DRAINAGE MEMORANDUM
FOR DEFINITIVE SITE PLAN APPROVAL

DCU / Retail Expansion Project
225 Shrewsbury Street | Worcester, MA

Project Address:	225 Shrewsbury Street Worcester, MA 01604
Date Prepared:	June 06, 2024
Project Number:	24009
Prepared for:	Lundgren Equity Partners 163 Washington Street Auburn, MA 01501
Prepared by:	**Highpoint Engineering Inc.** Dedham Executive Center 980 Washington Street, Suite 216 Dedham, MA 02026 www.highpointeng.com

June 6, 2024

Re: Stormwater and Sewer Analysis Memorandum
225 Shrewsbury Street
Worcester, Massachusetts

On behalf of our Client, Lundgren Equity Partners LLC, (the "Applicant"), Highpoint Engineering Inc. (Highpoint) hereby submits this technical memorandum summarizing the stormwater management strategy associated with the proposed redevelopment of the commercial property at 225 Shrewsbury Street(The Project).

The site is approximately 2.38± acres in area and is bounded by Shrewsbury Street to the north, Casco Street to the east, Albany Street to the south and the City of Worcester DWP Lot at 29 Albany Street to the west. The site is the current location of the Shrewsbury Street Marketplace which includes a restaurant, café, Bank, Dentist, and 6,000 ft² vacant retail space. These uses are located within a 25,600± ft² building situated in the northeast corner of the property. A 7,100 ft² vacant ambulance storage building exists to the east of the retail building in the northeast corner of the property. This building has been vacant for a number of years. A 46'± wide driveway is located between the two buildings. This driveway contains two drive-thru lanes, one for the bank teller window and the other for the drive-up ATM, and a by-pass lane exiting onto Casco Street. Existing Stormwater runoff from 225 Shrewsbury St. travels northwest across the paved parking lot to one of four (4) leaching catch basins located in the northwest portion of the parking lot. The collected runoff receives no pretreatment prior to entering the leaching catch basins. This system is also hydraulically connected to the Shrewsbury Street drainage system.

Stormwater Management

The Project proposes the demolition of the existing vacant ambulance storage building and construction of a new 15,375 SF commercial building in the southern area of the property.

Site parking improvements will result in a total of 125 parking spaces which will be provided for the entire Project site, 101 standard parking and 19 compact parking spaces.

Based upon the Massachusetts Stormwater Management Handbook and Stormwater Standards (the Handbook), the Project qualifies as a Redevelopment, as the overall impervious cover will be reduced by approximately 5,032 ft²±. This is achieved by installing landscape islands throughout the proposed surface parking lots and landscape around the New Building and around the boundary of the property. Due to the reduction of impervious area, the Project complies with Standard 3 – Peak Flow Attenuation of the Handbook.

Based on discussions with the City of Worcester DPW, the sanitary and drainage services for the Project can be discharged to the municipal systems within Casco Street. Moreover, the Project qualifies as a Redevelopment project as defined in the Massachusetts Stormwater Handbook. Stormwater Best Management Practices (BMP's) to mitigate potential stormwater impacts include the installation of four (4) new deep sump catch basins with hooded outlets to capture the generated runoff. The Project will clean and inspect the three (3) existing catch basin infrastructure for reuse.

The portion of the drainage system for 225 Shrewsbury Street will be routed to a water quality treatment unit prior to connecting to the municipal drainage system within Casco Street, ultimately combining with

Shrewsbury Street drainage network. The existing drainage infrastructure will remain as is, which routes directly to Shrewsbury Street. The pipe capacity analysis for the Project storm drain collection system has been conducted using Manning's Equation for Uniform Pipe Flow, which is industry standard for this type of analysis (**See Attachments**).

Although the Project is considered a Redevelopment, The Project meet's Standard 4 – Water Quality of the Handbook with water quality units designed to provide a minimum 80% TSS removal for a 1" rainfall depth (calculations utilized a 1" rainfall rather than the 0.5" rainfall that is required for a redevelopment), which complies with MassDEP stormwater regulations for proprietary unit sizing (**See Attachments**). It was brought to Highpoint's attention that the drainage collection system within Shrewsbury Street is a dry/wet weather combined system (inclusive of both stormwater water and sanitary sewer infrastructures). Although the utilities are separated within the same subsurface conveyance structure, we understand that combined sewer overflows exist during significant wet weather events.

Soil Investigation

Soil exploration on the Project was conducted by KMM Geotechnical Consultants, LLC on July 13th, 2017 (**See Attachments**). Five (5) test borings were set within the area of the currently proposed commercial expansion building. Based on the geotechnical report and finding all soil borings appeared to have consistent soil characteristic. Fill was predominantly observed for the first 5 feet which includes rubble, traces of concrete, gravel and medium brown sand. Groundwater was observed between 5-7 ft below existing grades. Organic materials were prevalent as you approach the 10-15 ft range, which is further confirmation of a previously undisturbed subsurface overlain by urban fill.

Based upon the soil boring results, unsuitable soil conditions and shallow groundwater exist on the Project site, and we therefore have concluded that stormwater infiltration is not feasible.

Sewer

The proposed 15,375 SF commercial building is expected to generate approximately 857.5 GPD of sanitary sewer discharge based upon 310 CMR 15.00 (Title 5);

4,750 SF of proposed Retail Space: 4,750 SF x (50 GPD / 1,000 SF) = 237.5 GPD

4,750 SF of proposed Retail Space: 4,750 SF x (50 GPD / 1,000 SF) = 237.5 GPD

5,100 SF of proposed Bank (Office): 5,100 SF x (75 GPD / 1,000 SF) = 382.5 GPD

Total GPD = 857.5 DPG

A flow capacity analysis of the 8" dia. receiving sewer within Casco Street has been conducted using Manning's Equation for Uniform Pipe Flow. This analysis evaluates the Project's net effect on existing sewer pipe flow capacity under both average daily and peak flow sewer discharge conditions from the Project.

Based on the existing conditions plan dated 7-29-22, the most restrictive segment of sewer within Casco Street has a pipe slope of approximately 0.7**% (The design will utilize a 0.2% slope based on recent field verifications from the City of Worcester Engineering Department)**. Assuming 8" dia. PVC pipe with a 0.012 Manning's roughness coefficient, the pipe full-flow peak capacity is approximately = 0.59 CFS

(381,326 GPD or 265 GPM). The Proposed commercial sewer discharge is estimated to = 857.5 GPD (0.0013 CFS or 0.595 GPM). Therefore, the percentage of pipe flow capacity required for average daily sewage flows from the Project = 0.22% of full flow capacity.

Regarding receiving sewer peak flow capacity analysis, a 4.0 peaking factor is applied to the average daily flow to assess the instantaneous peak flow that could be discharged to the receiving sewer. Applying the 4.0 peaking factor to the average daily flow in GPM, the resulting estimated peak sewer discharge:

Peak Sewer Discharge: 0.595 GPM x 4.0 peak factor = 2.38 GPM

This peak discharge accounts for approximately 0.22% of receiving sewer peak flow capacity. We note that the estimated sewage discharge values are conservative as they are adapted from Title 5, which is approximately 25%-30% greater than what the actual water usage and sewage discharge is expected to produce.

Conclusion

The Project will improve existing and future stormwater discharges by providing the following:

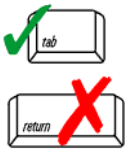
1. Reduction in the amount of existing surface parking on the Project through construction of the New Buildings. Building roof generates clean stormwater runoff vs. the surface parking stormwater runoff that occurs today.
2. Reduction in the amount of surface stormwater runoff flowing towards the existing drainage infrastructure which reduces maintenance and potential overburdening of the older drainage infrastructure.
3. Regrading of the parking lot to improve surface runoff conveyance and reduce localize ponding.
4. Reduce impervious area by approximately 5,032 sf thereby reducing peak flows to the municipal drainage system.
5. Implement stormwater BMP's that provide water quality treatment in accordance with the Handbook.

