GEOTECHNICAL EXPLORATION and ENGINEERING REVIEW

VA Building 1 Expansion

Fargo, North Dakota

NTI Project 20.FGO 10880

Prepared For:

FOURFRONT Design, Inc.
517 7th Street
Rapid City, SD

NTI Northern Technologies, LLC
3522 4th Avenue South
Fargo, ND 58103
P: 701.232.1822 F: 701.232.1864
www.NTIgeo.com

Unearthing confidence™

December 3, 2020

FOURFRONT Design, Inc.
517 7th Street
Rapid City, SD 57701

Attn: Mr. Karl Parson, Project Manager

Subject: Geotechnical Exploration and Engineering Review
VA Building 1 Expansion
Fargo, North Dakota
NTI Project 20.FGO 10880

In accordance with your request and subsequent October 6, 2020 authorization, Northern Technologies, LLC (NTI) conducted a Geotechnical Exploration for the above referenced project. Our services included advancement of exploration borings, laboratory testing, and preparation of an engineering report with recommendations developed from our geotechnical services. We performed our work in general accordance with our proposal of July 31, 2020.

We will retain soil samples for 60 days after which we will discard the samples. Please advise us in writing if you wish to have us retain them for a longer period. You will be assessed an additional fee if soil samples are retained beyond 60 days.

We appreciate the opportunity to have been of service on this project. Please contact us at your convenience if there are any questions regarding the soils explored, or our review and recommendations.

Northern Technologies, LLC

Dan Gibson, P.E.
Senior Engineer

Josh Holmes, P.E.
Engineer

Contents

GEOTECHNICAL EXPLORATION AND ENGINEERING REVIEW

VA Building 1 Expansion

Fargo North Dakota

NTI Project 20.FGO 10880

1.0 EXECUTIVE SUMMARY

We briefly summarize below our geotechnical recommendations for the proposed project. You must read this summary in complete context with our report.

We conclude you may support the proposed VA Building 1 Expansion [Addition] using a deep foundation system bearing within the hard glacial till soils occurring at depth below project site. Major items of issue for your project include the following:

- Our original "scope of services" for project excluded assessment of stability for embankments / excavations. We direct you to other report discussion concerning independent assessment of stability under Contractor's "means and methods".

  The deeper excavations anticipated for project necessitate either widened excavations east and south of the Addition, the installation of earth retention system, or composite system employing both excavation and earth retention of site clays. We present discussion concerning such excavations and the alternative use of earth retention within other sections of this report.

- Our exploration indicates topsoil and fill (clay / sand) extend from approximately 6.2 to 15 feet below present ground surface. Concrete sidewalks are present on the eastern side of the addition. Included within this area is a number of existing and abandoned utilities. The fill represents prior backfill material for these utilities and the former chiller units.

- We did not encounter measurable groundwater during or after completion of drilling operations. However, we anticipate some groundwater seepage into excavations required for construction of basement level.

  The moisture content of lens soils and the host clays can vary annually and per recent precipitation. Such soils and other regional dependent conditions may produce groundwater entry of project excavations. We direct your attention to other report sections and appendices attachments concerning groundwater issues and subsurface drainage recommendations.

- The higher structural loads and integration of the Addition with existing structure necessitate use of deep foundations in support of construction. Deep foundations may include caisson drilled shaft, driven piles, auger cast piles, or helical piles. The first three items of this listing, while applicable for use, have detrimental or economic implications which, in our opinion, preclude their use for support of the Addition. Please contact us if you would like further discussion on the excluded deep foundation systems.

We therefore recommend use of rotary advanced helical piles for support of the Addition. We provide within other report section discussion on their use and likely capacity. It is generally accepted that such foundation elements are independently designed by professional engineer retained by the Contractor or their sub-contractor, with such design then verified by project Structural Engineer of Record. We herein presume such independent design / build of deep foundations will be provided in support of Addition.

- Through material composition, clay soils have a tendency to swell with absorption of moisture. This is especially true for fat clays (CH) or silty fat clays (CH-MH) due to increased montmorillonite mineral content. The attachment presented within the appendices provides a brief description of the swell process of clay, and provides limited recommendation(s) for reducing this risk on your project. Note a major attribute contributing to swell of clays is absorption of moisture under reduced confinement. Continuous drainage of site excavations is necessary to reduce swelling impacts to your project.

2.0 INTRODUCTION

2.1 Site / Project Description

We understand the Addition will be constructed on the south side of the existing VA building 1 located at 2101 Elm Street North in Fargo, North Dakota. Table 1 lists proposed construction for the Addition.

Table 1: Project & Site Description

Item	Description
Building Type:	A multi level, heavy concrete and structural steel with deep basement addition to existing building. Plans are for basement (near existing grade) and one levels above with future construction of 4 additional floors.
Floor Elevations:	200.0 feet [NTI assigned elevation to receiving dock floor, Temporary Benchmark, referece boring diagram]. Estimated elevation of 893 per site topo plan provided. Estimated basement level to be 893 or near our TBM of 200 ft.
Maximum Change in Site Elevation:	2.7 feet of change in site grade occurs from north to south between soil borings.
Depth of Excavation at Site:	Estimated to be nominal 13 to 16 feet from present grade for construction of basement.
Below Grade Foundation Walls	Basement Level Construction.
Existing Land Use	Present facility includes heavy, multi level health care facility of heavy construction and surrounding parking and driveways.

Note: After completion of the soil borings it was decided to move the addition to the south side of Building 1. Additional borings may be warranted. We have included a site plan and soil borings from a previous expansion in this area for reference.

2.2 Scope of Services

The purpose of this report is to present a summary of our geotechnical exploration and provide generalized opinions and recommendations regarding the soil conditions and design parameters for founding of the project. Our "scope of services" was limited to the following:

1. Explore the project subsurface by means of four standard penetration borings extending from 26 to maximum depth of 111 feet, and conduct laboratory tests on representative samples to characterize the engineering and index properties of the soils.
2. Prepare a report presenting our findings from our field exploration, laboratory testing, and engineering recommendations for foundation depths, allowable bearing capacity, estimated settlements, floor slab support, excavation, engineered fill, backfill, compaction and potential construction difficulties related to excavation, backfilling and drainage.

Our current authorized "scope of services" did not include assessment of environmental issues, or analysis and discussion of stability for project.

3.0 EXPLORATION PROGRAM RESULTS

3.1 Exploration Scope

Site geotechnical drilling occurred on October 7, 8, & 9, 2020 with individual borings advanced at approximate locations as presented on the diagram within the appendices. NTI located the borings relative to existing site features, and determined the approximate elevation of the borings relative to the temporary benchmark (TBM); the the concrete floor at the receiving dock north of the proposed Addition (reference boring diagram). We assigned an elevation of 200 feet to the TBM.

