City of North Branch
6408 Elm Street • North Branch, MN 55056

GEOTECHNICAL Report

November 2015

Interstate Business Park

North Branch, MN

WSB Project No. 01656-040

WSB
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Northfield, MN 55057
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PRELIMINARY GEOTECHNICAL REPORT

INTERSTATE BUSINESS PARK

NORTH BRANCH, MINNESOTA

Prepared For:
City of North Branch
6408 Elm Street
North Branch, MN 55056

Prepared by:

WSB & Associates, Inc.
1604 Riverview Lane
Northfield, MN 55057
(507) 645-0964
WSB Project#: 01656-040

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Name: Mark Osborn, P.E. Signature: _____

Date: November 17, 2015 License #: 41362

November 17, 2015

City of North Branch
6408 Elm Street
North Branch, MN 55056

Re: Preliminary Geotechnical Report
Interstate Business Park
North Branch, Minnesota
WSB Project#: 01656-040

We have conducted a geotechnical subsurface exploration program for the above referenced project. This report contains our soil boring logs, an evaluation of the conditions encountered in the borings and our preliminary recommendations for suitable foundation types, allowable soil bearing pressures for footing design and other geotechnical related design and construction considerations. We anticipate additional drilling will be completed for each lot as the building size and footprint are established.

If you have any questions concerning this report or our recommendations, please call us at (507) 645-0964. To arrange for our construction testing services during the construction phase of this project, please call Barry Becker at 507-218-3360.

Very truly yours,
WSB & Associates, Inc.

Mark Osborn, PE
Geotechnical Project Engineer

Attachment
Geotechnical Report
MWO/mwo

TABLE OF CONTENTS

GEOTECHNICAL REPORT
INTERSTATE BUSINESS PARK
NORTH BRANCH, MINNESOTA
WSB PROJECT #: 01656-040

1: INTRODUCTION

1.1 Project Location

The site is located between 400th Street and 410th Street, and between Interstate 35 and County Road 30 / Forest Boulevard in North Branch, Minnesota. The location of the soil borings can be seen on the map in Appendix A.

1.2 Project Description

We understand the business park will attract commercial and industrial businesses. It is anticipated that many of these buildings will consist of 1 to 2 story structures constructed with masonry block, wood, or metal walls, and will likely be supported on shallow footings. Building loads will likely range between 2 to 6 kips per linear foot for foundation walls, with column loads expected to be between 50 and 125 kips.

We anticipate that building floor slab elevations will not be altered by more than 5 feet, and that at some locations basements may be constructed.

WSB has developed foundation recommendations for this project in consideration of the proposed layout, loadings, and structural configurations as understood at this time. When the architect and/or structural engineer develops additional information about final design column loadings, building configuration, or other significant factors, the recommendations presented herein may no

longer apply. WSB must be made aware of the revised or additional information in order to evaluate the recommendations for continued applicability.

1.3 Purpose and Project Scope of Services

We have developed preliminary recommendations for designing foundations, retaining walls, slabs and pavements at this site. As such, we have completed a subsurface exploration program and prepared a geotechnical report for the referenced site. This stated purpose was a significant factor in determining the scope and level of service provided. Should the purpose of the report change the report immediately ceases to be valid and use of it without WSB's prior review and written authorization shall be at the user's sole risk.

Our authorized scope of work has been limited to:

1. Mobilization / Demobilization of a Truck Mounted Drill Rig
2. Clearing underground utilities utilizing the Gopher State One Call.
3. Drilling 11 standard penetration borings to 20 foot depths.
4. Sealing the borings per Minnesota Department of Health procedures.
5. Perform soil classification and analysis
6. Review of readily available project information and geologic data.
7. Providing this preliminary geotechnical report containing:
    A. Summary of our findings.
    B. Discussion of subsurface soil and groundwater conditions and how they may affect the proposed construction of foundations, retaining walls, slabs, and pavements.
    C. Preliminary Public Road Pavement Section recommendations
    D. A discussion of soils for use as structural fill and site fill.

2: PROCEDURES

2.1 Boring Layout and Soil Sampling Procedures

The City of North Branch requested we complete 11 soil borings within the business park area for a review of general soil conditions. The City of North Branch recommended the boring depths and selected the desired locations. Borings were staked in the field by a survey crew of WSB, and were moved as necessary by the drillers due to site accessibility. The approximate boring locations are shown on the Soil Boring Exhibit in the Appendix which is a partial reproduction of the site plan. The ground surface elevations at the borings were determined by our surveyors as well, with the exception of Boring PB-10 which was moved 95 feet to the west to keep it out of a large depression. Elevations for Boring PB-10 are estimated based on aerial contour maps and are accurate to +/- 1 foot.

We drilled the borings on November 3 and 4, 2015 with a truck-mounted CME-55 drill rig operated by a two person crew. The drill crew advanced the borings using continuous hollow stem augers. Drilling methods, crew chief, depths, sampling interval, casing usage, groundwater observations, test data and other drilling information are indicated on the boring logs.

Generally, the drill crew sampled the soil in advance of the auger tip at 2.5 foot intervals of depth to 15 feet and at 5 foot intervals thereafter. The soil samples were obtained using a split-barrel sampler which was driven into the ground during standard penetration tests in accordance with ASTM D-1586, Standard Method of Penetration Test and Split-Barrel Sampling of Soils.

The materials encountered were described on field logs and representative samples were containerized, and transported to our laboratory for further examination and testing.

The flight auger samples were visually examined to estimate the distribution of grain sizes, plasticity, consistency, moisture condition, color, presence of lenses and seams, and apparent geologic origin. We classified the soils according to type using the Unified Soil Classification

System (USCS). A chart describing the Unified Soil Classification System is included in the Appendix.

2.2 Groundwater Measurements and Borehole Abandonment

The drill crew observed the borings for free groundwater while drilling and after completion. These observations and measurements are noted on the boring logs. The crew then backfilled the borings with soil cuttings to comply with Minnesota Department of Health regulations.

2.3 Boring Log Procedures and Qualifications

The subsurface conditions encountered by the test borings are illustrated on the attached boring logs. Similar soils were grouped into the strata shown on the boring logs, and the appropriate estimated USCS classification symbols were also added. The depths and thickness of the subsurface strata indicated on the boring logs were estimated from the drilling results.

