GEOTECHNICAL INVESTIGATION REPORT
Multi-Unit Residential Development
Beitner and Woodmere

December 2022

Prepared For:

Traverse City

Prepared By:

Otwell Mawby, P.C.
Consulting Engineers
309 East Front St.
Traverse City, Michigan 49684

OMPC PN: 18-187A

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1.0 INTRODUCTION

Otwell Mawby has completed a geotechnical investigation for a proposed residential development on vacant property at the NE corner of Beitner and Woodmere in Traverse City, Michigan. Included herein is a description of our project understanding, the field investigation, site and subsurface conditions, and geotechnical recommendations.

The details of the project are conceptual at this time but a multi-story residential structure is planned. The site is currently vacant, but has seen extensive historical use and development. The details of the historic development are limited but did include several structures, including some below grade structural components and infrastructure. The proposed building will be located on the approximate western three quarters of the site. The elevation change is about 2.5 feet across the proposed building footprint with the east side being lower than the west. The investigation indicates that there is historic fill and below grade disturbance due to the historical development and use. Compressible clayey silt was encountered in several of the borings. Special subgrade preparation or deep foundations will be needed to support the development.

2.0 TYPE OF CONSTRUCTION

The details of the development are limited and conceptual at the time of this report, although a conceptual plan calls for a three to four story, multi-unit residential building. The building will be slab on grade construction and will be located on the western three quarters of the site. The western portion of the site will be utilized for parking. Once details of the developmental are finalized the recommendations in this report should be reviewed and modified if necessary.

The design is conceptual and we should be informed of any changes from these design considerations as they may affect our recommendations.

3.0 FIELD INVESTIGATION

Otwell Mawby completed a series of seven conventional soil borings on December 6, 2022. The borings were advanced with a track mounted Aker Renegade drill rig equipped with 4 ¼" hollow stem augers. The boring locations are shown on the site plan contained in Appendix A. Samples were obtained by the Standard Penetration Test, ASTM D 1586. Split-spoon samples recovered from the Standard Penetration Test were classified in the field and returned to our Traverse City laboratory. Classification was performed in accordance with the Unified Soil Classification System visual-manual procedure, ASTM D 2488. Laboratory testing including moisture content and Atterberg Limits were completed on select soil samples. Laboratory test results are summarized in Appendix B.

The approximate boring locations are indicated on the attached Site Location Map, Appendix A. Boring elevations were approximated based on an assumed elevation of 100 feet on the storm water drain grate located along the north side of Beitner road near the center of the proposed building. A registered land surveyor should be retained if more precise boring location or elevation data is desired.

Borings were performed for geotechnical information only. Environmental considerations are not included in the geotechnical scope of service, but have been addressed in a separate report.

4.0 SITE AND SUBSURFACE CONDITIONS

The project site is located in the City of Traverse City, Michigan on the north east corner of Beitner and Woodmere streets. The site is currently vacant but historically several buildings had existed on the property which have been demolished. Some the buildings had below grade elements and infrastructure. The site slopes upward from the east to the west approximately 2.5 feet.

The soil borings encountered an upper layer of sand across the site. The sand was typically fine to medium grained, contained occasional gravel, with trace to some silt and clay. The upper sand was logged as fill in most borings and is a result of the historic development of the property. The fill extended to depths of 4 to 6.5 feet, but could be deeper at locations between borings. Underlying the fill sand in boring B-1, 2, 3 and 6 a fine to medium grained sand was encountered which extended to

the boring termination depth of 20 to 30 feet. This sand was typical loose to medium dense as indicated by standard penetration test results, but occasionally was encountered in a dense state.

In soil borings B-4, 7 and 8 a clayey silt was encountered below the fill. The clayey silt extended to depths of 7 to 13.5 feet below grade. Laboratory analysis of the silt indicated high natural water contents of 26 to 50 percent and a liquid limit of 46.7 percent.

The clayey silt would be characterized as having low bearing capacity and high settlement potential and would not be a recommended to support a multi-story structure without subgrade improvement. Below the clayey silt, a fine to medium grained sand was encountered which extended to the boring termination depths of 20 to 30 feet.

