28	4.22	778
71.78	71.13	71.13	3.28	4.13	795
75.07	74.41	74.41	3.28	4.08	804
78.35	77.69	77.69	3.28	4.07	806
81.63	80.97	80.97	3.28	3.96	829
84.91	84.25	84.25	3.28	3.85	853
88.19	87.53	87.53	3.28	3.87	847
91.47	90.81	90.81	3.28	3.62	907
93.24	92.59	92.59	1.77	1.81	979

SCPTu Test Plots

OTO Engineering Associates

Job No: 25-53-28903
Date: 2025-01-08 09:54
Site: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-01
Cone: 990:T1000F10U35 Area=15 cm²



Max Depth: 30.950 m / 101.54 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-53-28903_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 18 N: 4677314m E: 700742m

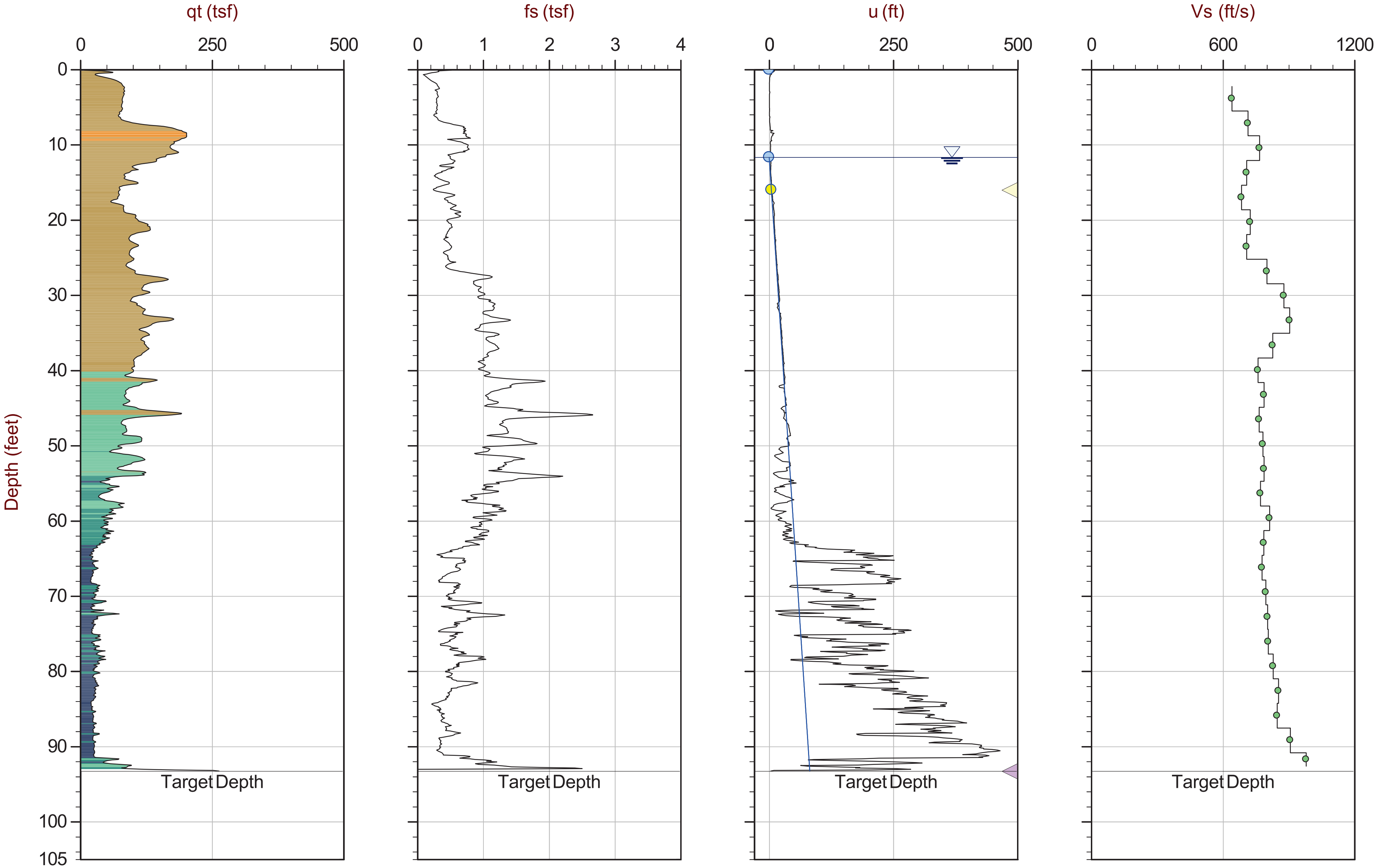
Overplot Item: —— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved ◁ PPD, Ueq assumed

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

OTO Engineering Associates

Job No: 25-53-28903
Date: 2025-01-08 13:34
Site: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-02
Cone: 990:T1000F10U35 Area=15 cm²



Max Depth: 28.425 m / 93.26 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-53-28903_SP02.COR
Unit Wt: SBTQtn (PKR2009)

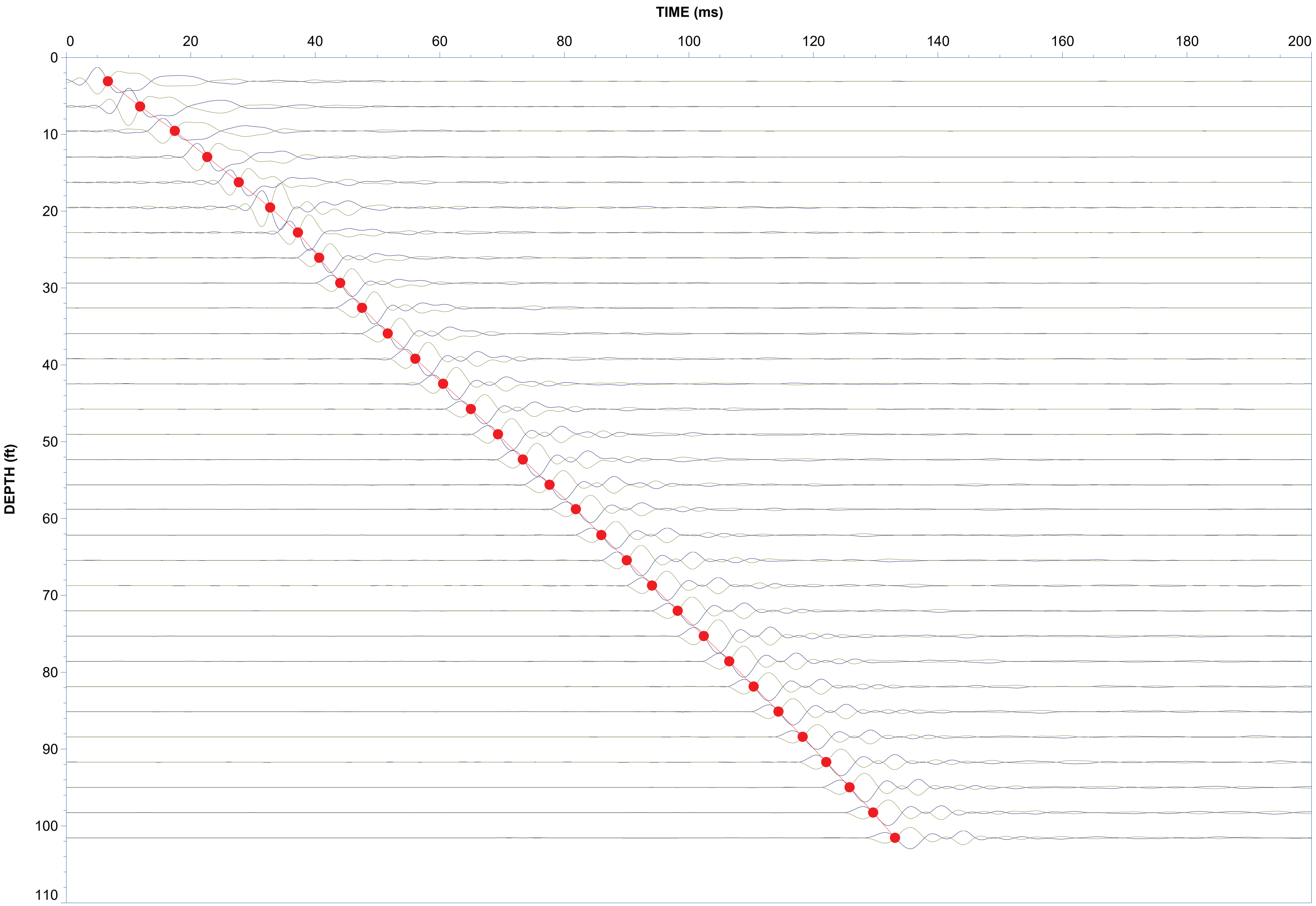
SBT: Robertson, 2009 and 2010
Coords: UTM Zone 18 N: 4677279m E: 700591m

Overplot Item: —— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved ◁ PPD, Ueq assumed

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

SCPTu Velocity Wave Traces

Job No: 25-53-28903 Date: 08-Jan-2025	Client: OTO Engineering Associates	Project: Old Lyman Road - South Hadley, MA	Sounding: SCPT25-01	Filter: BP 0-250 Hz



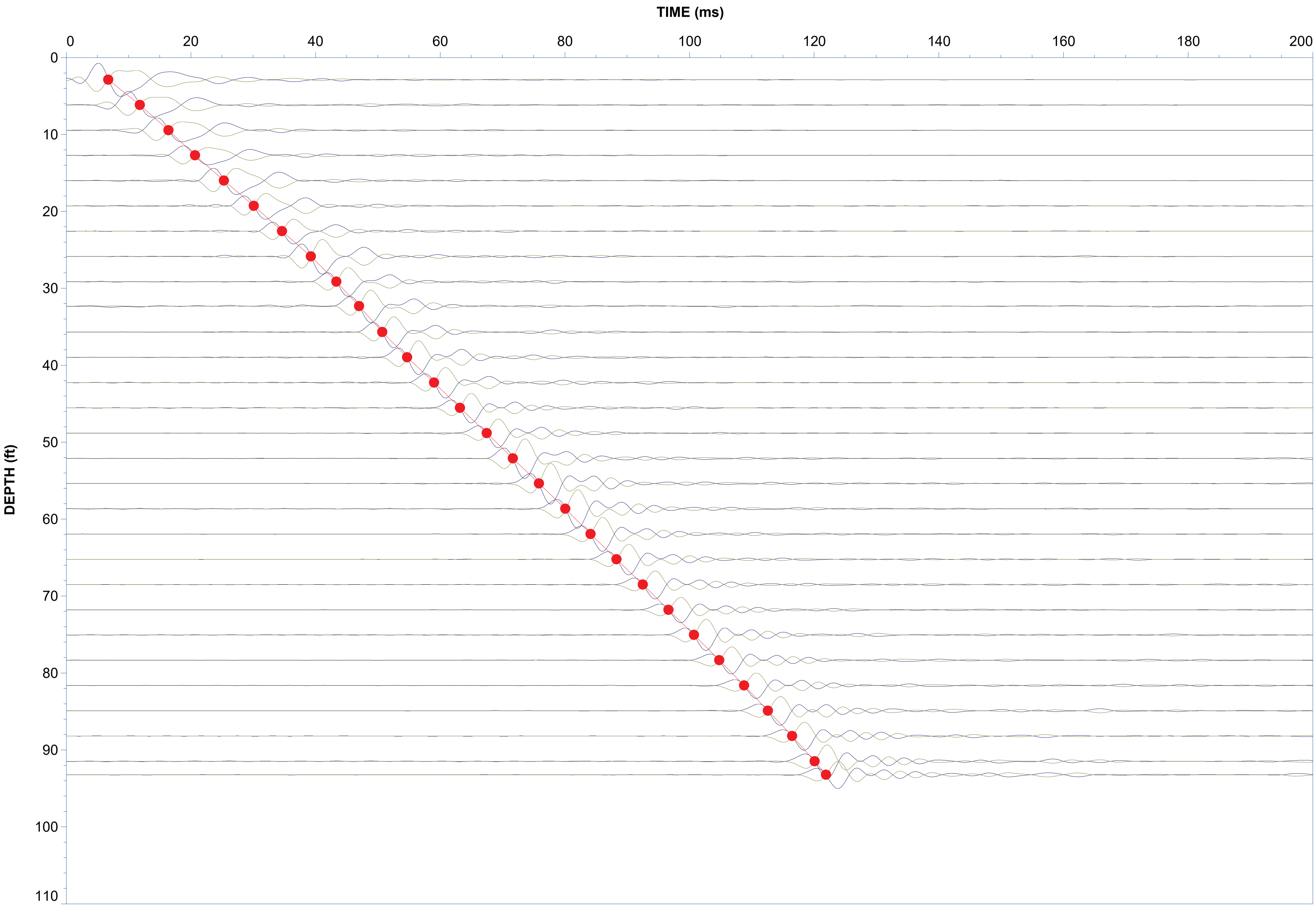
Job No: 25-53-28903
Date: 08-Jan-2025

Client: OTO Engineering Associates

Project: Old Lyman Road - South Hadley, MA

Sounding: SCPT25-02

Filter: BP 0-250 Hz



Supporting Documents and Materials

SUPPORTING DOCUMENTS AND MATERIALS

The documents and materials listed below are included in the report:

- **Methodology Statements**
- **Cone Penetration Digital File Formats**
- **Description of Methods for Calculated CPTu Geotechnical Parameters**
- **Calibration Records**

Methodology Statements

METHODOLOGY STATEMENTS

CONE PENETRATION TEST (CPTu) - eSeries

Cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd., a subsidiary of ConeTec.

ConeTec's piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and two geophone sensors for recording seismic signals. All signals are amplified and measured with minimum sixteen-bit resolution down hole within the cone body, and the signals are sent to the surface using a high bandwidth, error corrected digital interface through a shielded cable.

ConeTec penetrometers are manufactured with various tip, friction and pore pressure capacities in both 10 cm^2 and 15 cm^2 tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table. The 15 cm^2 penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm^2 piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 millimeters diameter over a length of 32 millimeters with tapered leading and trailing edges) located at a distance of 585 millimeters above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

All ConeTec piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the "u_2" position (ASTM Type 2). The filter is six millimeters thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. ConeTec's calibration criteria also meets or exceeds those of the current ASTM D5778 standard. An illustration of the piezocone penetrometer is presented in Figure CPTu.

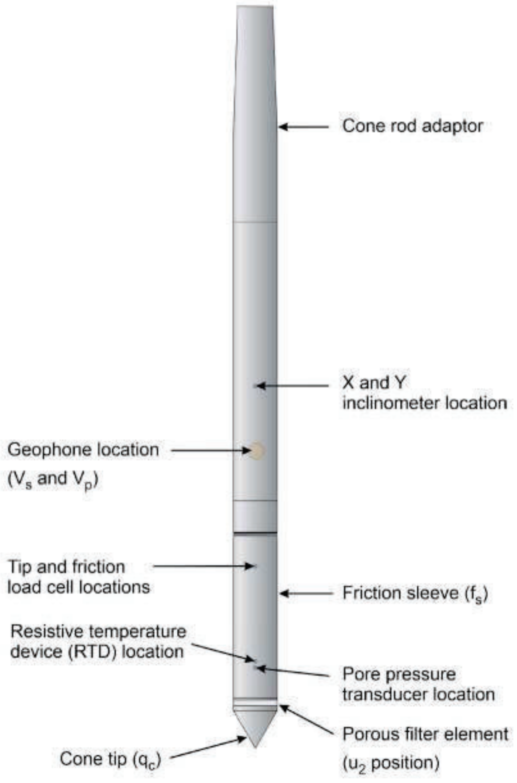


Figure CPTu. Piezocone Penetrometer (15 cm^2)

The ConeTec data acquisition system consists of a Windows based computer, signal interface box, and power supply. The signal interface combines depth increment signals, seismic trigger signals and the downhole digital data. This combined data is then sent to the Windows based computer for collection and presentation. The data is recorded at fixed depth increments using a depth encoder that is either portable or integrated into the rig. The typical recording interval is 2.5 centimeters; custom recording intervals are possible.

The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q_c)
- Sleeve friction (f_s)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to ConeTec's CPTu operating procedures which are in general accordance with the current ASTM D5778 standard.

Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of two centimeters per second, within acceptable tolerances. Typically one meter length rods with an outer diameter of 1.5 inches are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to ConeTec's cone penetration testing procedures:

- Each filter is saturated in silicone oil under vacuum pressure prior to use
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

The interpretation of piezocone data for this report is based on the corrected tip resistance (q_t), sleeve friction (f_s) and pore water pressure (u). The interpretation of soil type is based on the correlations developed by Robertson, P.K., 2010. The Soil Behavior Type (SBT) classification chart developed by Robertson, P.K., 2010 is presented in Figure SBT. It should be noted that it is not always possible to accurately identify a soil behavior type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behavior type.

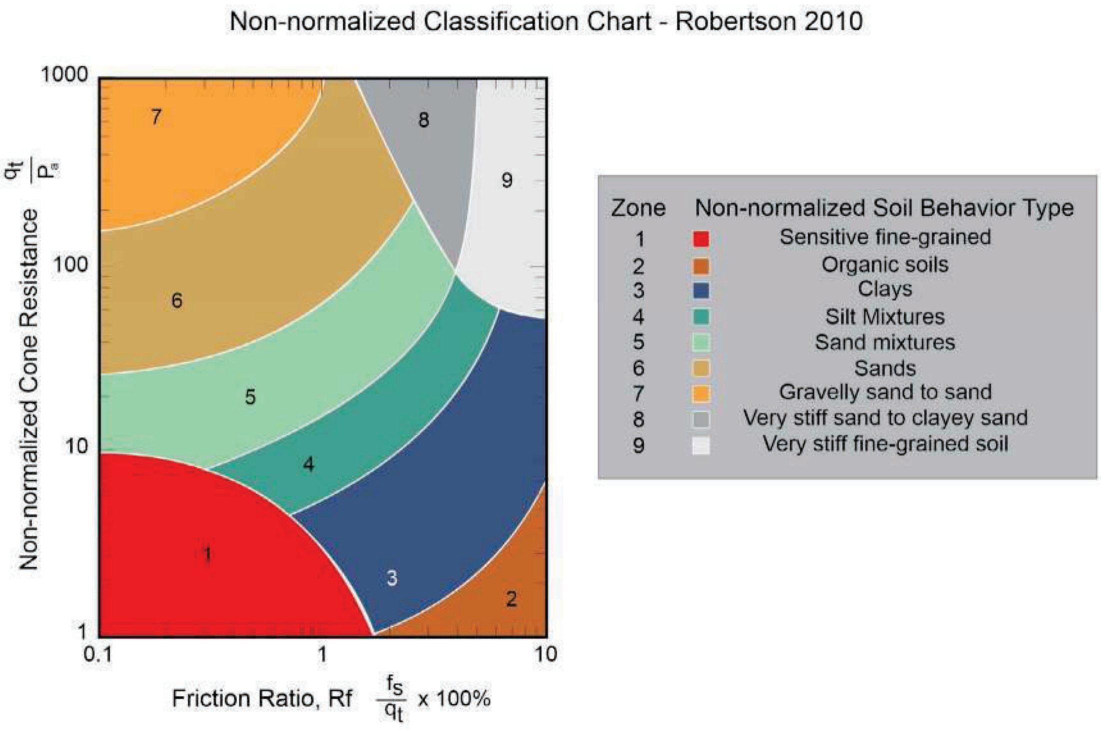


Figure SBT. Non-Normalized Soil Behavior Type Classification Chart (SBT)

The recorded tip resistance (q_c) is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance (q_t) according to the following expression presented in Robertson et al. (1986):

$$q_t = q_c + (1-a) \cdot u_2$$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)

The sleeve friction (f_s) is the frictional force on the sleeve divided by its surface area. As all ConeTec piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (Rf) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

For additional information on CPTu interpretations and calculated geotechnical parameters, refer to Robertson et al. (1986), Lunne et al. (1997), Robertson (2009), Mayne (2013, 2014) and Mayne and Peuchen (2012).

REFERENCES

ASTM D5778-20, 2020, “Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils”, ASTM International, West Conshohocken, PA. DOI: 10.1520/D5778-20.

Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, “Cone Penetration Testing in Geotechnical Practice”, Blackie Academic and Professional.

Mayne, P.W., 2013, “Evaluating yield stress of soils from laboratory consolidation and in-situ cone penetration tests”, Sound Geotechnical Research to Practice (Holtz Volume) GSP 230, ASCE, Reston/VA: 406-420. DOI: 10.1061/9780784412770.027.

Mayne, P.W. and Peuchen, J., 2012, “Unit weight trends with cone resistance in soft to firm clays”, Geotechnical and Geophysical Site Characterization 4, Vol. 1 (Proc. ISC-4, Pernambuco), CRC Press, London: 903-910.

Mayne, P.W., 2014, “Interpretation of geotechnical parameters from seismic piezocone tests”, CPT’14 Keynote Address, Las Vegas, NV, May 2014.

Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, “Use of Piezometer Cone Data”, Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.

Robertson, P.K., 2009, “Interpretation of cone penetration tests – a unified approach”, Canadian Geotechnical Journal, Volume 46: 1337-1355. DOI: 10.1139/T09-065.

Robertson, P.K., 2010. Soil behavior type from the CPT: an update. 2nd International Symposium on Cone Penetration Testing, CPT’10, Huntington Beach, CA, USA

PORE PRESSURE DISSIPATION TEST

The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).

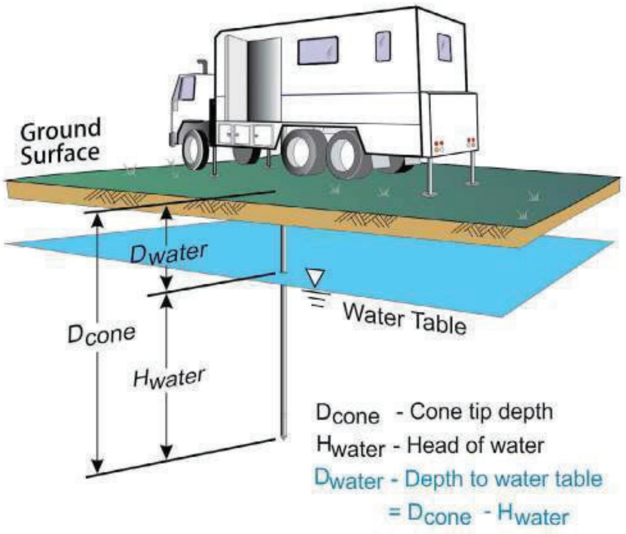
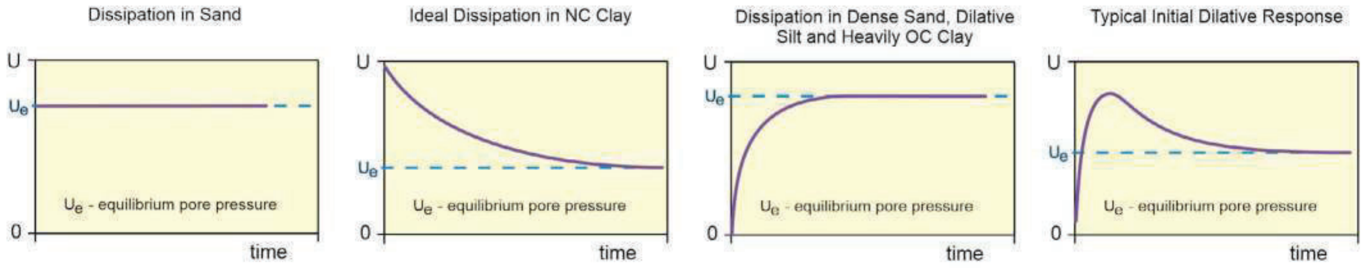


Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behavior.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.


Dissipation in Sand

Ideal Dissipation in NC Clay

Dissipation in Dense Sand, Dilative Silt and Heavily OC Clay

Typical Initial Dilative Response

Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure (u_{eq}) and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve in Figure PPD-2.

SEISMIC CONE PENETRATION TEST (SCPTu) - eSeries

Shear wave velocity (Vs) testing is performed in conjunction with the piezocone penetration test (SCPTu) in order to collect interval velocities. For some projects seismic compression wave velocity (Vp) testing is also performed.

ConeTec's piezocone penetrometers are manufactured with one horizontally active geophone (28 hertz) and one vertically active geophone (28 hertz). Both geophones are rigidly mounted in the body of the cone penetrometer, 0.2 meters behind the cone tip. The vertically mounted geophone is more sensitive to compression waves.

Shear waves are typically generated by using an impact hammer horizontally striking a beam that is held in place by a normal load. In some instances, an auger source or an imbedded impulsive source may be used for both shear waves and compression waves. The hammer and beam act as a contact trigger that initiates the recording of the seismic wave traces. For impulsive devices an accelerometer trigger may be used. The traces are recorded in the memory of the cone using a fast analog to digital converter. The seismic trace is then transmitted digitally uphole to a Windows based computer through a signal interface box for recording and analysis. An illustration of the shear wave testing configuration is presented in Figure SCPTu-1.

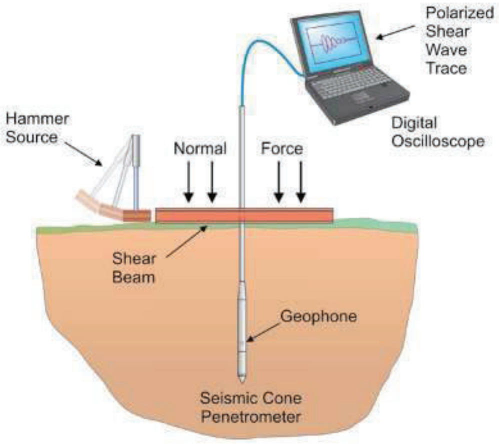


Figure SCPTu-1. Illustration of the SCPTu system

All testing is performed in accordance to ConeTec's SCPTu operating procedures which are in general accordance with the current ASTM D5778 and ASTM D7400 standards.

Prior to the start of a SCPTu sounding, the procedures described in the Cone Penetration Test section are followed. In addition, the active axis of the geophone is aligned parallel to the beam (or source) and the horizontal offset between the cone and the source is measured and recorded.

Prior to recording seismic waves at each test depth, cone penetration is stopped and the rods are decoupled from the rig to avoid transmission of rig energy down the rods. Typically, five wave traces for each orientation are recorded for quality control and uncertainty analysis purposes. After reviewing wave traces for consistency the cone is pushed to the next test depth (typically one meter intervals or as requested by the client). Figure SCPTu-2 presents an illustration of a SCPTu test.

For additional information on seismic cone penetration testing refer to Robertson et al. (1986).

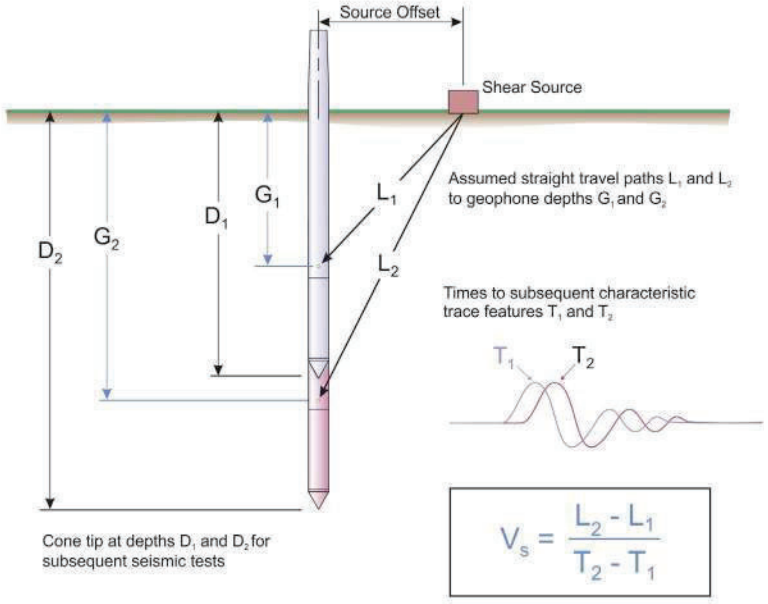


Figure SCPTu-2. Illustration of a seismic cone penetration test

For the determination of interval travel times the wave traces from all depths are displayed in analysis software. The results of the interval picks are supplied in the relevant appendix of this report. Standard practice for ConeTec is to record five wave traces for each source direction at each test depth. Outlier impacts are identified in the field and the impacts are repeated. For the final wave trace profile, the traces are stacked in the time domain to display a single average trace.

Calculation of the interval velocities are performed by visually picking a common feature (e.g. the first characteristic peak, trough, or crossover) on all of the recorded wave sets and taking the difference in ray path divided by the time difference between subsequent features. Ray path is defined as the straight line distance from the seismic source to the geophone, accounting for beam offset, source depth and geophone offset from the cone tip.

In some cases, usually for shear wave velocity testing, more than one characteristic marker may be used. If there is an overlap between different sets of characteristic markers, then the average time value for those sets of interval times is applied to the determination of velocity.

Ideally, all depths are used for the determination of the velocity profile. However, an interval may be skipped if there is some ambiguity or quality concern with a particular depth, resulting in a larger interval.

Tabular velocity results and SCPTu plots are presented in the relevant appendix.

For all SCPTu soundings that have achieved a depth of at least 100 feet (30 meters), the average shear wave velocity to a depth of 100 feet ($\overline{v}_S$) has been calculated and provided for all applicable soundings using the following equation presented in ASCE (2010).

$$\bar{v}_s = \frac{\sum_{i=1} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}}}$$

where: $\bar{v}_S$ = average shear wave velocity ft/s (m/s)
d_i = the thickness of any layer between 0 and 100 ft (30 m)
v_{Si} = the shear wave velocity in ft/s (m/s)
$\sum_{i=1}^{n} d_i$ = the total thickness of all layers between 0 and 100 ft (30 m)

Average shear wave velocity, $\bar{v}_S$ is also referenced to V_S100 or V_S30.

The layer travel times refers to the travel times propagating in the vertical direction, not the measured travel times from an offset source.

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ASTM D5778-20, 2020, “Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils”, ASTM International, West Conshohocken, PA. DOI: 10.1520/D5778-20.

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Robertson, P.K., Campanella, R.G., Gillespie D and Rice, A., 1986, “Seismic CPT to Measure In-Situ Shear Wave Velocity”, Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8: 791-803. DOI: 10.1061/(ASCE)0733-9410(1986)112:8(791).

Cone Penetration Digital File Formats

CONE PENETRATION DIGITAL FILE FORMATS - eSeries

CPT Data Files (COR Extension)

ConeTec CPT data files are stored in ASCII text files that are readable by almost any text editor. ConeTec file names start with the job number (which includes the two digit year number) an underscore as a separating character, followed by two letters based on the type of test and the sounding ID. The last character position is reserved for an identifier letter (such as b, c, d etc) used to uniquely distinguish multiple soundings at the same location. The CPT sounding file has the extension COR. As an example, for job number 21-02-00001 the first CPT sounding will have file name 21-02-00001_CP01.COR

The sounding (COR) file consists of the following components:

1. Two lines of header information
2. Data records
3. End of data marker
4. Units information

Header Lines

Line 1: Columns 1-6 may be blank or may indicate the version number of the recording software
Columns 7-21 contain the sounding Date and Time (Date is MM:DD:YY)
Columns 23-38 contain the sounding Operator
Columns 51-100 contain extended Job Location information

Line 2: Columns 1-16 contain the Job Location
Columns 17-32 contain the Cone ID
Columns 33-47 contain the sounding number
Columns 51-100 may contain extended sounding ID information

Data Records

The data records contain 4 or more columns of data in floating point format. A comma and spaces separate each data item:

Column 1: Sounding Depth (meters)
Column 2: Tip (q_c), recorded in units selected by the operator
Column 3: Sleeve (f_s), recorded in units selected by the operator
Column 4: Dynamic pore pressure (u), recorded in units selected by the operator
Column 5: Empty or may contain other requested data such as Gamma, Resistivity or UVIF data

End of Data Marker

After the last line of data there is a line containing an ASCII 26 (CTL-Z) character (small rectangular shaped character) followed by a newline (carriage return / line feed). This is used to mark the end of data.

Units Information

The last section of the file contains information about the units that were selected for the sounding. A separator bar makes up the first line. The second line contains the type of units used for depth, q_c, f_s and u. The third line contains the conversion values required for ConeTec's software to convert the recorded data to an internal set of base units (bar for q_c, bar for f_s and meters for u). Additional lines intended for internal ConeTec use may appear following the conversion values.

CPT Data Files (XLS Extension)

Excel format files of ConeTec CPT data are also generated from corresponding COR files. The XLS files have the same base file name as the COR file with a -BSC suffix. The information in the file is presented in table format and contains additional information about the sounding such as coordinate information, and tip net area ratio.

The BSCI suffix is given to XLS files which are enhanced versions of the BSC files and include the same data records in addition to inclination data collected for each sounding.

CPT Dissipation Files (XLS Extension)

Pore pressure dissipation files are provided in Excel format and contain each dissipation trace that exceeds a minimum duration (selected during post-processing) formatted column wise within the spreadsheet. The first column (Column A) contains the time in seconds and the second column (Column B) contains the time in minutes. Subsequent columns contain the dissipation trace data. The columns extend to the longest trace of the data set.

Detailed header information is provided at the top of the worksheet. The test depth in meters and feet, the number of points in the trace and the particular units are all presented at the top of each trace column.

CPT Dissipation files have the same naming convention as the CPT sounding files with a "–PPD" suffix.

Data Records

Each file will contain dissipation traces that exceed a minimum duration (selected during post-processing) in a particular column. The dissipation pore pressure values are typically recorded at varying time intervals throughout the trace; rapidly to start and increasing as the duration of the test lengthens. The test depth in meters and feet, the number of points in the trace and the trace number are identified at the top of each trace column.

Cone Type Designations

Cone ID	Cone Description	Tip Cross Sect. Area (cm^2)	Tip Capacity (bar)	Sleeve Area (cm^2)**	Sleeve Capacity (bar)	Pore Pressure Capacity (bar)
EC###	A15T1500F15U35	15	1500	225	15	35
EC###	A15T375F10U35	15	375	225	10	35
EC###	A10T1000F10U35	10	1000	150	10	35

refers to the Cone ID number

**Outer Cylindrical Area

Description of Methods for Calculated CPT Geotechnical Parameters

CALCULATED CPT GEOTECHNICAL PARAMETERS

A Detailed Description of the Methods Used in ConeTec's CPT Geotechnical Parameter Calculation and Plotting Software

Revision SZW-Rev 18

Revised February 10, 2023
Prepared by Jim Greig, M.A.Sc, P.Eng (BC, AB, ON)

Limitations

The geotechnical parameter output was prepared specifically for the site and project named in the accompanying report subject to objectives, site conditions and criteria provided to ConeTec by the client. The output may not be relied upon by any other party or for any other site without the express written permission of ConeTec Group (ConeTec) or any of its affiliates. For this project, ConeTec has provided site investigation services, prepared factual data reporting and produced geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

To understand the calculations that have been performed and to be able to reproduce the calculated parameters the user is directed to the basic descriptions for the methods in this document and the detailed descriptions and their associated limitations and appropriateness in the technical references cited for each parameter.

BETTER INFORMATION, **BETTER DECISIONS**

ConeTec's Calculated CPT Geotechnical Parameters as of February 10, 2023.

ConeTec's CPT parameter calculation and plotting routine provides a tabular output of geotechnical parameters based on current published CPT correlations and is subject to change to reflect the current state of practice. Due to drainage conditions and the basic assumptions and limitations of the correlations, not all geotechnical parameters provided are considered applicable for all soil types. The results are presented only as a guide for geotechnical use and should be carefully examined for consideration in any geotechnical design. Reference to current literature is strongly recommended. ConeTec does not warranty the correctness or the applicability of any of the geotechnical parameters calculated by the program and does not assume liability for any use of the results in any design or review. For verification purposes we recommend that representative hand calculations be done for any parameter that is critical for design purposes. The end user of the parameter output should also be fully aware of the techniques and the limitations of any method used by the program. The purpose of this document is to inform the user as to which methods were used and to direct the end user to the appropriate technical papers and/or publications for further reference.

The geotechnical parameter output was prepared specifically for the site and project named in the accompanying report subject to objectives, site conditions and criteria provided to ConeTec by the client. The output may not be relied upon by any other party or for any other site without the express written permission of ConeTec Group (ConeTec) or any of its affiliates.

The CPT calculations are based on values of tip resistance, sleeve friction and pore pressures considered at each data point or averaged over a user specified layer thickness (e.g., 0.20 m). Note that q_t is the tip resistance corrected for pore pressure effects and q_c is the recorded tip resistance. The corrected tip resistance (corrected using u_2 pore pressure values) is used for all calculations. Since all ConeTec cones have equal end area friction sleeves pore pressure corrections to sleeve friction, f_s, are not performed.

Corrected tip resistance: $q_t = q_c + (1-a) \cdot u_2$ (consistent units are required)

where: q_t is the corrected tip resistance

q_c is the recorded tip resistance

u_2 is the recorded dynamic pore pressure from behind the tip (u_2 position)

a is the Net Area Ratio for the cone (typically 0.80 for ConeTec cones)

The total stress calculations are based on soil unit weight values that have been assigned to the Soil Behavior Type (SBT) zones, from a user defined unit weight profile, by using a single uniform value throughout the profile, through unit weight estimation techniques described in various technical papers or from a combination of these methods. The parameter output files indicate the method(s) used.

Effective vertical overburden stresses are calculated using the total stress and equilibrium pore pressure (u_{eq} or u_o) values derived from an assumed hydrostatic distribution of pore pressures below the water table or from a user defined equilibrium pore pressure profile (typically obtained from CPT dissipation tests) or a combination of the two. For over water projects the stress effects of the column of water above the mudline are taken into account as is the appropriate unit weight of water. How this is done depends on where the instruments are zeroed (i.e. on deck or at the mudline). The parameter output files indicate the method(s) used.

A majority of parameter calculations are derived from or driven by results based on material types as determined by the various soil behavior type charts depicted in Figures 1 through 6. The parameter output files indicate the method(s) used.

The Soil Behavior Type classification chart shown in Figure 1 is the classic non-normalized SBT Chart developed at the University of British Columbia and reported in Robertson, Campanella, Gillespie and Greig (1986). Figure 2 shows the original normalized (linear method) SBTn chart developed by Robertson (1990). The Bq classification charts shown in Figures 3a and 3b incorporate pore pressures into the SBT classification and are based on the methods described in Robertson (1990). Many of these charts have been summarized in Lunne, Robertson and Powell (1997). The Jefferies and Davies SBT chart shown in Figure 3c is based on the techniques discussed in Jefferies and Davies (1993) which introduced the concept of the Soil Behavior Type Index parameter, I_c. Take note that the I_c parameter developed by Robertson and Fear (1995) and Robertson and Wride (1998) is similar in concept but uses a slightly different calculation method than that defined by Jefferies and Davies (1993) as the latter incorporates pore pressure in their technique through the use of the Bq parameter. The normalized Qtn SBT chart shown in Figure 4 is based on the work by Robertson (2009) utilizing a variable stress ratio exponent, n, for normalization based on a slightly modified redefinition and iterative approach for I_c. The boundary curves drawn on the chart are based on the work described in Robertson (2010).

Figure 5 shows a revised 1986 SBT Chart presented to CPT'10 by Robertson (2010b). It is known as the Updated non-normalized Soil Behavior Chart (also referred to as the Rev SBT Chart (PKR2010) in our output files). This chart was produced to be more in line with all post-1986 Robertson charts having the same 9 soil type zones, a $\log_{10}$ axis for friction ratio, R_f in this case, and a unitless tip resistance axis.

Figure 6 shows a revised behavior based chart by Robertson (2016) depicting contractive-dilative zones. As the zones represent material behavior rather than soil gradation ConeTec has chosen a set of zone colors that are less likely to be confused with material type colors from previous SBT charts. These colors differ from those used by Dr. Robertson. A green palette was selected for the dilative (desirable) side of the chart and a red palette for the contractive side of the chart.

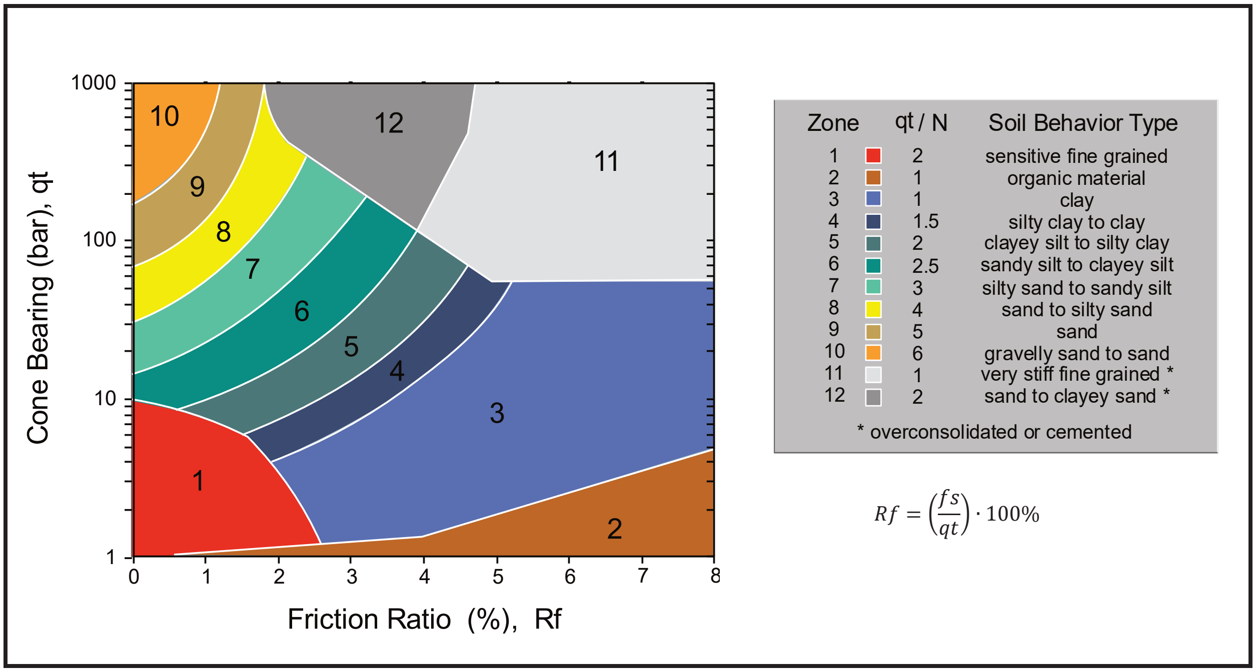


Figure 1. Non-normalized Soil Behavior Type Classification Chart (SBT)

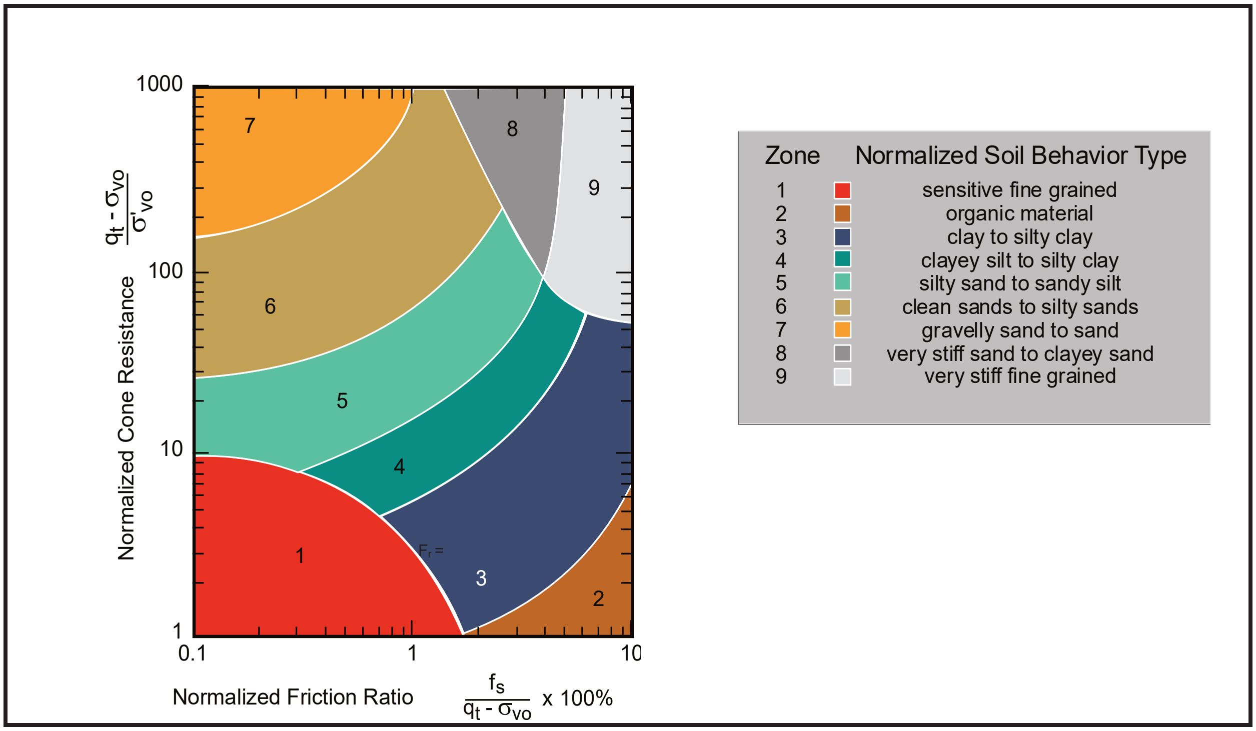


Figure 2. Normalized Soil Behavior Type Classification Chart (SBTn)

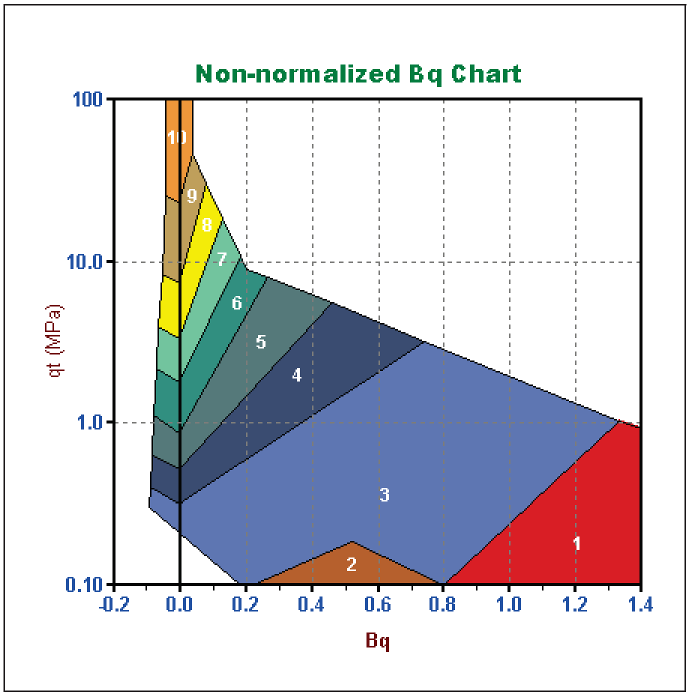


Figure 3a. Alternate Soil Behavior Type Chart (SBT Bq): q_t - B_q

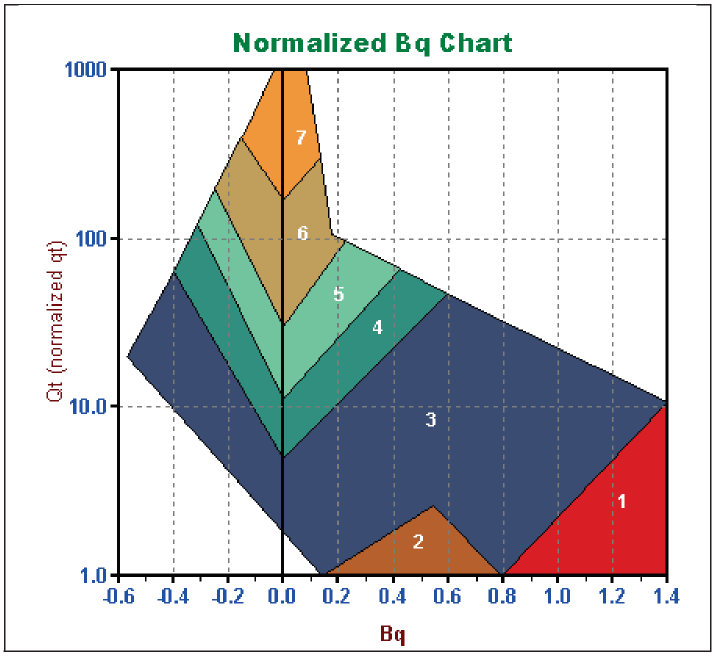


Figure 3b. Alternate Soil Behavior Type Charts (SBT Bqn): Q_t-B_q

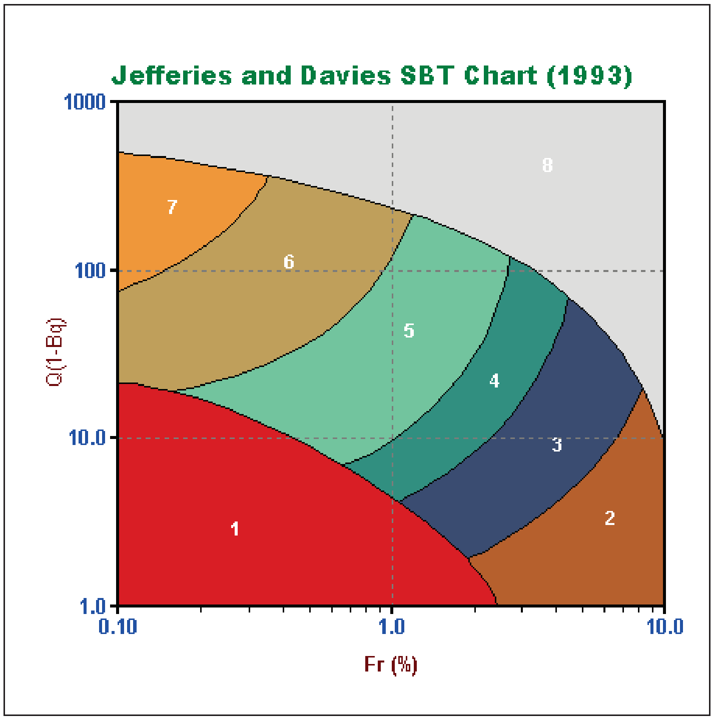


Figure 3c. Alternate Soil Behavior Type Charts: $Q(1-B_q)$ - F_r

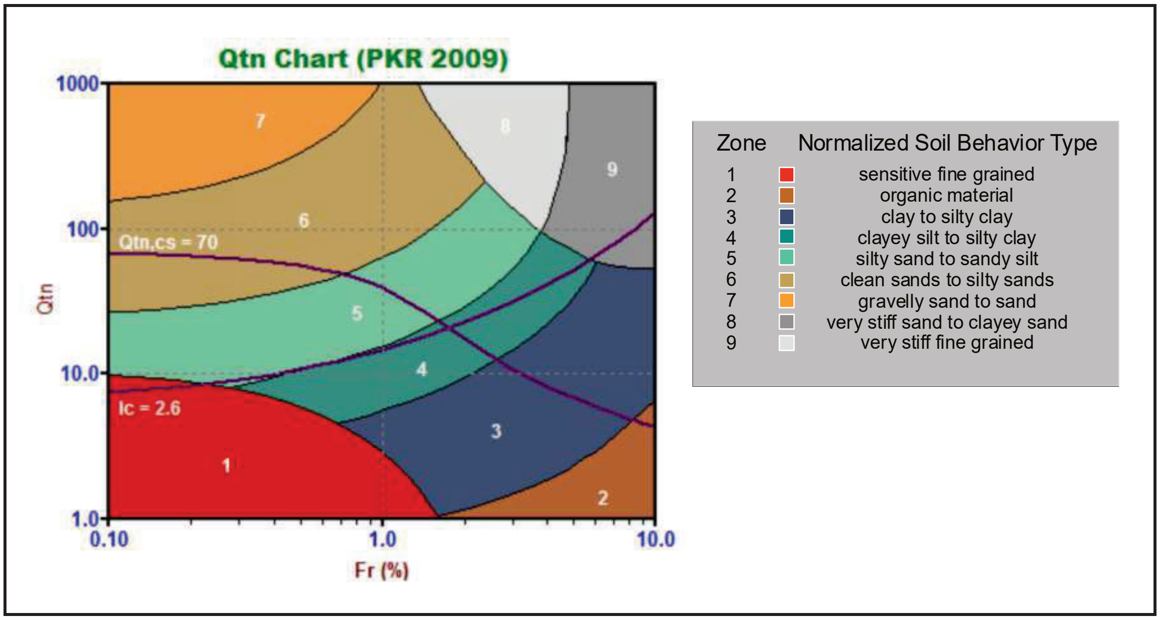


Figure 4. Normalized Soil Behavior Type Chart using Q_{tn} (SBT Qtn)

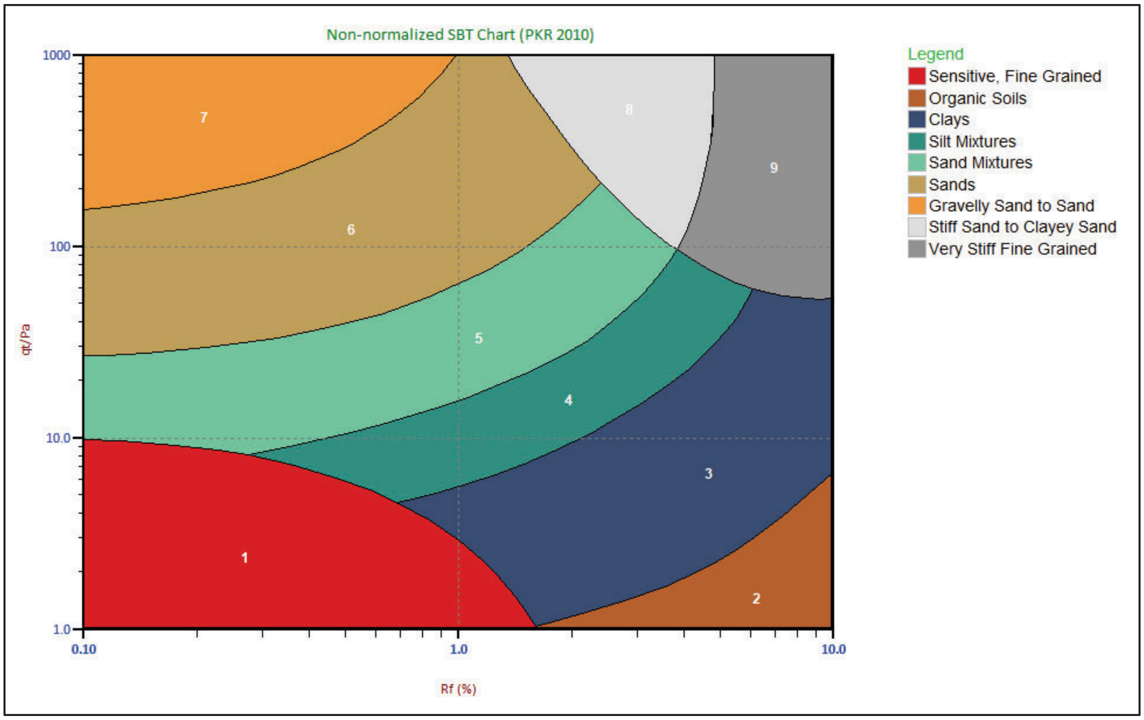


Figure 5. Non-normalized Soil Behavior Type Chart (2010)

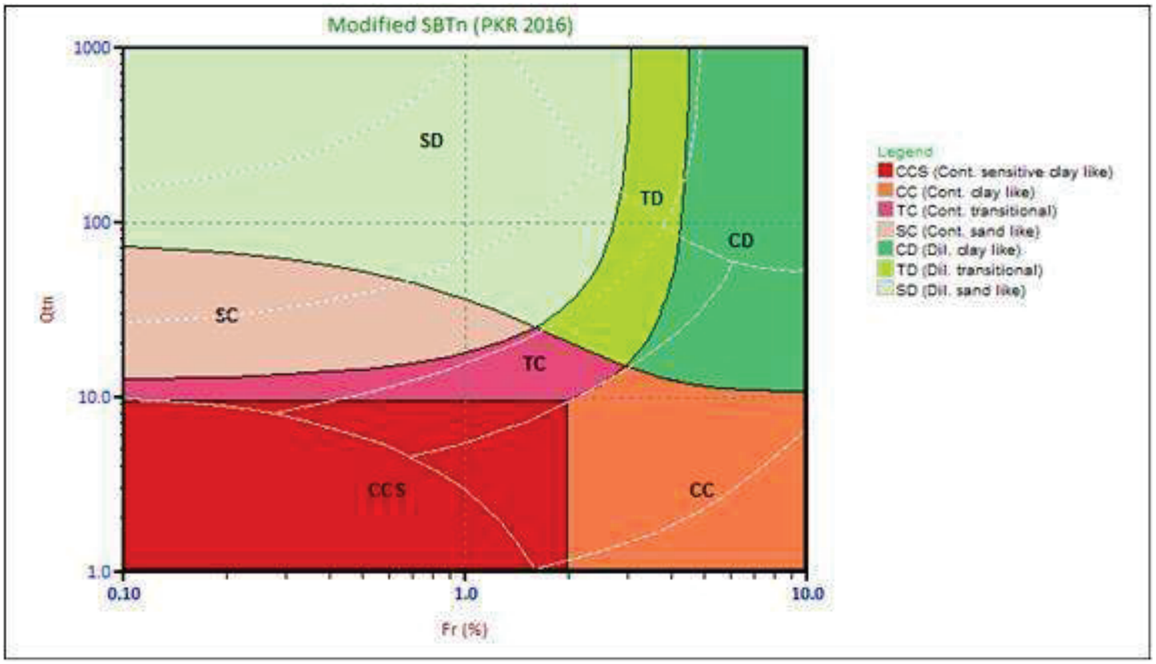


Figure 6. Modified SBTn Behavior Based Chart

Details regarding the geotechnical parameter calculations are provided in Tables 1a and 1b. The appropriate references cited are listed in Table 2. Non-liquefaction specific parameters are detailed in Table 1a and liquefaction specific parameters are detailed in Table 1b.