3.2 Surface Conditions

The Addition property surface is currently green space and concrete sidewalk. The area south of Building 1 consists of parking lot and a small retaining wall. We understand prior development of the property where the borings were conducted consisted of chiller pads and existing or abandoned utilities. Surface drainage appears to flow towards the existing storm water system.

3.3 Subsurface Conditions

Please refer to the boring logs within the appendices for a detailed description and depths of stratum at each boring. The boreholes were backfilled with auger cuttings, or were abandoned using high solids bentonite or neat cement grout as per appropriate local and state statutes. Minor settlement of the boreholes will occur. Owner is responsible for final closure of the boreholes.

Based on results of the current geotechnical exploration, Table 2 provides a general depiction of subsurface conditions at the project site. We present additional comment on the evaluation of recovered soil samples within the report appendices.

Table 2: Typical Subsurface Stratigraphy at Project Site [Note 1]

Stratum	Elevation / Depth to Base of Stratum (ft)	Material Description	Relative Density / Consistency
Surface	193.2 to 195.9		
No. 1	189.4 to 178.2 / 6.2 to 15	Topsoil, Concrete, Fill, Existing Utilities	NA
No. 2	102 / 91.5 to 93	Fat Clay - Glacial Lake Agassiz	Rather Stiff to Soft
No. 3	Below 102 / -	Lean Clay, Silty Glaciated Sand - Glacial Till	Very Stiff and Very Dense

Note 1 Table summary is a generalization of subsurface conditions and may not reflect variation in subsurface strata occurring on site. The upper portion of each boring is approximate as such was sampled using flight auger.

3.4 Groundwater Conditions

The drill crew observed the borings for groundwater and noted cave-in depth of the borings, if any, during and at the completion of drilling activities. We did not encounter measurable groundwater during or after completion of drilling operations. However, we anticipate some groundwater seepage into excavations required for construction of basement level.

The moisture content of lens soils and the host clays can vary annually and per recent precipitation. Such soils and other regional dependent conditions may produce groundwater entry of project excavations. We direct your attention to other report sections and appendices attachments concerning groundwater issues and subsurface drainage recommendations.

3.5 Laboratory Test Program

We base our analysis and report recommendations upon our interpretation of the standard penetration resistance determined while sampling soils, hand penetrometer test results obtained during classification of retained soils, and experience with similar soils from other sites near the project. We summarize such results on appended boring logs or attached forms.

4.0 ENGINEERING REVIEW AND RECOMMENDATIONS

We base our report recommendation on our present knowledge of the project. We ask that you or your design team notify us immediately if you implement any significant changes to project size, location or design, as this notification would allow our review of current recommendations, and provide means for our issue of modified or different recommendations with respect to such change(s).

4.1 Project Scope

We understand the Addition will include concrete foundation walls and deep foundations for support of above grade construction. Table 3 presents our premise of foundations and basement level loads as loading and finished floor information has not been provided at the time of report issue.

Table 3: Presumed Foundation Loads / Change in Grade / Bearing Elevation

Building Element	***Load / Condition***
Basement Perimeter Strip Footings	10 kips / lf
Perimeter Column Footings (integral to basement strip footings)	500 kips
Basement Interior Column Footings	1000 to 1200 kips
Change in Overall Site Grade (from original ground)	On the order of 3 feet.
Basement Excavation	Estimated excavation of 0 to 6 feet for basement level.

4.2 Site Preparation

Project construction, as proposed, will involve stripping of the site and implementation of corrective grading. We recommend removal of all topsoil, concrete, fill, debris (from old utilities), and/or any unsuitable material(s) encountered during advancement of project excavations. Our field exploration indicates removal of topsoil, concrete, and fill should result in excavations extending from approximately 6.2 to 15 feet below existing grade. ***These depths likely no longer apply but you should be prepared to remove a significant amount of fill on the south side of Building 1. Additional borings may be warranted to determine fill depths.***

You must oversize all earthwork improvements and excavations that include placement of engineered fill below foundations. The minimum excavation oversize should extend per the requirements outlined on appended *Figure 1: Excavation Oversize*. Table 4 presents summary of excavation necessary for the removal of unsuitable materials [at respective borings]. Additional excavation will be necessary to achieve basement elevation in select areas.

Table 4: Summary of Project Excavation Note 1

Boring Number	***Existing Ground Elev.*** (NTI Datum feet)	***Depth*** (feet)	***Unsuitable Soil / Material***	***Est. Excavation Elevation*** (feet)
SB-1	193.2	15	4.5” Concrete over Fill	178.2
SB-2	194.7	6.5	Topsoil and Clay Fill	188.2
SB-3	194.7	6.2	Topsoil and Clay Fill	188.5
SB-4	195.9	6.5	Topsoil and Clay Fill	189.4

Note 1: Refer to report for excavation at, and within, the vicinity of the soil borings.

You must pump seepage from excavations continuously until the Geotechnical Engineer of Record or their designated representative determines such seepage no longer influences bearing soils, engineered fill system, backfill system or soils and concrete placement.

The Geotechnical Engineer of Record or their designated representative must review project excavations to verify removal of unsuitable material(s), and determine exposed soils provide adequate bearing support of proposed construction. All such observations must occur prior to the placement of engineered fill, or construction of footings and floor slabs.

Native soils and any fill placed for support of footings (if required) can weaken by construction operations. You should consider and, where necessary, place a lean concrete "mud slab" below footing and floor slab construction if site conditions become disturbed or supporting soils are excessively wet and/or compromised by site activities. This placement will reduce loss of foundation support and minimize future soil removal due to continued disturbance. We direct you to appendices attachment on discussion relative to "mud slab" construction.

While not mandatory, you should place geotextile separation fabric as part of corrective earthwork below footing and floor slab construction [especially at locations lacking the above lean concrete "mud slab"]. The Geotechnical Engineer of Record or their designated representative should determine need for geotextile placement after observation of completed excavations. We present within appendices attachment comment and recommendations for materials type and placement of geotextile.

Engineered fill for overall corrective earthwork and for support of project perimeter foundations should consist of native, non-organic clay. Engineered fill placed interior to and above the base of perimeter frost footings should consist of granular soils that comply with the material properties listed for granular fill placement below floor slab construction.

Unless otherwise directed specifically within this report, you should temper engineered fill for correct moisture content and then place and compact individual lifts of engineered fill to criteria as presented within the appendix.