Groundwater was typical encountered about 9 feet below grade although a groundwater depth of 6.25 feet was observed in soil boring B-7 in delayed reading after drilling. The groundwater observations made during drilling should be considered approximate as water was added to the augers during drilling to prevent soil heave in the augers. Groundwater was observed at a depth of 9.5 feet in an environmental investigation in 2018. Groundwater levels are influenced by significant rainfall or snowmelt events and can fluctuate significantly from the levels observed during drilling or the 2018 environmental study.

This section has summarized soil and groundwater conditions at the site and it is recommended that the boring logs contained in Appendix C be reviewed for specific soil stratigraphy, SPT results and groundwater levels.

5.0 ENGINEERING ALALYSIS

5.1 Subgrade Improvement

Construction of conventional foundations bearing in the existing subgrade is not recommended due to the risk of excessive settlement. The clayey silt encountered in the borings and the uncontrolled fill support this conclusion. However, subgrade improvement technology is available that would reduce the risk of settlement to acceptable levels. Based on our project understanding we expect that stone columns are appropriate for the site.

Stone Columns (vibro-replacement, rammed aggregate piers) are constructed by advancing a mandrel into the ground to a specified depth and placing layers of compacted aggregate, either through the stem of the tool or around the annulus. Stone columns provide subgrade improvement both by replacement of marginal soils as well as by densification of the surrounding soil matrix. Densification is achieved both through vibrations from construction activity as well as displacement by the tooling and aggregate material. The result of stone column construction is a matrix of stone and soil that is stiffer than the original subgrade material, providing for the distribution of foundation loads to lower bearing strata with less settlement. Stone column design parameters include the required depth, size and frequency, and material selection. Typical stone column spacing is on the order of 4 to 10 ft. Subsequent to stone column construction, conventional foundations are constructed bearing directly on the improved subgrade, generally with modest additional requirements for preparation (such as compaction of the subgrade surface).

The subgrade improvement contractor should submit qualifications along with his bid. The qualifications should include a proposed project team including a project manager and field superintendent, each with a minimum of 5 years of experience on similar projects. The submittal should include a list of at least five previously completed projects of similar scope and purpose including references. The subgrade improvement contractor should be provided a foundation plan with building loads, bottom of footing elevations, and the Geotechnical Investigation Report, as part of the contract documents.

The subgrade improvement contractor should prepare a submittal, sealed by a Professional Engineer licensed in Michigan, which includes the following information:

- A subgrade improvement design that demonstrates the required tolerances (3,500 - 4,500 psf allowable bearing pressure for conventional foundations with maximum total settlement of less than 1 inch and maximum differential settlement less than ½ inch, or more restrictive tolerances if desired) .
- A subgrade improvement quality control plan.
- Shop drawing indicating spacing, location and depth of subgrade improvement elements.

- Load test detail and setup. A minimum of two load tests should be performed for each subgrade improvement element type. Load tests should be performed in accordance with ASTM D1143 at locations approved by the engineer.
- Acknowledgement of subgrade conditions described in the geotechnical report and presented in boring logs.
- A plan for monitoring vibrations and potential impact to the adjacent Points North structure due to vibration induced during subgrade improvement.

The contractor should submit daily records of the subgrade improvement production including identification, start and finish times, applicable equipment records, and material quantities. The contractor's Professional Engineer should submit a letter documenting the observations and results of the tests and certifying that the bearing pressure has been achieved within settlement tolerances. The subgrade improvement contractor should provide a warranty for foundation performance valid for 5 years from the completion of subgrade improvement construction. The project surveyor should establish control points as soon as practical after foundation/building construction to monitor settlement and enforce the warranty.

Subgrade improvement construction will produce vibrations that may be discernible at nearby structures. It is not anticipated that vibrations will be sufficient to cause structural distress. However, it is recommended that a pre-construction video survey be performed and that crack and settlement monitors be installed prior to construction and hat vibrations be monitored during the subgrade improvement process. Vibration limits should be established and monitored. The monitors should be observed on each day that subgrade improvement work is completed. If settlement or crack expansion is observed, work should be halted and a revised construction plan should be prepared. Managing the vibrations and mitigating potential impact on adjacent structures shall be the responsibility and obligation of the Contractor.