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

Signature and Date

Checklist

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

☐ New development

☑ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

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

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:

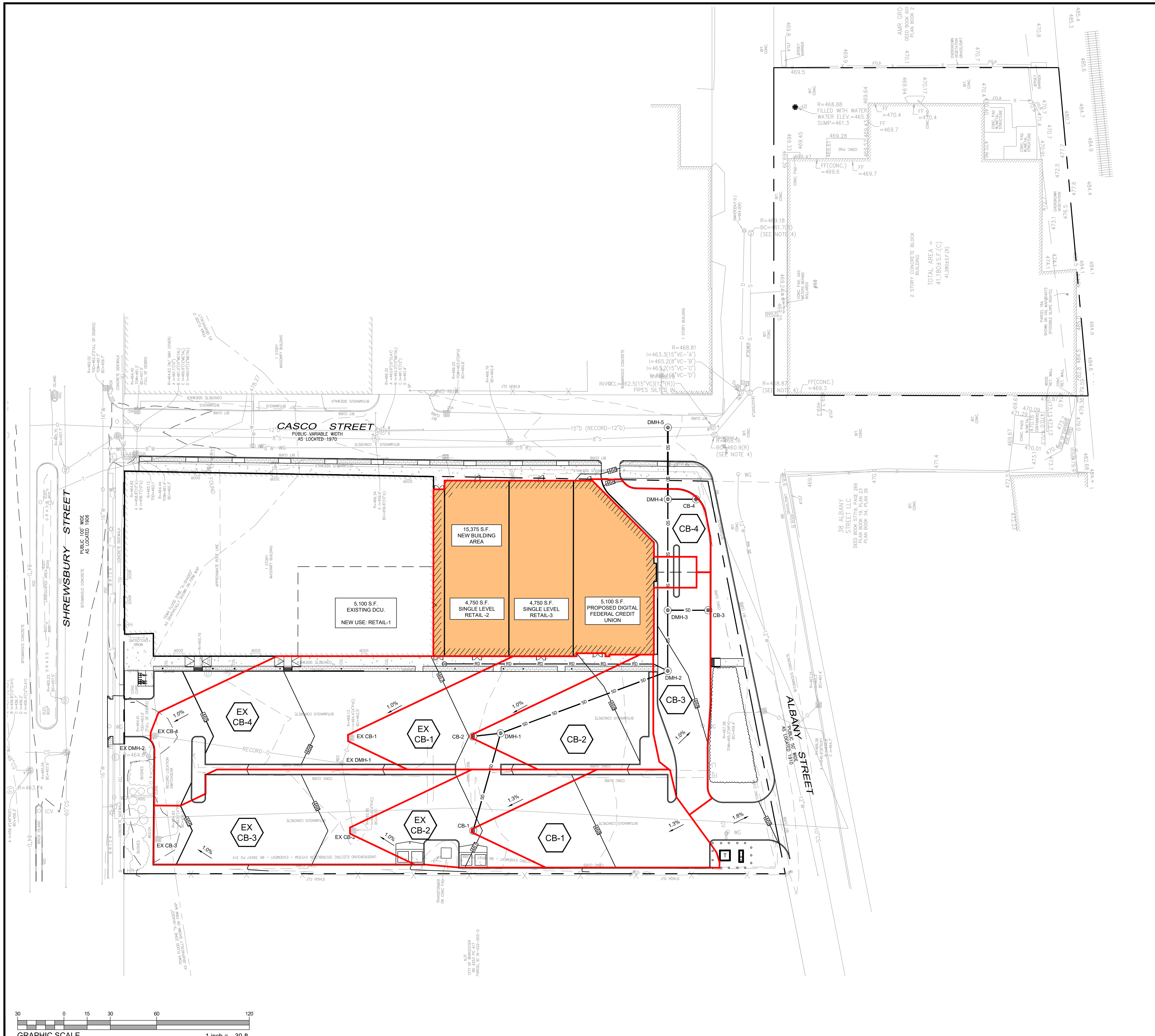
- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity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



SYMBOL LEGEND

(red line)	CATCHMENT BOUNDARY
CB-1	CATCH BASIN DESIGNATION

SUBCATCHMENT WATERSHED AREA SUMMARY

WATERSHED CB-1
TOTAL (AREA) = 5,546 sf
GRASS = 560 sf
IMPERVIOUS AREA = 4,986 sf
WEIGHTED COEFFICIENT = 0.87
TIME OF CONCENTRATION (tc) = 5.0 min

WATERSHED CB-2
TOTAL (AREA) = 6,999 sf
GRASS = 216 sf
IMPERVIOUS AREA = 6,783 sf
WEIGHTED COEFFICIENT = 0.88
TIME OF CONCENTRATION (tc) = 5.0 min

WATERSHED CB-3
TOTAL (AREA) = 4,846 sf
GRASS = 400 sf
IMPERVIOUS AREA = 4,446 sf
WEIGHTED COEFFICIENT = 0.87
TIME OF CONCENTRATION (tc) = 5.0 min

WATERSHED CB-4
TOTAL (AREA) = 2,266 sf
GRASS = 0 sf
IMPERVIOUS AREA = 2,266 sf
WEIGHTED COEFFICIENT = 0.90
TIME OF CONCENTRATION (tc) = 5.0 min

WATERSHED EX CB-1
TOTAL (AREA) = 6,011 sf
GRASS = 164 sf
IMPERVIOUS AREA = 5,847 sf
WEIGHTED COEFFICIENT = 0.88
TIME OF CONCENTRATION (tc) = 5.0 min

WATERSHED EX CB-2
TOTAL (AREA) = 5,098 sf
GRASS = 537 sf
IMPERVIOUS AREA = 4,561 sf
WEIGHTED COEFFICIENT = 0.87
TIME OF CONCENTRATION (tc) = 5.0 min

WATERSHED EX CB-3
TOTAL (AREA) = 8,978 sf
GRASS = 495 sf
IMPERVIOUS AREA = 8,483 sf
WEIGHTED COEFFICIENT = 0.88
TIME OF CONCENTRATION (tc) = 5.0 min

WATERSHED EX CB-4
TOTAL (AREA) = 11,527 sf
GRASS = 712 sf
IMPERVIOUS AREA = 10,815 sf
WEIGHTED COEFFICIENT = 0.88
TIME OF CONCENTRATION (tc) = 5.0 min

HIGHPOINT ENGINEERING, INC.
LAND PLANNING
PERMIT EXPEDITING
CIVIL ENGINEERING
CONSULTING
980 WASHINGTON STREET
SUITE 216
DEDHAM, MA 02026
www.HighpointEng.com

CLIENT:
LUNDGREN EQUITY PARTNERS
163 Washington street
Auburn, MA 01501

CONSULTANT:

SEAL

DCU/RETAIL EXPANSION PROJECT

225 SHREWSBURY STREET
WORCESTER, MA

OWNER/APPLICANT: LUNDGREN EQUITY PARTNERS

REV	DATE	DESCRIPTION

ISSUE TYPE: PERMIT
ISSUE DATE: 06/06/2024
PROJECT NUMBER: 24009

DRAWN BY: MJH
CHECKED BY: DTB/DJH

SHEET TITLE:
SUBCATCHMENT WATERSHED MAP

SHEET NUMBER:
SUBCAT

ISSUED FOR : PERMIT

HIGHPOINT ENGINEERING, INC.
DEDHAM EXECUTIVE CENTER
980 WASHINGTON STREET, SUITE 216
DEDHAM, MASSACHUSETTS 02026

Location: 225 Shrewsbury Street, Worcester, MA
Development: DCU / Retail Expansion Project
Project No.: 24009
Storm Frequency: 25 Year Storm
Run: **1 Run**