4.3 Global Stability of Excavation / Earth Retention

NOTE OUR WORK RELATIVE TO THIS SECTION OF REPORT IS CONCEPTUAL ONLY AND INTENDED AS GUIDE TO YOUR / CONTRACTOR INDEPENDENT ASSESSMENT OF GLOBAL STABILITY / DESIGN OF EARTH RETENTION FOR PROJECT. ALL SUCH DISCUSSION DOES NOT CONSTITUTE OPINION AS TO SAFE STABILITY OF SYSTEM OR DESIGN OF EARTH RETENTION FOR PROJECT.

The deep basement of Addition will necessitate that you "lay back" the excavation face at a two horizontal to one vertical or flatter (2H: 1V or flatter) profile should you construct project without earth retention. This preliminary finding is based on premise silt / granular soils are not present within the exposed embankment nor is there seepage occurring from exposed embankment. Such finding is void if any of above limitation exist at location or if soil mass / construction materials / staging of equipment occurs within 30 feet of excavation crest.

Advancement of excavation to such lateral extent beyond exterior of periphery wall may be restricted by site limitations / property boundary. As such we recommend you consider use of a hybrid system of partial depth excavation and installation of sheet piling (with or without whale / strut) as means of retaining the excavation as needed. *All such analysis and design of earth retention system must be based on means and methods of Contractor, who is responsible for design of system via professional engineer retained under their sole directive.*

4.4 Lateral Earth Pressure

Foundation walls for basement area or other areas of unbalanced earthen fill will experience lateral loading from retained soils. You may model this lateral loading as an equivalent earth pressure applied to the foundation wall providing site geometric and related conditions complies with the parameters supporting such modeling. We recommend use of the Table 5 at-rest "equivalent fluid earth pressures" for establishing lateral loading of basement foundations walls with unbalanced earthen fill.

Table 5: Retained Soil - Equivalent Fluid Weight / Coefficient of Friction

Soil Type	*Friction Factor for Sliding Resistance* [2]	*Equivalent Fluid Unit Weight of Retained Soil* [1]		
		"At Rest" Condition (pcf)	*"Active" Condition* (pcf)	*"Passive Condition* (pcf)
Engineered Fat Clay Fill	0.30	95	75	145
Engineered Sand Fill	0.50	65	45	250
Native Fat Clay	0.25	100	90	130

1 The "equivalent fluid weight" recommendation based solely on premise of sloping ground and/or surcharge loads. We caution design professional that actual loads imparted to the structure will be dependent on soil conditions, site geometric considerations, and surcharge loads imparted to the structure.

2 The determination of resistance to sliding determined based on multiplication of the respective coefficient of friction by the effective vertical stress occurring at the elevation of interest.

4.5 Deep Foundations

Site conditions and heavy loads from project necessitate support of project using a deep foundation system. We base our report bearing recommendations for the design of deep foundations that will bear within competent glacial till per report discussion. You must notify us of any changes made to the project size, location, design, or site grades so we can assess how such changes influences our recommendations. It is our premise foundation elements will impose maximum vertical loads as listed within Table 3.

We previously noted multiple options available for foundation support of Addition. The relatively small footprint of the Addition and cost of mobilization of type specific equipment for the installation of drilled caissons, driven piles, and auger cast piles would, in our opinion result in unfavorable pricing. Other adverse issues associated with these deep foundations include:

- Caisson construction would require extensive soil removal and mobilization of specialty drilling equipment not as readily available. We have also noticed these foundations are not as economical as other deep foundation options.

- Driven piles will produce significant noise during installation while also producing ground movement (seismic wave) within site soils. Such impacts would be a nuisance to VA patients and personnel, as well as possible damage to the existing building.
- The installation of auger cast foundations at location necessitate retention of contractor from significant distance from project. We believe the mobilization cost alone limits use of this system. Additionally, small, non-cased auger cast foundation have a high risk of “necking” of the GLA soils / collapse of bore opening during drilling operations, or during placement of cementitious grout.

The above discussion presents our reasoning for limiting foundation support to rotary advanced helical piles in support of the Addition. Benefits from this installation include, minimal adverse installation noise and no ground vibration, and local available contractors with extensive experience in installation of foundation type. The following subsection provides additional discussion and general estimate of foundation type.

4.5.1 Helical Pile Foundations

Rotary advanced helical piles, like driven piles, provide foundation support via deeply installed members. However, helical piles derive their bearing support via end bearing of the helix flights within competent soils while driven piles relying primarily on adhesive skin resistance to derive capacity. It is for this reason we do not assign significant reduction in ultimate bearing capacity of helical piles [helix flights to bear within glacial till, no bearing resistance of GLA clays included in assessing adhesive skin resistance of helical pile shaft].

The design of helical piles for this project must include allowance for presence of cobbles / boulders present within the glaciated alluvium stratum at depth. We recommend that helical piles increase the pitch ratio of helix flights and provide further spacing of helix flights, and increase the section of helix flights to address presence of cobbles / boulders.

Design of conventional helical piles is governed by AC 358 - “Acceptance Criteria for Helical Pile Systems and Devices”. Note such document covers helical methods of analysis and acceptance criteria for helical pile shafts of up to 4 1/2 inch outside diameter (OD) [nominal 16-inch OD maximum helix flight]. Over the last 10 plus years, the helical pile industry has expanded the capacity of helical piles with shaft size and helix flight increasing to nominal 13 3/4 inch OD shaft with helix flights of up to 48-inch OD. The theoretical capacity of these heavy systems approach or exceed 350 kips design capacity.

While not specific to large helical pile systems, we recommend design of helical pile support for the Addition be based on similar analysis as defined per AC 358, as herein amended to address use of helical piles in excess of 4 1/2” OD. Sizing of helix flights of heavy helical pile may be based on the ultimate soil shear strengths listed within Table 6.

Conceptually, large helical piles installed with bearing within the pre-till or glacial till soils are capable of 150 to 350 kips design capacity per member. Helix plates along shaft of lead section should be spaced at a minimum of three and one half to four times the diameter of smaller plate member. Normal practice is to provide a spacing factor equal to or greater than three times the diameter of the largest helix bearing plate as lateral separation of helical piles [for bearing support].

However, the extreme strength of the glacial till soils at this location would, in our opinion, allow this lateral spacing factor to be reduced to no less than 2 1/2 times the OD of largest helix flight. We recommend assessment of helical pile lateral capacity occur as recommended for driven piles. The ultimate bearing capacity of helical piles must be no less than twice the design capacity of member. Static load testing of helical pile should be performed to optimize / verify capacity of installed member(s).

Soils displaced by helical pile foundations, while less than driven piling, will cause a slight upward heave of the excavation base due to the nominal one to one volumetric relationship of the GLA clays. We recommend you include additional 3-inch allowance and hold down of granular fill placed as drainage / working platform of deeper construction at site as preparation to installation of deep foundations.

