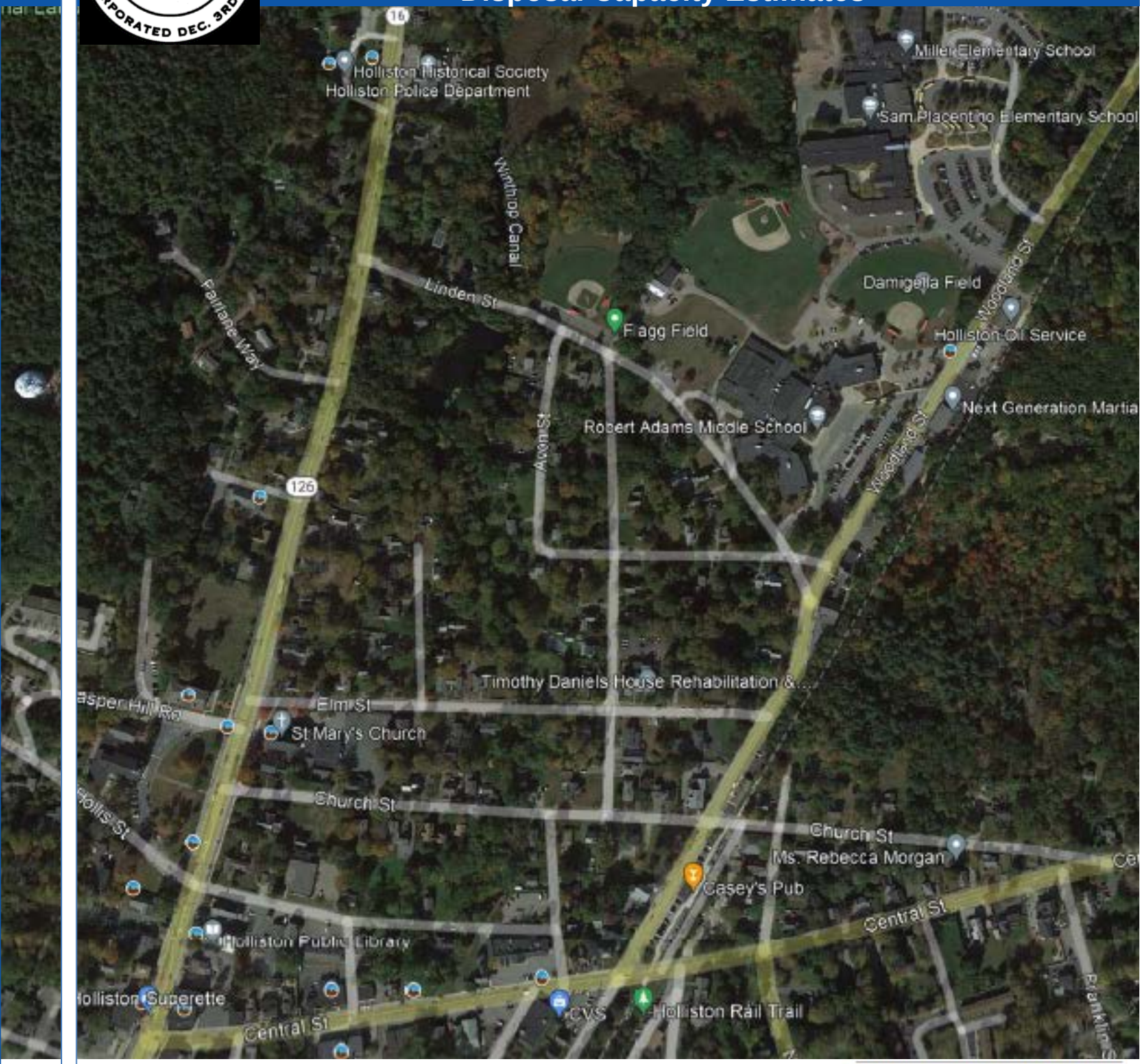
Holliston Woodland Street Schools Complex
Existing Hydrogeologic Conditions Report & Disposal Capacity Estimates



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Updated as April 4, 2023 with Verdantas

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EXECUTIVE SUMMARY

This Report provide tables and figures of relevant project information with minimal text as the tables and figures are self-explanatory.

The determinants of site capacity for effluent disposal / reuse are described in Section 6 and summarized below.

1. Using Darcy's Law determine the volume of water that could be discharged from the site while maintaining subsurface flow to receiving surface water bodies. The Darcy's Law key parameters are:
    a. Site hydraulic conductivity, K
    b. Groundwater slope, i
    c. Unsaturated depth through which the additional flow can discharge to a surface water body

Based upon data collected to date, preliminary estimate of the site wastewater design capacity is approximately 50,000 gpd.

2. Groundwater mounding analysis. The key site parameter is for mounding analysis is:
    a. Site hydraulic conductivity, K
    b. The sophisticated mounding analytical model MODFLOW needs to be used due to the limitations of the Hantush method. Site groundwater slopes, multiple groundwater directions and interaction amongst potential drainfields at the site requires the more sophisticated MODFLOW model versus Hantush method.

While slug tests results were lower than expected other techniques - and groundwater elevation monitoring is necessary to determine slope(s), hydraulic conductivity and unsaturated depth.

Figure ES-1 WWTP and Woodland School Complex – Aerial Photograph

Table ES-1 Darcy's Law - Disposal Capacity Estimates

Holliston Woodlsand Street School Complex Site - Discharge Capacity Initial Estimates with Sensivitity Analysis of Values for K & Unsaturated Thickness Available for Discharge	
Q = K*A*i	Q = volumetric flow (cf/day),
	K = Hydraulic conductivity (ft/day) of unsaturated zone
	A = cross sectional area (sf) of discharge/flux area
	i = groundwater slope

K (ft/day)	5	10			
Area (sf)	17,500	17,500			
Length	3,500	3,500			
Width	5	5			
i	0.0217	0.0217			
Q (cf/day)	1,899	3,798			
Q (gpd)	14,203	28,405			
Add'l WW design Flow Capacity (gpd)	18,000	36,000			
Existing WW Design Capacity (gpd)	15,000	15,000			
Total Capacity (gpd)	33,000	51,000			

Existing School WW design Flow (gpd)	15,000
Existing Downtown WW design Flow (gpd)	30,000
Total Exist School & Downtown WW Design Flow (gpd)	45,000

Holliston Woodlsand Street School Complex Site						
					GW Elev	
MW #	GW Elev		Distance	(ft)	change	slope (i)
1	170.49		MW #1 to #2	350	7.6	0.0217
2	178.09					
3	177.15		MW #3 to #5	750	7.51	0.0100
5	169.64					

1 INTRODUCTION

This Report presents a summary of hydrogeologic information for watersheds that affect or are affected by reclaimed water reuse/disposal from the Holliston Woodland Street School Complex Wastewater Treatment Plant (WWTP). Historical and project collected data is presented, along with a preliminary groundwater collection plan.

The WWTP receives approximately 7,500 gallons per day (gpd) of wastewater from:

- ✓ Adams Middle School
- ✓ Placentino Elementary Middle School
- ✓ Miller Elementary School

with the treated effluent discharging to three (3) drainfields as shown on Figure 1-1.

MassDEP Groundwater Discharge Permit WP12 GW #652-3 states that "if the 5-day average recorded wastewater flow from the school complex exceeds 22,915 gpd, the mounding in the leach fields shall be re-evaluated."

Average daily wastewater flow is approximately 6,000 gpd for 7-day week and 8,500 gpd for 5-day week.

Sources of existing information are:

- ✓ Simulation of Ground-Water Flow and Evaluation of Water-Management Alternatives in the Upper Charles River Basin, Eastern Massachusetts, by Leslie A. Desimone, Donald A. Walter, John R. Eggleston, and Mark T. Nimiroski, Water-Resources Investigations Report 02-4234, 2002
- ✓ Town of Holliston GIS Web Site, https://www.mapsonline.net/hollistonma/index.html#x=-7953060.534904,5190297.909296,-7948474.313208,5192399.927574
- ✓

While LAI has reviewed the circa 1998 groundwater mounding reports, no data from those reports is being used.

Figure 1-2 illustrates the available area on the property for treated effluent reuse/dispersal. It is anticipated that drip irrigation will be used to maximize site capacity for wastewater disposal.

To place the analysis in context, the analysis objective is to determine the maximum amount of wastewater flow coming from the Holliston downtown area that can be discharged at the School site and be permitted by MassDEP.

Figure 1-1 WWTP and Woodland School Complex – Aerial Photograph

Priority	Location	Approx. Available Area	
		acres	sf
1	Unnamed Ballfield	1.0	43,560
2	West of W Adams DF	0.5	21,780
3	East of East Adams DF	0.5	21,780
4	Former Flagg School	1.0	43,560
5	Adjacent to Miller DF	0.33	14,375
	Total	3.3	145,055

Figure 1-2 Available Areas for Subsurface Disposal

2 WATERSHED INFORMATION

Figure 2-1 presents the watershed areas that affect and are affected by project site.

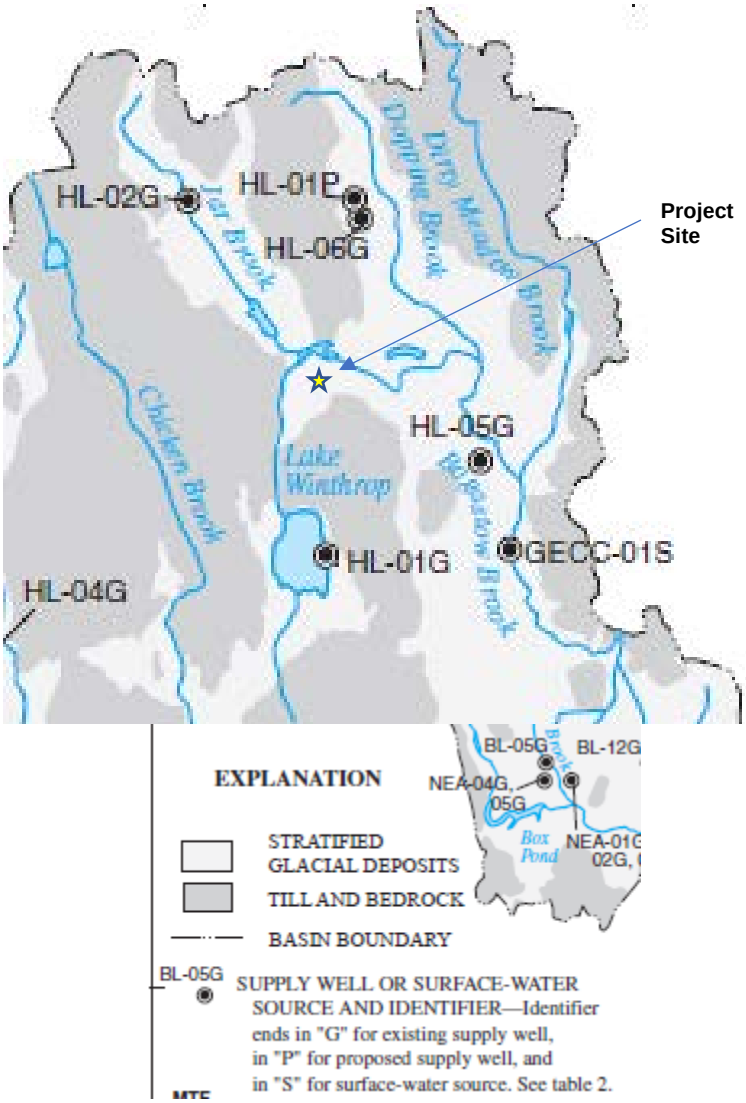


Figure 2-1 Project Site - Watershed Areas

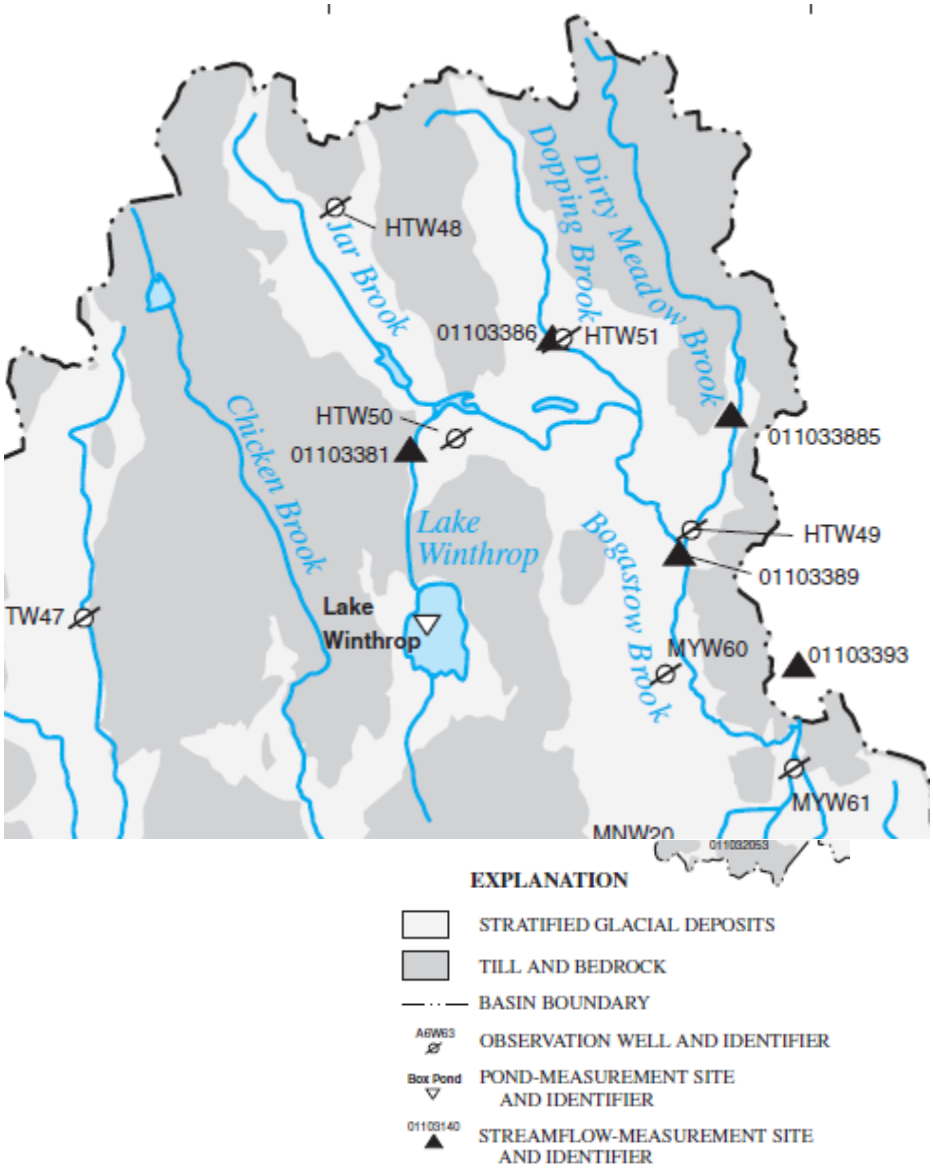


Figure 2-2 USGS Observation wells & streamflow-measurement sites Near Project Area

Figure 2-2A USGS Observation well on Aerial Photo

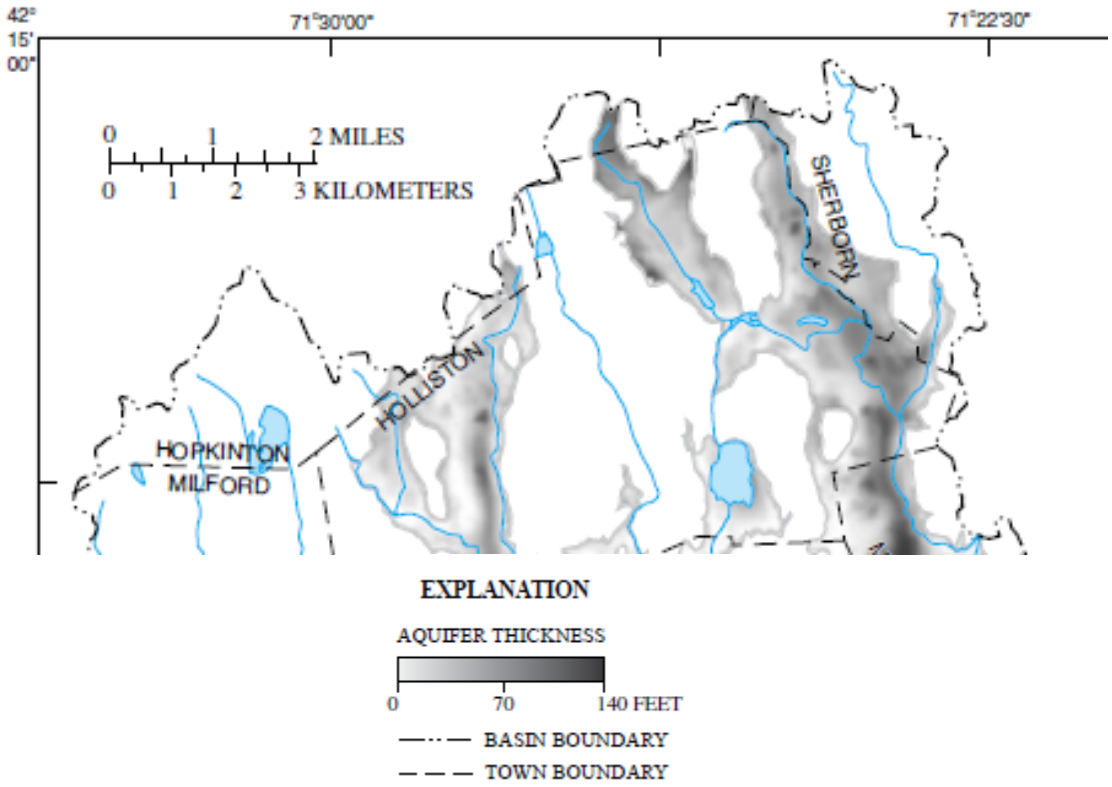


Figure 2-3 USGS 2002 Estimated Thickness of the stratified glacial aquifers

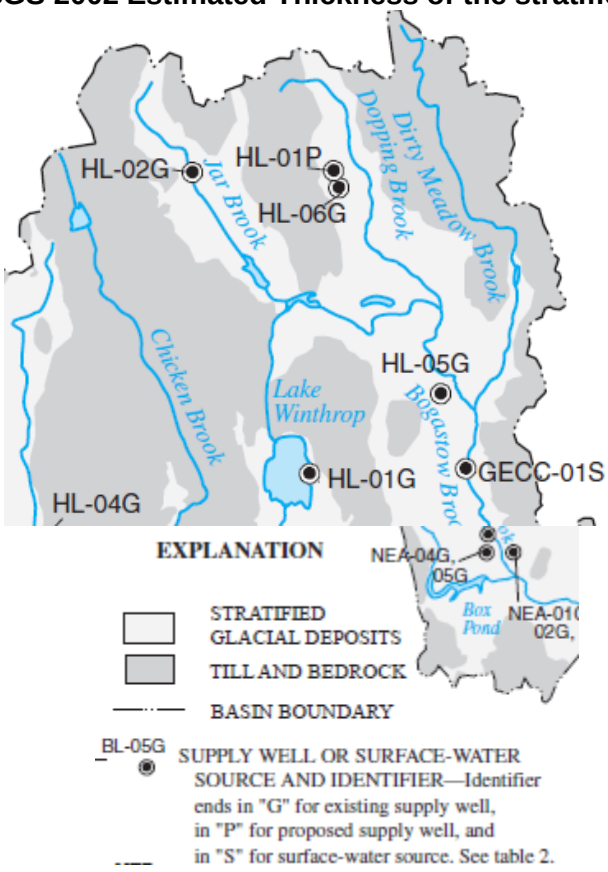


Figure 2-4 Municipal Water Supply Wells in Project Area

Table 2-1 Holliston Water Supply Wells

Well identifier	Town	Source name	Source type	Well depth (feet)	Mean annual withdrawal or discharge rate, 1989–98 (Mgal/d)	Maximum permitted withdrawal rate (Mgal/d)
HL-01G	Holliston	Well No. 1 Lake Winthrop	GW	50	.05	.32
HL-02G	Holliston	Well No. 2 Maple St.	GW	40	.06	.31
HL-04G	Holliston	Well No. 4 Washington St.	GW	50	.14	.48
HL-05G	Holliston	Well No. 5 Central St.	GW	60	.45	.71
HL-06G	Holliston	Well No. 6 Brook St.	GW	60	.45	.86
HL-01P	Holliston	Proposed well No. 7	GW	--	--	.86

Aquifer test well site	Predominant grain size of tested interval	Length of test (days)	Well discharge (gal/min)	Transmissivity (ft^2/d) Mean	Transmissivity (ft^2/d) Mini-mum	Transmissivity (ft^2/d) Maxi-mum	Saturated thickness (ft)	Mean hydraulic conductivity (ft/d)	Specific yield	Reference
HL-01G	Medium to coarse sand and gravel, silt	2	190	7,550	7,032	7,990	60	126	0.07–0.14	Whitman and Howard, Inc., 1996
HL-02G	Medium to coarse sand and gravel	2	240	4,850	4,520	5,070	30	162	0.13–0.15	Whitman and Howard, Inc., 1996
HL-05G	Medium to coarse sand and gravel	2	440	12,800	11,900	13,800	52	247	0.19	Whitman and Howard, Inc., 1996
HL-06G	--	--	--	11,230	--	--	47	239	--	Whitman and Howard, Inc., 1996

Station No.	Station name	Years of historical data	Total number of measure-ments	Drainage-area characteristics: Area (mi^2)	Drainage-area characteristics: Area of sand and gravel (percent)	Drainage-area characteristics: Mean slope (percent)
Bogastow Brook and Tributaries						
01103381	Winthrop Canal at Lindon Street, Holliston	none	11	2.7	11	1.9

Well identifier or pond name	Latitude ° ′ ″	Longitude ° ′ ″	Well depth (feet below and surface)	Mean depth to water (feet below land surface)	Mean water-level elevation (feet above sea level): Water year 2000	Mean water-level elevation (feet above sea level): Estimated, 1989–98
Holliston						
HTW50	42 12 22	071 25 13	12.0	6.71	167.16	167.07

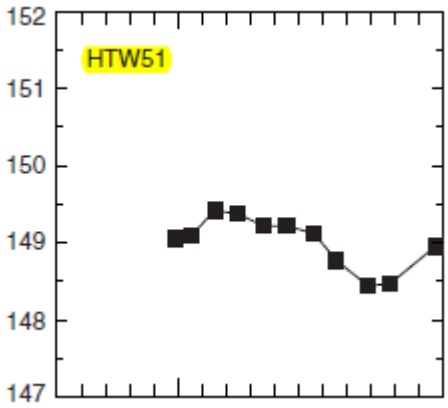


Figure 2-5 Ground-water levels measured in selected observation wells 1999–2000

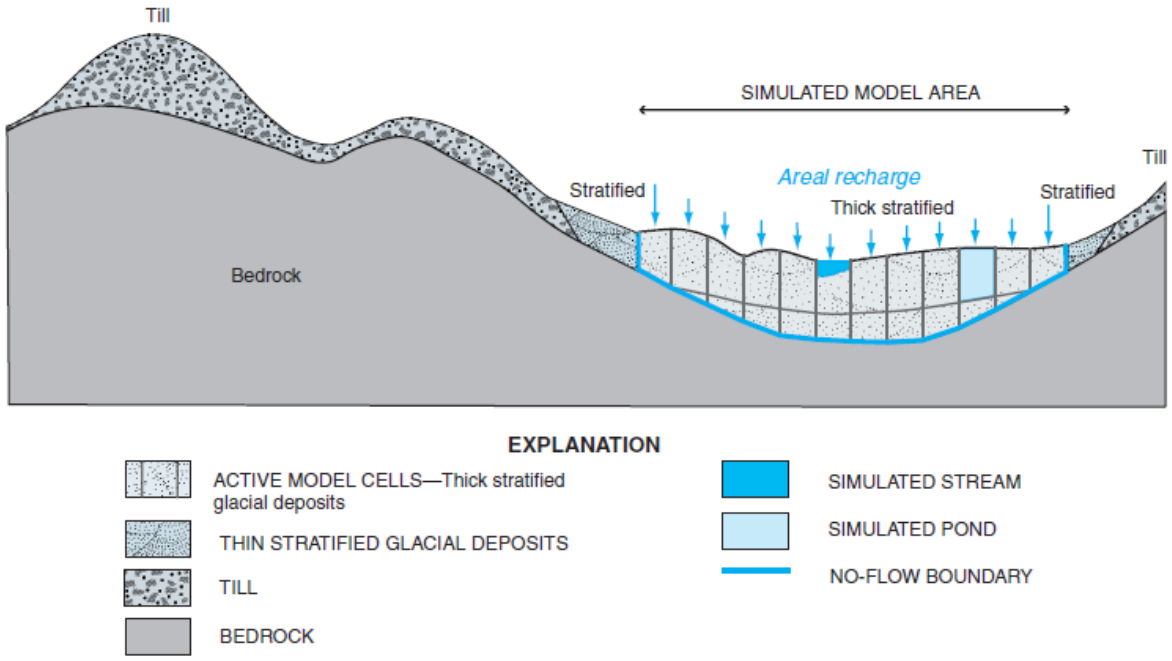


Figure 2-6 Schematic diagram of hydrogeologic units & flow components of water balance

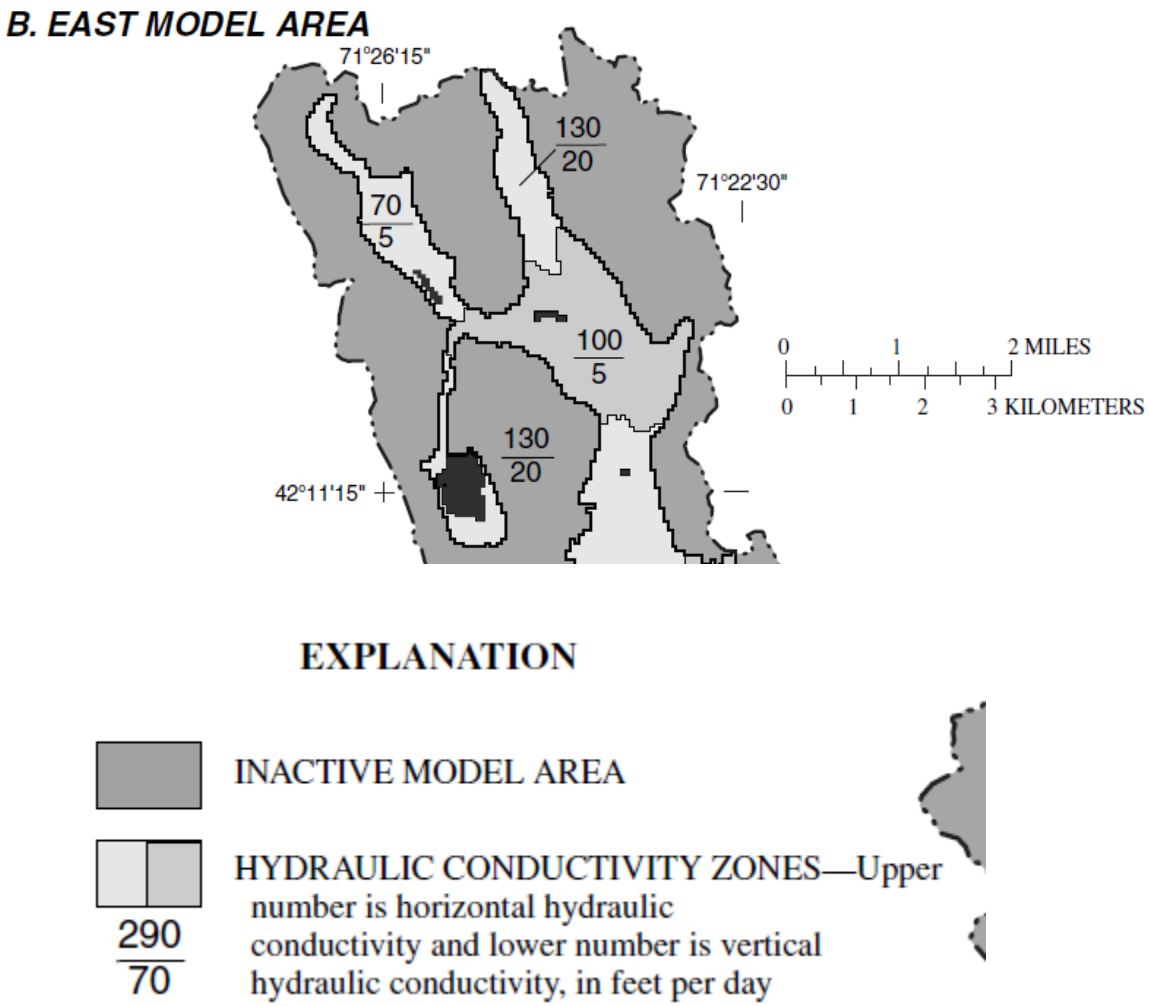


Figure 2-7 Hydraulic conductivity zones for the USGS 2002 simulation models

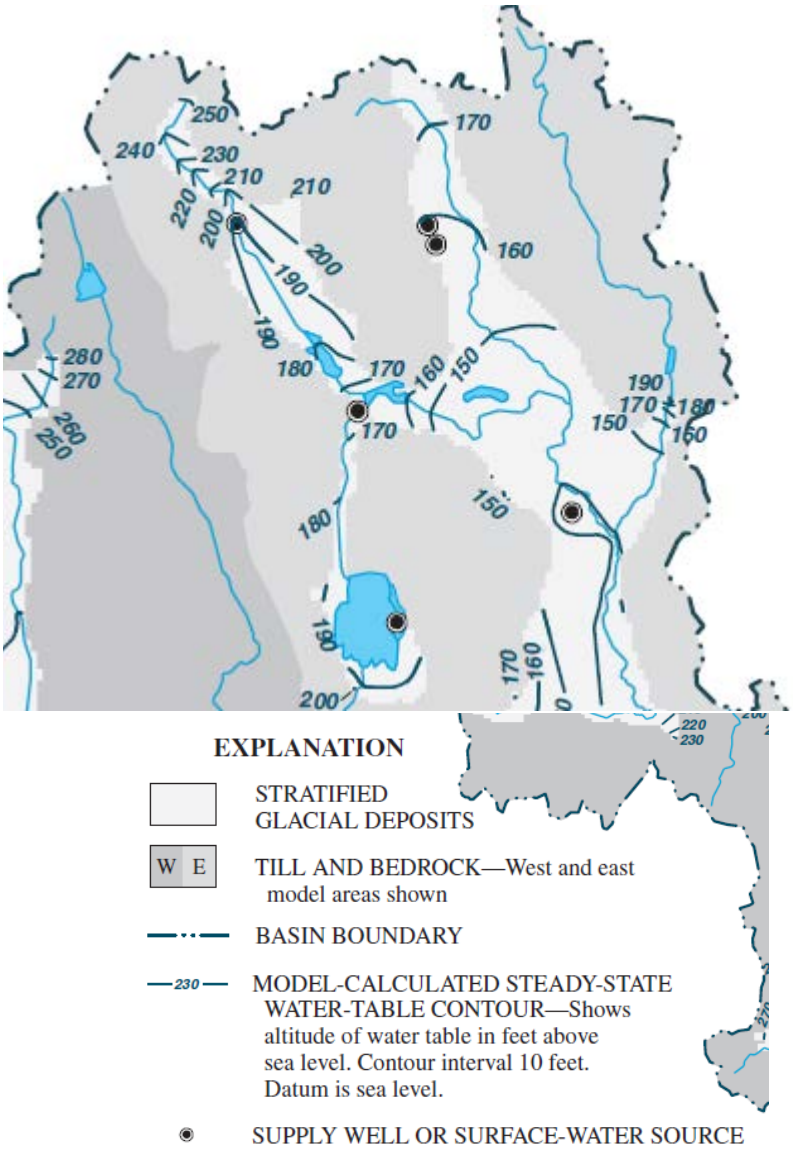


Figure 2-8 Model-calculated steady-state water table

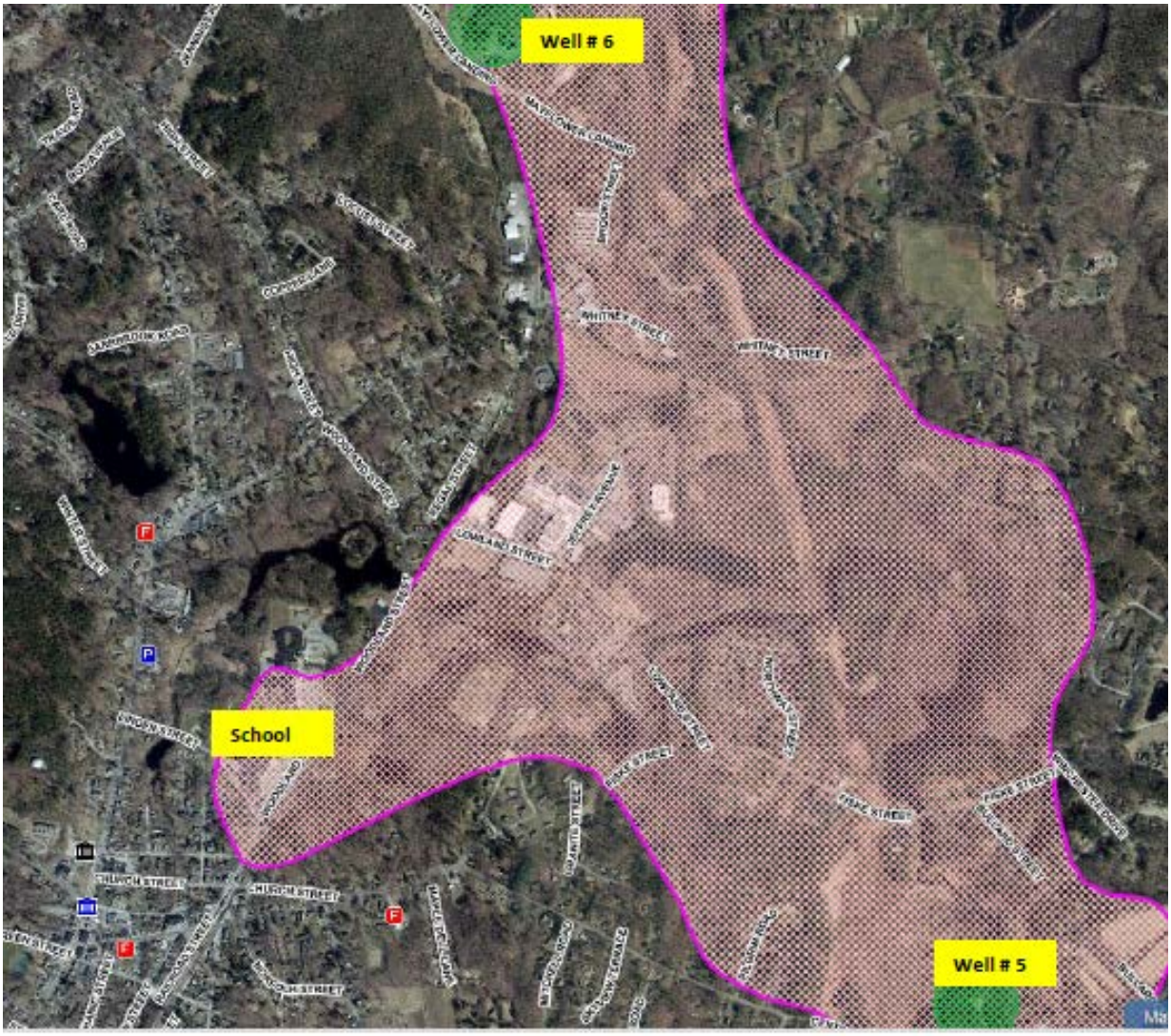


Figure 2-9 Zone II near School Site

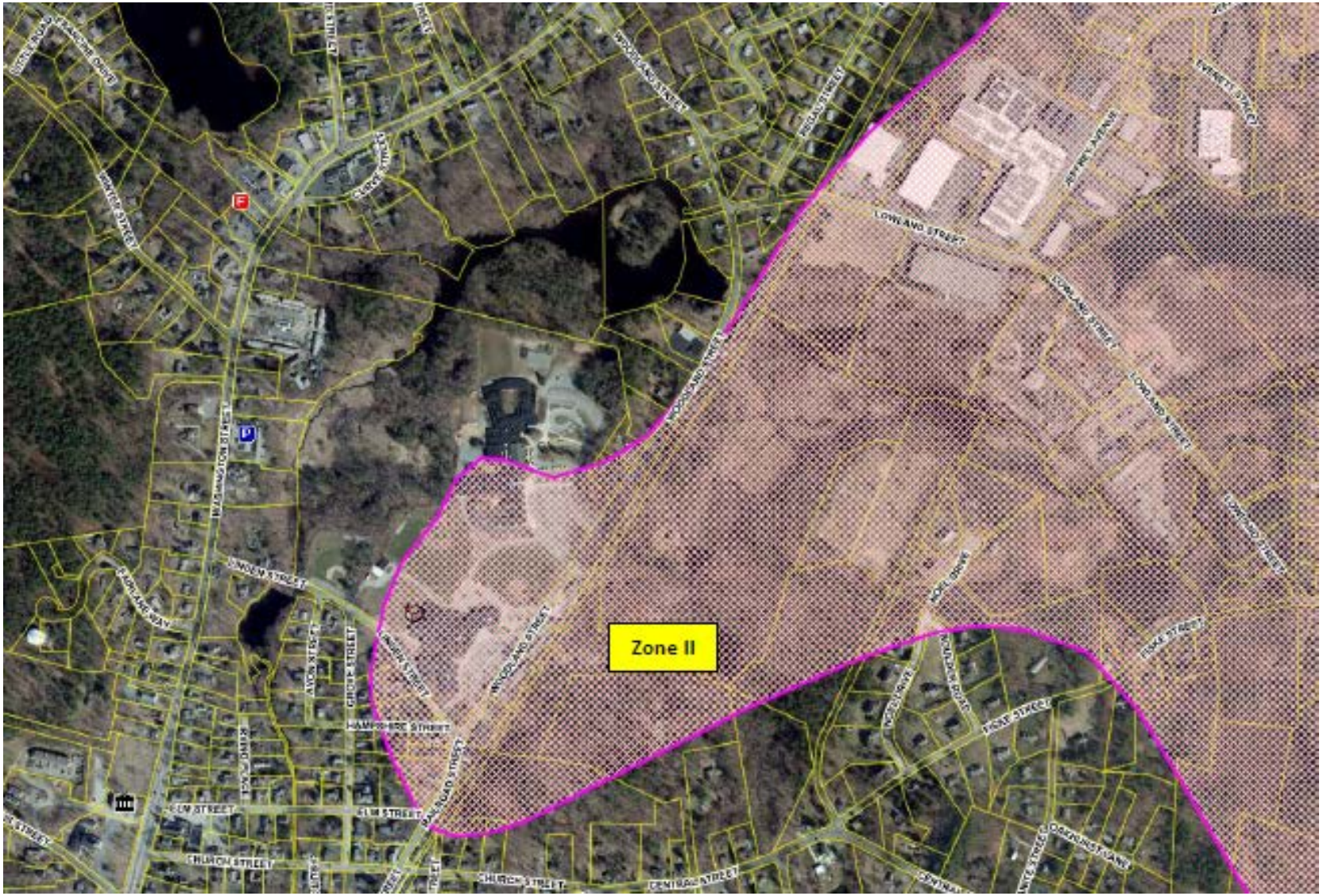


Figure 2-10 Holliston Zone II Map on Aerial at Project Site

Figure 2-11 Wetlands Map

3 PROJECT SITE BORINGS, SIEVE ANALYSIS, SLUG TESTS, HYDRAULIC CONDUCTIVITY ESTIMATES & GROUNDWATER MONITORING WELLS/ELEVATIONS

The Verdantas hydrogeology report is presented in Appendix C

3.1 SITE BORINGS

The location of August 2022 project performed borings are illustrated on Figure 3-1 and presented on Table 3-1.