Stone column construction should be performed under the observation of the Geotechnical Engineer to confirm the stone column spacing, depth, load tests, materials, and other considerations.

5.2 Over Excavation and Replacement

An option to stone Colum improvement of the subgrade soils is to remove the uncontrolled fill and clayey silt and replace these soils with compacted engineered fill. This would require over excavation to at least a depth of 13.5 feet at the B-7 location which will require dewatering to accomplish. Some of the site soils could be reutilized as compacted fill, but a large volume of soils would require removal from the site and replacement with MDOT Class 2 fill.

5.3 Deep Foundation Support of Foundations – Piles

The foundation loads could be transmitted through the uncontrolled fill and compressible clayey silt with a system of pile foundations and grade beams. The piles would be installed thru the fill and clayey silt and bear in the underlying medium dense sand layer. There are many types of pile such as driven (wood, pipe, H-piles), auger cast or helical piles. We can provide preliminary pile capacities when details of the structure are available if a pile foundation is desired. Typically, a pile and grade beam deep foundation system is more costly than subgrade improvement such as stone columns.

5.4 Floor Slabs

Subgrade preparation for floor slabs should include removal of topsoil, vegetation, historic building remnants, and debris prior to the placement of any fill required. Due to the compressible and variable soil profile under the proposed building we recommend that vibro-densification/stone columns soil improvement be completed beneath the floor slab as well as all load bearing foundation elements.

If the floor slab will have a moisture sensitive covering or be within a moisture-controlled area, a vapor barrier should be provided as recommended in ACI 302.1R *Guide for Concrete Floor and Slab Construction*.

5.5 Groundwater

At the time of our investigation, groundwater was encountered at depths of 6.5 feet to 9 feet below grade. Given the proximity of the project to Boardman Lake, the aquifer elevation will be influenced by the Boardman Lake water level. Water levels can fluctuate significantly. Water levels significantly higher or lower than observed during our investigation are possible.

Utilities may extend below the groundwater and if a soil removal and replacement option for foundation sub grade improvement is selected groundwater control will be required.

The contractor should be prepared to control groundwater and have experience on similar sites. If construction will require excavation beneath the water table, substantial groundwater control such as, but not necessarily limited to, wellpoints or dewatering wells may be required. Any groundwater control should include suitable silt and sediment traps and discharge to an approved location.

Damp-proofing or waterproofing of below grade structures should be provided in accordance with the Michigan Building Code. If building elements extend beneath the design groundwater level, they should be waterproofed and designed to resist hydrostatic pressure and uplift.

6.0 LIMITATIONS

The evaluations and recommendations presented in this report have been developed on the basis of available data relating to the type, location, and finish elevations for the proposed mulit-unit residential project at Beitner and Woodmere in Traverse City, Michigan. Variations in the soil conditions between soil borings is possible and such variation may not become evident until construction occurs. Any changes in the locations, configurations, or structural plans, or if construction reveals significant differences in the soil conditions than that used in our analysis, we request the opportunity to review and, if necessary, revise our recommendations.

Very truly yours,

OTWELL MAWBY, P.C.