We expect installed helical piles will likely attain bearing support within the glacial till soils occurring approximately 100 feet below present ground surface. The high stiffness of the glacial till soils at this location present challenge with respect to seating of helix flights within the bearing material. It is likely helical piles for this project may be designed with two helix flights of differing diameter. However, all such design must take into account that the entire load of helical pile is supported by a single helix flight. We recommend that all helical pile design for this project include structural assessment of helix and of pipe shaft to confirm stress of member does not exceed allowable design limits.

Table 6: Recommended Soil Design Criteria for Deep Foundations Notes 1, 2, 3

Stratum	***Nominal Datum Elevation / Depth from Ground Surface***	***Estimated Modulus E***	***Net Allowable End Bearing Capacity*** [2]	***Skin Adhesion*** (Comp.) [3]	(Tension) [3]
Glacial Lake Agassiz Clay	102 / 93 feet	NA	NA	None	None
Weathered Glacial Till/Glaciated Sand	92/103 feet	0.8	6 ksf	0.3 ksf	0.2 ksf
Glacial Till	82 /111 feet	11 ksi	25 ksf	1.8 ksf	1.3 ksf

1. We do not recommend assigning any skin friction to the GLA soils as these soils can easily lose cohesive capacity when clay minerals shift relative to adjacent mineral particles (slickenside effect).
2. Net Allowable End Bearing based on surface area of element at bearing elevations _with two or higher safety factor_ applied from ultimate soil capacity.
3. Adhesion capacity (compressive or tension) based on applying allowable design values (_with applied two safety factor_) to cylindrical surface area of shaft occurring within indicated stratum to till soils only.

We recommend that you infill rotary advanced helical piles and push piers with 6,000 psi minimum compressive strength cementitious grout. This infill will assist in stabilizing of respective shaft section against excessive bending stress as well as assist in conveyance of applied compressive loads to supporting glacial till.

We understand the depth of construction will provide adequate cover against adverse frost action to basement foundation walls. We recommend that the bottom of basement foundation walls and pile caps extend no less than 2 feet below bottom of basement floor. This recommendation is provided with understanding such placement will provide initial lateral restraint of soils and lessen seepage to interior of basement.

We previously noted clay soils swell with absorption of moisture. This is especially true when clay soils absorb excess runoff, pooled within excavations. Partially constructed foundations, foundations of reduced confining load, and more importantly, lightly loaded on-grade floor construction may heave due to clay soil swell. You must maintain constant automated subsurface drainage of the construction site to reduce this risk of heaved foundations.

4.6 Load Test of Deep Foundations

The deep foundation support of project warrants static load testing of helical piles. Static load testing should be completed via general conformance to the "Quick Load Test" of ASTM D1143 "Method of Testing Individual Piles Under Static Axial Compressive Load". We recommend at a minimum one (1) load test per helical pier size and an overall minimum of two (2) load tests if they are all sized for the same capacity.

4.7 Estimate of Settlement

In our opinion, the overall lack of any additional soil placement at site for the Addition should minimize future consolidation of the underlying GLA clays. It is likely that engineered clay and engineered granular fill placed as backfill of basement foundation walls may settle from 1 to 2 inches. Final grading of site must account for this internal settlement of placed soils.

We anticipate settlement of the basement level at-grade floor should be less than ½ inch as referenced to movement of the structure [i.e. does not address or include mass movement of site due to soil placement]. Furthermore, total and differential movement of footings and floor slabs could be significantly greater than the above estimates if you support construction on frozen soils, the moisture content of the bearing soils significantly changes from insitu conditions, and/or you incorporate snow or ice lenses into site earthwork.

We present within Table 7 our estimate of settlement for Deep Foundation support of project.

Table 7: Estimated Settlement of Deep Foundations Notes 1

	Rotary Advanced Helical Piles	
Location	Est. Total Settlement	Est. Differential Settlement
Existing Basement Foundation	NA	NA
New Basement Foundation Wall (as grade beam)	1/2 to 1 inch	1/4 to 1/2 inch
Integral Colum with Basement Foundation Wall	1/2 to 1 inch	1/4 to 1/2 inch
Basement Isolated Column	1/2 to 1 inch	1/4 to 1/2 inch

4.8 Subsurface Drainage

We recommend you install subsurface drainage at the exterior and interior base of basement foundation walls. As a general guideline, subsurface drainage consists of a geotextile and coarse drainage encased slotted or perforated pipe extending to sump basin(s). The project Architect and/or Structural Engineer of Record should determine the need / type of subsurface drainage.

4.9 Utilities

Placement of underground utilities typically includes granular bedding for support of piped systems. Placement of granular soils within underground utility construction promotes migration of subsurface moisture towards and below the bearing stratum of footing construction. This, in turn, can lead to moisture uptake by native clays producing heave of construction, loss of shear strength and/or differential settlement of footing and floors.

Therefore, we recommend that you eliminate placement of all granular bedding soils within 10 feet of project excavations creating a zone where cohesive soils or lean concrete (i.e. controlled density fill) is used for all soil replacement within utility trenches. This “zone of control” should significantly reduce moisture migration below the project foundations. You should place and compact all clay-bedding fill to same criteria recommended for utility trench backfill.

In lieu of placing clay soils within the above referenced “zone of control”, you may provide alternate means of interception and blockage of drainage along site utilities pending review and approval by Geotechnical Engineer of Record.

You should place wetter soils in the lower portion of utility trench construction, and dryer soils in the upper most portion of trench fill. You should temper the utility trench fill for correct moisture content and then place and compact individual lifts of trench fill to criteria established within the report appendices.

There is a high probability that fine and coarse alluvium laminations occur within site soils and may be present along utility trench excavations. Such formations and other regional dependent soil conditions may be water bearing. While it is our opinion small pumps should handle typical seepage from site clays, we caution that exposure of a major “water bearing” strata could produce significant seepage of utility construction. Therefore, we recommend that you include provisions within construction document for pumping of seepage from utility excavations.

4.10 Basement Slab-on-Grade Floor

Our borings indicate support of basement floor and underlying engineered aggregate section will be provided by native fat clays. We understand finished floor will be set at a common elevation with the existing basement/lower level floor of the existing building.