Figure 3-1 WWTP and Woodland School Complex – Photo with Recent Borings

Table 3-1 Soil Boring Coordinates

Woodland Street School Complex		
Soil Boring Locations		
Label	Latitude	Longitude
B-1	42.205079	-71.424718
B-2	42.204784	-71.424322
B-3	42.205141	-71.424420
B-4	42.205277	-71.424072
B-5	42.205084	-71.423981
B-6	42.205493	-71.422611
B-7	42.205504	-71.422119
B-8	42.205664	-71.421899
B-9	42.205554	-71.421451
B-10	42.205657	-71.423118
B-11	42.206182	-71.424024
B-12	42.208810	-71.421520
B-13	42.208723	-71.422010
B-14	42.208802	-71.422457
B-15	42.208262	-71.422396

3.2 HYDRAULIC CONDUCTIVITY ESTIMATES BASED UPON SIEVE AND SLUG TESTS

Table 3-2 Hydraulic Conductivity Estimates Based Upon Sieve Analysis

Hydraulic Conductivity Estimates Based Upon Sieve Analysis				
Boring Location	Depth Below Surface Interval	Geo Mean (ft/day	Arith Mean (ft/day	Soils Description
B4	0-10	33	133	poorly sorted gravelly sand low in fines
	10-16	98	267	poorly sorted sandy gravel low in fines
	16+	55	858	poorly sorted sandy gravel low in fines
B6	5-12	18	82	poorly sorted gravelly sand low in fines
	10-15	33	138	poorly sorted gravelly sand low in fines
	15+	32	150	poorly sorted sandy gravel low in fines
B9	15-17.5	15	57	poorly sorted gravelly sand low in fines
	0-9	27	94	poorly sorted gravelly sand low in fines
	9-14.5	87	184	poorly sorted gravelly sand low in fines
B11	5-10	20	91	poorly sorted gravelly sand low in fines
	10-14	32	142	poorly sorted gravelly sand low in fines
B12	0-10	2	14	poorly sorted gravelly sand low in fines
B-13	5-15	0.4	33	poorly sorted sandy silt low in fines
	15-20	1	29	poorly sorted sand low in fines

Table 3-3 Hydraulic Conductivity Estimates Based on Sieves Utilizing Various Techniques – B-4 Site Only

B-4 0 - 10 feet below grade	
Estimation of Hydraulic Conductivity	**ft/day**
Hazen	
Hazen K (cm/s) = d10 (mm)	
Slichter	
Terzaghi	1.26
Beyer	
Sauerbrei	3.74
Kruger	
Kozeny-Carmen	254
Zunker	197
Zamarin	236
USBR	
Barr	0.94
Alyamani and Sen	277
Chapuis	
Krumbein and Monk	94.72
Geometric mean	33
Arithmetic mean	133

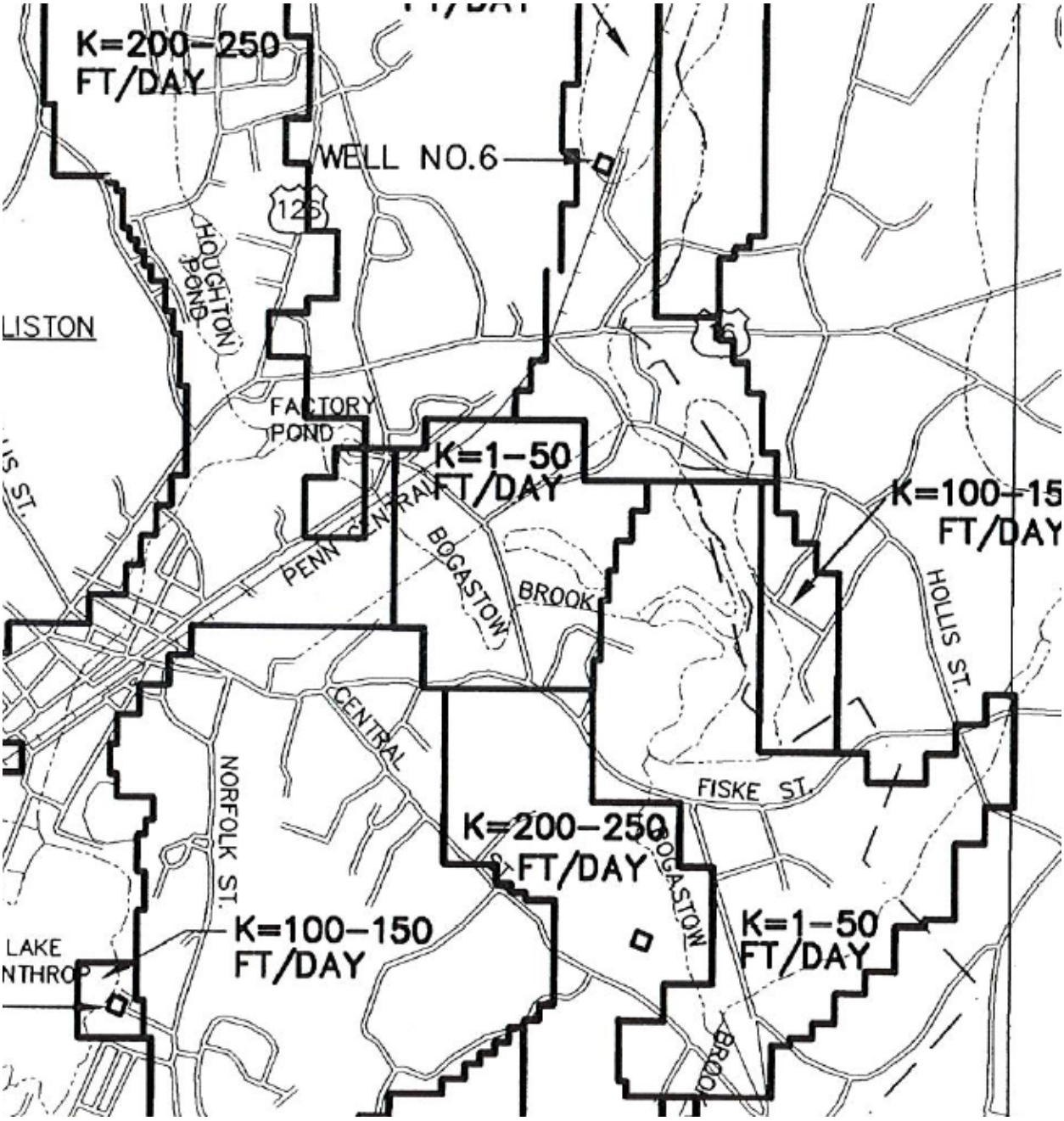
Table 3-4 Slug Tests Hydraulic Conductivity Results

Summary of Slug Test Results in Feet per Day
Holliston School December 2022

Well	Trial 1	Trial 2	Notes
MW-1	5	n/a	
MW-2	20	15	note 1
MW-3	7	n/a	note 1
MW-4	n/a	n/a	no well installed
MW-5	2	2	
MW-6	n/a	n/a	dry
MW-7	5	4	
MW-8	6	5	
USGS	1	n/a	assumed 10 foot screen

Notes
1. Analysis from slug in data which is not valid for wells without a fully saturated screen.
Results are presented because slug out data was unusable.
Despite this, MW-3 results are comparable to others.
However, higher MW-2 results should be viewed as questionable.

Hydraulic Conductivities of Zone II Model – 1999 Bogatsow Brook Aquifer Layer 1



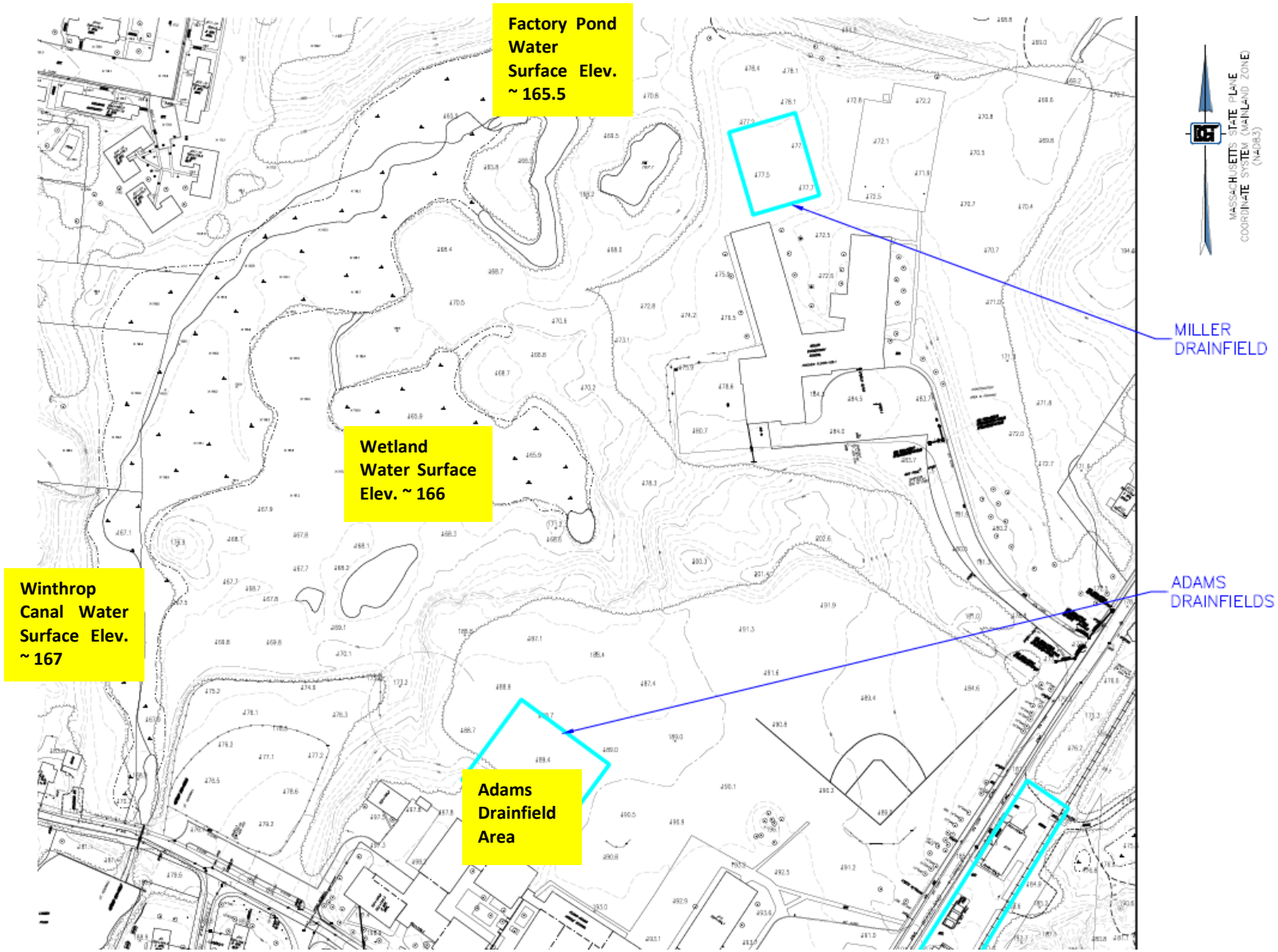
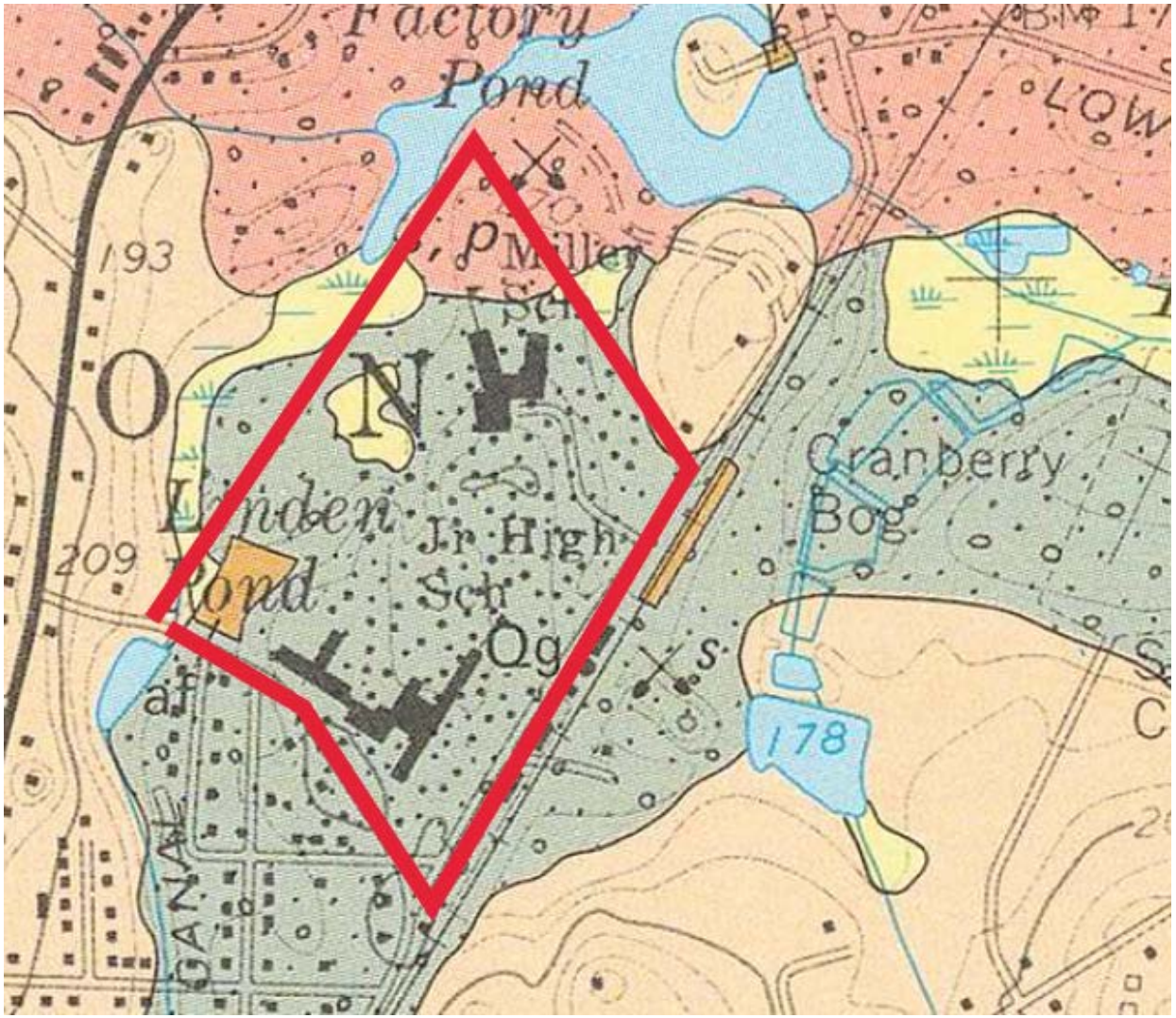


Figure 3-2 1998 Survey



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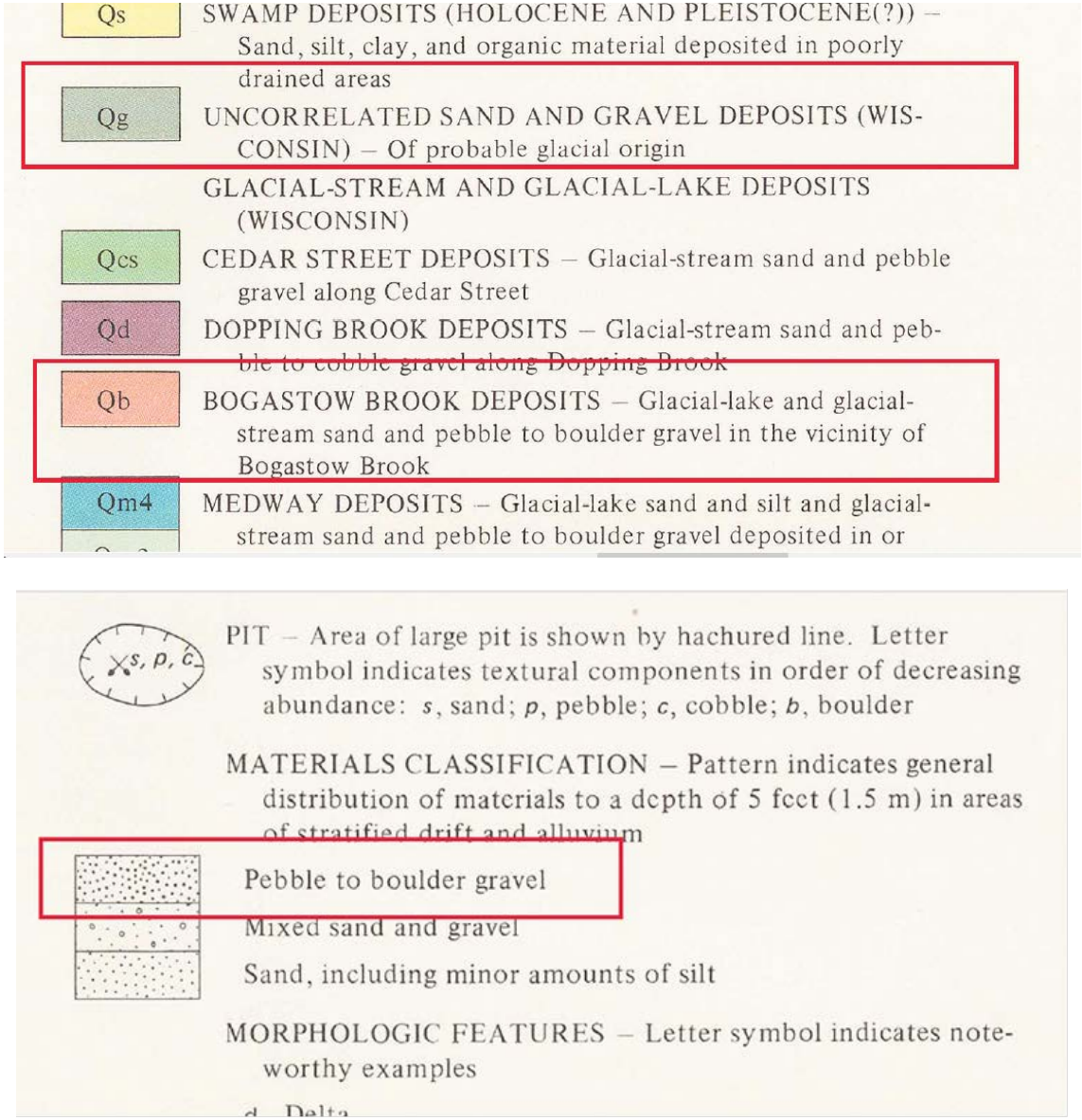
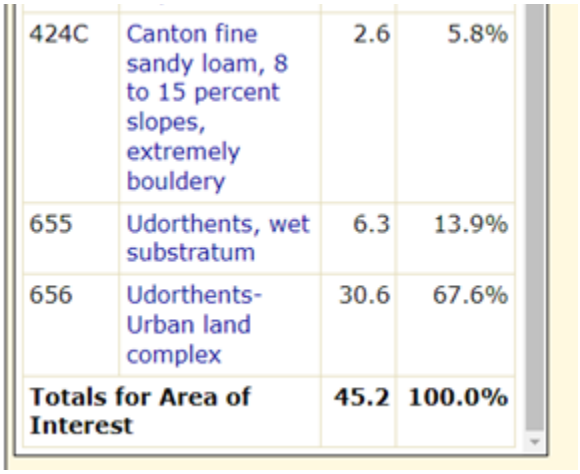


Figure 3-3 USGS Surficial Geology Map

Figure 3-4 Site Soils Map

Table 3-6 Site Soils Units



424C	Canton fine sandy loam, 8 to 15 percent slopes, extremely bouldery	2.6	5.8%
655	Udorthents, wet substratum	6.3	13.9%
656	Udorthents-Urban land complex	30.6	67.6%
Totals for Area of Interest		**45.2**	**100.0%**

Site soils are primarily are in the map unit symbol 656.

4 GROUNDWATER ELEVATION MONITORING RESULTS

4.1 GROUNDWATER MONITORING WELLS, ELEVATIONS AND CONTOURS

Fifteen (15) wells (B-1 through B-15) were installed in August 2022 and seven (7) of the proposed eight (8) (GW MW #4 not installed) groundwater monitoring wells were installed in Nov. 28 -30, 2022 – see Figures 4-1A and Figure 4-1B.

Figure 4-1A Locations of Temporary & Permanent GW Monitoring Wells

Figure 4-1B Locations of Permanent GW Monitoring Wells

Figure 4-2 Soils Cross Sections - August 2022 Borings

Table 4-1 Groundwater Elevations – August 2022 Data

Holliston Schools Site – 100 Linden Street - Soil Boring Locations													
Field	**LAI Location ID**	**Verd Location ID**	**Description**	**Original Survey Elev.**	**Approx. Surface elev.**	**Boring Date**	**Boring Depth (ft)**	**Depth to GW (ft)**	**Depth to Refusal (ft)**		**Est. DGW**	**Est GW Elev**	**Est Avg GW Elev**
Damigella Field	D-1	B-6	NW corner / Left field corner	191.07		15-Aug-22	19.5	>19.5	19.5		20	171.07	
		B-7		189.40		15-Aug-22	17	>17	17		20	169.40	173.77
	D-2	B-8	Center field	191.20		16-Aug-22	13	12	13			179.20	
	D-3	B-9	right field	188.40		16-Aug-22	17.5	13	17.5			175.40	
Former Flagg School	F-1	B-2	South	197.54		15-Aug-22	10.5	> 10.5	> 10.5		11	186.54	
	F-2	B-1	NW	197.99		15-Aug-22	11.5	> 11.5	> 11.5		12	185.99	
	F-3	B-3	North	197.98		15-Aug-22	5	>5	>5		6	191.98	~ 177
		B-5	East	198.00		15-Aug-22	17	>17	17		20	178.00	
	F-4	B-4	NE	197.27		15-Aug-22	19	~19+	19		20	177.27	
Adams Ballfield with Drainfields	W-1	B-10	East	189.46		16-Aug-22	24	15	24			174.46	
													174.08
	W-3	B-11	West	188.70		16-Aug-22	13	>13	13		15	173.70	
Miller School Field	M-1	B-15	South	176.51		16-Aug-22	15	14	>15			162.51	
	M-2	B-14	NW	176.16		16-Aug-22	20	15	>20			161.16	162.89
	M-3			172.00		16-Aug-22	25	7	>25			165.00	
Esker Area	E-1	B-12	Top of Esker	184.00		16-Aug-22	25	17	>25			167.00	

Table 4-2 Groundwater Elevations – Nov. 2022 – April 2023 Data

			Well Depth			Depth to GW (feet)					
Brief Description	GW MW Location #	Top of casing	11/30/22	12/15/22	Bottom Elev	30-Nov-22	15-Dec-23	14-Jan-23	25-Jan-23	13-Mar-23	13-Apr-23
New Wells											
Western edge of Adams Ballfield	1	191.21	24	23.2	168.01	21.5	20.72	19.93	19.29	20.5	20.63
Kindergarden playground area	2	188.76	18	17.8	170.96	11.0	10.67	9.58	9.27	9.65	9.77
Entrance - across from Holl Oil	3	187.86	20	18.75	169.11	14.5	10.71	9.19	8.82	9.03	9.22
N main entrance - across from USGS well	4		10								
eastern edge property	5	176.64	17	16.6	160.04	9.0	**7.00**	**5.00**			
Flagg School area	6	198.10	13.5		184.60	>13.5	>13.5	13.5	12.85	>13.5	>13.5
SE entrance along woodland St	7	193.70	19.2	18.8	174.90	14.49	14.31	13.3	13.02	12.53	12.45
NE of Miller School	8	171.01	14	13.8	157.21	3.57	3.62	2.63	2.15	2.89	3.2
Existing wells											
Flagg School	1	198.1	19.4		178.70	dry	dry	18.18		18.16	18.23
Miller School	2	178.93	16.92		178.93	11.95		11.13	10.67	11.49	11.8
USGS	HTW 50	181.07	13	13	168.07	8.4	7.92	6.6	6.02	6.88	7.15

	GW Elevation (feet)					
Brief Description	**30-Nov-23**	**15-Dec-23**	**14-Jan-23**	**25-Jan-23**	**13-Mar-23**	**13-Apr-23**
New Wells						
Western edge of Adams Ballfield	169.71	170.49	171.28	171.92	170.71	170.58
Kindergarden playground area	177.76	178.09	179.18	179.49	179.11	178.99
Entrance - across from Holl Oil	173.36	177.15	178.67	179.14	178.83	178.64
N main entrance - across from USGS well						
eastern edge property	167.64	169.64	171.64	172.29	172.07	171.91
Flagg School area	<184.6	<184.6	<184.6	185.25	<184.6	<184.6
SE entrance along woodland St	179.21	179.39	180.40	180.68	181.17	181.25
NE of Miller School	167.44	167.39	168.38	168.86	168.12	167.81
Existing wells						
Flagg School			179.92		179.94	179.87
Miller School	166.98		167.80	168.26	167.44	167.13
USGS	172.67	173.15	174.47	175.05	174.19	173.92

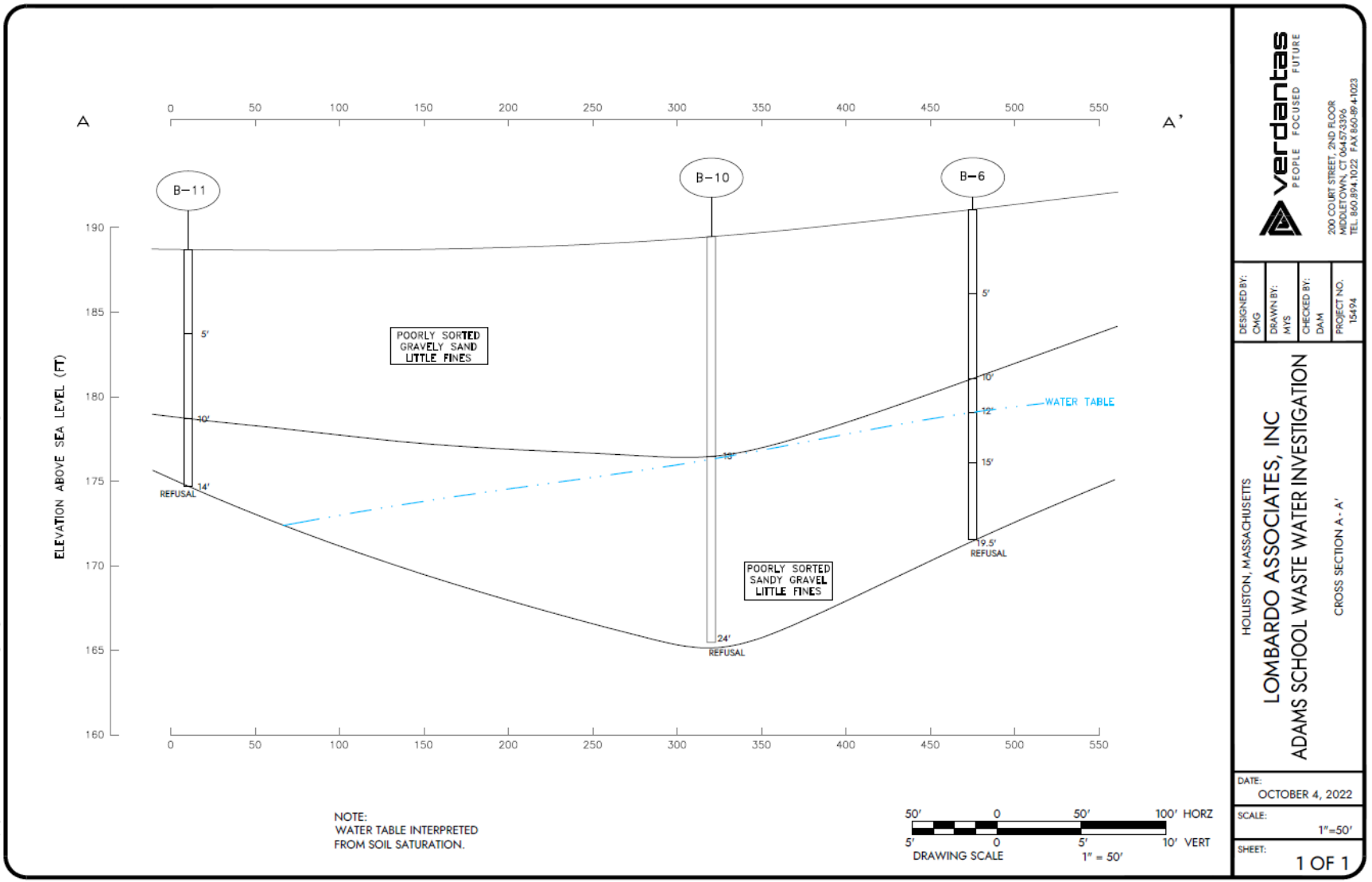


Figure 4-3 Soil Boring Cross Section A – A'

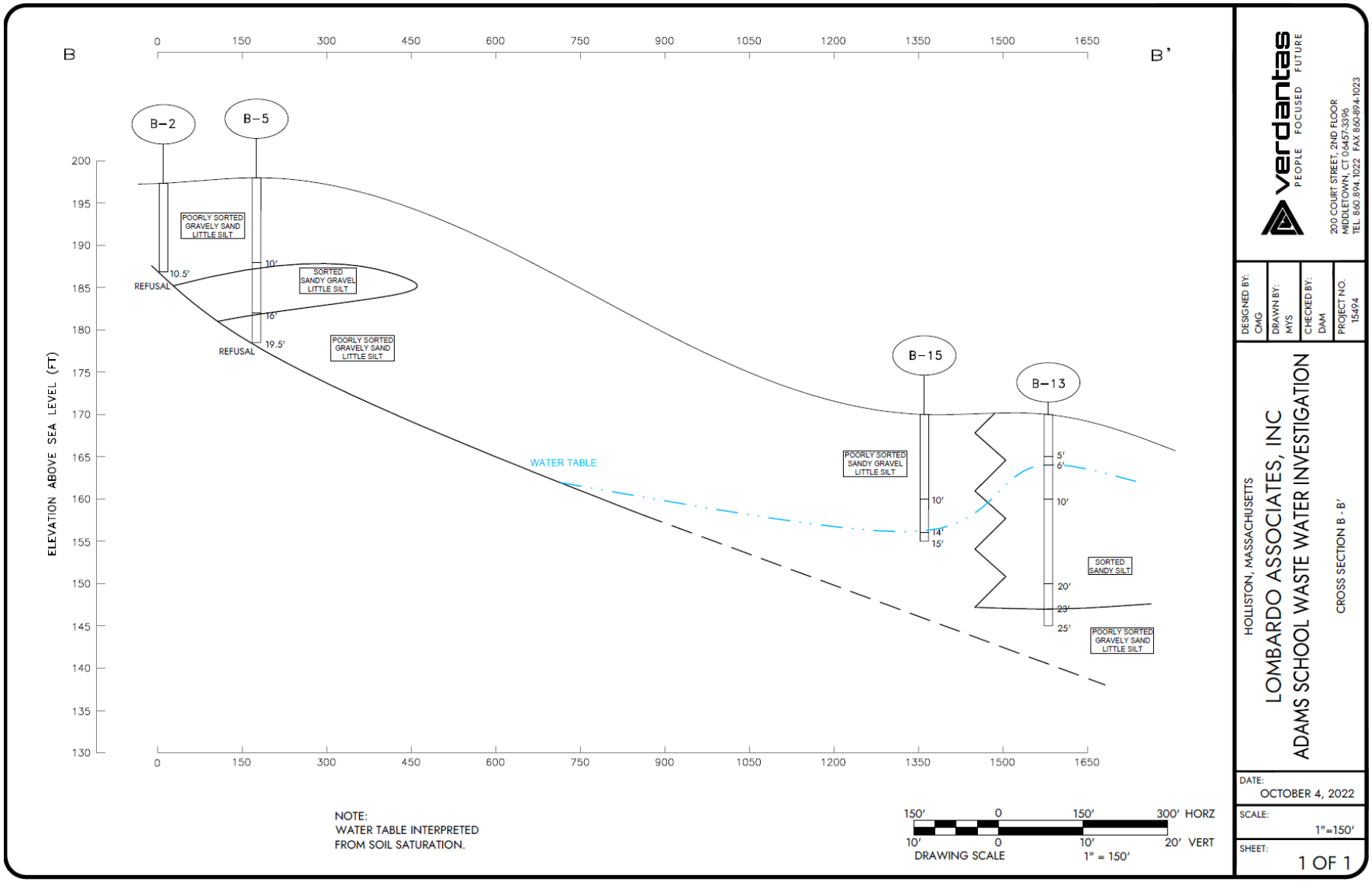


Figure 4-4 Soil Boring Cross Section B – B'

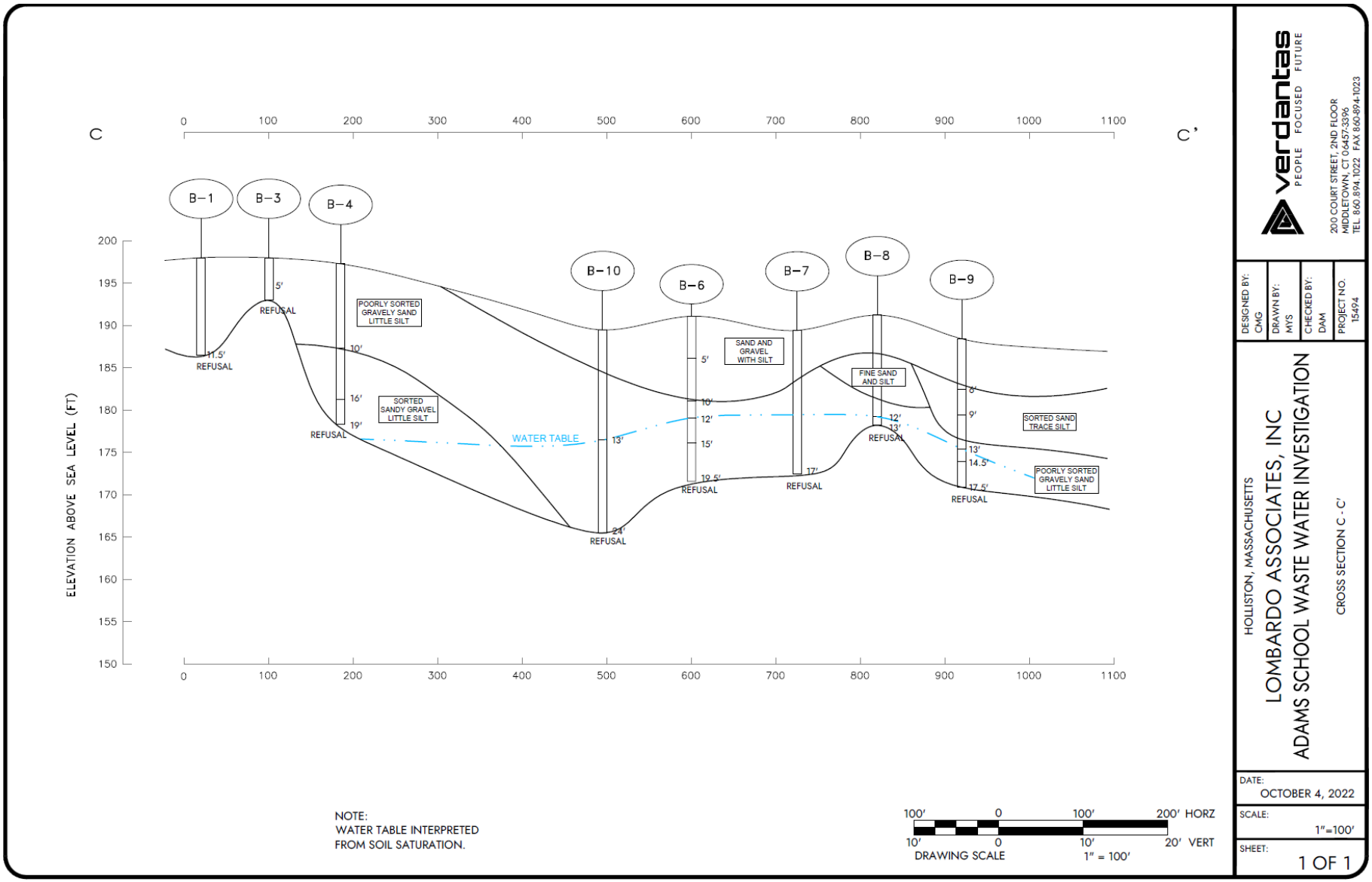


Figure 4-5 Soil Boring Cross Section C – C'

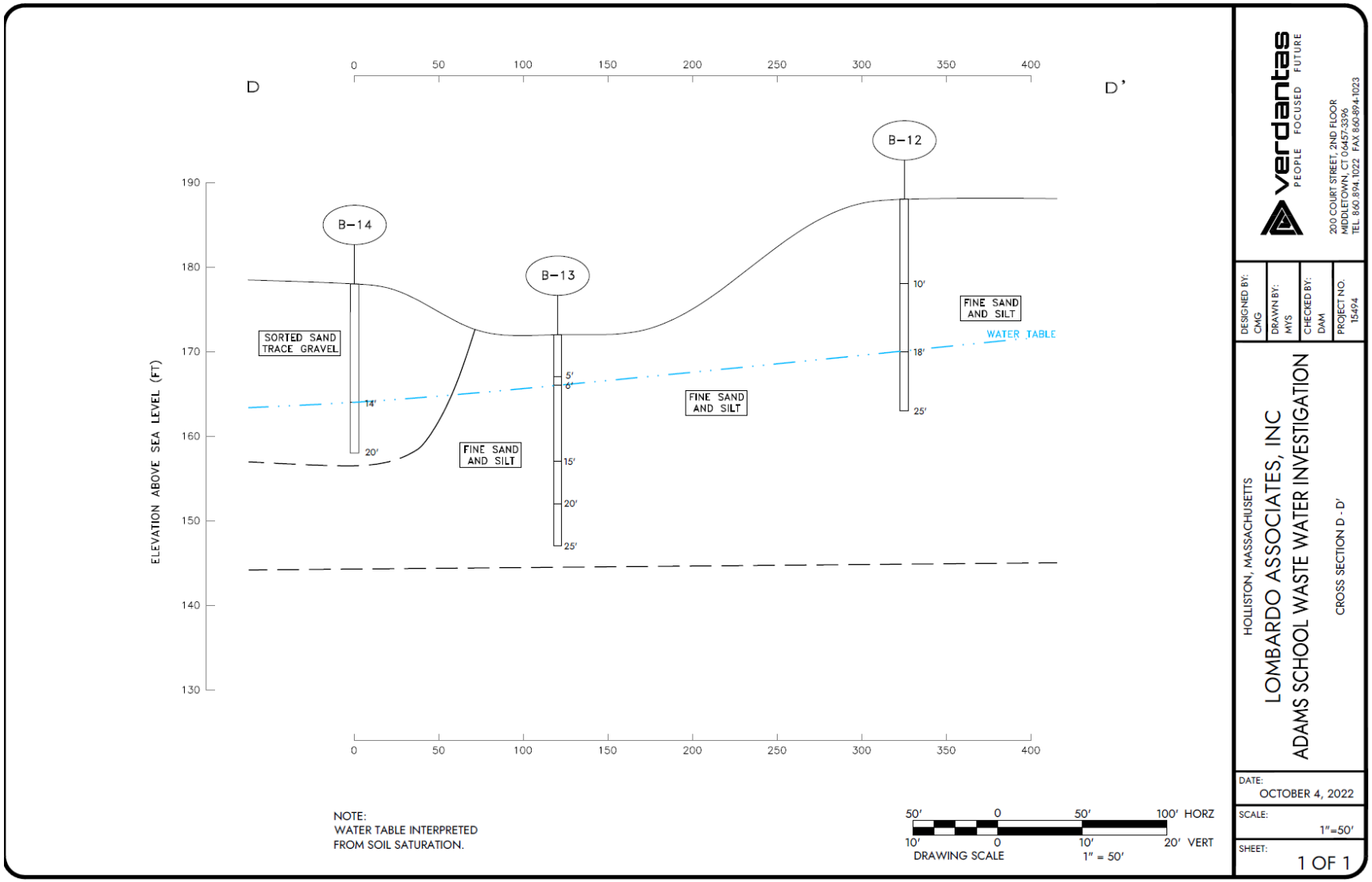


Figure 4-6 Soil Boring Cross Section D – D'