Sr. Geotechnical Engineer

APPENDICES

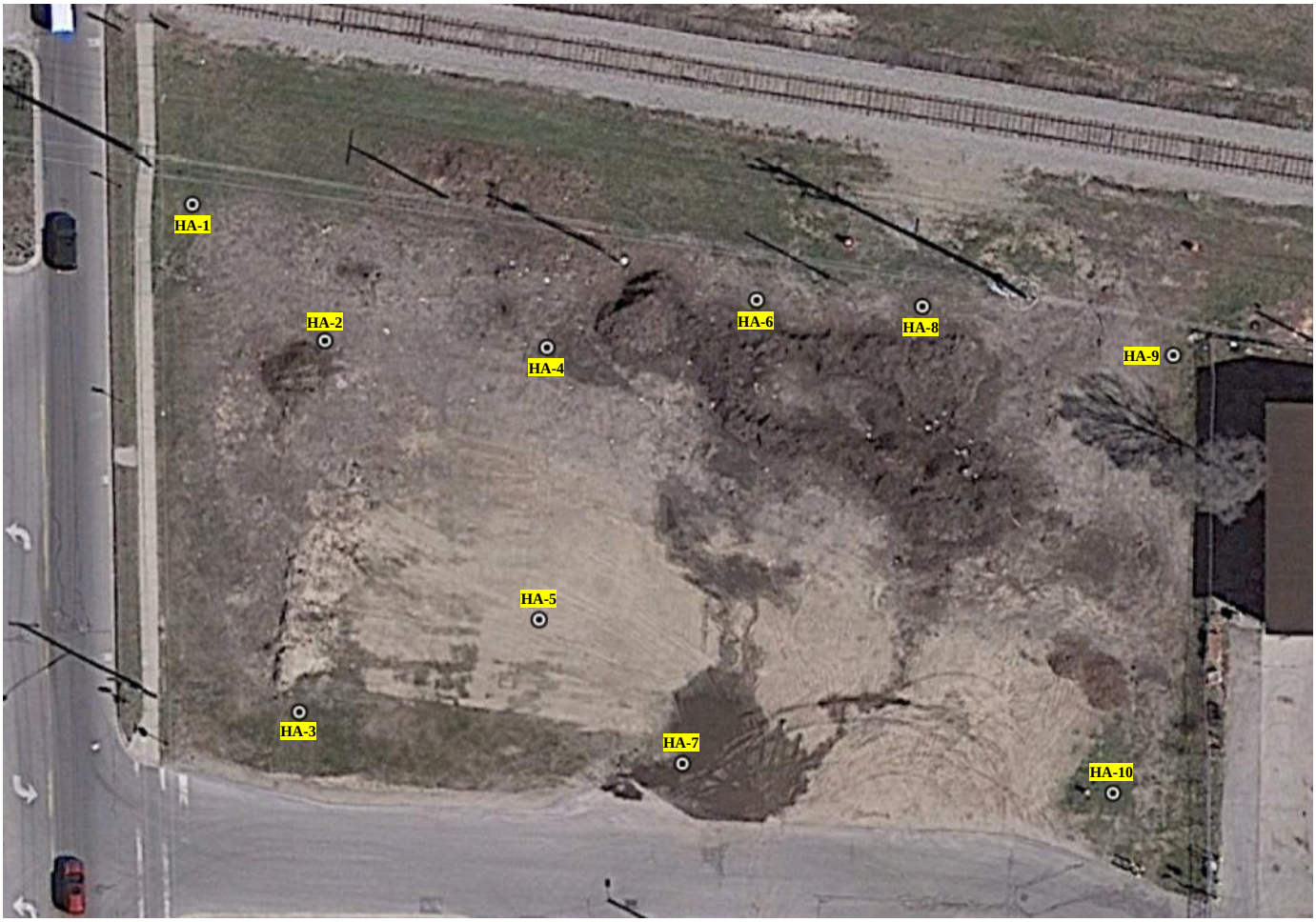
Appendix A – Site Plan

Appendix B – Laboratory Results Summary

Appendix C –Boring Logs

Appendix A

Site Plan



◉ **HA-1 - Hand Auger Soil Location**

Sample Identification	Global Positioning System Coordinates (Latitude/ Longitude)	Sample Identification	Global Positioning System Coordinates (Latitude/ Longitude)
HA-1	44°45'27.36"N, 85°36'26.71"W	HA-6	44°45'27.10"N, 85°36'24.55"W
HA-2	44°45'26.99"N, 85°36'26.20"W	HA-7	44°45'25.83"N, 85°36'24.83"W
HA-3	44°45'26.97"N, 85°36'25.35"W	HA-8	44°45'27.09"N, 85°36'23.91"W
HA-4	44°45'25.97"N, 85°36'26.30"W	HA-9	44°45'26.95"N, 85°36'22.95"W
HA-5	44°45'26.23"N, 85°36'25.38"W	HA-10	44°45'25.76"N, 85°36'23.17"W