Construction of project foundations will likely include movement of equipment across the floor of the Addition basement. This movement may include heavy equipment necessary for the installation of deep foundations. Subgrade preparation will need to establish a stable base for construction of project. The native soils at the base of basement excavation can easily loose structural capacity with uptake of moisture, are easily disturbed, and may rut with excessive movement of construction equipment across bare ground. We thus recommend that you install geotextile separation fabric between the exposed cohesive soils and overlying aggregate section to limit this displacement / distress. It is our opinion this geotextile should consist of a "polypropylene yarn based" fabric with the Table 8 properties:

Table 8: Geotextile Separation Fabric Properties

Parameter	***Requirement*** Note 1
Base Yarn	Non-Woven, Fused Polypropylene
Apparent Opening Size [AOS, US Sieve]	40 - 70
Permitivity [gal/min/sq. ft CH, ASTM D 4491]	Nominal, 110 gpm/sq. ft.
Grab Tensile Strength [lbs, %, ASTM D 4632]	160 x 160 @ 50%
Installation (Panels)	Minimum 2 feet overlap of side seams and 3 feet overlap of butt seams (nominal 12 ft panel width)

1. All physical strength properties are minimum average roll values [MARV], unless noted otherwise.

Engineered fill placement above the subgrade separation fabric [i.e. from native soils to within 6 inches of the bottom of floor slab / nominal 24 inches of *Bearing Aggregate*] should consist of natural stone / sand mixture or crushed concrete material conforming to the Table 9 mechanical analysis. You must temper the granular material for correct moisture, place 8-inch maximum depth loose lifts, and compact the Bearing Aggregate to no less than 95% of Standard Proctor maximum dry density.

Fill placement within 6 inches of the bottom of basement floor [i.e. *Drainage Aggregate*] should occur after completion of regraded and compacted the underlying granular material. This Drainage Aggregate should consist of a material conforming to the Table 9 mechanical analysis requirement. You should temper the Drainage Aggregate from plus or minus 3% of optimum moisture content and then compact individual lifts of material to no less than 95% of Standard Proctor maximum dry density.

Table 9: Mechanical Analysis of Granular Fill for Floor Slab Construction

U.S. Sieve Designation	***Bearing Aggregate*** ***Percent Passing*** (by dry weight of material)	***Drainage Aggregate*** ***Percent Passing*** (by dry weight of material)
1 inch	100%	
1/2	70 - 85	100%
No. 4	50 – 65	50 - 75
10	40 – 50	40 - 60
40	20 – 40	20 - 40
200	2 – 10	0 - 5

You may design of the floor slab based on an estimated subgrade reaction modulus (k) of 150 lbs/ in^3 providing a minimum of 36 inches of granular fill supports floor construction. Otherwise, we recommend you use a subgrade reaction modulus of 50 lbs/ in^3 for design of at grade or basement floor slab. While it is our opinion that you reinforce floor slab construction, the Structural Engineer should determine need for inclusion of reinforcement within at-grade floor construction.

All areas of basement floor with impervious or near impervious surfacing such as, but not limited to, paint, hardening agent, vinyl tile, ceramic tile, or wood flooring, will require your installation of a commercial grade vapor barrier system. Historically, vapor barrier systems can consist of many different types of synthetic membrane with placement either below sand cushion materials or at the underside of the concrete floor. All such issues are contentious and have positive and negative aspects associated with long-term performance of floor. Overall, we recommend you install some form of vapor barrier below the project basement floor.

You should isolate the basement floor from other building components. It is our opinion such isolation should include installation of a ½ inch thick expansion joint between the floor and walls, and/or columns to minimize binding between construction materials. This construction should also include application of a compatible sealant after curing of the floor slab to reduce moisture penetration though the expansion joint. As a minimum, you must install bond breaker to isolate and reduce binding between building components.

We previously noted risk of heave of on-grade floor slab construction if exposed clay soils absorb moisture. We direct your attention to the attachment "Swell of Clay Soils" provided within the report appendices.

4.11 Exterior Backfill

Exterior fill placement around the foundation and associated final grading adjacent to the building can significantly influence the performance of a structure. We recommend you install subsurface drainage of the basement foundation system as previously noted per this report.

Exterior backfill for basement foundation should consist of a native, coarse alluvium or "pit run" granular soil with a fine content equal to or less than 40 percent passing the No. 40 US Sieve opening and 12 percent passing the No. 200 US Sieve opening (i.e. fill extending to within 2 feet of final grade). The final two to three feet of exterior backfill within lawn areas should consist of clay and topsoil while exterior backfill below sidewalks and pavements should consist of a free draining aggregate base. You should temper all backfill for correct moisture content and then place and compact individual lifts of exterior backfill per criteria presented within the appendix attachment. *You must limit placement of exterior backfill until lateral restraint of foundation walls complies with minimum criteria of Structural Engineer of Record.*

4.12 Surface Drainage

You should maintain positive drainage during and after construction of project and eliminate ponding of water on site soils. We recommend you include provisions within construction documents for positive drainage of site. You should install sumps at critical areas around project to assist in removal of seepage and runoff from site. We present within appendices attachment recommendations for sump construction.

You should maintain the moisture content of site clays as close to existing as possible as excessive changes can cause shrinkage or expansion of the soil, and lead to distress of construction.

We understand sidewalks, curbing, pavements, and lawn will direct drainage from structure. You should grade exterior to slope from building(s). We recommend that you provide a five percent gradient within 10 feet of building for drainage from lawn, and two percent minimum gradient from building for drainage of sidewalks / pavements. All pavements should drain to on-site storm collection, municipal collection system, or roadside ditching.

You should direct roof runoff from building by a system of interior roof and scupper drains, or rain gutters, down spouts and splash pads. It is our opinion interior roof drains plumbed directly to the storm water piping system provide the most favorable method of conveying drainage from the roof as interior drains do not freeze or discharge runoff onto exterior sidewalks and pavements.

4.13 Vegetation

Vegetation planting near structures can change the soil moisture content via uptake by or excessive watering of plantings. The resulting change in soil moisture contributes to lateral earth pressure development and frost related heave of local soils. You should eliminate planting of trees or shrubs within 10 feet of the structures as a cautionary measure to reduce the seasonal fluctuation of soil moisture.

5.0 CONSTRUCTION CONSIDERATIONS

5.1 Excavation Stability / Person in Charge

Excavation depth and sidewall inclination should not exceed those specified in local, state, or federal regulations. You may need to widen and slope, or temporarily brace excavations to maintain or develop a safe work environment. A licensed Professional Engineer retained by Contractor must design temporary shoring in accordance with applicable regulatory requirements.

We base all report stability findings on premise with respect to loading, site conditions, groundwater issues, and likely extent of work / surcharge conditions as listed. Such findings do not imply or intend actual excavations advanced at project, or findings relative to 29 CFR 1926.6 as referenced above. *Contractor is solely responsible per "means and methods" for ascertaining stability of embankments / excavations, or any other work occurring on site.*

5.2 Engineered Fill & Winter Construction

The Geotechnical Engineer of Record or their designated representative must observe and evaluate excavations to verify removal of uncontrolled fills, topsoil, and/or unsuitable material(s), and adequacy of bearing support of exposed soils. Such observation should occur prior to construction of foundations or placement of engineered fill supporting excavations. Lacking observation(s), you cannot hold NTI, its officers and professional engineers responsible for issues resulting from undocumented site conditions.