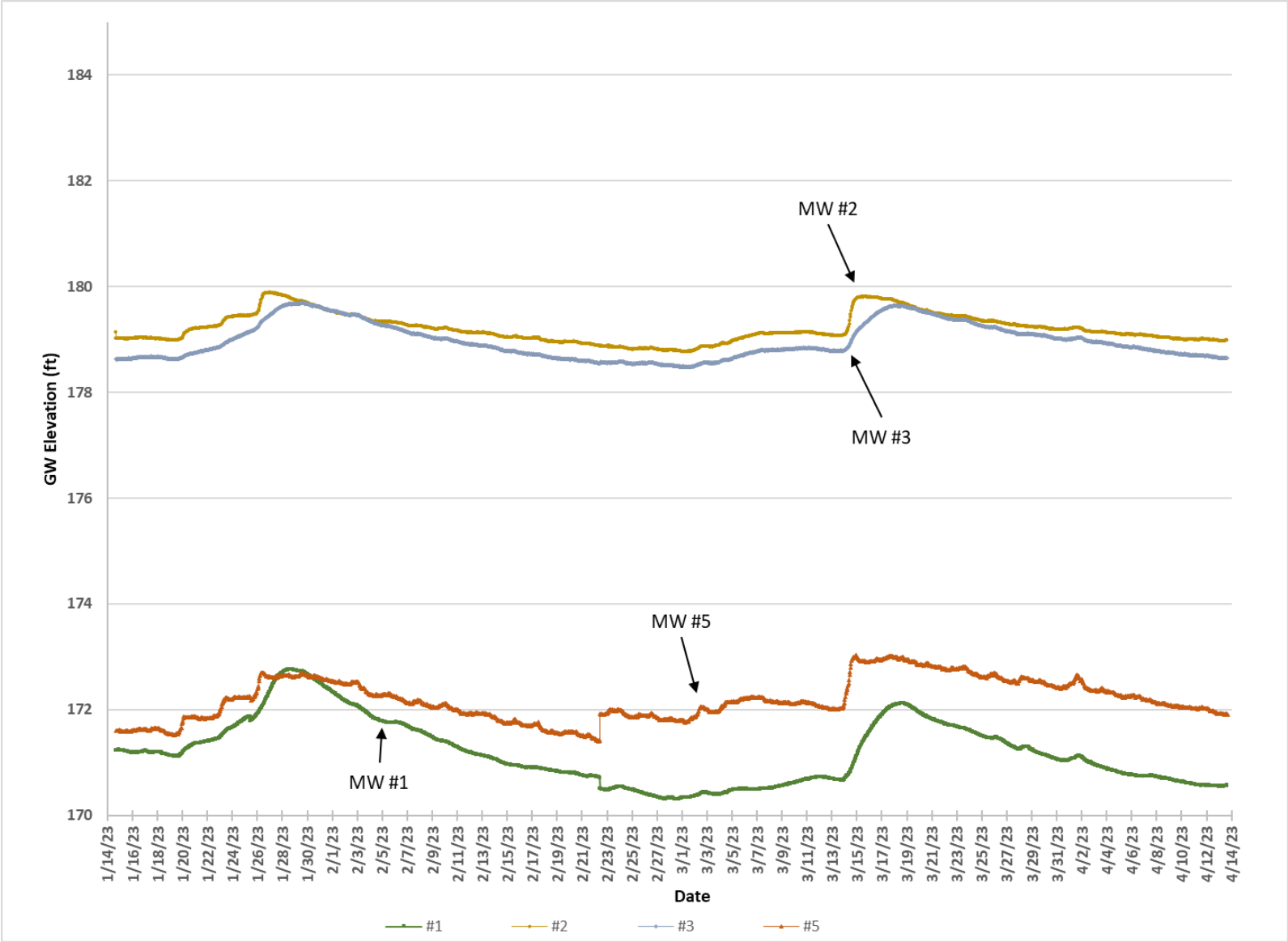


Figure 4-7 Groundwater Elevations at Wells # 1, #2, #3 & #5

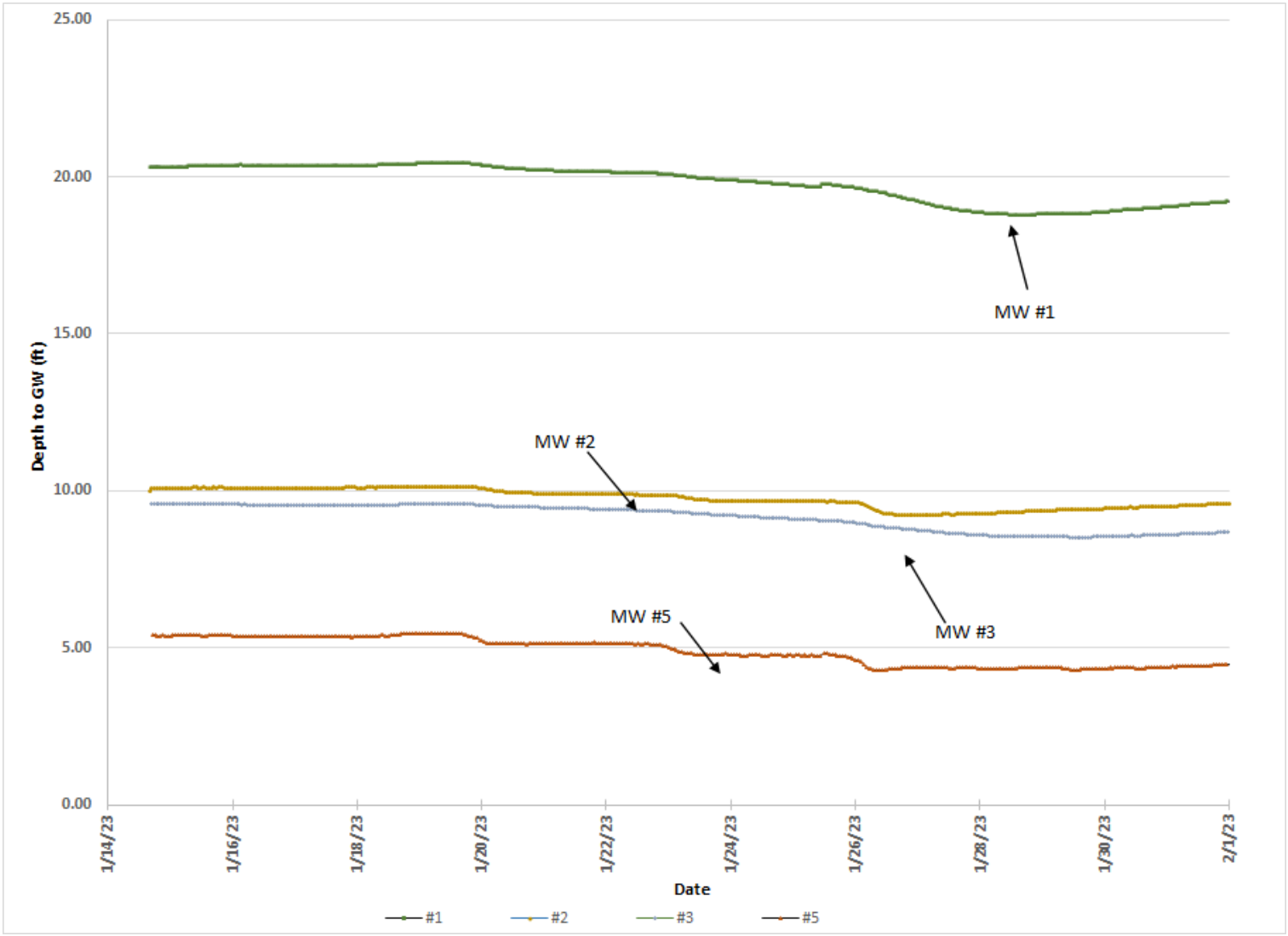


Figure 4-8 Depth to Groundwater at Wells # 1, #2, #3 & #4

4.2 GROUNDWATER CONTOURS

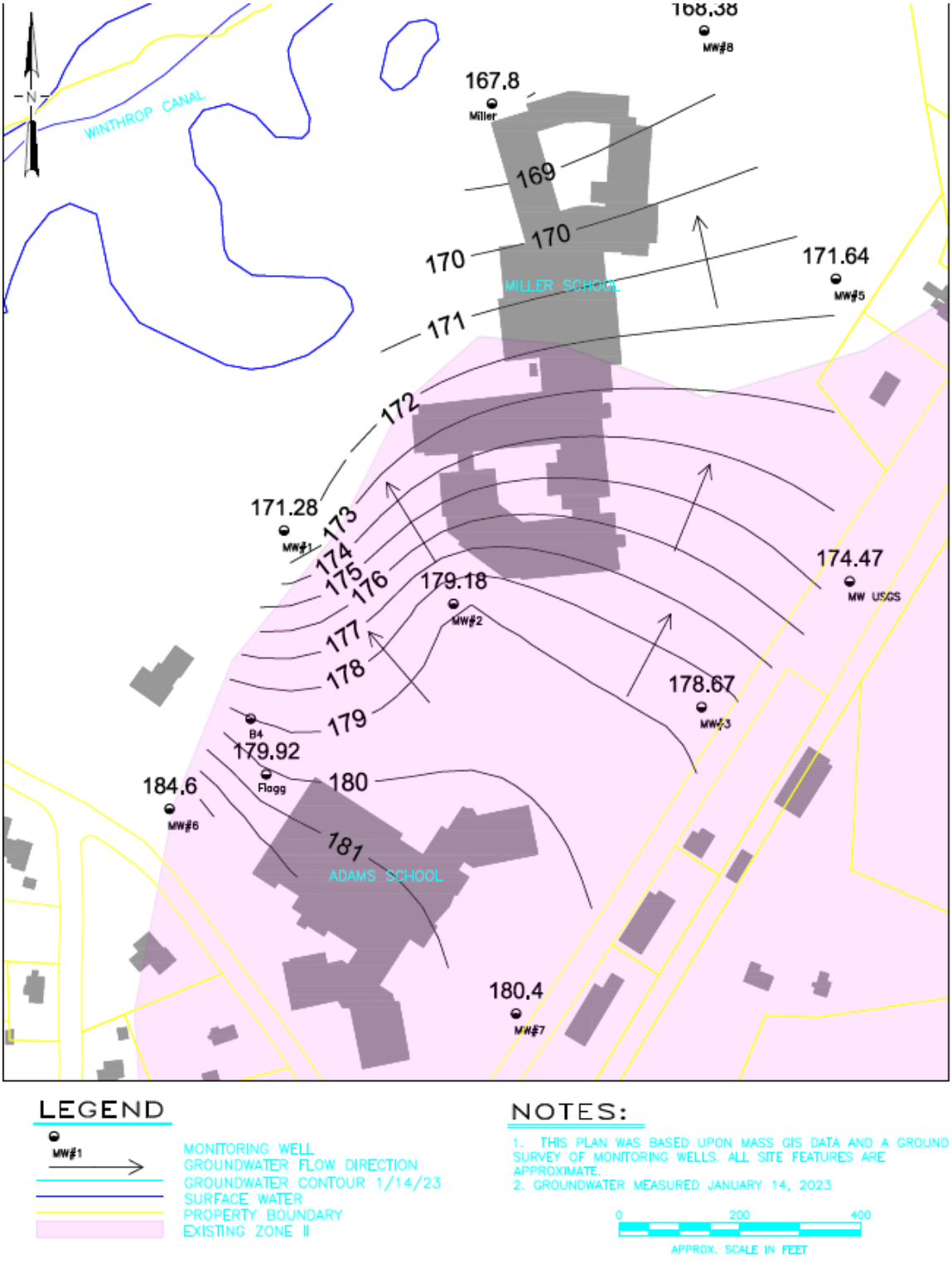


Figure 4-9 Groundwater Contour Map

4.3 GROUNDWATER SLOPE

Table 4-2 Groundwater Slope

30-Nov-23	15-Dec-23	14-Jan-23	25-Jan-23	13-Mar-23	13-Apr-23
GW Elev Change (ft)					
8.05	7.6	7.9	7.57	8.4	8.41
7.51	7.03	6.85	6.85	6.76	6.73
Slope					
0.0230	0.0217	0.0226	0.0216	0.0240	0.0240
0.0100	0.0094	0.0091	0.0091	0.0090	0.0090

4.4 GROUNDWATER VELOCITY & TRAVEL TIME

Groundwater Velocity = K * i / n

= 10 feet/day * .02 / 0.25 = 0.8 feet / day

6 months = 183 days = 146.4 feet

12 months = 365 days = 292 feet

Water supply well # 5 is at 42°11'56"N, 71°23'52"W, approximately 13,000 feet downstream in Bogastow Brook from School area. Well is off Central Street near Powderhorn Lane

5 SITE CAPACITY & MOUNDING ANALYSIS

Given the criticality of hydraulic conductivity, it is proposed to be measured in the field by slug tests in the wells using an electronic data logger for measurement of groundwater levels. The test data will be reduced and analyzed using standard methods to estimate hydraulic conductivity of the aquifer.

5.1 PRELIMINARY SITE CAPACITY ANALYSIS

Preliminary Darcy's Law capacity estimates are presented to provide initial insights and sensitivity analysis to the disposal capacities of the School Property.

Darcy's Law Capacity Estimates Methodology

Treated wastewater disposal capacity of candidate areas on the School Property were estimated in the following manner:

1. Available Area determined as shown on Figure 1-2.

2. Darcy's Law disposal capacity of the dispersal zones was calculated at the downgradient face of the zones as follows:

Q = K*A*i, where Q = volumetric flow (cf/day),
K = Hydraulic conductivity (ft/day) of unsaturated zone,
A = cross sectional area (sf) of discharge cross sectional area
i = groundwater slope

i. Hydraulic conductivity (K) of 20 feet/day, with sensitivity analysis to 140 feet/day per USGS model (Figure 2-7);

ii. Test pit data (as presented in Section 4) reviewed to estimate depth to groundwater (GW) / bedrock – see Figures 4-3 through 4-6,

iii. Cross Sectional area computed by:

- ✓ Length measured as the furthest downgradient face of zone
- ✓ Depth estimated at 3 - 5 feet

4. Darcy's Law flow estimates calculated, with recognition that GW elevations represent ~ 7,500 gpd average daily discharge at the schools which is 15,000 gpd wastewater design flow, which is 12,000 gpd of modelled discharge.

To place the analysis in context, the analysis objective is to determine the maximum amount of wastewater flow coming from the Holliston downtown area that can be discharged at the School site and be permitted by MassDEP.

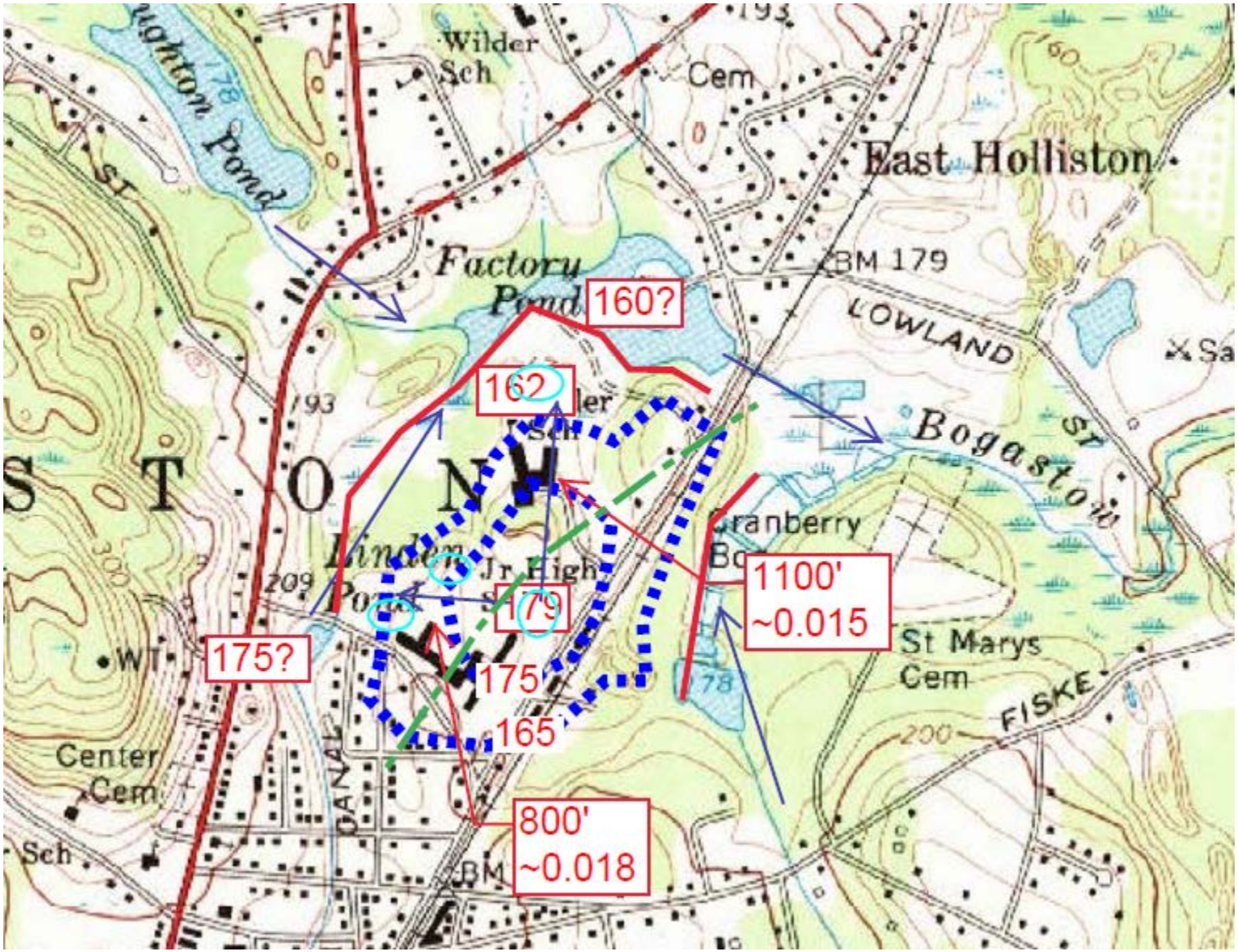


Figure 5-1 Estimated GW Elevations and GW Discharging Flux Lengths

Table 5-1 Disposal Capacity Preliminary Estimates

Holliston Woodlsand Street School Complex Site - Discharge Capacity Initial Estimates with Sensivitity Analysis of Values for K & Unsaturated Thickness Available for Discharge	
Q = K*A*i	Q = volumetric flow (cf/day),
	K = Hydraulic conductivity (ft/day) of unsaturated zone
	A = cross sectional area (sf) of discharge/flux area
	i = groundwater slope

K (ft/day)	5	10			
Area (sf)	17,500	17,500			
Length	3,500	3,500			
Width	5	5			
i	0.0217	0.0217			
Q (cf/day)	1,899	3,798			
Q (gpd)	14,203	28,405			
Add'l WW design Flow Capacity (gpd)	18,000	36,000			
Existing WW Design Capacity (gpd)	15,000	15,000			
Total Capacity (gpd)	33,000	51,000			

Existing School WW design Flow (gpd)	15,000
Existing Downtown WW design Flow (gpd)	30,000
Total Exist School & Downtown WW Design Flow (gpd)	45,000

Holliston Woodlsand Street School Complex Site						
					GW Elev	
MW #	GW Elev		Distance	(ft)	change	slope (i)
1	170.49		MW #1 to #2	350	7.6	0.0217
2	178.09					
3	177.15		MW #3 to #5	750	7.51	0.0100
5	169.64					

5.2 PRELIMINARY MOUNDING ANALYSIS

It is noted that depth from surface to GW needs to consider 1 foot separation between grade and bottom of drip system and 4 foot separation drip bottom to max mounded GW elevation. Therefore minimum five (5) foot separation grade to maximum mounded GW elevation.

The sophisticated mounding analytical model MODFLOW needs to be used due to the limitations of the Hantush method, which assumes a flat groundwater. Site groundwater slopes, multiple groundwater directions and interaction amongst potential drainfields at at the site requires the more sophisticated MODFLOW model versus Hantush method.

APPENDIX A SOIL BORING LOGS – AUGUST & NOVEMBER 2022

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-1	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** 197.99	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/15/22	**Date Completed:** 8/15/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/30	0-5		0-8": Topsoil	Sand and Gravel with Silt		
1					8-18": Brown, very fine to coarse SAND, some Silt, some Gravel, trace Cobbles, trace Brick, trace asphalt, damp.			
2					18-30": Ligtht brown, fine to coarse SAND, some Gravel, some Silt, trace cobbles, damp.			
3								
4								
5	S-2	60/28	5-10		0-28": Light brown, very fine to coarse SAND, some Silt, little Gravel, trace cobbles, damp.			
6								
7								
8								
9								
10	S-3	18/10	10-11.5		0-10": Gray/brown, very fine to coarse SAND, some Gravel, little Silt, trace cobbles, damp.			
11								
12					Refusal encountered at 11.5 feet below ground surface.			
13								
14								
15								
16								
17								
18								
19								
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	**Density**	**Blows/ft.**	**Consistency**
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

First attempt refusal encountered at 6.5 feet below ground surface.
Groundwater not encountered.

SOIL BORING LOG

verdantas

Client: Lombardo Associates, Inc.		**Boring Identification:** B-2	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/15/22	**Date Completed:** 8/15/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/30	0-5		0-8": Topsoil 8-24": Brown, very fine to coarse SAND, some Silt, little Grave, trace Cobbles, damp. 24-30": Light Brown, fine to medium SAND, little Silt, damp.			
5	S-2	60/35	5-10		0-35": Brown, very fine to coarse SAND, some Gravel, some Silt, trace Cobbles, damp.	Sand and Gravel with Silt		
10	S-3	18/10	10-10.5		0-6": Light brown, very fine to medium SAND, some Silt, trace Gravel, damp. 6-10": Brown, fine SAND, trace Silt, damp. Refusal encountered at 10.5 feet below ground surface.			
15								
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater not encountered.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-3	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/15/22	**Date Completed:** 8/15/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	48/24	0-5		0-4": Topsoil 4-24": Brown, fine to coarse SAND and GRAVEL, some Silt, trace cobbles, damp.	Sand and Gravel with Silt		
5					Refusal encountered at 5 feet below ground surface.			
10								
15								
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

First attempt refusal at 4 feet below ground surface.
Groundwater not encountered.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-4	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/15/22	**Date Completed:** 8/15/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/24	0-5		0-8": Topsoil			
1					8-12": Gray, very fine to coarse SAND and GRAVEL, some Silt, trace cobbles, damp.			
2					12-24": Brown, very fine to coarse SAND and GRAVEL, some Silt, trace cobbles, damp.			
3								
4								
5	S-2	60/18	5-10		0-8": Dark brown, very fine to coarse SAND, some Silt, trace Gravel, damp.	Sand and Gravel with Silt		
6					8-18": Light brown, very fine to coarse SAND, little Gravel, little Silt, trace Cobbles, little Silt, damp.			
7								
8								
9								
10	S-3	60/24	10-15		0-12": Brown/gray, very fine to coarse SAND, some Silt, trace Gravel, trace cobbles, damp.			
11					12-24": Light Brown, medium to coarse SAND, some Gravel, trace fine Sand, trace Silt, damp. (sorted)			
12								
13						Sorted Sand and Gravel		
14								
15	S-4	48/40	15-19		0-16": Brown, medium to coarse SAND, little Gravel, trace fine Sand, trace Silt, damp. (sorted)			
16								
17					16-40": Brown, very fine to coarse SAND, some Gravel, some Silt, trace cobbles, damp.			
18						Sand and Gravel with Silt		
19					Refusal encountered at 19 feet below ground surface.			
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater not encountered.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-5	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/15/22	**Date Completed:** 8/15/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/24	0-5		0-6": Topsoil			
1					6-24": Brown, very fine to coarse SAND, some Gravel, little Silt, trace cobbles, damp.			
2								
3								
4								
5	S-2	60/24	5-10		0-24": Dark brown/brown, fine to coarse SAND, some Silt, little Gravel, trace cobbles, damp.	Sand and Gravel with Silt		
6								
7								
8								
9								
10	S-3	60/18	10-15		0-18": Light brown, medium to coarse SAND, little Gravel, trace fine Sand, trace Silt, trace cobbles, damp. (sorted)	Sorted Sand and Gravel		
11								
12								
13								
14								
15	S-4	24/20	15-17		0-6": Brown, medium to coarse SAND, little Gravel, trace fine Sand, trace Silt, trace cobbles, wet. (more sorted)			
16								
17					6-20": Brown, fine to coarse SAND and GRAVEL, little Silt, trace cobbles, wet.	Sand and Gravel with Silt		
18								
19					Refusal encountered at 17 feet below ground surface.			
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

First attempt refusal encountered at 3 feet below ground surface.
Groundwater not encountered.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-6	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/15/22	**Date Completed:** 8/15/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/18	0-5		0-6": Topsoil			
1					12-18": Brown, very fine to coarse SAND, some Silt, little Gravel, trace cobbles, damp.			
2								
3						Sand and Gravel with some Silt		
4								
5	S-2	60/18	5-10		0-18": Brown, fine to coarse SAND, some Gravel, little Silt, trace cobbles, damp.			
6								
7								
8								
9								
10	S-3	60/24	10-15		0-24": Gray, fine to coarse SAND, little Gravel, little Silt, trace cobbles, wet at 12 feet below ground surface.			
11								
12								
13						Sand and Gravel with little Silt		
14								
15	S-4	54/30	15-19.5		0-30": Gray, fine to coarse SAND, little Gravel, little Silt, trace cobbles, wet.			
16								
17								
18								
19								
20					Refusal encountered at 19.5 feet below ground surface.			

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

First attempt refusal encountered at 6 feet below ground surface.
Concrete drain encountered at 6 feet below ground surface.
Groundwater encountered at 12 feet below ground surface.
Septic odor observed.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-7	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/15/22	**Date Completed:** 8/15/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0					No samples collected.			
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17					Refusal encountered at 17 feet below ground surface.			
18								
19								
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater was not measured. Augers used.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-8	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/16/22	**Date Completed:** 8/16/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/24	0-5		0-6": Topsoil			
1					12-24": Brown, very fine to coarse SAND, little Gravel, some Silt, trace cobbles, damp.	Sand and Gravel with Silt		
2								
3								
4								
5	S-2	60/42	5-10		0-24": Brown/orange, very fine to fine SAND, some Silt, trace roots, damp.	Fine Sand and Silt		
6								
7					24-42": Light brown, very fine to coarse SAND, little Gravel, little Silt, damp.	Sand and Gravel with Silt		
8								
9								
10	S-3	60/26	10-15		0-12": Brown, fine to coarse SAND, little Gravel, trace Silt, trace Cobbles, damp.	Sand and Gravel		
11					12-24": Brown, medium to coarse SAND, little Gravel, trace Silt, trace Cobbles, damp.			
12					24-26": Gray, fine SAND, rock.	Cobble		
13					Refusal encountered at 13 feet below ground surface.			
14								
15								
16								
17								
18								
19								
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater encountered at approximatly 12 feet below ground surface.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-9	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/16/22	**Date Completed:** 8/16/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/36	0-5		0-6": Topsoil 6-12": Light brown, very fine to coarse SAND, little Gravel, little Silt, damp. 12-24": Light brown, very fine to coarse SAND, some Gravel, little Silt, trace Cobbles, damp. 24-36": Brown/orange, very fine to coarse SAND, some Gravel, trace Silt.	Sand and Gravel with Silt		
5	S-2	60/24	5-10		0-18": Brown, fine to coarse SAND, some Gravel, trace cobbles, trace Silt, damp. 18-24": Brown/orange medium to coarse SAND, trace Gravel, trace fine Sand, trace Silt, (sorted) damp.	Sorted Sand and Gravel		
10	S-3	60/30	10-15		0-24": Light brown, medium to coarse SAND, little Gravel, trace Silt, (sorted) damp. 24-30": Gray, fine to medium SAND, some Silt, little Gravel, trace cobbles, wet.	Sand and Gravel with Silt		
15	S-4	54/18	15-17.5		0-18": Gray, fine to coarse SAND, some Gravel, some Silt, trace cobbles, wet. Refusal encountered at 17.5 feet below ground surface.			
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater encountered at approximately 13 feet below ground surface.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-10	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 2
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/16/22	**Date Completed:** 8/16/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/42	0-5		0-6": Topsoil			
1					6-12": Gray, very fine to coarse SAND, some Gravel, little Silt, damp.			
2					12-42": Brown, very fine to coarse SAND, little Gravel, little Silt, damp.			
3								
4								
5	S-2	60/10	5-10		0-10": Brown, very fine to coarse SAND, some Gravel, some Silt, trace cobbles, damp.			
6								
7						Sand and Gravel with Silt		
8								
9								
10	S-3	60/8	10-15		0-8": Brown, fine to coarse SAND and GRAVEL, some Silt, trace cobbles, damp.			
11								
12								
13								
14								
15	S-4	54/24	15-24		0-8": Brown/gray, medium to coarse SAND, little Silt, trace cobbles, wet.			
16					8-24": Brown/gray fine to coarse SAND and GRAVEL, little Silt, trace cobbles, wet.			
17						Sand and Gravel		
18								
19								
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	**Density**	**Blows/ft.**	**Consistency**
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater encountered at approximately at 15 feet below ground surface.
Low recovery in 10-15 sleeve groundwater could be as high as 13 feet.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-10	
Project: Adams School Waste Water Investigation			**Sheet:** 2 of 2
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/16/22	**Date Completed:** 8/16/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
20	S-1	60/42	20-25		0-32": Brown medium to coarse SAND, little Gravel, trace Silt, wet.	Sand and Gravel		
21								
22					32-42": Gray, fine SAND, some Silt, trace cobbles, wet.	Sand and Gravel with Silt		
23								
24					Refusal encountered at 24 feet below ground surface.			
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	**Density**	**Blows/ft.**	**Consistency**
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater encountered at approximately at 15 feet below ground surface.
Low recovery in 10-15 sleeve groundwater could be as high as 13 feet.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-11	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/16/22	**Date Completed:** 8/16/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/24	0-5		0-6": Topsoil	Sand and Gravel with Silt		
1					6-24": Light brown, very fine to coarse SAND, some Gravel, some Silt, trace cobbles, damp.			
2								
3								
4								
5	S-2	60/32	5-10		0-32": Light brown, very fine to coarse SAND, some Silt, little Gravel, trace cobbles, damp.			
6								
7								
8								
9								
10	S-3	60/30	10-15		0-30": Light brown, very fine to coarse SAND, some Gravel, little Silt, trace cobbles, damp.			
11								
12								
13					Refusal encountered at 13 feet below ground surface.			
14								
15								
16								
17								
18								
19								
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	**Density**	**Blows/ft.**	**Consistency**
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

First attempt refusal encountered at 4 feet below ground surface.
Second attempt refusal encountered at 2 feet below ground surface.
Groundwater not encountered.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-12	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 2
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/16/22	**Date Completed:** 8/16/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/48	0-5		0-48": Light brown, very fine SAND, some Silt, damp.	Fine Sand and Silt		
5	S-2	60/50	5-10		0-50": Light brown, very fine SAND, some Silt, damp.			
10	S-3	60/50	10-15		0-50": Light brown, very fine SAND, some Silt, damp.			
15	S-4	60/48	15-20		0-24": Brown, very fine SAND and SILT, damp. 24-48": Brown, very fine SAND and SILT, wet.			
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater encountered at approximately 17 feet below ground surface.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-12	
Project: Adams School Waste Water Investigation			**Sheet:** 2 of 2
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/16/22	**Date Completed:** 8/16/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
20	S-1	60/50	20-25		0-50": Brown, very fine SAND and SILT, wet.	Fine Sand and Silt		
25					Boring terminated at 25 feet below ground surface. Refusal not encountered.			

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater encountered at approximately 17 feet below ground surface.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-13	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 2
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/16/22	**Date Completed:** 8/16/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/36	0-5		0-36": Light brown, very fine SAND, some Silt, damp.			
5	S-2	60/48	5-10		0-48": Brown/gray, fine SAND, some Silt, wet.			
10	S-3	60/50	10-15		0-50": Brown/orange, fine SAND, some Silt, wet.	Fine Sand and Silt		
15	S-4	60/24	15-20		0-24": Gray, very fine SAND and SILT, wet.			
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater encountered at approximately 7 feet below ground surface.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-13	
Project: Adams School Waste Water Investigation			**Sheet:** 2 of 2
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/16/22	**Date Completed:** 8/16/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
20	S-1	60/48	20-25		0-20": Brown, very fine SAND and SILT, wet.	Sand and Silt		
21								
22					20-48": Brown/orange, fine to coarse SAND, some Silt, little Gravel, trace cobbles, wet.			
23								
						Sand and Gravel with Silt		
24								
25					Boring terminated at 25 feet below ground surface. Refusal not encountered.			
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater encountered at approximately 7 feet below ground surface.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-14	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/16/22	**Date Completed:** 8/16/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/24	0-5		0-24": Light brown, fine ro coarae SAND, trace Silt, trace Gravel, damp.			
5	S-2	60/24	5-10		0-24": Light brown, fine to coarse SAND, trace Gravel, little Silt, damp.			
10	S-3	60/12	10-15		0-12": Brown, fine SAND, some Silt, wet.	SAND		
15	S-4	60/24	15-20		0-24": Brown medium to coarse SAND, trace Gravel, trace Silt, wet.			
20					Boring terminated at 20 feet below ground surface refusal not encountered.			

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	**Density**	**Blows/ft.**	**Consistency**
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater encountered at approximately 15 feet below ground surface.

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** B-15	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Checked By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:** See Site Plan	
Foreman: Ed		**Ground Surface Elevation:** NA	**Datum:** NA
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 8/16/22	**Date Completed:** 8/16/22

DRILLING METHOD	SAMPLER
Vehicle: Track Geoprobe	**Type:** 5' acetate sleeve
Model: 7822DT	**Hammer (lb):** NA
Method: Direct Push	**Fall (in):** NA

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0	S-1	60/30	0-5		0-6": Top Soil.			
1					6-30": Light Brown, fine to coarse SAND, little Gravel, trace Silt, damp.			
2								
3								
4								
5	S-2	60/32	5-10		0-32": Brown, fine to coarse SAND, little Gravel, trace Silt, damp.	SAND		
6								
7								
8								
9								
10	S-3	60/24	10-15		0-24": Brown, fine to coarse SAND, some Gravel, little Silt, wet.			
11								
12						Sand and Gravel		
13								
14								
15					Boring terminated at 15 feet below ground surface, refusal not encountered.			
16								
17								
18								
19								
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

Groundwater encountered at approximately 14 feet below ground surface.

SOIL BORING / WELL COMPLETION LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** SB- 101	**Well ID:** MW-1
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Chkd. By:** DGH	**Project Number:** 15494
Drilling Company: Geosearch, Inc	**Boring Location:**		
Foreman: Mike	**Top of PVC Riser Elevation:**		**Datum:**
GeoInsight Engineer/Geologist: Chris Griffin	**Top of Protector Elevation:**		**Ground Elevation:**
	Date Started: 11/28/22		**Date Completed:** 11/28/22

DRILLING METHOD	SAMPLER
Vehicle: Truck	**Type:** Split-Spoon
Model: CME 75	**Hammer (lb):** 140
Method: Hollow Stem Auger	**Fall (in):** 30

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
11/30/2022	21.38	Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	WELL COMPLETION DETAIL	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0									
1									
2									
3									
4									
5	S-1	24/6	5-7	2		5-7': M. Dense, brown, fine to coarse SAND, little Gravel, little Silt, damp.			
6				6					
				7					
7				13					
8									
9									
10	S-2	24/18	10-12	1		10-12': Loose, light brown/orange, fine to medium SAND, little Silt, trace roots, damp.			
11				2					
				3					
12				4					
13									
14									
15	S-3	24/10	15-17	7		15-17': M. Dense, brown, fine to coarse SAND, trace Gravel, trace Silt, damp.			
16				7					
				8					
17				5					
18									
19									
20									

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	5-8	M. STIFF
31-50	DENSE	9-15	STIFF
>50	V. DENSE	16-30	V. STIFF
		>30	HARD

WELL CONSTRUCTION NOTES

WELL MATERIALS	INTERVAL (feet bgs)
Concrete	0-0.5
Backfill	0.5-11
Grout	NA
Bentonite: Chips	11-12
Sandpack: # 2 Sand	12-24
Riser	0-14
Screen	14-24

LEGEND

NOTES

SOIL BORING / WELL COMPLETION LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** SB- 101	**Well ID:** MW-1
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 2
Location: Holliston, Massachusetts		**Chkd. By:** DGH	**Project Number:** 15494
Drilling Company: Geosearch, Inc	**Boring Location:**		
Foreman: Mike	**Top of PVC Riser Elevation:**		**Datum:**
GeoInsight Engineer/Geologist: Chris Griffin	**Top of Protector Elevation:**		**Ground Elevation:**
	Date Started: 11/28/22		**Date Completed:** 11/28/22

DRILLING METHOD	SAMPLER
Vehicle: Truck	**Type:** Split-Spoon
Model: CME 75	**Hammer (lb):** 140
Method: Hollow Stem Auger	**Fall (in):** 30

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
11/30/2022	21.38	Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	WELL COMPLETION DETAIL	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
20	S-4	19/4	20-22	4		20-22': Refusal, gray/brown, fine to coarse SAND, little Silt, little Gravel, rock in tip, wet.			
21				13					
				35					
22				50+					
23									
24						Refusal encountered with augers at 24 feet bgs.			
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35	S-3	24/10	15-17	7					
36				7					
37				8					
38				5					
39									
40									

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	5-8	M. STIFF
31-50	DENSE	9-15	STIFF
>50	V. DENSE	16-30	V. STIFF
		>30	HARD

WELL CONSTRUCTION NOTES	WELL MATERIALS	INTERVAL (feet bgs)	LEGEND
	Concrete	0-0.5	
	Backfill	0.5-11	
	Grout	NA	
	Bentonite: Chips	11-12	
	Sandpack: # 2 Sand	12-24	
	Riser	0-14	
	Screen	14-24	

NOTES

SOIL BORING / WELL COMPLETION LOG

Client: Lombardo Associates, Inc.	**Boring Identification:** SB- 101	**Well ID:** MW-1
Project: Adams School Waste Water Investigation		**Sheet:** 1 of 1
Location: Holliston, Massachusetts	**Chkd. By:** DGH	**Project Number:** 15494

Drilling Company: Geosearch, Inc	**Boring Location:**	
Foreman: Mike	**Top of PVC Riser Elevation:**	**Datum:**
GeoInsight Engineer/Geologist: Chris Griffin	**Top of Protector Elevation:**	**Ground Elevation:**
	Date Started: 11/29/22	**Date Completed:** 11/29/22

DRILLING METHOD	SAMPLER
Vehicle: Truck	**Type:** Split-Spoon
Model: CME 75	**Hammer (lb):** 140
Method: Hollow Stem Auger	**Fall (in):** 30

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
11/30/2022	11.11	Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	WELL COMPLETION DETAIL	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0									
1									
2									
3									
4									
5	S-1	24/7	5-7	2		5-7': Loose, brown, fine to medium SAND, trace Silt, damp.			
6				3					
7				5					
8				5					
9									
10	S-2	24/14	10-12	6		10-12': M. Dense, brown, fine to coarse SAND, little Silt, wet.			
11				13					
12				13					
13				16					
14									
15	S-3	24/10	15-17	1		15-17': Loose, brown, fine to coarse SAND, trace Silt, trace Gravel, wet.			
16				3					
17				3					
18				7					
19						Boring terminated at 18 feet bgs, refusal not encountered.			
20									

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	5-8	M. STIFF
31-50	DENSE	9-15	STIFF
>50	V. DENSE	16-30	V. STIFF
		>30	HARD

WELL CONSTRUCTION NOTES

WELL MATERIALS	INTERVAL (feet bgs)
Concrete	0-0.5
Backfill	0.5-4
Grout	NA
Bentonite: Chips	4-5
Sandpack: # 2 Sand	4-15
Riser	0-8
Screen	8-18

LEGEND

NOTES

SOIL BORING / WELL COMPLETION LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** SB- 103	**Well ID:** MW-3
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Chkd. By:** DGH	**Project Number:** 15494
Drilling Company: Geosearch, Inc	**Boring Location:**		
Foreman: Mike	**Top of PVC Riser Elevation:**		**Datum:**
GeoInsight Engineer/Geologist: Chris Griffin	**Top of Protector Elevation:**		**Ground Elevation:**
	Date Started: 11/29/22		**Date Completed:** 11/29/22

DRILLING METHOD	SAMPLER
Vehicle: Truck	**Type:** Split-Spoon
Model: CME 75	**Hammer (lb):** 140
Method: Hollow Stem Auger	**Fall (in):** 30

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
0.5-12	11.20	Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	WELL COMPLETION DETAIL	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0									
1									
2									
3									
4									
5	S-1	24/4	5-7	9		5-7': M. Dense, light brown/gray, fine to coarse SAND, little Gravel, little Silt, damp.			
6				10					
7				10					
8				10					
9									
10	S-2	24/3	10-12	10		10-12': M. Dense, light brown, fine to coarse SAND, little Gravel, trace trace, damp.			
11				11					
12				14					
13				13					
14									
15	S-3	24/10	15-17	6		15-17': M. Dense, gray, fine SAND, little Silt, trace Gravel, wet.			
16				12					
17				10					
18				10					
19									
20									

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	5-8	M. STIFF
31-50	DENSE	9-15	STIFF
>50	V. DENSE	16-30	V. STIFF
		>30	HARD

WELL CONSTRUCTION NOTES

Boring terminated at 20 feet bgs, refusal not encountered.

WELL MATERIALS	INTERVAL (feet bgs)	LEGEND
Concrete	0-0.5	
Backfill	0.5-8	
Grout	NA	
Bentonite: Chips	8-9	
Sandpack: # 2 Sand	9-10	
Riser	0-10	
Screen	10-20	

NOTES

SOIL BORING / WELL COMPLETION LOG

Client: Lombardo Associates, Inc.	**Boring Identification:** SB- 105	**Well ID:** MW-5
Project: Adams School Waste Water Investigation		**Sheet:** 1 of 1
Location: Holliston, Massachusetts	**Chkd. By:** DGH	**Project Number:** 15494

Drilling Company: Geosearch, Inc	**Boring Location:**	
Foreman: Mike	**Top of PVC Riser Elevation:**	**Datum:**
GeoInsight Engineer/Geologist: Chris Griffin	**Top of Protector Elevation:**	**Ground Elevation:**
	Date Started: 11/29/22	**Date Completed:** 11/29/22

DRILLING METHOD	SAMPLER
Vehicle: Truck	**Type:** Split-Spoon
Model: CME 75	**Hammer (lb):** 140
Method: Hollow Stem Auger	**Fall (in):** 30

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
11/30/2022	7.71	Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	WELL COMPLETION DETAIL	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0									
1									
2									
3									
4									
5	S-1	24/10	5-7	8		5-7': V. Dense, gray, fine to coarse SAND, little Gravel, trace Silt, damp.			
6				33					
7				37					
8				50+					
9									
10									
11	S-2	24/14	10-12	24		10-12': V. Dense, gray, fine to coarse SAND, some Gravel, little Silt, wet.			
12				35					
13				36					
14				27					
15									
16	S-3	24/10	15-17	20		15-17': Dense, brown/gray, fine to coarse SAND, little Gravel, little Silt, wet.			
17				17					
18				17					
19				14					
20						Boring terminated at 18 feet bgs, refusal not encountered.			