Date: 6-Jun-24
Revised:
Computed By: MJH
Checked By: DTB

From	To	Drainage Area (s.f.)	C	Total C x A (acres)	Tc (min)	I(25) (in/hr)	Q = (CIA) (cfs)	Flow from others (cfs)	Total Q (cfs)	Min. Slope (ft/ft)	Pipe Material	Manning's n	Dia (in)	Q (full) (cfs)	V (full) (fps)	Q/Q(full) < 1?	INV. IN (ft)	INV. OUT (ft)	Length (ft)	Hydraulic Pipe Rad. (ft)	Hydraulic Radius (ft)	Area (ft2)	Perimeter (ft)
RUN #1 TO STORMWATER SYSTEM																							
Subcat #1	CB #1	0	0.20																				
		560	0.30																				
		4986	0.90																				
				0.11	5	5.30	0.57	0.00	0.57														
CB #1	DMH #1	0	0.20																				
		0	0.30																				
		0	0.90																				
				0.00	5	0.00	0.00	0.57	0.57	0.005	DIP	0.01	8	1.10	3.16	0.51	464.05	464.35	61	0.3333333	0.1667	0.349	2.094
Subcat #2	CB #2	0	0.20																				
		216	0.30																				
		6783	0.90																				
				0.14	5	5.30	0.75	0.00	0.75														
CB #2	DMH #2	0	0.20																				
		0	0.30																				
		0	0.90																				
				0.00	5	0.00	0.00	0.75	0.75	0.005	DIP	0.01	8	1.11	3.19	0.67	464.05	464.12	13	0.3333333	0.1667	0.349	2.094
DMH #1	DMH #2	0	0.20																				
		0	0.30																				
		0	0.90																				
				0.00	5	0.00	0.00	1.32	1.32	0.005	HDPE	0.011	12	2.99	3.80	0.44	463.5	464.05	110	0.5	0.25	0.785	3.142
DMH #2	DMH-3	0	0.20																				
		0	0.30																				
		0	0.90																				
				0.00	0	0.00	0.00	1.32	1.32	0.006	HDPE	0.011	12	3.27	4.16	0.40	463.29	463.5	35	0.5	0.25	0.785	3.142
Subcat #3	CB #3	0	0.20																				
		400	0.30																				
		4446	0.90																				
				0.09	5	5.30	0.50	0.00	0.50														
CB #3	DMH #3	0	0.20																				
		0	0.30																				
		0	0.90																				
				0.00	5	0.00	0.00	0.50	0.50	0.005	DIP	0.01	8	1.11	3.19	0.45	463.29	463.5	22	0.3333333	0.1667	0.349	2.094
DMH #3	DMH #4 (WQU)	0	0.20																				
		0	0.30																				

From	To	Drainage Area (s.f.)	C	Total C x A (acres)	Tc (min)	I(25) (in/hr)	Q = (CIA) (cfs)	Flow from others (cfs)	Total Q (cfs)	Min. Slope (ft/ft)	Pipe Material	Manning's n	Dia (in)	Q (full) (cfs)	V (full) (fps)	Q/Q(full) < 1?	INV. IN (ft)	INV. OUT (ft)	Length (ft)	Pipe Rad. (ft)	Hydraulic Radius (ft)	Area (ft2)	Perimeter (ft)
		0	0.90																				
				0.00	5	0.00	0.00	1.82	1.82	0.005	HDPE	0.011	12	2.99	3.80	0.61	462.95	463.29	67	0.5	0.25	0.785	3.142
Subcat #4	CB #4	0	0.20																				
		0	0.30																				
		2266	0.90																				
				0.05	5	5.30	0.25	0.00	0.25														
CB #4	DMH #4 (WQU)	0	0.20																				
		0	0.30																				
		0	0.90																				
				0.00	5	0.00	0.00	0.25	0.25	0.005	PVC	0.011	8	1.01	2.90	0.25	462.95	463.08	13	0.3333333	0.1667	0.349	2.094
DMH #4 (WQU)	DMH #5	0	0.20																				
		0	0.30																				
		0	0.90																				
				0.00	5	0.00	0.00	2.07	2.07	0.009	RCP	0.012	12	3.74	4.76	0.55	462.27	462.7	46	0.5	0.25	0.785	3.142

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD

DCU RETAIL EXPANSION PROJECT
WORECSTER, MA

Area	0.79 ac	Unit Site Designation	DMH 4 WQU
Weighted C	0.9	Rainfall Station #	70
t_c	6 min		
CDS Model	1515-3	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.04	15.1%	15.1%	0.03	0.03	14.4
0.08	24.6%	39.7%	0.06	0.06	22.9
0.12	13.7%	53.4%	0.09	0.09	12.5
0.16	9.4%	62.8%	0.11	0.11	8.4
0.20	6.6%	69.5%	0.14	0.14	5.8
0.24	5.2%	74.7%	0.17	0.17	4.5
0.28	4.8%	79.5%	0.20	0.20	4.0
0.32	3.1%	82.6%	0.23	0.23	2.6
0.36	2.7%	85.3%	0.26	0.26	2.2
0.40	2.1%	87.4%	0.28	0.28	1.6
0.48	2.5%	89.9%	0.34	0.34	1.8
0.56	2.0%	91.9%	0.40	0.40	1.4
0.64	1.4%	93.3%	0.45	0.45	0.9
0.72	1.0%	94.3%	0.51	0.51	0.6
0.80	1.1%	95.4%	0.57	0.57	0.6
1.00	1.6%	97.1%	0.71	0.71	0.8
1.20	0.9%	98.0%	0.85	0.85	0.4
1.40	0.6%	98.6%	0.99	0.99	0.2
1.60	0.5%	99.1%	1.14	1.00	0.1
1.80	0.5%	99.6%	1.28	1.00	0.1
0.00	0.0%	99.6%	0.00	0.00	0.0
0.00	0.0%	99.6%	0.00	0.00	0.0
0.00	0.0%	99.6%	0.00	0.00	0.0
0.00	0.0%	99.6%	0.00	0.00	0.0
					86.0
				Removal Efficiency Adjustment[2] =	0.0%
				Predicted % Annual Rainfall Treated =	99.4%
				Predicted Net Annual Load Removal Efficiency =	**86.0%**

1 - Based on 14 years of 15-minute rainfall data from NCDC Station 2107, East Brimfield Lake, Worcester County, M
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Project: DCU Retail Expansion Project
Location: Worecster, MA
Prepared For: Highpoint Engineering

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

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

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

Compute Q Rate using the following equation:

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

where:

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

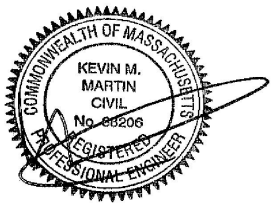
Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
DMH 4 WQU	0.79	0.0012325	6.0	0.100	1.00	774.00	0.95

The WQf sizing calculation selects the minimum size CDS/Cascade/StormCeptor model capable of operating at the computed WQf peak flowrate prior to bypassing. It assumes free discharge of the WQf through the unit and ignores the routing effect of any upstream storm drain piping. As with all hydrodynamic separators, there will be some impact to the Hydraulic Gradient of the corresponding drainage system, and evaluation of this impact should be considered in the design.

KEVIN M. MARTIN, P.E.
KMM GEOTECHNICAL CONSULTANTS, LLC
7 Marshall Road
Hampstead, NH 03841
603-489-5556 (p)/ 603-489-5558 (f)/781-718-4084(m)
kevinmartinpe@aol.com

MEMORANDUM

TO: CM& B, Inc.
75 Sylvan Street, Building C
Danvers, MA 01923



FROM: Kevin M. Martin, P.E.
Geotechnical Engineer

DATE: July 13, 2017

RE: **PRELIMINARY GEOTECHNICAL SUMMARY**
PROPOSED MEDICAL OFFICE BUILDING
225 SHREWSBURY STREET
WORCESTER, MASSACHUSETTS

This memorandum report serves as a preliminary geotechnical summary report for the referenced project. The contents of this memorandum are subject to the attached ***Limitations***.