The transition between materials (horizontal and vertical) is approximate and is usually far more gradual than shown. Information on actual subsurface conditions exists only at the specific locations indicated and is relevant only to the time exploration was performed. Subsurface conditions and groundwater levels at other locations may differ from conditions found at the indicated locations. The nature and extent of which would not become evident until exposed by construction excavation. These stratification lines were used for our analytical purposes and, due to the aforementioned limitations, should not be used as a basis of design or construction cost estimates.

3: EXPLORATION RESULTS

3.1 Site and Geology

Most of the site was comprised of agricultural fields that had recently been harvested. The southern 1/3 of the site was generally undeveloped land with clumps of vegetation and bare soils at the surface.

The site was generally flat, with soil borings ranging from 914.9 to 920.3. A drainage area was noted at the center of the site that continued to the south towards 402nd Street.

The Geologic Atlas of Chisago County indicated the site predominately consists of fine to medium grained sands, silty in places, with scattered lenses of silt to silty clay occurring at depth. Gravelly sand occurs locally near the surface and at depth in places.

3.2 Subsurface Soil and Groundwater Conditions

The boring profile generally consisted of a very thin layer of topsoil or sod overlying coarse alluvial deposits.

The topsoil measured from less than 1 inch of organics at grade to 2 feet in thickness. In most areas the topsoil consisted merely of crop residue.

The underlying coarse alluvial soils consisted of silty sands, sands with silt, and fine grained sands. These soils are generally consistent with the Geologic Atlas. Coarse alluvial soils were encountered to termination depths of 21 feet.

3.3 Strength Characteristics

The penetration resistance N- values of the materials encountered was recorded during drilling and are indicated as blows per foot (BPF). Those values provide an indication of soil strength

characteristics and are indicated on the boring log sheets. Also, visual-manual classification techniques and apparent moisture contents were also utilized to make an engineering judgment of the consistency of the materials. The following table (Table 1) presents a summary of the penetration resistances in the soils for the borings completed in the proposed addition area and remarks regarding the material strengths of the soils.

Table 1: Penetration Resistances

Soil Type	Classification	Penetration Resistances	Remarks
Silty Sand	SM	2 - 16 BPF	Very loose to medium dense, typically loose to medium dense
Sand with Silt	SP-SM	8 - 11 BPF	Loose to medium dense
Sand	SP	2 - 35 BPF	Very loose to dense, generally loose to medium dense

The preceding is a generalized description of soil conditions at this site. Variations from the generalized profile exist and should be assessed from the boring logs, the normal geologic character of the deposits, and the soils uncovered during site excavation.

3.4 Groundwater Conditions

Table 2: Groundwater Measurements

Boring	Ground Surface Elevation	Depth to Groundwater after Drilling	Estimated Groundwater Elevation
PB-1	920.3	n/a	Below 900
PB-2	919.4	n/a	Below 899
PB-3	917.4	18	899.4
PB-4	914.9	18.2	896.7
PB-5	921.8	n/a	Below 901
PB-6	916.5	17.7	898.8
PB-7	918.0	19.3	898.7
PB-8	919.4	n/a	Below 899
PB-9	915.6	15.5	900.1
PB-10	903.8	18.2	899.9
PB-11	918.8	n/a	Below 898

n/a – indicates ground water was not encountered.

WSB took groundwater level readings in the exploratory borings, reviewed the data obtained, and discussed its interpretation of the data in the text of the report. Note that groundwater levels may fluctuate due to seasonal variations, e.g. precipitation, snowmelt and rainfall, and/or other factors not evident at the time of measurement.

Groundwater was encountered in several of the borings, from elevations of 896.7 to 900.1 feet. Water was noted at depths of 15.5 to 19.3 feet below grade, and should not impact shallow foundation construction. It is possible that fluctuations in the groundwater could affect construction of basements or require damp proofing. Installation of piezometers would be required to determine the fluctuations of the groundwater table.

4: ENGINEERING ANALYSIS AND RECOMMENDATIONS

4.1 Discussion

The onsite coarse alluvial soils are capable of supporting light to moderate foundation loads. We would expect these soils to be suitable to support typical one to two story commercial and industrial buildings.

The onsite soils would provide a moderate to good subgrade for pavement sections. Granular soils typically provide suitable subgrade support and allow for adequate drainage. Any silt pockets encountered should be excavated from building and roadway areas.

The fine grained sands, sands with silt, and silty sands would generally be suitable for backfill materials and for placement below the foundations.

4.2 Building Area Preparation

We recommend the vegetation and topsoil be removed from the construction area.

Any loose/loosened sands either at bottom of footing or slab subgrade elevations should be surface compacted with a large vibratory roller having a drum diameter of at least 5 feet and a static dead weight of at least 10 tons.

Any sub-excavations below the footings should be oversized at least 1 foot beyond the edge of footings for each foot of depth below the bottom of footing elevations (1 horizontal : 1 vertical lateral oversizing). Because the depth and lateral extent of the sub-excavations will vary away from our borings, we recommend a qualified engineering technician working under the direction of a registered professional geotechnical engineer observe and test the excavation bases during construction.

Based on the borings, it appears that the on-site soils can generally be reused as structural backfill provided they are moisture conditioned and can be compacted to project specifications.

Because of the large area of the site and the limited number of borings, additional site specific borings or test pit exploration programs would be required for us to provide more detailed recommendations regarding site development.

4.3 Foundation Recommendations

As indicated previously, we anticipate construction at this site will consist of one to two story commercial and industrial buildings with foundation loads of 2 to 6 kips per linear foot along perimeter walls and 50 to 125 kip column loads.

The onsite soils are generally capable of bearing the assumed foundation loads with normal footings sizes. We recommend that the building in this development be supported on conventional spread footings bearing on naturally occurring coarse alluvial soils or on controlled

compacted fill. We anticipate footings will be designed for a net allowable soil bearing pressure of 3,000 to 4,000 pounds per square foot (psf). In some areas the contractor may be required to excavate the existing coarse alluvial soils and reuse as a compacted fill, or use surface compaction to meet these allowable bearing capacities.

