April 12, 2024

STORMWATER MANAGEMENT REPORT

100 New Bond Street

Worcester, MA 01606

Prepared for:

Saint Gobain
1 New Bond Street,
Worcester, MA 01606

Prepared by:

William J. Scully
MA LICENSE NO. 33298

Kimley»Horn

Table of Contents

1. PROJECT INFORMATION

1.1 – Introduction and Project Background

The project site is located at 100 New Bond Street, Worcester, MA. The applicant proposes a redevelopment in about 2.99 acres of the 28.43 acres existing parcel. The location of proposed redevelopment is within the parking lot to the east of Stores Street. Elevations on the portion of the site to be redeveloped range from 545' at north to 534' at the south end of the parking area. This project proposes an office building of 21,434 square foot building, with associated asphalt paving for parking lot, and landscape.

1.2 – Soils

Based on the Web Soil Survey provided by Natural Resources Conservation Service (NRCS), the site contains soil components of:

- Urban Land – (Map Unit 602), Hydrologic Soil Group Not Applicable

2. STORMWATER MANAGEMENT ANALYSIS

2.1 – Existing Onsite Drainage

The existing site runoff sheet flows to individual catch basins to the south of the proposed development, which discharge into the existing 84" concrete culvert in the site. For the purpose of this project, the study of drainage is limited to the limit of disturbance of the area being redeveloped.

This report analyzes approximately 2.99 acres of the limit of disturbance area within the entire 28.43 acre site. See **Exhibit 1** for a detailed drainage area map of the property and **Appendix B** for HydroCAD analysis for existing conditions.

The Soil Conservation Service Runoff Curve Number Method (SCS Method) was implemented to assess the existing peak flow from the site. In the pre-development state, it was calculated that the area of disturbance was composed of 2.70 acres of impervious surface and 0.30 acres of pervious surface. This scenario was modeled to provide a baseline for comparison to the post-development scenario.

2.2 – Proposed Onsite Drainage

The proposed redevelopment will not increase the amount of impervious on site. The impervious area is being reduced to 2.17 acres and the pervious area with landscape is increased to 0.82 acres. The groundwater table for the site is about 2.8 to 3.5 ft below the existing ground, which creates a constraint for providing a Best Management Practice (BMP) that requires separation from the groundwater table. As a result, multiple deep sumps catch basins are proposed in the site to capture the runoff. The existing site has a series of storm pipes connected through catch basins. The proposed site redevelopment is to tie into one of the existing catch basins to connect to the existing storm system. All proposed storm piping has the catch basin to manhole connection as per the City of Worcester requirements. The stormwater network

proposed within the site will capture some of the runoff from the site and will have the remaining runoff flow into the existing catch basin as it does in the existing condition.

2.3 – Stormwater Modeling

To evaluate the impact of the proposed improvements on the stormwater runoff from the site, a procedure based on the USDA Soil Conservation Service (SCS), TR-20 Method was chosen. The site area was divided into sub-watersheds using requirements set forth in the Massachusetts Stormwater Handbook. The SCS methods developed in TR-20 model the drainage shed's response to rainfall in the form of an excess rainfall (runoff) hydrograph. A drainage shed's response is dependent upon the individual parameters which affect runoff. These parameters include:

1. Storm rainfall amount
2. Watershed size and shape
3. Hydrologic soils group
4. Land use and treatment classification
5. Time of concentration.

The time of concentrations (Tc) for the analyzed area were based on SCS TR-20 Methodology. A minimum Tc of 5 minutes for impervious and directly connected pervious, were used in the calculations. For the Site Stormwater Management analysis, a HydroCAD v10.20-3c computer program developed by HydroCAD software solutions LLC was used. The program is modeled after the SCS, USDA TR-20 Program. The design storm depth is determined from rainfall maps, based on the return period being modeled. Combined with the rainfall distribution, this always specifies the cumulative rainfall depth during the storm.

3. STORMWATER CHECKLIST

3.1 – Standard #1: No New Untreated Discharges

No new stormwater conveyances may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

The proposed improvements will not increase the impervious area of the site. No new untreated discharges are proposed with the project.

3.2 – Standard #2: Peak Rate Attenuation

Stormwater management systems must be designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates.

There is a reduction in the impervious coverage on the site. Subsequently, there will be no increase in the peak runoff flow runoff rate post-development. The post development rate of runoff from the site will be less than the predevelopment rate. HydroCAD calculations are provided in Appendices B and C and are summarized in the table below.

Table 1: Rate of Discharge

Study Point (Limit of Disturbance)	Peak Rate of Runoff for 2-year Storm Event (3.16")	Peak Rate of Runoff for 10-year Storm Event (4.88")	Peak Rate of Runoff for 2-year Storm Event (5.95")	Peak Rate of Runoff for 2-year Storm Event (7.60")
Pre-Development	13.12 cfs	20.74 cfs	25.44 cfs	32.67 cfs
Post-Development	12.17 cfs	19.92 cfs	24.69 cfs	31.99 cfs

3.3 – Standard #3: Recharge

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

The calculated recharge volume is based upon the amount of proposed impervious area and the hydrologic soil classification of the on-site soils, as determined by the published NRCS Soil Survey. There is reduction in impervious coverage on the site. Subsequently, there will be no change to the existing recharge volume. In addition, a review of the NRCS Soil Survey indicates the on-site soils have low permeability throughout the project site, and do not provide substantial recharge of rainfall.

3.4 – Standard #4: Water Quality

Stormwater management systems shall be designed to remove 90% of the average annual post-construction load of Total Suspended Solids (TSS). This Standard is met when:

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

This project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a redevelopment project. Deep Sump and Hooded Catch Basin and Street Sweeping – 10% is proposed for the project. The high water table on the site does not allow for any other BMPs on the site.

3.5 – Standard #5: Land Uses with Higher Potential Pollutant Loads (LUHPPL's)

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

21, §§ 26-53, and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

The proposed redevelopment and use designation will not generate the significant number of vehicle trips to qualify as a Land Use with Higher Potential Pollutant Loads (LUHPPLs).

3.6 – Standard #6: Critical Areas

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

The proposed project area is not known to contain or discharge to any critical areas.

3.7 – Standard #7: Redevelopments and Other Projects Subject to the Standards Only to the Maximum Extent Practicable

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

This project is considered a redevelopment since this project is limited to reconstruction within an existing parking area. No increase in impervious area will be created due to this project. This project seeks to adhere to all applicable standards to the maximum extent practicable. Standards 1, 8, 9, and 10 are fully met.

3.8 – Standard #8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

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

A detailed Soil Erosion and Sediment Control Plan, with associated Details, has been provided with the civil set.

3.9 – Standard #9: Operation and Maintenance Plan

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

An Operation and Maintenance Plan (O&M Plan) for the site facilities is included in **Appendix E** of this report. The property owner shall maintain the site to sustain functionality and aesthetic appeal.

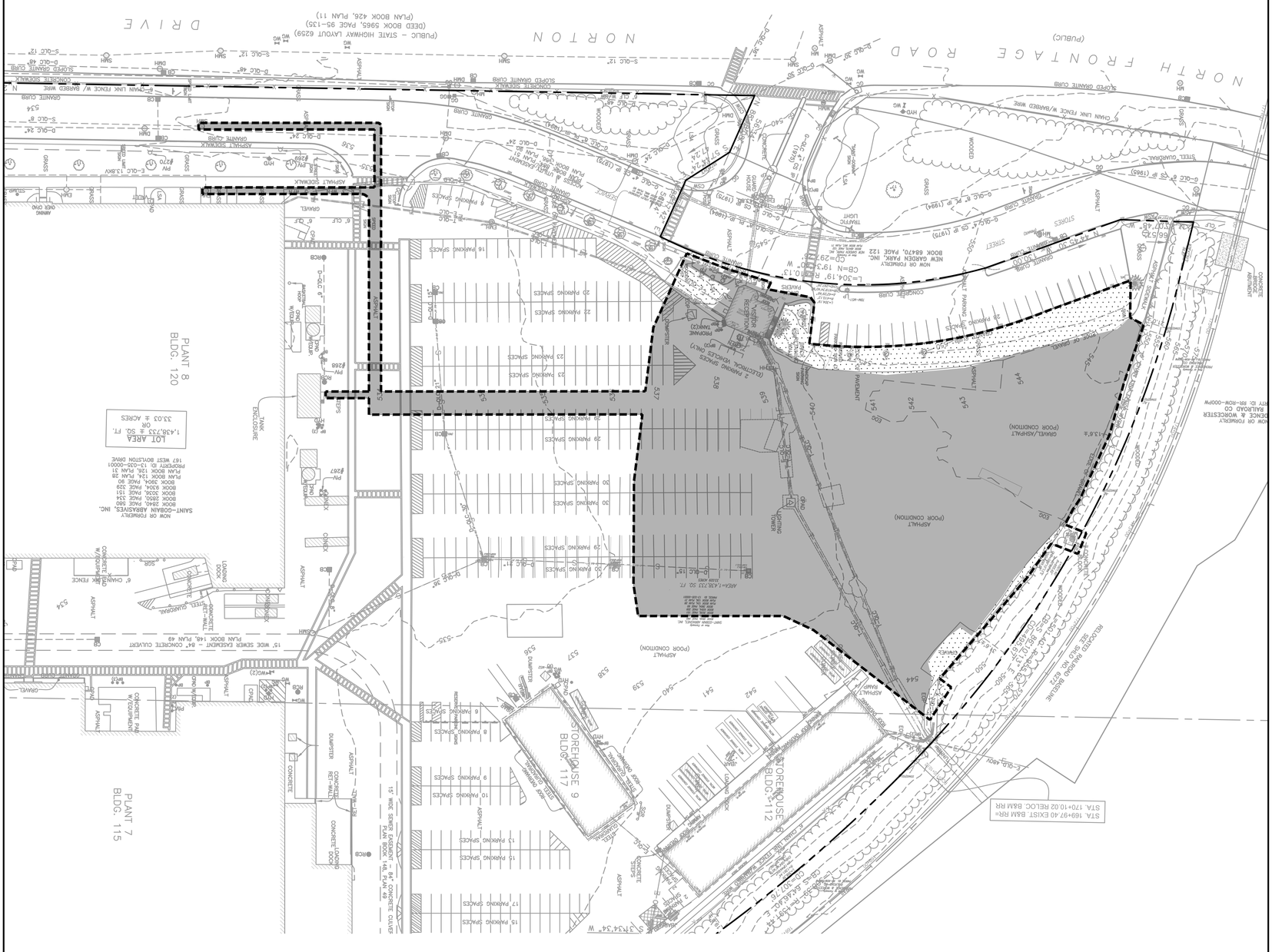
3.10 – Standard #10: No Illicit Discharges

All illicit discharges to the stormwater management system are prohibited.

An Illicit Discharge Statement is attached and can be found in **Appendix F.**

5. EXHIBITS

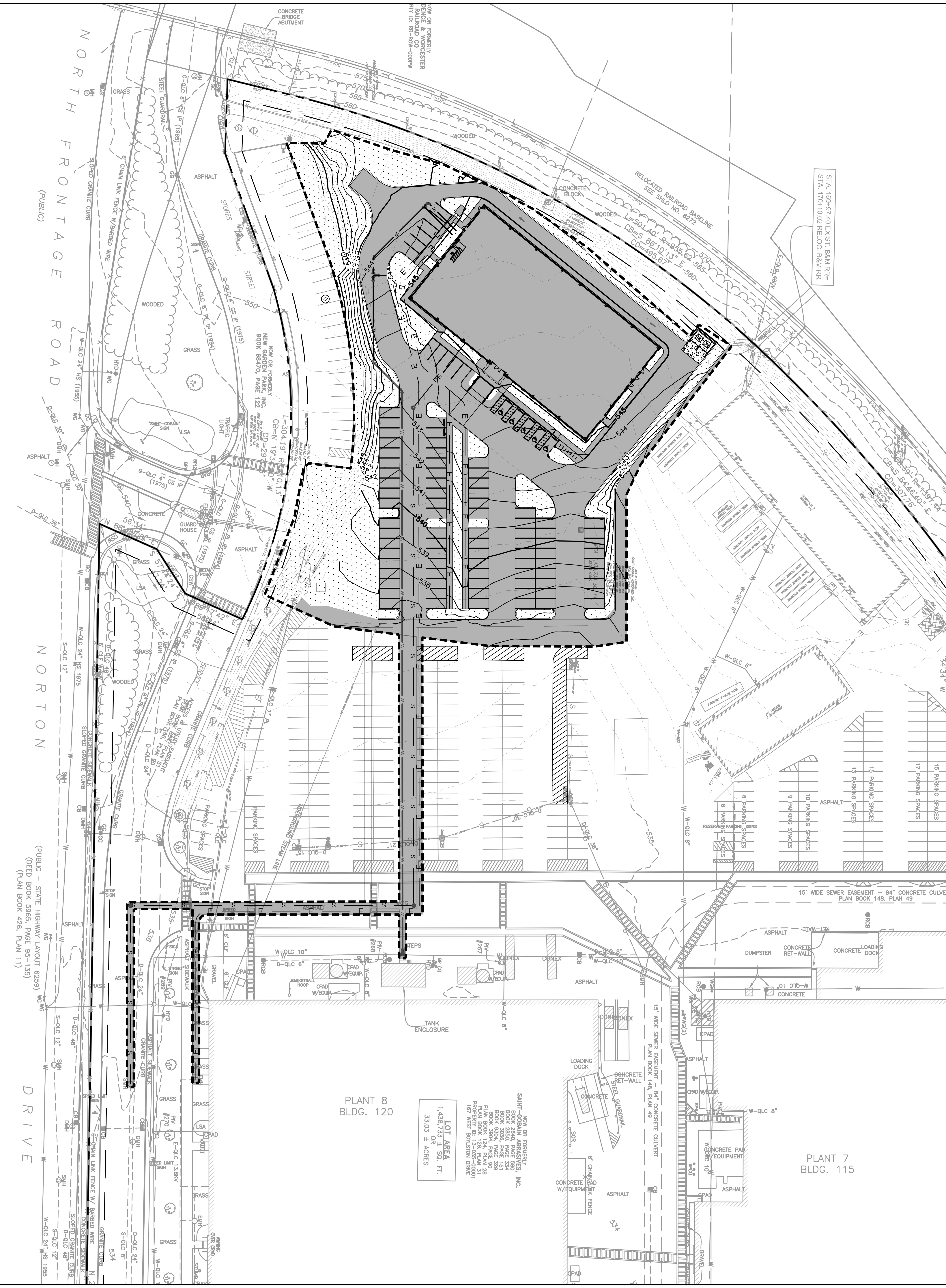
EXHIBIT 1 – EXISTING CONDITION DRAINAGE MAP



PRE- DEVELOPMENT LANDCOVER SUMMARY		
	OVERALL AREA (AC)	PERCENTAGE
TOTAL AREA	2.99	
PERVIOUS AREA	2.70	90.0%
IMPERVIOUS AREA	0.30	10.0%

SHEET NUMBER	PROJECT		KHA PROJECT 112968000	LICENSED PROFESSIONAL	Kimley»Horn	No.	REVISIONS	DATE	BY
C-503	PROJECT EUROPA PREPARED FOR PURE DEVELOPMENT CITY OF WORCESTER MASSACHUSETTS	PRE DEVELOPMENT DRAINANGE AREA MAP	DATE 04/12/2024 SCALE AS SHOWN DESIGNED BY: SP DRAWN BY: EIW CHECKED BY: DDL	DATE: 04/12/2024	 271 WAVERLEY OAKS ROAD, SUITE 302, WALTHAM, MA 02452 PHONE: 781-328-0676 WWW.KIMLEY-HORN.COM	7 6 5 4 3 2 1	---- ---- ---- ---- ---- ---- ----	---- ---- ---- ---- ---- ---- ----	---- ---- ---- ---- ---- ---- ----

EXHIBIT 2 – PROPOSED CONDITION DRAINAGE MAP



NORTH

GRAPHIC SCALE IN FEET
0 25 50 100

LEGEND	
(shaded)	IMPERVIOUS
(stippled)	PERVIOUS

POST- DEVELOPMENT LANDCOVER SUMMARY		
	OVERALL AREA	PERCENTAGE
TOTAL AREA	2.99	
PERVIOUS AREA	0.82	27.5%
IMPERVIOUS AREA	2.17	72.5%

No.	REVISIONS	DATE	BY

Kimley»Horn

271 WAVERLEY OAKS ROAD, SUITE 302, WALTHAM, MA 02452
PHONE: 781-328-0676
WWW.KIMLEY-HORN.COM

LICENSED PROFESSIONAL
WILLIAM J. SCULLY CIVIL No. 33268
DATE: 04/12/2024

KHA PROJECT 112968000
DATE 04/12/2024
SCALE AS SHOWN
DESIGNED BY: SP
DRAWN BY: EIW
CHECKED BY: DDL

POST DEVELOPMENT DRAINAGE AREA MAP

PROJECT EUROPA
PREPARED FOR
PURE DEVELOPMENT

CITY OF WORCESTER MASSACHUSETTS

SHEET NUMBER
C-504

6. APPENDICES

APPENDIX A – SOIL TYPE AND GEOTECH REPORT

Memo

To: William J. Scully, P.E./Kimley-Horn and Associates, Inc.

From: Joseph R. Giampa, Ph.D., P.E. and Stephen J. Sarandis, P.E.

Date: April 8, 2024

Re: Preliminary Geotechnical Recommendations
351 Stores Street
Worcester, Massachusetts
GEI Project 2400599

This memorandum presents our preliminary results of our geotechnical explorations and our preliminary geotechnical recommendations for the proposed office building located at 351 Stores Street in Worcester, Massachusetts.

Project Description

The project site is located at 351 Stores Street in Worcester, Massachusetts and currently consists of a parking area and occupied warehouses/manufacturing facilities. We understand that the project will consist of constructing a new 212 feet by 112 feet, two-story office building and upgraded parking area around the proposed building. The proposed building will be slab-on-grade construction with no basement. Based on discussions with you, the lowest-level floor elevation will be at about El. 545.5. The existing grade across the site ranges from approximately El. 545 at the north to El. 534 at the south end of the parking area. We understand that there will be up to about 5 feet of fill placed in the eastern portion of the proposed building.

Elevations in this memorandum are in feet and are referenced to the North American Vertical Datum of 1988 (NAVD 88).

Subsurface Conditions

We engaged Northern Drill Service, Inc. (Northern) to drill eight borings and install one groundwater observation well at the site between February 22 and February 27, 2024. We also engaged Geosearch, Inc. (Geosearch) of Sterling, Massachusetts to drill eight supplemental borings within the footprint of the proposed office building and within the area of a proposed retaining wall between March 22 and March 26, 2024.

The borings were performed in the existing paved parking lot areas onsite and generally encountered 1- to 6-inches of asphalt. Below the asphalt, the borings generally encountered about 1- to 12-feet of medium dense to very dense compacted granular fill with varying amounts of silt and sand and gravel, overlaying a very loose to very dense natural sand/sand and gravel deposit. On the west side of the proposed building footprint, dense to very dense glacial till consisting of varying amounts of clay, silt, sand, and gravel was generally encountered below the existing fill. All borings were terminated in the natural sand/sand and gravel or glacial till deposits. Bedrock was not encountered.

On the east side of the proposed building footprint, a thin zone of looser soils at the top of the natural sand and gravel layer, directly below the existing fill, was encountered.

Depth to groundwater was measured in the observation well on February 22, 23, and 26, 2024, and ranged from about 2.8 to 3.5 feet below the existing ground surface (El. 539.2 to El. 538.5).

Seismic Design

Based on our review of existing subsurface information it is our opinion that the site classification is Site Class D for seismic design, in accordance with Section 1613.3.2 of the IBC (which references Chapter 20 of ASCE 7). Corresponding design values for the Town of Worcester (per Massachusetts Amendments to Chapter 16 of the IBC) are:

S_S = 0.180 g

S_1 = 0.066 g

Site Coefficients from IBC Section 1613.3.3 are:

F_a = 1.6

F_v = 2.4

Resulting seismic design parameters are:

S_{DS} = 0.192 g

S_{D1} = 0.106 g

Based on criteria provided in Section 1806.4 of the Building Code (Massachusetts Amendments to the IBC), the soils below the foundation level are not considered susceptible to liquefaction.

Preliminary Building Recommendations

We recommend that the proposed building be supported on spread or strip footings bearing on the existing fill or natural sand and gravel/glacial till with a maximum allowable bearing pressure of 4 kips per square foot (ksf), provided that the footing subgrades are prepared as described below.

Per Section 1806.1 of the Massachusetts Building Code, 9th Edition, which consists of the 2015 International Building Code (IBC) and a separate package of Massachusetts Amendments, the 4 ksf value of allowable bearing pressure is intended for use with allowable stress design load combinations. If the alternative basic load combinations (IBC Section 1605.3.2) are used, then the allowable bearing pressure may be increased by one-third for load combinations that include wind or earthquake.

Footings designed for this allowable bearing pressure should be at least 3 feet wide. The footings may be designed as narrow as 2 feet with a reduced allowable bearing pressure of 2.67 ksf. Exterior footings and footings in unheated portions of the buildings should bear at least 4 feet below the finished grade for frost protection. Interior footings bearing on soil should bear at least 18 inches below the bottom of the floor slab.

The existing fill should be over-excavated to a depth of at least one foot below the footing bearing level. The exposed subgrade should then be proof-compacted and observed by the Geotechnical Engineer. Any soft or unstable material observed at the over-excavated subgrade level should be removed and the over-excavated depth should then be backfilled with compacted Structural Fill (Table 1). Existing on-site fill material that meets the requirements for Structural Fill can be used.

The over-excavation and replacement of the subgrade soil described above is not required if the subgrade soil is the natural sand and gravel or glacial till. However, the exposed subgrade will need to be proof-compacted and observed by the Geotechnical Engineer.

Floor slabs can be designed as slabs-on-grade with a minimum of 9 inches of compacted Structural Fill below the slab.

We estimate that the total settlements of the proposed building addition will be less than ¾ inch, and differential settlements between footings will be less than ½ inch. Most of the settlement is expected to occur during construction.

Preliminary Construction Considerations

We recommend that Structural Fill within the building footprint be placed prior to footing construction.

The slab-on-grade floor slab should be placed on a minimum of 9 inches of Structural Fill placed on a prepared subgrade. Any soft or unstable material observed at the over-excavated subgrade level should be removed and the over-excavated depth should then be backfilled with compacted Structural Fill.

Any fill placed within the limits of the building should meet the gradation and compaction requirements for Structural Fill.

Some of the site soils may be suitable for re-use as Structural Fill below the building. This should be confirmed during construction.

If you have any questions or would like us to provide additional information or recommendations, please call Steve at 781-721-4048 or Joe at 781-721-4037.