SITE & PROJECT DESCRIPTION

Present development includes an existing single-story block garage building with associated pavement areas. This building will be razed to accommodate the project. It is not certain what type of foundation the building is supported. Test pits were not completed in this regard. KMM has no further information regarding the past use, development and/or construction at the site. Limited Plans were available at this time. Site grades are relatively level.

Based on review of the *USGS Quadrangle*, the site is located in a low lying valley with ascending elevation to the NW and SE.

The project includes a new, multi-story, medical office building about ≈14,000 ft² in footprint. The building may be 2, 3 or 4 stories in height. Project plans are preliminary at this time. It is intended to support the building on a shallow foundation using conventional spread footings (no basement). Minor grade change is expected for the project.


225 Shrewsbury St
KENWELD
© 2016 Google
Google Earth
1995
42°15'58.79" N 71°46'58.76" W elev 477 ft eye alt 702 ft

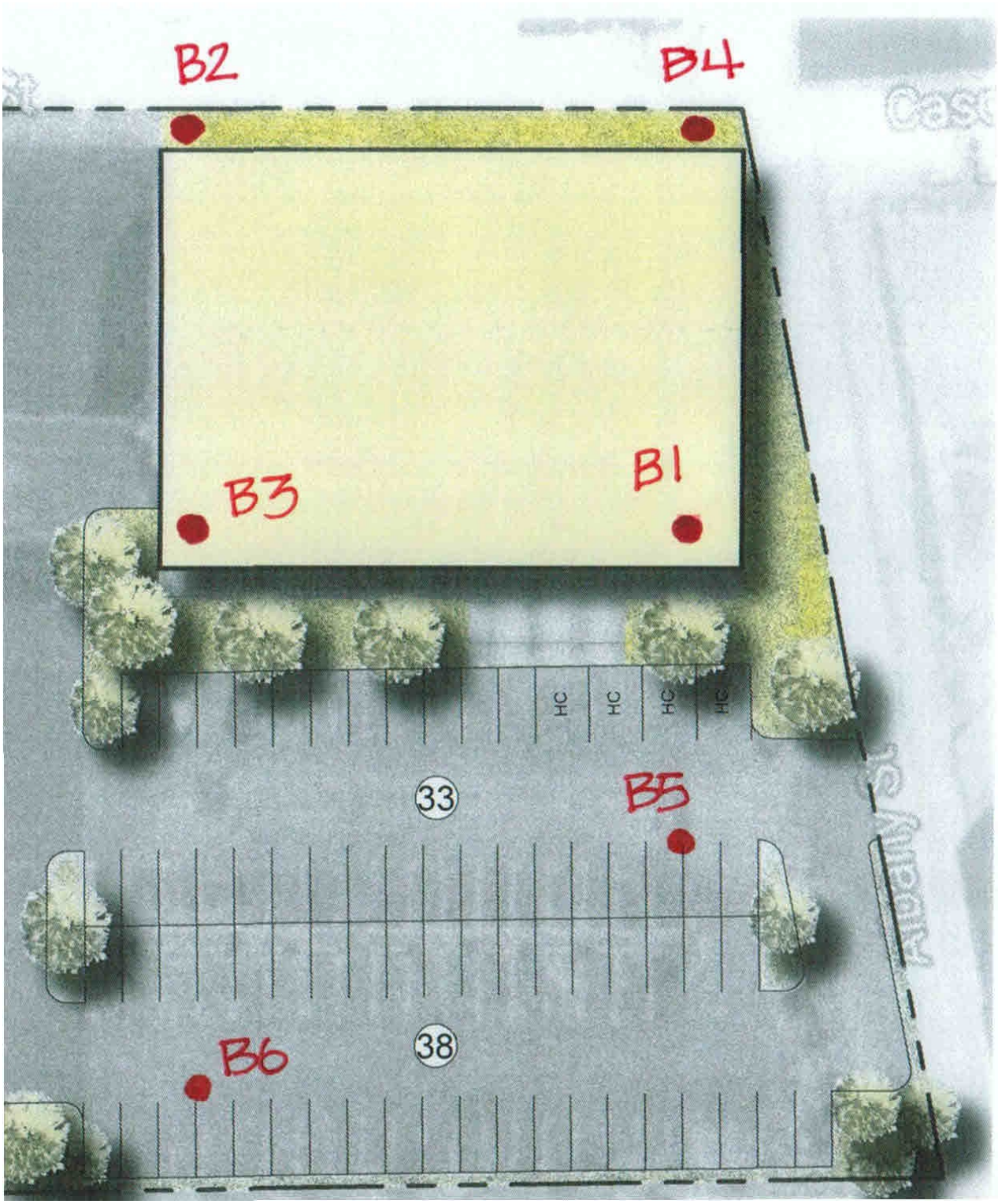

20 Casco St
Exit Street View
© 2016 Google
© 2017 Google
Google Earth
42°15'58.58" N 71°46'58.20" W elev 470 ft eye alt 479 ft

The purpose of this study is to review the subgrade conditions and provide a preliminary geotechnical evaluation related to foundation design and construction as required by the *Massachusetts State Building Code*. This report does not include an environmental assessment relative to oil, gasoline, solid waste and/or other hazardous materials. The environmental conditions of the property should be addressed by others as necessary. This study also does not include review of site design or construction issues such as infiltration systems, dry wells, retaining walls, excavation support systems, underground utilities, temporary crane pads, protection of surrounding buildings/utilities or other site and/or temporary design unless specifically addressed herein.