Where methods are based on charts or techniques that are too complex to describe in this summary, we recommend that the user refer to the cited material. Specific limitations for each method are described in the cited material.

Where the results of a calculation/correlation are deemed *'invalid'* the value will be represented by the text strings "-9999", "-9999.0", the value 0.0 (Zero) or an empty cell. Invalid results will occur because of (and not limited to) one or a combination of:

1. Invalid or undefined CPT data (e.g., drilled out section or data gap).

2. Where the calculation method is inappropriate, for example, drained parameters in a material behaving in an undrained manner (and vice versa).

3. Where input values are beyond the range of the referenced charts or specified limitations of the correlation method.

4. Where pre-requisite or intermediate parameter calculations are invalid.

The parameters selected for output from the program are often specific to a particular project. As such, not all of the calculated parameters listed in Tables 1and 1a may be included in the output files delivered with this report.

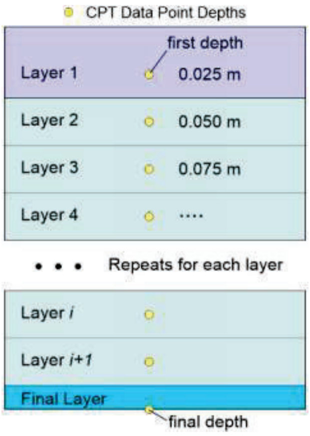
The output files are typically provided in Microsoft Excel XLS, XLSX or CSV format. The ConeTec software has several options for output depending on the number or types of calculated parameters desired or those specifically contracted for by the client. Each output file is named using the original file base name (from the .COR file) followed by a three or four character indicator of the output set selected (e.g. BSC, TBL, NLI, NL2, IFI, IFI2, IFI3) and possibly followed by an operator selected suffix identifying the characteristics of the particular calculation run.

Table 1a. CPT Parameter Calculation Methods – Non liquefaction Parameters

Reference Notes: CK* - Common Knowledge, U* - Unpublished

Calculated Parameter	Description	Equation	Ref
Depth	Mid Layer Depth *(where calculations are done at each point then Mid Layer Depth = Recorded Depth)*	*[Depth (Layer Top) + Depth (Layer Bottom)]/ 2.0*	CK*
Elevation	Elevation of Mid Layer is based on the sounding collar elevation supplied by the client or through a site survey In Sweden a variation of elevation is used where the elevation increases with depth. We refer to this as inverse elevation.	Elevation = Collar Elevation – Depth InverseElevation = Collar Elevation + Depth	CK* N/A
Avg qc	Averaged recorded tip value (q_c)	$Avgqc = \frac{1}{n}\sum_{i=1}^{n} q_c$ *n=1 when calculations are done at each point*	CK*
Avg qt	Averaged corrected tip (q_t) where: $q_t = q_c + (1 - a) \cdot u_2$ Averaged q_t is not calculated using the average q_c and averaged u values. Averaged q_t is based on the average of the q_t values calculated at each data point.	$Avgqt = \frac{1}{n}\sum_{i=1}^{n} q_t$ *n=1 when calculations are done at each point*	1
Avg fs	Averaged sleeve friction (f_s) No pore pressure corrections are applied to f_s.	$Avgfs = \frac{1}{n}\sum_{i=1}^{n} fs$ *n=1 when calculations are done at each point*	CK*
Avg Rf	Averaged friction ratio (R_f) where friction ratio is defined as: $R_f = 100\% \cdot \frac{fs}{q_t}$	$AvgRf = 100\% \cdot \frac{Avgfs}{Avgqt}$ *not an average of individual R_f values*	CK*
Avg u	Averaged dynamic pore pressure *(u)*	$Avgu = \frac{1}{n}\sum_{i=1}^{n} u_i$ *n=1 when calculations are done at each point*	CK*
Avg Res	Averaged Resistivity (this data is not always available since it is a specialized test requiring an additional module)	$AvgRes = \frac{1}{n}\sum_{i=1}^{n} Resistivity_i$ *n=1 when calculations are done at each point*	CK*
Avg UVIF	Averaged UVIF ultra-violet induced fluorescence (this data is not always available since it is a specialized test requiring an additional module)	$AvgUVIF = \frac{1}{n}\sum_{i=1}^{n} UVIF_i$ *n=1 when calculations are done at each point*	CK*
Avg Temp	Averaged Temperature (this data is not always available)	$AvgTemp = \frac{1}{n}\sum_{i=1}^{n} Temperature_i$ *n=1 when calculations are done at each point*	CK*
Avg Gamma	Averaged Gamma Counts (this data is not always available since it is a specialized test requiring an additional module)	$AvgGamma = \frac{1}{n}\sum_{i=1}^{n} Gamma_i$ *n=1 when calculations are done at each point*	CK*
SBT	Soil Behavior Type as defined by Robertson et al 1986 (often referred to as Robertson and Campanella, 1986)	See Figure 1	1, 5
SBTn	Normalized Soil Behavior Type as defined by Robertson 1990 (linear normalization using Q_t, now referred to as Q_{t1})	See Figure 2	2, 5

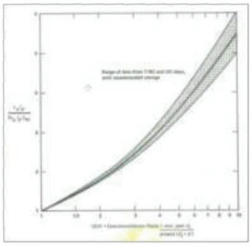
Calculated Parameter	Description	Equation	Ref
SBT-Bq	Non-normalized Soil Behavior type based on non-normalized tip resistance and the B_q parameter	See Figure 3a	1, 2, 5
SBT-Bqn	Normalized Soil Behavior type based on normalized tip resistance (Q_t, now called Q_{t1}) and the B_q parameter	See Figure 3b	2, 5
SBT-JandD	Soil Behavior Type as defined by Jeffries and Davies	See Figure 3c	7
SBT Qtn	Soil Behavior Type as defined by Robertson (2009) using a variable stress ratio exponent for normalization based on $I_{c\ (PKR\ 2009)}$	See Figure 4	15
Modified Non-normalized SBT Chart SBT (PKR2010)	This is a revised version of the simple 1986 non-normalized SBT chart (presented at CPT '10). The revised version has been reduced from 12 zones to 9 zones to be similar to the normalized Robertson charts. Other updates include a dimensionless tip resistance normalized to atmospheric pressure, q_t/P_a, on the vertical axis and a log scale for non-normalized friction ratio, R_f, along the horizontal axis.	See Figure 5	33
Modified SBTn (contractive /dilative)	Modified SBTn chart as defined by Robertson (2016) indicating zones of contractive/dilative behavior. Note that ConeTec displays the chart with colors different from Robertson. ConeTec's colors were chosen to avoid confusion with soil type descriptions.	See Figure 6	30
Unit Wt.	Unit Weight of soil determined from one of the following user selectable options: 1) uniform value 2) value assigned to each SBT zone 3) value assigned to each SBTn zone 4) value assigned to SBTn zone as determined from Robertson and Wride (1998) based on q_{c1n} 5) values assigned to SBT Qtn zones 6) values based on Robertson updated non-normalized Soil Behavior Type Chart (2010b) 6) Mayne f_s (sleeve friction) method 7) Robertson and Cabal 2010 method 8) user supplied unit weight profile The last option may co-exist with any of the other options.	See references	3, 5, 15, 21, 24, 29, 33

Calculated Parameter	Description	Equation	Ref
TStress σ_v	Total vertical overburden stress at Mid Layer Depth *A layer is defined as the averaging interval specified by the user where depths are reported at their respective mid-layer depth.* For data calculated at each point layers are defined using the recorded depth as the mid-point of the layer. Thus, a layer starts half-way between the previous depth and the current depth unless this is the first point in which case the layer start is at zero depth. The layer bottom is half-way from the current depth to the next depth unless it is the last data point. Defining layers affects how stresses are calculated since the unit weight attributed to a data point is used throughout the entire layer. This means that to calculate the stresses the total stress at the top and bottom of a layer are required. The stress at mid layer is determined by adding the incremental stress from the layer top to the mid-layer depth. The stress at the layer bottom becomes the stress at the top of the subsequent layer. Stresses are NOT calculated from mid-point to mid-point. For over-water work the total stress due to the column of water above the mud line is taken into account where appropriate.	$TStress = \sum_{i=1}^{n} \gamma_i h_i$ *where* γ_i is layer unit weight h_i is layer thickness 	CK*
EStress σ_v'	Effective vertical overburden stress at mid-layer depth.	$\sigma_v' = \sigma_v - u_{eq}$	CK*
Equil u u_{eq} or u_0	Equilibrium pore pressures are determined from one of the following user selectable options: 1) hydrostatic below the water table 2) user supplied profile 3) combination of those above When a user supplied profile is used/provided a linear interpolation is performed between equilibrium pore pressures defined at specific depths. If the profile values start below the water table then a linear transition from zero pressure at the water table to the first defined pointed is used. Equilibrium pore pressures may come from dissipation tests, adjacent piezometers or other sources. Occasionally, an extra equilibrium point ("assumed value") will be provided in the profile that does not come from a recorded value to smooth out any abrupt changes or to deal with material interfaces. These "assumed" values will be indicated on our plots and in tabular summaries.	For the hydrostatic option: $u_{eq} = \gamma_w \cdot (D - D_{wt})$ where u_{eq} is equilibrium pore pressure γ_w is the unit weight of water D is the current depth D_{wt} is the depth to the water table	CK*
K_0	Coefficient of earth pressure at rest, K_0.	$K_O = (1 - \sin\Phi') \, OCR^{\sin\Phi'}$	17
C_n	Overburden stress correction factor used for $(N_1)_{60}$ and older CPT parameters.	$C_n = (P_a/\sigma_v')^{0.5}$ where $0.0 < C_n < 2.0$ *(user adjustable, typically ranging from 1.7 to 2.0)* P_a *is atmospheric pressure (100 kPa)*	4, 12

Calculated Parameter	Description	Equation	Ref
C_q	Overburden stress normalizing factor.	$C_q = 1.8 / [0.8 + (\sigma_v'/P_a)]$ where *$0.0 < C_q < 2.0$ (user adjustable)* *P_a is atmospheric pressure (100 kPa)* *Robertson and Wride define C_q to be the same as C_n. The Olson definition above is used in the program.*	3, 12
N_{60}	SPT N value at 60% energy calculated from q_t/N ratios assigned to each SBT zone. This method has abrupt N value changes at zone boundaries.	*See Figure 1*	5
$(N_1)_{60}$	SPT N_{60} value corrected for overburden pressure.	$(N_1)_{60} = C_n \bullet N_{60}$	4
$N_{60}I_c$	SPT N_{60} values based on the I_c parameter, as defined by Robertson and Wride 1998 (3), or by Robertson 2009 (15).	$(q_t/P_a)/ N_{60} = 8.5 (1 – I_c/4.6)$ $(q_t/P_a)/ N_{60} = 10^{(1.1268 – 0.2817Ic)}$ P_a being atmospheric pressure	3, 5 15, 31
$(N_1)_{60}I_c$	SPT N_{60} value corrected for overburden pressure (using N_{60} I_c). User has 3 options.	1) $(N_1)_{60}Ic= C_n \bullet (N_{60} I_c)$ 2) $q_{c1n}/ (N_1)_{60}I_c = 8.5 (1 – I_c/4.6)$ 3) $(Q_{tn})/ (N_1)_{60}I_c = 10^{(1.1268 – 0.2817Ic)}$	4 5 15, 31
S_u or S_u (N_{kt})	Undrained shear strength based on q_t S_u factor N_{kt} is user selectable.	$Su = \frac{qt - \sigma_v}{N_{kt}}$	1, 5
S_u or S_u (N_{du}) or S_u ($N_{\Delta u}$)	Undrained shear strength based on pore pressure S_u factor $N_{\Delta u}$ is user selectable.	$Su = \frac{u_2 - u_{eq}}{N_{\Delta u}}$	1, 5
D_r	Relative Density determined from one of the following user selectable options: 1) Ticino Sand 2) Hokksund Sand 3) Schmertmann (1978) 4) Jamiolkowski (1985) - All Sands 5) Jamiolkowski et al (2003) (various compressibilities, K_o)	See reference (methods 1 through 4) Jamiolkowski et al (2003) reference	5 14
PHI ϕ	Friction Angle determined from one of the following user selectable options (methods 1 through 4 are for sands and method 5 is for silts and clays): 1) Campanella and Robertson 2) Durgunoglu and Mitchel 3) Janbu 4) Kulhawy and Mayne 5) NTH method (clays and silts)	See appropriate reference	5 5 5 11 23
Delta U/q_t $\Delta u/q_t$ du/q_t	Differential pore pressure ratio (older parameter used before B_q was established)	$= \frac{\Delta u}{qt}$ *where:* $\Delta u = u - u_{eq}$ *and u = dynamic pore pressure* *u_{eq} = equilibrium pore pressure*	39

Calculated Parameter	Description	Equation	Ref
B_q	Pore pressure parameter	$Bq = \frac{\Delta u}{qt - \sigma_v}$ where: $\Delta u = u - u_{eq}$ *and* *u = dynamic pore pressure* *u_{eq} = equilibrium pore pressure*	1, 2, 5
Net q_t or qtNet	Net tip resistance (used in many subsequent correlations)	$qt - \sigma_v$	36
q_e or qE or q_E	Effective tip resistance (using the dynamic pore pressure u_2 and not equilibrium pore pressure)	$q_t - u_2$	36
qeNorm	Normalized effective tip resistance	$\frac{qt - u_2}{\sigma_v'}$	36
Q_t or Norm: Qt or Q_{t1}	Normalized q_t for Soil Behavior Type classification as defined by Robertson (1990) using a linear stress normalization. Note this is different from Q_{tn}. This parameter was renamed to Q_{t1} in Robertson, 2009. Without normalization limits this parameter calculates to very high unrealistic values at low stresses.	$Qt = \frac{qt - \sigma_v}{\sigma_v'}$	2, 5, 15
F_r or Norm: Fr	Normalized Friction Ratio for Soil Behavior Type classification as defined by Robertson (1990)	$Fr = 100\% \cdot \frac{fs}{qt - \sigma_v}$	2, 5
Q(1-B_q) Q(1-B_q) + 1	Q(1-B_q) grouping as suggested by Jefferies and Davies for their classification chart and the establishment of their I_c parameter. Later papers added the +1 term to the equation.	$Q \cdot (1 - Bq)$ $Q \cdot (1 - Bq) + 1$ *where Bq is defined as above and Q is the same as the normalized tip resistance, Q_{t1}, defined above*	6, 7, 34
q_{c1}	Normalized tip resistance, q_{c1}, using a fixed stress ratio exponent, n (this method has stress units)	$q_{c1} = q_t \cdot (Pa/\sigma_v')^{0.5}$ where: P_a = atmospheric pressure	21
q_{c1} (0.5)	Normalized tip resistance, q_{c1}, using a fixed stress ratio exponent, n (this method is unit-less)	q_{c1} *(0.5)=* $(q_t/P_a) \cdot (Pa/\sigma_v')^{0.5}$ where: P_a = atmospheric pressure	5
q_{c1} (C_n)	Normalized tip resistance, q_{c1}, based on C_n (this method has stress units)	$q_{c1}(Cn) = C_n * q_t$	5, 12
q_{c1} (C_q)	Normalized tip resistance, q_{c1}, based on C_q (this method has stress units)	$q_{c1}(Cq) = C_q * q_t$ (some papers use q_c)	5, 12
q_{c1n}	normalized tip resistance, q_{c1n}, using a variable stress ratio exponent, n (where n=0.0, 0.70, or 1.0) (this method is unit-less)	$q_{c1n} = (q_t / P_a)(P_a/\sigma_v')^n$ where: P_a = atm. Pressure and n varies as described below	3

Calculated Parameter	Description	Equation	Ref
I_c or Ic (RW1998)	Soil Behavior Type Index as defined by Robertson and Wride (1997, 1998) for estimating grain size characteristics and providing smooth gradational changes across the SBTn chart. Ic(RW1998) is different from that of Jefferies and Davies (7) and is different from Ic(PKR2009).	$I_c = [(3.47 - \log_{10}Q)^2 + (\log_{10} Fr + 1.22)^2]^{0.5}$ *Where:* $Q = \left(\frac{qt - \sigma_v}{P_a}\right)\left(\frac{P_a}{\sigma_v'}\right)^n$ *Or* $Q = q_{c1n} = \left(\frac{qt}{P_a}\right)\left(\frac{P_a}{\sigma_v'}\right)^n$ *depending on the iteration in determining* I_c *And* *Fr is in percent* P_a *= atmospheric pressure* *n has the following distinct values:* *0.5, 0.75 and 1.0* *and is determined in an iterative manner based on the resulting* I_c *in each iteration* *Note that NCEER replaced 0.75 with 0.70*	3, 4, 5 10
I_c (PKR 2009)	Soil Behavior Type Index, I_c (PKR 2009) is based on a variable stress ratio exponent n, which itself is based on I_c (PKR 2009). An iterative calculation is required to determine I_c (PKR 2009) and its corresponding n (PKR 2009).	I_c *(PKR 2009) =* $[(3.47 - \log_{10}Q_{tn})^2 + (1.22 + \log_{10}F_r)^2]^{0.5}$	15
n (PKR 2009)	Stress ratio exponent n, based on I_c (PKR 2009). An iterative calculation is required to determine n (PKR 2009) and its corresponding I_c (PKR 2009).	$n \text{ (PKR 2009)} = 0.381 (I_c) + 0.05 (\sigma_v'/P_a) - 0.15$	15
Q_{tn} (PKR 2009)	Normalized tip resistance using a variable stress ratio exponent based on I_c (PKR 2009) and n (PKR 2009). An iterative calculation is required to determine Q_{tn} (PKR 2009).	$Q_{tn} = [(qt - \sigma_v)/P_a](P_a/\sigma_v')^n$ *where* P_a *= atmospheric pressure (100 kPa)* *n = stress ratio exponent described above*	15
FC	Apparent fines content (%)	$FC=1.75(Ic^{3.25}) - 3.7$ $FC=100$ *for* $I_c > 3.5$ $FC=0$ *for* $I_c < 1.26$ $FC = 5\%$ *if* $1.64 < I_c < 2.6$ *AND* $F_r<0.5$	3
I_c Zone	This parameter is the Soil Behavior Type zone based on the I_c parameter (valid for zones 2 through 7 on SBTn or SBT Qtn charts)	$I_c < 1.31$ Zone = 7 $1.31 < I_c < 2.05$ Zone = 6 $2.05 < I_c < 2.60$ Zone = 5 $2.60 < I_c < 2.95$ Zone = 4 $2.95 < I_c < 3.60$ Zone = 3 $I_c > 3.60$ Zone = 2	3
CD	The contractive / dilative boundary on Robertson's Modified SBTn (contractive/dilative) Chart shown in Figure 6 above. The boundary is marked as CD = 70 on the chart in the relevant paper. Similar to the $Q_{tn,cs} = 70$ line in Figure 4.	$CD = 70 = (Q_{tn} - 11) (1 + 0.06F_r)^{17}$ lower bound of CD = 60: $CD = 60 = (Q_{tn} - 9.5) (1 + 0.06F_r)^{17}$	30

Calculated Parameter	Description	Equation	Ref
I_B	Hyberbolic fit defining the boundary between SBT soil types proposed by Schneider as a better fit than the I_c circles. I_B = 32 represents the boundary for most sand like soils. I_B = 22 represents the upper boundary for most clay like soils. The region between I_B=22 and I_B=32 is the "transitional soil" zone.	$I_B = 100\ (Q_{tn} + 10) / (70 + Q_{tn}\ F_r)$	30
State Param or State Parameter or ψ	The state parameter index, ψ, is defined as the difference between the current void ratio, e, and the critical void ratio, e_c. Positive ψ - contractive soil Negative ψ - dilative soil This is based on the work by Been and Jefferies (1985) and Plewes, Davies and Jefferies (1992) This method uses mean normal stresses based on a uniform value of K_0 or a calculated K_0 using methods described elsewhere in this document	See reference	6, 8
Yield Stress σ_p'	Yield stress is calculated using the following methods 1) General method 2) 1st order approximation using q_tNet (clays) 3) 1st order approximation using Δu_2 (clays) 4) 1st order approximation using q_e (clays) 5) Based on Vs	All stresses in kPa 1) $\sigma_p' = 0.33 \cdot (q_t - \sigma_v)^{m'}\ (\sigma_{atm}/100)^{1-m'}$ where $m' = 1 - \frac{0.28}{1+(I_c/2.65)^{25}}$ 2) $\sigma_p' = 0.33 \cdot (q_t - \sigma_v)$ 3) $\sigma_p' = 0.54 \cdot (\Delta u_2)$ $\Delta u_2 = u_2 - u_0$ 4) $\sigma_p' = 0.60 \cdot (q_t - u_2)$ 5) $\sigma_p' = (Vs/4.59)^{1.47}$	19 20 20 20 18
OCR OCR(JS1978)	Over Consolidation Ratio based on 1) Schmertmann (1978) method involving a plot plot of S_u/σ_v' /(S_u/σ_v')$_{NC}$ and OCR 	1) requires a user defined value for NC Su/P_c' ratio	9
YSR(Mayne2014) YSR (qtNet) YSR (deltaU) YSR (qe) YSR (Vs) OCR (PKR2015)	2) based on Yield stresses described above 3) approximate version based on qtNet 4) approximate version based on Δu 5) approximate version based on effective tip, q_e 6) approximate version based on shear wave velocity, V_s and σ_v' 7) based on Qt	2 through 5) *based on yield stresses* 6) YSR (Vs) = $\sigma_p'(Vs) / \sigma_v'$ 7) OCR = $0.25 \cdot (Qt)^{1.25}$	19 20 20 20 18 32
Es/qt	Intermediate parameter for calculating Young's Modulus, E, in sands. It is the Y axis of the reference chart. Note that Figured 5.59 from reference 5, Lunne, Robertson and Powell, (LRP) has an error. The X axis values are too high by a factor of 10. The plot is based on Baldi's (not Bellotti as cited in	Based on Figure 5.59 in the reference	5, 37

Calculated Parameter	Description	Equation	Ref
	LRP) original Figure 3 where the X axis is: $\frac{q_c}{\sqrt{\sigma'_v}}$ (both in kPa) with a range of 200 to 3000. Figure 5.59 from LRP shows a dimensionless form of the equation, q_{c1}, displaying the same range of values. Figure 5.59's X axis uses $q_{c1} = \left(\frac{q_c}{P_a}\right)\left(\frac{P_a}{\sigma'_v}\right)^{0.5}$ The two expressions are not the same: they differ by a factor of $\frac{\sqrt{P_a}}{P_a}$. With P_a taken to be 100 kPa the factor is 1/10. Substituting typical values of 200 bar (20000 kPa) for q_c and 225 kPa for σ_v' one gets: 20000 / 15 = 1333.33 for Bellotti's axis and $(200/1)(100/225)^{0.5}$ = 200 * (10/15) = 133.3 for LRP's axis (noting that P_a = 1 bar) showing a factor of 10 difference.		
Es or E_s Young's Modulus E	Young's Modulus based on the work done in Italy. There are three types of sands considered in this technique. The user selects the appropriate type for the site from: a) OC Sands b) Aged NC Sands c) Recent NC Sands Each sand type has a family of curves that depend on mean normal stress. The program calculates mean normal stress and linearly interpolates between the two extremes provided in the E_s/q_t chart. E_s is evaluated for an axial strain of 0.1%.	Mean normal stress is evaluated from: $$\sigma'_m = \frac{1}{3}(\sigma'_v + \sigma'_h + \sigma'_h)$$ where σ_v'= vertical effective stress σ_h'= horizontal effective stress *and* $\sigma_h = K_o \cdot \sigma_v'$ with K_o assumed to be 0.5	5
Delta U/TStress $\Delta u / \sigma_v$	Differential pore pressure ratio with respect to total stress	$= \frac{\Delta u}{\sigma_v}$ *where:* $\Delta u = u - u_{eq}$	39
Delta U/EStress, P Value, Excess Pore Pressure Ratio $\Delta u/\sigma_v'$	Differential pore pressure ratio with respect to effective stress. Key parameter (P, Normalized Pore Pressure Parameter, Excess Pore Pressure Ratio) in the Winckler et. al. static liquefaction method.	$= \frac{\Delta u}{\sigma'_v}$ *where:* $\Delta u = u - u_{eq}$	25, 25a
Su/EStress S_u/σ_v'	Undrained shear strength ratio with respect to vertical effective overburden stress using the S_u (N_{kt}) method	$= Su(N_{kt}) / \sigma_v'$	9, 23
Vs or V_s	Recorded shear wave velocities (not estimated). The shear wave velocities are typically collected over 1 m depth intervals. Each data point over the relevant depth range is assigned the same V_s value.	recorded data	27
Vp or V_p	Recorded compression wave (or P wave) velocities (not estimated). The P wave velocities are typically collected over 1 m depth intervals. Each data point over the relevant depth range is assigned the same V_p value.	recorded data	27

Calculated Parameter	Description	Equation	Ref
V_{s30} V_{s100}	The average shear wave velocity of the near surface materials to a depth of 30 m (100 ft). It is based on the sum of all travel times through all layers in the top 30m (100 ft). V_{s100} is the same calculation as V_{s30} except down to a depth of 100 feet.	$V_{s30} = \frac{total\ thickness\ of\ all\ layers\ to\ 30\ m}{\Sigma\left(\frac{layer\ thickness}{layer\ shear\ wave\ velocity}\right)}$ $V_{s30} = \frac{total\ thickness\ of\ all\ layers\ to\ 30\ m}{\Sigma\ (layer\ travel\ times)}$	38
G_{max}	G_{max} determined from SCPT shear wave velocities (not estimated values). Note that seismic data (V_s) is collected over set depth intervals (typically 1 meter). Each data point over the test segment is assigned the same V_s value. Since soil density changes with depth, slightly different G_{max} values may be calculated over the test depth interval.	$G_{max} = \rho V_s^2$ where ρ is the mass density of the soil determined from the estimated unit weights at each test depth	27
qtNet/G_{max}	Net tip resistance ratio with respect to the small strain modulus G_{max} determined from SCPT shear wave velocities (not estimated values)	$= (qt - \sigma_v) / G_{max}$ where $G_{max} = \rho V_s^2$ and ρ is the mass density of the soil determined from the estimated unit weights at each test depth	15, 28, 30
qUlt	A site specific and client specific parameter for estimating the limiting stress for "crane walk" accessibility	$q_{ult} = CraneWalkFactor \cdot S_u$ Where: *CraneWalkFactor* is client provided	U*
Estimated G_o	Estimated value for small strain shear modulus	$G_o = 0.0188[10^{(0.55Ic + 1,68)}](q_t - \sigma_v)$	15
Estimated E_{25}	Estimated value for Young's Modulus, E, at a 25% working load	$E_{25} = \alpha_E$ (qtNet) where $\alpha_E = 0.015[10^{(0.55Ic + 1,68)}]$	15
k_{SBT}	Estimated soil permeability derived from Soil Behavior Type (SBT) Chart I_c values.	For $1.0 < I_c \leq 3.27$: $k = 10^{(0.952 - 3.04Ic)}$ in m/s For $3.27 < Ic < 4.0$: $k = 10^{(-4.52 - 1.37Ic)}$ in m/s	35
M or D' Constrained Modulus	Constrained Modulus based on 1) Robertson, M 2) Mayne, D'	1) Robertson $M = \alpha_M (q_t - \sigma_v)$ $I_c > 2.2$ (fine grained) $\alpha_M = Qt$ when $Qt < 14$ $\alpha_M = 14$ when $Qt > 14$ $Ic < 2.2$ (coarse grained) $\alpha_M = 0.0188\ [10^{(0.55Ic + 1.68)})$ $D' = \alpha_D (qt - \sigma_v)$ where $\alpha_D = 5$	32 23

Table 1b. CPT Parameter Calculation Methods – Liquefaction Parameters

Calculated Parameter	Description	Equation	Ref
K_{SPT} or K_s	Equivalent clean sand factor for $(N_1)60$	$K_{SPT} = 1 + ((0.75/30) \cdot (FC - 5))$	10
K_{CPT} or K_c (RW1998)	Equivalent clean sand correction for q_{c1N}	$K_{cpt} = 1.0$ for $I_c \leq 1.64$ $K_{cpt} = f(I_c)$ for $I_c > 1.64$ (see reference) $K_c = - 0.403\ I_c^4 + 5.581\ I_c^3 - 21.63 I_c^2 + 33.75\ I_c - 17.88$	3, 10
K_c (PKR 2010)	Clean sand equivalent factor to be applied to Q_{tn}	$K_c = 1.0$ for $I_c \leq 1.64$ $K_c = - 0.403\ I_c^4 + 5.581\ I_c^3 - 21.63 I_c^2 + 33.75\ I_c - 17.88$ for $I_c > 1.64$	16
$(N_1)_{60cs}I_c$	Clean sand equivalent SPT $(N_1)_{60}I_c$. User has 3 options.	1) $(N_1)_{60cs}Ic = \alpha + \beta((N_1)_{60}I_c)$ 2) $(N_1)_{60cs}Ic = K_{SPT} * ((N_1)_{60}I_c)$ 3) $(q_{c1ncs})/ (N_1)_{60cs}I_c = 8.5\ (1 - I_c/4.6)$ FC ≤ 5%: $\alpha = 0$, $\beta=1.0$ FC ≥ 35% $\alpha = 5.0$, $\beta=1.2$ 5% < FC < 35% $\alpha = \exp[1.76 - (190/FC^2)]$ $\beta = [0.99 + (FC^{1.5}/1000)]$	10 10 5
q_{c1ncs}	Clean sand equivalent q_{c1n}	$q_{c1ncs} = q_{c1n} \cdot K_{cpt}$	3
$Q_{tn,cs}$ (PKR 2010)	Clean sand equivalent for Q_{tn} described above - Q_{tn} being the normalized tip resistance based on a variable stress exponent as defined by Robertson (2009)	$Q_{tn,cs} = Q_{tn} \cdot K_c$ (PKR 2016)	16
Su(Liq)/ESv or $S_u(Liq)/\sigma_v'$	Liquefied shear strength ratio as defined by Olson and Stark	$\frac{S_u(Liq)}{\sigma_v'} = 0.03 + 0.0143(q_{c1})$ Note: σ_v' and s_v' are synonymous	13
Su(Liq)/ESv or $S_u(Liq)/\sigma_v'$ (PKR 2010)	Liquefied shear strength ratio as defined by Robertson (2010)	$\frac{S_u(Liq)}{\sigma_v'}$ Based on a function involving $Q_{tn,cs}$	16
S_u (Liq) (PKR 2010)	Liquefied shear strength derived from the liquefied shear strength ratio and effective overburden stress	$S_u(Liq) = \sigma_v' \cdot \left(\frac{S_u(Liq)}{\sigma_v'}\right)$	16
Cont/Dilat Tip	Contractive / Dilative q_{c1} Boundary based on $(N_1)_{60}$	$(\sigma_v')_{boundary} = 9.58 \times 10^{-4}\ [(N_1)_{60}]^{4.79}$ q_{c1} is calculated from specified q_t(MPa)/N ratio	13
CRR	Cyclic Resistance Ratio (for Magnitude 7.5)	$q_{c1ncs} < 50$: $CRR_{7.5} = 0.833\ [q_{c1ncs}/1000] + 0.05$ $50 \leq q_{c1ncs} < 160$: $CRR_{7.5} = 93\ [q_{c1ncs}/1000]^3 + 0.08$	10
Kg or K_g	Small strain Stiffness Ratio Factor, K_g	$[G_{max}/q_t]/[q_{c1n}{}^{-m}]$ m = empirical exponent, typically 0.75	26

Calculated Parameter	Description	Equation	Ref
K_g*	Revised K_g factor extended to fine grained soils (Robertson).	$K_g^* = (G_o / q_n)(Q_{tn})^{0.75}$ where q_n is the net tip resistance = $q_t - \sigma_v$	30
SP Distance	State Parameter Distance, Winckler static liquefaction method	Perpendicular distance on Q_{tn} chart from plotted point to state parameter Ψ = -0.05 curve	25
URS NP Fr	Normalized friction ratio point on Ψ = -0.05 curve used in SP distance calculation		25
URS NP Q_{tn}	Normalized tip resistance (Q_{tn}) point on Ψ = -0.05 curve used in SP Distance calculation		25

Table 2. References

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38	Crow, H.L, Hunter, J.A. and Bobrowsky, P.T., 2012, "National shear wave measurement guidelines for Canadian seismic site assessment", Proceedings of GeoManitoba 2012, the 65th Canadian Geotechnical Conference.
39	Campanella, R.G., Robertson, P.K., Gillespie, D., 1982, "Cone penetration testing in deltaic soils", Canadian Geotechnical Journal, 20: 23-35.

Calibration Records

ADARA

Adara Systems Ltd.
201-8327 Eastlake Drive, Burnaby, BC, Canada V5A4W2
Tel: 1-604-273-6013

CERTIFICATE OF CALIBRATION

Calibration Information			
Cone Serial Number	EC990	Model	A15 T1000 F10 U35
Calibration Date (YYYY-MM-DD)	2024-12-11		
Calibration Due (YYYY-MM-DD)	2025-12-11		
Calibration Performed By	Diane Eden	Signature	Digitally signed by Diane Eden Date: 2024-12-12
Calibration Approved By	Vishrut Khunt	Signature	Digitally signed by Vishrut Khunt Date: 2024-12-12

Lab Condition	As Found	As Left		
Lab Temperature	N/A	23˚C		
Lab Humidity	N/A	26%	Reason for Calibration	Repair

Cone Information				
Tip Stress Limit	1000	bar	Tip End Area	15 cm²
Friction Stress Limit	10	bar	Friction Surface Area	225 cm²
Pressure Limit	35	bar	RTD Location	Pressure Carrier
X-Inclinometer Limit	30	degrees	Geophone	X and Z
Y-Inclinometer Limit	30	degrees	Temperature Range	-20°C to 60°C

Baseline Summary: (For Reference Only)

Channel	Units	As Found	As Left
Tip	bar	N/A	0.197
Sleeve	bar	N/A	-0.021
Pressure	bar	N/A	1.008
X-Inclinometer	degrees	N/A	-0.018
Y-Inclinometer	degrees	N/A	0.011
Temperature	˚C	N/A	23.188

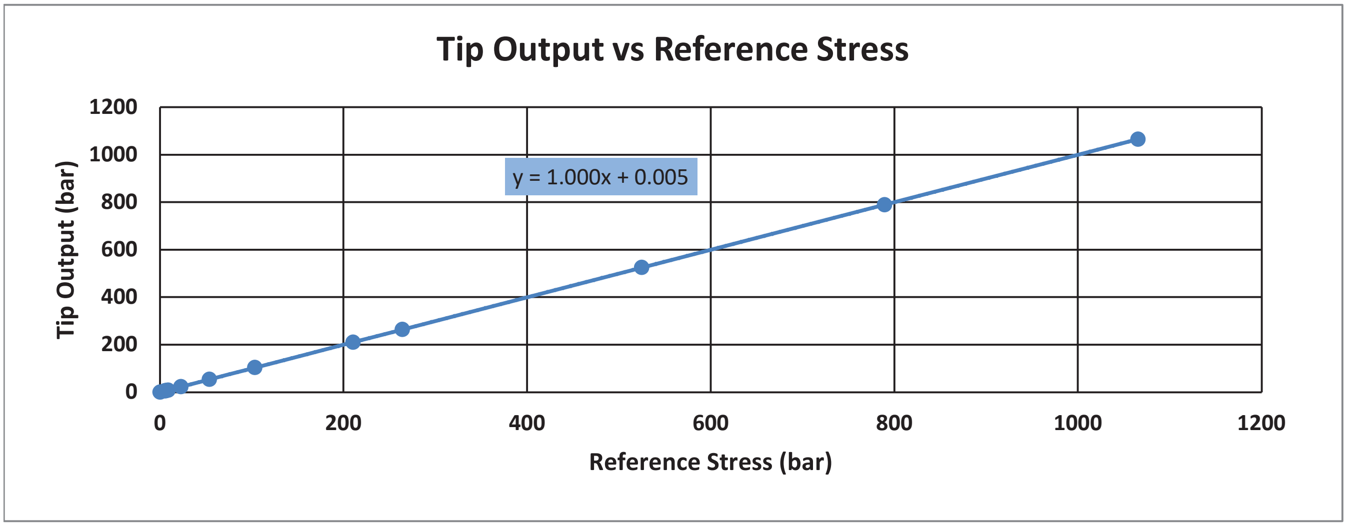
Classified in accordance with ISO 22476-1:2012 Class 1
Classified in accordance with ISO 22476-1:2012 Class 2

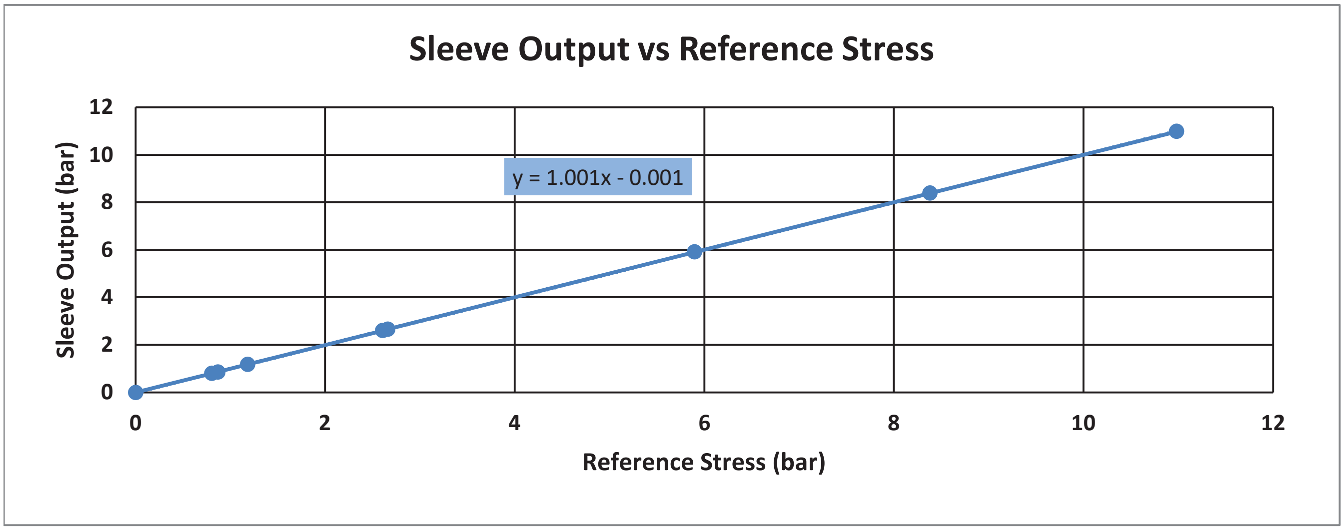
Calibrated in general accordance with the ASTM D5778-20 and D7400-19 standards

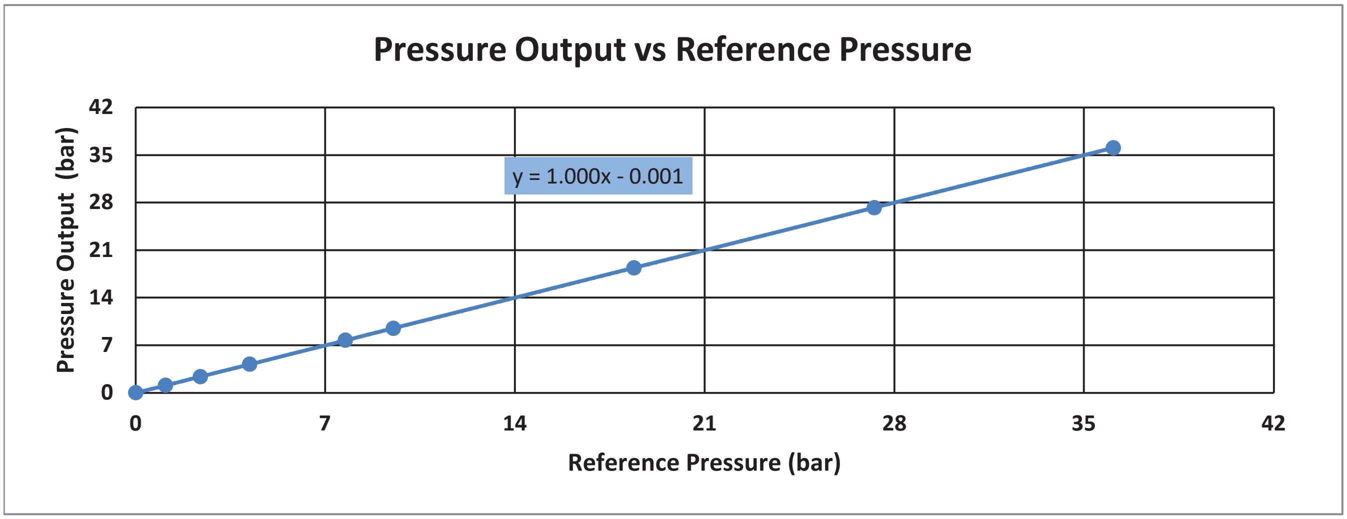
Calibrated with Adara calibration procedure EC_CPTCAL-2.3

Collective uncertainty of the measurement standards conforms to a test uncertainty ratio (TUR) of 3:1 for tip and sleeve measurement and 4:1 for pressure measurement with a confidence level k=2

Cone Output vs Reference Stress/Pressure Plots







Calibration Results

Tip Calibration					
As Found			As Left		
Max. Non Linearity	0.00%	PASS	Max. Non Linearity	0.01%	PASS
Calibration Error	0.04%	PASS	Calibration Error	0.03%	PASS

Sleeve Calibration					
As Found			As Left		
Max. Non Linearity	0.55%	FAIL	Max. Non Linearity	0.13%	PASS
Calibration Error	1.12%	FAIL	Calibration Error	0.29%	PASS

Pressure Calibration					
As Found			As Left		
Max. Non Linearity	N/A	N/A	Max. Non Linearity	0.04%	PASS
Calibration Error	N/A	N/A	Calibration Error	0.10%	PASS

X-Inclinometer Calibration					
As Found			As Left		
Max. Non Linearity	N/A	N/A	Max. Non Linearity	0.54%	PASS
Calibration Error	N/A	N/A	Calibration Error	-1.08%	PASS

Y-Inclinometer Calibration					
As Found			As Left		
Max. Non Linearity	N/A	N/A	Max. Non Linearity	-0.25%	PASS
Calibration Error	N/A	N/A	Calibration Error	0.50%	PASS

Seismic Calibration					
As Found			As Left		
Trigger Delay Error	N/A	N/A	Trigger Delay Error	0.01%	PASS

Temperature Calibration			
Full Scale Error	0.10%	PASS	

Channel	Cold	Room	Hot	Units
Ref_Temp	2.7	24.2	43.0	˚C
Tip	1.227	-0.129	-0.583	bar
Sleeve	-0.028	-0.023	-0.004	bar
Pressure	1.041	1.064	1.065	bar
Temperature	2.567	24.158	42.951	˚C

Tip Temperature Coefficient	-0.045 bar/˚C	PASS
Sleeve Temperature Coefficient	0.001 bar/˚C	PASS
Pressure Temperature Coefficient	0.001 bar/˚C	PASS

Testing Equipment Details

Testing Machines	Model Number	Serial Number	Calibration Number	Due Date
Tip Load Cell	Precision	P-10289	101141	2025-07-03
Sleeve Load Cell	Precision	P-11313	101214	2025-10-21
Digital Loadcell Indicator	4215	62140	101141	2025-07-02
Fluke Reference Pressure Monitor	RPM4 A10Ms	3910	100835	2024-12-12
Tektronix Function Generator	AFG1022	1820013	101200	2025-09-30
Thermometer	THS-222-555	D23255834	101116	2025-06-27
Thermometer	THS-222-555	D23255829	101116	2025-06-27
Thermometer	THS-222-555	D20345575	101116	2025-06-27

Adara Error Definitions

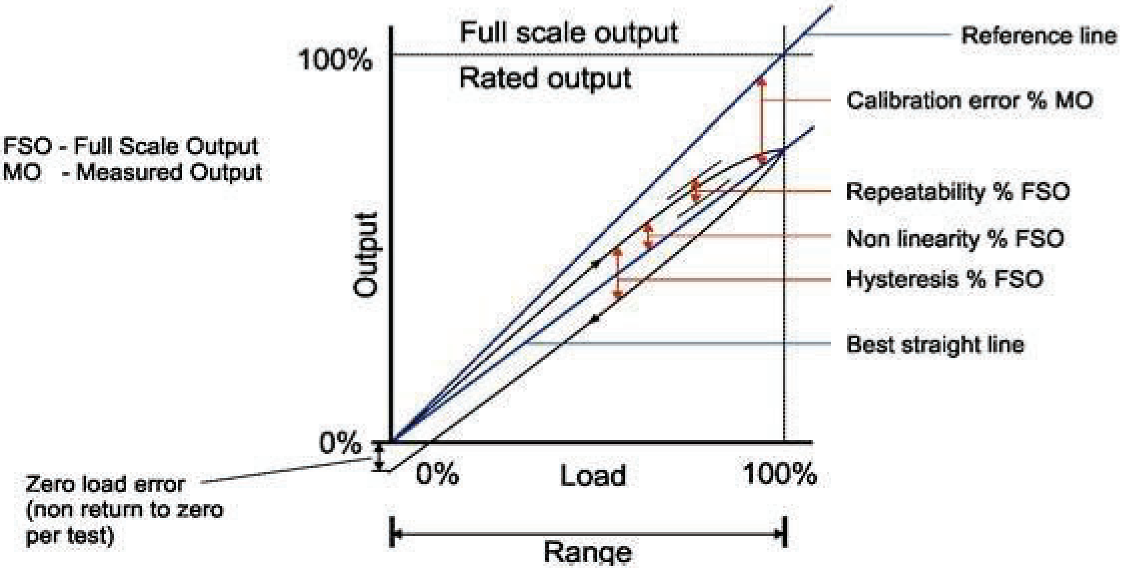


Figure 1: Definition of Calibration Terms for Load Cell and Transducers (Adapted from [1])

Actual Sensitivity	The slope of the best fit line through all data points starting at zero load.
Slope Error	The error in the best fit line compared to the ideal linear calibration in % . Slope Error = (Best Fit Slope - Ideal Slope) / Ideal Slope
Maximum Non Linearity	This value represents the maximum error (absolute value) relative to the best fit line considering each calibration point starting at loads greater than approximately 10% of FSO. The reported errors are a percent error of FSO. Adara's Pass/Fail criteria is 0.5% of FSO (ASTM is 0.5% of FSO at loads > 20% FSO).
Calibration Error	This value represents the maximum error (absolute value) in the recorded load value as compared to the actual load value for each calibration point for loads greater than approximately 10% of FSO. Adara's Pass/Fail criteria for the tip and sleeve is 0.5% of MO and 1.0% of MO for the pore pressure (ASTM for the tip and sleeve is 1.5% and 1.0% of MO respectively at loads greater than 20% of FSO)

Temperature Check Passing Criteria

Tip Temperature Coefficient	<0.200	bar/˚C
Sleeve Temperature Coefficient	<0.005	bar/˚C
Pressure Temperature Coefficient	<0.0196	bar/˚C

ASTM D5778-20 Annex A Summary [1]

A1.4 Force Transducer Calibration Requirements

A1.4.1 states the following limits:

Non Linearity	Tip	≤ +0.5% of FSO
	Sleeve	≤ +1.0% of FSO
Calibration Error	Tip	≤ +1.5% of MO at loads > 20% FSO
	Sleeve	≤ +1.0% of MO at loads > 20% FSO

A1.5 Pressure Transducer Calibrations

A1.5.1 limits:

Non Linearity	Pore Pressure	≤ +1.0% of FSO
Calibration Error	Pore Pressure	not specified

ISO 22476 -1:2012 Summary [2]

Section 5.2 states the following allowable minimum accuracy

Class 1	Cone Resistance	35 kPa or 5%
	Sleeve Friction	5 kPa or 10%
	Pore Pressure	10 kPa or 2%
Class 2	Cone Resistance	100 kPa or 5%
	Sleeve Friction	15 kPa or 15%
	Pore Pressure	25 kPa or 3%

Note: ISO Compliance is based on low end calibration only.