Attachments:

Table 1 – Structural Fill

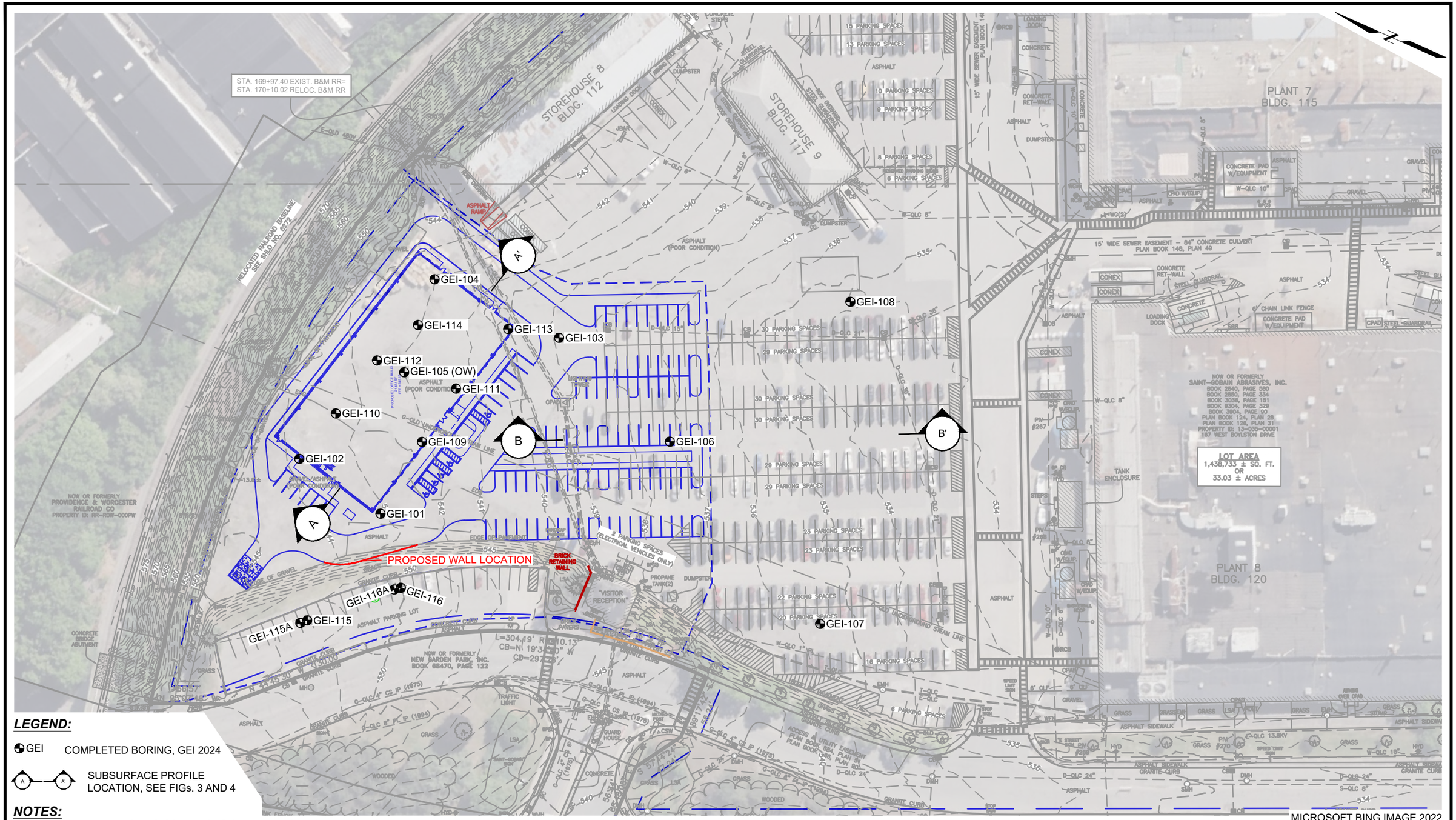
JRG:SJS:jam
B:\Working\KIMLEY HORN AND ASSOCIATES INC\2400599 351 Stores St Worcester MA\11_REPORTS & LETTERS\Prelim. Geotechnical Letter\2400599_351 Stores St Worcester MEMO - 2024 Apr.docx

Table 1. Requirements for Structural Fill
351 Stores Street
Worcester, Massachusetts

Structural Fill shall consist of hard, durable sand and gravel, free of clay, organic matter, surface coatings, and other deleterious materials. Soil finer than the No. 200 sieve (the "fines") shall be non-plastic. Structural Fill shall meet the following gradation requirements:

Sieve Size	Percent Passing by Weight
3 inches	100
½ inch	50 – 100
No. 4	35 – 85
No. 16	20 – 65
No. 50	5 – 40
No. 200 (fines)	0 – 8

Structural Fill shall be compacted in maximum 9-inch-thick, loose lifts to at least 95 percent of the maximum dry density determined in accordance with ASTM D1557 (Modified AASHTO Compaction).



LEGEND:

GEI COMPLETED BORING, GEI 2024

A — A' SUBSURFACE PROFILE LOCATION, SEE FIGs. 3 AND 4

NOTES:

1. BASE PLAN AND EXISTING CONDITIONS SURVEY BASED ON DRAWING TITLED "W-6170_04ALTA-01" PROVIDED BY KIMLEY-HORN ASSOCIATES, INC. ON FEBRUARY 6, 2024.
2. PROPOSED CONDITIONS BASED ON DRAWING TITLED "xBM-112968000 10" PROVIDED BY KIMLEY-HORN ASSOCIATES, INC. ON APRIL 3, 2024.
3. ELEVATIONS ARE IN FEET AND REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

0 80 160

SCALE, FEET

MICROSOFT BING IMAGE 2022.

351 Stores Street
Worcester, Massachusetts

Kimley-Horn and Associates, Inc.
Waltham, Massachusetts

GEI Consultants

BORING LOCATION PLAN

Project 2400599 | April 2024 | Fig. 2

GIAMPA, JOE \\geiconsultants.com\data\Data_Storage\Working\KIMLEY HORN AND ASSOCIATES INC\2400599 351 Stores St Worcester MA\00_CAD\Figures\Gt\NEW 02 and 03 sheets\2400599-02 04-03-24.dwg - 4/8/2024

BORING INFORMATION

NORTHING (ft): 2,936,388 **EASTING (ft):** 573,274
GROUND SURFACE EL. (ft): 543 **DATE START/END:** 2/23/2024 - 2/23/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Northern Drill Service, Inc.
TOTAL DEPTH (ft): 31.0 **DRILLER NAME:** M. Fleming
LOGGED BY: A. Roshan **RIG TYPE:** Mobile B-53

BORING

GEI-101

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** 4 inch/ 4.5 inch **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: NA / NA **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Rotary Drilling with Casing
WATER LEVEL ELEVATIONS (ft): ▼ 536.1 2/23/2024 11:00 am

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Depth (ft)	Pen./ Rec. (in)	Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
540	0	S1	0 to 2	24/14	8-21-23-21	PID = 0 ppm	FILL	S1 (0-5"): WIDELY GRADED SAND WITH GRAVEL (SW); ~50% fine to coarse sand, ~45% fine to coarse gravel, ~5 nonplastic fines, black, moist. S1 (5"-24"): WIDELY GRADED SAND WITH GRAVEL (SW); ~80% fine to coarse sand, ~15% fine to coarse gravel, ~5% nonplastic fines, light brown, wet. Concrete fragments present. S2 (0-4"): CONCRETE. S2 (4"-16"): WIDELY GRADED GRAVEL WITH SAND (GW); ~60% fine to coarse subrounded to subangular gravel up to 1.5", ~35% fine to coarse sand, ~5% nonplastic fines, light brown, moist. S3: WIDELY GRADED SAND WITH GRAVEL (SW); ~50% fine to coarse sand, ~50% fine to coarse subrounded to subangular gravel up to 1.5", brown, wet. S4: WIDELY GRADED SAND WITH GRAVEL (SW); Similar to S3. S5: WIDELY GRADED SAND WITH GRAVEL (SW); ~70% fine to coarse sand, ~25% fine to coarse subrounded to subangular gravel up to 1.25", ~5% nonplastic fines, brown, wet.
		S2	2 to 4	24/16	30-23-18-31	PID = 0 ppm		
	5	S3	4 to 6	24/12	15-14-20-26	Cased to 4' PID = 0 ppm		
		S4	6 to 8	24/9	27-22-18-16	Rig chatter 6'-8' PID = 0 ppm		
		S5	8 to 10	24/12	11-12-24-27	Cased to 8' PID = 0 ppm		
	10							
530							GLACIAL TILL	
	15	S6	14 to 16	24/8	34-22-16-13	Cased to 14'		S6: LEAN CLAY WITH GRAVEL (CL); ~60% low plasticity clay, ~20% fine to coarse subrounded to subangular gravel up to 1.5", ~20% fine to coarse sand, gray and brown, wet.
	20	S7	19 to 21	24/17	21-24-26-26			S7: LEAN CLAY WITH SAND (CL); ~70% low plasticity clay, ~20% fine sand, ~10% fine to coarse subrounded to subangular gravel, gray and brown, wet.
520								

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

NORTHING (ft): 2,936,388 **EASTING (ft):** 573,274
GROUND SURFACE EL. (ft): 543 **DATE START/END:** 2/23/2024 - 2/23/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Northern Drill Service, Inc.

BORING GEI-101

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
	25	S8	24 to 26	24/20	10-17-12-15		GLACIAL TILL	S8: SANDY LEAN CLAY (CL); ~60% low plasticity clay, ~30% fine to medium sand, ~10% fine to coarse subrounded to subangular gravel, gray with purple staining, wet.
	30	S9	29 to 31	24/14	11-17-14-16			S9: LEAN CLAY WITH SAND (CL); ~70% low plasticity clay, ~15% fine to coarse sand, ~15% fine to coarse subrounded to subangular gravel up to 1", gray, wet.
510	35							Bottom of the boring at 31 feet. Backfilled with cuttings and gravel.
500	40							
	45							
490	50							
	55							

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,473 **EASTING (ft):** 573,285
GROUND SURFACE EL. (ft): 544 **DATE START/END:** 2/23/2024 - 2/23/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Northern Drill Service, Inc.
TOTAL DEPTH (ft): 21.0 **DRILLER NAME:** M. Fleming
LOGGED BY: A. Roshan **RIG TYPE:** Mobile B-53

BORING

GEI-102

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** 4 inch/ 4.5 inch **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: NA / NA **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Rotary Drilling with Casing
WATER LEVEL ELEVATIONS (ft): ▼ 539.5 2/23/2024 1:59 pm

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample No.	Sample Depth (ft)	Pen./ Rec. (in)	Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
540	0	S1	0 to 2	24/15	6-14-10-27	PID = 0 ppm	FILL	S1 (0-4"): WIDELY GRADED SAND WITH SILT AND GRAVEL (SW-SM); ~70% fine to coarse sand, ~20% fine to coarse subrounded to subangular gravel, ~10% nonplastic fines, black, moist. S1 (4"-15"): WIDELY GRADED SAND WITH GRAVEL (SW); ~70% fine to coarse sand, ~25% fine to coarse subrounded to subangular gravel up to 1.25", ~5% nonplastic fines, light brown, moist.
		S2	2 to 4	24/16	18-24-28-26	PID = 0 ppm. Rig chatter from 3.5'-4'.		S2: WIDELY GRADED SAND WITH GRAVEL (SW); ~45% fine to coarse sand, ~30% fine to coarse subrounded to subangular gravel up to 1.5", ~5% nonplastic fines, light brown, moist.
	5	S3	4 to 6	24/14	20-23-24-19	Cased to 4' PID = 0 ppm		S3: WIDELY GRADED SAND WITH GRAVEL (SW); ~55% fine to coarse sand, ~40% fine to coarse subrounded to subangular gravel up to 1.5", ~5% nonplastic fines, light brown, moist.
		S4	6 to 8	24/20	10-13-16-22	PID = 0 ppm		S4: WIDELY GRADED SAND WITH GRAVEL (SW); ~80% fine to coarse sand, ~15% fine to coarse subrounded to subangular gravel, ~5% nonplastic fines, light brown, moist. 1" quartz pieces at tip of spoon.
		S5	8 to 10	24/14	28-14-16-14	Cased to 8'. Rig chatter from 8'-12'. PID = 0 ppm		S5 (0-5"): WIDELY GRADED GRAVEL (GW); ~85% fine to coarse subrounded to subangular gravel up to 1.5", ~10% fine to coarse sand, ~5% nonplastic fines, black, wet. Slight petroleum-like odor. S5 (5"-14"): WIDELY GRADED GRAVEL WITH SILT AND SAND (GW-GM); ~60% fine to coarse subrounded to subangular gravel up to 1", ~30% fine to coarse sand, ~10% nonplastic fines, red and brown, wet.
	10							
530		S6	14 to 16	24/14	32-33-15-17		GLACIAL TILL	S6: SILTY GRAVEL WITH SAND (GM); ~50% fine to coarse subrounded to subangular gravel up to 1.5", ~30% nonplastic silt, ~20% fine to medium sand, gray and brown, wet. Gravel seam from 3"-7".
	15							
		S7	19 to 21	24/18	15-20-14-20			S7 (0-7.5"): WIDELY GRADED GRAVEL WITH SILT AND SAND (GW-GM); ~60% fine to coarse subrounded to subangular gravel up to 1.5", ~30% fine to coarse sand (mostly coarse sand), ~10% nonplastic fines, black, wet. S7 (7.5"-18"): CLAYEY SAND (SC); ~45% fine to coarse sand, ~40% low plasticity clay, ~5% fine to medium subrounded to subangular gravel, gray and brown with occasional orange spots, wet.
	20							Bottom of the boring at 21 feet. Backfilled with cuttings and gravel. Patched the top with asphalt.

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,313 **EASTING (ft):** 573,471
GROUND SURFACE EL. (ft): 539 **DATE START/END:** 2/26/2024 - 2/26/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Northern Drill Service, Inc.
TOTAL DEPTH (ft): 31.0 **DRILLER NAME:** T. Tucker
LOGGED BY: D. Blanchard **RIG TYPE:** Mobile B-53

BORING

GEI-103

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** 4 inch/ 4.5 inch **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: NA / NA **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Rotary Drilling with Casing
WATER LEVEL ELEVATIONS (ft): ▼ 534.1 2/26/2024 1:38 pm

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
		S1	0 to 2	24/18	18-12-15-11	PID = 0 ppm	FILL	S1 (0-6"): ASPHALT. S1 (6"-18"): WIDELY GRADED SAND WITH GRAVEL (SW); ~60% fine to coarse sand, ~35% mostly coarse gravel, ~5% nonplastic fines, brown, dry.
		S2	2 to 4	24/17	9-10-9-8	PID = 0 ppm		S2: NARROWLY GRADED SAND (SP); 82.3% fine to coarse sand (mostly fine to medium), 13.3% fine to coarse gravel, 4.4% nonplastic fines, brown, wet. [GRAIN SIZE PERFORMED]
	5	S3	4 to 6	24/7	5-11-13-11	Cased to 4' PID = 0 ppm		S3: NARROWLY GRADED GRAVEL WITH SILT AND SAND (GP-GM); ~60% fine to coarse gravel (mostly coarse gravel), ~30% fine to coarse sand, ~10% nonplastic fines, orange and brown, wet.
		S4	6 to 8	24/12	16-22-13-8	PID = 0 ppm		S4: NARROWLY GRADED GRAVEL WITH SILT AND SAND (GP-GM); Similar to S3.
530		S5	8 to 10	24/7	5-2-1-2	Cased to 8' PID = 0 ppm	SAND	S5: NARROWLY GRADE SAND (SP); ~90% fine to medium sand, ~10% mostly coarse gravel, brown, wet.
	10					Cased to 12'		
		S6	14 to 16	24/9	1-3-4-3			S6: NARROWLY GRADED SAND (SP); ~90% fine to coarse sand (mostly fine to medium sand), ~5% fine gravel, ~5% nonplastic fines, brown, moist.
	15					Cased to 16'		
520		S7	19 to 21	24/10	4-2-3-4			S7: NARROWLY GRADED SAND (SP); ~95% fine sand, ~5% nonplastic fines, light brown with orange staining, moist.
	20					Cased to 20'		

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

NORTHING (ft): 2,936,313 **EASTING (ft):** 573,471
GROUND SURFACE EL. (ft): 539 **DATE START/END:** 2/26/2024 - 2/26/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Northern Drill Service, Inc.

BORING GEI-103

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
	25	S8	24 to 26	24/18	4-5-5-7		SAND	S8 (0-14"): SANDY SILT (ML); ~70% nonplastic fines, ~30% fine sand, light brown, moist. S8 (14"-18"): NARROWLY GRADED SAND (SP); ~90% fine to coarse sand (mostly medium to coarse sand), ~5% coarse gravel, ~5% nonplastic fines, brown, moist.
510	30	S9	29 to 31	24/12	12-15-17-18			S9: NARROWLY GRADED SAND (SP); ~90% fine to medium sand, ~5% fine to coarse gravel, ~5% nonplastic fines, brown, moist.
								Bottom of the boring at 31 feet. Backfilled with cuttings and gravel. Patched the top with asphalt.
500	35							
	40							
	45							
490	50							
	55							

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,422 **EASTING (ft):** 573,468
GROUND SURFACE EL. (ft): 542 **DATE START/END:** 2/26/2024 - 2/26/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Northern Drill Service, Inc.
TOTAL DEPTH (ft): 21.0 **DRILLER NAME:** T. Tucker
LOGGED BY: D. Blanchard **RIG TYPE:** Mobile B-53

BORING

GEI-104

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** 4 inch/ 4.5 inch **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: NA / NA **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Rotary Drilling with Casing
WATER LEVEL ELEVATIONS (ft): ▼ 536.0 2/26/2024 9:38 am

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
		S1	0 to 2	24/17	9-7-9-11	PID = 0 ppm	FILL	S1 (0-6"): ASPHALT. S1 (6"-17"): WIDELY GRADED SAND (SW); ~90% fine to coarse sand, ~5% fine to coarse gravel, ~5% nonplastic fines, light brown, dry.
540		S2	2 to 4	24/8	12-16-17-16	PID = 0 ppm		S2: WIDELY GRADED SAND (SW); Similar to S1.
	5	S3	4 to 6	24/12	37-19-23-34	Cased to 4' PID = 0 ppm		S3: NARROWLY GRADED SAND WITH GRAVEL (SP); ~75% fine to medium sand, ~20% fine to coarse gravel, ~5% nonplastic fines, brown, moist.
		S4	6 to 8	24/14	34-22-16-20	PID = 0 ppm		S4: WIDELY GRADED GRAVEL WITH SAND (GW); ~50% fine to coarse gravel, ~45% fine to coarse sand, ~5% nonplastic fines, brown, wet.
		S5	8 to 10	24/9	11-10-5-6	Cased to 8' PID = 0 ppm	SAND	S5: WIDELY GRADED SAND WITH SILT AND GRAVEL (SW-SM); ~50% fine to coarse sand, ~40% fine to coarse gravel, ~10% nonplastic fines, brown, moist.
	10							
530						Cased to 12'		
	15	S6	14 to 16	24/5	3-4-3-4			S6: NARROWLY GRADED SAND (SP); ~95% fine sand, ~5% nonplastic fines, light brown, moist.
						Cased to 16'		
	20	S7	19 to 21	24/10	7-5-4-5			S7: NARROWLY GRADED SAND (SP); ~90% fine sand, ~5% coarse gravel, ~5% nonplastic fines, brown, moist.
520								Bottom of the boring at 21 feet. Backfilled with cuttings and gravel. Patched the top with asphalt.

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,417 **EASTING (ft):** 573,387
GROUND SURFACE EL. (ft): 542 **DATE START/END:** 2/23/2024 - 2/23/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Northern Drill Service, Inc.
TOTAL DEPTH (ft): 51.0 **DRILLER NAME:** T. Tucker
LOGGED BY: A. Roshan **RIG TYPE:** Mobile B-53

BORING

GEI-105 (OW)

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** 4 inch/ 4.5 inch **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: NA / NA **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Rotary Drilling with Casing
WATER LEVEL ELEVATIONS (ft): ▼ 538.5 2/22/2024 1:25 pm ▼ 539.2 2/23/2024 2:34 pm

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
540	0	S1	0 to 2	24/16	22-13-7-2	PID = 0 ppm	FILL	S1 (0"-6"): ASPHALT. S1 (6"-12"): WIDELY GRADED SAND WITH GRAVEL (SW); ~70% fine to coarse sand, ~25% fine to coarse subrounded to angular gravel, ~5% nonplastic fines, dark brown, moist. S1 (12"-16"): ORGANIC SOIL (OH/OL); ~80% organic soil, ~10% fine to coarse gravel, ~10% fine to medium sand, dark brown, wet. Possible topsoil.
		S2	2 to 4	24/8	1-2-6-13	Hammer dropped 5" at 2' PID = 0 ppm Rig chatter 3.5'-4'		S2 (0-2"): ORGANIC SOIL (OH/OL); Similar to S1 (12"-16"). S2 (2"-8"): SILTY SAND WITH GRAVEL (SM); ~60% fine to coarse sand, ~25% fine to coarse subrounded to subangular gravel, ~15% organic fines, dark brown, wet.
	5	S3	4 to 6	24/15	19-25-16-28	Cased to 4' PID = 0 ppm		S3: WIDELY GRADED SAND WITH GRAVEL (SW); ~60% fine to coarse sand, ~30% fine to coarse subrounded to subangular gravel up to 1.25", ~5% nonplastic fines, brown, wet.
		S4	6 to 8	24/19	37-27-24-25	PID = 0 ppm		S4: WIDELY GRADED SAND WITH GRAVEL (SW); ~55% fine to coarse sand, ~40% fine to coarse subrounded to subangular gravel up to 1.5", ~5% nonplastic fines, brown, wet.
		S5	8 to 10	24/5	43-36-33-19	Cased to 8' PID = 0 ppm		S5: WIDELY GRADED GRAVEL WITH SAND (GW); ~70% fine to coarse subrounded to subangular gravel up to 1.5", ~25% fine to coarse sand, ~5% nonplastic fines, light brown, wet. Gravel is fractured granite.
530	10						SAND AND GRAVEL	
	15	S6	14 to 16	24/10	11-8-10-11	Cased to 14'		S6: NARROWLY GRADED SAND WITH GRAVEL (SP); ~50% mostly coarse sand, ~45% fine to coarse subrounded to subangular gravel up to 1.5", ~5% nonplastic fines, brown, wet.
	20	S7	19 to 21	24/16	36-44-29-28	Cased to 19'		S7: SILTY SAND WITH GRAVEL (SM); ~50% fine to coarse sand, ~35% fine to coarse subrounded to subangular gravel up to 1.5", ~15% nonplastic fines, brown, wet.
520								

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

NORTHING (ft): 2,936,417 **EASTING (ft):** 573,387
GROUND SURFACE EL. (ft): 542 **DATE START/END:** 2/23/2024 - 2/23/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Northern Drill Service, Inc.