SUBSURFACE EXPLORATION PROGRAM

Test Borings

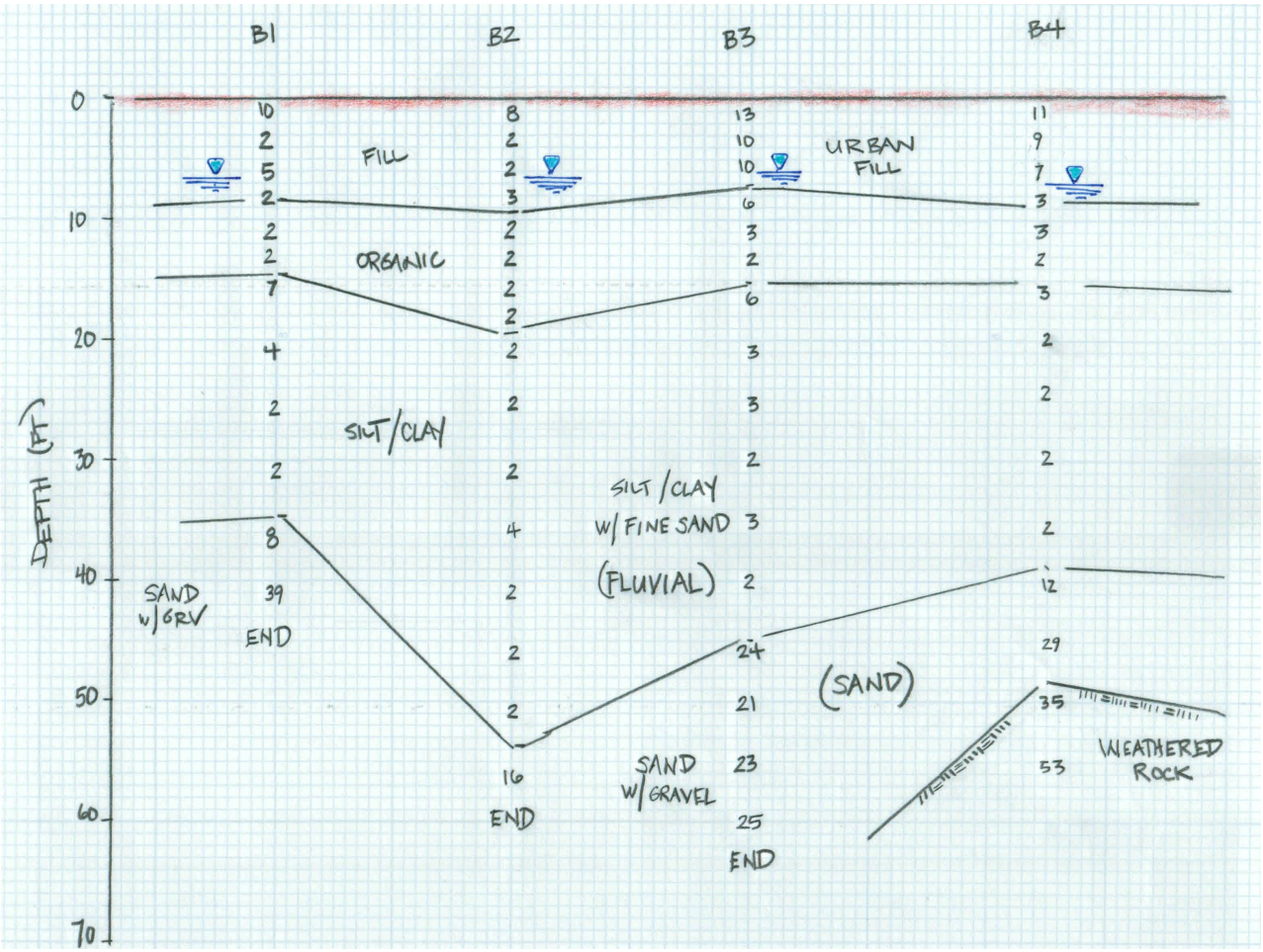
The subsurface exploration program included the completion of six (6) deep test borings around the proposed building limits. The test borings (B1 to B6) were advanced to depths of ≈30-61 ft utilizing either 4½ inch continuous flight hollow stem augers or NW casing. Soil samples were typically retrieved at no greater than 5 ft intervals with a 2 inch diameter split-spoon sampler. Standard Penetration Tests (SPTs) were performed at the sampling intervals in general accordance with ASTM-D1586 (*Standard Method for Penetration Test and Split-Barrel Sampling of Soils*). Field descriptions and penetration resistance of the soils encountered, observed depth to groundwater, depth to apparent refusal and other pertinent data are contained on the attached *Test Boring Logs*. The explorations were located by referencing existing site features and are illustrated on the enclosed *Test Boring Plan*.



TEST BORE LOCATIONS

SUBSURFACE CONDITIONS

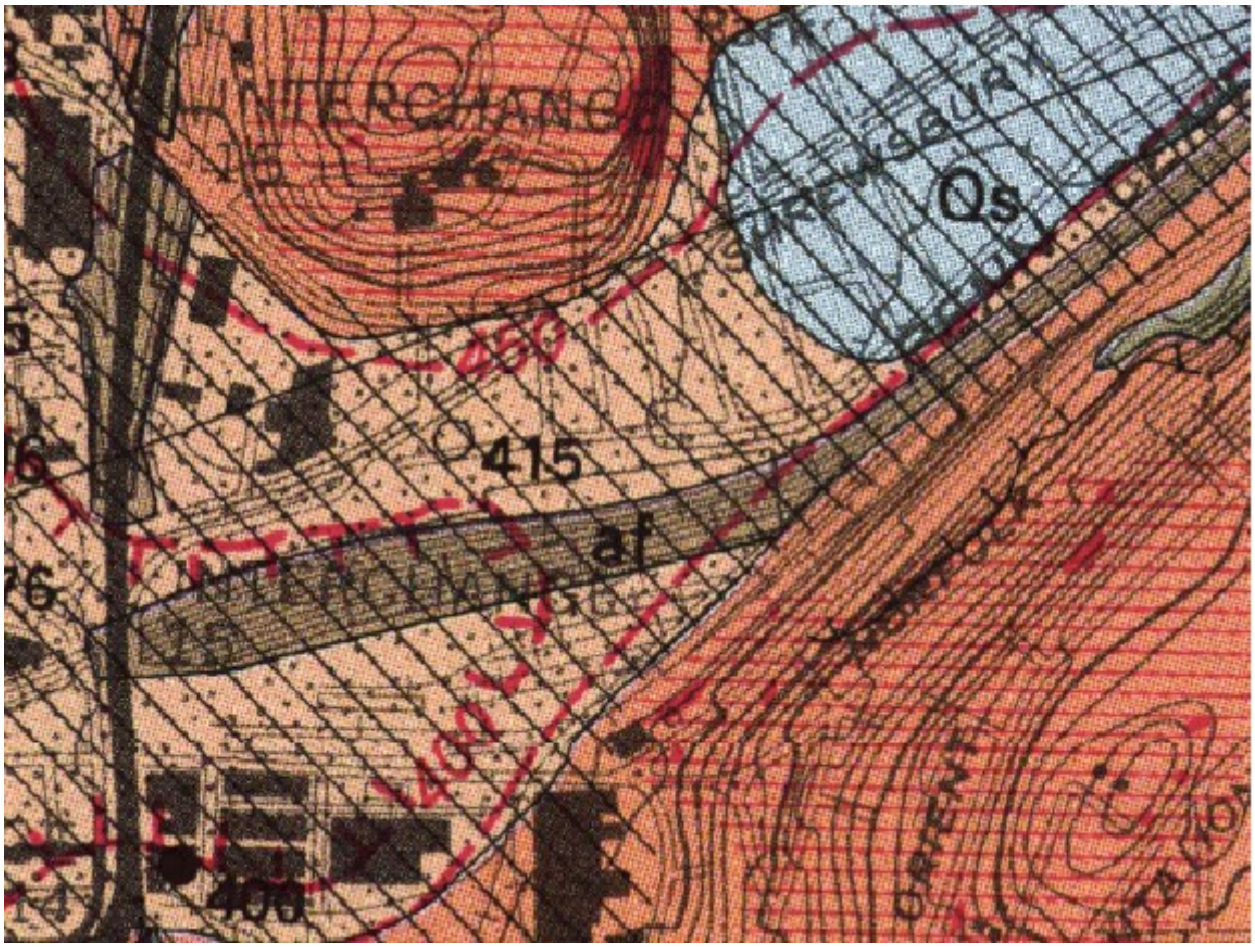
The subsurface conditions below (1) Urban Fill generally include (2) a buried Organic Silt and/or Peat then (3) Fluvial soils, (4) deeper Sand then (5) Weathered Ledge. These conditions suggest a filled wetland. A *Subsurface Profile* depicting the soil and groundwater conditions is attached for review.



SUBSURFACE PROFILE

Undocumented Fill was encountered in ALL the test borings to depths of ≈9-12 ft. The Fill is variable in composition but generally includes a mixture of Sand with ash, cinders, gravel, rubble, silt and trace wood, glass, organic and other matter are embedded in the Fill. The Fill is generally loose suggesting minimal compaction.

Below the Fill is a buried Organic layer which suggests the site to be a filled wet area. The Organic soils vary from an silty-fibrous Peat to an Organic Silt with fibers. The Organic soils are generally loose, soft, weak and compressible. The Organic soils extend about ≈15-20 ft below grade being about ≈5-10 ft in thickness.



USGS Surficial Geologic Map of the Worcester North Quadrangle (1980)

This Map shows the low lying location of the site with Artificial Fill (af) or Swamp Deposits (Qs) as the surficial conditions. These conditions are consistent with our findings.