Woodmere and Beitner Commercial Properties **535 Woodmere Avenue & 715/ 723 Beitner Street** **Traverse City, Grand Traverse County, Michigan** **Phase II Environmental Site Assessment**	**Figure 3:** **Sample Locations Map**		**NORTH**
Otwell Mawby, PC **Traverse City, Michigan**	**Project No:** **18-187A**	**Date:** **11/8/22**	**Source:** **City of T.C.**

Appendix B

Laboratory Results Summary

Lab Analysis Summary

Borings	Depth	Natural Water Content (%)	Liquid Limit (%)
B-4	4-5’	44.1/50.6	45.7
B-7	8-10’	39.8	-
B-8	6-8’	26.1	-

Client: City of Traverse City
Project: 535 Woodmere Ave, 18-187A
Location: Traverse City, MI

Boring Log Of: B - 1
Date Drilled: 12/6/22
Drilling Contractor: Pearson
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Std. Penetration Resistance (N)	Recovery (inches)	Sample Method	Sample Type/Interval	Depth (feet)	Soil Type	Soil Description	Pocket Pentrometer	Comments
						Surface Conditions: Grass		
						TOPSOIL (3")		Boring advanced using a track mounted Aker Renegade with 3 1/4' augers and a split spoon
9, 4, 4, 4	18	SS				SAND, fine to coarse grained, with some silt and trace gravel, brown, moist, possible fill		
2, 3, 2, 1	14	SS		5				
4, 4, 6, 7	14	SS				SAND, fine to course grained, with gravel, tan, moist		
						-grades with trace gravel		
3, 2, 3, 3	13	SS		10				Cave-in at 10'
						Silty SAND, fine grained, tan, wet	1.0	
2, 2, 4, 5	13	SS		15		SAND, medium to fine grained, tan, wet	1.5	-Augers charged with water from 15'
						-grades with trace gravel		
7, 11, 19, 19	12	SS		20				
						-grades fine to coarse grained sand		
13, 9, 13, 15	9	SS		25				
17, 21, 22, 20	12	SS		30				
						End of Boring at 30'		

Top of Casing : N/A
Ground Elev.: 103.1
Casing: N/A
Screen: N/A
Screen Setting: N/A

Well Construction / Boring Data

Water Encountered: 10' +/-
Date: 12/6/22
Logging Method: Visual/Manual
Development Method: None

Driller: WP
Helper: CH
Logged By: SH

Otwell Mawby, P.C.
309 E. Front Street
Traverse City, MI 49684
231-946-5200
Fax 231-946-5216

Client: City of Traverse City
Project: 535 Woodmere Ave, 18-187A
Location: Traverse City, MI

Boring Log Of: B - 2
Date Drilled: 12/6/22
Drilling Contractor: Pearson
Page 1 of 1

Std. Penetration Resistance (N)	Recovery (inches)	Sample Method	Sample Type/Interval	Depth (feet)	Soil Type	Soil Description	Pocket Pentrometer	Comments
						Surface Conditions: Grass		
4, 4, 5, 4	14	SS				SAND, medium to fine grained, with some silt, gray, moist (fill)		Boring advanced using a track mounted Aker Renegade with 3 1/4' augers and a split spoon
						SAND with some clay, brown, stiff, moist (fill)	1.5	
7, 3, 3, 4	16	SS		5		SAND, medium to fine grained, with occasional gravel, brown, moist -marl lens (1")		
3, 5, 7, 7	12	SS				SAND, fine to coarse grained, with gravel and some silt, tan, moist		
2, 3, 3, 3	15	SS		10		SAND, medium to fine grained, tan, moist -grades wet		
4, 3, 7, 9	16	SS		15		SAND, fine to coarse grained, with occasional gravel, tan, wet		-Augers charged with water from 15'
6, 8, 15, 17	17	SS		20		End of Boring at 20'		
				25				
				30				

Top of Casing : N/A
Ground Elev.: 101.6
Casing: N/A
Screen: N/A
Screen Setting: N/A

Well Construction / Boring Data

Water Encountered: 9' +/-
Date: 12/6/22
Logging Method: Visual/Manual
Development Method: None