Perimeter building footings should be based at least 42 inches below outside finished grade for frost protection. Unheated garage or deck footings should be based at least 5 feet below grade. Continuous strip footings under exterior bearing walls should be at least 22 inches wide. Individual interior column footings in houses should bear at least 16 inches below the top of the floor slab.

4.4 At Grade Floor Slab

If portions of the new floor slabs are to have a non-breathable covering, such as vinyl tile or linoleum, or if there is to be a room with wood flooring, we recommend that a vapor barrier should be installed below those portions of the slab. If a vapor barrier is used, it should be installed in accordance with the recommendations given in the ACI Manual of Concrete Practice, Part 2, Section 302.3.2.3.

The onsite coarse alluvial soils would have a moderate to high modulus of subgrade reaction (k) ranging from 200 to 300 pci.

4.5 Backfill and Fill Selection and Compaction

The on-site non-organic soils may be reused as backfill and fill provided they are moisture conditioned and can be compacted to their specified densities. We recommend that sandy soils be moisture conditioned to meet compaction specifications. Sandy fill should be spread in 8 to 10 inch loose lifts.

4.6 Utilities

Invert elevations are anticipated to be within 20 feet of existing grades and we anticipate the subgrade soils for the utilities will consist chiefly of fine grained sand, silty sand and sand with silt soils. We anticipate water seepage (if any) will be relatively slow. Dewatering (if necessary) can likely be accomplished with sumps and pumps placed at low points in the utility trenches. In addition, we recommend sand conforming to Mn/DOT Specification 3149.2F Granular Bedding be placed in the bottom of an unstable or wet excavation. The sand should have 100 percent by weight passing the 1 inch sieve and less than 10 percent by weight passing the #200 sieve. The granular bedding should be placed to at least the crown of the pipe. Trench backfill above this point may consist of the non-organic excavated soils once properly moisture conditioned.

4.7 Pavement Areas

After stripping the vegetation and root zone, we recommend the pavement subgrades be proofrolled with a loaded dump truck to help identify areas that may require corrective action such as compaction or sub-excavations. We also recommend a proofroll be performed prior to placement of aggregate base and again just prior to placement of the bituminous pavement.

Once the site has been prepared as recommended, we anticipate the subgrade will consist of a mixture of compacted silty sand and fine grained sand soils. The Mn/DOT Flexible Pavement Design Guidance from June 2014 indicates soils such as those indicated have R-values ranging from about 20 to 70. The predominant upper soils consist of silty sands which have a typical R-value of 20 to 30. We would expect an R-value near 25 would be used for design purposes.

We expect the pavement section would consist of a bituminous asphalt wear and base section placed over a Class 5 Aggregate Base material.

Within several years after initial paving, some thermal shrinkage cracks will develop. We typically recommend routine maintenance be performed to improve pavement performance and

increase pavement life. These should be sealed with a liquid bitumen sealer, to retard water intrusion into the base course and subgrade. Localized patch failures may also develop where trucks or buses turn on the pavement. When these occur, they should be cut out and patch repaired. Periodic seal coating should also be applied, to preserve the longevity of the pavement.

4.8 Construction Considerations

Good surface drainage should be maintained throughout the work. The excavation for any soil correction to densify loose fill, or for excavation to shallow footing depths, should not encounter groundwater intrusion. However if water does enter excavations, it should be promptly removed prior to further construction activities. Under no circumstances should fill or concrete be placed into standing water. Trenches for underground utility lines serving the building addition are also expected to be dry.

It is important to review the fill limits and total depth of fill when placing structures upon compacted materials and when filling the excavation. The location of the footings must allow for at least a 1:1 slope from the bottom of the footing to the outside limits of the engineered fill. It is important to check this at the time of construction and to assure that during filling, unsuitable soils do not encroach within the 1:1 limits and extending downward and outward from future footings.

4.9 Construction Safety

All excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P "Excavations and Trenches". This document states that excavation safety is the responsibility of the contractor. Reference to this OSHA requirement should be included in the job specifications.

The responsibility to provide safe working conditions on this site, for earthwork, building construction, or any associated operations is solely that of the contractor. This responsibility is

not borne in any manner by WSB.

4.10 Cold Weather Construction

It is our understanding that construction is unlikely to occur during the winter months. However, if the construction does continue into the winter months we recommend the following guidelines.

Only unfrozen fill should be used. Placement of fill and/or foundation concrete must not be permitted on frozen soil, and the bearing soils under footings or under the floor slab should not be allowed to freeze after concrete is placed, because excessive post-construction settlement could occur as the frozen soils thaw.

All subgrades for foundation and slab support should be protected against freezing temperatures. It is our recommendation that all frozen soils be removed from the areas to be filled or where concrete foundations and slabs are to be placed. We recommend that no frozen soils be placed as fill. Furthermore, proper precautions should also be taken to prevent frost penetration beneath the foundations and slabs following their construction.

4.11 Field Observation and Testing

The soil conditions illustrated on the attached boring logs are indicative of the conditions only at the boring locations. For this reason, we recommend that all excavations at this site be observed by a soils engineer or technician prior to fill or backfill placement or construction of any foundation elements to determine the soils are capable of supporting the fill backfill and/or foundation loads. These observations would be necessary to judge if all unsuitable materials have been removed from within the planned construction area and an appropriate degree of lateral oversize has been provided.

We also recommend a representative number of field density tests be taken in all engineered fill and backfill placed to aid in judging its suitability. Fill placement and compaction should be monitored and tested to determine that the resulting fill and backfill conforms to specified density, strength or compressibility requirements. Prior to use, any proposed fill and backfill material should be submitted to our laboratory for testing to verify compliance with our recommendations and project specifications.

Subgrades for slabs and pavements should also be observed and tested and unsuitable areas improved.

WSB would be pleased to provide the necessary field observation, monitoring and testing services during construction.

4.12 Plan Review and Remarks

The observations, recommendations and conclusions described in this report are based primarily on information provided to us and obtained from our subsurface exploration, our experience, several necessary assumptions and the scopes of service developed for this project and are for the sole use of our client. We recommend that WSB be retained to perform a review of final design drawing and specifications to evaluate that the geotechnical engineering report has not been misinterpreted. Should there be any changes in the design or location of the structures related to this project or if there are any uncertainties in the report we should be notified. We would be pleased to review any project changes and modify the recommendations in this report (if necessary) or provide any clarification in writing.