The parent, inorganic overburden soils include fine-grained Fluvial soils underlain by deeper Sand with variable gravel. The Fluvial soils include an unconsolidated mixture of Silt & Clay w/ Fine Sand. These soils extend about ≈25-54 ft below grade being deepest in B2 & B6. The depth and thickness of the Fluvial soils does vary across the site.

At depth, a Clean Sand with variable gravel was present. These soils include Clean Sand with lesser amounts of gravelly Sand and/or sandy Gravel. In several bores, the Sand was just tagged or penetrated limited depth. In other holes, it varied from ≈7 ft to greater than ≈17 ft in thickness. The Sand is stable and compact.

Weathered Rock was encountered at B2 about ≈48 ft below grade and "tagged" at B6 about ≈61 ft below grade. The Weathered Rock was penetrated and sampled ≈8 ft @ B2.

Groundwater was encountered in the test holes at depths of ≈5-7 below grade upon completion. It should be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, utilities, flooding and other factors differing from the time of the measurements. This study was completed at a time of seasonally normal groundwater.

PRELIMINARY GEOTECHNICAL EVALUATION

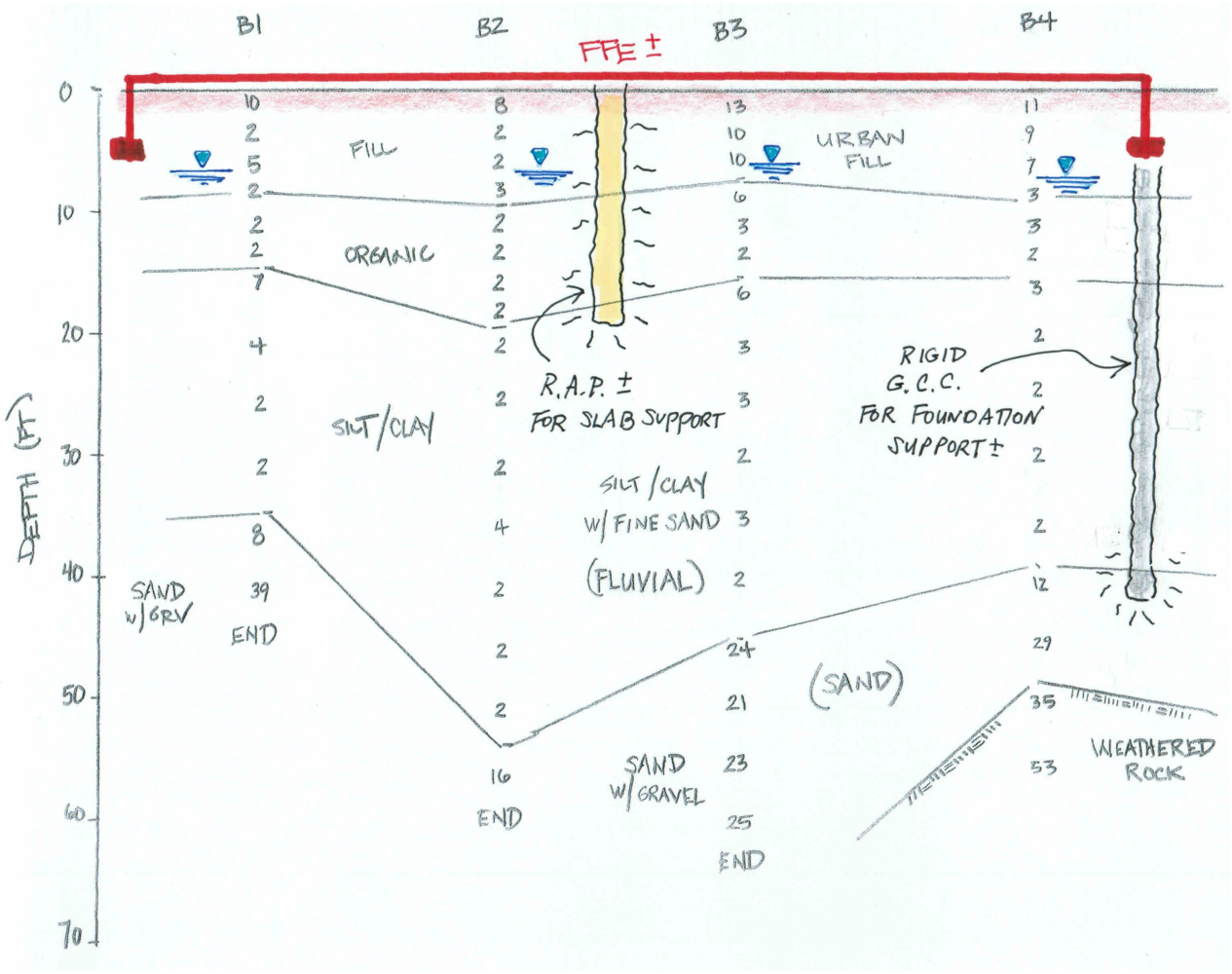
Based on our review, we provide the following preliminary geotechnical evaluation related to the proposed project.

- The existing fill and buried organic soils are **not** considered suitable for foundation bearing support due to their poor strength and compressibility characteristics. Relying on these soils for foundation bearing support will likely translate intolerable settlement to the proposed building. Options for foundation support include (1) a Pile supported foundation or (2) ground improvement via rammed aggregate piers (RAP) and/or GeoConcrete Columns™ (GCC) or similar. Given the subgrade conditions, it is our technical opinion that ground improvement with GCC and RAPs will likely be the most cost effective means to support a conventional spread footing foundation with a concrete floor slab-on-grade. This concept was also discussed with a local Specialty Contractor (GeoPier).

- Ground improvement with GeoConcrete Columns™ (GCC) or similar concept could likely be considered and provide means to support a conventional spread footing foundation. The GCC are unreinforced concrete columns that transfer load to the competent bearing stratum (Sand). Ground Improvement is a proprietary and patented design-build product. High bearing capacity is typically attained with GCC. Preliminary review by Geopier suggest GCC below the footings with GeoPiers (Rammed Aggregate Piers) below the floor slab and other lightly loaded foundations.

- The foundation support of the existing building should be considered for the project. If supported on piles or other deep foundation, these may become obstructions for the new foundation. Shallow foundations and other obstructions should be fully removed and properly backfilled.

- Ground improvement is a proprietary and patented design-build product offered by a qualified Geotechnical Contractor. The review and design should be completed by a Professional Engineer licensed in Massachusetts. A *Technical Design Submittal* shall be provided for the project which details the Design, Quality Control and Specification. It is recommended that qualified Geotechnical Contractors review the project for technical and cost feasibility. It is expected that GCCs will need to penetrate the soft Fluvial soils which extend to depths of ≈30-54 ft. The RAPs are expected to extend shallow depth into the Fluvial soils given lighter load transfer. This is shown on the attached *Profile*.



PROPOSED GROUND IMPROVEMENT CONCEPT

CLOSING COMMENTS

Depending upon the selected foundation system, it is recommended that KMM review the final engineering design and Technical Submittals. This is to observe compliance with the *Massachusetts State Building Code* and the recommendations provided herein. KMM should review technical submittals or provide technical specifications for the selected foundation system. Additional test bores should also be considered for final design given the questionable, deep and variable subgrade.

We trust the contents of this memorandum report are responsive to your needs at this time. Should you have any questions or require additional assistance, please do not hesitate to contact our office.

LIMITATIONS

Explorations

1. The analyses, recommendations and designs submitted in this report are based in part upon the data obtained from preliminary subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report.

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

3. Water level readings have been made in the test pits and/or test borings under conditions stated on the logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors differing from the time the measurements were made.

Review

4. It is recommended that this firm be given the opportunity to review final design drawings and specifications to evaluate the appropriate implementation of the recommendations provided herein.