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	5-8	M. STIFF
31-50	DENSE	9-15	STIFF
>50	V. DENSE	16-30	V. STIFF
		>30	HARD

WELL CONSTRUCTION NOTES

WELL MATERIALS	INTERVAL (feet bgs)
Concrete	0-0.5
Backfill	0.5-6
Grout	NA
Bentonite: Chips	6-7
Sandpack: # 2 Sand	7-18
Riser	0-8
Screen	8-18

LEGEND

NOTES

Client: Lombardo Associates, Inc.		**Boring Identification:** SB- 106	**Well ID:** MW-6
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Chkd. By:** DGH	**Project Number:** 15494
Drilling Company: Geosearch, Inc	**Boring Location:**		
Foreman: Mike	**Top of PVC Riser Elevation:**		**Datum:**
GeoInsight Engineer/Geologist: Chris Griffin	**Top of Protector Elevation:**		**Ground Elevation:**
	Date Started: 11/28/22		**Date Completed:** 11/28/22

DRILLING METHOD	SAMPLER
Vehicle: Truck	**Type:** Split-Spoon
Model: CME 75	**Hammer (lb):** 140
Method: Hollow Stem Auger	**Fall (in):** 30

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
11/30/2022	Dry	Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	WELL COMPLETION DETAIL	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0									
1									
2									
3									
4									
5	S-1	24/0	5-7	7		5-7': M. Dense, no recovery.			
6				10					
				6					
7				5					
8									
9									
10	S-2	24/6	10-12	7		10-12': M. Dense, brown, fine to coarse SAND, little Gravel, trace Silt, rock in tip, damp.			
11				9					
				12					
12				17					
13									
14						Refusal encountered with augers at 13.5 feet bgs.			
15									
16									
17									
18									
19									
20									

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	5-8	M. STIFF
31-50	DENSE	9-15	STIFF
>50	V. DENSE	16-30	V. STIFF
		>30	HARD

WELL CONSTRUCTION NOTES

WELL MATERIALS	INTERVAL (feet bgs)	LEGEND
Concrete	0-0.5	
Backfill	0.5-1.5	
Grout	NA	
Bentonite: Chips	1.5-2.5	
Sandpack: # 2 Sand	2.5-13.5	
Riser	0-3.5	
Screen	3.5-13.5	

NOTES

SOIL BORING / WELL COMPLETION LOG

verdantas

Client: Lombardo Associates, Inc.		**Boring Identification:** SB- 107	**Well ID:** MW-7
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Chkd. By:** DGH	**Project Number:** 15494
Drilling Company: Geosearch, Inc	**Boring Location:**		
Foreman: Mike	**Top of PVC Riser Elevation:**		**Datum:**
GeoInsight Engineer/Geologist: Chris Griffin	**Top of Protector Elevation:**		**Ground Elevation:**
	Date Started: 11/30/22		**Date Completed:** 11/30/22

DRILLING METHOD	SAMPLER
Vehicle: Truck	**Type:** Split-Spoon
Model: CME 75	**Hammer (lb):** 140
Method: Hollow Stem Auger	**Fall (in):** 30

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
11/30/2022	14.49	Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	WELL COMPLETION DETAIL	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0						Pre-cleared wth vactor to 8 feet bgs.			
1									
2									
3									
4									
5									
6									
7									
8									
9									
10	S-1	24/8	10-12	3		5-7': Loose, light brown, fine to medium SAND, trace Silt, damp.			
11				4					
				4					
12				4					
13									
14									
15	S-2	24/12	15-17	3		15-17': Loose, light brown, fine to medium SAND, trace Silt, wet.			
16				4					
				3					
17				3					
18									
19									
20									

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	5-8	M. STIFF
31-50	DENSE	9-15	STIFF
>50	V. DENSE	16-30	V. STIFF
		>30	HARD

WELL CONSTRUCTION NOTES	WELL MATERIALS	INTERVAL (feet bgs)	LEGEND
	Concrete	0-0.5	
	Backfill	0.5-9	
	Grout	NA	
	Bentonite: Chips	9-10	
	Sandpack: # 2 Sand	10-22	
	Riser	0-12	
	Screen	12-22	

NOTES

SOIL BORING / WELL COMPLETION LOG

verdantas

Client: Lombardo Associates, Inc.		**Boring Identification:** SB- 107	**Well ID:** MW-7
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Chkd. By:** DGH	**Project Number:** 15494
Drilling Company: Geosearch, Inc		**Boring Location:**	
Foreman: Mike		**Top of PVC Riser Elevation:**	**Datum:**
GeoInsight Engineer/Geologist: Chris Griffin		**Top of Protector Elevation:**	**Ground Elevation:**
		Date Started: 11/30/22	**Date Completed:** 11/30/22

DRILLING METHOD	SAMPLER
Vehicle: Truck	**Type:** Split-Spoon
Model: CME 75	**Hammer (lb):** 140
Method: Hollow Stem Auger	**Fall (in):** 30

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	WELL COMPLETION DETAIL	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
20	S-4	19/4	20-22	3		20-22': Loose, light brown, fine SAND, little Silt, wet.			
21				5					
				5					
22				5					
						Boring terminated at 22 feet bgs, refusal not encountered.			
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	5-8	M. STIFF
31-50	DENSE	9-15	STIFF
>50	V. DENSE	16-30	V. STIFF
		>30	HARD

WELL CONSTRUCTION NOTES	WELL MATERIALS	INTERVAL (feet bgs)	LEGEND
	Concrete	0-0.5	
	Backfill	0.5-9	
	Grout	NA	
	Bentonite: Chips	9-10	
	Sandpack: # 2 Sand	10-22	
	Riser	0-12	
	Screen	12-22	

NOTES

SOIL BORING / WELL COMPLETION LOG

verdantas

Client: Lombardo Associates, Inc.		**Boring Identification:** SB- 101	**Well ID:** MW-1
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Chkd. By:** DGH	**Project Number:** 15494
Drilling Company: Geosearch, Inc	**Boring Location:**		
Foreman: Mike	**Top of PVC Riser Elevation:**		**Datum:**
GeoInsight Engineer/Geologist: Chris Griffin	**Top of Protector Elevation:**		**Ground Elevation:**
	Date Started: 11/30/22		**Date Completed:**11/30/22

DRILLING METHOD	SAMPLER
Vehicle: Truck	**Type:** Split-Spoon
Model: CME 75	**Hammer (lb):** 140
Method: Hollow Stem Auger	**Fall (in):** 30

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
11/30/2022	3.87	Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	WELL COMPLETION DETAIL	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0									
1									
2									
3									
4									
5	S-1	24/14	5-7	8		5-7': M. Dense, brown/gray, fine to medium SAND, trace coarse SAND, trace Silt, wet.			
6				9					
7				13					
8				15					
9									
10	S-1	24/8	10-12	9		10-12': M. Dense, brown, fine to coarse SAND, trace Silt, wet.			
11				8					
12				11					
13				9					
14									
15						Boring terminated at 15 feet bgs, refusal not encountered.			
16									
17									
18									
19									
20									

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	5-8	M. STIFF
31-50	DENSE	9-15	STIFF
>50	V. DENSE	16-30	V. STIFF
		>30	HARD

WELL CONSTRUCTION NOTES	WELL MATERIALS	INTERVAL (feet bgs)	LEGEND
	Concrete	0-0.5	
	Backfill	0.5-4	
	Grout	NA	
	Bentonite: Chips	4-5	
	Sandpack: # 2 Sand	4-15	
	Riser	0-5	
	Screen	5-15	

NOTES

SOIL BORING LOG

Client: Lombardo Associates, Inc.		**Boring Identification:** SB-104	
Project: Adams School Waste Water Investigation			**Sheet:** 1 of 1
Location: Holliston, Massachusetts		**Chkd. By:** DGH	**Project Number:**
Drilling Company: Geosearch, Inc		**Boring Location:**	
Foreman: Mike		**Ground Surface Elevation:**	**Datum:**
GeoInsight Engineer/Geologist: Chris Griffin		**Date Started:** 11/28/22	**Date Completed:** 11/28/22

DRILLING METHOD	SAMPLER
Vehicle: Truck	**Type:** Split-Spoon
Model: CME 75	**Hammer (lb):** 140
Method: Hollow Stem Auger	**Fall (in):** 30

GROUNDWATER MEASUREMENTS

Date	Depth (ft)	Reference	Stabilization
		Ground Surface	

DEPTH (ft)	SAMPLE INFORMATION #	Pen/Rec (in)	Depth (ft)	Blows/6"	SAMPLE DESCRIPTION	STRATUM DESCRIPTION	FIELD SCREENING (ppm)	NOTE
0								
1								
2								
3								
4								
5	S-1	24/10	5-7	7	5-7': M. Dense, brown, fine to coarse SAND, little Gravel, trace Silt, damp.			
6				12				
				17				
7				26				
8								
9								
10								
11	S-2	6/4	10-10.5	37	10-10.5': Refusal, brown/gray, fine to coarse SAND, little Silt, trace Gravel, rock in tip, damp.			
12				50+				
13					Refusal encountered with augers, did not set well.			
14								
15								
16								
17								
18								
19								
20								

GRANULAR SOILS		COHESIVE SOILS	
Blows/ft.	Density	Blows/ft.	Consistency
0-4	V. LOOSE	<2	V. SOFT
5-10	LOOSE	2-4	SOFT
11-30	M. DENSE	4-8	M. STIFF
31-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

NOTES

APPENDIX B VERDANTAS SITE HYDROGEOLOGY REPORT WITH LOGS & SIEVE ANALYSIS

February 8, 2023 Project Number 15494-000

Pio Lombardo, P.E.
Lombardo Associates, Inc.
188 Church Street
Newton, Massachusetts 02458

Re: Hydraulic Conductivity Estimates
Adams School Wastewater Investigation, Holliston Massachusetts

Dear Mr. Lombardo:

Verdantas LLC (Verdantas) prepared the following hydraulic conductivity estimates to assist Lombardo and Associates, Inc. (Lombardo) with hydrogeologic analysis related to wastewater discharge at the Adams Middle School (the School), in Holliston, Massachusetts. Lombardo is evaluating expansion of a wastewater treatment system to potentially serve downtown businesses in Holliston as it appears the School's wastewater system is potentially over designed. Lombardo previously provided Verdantas with groundwater data, mounding calculations, boring logs, and supporting information from studies used to design the original system for the school. Lombardo requested Verdantas' assistance in overseeing a field investigation to evaluate the extent and hydraulic properties of suitable surficial outwash material for wastewater discharge. With this information, Lombardo can estimate future wastewater loading rates, develop preliminary designs, and proceed with regulatory permitting provided subsurface conditions are suitable.

SOIL BORINGS AND GRAIN SIZE ANALYSIS

Fifteen soil borings were completed in August 2022. All were drilled to refusal with depths ranging from 5 feet at B3 to 25 feet in both B12 and B13. Refer to figures prepared by Lombardo for the location of these borings. Sediment samples were selected in communication with Lombardo in areas thought to be representative of future wastewater discharge locations. Samples were submitted to Miller Engineering and Testing, Inc. for laboratory grain size analysis. Hydraulic conductivity (K) estimates were made using the Excel spreadsheet calculator "HydrogoSieveXL" by J.F. Devlin (2015)[1]. This spreadsheet uses grain size distributions from sieve analysis to estimate K by as many as 15 different published methods depending on how many method's criteria are met by the sample. These results are summarized in Table 1. Laboratory reports and spreadsheet analysis are provided in Attachment 1.

[1] Devlin, J.F. 2015. *HydrogeoSieveXL: an Excel-based tool to estimate hydraulic conductivity from grain size analysis.* Hydrogeology Journal, DOI 10.1007/s10040-015-1255-0.

WELL INSTALLATIONS AND SLUG TESTS

Seven monitoring wells (MW-1 through MW-8; MW-4 was not installed) were installed in November 2022. These wells were standard construction 2-inch PVC with 10-foot, 10-slot screens. Depths ranged from 24 feet in MW-1 to 13.5-feet in MW-6. In December 2022, depths to groundwater ranged from 3.62 feet in MW-8 to 20.72 feet in MW-1. MW-6 was dry at 13.5 feet. Boring logs and well construction diagrams were previously provided to Lombardo.

Slug tests were conducted in wells MW-1, MW-2, MW-3, MW-5, MW-7, MW-8 and an existing USGS well located generally between MW-3 and MW-5 in December 2022. These tests were conducted by installing a pressure transducer with a datalogger in the well to record water levels, then inserting a solid bar (slug) below the water level to displace the water in the well. Once the water in the well has stabilized to a static condition, the slug is then quickly removed and the water level recovery over time in the well is recorded. These data are analyzed by accepted methods to estimate the hydraulic conductivity of the material in which the well is screened. Slug test results are included as Attachment 2 and results of this analysis are given in Table 2.

CONCLUSIONS

Grain size analysis supports a K estimation of approximately 30 feet per day and slug tests support a lower K estimation of approximately 5 feet per day. There is a large range of grain size analysis results and these only apply to material included in the soil sample. Slug test results evaluate a larger thickness of aquifer material (the length of the saturated well screen in comparison to the volume of a soil sample) and typically provide a more accurate estimate of hydraulic conductivity.

LIMITATIONS

Verdantas provided the opinions and conclusions contained within this report based upon an evaluation of subsurface conditions observed and/or reported, as documented in the report text and attached materials. Verdantas believes the subsurface explorations, testing and evaluations described herein were performed in a manner consistent with the services that would have been provided by other hydrogeologic professionals under similar circumstances. However, given the variable nature of soil deposits and hydrogeology, we cannot represent that the subsurface conditions and hydrogeologic properties described in this report are exact.

The findings presented herein do not present certainties, but rather our opinion of likely conditions founded on available information, limited test data, our professional judgement, and a reasonable degree of confidence in our conclusions. While our evaluation accounts for reasonable variations in input parameters for our analyses, disparities in the Site subsurface conditions from those included in our analyses could result in differing findings from those presented.

Sincerely,
VERDANTAS LLC

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Attachment 1- Grain Size Analyses
Attachment 2- Slug Test Analysis

\\geoinc.com\DFS\Project Files\15000\15494\Nov 22 2022 authorization deliverable\K report\15494 2023-2-8 K Results.docx

Table 1
Summary of Hydraulic Conductivity Results from Grain Size Analysis
Holliston School August 2022

Boring	Sample Depth	K ft/day	Soil Description
B4	0-10	33	poorly sorted gravelly sand low in fines
	10-16	98	poorly sorted sandy gravel low in fines
	16+	55	poorly sorted sandy gravel low in fines
B6	5-12	18	poorly sorted gravelly sand low in fines
	10-15	33	poorly sorted gravelly sand low in fines
	15+	32	poorly sorted sandy gravel low in fines
B9	15-17.5	15	poorly sorted gravelly sand low in fines
	0-9	27	poorly sorted gravelly sand low in fines
	9-14.5	87	poorly sorted gravelly sand low in fines
B11	5-10	20	poorly sorted gravelly sand low in fines
	10-14	32	poorly sorted gravelly sand low in fines
B12	0-10	2	poorly sorted gravelly sand low in fines
B-13	5-15	0.4	poorly sorted sandy silt low in fines
	15-20	1	poorly sorted sand low in fines

Table 2
Summary of Slug Test Results in Feet per Day
Holliston School December 2022

Well	Trial 1	Trial 2	Notes
MW-1	5	n/a	
MW-2	20	15	note 1
MW-3	7	n/a	note 1
MW-4	n/a	n/a	no well installed
MW-5	2	2	
MW-6	n/a	n/a	dry
MW-7	5	4	
MW-8	6	5	
USGS	1	n/a	assumed 10 foot screen

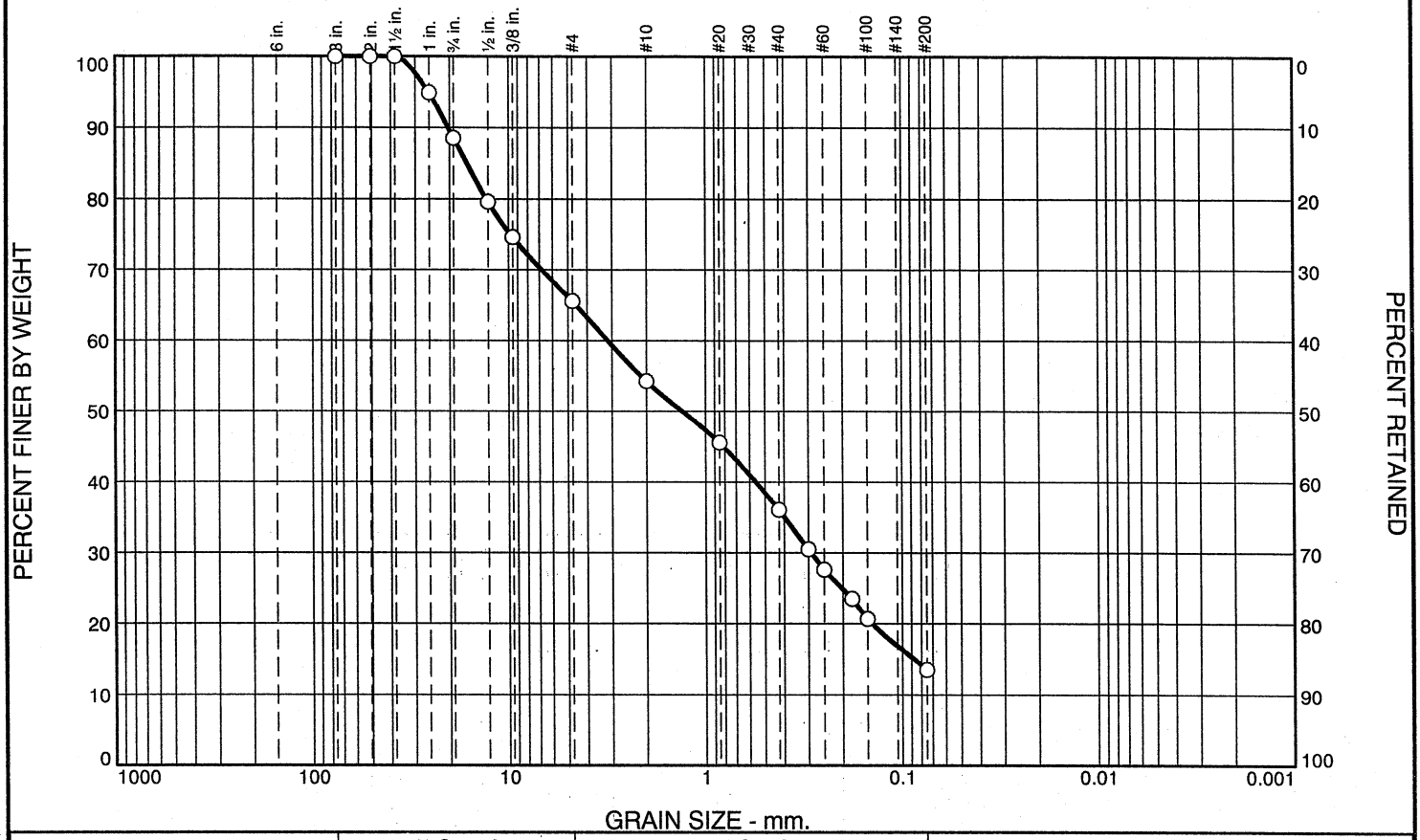
Notes

1. Analysis from slug in data which is not valid for wells without a fully saturated screen.
Results are presented because slug out data was unusable.
Despite this, MW-3 results are comparable to others.
However, higher MW-2 results should be viewed as questionable.

ATTACHMENT 1

GRAIN SIZE ANALYSIS

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	11	23	12	18	22	14	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	95		
3/4"	89		
1/2"	80		
3/8	75		
#4	66		
#10	54		
#20	46		
#40	36		
#50	31		
#60	28		
#80	24		
#100	21		
#200	14		

* (no specification provided)

Soil Description

B-4

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 20.3045 D_{85}= 16.2936 D_{60}= 3.1339
D_{50}= 1.3067 D_{30}= 0.2906 D_{15}= 0.0869
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

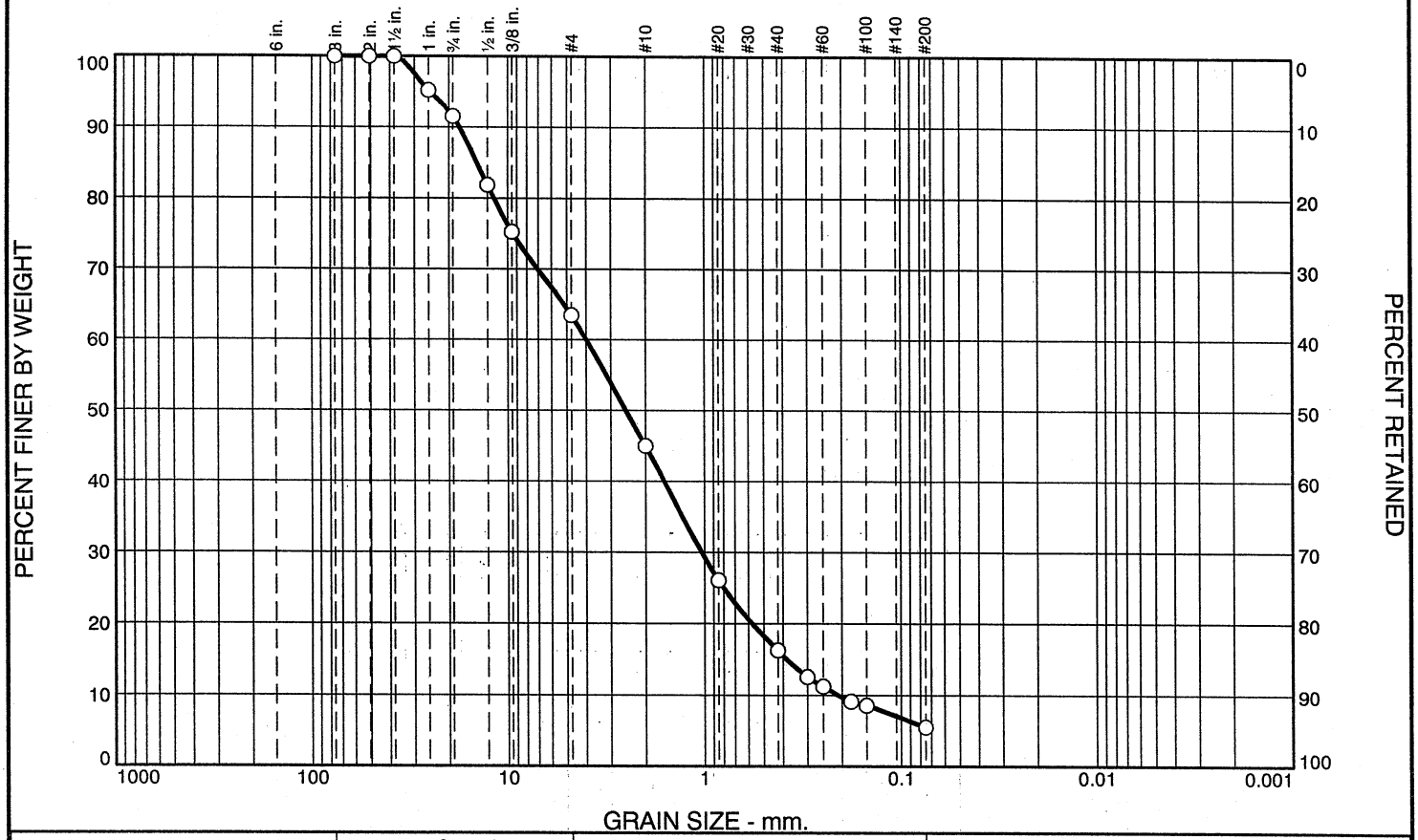
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 0-10'
Sample Number: L22286A **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22 154.NH
Project No: VERDANTAS QC **Figure** L22286A

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	8	29	18	29	10	6	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	95		
3/4"	92		
1/2"	82		
3/8	75		
#4	63		
#10	45		
#20	26		
#40	16		
#50	13		
#60	11		
#80	9		
#100	9		
#200	5.5		

* (no specification provided)

Soil Description

B-4

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 17.6282 D_{85}= 14.4005 D_{60}= 3.9886
D_{50}= 2.5105 D_{30}= 1.0341 D_{15}= 0.3817
D_{10}= 0.2098 C_u= 19.01 C_c= 1.28

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

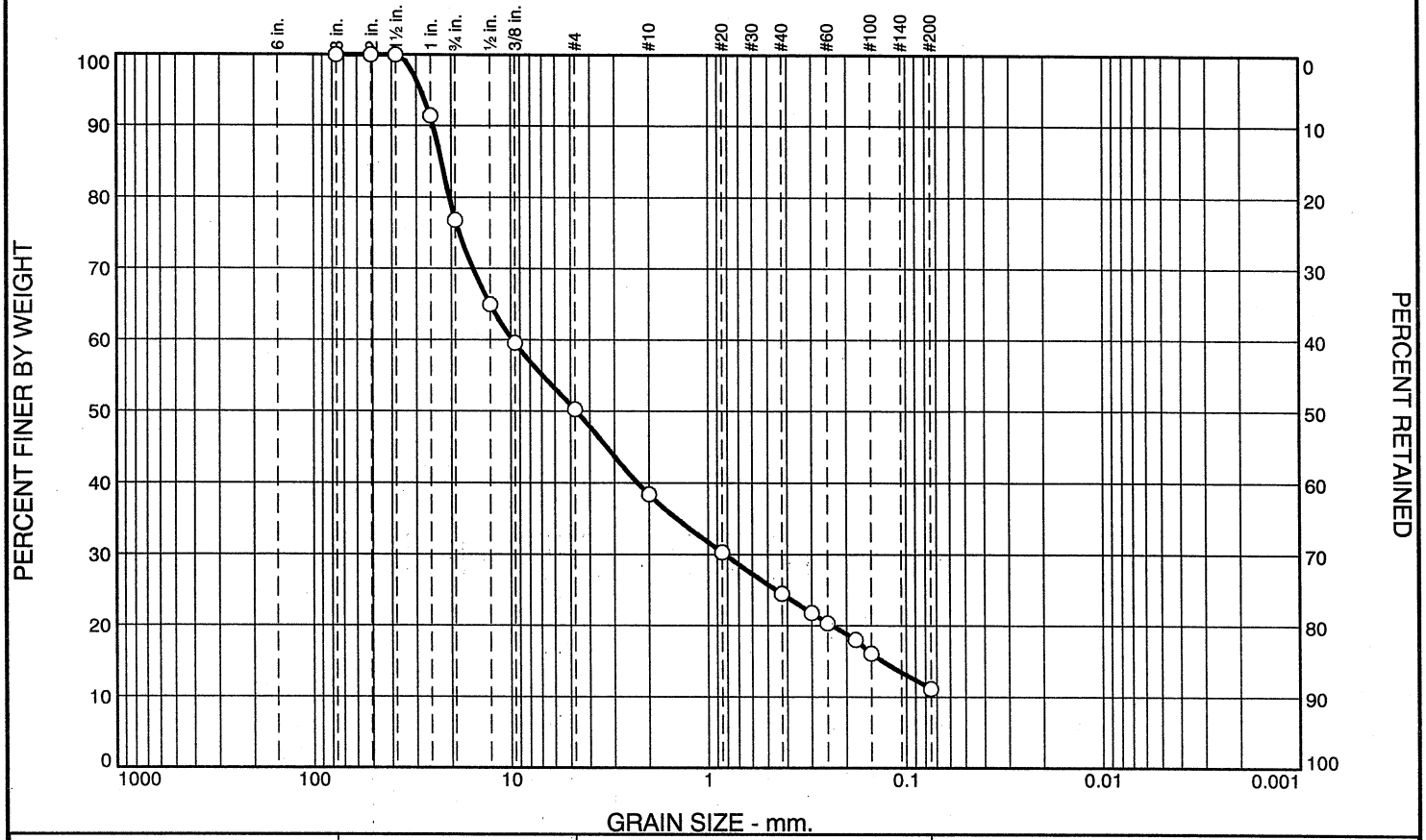
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 10'-16'
Sample Number: L22286B **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286B

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	23	27	12	14	13	11	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	91		
3/4"	77		
1/2"	65		
3/8	60		
#4	50		
#10	38		
#20	30		
#40	24		
#50	22		
#60	20		
#80	18		
#100	16		
#200	11		

* (no specification provided)

Soil Description

B-4

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 24.5290 D_{85}= 22.2888 D_{60}= 9.7867
D_{50}= 4.6511 D_{30}= 0.8213 D_{15}= 0.1310
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

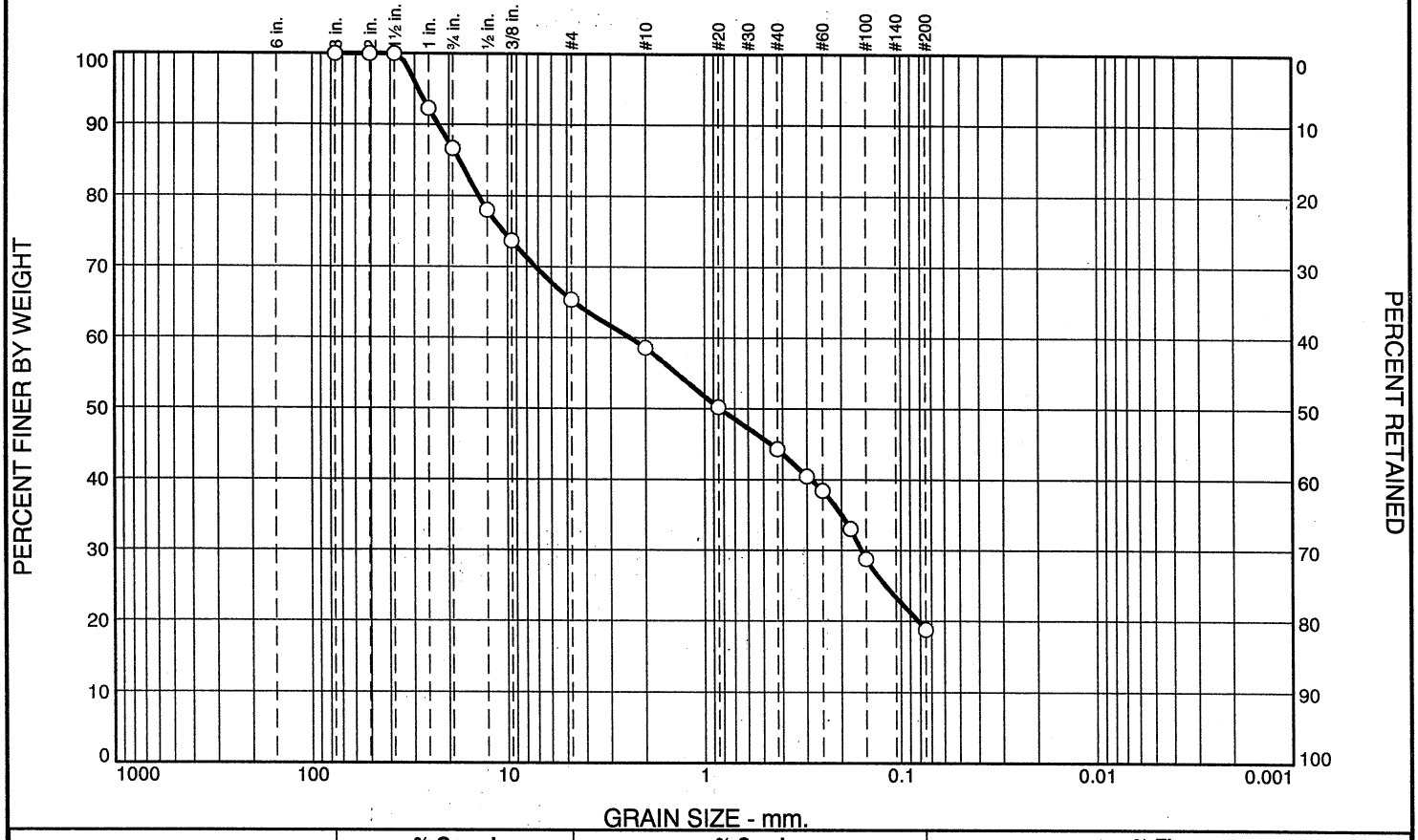
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 16' +
Sample Number: L22286C **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286C

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	13	22	6	15	25	19	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	92		
3/4"	87		
1/2"	78		
3/8	74		
#4	65		
#10	59		
#20	50		
#40	44		
#50	40		
#60	38		
#80	33		
#100	29		
#200	19		

* (no specification provided)

Soil Description

B-6

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 22.5511 D_{85}= 17.6136 D_{60}= 2.3758
D_{50}= 0.8289 D_{30}= 0.1587 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

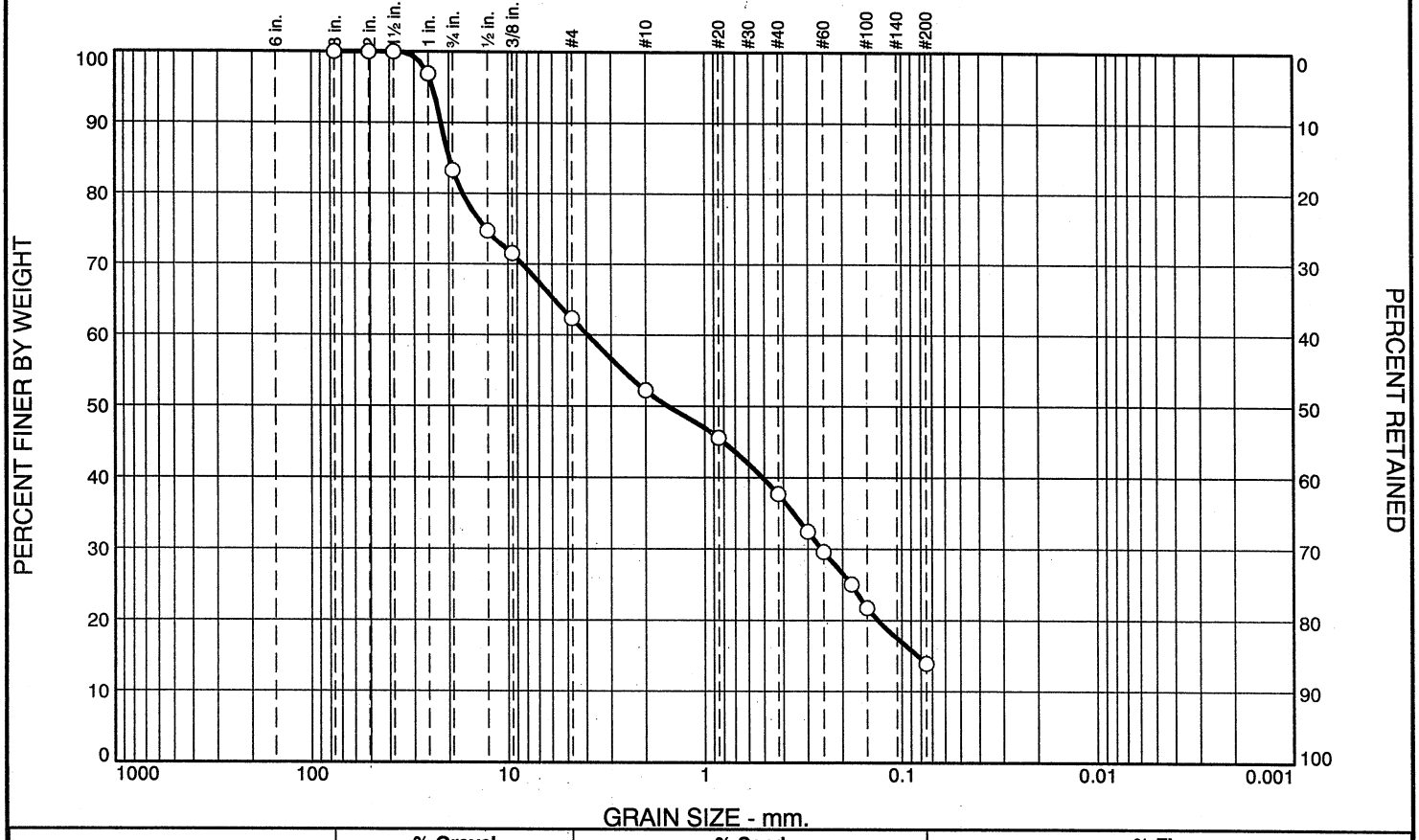
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 5'-12'
Sample Number: L22286D **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286D

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	17	21	10	14	24	14	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	97		
3/4"	83		
1/2"	75		
3/8	72		
#4	62		
#10	52		
#20	46		
#40	38		
#50	32		
#60	30		
#80	25		
#100	22		
#200	14		

* (no specification provided)

Soil Description

B-6

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 21.7976 D_{85}= 19.8595 D_{60}= 3.9308
D_{50}= 1.5290 D_{30}= 0.2565 D_{15}= 0.0827
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

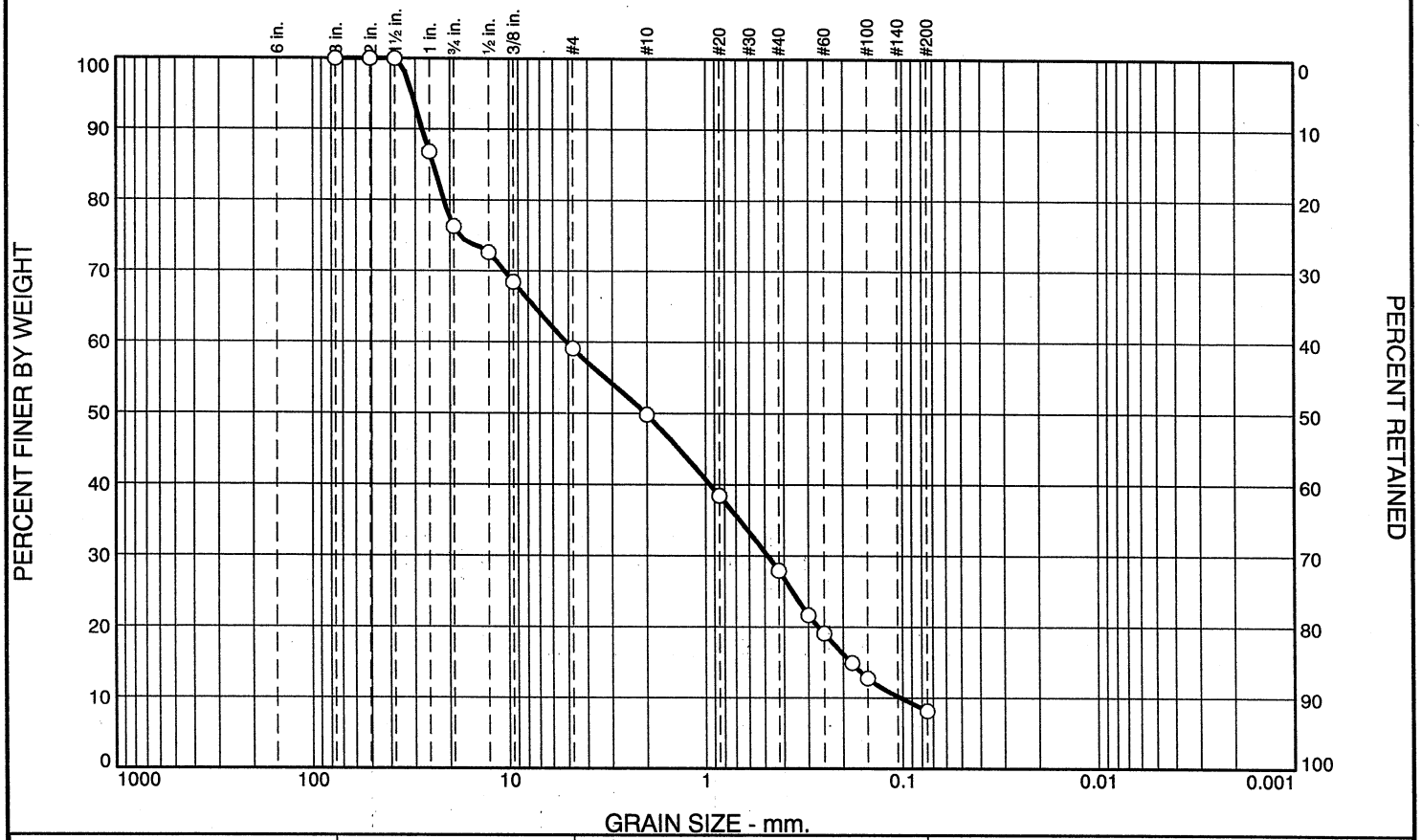
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 10'-15'
Sample Number: L22286E **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286E

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	24	17	9	22	20	8	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	87		
3/4"	76		
1/2"	73		
3/8	68		
#4	59		
#10	50		
#20	38		
#40	28		
#50	22		
#60	19		
#80	15		
#100	13		
#200	8.1		

* (no specification provided)

Soil Description

B-6

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 27.5586 D_{85}= 24.1943 D_{60}= 5.1019
D_{50}= 2.0221 D_{30}= 0.4821 D_{15}= 0.1809
D_{10}= 0.1023 C_u= 49.89 C_c= 0.45

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

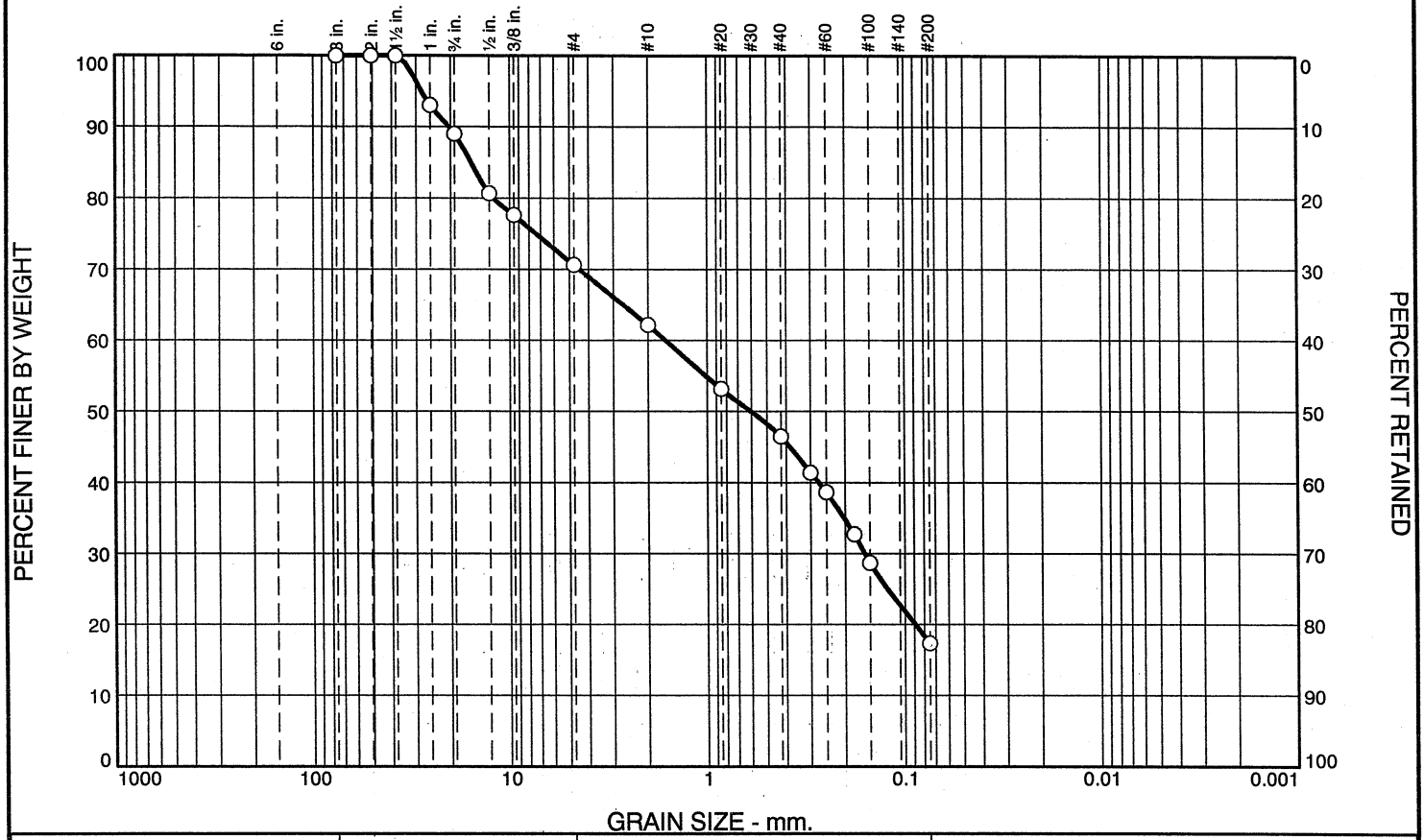
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 15'-+
Sample Number: L22286F **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286F