The entire report should be kept together e.g. boring logs should not be removed and placed in the specifications separately.

The boring logs and related information included in this report are indicators of the subsurface conditions only at the specific locations indicated on the Soil Boring Exhibit and times noted on

the Log of Test Boring sheets. The subsurface conditions, including groundwater levels, at other locations on the site may differ significantly from conditions that existed at the time of sampling and at the boring locations.

The test borings were put down by WSB solely to obtain indications of subsurface conditions as part of a geotechnical exploration program. No services were performed to evaluate subsurface environmental conditions.

WSB has not performed any observations, investigations, studies or testing that is not specifically listed in the scope of service. WSB shall not be liable for failing to discover any condition whose discovery required the performance of services not authorized by the Agreement

5: STANDARD OF CARE

The recommendations and opinions contained in this report are based on our professional judgment. The soil testing and geotechnical engineering services performed for this project have been performed with the level of skill and diligence ordinarily exercised by reputable members of the same profession under similar circumstances, at the same time and in the same or a similar locale. No warranty, either express or implied, is made.

APPENDIX A

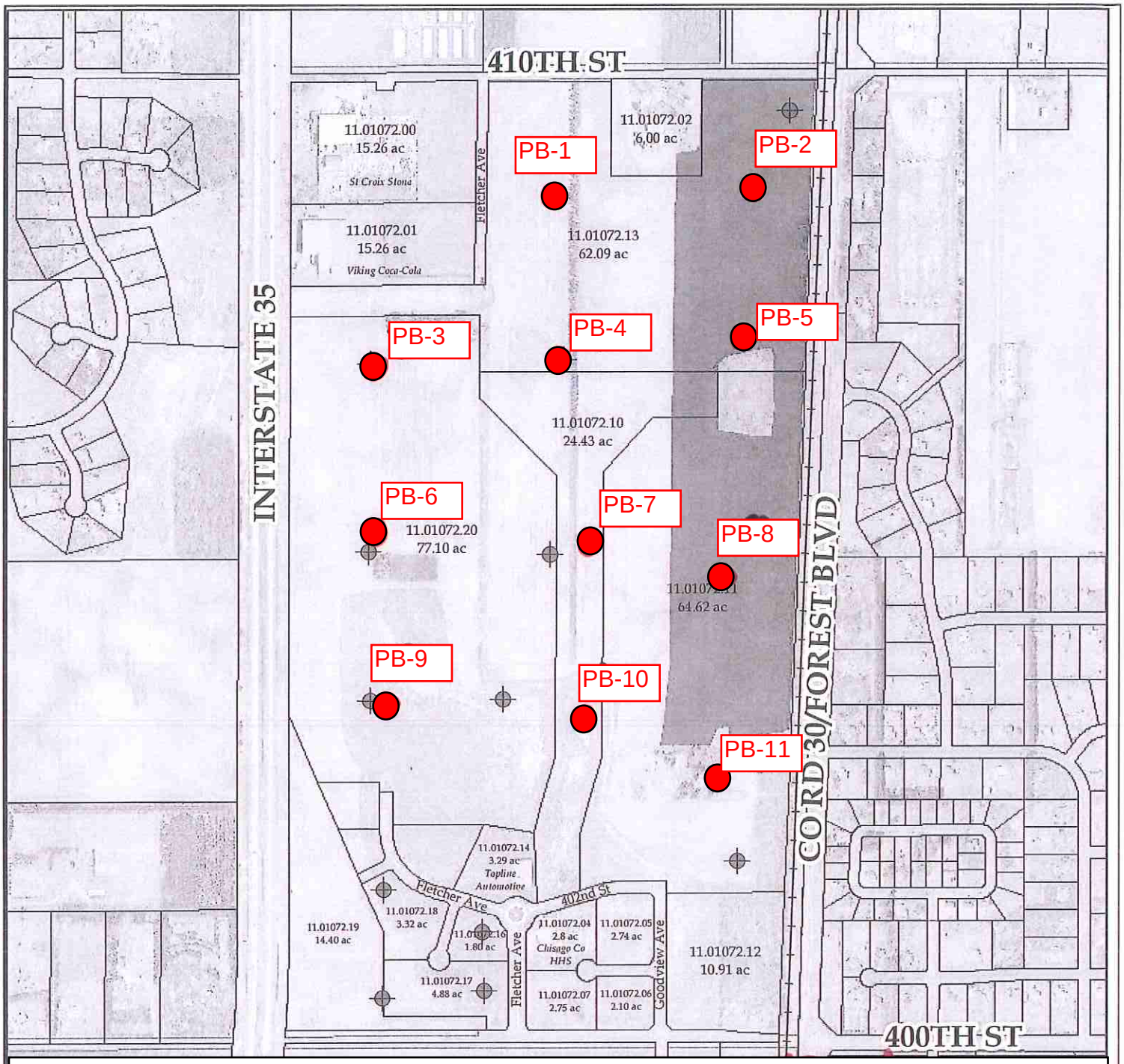
LOCATION MAP

LOGS OF PENETRATION TEST BORINGS

SYMBOLS AND TERMINOLOGY ON TEST BORING LOG

NOTICE TO REPORT USERS BORING LOG INFORMATION

UNIFIED SOIL CLASSIFICATION SHEET



SOIL BORING LOCATIONS

Proposed Soil Borings

Proposed Soil Boring Locations

INTERSTATE BUSINESS PARK
CITY OF NORTH BRANCH, MN

Location Map

Scale: 1"::750'

Date: 26-OCT-2015

LOG OF TEST BORING

PROJECT NAME: Interstate Business Park
CLIENT/WSB #: 01656-040
PROJECT LOCATION: North Branch, MN
SURFACE ELEVATION: 920.3 ft