5. In the event that any changes in the nature, design, or location of the proposed areas are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of the report modified or verified in writing by KMM Geotechnical Consultants, LLC.

Construction

6. It is recommended that this firm be retained to provide geotechnical engineering services during the earthwork phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

Use of Report

7. This report has been prepared for the exclusive use of CM&B, Inc. in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

8. This report has been prepared for this project by KMM Geotechnical Consultants, LLC. This report was completed for preliminary design purposes and may be limited in its scope to complete an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to preliminary geotechnical design considerations only.

TABLE 1

Medical Office Building
225 Shrewsbury Street
Worcester, Massachusetts

Recommended Soil Gradation & Compaction Specifications

Clean Granular Fill
(Select GRAVEL borrow)

SIEVE SIZE	PERCENT PASSING BY WEIGHT
3 inch	100
3/4 inch	60-90
No. 4	30-70
No. 200	2-8

NOTES: For minimum 8-inch base below Concrete Floor Slab-on-Grade;
For 14-inch base below exterior concrete slabs exposed to frost
For minimum 20-inch base at entrances, ramps and aprons.
Shall have less than 12% fines (No. 200 sieve) based on the Sand fraction

Structural Fill
(Gravelly SAND)

SIEVE SIZE	PERCENT PASSING BY WEIGHT
5 inch	100
3/4 inch	60-100
No. 4	20-80
No. 200	0-10

NOTES: For use below building foundations for structural bearing support
A ¾-inch crushed stone may be used for Structural Fill in wet conditions
For use as backfill behind unbalanced foundation/basement walls
Shall have less than 20% fines (No. 200 sieve) based on the Sand fraction

Structural Fill placed beneath the foundation should include the *Footing Zone of Influence* which is defined as that area extending laterally one foot from the edge of the footing then outward and downward at a 1H:1V splay. Structural Fill should be placed in loose lifts not exceeding 12 inches for heavy vibratory rollers and 8 inches for vibratory plate compactors. All the fill on the project should be compacted to at least 95 percent of maximum dry density as determined by the Modified Proctor Test (ASTM-D1557). The fill shall be compacted within ±2 of the optimum moisture content. The adequacy of the compaction efforts should be verified by field density testing which is also a requirement of the *Massachusetts State Building Code*.

TEST BORING LOG

SHEET 1

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Proposed Building
Site: 233 Shrewsbury St.
Worcester, MA

BORING B-1 (Page 1/2)

PROJECT NO. 17-0604

DATE: June 2, 2017

Ground Elevation:
Date Started: June 2, 2017
Date Finished: June 2, 2017
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
6/2/17	7 ft	n/a	Upon Completion

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
						3"	Asphalt
1		1	12"	0'0"-2'0"	8-6-4-3		Brown, fine to medium Sand, some gravel, little silt (FILL)
		2	9"	2'0"-4'0"	2-1-1-1		Sand, gravel, ash, cinders (FILL)
5		3	15"	5'0"-7'0"	3-2-3-2		Same, trace brick (URBAN FILL)
		4	15"	7'0"-9'0"	2-1-1-1		Same, wet
						10'	
10		5	18"	10'0"-12'0"	woh-1-1-1		
		6	24"	12'0"-14'0"	1-1-1-1		Black, Organic silty-fibrous Peat, wet (ORGANIC)
						15'	
15		7	21"	15'0"-17'0"	3-4-3-2		Grey, Silt, Clay & Fine Sand (FLUVIAL)
20		8	21"	20'0"-22'0"	2-2-2-3		Grey, Silt w/ clay, wet
25		9	24"	25'0"-27'0"	woh-1-1-1		Brown, Silt & Clay, wet w/ sand seams
30		10	21"	30'0"-32'0"	woh-1-1-1		Brown, Fine Sand w/ silt and clay (FLUVIAL)
						34'	
35		11	18"	35'0"-37'0"	3-4-4-5		Tan, fine to medium Sand, trace gravel, trace silt, wet
							(Continued)

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 2

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Proposed Building
Site: 233 Shrewsbury St.
Worcester, MA

BORING B-1 (Page 2/2)

PROJECT NO. 17-0604

DATE: June 2, 2017

Ground Elevation:
Date Started: June 2, 2017
Date Finished: June 2, 2017
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
6/2/17	7 ft	n/a	Upon Completion

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
40		12	18"	40'0"-42'0"	13-18-21-26		Grey, coarse Sand & Gravel, little silt
45							End of boring 42 ft Water at 7 ft upon completion
50							
55							
60							
65							
70							
75							
79							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 3

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Proposed Building
Site: 233 Shrewsbury St.
Worcester, MA

BORING B-2 (Page 1/2)

PROJECT NO. 17-0604

DATE: June 2, 2017

Ground Elevation:
Date Started: June 2, 2017
Date Finished: June 2, 2017
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
6/2/17	5 ft	n/a	Upon Completion

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
						5"	Asphalt
1		1	15"	0'0"-2'0"	3-4-4-3		
		2	6"	2'0"-4'0"	2-1-1-2		Sand, silt, gravel, ash, cinders
							(URBAN FILL)
5		3	9"	5'0"-7'0"	2-1-1-1		Same, trace brick, rubble, wet
		4	6"	7'0"-9'0"	1-1-2-2		
						10'	
10		5	15"	10'0"-12'0"	1-1-1-1		
		6	18"	12'0"-14'0"	1-1-1-2		Black, Organic, silty-fibrous Peat (ORGANIC)
15		7	21"	15'0"-17'0"	woh-1-1-2		Dark Brown, Organic Silt w/ fibers, wet (ORGANIC)
		8	24"	17'0"-19'0"	2-1-1-1		
						20'	
20		9	21"	20'0"-22'0"	1-1-1-2		
							Grey, Silt, Clay & Fine Sand, wet (FLUVIAL)
25		10	21"	25'0"-27'0"	woh-1-1-1		
30		11	21"	30'0"-32'0"	woh-1-1-2		Brown, Silt & Clay w/ fine sand, wet
35		12	24"	35'0"-37'0"	1-2-2-1		Tan, Silt, wet (FLUVIAL)
							(Co ntinued)

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 4

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Proposed Building
Site: 233 Shrewsbury St.
Worcester, MA

BORING B-2 (Page 2/2)

PROJECT NO. 17-0604

DATE: June 2, 2017

Ground Elevation:
Date Started: June 2, 2017
Date Finished: June 2, 2017
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
40		13	21"	40'0"-42'0"	woh-1-1-1		Tan, Silt & Clay wet w/ sand seams
45		14	24"	45'0"-47'0"	1-1-1-1		(FLUVIAL)
50		15	18"	50'0"-52'0"	woh-1-1-2		Brown, Silt, Clay & Fine Sand
						53'	
55		16	21"	55'0"-57'0"	6-8-8-9		Tan, fine to medium Sand, trace gravel, trace silt (SAND)
60							End of boring 57 ft Water at 6 ft upon completion
65							
70							
75							
79							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 5

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Proposed Building
Site: 233 Shrewsbury St.
Worcester, MA

BORING B-3 (Page 1/2)