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	11	18	9	15	30	17	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	93		
3/4"	89		
1/2"	81		
3/8	78		
#4	71		
#10	62		
#20	53		
#40	47		
#50	41		
#60	39		
#80	33		
#100	29		
#200	17		

* (no specification provided)

Soil Description

B-9

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 20.2363 D_{85}= 15.7123 D_{60}= 1.6218
D_{50}= 0.5994 D_{30}= 0.1594 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

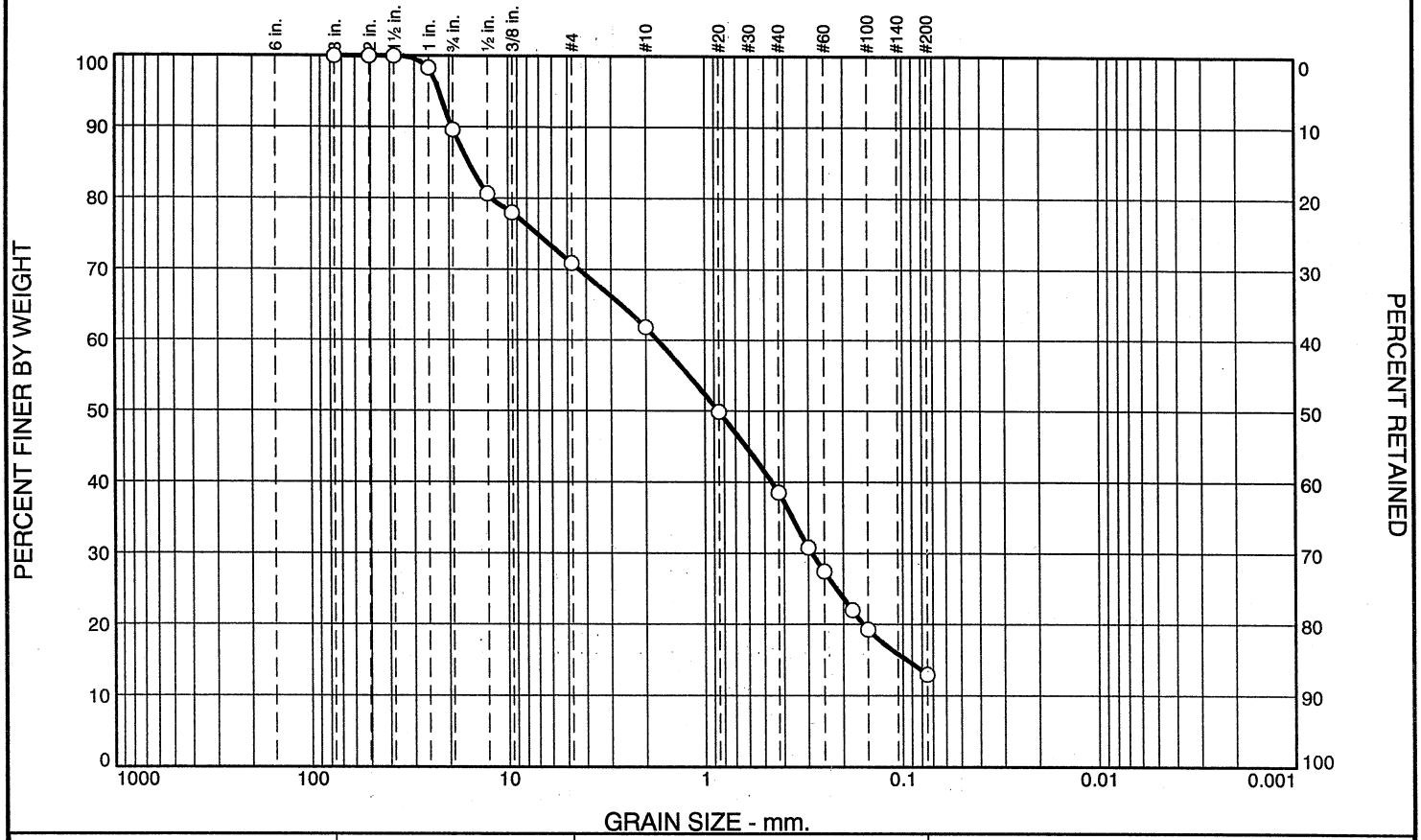
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 1 ST
Sample Number: L22286G **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286G

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	10	19	9	23	26	13	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	98		
3/4"	90		
1/2"	81		
3/8	78		
#4	71		
#10	62		
#20	50		
#40	39		
#50	31		
#60	27		
#80	22		
#100	19		
#200	13		

* (no specification provided)

Soil Description

B-9

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 19.3152 D_{85}= 15.8350 D_{60}= 1.7292
D_{50}= 0.8569 D_{30}= 0.2878 D_{15}= 0.0956
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

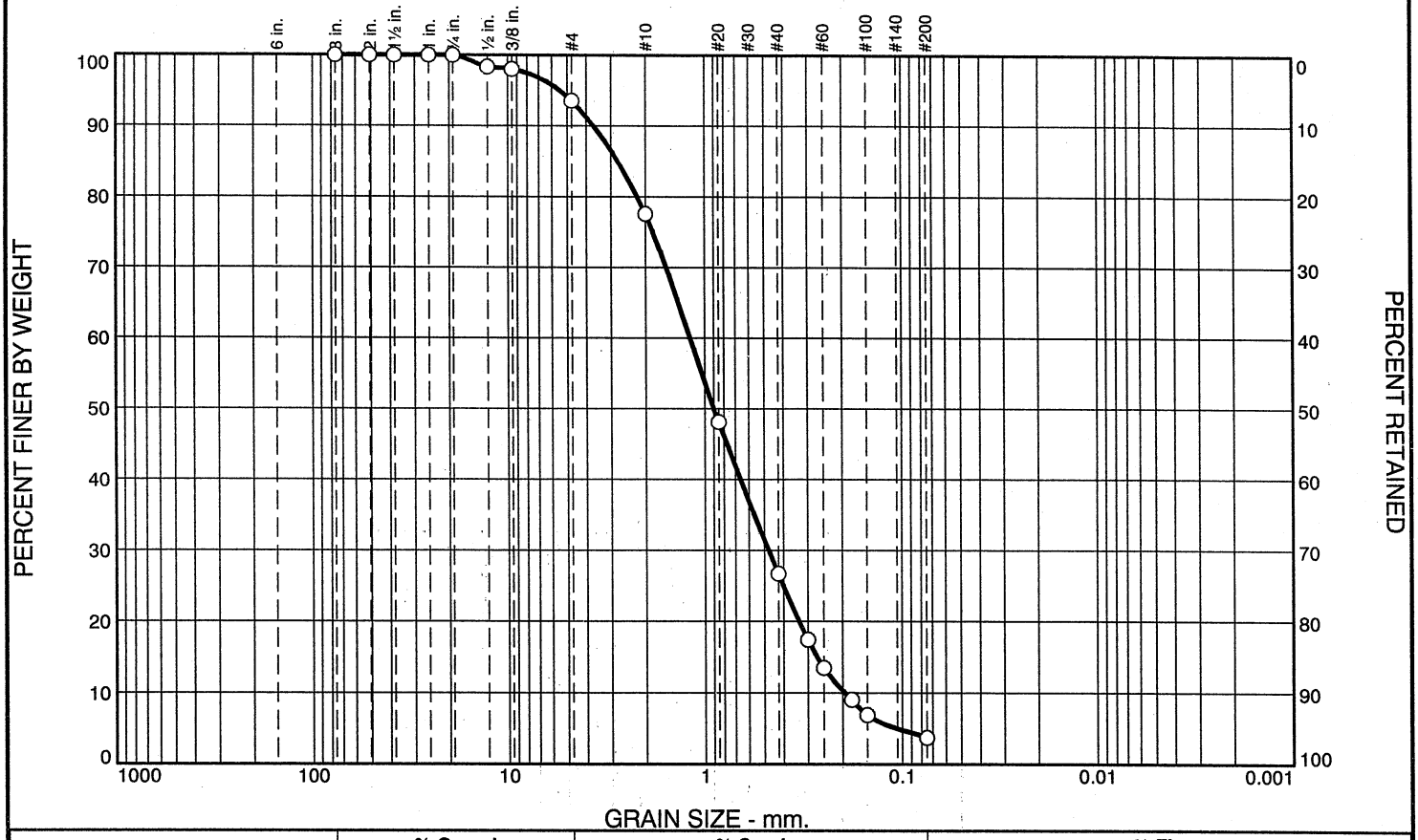
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 0-9'
Sample Number: L22286H **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286H

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	6	16	51	23	4	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	100		
3/4"	100		
1/2"	98		
3/8	98		
#4	94		
#10	78		
#20	48		
#40	27		
#50	17		
#60	13		
#80	9		
#100	7		
#200	3.7		

* (no specification provided)

Soil Description

B-9

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 3.6724 D_{85}= 2.7609 D_{60}= 1.1853
D_{50}= 0.8984 D_{30}= 0.4749 D_{15}= 0.2698
D_{10}= 0.1945 C_u= 6.10 C_c= 0.98

Classification

USCS= SP AASHTO=

Remarks

SMALL BAG SAMPLE.

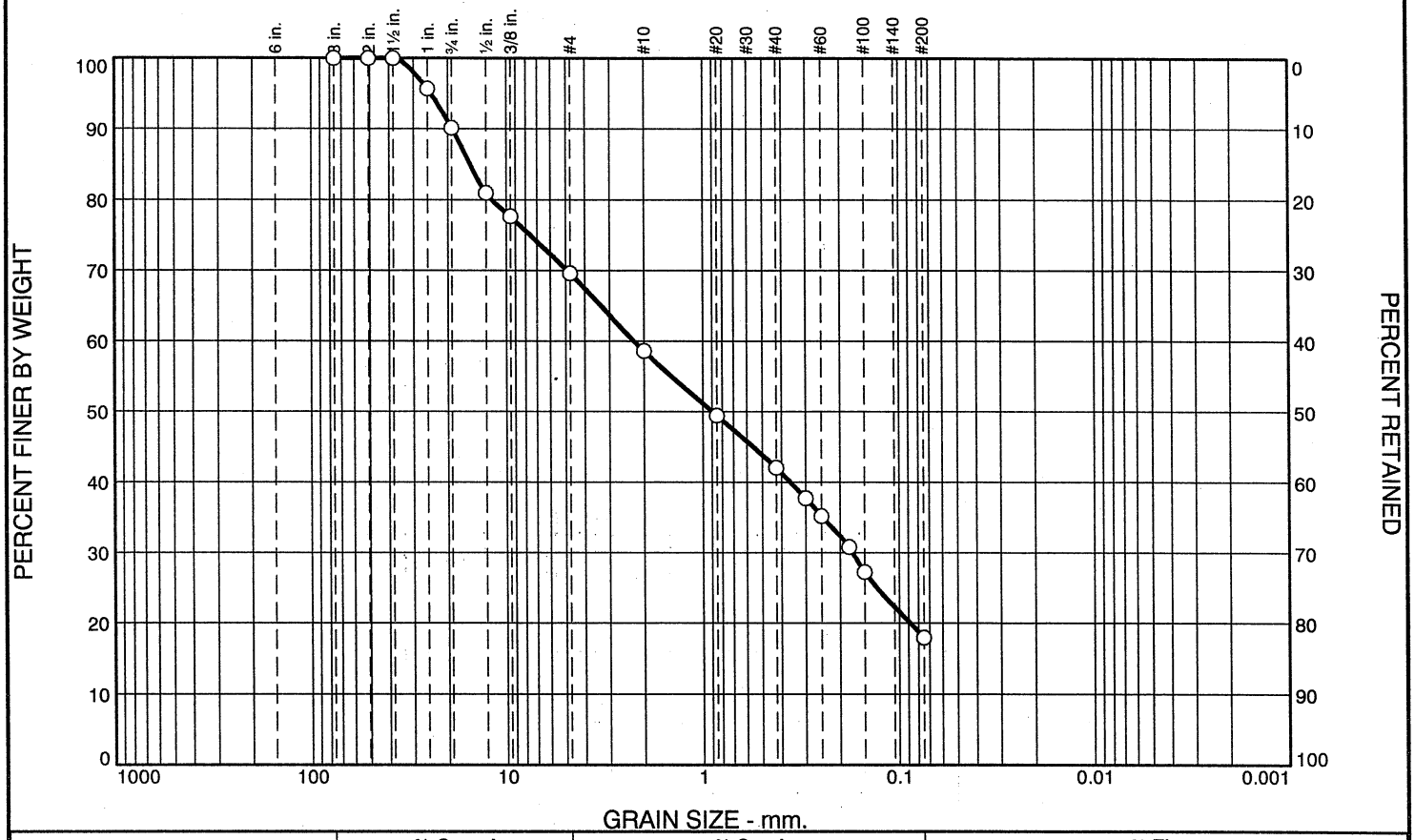
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 9'-14.5'
Sample Number: L22286I **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286I

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	10	20	11	17	24	18	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	96		
3/4"	90		
1/2"	81		
3/8	78		
#4	70		
#10	59		
#20	49		
#40	42		
#50	38		
#60	35		
#80	31		
#100	27		
#200	18		

* (no specification provided)

Soil Description

B-11

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 18.9030 D_{85}= 15.3208 D_{60}= 2.2404
D_{50}= 0.8923 D_{30}= 0.1721 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

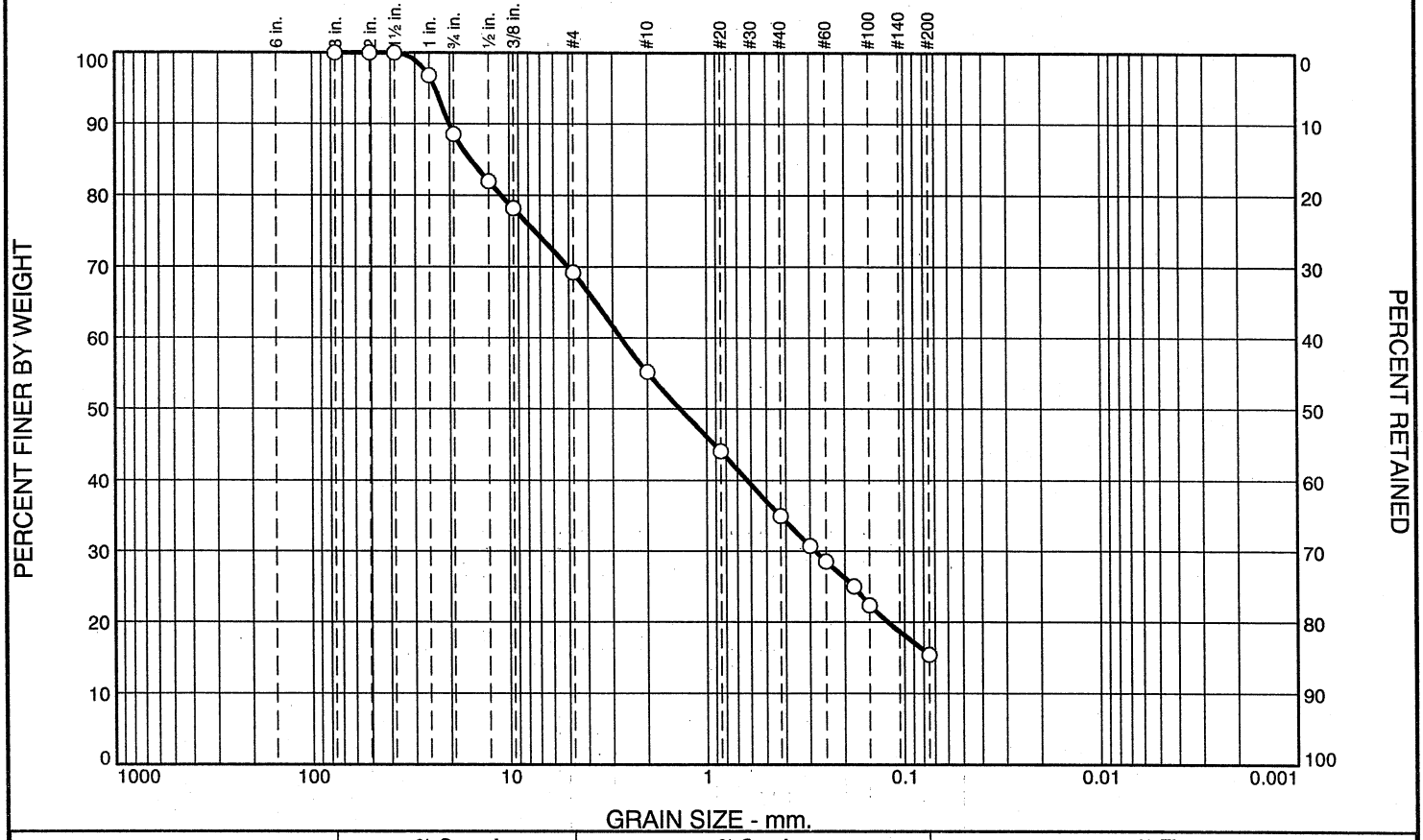
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 5'-10'
Sample Number: L22286J **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286J

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	11	20	14	20	20	15	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	97		
3/4"	89		
1/2"	82		
3/8	78		
#4	69		
#10	55		
#20	44		
#40	35		
#50	31		
#60	29		
#80	25		
#100	22		
#200	15		

* (no specification provided)

Soil Description

B-11

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 20.1206 D_{85}= 15.6816 D_{60}= 2.7069
D_{50}= 1.3586 D_{30}= 0.2824 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

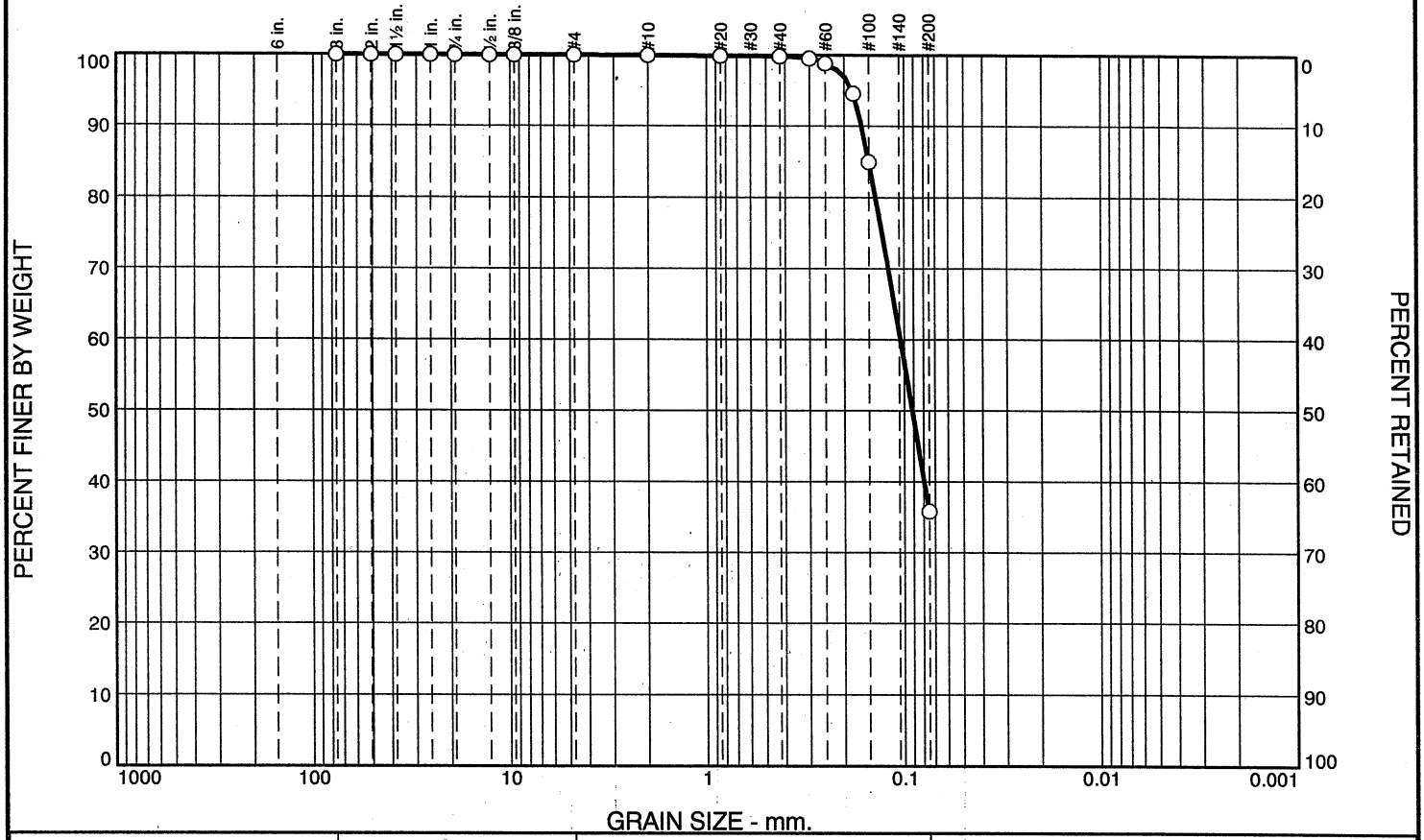
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 10'-14'
Sample Number: L22286K **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286K

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	0	64	36	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8	100		
#4	100		
#10	100		
#20	100		
#40	100		
#50	100		
#60	99		
#80	95		
#100	85		
#200	36		

* (no specification provided)

Soil Description

B-12

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1631 D_{85}= 0.1501 D_{60}= 0.1044
D_{50}= 0.0911 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

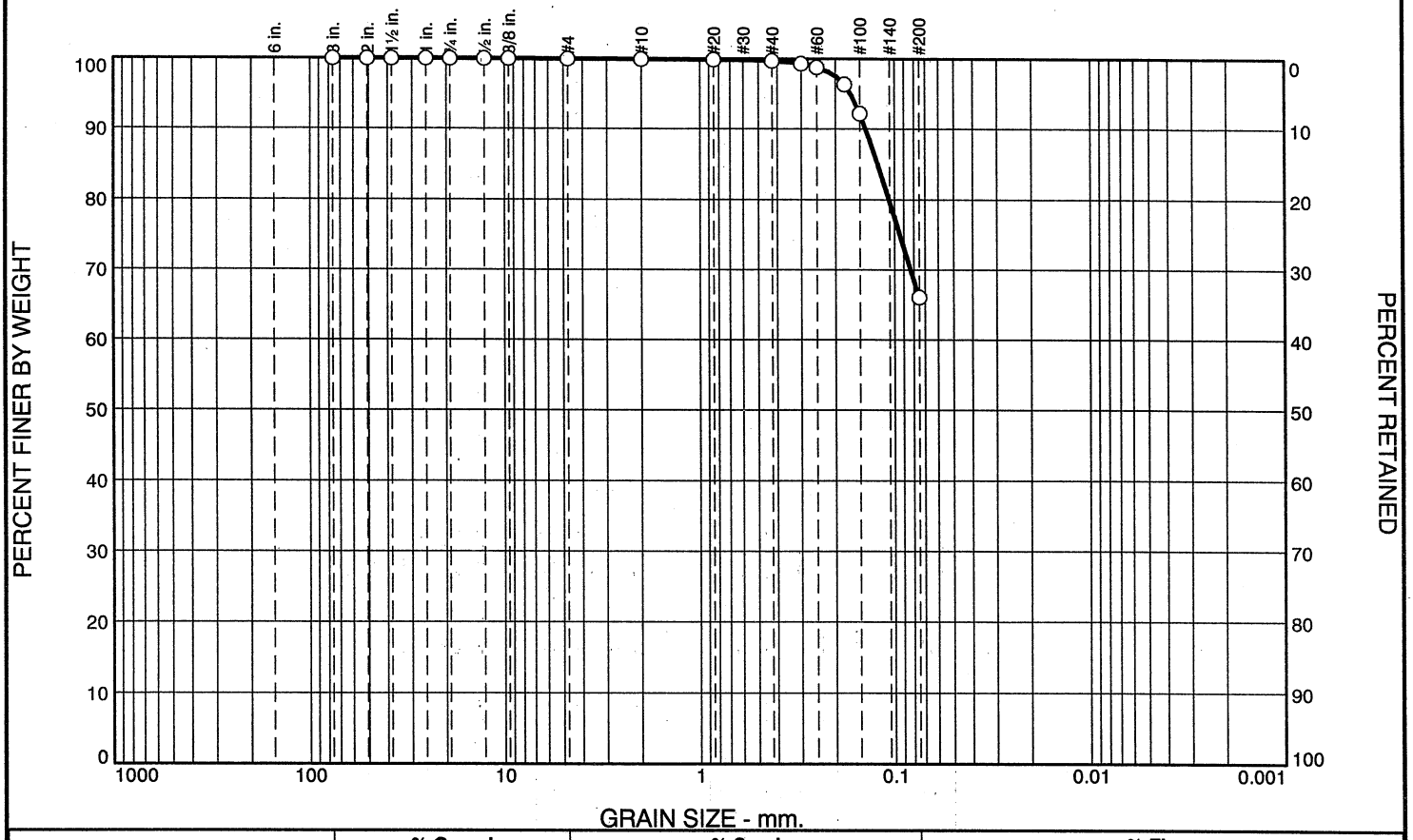
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 0-10'
Sample Number: L22286L **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286L

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	0	34	66	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8	100		
#4	100		
#10	100		
#20	100		
#40	100		
#50	99		
#60	99		
#80	96		
#100	92		
#200	66		

* (no specification provided)

Soil Description

B-13

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1400 D_{85}= 0.1215 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

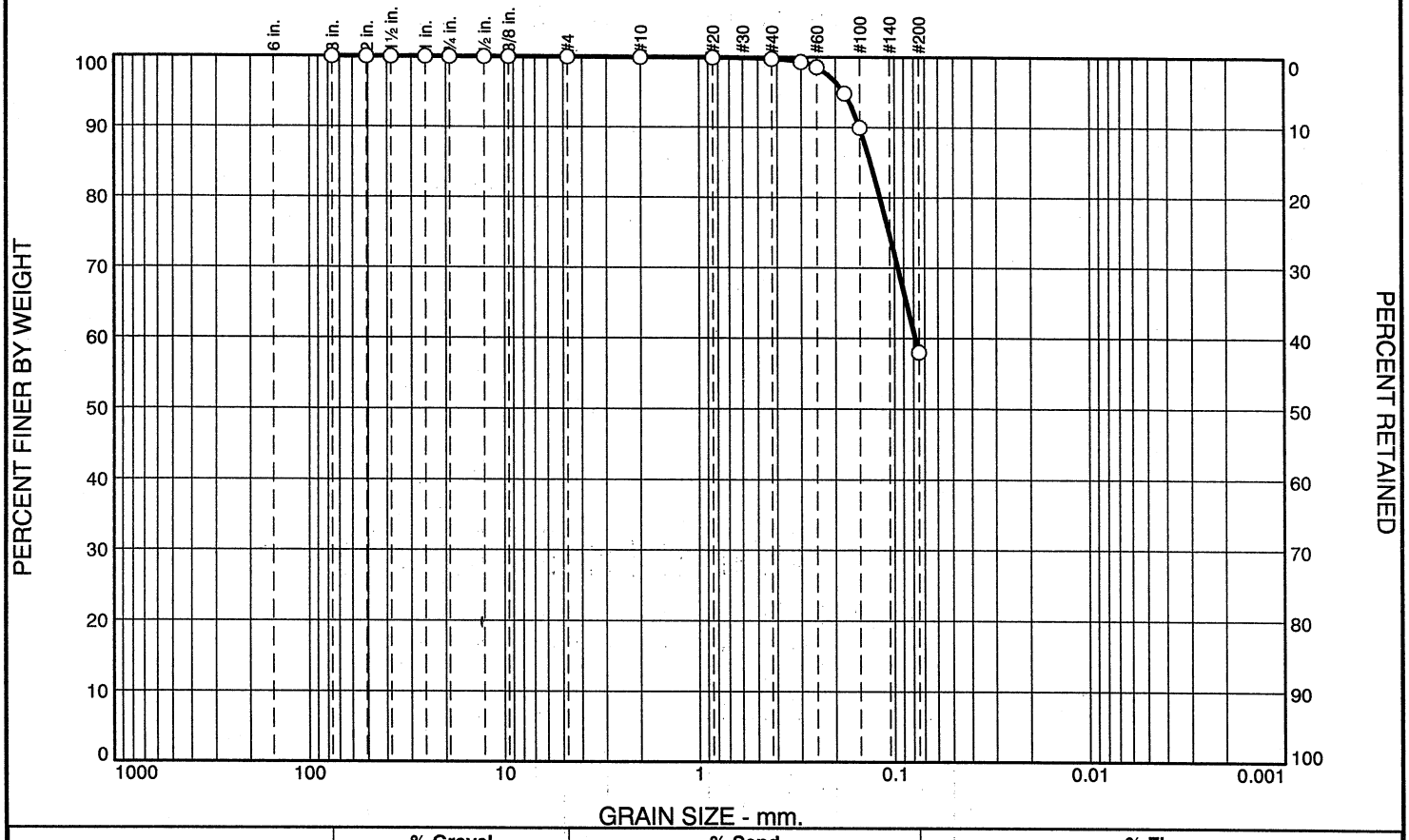
Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 5'-15'
Sample Number: L22286M **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286M

Tested By: DM NL

GRAINSIZE DISTRIBUTION REPORT



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	0	42	58	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100		
2"	100		
1.5"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8	100		
#4	100		
#10	100		
#20	100		
#40	100		
#50	99		
#60	99		
#80	95		
#100	90		
#200	58		

* (no specification provided)

Soil Description

B-13

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1502 D_{85}= 0.1324 D_{60}= 0.0782
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

SMALL BAG SAMPLE.

Source of Sample: HOLLASTON MA,PROJECT # 15494 **Depth:** 15'-20'
Sample Number: L22286N **Date:** 9-8-22

MILLER ENGINEERING & TESTING, INC.

Client:
Project: 22.154.NH
Project No: VERDANTAS QC **Figure** L22286N

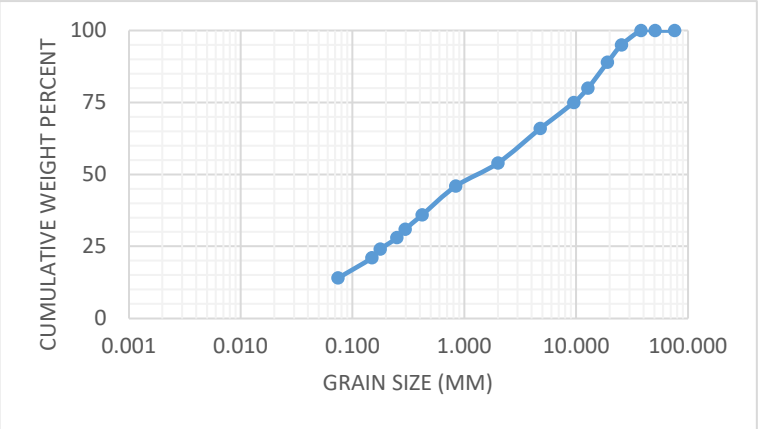
Tested By: DM NL

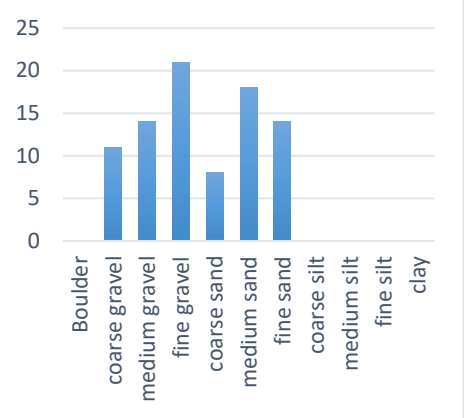
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-4 0-10

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	5	0.05	95
19.05	6	0.06	89
12.7	9	0.09	80
9.525	5	0.05	75
4.76	9	0.09	66
2	12	0.12	54
0.841	8	0.08	46
0.42	10	0.1	36
0.297	5	0.05	31
0.25	3	0.03	28
0.177	4	0.04	24
0.149	3	0.03	21
0.074	7	0.07	14

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.053	Uniformity Coef.	63.95
d17	0.106	n computed	0.26
d20	0.138	g (cm/s^2)	980.00
d50	1.421	ρ (g/cm^3)	0.9981
d60	3.380	μ (g/cm s)	0.0098
de (Kruger)	0.655	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.603	tau (Sauerbrei)	1.053
de (Zunker)	0.620	$d_{geometric\ mean}$	1.885
de (Zamarin)	0.638	σ_ϕ	3.338
lo (Alyameni)	-0.289		

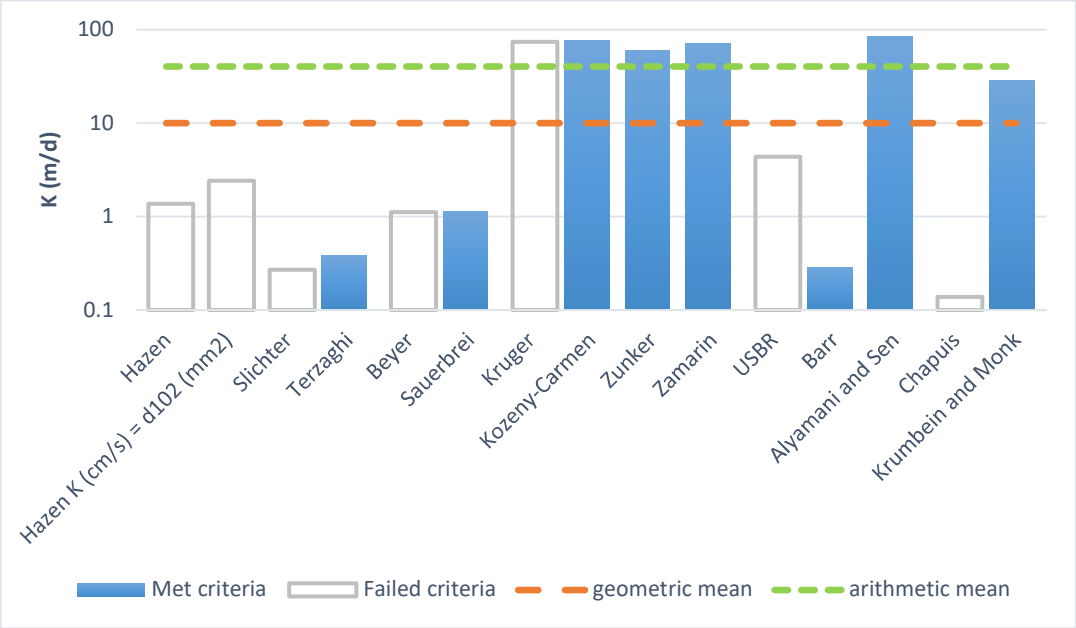
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	11
8 - 16	medium gravel	14
2 - 8	fine gravel	21
0.5 - 2	coarse sand	8
0.25 - 0.5	medium sand	18
0.063 - 0.25	fine sand	14
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-4 0-10

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines



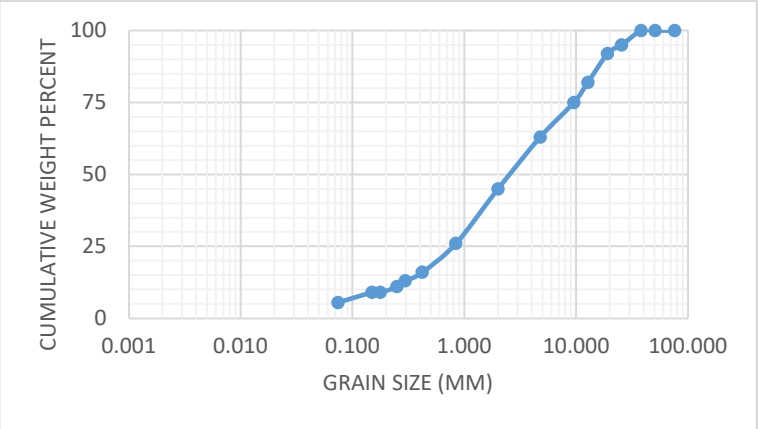
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.158E-02	.158E-04	1.37	
Hazen K (cm/s) = d_{10} (mm)	.279E-02	.279E-04	2.41	
Slichter	.311E-03	.311E-05	0.27	
Terzaghi	.443E-03	.443E-05	0.38	1.26
Beyer	.129E-02	.129E-04	1.11	
Sauerbrei	.132E-02	.132E-04	1.14	3.74
Kruger	.853E-01	.853E-03	73.67	
Kozeny-Carmen	.896E-01	.896E-03	77.39	253.84
Zunker	.694E-01	.694E-03	59.92	196.55
Zamarin	.832E-01	.832E-03	71.86	235.71
USBR	.504E-02	.504E-04	4.35	
Barr	.333E-03	.333E-05	0.29	0.94
Alyamani and Sen	.977E-01	.977E-03	84.44	276.97
Chapuis	.159E-03	.159E-05	0.14	
Krumbein and Monk	.334E-01	.334E-03	28.88	94.72
geometric mean	.116E-01	.116E-03	10.03	32.89
arithmetic mean	.469E-01	.469E-03	40.54	132.97

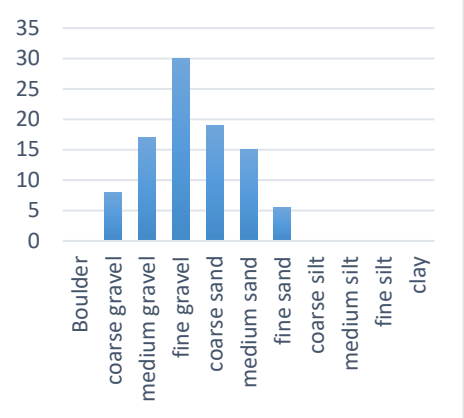
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-4 10-16

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy gravel low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	5	0.05	95
19.05	3	0.03	92
12.7	10	0.1	82
9.525	7	0.07	75
4.76	12	0.12	63
2	18	0.18	45
0.841	19	0.19	26
0.42	10	0.1	16
0.297	3	0.03	13
0.25	2	0.02	11
0.177	2	0.02	9
0.149	0	0	9
0.074	3.5	0.035	5.5

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.214	Uniformity Coef.	20.14
d17	0.462	n computed	0.26
d20	0.588	g (cm/s^2)	980.00
d50	2.767	ρ (g/cm^3)	0.9981
d60	4.300	μ (g/cm s)	0.0098
de (Kruger)	1.061	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.954	tau (Sauerbrei)	1.053
de (Zunker)	0.989	$d_{geometric\ mean}$	2.634
de (Zamarin)	1.025	σ_ϕ	2.561
lo (Alyameni)	-0.425		

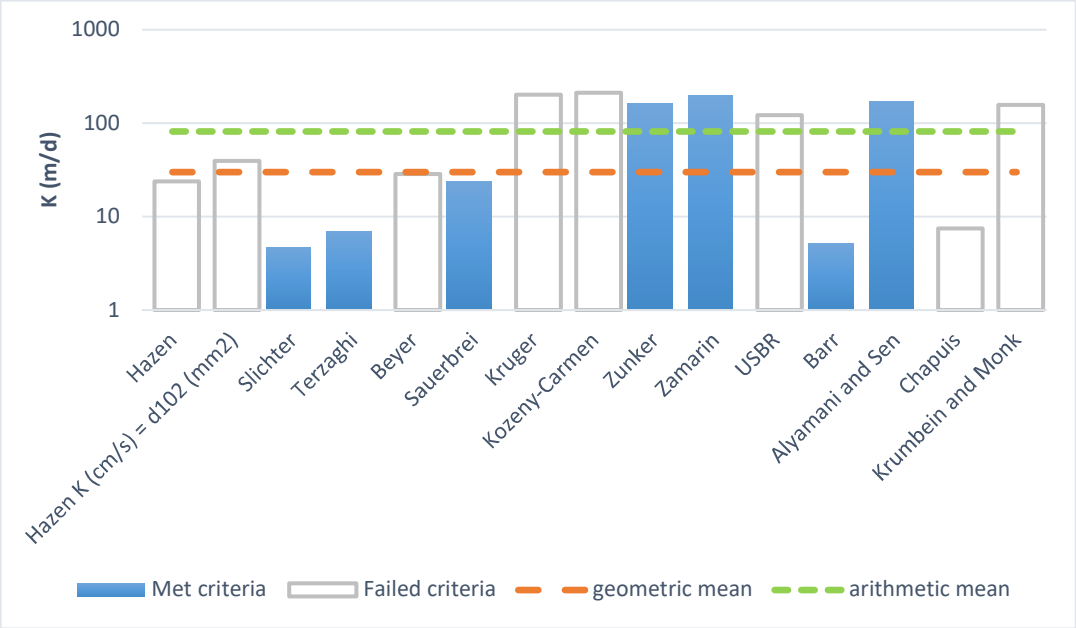
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	8
8 - 16	medium gravel	17
2 - 8	fine gravel	30
0.5 - 2	coarse sand	19
0.25 - 0.5	medium sand	15
0.063 - 0.25	fine sand	5.5
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-4 10-16