References

[1] ASTM D5778-20. "Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils". ASTM, West Conshohocken, PA, USA.

[2] ISO 22476-1:2012. "Geotechnical investigation and testing - Field Testing - Part 1: Electrical cone and piezocone penetration test". ISO, Geneva, Switzerland.

ASTM D7400-19. "Standard Test Methods for Downhole Seismic Testing". ASTM, West Conshohocken, PA, USA.

APPENDIX C

SOIL BORING LOGS

BORING LOGS

SUMMARY OF THE BURMISTER SOIL CLASSIFICATION SYSTEM (MODIFIED)

RELATIVE DENSITY (of non-plastic soils) OR CONSISTENCY (of plastic soils)

STANDARD PENETRATION TEST (SPT)
Method: Samples were collected in accordance with ASTM D1586, using a 2" diameter split spoon sampler driven 24 inches. If samples were collected using direct push methodology (Geoprobe), SPTs were not performed and relative density/consistency were not reported. N-Value: The number of blows with a 140 lb. hammer required to drive the sampler the middle 12 inches. WOR: Weight Of Rod (depth dependent) WOH: Weight Of Hammer (140 lbs.)

COHESIONLESS SOILS		COHESIVE SOILS	
BLOWS/FOOT (SPT N-Value)	RELATIVE DENSITY	BLOWS/FOOT (SPT N-Value)	CONSISTENCY
0-4	Very loose	<2	Very soft
4-10	Loose	2-4	Soft
10-30	Medium dense	4-8	Medium Stiff
30-50	Dense	8-15	Stiff
>50	Very dense	15-30	Very stiff
*Based upon uncorrected field N-values		>30	Hard

MATERIAL: (major constituent identified in CAPITAL letters)

COHESIONLESS SOILS		
MATERIAL	FRACTION	GRAIN SIZE RANGE
GRAVEL	Coarse	3/4" to 3"
	Fine	1/4" to 3/4"
SAND	Coarse	1/16" to 1/4"
	Medium	1/64" to 1/16"
	Fine	Finest visible & distinguishable particles
SILT/CLAY	see adjacent table	Cannot distinguish individual particles
COBBLES	3" to 6" in diameter	
BOULDERS	> 6" in diameter	
Note: Boulders and cobbles are observed in test pits and/or auger cuttings.		

COHESIVE SOILS		
SMALLEST DIAMETER	PLASTICITY	IDENTITY
None	Non-plastic	**SILT**
1/4" (pencil)	Slight	**Clayey SILT**
1/8"	Low	**SILT & CLAY**
1/16"	Medium	**CLAY & SILT**
1/32"	High	**Silty CLAY**
1/64"	Very High	**CLAY**
Wetted sample is rolled in hands to smallest possible diameter before breaking.		

ORGANIC SILT: Typically gray to dark gray, often has strong H_2S odor. May contain shells or shell fragments. Light weight.

Fibrous PEAT: Light weight, spongy, mostly visible organic matter, water squeezed readily from sample. Typically near top of layer.

Fine grained PEAT: Light weight, spongy, little visible organic matter, water squeezed from sample. Typically below fibrous peat.

DEBRIS: Detailed contents described in parentheses (wood, glass, ash, crushed brick, metal, etc.)

BEDROCK: Underlying rock beneath loose soil, can be weathered (easily crushed) or competent (difficult to crush).

ADDITIONAL CONSTITUENTS

TERM	% OF TOTAL
and	35-50%
some	20-35%
little	10-20%
trace	1-10%

COMMON TERMS

Glacial till: Very dense/hard, heterogeneous mixture of sand, silt, clay, sub-angular gravel. Deposited at base of glaciers, which covered all of New England.

Varved clay: Fine-grained, post-glacial lake sediments characterized by alternating layers (or varves) of silt, sand and clay.

Fill: Material used to raise ground, can be engineered or non-engineered.

COMMON FIELD MEASUREMENTS

Torvane: Undrained shear strength is estimated using a pocket torvane. Values in tons/ft^2 (tsf).

Penetrometer: Unconfined compressive strength is estimated using a pocket penetrometer. Values in tons/ft^2 (tsf).

RQD: Rock Quality Designation is determined by measuring total length of pieces of core 4" or greater and dividing by the total length of the run, expressed as %. 100-90% excellent; 90-75% good; 75-50% fair; 50-25% poor; 25-0% very poor.

PID: Soil screened for volatile organic compounds (VOCs) using a photoionization detector (PID) referenced to benzene in air. Readings in parts per million (ppm) by volume.

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LOG OF BORING B-1

Page 1 of 1

PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC		
JOB NUMBER	0381-63-01	FINAL DEPTH (ft)	22.0	DRILLING EQUIPMENT	D-50 Track Mounted Rig		
LOCATION	South Hadley, MA	SURFACE ELEV (ft)	--	FOREMAN	Nick	CASING	
START DATE	1/27/2025	DISTURBED SAMPLES	7	HELPER	Keeler	CASE DIAMETER	N/A
FINISH DATE	1/27/2025	UNDISTURBED SAMPLES	0	BIT TYPE	Hollow Stem Auger	HAMMER WGT	N/A
ENGINEER/SCIENTIST	Pierre Carriere	WATER LEVEL		ROD TYPE	A (1 5/8" O.D.)	HAMMER DROP	N/A
BORING LOCATION	North portion of proposed office building	FIRST (ft)	9.0	SAMPLER	2" O.D. Split Spoon	ROCK CORING INFORMATION	
		LAST (ft)	N/A	HAMMER TYPE	Automatic	TYPE	N/A
		TIME (hr)	N/A	HAMMER WGT/DROP	140 lb / 30"	SIZE	N/A

DEPTH (ft)/ SAMPLES	SAMPLES PENETR. RESIST. (bl / 6 in)	REC. (in)	TYPE/ NO.	FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
	3/4/6/7	19/24	S-1 (0'-2')	PID 1.6 ppm	Top 8": Medium dense, brown, fine SAND, little medium sand, trace coarse sand, trace silt, trace organics (roots), damp (TOPSOIL) Bottom 11": Medium dense, brown to light brown, fine SAND, trace medium sand, trace silt, damp	TOPSOIL FINE SAND	1.
	9/13/13/12	20/24	S-2 (2'-4')	PID 8.4 ppm	Medium dense, light brown, fine SAND, trace medium sand, trace silt, damp Bottom 17": Medium dense, light brown, fine SAND, trace medium sand, trace silt, damp		
5'	6/8/9/11	23/24	S-3 (5'-7')	PID 0.3 ppm	Top 15": Medium dense, light brown, fine SAND, trace (+) silt, moist Bottom 7": Medium dense, very light brown, fine SAND, little medium sand, trace silt, damp (5% redoximorphic features)		
	9/10/10/11	22/24	S-4 (7'-9')	PID 0.2 ppm	Top 11": Medium dense, very light brown, fine SAND, trace medium sand, trace (+) silt, moist Bottom 11": Medium dense, very light brown, fine SAND, little medium sand, trace coarse sand, trace silt, moist (wet at tip)	8.0 F-M SAND ▽	
10'	4/7/8/7	22/24	S-5 (10'-12')	PID 0.0 ppm			
15'	1/3/5/9	24/24	S-6 (15'-17')	PID 0.0 ppm	Top 19": Loose, light brown, fine to medium SAND, trace coarse sand, trace (+) silt, wet Bottom 5": Loose, light brown, fine SAND, little medium sand, little silt, wet		
20'	4/5/7/10	24/24	S-7 (20'-22')	PID 0.0 ppm	Top 6": Medium dense, light brown, fine to medium SAND, trace coarse sand, trace silt, wet Bottom 18": Medium dense, light brown, fine SAND, little silt, trace medium sand, wet (pocket of red, silty clay with fine sand in sample)	20.5 SILTY FINE SAND 22.0	
					End of exploration at 22'		
25'							

Remarks:
1. Soil screened in field using MiniRAE Lite photoionization detector (PID) referenced to benzene in air. Readings in parts per million (ppm) by volume.

PROJECT NO.
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LOG OF BORING
B-1

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LOG OF BORING B-2

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PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC		
JOB NUMBER	0381-63-01	FINAL DEPTH (ft)	22.0	DRILLING EQUIPMENT	B-53 Truck Mounted Rig		
LOCATION	South Hadley, MA	SURFACE ELEV (ft)	--	FOREMAN	Nick	CASING	
START DATE	1/28/2025	DISTURBED SAMPLES	7	HELPER	Keeler	CASE DIAMETER	N/A
FINISH DATE	1/28/2025	UNDISTURBED SAMPLES	0	BIT TYPE	Hollow Stem Auger	HAMMER WGT	N/A
ENGINEER/SCIENTIST	Pierre Carriere	WATER LEVEL		ROD TYPE	A (1 5/8" O.D.)	HAMMER DROP	N/A
BORING LOCATION	South portion of proposed office building	FIRST (ft)	15.0	SAMPLER	2" O.D. Split Spoon	ROCK CORING INFORMATION	
		LAST (ft)	N/A	HAMMER TYPE	Automatic	TYPE	N/A
		TIME (hr)	N/A	HAMMER WGT/DROP	140 lb / 30"	SIZE	N/A

DEPTH (ft)/ SAMPLES	SAMPLES				SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
	PENETR. RESIST. (bl / 6 in)	REC. (in)	TYPE/ NO.	FIELD TEST DATA			
☒	2/2/3/4	23/24	S-1 (0'-2')	PID 16.0 ppm	Top 1": Loose, dark brown, fine SAND, trace medium sand, trace (+) silt, trace organics (roots), damp (TOPSOIL) Next 6": Loose, brown, fine SAND, trace medium sand, trace silt, damp Bottom 16": Loose, light brown, fine SAND, trace medium sand, trace silt, damp	TOPSOIL FINE SAND	1.
☒	4/3/4/3	24/24	S-2 (2'-4')	PID 0.0 ppm	Medium dense, light brown, fine SAND, trace medium sand, trace silt, damp		
5' ☒	3/4/3/4	22/24	S-3 (5'-7')	PID 0.0 ppm	Loose, light brown, fine SAND, trace medium sand, trace silt, damp		
☒	3/4/4/4	22/24	S-4 (7'-9')	PID 0.0 ppm	Loose, light brown, fine SAND, trace medium sand, trace silt, damp		
10' ☒	4/8/11/14	24/24	S-5 (10'-12')	PID 0.0 ppm	Medium dense, light brown to very light brown, fine SAND, little to trace medium sand, trace silt, moist (trace coarse sand in bottom 4")	10.0 FINE TO MEDIUM SAND	
15' ☒	6/8/7/8	20/24	S-6 (15'-17')	PID 0.1 ppm	Top 4": Medium dense, brown to light brown, fine SAND, trace medium sand, trace (+) silt, wet Next 5": Medium dense, brown, fine to medium SAND, trace coarse sand, trace fine gravel, trace silt, wet Next 5": Medium dense, grayish brown, fine SAND, little medium sand, trace (+) silt, wet Bottom 6": Medium dense, brown, fine to medium SAND, trace coarse sand, trace fine gravel, trace silt, wet	▽	
20' ☒	4/7/7/11	24/24	S-7 (20'-22')	PID 0.1 ppm	Medium dense, brown to grayish brown, fine SAND, little to trace medium sand, trace (+) silt, wet (heavy rust staining near middle)	22.0	
					End of exploration at 22'		
25'							

Remarks:
1. Soil screened in field using MiniRAE Lite photoionization detector (PID) referenced to benzene in air. Readings in parts per million (ppm) by volume.

PROJECT NO.
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LOG OF BORING
B-2

O'Reilly, Talbot & Okun
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LOG OF BORING B-3

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PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC		
JOB NUMBER	0381-63-01	FINAL DEPTH (ft)	22.0	DRILLING EQUIPMENT	B-53 Truck Mounted Rig		
LOCATION	South Hadley, MA	SURFACE ELEV (ft)	--	FOREMAN	Nick	CASING	
START DATE	1/27/2025	DISTURBED SAMPLES	7	HELPER	Keeler	CASE DIAMETER	N/A
FINISH DATE	1/27/2025	UNDISTURBED SAMPLES	0	BIT TYPE	Hollow Stem Auger	HAMMER WGT	N/A
ENGINEER/SCIENTIST	Pierre Carriere	WATER LEVEL		ROD TYPE	A (1 5/8" O.D.)	HAMMER DROP	N/A
BORING LOCATION	East portion of proposed garage building	FIRST (ft)	5.0	SAMPLER	2" O.D. Split Spoon	ROCK CORING INFORMATION	
		LAST (ft)	N/A	HAMMER TYPE	Automatic	TYPE	N/A
		TIME (hr)	N/A	HAMMER WGT/DROP	140 lb / 30"	SIZE	N/A

DEPTH (ft)/ SAMPLES	SAMPLES PENETR. RESIST. (bl / 6 in)	REC. (in)	TYPE/ NO.	FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
	2/3/3/3	18/24	S-1 (0'-2')	PID 0.2 ppm	Top 5": Loose, dark brown to brown, fine SAND, little silt, trace medium sand, trace organics (roots), damp Bottom 13": Loose, brown, fine SAND, trace medium sand, trace silt, damp	TOPSOIL FINE SAND	1.
	3/3/4/4	22/24	S-2 (2'-4')	PID 0.1 ppm	Medium dense, light brown, fine SAND, trace medium sand, trace silt, damp Bottom 10": Loose, light brown, fine SAND, little medium sand, trace silt, trace coarse sand, damp		
5'	4/5/6/7	20/24	S-3 (5'-7')	PID 0.1 ppm	Medium dense, light brown, fine SAND, little to trace medium sand, trace coarse sand, trace silt, wet	5.0 FINE TO MEDIUM SAND	
	5/6/5/6	21/24	S-4 (7'-9')	PID 0.1 ppm	Medium dense, light brown, fine to medium SAND, trace coarse sand, trace silt, wet		
10'	2/2/2/7	24/24	S-5 (10'-12')	PID 0.0 ppm	Loose, light brown to brown, fine SAND, little to trace medium sand, trace (+) silt, wet (heavy rust staining in bottom half of sample)		
15'	8/14/18/21	24/24	S-6 (15'-17')	PID 0.2 ppm	Top 8": Dense, brown, fine SAND, little medium sand, trace (+) silt, wet Bottom 16": Dense, brown, fine SAND, little silt, wet		
20'	9/11/11/10	24/24	S-7 (20'-22')	PID 0.1 ppm	Medium dense, brown, fine SAND, little to trace medium sand, trace (+) silt, wet (heavy rust staining near bottom)	22.0	
					End of exploration at 22'		
25'							

Remarks:
1. Soil screened in field using MiniRAE Lite photoionization detector (PID) referenced to benzene in air. Readings in parts per million (ppm) by volume.

PROJECT NO.
0381-63-01

LOG OF BORING
B-3

O'Reilly, Talbot & Okun
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PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC		
JOB NUMBER	0381-63-01	FINAL DEPTH (ft)	22.0	DRILLING EQUIPMENT	B-53 Truck Mounted Rig		
LOCATION	South Hadley, MA	SURFACE ELEV (ft)	--	FOREMAN	Nick	CASING	
START DATE	1/28/2025	DISTURBED SAMPLES	7	HELPER	Keeler	CASE DIAMETER	N/A
FINISH DATE	1/28/2025	UNDISTURBED SAMPLES	0	BIT TYPE	Hollow Stem Auger	HAMMER WGT	N/A
ENGINEER/SCIENTIST	Pierre Carriere	WATER LEVEL		ROD TYPE	A (1 5/8" O.D.)	HAMMER DROP	N/A
BORING LOCATION	Eastern portion of proposed warehouse building	FIRST (ft)	8.0	SAMPLER	2" O.D. Split Spoon	ROCK CORING INFORMATION	
		LAST (ft)	N/A	HAMMER TYPE	Automatic	TYPE	N/A
		TIME (hr)	N/A	HAMMER WGT/DROP	140 lb / 30"	SIZE	N/A

DEPTH (ft)/ SAMPLES	SAMPLES PENETR. RESIST. (bl / 6 in)	REC. (in)	TYPE/ NO.	FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
	2/3/4/4	21/24	S-1 (0'-2')	PID 1.2 ppm	Top 6": Loose, dark brown, fine SAND, trace medium sand, trace (+) silt, trace organics (roots), damp (TOPSOIL) Bottom 15": Loose, brown, fine SAND, trace medium sand, trace silt, damp	TOPSOIL FINE SAND	1.
	4/4/3/4	22/24	S-2 (2'-4')	PID 0.0 ppm	Medium dense, light brown, fine SAND, trace medium sand, trace silt, damp Bottom 20": Loose, light brown, fine SAND, trace medium sand, trace silt, damp		
5'							
	3/5/5/6	22/24	S-3 (5'-7')	PID 0.0 ppm	Top 20": Medium dense, light brown to very light brown, fine SAND, trace medium sand, trace (+) silt, damp Bottom 2": Medium dense, light brown, fine to medium SAND, trace coarse sand, trace silt, trace fine gravel, damp	7.0	
	5/6/8/7	20/24	S-4 (7'-9')	PID 0.0 ppm	Medium dense, light brown to very light brown, fine SAND, little to trace medium sand, trace coarse sand, trace silt, moist (wet in bottom half of sample; 5% redoximorphic features)	F-M SAND ▽	
10'							
	5/5/6/8	22/24	S-5 (10'-12')	PID 0.1 ppm	Medium dense, brown to light brown, fine SAND, little medium sand, trace coarse sand, trace silt, wet (15% redoximorphic features)		
15'							
	5/5/6/6	24/24	S-6 (15'-17')	PID 0.1 ppm	Top 12": Medium dense, brown to light brown, fine SAND, little medium sand, trace coarse sand, trace silt, wet Bottom 12": Medium dense, grayish brown, fine SAND, trace medium sand, trace (+) silt, wet	16.0 SILTY FINE SAND	
20'							
	6/6/13/19	14/24	S-7 (20'-22')	PID 0.0 ppm	Medium dense, grayish brown, fine SAND, little to trace (+) silt, trace medium sand, wet (heavy rust staining near top)	22.0	
					End of exploration at 22'		
25'							

Remarks:
1. Soil screened in field using MiniRAE Lite photoionization detector (PID) referenced to benzene in air. Readings in parts per million (ppm) by volume.

PROJECT NO.
0381-63-01

LOG OF BORING
B-4

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

LOG OF BORING B-5

Page 1 of 1

PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC		
JOB NUMBER	0381-63-01	FINAL DEPTH (ft)	22.0	DRILLING EQUIPMENT	B-53 Truck Mounted Rig		
LOCATION	South Hadley, MA	SURFACE ELEV (ft)	--	FOREMAN	Nick	CASING	
START DATE	1/28/2025	DISTURBED SAMPLES	7	HELPER	Keeler	CASE DIAMETER	N/A
FINISH DATE	1/28/2025	UNDISTURBED SAMPLES	0	BIT TYPE	Hollow Stem Auger	HAMMER WGT	N/A
ENGINEER/SCIENTIST	Pierre Carriere	WATER LEVEL		ROD TYPE	A (1 5/8" O.D.)	HAMMER DROP	N/A
BORING LOCATION	Western portion of proposed warehouse and garage buildings	FIRST (ft)	12.0	SAMPLER	2" O.D. Split Spoon	ROCK CORING INFORMATION	
		LAST (ft)	N/A	HAMMER TYPE	Automatic	TYPE	N/A
		TIME (hr)	N/A	HAMMER WGT/DROP	140 lb / 30"	SIZE	N/A

DEPTH (ft)/ SAMPLES	SAMPLES				SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
	PENETR. RESIST. (bl / 6 in)	REC. (in)	TYPE/ NO.	FIELD TEST DATA			
	6/6/3/4	20/24	S-1 (0'-2')	PID 0.1 ppm	Top 10": Loose, brown, fine SAND, trace medium sand, trace silt, trace organics (roots), damp Bottom 10": Loose, light brown, fine SAND, trace medium sand, trace silt, damp	FINE SAND	1.
	3/3/3/4	22/24	S-2 (2'-4')	PID 0.0 ppm	Medium dense, light brown, fine SAND, trace medium sand, trace silt, damp		
5'	3/4/5/7	24/24	S-3 (5'-7')	PID 0.1 ppm	Loose, light brown, fine SAND, trace medium sand, trace silt, damp		
	5/7/9/11	24/24	S-4 (7'-9')	PID 0.0 ppm	Top 12": Medium dense, brown to light brown, fine SAND, trace medium sand, trace silt, moist Next 5": Medium dense, light brown, fine SAND, little medium sand, trace coarse sand, trace silt, moist Bottom 7": Medium dense, very light brown, fine SAND, trace medium sand, trace silt, moist	8.0 FINE TO MEDIUM SAND	
10'	5/7/7/7	24/24	S-5 (10'-12')	PID 0.1 ppm	Medium dense, brown to light brown, fine SAND, little to trace medium sand, trace silt, moist (wet at tip)	▽	
15'	4/5/5/11	20/24	S-6 (15'-17')	PID 0.1 ppm	Top 15": Medium dense, brown to light brown, fine SAND, little to trace medium sand, trace (+) silt, wet Bottom 5": Medium dense, grayish brown, fine SAND, little silt, trace medium sand, wet	16.5 SILTY FINE SAND	
20'	1/2/3/4	24/24	S-7 (20'-22')	PID 0.1 ppm	Loose, grayish brown, fine SAND, trace (+) silt, trace medium sand, wet	22.0	
					End of exploration at 22'		
25'							

Remarks:
1. Soil screened in field using MiniRAE Lite photoionization detector (PID) referenced to benzene in air. Readings in parts per million (ppm) by volume.

PROJECT NO.
0381-63-01

LOG OF BORING
B-5

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

LOG OF BORING B-6

PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC		
JOB NUMBER	0381-63-01	FINAL DEPTH (ft)	42.0	DRILLING EQUIPMENT	B-53 Truck Mounted Rig		
LOCATION	South Hadley, MA	SURFACE ELEV (ft)	--	FOREMAN	Nick	CASING	
START DATE	1/27/2025	DISTURBED SAMPLES	11	HELPER	Keeler	CASE DIAMETER	N/A
FINISH DATE	1/27/2025	UNDISTURBED SAMPLES	0	BIT TYPE	Hollow Stem Auger	HAMMER WGT	N/A
ENGINEER/SCIENTIST	Pierre Carriere	WATER LEVEL		ROD TYPE	A (1 5/8" O.D.)	HAMMER DROP	N/A
BORING LOCATION	Central portion of proposed office building	FIRST (ft)	15.0	SAMPLER	2" O.D. Split Spoon	ROCK CORING INFORMATION	
		LAST (ft)	N/A	HAMMER TYPE	Automatic	TYPE	N/A
		TIME (hr)	N/A	HAMMER WGT/DROP	140 lb / 30"	SIZE	N/A

DEPTH (ft)/ SAMPLES	SAMPLES				SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE	REMARKS/ WELL CONSTRUCTION
	PENETR. RESIST. (bl / 6 in)	REC. (in)	TYPE/ NO.	FIELD TEST DATA		DEPTH (ft) ELEV.	
	6/18/13/11	19/24	S-1 (0'-2')	PID 0.0 ppm	Top 4": Dense, brown, fine SAND, little medium sand, trace silt, damp Next 7: Dense, dark brown, fine SAND, little medium sand, trace silt, trace organics (roots), damp (wood or tree root near top) Bottom 8": Dense, light brown, fine SAND, trace silt, trace medium sand, damp	FINE SAND TOPSOIL FINE SAND	1.
	8/8/7/5	20/24	S-2 (2'-4')	PID 0.0 ppm	Medium dense, light brown, fine SAND, trace medium sand, trace silt, damp		
5'	6/5/4/6	10/24	S-3 (5'-7')	PID 0.0 ppm	Loose, light brown, fine SAND, trace medium sand, trace silt, damp		
	4/4/5/5	18/24	S-4 (7'-9')	PID 0.0 ppm	Loose, light brown, fine SAND, trace medium sand, trace silt, damp		
10'	6/9/13/14	16/24	S-5 (10'-12')	PID 0.0 ppm	Top 8": Medium dense, light brown, fine SAND, trace medium sand, trace silt, damp Bottom 8": Medium dense, very light brown, fine SAND, little medium sand, trace coarse sand, damp		
15'	5/5/4/5	22/24	S-6 (15'-17')	PID 0.0 ppm	Loose, brown to light brown, fine to medium SAND, trace coarse sand, trace fine gravel, trace silt, wet	▽ = FINE TO MEDIUM SAND	
20'	4/5/5/6	24/24	S-7 (20'-22')	PID 0.0 ppm	Medium dense, light brown, fine SAND, little to trace medium sand, trace silt, trace coarse sand, wet		
25'	4/4/6/9	24/24	S-8 (25'-27')	PID 0.0 ppm	Top 16": Medium dense, light brown, fine to medium SAND, trace coarse sand, trace fine gravel, trace silt, wet Bottom 8": Medium dense, light grayish brown, fine SAND, trace (+) silt, trace medium sand, wet	26.0 SILTY FINE SAND	

Remarks:
1. Soil screened in field using MiniRAE Lite photoionization detector (PID) referenced to benzene in air. Readings in parts per million (ppm) by volume.
2. WOR = Weight of rods.

PROJECT NO.
0381-63-01

LOG OF BORING
B-6

Job No. 0381-63-01

LOG OF BORING B-6

Page 2 of 2

DEPTH (ft)/ SAMPLES	SAMPLES				SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
	PENETR. RESIST. (bl / 6 in)	REC. (in)	TYPE/ NO.	FIELD TEST DATA			
						SILTY FINE SAND (CONTINUED)	
30'	8/8/8/11	24/24	S-9 (30'-32')	PID 0.0 ppm	Top 7": Medium dense, light brown, fine SAND, little medium sand, trace silt, wet Bottom 17": Medium dense, brown, fine SAND, little silt, trace medium sand, wet		
					Medium dense, light brown, fine SAND, trace medium sand, trace silt, damp		
35'	2/3/4/5	24/24	S-10 (35'-37')	PID 0.0 ppm	Top 7": Loose, brown, fine SAND, little medium sand, trace (+) silt, wet Next 13": Loose, brown, fine SAND, little silt, trace medium sand, wet Bottom 4": Loose, gray, fine sand, little silt, wet		
40'	WOR 12"/2/4	24/24	S-11 (40'-42')	PID 0.0 ppm	Very loose, grayish brown, fine SAND, little silt, wet	42.0	2.
					End of exploration at 42'		
45'							
50'							
55'							
60'							

APPENDIX D

TEST PIT LOGS AND PHOTOGRAPHS

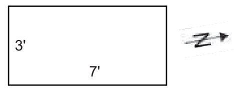
O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

LOG OF TEST PIT T-1

PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC
JOB NO.	0381-63-01	DATE	1/8/2025	OPERATOR	David
LOCATION	South Hadley, MA	WEATHER	Mostly sunny, windy, 23°F	BACKHOE	Komatsu PC40MR
TEST PIT LOCATION	Central portion of proposed staff parking lot	START TIME	11:10	CAPACITY (cy)	0.3
		FINISH TIME	11:35	GS ELEV. (ft)	--
		OTO STAFF	Pierre Carriere	FINAL DEPTH (ft)	9.0

DEPTH (ft)	SOIL DESCRIPTION	EXCAV. EFFORT	BOULDERS/ COBBLES COUNT	CLASS	SAMPLE NO.	FIELD TEST DATA	REMARKS
	0.0'-0.7': Brown, fine to medium SAND, little to trace (+) silt, trace organics (roots), damp	E	0	--	--	--	
1'	0.7'-3.5': Brown to light brown, fine SAND, little medium sand, trace silt, damp		0	--	--	--	
2'	5% rust mottling at 2'						
3'							
4'	3.5'-9.0': Light brown to very light brown, fine to medium SAND, trace silt, damp		0	--	--	--	
5'	10% rust mottling at 5.0'						
6'	20% rust mottling at 6.0'						
	Heavy rust staining and moist soils at 6.5'						
7'							
8'	Groundwater seepage and wet soils at 8.0'						
9'	Side walls caving at 9.0'						
	End of Exploration at 9.0'						
10'							
11'							

TEST PIT PLAN



APPROXIMATE VOLUME = 7.0 cy

EXCAVATION EFFORT

Easy .....E
Moderate .....M
Difficult .....D
Very Difficult V

BOULDER/COBBLE CLASS

Type	Size	Abbr.
Cobble	3" - 6"	C
Small	6" - 18"	S
Medium	18" - 36"	M
Large	36" and Larger	L

PROPORTIONS USED

Term	Relative Quantity
and	35% - 50%
some	20% - 35%
little	10% - 20%
trace	10% or less

GROUNDWATER CONDITIONS

GW Encountered?: Yes
GW Depth (ft): 8.0
GW Elevation (ft): --
Elapsed Time (min): N/A

Remarks:

PROJECT NO.

0381-63-01

LOG OF TEST PIT

T-1

TEST PIT PHOTOGRAPHS T-1

Test pit T-1

T-1 side wall

T-1 side wall

T-1 spoils pile

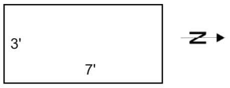
Remarks:	**PROJECT NO.** **0381-63-01**
	LOG OF TEST PIT **T-1**

LOG OF TEST PIT T-2

PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC
JOB NO.	0381-63-01	DATE	1/8/2025	OPERATOR	David
LOCATION	South Hadley, MA	WEATHER	Mostly sunny, windy, 25°F	BACKHOE	Komatsu PC40MR
TEST PIT LOCATION	North portion of proposed stormwater basin in northeast portion of site	START TIME	14:25	CAPACITY (cy)	0.3
		FINISH TIME	15:20	GS ELEV. (ft)	--
		OTO STAFF	Pierre Carriere	FINAL DEPTH (ft)	10.0

DEPTH (ft)	SOIL DESCRIPTION	EXCAV. EFFORT	BOULDERS/ COBBLES		SAMPLE NO.	FIELD TEST DATA	REMARKS
			COUNT	CLASS			
	0.0'-0.5': Dark brown, fine to medium SAND, little silt, trace organics (roots), damp (TOPSOIL)	E	0	--	--	--	
1'	0.5'-2.0': Brown, fine SAND, trace medium sand, trace silt, damp		0	--	--	--	
2'	2.0'-5.0': Light brown, fine SAND, little medium sand, trace silt, damp <5% rust mottling at 2.0'		0	--	--	--	
3'							1.
4'							
5'	5.0'-10.0': Very light brown, fine to medium SAND, trace silt, damp 15% rust mottling at 5.0'		0	--	--	--	
6'							
7'	Moist soils at 7.0'						
8'	Groundwater seepage and wet soils at 8.0'						
9'							
10'	Side walls caving at 10.0'	↓					
	End of exploration at 10.0'						
11'							

TEST PIT PLAN



APPROXIMATE VOLUME = 7.8 cy

EXCAVATION EFFORT

Easy .....E
Moderate .....M
Difficult .....D
Very Difficult V

BOULDER/COBBLE CLASS

Type	Size	Abbr.
Cobble	3" - 6"	C
Small	6" - 18"	S
Medium	18" - 36"	M
Large	36" and Larger	L

PROPORTIONS USED

Term	Relative Quantity
and	35% - 50%
some	20% - 35%
little	10% - 20%
trace	10% or less

GROUNDWATER CONDITIONS

GW Encountered?: Yes
GW Depth (ft): 8.0
GW Elevation (ft): --
Elapsed Time (min): N/A

Remarks:
1. Permeability test performed adjacent to test pit T-2 at a depth of 3.0' below ground surface.

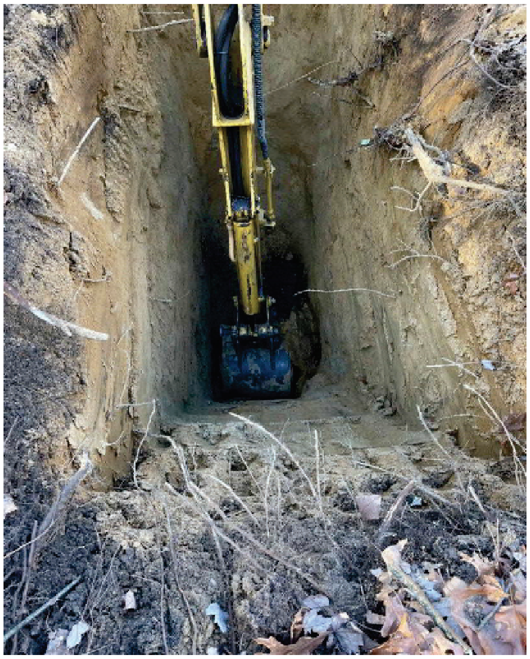
PROJECT NO.

0381-63-01

LOG OF TEST PIT

T-2

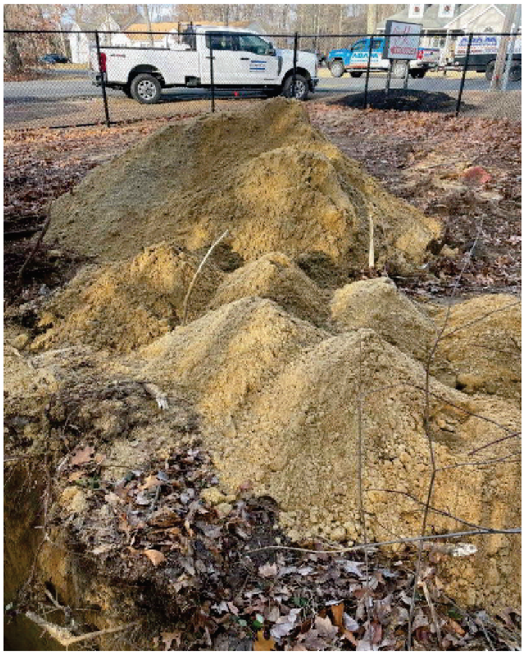
TEST PIT PHOTOGRAPHS T-2



Test pit T-2

T-2 side wall

T-2 side wall



T-2 spoils pile

Remarks:	**PROJECT NO.** **0381-63-01**
	LOG OF TEST PIT **T-2**

LOG OF TEST PIT T-3

PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC
JOB NO.	0381-63-01	DATE	1/8/2025	OPERATOR	David
LOCATION	South Hadley, MA	WEATHER	Mostly sunny, windy, 24°F	BACKHOE	Komatsu PC40MR
TEST PIT LOCATION	Proposed stormwater basin in southwestern portion of site	START TIME	13:00	CAPACITY (cy)	0.3
		FINISH TIME	14:00	GS ELEV. (ft)	--
		OTO STAFF	Pierre Carriere	FINAL DEPTH (ft)	11.0

DEPTH (ft)	SOIL DESCRIPTION	EXCAV. EFFORT	BOULDERS/ COBBLES		SAMPLE NO.	FIELD TEST DATA	REMARKS
			COUNT	CLASS			
1' 2' 3' 4' 5' 6'	0.0'-6.0': Very light brown, fine SAND, trace medium sand, trace silt, damp	E	0	--	--	--	1.
7' 8'	6.0'-8.0': Light brown, fine SAND, little medium sand, trace silt, moist		0	--	--	--	1.
9' 10' 11'	8.0'-11.0': Very light brown, fine to medium SAND, trace (+) silt, moist 15% rust mottling at 8.0' Groundwater seepage at 11.0'		0	--	--	--	
	End of exploration at 11.0'						

TEST PIT PLAN

APPROXIMATE VOLUME = 8.6 cy

EXCAVATION EFFORT

Easy .....E
Moderate .....M
Difficult .....D
Very Difficult V

BOULDER/COBBLE CLASS

Type	Size	Abbr.
Cobble	3" - 6"	C
Small	6" - 18"	S
Medium	18" - 36"	M
Large	36" and Larger	L

PROPORTIONS USED

Term	Relative Quantity
and	35% - 50%
some	20% - 35%
little	10% - 20%
trace	10% or less

GROUNDWATER CONDITIONS

GW Encountered?: Yes
GW Depth (ft): 11.0
GW Elevation (ft): --
Elapsed Time (min): N/A

Remarks:
1. Permeability tests performed adjacent to test pit T-3 at depths of 3.0' and 7.5' below ground surface.

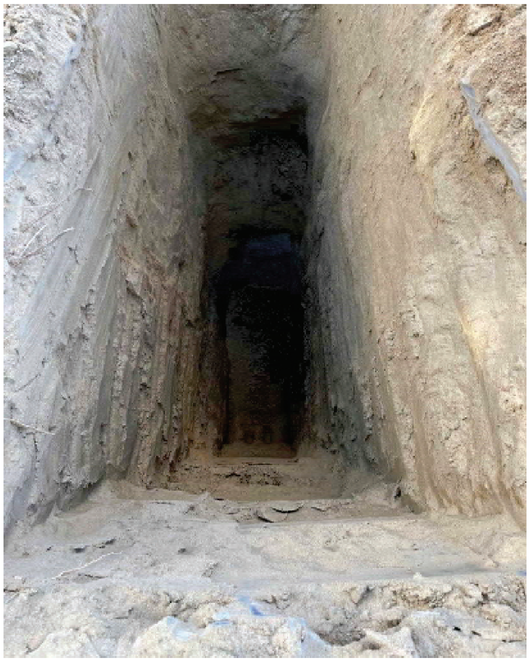
PROJECT NO.

0381-63-01

LOG OF TEST PIT

T-3

TEST PIT PHOTOGRAPHS T-3



Test pit T-3

T-3 side wall

T-3 side wall

T-3 spoils pile

Remarks:	**PROJECT NO.** **0381-63-01**
	LOG OF TEST PIT **T-3**

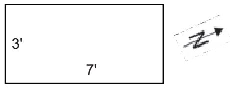
O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

LOG OF TEST PIT T-4

PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC
JOB NO.	0381-63-01	DATE	1/8/2025	OPERATOR	David
LOCATION	South Hadley, MA	WEATHER	Mostly sunny, windy, 24°F	BACKHOE	Komatsu PC40MR
TEST PIT LOCATION	Near east portion of proposed covered storage in southern part of site	START TIME	12:20	CAPACITY (cy)	0.3
		FINISH TIME	12:50	GS ELEV. (ft)	--
		OTO STAFF	Pierre Carriere	FINAL DEPTH (ft)	10.0

DEPTH (ft)	SOIL DESCRIPTION	EXCAV. EFFORT	BOULDERS/ COBBLES COUNT	CLASS	SAMPLE NO.	FIELD TEST DATA	REMARKS
	0.0'-0.7': Dark brown, fine to medium SAND, little silt, trace organics (roots), damp (TOPSOIL)	E	0	--	--	--	
1'	0.7'-2.0': Brown, fine SAND, trace medium sand, trace (+) silt, damp	↓	0	--	--	--	
2'	2.0'-6.5': Light brown, fine SAND, little medium sand, trace silt, damp		0	--	--	--	
	5% rust mottling at 2.5'						
3'							
	15% rust mottling at 3.5'						
4'							
5'							
6'	6.5'-10.0': Light brown, fine to medium SAND, trace silt, trace coarse sand, damp		0	--	--	--	
7'							
	Groundwater seepage and wet soils at 7.5'						
8'							
9'							
10'	Side walls caving at 10.0'	↓					
	End of exploration at 10.0'						
11'							

TEST PIT PLAN



APPROXIMATE VOLUME = 7.8 cy

EXCAVATION EFFORT

Easy .....E
Moderate .....M
Difficult .....D
Very Difficult V

BOULDER/COBBLE CLASS

Type	Size	Abbr.
Cobble	3" - 6"	C
Small	6" - 18"	S
Medium	18" - 36"	M
Large	36" and Larger	L

PROPORTIONS USED

Term	Relative Quantity
and	35% - 50%
some	20% - 35%
little	10% - 20%
trace	10% or less

GROUNDWATER CONDITIONS

GW Encountered?: Yes
GW Depth (ft): 7.5
GW Elevation (ft): --
Elapsed Time (min): N/A

Remarks:

PROJECT NO.

0381-63-01

LOG OF TEST PIT

T-4

TEST PIT PHOTOGRAPHS T-4

Test pit T-4

T-4 side wall

T-4 side wall

T-4 spoils pile

Remarks:	PROJECT NO. 0381-63-01
	LOG OF TEST PIT T-4

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

LOG OF TEST PIT T-5

PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC
JOB NO.	0381-63-01	DATE	1/8/2025	OPERATOR	David
LOCATION	South Hadley, MA	WEATHER	Mostly sunny, windy, 23°F	BACKHOE	Komatsu PC40MR
TEST PIT LOCATION	East portion of proposed stormwater basin in northern portion of site	START TIME	10:25	CAPACITY (cy)	0.3
		FINISH TIME	11:00	GS ELEV. (ft)	--
		OTO STAFF	Pierre Carriere	FINAL DEPTH (ft)	9.0

DEPTH (ft)	SOIL DESCRIPTION	EXCAV. EFFORT	BOULDERS/ COBBLES		SAMPLE NO.	FIELD TEST DATA	REMARKS
			COUNT	CLASS			
	0.0'-5.0': Light brown to very light brown, fine SAND, trace medium sand, trace silt, damp	E	0	--	--	--	
1'							
2'							
3'							
4'							
5'							
	5.0'-9.0': Light brown, fine to medium sand, trace silt, trace coarse sand, damp		0	--	--	--	
	10% rust mottling at 5.0'						1.
6'							
	20% rust mottling and moist soils at 6.0'						
7'							
8'							
	Groundwater seepage and wet soils at 8.5'						
9'	Side walls caving at 9.0'						
	End of exploration at 9.0'						
10'							
11'							

TEST PIT PLAN

APPROXIMATE VOLUME = 7.0 cy

EXCAVATION EFFORT

Easy .....E
Moderate .....M
Difficult .....D
Very Difficult V

BOULDER/COBBLE CLASS

Type	Size	Abbr.
Cobble	3" - 6"	C
Small	6" - 18"	S
Medium	18" - 36"	M
Large	36" and Larger	L

PROPORTIONS USED

Term	Relative Quantity
and	35% - 50%
some	20% - 35%
little	10% - 20%
trace	10% or less

GROUNDWATER CONDITIONS

GW Encountered?:	Yes
GW Depth (ft):	8.5
GW Elevation (ft):	--
Elapsed Time (min):	N/A

Remarks:
1. Permeability test performed adjacent to test pit T-2 at a depth of 5.5' below ground surface.

PROJECT NO.

0381-63-01

LOG OF TEST PIT

T-5

TEST PIT PHOTOGRAPHS T-5

Test pit T-5

T-5 side wall

T-5 side wall

T-5 spoils pile

Remarks:	**PROJECT NO.** **0381-63-01**
	LOG OF TEST PIT **T-5**

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

LOG OF TEST PIT T-6

PROJECT	Proposed SHELD Facility			CONTRACTOR	Seaboard Drilling, LLC
JOB NO.	0381-63-01	DATE	1/8/2025	OPERATOR	David
LOCATION	South Hadley, MA	WEATHER	Mostly sunny, windy, 24°F	BACKHOE	Komatsu PC40MR
TEST PIT LOCATION	Proposed pavement area in southern central portion of site	START TIME	11:40	CAPACITY (cy)	0.3
		FINISH TIME	12:10	GS ELEV. (ft)	--
		OTO STAFF	Pierre Carriere	FINAL DEPTH (ft)	9.5

DEPTH (ft)	SOIL DESCRIPTION	EXCAV. EFFORT	BOULDERS/ COBBLES COUNT	CLASS	SAMPLE NO.	FIELD TEST DATA	REMARKS
	0.0'-1.2': Dark brown, fine to medium SAND, little silt, trace coarse sand, trace organics (roots), damp (TOPSOIL)	E	0	--	--	--	
1'							
	1.2'-2.5': Brown, fine SAND, trace medium sand, trace silt, damp		0	--	--	--	
2'							
	2.5'-9.5': Light brown, fine to medium SAND, trace (+) silt, damp		0	--	--	--	
3'							
4'							
5'							
6'							
7'							
8'							
9'							
	Groundwater seepage and wet soils at 9.0'						
	End of exploration at 9.5'						
10'							
11'							

TEST PIT PLAN

APPROXIMATE VOLUME = 7.4 cy

EXCAVATION EFFORT

Easy .....E
Moderate .....M
Difficult .....D
Very Difficult V

BOULDER/COBBLE CLASS

Type	Size	Abbr.
Cobble	3" - 6"	C
Small	6" - 18"	S
Medium	18" - 36"	M
Large	36" and Larger	L

PROPORTIONS USED

Term	Relative Quantity
and	35% - 50%
some	20% - 35%
little	10% - 20%
trace	10% or less

GROUNDWATER CONDITIONS

GW Encountered?: Yes
GW Depth (ft): 9.0
GW Elevation (ft): --
Elapsed Time (min): N/A

Remarks:

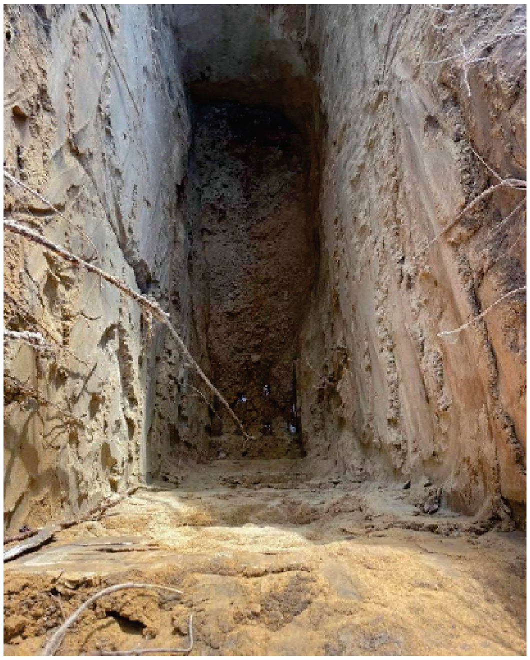
PROJECT NO.

0381-63-01

LOG OF TEST PIT

T-6

TEST PIT PHOTOGRAPHS T-6



Test pit T-6

T-6 side wall

T-6 side wall

T-6 spoils pile

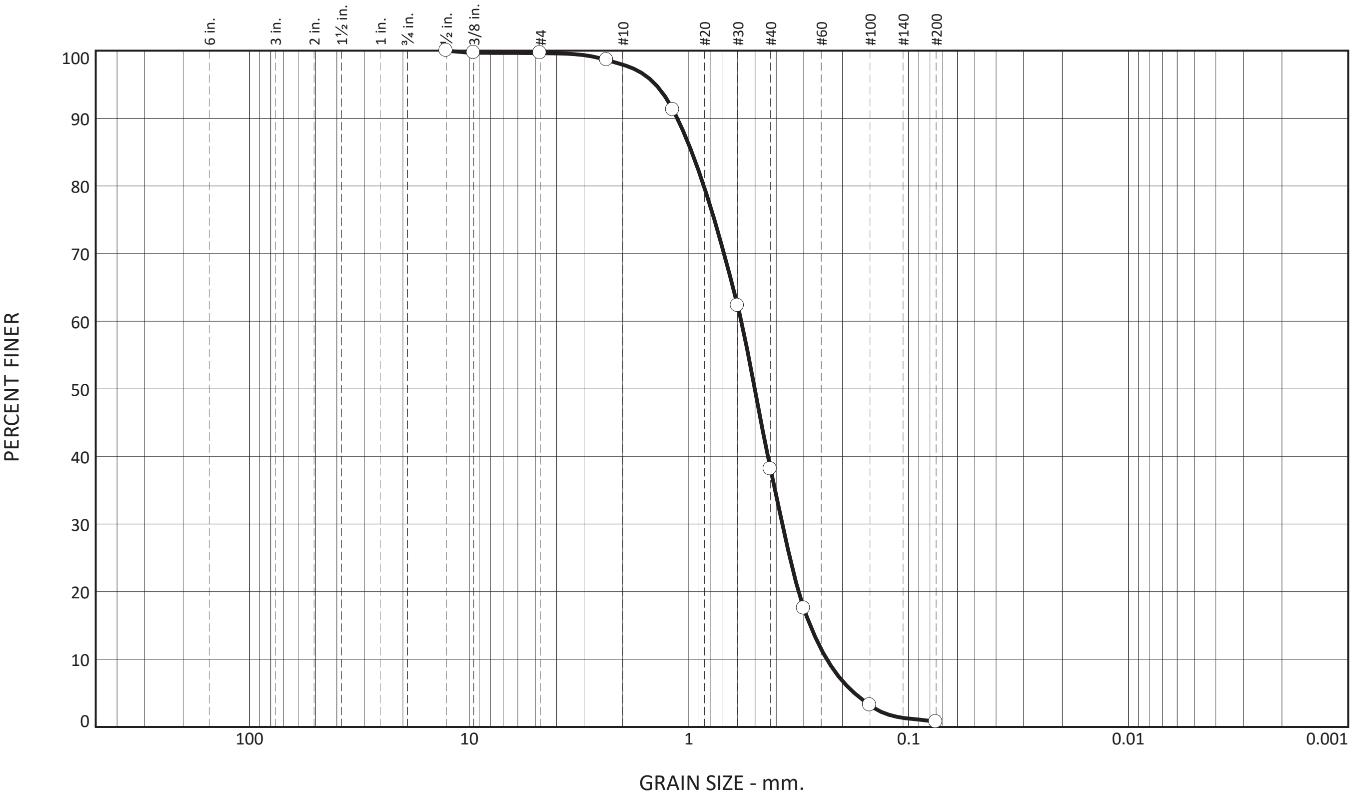
Remarks:	PROJECT NO. 0381-63-01
	LOG OF TEST PIT T-6

APPENDIX E

LABORATORY DATA SHEETS

Particle Size Distribution Report

ASTM C117 & C136



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	1.7	59.8	37.4	0.7	

Test Results (ASTM C117 & C136)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)	Pct. of Fines
1/2	100.0			
3/8	99.7			
#4	99.6			
#8	98.6			
#16	91.2			
#30	62.3			
#40	38.1			
#50	17.5			
#100	3.2			
#200	0.7			

* (no specification provided)

Material Description

T-4 (2'-6.5')

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.1288 D_{85}= 0.9702 D_{60}= 0.5774
D_{50}= 0.5012 D_{30}= 0.3756 D_{15}= 0.2804
D_{10}= 0.2357 C_u= 2.45 C_c= 1.04

Classification

USCS= SP AASHTO=

Test Remarks

This sample was delivered to ATL. This sample was washed.

Sample Number: 1743

Sample Date: 1/9/25

ALLIED TESTING
LABORATORIES, INC.
Springfield, Massachusetts

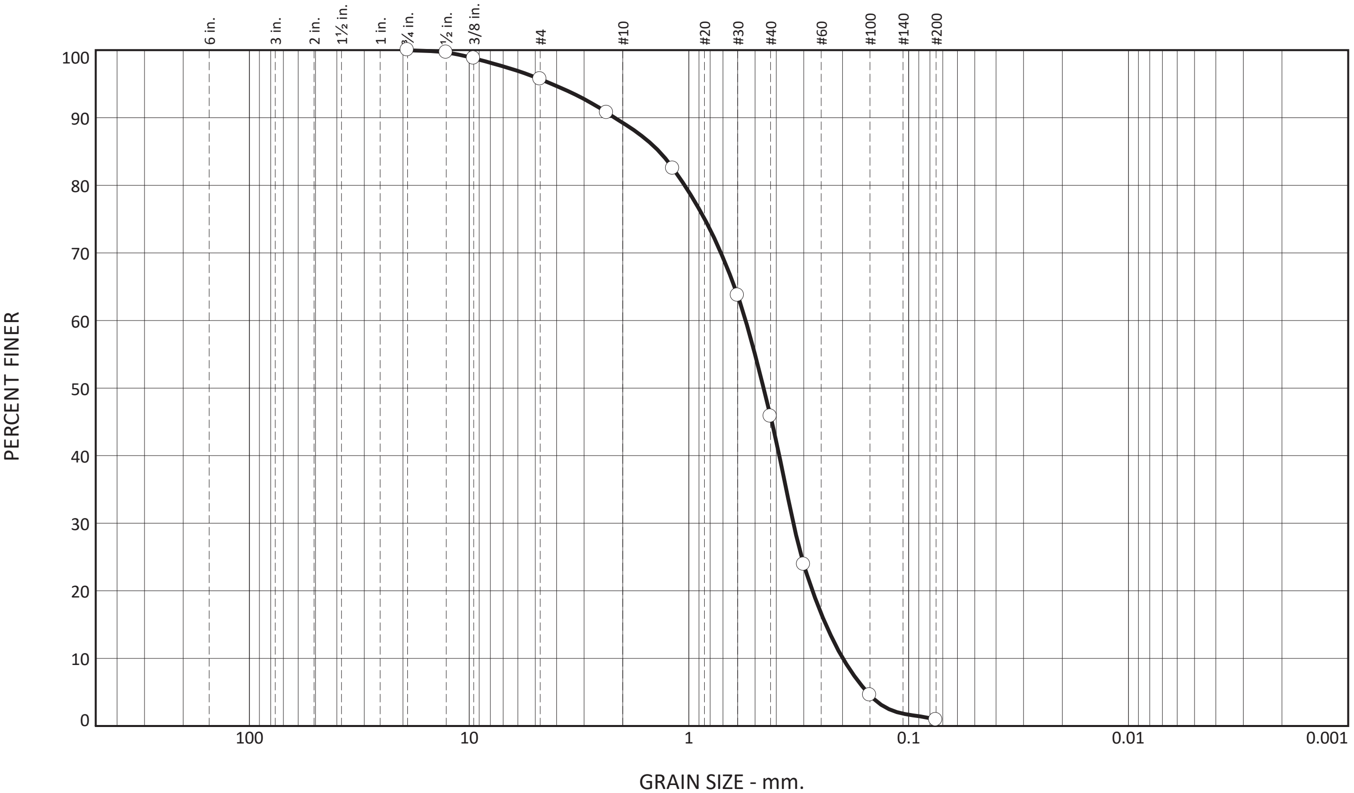
Client: OTO
Project: South Hadley Electric Light Dept.