BORING GEI-105 (OW)

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
	25	S8	24 to 26	24/10	54-27-15-14	Cased to 24'	SAND AND GRAVEL	S8 (0-4"): SILTY GRAVEL (GM); ~70% fine to coarse subrounded to subangular gravel up to 1.25", ~20% nonplastic to low plasticity fines, ~10% fine to coarse sand, gray and brown, wet. S8 (4"-10"): SILTY SAND WITH GRAVEL (SM); ~40% fine to coarse sand, ~30% fine to coarse subrounded to subangular gravel up to 1", ~30% nonplastic fines, orange and brown, wet.
	30	S9	29 to 31	24/12	30-23-18-14	Cased to 29'		S9: NARROWLY GRADED SAND WITH GRAVEL (SP); ~75% mostly fine to medium sand, ~20% fine to coarse subrounded to subangular gravel up to 1.5", ~5% nonplastic fines, light brown, wet.
510								
	35	S10	34 to 36	24/20	12-48-26-19	Cased to 34'	GLACIAL TILL	S10: LEAN CLAY WITH GRAVEL (CL); ~55% low plasticity clay, ~25% fine to coarse subrounded to subangular gravel, ~20% fine to coarse sand, gray and brown, wet.
	40	S11	39 to 41	24/20	57-29-35-40			S11: LEAN CLAY (CL); ~80% low plasticity clay, ~15% fine to coarse sand (mostly fine), ~5% fine to coarse gravel, gray and brown, wet.
500								
	45	S12	44 to 46	24/19	23-35-29-34			S12: LEAN CLAY WITH SAND (CL); ~75% low plasticity clay, ~15% fine to coarse sand, ~10% fine to coarse gravel, gray and brown, wet.
	50	S13	49 to 51	24/22	28-50-43-48			S13: LEAN CLAY WITH SAND (CL); Similar to S12.
490								Bottom of the boring at 51 feet. Installed groundwater observation well and roadbox.
	55							

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,160 **EASTING (ft):** 573,443
GROUND SURFACE EL. (ft): 537 **DATE START/END:** 2/27/2024 - 2/27/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Northern Drill Service, Inc.
TOTAL DEPTH (ft): 15.0 **DRILLER NAME:** T. Tucker
LOGGED BY: D. Blanchard **RIG TYPE:** Mobile B-53

BORING

GEI-106

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** 4 inch/ 4.5 inch **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: NA / NA **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Rotary Drilling with Casing
WATER LEVEL ELEVATIONS (ft): ▼ 531.5 2/27/2024 8:22 am

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
		S1	0 to 2	24/16	26-15-13-9	PID = 0 ppm	FILL	S1 (0-6"): ASPHALT. S1 (6"-16"): NARROWLY GRADED SAND WITH GRAVEL (SP); ~65% fine to medium sand, ~30% fine to coarse gravel, ~5% nonplastic fines, dark brown, dry.
		S2	2 to 4	24/14	6-7-9-15	PID = 0 ppm		S2: NARROWLY GRADED GRAVEL WITH SILT AND SAND (GP-GM); 47.9% fine to coarse angular gravel, 41.6% fine to coarse sand, 10.5% nonplastic fines, brown and black, dry. Trace organic soil present. [GRAIN SIZE PERFORMED]
	5	S3	4 to 6	24/10	17-17-11-10	Cased to 4' PID = 0 ppm		S3: WIDELY GRADED GRAVEL WITH SAND (GW); ~60% fine to coarse angular gravel, ~35% mostly coarse sand, ~5% nonplastic fines, brown, moist.
530		S4	6 to 8	24/15	6-5-2-5	PID = 0 ppm	SAND AND GRAVEL	S4: WIDELY GRADED SAND WITH GRAVEL (SW); ~80% fine to coarse sand, ~15% fine to coarse gravel, ~5% nonplastic fines, light brown, moist.
		S5	8 to 10	24/14	3-5-8-6	Cased to 8' PID = 0 ppm		S5: NARROWLY GRADED SAND (SP); ~95% fine sand, ~5% nonplastic fines, light brown, moist.
	10					Cased to 12'		
		S6	13 to 15	24/5	10-7-7-5			S6: WIDELY GRADED SAND WITH GRAVEL (SW); ~55% fine to medium sand, ~40% mostly coarse gravel, ~5% nonplastic fines, brown, moist.
	15							Bottom of boring at 15 feet. Backfilled with cuttings and gravel. Patched the top with asphalt.
520								
	20							

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,011 **EASTING (ft):** 573,351
GROUND SURFACE EL. (ft): 536 **DATE START/END:** 2/27/2024 - 2/27/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Northern Drill Service, Inc.
TOTAL DEPTH (ft): 15.0 **DRILLER NAME:** T. Tucker
LOGGED BY: D. Blanchard **RIG TYPE:** Mobile B-53

BORING

GEI-107

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** 4 inch/ 4.5 inch **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: NA / NA **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Rotary Drilling with Casing
WATER LEVEL ELEVATIONS (ft): ▼ 530.0 2/27/2024 11:49 am

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Depth (ft)	Pen./ Rec. (in)	Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
		S1	0 to 2	24/18	10-11-9-5	PID = 0 ppm	FILL	S1 (0-6"): ASPHALT. S1 (6"-18"): SILTY SAND WITH GRAVEL (SM); 44.5% fine to coarse sand, 33.4% fine to coarse gravel, 22.1% nonplastic fines, brown, gray, and white, dry. [GRAIN SIZE PERFORMED]
		S2	2 to 4	24/7	3-2-4-3	PID = 0 ppm		S2: NARROWLY GRADED SAND (SP); ~90% fine to medium sand, ~5% fine gravel, ~5% nonplastic fines, brown, dry.
	5	S3	4 to 6	24/9	10-11-15-16	Cased to 4' PID = 0 ppm		S3: WIDELY GRADED SAND WITH SILT AND GRAVEL (SW-SM); ~65% fine to coarse sand, ~25% fine to coarse gravel, ~10% nonplastic fines, brown, moist.
530		S4	6 to 8	24/15	13-10-14-12	PID = 0 ppm	SAND AND GRAVEL	S4: NARROWLY GRADED SAND WITH GRAVEL (SP); ~80% medium to coarse sand, ~15% fine to coarse gravel, ~5% nonplastic fines, brown, moist.
		S5	8 to 10	24/10	14-15-16-15	Cased to 8' PID = 0 ppm		S5: WIDELY GRADED GRAVEL WITH SAND (GW); ~80% fine to coarse gravel, ~15% fine to coarse sand, ~5% nonplastic fines, brown and gray, moist.
	10					Cased to 12'		
		S6	13 to 15	24/8	17-12-9-6			S6: WIDELY GRADED GRAVEL (GW); ~80% fine to coarse gravel, ~15% fine to coarse sand, ~5% nonplastic fines, gray, moist.
	15							Bottom of boring at 15 feet. Backfilled with cuttings and gravel. Patched the top with asphalt.
520								
	20							

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

GEI WOBURN STD 5-NORTH-EAST-LAYER NAME 2400599_GINT LOGS.GPJ 4/16/24

BORING INFORMATION

NORTHING (ft): 2,936,058 **EASTING (ft):** 573,575
GROUND SURFACE EL. (ft): 534 **DATE START/END:** 2/27/2024 - 2/27/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Northern Drill Service, Inc.
TOTAL DEPTH (ft): 15.0 **DRILLER NAME:** T. Tucker
LOGGED BY: D. Blanchard **RIG TYPE:** Mobile B-53

BORING

GEI-108

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** 4 inch/ 4.5 inch **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: NA / NA **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Rotary Drilling with Casing
WATER LEVEL ELEVATIONS (ft): ▼ 530.1 2/27/2024 10:03 am

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample No.	Sample Depth (ft)	Pen./ Rec. (in)	Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
		S1	0 to 2	24/17	38-9-8-6	PID = 0 ppm	FILL	S1 (0-6"): ASPHALT. S1 (6"-15"): NARROWLY GRADED SAND WITH SILT AND GRAVEL (SP-SM); 63.1% fine to coarse sand, 29.1% fine to coarse gravel, 7.8% nonplastic fines, brown, dry. [GRAIN SIZE PERFORMED]
		S2	2 to 4	24/0	6-1-1-2	PID = 0 ppm	ORG.	S1 (15"-17"): SILTY SAND (SM); ~65" fine sand, ~30% organic silt, ~5% fine gravel, black and brown, dry. Contains wood chips. S2: NO RECOVERY.
530	5	S3	4 to 6	24/8	WOH-1-7-9	Cased to 4' PID = 0 ppm	SAND, SILT, AND GRAVEL	S2 (3" SPOON): WIDELY GRADED SAND WITH GRAVEL (SW); ~80% fine to coarse sand, ~15% fine to coarse gravel, ~5% nonplastic fines, black and brown, dry. S3 (0-3"): ORGANIC SOIL (OH/OL); ~95% organic soil, ~5% fine sand, black, wet.
		S4	6 to 8	24/17	7-7-6-4	PID = 0 ppm		S3 (3"-8"): WIDELY GRADED GRAVEL WITH SILT (GW-GM); ~80% fine to coarse gravel, ~10% fine to coarse sand, ~10% nonplastic fines, gray, moist. S4 (0-15"): NARROWLY GRADED SAND WITH GRAVEL (SP); ~75% medium to coarse sand, ~20% fine to coarse gravel, ~5% nonplastic fines, gray/orange/brown, moist.
		S5	8 to 10	24/16	11-13-10-10	Cased to 8' PID = 0 ppm		S4 (15"-17"): SILT (ML); ~90% nonplastic fines, ~10% fine sand, light brown, dry. S5 (0-5"): GRAVELLY SILT (ML); ~60% nonplastic fines, ~30% fine to coarse gravel, ~10% fine to coarse sand, gray, moist. S5 (5"-16"): WIDELY GRADED SAND WITH SILT AND GRAVEL (SW-SM); ~70% fine to coarse sand, ~20% fine to coarse gravel, ~10% nonplastic fines, orange/gray/brown, moist.
	10					Cased to 12'		
520		S6	13 to 15	24/5	6-5-5-5			S6: NARROWLY GRADED SAND (SP); ~90% mostly coarse gravel, ~5% fine to coarse sand, ~5% nonplastic fines, gray, moist.
	15							Bottom of boring at 15 feet. Backfilled with cuttings and gravel. Patched the top with asphalt.
	20							

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

GEI WOBURN STD 5-NORTH-EAST-LAYER NAME 2400599_GINT LOGS.GPJ 4/16/24

BORING INFORMATION

NORTHING (ft): 2,936,381 **EASTING (ft):** 573,341
GROUND SURFACE EL. (ft): 542 **DATE START/END:** 3/25/2024 - 3/25/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.
TOTAL DEPTH (ft): 21.0 **DRILLER NAME:** R. Dean
LOGGED BY: A. Roshan **RIG TYPE:** CME-55 Truck-Mounted

BORING

GEI-109

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** NA/ NA **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: 3.75 inch / 6.25 inch **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Hollow Stem Auger
WATER LEVEL ELEVATIONS (ft): ▼ 538.7 3/25/2024

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Depth (ft)	Pen./ Rec. (in)	Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
		S1	0 to 2	24/13	7-10-9-9		FILL	1" ASPHALT. S1: WIDELY GRADED SAND WITH GRAVEL (SW); ~70% fine to coarse sand, ~25% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, brown, moist.
540		S2	2 to 4	24/11	15-15-6-6	PID = 0.1 ppm		S2: WIDELY GRADED SAND WITH GRAVEL (SW); ~55% fine to coarse sand, ~40% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, brown, moist.
	5	S3	4 to 6	24/13	7-16-23-27	PID = 0.1 ppm		S3: WIDELY GRADED SAND WITH GRAVEL (SW); ~50% fine to coarse sand, ~45% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, brown, moist.
		S4	6 to 8	24/15	33-47-46-41			S4: WIDELY GRADED SAND WITH GRAVEL (SW); ~60% fine to coarse sand, ~35% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, brown, moist.
		S5	8 to 9.4	17/17	33-40-50/5"	PID = 0.1 ppm		S5: WIDELY GRADED GRAVEL WITH SILT AND SAND (GW-GM); ~60% fine to coarse subangular to subrounded gravel, ~30% fine to coarse sand, ~10% nonplastic fines, brown, wet.
	10					Rig chatter from 10'-13'		
530							SAND AND GRAVEL	
	15	S6	14 to 16	24/23	4-8-8-14			S6: WIDELY GRADED SAND WITH GRAVEL (SW); ~75% fine to coarse sand, ~20% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, brown, wet.
	20	S7	19 to 21	24/18	3-6-9-18			S7: NARROWLY GRADED SAND WITH GRAVEL (SP); ~55% coarse sand, ~40% fine to coarse gravel, ~5% nonplastic fines, brown, wet.
520								Bottom of boring at 21 feet. Backfilled with cuttings. Patched the top with asphalt.

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,460 **EASTING (ft):** 573,334
GROUND SURFACE EL. (ft): 543 **DATE START/END:** 3/25/2024 - 3/25/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.
TOTAL DEPTH (ft): 21.0 **DRILLER NAME:** R. Dean
LOGGED BY: A. Roshan **RIG TYPE:** CME-55 Truck-Mounted

BORING

GEI-110

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** NA/ NA **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: 3.75 inch / 6.25 inch **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Hollow Stem Auger
WATER LEVEL ELEVATIONS (ft): ▼ 535.0 3/25/2024

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Depth (ft)	Pen./ Rec. (in)	Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
		S1	0 to 2	24/12	9-16-19-18		FILL	1" ASPHALT. S1: WIDELY GRADED SAND WITH GRAVEL (SW); ~70% fine to coarse sand, ~25% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, brown, dry.
540		S2	2 to 4	24/13	13-33-26-22			S2: WIDELY GRADED SAND WITH GRAVEL (SW); ~60% fine to coarse sand, ~35% fine to coarse subangular to subrounded gravel up to 1.25", ~5% nonplastic fines, tan, dry.
	5	S3	4 to 6	24/10	5-15-13-32			S3: WIDELY GRADED GRAVEL WITH SILT AND SAND (GW-GM); ~55% fine to coarse subangular to subrounded gravel up to 1.5", ~35% fine to coarse sand, ~10% nonplastic fines, brown, wet.
		S4	6 to 8	24/24	32-47-36-28			S4: WIDELY GRADED GRAVEL WITH SILT AND SAND (GW-GM); ~50% fine to coarse subangular to subrounded gravel up to 1.5", ~45% fine to coarse sand, ~5% nonplastic fines, brown and black, wet.
		S5	8 to 10	24/13	17-15-16-14		SAND AND GRAVEL	S5: NARROWLY GRADED SAND WITH GRAVEL (SP); ~70% medium to coarse sand, ~25% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, brown, wet. Some orange staining at lower 4" of spoon.
	10							
530								
	15	S6	14 to 16	24/16	4-5-7-19			S6: NARROWLY GRADED SAND WITH GRAVEL (SP); ~75% medium to coarse sand ~20% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, brown, wet.
		S7	19 to 21	24/24	13-22-19-28		GLACIAL TILL	S7: SILTY SAND WITH GRAVEL (SM); ~45% fine to coarse sand, ~30% nonplastic fines, ~25% fine to coarse subangular to subrounded gravel up to 1.5", gray, wet.
	20							Bottom of boring at 21 feet. Backfilled with cuttings. Patched the top with asphalt.
520								

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

GEI WOBURN STD 5-NORTH-EAST-LAYER NAME 2400599_GINT LOGS.GPJ 4/16/24

BORING INFORMATION

NORTHING (ft): 2,936,373 **EASTING (ft):** 573,396
GROUND SURFACE EL. (ft): 542 **DATE START/END:** 3/25/2024 - 3/25/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.
TOTAL DEPTH (ft): 16.0 **DRILLER NAME:** R. Dean
LOGGED BY: A. Roshan **RIG TYPE:** CME-55 Truck-Mounted

BORING

GEI-111

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** NA/ NA **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: 3.75 inch / 6.25 inch **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Hollow Stem Auger
WATER LEVEL ELEVATIONS (ft): ▼ 538.3 3/25/2024

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Depth (ft)	Pen./ Rec. (in)	Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
540	0	S1	0 to 2	24/14	11-15-18-15	PID = 0.1 ppm	FILL	1" ASPHALT. S1: NARROWLY GRADED SAND WITH GRAVEL (SP); ~65% fine to medium sand, ~30% fine to coarse subangular to subrounded gravel up to 1.25", ~5% nonplastic fines, brown, dry.
		S2	2 to 4	24/14	21-30-25-15			S2: NARROWLY GRADED SAND WITH GRAVEL (SP); Similar to S1.
	5	S3	4 to 6	24/11	6-14-16-18			S3: NARROWLY GRADED SAND WITH GRAVEL (SP); ~60% fine to coarse sand (mostly coarse sand), ~35% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, brown, wet.
		S4	6 to 8	24/19	17-15-18-12			S4: NARROWLY GRADED SAND WITH GRAVEL (SP); ~75% medium to coarse sand, ~20% fine to coarse subangular to subrounded gravel up to 1", ~5% nonplastic fines, brown, wet.
		S5	8 to 10	24/15	9-16-7-6		SAND AND GRAVEL	S5: WIDELY GRADED GRAVEL WITH SAND (GW); ~50% fine to coarse subangular to subrounded gravel up to 1.5", ~45% fine to coarse sand, ~5% nonplastic fines, brown, wet.
530	10							
	15	S6	14 to 16	24/24	6-10-20-23			S6: WIDELY GRADED GRAVEL WITH SAND (GW); ~60% fine to coarse subangular to round gravel up to 1", ~35% coarse sand, ~5% nonplastic fines, brown, wet.
520	20							Bottom of boring at 16 feet. Backfilled with cuttings. Patched the top with asphalt.

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,446 **EASTING (ft):** 573,390
GROUND SURFACE EL. (ft): 543 **DATE START/END:** 3/25/2024 - 3/25/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.
TOTAL DEPTH (ft): 21.0 **DRILLER NAME:** R. Dean
LOGGED BY: A. Roshan **RIG TYPE:** CME-55 Truck-Mounted

BORING

GEI-112

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** NA/ NA **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: 3.75 inch / 6.25 inch **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Hollow Stem Auger
WATER LEVEL ELEVATIONS (ft): ▼ 541.0 3/25/2024

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
		S1	0 to 2	24/13	6-8-5-7		FILL	0-1": ASPHALT. S1: SILTY SAND WITH GRAVEL (SM); ~70% fine to medium sand, ~15% fine to coarse subangular to subrounded gravel up to 1.5", ~15% nonplastic fines, brown, moist. Some topsoil present.
		S2	2 to 4	24/9	9-8-18-34			S2: NARROWLY GRADED SAND WITH GRAVEL (SP); ~80% fine to medium sand, ~15% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, brown, moist.
540						Rig chatter from 3'-4'		
	5	S3	4 to 6	24/13	11-19-19-36			S3: WIDELY GRADED GRAVEL WITH SAND (GW); ~70% fine to coarse subangular to subrounded gravel up to 1.25", ~25% fine to coarse sand, ~5% nonplastic fines, brown, wet.
		S4	6 to 6.3	3/3	50/3"			S4: WIDELY GRADED SAND WITH GRAVEL (SW); ~55% fine to coarse sand, ~40% fine to coarse subangular to subrounded gravel up to 1", ~5% nonplastic fines, brown, wet.
		S5	8 to 10	24/18	10-12-16-9			S5: WIDELY GRADED GRAVEL WITH SILT (GW-GM); 80% fine to coarse subangular to subrounded gravel up to 1.75", ~10% fine to coarse sand, ~10% nonplastic fines, brown, wet.
	10							
530							SAND AND GRAVEL	
	15	S6	14 to 16	24/18	6-6-9-10			S6: WIDELY GRADED GRAVEL WITH SAND (GW); ~60% fine to coarse subangular to subrounded gravel up to 1.5", ~35% coarse sand, ~5% nonplastic fines, brown, wet.
	20	S7	19 to 21	24/11	10-12-15-16			S7 (0-8"): SILTY SAND WITH GRAVEL (SM); ~55% fine to medium sand, ~30% nonplastic fines, ~15% fine to coarse subangular to subrounded gravel, brown, wet. S7 (8"-11"): SILTY SAND (SM); ~70% fine to medium sand, ~20% low plasticity fines, ~10% fine to coarse subangular gravel, brown, wet.
520								Bottom of boring at 21 feet. Backfilled with cuttings. Patched the top with asphalt.

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,349 **EASTING (ft):** 573,458
GROUND SURFACE EL. (ft): 540 **DATE START/END:** 3/22/2024 - 3/22/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.
TOTAL DEPTH (ft): 31.0 **DRILLER NAME:** R. Dean
LOGGED BY: A. Roshan **RIG TYPE:** CME-55 Truck-Mounted

BORING

GEI-113

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** NA/ NA **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: 3.75 inch / 6.25 inch **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Hollow Stem Auger
WATER LEVEL ELEVATIONS (ft): ▼ 535.9 3/22/2024

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Depth (ft)	Pen./ Rec. (in)	Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
		S1	0 to 2	24/14	9-16-11-10	PID = 0.1 ppm	FILL	1" ASPHALT S1 (0-6"): NARROWLY GRADED SAND WITH GRAVEL (SP); ~80% fine to medium sand, ~25% fine to coarse subangular to subrounded gravel up to 1.25", ~5% nonplastic fines, dark brown, moist. S1 (6"-14"): NARROWLY GRADED SAND (SP); ~85% fine to medium sand, ~10% fine to coarse subangular to subrounded gravel up to 1", ~5% nonplastic fines, light brown and tan, dry. Concrete fragments throughout.
		S2	2 to 4	24/13	7-8-6-13	PID = 0.1 ppm		S2: NARROWLY GRADED SAND (SP); ~85% medium to coarse sand, ~10% fine to coarse subangular to subrounded gravel up to 1", ~5% nonplastic fines, dark brown, wet.
	5	S3	4 to 6	24/13	3-7-10-12	PID = 0.1 ppm		S3 (0-6"): NARROWLY GRADED SAND (SP); Similar to S2 S3 (6"-13"): NARROWLY GRADED SAND WITH SILT (SP-SM); ~80% fine to medium sand, ~10% fine to coarse subangular to subrounded gravel up to 1", ~10% nonplastic fines, dark brown and orange, wet.
		S4	6 to 8	24/15	17-9-8-9	PID = 0.1 ppm		S4 (0-9"): WIDELY GRADED SAND WITH GRAVEL (SW); ~75% fine to coarse sand, ~20% fine to coarse subangular to subrounded gravel up to 1.75", ~5% nonplastic fines, orange, wet. S4 (9"-15"): NARROWLY GRADED SAND WITH SILT (SP-SM); ~95% fine to medium sand, ~5% fine gravel, gray and brown, wet.
		S5	8 to 10	24/12	WOH/12"-1-1	PID = 0.1 ppm	SAND AND GRAVEL	S5: WIDELY GRADED SAND (SW); ~90% fine to coarse sand, 5% fine to coarse subangular to subrounded gravel, ~5% nonplastic fines, brown, wet.
530	10	S6	10 to 12	24/22	1-2-3-6	PID = 0 ppm		S6: WIDELY GRADED SAND (SW); Similar to S5.
		S7	14 to 16	24/20	1-3-4-8			S7: NARROWLY GRADED SAND (SP); ~95% fine to medium sand, 5% fine gravel, brown and tan, wet.
	15					PID = 0.1 ppm		
520	20	S8	19 to 21	24/24	2-3-4-10	PID = 0 ppm		S8: SILTY SAND (SM); ~65% fine to coarse sand, ~30% nonplastic fines, ~5% fine to coarse gravel, light brown with orange spotting, wet.

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

NORTHING (ft): 2,936,349 **EASTING (ft):** 573,458
GROUND SURFACE EL. (ft): 540 **DATE START/END:** 3/22/2024 - 3/22/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.