We must evaluate engineered fill for moisture content, mechanical analysis and/or Atterberg limits prior to placement. You must also temper engineered fill for correct moisture content and then place and compact individual lifts of engineered fill to criteria established within this report.

You must never use frozen soil as engineered fill or backfill nor should you support foundations on frozen soils. Moisture freezing within the soil matrix of fine grained and/or cohesive soils produces ice lenses. Such soils gain moisture from capillary action and, with continued growth, heave with formation of ice lenses within the soil matrix. Foundations constructed on frozen soils settle after thaw resulting in distress or failure of construction.

You must protect excavations and foundations from freezing conditions or accumulation of snow, and remove frozen soils, snow, and ice from within excavations, fill section or from below proposed foundations. Replacement soil should consist of similar material as removed from excavation with moisture content, placement, and compaction conforming to report criteria.

5.3 Operation of Project Sumps

We previously noted the importance of removal of seepage and runoff from project excavations. You must maintain temporary drainage of project excavations until such time that the Geotechnical Engineer of Record determines excess groundwater pore pressure, seepage, and/or runoff no longer influences the strength or support of construction.

We presented within appendices attachment typical recommendations for temporary project sumps. Such provides general guideline of the minimum temporary drainage of project. It is our premise the Contractor is solely responsible for establishing the magnitude, type, and operation of subsurface drainage for project.

6.0 CLOSURE

Our conclusions and recommendations, as represented within this report, imply NTI's future observation and testing of earthwork under the direction of the Geotechnical Engineer of Record. We arrived at our opinions based on presumptive data collected from the site. Note that the collection of such data results from limited sampling of site conditions typical of geotechnical explorations performed for projects of similar scope. For this and other reasons, we do not warrant conditions between or below the depth of our borings, or that the strata logged from our borings are necessarily typical of the site. Thus, you agree herein to relieve, hold harmless, and indemnify NTI, its officers and engineering staff of responsibility pending any deviation(s) from our recommendations by plans, written specifications, or field applications, unless you establish and receive from NTI prior issued written concurrence with such deviations.

We have prepared this report for FOURFRONT Design, Inc. in specific application to proposed "VA Building 1 Expansion" project in Fargo, North Dakota. Northern Technologies, LLC has endeavored to comply with generally accepted geotechnical engineering practice common to the local area. Northern Technologies, LLC makes no other warranty, expressed or implied.

Northern Technologies, LLC

Dan Gibson, P.E.
Senior Engineer

Josh Holmes, P.E.
Engineer

DG:jh

Attachments

DANIEL GIBSON
REGISTERED
PROFESSIONAL
PE-5444
ENGINEER
NORTH DAKOTA

Daniel Gibson, P.E.
Date: 12/3/2020

R:\Fargo\PROJECTS\Geo\GEOREP 2020\Fargo VA Bldg 1 Addition\GEOTECHNICAL REPORT - VA Bldg 1 Expansion - Fargo, ND.docx

APPENDIX A

This page intentionally left blank.

GEOTECHNICAL EVALUATION OF RECOVERED SOIL SAMPLES

We visually examined recovered soil samples to estimate color, distribution of grain sizes, plasticity, consistency, moisture condition, and presence of lenses and seams. We then classified the soils according to the Unified Soil Classification System (ASTM D2488). We provide a chart describing this classification system and general notes explaining sampling procedures.

We estimated the stratification lines between soil types based on the available data from our borings only. Insitu, the transition between type(s) may be distinct or gradual in the horizontal or vertical directions. Variations in the soil stratigraphy may occur between and around the borings, with the nature and extent of such change not readily evident until exposed by excavation. You must properly assess these variations when utilizing information presented on the boring logs.

FIELD EXPLORATION PROCEDURES

Soil Sampling – Standard Penetration Boring:

We performed soil sampling according to the procedures described by ASTM D-1586. Using this procedure, we drive a 2-inch outside diameter “split barrel sampler” into the soil by a 140-pound weight falling 30 inches. After an initial set of six inches, the number of blows required to drive the sampler an additional 12 inches is recorded (known as the penetration resistance (i.e. “N-value”) of the soil at the point of sampling. This N-value, as corrected for efficiency of equipment operation is an index of the relative density of cohesionless soils and an approximation of the consistency of cohesive soils [i.e. N_{60}].

Soil Sampling – Power Auger Boring:

The boring(s) was/were advanced with a 6-inch nominal diameter continuous flight auger. As a result, samples recovered from the boring are disturbed, and our determination of the depth, extend of various stratum and layers, and relative density or consistency of the soils is approximate.

Soil Classification:

Soil samples were visually and manually classified in general conformance with ASTM D-2488 at removal from the sampler(s). We then sealed within containers and returned representative fractions of soil samples to the laboratory for further examination and verification of the field classification. We also submitted representative soil samples for laboratory tests. We document on the boring logs and individual test reports sample information, identification of sampling methods, method of advancement of samples, and other pertinent information concerning the soil samples.

General Notes

DRILLING & SAMPLING SYMBOLS		LABORATORY TEST SYMBOLS	
SYMBOL	DEFINITION	SYMBOL	DEFINITION
C.S.	Continuous Sampling	W	Moisture content-percent of dry weight
P.D.	2-3/8” Pipe Drill	D	Dry Density-pounds per cubic foot
C.O.	Cleanout Tube	LL, PL	Liquid and plastic limits determined in accordance with ASTM D 423, ASTM D 424
3 HSA	3 ¼” I.D. Hollow Stem Auger	Qu	Unconfined compressive strength-pounds per square foot in accordance with ASTM D 2166-66
4 FA	4” Diameter Flight Auger		
6 FA	6” Diameter Flight Auger		
2 ½ C	2 ½” Casing		
4 C	4” Casing	Additional insertions in Qu Column	
D.M.	Drilling Mud	Pq	Penetrometer reading-tons/square foot
J.W.	Jet Water	S	Torvane reading-tons/square foot
H.A.	Hand Auger	G	Specific Gravity – ASTM D 854-58
NXC	Size NX Casing	SL	Shrinkage limit – ASTM 427-61
BXC	Size BX Casing	pH	Hydrogen ion content-meter method
AXC	Size AX casing	O	Organic content-combustion method
SS	2” O.D. Split Spoon Sample	M.A.*	Grain size analysis
2T	2” Thin Wall Tube Sample	C*	One dimensional consolidation
3T	3” Thin Wall Tube Sample	Qc*	Triaxial Compression
		* See attached data Sheet and/or graph	

Water Level Symbol

Water levels shown on the boring logs were determined at the time and under the conditions indicated. In sand, you may consider the indicated levels reliable for most site conditions. In clay soils, it is not possible to determine the groundwater level within the normal scope of a geotechnical investigation, except where lenses or layers of more pervious water bearing soil are present; and then a long period may be necessary to reach equilibrium. Therefore, the position of the water level symbol for cohesive or mixed soils may not indicate the true level of the groundwater table. We present, if any, available water level information on the boring logs.