Project No: 0381-63-01 **Figure**

Checked By: John McGreevy

Particle Size Distribution Report

ASTM C117 & C136



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.3	6.5	43.4	44.9	0.9	

Test Results (ASTM C117 & C136)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)	Pct. of Fines
3/4	100.0			
1/2	99.7			
3/8	98.8			
#4	95.7			
#8	90.7			
#16	82.5			
#30	63.7			
#40	45.8			
#50	23.9			
#100	4.6			
#200	0.9			

* (no specification provided)

Material Description

T-5 (5'-9')

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.1767 D_{85}= 1.3643 D_{60}= 0.5514
D_{50}= 0.4572 D_{30}= 0.3347 D_{15}= 0.2382
D_{10}= 0.1991 C_u= 2.77 C_c= 1.02

Classification

USCS= SP AASHTO=

Test Remarks

This sample was delivered to ATL. This sample was washed.

Sample Number: 1744

Sample Date: 1/9/25

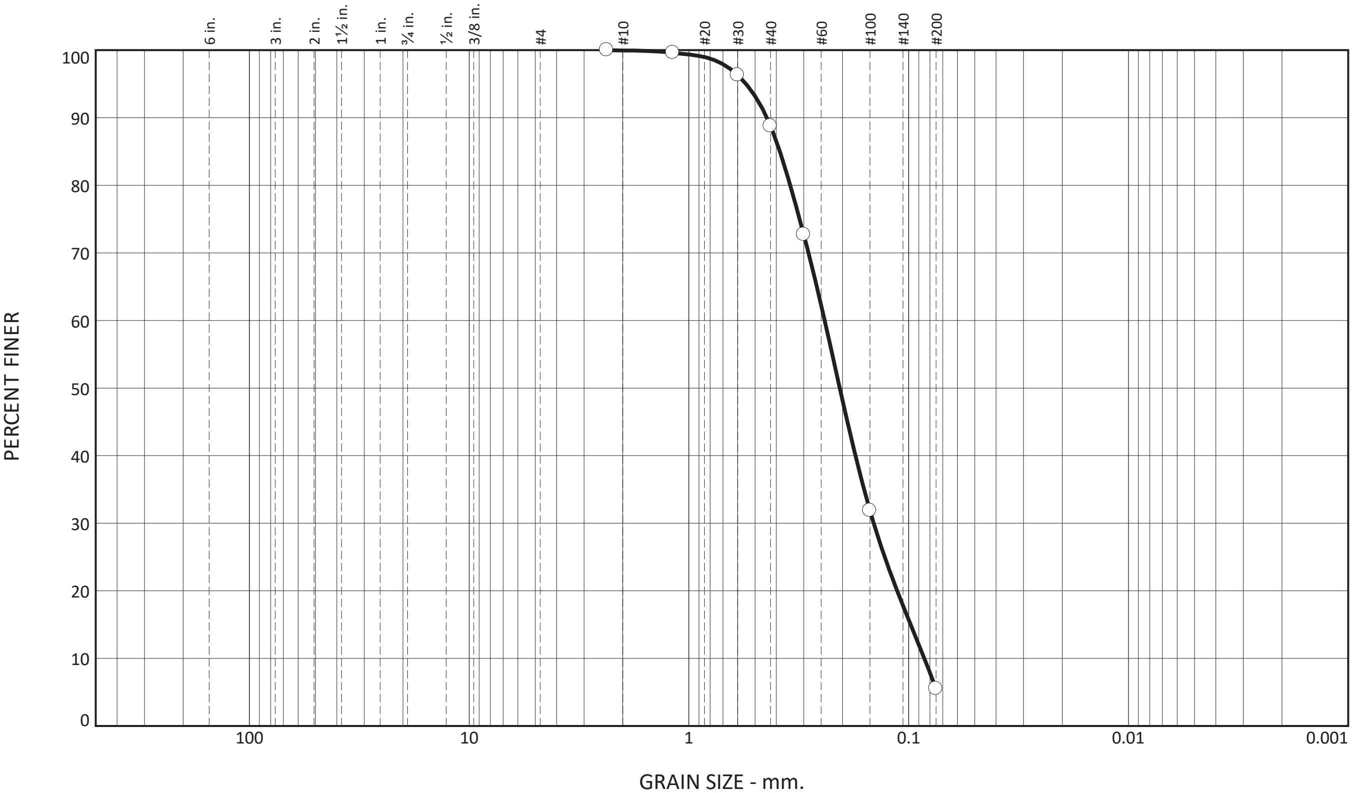
ALLIED TESTING LABORATORIES, INC.
Springfield, Massachusetts

Client: OTO
Project: South Hadley Electric Light Dept.
Project No: 0381-63-01
Figure

Checked By: John McGreevy

Particle Size Distribution Report

ASTM C117 & C136



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	11.2	83.3	5.5	

Test Results (ASTM C117 & C136)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)	Pct. of Fines
#8	100.0			
#16	99.6			
#30	96.3			
#40	88.8			
#50	72.7			
#100	31.9			
#200	5.5			

* (no specification provided)

Material Description

T-5 (0'-5')

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4414	D_{85}= 0.3854	D_{60}= 0.2412
D_{50}= 0.2057	D_{30}= 0.1442	D_{15}= 0.0980
D_{10}= 0.0848	C_u= 2.84	C_c= 1.02

Classification

USCS= AASHTO=

Test Remarks

This sample was delivered to ATL. This sample was washed.

Sample Number: 1745

Sample Date: 1/9/25

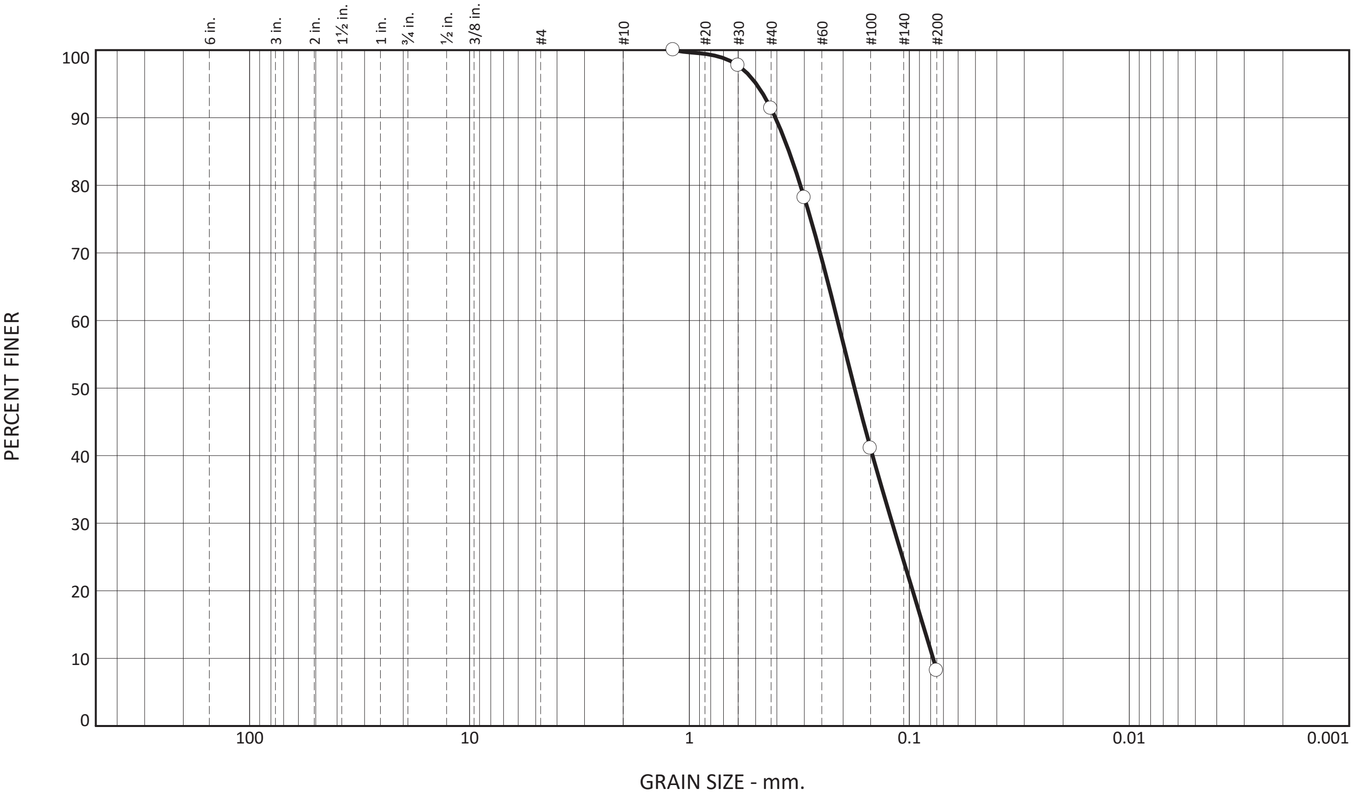
ALLIED TESTING LABORATORIES, INC.
Springfield, Massachusetts

Client: OTO
Project: South Hadley Electric Light Dept.
Project No: 0381-63-01
Figure

Checked By: John McGreevy

Particle Size Distribution Report

ASTM C117 & C136



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	8.7	83.1	8.2	

Test Results (ASTM C117 & C136)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)	Pct. of Fines
#16	100.0			
#30	97.7			
#40	91.3			
#50	78.1			
#100	41.1			
#200	8.2			

* (no specification provided)

Material Description

T-6 (2.5'-4.5')

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4061 D_{85}= 0.3524 D_{60}= 0.2121
D_{50}= 0.1774 D_{30}= 0.1195 D_{15}= 0.0867
D_{10}= 0.0779 C_u= 2.72 C_c= 0.86

Classification

USCS= AASHTO=

Test Remarks

This sample was delivered to ATL. This sample was washed.

Sample Number: 1746

Sample Date: 1/9/25

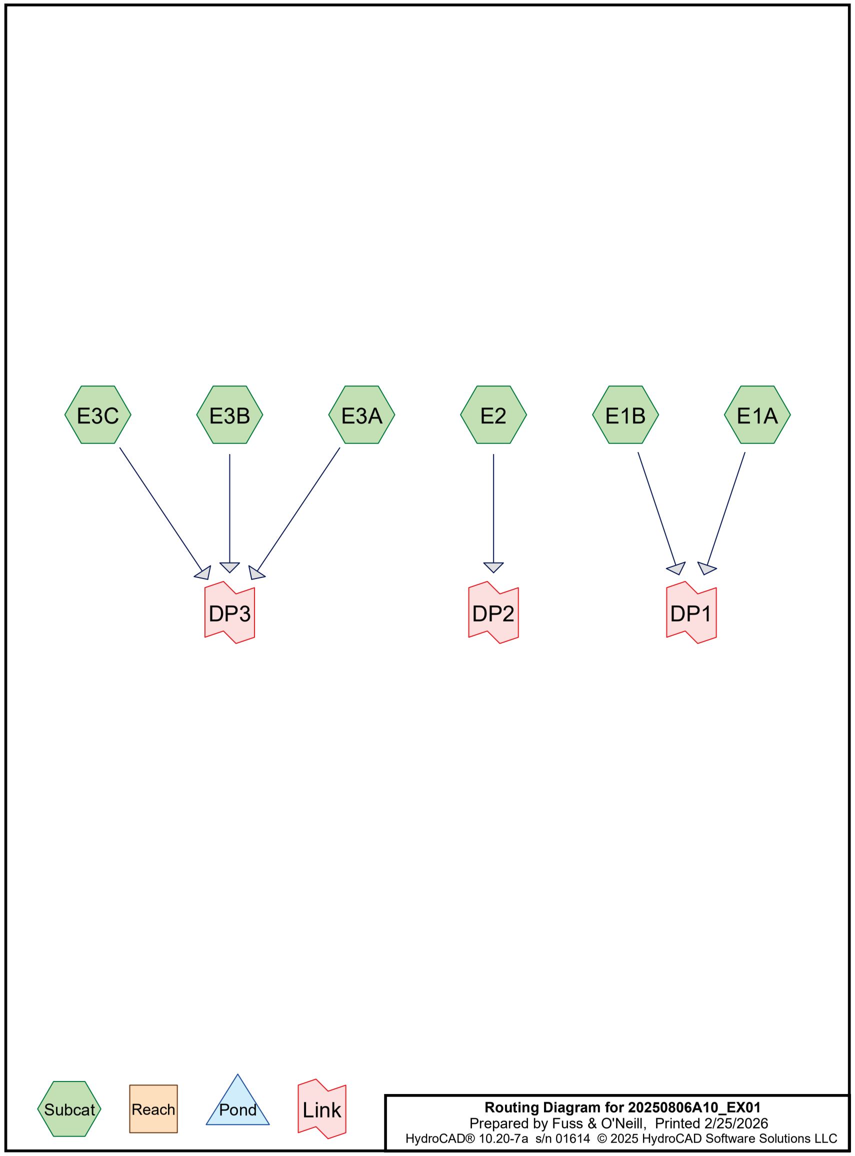
ALLIED TESTING LABORATORIES, INC.
Springfield, Massachusetts

Client: OTO
Project: South Hadley Electric Light Dept.
Project No: 0381-63-01
Figure

Checked By: John McGreevy

Appendix D

Pre-Development Hydrologic Analysis



Routing Diagram for 20250806A10_EX01
Prepared by Fuss & O'Neill, Printed 2/25/2026
HydroCAD® 10.20-7a s/n 01614 © 2025 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-YR	Type III 24-hr		Default	24.00	1	3.09	2
2	10-YR	Type III 24-hr		Default	24.00	1	4.98	2
3	25-YR	Type III 24-hr		Default	24.00	1	6.16	2
4	100-YR	Type III 24-hr		Default	24.00	1	7.98	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.930	49	50-75% Grass cover, Fair, HSG A (E1A, E1B, E2, E3A, E3B, E3C)
0.322	72	Dirt roads, HSG A (E3A)
1.499	98	Paved parking, HSG A (E1A, E1B, E2, E3A, E3B, E3C)
0.129	98	Roofs, HSG A (E1A)
5.557	30	Woods, Good, HSG A (E1A, E1B, E2, E3A, E3B)
10.438	**47**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
10.438	HSG A	E1A, E1B, E2, E3A, E3B, E3C
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
10.438		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
2.930	0.000	0.000	0.000	0.000	2.930	50-75% Grass cover, Fair	E1A, E1B, E2, E3A, E3B, E3C
0.322	0.000	0.000	0.000	0.000	0.322	Dirt roads	E3A
1.499	0.000	0.000	0.000	0.000	1.499	Paved parking	E1A, E1B, E2, E3A, E3B, E3C
0.129	0.000	0.000	0.000	0.000	0.129	Roofs	E1A
5.557	0.000	0.000	0.000	0.000	5.557	Woods, Good	E1A, E1B, E2, E3A, E3B
10.438	**0.000**	**0.000**	**0.000**	**0.000**	**10.438**	**TOTAL AREA**	

Time span=0.00-60.00 hrs, dt=0.03 hrs, 2001 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentE1A: Runoff Area=63,648 sf 36.72% Impervious Runoff Depth=0.47"
Tc=6.0 min CN=63 Runoff=0.55 cfs 0.057 af

SubcatchmentE1B: Runoff Area=266,973 sf 6.74% Impervious Runoff Depth=0.00"
Flow Length=354' Tc=29.7 min CN=39 Runoff=0.00 cfs 0.000 af

SubcatchmentE2: Runoff Area=42,839 sf 21.35% Impervious Runoff Depth=0.06"
Flow Length=292' Tc=14.3 min CN=47 Runoff=0.01 cfs 0.005 af

SubcatchmentE3A: Runoff Area=57,099 sf 0.57% Impervious Runoff Depth=0.11"
Flow Length=555' Tc=25.5 min CN=50 Runoff=0.02 cfs 0.012 af

SubcatchmentE3B: Runoff Area=15,086 sf 76.24% Impervious Runoff Depth=1.74"
Tc=6.0 min CN=86 Runoff=0.70 cfs 0.050 af

SubcatchmentE3C: Runoff Area=9,018 sf 95.07% Impervious Runoff Depth=2.64"
Tc=6.0 min CN=96 Runoff=0.59 cfs 0.046 af

Link DP1: Inflow=0.55 cfs 0.057 af
Primary=0.55 cfs 0.057 af

Link DP2: Inflow=0.01 cfs 0.005 af
Primary=0.01 cfs 0.005 af

Link DP3: Inflow=1.30 cfs 0.107 af
Primary=1.30 cfs 0.107 af

Total Runoff Area = 10.438 ac Runoff Volume = 0.170 af Average Runoff Depth = 0.19"
84.40% Pervious = 8.810 ac 15.60% Impervious = 1.628 ac

Summary for Subcatchment E1A:

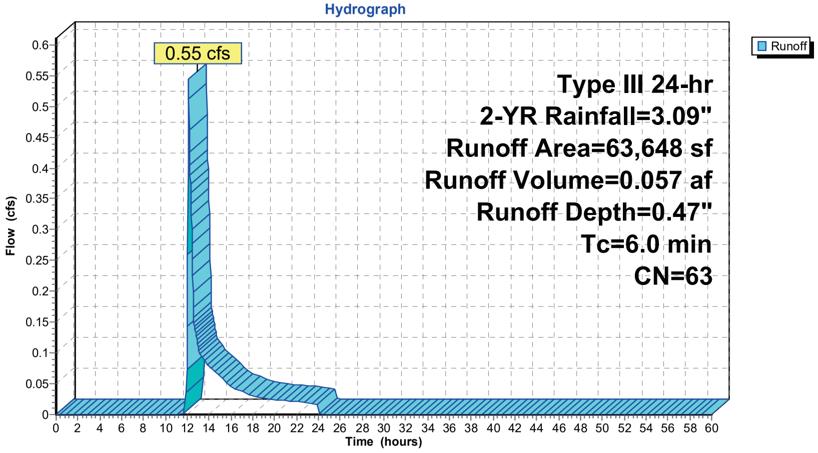
Runoff = 0.55 cfs @ 12.12 hrs, Volume= 0.057 af, Depth= 0.47"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
17,757	98	Paved parking, HSG A
26,041	49	50-75% Grass cover, Fair, HSG A
14,235	30	Woods, Good, HSG A
5,615	98	Roofs, HSG A
63,648	63	Weighted Average
40,276		63.28% Pervious Area
23,372		36.72% Impervious Area

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

Subcatchment E1A:



Summary for Subcatchment E1B:

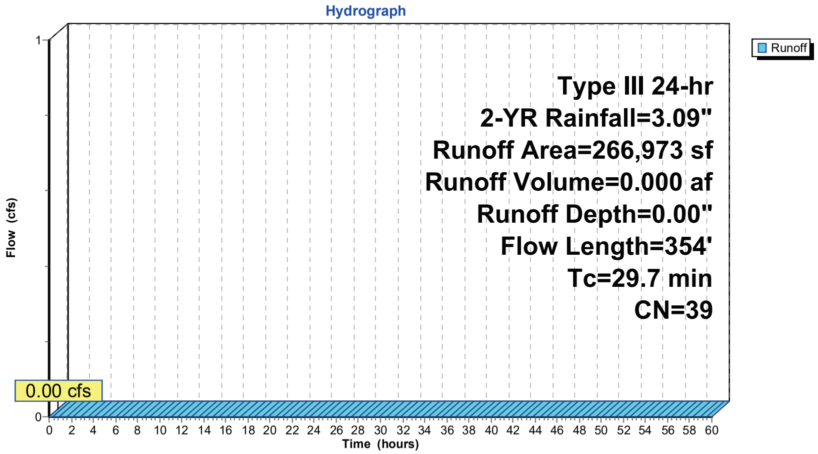
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
18,002	98	Paved parking, HSG A
62,428	49	50-75% Grass cover, Fair, HSG A
186,543	30	Woods, Good, HSG A
266,973	39	Weighted Average
248,971		93.26% Pervious Area
18,002		6.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0746	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
3.4	165	0.0258	0.80		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.9	139	0.0006	0.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
29.7	354	Total			

Subcatchment E1B:



Summary for Subcatchment E2:

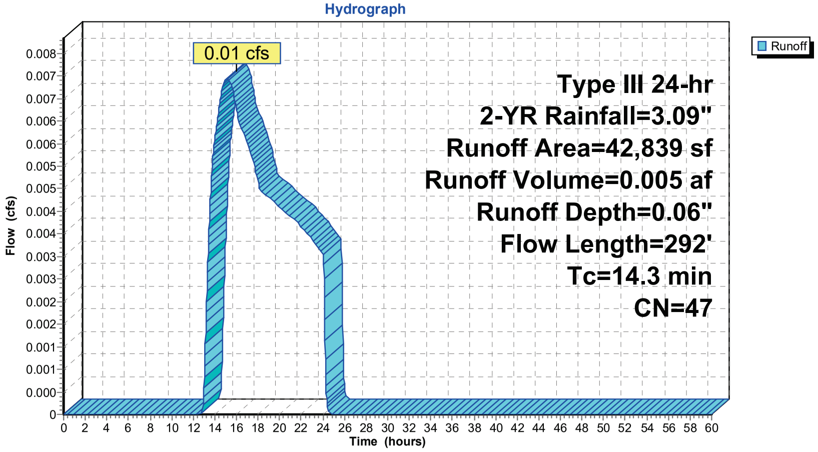
Runoff = 0.01 cfs @ 15.15 hrs, Volume= 0.005 af, Depth= 0.06"
Routed to Link DP2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
9,145	98	Paved parking, HSG A
6,651	49	50-75% Grass cover, Fair, HSG A
27,043	30	Woods, Good, HSG A
42,839	47	Weighted Average
33,694		78.65% Pervious Area
9,145		21.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.7	50	0.0384	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
4.6	242	0.0307	0.88		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	292	Total			

Subcatchment E2:



Summary for Subcatchment E3A:

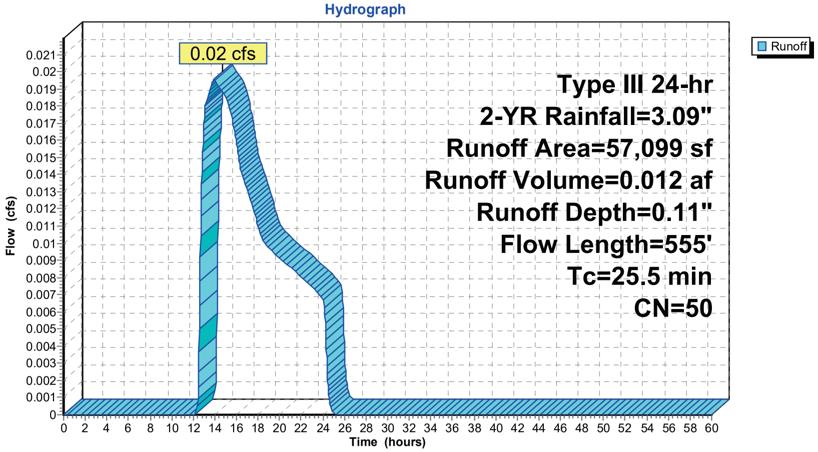
Runoff = 0.02 cfs @ 13.93 hrs, Volume= 0.012 af, Depth= 0.11"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
324	98	Paved parking, HSG A
28,583	49	50-75% Grass cover, Fair, HSG A
14,153	30	Woods, Good, HSG A
14,039	72	Dirt roads, HSG A
57,099	50	Weighted Average
56,775		99.43% Pervious Area
324		0.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.6	40	0.1617	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
2.3	10	0.0009	0.07		**Sheet Flow,** Fallow n= 0.050 P2= 3.09"
1.9	175	0.0090	1.53		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
7.4	104	0.0022	0.23		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.7	118	0.0057	0.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.6	108	0.0021	0.32		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
25.5	555	Total			

Subcatchment E3A:



Summary for Subcatchment E3B:

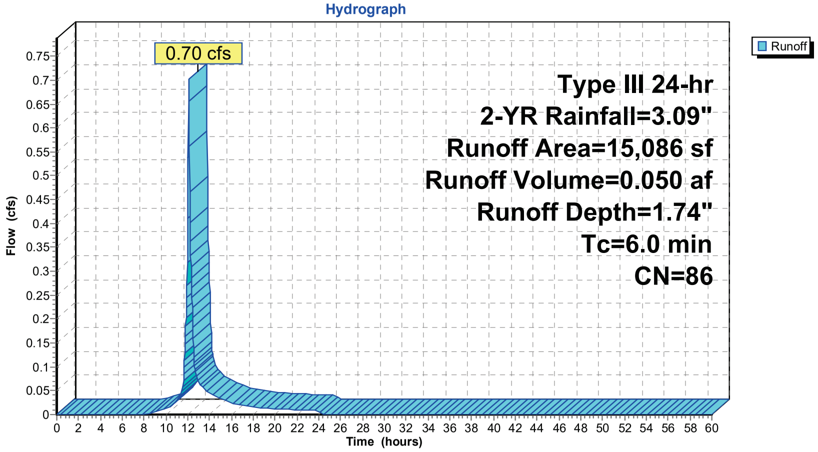
Runoff = 0.70 cfs @ 12.09 hrs, Volume= 0.050 af, Depth= 1.74"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
11,501	98	Paved parking, HSG A
3,491	49	50-75% Grass cover, Fair, HSG A
94	30	Woods, Good, HSG A
15,086	86	Weighted Average
3,585		23.76% Pervious Area
11,501		76.24% Impervious Area

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

Subcatchment E3B:



Summary for Subcatchment E3C:

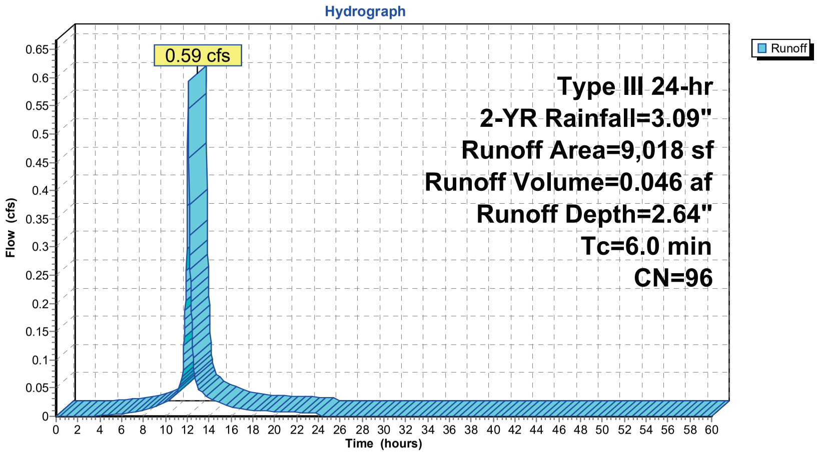
Runoff = 0.59 cfs @ 12.09 hrs, Volume= 0.046 af, Depth= 2.64"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
8,573	98	Paved parking, HSG A
445	49	50-75% Grass cover, Fair, HSG A
9,018	96	Weighted Average
445		4.93% Pervious Area
8,573		95.07% Impervious Area

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

Subcatchment E3C:

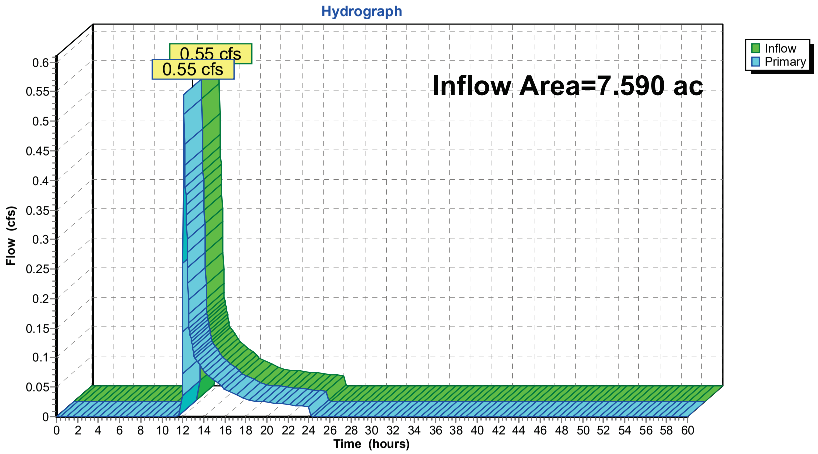


Summary for Link DP1:

Inflow Area = 7.590 ac, 12.51% Impervious, Inflow Depth = 0.09" for 2-YR event
Inflow = 0.55 cfs @ 12.12 hrs, Volume= 0.057 af
Primary = 0.55 cfs @ 12.12 hrs, Volume= 0.057 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP1:

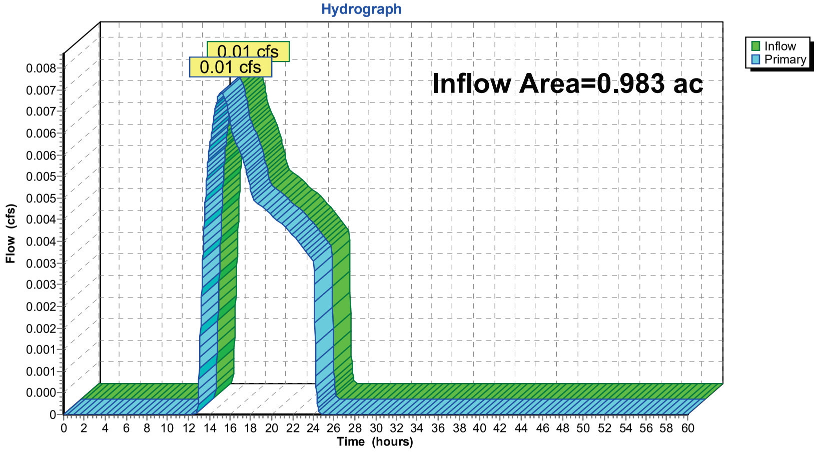


Summary for Link DP2:

Inflow Area = 0.983 ac, 21.35% Impervious, Inflow Depth = 0.06" for 2-YR event
Inflow = 0.01 cfs @ 15.15 hrs, Volume= 0.005 af
Primary = 0.01 cfs @ 15.15 hrs, Volume= 0.005 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP2:

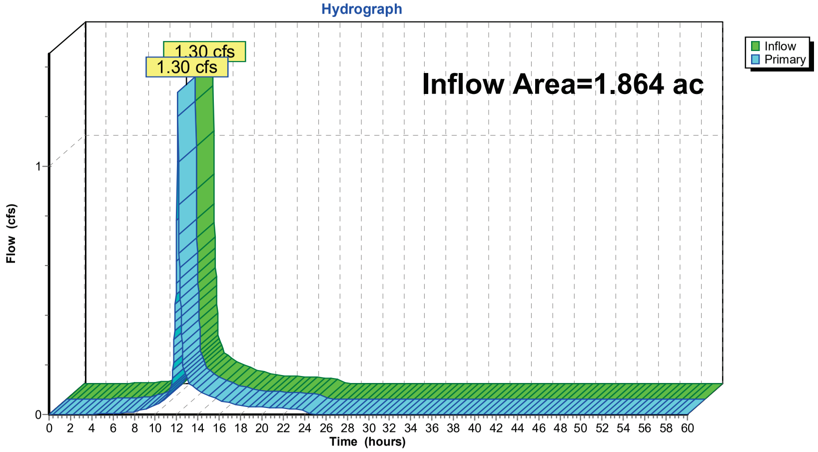


Summary for Link DP3:

Inflow Area = 1.864 ac, 25.12% Impervious, Inflow Depth = 0.69" for 2-YR event
Inflow = 1.30 cfs @ 12.09 hrs, Volume= 0.107 af
Primary = 1.30 cfs @ 12.09 hrs, Volume= 0.107 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP3:



Time span=0.00-60.00 hrs, dt=0.03 hrs, 2001 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentE1A: Runoff Area=63,648 sf 36.72% Impervious Runoff Depth=1.50"
Tc=6.0 min CN=63 Runoff=2.38 cfs 0.182 af

SubcatchmentE1B: Runoff Area=266,973 sf 6.74% Impervious Runoff Depth=0.20"
Flow Length=354' Tc=29.7 min CN=39 Runoff=0.17 cfs 0.100 af

SubcatchmentE2: Runoff Area=42,839 sf 21.35% Impervious Runoff Depth=0.53"
Flow Length=292' Tc=14.3 min CN=47 Runoff=0.24 cfs 0.043 af

SubcatchmentE3A: Runoff Area=57,099 sf 0.57% Impervious Runoff Depth=0.68"
Flow Length=555' Tc=25.5 min CN=50 Runoff=0.43 cfs 0.075 af

SubcatchmentE3B: Runoff Area=15,086 sf 76.24% Impervious Runoff Depth=3.45"
Tc=6.0 min CN=86 Runoff=1.37 cfs 0.100 af

SubcatchmentE3C: Runoff Area=9,018 sf 95.07% Impervious Runoff Depth=4.51"
Tc=6.0 min CN=96 Runoff=0.99 cfs 0.078 af

Link DP1: Inflow=2.38 cfs 0.282 af
Primary=2.38 cfs 0.282 af

Link DP2: Inflow=0.24 cfs 0.043 af
Primary=0.24 cfs 0.043 af

Link DP3: Inflow=2.38 cfs 0.252 af
Primary=2.38 cfs 0.252 af

Total Runoff Area = 10.438 ac Runoff Volume = 0.578 af Average Runoff Depth = 0.66"
84.40% Pervious = 8.810 ac 15.60% Impervious = 1.628 ac

Summary for Subcatchment E1A:

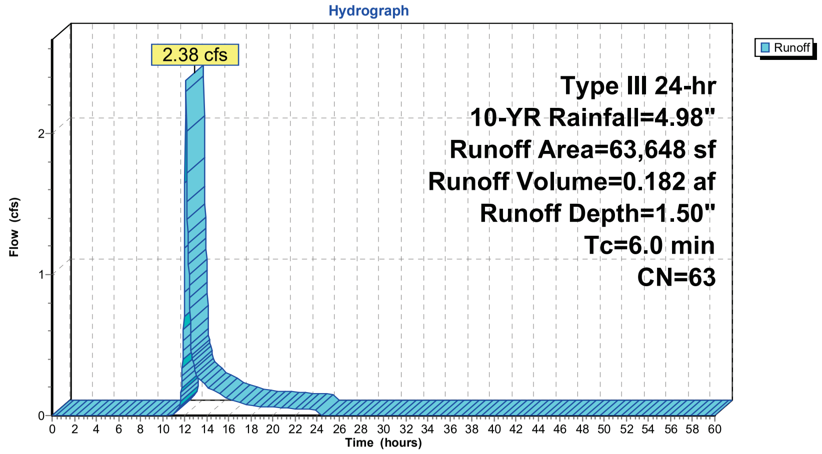
Runoff = 2.38 cfs @ 12.10 hrs, Volume= 0.182 af, Depth= 1.50"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
17,757	98	Paved parking, HSG A
26,041	49	50-75% Grass cover, Fair, HSG A
14,235	30	Woods, Good, HSG A
5,615	98	Roofs, HSG A
63,648	63	Weighted Average
40,276		63.28% Pervious Area
23,372		36.72% Impervious Area

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

Subcatchment E1A:



Summary for Subcatchment E1B:

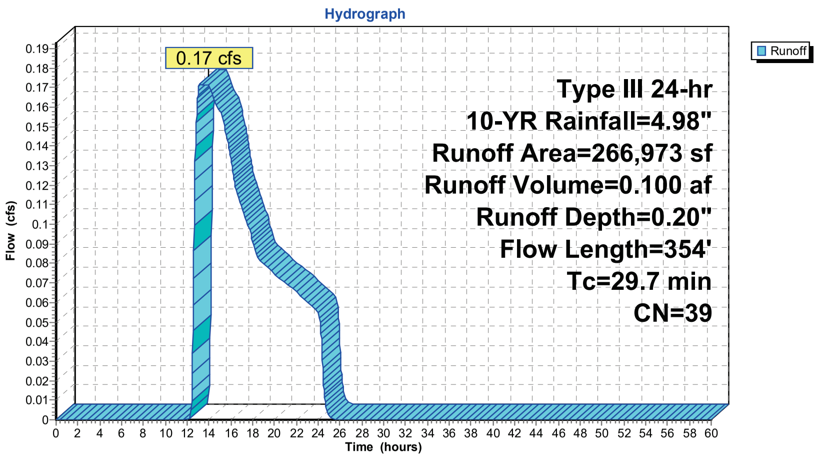
Runoff = 0.17 cfs @ 13.17 hrs, Volume= 0.100 af, Depth= 0.20"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
18,002	98	Paved parking, HSG A
62,428	49	50-75% Grass cover, Fair, HSG A
186,543	30	Woods, Good, HSG A
266,973	39	Weighted Average
248,971		93.26% Pervious Area
18,002		6.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0746	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
3.4	165	0.0258	0.80		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.9	139	0.0006	0.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
29.7	354	Total			

Subcatchment E1B:



Summary for Subcatchment E2:

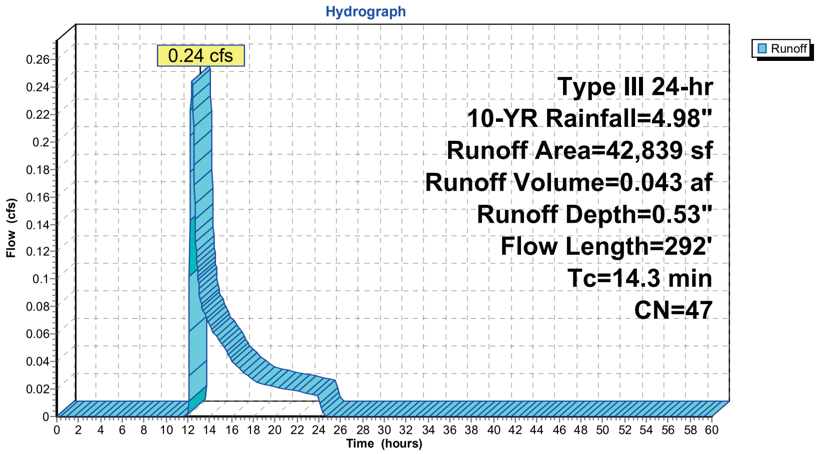
Runoff = 0.24 cfs @ 12.39 hrs, Volume= 0.043 af, Depth= 0.53"
Routed to Link DP2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
9,145	98	Paved parking, HSG A
6,651	49	50-75% Grass cover, Fair, HSG A
27,043	30	Woods, Good, HSG A
42,839	47	Weighted Average
33,694		78.65% Pervious Area
9,145		21.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.7	50	0.0384	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
4.6	242	0.0307	0.88		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	292	Total			

Subcatchment E2:



Summary for Subcatchment E3A:

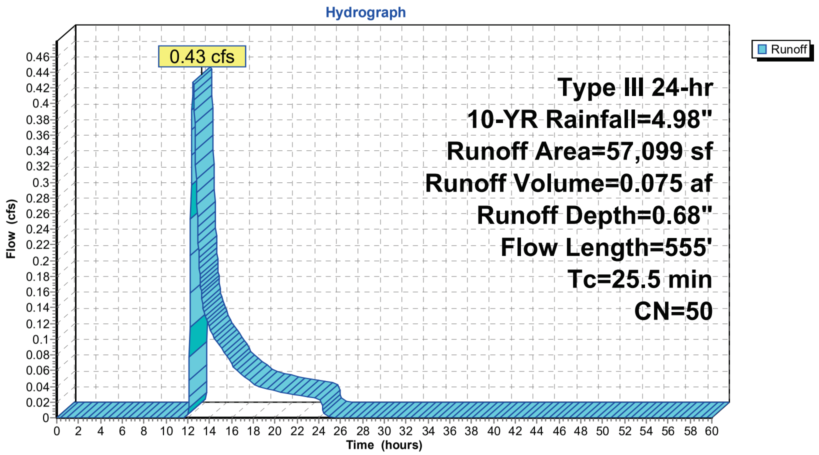
Runoff = 0.43 cfs @ 12.49 hrs, Volume= 0.075 af, Depth= 0.68"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
324	98	Paved parking, HSG A
28,583	49	50-75% Grass cover, Fair, HSG A
14,153	30	Woods, Good, HSG A
14,039	72	Dirt roads, HSG A
57,099	50	Weighted Average
56,775		99.43% Pervious Area
324		0.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.6	40	0.1617	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
2.3	10	0.0009	0.07		**Sheet Flow,** Fallow n= 0.050 P2= 3.09"
1.9	175	0.0090	1.53		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
7.4	104	0.0022	0.23		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.7	118	0.0057	0.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.6	108	0.0021	0.32		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
25.5	555	Total			

Subcatchment E3A:



Summary for Subcatchment E3B:

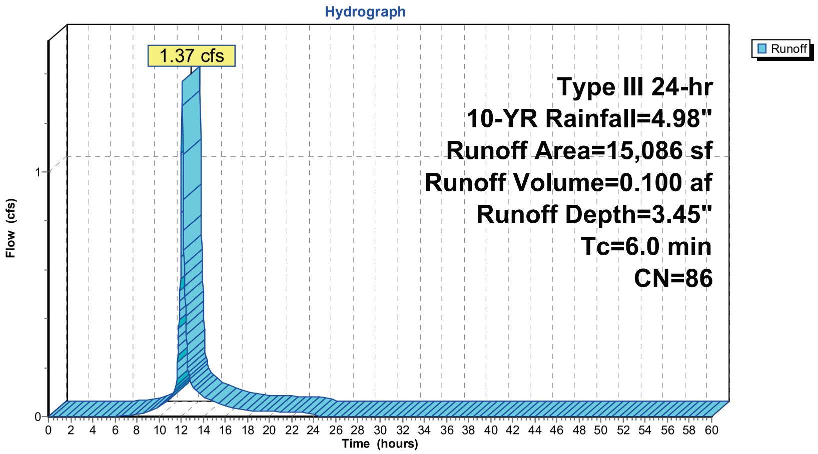
Runoff = 1.37 cfs @ 12.09 hrs, Volume= 0.100 af, Depth= 3.45"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
11,501	98	Paved parking, HSG A
3,491	49	50-75% Grass cover, Fair, HSG A
94	30	Woods, Good, HSG A
15,086	86	Weighted Average
3,585		23.76% Pervious Area
11,501		76.24% Impervious Area

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

Subcatchment E3B:



Summary for Subcatchment E3C:

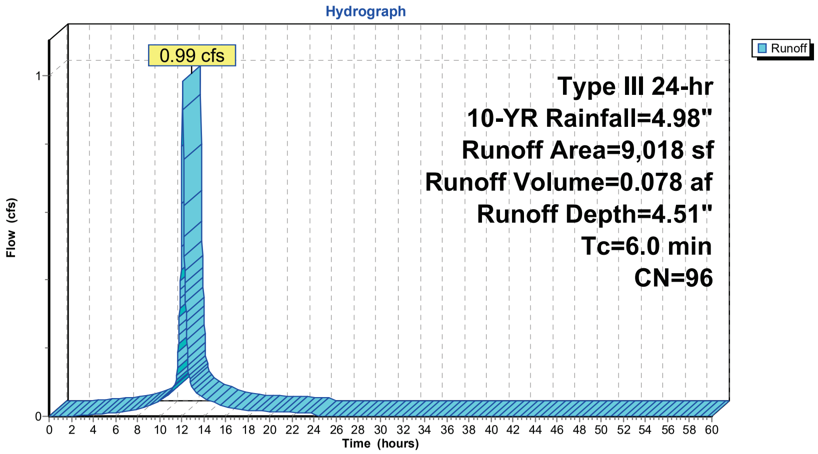
Runoff = 0.99 cfs @ 12.08 hrs, Volume= 0.078 af, Depth= 4.51"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
8,573	98	Paved parking, HSG A
445	49	50-75% Grass cover, Fair, HSG A
9,018	96	Weighted Average
445		4.93% Pervious Area
8,573		95.07% Impervious Area

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

Subcatchment E3C:

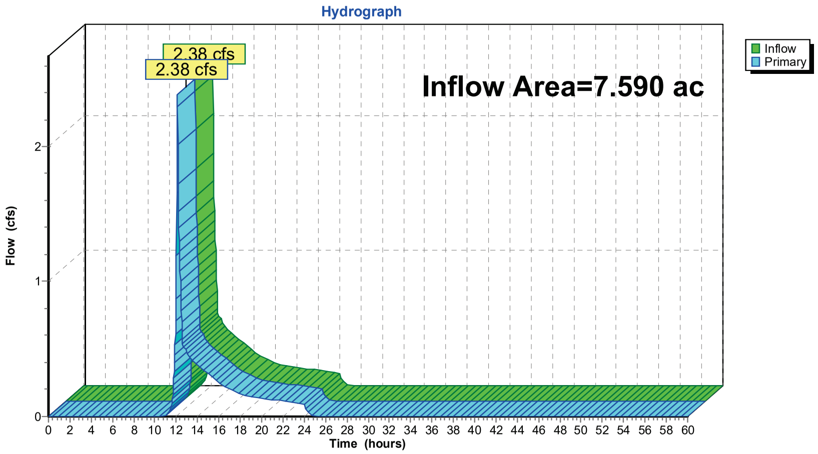


Summary for Link DP1:

Inflow Area = 7.590 ac, 12.51% Impervious, Inflow Depth = 0.45" for 10-YR event
Inflow = 2.38 cfs @ 12.10 hrs, Volume= 0.282 af
Primary = 2.38 cfs @ 12.10 hrs, Volume= 0.282 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP1:

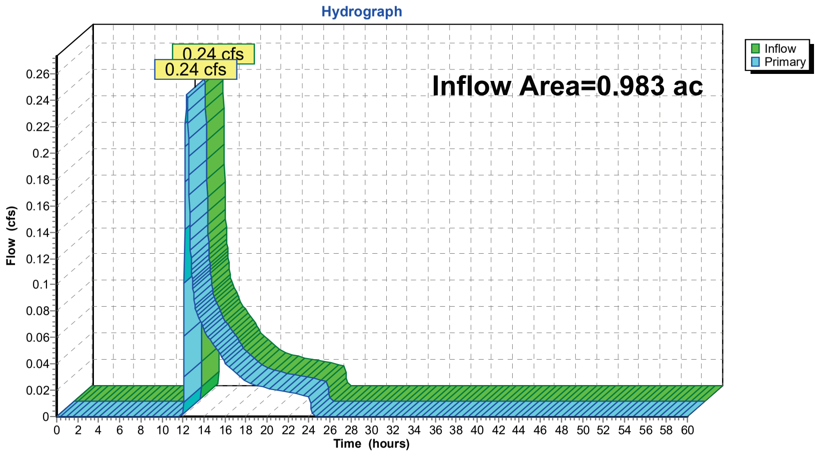


Summary for Link DP2:

Inflow Area = 0.983 ac, 21.35% Impervious, Inflow Depth = 0.53" for 10-YR event
Inflow = 0.24 cfs @ 12.39 hrs, Volume= 0.043 af
Primary = 0.24 cfs @ 12.39 hrs, Volume= 0.043 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP2:

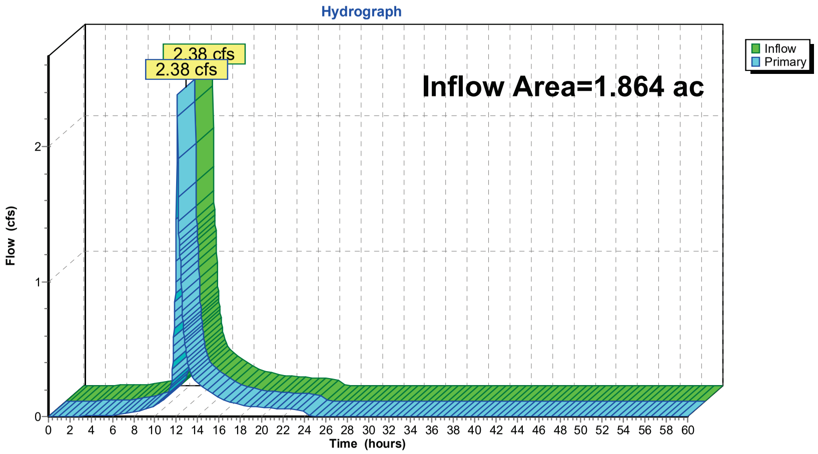


Summary for Link DP3:

Inflow Area = 1.864 ac, 25.12% Impervious, Inflow Depth = 1.62" for 10-YR event
Inflow = 2.38 cfs @ 12.09 hrs, Volume= 0.252 af
Primary = 2.38 cfs @ 12.09 hrs, Volume= 0.252 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP3:



Time span=0.00-60.00 hrs, dt=0.03 hrs, 2001 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentE1A:	Runoff Area=63,648 sf 36.72% Impervious Runoff Depth=2.29" Tc=6.0 min CN=63 Runoff=3.79 cfs 0.279 af
SubcatchmentE1B:	Runoff Area=266,973 sf 6.74% Impervious Runoff Depth=0.49" Flow Length=354' Tc=29.7 min CN=39 Runoff=0.93 cfs 0.251 af
SubcatchmentE2:	Runoff Area=42,839 sf 21.35% Impervious Runoff Depth=1.00" Flow Length=292' Tc=14.3 min CN=47 Runoff=0.63 cfs 0.082 af
SubcatchmentE3A:	Runoff Area=57,099 sf 0.57% Impervious Runoff Depth=1.22" Flow Length=555' Tc=25.5 min CN=50 Runoff=0.92 cfs 0.134 af
SubcatchmentE3B:	Runoff Area=15,086 sf 76.24% Impervious Runoff Depth=4.56" Tc=6.0 min CN=86 Runoff=1.80 cfs 0.132 af
SubcatchmentE3C:	Runoff Area=9,018 sf 95.07% Impervious Runoff Depth=5.69" Tc=6.0 min CN=96 Runoff=1.23 cfs 0.098 af
Link DP1:	Inflow=3.79 cfs 0.530 af Primary=3.79 cfs 0.530 af
Link DP2:	Inflow=0.63 cfs 0.082 af Primary=0.63 cfs 0.082 af
Link DP3:	Inflow=3.20 cfs 0.363 af Primary=3.20 cfs 0.363 af

Total Runoff Area = 10.438 ac Runoff Volume = 0.976 af Average Runoff Depth = 1.12"
84.40% Pervious = 8.810 ac 15.60% Impervious = 1.628 ac

Summary for Subcatchment E1A:

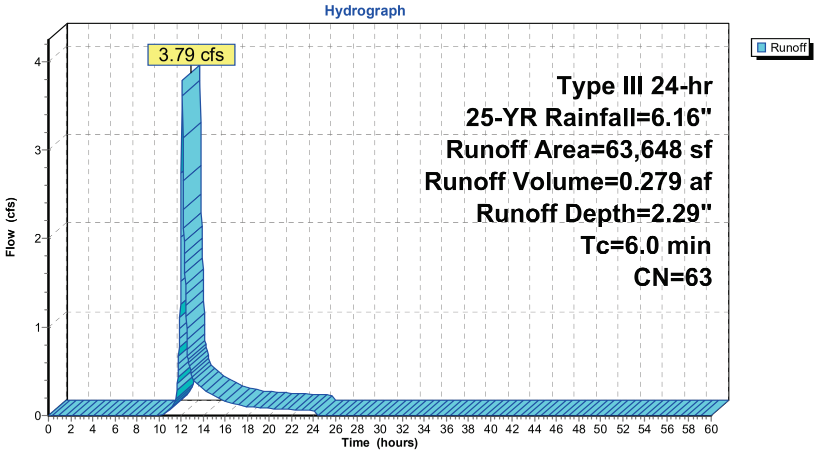
Runoff = 3.79 cfs @ 12.09 hrs, Volume= 0.279 af, Depth= 2.29"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
17,757	98	Paved parking, HSG A
26,041	49	50-75% Grass cover, Fair, HSG A
14,235	30	Woods, Good, HSG A
5,615	98	Roofs, HSG A
63,648	63	Weighted Average
40,276		63.28% Pervious Area
23,372		36.72% Impervious Area