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy gravel low in fines



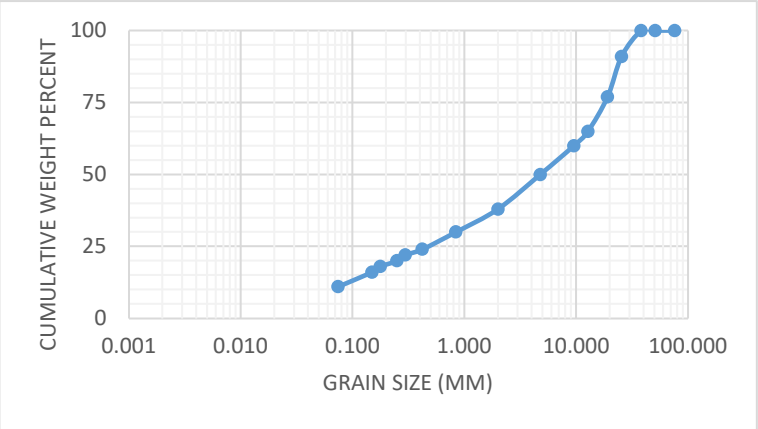
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.274E-01	.274E-03	23.70	
Hazen K (cm/s) = d_{10} (mm)	.456E-01	.456E-03	39.38	
Slichter	.547E-02	.547E-04	4.73	15.51
Terzaghi	.798E-02	.798E-04	6.90	22.62
Beyer	.328E-01	.328E-03	28.37	
Sauerbrei	.273E-01	.273E-03	23.55	77.25
Kruger	.233E+00	.233E-02	200.89	
Kozeny-Carmen	.244E+00	.244E-02	211.04	
Zunker	.188E+00	.188E-02	162.12	531.75
Zamarin	.229E+00	.229E-02	198.12	649.84
USBR	.141E+00	.141E-02	121.64	
Barr	.592E-02	.592E-04	5.12	16.79
Alyamani and Sen	.196E+00	.196E-02	169.38	555.57
Chapuis	.865E-02	.865E-04	7.47	
Krumbein and Monk	.180E+00	.180E-02	155.95	
geometric mean	.346E-01	.346E-03	29.90	98.09
arithmetic mean	.942E-01	.942E-03	81.42	267.05

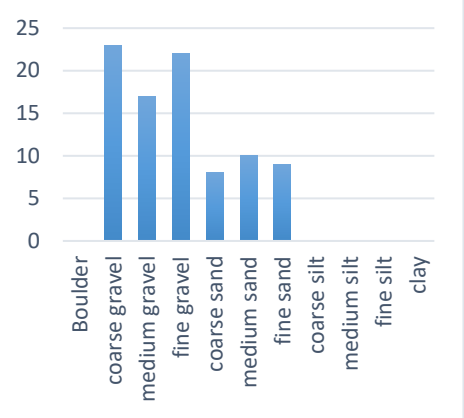
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-4 16

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy gravel low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	9	0.09	91
19.05	14	0.14	77
12.7	12	0.12	65
9.525	5	0.05	60
4.76	10	0.1	50
2	12	0.12	38
0.841	8	0.08	30
0.42	6	0.06	24
0.297	2	0.02	22
0.25	2	0.02	20
0.177	2	0.02	18
0.149	2	0.02	16
0.074	5	0.05	11

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.067	Uniformity Coef.	141.59
d17	0.163	n computed	0.26
d20	0.250	g (cm/s^2)	980.00
d50	4.760	ρ (g/cm^3)	0.9981
d60	9.525	μ (g/cm s)	0.0098
de (Kruger)	0.984	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.899	tau (Sauerbrei)	1.053
de (Zunker)	0.927	$d_{geometric\ mean}$	3.596
de (Zamarin)	0.956	σ_ϕ	3.298
lo (Alyameni)	-1.106		

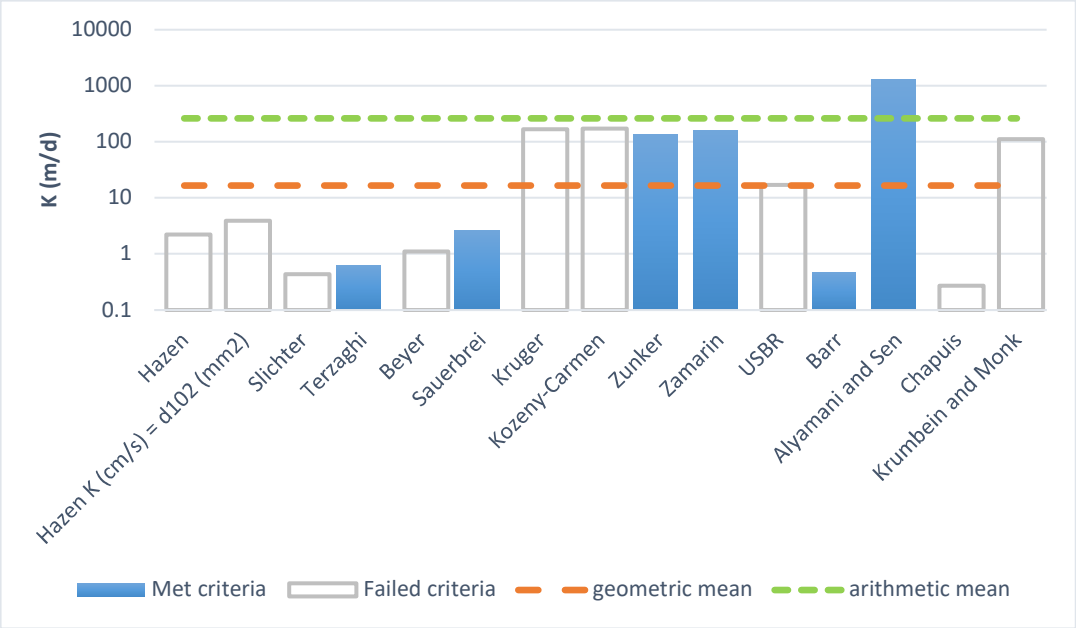
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	23
8 - 16	medium gravel	17
2 - 8	fine gravel	22
0.5 - 2	coarse sand	8
0.25 - 0.5	medium sand	10
0.063 - 0.25	fine sand	9
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-4 16

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy gravel low in fines



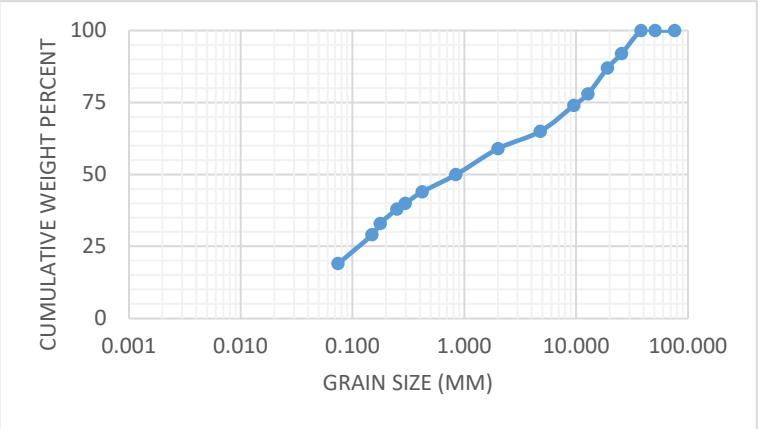
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.256E-02	.256E-04	2.21	
Hazen K (cm/s) = d_{10} (mm)	.453E-02	.453E-04	3.91	
Slichter	.504E-03	.504E-05	0.44	
Terzaghi	.718E-03	.718E-05	0.62	2.03
Beyer	.128E-02	.128E-04	1.11	
Sauerbrei	.311E-02	.311E-04	2.69	8.82
Kruger	.192E+00	.192E-02	166.19	
Kozeny-Carmen	.199E+00	.199E-02	172.17	
Zunker	.155E+00	.155E-02	133.92	439.27
Zamarin	.187E+00	.187E-02	161.38	529.31
USBR	.197E-01	.197E-03	16.99	
Barr	.540E-03	.540E-05	0.47	1.53
Alyamani and Sen	.147E+01	.147E-01	1270.51	4167.26
Chapuis	.313E-03	.313E-05	0.27	
Krumbein and Monk	.128E+00	.128E-02	110.70	
geometric mean	.193E-01	.193E-03	16.66	54.64
arithmetic mean	.303E+00	.303E-02	261.60	858.04

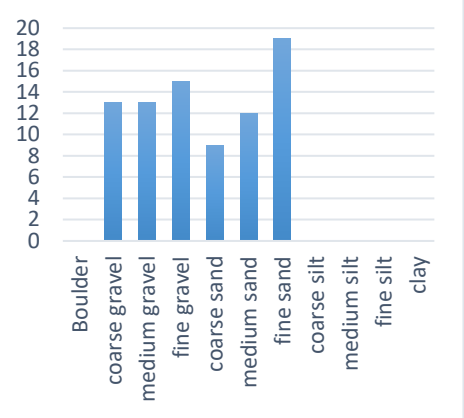
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-6 5-12

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	8	0.08	92
19.05	5	0.05	87
12.7	9	0.09	78
9.525	4	0.04	74
4.76	9	0.09	65
2	6	0.06	59
0.841	9	0.09	50
0.42	6	0.06	44
0.297	4	0.04	40
0.25	2	0.02	38
0.177	5	0.05	33
0.149	4	0.04	29
0.074	10	0.1	19

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.039	Uniformity Coef.	63.16
d17	0.066	n computed	0.26
d20	0.082	g (cm/s^2)	980.00
d50	0.841	ρ (g/cm^3)	0.9981
d60	2.460	μ (g/cm s)	0.0098
de (Kruger)	0.567	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.520	tau (Sauerbrei)	1.053
de (Zunker)	0.536	$d_{geometric\ mean}$	1.751
de (Zamarin)	0.551	σ_ϕ	3.627
Io (Alyameni)	-0.162		

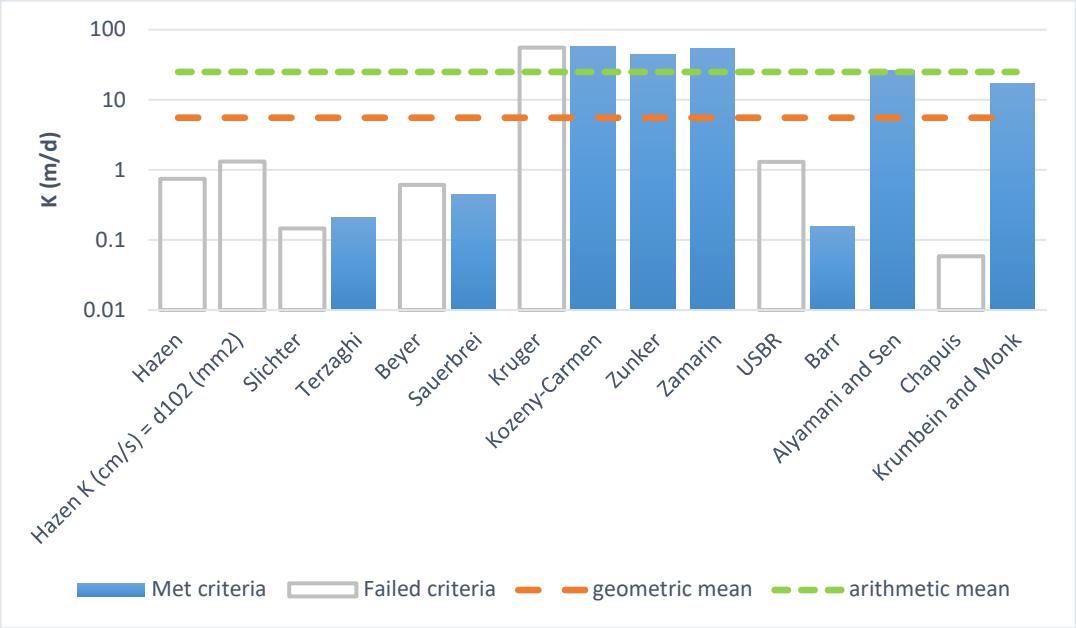
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	13
8 - 16	medium gravel	13
2 - 8	fine gravel	15
0.5 - 2	coarse sand	9
0.25 - 0.5	medium sand	12
0.063 - 0.25	fine sand	19
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-6 5-12

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines



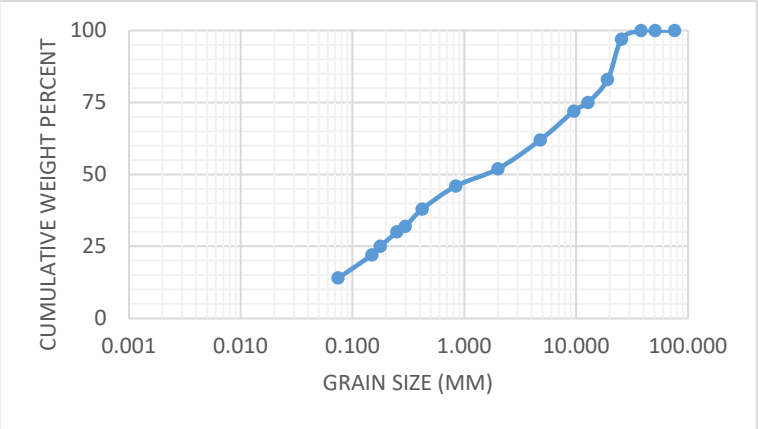
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.859E-03	.859E-05	0.74	
Hazen K (cm/s) = d_{10} (mm)	.152E-02	.152E-04	1.31	
Slichter	.169E-03	.169E-05	0.15	
Terzaghi	.241E-03	.241E-05	0.21	0.68
Beyer	.704E-03	.704E-05	0.61	
Sauerbrei	.514E-03	.514E-05	0.44	1.46
Kruger	.638E-01	.638E-03	55.12	
Kozeny-Carmen	.667E-01	.667E-03	57.64	189.06
Zunker	.517E-01	.517E-03	44.69	146.60
Zamarin	.621E-01	.621E-03	53.68	176.08
USBR	.149E-02	.149E-04	1.29	
Barr	.181E-03	.181E-05	0.16	0.51
Alyamani and Sen	.301E-01	.301E-03	26.03	85.39
Chapuis	.671E-04	.671E-06	0.06	
Krumbein and Monk	.197E-01	.197E-03	17.05	55.92
geometric mean	.641E-02	.641E-04	5.54	18.17
arithmetic mean	.289E-01	.289E-03	24.99	81.96

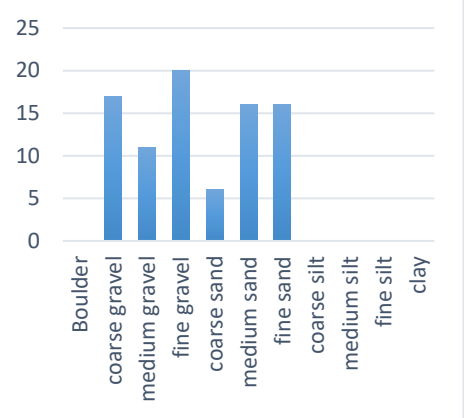
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-6 10-15

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	3	0.03	97
19.05	14	0.14	83
12.7	8	0.08	75
9.525	3	0.03	72
4.76	10	0.1	62
2	10	0.1	52
0.841	6	0.06	46
0.42	8	0.08	38
0.297	6	0.06	32
0.25	2	0.02	30
0.177	5	0.05	25
0.149	3	0.03	22
0.074	8	0.08	14

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.053	Uniformity Coef.	79.61
d17	0.102	n computed	0.26
d20	0.130	g (cm/s^2)	980.00
d50	1.614	ρ (g/cm^3)	0.9981
d60	4.208	μ (g/cm s)	0.0098
de (Kruger)	0.623	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.574	tau (Sauerbrei)	1.053
de (Zunker)	0.590	$d_{geometric\ mean}$	2.021
de (Zamarin)	0.607	σ_ϕ	3.422
lo (Alyameni)	-0.337		

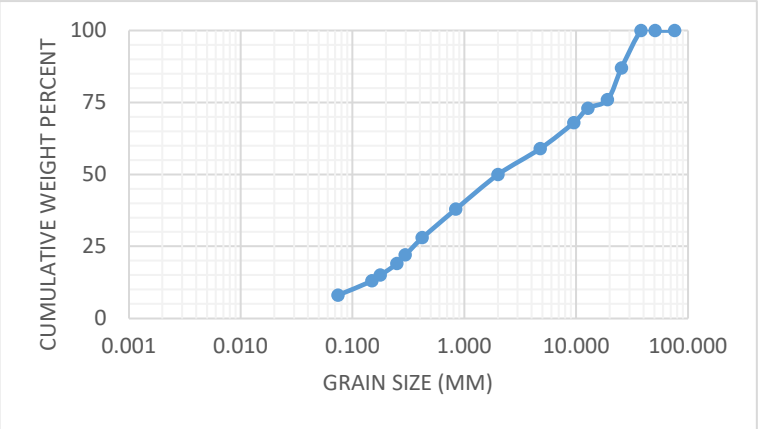
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	17
8 - 16	medium gravel	11
2 - 8	fine gravel	20
0.5 - 2	coarse sand	6
0.25 - 0.5	medium sand	16
0.063 - 0.25	fine sand	16
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

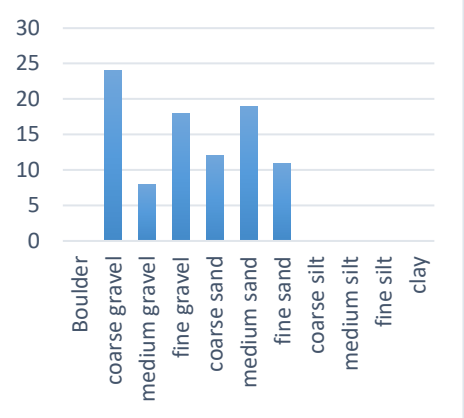
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-6 15+

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy gravel low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	13	0.13	87
19.05	11	0.11	76
12.7	3	0.03	73
9.525	5	0.05	68
4.76	9	0.09	59
2	9	0.09	50
0.841	12	0.12	38
0.42	10	0.1	28
0.297	6	0.06	22
0.25	3	0.03	19
0.177	4	0.04	15
0.149	2	0.02	13
0.074	4.9	0.049	8.1

Effective Grain Diameters (mm)	
d10	0.103
d17	0.214
d20	0.266
d50	2.000
d60	5.289
de (Kruger)	0.755
de (Kozeny)	0.696
de (Zunker)	0.715
de (Zamarin)	0.735
Io (Alyameni)	-0.371

Other Useful Parameters	
Uniformity Coef.	51.31
n computed	0.26
g (cm/s^2)	980.00
ρ (g/cm^3)	0.9981
μ (g/cm s)	0.0098
ρg/μ (1/cm s)	9.9327E+04
tau (Sauerbrei)	1.053
$d_{geometric\ mean}$	2.536
σ_ϕ	3.171

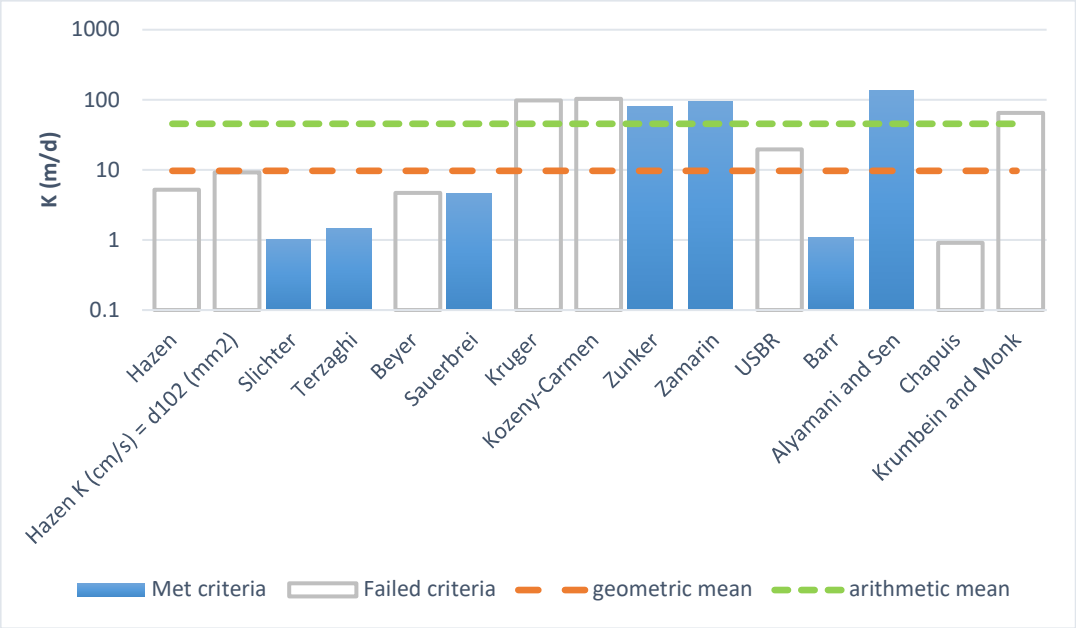
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	24
8 - 16	medium gravel	8
2 - 8	fine gravel	18
0.5 - 2	coarse sand	12
0.25 - 0.5	medium sand	19
0.063 - 0.25	fine sand	10.9
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-6 15+

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy gravel low in fines



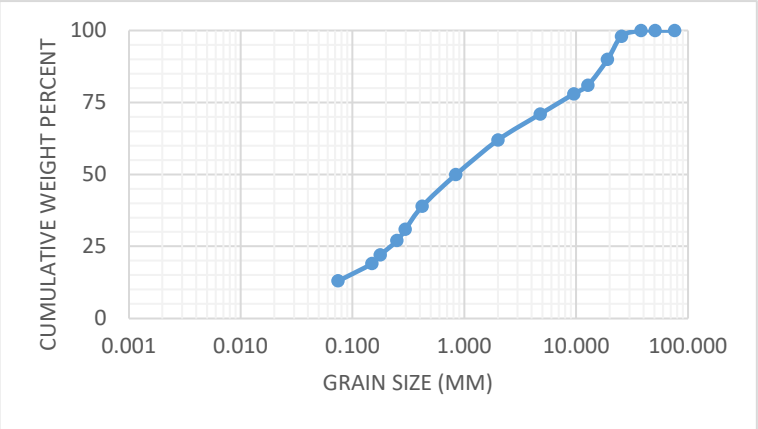
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.602E-02	.602E-04	5.20	
Hazen K (cm/s) = d_{10} (mm)	.106E-01	.106E-03	9.18	
Slichter	.118E-02	.118E-04	1.02	3.35
Terzaghi	.169E-02	.169E-04	1.46	4.78
Beyer	.543E-02	.543E-04	4.69	
Sauerbrei	.534E-02	.534E-04	4.62	15.14
Kruger	.113E+00	.113E-02	97.81	
Kozeny-Carmen	.119E+00	.119E-02	103.09	
Zunker	.923E-01	.923E-03	79.73	261.53
Zamarin	.111E+00	.111E-02	95.52	313.31
USBR	.226E-01	.226E-03	19.53	
Barr	.127E-02	.127E-04	1.10	3.59
Alyamani and Sen	.158E+00	.158E-02	136.24	446.86
Chapuis	.104E-02	.104E-04	0.90	
Krumbein and Monk	.753E-01	.753E-03	65.04	
geometric mean	.112E-01	.112E-03	9.65	31.66
arithmetic mean	.529E-01	.529E-03	45.67	149.79

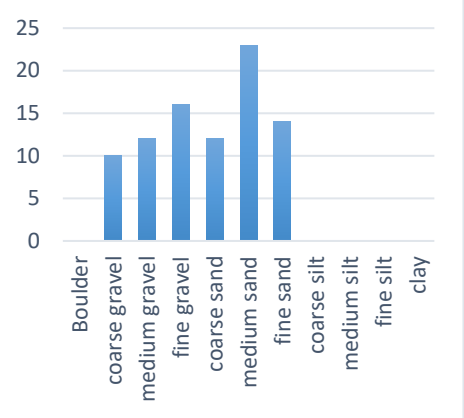
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-9 0-9

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	2	0.02	98
19.05	8	0.08	90
12.7	9	0.09	81
9.525	3	0.03	78
4.76	7	0.07	71
2	9	0.09	62
0.841	12	0.12	50
0.42	11	0.11	39
0.297	8	0.08	31
0.25	4	0.04	27
0.177	5	0.05	22
0.149	3	0.03	19
0.074	6	0.06	13

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.057	Uniformity Coef.	31.74
d17	0.124	n computed	0.26
d20	0.158	g (cm/s^2)	980.00
d50	0.841	ρ (g/cm^3)	0.9981
d60	1.807	μ (g/cm s)	0.0098
de (Kruger)	0.612	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.567	tau (Sauerbrei)	1.053
de (Zunker)	0.582	$d_{geometric\ mean}$	1.554
de (Zamarin)	0.597	σ_ϕ	3.227
Io (Alyameni)	-0.139		

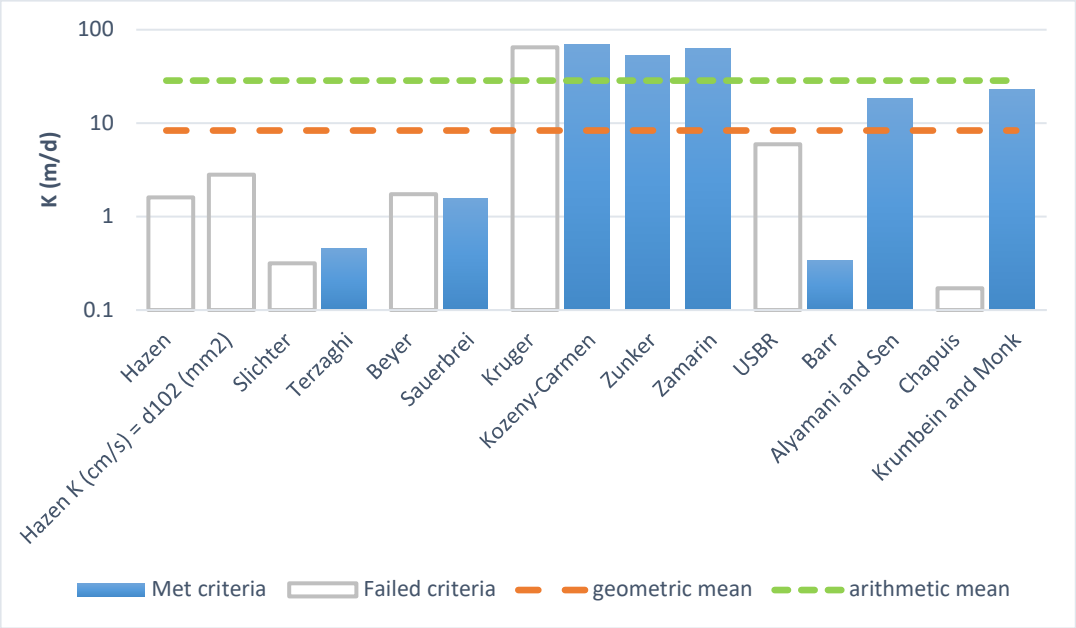
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	10
8 - 16	medium gravel	12
2 - 8	fine gravel	16
0.5 - 2	coarse sand	12
0.25 - 0.5	medium sand	23
0.063 - 0.25	fine sand	14
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-9 0-9

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines



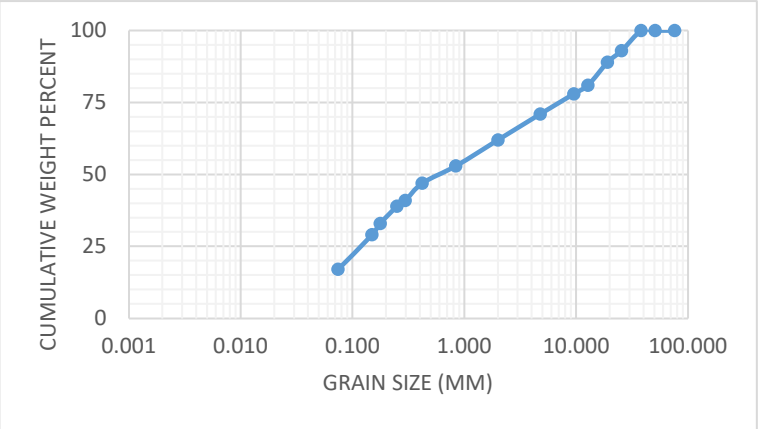
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.185E-02	.185E-04	1.60	
Hazen K (cm/s) = d_{10} (mm)	.324E-02	.324E-04	2.80	
Slichter	.364E-03	.364E-05	0.31	
Terzaghi	.520E-03	.520E-05	0.45	1.47
Beyer	.200E-02	.200E-04	1.73	
Sauerbrei	.182E-02	.182E-04	1.57	5.16
Kruger	.747E-01	.747E-03	64.55	
Kozeny-Carmen	.799E-01	.799E-03	69.04	226.46
Zunker	.615E-01	.615E-03	53.10	174.15
Zamarin	.734E-01	.734E-03	63.43	208.05
USBR	.688E-02	.688E-04	5.94	
Barr	.390E-03	.390E-05	0.34	1.11
Alyamani and Sen	.215E-01	.215E-03	18.56	60.89
Chapuis	.198E-03	.198E-05	0.17	
Krumbein and Monk	.262E-01	.262E-03	22.68	74.38
geometric mean	.965E-02	.965E-04	8.34	27.34
arithmetic mean	.332E-01	.332E-03	28.65	93.96

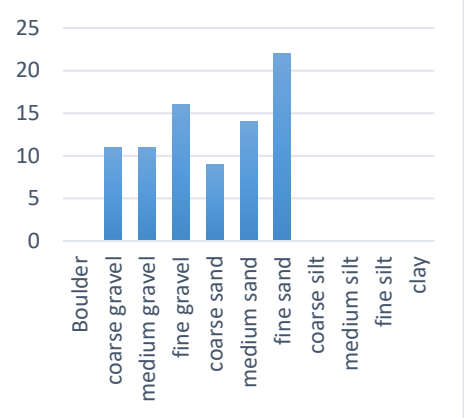
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-9 1st

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	7	0.07	93
19.05	4	0.04	89
12.7	8	0.08	81
9.525	3	0.03	78
4.76	7	0.07	71
2	9	0.09	62
0.841	9	0.09	53
0.42	6	0.06	47
0.297	6	0.06	41
0.25	2	0.02	39
0.177	6	0.06	33
0.149	4	0.04	29
0.074	12	0.12	17

Effective Grain Diameters (mm)	
d10	0.044
d17	0.074
d20	0.093
d50	0.631
d60	1.742
de (Kruger)	0.488
de (Kozeny)	0.448
de (Zunker)	0.461
de (Zamarin)	0.474
Io (Alyameni)	-0.103

Other Useful Parameters	
Uniformity Coef.	40.03
n computed	0.26
g (cm/s^2)	980.00
ρ (g/cm^3)	0.9981
μ (g/cm s)	0.0098
ρg/μ (1/cm s)	9.9327E+04
tau (Sauerbrei)	1.053
$d_{geometric\ mean}$	1.430
σ_ϕ	3.513

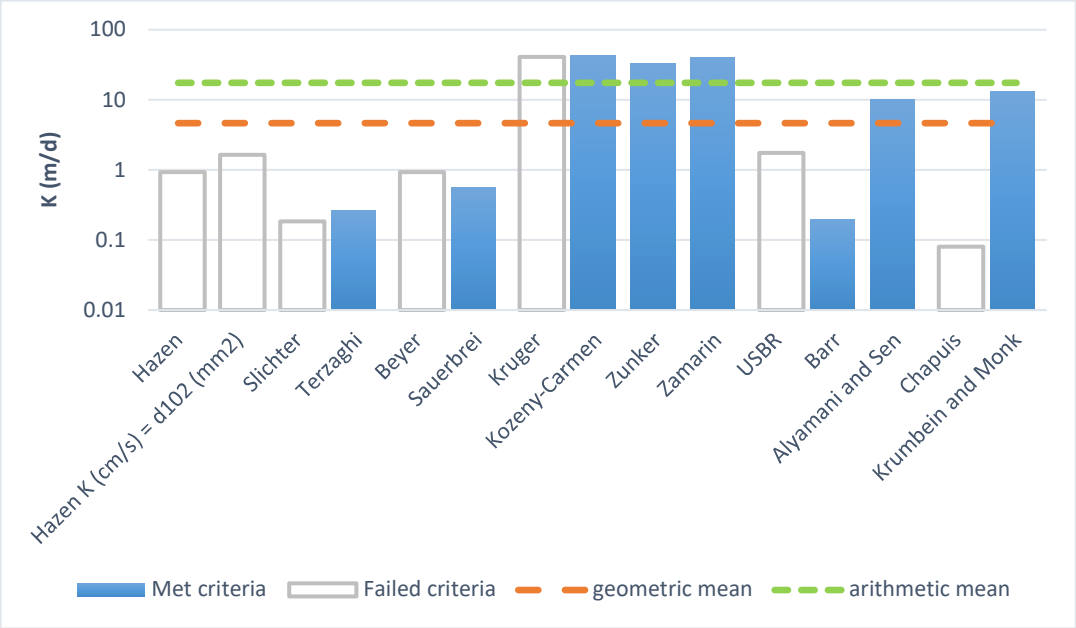
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	11
8 - 16	medium gravel	11
2 - 8	fine gravel	16
0.5 - 2	coarse sand	9
0.25 - 0.5	medium sand	14
0.063 - 0.25	fine sand	22
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-9 1st

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines



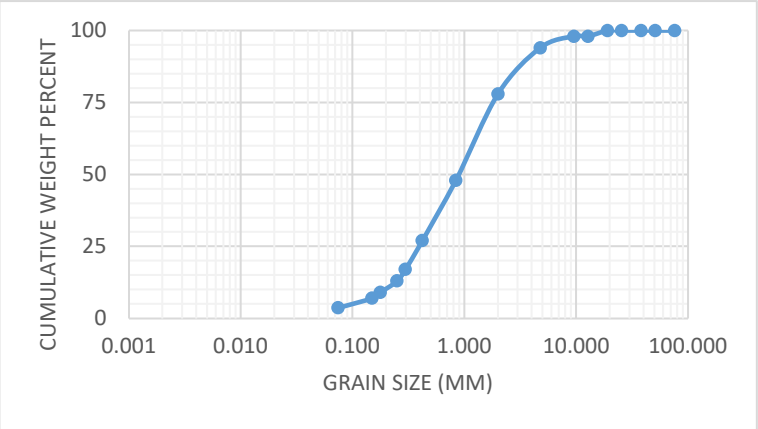
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.107E-02	.107E-04	0.93	
Hazen K (cm/s) = d_{10} (mm)	.189E-02	.189E-04	1.64	
Slichter	.211E-03	.211E-05	0.18	
Terzaghi	.301E-03	.301E-05	0.26	0.85
Beyer	.107E-02	.107E-04	0.93	
Sauerbrei	.643E-03	.643E-05	0.56	1.82
Kruger	.473E-01	.473E-03	40.86	
Kozeny-Carmen	.494E-01	.494E-03	42.71	140.08
Zunker	.383E-01	.383E-03	33.11	108.62
Zamarin	.461E-01	.461E-03	39.80	130.54
USBR	.201E-02	.201E-04	1.74	
Barr	.227E-03	.227E-05	0.20	0.64
Alyamani and Sen	.118E-01	.118E-03	10.19	33.43
Chapuis	.921E-04	.921E-06	0.08	
Krumbein and Monk	.153E-01	.153E-03	13.21	43.34
geometric mean	.537E-02	.537E-04	4.64	15.22
arithmetic mean	.203E-01	.203E-03	17.50	57.41

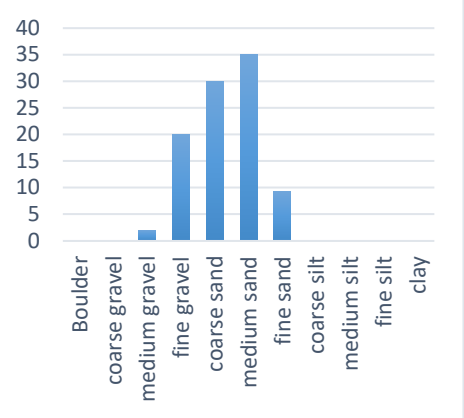
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-9 9-14.5

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	0	0	100
19.05	0	0	100
12.7	2	0.02	98
9.525	0	0	98
4.76	4	0.04	94
2	16	0.16	78
0.841	30	0.3	48
0.42	21	0.21	27
0.297	10	0.1	17
0.25	4	0.04	13
0.177	4	0.04	9
0.149	2	0.02	7
0.074	3.3	0.033	3.7

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.195	Uniformity Coef.	6.68
d17	0.297	n computed	0.33
d20	0.334	g (cm/s^2)	980.00
d50	0.918	ρ (g/cm^3)	0.9981
d60	1.305	μ (g/cm s)	0.0098
de (Kruger)	0.614	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.563	tau (Sauerbrei)	1.053
de (Zunker)	0.579	$d_{geometric\ mean}$	0.952
de (Zamarin)	0.596	σ_ϕ	1.738
lo (Alyameni)	0.014		

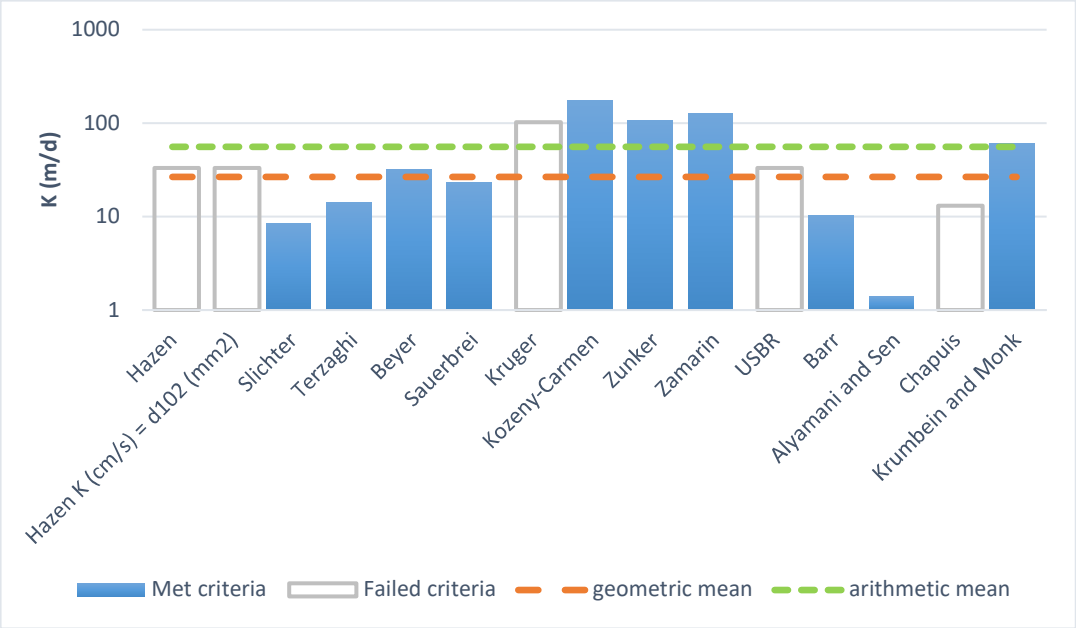
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	0
8 - 16	medium gravel	2
2 - 8	fine gravel	20
0.5 - 2	coarse sand	30
0.25 - 0.5	medium sand	35
0.063 - 0.25	fine sand	9.3
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-9 9-14.5

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines



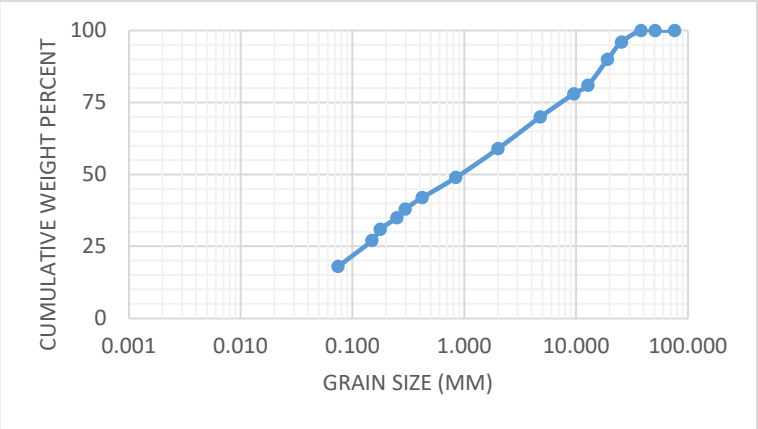
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.383E-01	.383E-03	33.06	
Hazen K (cm/s) = d_{10} (mm)	.381E-01	.381E-03	32.94	
Slichter	.974E-02	.974E-04	8.42	27.62
Terzaghi	.163E-01	.163E-03	14.11	46.28
Beyer	.369E-01	.369E-03	31.88	104.58
Sauerbrei	.272E-01	.272E-03	23.48	77.01
Kruger	.118E+00	.118E-02	102.36	
Kozeny-Carmen	.205E+00	.205E-02	177.04	580.69
Zunker	.124E+00	.124E-02	106.71	350.01
Zamarin	.147E+00	.147E-02	126.98	416.51
USBR	.382E-01	.382E-03	33.05	
Barr	.120E-01	.120E-03	10.33	33.88
Alyamani and Sen	.160E-02	.160E-04	1.38	4.52
Chapuis	.151E-01	.151E-03	13.01	
Krumbein and Monk	.693E-01	.693E-03	59.85	196.31
geometric mean	.309E-01	.309E-03	26.67	87.47
arithmetic mean	.648E-01	.648E-03	56.02	183.74

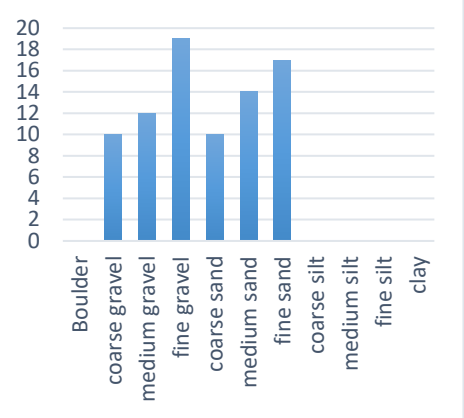
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-11 5-10

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	4	0.04	96
19.05	6	0.06	90
12.7	9	0.09	81
9.525	3	0.03	78
4.76	8	0.08	70
2	11	0.11	59
0.841	10	0.1	49
0.42	7	0.07	42
0.297	4	0.04	38
0.25	3	0.03	35
0.177	4	0.04	31
0.149	4	0.04	27
0.074	9	0.09	18