BORING GEI-113

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
	25	S9	24 to 26	24/24	1-4-7-18	PID = 0.1 ppm	SAND AND GRAVEL	S9 (0-18"): SILTY SAND (SM); ~60% medium to coarse sand, ~40% low plasticity fines, light brown, wet. S9 (18"-24"): WIDELY GRADED SAND WITH GRAVEL (SW); ~70% fine to coarse sand, ~25% fine to coarse gravel up to 1", ~5% nonplastic fines, dark brown, wet.
510	30	S10	29 to 31	24/15	12-22-27-38	PID = 0.2 ppm		S10: WIDELY GRADED SAND WITH GRAVEL (SW); ~65% medium to coarse sand, ~30% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, dark brown, wet.
	35							Bottom of boring at 31 feet. Backfilled with cuttings. Patched the top with asphalt.
500	40							
	45							
490	50							
	55							

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,426 **EASTING (ft):** 573,433
GROUND SURFACE EL. (ft): 542 **DATE START/END:** 3/22/2024 - 3/22/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.
TOTAL DEPTH (ft): 31.0 **DRILLER NAME:** R. Dean
LOGGED BY: A. Roshan **RIG TYPE:** CME-55 Truck-Mounted

BORING

GEI-114

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** NA/ NA **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: 3.75 inch / 6.25 inch **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Hollow Stem Auger
WATER LEVEL ELEVATIONS (ft): ▼ 537.4 3/22/2024

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Depth (ft)	Pen./ Rec. (in)	Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
							FILL	1" ASPHALT
540		S1	0 to 2	24/13	6-14-14-10	PID = 0.1 ppm		S1 (0-4"): NARROWLY GRADED SAND WITH GRAVEL (SP); ~80% fine to medium sand, ~15% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, dark brown, dry. S1 (4"-13"): NARROWLY GRADED SAND WITH GRAVEL (SP); ~55% fine to medium sand, ~40% fine to coarse subangular to subrounded gravel up to 1", ~5% nonplastic fines, white and brown, dry.
		S2	2 to 4	24/17	7-6-8-8			S2 (0-4"): NARROWLY GRADED SAND (SP); ~85% fine to medium sand, ~10% fine to coarse subangular to subrounded gravel, ~5% nonplastic fines, brown, dry. Some roots present. S2 (4"-17"): NARROWLY GRADED SAND WITH SILT (SP-SM); ~85% fine sand, ~10% low plasticity fines, ~5% fine to coarse gravel, gray, wet.
	5	S3	4 to 6	24/14	2-4-6-7			S3: WIDELY GRADED SAND (SW); ~90% fine to coarse sand, ~5% fine to coarse subangular to subrounded gravel up to 1", ~5% nonplastic fines, brown, wet.
		S4	6 to 8	24/22	22-21-26-47	Rig chatter from 6'-9'		S4: WIDELY GRADED SAND WITH GRAVEL (SW); ~70% fine to coarse sand, ~25% fine to coarse subangular to subrounded gravel up to 1.5", ~5% nonplastic fines, dark brown, wet.
		S5	8 to 10	24/20	7-12-12-17	Rig chatter from 8'-10'		S5: WIDELY GRADED SAND WITH GRAVEL (SW); ~60% fine to coarse sand, ~35% fine to coarse subangular to subrounded gravel up to 1", ~5% nonplastic fines, brown, wet.
	10							
530						Rig chatter from 12' -13'	SAND AND GRAVEL	
		S6	14 to 16	24/19	10-17-18-15			S6: WIDELY GRADED GRAVEL WITH SAND (GW); ~50% fine to coarse subangular to subrounded gravel up to 1.5", ~45% medium to coarse sand, ~5% nonplastic fines, brown, wet.
	15					Rig chatter from 15'-19'		
		S7	19 to 21	24/18	8-5-9-19	PID = 0.1 ppm		S7: NARROWLY GRADED SAND (SP); ~90% medium to coarse sand, ~10% fine to coarse subangular to subrounded gravel up to 1", brown, wet.
	20							
520								

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

NORTHING (ft): 2,936,426 **EASTING (ft):** 573,433
GROUND SURFACE EL. (ft): 542 **DATE START/END:** 3/22/2024 - 3/22/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.

BORING GEI-114

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
	25	S8	24 to 26	24/16	3-10-14-46	PID = 0.2 ppm	SAND AND GRAVEL	S8 (0-10"): NARROWLY GRADED SAND (SP); ~90% medium to coarse sand, ~10% fine to coarse subangular to subrounded gravel up to 1", brown, wet. S8 (10"-16"): WIDELY GRADED GRAVEL WITH SAND (GW); ~80% fine to coarse subangular to subrounded gravel up to 1.5", ~15% medium to coarse sand, ~5% nonplastic fines, brown, wet.
	30	S9	29 to 31	24/14	5-17-15-20	PID = 0.1 ppm	SAND AND GRAVEL / TILL	S9 (0-7"): NARROWLY GRADED SAND (SP); ~100% medium to coarse sand, brown, wet. S9 (7"-14"): SILTY SAND (SM); ~60% fine to medium sand, ~35% low plasticity fines, ~5% fine gravel, gray, wet.
510								Bottom of boring at 31 feet. Backfilled with cuttings. Patched the top with asphalt.
	35							
	40							
500								
	45							
	50							
490								
	55							

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,409 **EASTING (ft):** 573,159
GROUND SURFACE EL. (ft): 552 **DATE START/END:** 3/26/2024 - 3/26/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.
TOTAL DEPTH (ft): 18.5 **DRILLER NAME:** R. Dean
LOGGED BY: A. Maupin **RIG TYPE:** CME-55 Truck-Mounted

BORING

GEI-115

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** NA/ NA **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: 3.75 inch / 6.25 inch **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Hollow Stem Auger
WATER LEVEL ELEVATIONS (ft): Not measured.

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Depth (ft)	Pen./ Rec. (in)	Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
550	0	S1	0 to 1.8	22/15	9-11-14-20	PID = 0 ppm	FILL	0-2.5": ASPHALT/PAVEMENT S1: NARROWLY GRADED SAND WITH SILT AND GRAVEL (SP-SM); ~65% fine to medium sand, ~25% fine to coarse sand, ~10% nonplastic fines, brown with gray gravel, some rust coloring, dry.
		S2	2 to 4	24/15	26-25-18-12	PID = 0 ppm		S2: NARROWLY GRADED SAND WITH SILT AND GRAVEL (SP-SM); ~60% fine to medium sand, ~30% fine to coarse gravel, ~10% nonplastic fines, brown with gray gravel, some rust coloring, dry.
	5	S3	4 to 6	24/7	4-6-9-6	PID = 0.1 ppm		S3: NARROWLY GRADED SAND WITH SILT AND GRAVEL (SP-SM); Similar to S2, except moist.
		S4	6 to 8	24/16	26-22-20-18	PID = 0 ppm		S4 (0-1"): NARROWLY GRADED SAND WITH GRAVEL (SP); ~70% fine to medium sand, ~25% fine to coarse gravel, ~5% nonplastic fines, brown, moist. S4 (1"-15.5"): NARROWLY GRADED SAND WITH GRAVEL (SP); ~75% fine to medium sand, ~20% fine to coarse gravel, ~5% nonplastic fines, brown with gray and tan, moist. Some indications of rust.
		S5	8 to 10	24/17	6-17-27-50			S5: NARROWLY GRADED SAND WITH GRAVEL (SP); ~65% fine to medium sand, ~30% fine to coarse gravel, ~5% nonplastic fines, light brown with gray gravel and some minor rust covering, moist to wet from 0-1".
540	10							
	15	S6	14 to 16	24/17	7-25-32-30		GLACIAL TILL	S6 (0-6"): WIDELY GRADED GRAVEL WITH SAND (GW); ~50% fine to coarse gravel, ~45% fine to coarse sand, ~5% nonplastic fines, brown with gray gravel, some hints of rust color, moist. S6 (6"-17"): WIDELY GRADED SAND (SW); ~90% fine sand, ~5% fine gravel, ~5% nonplastic fines, light brown to grayish brown, moist.
						Auger refusal at 18.5'. Offset ~6.5' north to GEI-115A.		Bottom of boring at 18.5 ft. Backfilled with cuttings. Patched the top with asphalt.
	20							
530								

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,414 **EASTING (ft):** 573,154
GROUND SURFACE EL. (ft): 552 **DATE START/END:** 3/26/2024 - 3/26/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.
TOTAL DEPTH (ft): 30.9 **DRILLER NAME:** R. Dean
LOGGED BY: A. Maupin **RIG TYPE:** CME-55 Truck-Mounted

BORING

GEI-115A

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** NA/ NA **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: 3.75 inch / 6.25 inch **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Hollow Stem Auger
WATER LEVEL ELEVATIONS (ft): ▼ 527.5 3/26/2024

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
550	0						FILL	See GEI-115 for soil descriptions from 0 to 19 feet.
	5							
	10							
540								
	15						GLACIAL TILL	
	20	S1	19 to 20.3	16/10	12-50-50/4"			S1: NARROWLY GRADED SAND WITH GRAVEL (SP); ~75% fine to medium sand, ~20% fine to coarse gravel, ~5% nonplastic fines, brown, moist.
530								

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

GEI WOBURN STD 5-NORTH-EAST-LAYER NAME 2400599_GINT LOGS.GPJ 4/16/24

NORTHING (ft): 2,936,414 **EASTING (ft):** 573,154
GROUND SURFACE EL. (ft): 552 **DATE START/END:** 3/26/2024 - 3/26/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.

BORING GEI-115A

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
	25	S2	24 to 26	24/20	25-49-46-46	Drill cuttings red and gray at ~28'	GLACIAL TILL	S2: NARROWLY GRADED SAND WITH SILT AND GRAVEL (SP-SM); ~75% fine to medium sand, ~15% fine to coarse gravel, ~10% nonplastic fines, brown and gray, wet to moist. Weathered white rock from 12"-14", darker coloring from 0-12".
	30	S3	29 to 30.9	23/17	14-24-40-50/5"			S3: SILTY SAND WITH GRAVEL (SM); ~60% low plasticity fines, ~20% fine gravel, ~20% fine sand, gray, wet.
520								Bottom of boring at 30.9 feet. Backfilled with cuttings. Patched the top with asphalt.
	35							
	40							
510								
	45							
	50							
500								
	55							

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,346 **EASTING (ft):** 573,218
GROUND SURFACE EL. (ft): 550 **DATE START/END:** 3/26/2024 - 3/26/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.
TOTAL DEPTH (ft): 4.8 **DRILLER NAME:** R. Dean
LOGGED BY: A. Maupin **RIG TYPE:** CME-55 Truck-Mounted

BORING

GEI-116

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** NA/ NA **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: 3.75 inch / 6.25 inch **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Hollow Stem Auger
WATER LEVEL ELEVATIONS (ft): Not measured.

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
		S1	0 to 1.9	23/10	5-5-13-10	PID = 0 ppm	FILL	0-1": ASPHALT S1: WIDELY GRADED SAND WITH GRAVEL (SW); ~70% fine to coarse sand, ~25% fine to coarse gravel, ~5% nonplastic fines, brown, dry.
		S2	2 to 3.9	23/12	23-14-26-50/5"	PID = 0 ppm		S2: WIDELY GRADED GRAVEL WITH SAND (GW); ~55% fine to coarse gravel, ~40% fine to coarse sand, ~5% nonplastic fines, brown with gray gravel/weathered cobble, indications of rust at bottom 2", moist from 0-5".
	5					Driller indicated refusal on a possible boulder at ~4.8'. Offset ~5' 7" north to GEI-116A.		Bottom of boring at 4.8 feet. Backfilled with cuttings. Patched the top with asphalt.
540	10							
	15							
530	20							

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

BORING INFORMATION

NORTHING (ft): 2,936,351 **EASTING (ft):** 573,214
GROUND SURFACE EL. (ft): 550 **DATE START/END:** 3/26/2024 - 3/26/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.
TOTAL DEPTH (ft): 30.3 **DRILLER NAME:** R. Dean
LOGGED BY: A. Maupin **RIG TYPE:** CME-55 Truck-Mounted

BORING
GEI-116A

DRILLING INFORMATION

HAMMER TYPE: Automatic **CASING I.D./O.D.:** NA/ NA **CORE BARREL TYPE:** Not used
AUGER I.D./O.D.: 3.75 inch / 6.25 inch **DRILL ROD O.D.:** 2.625 inch **CORE BARREL I.D./O.D.:** NA / NA
DRILLING METHOD: Hollow Stem Auger
WATER LEVEL ELEVATIONS (ft): ▼ 526.3 3/26/2024

ABBREVIATIONS:
Pen. = Penetration Length
Rec. = Recovery Length
RQD = Rock Quality Designation = Length of Sound Cores>4 in / Pen.,%
WOR = Weight of Rods
WOH = Weight of Hammer
S = Split Spoon Sample
C = Core Sample
U = Undisturbed Sample
SC = Sonic Core
DP = Direct Push Sample
HSA = Hollow-Stem Auger
Qp = Pocket Penetrometer Strength
Sv = Pocket Torvane Shear Strength
LL = Liquid Limit
PI = Plasticity Index
PID = Photoionization Detector
I.D./O.D.= Inside Diameter/Outside Diameter
NA, NM = Not Applicable, Not Measured
Blows per 6 in.: 140-lb hammer falling 30 inches to drive a 2-inch-O.D. split spoon sampler.

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
							FILL	See GEI-116 for soil descriptions from 0 to 4 feet.
	5	S1	4 to 6	24/8	8-9-8-12	PID = 0 ppm		S1: WIDELY GRADED SAND WITH GRAVEL (SW); ~65% fine to coarse sand, ~30% fine to coarse gravel, ~5% nonplastic fines, brown with gray weathered cobble from 0-2" and 7"-8", dry.
		S2	6 to 8	24/11	7-19-23-34	PID = 0.1 ppm		S2: NARROWLY GRADED SAND WITH GRAVEL (SP); ~55% fine to medium sand, ~40% fine to coarse gravel, ~5% nonplastic fines, brown with gray, gravel, white weathered cobble from 4" to 8", moist.
		S3	8 to 10	24/9	2-48-55-33	PID = 0 ppm		S3: WIDELY GRADED GRAVEL WITH SAND (GW); ~75% fine to coarse gravel, ~20% fine sand, ~5% nonplastic fines, white with gray, dry. Gravel appears to be crushed rock, either weathered or from a boulder.
540	10							
	15	S4	14 to 16	24/18	14-23-21-25	PID = 0.1 ppm	GLACIAL TILL	S4: WIDELY GRADED GRAVEL WITH SILT AND SAND (GW-GM); ~60% fine to coarse gravel, ~30% fine to coarse sand, ~10% nonplastic fines, brown with gray and orange, wet.
530	20	S5	19 to 21	24/13	6-16-21-18	PID = 0 ppm		S5: NARROWLY GRADED SAND WITH GRAVEL (SP); ~70% fine sand, ~25% fine to coarse gravel, ~5% nonplastic fines, brown, moist.

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

NORTHING (ft): 2,936,351 **EASTING (ft):** 573,214
GROUND SURFACE EL. (ft): 550 **DATE START/END:** 3/26/2024 - 3/26/2024
VERT./HORIZ. DATUMS: NAVD 88/NAD 1983 **DRILLING COMPANY:** Geosearch Inc.

BORING GEI-116A

Elev. (ft)	Depth (ft)	Sample Information: Sample No.	Sample Information: Depth (ft)	Sample Information: Pen./ Rec. (in)	Sample Information: Blows per 6 in. or RQD	Drilling Remarks/ Field Test Data	Layer Name	Soil and Rock Description
	25	S6	24 to 26	24/23	3-16-20-30	PID = 0.1 ppm	GLACIAL TILL	S6: NARROWLY GRADED SAND WITH SILT (SP-SM); ~80% fine to medium sand, ~10% fine gravel, ~10% nonplastic fines, brown, moist.
520	30	S7	29 to 30.3	15/15	50-65-50/3"	PID = 0.2 ppm		S7: NARROWLY GRADED SAND WITH SILT (SP-SM); Similar to S6.
								Bottom of boring at 30.3 feet. Backfilled with cuttings. Patched the top with asphalt.
	35							
510	40							
	45							
500	50							
	55							

NOTES:
1. As-drilled coordinates recorded by hand-held Trimble GPS.
2. Ground surface elevation approximated using existing conditions survey provided by Kimley-Horn, Inc. on February 6, 2024.

PROJECT NAME: 351 Stores Street
CITY/STATE: Worcester, Massachusetts
GEI PROJECT NUMBER: 2400599

GEI Consultants

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for Worcester County, Massachusetts, Northeastern Part

March 8, 2024

Preface

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

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

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

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

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

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

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Contents

How Soil Surveys Are Made

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

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

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

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

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

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

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

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

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

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

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

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Custom Soil Resource Report
Soil Map

Map Scale: 1:2,120 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Worcester County, Massachusetts, Northeastern Part
Survey Area Data: Version 18, Sep 10, 2023

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

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
602	Urban land	12.2	100.0%
Totals for Area of Interest		**12.2**	**100.0%**

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

Worcester County, Massachusetts, Northeastern Part

602—Urban land

Map Unit Setting

National map unit symbol: w3q8
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Parent material: Excavated and filled land

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Glossary

Many of the terms relating to landforms, geology, and geomorphology are defined in more detail in the following National Soil Survey Handbook link: “National Soil Survey Handbook.”

ABC soil

A soil having an A, a B, and a C horizon.

Ablation till

Loose, relatively permeable earthy material deposited during the downwasting of nearly static glacial ice, either contained within or accumulated on the surface of the glacier.

AC soil

A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil

The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil

Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial cone

A semiconical type of alluvial fan having very steep slopes. It is higher, narrower, and steeper than a fan and is composed of coarser and thicker layers of material deposited by a combination of alluvial episodes and (to a much lesser degree) landslides (debris flow). The coarsest materials tend to be concentrated at the apex of the cone.

Alluvial fan

A low, outspread mass of loose materials and/or rock material, commonly with gentle slopes. It is shaped like an open fan or a segment of a cone. The material was deposited by a stream at the place where it issues from a narrow mountain valley or upland valley or where a tributary stream is near or at its junction with the main stream. The fan is steepest near its apex, which points upstream, and slopes gently and convexly outward (downstream) with a gradual decrease in gradient.

Alluvium

Unconsolidated material, such as gravel, sand, silt, clay, and various mixtures of these, deposited on land by running water.

Alpha,alpha-dipyridyl

A compound that when dissolved in ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction implies reducing conditions and the likely presence of redoximorphic features.

Animal unit month (AUM)

The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Aquic conditions

Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Argillic horizon

A subsoil horizon characterized by an accumulation of illuvial clay.

Arroyo

The flat-floored channel of an ephemeral stream, commonly with very steep to vertical banks cut in unconsolidated material. It is usually dry but can be transformed into a temporary watercourse or short-lived torrent after heavy rain within the watershed.

Aspect

The direction toward which a slope faces. Also called slope aspect.

Association, soil

A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity)

The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low: 0 to 3
Low: 3 to 6
Moderate: 6 to 9
High: 9 to 12
Very high: More than 12

Backslope

The position that forms the steepest and generally linear, middle portion of a hillslope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below.

Backswamp

A flood-plain landform. Extensive, marshy or swampy, depressed areas of flood plains between natural levees and valley sides or terraces.

Badland

A landscape that is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes and narrow interfluves. Badlands develop on surfaces that have little or no vegetative cover overlying unconsolidated or poorly cemented materials (clays, silts, or sandstones) with, in some cases, soluble minerals, such as gypsum or halite.

Bajada

A broad, gently inclined alluvial piedmont slope extending from the base of a mountain range out into a basin and formed by the lateral coalescence of a series of alluvial fans. Typically, it has a broadly undulating transverse profile, parallel to the mountain front, resulting from the convexities of component fans. The term is generally restricted to constructional slopes of intermontane basins.

Basal area

The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

Base saturation

The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Base slope (geomorphology)

A geomorphic component of hills consisting of the concave to linear (perpendicular to the contour) slope that, regardless of the lateral shape, forms an apron or wedge at the bottom of a hillside dominated by colluvium and slope-wash sediments (for example, slope alluvium).

Bedding plane

A planar or nearly planar bedding surface that visibly separates each successive layer of stratified sediment or rock (of the same or different lithology)

from the preceding or following layer; a plane of deposition. It commonly marks a change in the circumstances of deposition and may show a parting, a color difference, a change in particle size, or various combinations of these. The term is commonly applied to any bedding surface, even one that is conspicuously bent or deformed by folding.

Bedding system

A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock

The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography

A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bench terrace

A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum

Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout (map symbol)

A saucer-, cup-, or trough-shaped depression formed by wind erosion on a preexisting dune or other sand deposit, especially in an area of shifting sand or loose soil or where protective vegetation is disturbed or destroyed. The adjoining accumulation of sand derived from the depression, where recognizable, is commonly included. Blowouts are commonly small.

Borrow pit (map symbol)

An open excavation from which soil and underlying material have been removed, usually for construction purposes.

Bottom land

An informal term loosely applied to various portions of a flood plain.

Boulders

Rock fragments larger than 2 feet (60 centimeters) in diameter.

Breaks

A landscape or tract of steep, rough or broken land dissected by ravines and gullies and marking a sudden change in topography.

Breast height

An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Brush management

Use of mechanical, chemical, or biological methods to make conditions favorable for reseeding or to reduce or eliminate competition from woody vegetation and thus allow understory grasses and forbs to recover. Brush management increases forage production and thus reduces the hazard of erosion. It can improve the habitat for some species of wildlife.

Butte

An isolated, generally flat-topped hill or mountain with relatively steep slopes and talus or precipitous cliffs and characterized by summit width that is less than the height of bounding escarpments; commonly topped by a caprock of resistant material and representing an erosion remnant carved from flat-lying rocks.

Cable yarding

A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

Calcareous soil

A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche

A general term for a prominent zone of secondary carbonate accumulation in surficial materials in warm, subhumid to arid areas. Caliche is formed by both geologic and pedologic processes. Finely crystalline calcium carbonate forms a nearly continuous surface-coating and void-filling medium in geologic (parent) materials. Cementation ranges from weak in nonindurated forms to very strong in indurated forms. Other minerals (e.g., carbonates, silicate, and sulfate) may occur as accessory cements. Most petrocalcic horizons and some calcic horizons are caliche.

California bearing ratio (CBR)

The load-supporting capacity of a soil as compared to that of standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Canopy

The leafy crown of trees or shrubs. (See Crown.)

Canyon

A long, deep, narrow valley with high, precipitous walls in an area of high local relief.

Capillary water

Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena

A sequence, or “chain,” of soils on a landscape that formed in similar kinds of parent material and under similar climatic conditions but that have different characteristics as a result of differences in relief and drainage.

Cation

An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity

The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps

See Terracettes.

Cement rock

Shaly limestone used in the manufacture of cement.

Channery soil material

Soil material that has, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches (15 centimeters) along the longest axis. A single piece is called a channer.

Chemical treatment

Control of unwanted vegetation through the use of chemicals.

Chiseling

Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

Cirque

A steep-walled, semicircular or crescent-shaped, half-bowl-like recess or hollow, commonly situated at the head of a glaciated mountain valley or high on the side of a mountain. It was produced by the erosive activity of a mountain glacier. It commonly contains a small round lake (tarn).

Clay

As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay depletions

See Redoximorphic features.

Clay film

A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Clay spot (map symbol)

A spot where the surface texture is silty clay or clay in areas where the surface layer of the soils in the surrounding map unit is sandy loam, loam, silt loam, or coarser.

Claypan

A dense, compact subsoil layer that contains much more clay than the overlying materials, from which it is separated by a sharply defined boundary. The layer restricts the downward movement of water through the soil. A claypan is commonly hard when dry and plastic and sticky when wet.

Climax plant community

The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil

Sand or loamy sand.

Cobble (or cobblestone)

A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material

Material that has 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

COLE (coefficient of linear extensibility)

See Linear extensibility.

Colluvium

Unconsolidated, unsorted earth material being transported or deposited on side slopes and/or at the base of slopes by mass movement (e.g., direct gravitational action) and by local, unconcentrated runoff.

Complex slope

Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil

A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Concretions

See Redoximorphic features.

Conglomerate

A coarse grained, clastic sedimentary rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

Conservation cropping system

Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage

A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil

Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the “Soil Survey Manual.”

Contour stripcropping

Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section

The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat)

A type of limnic layer composed predominantly of fecal material derived from aquatic animals.

Corrosion (geomorphology)

A process of erosion whereby rocks and soil are removed or worn away by natural chemical processes, especially by the solvent action of running water, but also by other reactions, such as hydrolysis, hydration, carbonation, and oxidation.

Corrosion (soil survey interpretations)

Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Cover crop

A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Crop residue management

Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cropping system

Growing crops according to a planned system of rotation and management practices.

Cross-slope farming

Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

Crown

The upper part of a tree or shrub, including the living branches and their foliage.

Cryoturbate

A mass of soil or other unconsolidated earthy material moved or disturbed by frost action. It is typically coarser than the underlying material.

Cuesta

An asymmetric ridge capped by resistant rock layers of slight or moderate dip (commonly less than 15 percent slopes); a type of homocline produced by differential erosion of interbedded resistant and weak rocks. A cuesta has a long, gentle slope on one side (dip slope) that roughly parallels the inclined beds; on the other side, it has a relatively short and steep or clifflike slope (scarp) that cuts through the tilted rocks.