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

Subcatchment E1A:



Summary for Subcatchment E1B:

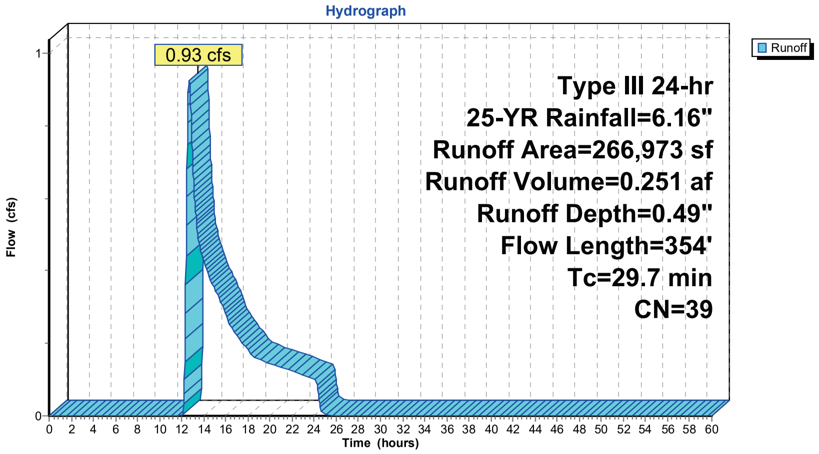
Runoff = 0.93 cfs @ 12.68 hrs, Volume= 0.251 af, Depth= 0.49"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
18,002	98	Paved parking, HSG A
62,428	49	50-75% Grass cover, Fair, HSG A
186,543	30	Woods, Good, HSG A
266,973	39	Weighted Average
248,971		93.26% Pervious Area
18,002		6.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0746	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
3.4	165	0.0258	0.80		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.9	139	0.0006	0.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
29.7	354	Total			

Subcatchment E1B:



Summary for Subcatchment E2:

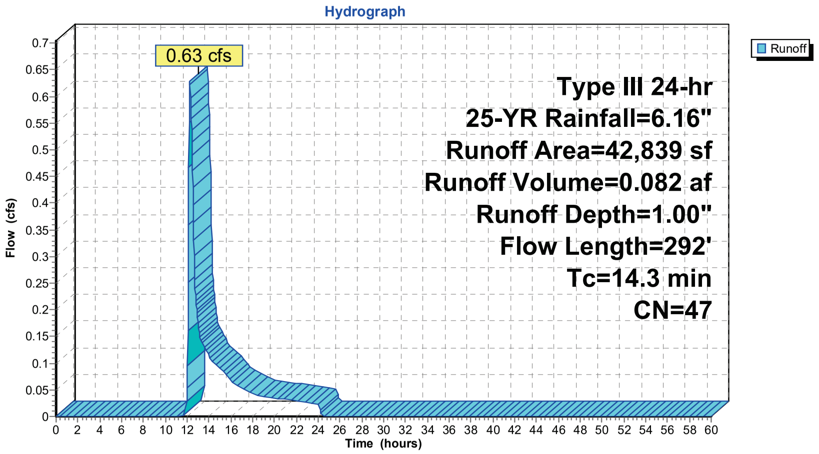
Runoff = 0.63 cfs @ 12.26 hrs, Volume= 0.082 af, Depth= 1.00"
Routed to Link DP2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
9,145	98	Paved parking, HSG A
6,651	49	50-75% Grass cover, Fair, HSG A
27,043	30	Woods, Good, HSG A
42,839	47	Weighted Average
33,694		78.65% Pervious Area
9,145		21.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.7	50	0.0384	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
4.6	242	0.0307	0.88		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	292	Total			

Subcatchment E2:



Summary for Subcatchment E3A:

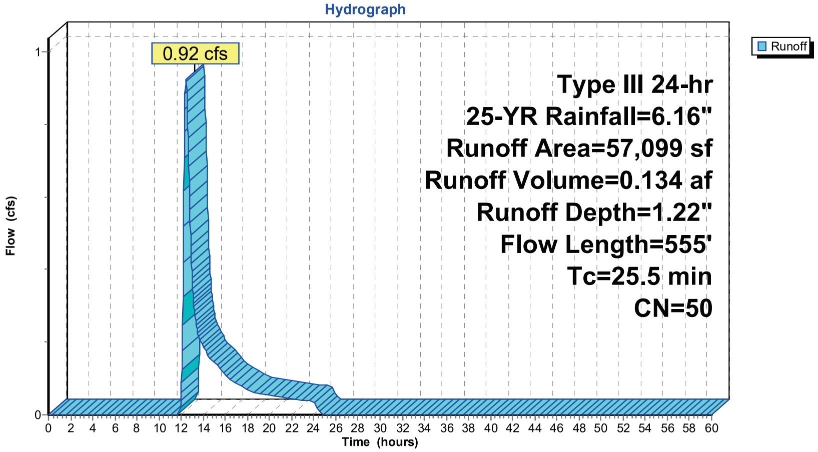
Runoff = 0.92 cfs @ 12.43 hrs, Volume= 0.134 af, Depth= 1.22"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
324	98	Paved parking, HSG A
28,583	49	50-75% Grass cover, Fair, HSG A
14,153	30	Woods, Good, HSG A
14,039	72	Dirt roads, HSG A
57,099	50	Weighted Average
56,775		99.43% Pervious Area
324		0.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.6	40	0.1617	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
2.3	10	0.0009	0.07		**Sheet Flow,** Fallow n= 0.050 P2= 3.09"
1.9	175	0.0090	1.53		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
7.4	104	0.0022	0.23		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.7	118	0.0057	0.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.6	108	0.0021	0.32		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
25.5	555	Total			

Subcatchment E3A:



Summary for Subcatchment E3B:

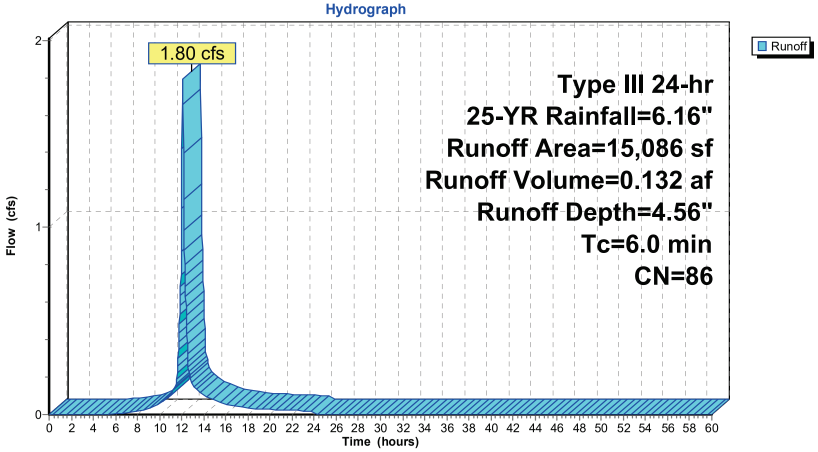
Runoff = 1.80 cfs @ 12.09 hrs, Volume= 0.132 af, Depth= 4.56"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
11,501	98	Paved parking, HSG A
3,491	49	50-75% Grass cover, Fair, HSG A
94	30	Woods, Good, HSG A
15,086	86	Weighted Average
3,585		23.76% Pervious Area
11,501		76.24% Impervious Area

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

Subcatchment E3B:



Summary for Subcatchment E3C:

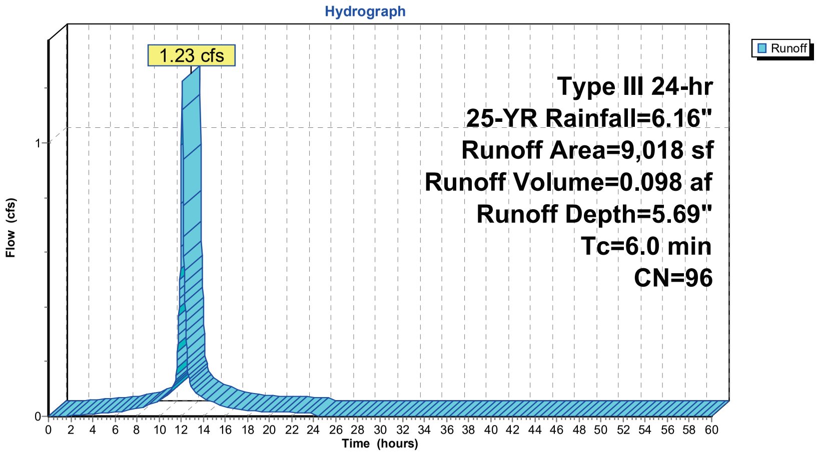
Runoff = 1.23 cfs @ 12.08 hrs, Volume= 0.098 af, Depth= 5.69"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
8,573	98	Paved parking, HSG A
445	49	50-75% Grass cover, Fair, HSG A
9,018	96	Weighted Average
445		4.93% Pervious Area
8,573		95.07% Impervious Area

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

Subcatchment E3C:

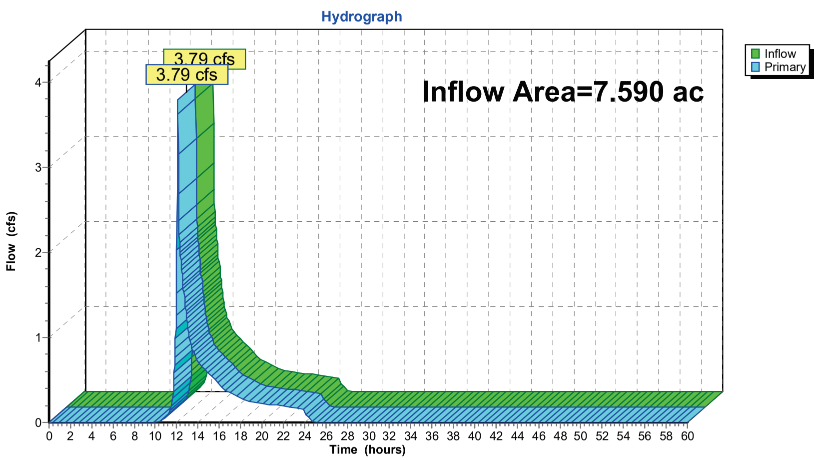


Summary for Link DP1:

Inflow Area = 7.590 ac, 12.51% Impervious, Inflow Depth = 0.84" for 25-YR event
Inflow = 3.79 cfs @ 12.10 hrs, Volume= 0.530 af
Primary = 3.79 cfs @ 12.10 hrs, Volume= 0.530 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP1:

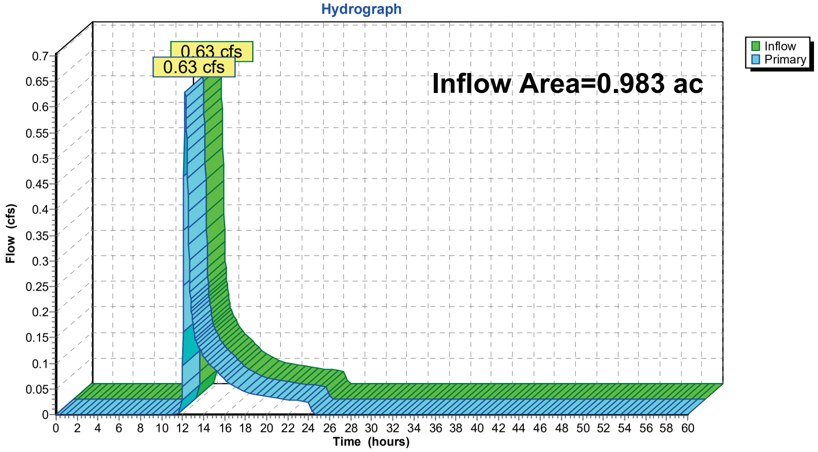


Summary for Link DP2:

```
Inflow Area =      0.983 ac,  21.35% Impervious,  Inflow Depth =   1.00"    for  25-YR event
Inflow      =      0.63 cfs @   12.26 hrs,  Volume=          0.082 af
Primary     =      0.63 cfs @   12.26 hrs,  Volume=          0.082 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP2:

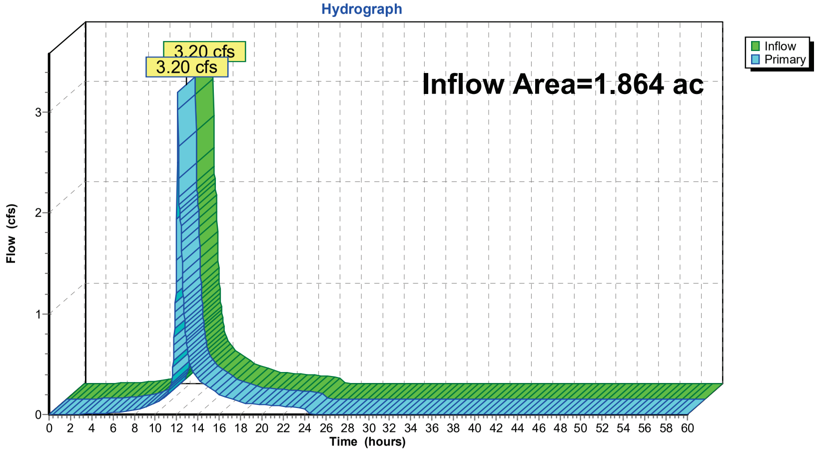


Summary for Link DP3:

```
Inflow Area =      1.864 ac,  25.12% Impervious,  Inflow Depth =   2.34"    for  25-YR event
Inflow      =      3.20 cfs @   12.09 hrs,  Volume=          0.363 af
Primary     =      3.20 cfs @   12.09 hrs,  Volume=          0.363 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP3:



Time span=0.00-60.00 hrs, dt=0.03 hrs, 2001 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentE1A: Runoff Area=63,648 sf 36.72% Impervious Runoff Depth=3.65"
Tc=6.0 min CN=63 Runoff=6.19 cfs 0.445 af

SubcatchmentE1B: Runoff Area=266,973 sf 6.74% Impervious Runoff Depth=1.15"
Flow Length=354' Tc=29.7 min CN=39 Runoff=3.26 cfs 0.587 af

SubcatchmentE2: Runoff Area=42,839 sf 21.35% Impervious Runoff Depth=1.93"
Flow Length=292' Tc=14.3 min CN=47 Runoff=1.48 cfs 0.158 af

SubcatchmentE3A: Runoff Area=57,099 sf 0.57% Impervious Runoff Depth=2.24"
Flow Length=555' Tc=25.5 min CN=50 Runoff=1.91 cfs 0.244 af

SubcatchmentE3B: Runoff Area=15,086 sf 76.24% Impervious Runoff Depth=6.31"
Tc=6.0 min CN=86 Runoff=2.44 cfs 0.182 af

SubcatchmentE3C: Runoff Area=9,018 sf 95.07% Impervious Runoff Depth=7.50"
Tc=6.0 min CN=96 Runoff=1.60 cfs 0.129 af

Link DP1: Inflow=6.36 cfs 1.031 af
Primary=6.36 cfs 1.031 af

Link DP2: Inflow=1.48 cfs 0.158 af
Primary=1.48 cfs 0.158 af

Link DP3: Inflow=4.66 cfs 0.556 af
Primary=4.66 cfs 0.556 af

Total Runoff Area = 10.438 ac Runoff Volume = 1.745 af Average Runoff Depth = 2.01"
84.40% Pervious = 8.810 ac 15.60% Impervious = 1.628 ac

Summary for Subcatchment E1A:

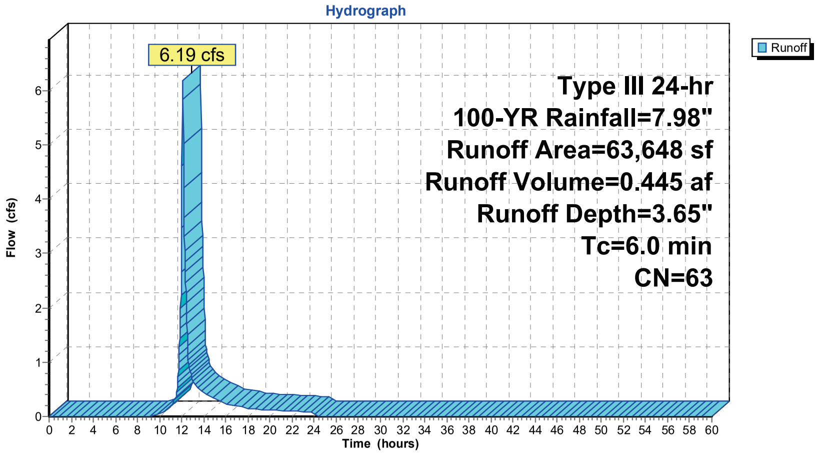
Runoff = 6.19 cfs @ 12.09 hrs, Volume= 0.445 af, Depth= 3.65"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
17,757	98	Paved parking, HSG A
26,041	49	50-75% Grass cover, Fair, HSG A
14,235	30	Woods, Good, HSG A
5,615	98	Roofs, HSG A
63,648	63	Weighted Average
40,276		63.28% Pervious Area
23,372		36.72% Impervious Area

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

Subcatchment E1A:



Summary for Subcatchment E1B:

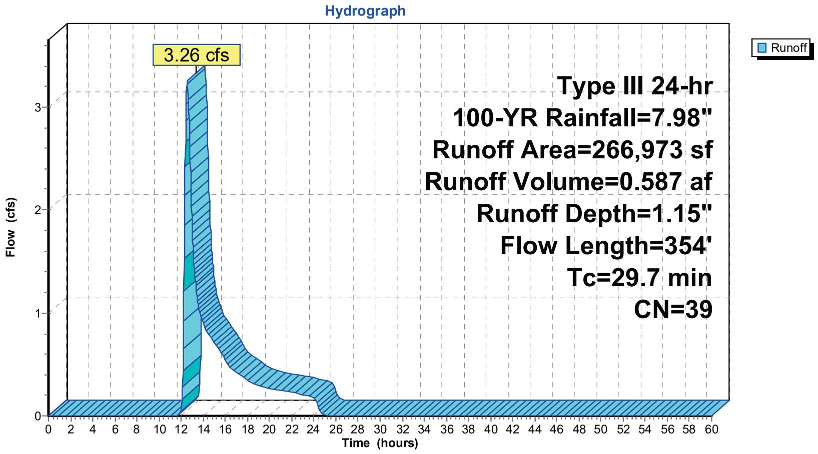
Runoff = 3.26 cfs @ 12.55 hrs, Volume= 0.587 af, Depth= 1.15"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
18,002	98	Paved parking, HSG A
62,428	49	50-75% Grass cover, Fair, HSG A
186,543	30	Woods, Good, HSG A
266,973	39	Weighted Average
248,971		93.26% Pervious Area
18,002		6.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0746	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
3.4	165	0.0258	0.80		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.9	139	0.0006	0.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
29.7	354	Total			

Subcatchment E1B:



Summary for Subcatchment E2:

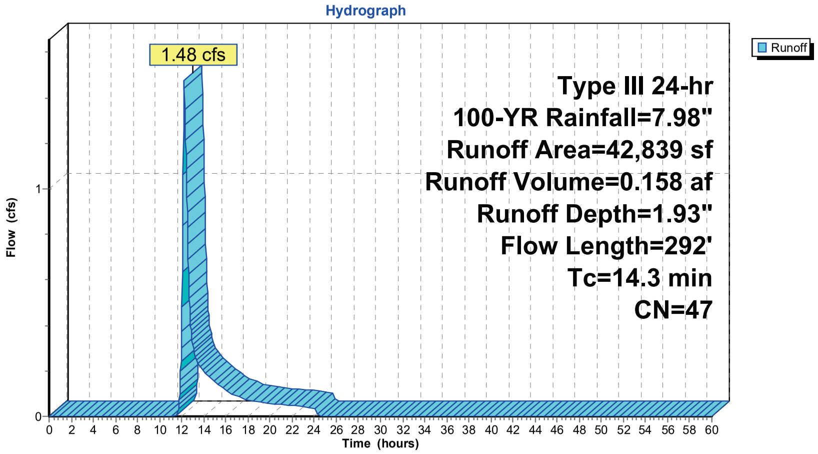
Runoff = 1.48 cfs @ 12.22 hrs, Volume= 0.158 af, Depth= 1.93"
Routed to Link DP2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
9,145	98	Paved parking, HSG A
6,651	49	50-75% Grass cover, Fair, HSG A
27,043	30	Woods, Good, HSG A
42,839	47	Weighted Average
33,694		78.65% Pervious Area
9,145		21.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.7	50	0.0384	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
4.6	242	0.0307	0.88		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	292	Total			

Subcatchment E2:



Summary for Subcatchment E3A:

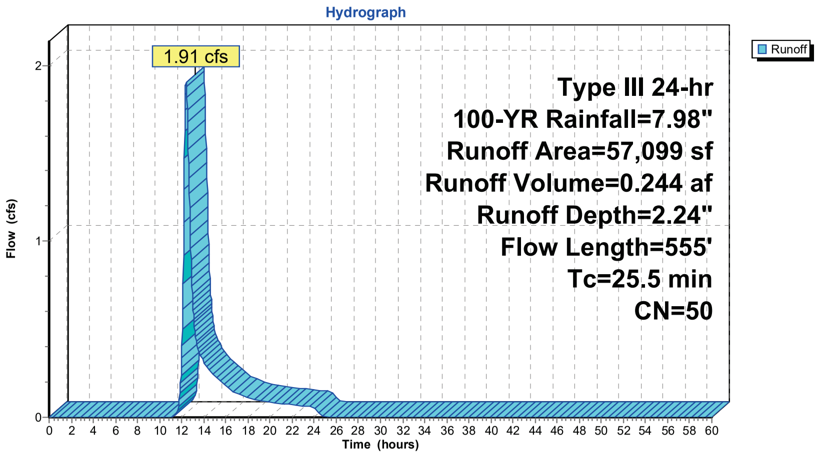
Runoff = 1.91 cfs @ 12.40 hrs, Volume= 0.244 af, Depth= 2.24"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
324	98	Paved parking, HSG A
28,583	49	50-75% Grass cover, Fair, HSG A
14,153	30	Woods, Good, HSG A
14,039	72	Dirt roads, HSG A
57,099	50	Weighted Average
56,775		99.43% Pervious Area
324		0.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.6	40	0.1617	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
2.3	10	0.0009	0.07		**Sheet Flow,** Fallow n= 0.050 P2= 3.09"
1.9	175	0.0090	1.53		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
7.4	104	0.0022	0.23		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.7	118	0.0057	0.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.6	108	0.0021	0.32		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
25.5	555	Total			

Subcatchment E3A:



Summary for Subcatchment E3B:

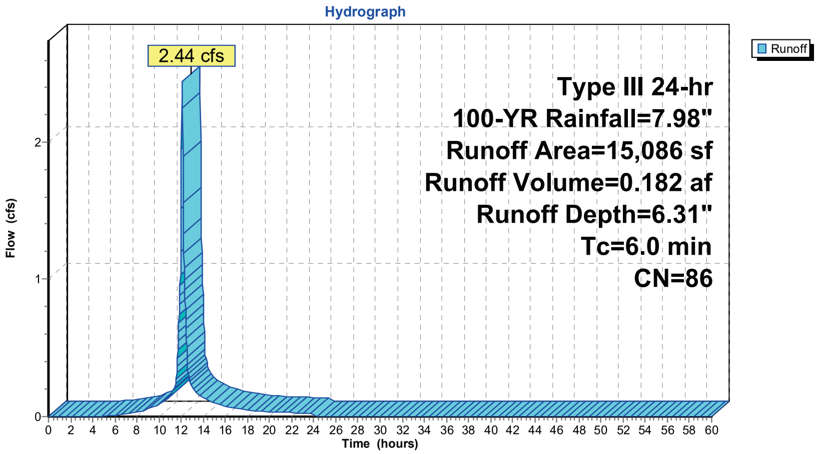
Runoff = 2.44 cfs @ 12.09 hrs, Volume= 0.182 af, Depth= 6.31"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
11,501	98	Paved parking, HSG A
3,491	49	50-75% Grass cover, Fair, HSG A
94	30	Woods, Good, HSG A
15,086	86	Weighted Average
3,585		23.76% Pervious Area
11,501		76.24% Impervious Area

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

Subcatchment E3B:



Summary for Subcatchment E3C:

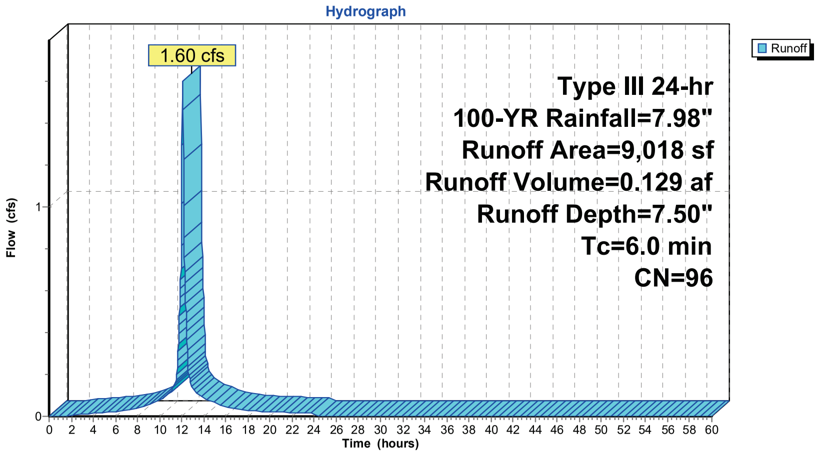
Runoff = 1.60 cfs @ 12.08 hrs, Volume= 0.129 af, Depth= 7.50"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
8,573	98	Paved parking, HSG A
445	49	50-75% Grass cover, Fair, HSG A
9,018	96	Weighted Average
445		4.93% Pervious Area
8,573		95.07% Impervious Area

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

Subcatchment E3C:

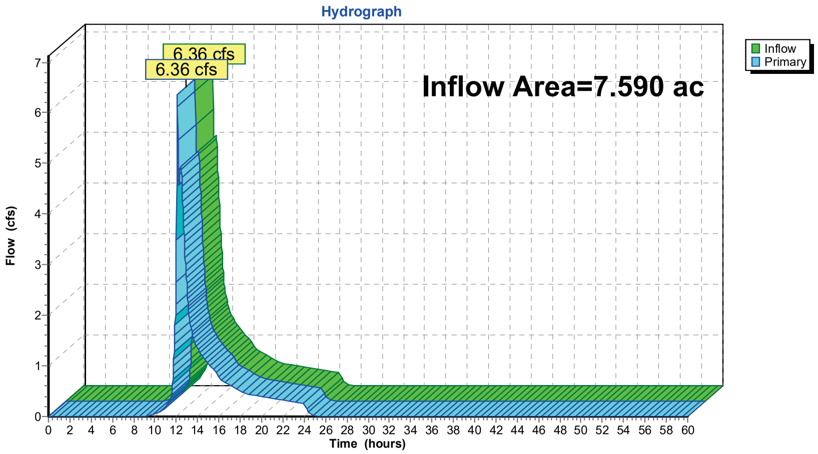


Summary for Link DP1:

Inflow Area = 7.590 ac, 12.51% Impervious, Inflow Depth = 1.63" for 100-YR event
Inflow = 6.36 cfs @ 12.10 hrs, Volume= 1.031 af
Primary = 6.36 cfs @ 12.10 hrs, Volume= 1.031 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP1:

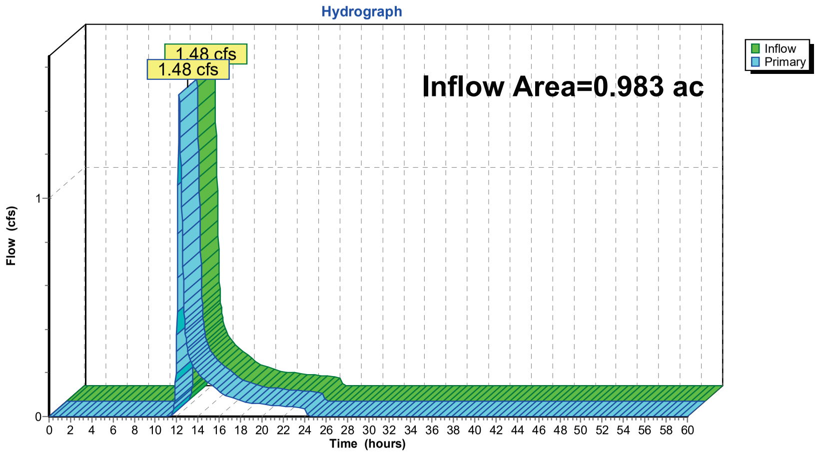


Summary for Link DP2:

Inflow Area = 0.983 ac, 21.35% Impervious, Inflow Depth = 1.93" for 100-YR event
Inflow = 1.48 cfs @ 12.22 hrs, Volume= 0.158 af
Primary = 1.48 cfs @ 12.22 hrs, Volume= 0.158 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP2:

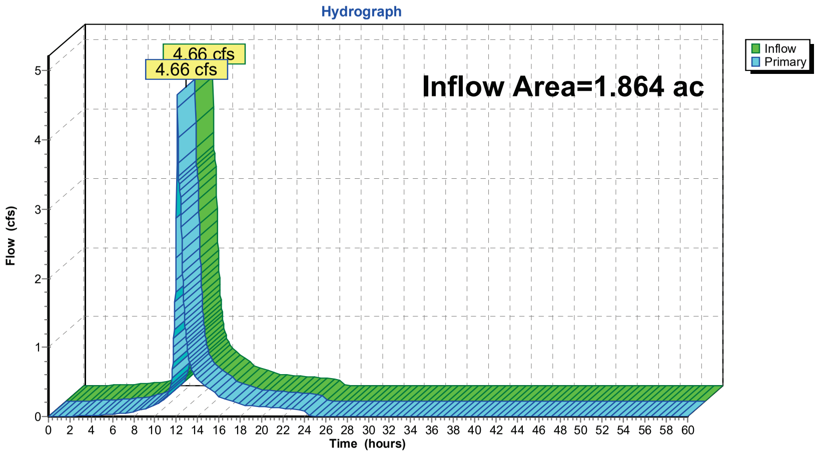


Summary for Link DP3:

```
Inflow Area =       1.864 ac,  25.12% Impervious,  Inflow Depth =   3.58"    for  100-YR event
Inflow      =       4.66 cfs @   12.09 hrs,  Volume=          0.556 af
Primary     =       4.66 cfs @   12.09 hrs,  Volume=          0.556 af,  Atten= 0%,  Lag= 0.0 min
```

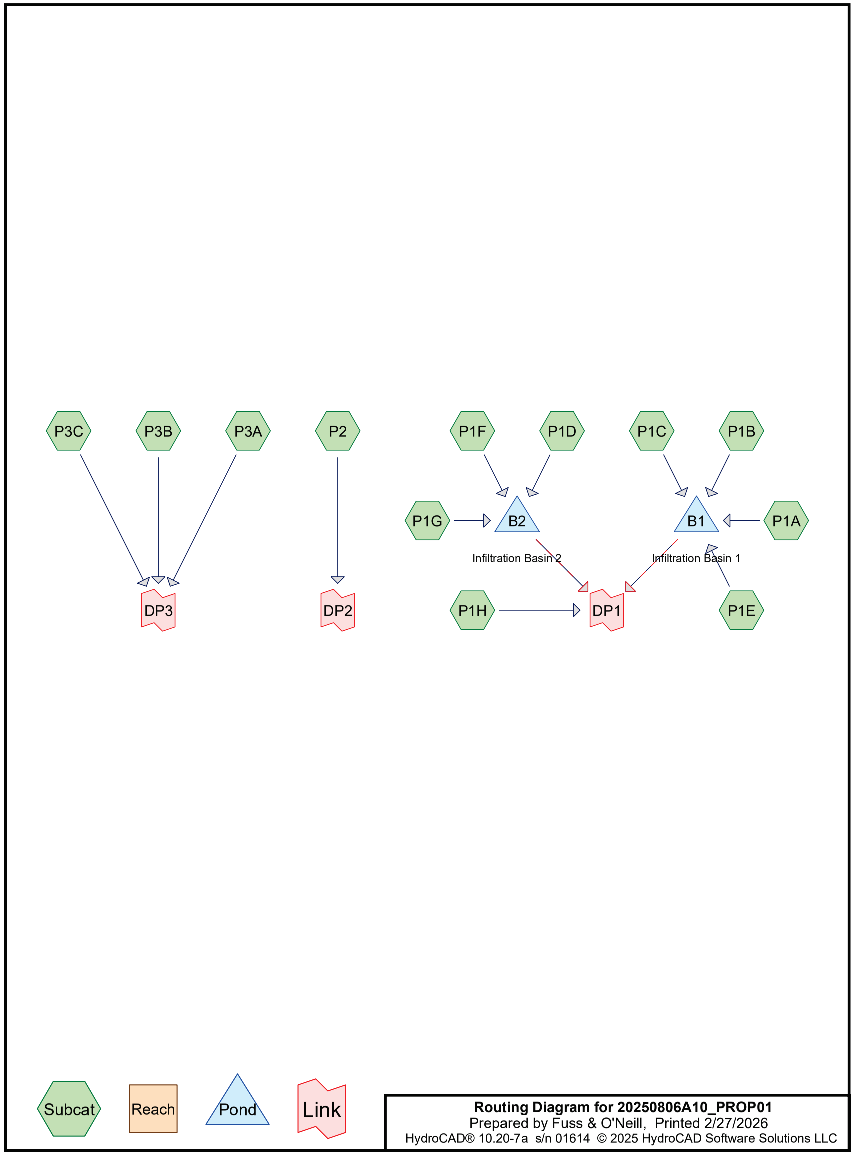
Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs

Link DP3:



Appendix E

Post-Development Hydrologic Analysis



Routing Diagram for 20250806A10_PROP01
Prepared by Fuss & O'Neill, Printed 2/27/2026
HydroCAD® 10.20-7a s/n 01614 © 2025 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-YR	Type III 24-hr		Default	24.00	1	3.09	2
2	10-YR	Type III 24-hr		Default	24.00	1	4.98	2
3	25-YR	Type III 24-hr		Default	24.00	1	6.16	2
4	100-YR	Type III 24-hr		Default	24.00	1	7.98	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.781	49	50-75% Grass cover, Fair, HSG A (P3A, P3B, P3C)
2.342	39	>75% Grass cover, Good, HSG A (P1A, P1B, P1C, P1G, P1H, P2)
0.022	76	Gravel roads, HSG A (P1B)
2.217	98	Paved parking, HSG A (P1A, P1B, P1C, P2, P3A, P3B, P3C)
0.861	98	Paved roads w/curbs & sewers, HSG A (P1G)
1.136	98	Roofs, HSG A (P1A, P1D, P1E, P1F, P1G)
0.417	98	Water Surface, 0% imp, HSG A (P1C, P1G)
2.662	30	Woods, Good, HSG A (P1A, P1B, P1C, P1G, P1H, P2, P3A, P3C)
10.438	**64**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
10.438	HSG A	P1A, P1B, P1C, P1D, P1E, P1F, P1G, P1H, P2, P3A, P3B, P3C
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
10.438		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.781	0.000	0.000	0.000	0.000	0.781	50-75% Grass cover, Fair	P3 A, P3 B, P3 C
2.342	0.000	0.000	0.000	0.000	2.342	>75% Grass cover, Good	P1 A, P1 B, P1 C, P1 G, P1 H, P2
0.022	0.000	0.000	0.000	0.000	0.022	Gravel roads	P1 B
2.217	0.000	0.000	0.000	0.000	2.217	Paved parking	P1 A, P1 B, P1 C, P2, P3 A, P3 B, P3 C
0.861	0.000	0.000	0.000	0.000	0.861	Paved roads w/curbs & sewers	P1 G
1.136	0.000	0.000	0.000	0.000	1.136	Roofs	P1 A, P1 D, P1 E, P1 F, P1 G

Ground Covers (all nodes) (continued)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.417	0.000	0.000	0.000	0.000	0.417	Water Surface, 0% imp	P1 C, P1 G
2.662	0.000	0.000	0.000	0.000	2.662	Woods, Good	P1 A, P1 B, P1 C, P1 G, P1 H, P2, P3 A, P3 C
10.438	**0.000**	**0.000**	**0.000**	**0.000**	**10.438**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)	Node Name
1	B1	238.75	238.25	78.0	0.0064	0.013	0.0	12.0	0.0	
2	B2	239.00	238.35	127.0	0.0051	0.013	0.0	12.0	0.0	

Time span=0.00-75.00 hrs, dt=0.05 hrs, 1501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentP1A: Runoff Area=58,806 sf 33.43% Impervious Runoff Depth=0.27"
Tc=6.0 min CN=57 Runoff=0.17 cfs 0.031 af

SubcatchmentP1B: Runoff Area=65,967 sf 58.25% Impervious Runoff Depth=0.97"
Tc=6.0 min CN=74 Runoff=1.59 cfs 0.122 af

SubcatchmentP1C: Runoff Area=48,750 sf 30.71% Impervious Runoff Depth=0.55"
Tc=6.0 min CN=65 Runoff=0.54 cfs 0.051 af

SubcatchmentP1D: Runoff Area=13,953 sf 100.00% Impervious Runoff Depth=2.86"
Tc=6.0 min CN=98 Runoff=0.94 cfs 0.076 af

SubcatchmentP1E: Runoff Area=9,956 sf 100.00% Impervious Runoff Depth=2.86"
Tc=6.0 min CN=98 Runoff=0.67 cfs 0.054 af

SubcatchmentP1F: Runoff Area=11,934 sf 100.00% Impervious Runoff Depth=2.86"
Tc=6.0 min CN=98 Runoff=0.80 cfs 0.065 af

SubcatchmentP1G: Runoff Area=70,407 sf 64.66% Impervious Runoff Depth=1.66"
Tc=6.0 min CN=85 Runoff=3.09 cfs 0.224 af

SubcatchmentP1H: Runoff Area=67,999 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=152' Tc=17.0 min CN=32 Runoff=0.00 cfs 0.000 af

SubcatchmentP2: Runoff Area=42,847 sf 20.69% Impervious Runoff Depth=0.04"
Tc=14.3 min CN=46 Runoff=0.01 cfs 0.004 af

SubcatchmentP3A: Runoff Area=40,162 sf 0.75% Impervious Runoff Depth=0.03"
Flow Length=416' Tc=21.8 min CN=45 Runoff=0.00 cfs 0.002 af

SubcatchmentP3B: Runoff Area=8,932 sf 96.13% Impervious Runoff Depth=2.64"
Tc=6.0 min CN=96 Runoff=0.58 cfs 0.045 af

SubcatchmentP3C: Runoff Area=14,946 sf 76.01% Impervious Runoff Depth=1.74"
Tc=6.0 min CN=86 Runoff=0.69 cfs 0.050 af

Pond B1: Infiltration Basin 1 Peak Elev=238.05' Storage=2,076 cf Inflow=2.87 cfs 0.258 af
Discarded=0.77 cfs 0.258 af Primary=0.00 cfs 0.000 af Secondary=0.00 cfs 0.000 af Outflow=0.77 cfs 0.258 af

Pond B2: Infiltration Basin 2 Peak Elev=239.04' Storage=4,370 cf Inflow=4.83 cfs 0.366 af
Discarded=0.91 cfs 0.366 af Primary=0.00 cfs 0.000 af Secondary=0.00 cfs 0.000 af Outflow=0.91 cfs 0.366 af

Link DP1: Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Link DP2: Inflow=0.01 cfs 0.004 af
Primary=0.01 cfs 0.004 af

Link DP3:

Inflow=1.26 cfs 0.097 af
Primary=1.26 cfs 0.097 af

Total Runoff Area = 10.438 ac Runoff Volume = 0.725 af Average Runoff Depth = 0.83"
59.63% Pervious = 6.224 ac 40.37% Impervious = 4.213 ac

Summary for Subcatchment P1A:

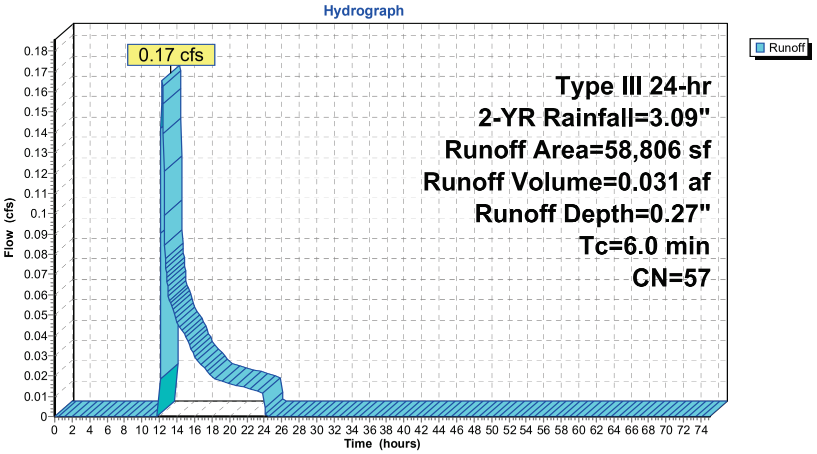
Runoff = 0.17 cfs @ 12.30 hrs, Volume= 0.031 af, Depth= 0.27"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
14,041	98	Paved parking, HSG A
25,305	39	>75% Grass cover, Good, HSG A
13,845	30	Woods, Good, HSG A
5,615	98	Roofs, HSG A
58,806	57	Weighted Average
39,150		66.57% Pervious Area
19,656		33.43% Impervious Area

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

Subcatchment P1A:



Summary for Subcatchment P1B:

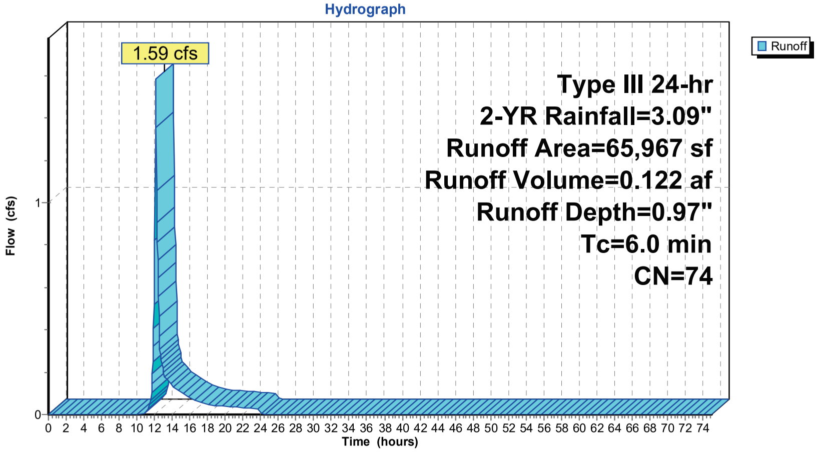
Runoff = 1.59 cfs @ 12.10 hrs, Volume= 0.122 af, Depth= 0.97"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
38,427	98	Paved parking, HSG A
941	76	Gravel roads, HSG A
26,404	39	>75% Grass cover, Good, HSG A
195	30	Woods, Good, HSG A
65,967	74	Weighted Average
27,540		41.75% Pervious Area
38,427		58.25% Impervious Area

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

Subcatchment P1B:



Summary for Subcatchment P1C:

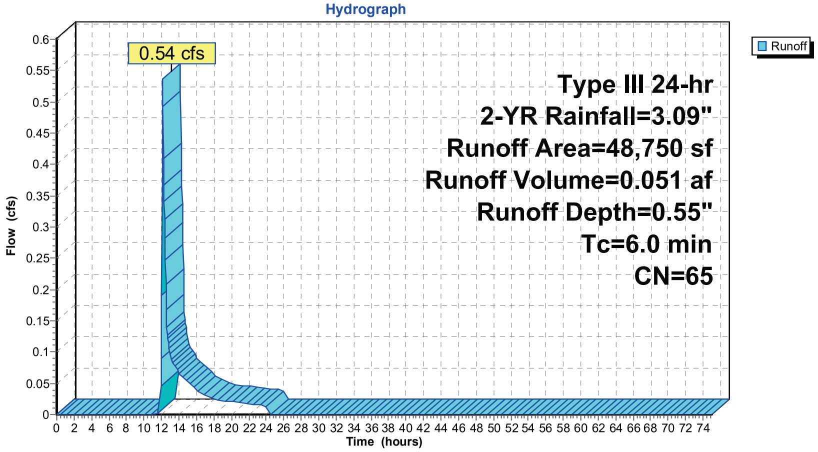
Runoff = 0.54 cfs @ 12.11 hrs, Volume= 0.051 af, Depth= 0.55"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
14,969	98	Paved parking, HSG A
12,574	39	>75% Grass cover, Good, HSG A
12,548	30	Woods, Good, HSG A
8,659	98	Water Surface, 0% imp, HSG A
48,750	65	Weighted Average
33,781		69.29% Pervious Area
14,969		30.71% Impervious Area

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

Subcatchment P1C:



Summary for Subcatchment P1D:

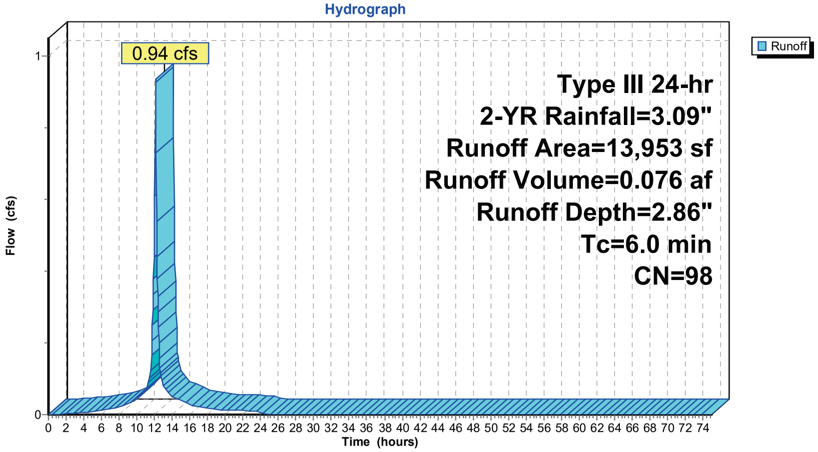
Runoff = 0.94 cfs @ 12.09 hrs, Volume= 0.076 af, Depth= 2.86"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
13,953	98	Roofs, HSG A
13,953		100.00% Impervious Area

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

Subcatchment P1D:



Summary for Subcatchment P1E:

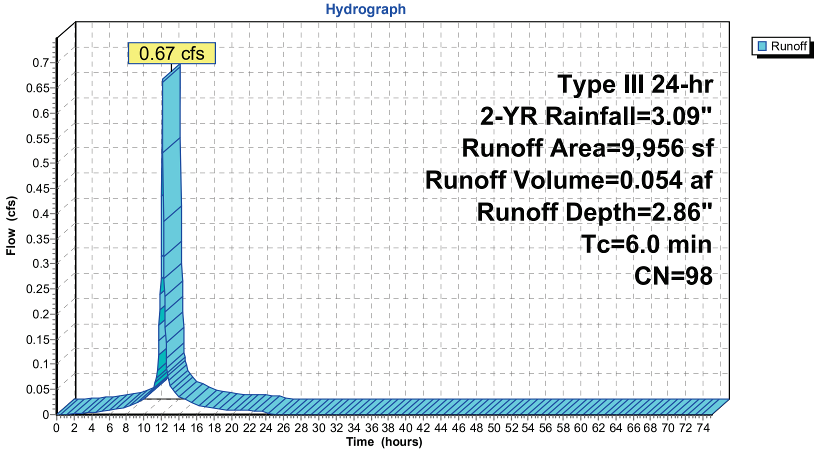
Runoff = 0.67 cfs @ 12.09 hrs, Volume= 0.054 af, Depth= 2.86"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
9,956	98	Roofs, HSG A
9,956		100.00% Impervious Area

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

Subcatchment P1E:



Summary for Subcatchment P1F:

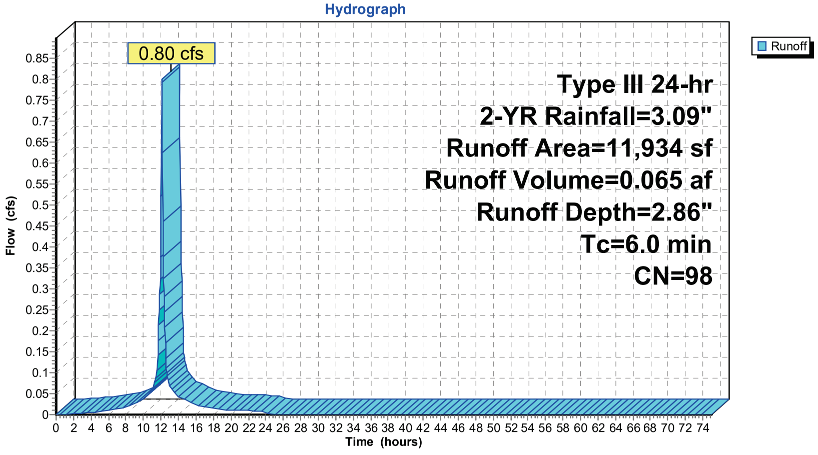
Runoff = 0.80 cfs @ 12.09 hrs, Volume= 0.065 af, Depth= 2.86"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
11,934	98	Roofs, HSG A
11,934		100.00% Impervious Area

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

Subcatchment P1F:



Summary for Subcatchment P1G:

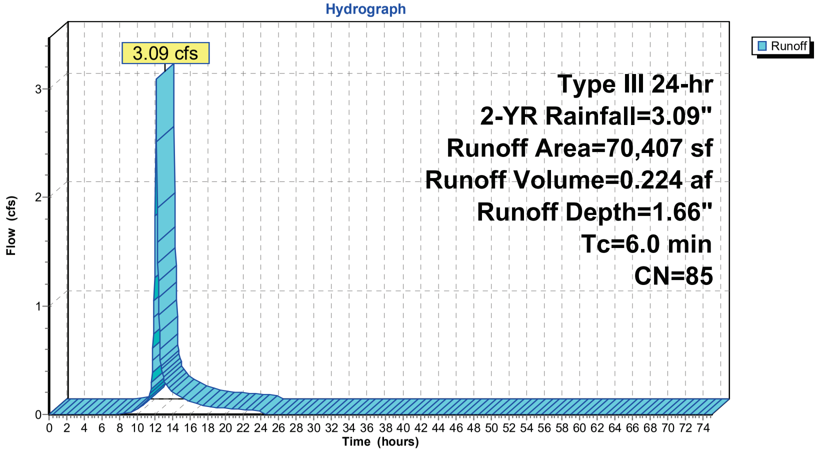
Runoff = 3.09 cfs @ 12.09 hrs, Volume= 0.224 af, Depth= 1.66"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
37,488	98	Paved roads w/curbs & sewers, HSG A
14,758	39	>75% Grass cover, Good, HSG A
611	30	Woods, Good, HSG A
8,038	98	Roofs, HSG A
9,512	98	Water Surface, 0% imp, HSG A
70,407	85	Weighted Average
24,881		35.34% Pervious Area
45,526		64.66% Impervious Area

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

Subcatchment P1G:



Summary for Subcatchment P1H:

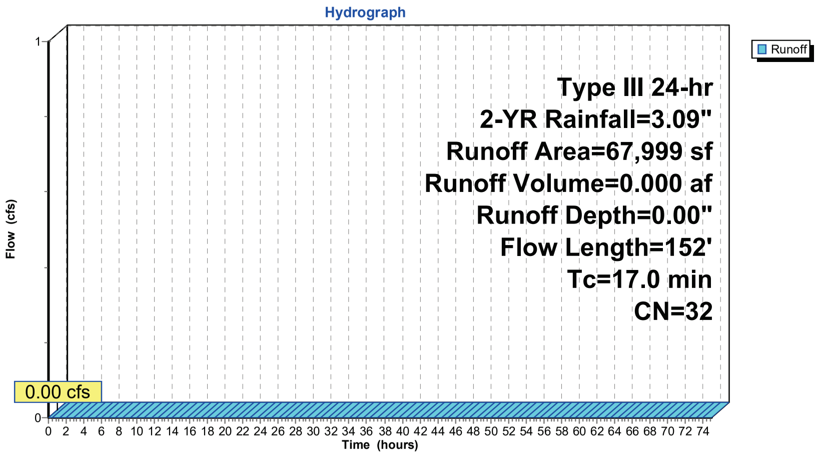
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
15,717	39	>75% Grass cover, Good, HSG A
52,282	30	Woods, Good, HSG A
67,999	32	Weighted Average
67,999		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.6	50	0.0136	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
2.4	102	0.0199	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
17.0	152	Total			