Descriptive Terminology

DENSITY		***CONSISTENCY***	
TERM	“N_{60}” VALUE	TERM	“N_{60}” VALUE
Very Loose	0-4	Soft	0-4
Loose	5-8	Medium	5-8
Medium Dense	9 – 15	Rather Stiff	9 – 15
Dense	16 – 30	Stiff	16 – 30
Very Dense	Over 30	Very Stiff	Over 30

Standard “N_{60}” Penetration: Blows per foot of a mechanical hammer using nominal 2-inch OD split spoon as corrected to reflect similar sampling using a Standard Safety Hammer.

Relative Proportions

TERMS	RANGE
Trace	0-5%
A little	5-15%
Some	15-30%
With	30-50%

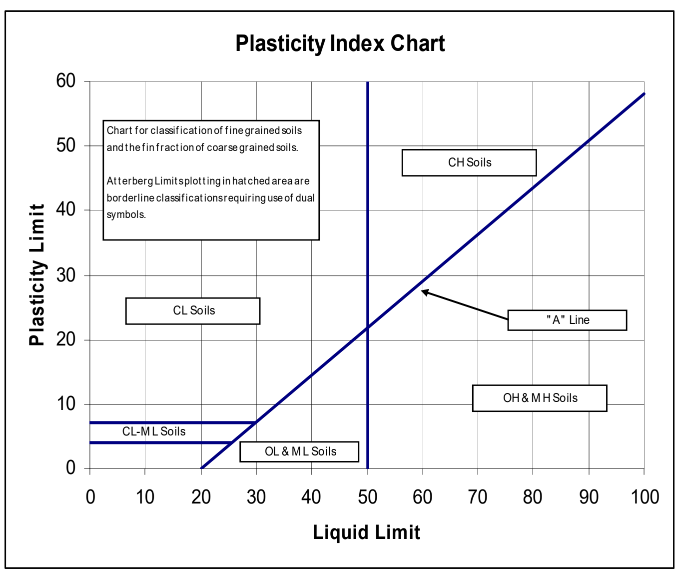
Particle Sizes

MATERIAL	DESTRIPTION	US SIEVE SIZE
Boulders		Over 3”
Gravel -	Coarse	¾” – 3”
	Medium	#4 – ¾”
Sand -	Coarse	#4 - #10
	Medium	#10 - #40
	Fine	#40 - #200
Silt and Clay	Determined by plasticity characteristics.	

Classification of Soils for Engineering Purposes

ASTM Designation D-2487 and D 2488 (Unified Soil Classification System)

Major Divisions			Group Symbol	Typical Name	Classification Criteria		
Course Grained Soils More than 50% retained on No. 200 sieve *	Gravels 50% or more of coarse fraction retained on No. 4 sieve.	Clean Gravels	**GW**	Well –graded gravels and gravel-sand mixtures, little or no fines.	**Classification on basis of percentage of fines.** Less than 5% passing No. 200 Sieve: GW, GP, SW, SP More than 12% passing No. 200 Sieve: GM, GC, SM, SC From 5% to 12% passing No. 200 Sieve: Borderline Classification requiring use of duel symbols.	Cu = D60 / D10 greater than 4. Cz = (D30)2 / (D10 x D60) between 1 & 3.	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines.		Not meeting both criteria for GW materials.	
		Gravels with Fines	**GM**	Silty gravels, gravel-sand-silt mixtures.		Atterberg limits below “A line”, or P.I. less than 4.	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols.
			GC	Clayey gravels, gravel-sand-clay mixtures.		Atterberg limits above “A line” with P.I. greater than 7.	
	Sands More than 50% of coarse fraction passes No 4 sieve.	Clean Sands	**SW**	Well-graded sands and gravelly sands, little or no fines.		Cu = D60 / D10 greater than 6. Cz = (D30)2 / (D10 x D60) between 1 & 3.	
			SP	Poorly-graded sands and gravelly sands, little or no fines.		Not meeting both criteria for SW materials.	
		Sands with Fines	**SM**	Silty sands, sand-silt mixtures.		Atterberg limits below “A line”, or P.I. less than 4.	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols.
			SC	Clayey sands, sand-clay mixtures.		Atterberg limits above “A line” with P.I. greater than 7.	
Fine Grained Soils More than 50% passes No. 200 sieve *	Silts and Clays Liquid Limit of 50% or less		**ML**	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.			
			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 greater than 50%.		**MH**	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.			
			CH	Inorganic clays of high plasticity, fat clays.			
			OH	Organic clays of medium to high plasticity.			
	Highly Organic Soils		**Pt**	Peat, muck and other highly organic soils.			



Excavation Oversize

Excavation oversize facilitates distribution of "load derived" stress to supporting soils. Unless otherwise superseded by report specific requirements, all construction should conform to the minimum oversize and horizontal offset requirements as presented within the diagram and associated chart.

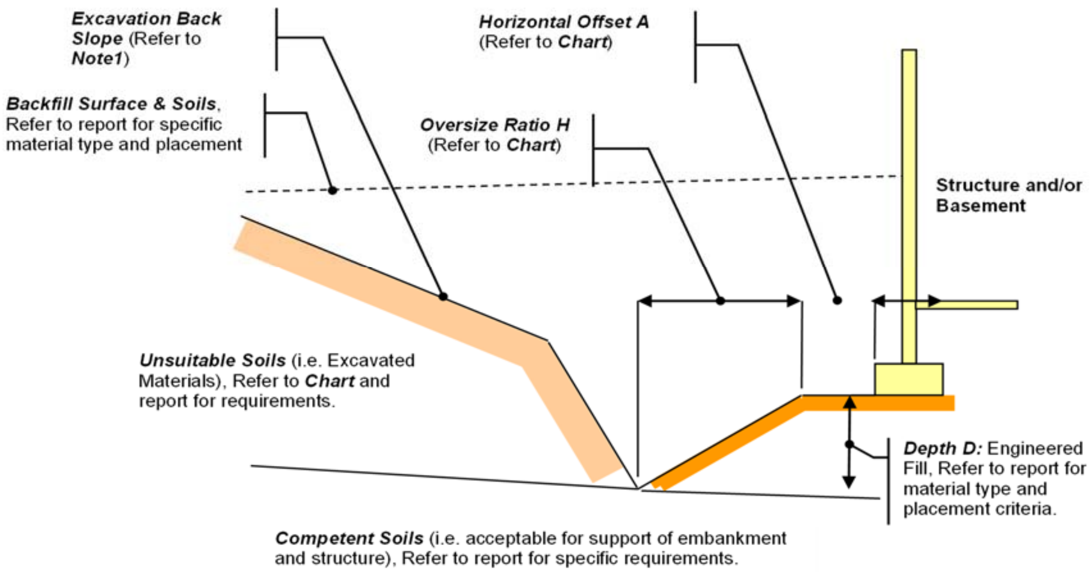


Figure 1: Excavation Oversize

Definitions

Oversize Ratio H: The ratio of the horizontal distance divided by the engineered fill depth (i.e. # Horizontal / Depth D). Refer to Chart for specific requirements.