BORING NUMBER PB-1
PAGE 1 OF 1

DEPTH (ft)	ELEV. (ft)	DESCRIPTION OF MATERIAL	USCS	GEOLOGIC ORIGIN	N_{60}	WL	SAMPLE No.	SAMPLE TYPE	LABORATORY TESTS MC (%)	DD (pcf)	LL (%)	PL (%)
0	920	SILTY SAND with Organics, dark brown, moist		Topsoil								
1	919				-		1	HSA				
2	918	SILTY SAND, brown, moist, medium dense to loose	SM	Coarse Alluvium								
3	917				11		2	SB				
4	916											
5	915											
6	914				10		3	SB				
7	913											
8	912				8		4	SB				
9	911											
10	910	SAND, fine grained, brown, moist, very loose to loose to dense	SP		4		5	SB				
11	909											
12	908											
13	907				6		6	SB				
14	906											
15	905											
16	904				9		7	SB				
17	903											
18	902											
19	901											
20	900				35		8	SB				
21	899	End of Boring 21.0 ft.										
22	898											
23	897											
24	896											

WATER LEVEL MEASUREMENTS

START: 11/03/2015 END: 11/03/2015

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER DEPTH	WATER ELEVATION	METHOD	Crew Chief:	Logged By:
								R. Kurth	DAJ
11/03/2015	3:50 pm	21	19.5		None		3 1/4" HSA 0' - 19.5'	Notes:	

LOG OF TEST BORING

PROJECT NAME: Interstate Business Park
CLIENT/WSB #: 01656-040
PROJECT LOCATION: North Branch, MN
SURFACE ELEVATION: 919.4 ft

BORING NUMBER PB-2
PAGE 1 OF 1

DEPTH (ft)	ELEV. (ft)	DESCRIPTION OF MATERIAL	USCS	GEOLOGIC ORIGIN	N_{60}	WL	SAMPLE No.	SAMPLE TYPE	LABORATORY TESTS MC (%)	DD (pcf)	LL (%)	PL (%)
1	918	SILTY SAND, a few Organics at grade, dark brown, moist, loose	SM	Coarse Alluvium	-		1	HSA				
2	917											
3	916				6		2	SB				
4	915	SAND WITH SILT, fine grained, brown, moist, loose to medium dense	SP-SM									
5	914											
6	913				10		3	SB				
7	912											
8	911				11		4	SB				
9	910											
10	909	SAND, fine grained, brown, moist, medium dense to loose to medium dense	SP		16		5	SB				
11	908											
12	907											
13	906				10		6	SB				
14	905											
15	904											
16	903				8		7	SB				
17	902											
18	901											
19	900											
20	899				30		8	SB				
21	898	End of Boring 21.0 ft.										
22	897											
23	896											
24	895											

WATER LEVEL MEASUREMENTS

START: 11/04/2015 END: 11/04/2015

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER DEPTH	WATER ELEVATION	METHOD	Crew Chief:	Logged By:
								R. Kurth	DAJ
11/04/2015	10:05 am	21	19.5		None		3 1/4" HSA 0' - 19.5'	Notes:	

LOG OF TEST BORING

PROJECT NAME: Interstate Business Park
CLIENT/WSB #: 01656-040
PROJECT LOCATION: North Branch, MN
SURFACE ELEVATION: 917.4 ft

BORING NUMBER PB-3
PAGE 1 OF 1

DEPTH (ft)	ELEV. (ft)	DESCRIPTION OF MATERIAL	USCS	GEOLOGIC ORIGIN	N_{60}	WL	SAMPLE No.	SAMPLE TYPE	LABORATORY TESTS MC (%)	DD (pcf)	LL (%)	PL (%)
1	916	SILTY SAND, a few Organics at grade, dark brown	SM	Coarse Alluvium	-		1	HSA				
2	915											
3	914	SILTY SAND, reddish brown, moist, loose to medium dense	SM		5		2	SB				
4	913											
5	912											
6	911				16		3	SB				
7	910											
8	909	SAND, fine grained, brown, moist to water bearing at 18 feet, medium dense to loose to very loose	SP		11		4	SB				
9	908											
10	907											
11	906				7		5	SB				
12	905											
13	904				7		6	SB				
14	903											
15	902											
16	901				4		7	SB				
17	900											
18	899					▽						
19	898											
20	897				2		8	SB				
21	896	End of Boring 21.0 ft.										
22	895											
23	894											
24	893											

WATER LEVEL MEASUREMENTS

START: 11/03/2015 END: 11/03/2015

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER DEPTH	WATER ELEVATION	METHOD	Crew Chief:	Logged By:
								R. Kurth	DAJ
11/03/2015	3:15 pm	21	19.5		18.0	899.4	3 1/4" HSA 0' - 19.5'	Notes:	

LOG OF TEST BORING

PROJECT NAME: Interstate Business Park
CLIENT/WSB #: 01656-040
PROJECT LOCATION: North Branch, MN
SURFACE ELEVATION: 914.9 ft

BORING NUMBER PB-4
PAGE 1 OF 1

DEPTH (ft)	ELEV. (ft)	DESCRIPTION OF MATERIAL	USCS	GEOLOGIC ORIGIN	N_{60}	WL	SAMPLE No.	SAMPLE TYPE	LABORATORY TESTS MC (%)	DD (pcf)	LL (%)	PL (%)
1	914	SILTY SAND, a few Organics at grade, dark brown, moist	SM	Coarse Alluvium	-		1	HSA				
2	913											
3	912	SILTY SAND, reddish brown, moist, loose to medium dense	SM		5		2	SB				
4	911											
5	910											
6	909				16		3	SB				
7	908	SAND, fine grained, brown, moist to waterbearing at 18.2 feet, medium dense to loose to very loose	SP									
8	907				11		4	SB				
9	906											
10	905											
11	904				7		5	SB				
12	903											
13	902				7		6	SB				
14	901											
15	900											
16	899				4		7	SB				
17	898											
18	897					▽						
19	896											
20	895				2		8	SB				
21	894	End of Boring 21.0 ft.										
22	893											
23	892											
24	891											

WATER LEVEL MEASUREMENTS

START: 11/03/2015 END: 11/03/2015

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER DEPTH	WATER ELEVATION	METHOD	Crew Chief:	Logged By:
								R. Kurth	DAJ
11/03/2015	4:30 pm	21	19.5		18.2	896.7	3 1/4" HSA 0' - 19.5'	Notes:	

WSB BORING LOG - WSB.GDT - 11/17/15 12:46 - K:\01656-040\GEOTECH-CMT\INTERSTATE BUSINESS PARK 01656-040.GPJ

LOG OF TEST BORING

PROJECT NAME: Interstate Business Park
CLIENT/WSB #: 01656-040
PROJECT LOCATION: North Branch, MN
SURFACE ELEVATION: 921.8 ft