Subcatchment P1H:



Summary for Subcatchment P2:

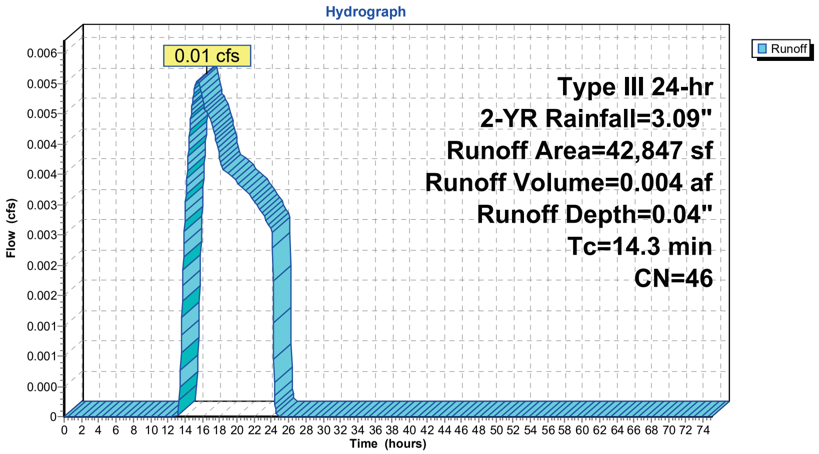
Runoff = 0.01 cfs @ 15.45 hrs, Volume= 0.004 af, Depth= 0.04"
Routed to Link DP2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
8,865	98	Paved parking, HSG A
7,279	39	>75% Grass cover, Good, HSG A
26,703	30	Woods, Good, HSG A
42,847	46	Weighted Average
33,982		79.31% Pervious Area
8,865		20.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry, Same as Pre-dev**

Subcatchment P2:



Summary for Subcatchment P3A:

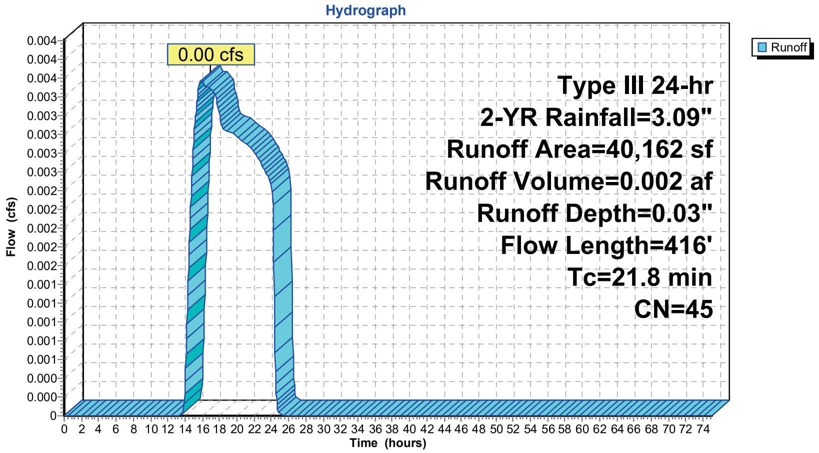
Runoff = 0.00 cfs @ 15.89 hrs, Volume= 0.002 af, Depth= 0.03"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
303	98	Paved parking, HSG A
30,163	49	50-75% Grass cover, Fair, HSG A
9,696	30	Woods, Good, HSG A
40,162	45	Weighted Average
39,859		99.25% Pervious Area
303		0.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	50	0.0430	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
0.6	26	0.0235	0.77		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	33	0.0588	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.2	81	0.0149	0.61		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.7	118	0.0057	0.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.6	108	0.0021	0.32		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
21.8	416	Total			

Subcatchment P3A:



Summary for Subcatchment P3B:

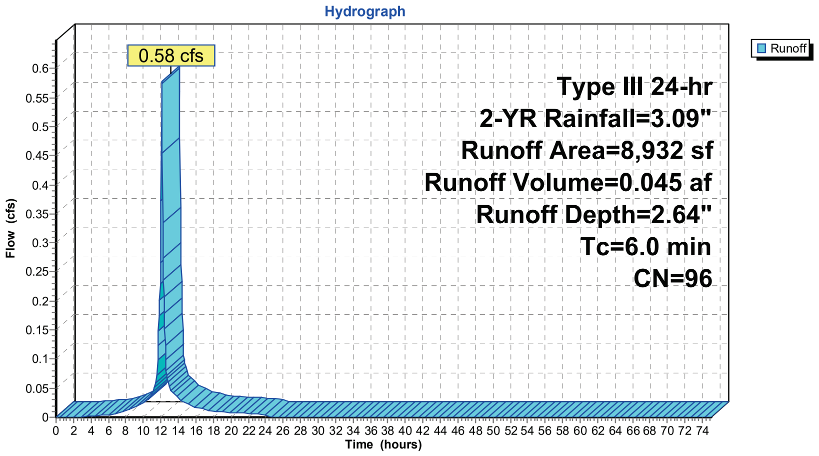
Runoff = 0.58 cfs @ 12.09 hrs, Volume= 0.045 af, Depth= 2.64"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
8,586	98	Paved parking, HSG A
346	49	50-75% Grass cover, Fair, HSG A
8,932	96	Weighted Average
346		3.87% Pervious Area
8,586		96.13% Impervious Area

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

Subcatchment P3B:



Summary for Subcatchment P3C:

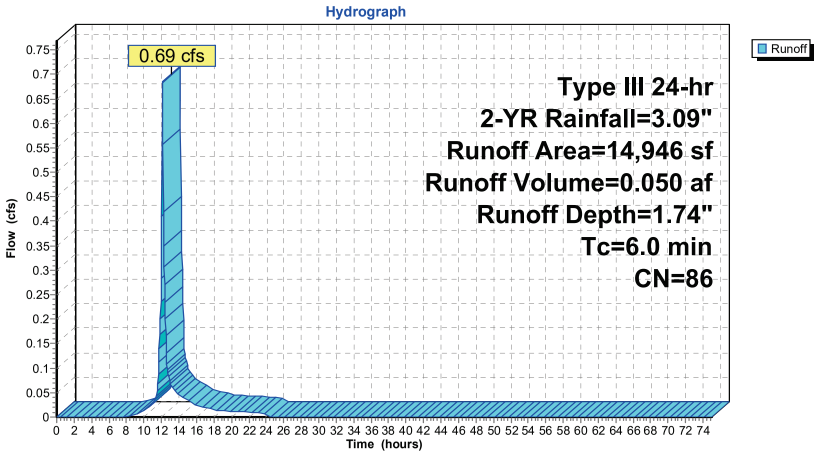
Runoff = 0.69 cfs @ 12.09 hrs, Volume= 0.050 af, Depth= 1.74"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.09"

Area (sf)	CN	Description
11,361	98	Paved parking, HSG A
3,491	49	50-75% Grass cover, Fair, HSG A
94	30	Woods, Good, HSG A
14,946	86	Weighted Average
3,585		23.99% Pervious Area
11,361		76.01% Impervious Area

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

Subcatchment P3C:



Summary for Pond B1: Infiltration Basin 1

Inflow Area = 4.212 ac, 45.24% Impervious, Inflow Depth = 0.74" for 2-YR event
Inflow = 2.87 cfs @ 12.10 hrs, Volume= 0.258 af
Outflow = 0.77 cfs @ 12.55 hrs, Volume= 0.258 af, Atten= 73%, Lag= 26.6 min
Discarded = 0.77 cfs @ 12.55 hrs, Volume= 0.258 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP1 :
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP1 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 238.05' @ 12.55 hrs Surf.Area= 4,033 sf Storage= 2,076 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 14.8 min (873.1 - 858.3)

Volume	Invert	Avail.Storage	Storage Description
#1	237.50'	26,990 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
237.50	3,493	0	0
238.00	3,978	1,868	1,868
239.00	5,033	4,506	6,373
240.00	6,202	5,618	11,991
241.00	7,569	6,886	18,876
242.00	8,659	8,114	26,990

Device	Routing	Invert	Outlet Devices
#1	Primary	238.75'	**12.0" Round Culvert** L= 78.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 238.75' / 238.25' S= 0.0064 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Secondary	241.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#3	Discarded	237.50'	**8.270 in/hr Exfiltration over Surface area**
#4	Device 1	240.50'	**24.0" x 24.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	239.60'	**9.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads

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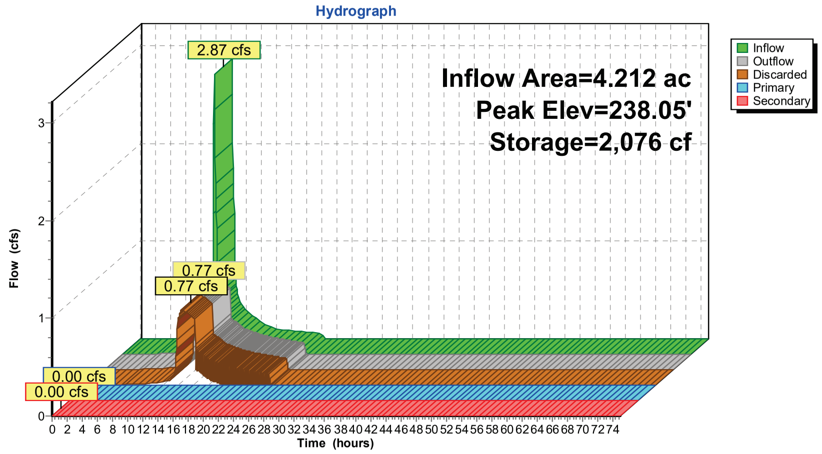
Discarded OutFlow Max=0.77 cfs @ 12.55 hrs HW=238.05' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.77 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=237.50' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Controls 0.00 cfs)
  ├─**4=Grate** (Controls 0.00 cfs)
  └─**5=Orifice** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=237.50' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond B1: Infiltration Basin 1



Summary for Pond B2: Infiltration Basin 2

Inflow Area = 2.211 ac, 74.16% Impervious, Inflow Depth = 1.99" for 2-YR event
Inflow = 4.83 cfs @ 12.09 hrs, Volume= 0.366 af
Outflow = 0.91 cfs @ 12.55 hrs, Volume= 0.366 af, Atten= 81%, Lag= 27.6 min
Discarded = 0.91 cfs @ 12.55 hrs, Volume= 0.366 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP1 :
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP1 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 239.04' @ 12.55 hrs Surf.Area= 4,735 sf Storage= 4,370 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 31.2 min (831.6 - 800.4)

Volume	Invert	Avail.Storage	Storage Description
#1	238.00'	32,644 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
238.00	3,639	0	0
239.00	4,684	4,162	4,162
240.00	5,843	5,264	9,425
241.00	7,114	6,479	15,904
242.00	8,427	7,771	23,674
243.00	9,513	8,970	32,644

Device	Routing	Invert	Outlet Devices
#1	Primary	239.00'	**12.0" Round Culvert** L= 127.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 239.00' / 238.35' S= 0.0051 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Secondary	242.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#3	Discarded	238.00'	**8.270 in/hr Exfiltration over Surface area**
#4	Device 1	241.50'	**24.0" x 24.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	239.60'	**4.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads

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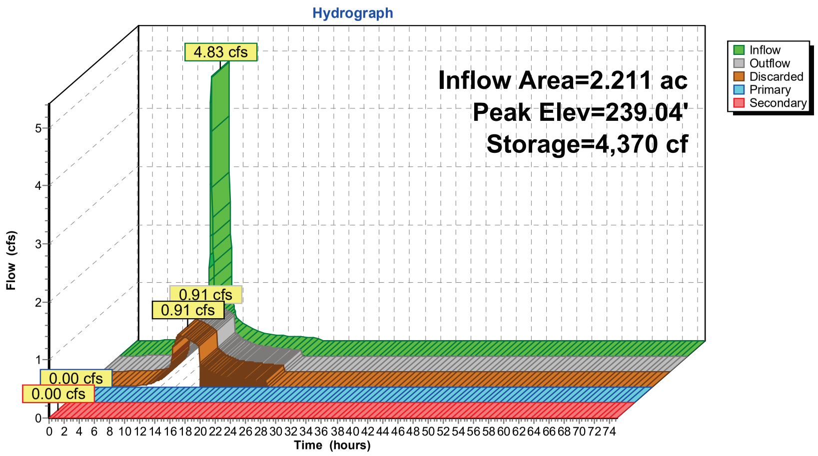
Discarded OutFlow Max=0.91 cfs @ 12.55 hrs HW=239.04' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.91 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=238.00' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Controls 0.00 cfs)
  ├─**4=Grate** (Controls 0.00 cfs)
  └─**5=Orifice** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=238.00' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond B2: Infiltration Basin 2

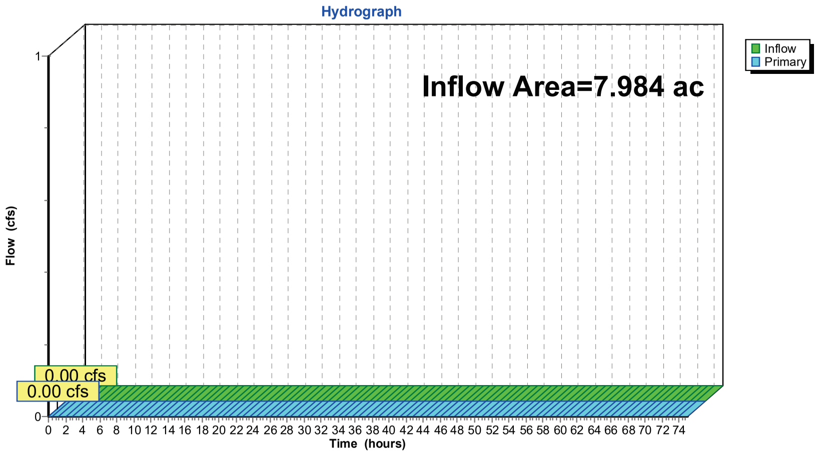


Summary for Link DP1:

Inflow Area = 7.984 ac, 44.40% Impervious, Inflow Depth = 0.00" for 2-YR event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP1:

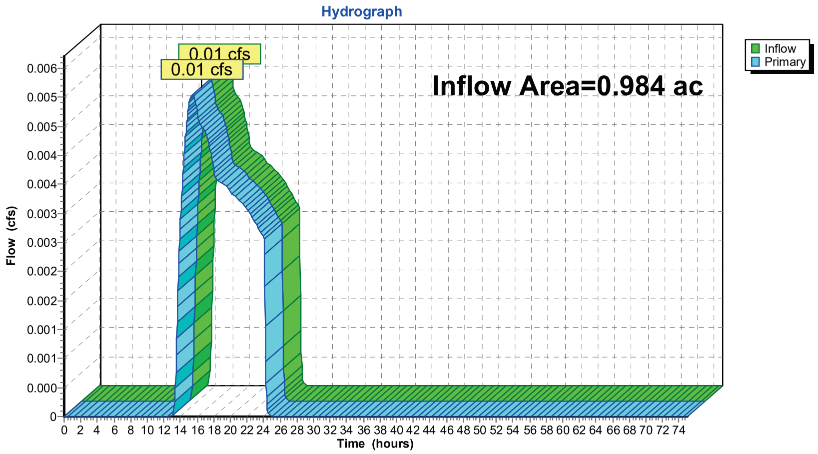


Summary for Link DP2:

Inflow Area = 0.984 ac, 20.69% Impervious, Inflow Depth = 0.04" for 2-YR event
Inflow = 0.01 cfs @ 15.45 hrs, Volume= 0.004 af
Primary = 0.01 cfs @ 15.45 hrs, Volume= 0.004 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP2:

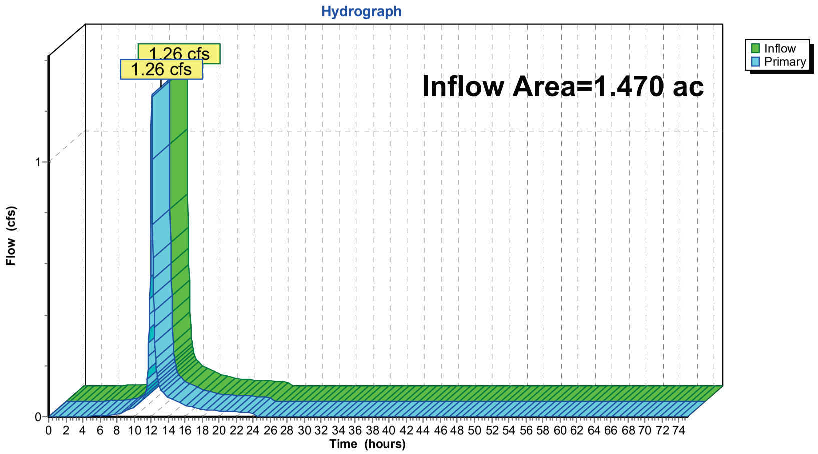


Summary for Link DP3:

Inflow Area = 1.470 ac, 31.62% Impervious, Inflow Depth = 0.79" for 2-YR event
Inflow = 1.26 cfs @ 12.09 hrs, Volume= 0.097 af
Primary = 1.26 cfs @ 12.09 hrs, Volume= 0.097 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP3:



Time span=0.00-75.00 hrs, dt=0.05 hrs, 1501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentP1A:	Runoff Area=58,806 sf 33.43% Impervious Runoff Depth=1.09" Tc=6.0 min CN=57 Runoff=1.44 cfs 0.123 af
SubcatchmentP1B:	Runoff Area=65,967 sf 58.25% Impervious Runoff Depth=2.35" Tc=6.0 min CN=74 Runoff=4.07 cfs 0.296 af
SubcatchmentP1C:	Runoff Area=48,750 sf 30.71% Impervious Runoff Depth=1.64" Tc=6.0 min CN=65 Runoff=2.01 cfs 0.153 af
SubcatchmentP1D:	Runoff Area=13,953 sf 100.00% Impervious Runoff Depth=4.74" Tc=6.0 min CN=98 Runoff=1.52 cfs 0.127 af
SubcatchmentP1E:	Runoff Area=9,956 sf 100.00% Impervious Runoff Depth=4.74" Tc=6.0 min CN=98 Runoff=1.09 cfs 0.090 af
SubcatchmentP1F:	Runoff Area=11,934 sf 100.00% Impervious Runoff Depth=4.74" Tc=6.0 min CN=98 Runoff=1.30 cfs 0.108 af
SubcatchmentP1G:	Runoff Area=70,407 sf 64.66% Impervious Runoff Depth=3.35" Tc=6.0 min CN=85 Runoff=6.15 cfs 0.451 af
SubcatchmentP1H:	Runoff Area=67,999 sf 0.00% Impervious Runoff Depth=0.02" Flow Length=152' Tc=17.0 min CN=32 Runoff=0.00 cfs 0.003 af
SubcatchmentP2:	Runoff Area=42,847 sf 20.69% Impervious Runoff Depth=0.48" Tc=14.3 min CN=46 Runoff=0.21 cfs 0.040 af
SubcatchmentP3A:	Runoff Area=40,162 sf 0.75% Impervious Runoff Depth=0.44" Flow Length=416' Tc=21.8 min CN=45 Runoff=0.15 cfs 0.033 af
SubcatchmentP3B:	Runoff Area=8,932 sf 96.13% Impervious Runoff Depth=4.51" Tc=6.0 min CN=96 Runoff=0.96 cfs 0.077 af
SubcatchmentP3C:	Runoff Area=14,946 sf 76.01% Impervious Runoff Depth=3.45" Tc=6.0 min CN=86 Runoff=1.34 cfs 0.099 af
Pond B1: Infiltration Basin 1	Peak Elev=239.62' Storage=9,696 cf Inflow=8.59 cfs 0.663 af Discarded=1.10 cfs 0.664 af Primary=0.00 cfs 0.000 af Secondary=0.00 cfs 0.000 af Outflow=1.10 cfs 0.664 af
Pond B2: Infiltration Basin 2	Peak Elev=240.10' Storage=10,014 cf Inflow=8.97 cfs 0.686 af Discarded=1.14 cfs 0.664 af Primary=0.24 cfs 0.023 af Secondary=0.00 cfs 0.000 af Outflow=1.39 cfs 0.687 af
Link DP1:	Inflow=0.24 cfs 0.026 af Primary=0.24 cfs 0.026 af
Link DP2:	Inflow=0.21 cfs 0.040 af Primary=0.21 cfs 0.040 af

Link DP3:

Inflow=2.30 cfs 0.209 af
Primary=2.30 cfs 0.209 af

Total Runoff Area = 10.438 ac Runoff Volume = 1.601 af Average Runoff Depth = 1.84"
59.63% Pervious = 6.224 ac 40.37% Impervious = 4.213 ac

Summary for Subcatchment P1A:

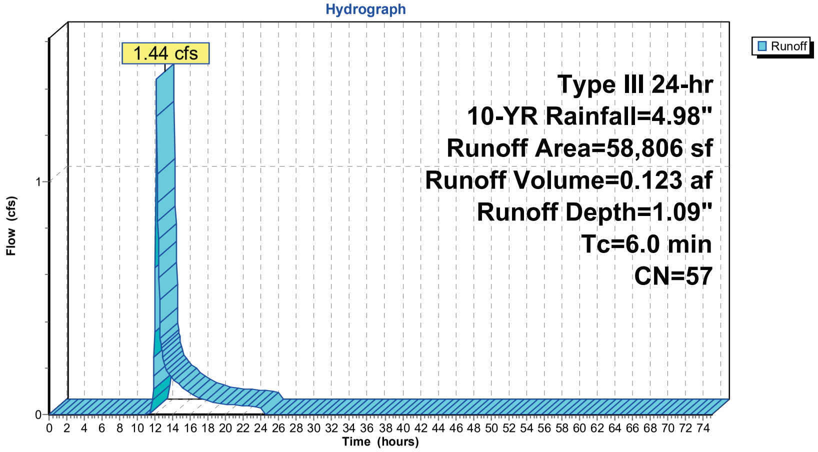
Runoff = 1.44 cfs @ 12.11 hrs, Volume= 0.123 af, Depth= 1.09"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
14,041	98	Paved parking, HSG A
25,305	39	>75% Grass cover, Good, HSG A
13,845	30	Woods, Good, HSG A
5,615	98	Roofs, HSG A
58,806	57	Weighted Average
39,150		66.57% Pervious Area
19,656		33.43% Impervious Area

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

Subcatchment P1A:



Summary for Subcatchment P1B:

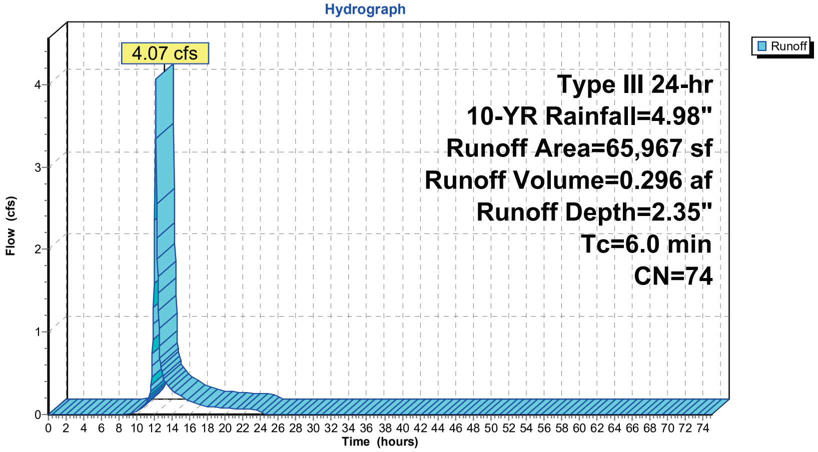
Runoff = 4.07 cfs @ 12.09 hrs, Volume= 0.296 af, Depth= 2.35"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
38,427	98	Paved parking, HSG A
941	76	Gravel roads, HSG A
26,404	39	>75% Grass cover, Good, HSG A
195	30	Woods, Good, HSG A
65,967	74	Weighted Average
27,540		41.75% Pervious Area
38,427		58.25% Impervious Area

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

Subcatchment P1B:



Summary for Subcatchment P1C:

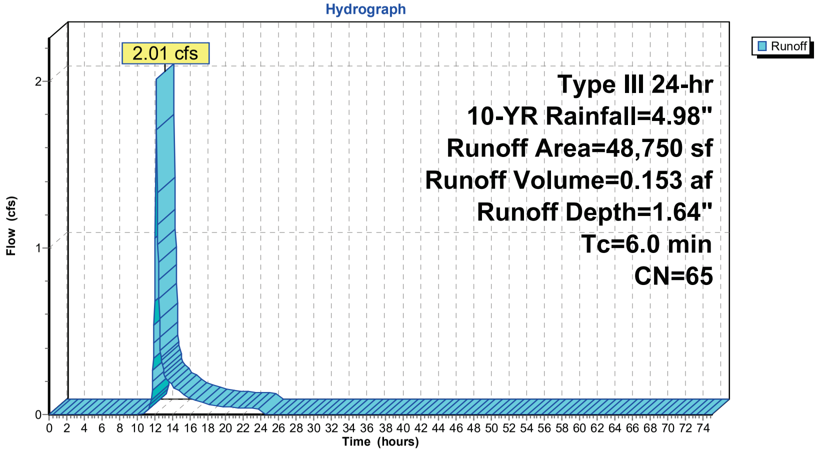
Runoff = 2.01 cfs @ 12.10 hrs, Volume= 0.153 af, Depth= 1.64"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
14,969	98	Paved parking, HSG A
12,574	39	>75% Grass cover, Good, HSG A
12,548	30	Woods, Good, HSG A
8,659	98	Water Surface, 0% imp, HSG A
48,750	65	Weighted Average
33,781		69.29% Pervious Area
14,969		30.71% Impervious Area

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

Subcatchment P1C:



Summary for Subcatchment P1D:

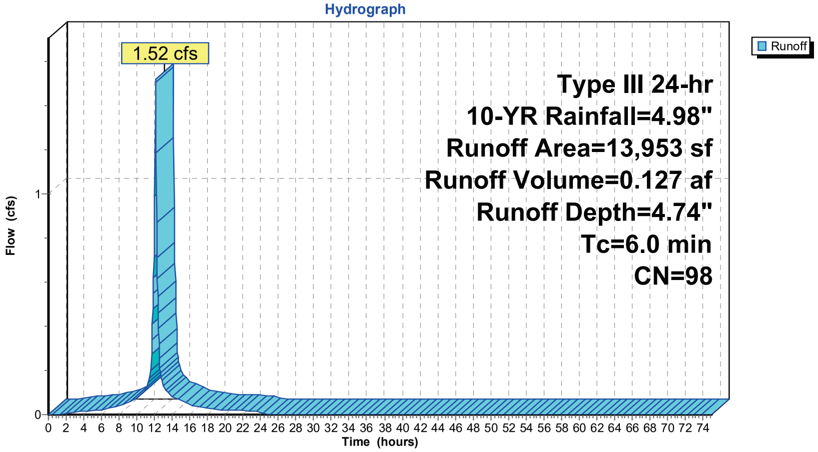
Runoff = 1.52 cfs @ 12.09 hrs, Volume= 0.127 af, Depth= 4.74"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
13,953	98	Roofs, HSG A
13,953		100.00% Impervious Area

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

Subcatchment P1D:



Summary for Subcatchment P1E:

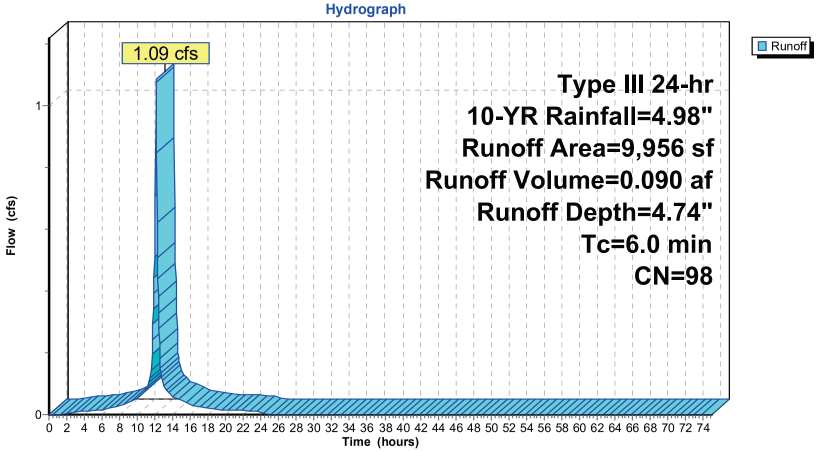
Runoff = 1.09 cfs @ 12.09 hrs, Volume= 0.090 af, Depth= 4.74"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
9,956	98	Roofs, HSG A
9,956		100.00% Impervious Area

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

Subcatchment P1E:



Summary for Subcatchment P1F:

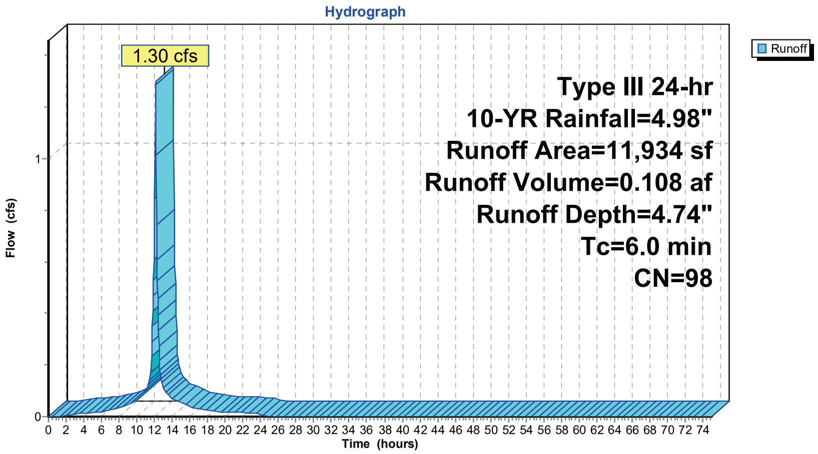
Runoff = 1.30 cfs @ 12.09 hrs, Volume= 0.108 af, Depth= 4.74"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
11,934	98	Roofs, HSG A
11,934		100.00% Impervious Area

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

Subcatchment P1F:



Summary for Subcatchment P1G:

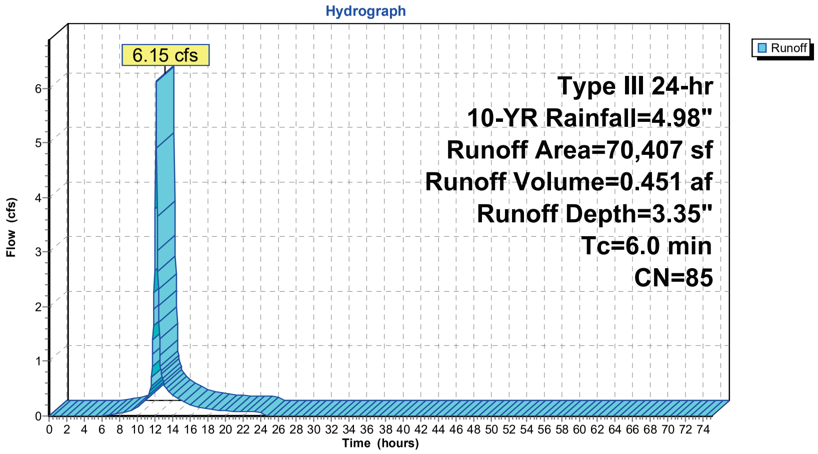
Runoff = 6.15 cfs @ 12.09 hrs, Volume= 0.451 af, Depth= 3.35"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
37,488	98	Paved roads w/curbs & sewers, HSG A
14,758	39	>75% Grass cover, Good, HSG A
611	30	Woods, Good, HSG A
8,038	98	Roofs, HSG A
9,512	98	Water Surface, 0% imp, HSG A
70,407	85	Weighted Average
24,881		35.34% Pervious Area
45,526		64.66% Impervious Area

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

Subcatchment P1G:



Summary for Subcatchment P1H:

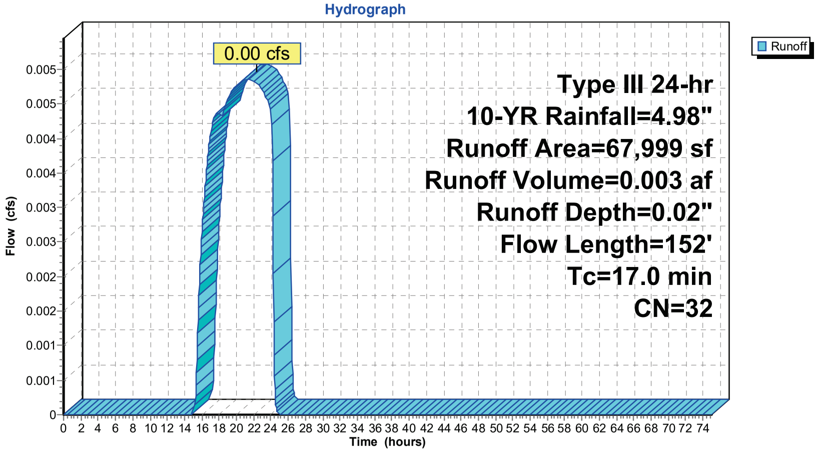
Runoff = 0.00 cfs @ 21.34 hrs, Volume= 0.003 af, Depth= 0.02"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
15,717	39	>75% Grass cover, Good, HSG A
52,282	30	Woods, Good, HSG A
67,999	32	Weighted Average
67,999		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.6	50	0.0136	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
2.4	102	0.0199	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
17.0	152	Total			

Subcatchment P1H:



Summary for Subcatchment P2:

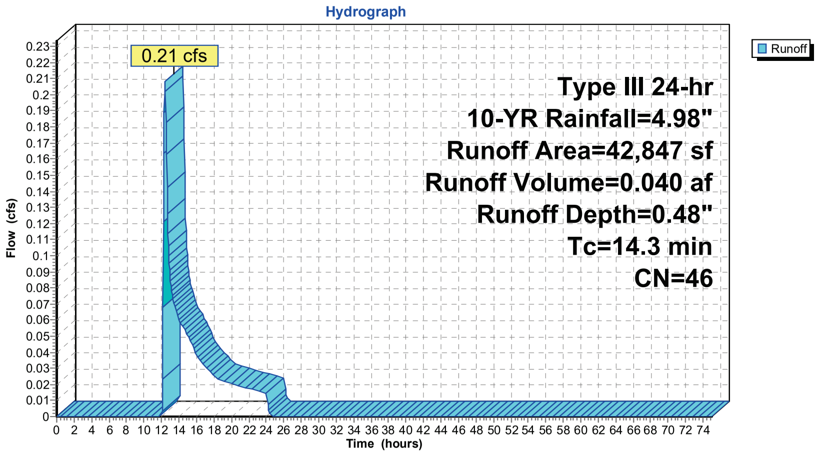
Runoff = 0.21 cfs @ 12.41 hrs, Volume= 0.040 af, Depth= 0.48"
Routed to Link DP2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
8,865	98	Paved parking, HSG A
7,279	39	>75% Grass cover, Good, HSG A
26,703	30	Woods, Good, HSG A
42,847	46	Weighted Average
33,982		79.31% Pervious Area
8,865		20.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry, Same as Pre-dev**

Subcatchment P2:



Summary for Subcatchment P3A:

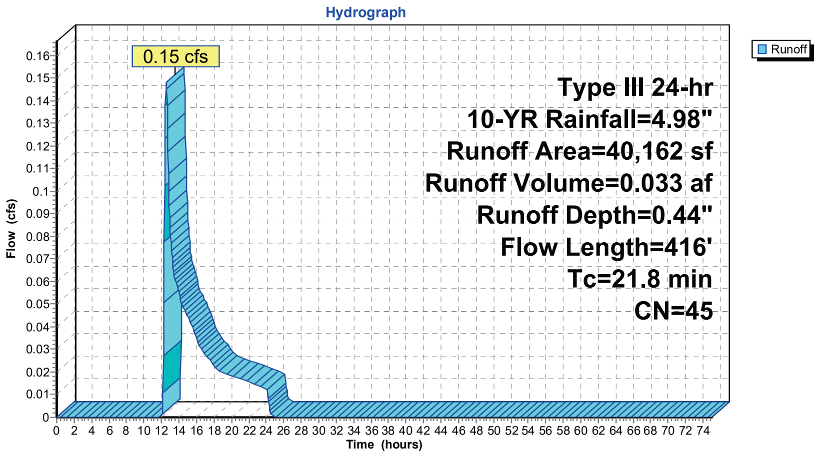
Runoff = 0.15 cfs @ 12.55 hrs, Volume= 0.033 af, Depth= 0.44"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
303	98	Paved parking, HSG A
30,163	49	50-75% Grass cover, Fair, HSG A
9,696	30	Woods, Good, HSG A
40,162	45	Weighted Average
39,859		99.25% Pervious Area
303		0.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	50	0.0430	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
0.6	26	0.0235	0.77		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	33	0.0588	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.2	81	0.0149	0.61		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.7	118	0.0057	0.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.6	108	0.0021	0.32		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
21.8	416	Total			

Subcatchment P3A:



Summary for Subcatchment P3B:

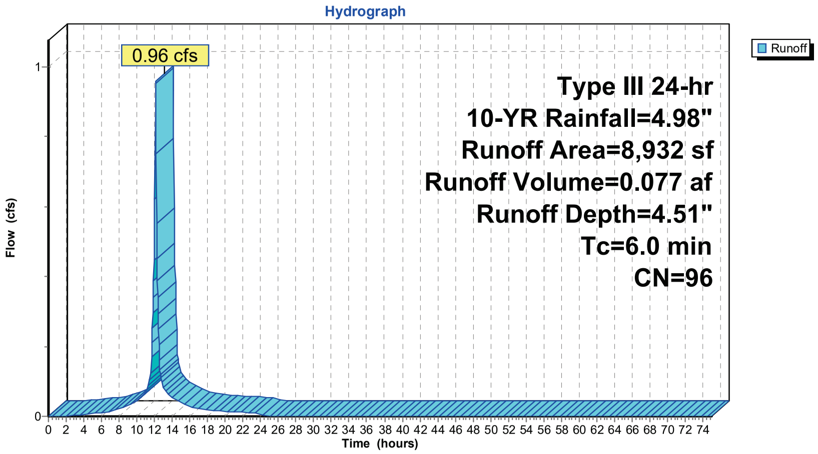
Runoff = 0.96 cfs @ 12.09 hrs, Volume= 0.077 af, Depth= 4.51"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
8,586	98	Paved parking, HSG A
346	49	50-75% Grass cover, Fair, HSG A
8,932	96	Weighted Average
346		3.87% Pervious Area
8,586		96.13% Impervious Area

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

Subcatchment P3B:



Summary for Subcatchment P3C:

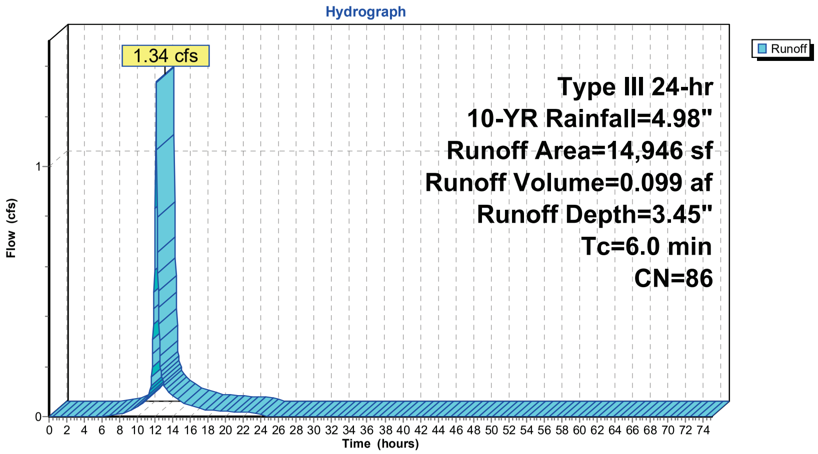
Runoff = 1.34 cfs @ 12.09 hrs, Volume= 0.099 af, Depth= 3.45"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.98"

Area (sf)	CN	Description
11,361	98	Paved parking, HSG A
3,491	49	50-75% Grass cover, Fair, HSG A
94	30	Woods, Good, HSG A
14,946	86	Weighted Average
3,585		23.99% Pervious Area
11,361		76.01% Impervious Area

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

Subcatchment P3C:



Summary for Pond B1: Infiltration Basin 1

Inflow Area = 4.212 ac, 45.24% Impervious, Inflow Depth = 1.89" for 10-YR event
Inflow = 8.59 cfs @ 12.10 hrs, Volume= 0.663 af
Outflow = 1.10 cfs @ 12.91 hrs, Volume= 0.664 af, Atten= 87%, Lag= 48.5 min
Discarded = 1.10 cfs @ 12.91 hrs, Volume= 0.664 af
Primary = 0.00 cfs @ 12.91 hrs, Volume= 0.000 af
Routed to Link DP1 :
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP1 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 239.62' @ 12.91 hrs Surf.Area= 5,753 sf Storage= 9,696 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 80.7 min (920.5 - 839.8)

Volume	Invert	Avail.Storage	Storage Description
#1	237.50'	26,990 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
237.50	3,493	0	0
238.00	3,978	1,868	1,868
239.00	5,033	4,506	6,373
240.00	6,202	5,618	11,991
241.00	7,569	6,886	18,876
242.00	8,659	8,114	26,990

Device	Routing	Invert	Outlet Devices
#1	Primary	238.75'	**12.0" Round Culvert** L= 78.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 238.75' / 238.25' S= 0.0064 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Secondary	241.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#3	Discarded	237.50'	**8.270 in/hr Exfiltration over Surface area**
#4	Device 1	240.50'	**24.0" x 24.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	239.60'	**9.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads

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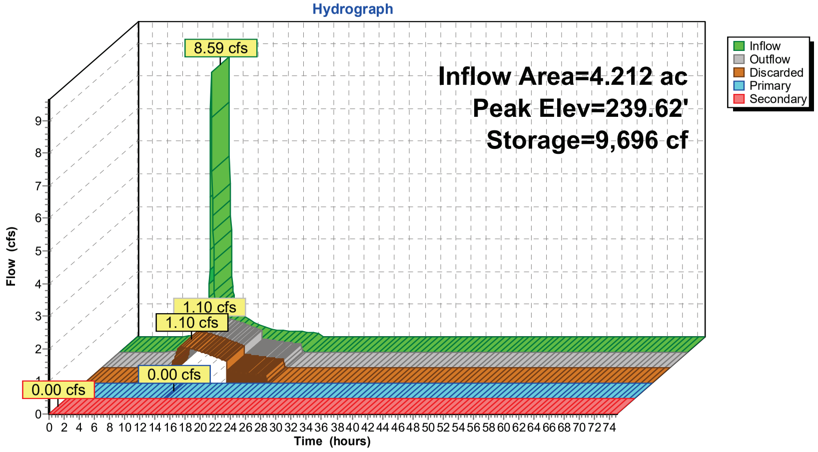
Discarded OutFlow Max=1.10 cfs @ 12.91 hrs HW=239.62' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 1.10 cfs)

Primary OutFlow Max=0.00 cfs @ 12.91 hrs HW=239.62' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.00 cfs of 1.95 cfs potential flow)
  ├─**4=Grate** (Controls 0.00 cfs)
  └─**5=Orifice** (Orifice Controls 0.00 cfs @ 0.43 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=237.50' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond B1: Infiltration Basin 1



Summary for Pond B2: Infiltration Basin 2

Inflow Area = 2.211 ac, 74.16% Impervious, Inflow Depth = 3.72" for 10-YR event
Inflow = 8.97 cfs @ 12.09 hrs, Volume= 0.686 af
Outflow = 1.39 cfs @ 12.59 hrs, Volume= 0.687 af, Atten= 85%, Lag= 30.1 min
Discarded = 1.14 cfs @ 12.59 hrs, Volume= 0.664 af
Primary = 0.24 cfs @ 12.59 hrs, Volume= 0.023 af
Routed to Link DP1 :
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP1 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 240.10' @ 12.59 hrs Surf.Area= 5,970 sf Storage= 10,014 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 64.3 min (851.6 - 787.3)

Volume	Invert	Avail.Storage	Storage Description
#1	238.00'	32,644 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
238.00	3,639	0	0
239.00	4,684	4,162	4,162
240.00	5,843	5,264	9,425
241.00	7,114	6,479	15,904
242.00	8,427	7,771	23,674
243.00	9,513	8,970	32,644

Device	Routing	Invert	Outlet Devices
#1	Primary	239.00'	**12.0" Round Culvert** L= 127.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 239.00' / 238.35' S= 0.0051 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Secondary	242.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#3	Discarded	238.00'	**8.270 in/hr Exfiltration over Surface area**
#4	Device 1	241.50'	**24.0" x 24.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	239.60'	**4.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads

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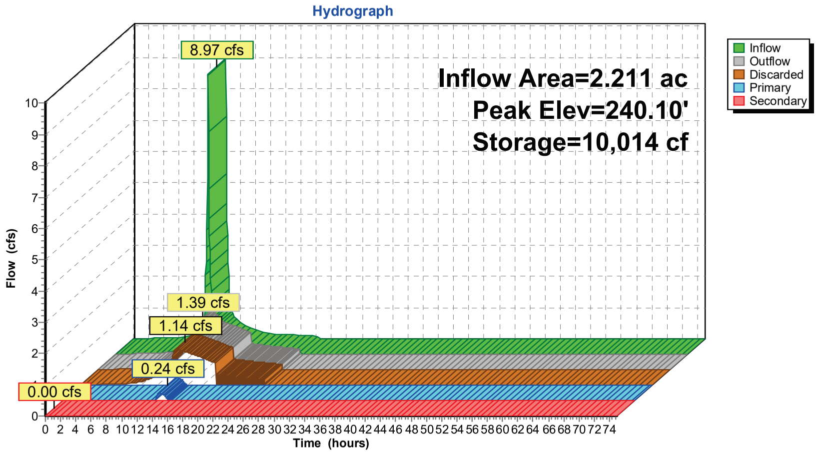
Discarded OutFlow Max=1.14 cfs @ 12.59 hrs HW=240.10' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 1.14 cfs)

Primary OutFlow Max=0.24 cfs @ 12.59 hrs HW=240.10' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.24 cfs of 2.50 cfs potential flow)
  ├─**4=Grate** (Controls 0.00 cfs)
  └─**5=Orifice** (Orifice Controls 0.24 cfs @ 2.78 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=238.00' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond B2: Infiltration Basin 2

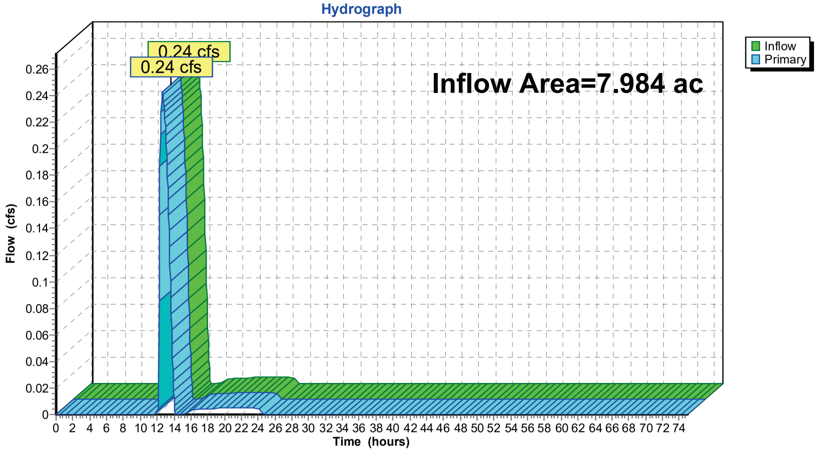


Summary for Link DP1:

Inflow Area = 7.984 ac, 44.40% Impervious, Inflow Depth = 0.04" for 10-YR event
Inflow = 0.24 cfs @ 12.59 hrs, Volume= 0.026 af
Primary = 0.24 cfs @ 12.59 hrs, Volume= 0.026 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP1:

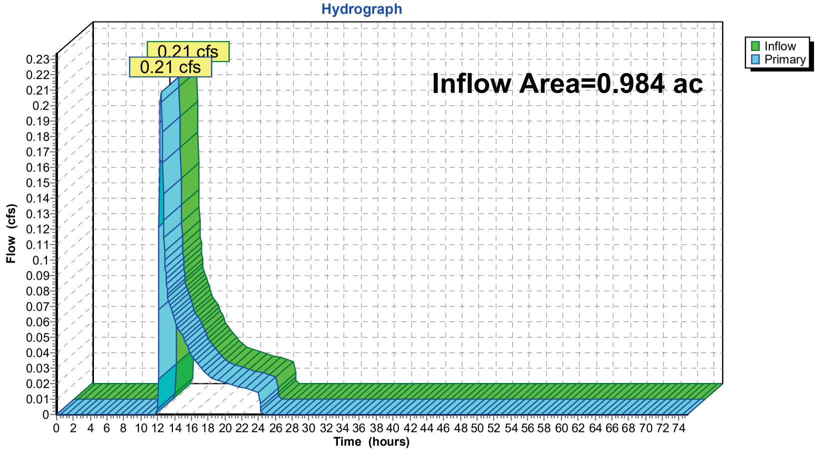


Summary for Link DP2:

Inflow Area = 0.984 ac, 20.69% Impervious, Inflow Depth = 0.48" for 10-YR event
Inflow = 0.21 cfs @ 12.41 hrs, Volume= 0.040 af
Primary = 0.21 cfs @ 12.41 hrs, Volume= 0.040 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP2:

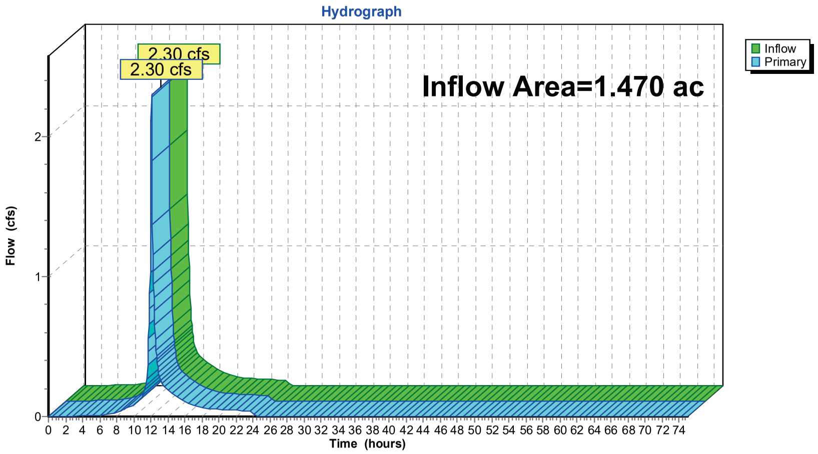


Summary for Link DP3:

Inflow Area = 1.470 ac, 31.62% Impervious, Inflow Depth = 1.71" for 10-YR event
Inflow = 2.30 cfs @ 12.09 hrs, Volume= 0.209 af
Primary = 2.30 cfs @ 12.09 hrs, Volume= 0.209 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP3:



Time span=0.00-75.00 hrs, dt=0.05 hrs, 1501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentP1A:	Runoff Area=58,806 sf 33.43% Impervious Runoff Depth=1.77" Tc=6.0 min CN=57 Runoff=2.55 cfs 0.200 af
SubcatchmentP1B:	Runoff Area=65,967 sf 58.25% Impervious Runoff Depth=3.32" Tc=6.0 min CN=74 Runoff=5.78 cfs 0.419 af
SubcatchmentP1C:	Runoff Area=48,750 sf 30.71% Impervious Runoff Depth=2.47" Tc=6.0 min CN=65 Runoff=3.12 cfs 0.230 af
SubcatchmentP1D:	Runoff Area=13,953 sf 100.00% Impervious Runoff Depth=5.92" Tc=6.0 min CN=98 Runoff=1.89 cfs 0.158 af
SubcatchmentP1E:	Runoff Area=9,956 sf 100.00% Impervious Runoff Depth=5.92" Tc=6.0 min CN=98 Runoff=1.35 cfs 0.113 af
SubcatchmentP1F:	Runoff Area=11,934 sf 100.00% Impervious Runoff Depth=5.92" Tc=6.0 min CN=98 Runoff=1.62 cfs 0.135 af
SubcatchmentP1G:	Runoff Area=70,407 sf 64.66% Impervious Runoff Depth=4.45" Tc=6.0 min CN=85 Runoff=8.09 cfs 0.600 af
SubcatchmentP1H:	Runoff Area=67,999 sf 0.00% Impervious Runoff Depth=0.16" Flow Length=152' Tc=17.0 min CN=32 Runoff=0.03 cfs 0.020 af
SubcatchmentP2:	Runoff Area=42,847 sf 20.69% Impervious Runoff Depth=0.93" Tc=14.3 min CN=46 Runoff=0.56 cfs 0.077 af
SubcatchmentP3A:	Runoff Area=40,162 sf 0.75% Impervious Runoff Depth=0.87" Flow Length=416' Tc=21.8 min CN=45 Runoff=0.41 cfs 0.067 af
SubcatchmentP3B:	Runoff Area=8,932 sf 96.13% Impervious Runoff Depth=5.69" Tc=6.0 min CN=96 Runoff=1.20 cfs 0.097 af
SubcatchmentP3C:	Runoff Area=14,946 sf 76.01% Impervious Runoff Depth=4.56" Tc=6.0 min CN=86 Runoff=1.75 cfs 0.130 af