Culmination of the mean annual increment (CMAI)

The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Cutbanks cave

The walls of excavations tend to cave in or slough.

Decreasers

The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing

Postponing grazing or resting grazing land for a prescribed period.

Delta

A body of alluvium having a surface that is fan shaped and nearly flat; deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Dense layer

A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depression, closed (map symbol)

A shallow, saucer-shaped area that is slightly lower on the landscape than the surrounding area and that does not have a natural outlet for surface drainage.

Depth, soil

Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Desert pavement

A natural, residual concentration or layer of wind-polished, closely packed gravel, boulders, and other rock fragments mantling a desert surface. It forms where wind action and sheetwash have removed all smaller particles or where rock fragments have migrated upward through sediments to the surface. It typically protects the finer grained underlying material from further erosion.

Diatomaceous earth

A geologic deposit of fine, grayish siliceous material composed chiefly or entirely of the remains of diatoms.

Dip slope

A slope of the land surface, roughly determined by and approximately conforming to the dip of the underlying bedrock.

Diversion (or diversion terrace)

A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Divided-slope farming

A form of field stripcropping in which crops are grown in a systematic arrangement of two strips, or bands, across the slope to reduce the hazard of water erosion. One strip is in a close-growing crop that provides protection from erosion, and the other strip is in a crop that provides less protection from erosion. This practice is used where slopes are not long enough to permit a full stripcropping pattern to be used.

Drainage class (natural)

Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained*. These classes are defined in the “Soil Survey Manual.”

Drainage, surface

Runoff, or surface flow of water, from an area.

Drainageway

A general term for a course or channel along which water moves in draining an area. A term restricted to relatively small, linear depressions that at some time move concentrated water and either do not have a defined channel or have only a small defined channel.

Draw

A small stream valley that generally is shallower and more open than a ravine or gulch and that has a broader bottom. The present stream channel may appear inadequate to have cut the drainageway that it occupies.

Drift

A general term applied to all mineral material (clay, silt, sand, gravel, and boulders) transported by a glacier and deposited directly by or from the ice or transported by running water emanating from a glacier. Drift includes unstratified material (till) that forms moraines and stratified deposits that form outwash plains, eskers, kames, varves, and glaciofluvial sediments. The term is generally applied to Pleistocene glacial deposits in areas that no longer contain glaciers.

Drumlin

A low, smooth, elongated oval hill, mound, or ridge of compact till that has a core of bedrock or drift. It commonly has a blunt nose facing the direction from which the ice approached and a gentler slope tapering in the other direction. The longer axis is parallel to the general direction of glacier flow. Drumlins are products of streamline (laminar) flow of glaciers, which molded the subglacial floor through a combination of erosion and deposition.

Duff

A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Dune

A low mound, ridge, bank, or hill of loose, windblown granular material (generally sand), either barren and capable of movement from place to place or covered and stabilized with vegetation but retaining its characteristic shape.

Earthy fill

See Mine spoil.

Ecological site

An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind and/or proportion of species or in total production.

Eluviation

The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Endosaturation

A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

Eolian deposit

Sand-, silt-, or clay-sized clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess.

Ephemeral stream

A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

Episaturation

A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of the surface.

Erosion

The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (accelerated)

Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Erosion (geologic)

Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion pavement

A surficial lag concentration or layer of gravel and other rock fragments that remains on the soil surface after sheet or rill erosion or wind has removed the finer soil particles and that tends to protect the underlying soil from further erosion.

Erosion surface

A land surface shaped by the action of erosion, especially by running water.

Escarpment

A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Most commonly applied to cliffs produced by differential erosion. Synonym: scarp.

Escarpment, bedrock (map symbol)

A relatively continuous and steep slope or cliff, produced by erosion or faulting, that breaks the general continuity of more gently sloping land surfaces. Exposed material is hard or soft bedrock.

Escarpment, nonbedrock (map symbol)

A relatively continuous and steep slope or cliff, generally produced by erosion but in some places produced by faulting, that breaks the continuity of more gently sloping land surfaces. Exposed earthy material is nonsoil or very shallow soil.

Esker

A long, narrow, sinuous, steep-sided ridge of stratified sand and gravel deposited as the bed of a stream flowing in an ice tunnel within or below the ice (subglacial) or between ice walls on top of the ice of a wasting glacier and left

behind as high ground when the ice melted. Eskers range in length from less than a kilometer to more than 160 kilometers and in height from 3 to 30 meters.

Extrusive rock

Igneous rock derived from deep-seated molten matter (magma) deposited and cooled on the earth's surface.

Fallow

Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grain is grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fan remnant

A general term for landforms that are the remaining parts of older fan landforms, such as alluvial fans, that have been either dissected or partially buried.

Fertility, soil

The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat)

The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity

The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fill slope

A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil

Sandy clay, silty clay, or clay.

Firebreak

An area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of firefighters and equipment. Designated roads also serve as firebreaks.

First bottom

An obsolete, informal term loosely applied to the lowest flood-plain steps that are subject to regular flooding.

Flaggy soil material

Material that has, by volume, 15 to 35 percent flagstones. Very flaggy soil material has 35 to 60 percent flagstones, and extremely flaggy soil material has more than 60 percent flagstones.

Flagstone

A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

Flood plain

The nearly level plain that borders a stream and is subject to flooding unless protected artificially.

Flood-plain landforms

A variety of constructional and erosional features produced by stream channel migration and flooding. Examples include backswamps, flood-plain splays, meanders, meander belts, meander scrolls, oxbow lakes, and natural levees.

Flood-plain splay

A fan-shaped deposit or other outspread deposit formed where an overloaded stream breaks through a levee (natural or artificial) and deposits its material (commonly coarse grained) on the flood plain.

Flood-plain step

An essentially flat, terrace-like alluvial surface within a valley that is frequently covered by floodwater from the present stream; any approximately horizontal surface still actively modified by fluvial scour and/or deposition. May occur individually or as a series of steps.

Fluvial

Of or pertaining to rivers or streams; produced by stream or river action.

Foothills

A region of steeply sloping hills that fringes a mountain range or high-plateau escarpment. The hills have relief of as much as 1,000 feet (300 meters).

Footslope

The concave surface at the base of a hillslope. A footslope is a transition zone between upslope sites of erosion and transport (shoulders and backslopes) and downslope sites of deposition (toeslopes).

Forb

Any herbaceous plant not a grass or a sedge.

Forest cover

All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type

A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Fragipan

A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Genesis, soil

The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai

Commonly, a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of clayey soils that shrink and swell considerably with changes in moisture content.

Glaciofluvial deposits

Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur in the form of outwash plains, valley trains, deltas, kames, eskers, and kame terraces.

Glaciolacustrine deposits

Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are bedded or laminated.

Gleyed soil

Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

Graded stripcropping

Growing crops in strips that grade toward a protected waterway.

Grassed waterway

A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel

Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravel pit (map symbol)

An open excavation from which soil and underlying material have been removed and used, without crushing, as a source of sand or gravel.

Gravelly soil material

Material that has 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Gravelly spot (map symbol)

A spot where the surface layer has more than 35 percent, by volume, rock fragments that are mostly less than 3 inches in diameter in an area that has less than 15 percent rock fragments.

Green manure crop (agronomy)

A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water

Water filling all the unblocked pores of the material below the water table.

Gully (map symbol)

A small, steep-sided channel caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage whereas a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard bedrock

Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hard to reclaim

Reclamation is difficult after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Hardpan

A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Head slope (geomorphology)

A geomorphic component of hills consisting of a laterally concave area of a hillside, especially at the head of a drainageway. The overland waterflow is converging.

Hemic soil material (mucky peat)

Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

High-residue crops

Such crops as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill

A generic term for an elevated area of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline. Slopes are generally more than 15 percent. The distinction between a hill and a mountain is arbitrary and may depend on local usage.

Hillslope

A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of a hill.

Horizon, soil

A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the “Soil Survey Manual.” The major horizons of mineral soil are as follows:

O horizon: An organic layer of fresh and decaying plant residue.

L horizon: A layer of organic and mineral limnic materials, including coprogenous earth (sedimentary peat), diatomaceous earth, and marl.

A horizon: The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon: The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon: The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon: The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon: Soft, consolidated bedrock beneath the soil.

R layer: Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

M layer: A root-limiting subsoil layer consisting of nearly continuous, horizontally oriented, human-manufactured materials.

W layer: A layer of water within or beneath the soil.

Humus

The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups

Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties include depth to a seasonal high water table, the infiltration rate, and depth to a layer that significantly restricts the downward movement of water. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Igneous rock

Rock that was formed by cooling and solidification of magma and that has not been changed appreciably by weathering since its formation. Major varieties include plutonic and volcanic rock (e.g., andesite, basalt, and granite).

Illuviation

The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil

A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers

Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration

The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity

The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate

The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate

The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Very low: Less than 0.2
Low: 0.2 to 0.4
Moderately low: 0.4 to 0.75
Moderate: 0.75 to 1.25
Moderately high: 1.25 to 1.75
High: 1.75 to 2.5
Very high: More than 2.5

Interfluve

A landform composed of the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction. An elevated area between two drainageways that sheds water to those drainageways.

Interfluve (geomorphology)

A geomorphic component of hills consisting of the uppermost, comparatively level or gently sloping area of a hill; shoulders of backwearing hillslopes can narrow the upland or can merge, resulting in a strongly convex shape.

Intermittent stream

A stream, or reach of a stream, that does not flow year-round but that is commonly dry for 3 or more months out of 12 and whose channel is generally below the local water table. It flows only during wet periods or when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders

On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following disturbance of the surface.

Iron depletions

See Redoximorphic features.

Irrigation

Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin: Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border: Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding: Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation: Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle): Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow: Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler: Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation: Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding: Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame

A low mound, knob, hummock, or short irregular ridge composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier; by a supraglacial stream in a low place or hole on the surface of the glacier; or as a ponded deposit on the surface or at the margin of stagnant ice.

Karst (topography)

A kind of topography that formed in limestone, gypsum, or other soluble rocks by dissolution and that is characterized by closed depressions, sinkholes, caves, and underground drainage.

Knoll

A small, low, rounded hill rising above adjacent landforms.

Ksat

See Saturated hydraulic conductivity.

Lacustrine deposit

Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Lake plain

A nearly level surface marking the floor of an extinct lake filled by well sorted, generally fine textured, stratified deposits, commonly containing varves.

Lake terrace

A narrow shelf, partly cut and partly built, produced along a lakeshore in front of a scarp line of low cliffs and later exposed when the water level falls.

Landfill (map symbol)

An area of accumulated waste products of human habitation, either above or below natural ground level.

Landslide

A general, encompassing term for most types of mass movement landforms and processes involving the downslope transport and outward deposition of soil and rock materials caused by gravitational forces; the movement may or may not involve saturated materials. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones

Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Lava flow (map symbol)

A solidified, commonly lobate body of rock formed through lateral, surface outpouring of molten lava from a vent or fissure.

Leaching

The removal of soluble material from soil or other material by percolating water.

Levee (map symbol)

An embankment that confines or controls water, especially one built along the banks of a river to prevent overflow onto lowlands.

Linear extensibility

Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $^{1}/_{3}$- or $^{1}/_{10}$-bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.

Liquid limit

The moisture content at which the soil passes from a plastic to a liquid state.

Loam

Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess

Material transported and deposited by wind and consisting dominantly of silt-sized particles.

Low strength

The soil is not strong enough to support loads.

Low-residue crops

Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Marl

An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions; formed primarily under freshwater lacustrine conditions but also formed in more saline environments.

Marsh or swamp (map symbol)

A water-saturated, very poorly drained area that is intermittently or permanently covered by water. Sedges, cattails, and rushes are the dominant vegetation in marshes, and trees or shrubs are the dominant vegetation in swamps. Not used in map units where the named soils are poorly drained or very poorly drained.

Mass movement

A generic term for the dislodgment and downslope transport of soil and rock material as a unit under direct gravitational stress.

Masses

See Redoximorphic features.

Meander belt

The zone within which migration of a meandering channel occurs; the flood-plain area included between two imaginary lines drawn tangential to the outer bends of active channel loops.

Meander scar

A crescent-shaped, concave or linear mark on the face of a bluff or valley wall, produced by the lateral erosion of a meandering stream that impinged upon and undercut the bluff.

Meander scroll

One of a series of long, parallel, close-fitting, crescent-shaped ridges and troughs formed along the inner bank of a stream meander as the channel migrated laterally down-valley and toward the outer bank.

Mechanical treatment

Use of mechanical equipment for seeding, brush management, and other management practices.

Medium textured soil

Very fine sandy loam, loam, silt loam, or silt.

Mesa

A broad, nearly flat topped and commonly isolated landmass bounded by steep slopes or precipitous cliffs and capped by layers of resistant, nearly horizontal rocky material. The summit width is characteristically greater than the height of the bounding escarpments.

Metamorphic rock

Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement at depth in the earth’s crust. Nearly all such rocks are crystalline.

Mine or quarry (map symbol)

An open excavation from which soil and underlying material have been removed and in which bedrock is exposed. Also denotes surface openings to underground mines.

Mine spoil

An accumulation of displaced earthy material, rock, or other waste material removed during mining or excavation. Also called earthy fill.

Mineral soil

Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage

Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area

A kind of map unit that has little or no natural soil and supports little or no vegetation.

Miscellaneous water (map symbol)

Small, constructed bodies of water that are used for industrial, sanitary, or mining applications and that contain water most of the year.

Moderately coarse textured soil

Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil

Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon

A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Moraine

In terms of glacial geology, a mound, ridge, or other topographically distinct accumulation of unsorted, unstratified drift, predominantly till, deposited primarily by the direct action of glacial ice in a variety of landforms. Also, a general term for a landform composed mainly of till (except for kame moraines, which are composed mainly of stratified outwash) that has been deposited by a glacier. Some types of moraines are disintegration, end, ground, kame, lateral, recessional, and terminal.

Morphology, soil

The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil

Irregular spots of different colors that vary in number and size. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Mountain

A generic term for an elevated area of the land surface, rising more than 1,000 feet (300 meters) above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides. A mountain can

occur as a single, isolated mass or in a group forming a chain or range. Mountains are formed primarily by tectonic activity and/or volcanic action but can also be formed by differential erosion.

Muck

Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mucky peat

See Hemic soil material.

Mudstone

A blocky or massive, fine grained sedimentary rock in which the proportions of clay and silt are approximately equal. Also, a general term for such material as clay, silt, claystone, siltstone, shale, and argillite and that should be used only when the amounts of clay and silt are not known or cannot be precisely identified.

Munsell notation

A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Natric horizon

A special kind of argillic horizon that contains enough exchangeable sodium to have an adverse effect on the physical condition of the subsoil.

Neutral soil

A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules

See Redoximorphic features.

Nose slope (geomorphology)

A geomorphic component of hills consisting of the projecting end (laterally convex area) of a hillside. The overland waterflow is predominantly divergent. Nose slopes consist dominantly of colluvium and slope-wash sediments (for example, slope alluvium).

Nutrient, plant

Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter

Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low: Less than 0.5 percent
Low: 0.5 to 1.0 percent
Moderately low: 1.0 to 2.0 percent
Moderate: 2.0 to 4.0 percent
High: 4.0 to 8.0 percent
Very high: More than 8.0 percent

Outwash

Stratified and sorted sediments (chiefly sand and gravel) removed or “washed out” from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of a glacier. The coarser material is deposited nearer to the ice.

Outwash plain

An extensive lowland area of coarse textured glaciofluvial material. An outwash plain is commonly smooth; where pitted, it generally is low in relief.

Paleoterrace

An erosional remnant of a terrace that retains the surface form and alluvial deposits of its origin but was not emplaced by, and commonly does not grade to, a present-day stream or drainage network.

Pan

A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material

The unconsolidated organic and mineral material in which soil forms.

Peat

Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped

An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedisediment

A layer of sediment, eroded from the shoulder and backslope of an erosional slope, that lies on and is being (or was) transported across a gently sloping erosional surface at the foot of a receding hill or mountain slope.

Pedon

The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation

The movement of water through the soil.

Perennial water (map symbol)

Small, natural or constructed lakes, ponds, or pits that contain water most of the year.

Permafrost

Ground, soil, or rock that remains at or below 0 degrees C for at least 2 years. It is defined on the basis of temperature and is not necessarily frozen.

pH value

A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Phase, soil

A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

Piping

Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting

Pits caused by melting around ice. They form on the soil after plant cover is removed.

Plastic limit

The moisture content at which a soil changes from semisolid to plastic.

Plasticity index

The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plateau (geomorphology)

A comparatively flat area of great extent and elevation; specifically, an extensive land region that is considerably elevated (more than 100 meters) above the adjacent lower lying terrain, is commonly limited on at least one side by an abrupt descent, and has a flat or nearly level surface. A comparatively large part of a plateau surface is near summit level.

Playa

The generally dry and nearly level lake plain that occupies the lowest parts of closed depressions, such as those on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff. Playa deposits are fine grained and may or may not have a high water table and saline conditions.

Plinthite

The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Plowpan

A compacted layer formed in the soil directly below the plowed layer.

Ponding

Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded

Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Pore linings

See Redoximorphic features.

Potential native plant community

See Climax plant community.

Potential rooting depth (effective rooting depth)

Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning

Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.

Productivity, soil

The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil

A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use

Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction capacity of the key plants and

promotes the accumulation of litter and mulch necessary to conserve soil and water.

Rangeland

Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil

A measure of acidity or alkalinity of a soil, expressed as pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid: Less than 3.5
Extremely acid: 3.5 to 4.4
Very strongly acid: 4.5 to 5.0
Strongly acid: 5.1 to 5.5
Moderately acid: 5.6 to 6.0
Slightly acid: 6.1 to 6.5
Neutral: 6.6 to 7.3
Slightly alkaline: 7.4 to 7.8
Moderately alkaline: 7.9 to 8.4
Strongly alkaline: 8.5 to 9.0
Very strongly alkaline: 9.1 and higher

Red beds

Sedimentary strata that are mainly red and are made up largely of sandstone and shale.

Redoximorphic concentrations

See Redoximorphic features.

Redoximorphic depletions

See Redoximorphic features.

Redoximorphic features

Redoximorphic features are associated with wetness and result from alternating periods of reduction and oxidation of iron and manganese compounds in the soil. Reduction occurs during saturation with water, and oxidation occurs when the soil is not saturated. Characteristic color patterns are created by these processes. The reduced iron and manganese ions may be removed from a soil if vertical or lateral fluxes of water occur, in which case there is no iron or manganese precipitation in that soil. Wherever the iron and manganese are oxidized and precipitated, they form either soft masses or hard concretions or nodules. Movement of iron and manganese as a result of redoximorphic processes in a soil may result in redoximorphic features that are defined as follows:

1. Redoximorphic concentrations.—These are zones of apparent accumulation of iron-manganese oxides, including:
   A. Nodules and concretions, which are cemented bodies that can be removed from the soil intact. Concretions are distinguished from nodules on the basis of internal organization. A concretion typically has concentric layers that are visible to the naked eye. Nodules do not have visible organized internal structure; *and*
   B. Masses, which are noncemented concentrations of substances within the soil matrix; *and*
   C. Pore linings, i.e., zones of accumulation along pores that may be either coatings on pore surfaces or impregnations from the matrix adjacent to the pores.
2. Redoximorphic depletions.—These are zones of low chroma (chromas less than those in the matrix) where either iron-manganese oxides alone or both iron-manganese oxides and clay have been stripped out, including:
   A. Iron depletions, i.e., zones that contain low amounts of iron and manganese oxides but have a clay content similar to that of the adjacent matrix; *and*
   B. Clay depletions, i.e., zones that contain low amounts of iron, manganese, and clay (often referred to as silt coatings or skeletans).
3. Reduced matrix.—This is a soil matrix that has low chroma *in situ* but undergoes a change in hue or chroma within 30 minutes after the soil material has been exposed to air.

Reduced matrix

See Redoximorphic features.

Regolith

All unconsolidated earth materials above the solid bedrock. It includes material weathered in place from all kinds of bedrock and alluvial, glacial, eolian, lacustrine, and pyroclastic deposits.

Relief

The relative difference in elevation between the upland summits and the lowlands or valleys of a given region.

Residuum (residual soil material)

Unconsolidated, weathered or partly weathered mineral material that accumulated as bedrock disintegrated in place.

Rill

A very small, steep-sided channel resulting from erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. A rill generally is not an obstacle to wheeled vehicles and is shallow enough to be smoothed over by ordinary tillage.

Riser

The vertical or steep side slope (e.g., escarpment) of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural, steplike landforms, such as successive stream terraces.

Road cut

A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments

Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rock outcrop (map symbol)

An exposure of bedrock at the surface of the earth. Not used where the named soils of the surrounding map unit are shallow over bedrock or where “Rock outcrop” is a named component of the map unit.

Root zone

The part of the soil that can be penetrated by plant roots.

Runoff

The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil

A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Saline spot (map symbol)

An area where the surface layer has an electrical conductivity of 8 mmhos/cm more than the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has an electrical conductivity of 2 mmhos/cm or less.

Sand

As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone

Sedimentary rock containing dominantly sand-sized particles.

Sandy spot (map symbol)

A spot where the surface layer is loamy fine sand or coarser in areas where the surface layer of the named soils in the surrounding map unit is very fine sandy loam or finer.

Sapric soil material (muck)

The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saturated hydraulic conductivity (Ksat)

The ease with which pores of a saturated soil transmit water. Formally, the proportionality coefficient that expresses the relationship of the rate of water movement to hydraulic gradient in Darcy's Law, a law that describes the rate of water movement through porous media. Commonly abbreviated as "Ksat." Terms describing saturated hydraulic conductivity are:

Very high: 100 or more micrometers per second (14.17 or more inches per hour)

High: 10 to 100 micrometers per second (1.417 to 14.17 inches per hour)

Moderately high: 1 to 10 micrometers per second (0.1417 inch to 1.417 inches per hour)

Moderately low: 0.1 to 1 micrometer per second (0.01417 to 0.1417 inch per hour)

Low: 0.01 to 0.1 micrometer per second (0.001417 to 0.01417 inch per hour)

Very low: Less than 0.01 micrometer per second (less than 0.001417 inch per hour).

To convert inches per hour to micrometers per second, multiply inches per hour by 7.0572. To convert micrometers per second to inches per hour, multiply micrometers per second by 0.1417.

Saturation

Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Scarification

The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

Sedimentary rock

A consolidated deposit of clastic particles, chemical precipitates, or organic remains accumulated at or near the surface of the earth under normal low temperature and pressure conditions. Sedimentary rocks include consolidated equivalents of alluvium, colluvium, drift, and eolian, lacustrine, and marine deposits. Examples are sandstone, siltstone, mudstone, claystone, shale, conglomerate, limestone, dolomite, and coal.

Sequum

A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil

A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Severely eroded spot (map symbol)

An area where, on the average, 75 percent or more of the original surface layer has been lost because of accelerated erosion. Not used in map units in which “severely eroded,” “very severely eroded,” or “gullied” is part of the map unit name.

Shale

Sedimentary rock that formed by the hardening of a deposit of clay, silty clay, or silty clay loam and that has a tendency to split into thin layers.

Sheet erosion

The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Short, steep slope (map symbol)

A narrow area of soil having slopes that are at least two slope classes steeper than the slope class of the surrounding map unit.

Shoulder

The convex, erosional surface near the top of a hillslope. A shoulder is a transition from summit to backslope.

Shrink-swell

The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Shrub-coppice dune

A small, streamlined dune that forms around brush and clump vegetation.

Side slope (geomorphology)

A geomorphic component of hills consisting of a laterally planar area of a hillside. The overland waterflow is predominantly parallel. Side slopes are dominantly colluvium and slope-wash sediments.