BORING NUMBER PB-5
PAGE 1 OF 1

DEPTH (ft)	ELEV. (ft)	DESCRIPTION OF MATERIAL	USCS	GEOLOGIC ORIGIN	N_{60}	WL	SAMPLE No.	SAMPLE TYPE	LABORATORY TESTS MC (%)	DD (pcf)	LL (%)	PL (%)
1	921	SILTY SAND, a few Organics at grade, brown, moist, loose to medium dense	SM	Coarse Alluvium	-		1	HSA				
2	920											
3	919				5		2	SB				
4	918											
5	917											
6	916				11		3	SB				
7	915	SAND WITH SILT, fine grained, brown, moist, loose	SP-SM									
8	914				9		4	SB				
9	913	SAND, fine grained, brown, moist, loose to medium dense	SP									
10	912											
11	911				6		5	SB				
12	910											
13	909				7		6	SB				
14	908											
15	907											
16	906				7		7	SB				
17	905											
18	904											
19	903											
20	902				16		8	SB				
21	901	End of Boring 21.0 ft.										
22	900											
23	899											
24	898											

WATER LEVEL MEASUREMENTS

START: 11/04/2015 END: 11/04/2015

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER DEPTH	WATER ELEVATION	METHOD	Crew Chief:	Logged By:
								R. Kurth	DAJ
11/04/2015	10:40 am	21	19.5		None		3 1/4" HSA 0' - 19.5'	Notes:	

LOG OF TEST BORING

PROJECT NAME: Interstate Business Park
CLIENT/WSB #: 01656-040
PROJECT LOCATION: North Branch, MN
SURFACE ELEVATION: 916.5 ft

BORING NUMBER PB-6
PAGE 1 OF 1

DEPTH (ft)	ELEV. (ft)	DESCRIPTION OF MATERIAL	USCS	GEOLOGIC ORIGIN	N_{60}	WL	SAMPLE No.	SAMPLE TYPE	LABORATORY TESTS MC (%)	DD (pcf)	LL (%)	PL (%)
1	916	SILTY SAND, a few Organics at grade, brown, moist, loose	SM	Coarse Alluvium	-		1	HSA				
2	915											
3	914				7		2	SB				
4	913											
5	912											
6	911				9		3	SB				
7	910	SAND WITH SILT, fine grained, moist, loose	SP-SM									
8	909				8		4	SB				
9	908	SAND, fine grained, brown, moist to waterbearing at 17.7 feet, loose to medium dense to loose	SP									
10	907											
11	906				5		5	SB				
12	905											
13	904				13		6	SB				
14	903											
15	902											
16	901				14		7	SB				
17	900					▽						
18	899											
19	898											
20	897				5		8	SB				
21	896	End of Boring 21.0 ft.										
22	895											
23	894											
24	893											

WATER LEVEL MEASUREMENTS

START: 11/03/2015 END: 11/03/2015

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER DEPTH	WATER ELEVATION	METHOD	Crew Chief:	Logged By:
								R. Kurth	DAJ
11/03/2015	2:35 pm	21	19.5		17.7	898.8	3 1/4" HSA 0' - 19.5'	Notes:	

LOG OF TEST BORING

PROJECT NAME: Interstate Business Park
CLIENT/WSB #: 01656-040
PROJECT LOCATION: North Branch, MN
SURFACE ELEVATION: 918 ft

BORING NUMBER PB-7
PAGE 1 OF 1

DEPTH (ft)	ELEV. (ft)	DESCRIPTION OF MATERIAL	USCS	GEOLOGIC ORIGIN	N_{60}	WL	SAMPLE No.	SAMPLE TYPE	LABORATORY TESTS MC (%)	DD (pcf)	LL (%)	PL (%)
0	918	SILTY SAND, a few Organics at grade, dark brown, moist, loose	SM	Coarse Alluvium								
1	917				-		1	HSA				
2	916											
3	915				6		2	SB				
4	914	SAND WITH SILT, fine grained, brown, moist, medium dense	SP-SM									
5	913											
6	912				11		3	SB				
7	911	SAND, fine grained, brown, moist to waterbearing at 19.3 feet, loose to very loose to loose to very loose	SP									
8	910				6		4	SB				
9	909											
10	908											
11	907				4		5	SB				
12	906											
13	905				7		6	SB				
14	904											
15	903											
16	902				6		7	SB				
17	901											
18	900											
19	899					▽						
20	898				4		8	SB				
21	897	End of Boring 21.0 ft.										
22	896											
23	895											
24	894											

WATER LEVEL MEASUREMENTS

START: 11/04/2015 END: 11/04/2015

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER DEPTH	WATER ELEVATION	METHOD	Crew Chief:	Logged By:
								R. Kurth	DAJ
11/04/2015	9:15 am	21	19.5		19.3	898.7	3 1/4" HSA 0' - 19.5'	Notes:	

LOG OF TEST BORING

PROJECT NAME: Interstate Business Park
CLIENT/WSB #: 01656-040
PROJECT LOCATION: North Branch, MN
SURFACE ELEVATION: 919.4 ft

BORING NUMBER PB-8
PAGE 1 OF 1

DEPTH (ft)	ELEV. (ft)	DESCRIPTION OF MATERIAL	USCS	GEOLOGIC ORIGIN	N_{60}	WL	SAMPLE No.	SAMPLE TYPE	LABORATORY TESTS MC (%)	DD (pcf)	LL (%)	PL (%)
0	919	SILTY SAND, a few Organics at grade, brown, moist loose to medium dense to loose	SM	Coarse Alluvium								
1	918				-		1	HSA				
2	917											
3	916				7		2	SB				
4	915											
5	914											
6	913				13		3	SB				
7	912											
8	911				10		4	SB				
9	910	SAND, fine grained, brown, moist, medium dense	SP									
10	909											
11	908				14		5	SB				
12	907											
13	906				22		6	SB				
14	905											
15	904											
16	903				15		7	SB				
17	902											
18	901											
19	900											
20	899				19		8	SB				
21	898	End of Boring 21.0 ft.										
22	897											
23	896											
24	895											