PROJECT NO. 17-0604

DATE: June 6, 2017

Ground Elevation:
Date Started: June 6, 2017
Date Finished: June 6, 2017
Driller: TF
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
6/6/17	6 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
						3"	Asphalt
1		1		1'0"-3'0"	7-6-7-5		Dark Brown, loamy, silty Sand w/ gravel (FILL)
		2		3'0"-5'0"	5-4-6-6	3'	Brown, Sand, ash, gravel, cinders (URBAN FILL)
5		3		5'0"-7'0"	4-5-5-6		Sand, silt, clay w/ trace wood, brick, organic
		4		7'0"-9'0"	3-3-3-4		Sand, silt, gravel w/ trace wood, brick, glass (FILL)
						9'	
10		5		10'0"-12'0"	1-2-1-2		Black, Organic Silt
		6		12'0"-14'0"	1-1-1-2		Black, Organic Silt, trace fibers, wet (ORGANIC)
15		7		15'0"-17'0"	2-3-3-3	15'	
							Grey, Silt & Clay w/ fine sand (FLUVIAL)
20		8		20'0"-22'0"	1-1-2-2		
							(FLUVIAL)
25		9		24'0"-26'0"	1-1-2-3		
30		10		29'0"-31'0"	woh-1-1-2		Grey, Fine Sand w/ silt, wet (FLUVIAL)
35		11		34'0"-36'0"	1-2-1-1		Grey, Silt & Clay w/ sand seams
							(Continued)

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V Dense.
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 6

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Proposed Building
Site: 233 Shrewsbury Street
Worcester, MA

BORING B-3 (Page 2/2)

PROJECT NO. 17-0604

DATE: June 6, 2017

Ground Elevation:
Date Started: June 6, 2017
Date Finished: June 6, 2017
Driller: TF
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
6/6/17	6 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
40		12	24"	39'0"-41'0"	1-1-1-1	44'	Brown, Silt & Clay, wet (FLUVIAL) w/ sand lenses
45		13	20"	44'0"-46'0"	11-11-13-15		Brown, fine to coarse Sand, little gravel, trace silt, wet
50		14	14"	49'0"-51'0"	9-10-11-9		Brown, fine to medium Sand, little silt (SAND)
55		15	14"	54'0"-56'0"	10-10-13-14		Brown, fine to medium Sand, trace/little silt
60		16	16"	59'0"-61'0"	9-12-13-12		Brown, fine to coarse Sand, some gravel, trace silt
65							End of boring 61 ft Water at 6 ft upon completion
70							
75							

Notes: NW Casing

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 7

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Proposed Buiding
Site: 233 Shrewsbury St.
Worcester, MA

BORING B-4 (Page 1/2)

PROJECT NO. 17-0604

DATE: June 12, 2017

Ground Elevation:
Date Started: June 12, 2017
Date Finished: June 12, 2017
Driller: TF
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
6/12/17	7 ft	n/a	Upon Completion

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
						4"	Asphalt
1		1	8"	1'0"-3'0"	7-5-6-5		Sand, cinders, ash, gravel
		2	6"	3'0"-5'0"	5-4-5-6		Same w/ rubble, dry (FILL)
5		3	8"	5'0"-7'0"	4-4-3-2		Brown Sand, ash, gravel, brick, glass (URBAN FILL)
		4	4"	7'0"-9'0"	1-2-1-2		Sand, gravel, trace ash (FILL)
						9'	
10		5	16"	10'0"-12'0"	1-1-2-2		Black, Organic Silt w/ fibers, wet (ORGANIC)
		6	16"	12'0"-14'0"	1-1-1-2		Black, Organic, silty-fibrous Peat
15		7	24"	15'0"-17'0"	2-1-2-1	15'	
20		8	18"	19'0"-21'0"	2-1-1-1		Clay & Silt w/ fine sand seams
25		9	24"	24'0"-26'0"	1-1-1-1		
30		10	24"	29'0"-31'0"	1-1-1-1		Brown, Silt & Clay (FLUVIAL) w/ sand seams
35		11	24"	34'0"-36'0"	woh-1-1-1		
						39'	
							Continued

Notes: NW Casing

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 8

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Proposed Building
Site: 233 Shrewsbury St.
Worcester, MA

BORING B-4 (Page 2/2)

PROJECT NO. 17-0604

DATE: June 12, 2017

Ground Elevation:
Date Started: June 12, 2017
Date Finished: June 12, 2017
Driller: TF
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
6/12/17	7 ft	n/a	Upon Completion

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
40		12	12"	39'0"-41'0"	5-6-6-7	39'	Brown, fine to medium Sand, trace silt (SAND)
45		13	12"	44'0"-46'0"	12-16-13-20		Brown, fine to coarse Sand, little gravel
50		14	12"	49'0"-51'0"	14-17-18-25	48'	weathered rock, shale (WEATHERED ROCK)
55		15	10"	54'0"-56'0"	19-24-29-52		End of Boring at 56 ft Water at 7 ft upon completion
60							
65							
70							
75							

Notes: NW Casing

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 1

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Proposed Building
Site: 233 Shrewsbury Street
Worcester, MA

BORING B-5

PROJECT NO. 17-0647

DATE: June 30, 2017

Ground Elevation:
Date Started: June 29, 2017
Date Finished: June 29, 2017
Driller: TF
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
6/29/17	7 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
						4"	Asphalt
1		1	12"	1'0" – 3'0"	4-5-7-6		Dark Brown, fine to medium Sand, little gravel, little trace, brick, cinders
5		2	6"	5'0" – 7'0"	4-4-6-6		Sand & Gravel w/ silt, rubble, ash, wet (FILL)
10		3	10"	10'0" – 12'0"	4-4-6-7		Brown, fine to coarse Sand, trace rubble, wet (FILL)
		4	12"	12'0" – 14'0"	1-1-1-1	12'	
15		5	12"	15'0"- 17'0"	9-8-4-3	15'	Dark Brown, Organic Silt, wood fibers (ORGANIC)
20		6	21"	20'0" – 22'0"	WOH-1-1-1		Grey, Clay & Silt, little fine sand (FLUVIAL)
						23'	
25		7	18"	25'0" – 27'0"	4-5-7-8		Brown, medium to coarse Sand, little gravel, minor silt, wet
30							End of Boring at 30 ft due to "Running Sand" Water at 7 ft upon completion
35							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 2

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Proposed Building
Site: 233 Shrewsbury Street
Worcester, MA

BORING B-6 (Page 1/2)

PROJECT NO. 17-0647

DATE: June 30, 2017

Ground Elevation:
Date Started: June 29, 2017
Date Finished: June 29, 2017
Driller: TF
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
6/29/17	8 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
						4"	Asphalt
1		1	10"	1'0" – 3'0"	5-7-8-6		Brown, fine to medium Sand, little gravel, little silt
5		2	6"	5'0" – 7'0"	4-5-9-7		Brick, rubble (FILL) Trace cinders, concrete
10		3	12"	10'0" – 12'0"	5-5-6-7		f-c Sand, little gravel, wet (FILL)
						14'	
15		4	12"	15'0"- 17'0"	2-2-2-3		Organic Silt, fibers (ORGANIC)
						18'	
20		5	24"	20'0" – 22'0"	WOH-1-1		
25		6	24"	25'0" – 27'0"	1-1-1-1		Clay & Silt little some fine sand seams and fine sand layers (FLUVIAL)
30		7	24"	30'0"-32'0"	WOH-1-1-1		
35		8	24"	35'0" – 37'0"	1-1-1-1		Co ntinued

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 3

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Proposed Building
Site: 233 Shrewsbury Street
Worcester, MA

BORING B-6 (page 2/2)

PROJECT NO. 17-0647

DATE: June 30, 2017

Ground Elevation:
Date Started: June 29, 2017
Date Finished: June 29, 2017
Driller: TF
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
6/29/17	8 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
40							
45		9	24"	45'0" – 47'0"	1-1-2-2		
							Clay & Silt little fine sand seams and fine sand layers
50		10	24"	50'0" – 52'0"	1-1-2-3		(FLUVIAL)
						54'	
55		11	12"	55'0" – 57'0"	11-16-17-22		Grey, fine to medium Sand, some gravel, some silt, cobble
							(GLACIAL)
60		12	10"	60'0" – 62'0"	17-25-29-43		weathered rock at bottom
							End of Boring at 62 ft Water at 8 ft upon completion
65							
70							
75							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	


KEN-WELD