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.041	Uniformity Coef.	54.75
d17	0.070	n computed	0.26
d20	0.091	g (cm/s^2)	980.00
d50	0.957	ρ (g/cm^3)	0.9981
d60	2.251	μ (g/cm s)	0.0098
de (Kruger)	0.589	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.541	tau (Sauerbrei)	1.053
de (Zunker)	0.556	$d_{geometric\ mean}$	1.631
de (Zamarin)	0.573	σ_ϕ	3.501
lo (Alyameni)	-0.188		

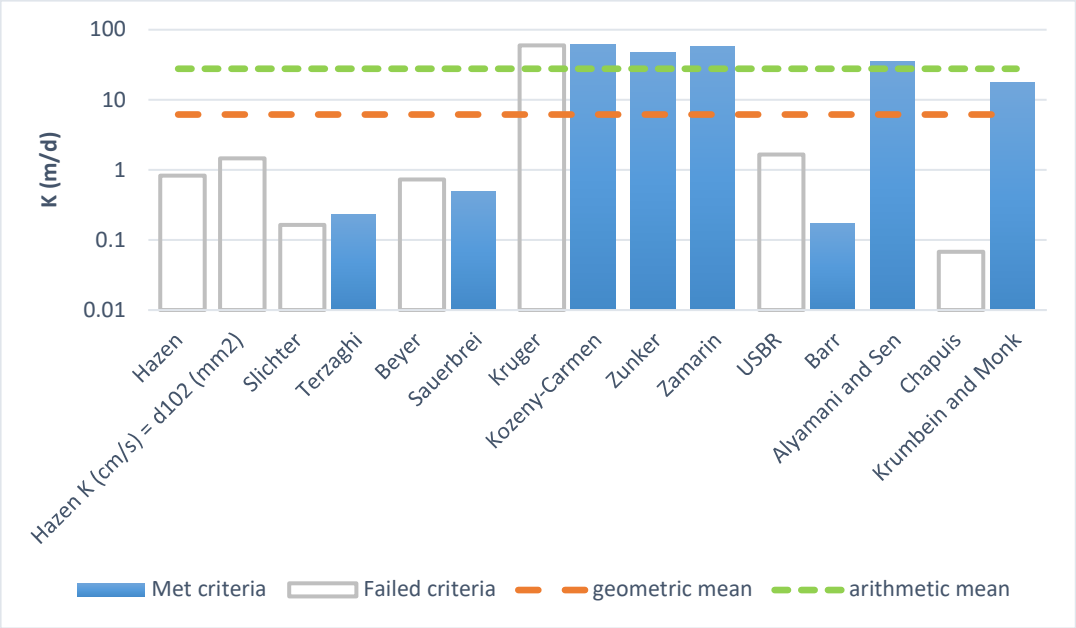
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	10
8 - 16	medium gravel	12
2 - 8	fine gravel	19
0.5 - 2	coarse sand	10
0.25 - 0.5	medium sand	14
0.063 - 0.25	fine sand	17
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-11 5-10

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines



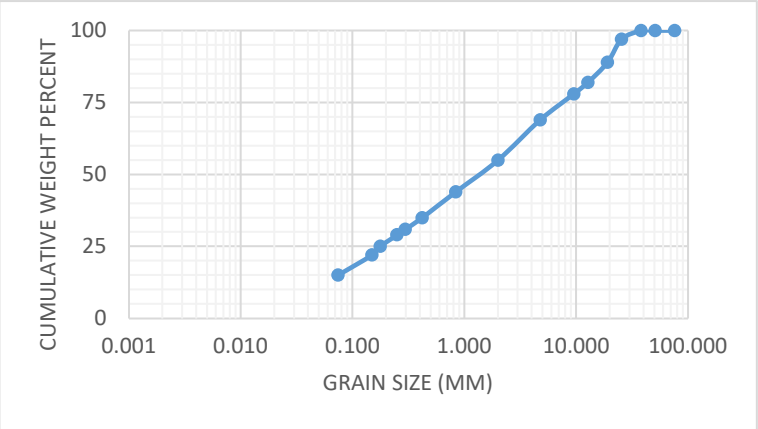
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.957E-03	.957E-05	0.83	
Hazen K (cm/s) = d_{10} (mm)	.169E-02	.169E-04	1.46	
Slichter	.188E-03	.188E-05	0.16	
Terzaghi	.268E-03	.268E-05	0.23	0.76
Beyer	.839E-03	.839E-05	0.72	
Sauerbrei	.572E-03	.572E-05	0.49	1.62
Kruger	.688E-01	.688E-03	59.44	
Kozeny-Carmen	.720E-01	.720E-03	62.21	204.06
Zunker	.558E-01	.558E-03	48.23	158.19
Zamarin	.670E-01	.670E-03	57.91	189.96
USBR	.191E-02	.191E-04	1.65	
Barr	.202E-03	.202E-05	0.17	0.57
Alyamani and Sen	.409E-01	.409E-03	35.37	116.00
Chapuis	.782E-04	.782E-06	0.07	
Krumbein and Monk	.202E-01	.202E-03	17.46	57.28
geometric mean	.716E-02	.716E-04	6.19	20.29
arithmetic mean	.321E-01	.321E-03	27.76	91.05

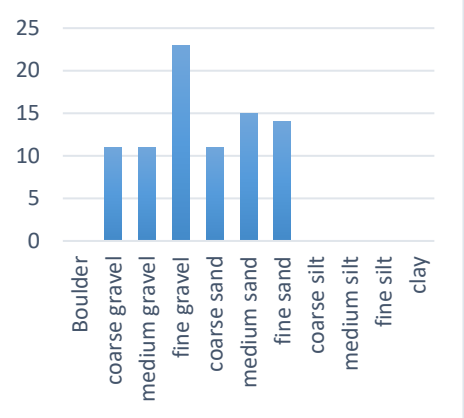
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-11 10-14

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	3	0.03	97
19.05	8	0.08	89
12.7	7	0.07	82
9.525	4	0.04	78
4.76	9	0.09	69
2	14	0.14	55
0.841	11	0.11	44
0.42	9	0.09	35
0.297	4	0.04	31
0.25	2	0.02	29
0.177	4	0.04	25
0.149	3	0.03	22
0.074	7	0.07	15

Effective Grain Diameters (mm)	
d10	0.049
d17	0.095
d20	0.128
d50	1.473
d60	2.986
de (Kruger)	0.680
de (Kozeny)	0.623
de (Zunker)	0.641
de (Zamarin)	0.661
Io (Alyameni)	-0.307

Other Useful Parameters	
Uniformity Coef.	60.52
n computed	0.26
g (cm/s^2)	980.00
ρ (g/cm^3)	0.9981
μ (g/cm s)	0.0098
ρg/μ (1/cm s)	9.9327E+04
tau (Sauerbrei)	1.053
$d_{geometric\ mean}$	1.835
σ_ϕ	3.357

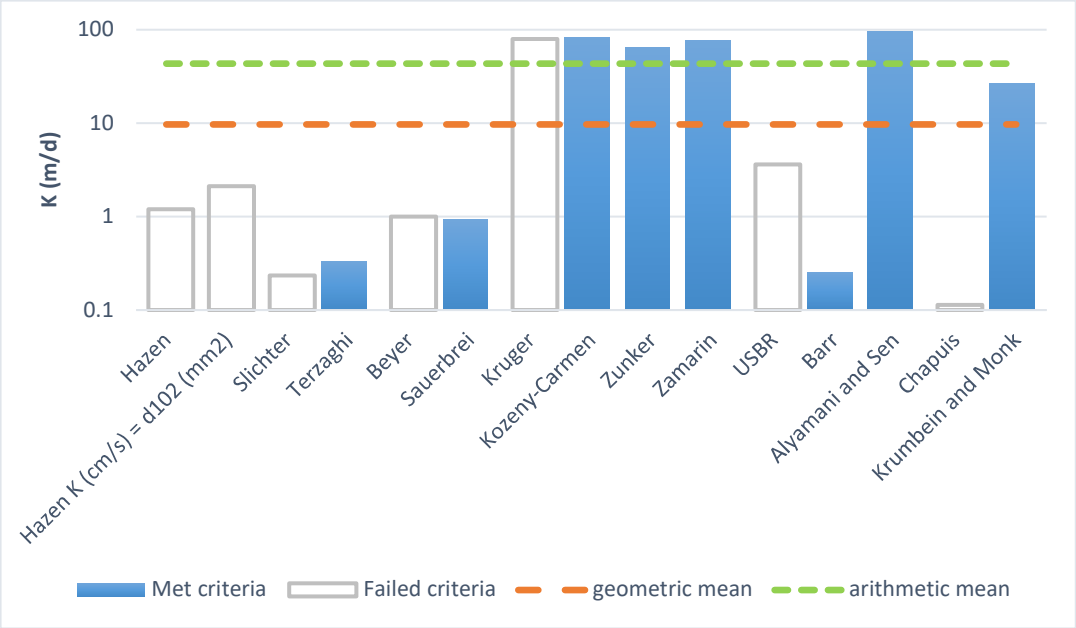
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	11
8 - 16	medium gravel	11
2 - 8	fine gravel	23
0.5 - 2	coarse sand	11
0.25 - 0.5	medium sand	15
0.063 - 0.25	fine sand	14
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-11 10-14

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines



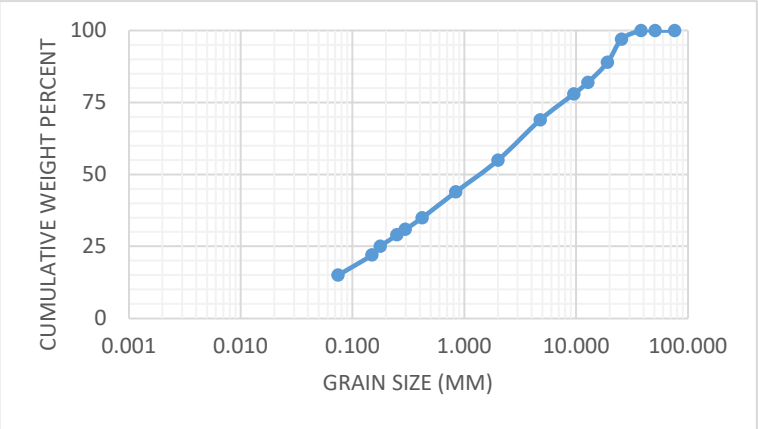
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.138E-02	.138E-04	1.19	
Hazen K (cm/s) = d_{10} (mm)	.243E-02	.243E-04	2.10	
Slichter	.271E-03	.271E-05	0.23	
Terzaghi	.386E-03	.386E-05	0.33	1.09
Beyer	.115E-02	.115E-04	1.00	
Sauerbrei	.107E-02	.107E-04	0.92	3.02
Kruger	.918E-01	.918E-03	79.30	
Kozeny-Carmen	.956E-01	.956E-03	82.58	270.87
Zunker	.742E-01	.742E-03	64.13	210.34
Zamarin	.893E-01	.893E-03	77.14	253.01
USBR	.418E-02	.418E-04	3.61	
Barr	.290E-03	.290E-05	0.25	0.82
Alyamani and Sen	.111E+00	.111E-02	95.50	313.23
Chapuis	.131E-03	.131E-05	0.11	
Krumbein and Monk	.309E-01	.309E-03	26.67	87.48
geometric mean	.113E-01	.113E-03	9.73	31.91
arithmetic mean	.503E-01	.503E-03	43.44	142.48

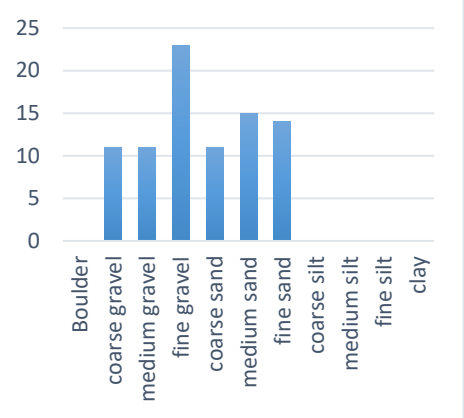
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-11 10-14

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
76.2	0	0	100
50.8	0	0	100
38.1	0	0	100
25.4	3	0.03	97
19.05	8	0.08	89
12.7	7	0.07	82
9.525	4	0.04	78
4.76	9	0.09	69
2	14	0.14	55
0.841	11	0.11	44
0.42	9	0.09	35
0.297	4	0.04	31
0.25	2	0.02	29
0.177	4	0.04	25
0.149	3	0.03	22
0.074	7	0.07	15

Effective Grain Diameters (mm)	
d10	0.049
d17	0.095
d20	0.128
d50	1.473
d60	2.986
de (Kruger)	0.680
de (Kozeny)	0.623
de (Zunker)	0.641
de (Zamarin)	0.661
Io (Alyameni)	-0.307

Other Useful Parameters	
Uniformity Coef.	60.52
n computed	0.26
g (cm/s^2)	980.00
ρ (g/cm^3)	0.9981
μ (g/cm s)	0.0098
ρg/μ (1/cm s)	9.9327E+04
tau (Sauerbrei)	1.053
$d_{geometric\ mean}$	1.835
σ_ϕ	3.357

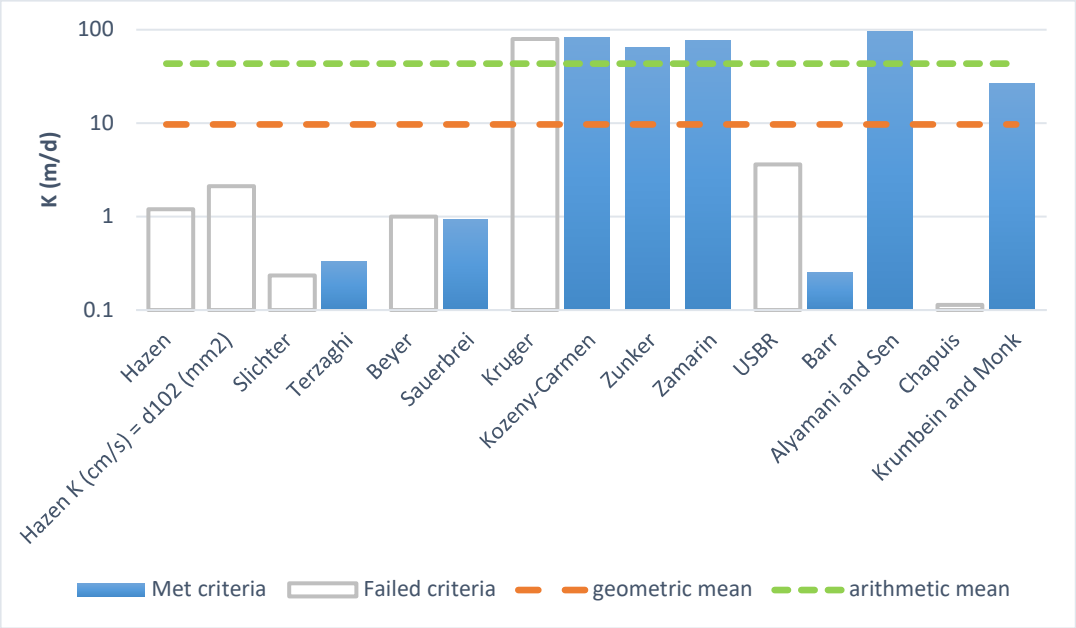
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	11
8 - 16	medium gravel	11
2 - 8	fine gravel	23
0.5 - 2	coarse sand	11
0.25 - 0.5	medium sand	15
0.063 - 0.25	fine sand	14
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-11 10-14

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines



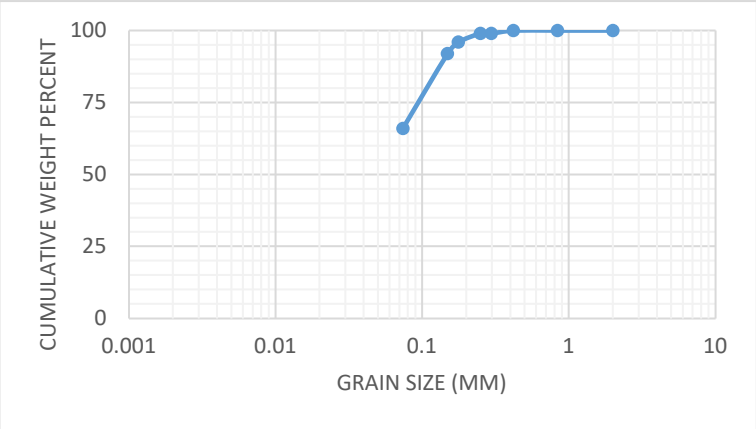
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.138E-02	.138E-04	1.19	
Hazen K (cm/s) = d_{10} (mm)	.243E-02	.243E-04	2.10	
Slichter	.271E-03	.271E-05	0.23	
Terzaghi	.386E-03	.386E-05	0.33	1.09
Beyer	.115E-02	.115E-04	1.00	
Sauerbrei	.107E-02	.107E-04	0.92	3.02
Kruger	.918E-01	.918E-03	79.30	
Kozeny-Carmen	.956E-01	.956E-03	82.58	270.87
Zunker	.742E-01	.742E-03	64.13	210.34
Zamarin	.893E-01	.893E-03	77.14	253.01
USBR	.418E-02	.418E-04	3.61	
Barr	.290E-03	.290E-05	0.25	0.82
Alyamani and Sen	.111E+00	.111E-02	95.50	313.23
Chapuis	.131E-03	.131E-05	0.11	
Krumbein and Monk	.309E-01	.309E-03	26.67	87.48
geometric mean	.113E-01	.113E-03	9.73	31.91
arithmetic mean	.503E-01	.503E-03	43.44	142.48

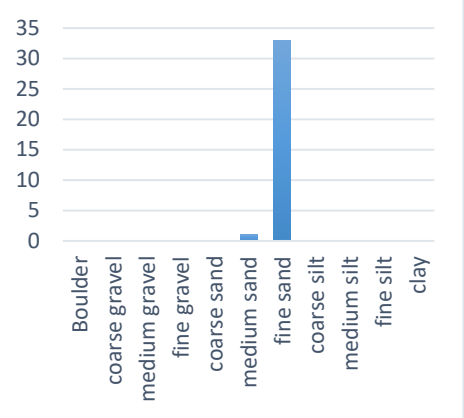
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-13 from 5' to 15'

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy silt low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
2	0	0	100
0.841	0	0	100
0.42	0	0	100
0.297	1	0.01	99
0.25	0	0	99
0.177	3	0.03	96
0.149	4	0.04	92
0.074	26	0.26	66

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.011	Uniformity Coef.	6.00
d17	0.019	n computed	0.34
d20	0.022	g (cm/s^2)	980.00
d50	0.056	ρ (g/cm^3)	0.9981
d60	0.067	μ (g/cm s)	0.0098
de (Kruger)	0.364	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.328	tau (Sauerbrei)	1.053
de (Zunker)	0.340	$d_{geometric\ mean}$	0.489
de (Zamarin)	0.352	σ_ϕ	1.449
lo (Alyameni)	0.000		

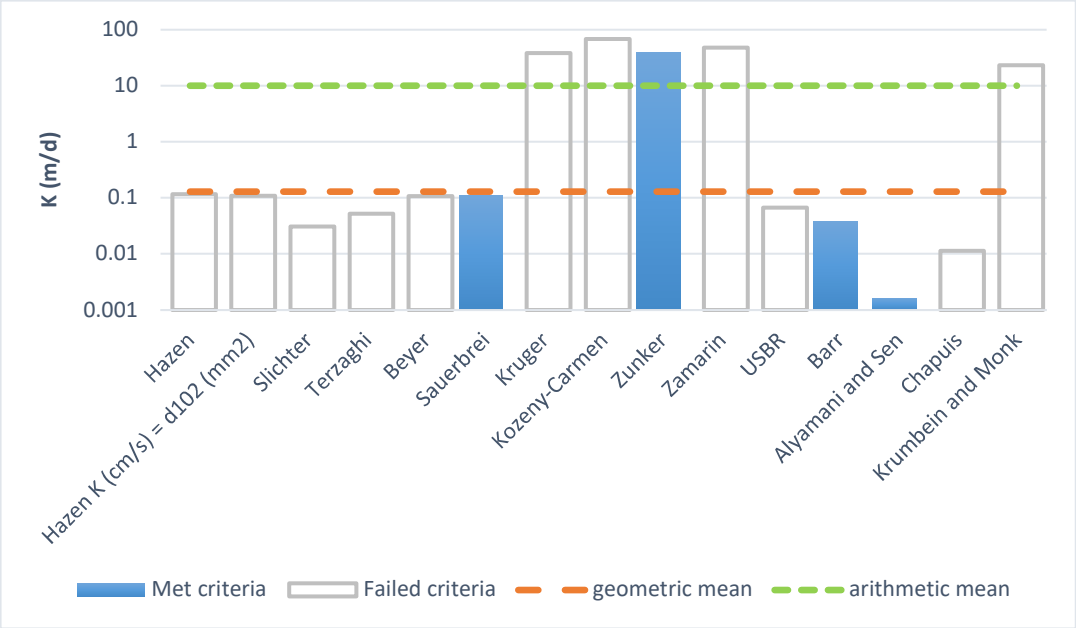
mm	0	% in sample
>64	Boulder	
16 - 64	coarse gravel	
8 - 16	medium gravel	
2 - 8	fine gravel	0
0.5 - 2	coarse sand	0
0.25 - 0.5	medium sand	1
0.063 - 0.25	fine sand	33
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-13 from 5' to 15'

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy silt low in fines



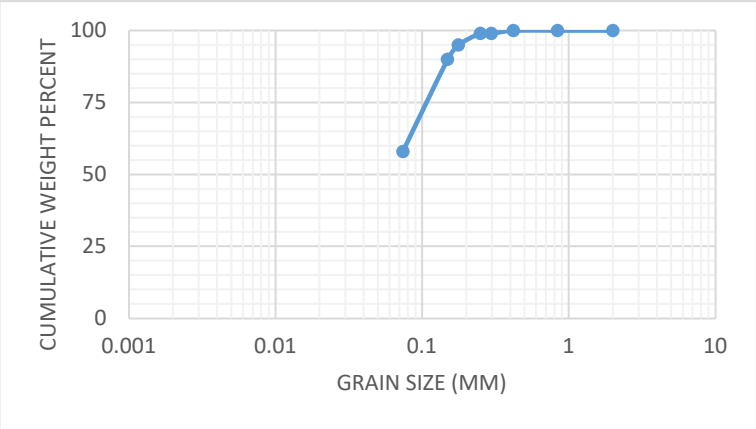
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.134E-03	.134E-05	0.12	
Hazen K (cm/s) = d_{10} (mm)	.126E-03	.126E-05	0.11	
Slichter	.354E-04	.354E-06	0.03	
Terzaghi	.600E-04	.600E-06	0.05	
Beyer	.125E-03	.125E-05	0.11	
Sauerbrei	.126E-03	.126E-05	0.11	0.36
Kruger	.443E-01	.443E-03	38.28	
Kozeny-Carmen	.784E-01	.784E-03	67.77	
Zunker	.464E-01	.464E-03	40.11	131.55
Zamarin	.554E-01	.554E-03	47.89	
USBR	.767E-04	.767E-06	0.07	
Barr	.444E-04	.444E-06	0.04	0.13
Alyamani and Sen	.189E-05	.189E-07	0.00	0.01
Chapuis	.130E-04	.130E-06	0.01	
Krumbein and Monk	.267E-01	.267E-03	23.05	
geometric mean	.149E-03	.149E-05	0.13	0.42
arithmetic mean	.116E-01	.116E-03	10.06	33.01

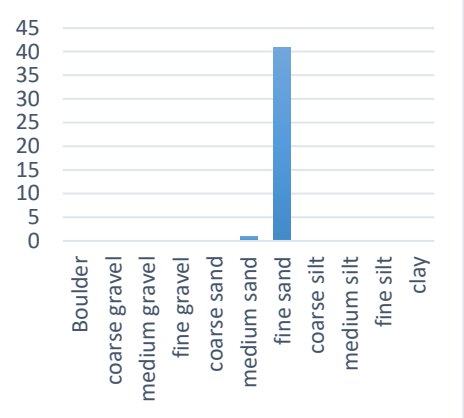
Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-13 from 15' to 20'

Mass Sample (g): 100 T (oC) 20

Poorly sorted sand low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
2	0	0	100
0.841	0	0	100
0.42	0	0	100
0.297	1	0.01	99
0.25	0	0	99
0.177	4	0.04	95
0.149	5	0.05	90
0.074	32	0.32	58

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.013	Uniformity Coef.	6.09
d17	0.022	n computed	0.34
d20	0.026	g (cm/s^2)	980.00
d50	0.064	ρ (g/cm^3)	0.9981
d60	0.078	μ (g/cm s)	0.0098
de (Kruger)	0.295	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.265	tau (Sauerbrei)	1.053
de (Zunker)	0.275	$d_{geometric\ mean}$	0.413
de (Zamarin)	0.285	σ_ϕ	1.393
lo (Alyameni)	0.000		

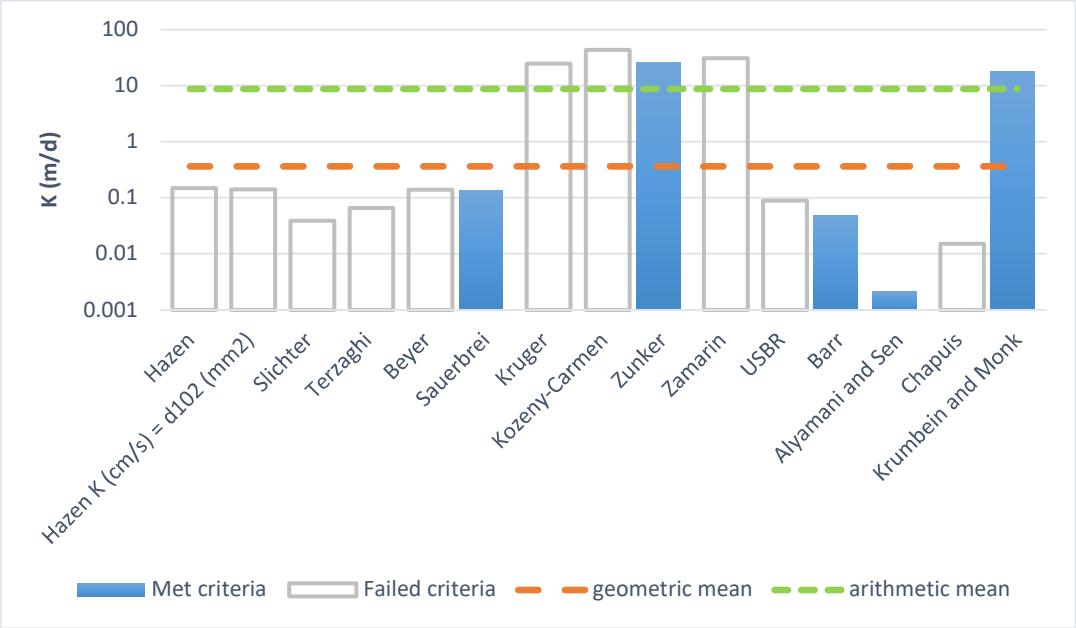
mm	0	% in sample
>64	Boulder	
16 - 64	coarse gravel	
8 - 16	medium gravel	
2 - 8	fine gravel	0
0.5 - 2	coarse sand	0
0.25 - 0.5	medium sand	1
0.063 - 0.25	fine sand	41
0.016 - 0.063	coarse silt	
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

K from Grain Size Analysis Report Date: 9/12/2022

Sample Name: B-13 from 15' to 20'

Mass Sample (g): 100 T (oC) 20

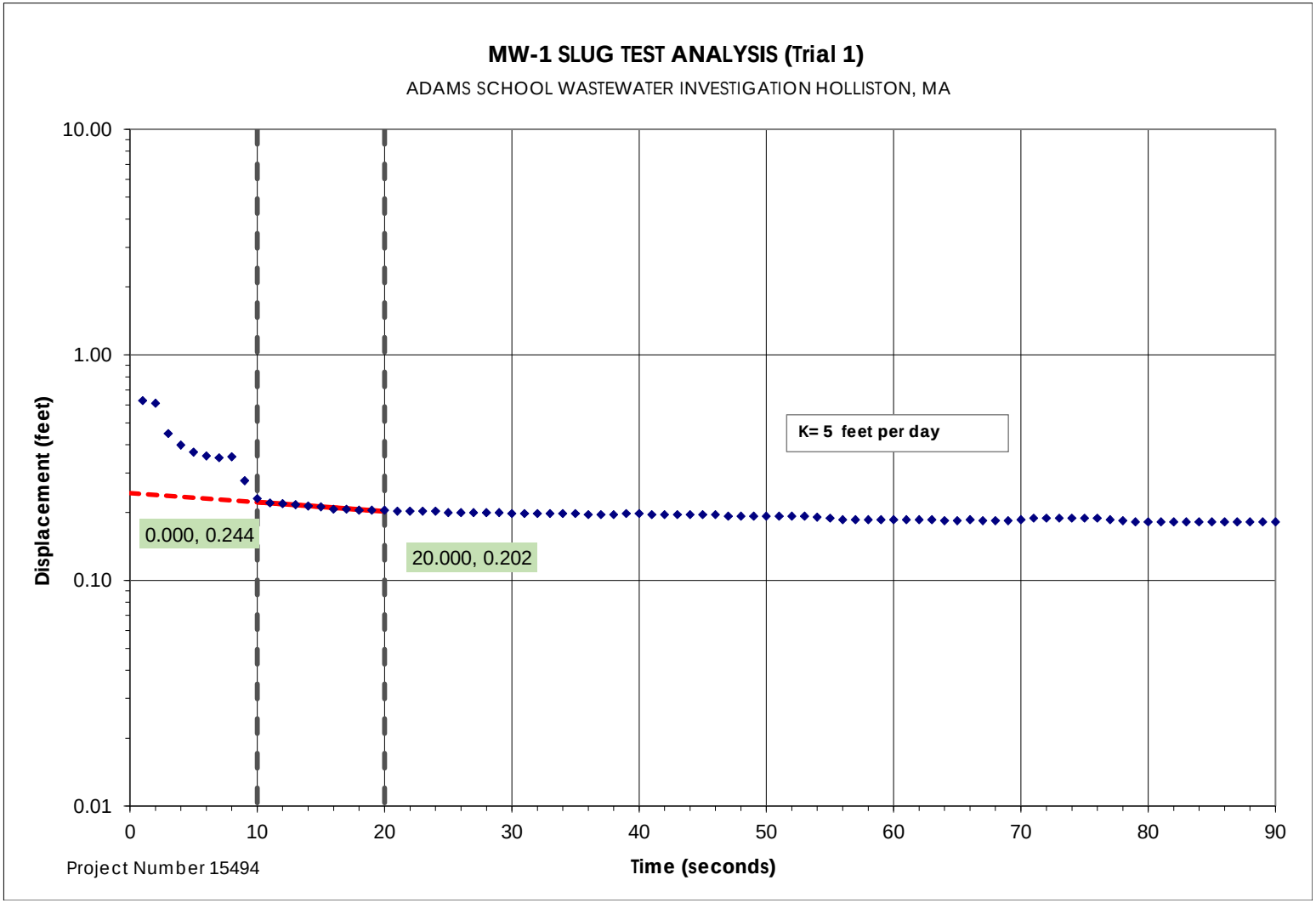
Poorly sorted sand low in fines

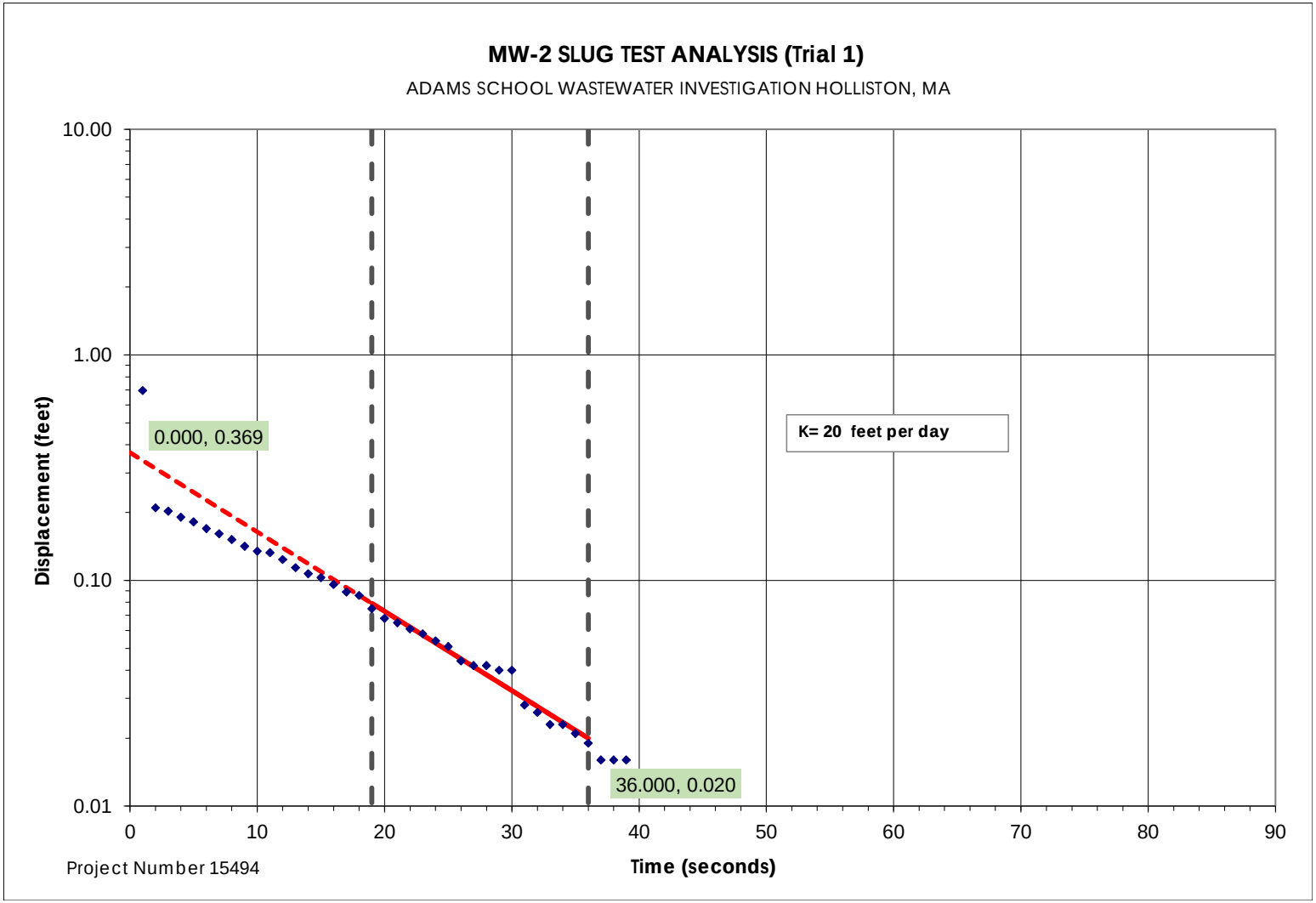


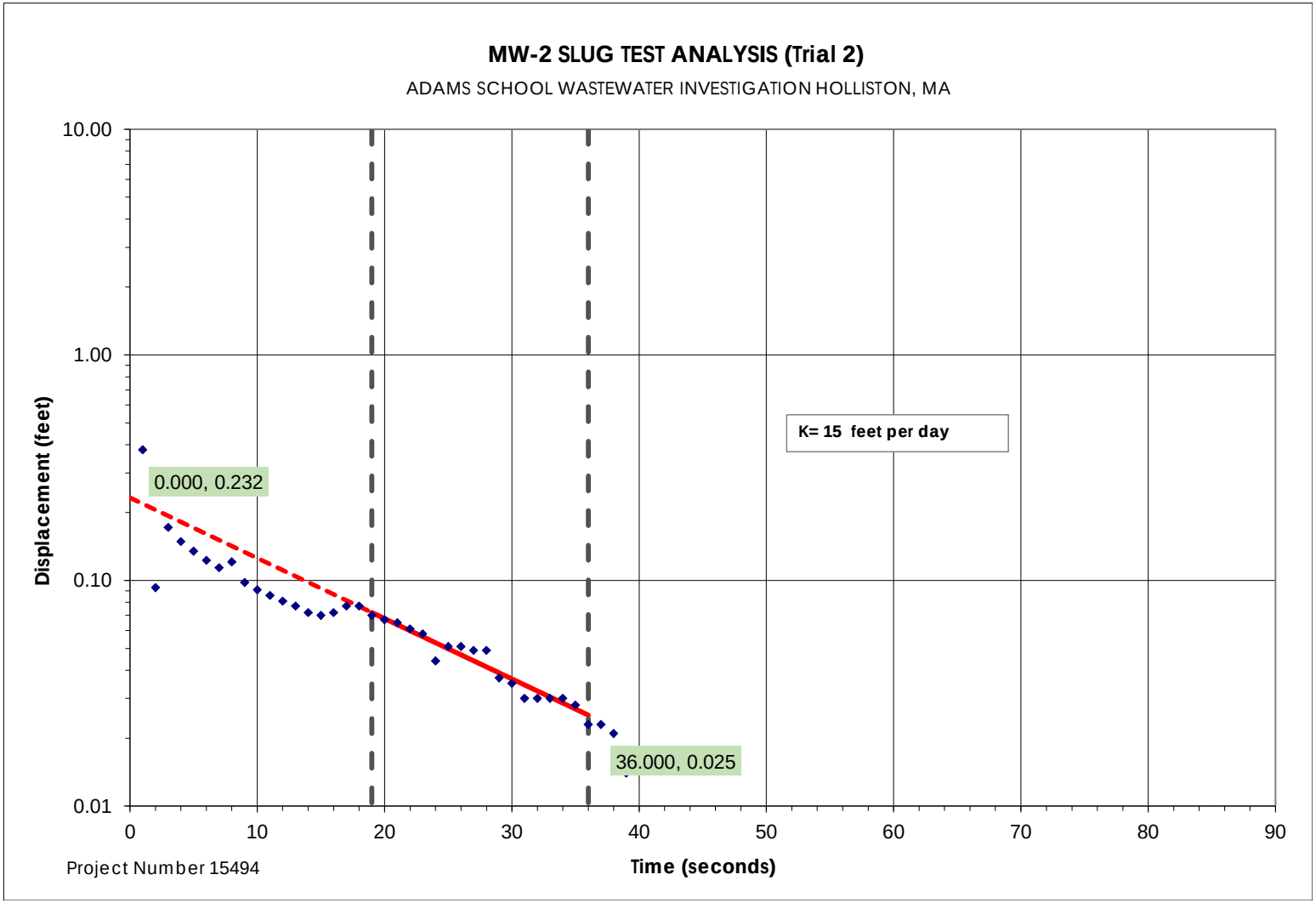
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	ft/day
Hazen	.172E-03	.172E-05	0.15	
Hazen K (cm/s) = d_{10} (mm)	.163E-03	.163E-05	0.14	
Slichter	.453E-04	.453E-06	0.04	
Terzaghi	.766E-04	.766E-06	0.07	
Beyer	.161E-03	.161E-05	0.14	
Sauerbrei	.161E-03	.161E-05	0.14	0.46
Kruger	.288E-01	.288E-03	24.88	
Kozeny-Carmen	.506E-01	.506E-03	43.73	
Zunker	.301E-01	.301E-03	25.98	85.20
Zamarin	.359E-01	.359E-03	31.05	
USBR	.103E-03	.103E-05	0.09	
Barr	.566E-04	.566E-06	0.05	0.16
Alyamani and Sen	.245E-05	.245E-07	0.00	0.01
Chapuis	.175E-04	.175E-06	0.02	
Krumbein and Monk	.205E-01	.205E-03	17.67	57.97
geometric mean	.424E-03	.424E-05	0.37	1.20
arithmetic mean	.101E-01	.101E-03	8.77	28.76