Driller: WP
Helper: CH
Logged By: SH

Otwell Mawby, P.C.
309 E. Front Street
Traverse City, MI 49684
231-946-5200
Fax 231-946-5216

Client: City of Traverse City
Project: 535 Woodmere Ave, 18-187A
Location: Traverse City, MI

Boring Log Of: B - 3
Date Drilled: 12/6/22
Drilling Contractor: Pearson
Page 1 of 1

Std. Penetration Resistance (N)	Recovery (inches)	Sample Method	Depth (feet)	Soil Type	Soil Description	Pocket Pentrometer	Comments
					Surface Conditions: Grass		
4, 4, 4, 3	16	SS			SAND, medium to fine grained, tan, moist		Boring advanced using a track mounted Aker Renegade with 3 1/4' augers and a split spoon
4, 4, 4, 4	17	SS	5				
1, 1, 2, 6	12	SS			-occasional gravel		
					SAND, mostly coarse, moist		
8, 7, 9, 12	13	SS	10		SAND, fine to coarse grained, with occasional gravel, tan, wet		
					Gravely SAND, fine to coarse grained, tan, wet		
9, 10, 11, 9	14	SS	15		-grades less gravel		-Augers charged with water from 15'
4, 4, 8, 17	12	SS	20		End of Boring at 20'		
			25				
			30				

Top of Casing : N/A
Ground Elev.: 101.0
Casing: N/A
Screen: N/A
Screen Setting: N/A

Well Construction / Boring Data

Water Encountered: 9' +/-
Date: 12/6/22
Logging Method: Visual/Manual
Development Method: None

Driller: WP
Helper: CH
Logged By: SH

Otwell Mawby, P.C.
309 E. Front Street
Traverse City, MI 49684
231-946-5200
Fax 231-946-5216

Client: City of Traverse City
Project: 535 Woodmere Ave, 18-187A
Location: Traverse City, MI

Boring Log Of: B - 4
Date Drilled: 12/6/22
Drilling Contractor: Pearson
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Std. Penetration Resistance (N)	Recovery (inches)	Sample Method	Sample Type/Interval	Depth (feet)	Soil Type	Soil Description	Pocket Pentrometer	Comments
						Surface Conditions: Sand		
9, 7, 6, 4	6	SS				Silty SAND, medium to fine grained, dark brown, moist (fill)		Boring advanced using a track mounted Aker Renegade with 3 1/4' augers and a split spoon
2, 3, 2, 2	14	SS				-grades with gravel		
				5		Clayey SILT, soft, white, moist	0.5 0.75	
5, 5, 7, 5	15	SS				SAND, fine to coarse grained, tan, moist		
2, 3, 2, 2	14	SS				-clay lens (2") orange, soft		
				10				
5, 11, 14, 18	18	SS				-grades with gravel		
				15				-Augers charged with water from 15'
8, 13, 15, 18	11	SS						
				20		End of Boring at 20'		
				25				
				30				

Top of Casing : N/A
Ground Elev.: 102.2
Casing: N/A
Screen: N/A
Screen Setting: N/A

Well Construction / Boring Data

Water Encountered: N/A
Date: 12/6/22
Logging Method: Visual/Manual
Development Method: None

Driller: WP
Helper: CH
Logged By: SH

Otwell Mawby, P.C.
309 E. Front Street
Traverse City, MI 49684
231-946-5200
Fax 231-946-5216

Client: City of Traverse City
Project: 535 Woodmere Ave, 18-187A
Location: Traverse City, MI

Boring Log Of: B - 6
Date Drilled: 12/6/22
Drilling Contractor: Pearson
Page 1 of 1