WATER LEVEL MEASUREMENTS

START: 11/04/2015 END: 11/04/2015

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER DEPTH	WATER ELEVATION	METHOD	Crew Chief:	Logged By:
								R. Kurth	DAJ
10/04/2015	11:15 am	21	19.5		None		3 1/4" HSA 0' - 19.5'	Notes:	

LOG OF TEST BORING

PROJECT NAME: Interstate Business Park
CLIENT/WSB #: 01656-040
PROJECT LOCATION: North Branch, MN
SURFACE ELEVATION: 915.6 ft

BORING NUMBER PB-9
PAGE 1 OF 1

DEPTH (ft)	ELEV. (ft)	DESCRIPTION OF MATERIAL	USCS	GEOLOGIC ORIGIN	N_{60}	WL	SAMPLE No.	SAMPLE TYPE	LABORATORY TESTS MC (%)	DD (pcf)	LL (%)	PL (%)
1	915	SILTY SAND, a few Organics at grade, dark brown, moist	SM	Coarse Alluvium	-		1	HSA				
2	914											
3	913	SILTY SAND, brown, moist, very loose to medium dense to loose	SM		4		2	SB				
4	912											
5	911											
6	910				11		3	SB				
7	909											
8	908				8		4	SB				
9	907	SAND, fine grained, moist to waterbearing at 15.5 feet, loose	SP									
10	906				7		5	SB				
11	905											
12	904											
13	903				8		6	SB				
14	902											
15	901											
16	900				6	▽	7	SB				
17	899											
18	898											
19	897	SILTY SAND, brown, waterbearing, very loose	SM									
20	896				2		8	SB				
21	895	End of Boring 21.0 ft.										
22	894											
23	893											
24	892											

WATER LEVEL MEASUREMENTS

START: 11/03/2015 END: 11/03/2015

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER DEPTH	WATER ELEVATION	METHOD	Crew Chief:	Logged By:
								R. Kurth	DAJ
10/03/2015	1:50 pm	21	19.5		15.5	900.1	3 1/4" HSA 0' - 19.5'	Notes:	

LOG OF TEST BORING

PROJECT NAME: Interstate Business Park
CLIENT/WSB #: 01656-040
PROJECT LOCATION: North Branch, MN
SURFACE ELEVATION: 903.8 ft

BORING NUMBER PB-10
PAGE 1 OF 1

DEPTH (ft)	ELEV. (ft)	DESCRIPTION OF MATERIAL	USCS	GEOLOGIC ORIGIN	N_{60}	WL	SAMPLE No.	SAMPLE TYPE	LABORATORY TESTS MC (%)	DD (pcf)	LL (%)	PL (%)
1	903	SILTY SAND, a few Organics, brown, moist, medium dense	SM	Coarse Alluvium	-		1	HSA				
2	902											
3	901				14		2	SB				
4	900	SAND, fine grained, brown, moist to waterbearing at 18.2 feet, loose to medium dense to loose to medium dense to loose	SP									
5	899											
6	898				5		3	SB				
7	897											
8	896				11		4	SB				
9	895											
10	894											
11	893				7		5	SB				
12	892											
13	891				24		6	SB				
14	890											
15	889											
16	888				21		7	SB				
17	887											
18	886					▽						
19	885											
20	884				6		8	SB				
21	883	End of Boring 21.0 ft.										
22	882											
23	881											
24	880											

WATER LEVEL MEASUREMENTS

START: 11/04/2015 END: 11/04/2015

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER DEPTH	WATER ELEVATION	METHOD	Crew Chief:	Logged By:
								R. Kurth	DAJ
11/04/2015	12:35 pm	21	19.5		18.2	885.6	3 1/4" HSA 0' - 19.5'	Notes:	

LOG OF TEST BORING

PROJECT NAME: Interstate Business Park
CLIENT/WSB #: 01656-040
PROJECT LOCATION: North Branch, MN
SURFACE ELEVATION: 918.8 ft

BORING NUMBER PB-11
PAGE 1 OF 1

DEPTH (ft)	ELEV. (ft)	DESCRIPTION OF MATERIAL	USCS	GEOLOGIC ORIGIN	N_{60}	WL	SAMPLE No.	SAMPLE TYPE	LABORATORY TESTS MC (%)	DD (pcf)	LL (%)	PL (%)
1	918	SILTY SAND, a few Organics, dark brown, moist	SM	Coarse Alluvium	-		1	HSA				
2	917											
3	916	SILTY SAND, brown, moist, loose to medium dense to loose	SM		7		2	SB				
4	915											
5	914											
6	913				12		3	SB				
7	912											
8	911				7		4	SB				
9	910	SAND, fine grained, brown, moist, loose to medium dense	SP									
10	909											
11	908				6		5	SB				
12	907											
13	906				8		6	SB				
14	905											
15	904											
16	903				17		7	SB				
17	902											
18	901											
19	900											
20	899				19		8	SB				
21	898	End of Boring 21.0 ft.										
22	897											
23	896											
24	895											

WATER LEVEL MEASUREMENTS

START: 11/04/2015 END: 11/04/2015

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER DEPTH	WATER ELEVATION	METHOD	Crew Chief:	Logged By:
								R. Kurth	DAJ
11/04/2015	11:45 am	21	19.5		None		3 1/4" HSA 0' - 19.5'	Notes:	

SYMBOLS AND TERMINOLOGOY ON TEST BORING LOG

SYMBOLS

Drilling and Sampling

Symbol	Description
HSA	3-1/4" LD. Hollow stem auger
_ FA	4", 6" or 10" diameter flight auger
_HA	2", 4", or 6" hand auger
_DC	2-1/2", 4", 5", or 6" steel drive casing
_RC	Size A, B or N rotary casing
PD	Pipe drill or cleanout tube
CS	Continuous split barrel sampling
DM	Drilling mud
JW	Jetting water
SB	2" O.D. split barrel sampling
_L	2-1/2" or 3-1/2" O.D. SB liner sampler
_T	2" or 3" thin walled tube sample
3TP	3" thin walled tube using pitcher sampler
_TO	2" or 3" thin walled tube using Osterberg sampler
W	Wash sample
B	Bag sample
P	Test pit sample
_Q	BQ, NQ, or PQ wire line system
_X	AX, BX, or NX double tube barrel
N	Standard penetration test, blows per foot
CR	Core recovery, percent
WL	Water level
▼	Water level
NMR	No measurement recorded, primarily due to presence of drilling or coring fluid.