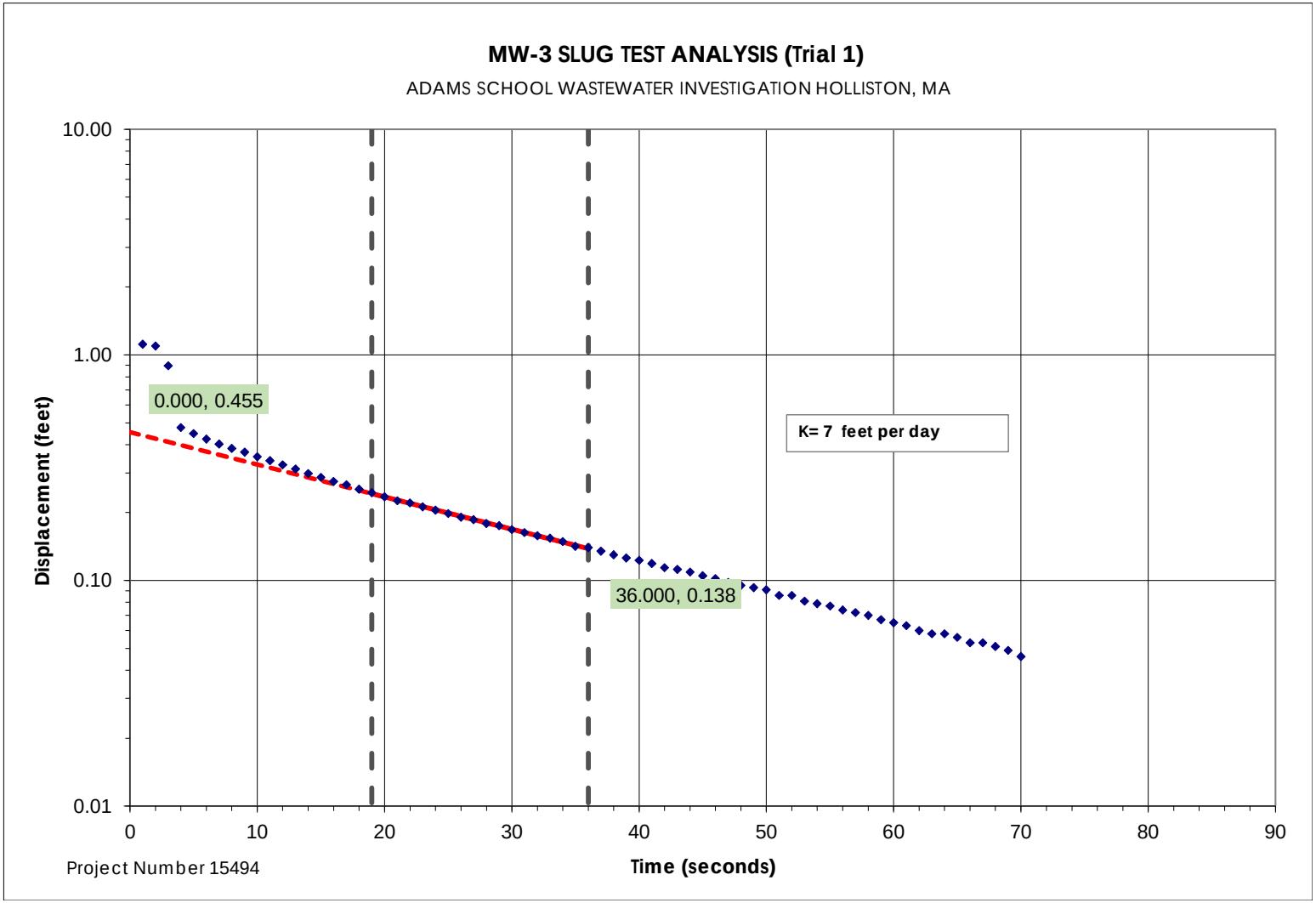
ATTACHMENT 2

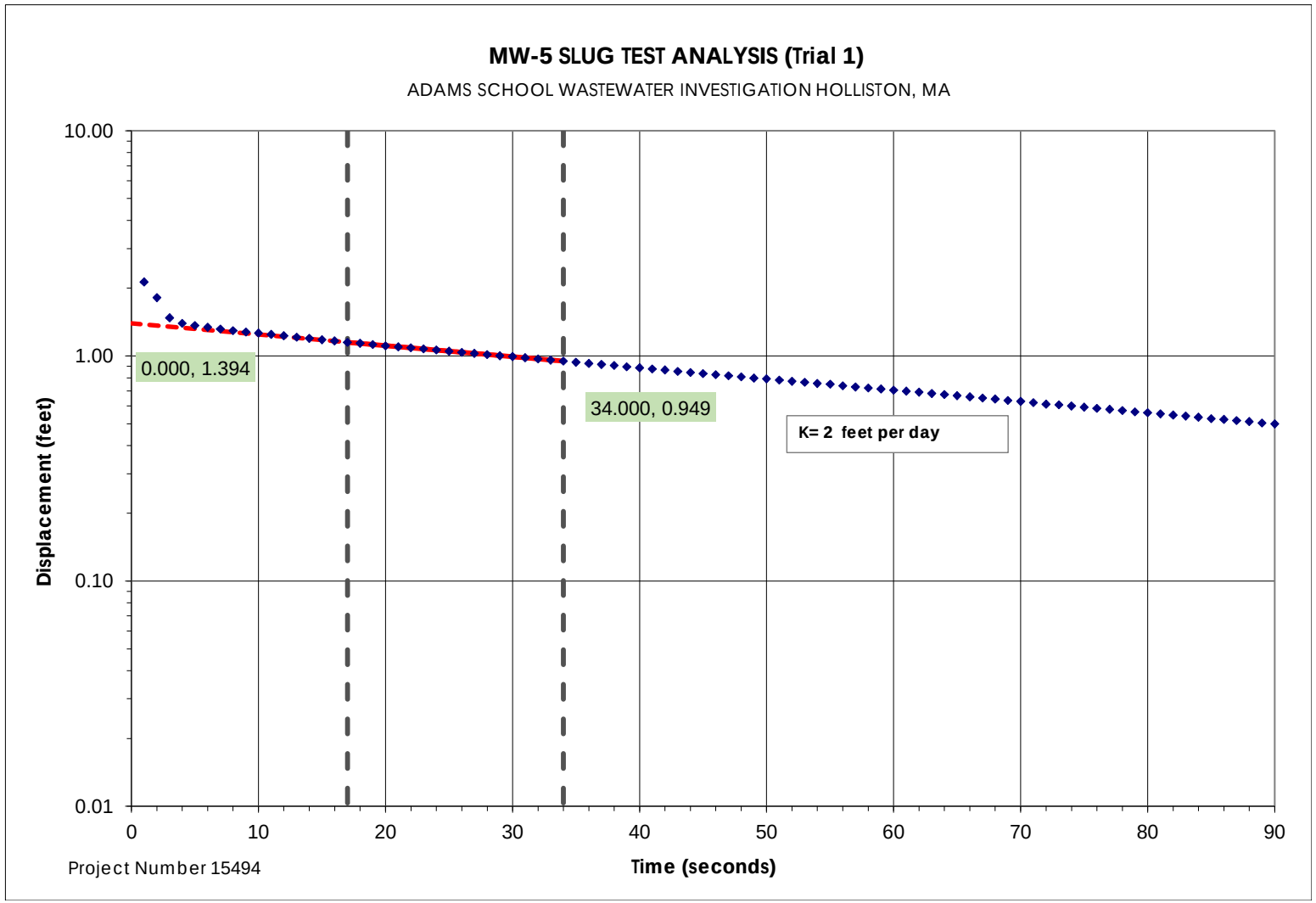
SLUG TEST ANALYSIS

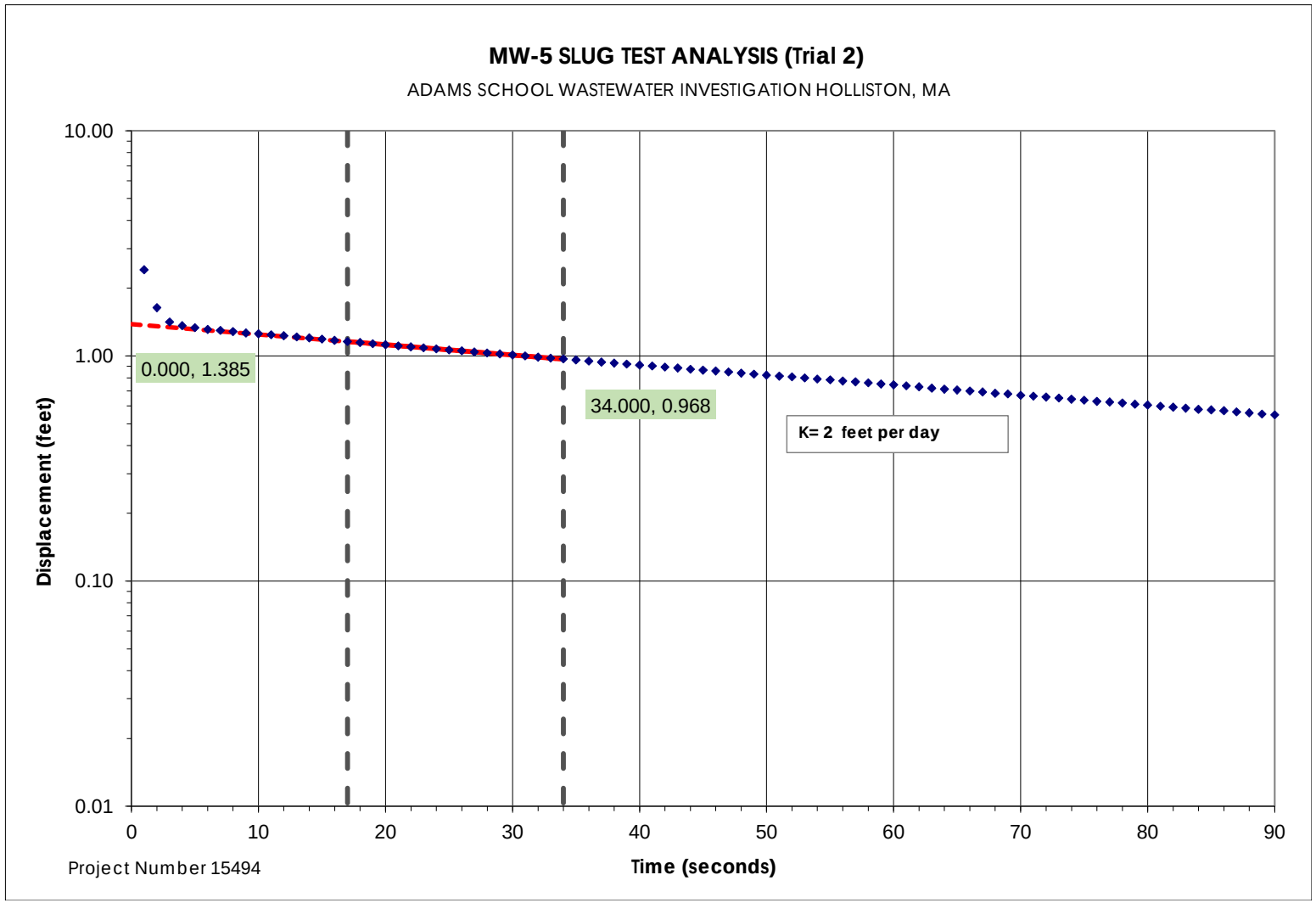

MW-1 SLUG TEST ANALYSIS (Trial 1)
ADAMS SCHOOL WASTEWATER INVESTIGATION HOLLISTON, MA
10.00
1.00
0.10
0.01
Displacement (feet)
K= 5 feet per day
0.000, 0.244
20.000, 0.202
0
10
20
30
40
50
60
70
80
90
Time (seconds)
Project Number 15494

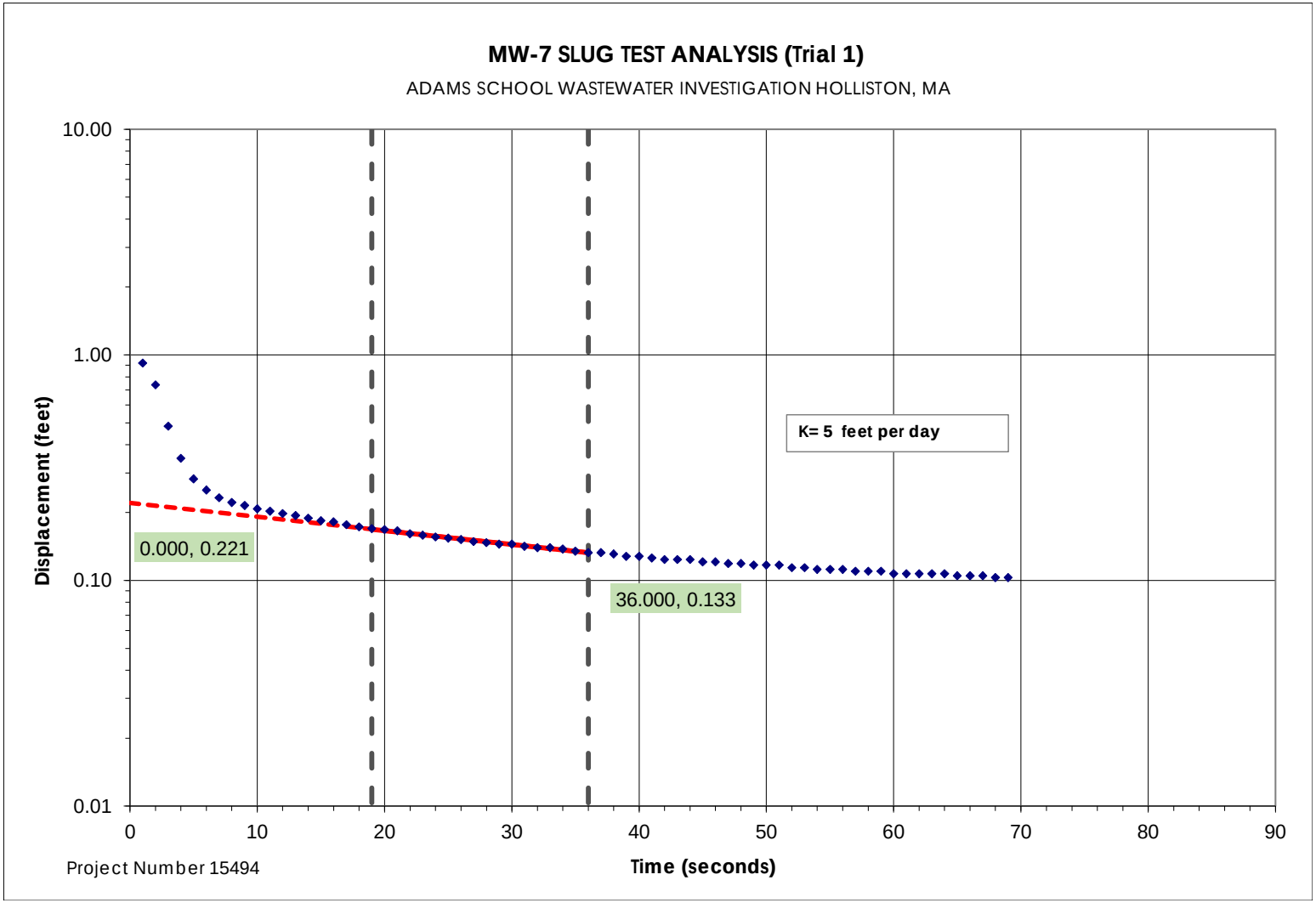

MW-2 SLUG TEST ANALYSIS (Trial 1)
ADAMS SCHOOL WASTEWATER INVESTIGATION HOLLISTON, MA
10.00
1.00
0.10
0.01
Displacement (feet)
0.000, 0.369
K= 20 feet per day
36.000, 0.020
0
10
20
30
40
50
60
70
80
90
Time (seconds)
Project Number 15494

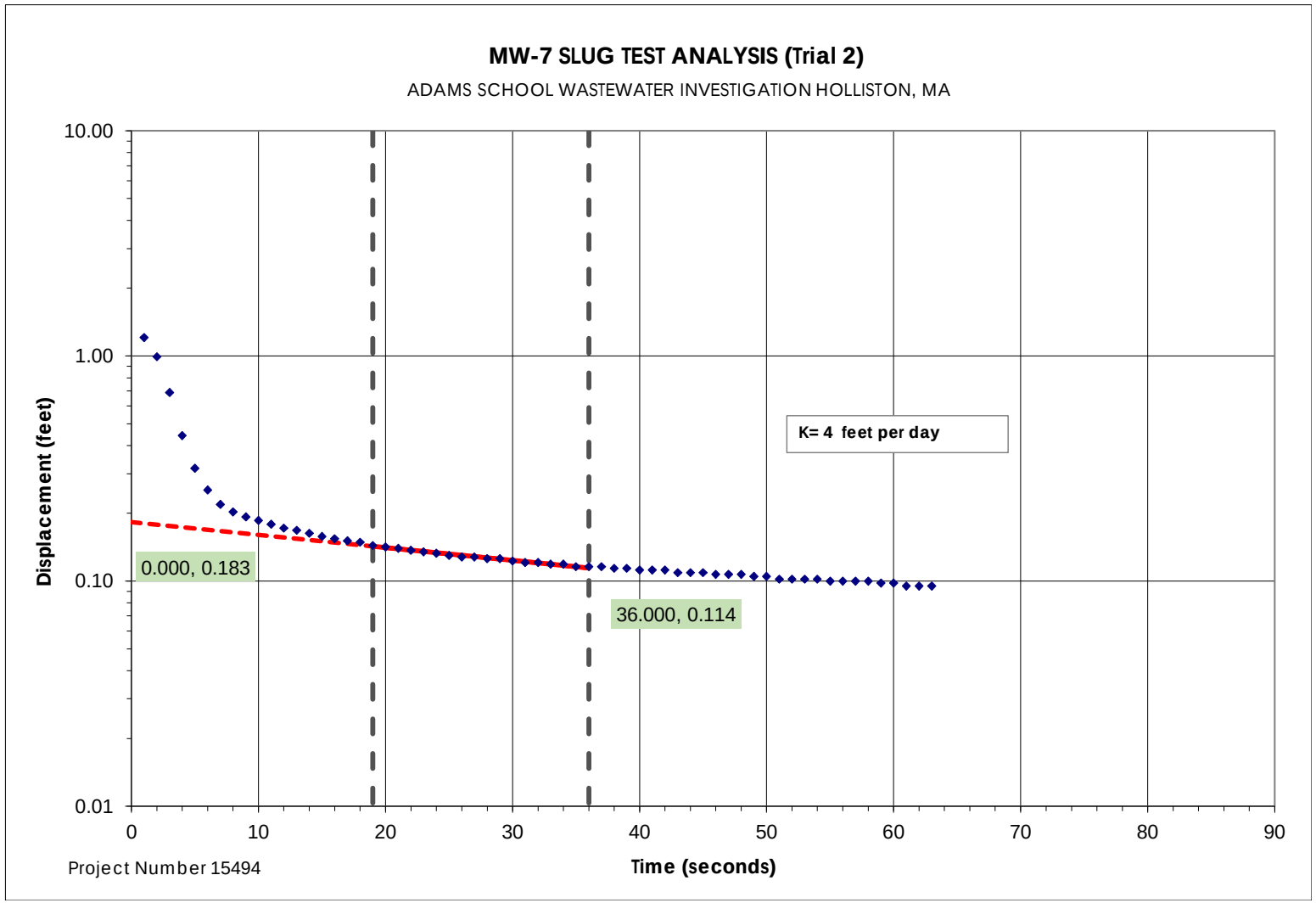

MW-2 SLUG TEST ANALYSIS (Trial 2)
ADAMS SCHOOL WASTEWATER INVESTIGATION HOLLISTON, MA
10.00
1.00
0.10
0.01
Displacement (feet)
0
10
20
30
40
50
60
70
80
90
Time (seconds)
K= 15 feet per day
0.000, 0.232
36.000, 0.025
Project Number 15494

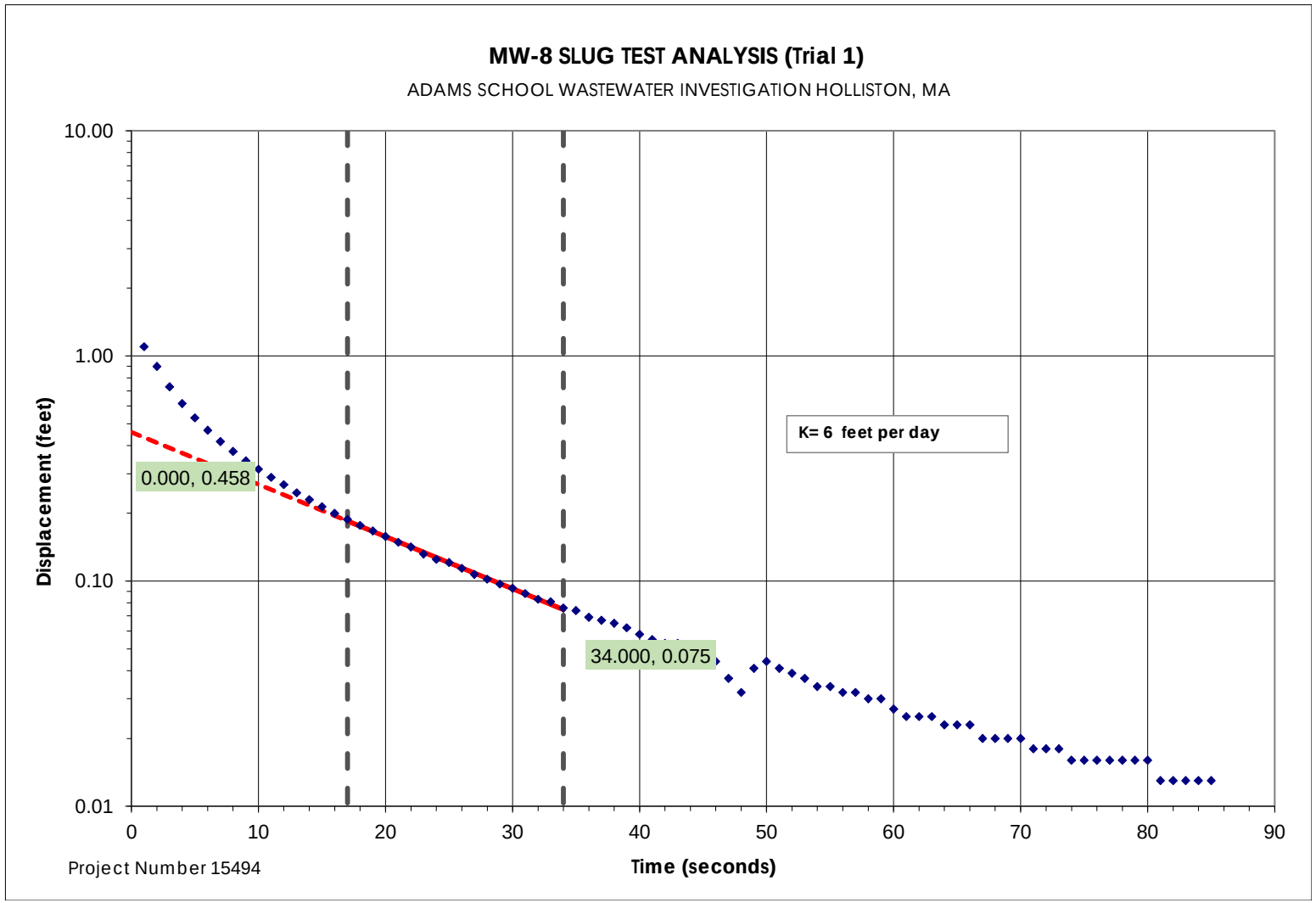

MW-3 SLUG TEST ANALYSIS (Trial 1)
ADAMS SCHOOL WASTEWATER INVESTIGATION HOLLISTON, MA
10.00
1.00
0.10
0.01
Displacement (feet)
0.000, 0.455
36.000, 0.138
K= 7 feet per day
0
10
20
30
40
50
60
70
80
90
Time (seconds)
Project Number 15494

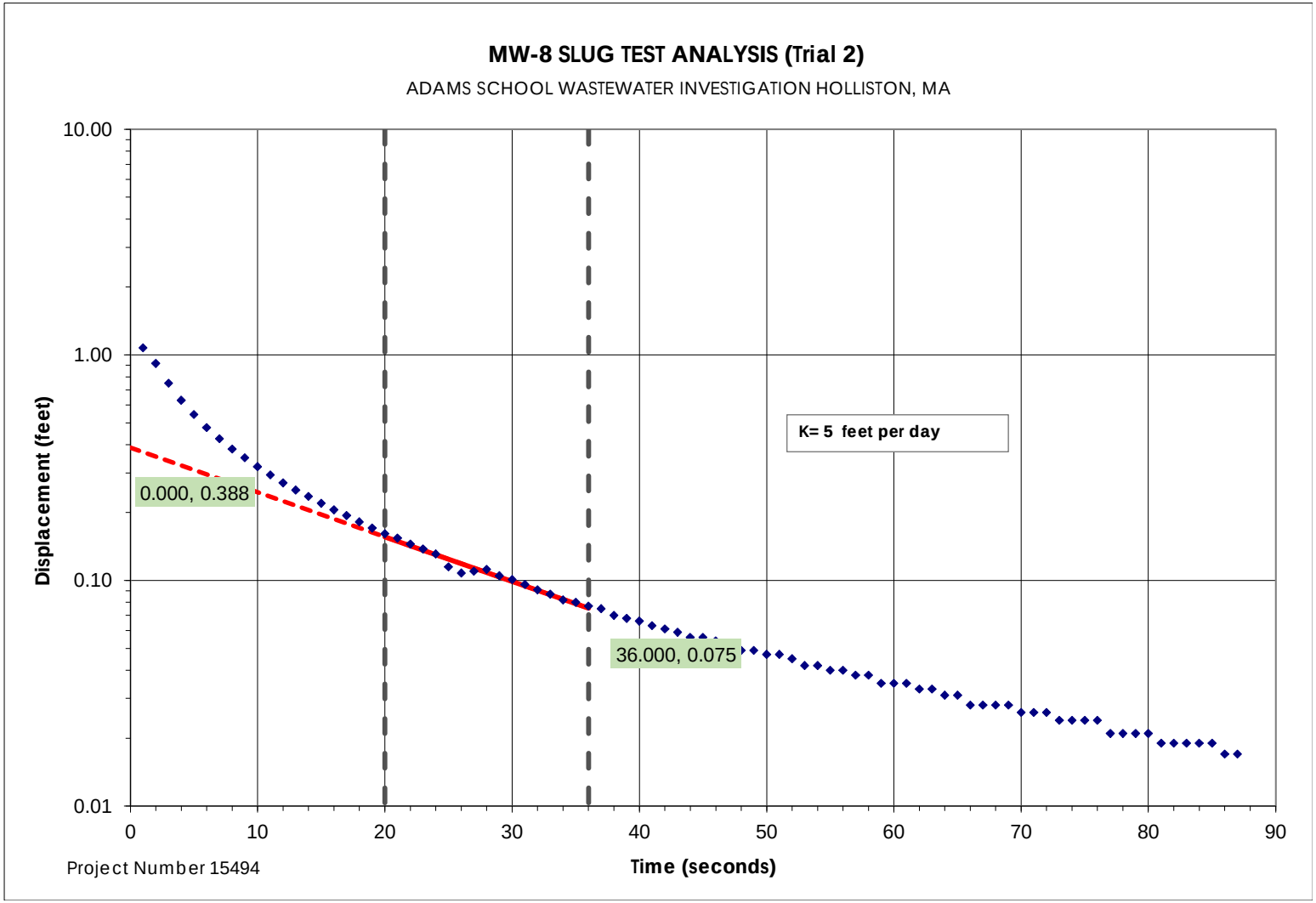

MW-5 SLUG TEST ANALYSIS (Trial 1)
ADAMS SCHOOL WASTEWATER INVESTIGATION HOLLISTON, MA
10.00
1.00
0.10
0.01
Displacement (feet)
0.000, 1.394
34.000, 0.949
K= 2 feet per day
0
10
20
30
40
50
60
70
80
90
Time (seconds)
Project Number 15494

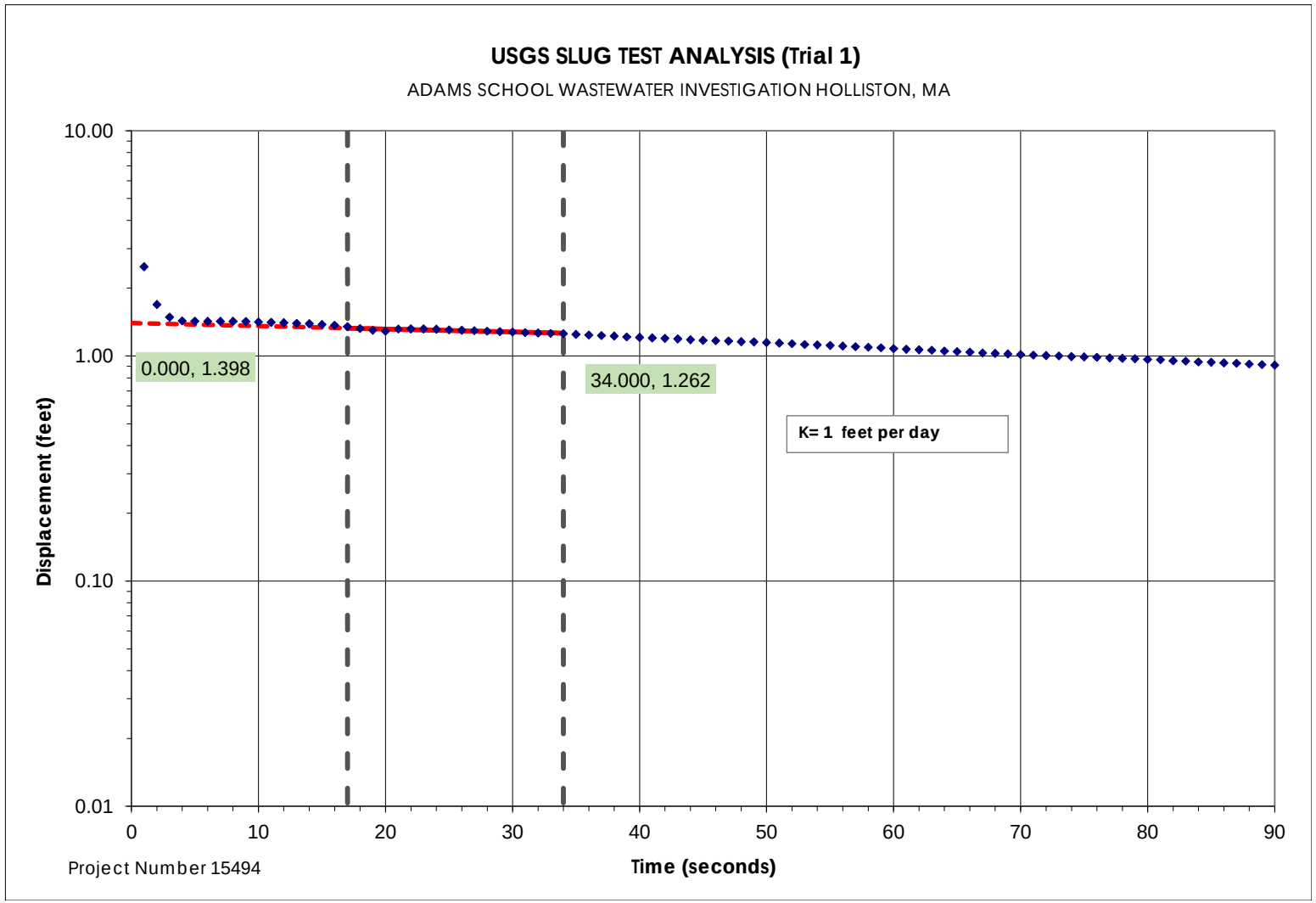

MW-5 SLUG TEST ANALYSIS (Trial 2)
ADAMS SCHOOL WASTEWATER INVESTIGATION HOLLISTON, MA
10.00
1.00
0.10
0.01
Displacement (feet)
0.000, 1.385
34.000, 0.968
K= 2 feet per day
0
10
20
30
40
50
60
70
80
90
Time (seconds)
Project Number 15494


MW-7 SLUG TEST ANALYSIS (Trial 1)
ADAMS SCHOOL WASTEWATER INVESTIGATION HOLLISTON, MA
10.00
1.00
0.10
0.01
Displacement (feet)
K= 5 feet per day
0.000, 0.221
36.000, 0.133
0
10
20
30
40
50
60
70
80
90
Time (seconds)
Project Number 15494


MW-7 SLUG TEST ANALYSIS (Trial 2)
ADAMS SCHOOL WASTEWATER INVESTIGATION HOLLISTON, MA
10.00
1.00
0.10
0.01
Displacement (feet)
K= 4 feet per day
0.000, 0.183
36.000, 0.114
0
10
20
30
40
50
60
70
80
90
Time (seconds)
Project Number 15494


MW-8 SLUG TEST ANALYSIS (Trial 1)
ADAMS SCHOOL WASTEWATER INVESTIGATION HOLLISTON, MA
10.00
1.00
0.10
0.01
Displacement (feet)
0
10
20
30
40
50
60
70
80
90
Time (seconds)
K= 6 feet per day
0.000, 0.458
34.000, 0.075
Project Number 15494


MW-8 SLUG TEST ANALYSIS (Trial 2)
ADAMS SCHOOL WASTEWATER INVESTIGATION HOLLISTON, MA
10.00
1.00
0.10
0.01
Displacement (feet)
K= 5 feet per day
0.000, 0.388
36.000, 0.075
0
10
20
30
40
50
60
70
80
90
Time (seconds)
Project Number 15494


USGS SLUG TEST ANALYSIS (Trial 1)
ADAMS SCHOOL WASTEWATER INVESTIGATION HOLLISTON, MA
10.00
1.00
0.10
0.01
Displacement (feet)
0.000, 1.398
34.000, 1.262
K= 1 feet per day
0
10
20
30
40
50
60
70
80
90
Time (seconds)
Project Number 15494

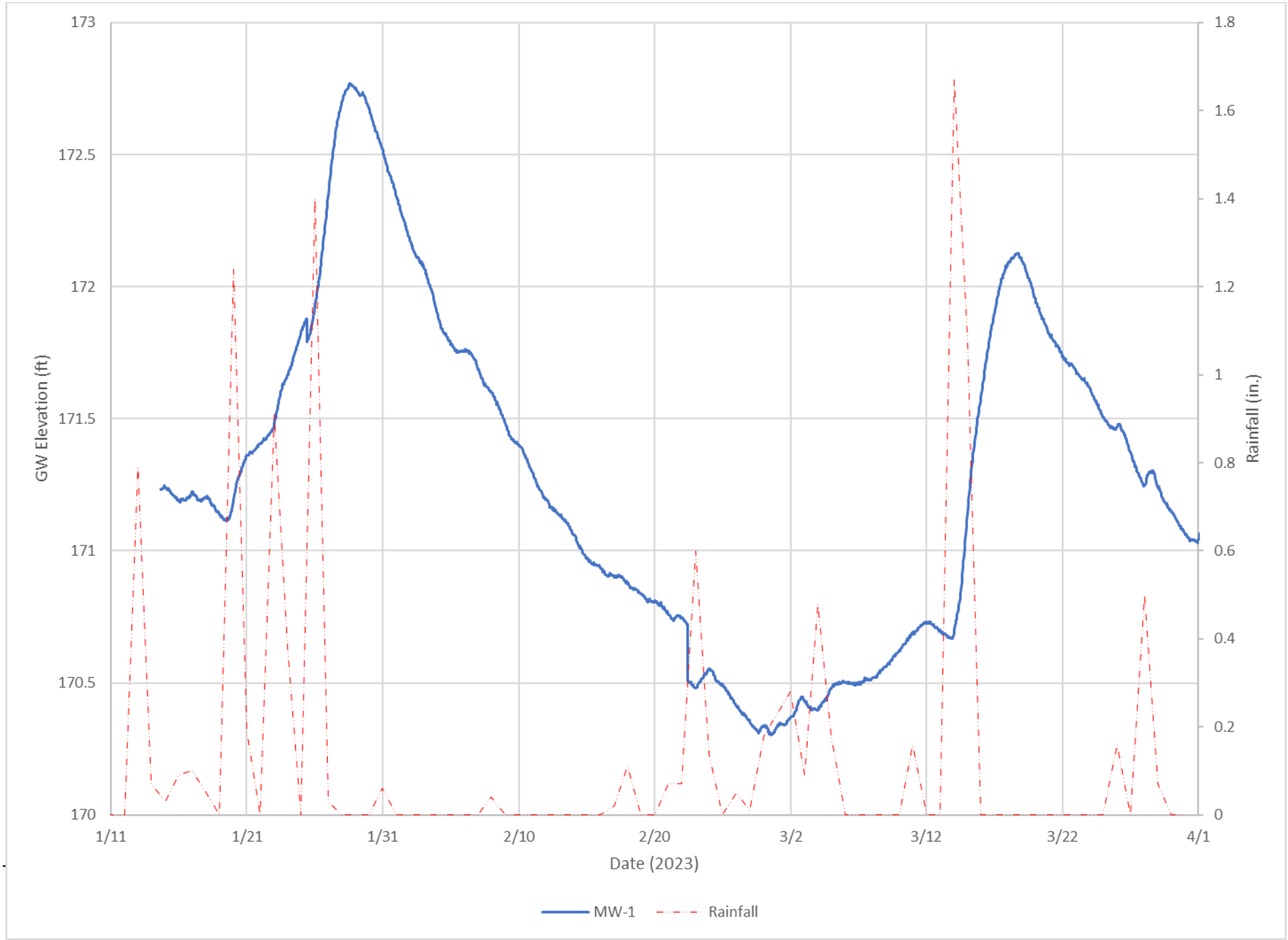
APPENDIX C RAIN DATA

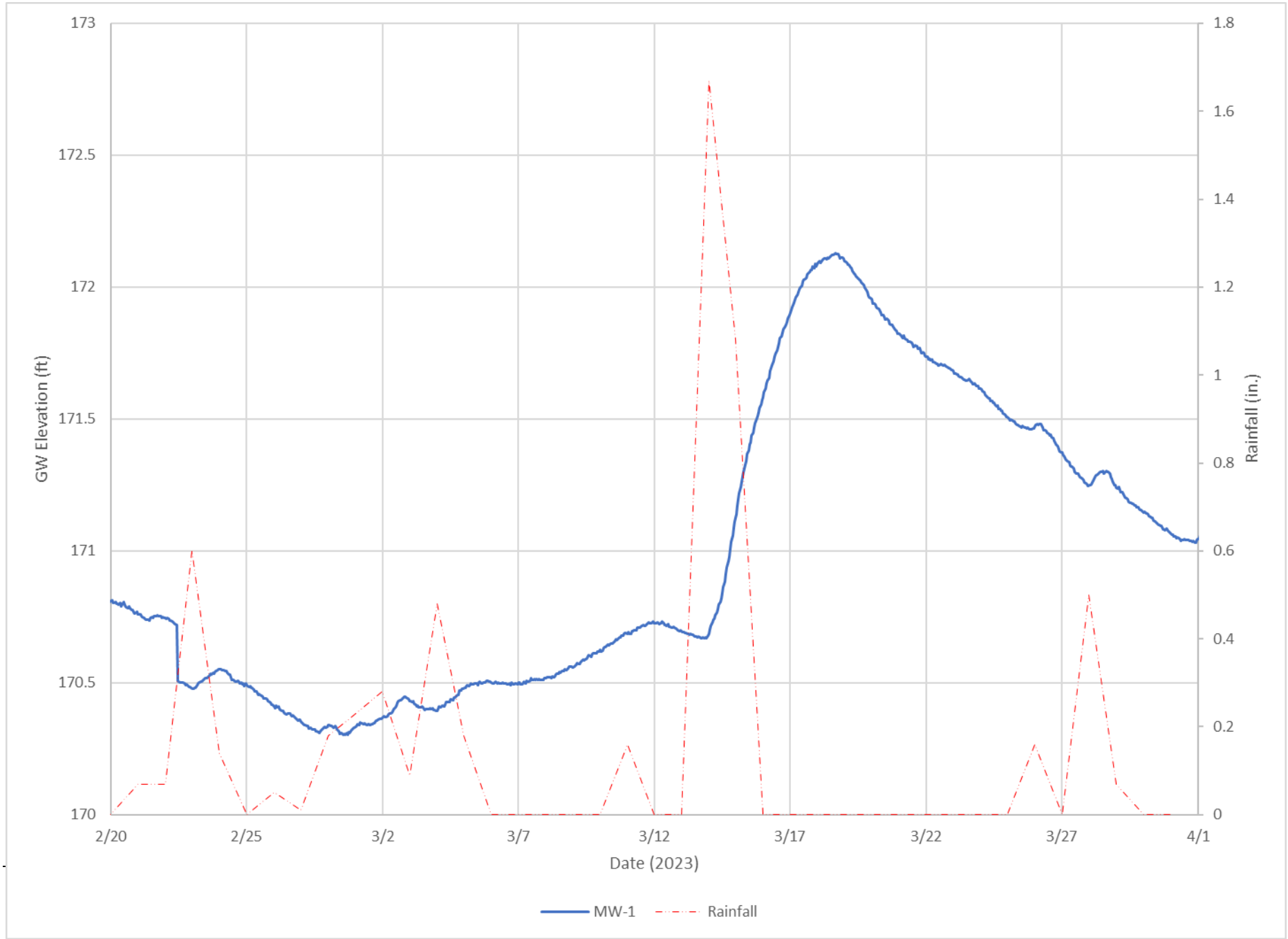
Rainfall Data Collected from Milford Weather Station

Day	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23
1	0	0.14	0.73	0.38	0	0.23
2	0.06	0.03	0	0	0	0.28
3	0.01	0	0	0.01	0	0.09
4	0	0	0.35	0.7	0	0.48
5	0.9	0	0	0.33	0	0.18
6	0.68	0	0	0.04	0	0
7	0	0	0.61	0.18	0	0
8	0.02	0	0.3	0	0.04	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0.16
12	0	0.68	0.09	0	0	0
13	0	0.15	0	0.79	0	0
14	0.81	0.21	0	0.07	0	1.67
15	0.77	0	0	0.03	0	1.08
16	0	0.67	0.53	0.09	0	0
17	0.02	0.15	1.34	0.1	0.02	0
18	0.83	0	0.05	0.05	0.11	0
19	0.08	0	0	0	0	0
20	0	0	0	1.24	0	0
21	0	0	0	0.19	0.07	0
22	0	0	0	0	0.07	0
23	0	0	1.7	0.91	0.6	0
24	0.09	0	0.77	0.38	0.14	0
25	0.16	0	0	0	0	0
26	0.42	0.03	0	1.4	0.05	0.16
27	0.07	0	0	0.03	0.01	0
28	0	0.77	0	0	0.18	0.5
29	0	0	0	0		0.07
30	0	0	0	0		0
31	0		0	0.06		0
Total	4.92	2.83	6.47	6.98	1.29	4.9
Cum. Total	4.92	7.75	14.22	21.2	22.49	27.39
Normal	4.98	3.96	4.73	3.73	3.27	
Cum. Normal	4.98	8.94	13.67	17.4	20.67	20.67

Figures showing early 2023 Rainfall and Ground Water Elevation

These figures show how the ground water elevations respond to rainfall. There is a significant rise in the elevation when there is heavy rainfall. The water level rises by about a foot and a half after a week with several rainy days in late January. There is a similar response in the ground water elevation from heavy rain on March 13th. There is a small time delay in this response, as the water continues to rise for a couple days after the rain stops. The water elevations proceed to drop during the periods of little rain, causing the elevation to fall from where it has risen to from the rain.


173
172.5
172
171.5
171
170.5
170
GW Elevation (ft)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Rainfall (in.)
1/11
1/21
1/31
2/10
2/20
3/2
3/12
3/22
4/1
Date (2023)
MW-1
Rainfall


173
172.5
172
171.5
171
170.5
170
GW Elevation (ft)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Rainfall (in.)
2/20
2/25
3/2
3/7
3/12
3/17
3/22
3/27
4/1
Date (2023)
MW-1
Rainfall