Std. Penetration Resistance (N)	Recovery (inches)	Sample Method	Depth (feet)	Soil Type	Soil Description	Pocket Pentrometer	Comments
					Surface Conditions: Grass		
					TOPSOIL (4")		Boring advanced using a track mounted Aker Renegade with 3 1/4' augers and a split spoon
5, 7, 5, 4	19	SS			SAND, medium to fine grained, with gravel and some silt, dark brown/brown, moist (fill)		
5, 4, 2, 2	14	SS	5		SAND, fine to course grained, tan, moist		
3, 2, 3, 3	13	SS			-grades with trace gravel		
2, 4, 3, 3	15	SS	10				
					SAND, medium to fine grained, tan, wet		
10, 5, 6, 5	16	SS	15				-Augers charged with water from 15'
					-grades with gravel		
8, 11, 22, 28	16	SS	20				
					End of Boring at 20'		
			25				
			30				

Top of Casing : N/A
Ground Elev.: 102.6
Casing: N/A
Screen: N/A
Screen Setting: N/A

Well Construction / Boring Data

Water Encountered: 11' +/-
Date: 12/6/22
Logging Method: Visual/Manual
Development Method: None

Driller: WP
Helper: CH
Logged By: SH

Otwell Mawby, P.C.
309 E. Front Street
Traverse City, MI 49684
231-946-5200
Fax 231-946-5216

Client: City of Traverse City
Project: 535 Woodmere Ave, 18-187A
Location: Traverse City, MI

Boring Log Of: B - 7
Date Drilled: 12/6/22
Drilling Contractor: Pearson
Page 1 of 1

Std. Penetration Resistance (N)	Recovery (inches)	Sample Method	Depth (feet)	Soil Type	Soil Description	Pocket Pentrometer	Comments
					Surface Conditions: Sand		
10, 4, 5, 3	12	SS			SAND, fine to coarse grained, dark brown/brown, moist, probable fill		Boring advanced using a track mounted Aker Renegade with 3 1/4' augers and a split spoon
4, 3, 3, 3	14	SS	5		-grades with silt		
6, 1, 1, 1	13	SS			Clayey SILT, soft, white, moist	0.5	
1, 1, 1, 13	10	SS	10		-grades wet	0.5 0 0	
4, 8, 9, 8	20	SS	15		SAND, fine to coarse grained, with gravel, tan, wet	0.75	Delayed water level 6.25'
2, 5, 6, 9	13	SS	20		End of Boring at 20'		
			25				
			30				

Top of Casing : N/A
Ground Elev.: 100.6
Casing: N/A
Screen: N/A
Screen Setting: N/A

Well Construction / Boring Data

Water Encountered: 9' +/-
Date: 12/6/22
Logging Method: Visual/Manual
Development Method: None

Driller: WP
Helper: CH
Logged By: SH

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309 E. Front Street
Traverse City, MI 49684
231-946-5200
Fax 231-946-5216

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Location: Traverse City, MI

Boring Log Of: B - 8
Date Drilled: 12/6/22
Drilling Contractor: Pearson
Page 1 of 1

Std. Penetration Resistance (N)	Recovery (inches)	Sample Method	Sample Type/Interval	Depth (feet)	Soil Type	Soil Description	Pocket Pentrometer	Comments
						Surface Conditions: Sand		
7, 4, 3, 3	18	SS				SAND, medium to fine grained, tan, moist (fill)		Boring advanced using a track mounted Aker Renegade with 3 1/4' augers and a split spoon
						-grades silty, black		
1, 2, 1, 1	10	SS		5		Silty CLAY, soft, white, moist	0.5	
7, 6, 13, 13	6	SS				-black organic sand inclusion in 6'-8' spoon, unknown thickness	0.5 0.75	-Augers charged with water from 8'
3, 6, 6, 8	11	SS		10		SAND, fine to coarse grained, tan, wet		
6, 7, 7, 7	9	SS		15		-grades with gravel		
17, 12, 15, 17	15	SS		20				
19, 27, 31, 28	8	SS		25				
25, 11, 11, 11	9	SS		30		-grades with more gravel		
						End of Boring at 30'		

Top of Casing : N/A
Ground Elev.: 100.4
Casing: N/A
Screen: N/A
Screen Setting: N/A

Well Construction / Boring Data

Water Encountered: 9' +/-
Date: 12/6/22
Logging Method: Visual/Manual
Development Method: None

Driller: WP
Helper: CH
Logged By: SH

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309 E. Front Street
Traverse City, MI 49684
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Fax 231-946-5216