Silica

A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio

The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt

As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone

An indurated silt having the texture and composition of shale but lacking its fine lamination or fissility; a massive mudstone in which silt predominates over clay.

Similar soils

Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole (map symbol)

A closed, circular or elliptical depression, commonly funnel shaped, characterized by subsurface drainage and formed either by dissolution of the surface of underlying bedrock (e.g., limestone, gypsum, or salt) or by collapse of underlying caves within bedrock. Complexes of sinkholes in carbonate-rock terrain are the main components of karst topography.

Site index

A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slickensides (pedogenic)

Grooved, striated, and/or glossy (shiny) slip faces on structural peds, such as wedges; produced by shrink-swell processes, most commonly in soils that have a high content of expansive clays.

Slide or slip (map symbol)

A prominent landform scar or ridge caused by fairly recent mass movement or descent of earthy material resulting from failure of earth or rock under shear stress along one or several surfaces.

Slope

The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope alluvium

Sediment gradually transported down the slopes of mountains or hills primarily by nonchannel alluvial processes (i.e., slope-wash processes) and characterized by particle sorting. Lateral particle sorting is evident on long slopes. In a profile sequence, sediments may be distinguished by differences in size and/or specific gravity of rock fragments and may be separated by stone lines. Burnished peds and sorting of rounded or subrounded pebbles or cobbles distinguish these materials from unsorted colluvial deposits.

Slow refill

The slow filling of ponds, resulting from restricted water transmission in the soil.

Slow water movement

Restricted downward movement of water through the soil. See Saturated hydraulic conductivity.

Sodic (alkali) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodic spot (map symbol)

An area where the surface layer has a sodium adsorption ratio that is at least 10 more than that of the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has a sodium adsorption ratio of 5 or less.

Sodicity

The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to $Ca^{++} + Mg^{++}$. The degrees of sodicity and their respective ratios are:

Slight: Less than 13:1
Moderate: 13-30:1
Strong: More than 30:1

Sodium adsorption ratio (SAR)

A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Soft bedrock

Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil

A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief and by the passage of time.

Soil separates

Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand: 2.0 to 1.0
Coarse sand: 1.0 to 0.5
Medium sand: 0.5 to 0.25
Fine sand: 0.25 to 0.10
Very fine sand: 0.10 to 0.05
Silt: 0.05 to 0.002
Clay: Less than 0.002

Solum

The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Spoil area (map symbol)

A pile of earthy materials, either smoothed or uneven, resulting from human activity.

Stone line

In a vertical cross section, a line formed by scattered fragments or a discrete layer of angular and subangular rock fragments (commonly a gravel- or cobble-sized lag concentration) that formerly was draped across a topographic surface and was later buried by additional sediments. A stone line generally caps material that was subject to weathering, soil formation, and erosion before burial. Many stone lines seem to be buried erosion pavements, originally formed by sheet and rill erosion across the land surface.

Stones

Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony

Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stony spot (map symbol)

A spot where 0.01 to 0.1 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surrounding soil has no surface stones.

Strath terrace

A type of stream terrace; formed as an erosional surface cut on bedrock and thinly mantled with stream deposits (alluvium).

Stream terrace

One of a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream; represents the remnants of an abandoned flood plain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition.

Stripcropping

Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind erosion and water erosion.

Structure, soil

The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are:

Platy: Flat and laminated

Prismatic: Vertically elongated and having flat tops

Columnar: Vertically elongated and having rounded tops

Angular blocky: Having faces that intersect at sharp angles (planes)

Subangular blocky: Having subrounded and planar faces (no sharp angles)

Granular: Small structural units with curved or very irregular faces

Structureless soil horizons are defined as follows:

Single grained: Entirely noncoherent (each grain by itself), as in loose sand

Massive: Occurring as a coherent mass

Stubble mulch

Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind erosion and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil

Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling

Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum

The part of the soil below the solum.

Subsurface layer

Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow

The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Summit

The topographically highest position of a hillslope. It has a nearly level (planar or only slightly convex) surface.

Surface layer

The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the “plow layer,” or the “Ap horizon.”

Surface soil

The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Talus

Rock fragments of any size or shape (commonly coarse and angular) derived from and lying at the base of a cliff or very steep rock slope. The accumulated mass of such loose broken rock formed chiefly by falling, rolling, or sliding.

Taxadjuncts

Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named.

Terminal moraine

An end moraine that marks the farthest advance of a glacier. It typically has the form of a massive arcuate or concentric ridge, or complex of ridges, and is underlain by till and other types of drift.

Terrace (conservation)

An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field

generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geomorphology)

A steplike surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, lake, or seashore. The term is usually applied both to the relatively flat summit surface (tread) that was cut or built by stream or wave action and to the steeper descending slope (scarp or riser) that has graded to a lower base level of erosion.

Terracettes

Small, irregular steplike forms on steep hillslopes, especially in pasture, formed by creep or erosion of surficial materials that may be induced or enhanced by trampling of livestock, such as sheep or cattle.

Texture, soil

The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.”

Thin layer

Otherwise suitable soil material that is too thin for the specified use.

Till

Dominantly unsorted and nonstratified drift, generally unconsolidated and deposited directly by a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, stones, and boulders; rock fragments of various lithologies are embedded within a finer matrix that can range from clay to sandy loam.

Till plain

An extensive area of level to gently undulating soils underlain predominantly by till and bounded at the distal end by subordinate recessional or end moraines.

Tilth, soil

The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toeslope

The gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear and are constructional surfaces forming the lower part of a hillslope continuum that grades to valley or closed-depression floors.

Topsoil

The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements

Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Tread

The flat to gently sloping, topmost, laterally extensive slope of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural steplike landforms, such as successive stream terraces.

Tuff

A generic term for any consolidated or cemented deposit that is 50 percent or more volcanic ash.

Upland

An informal, general term for the higher ground of a region, in contrast with a low-lying adjacent area, such as a valley or plain, or for land at a higher elevation than the flood plain or low stream terrace; land above the footslope zone of the hillslope continuum.

Valley fill

The unconsolidated sediment deposited by any agent (water, wind, ice, or mass wasting) so as to fill or partly fill a valley.

Variegation

Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve

A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Very stony spot (map symbol)

A spot where 0.1 to 3.0 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surface of the surrounding soil is covered by less than 0.01 percent stones.

Water bars

Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Weathering

All physical disintegration, chemical decomposition, and biologically induced changes in rocks or other deposits at or near the earth's surface by atmospheric or biologic agents or by circulating surface waters but involving essentially no transport of the altered material.

Well graded

Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wet spot (map symbol)

A somewhat poorly drained to very poorly drained area that is at least two drainage classes wetter than the named soils in the surrounding map unit.

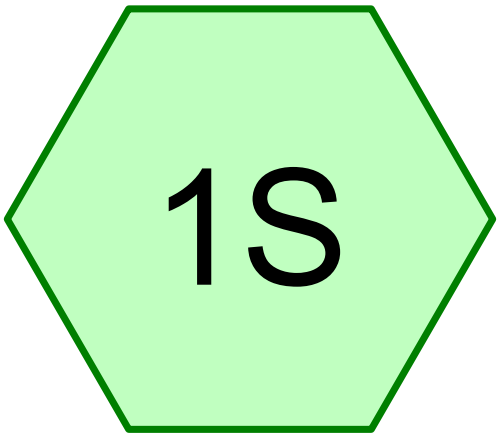
Wilting point (or permanent wilting point)

The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow

The uprooting and tipping over of trees by the wind.

APPENDIX B – HYDROCAD ANALYSIS-EXISTING



Pre development

Subcat Reach Pond Link

Routing Diagram for St. Gobain
Prepared by Kimley-Horn & Associates, Printed 4/12/2024

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Yrs	Type II 24-hr		Default	24.00	1	3.16	2
2	10-Yrs	Type II 24-hr		Default	24.00	1	4.88	2
3	25-Yrs	Type II 24-hr		Default	24.00	1	5.95	2
4	100-Yrs	Type II 24-hr		Default	24.00	1	7.60	2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.700	98	Building and pavement (1S)
0.300	80	Grass/Landscape area (1S)
3.000	**96**	**TOTAL AREA**

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre development Runoff Area=3.000 ac 90.00% Impervious Runoff Depth>2.53"
Tc=5.0 min CN=96 Runoff=13.12 cfs 0.634 af

Total Runoff Area = 3.000 ac Runoff Volume = 0.634 af Average Runoff Depth = 2.53"
10.00% Pervious = 0.300 ac 90.00% Impervious = 2.700 ac

Summary for Subcatchment 1S: Pre development

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

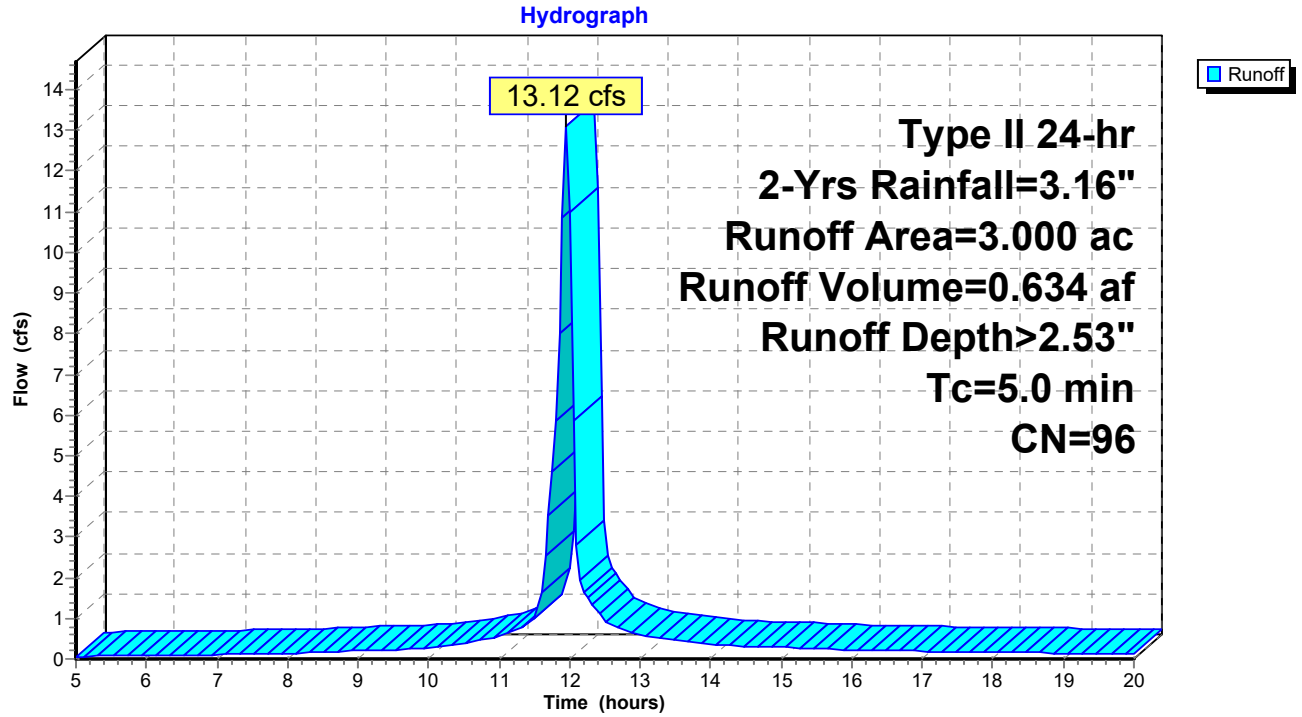
Runoff = 13.12 cfs @ 11.95 hrs, Volume= 0.634 af, Depth> 2.53"
Routed to nonexistent node 2R

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Yrs Rainfall=3.16"

	Area (ac)	CN	Description
*	2.700	98	Building and pavement
*	0.300	80	Grass/Landscape area
	3.000	96	Weighted Average
	0.300		10.00% Pervious Area
	2.700		90.00% Impervious Area

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

Subcatchment 1S: Pre development



Hydrograph for Subcatchment 1S: Pre development

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.20	0.03	0.06
5.25	0.21	0.03	0.06
5.50	0.23	0.04	0.07
5.75	0.24	0.04	0.08
6.00	0.25	0.05	0.08
6.25	0.27	0.06	0.09
6.50	0.28	0.06	0.10
6.75	0.30	0.07	0.10
7.00	0.31	0.08	0.11
7.25	0.33	0.09	0.12
7.50	0.35	0.10	0.12
7.75	0.36	0.11	0.13
8.00	0.38	0.12	0.14
8.25	0.40	0.14	0.15
8.50	0.42	0.15	0.17
8.75	0.44	0.16	0.19
9.00	0.46	0.18	0.22
9.25	0.49	0.20	0.23
9.50	0.52	0.22	0.23
9.75	0.54	0.24	0.26
10.00	0.57	0.26	0.29
10.25	0.61	0.29	0.34
10.50	0.64	0.32	0.39
10.75	0.69	0.36	0.47
11.00	0.74	0.40	0.56
11.25	0.81	0.46	0.73
11.50	0.89	0.54	0.95
11.75	1.22	0.83	**4.62**
12.00	2.10	1.67	**10.99**
12.25	2.23	1.80	1.51
12.50	2.32	1.89	0.97
12.75	2.39	1.95	0.73
13.00	2.44	2.00	0.61
13.25	2.48	2.05	0.53
13.50	2.52	2.09	0.46
13.75	2.56	2.12	0.41
14.00	2.59	2.15	0.36
14.25	2.62	2.18	0.34
14.50	2.65	2.21	0.32
14.75	2.67	2.23	0.30
15.00	2.70	2.25	0.29
15.25	2.72	2.28	0.27
15.50	2.74	2.30	0.25
15.75	2.76	2.32	0.24
16.00	2.78	2.34	0.22
16.25	2.80	2.35	0.21
16.50	2.82	2.37	0.21
16.75	2.83	2.39	0.20
17.00	2.85	2.40	0.19
17.25	2.87	2.42	0.19
17.50	2.88	2.43	0.18
17.75	2.90	2.45	0.18
18.00	2.91	2.46	0.17
18.25	2.92	2.48	0.17
18.50	2.94	2.49	0.16
18.75	2.95	2.50	0.15
19.00	2.96	2.52	0.15
19.25	2.98	2.53	0.14
19.50	2.99	2.54	0.14
19.75	3.00	2.55	0.13
20.00	**3.01**	**2.56**	0.12

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre development Runoff Area=3.000 ac 90.00% Impervious Runoff Depth>4.10"
Tc=5.0 min CN=96 Runoff=20.74 cfs 1.026 af

Total Runoff Area = 3.000 ac Runoff Volume = 1.026 af Average Runoff Depth = 4.10"
10.00% Pervious = 0.300 ac 90.00% Impervious = 2.700 ac

Summary for Subcatchment 1S: Pre development

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

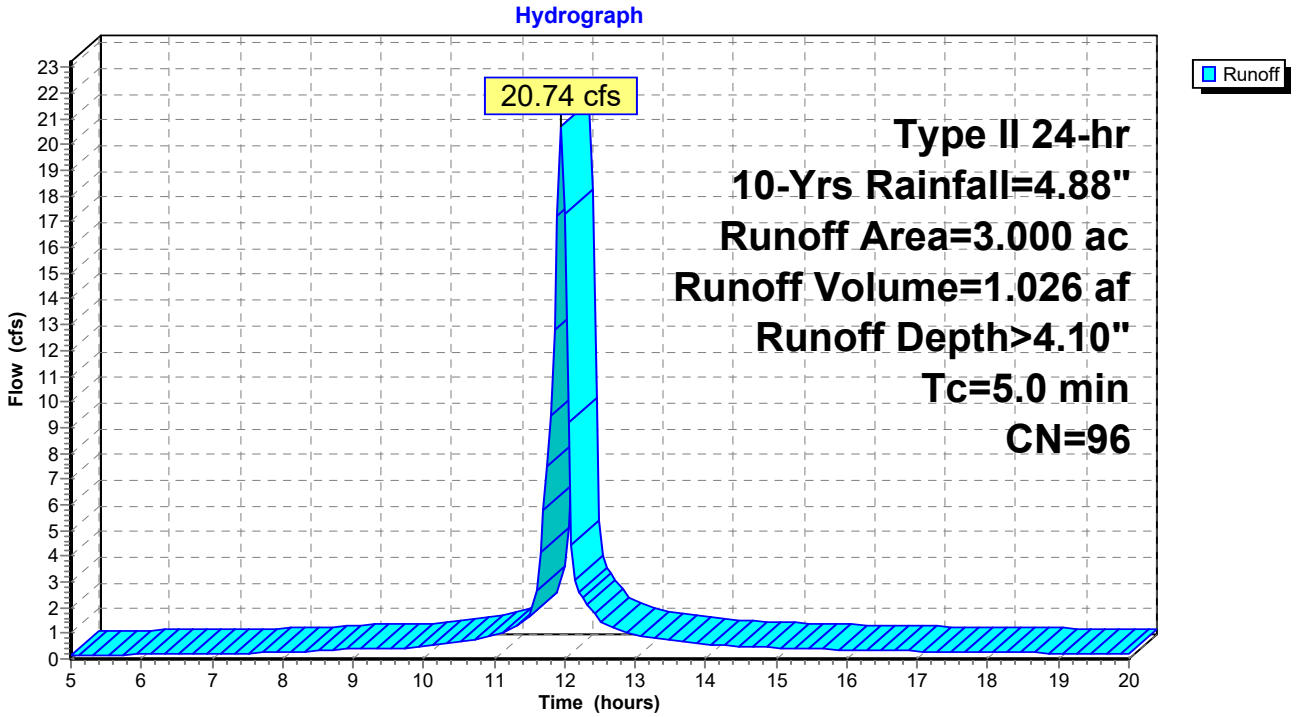
Runoff = 20.74 cfs @ 11.95 hrs, Volume= 1.026 af, Depth> 4.10"
Routed to nonexistent node 2R

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Yrs Rainfall=4.88"

	Area (ac)	CN	Description
*	2.700	98	Building and pavement
*	0.300	80	Grass/Landscape area
	3.000	96	Weighted Average
	0.300		10.00% Pervious Area
	2.700		90.00% Impervious Area

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

Subcatchment 1S: Pre development



Hydrograph for Subcatchment 1S: Pre development

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.31	0.08	0.13
5.25	0.33	0.09	0.14
5.50	0.35	0.10	0.15
5.75	0.37	0.12	0.16
6.00	0.39	0.13	0.17
6.25	0.41	0.15	0.18
6.50	0.44	0.16	0.19
6.75	0.46	0.18	0.21
7.00	0.48	0.20	0.22
7.25	0.51	0.21	0.23
7.50	0.53	0.23	0.24
7.75	0.56	0.25	0.25
8.00	0.59	0.27	0.25
8.25	0.61	0.30	0.28
8.50	0.65	0.32	0.32
8.75	0.68	0.35	0.35
9.00	0.72	0.38	0.39
9.25	0.76	0.42	0.40
9.50	0.80	0.45	0.41
9.75	0.84	0.49	0.45
10.00	0.88	0.53	0.50
10.25	0.94	0.57	0.58
10.50	1.00	0.63	0.67
10.75	1.07	0.69	0.79
11.00	1.15	0.76	0.93
11.25	1.25	0.86	1.21
11.50	1.38	0.98	1.56
11.75	1.89	1.47	**7.47**
12.00	3.24	2.78	**17.32**
12.25	3.45	2.99	2.36
12.50	3.59	3.13	1.53
12.75	3.69	3.23	1.14
13.00	3.77	3.31	0.95
13.25	3.84	3.38	0.82
13.50	3.90	3.44	0.72
13.75	3.95	3.49	0.64
14.00	4.00	3.54	0.56
14.25	4.05	3.59	0.52
14.50	4.09	3.63	0.50
14.75	4.13	3.67	0.47
15.00	4.17	3.70	0.45
15.25	4.20	3.74	0.42
15.50	4.23	3.77	0.40
15.75	4.27	3.80	0.37
16.00	4.29	3.83	0.34
16.25	4.32	3.86	0.33
16.50	4.35	3.89	0.32
16.75	4.38	3.91	0.31
17.00	4.40	3.94	0.30
17.25	4.43	3.96	0.29
17.50	4.45	3.99	0.28
17.75	4.47	4.01	0.28
18.00	4.49	4.03	0.27
18.25	4.52	4.05	0.26
18.50	4.54	4.07	0.25
18.75	4.56	4.09	0.24
19.00	4.58	4.11	0.23
19.25	4.59	4.13	0.22
19.50	4.61	4.15	0.21
19.75	4.63	4.16	0.20
20.00	**4.65**	**4.18**	0.19

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre development Runoff Area=3.000 ac 90.00% Impervious Runoff Depth>5.08"
Tc=5.0 min CN=96 Runoff=25.44 cfs 1.269 af

Total Runoff Area = 3.000 ac Runoff Volume = 1.269 af Average Runoff Depth = 5.08"
10.00% Pervious = 0.300 ac 90.00% Impervious = 2.700 ac

Summary for Subcatchment 1S: Pre development

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

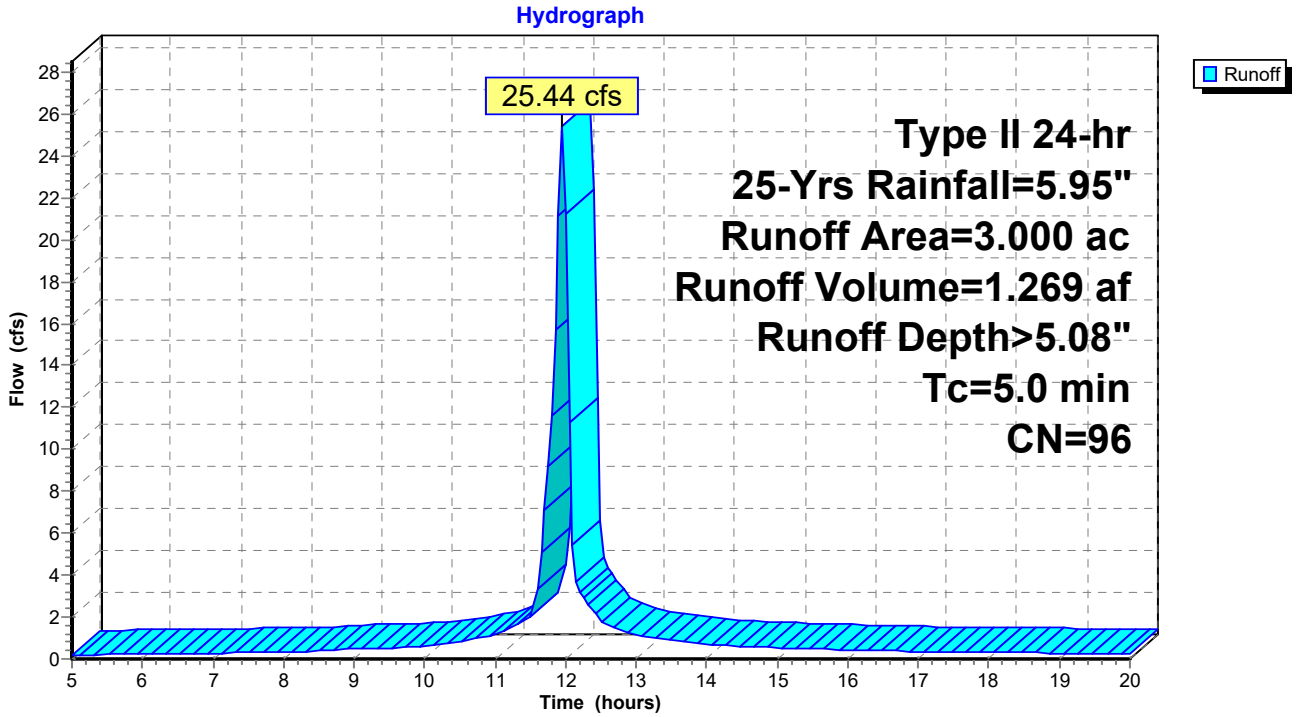
Runoff = 25.44 cfs @ 11.95 hrs, Volume= 1.269 af, Depth> 5.08"
Routed to nonexistent node 2R