Pond B1: Infiltration Basin 1 Peak Elev=240.33' Storage=14,144 cf Inflow=12.78 cfs 0.962 af
Discarded=1.27 cfs 0.845 af Primary=1.28 cfs 0.117 af Secondary=0.00 cfs 0.000 af Outflow=2.56 cfs 0.962 af

Pond B2: Infiltration Basin 2 Peak Elev=240.69' Storage=13,735 cf Inflow=11.59 cfs 0.893 af
Discarded=1.29 cfs 0.824 af Primary=0.40 cfs 0.070 af Secondary=0.00 cfs 0.000 af Outflow=1.69 cfs 0.893 af

Link DP1:	Inflow=1.69 cfs 0.207 af Primary=1.69 cfs 0.207 af
Link DP2:	Inflow=0.56 cfs 0.077 af Primary=0.56 cfs 0.077 af

Link DP3:

Inflow=2.99 cfs 0.294 af
Primary=2.99 cfs 0.294 af

Total Runoff Area = 10.438 ac Runoff Volume = 2.246 af Average Runoff Depth = 2.58"
59.63% Pervious = 6.224 ac 40.37% Impervious = 4.213 ac

Summary for Subcatchment P1A:

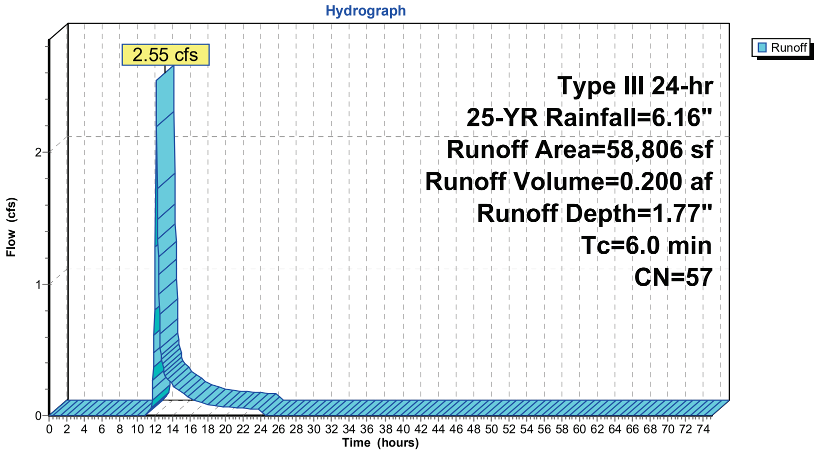
Runoff = 2.55 cfs @ 12.10 hrs, Volume= 0.200 af, Depth= 1.77"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
14,041	98	Paved parking, HSG A
25,305	39	>75% Grass cover, Good, HSG A
13,845	30	Woods, Good, HSG A
5,615	98	Roofs, HSG A
58,806	57	Weighted Average
39,150		66.57% Pervious Area
19,656		33.43% Impervious Area

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

Subcatchment P1A:



Summary for Subcatchment P1B:

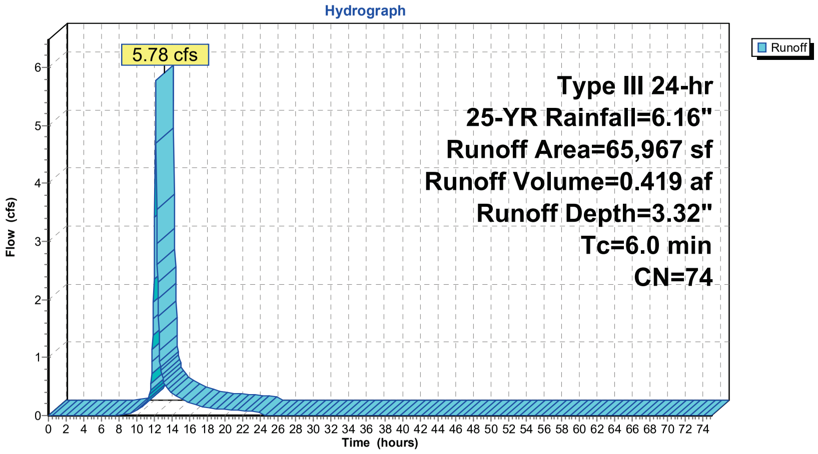
Runoff = 5.78 cfs @ 12.09 hrs, Volume= 0.419 af, Depth= 3.32"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
38,427	98	Paved parking, HSG A
941	76	Gravel roads, HSG A
26,404	39	>75% Grass cover, Good, HSG A
195	30	Woods, Good, HSG A
65,967	74	Weighted Average
27,540		41.75% Pervious Area
38,427		58.25% Impervious Area

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

Subcatchment P1B:



Summary for Subcatchment P1C:

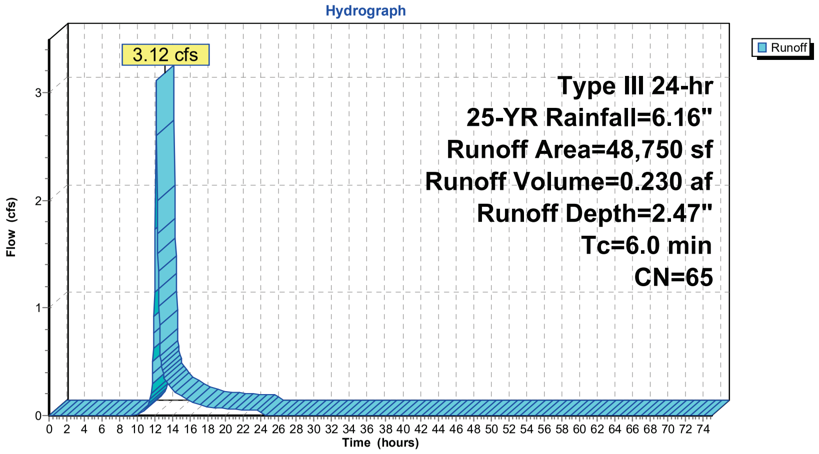
Runoff = 3.12 cfs @ 12.10 hrs, Volume= 0.230 af, Depth= 2.47"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
14,969	98	Paved parking, HSG A
12,574	39	>75% Grass cover, Good, HSG A
12,548	30	Woods, Good, HSG A
8,659	98	Water Surface, 0% imp, HSG A
48,750	65	Weighted Average
33,781		69.29% Pervious Area
14,969		30.71% Impervious Area

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

Subcatchment P1C:



Summary for Subcatchment P1D:

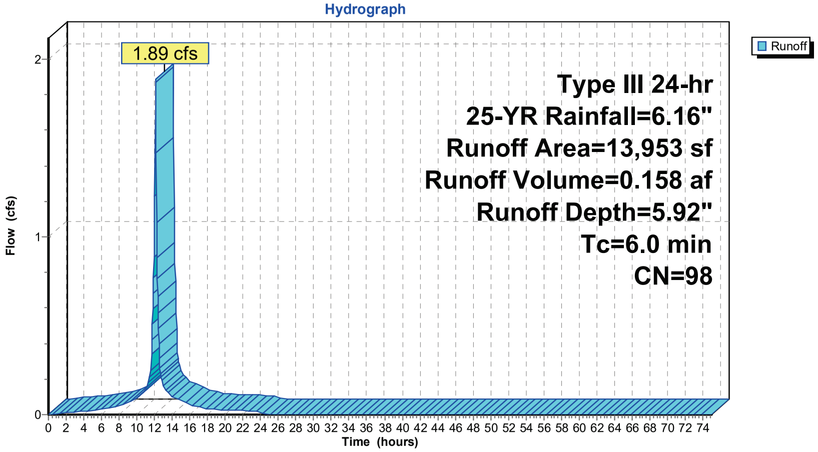
Runoff = 1.89 cfs @ 12.09 hrs, Volume= 0.158 af, Depth= 5.92"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
13,953	98	Roofs, HSG A
13,953		100.00% Impervious Area

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

Subcatchment P1D:



Summary for Subcatchment P1E:

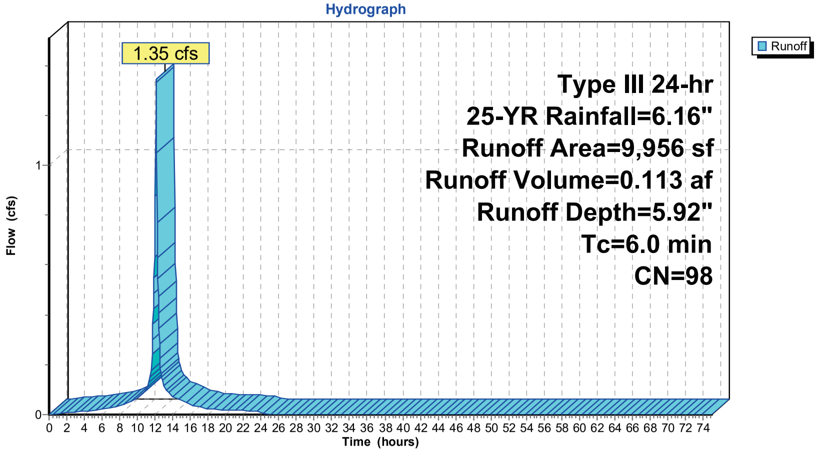
Runoff = 1.35 cfs @ 12.09 hrs, Volume= 0.113 af, Depth= 5.92"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
9,956	98	Roofs, HSG A
9,956		100.00% Impervious Area

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

Subcatchment P1E:



Summary for Subcatchment P1F:

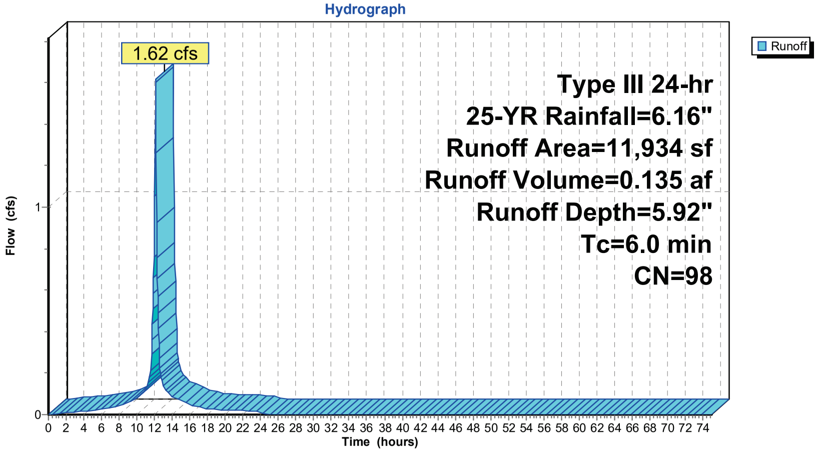
Runoff = 1.62 cfs @ 12.09 hrs, Volume= 0.135 af, Depth= 5.92"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
11,934	98	Roofs, HSG A
11,934		100.00% Impervious Area

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

Subcatchment P1F:



Summary for Subcatchment P1G:

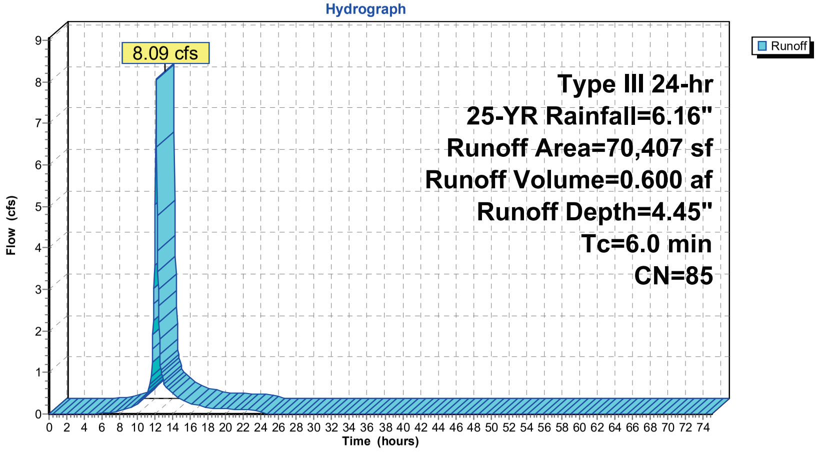
Runoff = 8.09 cfs @ 12.09 hrs, Volume= 0.600 af, Depth= 4.45"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
37,488	98	Paved roads w/curbs & sewers, HSG A
14,758	39	>75% Grass cover, Good, HSG A
611	30	Woods, Good, HSG A
8,038	98	Roofs, HSG A
9,512	98	Water Surface, 0% imp, HSG A
70,407	85	Weighted Average
24,881		35.34% Pervious Area
45,526		64.66% Impervious Area

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

Subcatchment P1G:



Summary for Subcatchment P1H:

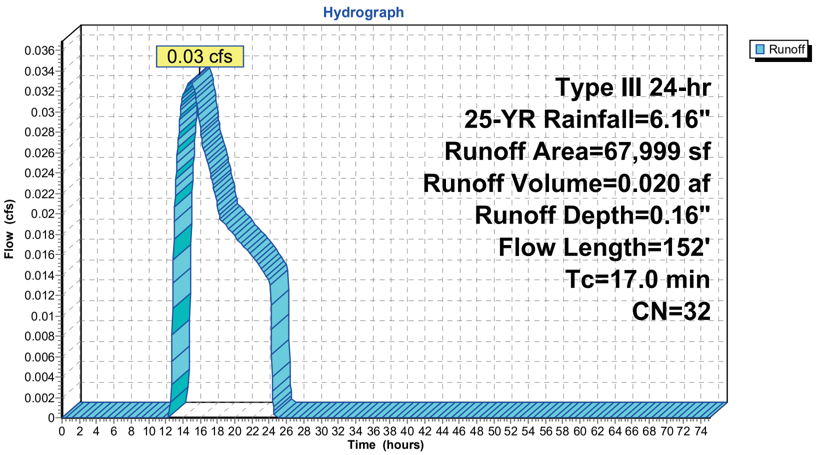
Runoff = 0.03 cfs @ 14.84 hrs, Volume= 0.020 af, Depth= 0.16"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
15,717	39	>75% Grass cover, Good, HSG A
52,282	30	Woods, Good, HSG A
67,999	32	Weighted Average
67,999		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.6	50	0.0136	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
2.4	102	0.0199	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
17.0	152	Total			

Subcatchment P1H:



Summary for Subcatchment P2:

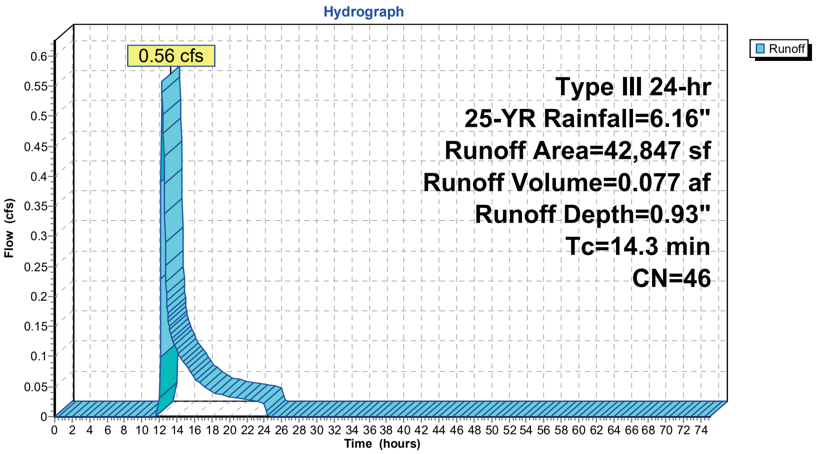
Runoff = 0.56 cfs @ 12.27 hrs, Volume= 0.077 af, Depth= 0.93"
Routed to Link DP2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
8,865	98	Paved parking, HSG A
7,279	39	>75% Grass cover, Good, HSG A
26,703	30	Woods, Good, HSG A
42,847	46	Weighted Average
33,982		79.31% Pervious Area
8,865		20.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry, Same as Pre-dev**

Subcatchment P2:



Summary for Subcatchment P3A:

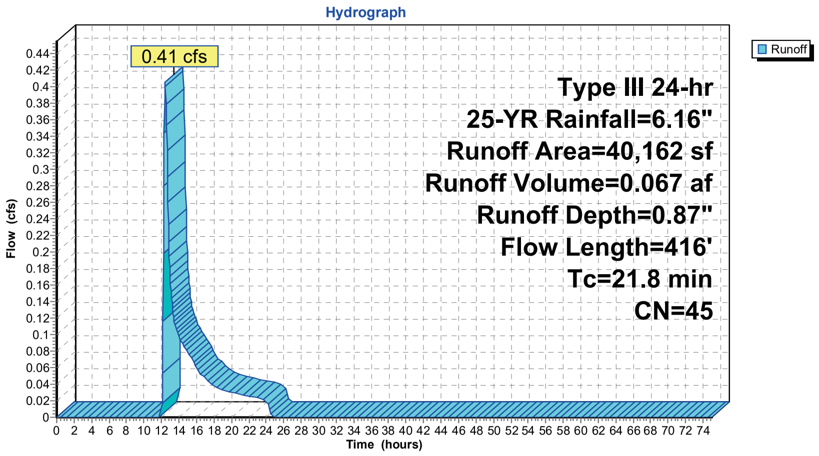
Runoff = 0.41 cfs @ 12.43 hrs, Volume= 0.067 af, Depth= 0.87"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
303	98	Paved parking, HSG A
30,163	49	50-75% Grass cover, Fair, HSG A
9,696	30	Woods, Good, HSG A
40,162	45	Weighted Average
39,859		99.25% Pervious Area
303		0.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	50	0.0430	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
0.6	26	0.0235	0.77		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	33	0.0588	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.2	81	0.0149	0.61		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.7	118	0.0057	0.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.6	108	0.0021	0.32		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
21.8	416	Total			

Subcatchment P3A:



Summary for Subcatchment P3B:

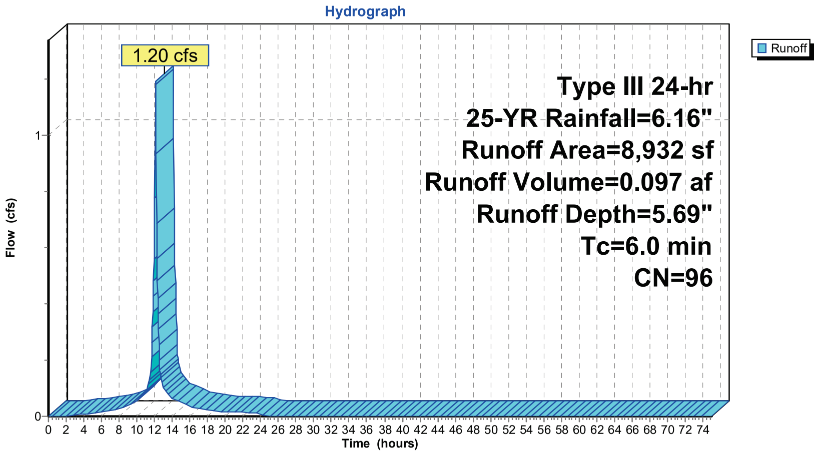
Runoff = 1.20 cfs @ 12.09 hrs, Volume= 0.097 af, Depth= 5.69"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
8,586	98	Paved parking, HSG A
346	49	50-75% Grass cover, Fair, HSG A
8,932	96	Weighted Average
346		3.87% Pervious Area
8,586		96.13% Impervious Area

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

Subcatchment P3B:



Summary for Subcatchment P3C:

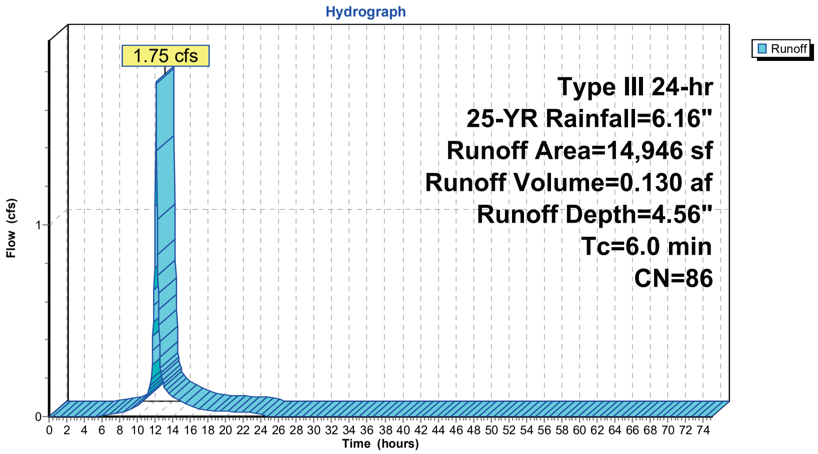
Runoff = 1.75 cfs @ 12.09 hrs, Volume= 0.130 af, Depth= 4.56"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=6.16"

Area (sf)	CN	Description
11,361	98	Paved parking, HSG A
3,491	49	50-75% Grass cover, Fair, HSG A
94	30	Woods, Good, HSG A
14,946	86	Weighted Average
3,585		23.99% Pervious Area
11,361		76.01% Impervious Area

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

Subcatchment P3C:



Summary for Pond B1: Infiltration Basin 1

Inflow Area =	4.212 ac,	45.24% Impervious,	Inflow Depth = 2.74"	for 25-YR event	
Inflow =	12.78 cfs @	12.10 hrs,	Volume=	0.962 af	
Outflow =	2.56 cfs @	12.56 hrs,	Volume=	0.962 af,	Atten= 80%, Lag= 28.0 min
Discarded =	1.27 cfs @	12.56 hrs,	Volume=	0.845 af	
Primary =	1.28 cfs @	12.56 hrs,	Volume=	0.117 af	
Routed to Link DP1 :					
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	
Routed to Link DP1 :					

Routing by Dyn-Stor-Ind method, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 240.33' @ 12.56 hrs Surf.Area= 6,660 sf Storage= 14,144 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 86.6 min (918.2 - 831.6)

Volume	Invert	Avail.Storage	Storage Description
#1	237.50'	26,990 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
237.50	3,493	0	0
238.00	3,978	1,868	1,868
239.00	5,033	4,506	6,373
240.00	6,202	5,618	11,991
241.00	7,569	6,886	18,876
242.00	8,659	8,114	26,990

Device	Routing	Invert	Outlet Devices
#1	Primary	238.75'	**12.0" Round Culvert** L= 78.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 238.75' / 238.25' S= 0.0064 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Secondary	241.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#3	Discarded	237.50'	**8.270 in/hr Exfiltration over Surface area**
#4	Device 1	240.50'	**24.0" x 24.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	239.60'	**9.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads

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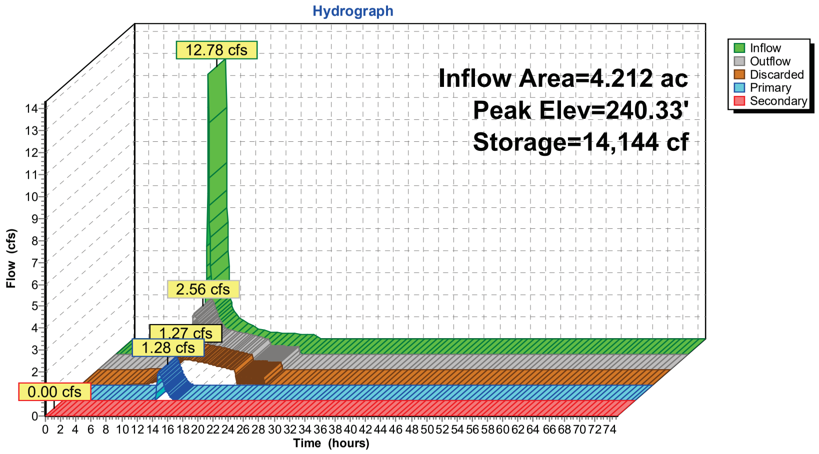
Discarded OutFlow Max=1.27 cfs @ 12.56 hrs HW=240.33' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 1.27 cfs)

Primary OutFlow Max=1.28 cfs @ 12.56 hrs HW=240.33' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.28 cfs of 3.30 cfs potential flow)
  ├─**4=Grate** (Controls 0.00 cfs)
  └─**5=Orifice** (Orifice Controls 1.28 cfs @ 2.92 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=237.50' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond B1: Infiltration Basin 1



Summary for Pond B2: Infiltration Basin 2

Inflow Area = 2.211 ac, 74.16% Impervious, Inflow Depth = 4.85" for 25-YR event
Inflow = 11.59 cfs @ 12.09 hrs, Volume= 0.893 af
Outflow = 1.69 cfs @ 12.60 hrs, Volume= 0.893 af, Atten= 85%, Lag= 30.9 min
Discarded = 1.29 cfs @ 12.60 hrs, Volume= 0.824 af
Primary = 0.40 cfs @ 12.60 hrs, Volume= 0.070 af
Routed to Link DP1 :
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP1 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 240.69' @ 12.60 hrs Surf.Area= 6,715 sf Storage= 13,735 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 75.8 min (857.4 - 781.6)

Volume	Invert	Avail.Storage	Storage Description
#1	238.00'	32,644 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
238.00	3,639	0	0
239.00	4,684	4,162	4,162
240.00	5,843	5,264	9,425
241.00	7,114	6,479	15,904
242.00	8,427	7,771	23,674
243.00	9,513	8,970	32,644

Device	Routing	Invert	Outlet Devices
#1	Primary	239.00'	**12.0" Round Culvert** L= 127.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 239.00' / 238.35' S= 0.0051 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Secondary	242.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#3	Discarded	238.00'	**8.270 in/hr Exfiltration over Surface area**
#4	Device 1	241.50'	**24.0" x 24.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	239.60'	**4.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads

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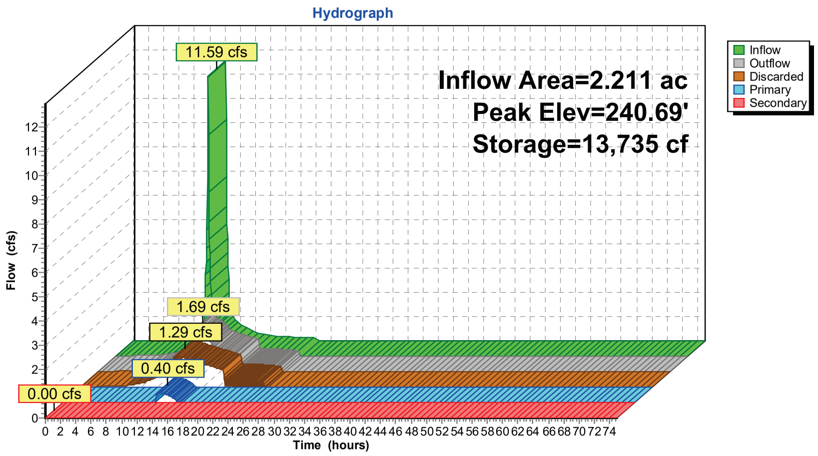
Discarded OutFlow Max=1.29 cfs @ 12.60 hrs HW=240.69' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 1.29 cfs)

Primary OutFlow Max=0.40 cfs @ 12.60 hrs HW=240.69' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.40 cfs of 3.11 cfs potential flow)
  ├─**4=Grate** (Controls 0.00 cfs)
  └─**5=Orifice** (Orifice Controls 0.40 cfs @ 4.62 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=238.00' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond B2: Infiltration Basin 2

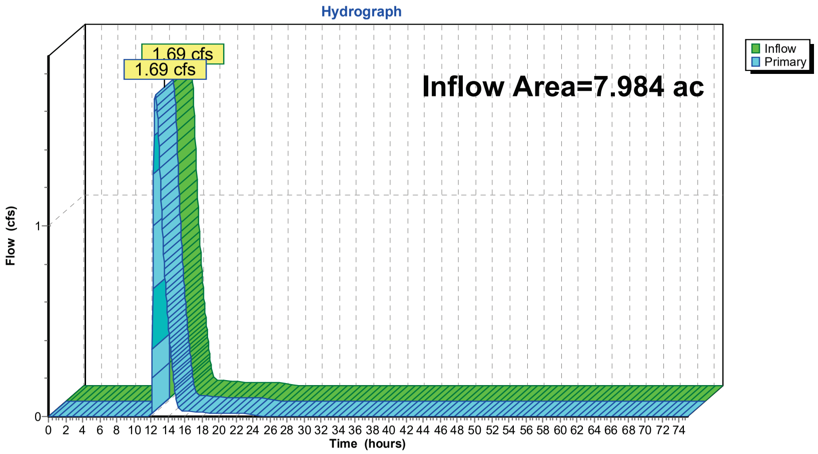


Summary for Link DP1:

Inflow Area = 7.984 ac, 44.40% Impervious, Inflow Depth = 0.31" for 25-YR event
Inflow = 1.69 cfs @ 12.57 hrs, Volume= 0.207 af
Primary = 1.69 cfs @ 12.57 hrs, Volume= 0.207 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP1:

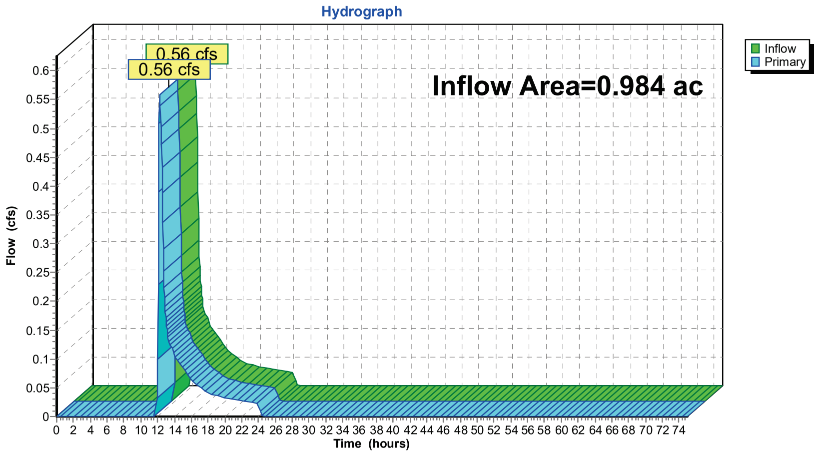


Summary for Link DP2:

Inflow Area = 0.984 ac, 20.69% Impervious, Inflow Depth = 0.93" for 25-YR event
Inflow = 0.56 cfs @ 12.27 hrs, Volume= 0.077 af
Primary = 0.56 cfs @ 12.27 hrs, Volume= 0.077 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP2:

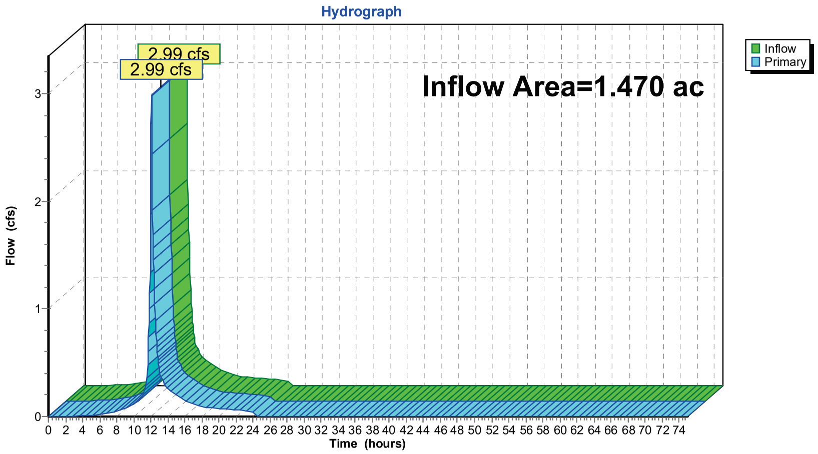


Summary for Link DP3:

Inflow Area = 1.470 ac, 31.62% Impervious, Inflow Depth = 2.40" for 25-YR event
Inflow = 2.99 cfs @ 12.09 hrs, Volume= 0.294 af
Primary = 2.99 cfs @ 12.09 hrs, Volume= 0.294 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP3:



Time span=0.00-75.00 hrs, dt=0.05 hrs, 1501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentP1A: Runoff Area=58,806 sf 33.43% Impervious Runoff Depth=2.99"
Tc=6.0 min CN=57 Runoff=4.52 cfs 0.336 af

SubcatchmentP1B: Runoff Area=65,967 sf 58.25% Impervious Runoff Depth=4.91"
Tc=6.0 min CN=74 Runoff=8.51 cfs 0.619 af

SubcatchmentP1C: Runoff Area=48,750 sf 30.71% Impervious Runoff Depth=3.88"
Tc=6.0 min CN=65 Runoff=4.98 cfs 0.362 af

SubcatchmentP1D: Runoff Area=13,953 sf 100.00% Impervious Runoff Depth=7.74"
Tc=6.0 min CN=98 Runoff=2.45 cfs 0.207 af

SubcatchmentP1E: Runoff Area=9,956 sf 100.00% Impervious Runoff Depth=7.74"
Tc=6.0 min CN=98 Runoff=1.75 cfs 0.147 af

SubcatchmentP1F: Runoff Area=11,934 sf 100.00% Impervious Runoff Depth=7.74"
Tc=6.0 min CN=98 Runoff=2.10 cfs 0.177 af

SubcatchmentP1G: Runoff Area=70,407 sf 64.66% Impervious Runoff Depth=6.19"
Tc=6.0 min CN=85 Runoff=11.06 cfs 0.834 af

SubcatchmentP1H: Runoff Area=67,999 sf 0.00% Impervious Runoff Depth=0.56"
Flow Length=152' Tc=17.0 min CN=32 Runoff=0.29 cfs 0.072 af

SubcatchmentP2: Runoff Area=42,847 sf 20.69% Impervious Runoff Depth=1.83"
Tc=14.3 min CN=46 Runoff=1.36 cfs 0.150 af

SubcatchmentP3A: Runoff Area=40,162 sf 0.75% Impervious Runoff Depth=1.73"
Flow Length=416' Tc=21.8 min CN=45 Runoff=1.01 cfs 0.133 af

SubcatchmentP3B: Runoff Area=8,932 sf 96.13% Impervious Runoff Depth=7.50"
Tc=6.0 min CN=96 Runoff=1.56 cfs 0.128 af

SubcatchmentP3C: Runoff Area=14,946 sf 76.01% Impervious Runoff Depth=6.31"
Tc=6.0 min CN=86 Runoff=2.38 cfs 0.180 af

Pond B1: Infiltration Basin 1 Peak Elev=241.10' Storage=19,655 cf Inflow=19.74 cfs 1.465 af
Discarded=1.47 cfs 1.043 af Primary=4.32 cfs 0.409 af Secondary=0.88 cfs 0.013 af Outflow=6.66 cfs 1.465 af

Pond B2: Infiltration Basin 2 Peak Elev=241.55' Storage=19,989 cf Inflow=15.61 cfs 1.218 af
Discarded=1.50 cfs 1.063 af Primary=0.82 cfs 0.154 af Secondary=0.00 cfs 0.000 af Outflow=2.32 cfs 1.218 af

Link DP1: Inflow=5.99 cfs 0.648 af
Primary=5.99 cfs 0.648 af

Link DP2: Inflow=1.36 cfs 0.150 af
Primary=1.36 cfs 0.150 af

Link DP3:

Inflow=4.24 cfs 0.441 af
Primary=4.24 cfs 0.441 af

Total Runoff Area = 10.438 ac Runoff Volume = 3.346 af Average Runoff Depth = 3.85"
59.63% Pervious = 6.224 ac 40.37% Impervious = 4.213 ac

Summary for Subcatchment P1A:

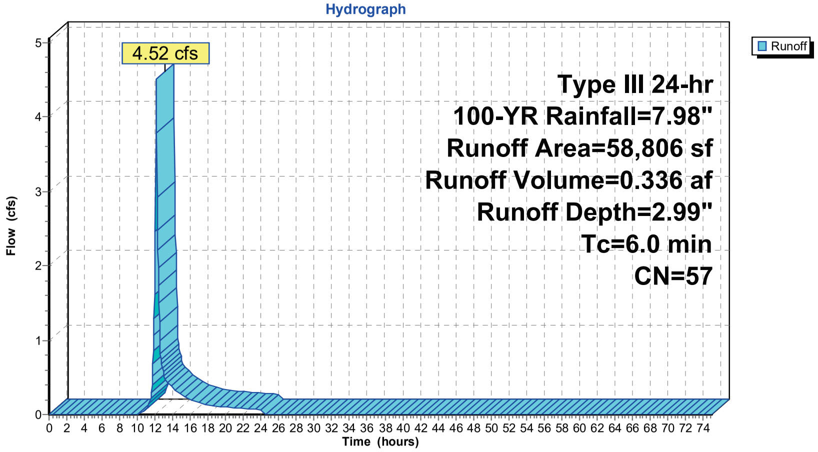
Runoff = 4.52 cfs @ 12.10 hrs, Volume= 0.336 af, Depth= 2.99"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
14,041	98	Paved parking, HSG A
25,305	39	>75% Grass cover, Good, HSG A
13,845	30	Woods, Good, HSG A
5,615	98	Roofs, HSG A
58,806	57	Weighted Average
39,150		66.57% Pervious Area
19,656		33.43% Impervious Area

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

Subcatchment P1A:



Summary for Subcatchment P1B:

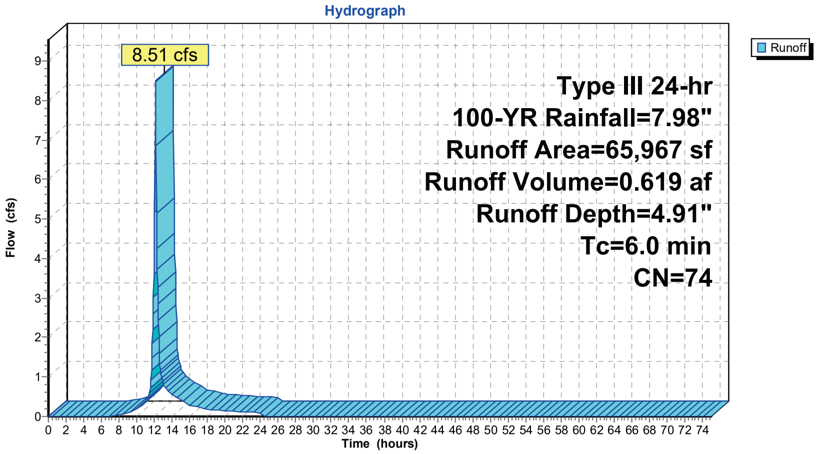
Runoff = 8.51 cfs @ 12.09 hrs, Volume= 0.619 af, Depth= 4.91"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
38,427	98	Paved parking, HSG A
941	76	Gravel roads, HSG A
26,404	39	>75% Grass cover, Good, HSG A
195	30	Woods, Good, HSG A
65,967	74	Weighted Average
27,540		41.75% Pervious Area
38,427		58.25% Impervious Area

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

Subcatchment P1B:



Summary for Subcatchment P1C:

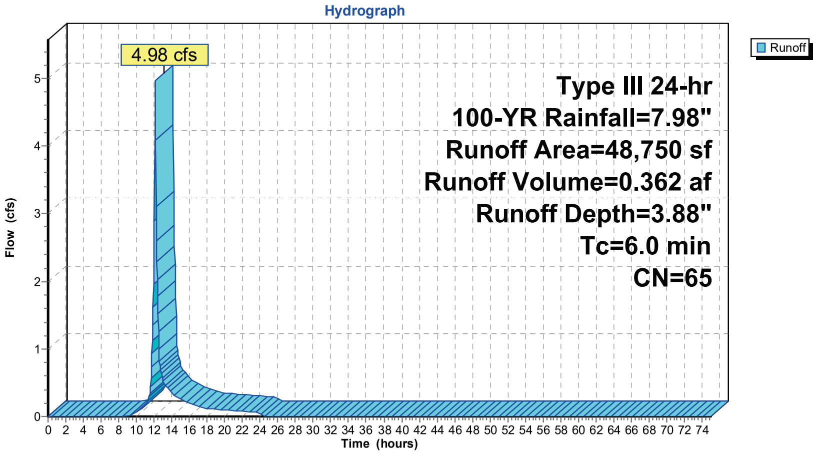
Runoff = 4.98 cfs @ 12.09 hrs, Volume= 0.362 af, Depth= 3.88"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
14,969	98	Paved parking, HSG A
12,574	39	>75% Grass cover, Good, HSG A
12,548	30	Woods, Good, HSG A
8,659	98	Water Surface, 0% imp, HSG A
48,750	65	Weighted Average
33,781		69.29% Pervious Area
14,969		30.71% Impervious Area

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

Subcatchment P1C:



Summary for Subcatchment P1D:

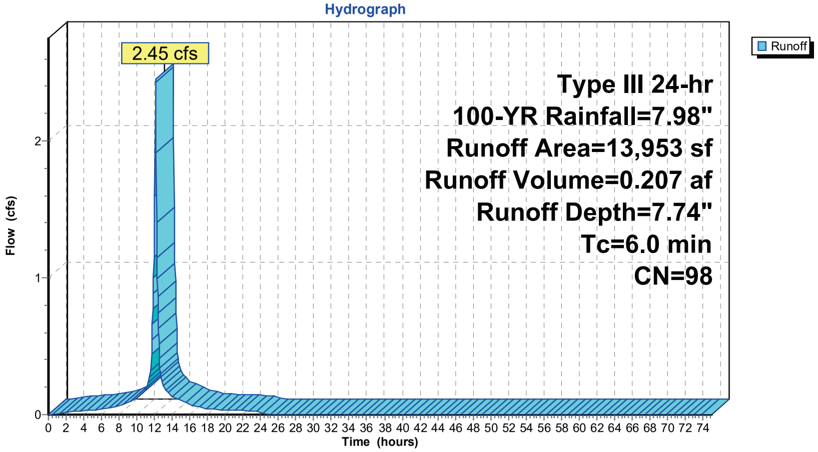
Runoff = 2.45 cfs @ 12.09 hrs, Volume= 0.207 af, Depth= 7.74"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
13,953	98	Roofs, HSG A
13,953		100.00% Impervious Area

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

Subcatchment P1D:



Summary for Subcatchment P1E:

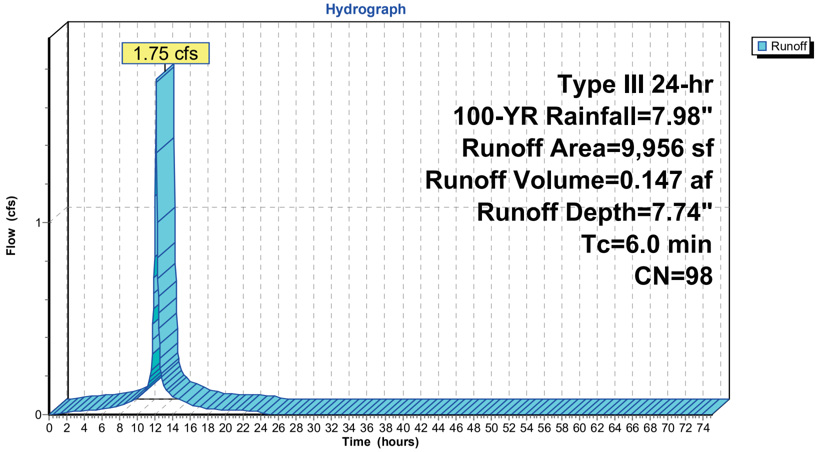
Runoff = 1.75 cfs @ 12.09 hrs, Volume= 0.147 af, Depth= 7.74"
Routed to Pond B1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
9,956	98	Roofs, HSG A
9,956		100.00% Impervious Area

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

Subcatchment P1E:



Summary for Subcatchment P1F:

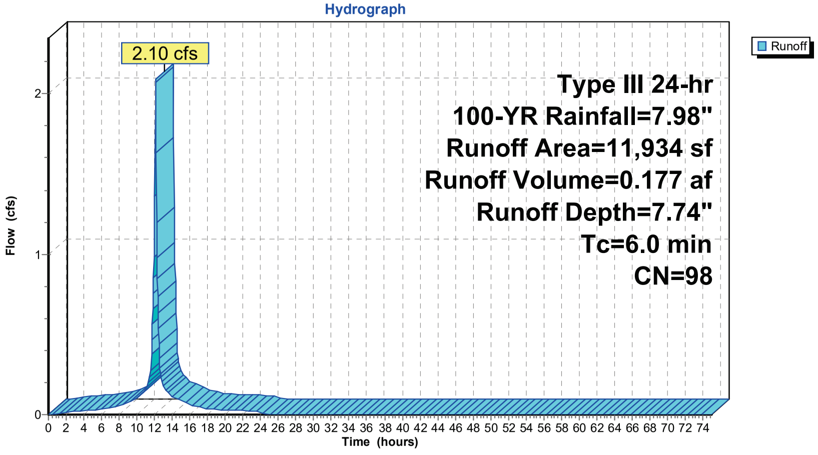
Runoff = 2.10 cfs @ 12.09 hrs, Volume= 0.177 af, Depth= 7.74"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
11,934	98	Roofs, HSG A
11,934		100.00% Impervious Area

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

Subcatchment P1F:



Summary for Subcatchment P1G:

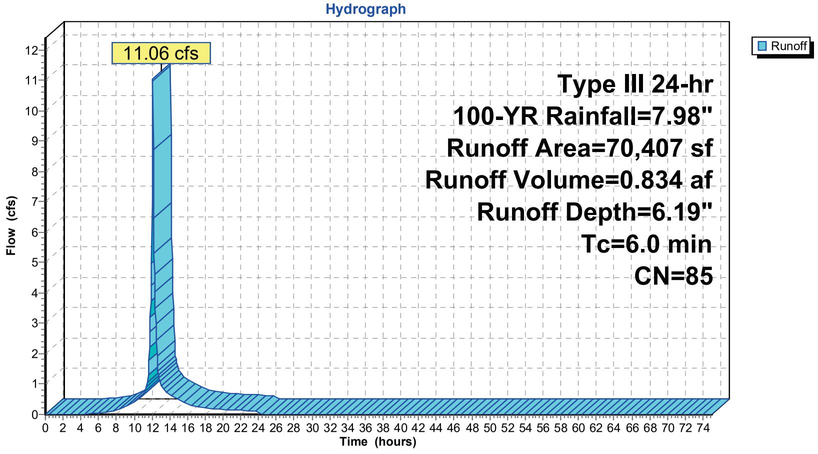
Runoff = 11.06 cfs @ 12.09 hrs, Volume= 0.834 af, Depth= 6.19"
Routed to Pond B2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
37,488	98	Paved roads w/curbs & sewers, HSG A
14,758	39	>75% Grass cover, Good, HSG A
611	30	Woods, Good, HSG A
8,038	98	Roofs, HSG A
9,512	98	Water Surface, 0% imp, HSG A
70,407	85	Weighted Average
24,881		35.34% Pervious Area
45,526		64.66% Impervious Area

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

Subcatchment P1G:



Summary for Subcatchment P1H:

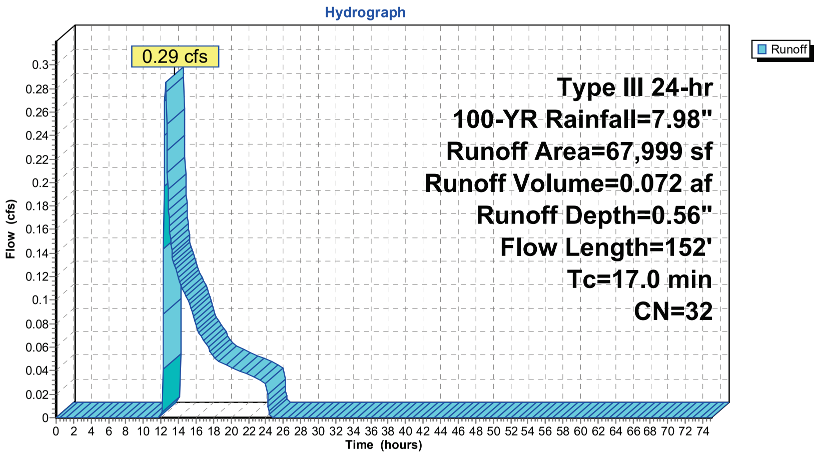
Runoff = 0.29 cfs @ 12.52 hrs, Volume= 0.072 af, Depth= 0.56"
Routed to Link DP1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
15,717	39	>75% Grass cover, Good, HSG A
52,282	30	Woods, Good, HSG A
67,999	32	Weighted Average
67,999		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.6	50	0.0136	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
2.4	102	0.0199	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
17.0	152	Total			

Subcatchment P1H:



Summary for Subcatchment P2:

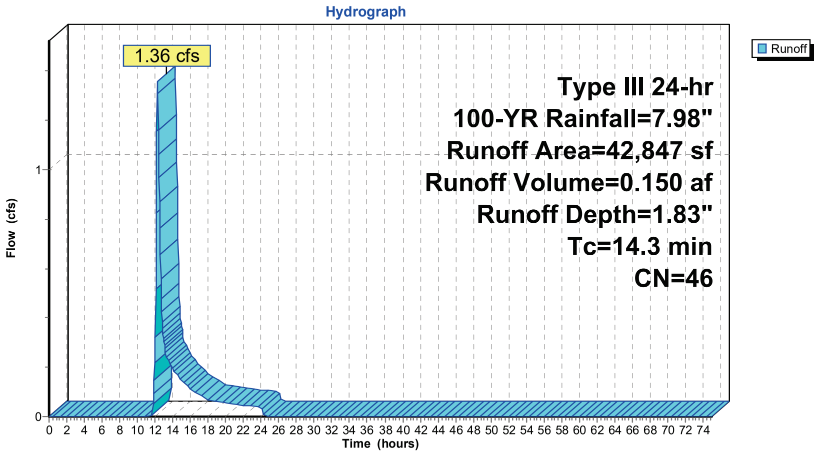
Runoff = 1.36 cfs @ 12.23 hrs, Volume= 0.150 af, Depth= 1.83"
Routed to Link DP2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
8,865	98	Paved parking, HSG A
7,279	39	>75% Grass cover, Good, HSG A
26,703	30	Woods, Good, HSG A
42,847	46	Weighted Average
33,982		79.31% Pervious Area
8,865		20.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry, Same as Pre-dev**

Subcatchment P2:



Summary for Subcatchment P3A:

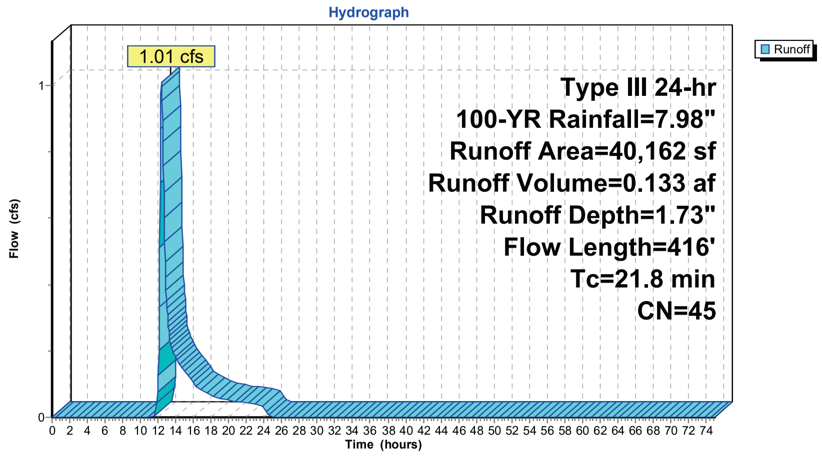
Runoff = 1.01 cfs @ 12.36 hrs, Volume= 0.133 af, Depth= 1.73"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
303	98	Paved parking, HSG A
30,163	49	50-75% Grass cover, Fair, HSG A
9,696	30	Woods, Good, HSG A
40,162	45	Weighted Average
39,859		99.25% Pervious Area
303		0.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	50	0.0430	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.09"
0.6	26	0.0235	0.77		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	33	0.0588	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.2	81	0.0149	0.61		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.7	118	0.0057	0.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.6	108	0.0021	0.32		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
21.8	416	Total			

Subcatchment P3A:



Summary for Subcatchment P3B:

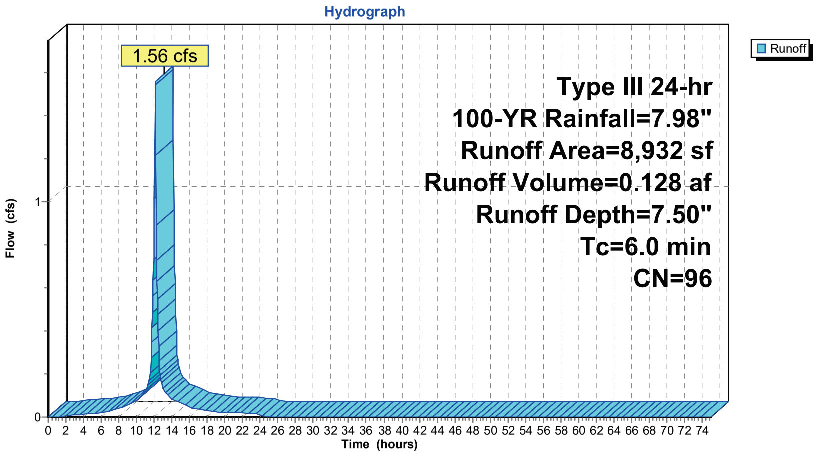
Runoff = 1.56 cfs @ 12.09 hrs, Volume= 0.128 af, Depth= 7.50"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
8,586	98	Paved parking, HSG A
346	49	50-75% Grass cover, Fair, HSG A
8,932	96	Weighted Average
346		3.87% Pervious Area
8,586		96.13% Impervious Area

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

Subcatchment P3B:



Summary for Subcatchment P3C:

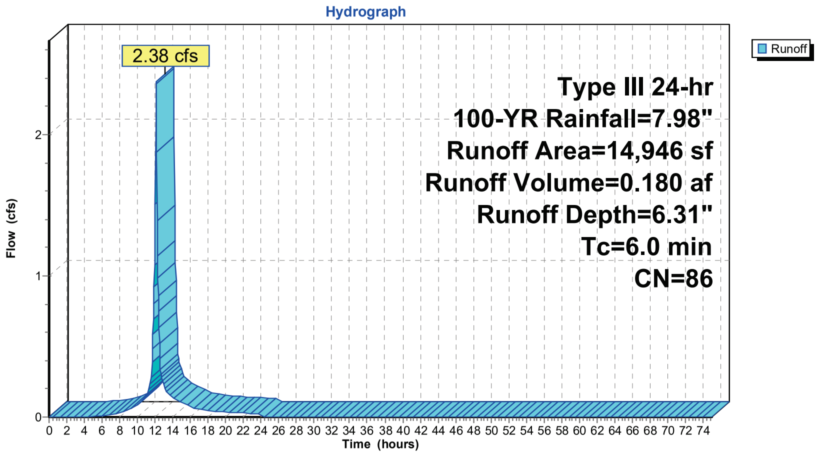
Runoff = 2.38 cfs @ 12.09 hrs, Volume= 0.180 af, Depth= 6.31"
Routed to Link DP3 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=7.98"

Area (sf)	CN	Description
11,361	98	Paved parking, HSG A
3,491	49	50-75% Grass cover, Fair, HSG A
94	30	Woods, Good, HSG A
14,946	86	Weighted Average
3,585		23.99% Pervious Area
11,361		76.01% Impervious Area

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

Subcatchment P3C:



Summary for Pond B1: Infiltration Basin 1

Inflow Area = 4.212 ac, 45.24% Impervious, Inflow Depth = 4.17" for 100-YR event
Inflow = 19.74 cfs @ 12.09 hrs, Volume= 1.465 af
Outflow = 6.66 cfs @ 12.41 hrs, Volume= 1.465 af, Atten= 66%, Lag= 19.3 min
Discarded = 1.47 cfs @ 12.42 hrs, Volume= 1.043 af
Primary = 4.32 cfs @ 12.42 hrs, Volume= 0.409 af
Routed to Link DP1 :
Secondary = 0.88 cfs @ 12.41 hrs, Volume= 0.013 af
Routed to Link DP1 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 241.10' @ 12.42 hrs Surf.Area= 7,680 sf Storage= 19,655 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 77.9 min (899.9 - 822.0)

Volume	Invert	Avail.Storage	Storage Description
#1	237.50'	26,990 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
237.50	3,493	0	0
238.00	3,978	1,868	1,868
239.00	5,033	4,506	6,373
240.00	6,202	5,618	11,991
241.00	7,569	6,886	18,876
242.00	8,659	8,114	26,990

Device	Routing	Invert	Outlet Devices
#1	Primary	238.75'	**12.0" Round Culvert** L= 78.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 238.75' / 238.25' S= 0.0064 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Secondary	241.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#3	Discarded	237.50'	**8.270 in/hr Exfiltration over Surface area**
#4	Device 1	240.50'	**24.0" x 24.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	239.60'	**9.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads

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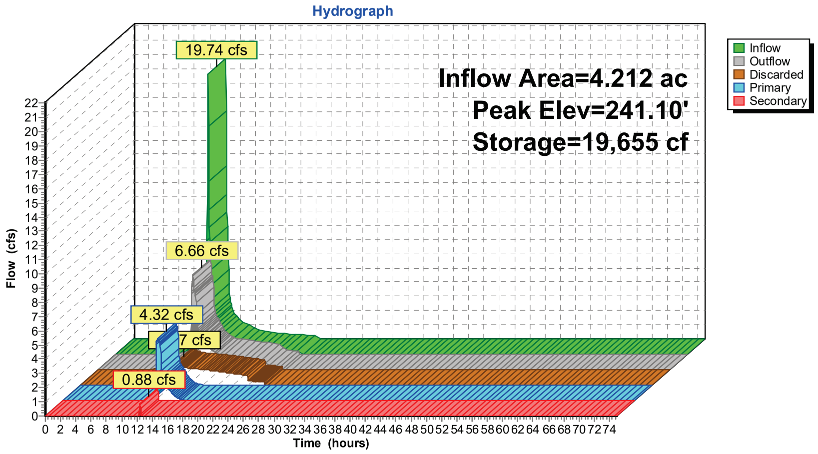
Discarded OutFlow Max=1.47 cfs @ 12.42 hrs HW=241.10' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 1.47 cfs)

Primary OutFlow Max=4.31 cfs @ 12.42 hrs HW=241.10' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 4.31 cfs @ 5.49 fps)
  ├─**4=Grate** (Passes < 12.14 cfs potential flow)
  └─**5=Orifice** (Passes < 2.26 cfs potential flow)

Secondary OutFlow Max=0.84 cfs @ 12.41 hrs HW=241.10' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 0.84 cfs @ 0.85 fps)

Pond B1: Infiltration Basin 1



Summary for Pond B2: Infiltration Basin 2

Inflow Area = 2.211 ac, 74.16% Impervious, Inflow Depth = 6.61" for 100-YR event
Inflow = 15.61 cfs @ 12.09 hrs, Volume= 1.218 af
Outflow = 2.32 cfs @ 12.59 hrs, Volume= 1.218 af, Atten= 85%, Lag= 30.4 min
Discarded = 1.50 cfs @ 12.59 hrs, Volume= 1.063 af
Primary = 0.82 cfs @ 12.59 hrs, Volume= 0.154 af
Routed to Link DP1 :
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP1 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 241.55' @ 12.59 hrs Surf.Area= 7,832 sf Storage= 19,989 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 93.0 min (868.0 - 775.0)

Volume	Invert	Avail.Storage	Storage Description
#1	238.00'	32,644 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
238.00	3,639	0	0
239.00	4,684	4,162	4,162
240.00	5,843	5,264	9,425
241.00	7,114	6,479	15,904
242.00	8,427	7,771	23,674
243.00	9,513	8,970	32,644

Device	Routing	Invert	Outlet Devices
#1	Primary	239.00'	**12.0" Round Culvert** L= 127.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 239.00' / 238.35' S= 0.0051 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Secondary	242.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#3	Discarded	238.00'	**8.270 in/hr Exfiltration over Surface area**
#4	Device 1	241.50'	**24.0" x 24.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	239.60'	**4.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads

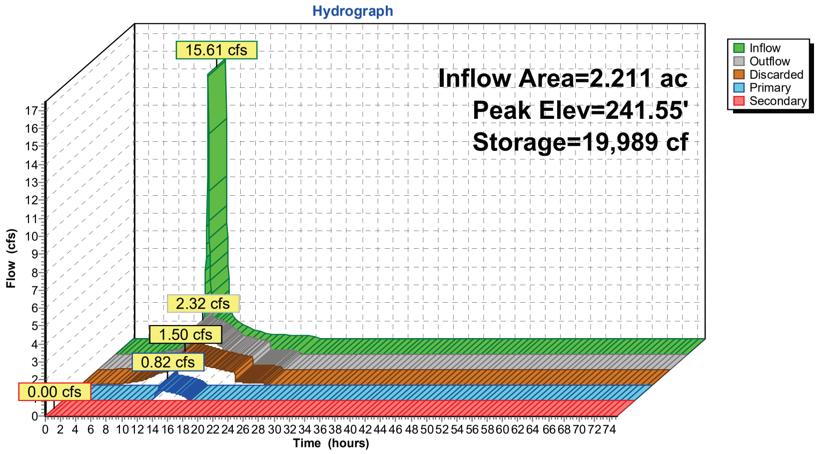
---

Discarded OutFlow Max=1.50 cfs @ 12.59 hrs HW=241.55' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 1.50 cfs)

Primary OutFlow Max=0.82 cfs @ 12.59 hrs HW=241.55' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.82 cfs of 3.99 cfs potential flow)
  ├─**4=Grate** (Weir Controls 0.26 cfs @ 0.70 fps)
  └─**5=Orifice** (Orifice Controls 0.56 cfs @ 6.42 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=238.00' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond B2: Infiltration Basin 2

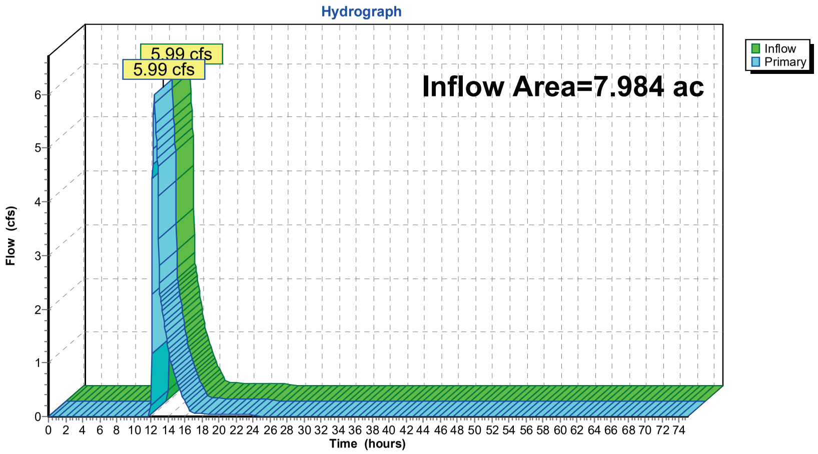


Summary for Link DP1:

```
Inflow Area =       7.984 ac, 44.40% Impervious, Inflow Depth =  0.97"   for 100-YR event
Inflow      =       5.99 cfs @  12.42 hrs, Volume=        0.648 af
Primary     =       5.99 cfs @  12.42 hrs, Volume=        0.648 af, Atten= 0%, Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP1:

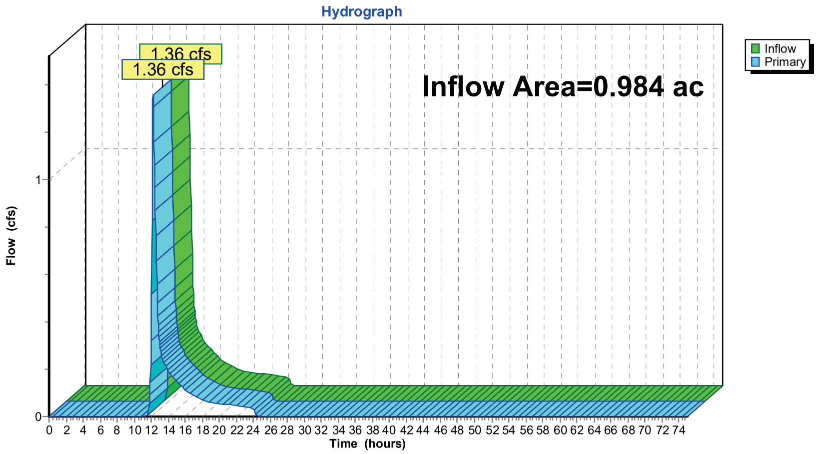


Summary for Link DP2:

```
Inflow Area =       0.984 ac, 20.69% Impervious, Inflow Depth =  1.83"   for 100-YR event
Inflow      =       1.36 cfs @  12.23 hrs, Volume=        0.150 af
Primary     =       1.36 cfs @  12.23 hrs, Volume=        0.150 af, Atten= 0%, Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP2:

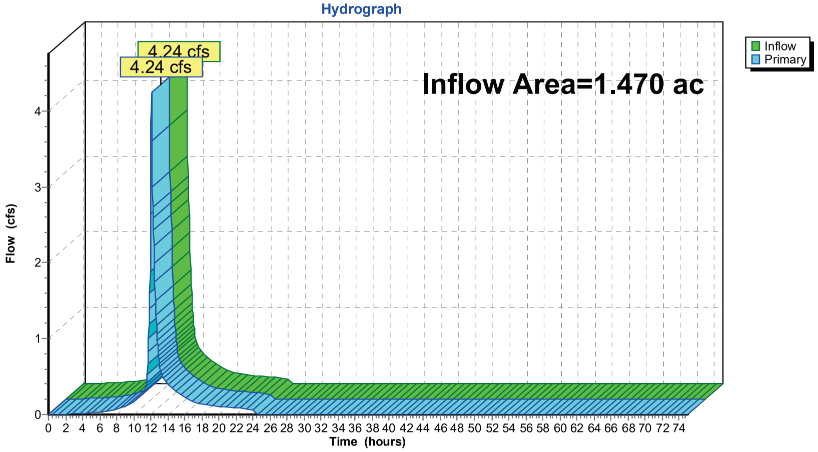


Summary for Link DP3:

Inflow Area = 1.470 ac, 31.62% Impervious, Inflow Depth = 3.60" for 100-YR event
Inflow = 4.24 cfs @ 12.09 hrs, Volume= 0.441 af
Primary = 4.24 cfs @ 12.09 hrs, Volume= 0.441 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-75.00 hrs, dt= 0.05 hrs

Link DP3:



Appendix F

Stormwater Management 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.

✓ tab

return ✗

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.

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

DANIEL F.
DELANY
CIVIL
NO. 43477

3/2/26

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 (continued)

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

☐ No disturbance to any Wetland Resource Areas

☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)

☐ Reduced Impervious Area (Redevelopment Only)

☐ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

- ☐ Credit 1
- ☐ Credit 2
- ☐ Credit 3

☐ Use of “country drainage” versus curb and gutter conveyance and pipe

☒ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☐ Other (describe): ______________________________

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

---

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

  ☐ is within the Zone II or Interim Wellhead Protection Area

  ☐ is near or to other critical areas

  ☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)

  ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist (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.

Appendix G

BMP Sizing Calculations

BMP Sizing Table

BMP	Required Rv (cf)	Required WQV (cf)	Provided Storage (cf)	Treatment %	Weighted Treatment %
1PB	5,513	9,188	9,603	105%	100%
2PB	4,046	6,744	7,181	106%	100%

Infiltration Basin B1

Objective: Size Best Management Practice (BMP) in accordance with Standards 3 and 4 of the MA Stormwater Handbook. BMP shall be sized to infiltrate the required recharge volume (Standard 3) and provide treatment for the required water quality volume (Standard 4).

1) Calculate Required Recharge Volume (Standard 3)

$Rv = (F/12)*(A_{IMP})$ 5,513 cf

F (target depth factor) 0.6 in (soil group C, Table 2.3.2 of MA Stormwater Handbook)
A_{IMP} (impervious area) 110,260 sf

2) Calculate Drawdown Time (Standard 3)

T_d=Storage Volume / (K*(1'/12")*Bottom Area)= 4 hours

Storage Volume 9,603 cf at lowest el. 239.60 orifice elevation (from HydroCad)
K (sat. hydraulic conductivity) 8.27 in/hr (Rawls Rate for Sandy Loam, Table 2.3.3 of MA Stormwater Handbook)
Bottom Area 3,493 sf (from HydroCAD)

4 < 72 hrs

3) Calculate Water Quality Volume (WQv) (Standard 4)

$V_{WQ} = (D_{WQ}/ 12)*(A_{IMP})=$ 9,188 cf

D_{WQ} (water quality depth) 1 in (1" for LUHPPL, Zone II, or critical area, 0.5" other)
A_{IMP} (impervious area) 110,260 sf

4) Size BMP to store greater of V_{WQ} and R_V

V_{WQ}= 9,188 cf
R_V= 5,513 cf
Actual Storage= 9,603 cf (from HydroCAD)

9,603 > 9,188

Infiltration Basin B2

Objective: Size Best Management Practice (BMP) in accordance with Standards 3 and 4 of the MA Stormwater Handbook. BMP shall be sized to infiltrate the required recharge volume (Standard 3) and provide treatment for the required water quality volume (Standard 4).

1) Calculate Required Recharge Volume (Standard 3)

$Rv = (F/12)*(A_{IMP})$ 4,046 cf

F (target depth factor)	0.6	in (soil group C, Table 2.3.2 of MA Stormwater Handbook)
A_{IMP} (impervious area)	80,925	sf

2) Calculate Drawdown Time (Standard 3)

T_d=Storage Volume / (K*(1'/12")*Bottom Area)= 3 hours

Storage Volume	7,181	cf at lowest el. 239.60 orifice elevation (from HydroCad)
K (sat. hydraulic conductivity)	8.27	in/hr (Rawls Rate for Sandy Loam, Table 2.3.3 of MA Stormwater Handbook)
Bottom Area	3,639	sf (from HydroCAD)

3 < 72 hrs

3) Calculate Water Quality Volume (WQv) (Standard 4)

$V_{WQ} = (D_{WQ}/ 12)*(A_{IMP})=$ 6,744 cf

D_{WQ} (water quality depth)	1	in (1" for LUHPPL, Zone II, or critical area, 0.5" other)
A_{IMP} (impervious area)	80,925	sf

4) Size BMP to store greater of V_{WQ} and R_V

$V_{WQ}=$	6,744	cf	
$R_V=$	4,046	cf	
Actual Storage=	7,181	cf	(from HydroCAD)

7,181 > 6,744

Appendix H

TSS Removal Calculations

Project: South Hadley Electric Light Department
Site Location: Old Lyman Road, South Hadley, MA
Project Number: 20250806.A10
Outfall Location: Pretreatment - DP1
Treatment Train: CB-B1

Prepared By: AHN
Date: 3/2/2026

BMP	TSS Removal Efficiency	Starting TSS Load	TSS Removed	TSS Remaining
Deep Sump Catch Basin	25%	1.00	0.25	0.75
Sediment Forebay	25%	0.75	0.19	0.56
		0.56	0.00	0.56
		0.56	0.00	0.56

Total TSS Removal Efficiency = **44%**

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Project: South Hadley Electric Light Department
Site Location: Old Lyman Road, South Hadley, MA
Project Number: 20250806.A10
Outfall Location: DP1
Treatment Train: CB-B1

Prepared By: AHN
Date: 3/2/2026

BMP	**TSS Removal Efficiency**	**Starting TSS Load**	**TSS Removed**	**TSS Remaining**
Deep Sump Catch Basin	25%	1.00	0.25	0.75
Infiltration Basin	80%	0.75	0.60	0.15
		0.15	0.00	0.15
		0.15	0.00	0.15

Total TSS Removal Efficiency = 85%

Project: South Hadley Electric Light Department
Site Location: Old Lyman Road, South Hadley, MA
Project Number: 20250806.A10
Outfall Location: Pretreatment - DP2
Treatment Train: CB-B2

Prepared By: AHN
Date: 3/2/2026

BMP	TSS Removal Efficiency	Starting TSS Load	TSS Removed	TSS Remaining
Deep Sump Catch Basin	25%	1.00	0.25	0.75
Sediment Forebay	25%	0.75	0.19	0.56
		0.56	0.00	0.56
		0.56	0.00	0.56

Total TSS Removal Efficiency = 44%

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Project:	South Hadley Electric Light Department	**Prepared By:**	AHN
Site Location:	Old Lyman Road, South Hadley, MA	**Date:**	3/2/2026
Project Number:	20250806.A10		
Outfall Location:	DP2		
Treatment Train:	CB-B2		

BMP	TSS Removal Efficiency	Starting TSS Load	TSS Removed	TSS Remaining
Deep Sump Catch Basin	25%	1.00	0.25	0.75
Infiltration Basin	80%	0.75	0.60	0.15
		0.15	0.00	0.15
		0.15	0.00	0.15

Total TSS Removal Efficiency = 85%

Appendix I

Long-Term Operation and Maintenance Plan

FUSS & O'NEILL
1550 Main Street, Suite 400
Springfield, MA 01103
413.452.0445
www.fando.com

Long-Term Operation and Maintenance Plan
South Hadley Electric Light Department
Willimansett Street, South Hadley, Massachusetts

Prepared For:

South Hadley Electric Light Department
South Hadley, Massachusetts

March 2, 2026

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B Annual O&M Budgetary Opinion of Cost

1 Introduction

The purpose of this Long-Term Operation and Maintenance Plan (O&M Plan) is to outline the requirements for source control and pollution prevention for the proposed South Hadley Light Department HQ Complex located on Willimansett Street in South Hadley, Massachusetts. The site is currently mostly undeveloped with grassed and wooded areas. An existing paved driveway is located on the northern portion of the site. The site is bound by the existing Big Y located to the west, Old Lyman Road to the east and private properties to the south. The project location is depicted on the Site Location Map attached as *Figure 1.*

The proposed includes the construction of a new South Hadley Electric Light District Headquarters, which includes a main office building, a warehouse, and a garage space, along with associated parking lots, sidewalks, stormwater infrastructure, utilities, and landscaping.

The Stormwater Management system is comprised of infiltration basins, and a stormwater collection system. *Figure 2* provides a map depicting the location of the BMPs.

The long-term requirements include following proper site operation procedures and implementing an inspection and maintenance program to ensure the success and minimize the deterioration of the stormwater system over time. The Contractor is responsible for implementing this O&M Plan during construction. The Owner (South Hadley Electric Light Department) is responsible thereafter. Maintenance operations shall be funded by the Owner. In the event the facility becomes owned by different entities, this Long-Term Operation and Maintenance Plan shall be transferred to the future owners/operators. Checklists to assist with the inspection and maintenance activities are provided in *Appendix A*.

This plan has been prepared in accordance with the requirements set forth in Standard 4 and Standard 9 of the Massachusetts Stormwater Handbook.

2 Pollution Prevention

The following pollution prevention activities shall be conducted to minimize potential impacts on stormwater runoff quality. The Contractor is responsible for all activities during construction. The Owner is responsible thereafter.

2.1 Good Housekeeping

Good housekeeping shall be implemented to minimize the impacts to protected areas by pollutants, soil, and fugitive sediment. The site shall be kept in good working order. Trash shall be kept in covered containers (i.e., dumpsters) to prevent waste from escaping. Fugitive litter that is deposited on the site shall be removed and placed in a proper enclosed container.

2.2 Vehicle Washing

The washing of vehicles is to occur on concrete aprons. Vehicle washing is not to occur during rain events.

During vehicle washing, the following procedure shall be followed:

1. Inspect vehicles for leaks.

2. Wash vehicles using domestic water and soaps recommended by the manufacturer for outdoor vehicle washing. Do not use harsh detergents or de-greasers. Do not wash materials from vehicles that could cause pollution in the environment. Do not wash the interior truck beds, engine compartments, undercarriages, or similar components.

3. Upon completion of vehicle washing, remove vehicle from area. Rinse concrete pad to divert residual wash water towards sediment forebay.

2.3 Chemical and Petroleum Products

All chemical and petroleum product containers stored on the site (excluding those contained within vehicles and equipment) shall be provided with impermeable containment which will hold at least 110% of the volume of the largest container, or 10% of the total volume of all containers in the area, whichever is larger, without overflow from the containment area. All chemicals and their containers shall be stored under a roofed area. Containers of 100 gallons capacity or more may be stored without a roof only if stored in a double-walled tank. On-site vehicles shall be monitored for leaks and receive maintenance as needed.

2.3.1 Spill Control Practices

Any discharge of waste oil or other pollutant to the stormwater system will be reported immediately to the Massachusetts Department of Environmental Protection (MA DEP). The Owner will be responsible for any incident of groundwater contamination resulting from the improper discharge of pollutants to the stormwater system and may be required by MA DEP to remediate incidents that may impact groundwater quality. Should property ownership be transferred, the subsequent owner/operator will be informed of the legal responsibilities associated with operation of the stormwater system, as indicated above.

The following practices shall be implemented to mitigate spills of material and prevent their release to the waters of the Commonwealth:

- The manufacturer's recommended methods for spill cleanup shall be clearly posted and site personnel will be made aware of the procedures and the location of the information and cleanup supplies.

- Materials and equipment necessary for spill cleanup will be kept in material storage areas. Equipment and materials will include but not be limited to brooms, dust pans, mops, rags, gloves, goggles, kitty litter, sand, sawdust, and plastic and metal trash containers specifically for this purpose.

- Spills will be cleaned up immediately after discovery.

- Spills of toxic or hazardous material will be reported to the appropriate State and local government agency, regardless of size.

2.4 Landscaped Areas

Lawn areas will be mowed during the growing seasons as required to maintain a healthy stand of vegetation. This is typically once a week but can vary depending on weather conditions. If bagged, grass clippings are to be removed from the site and legally disposed of at an off-site location.

Fertilizers, if required for the maintenance of lawn areas, will be applied only in the amounts recommended by the manufacturer. If kept on site, fertilizers will be stored in a covered area. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills.

2.5 Pet Waste Management

There are no provisions for accommodating pets as part of the public safety facility operation. If pets or service animals are required by facility staff, the O&M Plan shall be amended to include pet waste management practices.

2.6 Snow Management

Stormwater runoff caused by snow melt must be properly managed to prevent erosion and pollution. The removal of snow and ice during precipitation events is especially important for SHELD to ensure a safe means of egress from the site, allowing for faster emergency response times. Therefore, a snow management plan has been developed to identify storage areas throughout the site.

Determine the best areas on the site to stockpile snow, keeping pedestrians and car routes cleared. Also take into consideration the locations of BMPs to ensure proper functioning of the stormwater management system. *Figure 3*, Snow Storage Plan, provides a map showing the snow storage locations.

3 Inspection and Maintenance Requirements for Permanent Stormwater Controls

The following inspection and maintenance activities shall be conducted to ensure the success and minimize the deterioration of the stormwater system over time. *Figure 2* provides a map depicting the location of the components of the stormwater management system. Checklists to assist with the inspection and maintenance activities are provided in *Appendix A*.

3.1 Infiltration Basins

3.1.1 Post-Construction Inspections

Following construction, the infiltration basins shall be inspected after every storm event larger than one inch in the first six months. The appearance of standing water 48 to 72 hours post storm event may indicate that there is clogging. Clogging can be the result of upland sediment erosion, excessive compaction of soil, or low spots and should be addressed immediately.

Vegetation shall be watered once every two to three days for first two months, then sporadically after establishment during the first year after installation. If droughty, watering after the initial year may be required.

If at least 25 percent vegetation coverage is not established after the first growing season, reinforcement planting should be installed. If the surface of the basins becomes clogged to the point that standing water is observed on the surface 72 hours after precipitation events, remove accumulated sediment or till the surface to break up any hard-packed soil and then vegetate.

3.1.2 Monthly Periodic Inspections

The infiltration basins shall be inspected monthly for evidence for vegetation health and the presence of trash (e.g., litter, debris, etc.). Trash deposited on the surface of the basins shall be removed manually and shall be disposed of in accordance with applicable local, state, and federal guidelines and regulations. Mowing shall occur when vegetation reaches a height at which it cannot support its own weight (typically two (2) to twelve (12) times per year), remove grass clippings and accumulated organic matter to prevent an impervious organic mat from forming. Remove trash and debris at the same time. Inspect and clean pretreatment devices associated with basins at least twice a year, and ideally every other month.

3.1.3 Semiannual Inspections

Inspections should occur twice per year. During these inspections the infiltration basins should be checked for signs of differential settlement, cracking, erosion, leakage, conditions of riprap, sediment accumulation, and the health of the turf.

Sediment shall be removed from the basins when the accumulation exceeds one inch or when there is evidence that the infiltration capacity has been significantly reduced. Sediment and debris must be removed manually with rakes rather than heavy equipment to avoid compacting. Removed sediments shall be dewatered (if necessary) and disposed of in an acceptable manner.

Use deep tilling to break up clogged surfaces and revegetate immediately. Remove sediment from the basins as necessary but wait until the floor of the basins are thoroughly dry. Use light equipment to remove the top layer so as to not compact the underlying soil. Deeply till the remaining soil and revegetate as soon as possible.

Any areas within the extents of the basins that are subject to erosion or gullying shall be replenished with the original design material and re-vegetated according to design drawings. Prune vegetated areas and remove any dead materials. Separation of herbaceous vegetation rootstock should occur when over-crowding is observed, or approximately once every three years. If required, apply fertilizer to areas where vegetation is not fully established.

3.2 Sediment Forebays

3.2.1 Post-Construction Inspections

Sediment forebays shall be inspected after every storm event larger than one inch in the first six months following construction.

If the surface of the forebays becomes clogged to the point that standing water is observed on the surface 36 hours after precipitation events, remove accumulated sediment or till the surface to break up any hard-packed soil and then vegetate.

Vegetation shall be watered once every two to three days for the first two months, then sporadically after establishment during the first year after installation. If droughty, watering after the initial year may be required. If at least 25 percent vegetation coverage is not established after the first growing season, reinforcement planting should be installed.

3.2.2 Monthly Periodic Inspections

The sediment forebay shall be inspected monthly for evidence for vegetation health, the presence of trash (e.g., litter, debris, etc.), and sediment accumulation. Trash deposited on the surface of the forebays should be removed manually and shall be disposed of in accordance with applicable local, state, and federal guidelines and regulations.

If sediment has accumulated to half the depth of the forebay, remove the sediment. Otherwise, note the depth on the inspection checklist. Sediment and debris must be removed manually with rakes rather than heavy equipment to avoid compacting. Removed sediments shall be dewatered (if necessary) and disposed of in accordance with applicable local, state, and federal guidelines and regulations.

3.2.3 Quarterly Inspections

The quarterly inspection of the forebays should include checking for standing water or other evidence of clogging by accumulated sediments, checking inlets and outlets for signs of erosion and damage, checking the overflow structures for blockage and structural integrity, and checking the slopes of the forebays for erosion or gullying. Inspect stone to determine if high flows have caused scour beneath the channels or dislodged any of the stone. If repairs are needed, they should be performed immediately.

Remove accumulated sediment on a quarterly basis, regardless of the depth. Sediment and debris must be removed manually with rakes rather than heavy equipment to avoid compacting. Removed sediments shall be dewatered (if necessary) and disposed of in accordance with applicable local, state, and federal guidelines and regulations.

If the forebay is clogged, use deep tilling to break up clogged surfaces. If required, remove sediment from the forebays as necessary but wait until the floor of the forebays are thoroughly dry. Use light equipment to remove the top layer so as to not compact the underlying soil. Deeply till the remaining soil and revegetate as soon as possible.

Any areas that are subject to erosion or gullying shall be replenished with topsoil and re-vegetated according to design drawings. Erosion control blankets shall be used as needed to ensure stabilization of the floor and side slopes of the forebay during revegetation.

3.2.4 Mowing

The forebay shall be mowed as required to maintain a healthy stand of grass between three (3) and six (6) inches tall.

3.3 Drainage Structures

3.3.1 Post-Construction Inspections

Immediately prior to the end of construction and acceptance by the Owner, the Contractor shall clean all drainage structures.

3.3.2 Quarterly Inspections

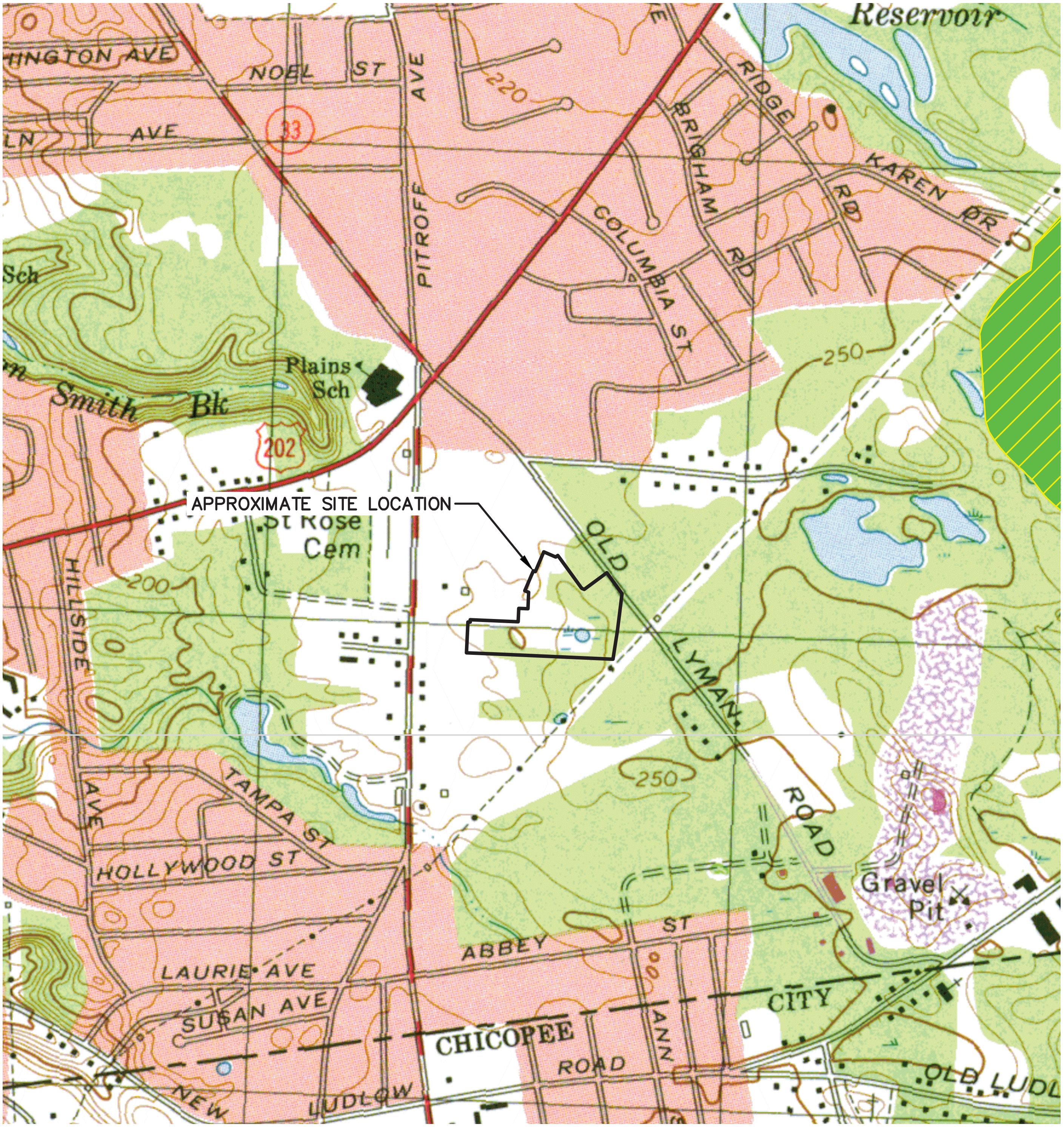
Drainage structures shall be inspected at minimum of four times per year, at minimum. Sediment shall be removed at least twice per year, or when the depth reaches half the height between the bottom of the structure and the lowest pipe invert elevation. Inspections shall include checking for debris, sediment, and hydrocarbons, and structural integrity or damage. Deficiencies must be corrected immediately. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations. Grates shall not be welded to the frame so the structures can be easily inspected and maintained.

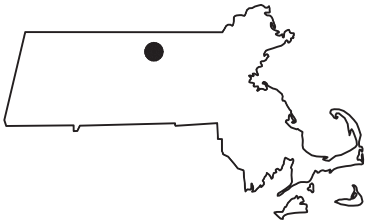
3.4 Anticipated Costs

The annual cost for the inspections and maintenance of the property is estimated to be from $15,000 to $23,000 per year, if performed by an independent third party. A budgetary opinion of cost of the maintenance is included in *Appendix B.*

Figure 1

Site Location Map





MAP REFERENCE
THIS MAP WAS PREPARED FROM THE FOLLOWING USGS
TOPOGRAHIC QUADRANGLE IMAGES: q113882, q113886.
QUADRANGLE IMAGES WERE PREPARED FROM MASS GIS
DATA RECEIVED FROM OLIVER GIS ON 02/19/2026.
ORIGINAL MAP UNITS IN METERS.

File: J:\DWG\P2025\0806\A10\Civil\Figures\20250806A10_LOC01.dwg Layout: FIG.01 Plotted: 2026-02-25 3:29 PM Saved: 2026-02-25 3:28 PM User: Amina.Nefic
PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO.STB

MS VIEW:

LAYER STATE:

SCALE:
HORZ.: 1" = 1000'
VERT.: -
DATUM:
HORZ.: -
VERT.: -

0 500' 1000'

GRAPHIC SCALE

FUSS & O'NEILL

1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

SHELD

SITE LOCATION MAP

SHELD HEADQUARTERS

SOUTH HADLEY MASSACHUSETTS

PROJ. No.: 20250806A10
DATE: 03/02/2026

FIG.01

Figure 2

BMP Location Plan

File: J:\DWG\P2025\0806\A10\Civil\Figures\20250806A10_BMP01.dwg Layout: BMP Plotted: 2026-02-27 2:59 PM Saved: 2026-02-27 2:58 PM User: Amina.Nefic

MS VIEW:	LAYER STATE:	PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO.STB

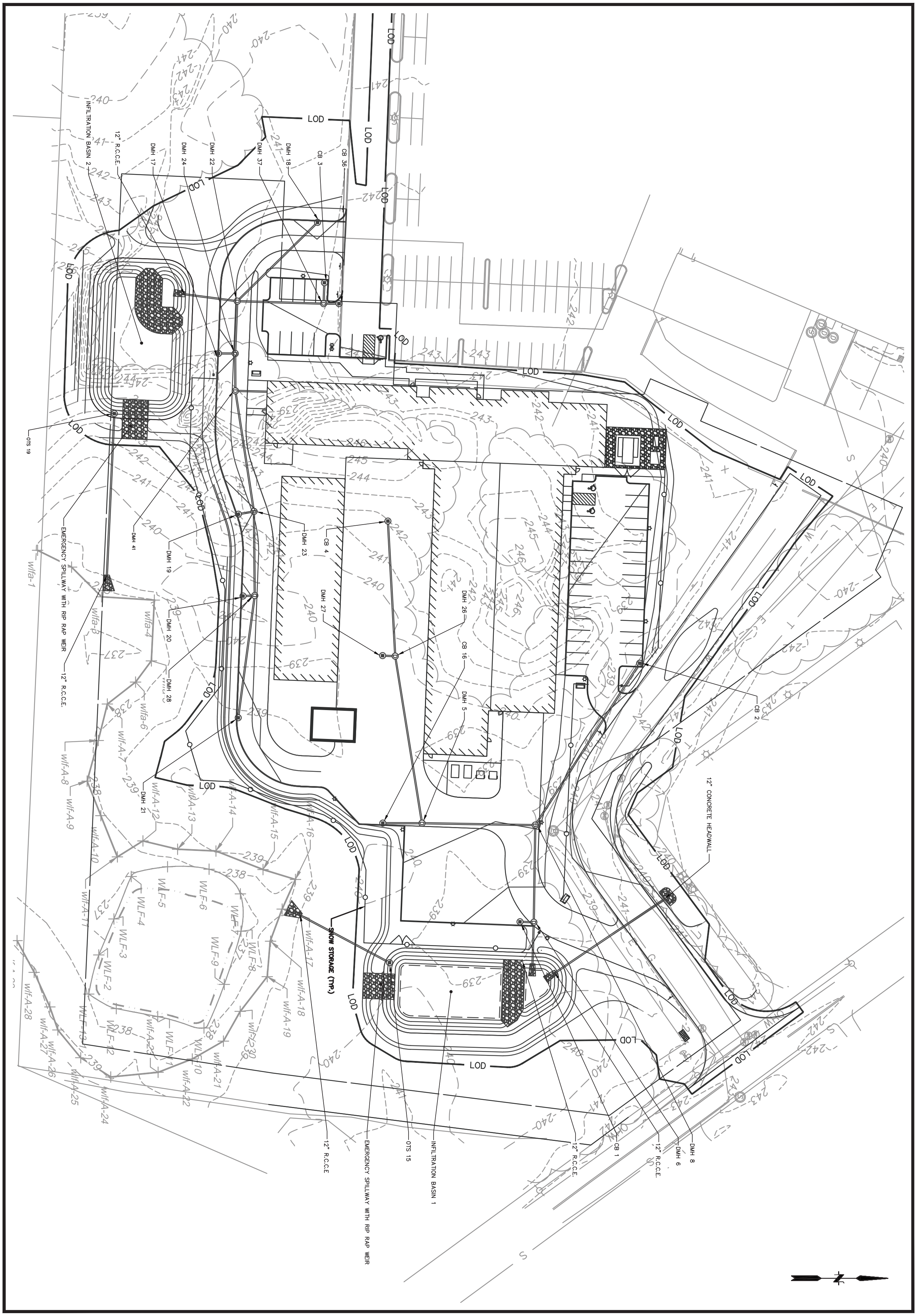


FIG.02	PROJ. No.: 20250806A10 DATE: 03/02/2026	SHELD BMP LOCATION MAP SHELD HEADQUARTERS SOUTH HADLEY MASSHUSETTS	FUSS & O'NEILL 1550 MAIN STREET, SUITE 400 SPRINGFIELD, MA 01103 413.452.0445 www.fando.com

SCALE:
HORZ.: 1" = 60'
VERT.: -
DATUM:
HORZ.: -
VERT.: -
0 30' 60'
GRAPHIC SCALE

Figure 3

Snow Storage Plan

File: J:\DWG\P2025\0806\A10\Civil\Figures\20250806A10_BMP01.dwg Layout: SNOW STORAGE Plotted: 2026-02-25 3:02 PM Saved: 2026-02-25 2:54 PM User: Amina.Nefic

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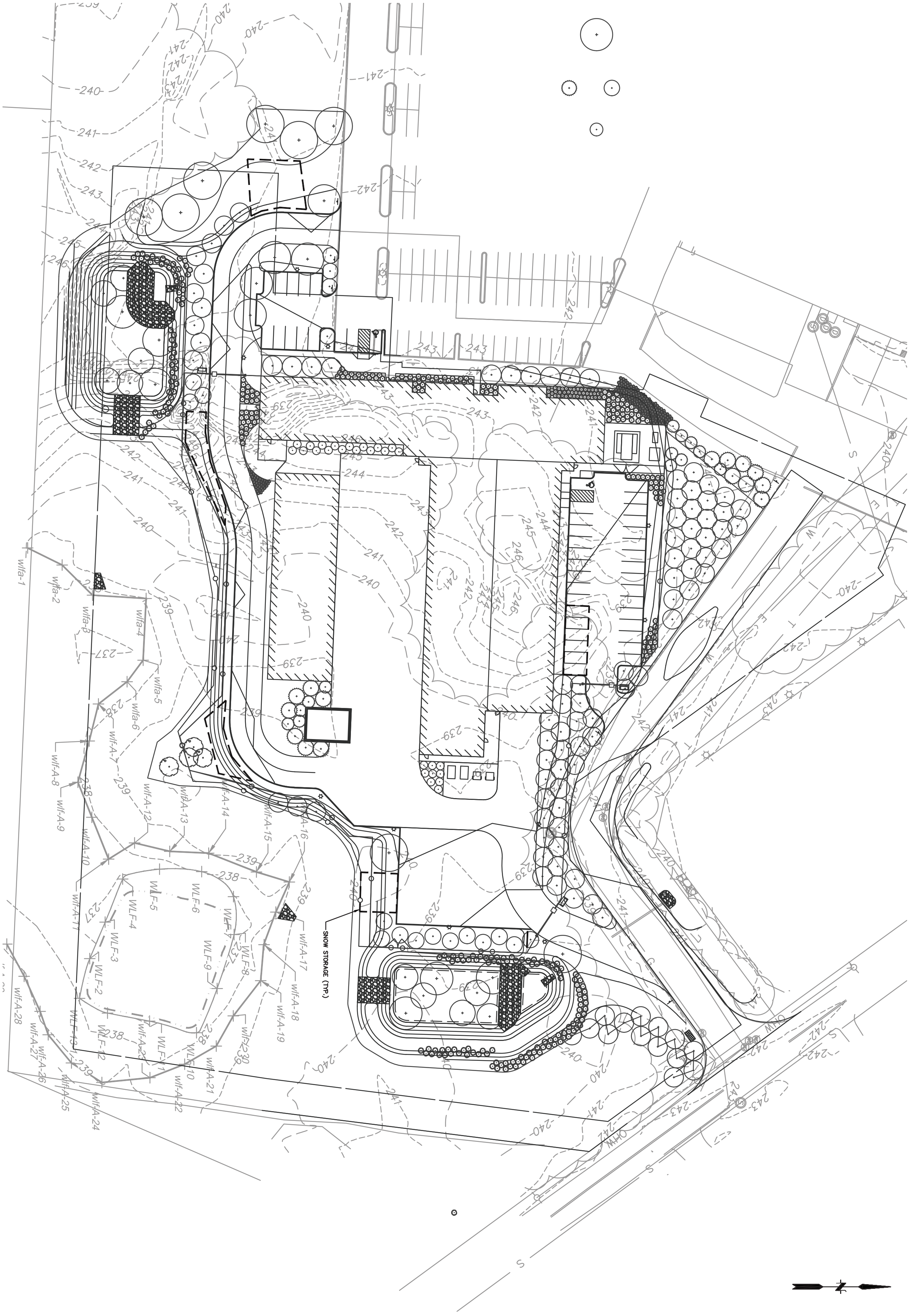

FIG.03

PROJ. No.: 20250806A10
DATE: 03/02/2026

SHELD

SNOW STORAGE PLAN

SHELD HEADQUARTERS

SOUTH HADLEY
MASSACHUSETTS

FUSS & O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

SCALE:
HORZ.: 1" = 70'
VERT.: -
DATUM:
HORZ.: -
VERT.: -

0 35' 70'
GRAPHIC SCALE

Appendix A

Operation, Maintenance, and Management Inspection Checklist

Operation, Maintenance, and Management Inspection Checklists
Master Checklist
South Hadley Electric Light Department

Inspection Year: ______________

<table>
<tr><th></th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td colspan="13">Infiltration Basins</td></tr>
<tr><td>Inspect for and remove trash (monthly)</td><td colspan="3"></td><td colspan="3"></td><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td>Mow (as needed)</td><td colspan="3">▨</td><td colspan="3"></td><td colspan="3"></td><td colspan="3">▨</td></tr>
<tr><td>Semi-Annual Inspection</td><td colspan="6"></td><td colspan="6"></td></tr>
<tr><td colspan="13">Sediment Forebay</td></tr>
<tr><td>Inspect for and Remove Trash (monthly)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mow (as required)</td><td colspan="3">▨</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">▨</td></tr>
<tr><td>Annual Inspection</td><td colspan="12"></td></tr>
<tr><td colspan="13">Drainage Structures</td></tr>
<tr><td>Quarterly Inspection</td><td colspan="3"></td><td colspan="3"></td><td colspan="3"></td><td colspan="3"></td></tr>
</table>

Operation, Maintenance, and Management Inspection Checklists
Infiltration Basins
South Hadley Electric Light Department

Inspector Name: ______________________________

Inspection Date: ______________________________

Reviewed By: ______________________________

Review Date: ______________________________

Type of Inspection (Circle One):

Monthly Semi-Annual

BMP Name:

____

No.	Monthly	Semi-Annual	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1			Trash/Debris	Basin is free of debris, litter, and waste.			
2			Turf	Grass has not reached a height at which it cannot support its own weight			
3	▨		Sediment	Depth of Sediment is less than one inch.			

Operation, Maintenance, and Management Inspection Checklists
Infiltration Basins
South Hadley Electric Light Department

4			Clogging	Basins appears to be draining freely and not clogged.			
5			Overflow Structures	Overflow structures are free of blockage and are structurally sound			
6			Erosion	There are no signs of erosion and scouring.			
7			Vegetation	Vegetation is satisfactorily pruned to remove any dead material. Rootstocks are not overcrowded.			

Operation, Maintenance, and Management Inspection Checklists
Sediment Forebay
South Hadley Electric Light Department

Inspector Name: ______________________________

Inspection Date: ______________________________

Reviewed By: ______________________________

Review Date: ______________________________

Type of Inspection (Circle One):

Monthly Annual

BMP Name:

____

No.	Monthly	Annual	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1			Trash/Debris	Basin is free of debris, litter, and waste.			
2			Turf	Grass is between three and six inches tall.			
3			Sediment	Depth of sediment is less than half the depth of the forebay.			

Operation, Maintenance, and Management Inspection Checklists
Sediment Forebay
South Hadley Electric Light Department

4			Clogging	Basins appears to be draining freely and not clogged.			
5			Overflow Structures	Overflow structures are free of blockage and are structurally sound			
6			Erosion	There are no signs of erosion and scouring.			
7			Vegetation	Vegetation is satisfactorily pruned to remove any dead material. Rootstocks are not overcrowded.			

Operation, Maintenance, and Management Inspection Checklists
Drainage Structures
South Hadley Electric Light Deparment

Inspector Name: ______________________________

Inspection Date: ______________________________

Reviewed By: ______________________________

Review Date: ______________________________

Type of Inspection (Circle One):

Quarterly

Structure Name:

____

No.	Quarterly	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1		Trash/Debris	Structure is free of debris, litter, and waste.			
2		Sediment	Depth of sediment is less than half the height between the bottom of the structure and the lowest pipe invert elevation and has been removed within the last six months.			
3		Concrete Surfaces	Concrete surfaces are structurally sound and have negligible spalling and cracking.			

Appendix B

Annual O&M Budgetary Opinion of Cost

FUSS & O'NEILL, INC.

BUDGETARY OPINION OF COST
DATE PREPARED : 03/02/2026
SHEET 1 OF 1
PROJECT : Peabody Public Safety Headquarters
LOCATION : 44 Willimantic Street, South Hadley, Massachusetts
DESCRIPTION: Long Term Stormwater O&M Costs
BASIS :
ESTIMATOR :
CHECKED BY :

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

ITEM NO.	ITEM DESCRIPTION	UNIT MEAS.	NO. UNITS	PER UNIT	TOTAL COST
1	Site Inspections(2)	EA	12	$ 500.00	$ 6,000.00
2	Monthly Removal of Trash(3)	EA	12	$ 250.00	$ 3,000.00
3	Mowing of Infiltration Basins(4)	EA	2	$ 550.00	$ 1,100.00
4	Sediment Removal from Infiltration Basins(5)	EA	2	$ 1,000.00	$ 2,000.00
5	Vacuum Truck - Drainage Structures(6)	EA	2	$ 2,800.00	$ 5,600.00
					$ 17,700.00
				TOTAL COST (-15% TO +30% ROUNDED)	**$15,000 TO $23,000**

Notes

1. The following equipment and labor rates were used for this estimate: Site Inspector - $1,000/day; Laborer - $500/day; Skidsteer & Operator - $1,000/day; Dump Truck - $500/day; Vacum Truck - $1800/day
2. Assume a Site Inspector is required for 1/2 day per inspection.
3. Assumes 1 Laborer for a 1/2 day.
4. Assumes 1 Laborer for a 1 day and an additional $50 for a weedwacker.
5. Assumes 1 Laborer, 1 Skidsteer & Operator, and 1 Dump Truck for 1/2 day.
6. Assumes 2 Laborers and 1 Vaccum Truck for 1 Day.

Appendix J

Illicit Discharge Compliance Statement

Illicit Discharge Compliance Statement
South Hadley Electric Light Department Headquarters
South Hadley, MA

No illicit discharges are proposed to enter the developed stormwater system located within the South Hadley Electric Light Department Headquarters project area. Inspection procedures outlined in the Long-Term Operation and Maintenance Plan will be strictly followed so contaminants do not enter the stormwater system. Illicit discharge detection and elimination procedures will be implemented routinely by visual inspections to prevent illicit discharges into the stormwater system. Further, I certify that the stormwater management system as shown on the referenced plans will be maintained in accordance with the conditions of the Long-Term Operation and Maintenance Plan.

Responsible Party: ___________________________________ Date: _________________