Laboratory Testing

Symbol	Description
W	Water content, % (ASTM** D2216)
D	Dry density, pcf
LL	Liquid limit (ASTM D4318)
PL	Plastic limit (ASTM D4318)
	-Inserts in last column (Qu or RQD)-
Qu	Unconfined compressive strength, psf (ASTM D2166)
Pq	Penetrometer reading, tsf (ASTM D1558)
Ts	Torvane reading, tsf
G	Specific gravity (ASTM D854)
SL	Shrinkage limits (ASTM D427)
OC	Organic content-combustion method (ASTM D2974)
SP	Swell pressure, tsf (ASTM D4546)
PS	Percent swell under pressure (ASTM D4546)
FS	Free swell, % (ASTM D4546)
SS	Shrink swell, % (ASTM D4546)
pH	Hydrogen ion content-Meter Method (ASTM D4972)
SC	Sulfate content, parts/million or mg/l
CC	Chloride content, parts/million or mg/l
C*	One dimensional consolidation (ASTM D2435)
Qc*	Triaxial compression (ASSTM D2850 and D4767)
D.S.*	Direct Shear (ASTM D3080)
K*	Coefficient of permeability, cm/sec (ASTM D2434)
P*	Pinhole test (ASTM D4647)
DH*	Double hydrometer (ASTM D4221)
MA*	Particle size analysis (ASTM D422)
R	Laboratory electrical resistivity, ohm-cm (ASTM G57)
E*	Pressuremeter deformation modulus, tsf (ASTM D4719)
PM*	Pressuremeter test (ASTM D4719)
VS*	Field vane shear (ASTM D2573)
IR*	Infiltrometer test (ASTM D3385)
RQD	Rock quality designation, percent

*Results shown on attached data sheet or graph

**ASTM designates American Society for Testing and Materials

TERMINOLOGY

Particle Sizes

Type	Size Range
Boulders	> 12"
Cobbles	3" – 12"
Coarse gravel	3/4" – 3"
Fine gravel	#4 sieve – 3/4"
Coarse sand	#4 - #10 sieve
Medium sand	#10-#40 sieve
Fine sand	#40-#200 sieve
Silt	100% passing #200 sieve and > 0.005mm
Clay	100% passing #200 sieve and < 0.005mm

Soil layering and Moisture

Term	Visual Observation
Lamination	Up to 1/4" thick stratum
Varved	Altering laminations of any combination of clay, silt, fine sand, or colors
Lenses	Small pockets of different soils in a soil mass
Stratified	Altering layers of varying materials or colors
Layer	1/4" to 12" thick stratum
Dry	Powdery, no noticeable water
Moist	Damp, below saturation
Waterbearing	Pervious soil below water
Wet	Saturated, above liquid limit

Gravel Content

Coarse-Grained Soils

% Gravel	Description
2-15	A little gravel
16-49	With gravel

Fine-Grained Soils

% Gravel	Description
< 5	Trace of gravel
5-15	A little gravel
16-30	With gravel
31-49	Gravelly

Standard Penetration Resistance

Cohesionless Soils

N-Value	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
> 50	Very dense

Cohesive Soils

N-Value	Consistency
0-4	Very soft
5-8	Soft
9-15	Firm
16-30	Hard
> 30	Very hard

NOTICE TO REPORT USERS BORING LOG INFORMATION

Subsurface Profiles

The subsurface stratification lines on the graphic representation of the test borings show an approximate boundary between soil types or rock. The transition between materials is approximate and is usually far more gradual than shown. Estimating excavation depths, soil volumes and other computations relying on the subsurface strata may not be possible to any degree of accuracy.

Water Level

WSB & Associates, Inc. took groundwater level readings in the exploratory borings, reviewed the data obtained, and discussed its interpretation of the data in the text of this report. The groundwater level may fluctuate due to seasonal variations caused by precipitation, snowmelt, rainfalls, construction or remediation activities, and/or other factors not evident at the time of measurement.

The actual determination of the subsurface water level is an interpretative process. Subsurface water level may not be accurately depicted by the levels indicated on the boring logs. Normally, a subsurface exploration obtains general information regarding subsurface features for design purposes. An accurate determination of subsurface water levels is not possible with a typical scope of work. The use of the subsurface water level information provided for estimating purposes or other site review can present a moderate to high risk of error.

The following information is obtained in the field and noted under "Water Level Measurements" at the bottom of the log.

Sampled Depth: The lowest depth of soil sampling at the time a water level measurement is taken.

Casing Depth: The depth to the bottom of the casing or hollow-stem auger at the time of water level measurement.

Cave-In Depth: The depth at which the measuring tape stops in the bore hole.

Water Level: The point in the bore hole at which free-standing water is encountered by a measuring tape dropped from the surface inside the casing.

Drilling Fluid Level: Similar to the water level, except the liquid in the bore hole is a drilling fluid.

Obstruction Depths

Obstructions and/or obstruction depths may be noted on the boring logs. Obstruction indicates the sampling equipment encountered resistance to penetration. It must be realized that continuation of drilling, the use of other drilling equipment or further exploration may provide information other than that depicted on the logs. The correlation of obstruction depths on the log with construction features such as rock excavation, foundation depths, or buried debris cannot normally be determined with any degree of accuracy. For example, penetration of weathered rock by soil sampling equipment may not correlate with removal by certain types of construction equipment. Using this information for estimating purposes often results in a high degree of misinterpretation.

Accurately identifying the obstruction or estimating depths where hard rock is present over the site requires a scope of service beyond the normal geotechnical exploration program. The risk of using the information noted on the boring logs for estimating purposes must be understood.

WSB & Associates, Inc.

UNIFIED SOIL CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)			
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)	SW	Well-graded sands, gravelly sands, little or no fines
		SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)			
SILTS AND CLAYS Liquid limit less than 50%		ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS		PT	Peat and other highly organic soils

LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent ..... GW, GP, SW, SP
More than 12 percent ..... GM, GC, SM, SC
5 to 12 percent ..... Borderline cases requiring dual symbols

PLASTICITY CHART