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Yrs Rainfall=5.95"

	Area (ac)	CN	Description
*	2.700	98	Building and pavement
*	0.300	80	Grass/Landscape area
	3.000	96	Weighted Average
	0.300		10.00% Pervious Area
	2.700		90.00% Impervious Area

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

Subcatchment 1S: Pre development



Hydrograph for Subcatchment 1S: Pre development

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.37	0.12	0.18
5.25	0.40	0.14	0.20
5.50	0.42	0.15	0.21
5.75	0.45	0.17	0.22
6.00	0.48	0.19	0.23
6.25	0.50	0.21	0.25
6.50	0.53	0.23	0.26
6.75	0.56	0.25	0.27
7.00	0.59	0.28	0.28
7.25	0.62	0.30	0.29
7.50	0.65	0.33	0.31
7.75	0.68	0.35	0.32
8.00	0.71	0.38	0.33
8.25	0.75	0.41	0.36
8.50	0.79	0.44	0.41
8.75	0.83	0.48	0.45
9.00	0.87	0.52	0.49
9.25	0.92	0.56	0.51
9.50	0.97	0.60	0.52
9.75	1.02	0.65	0.57
10.00	1.08	0.70	0.64
10.25	1.14	0.76	0.73
10.50	1.21	0.83	0.84
10.75	1.30	0.90	0.99
11.00	1.40	1.00	1.17
11.25	1.52	1.12	1.51
11.50	1.68	1.27	1.94
11.75	2.30	1.87	**9.23**
12.00	3.94	3.49	**21.23**
12.25	4.20	3.74	2.89
12.50	4.37	3.91	1.87
12.75	4.49	4.03	1.39
13.00	4.59	4.13	1.16
13.25	4.68	4.21	1.00
13.50	4.75	4.29	0.88
13.75	4.82	4.35	0.78
14.00	4.88	4.41	0.69
14.25	4.93	4.47	0.64
14.50	4.98	4.52	0.61
14.75	5.03	4.56	0.58
15.00	5.08	4.61	0.55
15.25	5.12	4.65	0.52
15.50	5.16	4.69	0.48
15.75	5.20	4.73	0.45
16.00	5.24	4.77	0.42
16.25	5.27	4.80	0.40
16.50	5.30	4.83	0.39
16.75	5.33	4.87	0.38
17.00	5.37	4.90	0.37
17.25	5.40	4.93	0.36
17.50	5.42	4.95	0.35
17.75	5.45	4.98	0.34
18.00	5.48	5.01	0.33
18.25	5.51	5.04	0.31
18.50	5.53	5.06	0.30
18.75	5.56	5.09	0.29
19.00	5.58	5.11	0.28
19.25	5.60	5.13	0.27
19.50	5.62	5.15	0.26
19.75	5.64	5.17	0.25
20.00	**5.66**	**5.19**	0.24

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre development Runoff Area=3.000 ac 90.00% Impervious Runoff Depth>6.57"
Tc=5.0 min CN=96 Runoff=32.67 cfs 1.642 af

Total Runoff Area = 3.000 ac Runoff Volume = 1.642 af Average Runoff Depth = 6.57"
10.00% Pervious = 0.300 ac 90.00% Impervious = 2.700 ac

Summary for Subcatchment 1S: Pre development

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

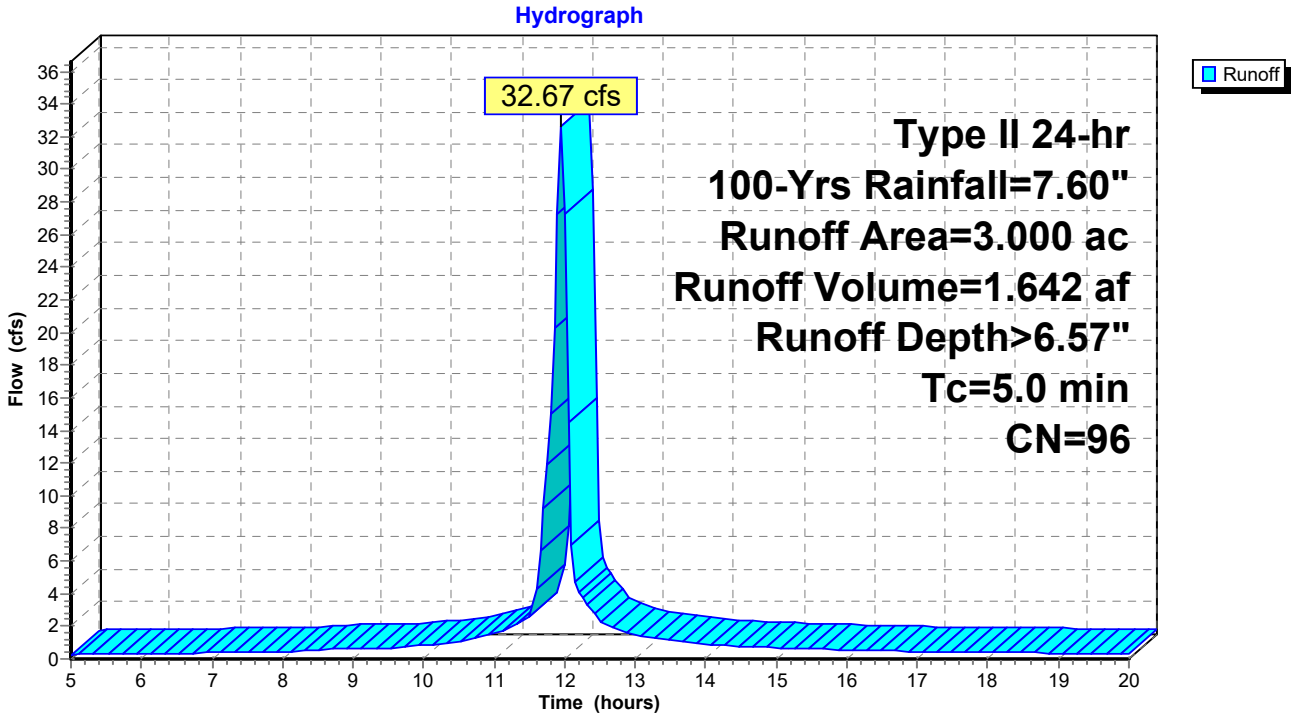
Runoff = 32.67 cfs @ 11.95 hrs, Volume= 1.642 af, Depth> 6.57"
Routed to nonexistent node 2R

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Yrs Rainfall=7.60"

	Area (ac)	CN	Description
*	2.700	98	Building and pavement
*	0.300	80	Grass/Landscape area
	3.000	96	Weighted Average
	0.300		10.00% Pervious Area
	2.700		90.00% Impervious Area

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

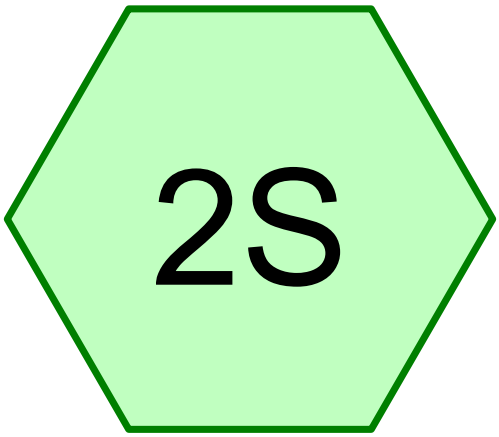
Subcatchment 1S: Pre development



Hydrograph for Subcatchment 1S: Pre development

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.48	0.19	0.27
5.25	0.51	0.22	0.28
5.50	0.54	0.24	0.30
5.75	0.57	0.27	0.31
6.00	0.61	0.29	0.33
6.25	0.64	0.32	0.34
6.50	0.68	0.35	0.36
6.75	0.71	0.38	0.37
7.00	0.75	0.41	0.39
7.25	0.79	0.45	0.40
7.50	0.83	0.48	0.42
7.75	0.87	0.51	0.43
8.00	0.91	0.55	0.44
8.25	0.96	0.59	0.49
8.50	1.01	0.63	0.54
8.75	1.06	0.68	0.60
9.00	1.12	0.74	0.66
9.25	1.18	0.79	0.68
9.50	1.24	0.85	0.68
9.75	1.30	0.91	0.75
10.00	1.38	0.98	0.84
10.25	1.46	1.05	0.96
10.50	1.55	1.14	1.09
10.75	1.66	1.25	1.29
11.00	1.79	1.37	1.52
11.25	1.95	1.52	1.97
11.50	2.15	1.72	2.51
11.75	2.94	2.49	**11.92**
12.00	5.04	4.57	**27.23**
12.25	5.37	4.90	3.70
12.50	5.59	5.12	2.39
12.75	5.74	5.27	1.79
13.00	5.87	5.40	1.49
13.25	5.98	5.50	1.29
13.50	6.07	5.60	1.13
13.75	6.16	5.68	1.00
14.00	6.23	5.76	0.88
14.25	6.30	5.83	0.82
14.50	6.37	5.89	0.78
14.75	6.43	5.95	0.74
15.00	6.49	6.01	0.70
15.25	6.54	6.07	0.66
15.50	6.59	6.12	0.62
15.75	6.64	6.17	0.58
16.00	6.69	6.21	0.54
16.25	6.73	6.26	0.52
16.50	6.77	6.30	0.50
16.75	6.81	6.34	0.49
17.00	6.85	6.38	0.47
17.25	6.89	6.42	0.46
17.50	6.93	6.45	0.45
17.75	6.96	6.49	0.43
18.00	7.00	6.52	0.42
18.25	7.03	6.56	0.40
18.50	7.07	6.59	0.39
18.75	7.10	6.62	0.37
19.00	7.13	6.65	0.36
19.25	7.16	6.68	0.35
19.50	7.18	6.71	0.33
19.75	7.21	6.73	0.32
20.00	**7.24**	**6.76**	0.30

APPENDIX C – HYDROCAD ANALYSIS-PROPOSED



Post Development

Subcat Reach Pond Link

Routing Diagram for St. Gobain
Prepared by Kimley-Horn & Associates, Printed 4/12/2024

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Yrs	Type II 24-hr		Default	24.00	1	3.16	2
2	10-Yrs	Type II 24-hr		Default	24.00	1	4.88	2
3	25-Yrs	Type II 24-hr		Default	24.00	1	5.95	2
4	100-Yrs	Type II 24-hr		Default	24.00	1	7.60	2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.170	98	Building and pavement (2S)
0.820	80	grass/landscape area (2S)
2.990	**93**	**TOTAL AREA**

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: Post Development Runoff Area=2.990 ac 72.58% Impervious Runoff Depth>2.26"
Tc=5.0 min CN=93 Runoff=12.17 cfs 0.563 af

Total Runoff Area = 2.990 ac Runoff Volume = 0.563 af Average Runoff Depth = 2.26"
27.42% Pervious = 0.820 ac 72.58% Impervious = 2.170 ac

Summary for Subcatchment 2S: Post Development

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

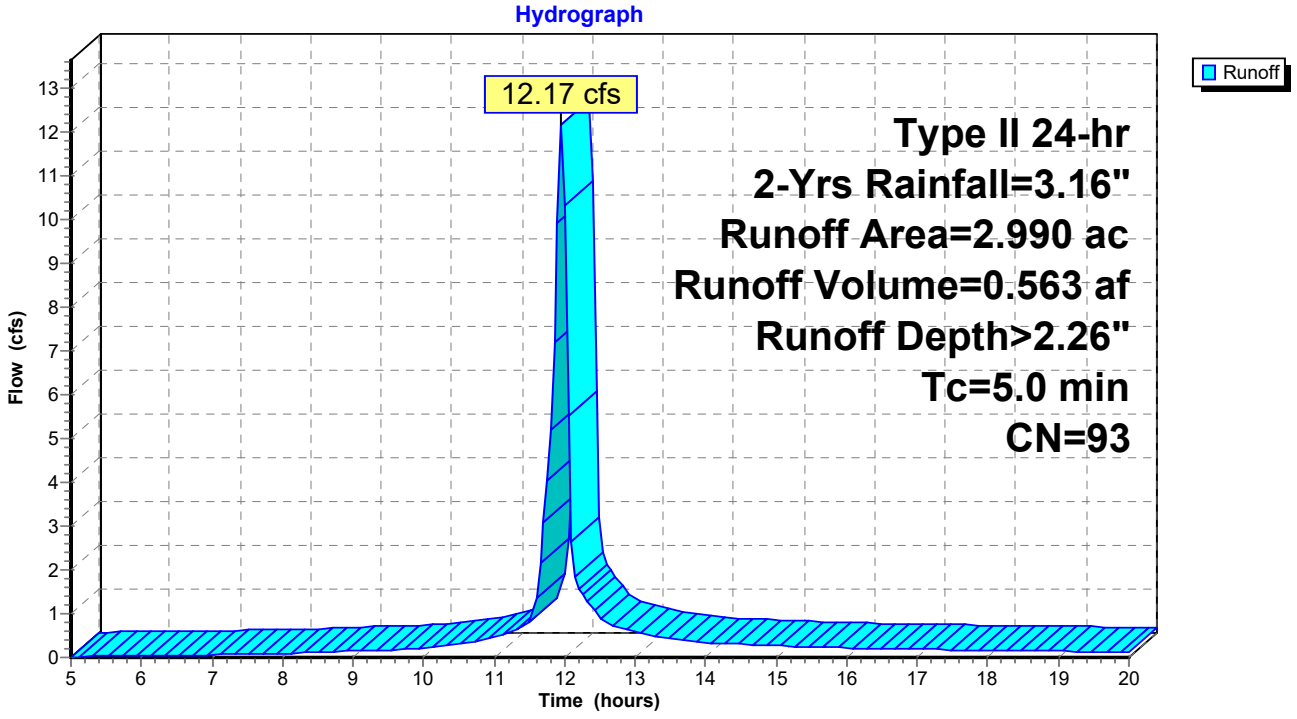
Runoff = 12.17 cfs @ 11.95 hrs, Volume= 0.563 af, Depth> 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Yrs Rainfall=3.16"

	Area (ac)	CN	Description
*	2.170	98	Building and pavement
*	0.820	80	grass/landscape area
	2.990	93	Weighted Average
	0.820		27.42% Pervious Area
	2.170		72.58% Impervious Area

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

Subcatchment 2S: Post Development



Hydrograph for Subcatchment 2S: Post Development

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.20	0.00	0.02
5.25	0.21	0.00	0.02
5.50	0.23	0.01	0.03
5.75	0.24	0.01	0.03
6.00	0.25	0.01	0.04
6.25	0.27	0.02	0.04
6.50	0.28	0.02	0.05
6.75	0.30	0.02	0.05
7.00	0.31	0.03	0.06
7.25	0.33	0.03	0.07
7.50	0.35	0.04	0.07
7.75	0.36	0.05	0.08
8.00	0.38	0.05	0.08
8.25	0.40	0.06	0.10
8.50	0.42	0.07	0.11
8.75	0.44	0.08	0.13
9.00	0.46	0.09	0.15
9.25	0.49	0.11	0.16
9.50	0.52	0.12	0.16
9.75	0.54	0.13	0.19
10.00	0.57	0.15	0.22
10.25	0.61	0.17	0.25
10.50	0.64	0.20	0.30
10.75	0.69	0.23	0.37
11.00	0.74	0.26	0.45
11.25	0.81	0.31	0.60
11.50	0.89	0.37	0.79
11.75	1.22	0.63	**4.04**
12.00	2.10	1.40	**10.29**
12.25	2.23	1.53	1.43
12.50	2.32	1.61	0.93
12.75	2.39	1.67	0.70
13.00	2.44	1.72	0.58
13.25	2.48	1.77	0.50
13.50	2.52	1.80	0.44
13.75	2.56	1.84	0.39
14.00	2.59	1.87	0.35
14.25	2.62	1.89	0.32
14.50	2.65	1.92	0.31
14.75	2.67	1.94	0.29
15.00	2.70	1.97	0.28
15.25	2.72	1.99	0.26
15.50	2.74	2.01	0.24
15.75	2.76	2.03	0.23
16.00	2.78	2.05	0.21
16.25	2.80	2.06	0.20
16.50	2.82	2.08	0.20
16.75	2.83	2.09	0.19
17.00	2.85	2.11	0.19
17.25	2.87	2.13	0.18
17.50	2.88	2.14	0.18
17.75	2.90	2.15	0.17
18.00	2.91	2.17	0.17
18.25	2.92	2.18	0.16
18.50	2.94	2.19	0.15
18.75	2.95	2.21	0.15
19.00	2.96	2.22	0.14
19.25	2.98	2.23	0.14
19.50	2.99	2.24	0.13
19.75	3.00	2.25	0.13
20.00	**3.01**	**2.26**	0.12

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: Post Development Runoff Area=2.990 ac 72.58% Impervious Runoff Depth>3.82"
Tc=5.0 min CN=93 Runoff=19.92 cfs 0.952 af

Total Runoff Area = 2.990 ac Runoff Volume = 0.952 af Average Runoff Depth = 3.82"
27.42% Pervious = 0.820 ac 72.58% Impervious = 2.170 ac

Summary for Subcatchment 2S: Post Development

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

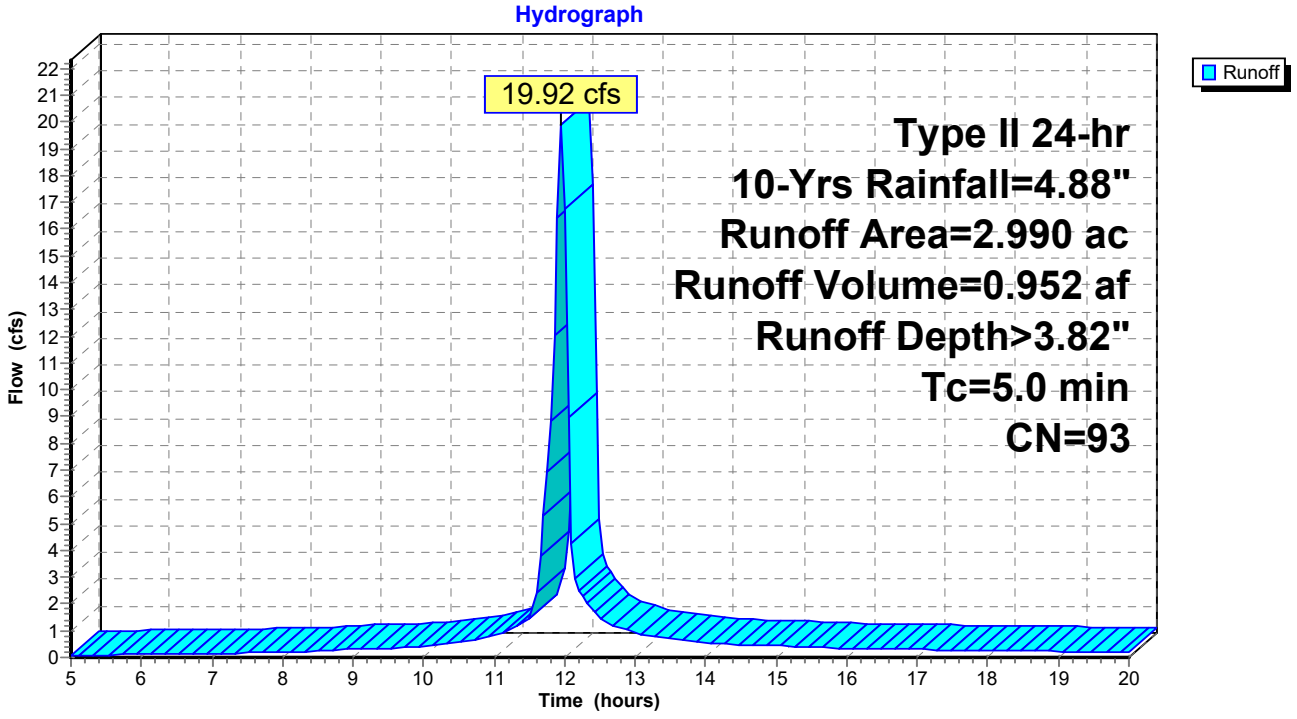
Runoff = 19.92 cfs @ 11.95 hrs, Volume= 0.952 af, Depth> 3.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Yrs Rainfall=4.88"

	Area (ac)	CN	Description
*	2.170	98	Building and pavement
*	0.820	80	grass/landscape area
	2.990	93	Weighted Average
	0.820		27.42% Pervious Area
	2.170		72.58% Impervious Area

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

Subcatchment 2S: Post Development



Hydrograph for Subcatchment 2S: Post Development

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.31	0.03	0.07
5.25	0.33	0.03	0.08
5.50	0.35	0.04	0.09
5.75	0.37	0.05	0.10
6.00	0.39	0.06	0.11
6.25	0.41	0.07	0.12
6.50	0.44	0.08	0.13
6.75	0.46	0.09	0.14
7.00	0.48	0.10	0.15
7.25	0.51	0.12	0.16
7.50	0.53	0.13	0.17
7.75	0.56	0.14	0.18
8.00	0.59	0.16	0.19
8.25	0.61	0.18	0.21
8.50	0.65	0.20	0.24
8.75	0.68	0.22	0.27
9.00	0.72	0.24	0.31
9.25	0.76	0.27	0.32
9.50	0.80	0.30	0.33
9.75	0.84	0.33	0.37
10.00	0.88	0.36	0.42
10.25	0.94	0.40	0.49
10.50	1.00	0.45	0.57
10.75	1.07	0.50	0.69
11.00	1.15	0.57	0.82
11.25	1.25	0.65	1.08
11.50	1.38	0.76	1.41
11.75	1.89	1.21	**6.93**
12.00	3.24	2.48	**16.72**
12.25	3.45	2.68	2.30
12.50	3.59	2.82	1.49
12.75	3.69	2.91	1.11
13.00	3.77	2.99	0.93
13.25	3.84	3.06	0.80
13.50	3.90	3.12	0.70
13.75	3.95	3.17	0.62
14.00	4.00	3.22	0.55
14.25	4.05	3.26	0.51
14.50	4.09	3.31	0.49
14.75	4.13	3.34	0.46
15.00	4.17	3.38	0.44
15.25	4.20	3.42	0.41
15.50	4.23	3.45	0.39
15.75	4.27	3.48	0.36
16.00	4.29	3.51	0.34
16.25	4.32	3.53	0.32
16.50	4.35	3.56	0.32
16.75	4.38	3.59	0.31
17.00	4.40	3.61	0.30
17.25	4.43	3.63	0.29
17.50	4.45	3.66	0.28
17.75	4.47	3.68	0.27
18.00	4.49	3.70	0.26
18.25	4.52	3.72	0.25
18.50	4.54	3.74	0.24
18.75	4.56	3.76	0.23
19.00	4.58	3.78	0.23
19.25	4.59	3.80	0.22
19.50	4.61	3.82	0.21
19.75	4.63	3.83	0.20
20.00	**4.65**	**3.85**	0.19

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: Post Development Runoff Area=2.990 ac 72.58% Impervious Runoff Depth>4.80"
Tc=5.0 min CN=93 Runoff=24.69 cfs 1.196 af

Total Runoff Area = 2.990 ac Runoff Volume = 1.196 af Average Runoff Depth = 4.80"
27.42% Pervious = 0.820 ac 72.58% Impervious = 2.170 ac

Summary for Subcatchment 2S: Post Development

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

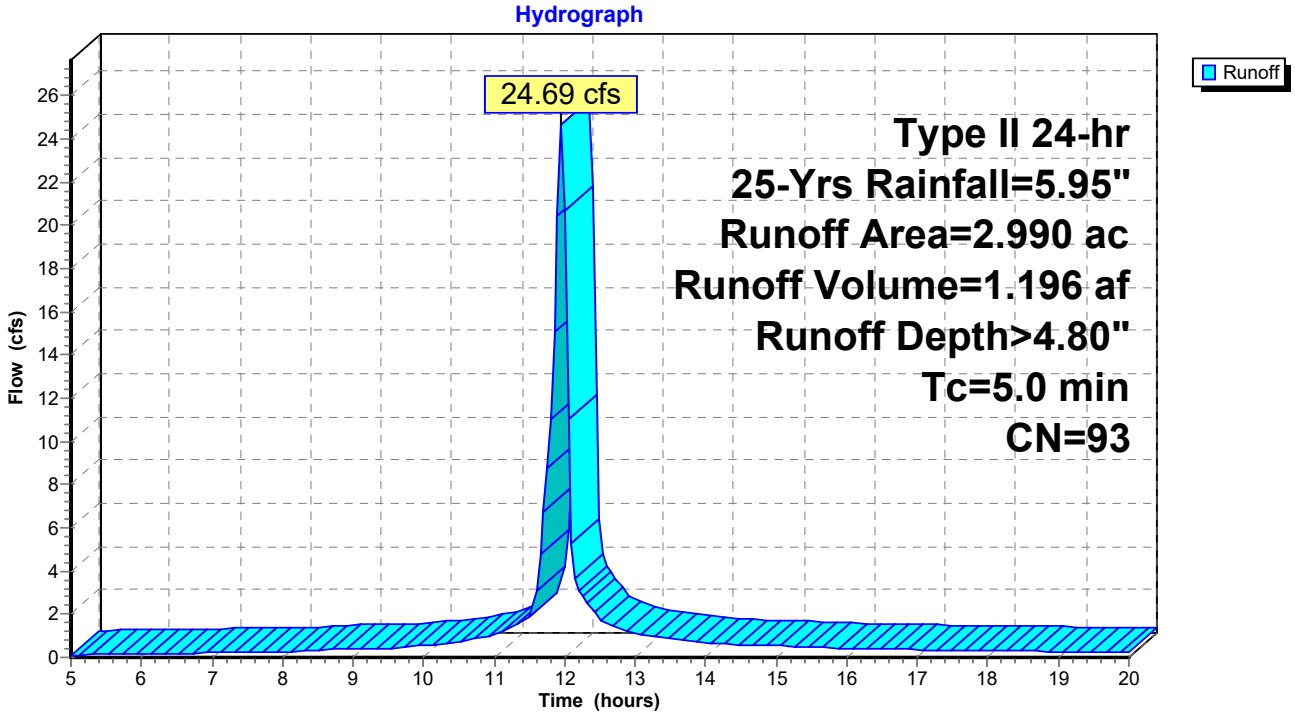
Runoff = 24.69 cfs @ 11.95 hrs, Volume= 1.196 af, Depth> 4.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Yrs Rainfall=5.95"

	Area (ac)	CN	Description
*	2.170	98	Building and pavement
*	0.820	80	grass/landscape area
	2.990	93	Weighted Average
	0.820		27.42% Pervious Area
	2.170		72.58% Impervious Area

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

Subcatchment 2S: Post Development



Hydrograph for Subcatchment 2S: Post Development

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.37	0.05	0.11
5.25	0.40	0.06	0.12
5.50	0.42	0.07	0.14
5.75	0.45	0.09	0.15
6.00	0.48	0.10	0.16
6.25	0.50	0.11	0.17
6.50	0.53	0.13	0.19
6.75	0.56	0.14	0.20
7.00	0.59	0.16	0.21
7.25	0.62	0.18	0.22
7.50	0.65	0.20	0.24
7.75	0.68	0.22	0.25
8.00	0.71	0.24	0.26
8.25	0.75	0.26	0.29
8.50	0.79	0.29	0.33
8.75	0.83	0.32	0.37
9.00	0.87	0.36	0.41
9.25	0.92	0.39	0.43
9.50	0.97	0.43	0.44
9.75	1.02	0.47	0.49
10.00	1.08	0.51	0.55
10.25	1.14	0.56	0.64
10.50	1.21	0.62	0.74
10.75	1.30	0.69	0.89
11.00	1.40	0.78	1.06
11.25	1.52	0.89	1.38
11.50	1.68	1.03	1.79
11.75	2.30	1.59	**8.72**
12.00	3.94	3.17	**20.68**
12.25	4.20	3.42	2.83
12.50	4.37	3.58	1.83
12.75	4.49	3.70	1.37
13.00	4.59	3.80	1.14
13.25	4.68	3.88	0.99
13.50	4.75	3.96	0.86
13.75	4.82	4.02	0.77
14.00	4.88	4.08	0.68
14.25	4.93	4.13	0.63
14.50	4.98	4.18	0.60
14.75	5.03	4.23	0.57
15.00	5.08	4.27	0.54
15.25	5.12	4.32	0.51
15.50	5.16	4.36	0.48
15.75	5.20	4.39	0.45
16.00	5.24	4.43	0.42
16.25	5.27	4.46	0.40
16.50	5.30	4.50	0.39
16.75	5.33	4.53	0.38
17.00	5.37	4.56	0.37
17.25	5.40	4.59	0.35
17.50	5.42	4.62	0.34
17.75	5.45	4.64	0.33
18.00	5.48	4.67	0.32
18.25	5.51	4.70	0.31
18.50	5.53	4.72	0.30
18.75	5.56	4.74	0.29
19.00	5.58	4.77	0.28
19.25	5.60	4.79	0.27
19.50	5.62	4.81	0.26
19.75	5.64	4.83	0.24
20.00	**5.66**	**4.85**	0.23

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: Post Development Runoff Area=2.990 ac 72.58% Impervious Runoff Depth>6.31"
Tc=5.0 min CN=93 Runoff=31.99 cfs 1.571 af

Total Runoff Area = 2.990 ac Runoff Volume = 1.571 af Average Runoff Depth = 6.31"
27.42% Pervious = 0.820 ac 72.58% Impervious = 2.170 ac

Summary for Subcatchment 2S: Post Development

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

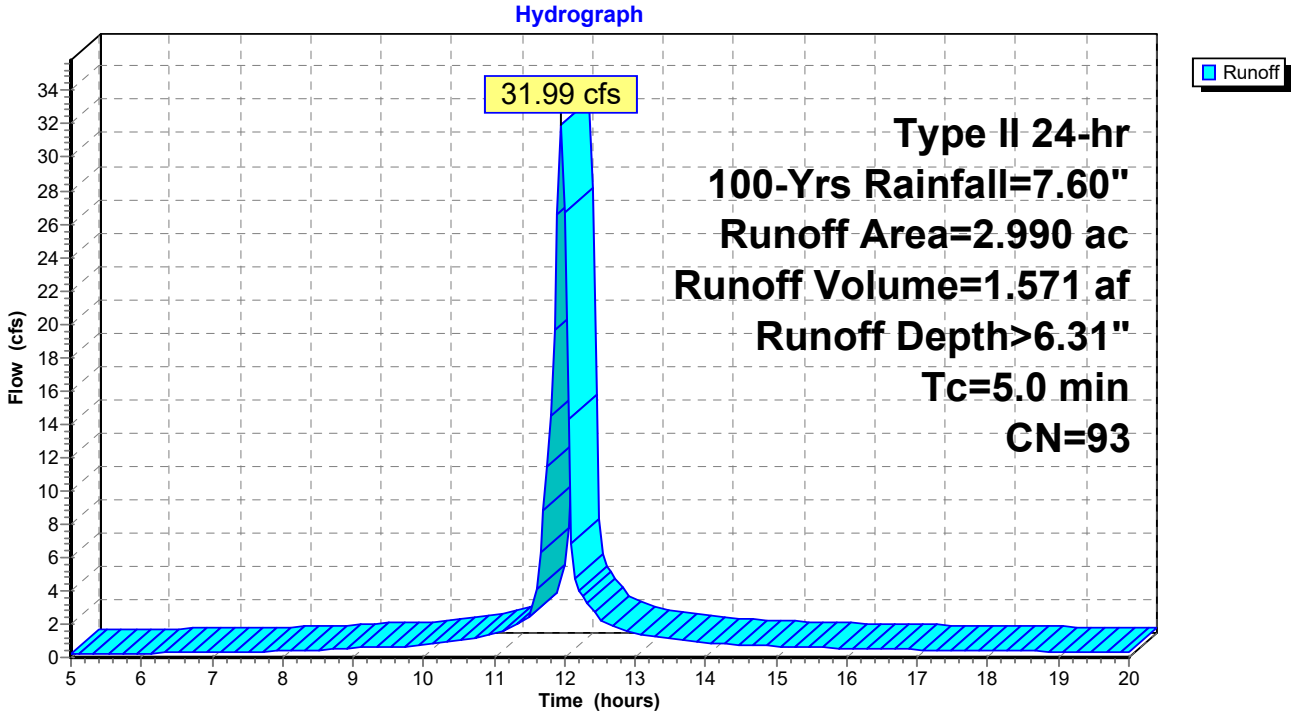
Runoff = 31.99 cfs @ 11.95 hrs, Volume= 1.571 af, Depth> 6.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Yrs Rainfall=7.60"

	Area (ac)	CN	Description
*	2.170	98	Building and pavement
*	0.820	80	grass/landscape area
	2.990	93	Weighted Average
	0.820		27.42% Pervious Area
	2.170		72.58% Impervious Area

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

Subcatchment 2S: Post Development



Hydrograph for Subcatchment 2S: Post Development

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.48	0.10	0.18
5.25	0.51	0.12	0.20
5.50	0.54	0.13	0.22
5.75	0.57	0.15	0.23
6.00	0.61	0.17	0.25
6.25	0.64	0.19	0.26
6.50	0.68	0.22	0.28
6.75	0.71	0.24	0.30
7.00	0.75	0.27	0.31
7.25	0.79	0.29	0.33
7.50	0.83	0.32	0.34
7.75	0.87	0.35	0.36
8.00	0.91	0.38	0.37
8.25	0.96	0.42	0.41
8.50	1.01	0.45	0.47
8.75	1.06	0.50	0.52
9.00	1.12	0.54	0.58
9.25	1.18	0.59	0.60
9.50	1.24	0.64	0.61
9.75	1.30	0.70	0.67
10.00	1.38	0.76	0.76
10.25	1.46	0.83	0.87
10.50	1.55	0.91	1.00
10.75	1.66	1.01	1.20
11.00	1.79	1.12	1.42
11.25	1.95	1.26	1.85
11.50	2.15	1.45	2.38
11.75	2.94	2.20	**11.46**
12.00	5.04	4.24	**26.74**
12.25	5.37	4.56	3.65
12.50	5.59	4.77	2.36
12.75	5.74	4.93	1.76
13.00	5.87	5.05	1.47
13.25	5.98	5.16	1.27
13.50	6.07	5.25	1.11
13.75	6.16	5.34	0.99
14.00	6.23	5.41	0.87
14.25	6.30	5.48	0.81
14.50	6.37	5.54	0.77
14.75	6.43	5.61	0.73
15.00	6.49	5.66	0.69
15.25	6.54	5.72	0.65
15.50	6.59	5.77	0.61
15.75	6.64	5.82	0.57
16.00	6.69	5.86	0.53
16.25	6.73	5.91	0.51
16.50	6.77	5.95	0.50
16.75	6.81	5.99	0.48
17.00	6.85	6.03	0.47
17.25	6.89	6.06	0.46
17.50	6.93	6.10	0.44
17.75	6.96	6.14	0.43
18.00	7.00	6.17	0.41
18.25	7.03	6.20	0.40
18.50	7.07	6.24	0.38
18.75	7.10	6.27	0.37
19.00	7.13	6.30	0.36
19.25	7.16	6.33	0.34
19.50	7.18	6.35	0.33
19.75	7.21	6.38	0.31
20.00	**7.24**	**6.40**	0.30

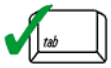
APPENDIX D – CHECKLIST FOR STORMWATER

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

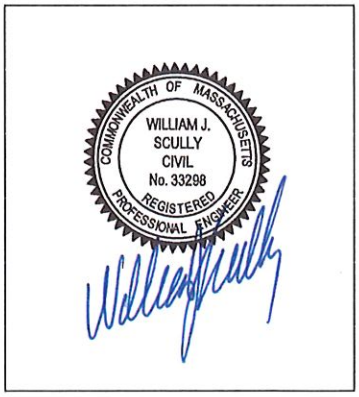
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



Signature and Date

Checklist

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

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☐ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☐ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

☐ Site is comprised solely of C and D soils and/or bedrock at the land surface

☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000

☐ Solid Waste Landfill pursuant to 310 CMR 19.000

☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☐ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☐ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☐ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☐ The BMP is sized (and calculations provided) based on:

- ☐ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☒ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☒ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☐ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☐ Name of the stormwater management system owners;
- ☐ Party responsible for operation and maintenance;
- ☐ Schedule for implementation of routine and non-routine maintenance tasks;
- ☐ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☐ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

APPENDIX E – OPERATION AND MAINTENANCE (O+M) PLAN

April 2024

STORMWATER MANAGEMENT
OPERATION AND MAINTENANCE MANUAL

100 NEW BOND STREET

WORCESTER, MASSACHUSETTS

Prepared for:

Saint Gobain Corporation
1 New Bond Street
Worcester, MA 01606

Prepared by:

William J, Scully
MA LICENSE NO. 33298

Kimley»Horn

TABLE OF CONTENTS

Contact Information

Stormwater Management Practices Owner

Saint-Gobain Corporation
Robert Doherty Facility & Ground Manager
1 New Bond Street
Worcester, MA
(508) 795-2989
robert.a.doherty@saint-gobain.com

Responsible Party for Operation and Maintenance

Saint-Gobain Corporation
Robert Doherty Facility & Ground Manager
1 New Bond Street
Worcester, MA
(508) 795-2989
robert.a.doherty@saint-gobain.com

Engineer of Record

William J Scully
271 Waverley Oaks Rd, Suite 302
Waltham, MA 02452
617-466-6347
Bill.scully@Kimley-Horn.com

Kimley»Horn

Overview

In accordance with local, state, and federal regulations the subject site contains several deep sumps catch basin that serve as best management practices (BMPs) to collect and convey stormwater, control erosion and sediment, attenuate peak flow rates of runoff, and remove stormwater pollutants. The corresponding Field Manuals for the stormwater management measures are included in the Maintenance Plan. Each measure noted will require maintenance and specific upkeep in order to maintain its functionality as well as remain aesthetically pleasing and assimilate with the surrounding landscaping.

This manual has been prepared to outline general procedures to assist the responsible party in fulfilling operation and maintenance duties of the stormwater management facilities. Please note that the inspection, operation, and maintenance guidelines presented may need to be updated based on actual conditions encountered during the life of the facility.

Saint-Gobain Corporation is the current stormwater management system owner responsible for the operation and maintenance of the existing stormwater management system. If the property is ever transitioned to a new owner, the future property owner inherits responsibility for this operations and maintenance program. This Stormwater Management Practices Operation and Maintenance Manual shall be transferred to the future owner along with the property documents.

Note that some or all of the SWM / BMP facilities may require the Owner to submit inspection reports from a qualified professional. All inspection and maintenance costs shall be the responsibility of the Owner.

Stormwater Management Practices Descriptions

Drainage Structures and Pipes

Stormwater runoff from the site will be collected and conveyed by a system of inlet structures and subsurface drainage piping throughout the project area. Drainage inlets are reinforced concrete boxes with metal grates or curb openings located throughout the site, primarily in low-lying areas. The inlets are collected via a network of pipes that direct stormwater runoff to designated outfall locations by gravity flow. The service life of a concrete, subsurface drainage system is in excess of 50 years.

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Maintenance Procedures

General Routine Maintenance

General Routine Maintenance Activities		
No.	**Maintenance Task**	**Frequency of Task**
1	Sweep parking lot and other paved areas	Spring and fall, After significant winter storm where salt or sand has been applied, As necessary
2	Maintain landscaping properly by mowing and pruning	As necessary
3	Replace any dying or diseased plant species	As necessary
4	Pick up trash and litter on-site before stormwater runoff can transport debris to the BMPs	Ongoing
5	Walk entire site to inspect for erosion, drainage problems, and damage to the stormwater management practices	Quarterly
6	Inspect pavement over system for any signs of settlement or abnormal cracking	Quarterly
7	Document all inspections using the log provided	Quarterly
8	Remove snow from site as it accumulates – There is no Snow Storage Plan for the site.	After significant winter storms

Drainage Structures and Pipes

Routine Maintenance Activities for Drainage Pipe Networks		
No.	**Maintenance Task**	**Frequency of Task**
1	Visually inspect for inlets and drainage structures for signs of damage such as exposed reinforcement and concrete cracking	Quarterly
2	Vacuum accumulated sediment from inlets once depth is greater than 6 inches and dispose of in an approved off-site location	As necessary
3	Vacuum accumulated sediment from pipes once depth is greater than 3 inches and dispose of in an approved off-site location	As necessary
4	Remove any debris or obstructions from inlets	As necessary
5	Remove ice and snow from inlets	As necessary during winter months, After significant winter storms

Appendix A
Stormwater Best Management Practices Map

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Appendix B
Inspection Checklists and Maintenance Logs

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Inspection Checklist and Maintenance Log
Drainage Structures and Pipes

Project Name: _____ Inspection Date: _____
Project Location: _____ Inspection Personnel: _____
Location of Stormwater Management Practice: _____

Inspection Item	Yes	No	N/A	Corrective Action Required	Completion Date
Damage to Structure?					
Damage to Inlet Pipe(s)?					
Damage to Outlet Pipe(s)?					
Damage to Trash Rack(s)?					
Obstruction(s)?					
Undermining/Undercutting?					
Ponding around Inlets?					
Outlet Protection Washout?					
Settlement above Pipes?					
Accumulated Sediment?					
Accumulated Debris?					

Assessment Item	Good	Fair	Poor	Replace	N/A	Comments
Pavement condition above pipes						

Maintenance Activity Description:

_____

_____

Follow Up Requirements:

_____

_____

Inspector Signature: _____

APPENDIX F – ILLICIT DISCHARGE STATEMENT

Illicit Discharge Compliance Statement

Responsibility:

The owner is responsible for the ultimate compliance with all provisions of the Massachusetts Stormwater Management Policy, the USEPA NPDES Construction General Permit and responsible for identifying and eliminating illicit discharges (as defined by the USEPA).

OWNER NAME: Saint Gobain Corporation

ADDRESS: 1 New Bond Street

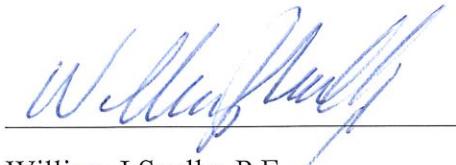
WORCESTER, MA 01606,

TEL. NUMBER: 508-795-5000

Engineer's Compliance Statement:

To the best of my knowledge, the attached plans, computations, and specifications meet the requirements of Standard 10 of the Massachusetts Stormwater Handbook regarding illicit discharges to the stormwater management system, and that no detectable illicit discharges exist on the site. All documents and attachments were prepared under my direction and qualified personnel properly gathered and evaluated the information submitted to the best of my knowledge.

Included with this statement are site plans, drawn to scale, that identify the location of systems for conveying stormwater on the site and show that these systems do not allow the entry of any illicit discharges into the stormwater management system. The plans also show any systems for conveying wastewater and/or groundwater on the site and show that there are no connections between the stormwater and wastewater systems.



William J Scully, P.E.

Kimley-Horn and Associates, Inc.

04/12/2024

Date

APPENDIX G – PIPE SIZING CALCULATION

Conduit FlexTable

Label	-Node- Upstream Downstream	-Depth- Upstream Downstream (ft)	-EGL- Upstream Downstream (ft)	-Ground- Upstream Downstream (ft)	-HGL- Upstream Downstream (ft)	-Invert- Upstream Downstream (ft)	Section Discharge Capacity (cfs)	-X- Upstream Downstream (ft)	-Y- Upstream Downstream (ft)
ST3 TO ST5 (STRM)	ST3 (STRM)	0.91	535.70	544.41	535.60	534.69	2.44	573,449.39	2,936,479.67
	ST5 (STRM)	1.14	535.62	544.45	535.56	534.42	4.57	573,502.85	2,936,466.50
ST5 TO ST6 (STRM)	ST5 (STRM)	1.14	535.62	544.45	535.56	534.42	2.40	573,502.85	2,936,466.50
	ST6 (STRM)	1.23	535.59	544.22	535.53	534.30	4.57	573,514.55	2,936,447.13
ST2 TO ST3 (STRM)	ST2 (STRM)	0.45	535.82	544.35	535.66	535.20	1.29	573,350.16	2,936,504.11
	ST3 (STRM)	0.91	535.63	544.41	535.60	534.69	4.57	573,449.39	2,936,479.67
ST4 TO ST3 (STRM)	ST4 (STRM)	0.44	539.18	544.18	539.02	538.58	1.22	573,450.86	2,936,485.48
	ST3 (STRM)	0.91	535.63	544.41	538.91	534.69	6.46	573,449.39	2,936,479.67
ST1 TO ST2 (STRM)	ST1 (STRM)	0.45	535.85	544.05	535.69	535.23	1.29	573,351.59	2,936,509.94
	ST2 (STRM)	0.45	535.82	544.35	535.66	535.20	4.57	573,350.16	2,936,504.11
ST6 TO ST7 (STRM)	ST6 (STRM)	1.23	535.59	544.22	535.53	534.30	2.39	573,514.55	2,936,447.13
	ST7 (STRM)	1.79	535.38	541.70	535.33	533.54	11.20	573,478.00	2,936,298.87
ST10 TO ST11 (STRM)	ST10 (STRM)	0.73	539.32	542.53	539.01	538.28	3.30	573,251.37	2,936,381.82
	ST11 (STRM)	0.73	539.06	543.25	538.53	537.90	6.46	573,276.75	2,936,353.38
ST11 TO ST7 (STRM)	ST11 (STRM)	0.73	538.93	543.25	538.63	537.90	3.28	573,276.75	2,936,353.38
	ST7 (STRM)	1.79	535.38	541.70	535.61	533.54	7.57	573,478.00	2,936,298.87
ST9 TO ST10 (STRM)	ST9 (STRM)	0.73	539.44	542.41	539.13	538.40	3.30	573,260.58	2,936,389.50
	ST10 (STRM)	0.73	539.42	542.53	538.93	538.28	6.46	573,251.37	2,936,381.82
ST7 TO ST8 (STRM)	ST7 (STRM)	1.79	535.74	541.70	535.33	533.54	6.36	573,478.00	2,936,298.87
	ST8 (STRM)	1.34	534.84	536.87	534.40	533.06	11.20	573,518.00	2,936,211.42
PIPE -14 (STRM)	ST7A (STRM)	0.43	536.02	538.87	535.86	535.44	1.17	573,514.14	2,936,315.76
	ST7 (STRM)	1.79	535.38	541.70	535.40	533.54	6.46	573,478.00	2,936,298.87
ST8 TO EX-1 (STRM)	ST8 (STRM)	1.34	534.80	536.87	534.40	533.06	10.08	573,518.00	2,936,211.42
	O-1	(N/A)	(N/A)	535.28	534.20	532.80	11.20	573,543.23	2,936,166.49
PIPE -24 (STRM)	ST8A (STRM)	0.84	534.86	536.84	534.48	533.64	4.31	573,523.66	2,936,214.01
	ST8 (STRM)	1.34	534.84	536.87	534.36	533.06	6.46	573,518.00	2,936,211.42