Horizontal Offset A: The horizontal distance between the outside edge of footing or critical position, and the crest of the engineered fill section. Refer to Chart for specific requirements.

Note 1: Excavation depth and sidewall inclination should not exceed those specified in local, state or federal regulations including those defined by Subpart P of Chapter 27, 29 CFR Part 1926 (of Federal Register). You may need to widen and slope, or temporarily brace excavations to maintain or develop a safe work environment. Contractor is solely responsible for assessing stability under "means and methods".

Condition	***Unsuitable Soil Type***	***Horizontal Offset A***	***Oversize Ratio H***
Foundation Unit Load equal to or less than 3,000 psf.	SP, SM soils, CL & CH soils with cohesion greater than 1,000 psf	2 feet or width of footing, whichever is greater	Equal to or greater than one (1) x Depth D
Foundation Unit Load greater than 3,000 psf	SP, SM soils, CL & CH soils with cohesion less than 1,000 psf	5 feet or width of footing, whichever is greater	Equal to or greater than one (1) x Depth D
Foundation Unit Load equal to or less than 3,000 psf.	Topsoil or Peat	2 feet or width of footing, whichever is greater	Equal to or greater than two (2) x Depth D
Foundation Unit Load greater than 3,000 psf	Topsoil or Peat	5 feet or width of footing, whichever is greater	Equal to or greater than two (3) x Depth D

APPENDIX B

This page intentionally left blank.

GROUNDWATER ISSUES

The following presents additional comment and soil specific issues related to measurement of groundwater conditions at your project site.

Note that our groundwater measurements, or lack thereof, will vary depending on the time allowed for equilibrium to occur in the borings. Extended observation time was not available during the scope of the field exploration program and, therefore, groundwater measurements as noted on the boring logs may or may not accurately reflect actual conditions at your site.

Seasonal and yearly fluctuations of the groundwater level, if any, occur. Perched groundwater may be present within sand and silt lenses bedded within cohesive soil formations. Groundwater typically exists at depth within cohesive and cohesionless soils.

Documentation of the local groundwater surface and any perched groundwater conditions at the project site would require installation of temporary piezometers and extended monitoring due to the relatively low permeability exhibited by the site soils. We have not performed such groundwater evaluation due to the scope of services authorized for this project.

We anticipate pumps installed within temporary sumps should control subsurface seepage from perched conditions. However, we caution such seepage from such formations and any water entry from excavations below the groundwater table may be heavy and will vary based on seasonal and annual precipitation, and ground related impacts in vicinity of project.

GEOTEXTILE FABRIC and GEOGRID REINFORCEMENT

Unless otherwise amended by report, we recommend installation of a geotextile separation fabric between the native soils and the engineered fill section below project foundations, floors and/or between a clay subgrade and aggregate base of pavement construction. It is our opinion this geotextile should consist of a non-woven, needle punched or woven, fabric conforming to the following tabulated parameters.

Geotextile Separation Fabric Properties [1]

Parameter	***Requirement***
Base Yarn	Polypropylene
Apparent Opening Size [AOS, US. Sieve]	40 – 70
Permitivity [gal/min/sq. ft CH, ASTM D 4491]	110
Grab Tensile Strength [lbs, %, ASTM D 4632]	160 lbs by 160 lbs at 50% by 50% strain

1. All physical strength properties are minimum average roll values [MARV], unless noted otherwise.

We recommend that the geotextile panels be oriented parallel with proposed aggregate placement activities, and occur in such a manner that the overall number of individual panels are kept to a minimum. As placed, individual panels of geotextile should have a width equal to or greater than 12 feet. We recommend that the Contractor overlap longitudinal and butt seam of adjacent panels a minimum of 18 inches with such joints oriented to follow initial construction traffic (shingles profile with traffic).

Geogrid Reinforcement provided for support of permanent structural loads requires separate evaluation based on project specific conditions and applied loading. Such work is beyond the scope of findings as presented by this report.

Unless otherwise amended by report, Geogrid Reinforcement for placement below pavements should consist of material and provide properties as outlined within the following tabulation.

Geogrid Reinforcement of Aggregate Base Section [1]

Parameter	***Requirement***
Base Yarn	Polypropylene
Aperture Size [inch by inch]	Minimum 1.5 by 1.5, Maximum 1.75 by 1.75
Wide Width Tensile Strength [lbs/ft, ASTM D 6637]	Minimum 800 MD by 800 CD at 2% strain
	Minimum 1600 MD by 1,600 CD at 5% strain
	Minimum 2,000 MD by 2,000 CD at ultimate strain
Tensile Modulus [lb/ft, ASTM D 6637	Minimum 41,000 MD by 41,000 CD at 2% strain
	Minimum 32,000 MD by 32,000 CD at 5% strain

2. All physical strength properties are minimum average roll values [MARV], unless noted otherwise.

The Table B geogrid should be placed above the above recommended geotextile separation fabric with individual 12-foot minimum width individual panels of geogrid reinforcement oriented parallel to major traffic movement. Side seams of geogrid reinforcement must be overlapped no less than 12 inches while butt seams of geogrid should be overlapped no less than 24 inches.

PLACEMENT and COMPACTION OF ENGINEERED FILL

Unless otherwise superseded within the body of the Geotechnical Exploration Report, we recommend you following the following criteria for placement of engineered fill on project. This includes, but is not limited to earthen fill placement to improve site grades, fill placed below structural footings, fill placed interior of structure, and fill placed as backfill of foundations.

Engineered fill placed for construction, if necessary, should consist of natural, non-organic, competent soils native to the project area. Such soils may include, but are not limited to gravel, sand, or clays with Unified Soil Classification System (ASTM D2488) classifications of GW, SP, SM, CL or CH. Use of silt or clayey silt as project fill will require additional review and approval of project Geotechnical Engineer of Record. Such soils have USCS classifications of ML, MH, ML-CL, and MH-CH. *You must never use topsoil, marl, peat, other organic soils construction debris, and/or other unsuitable materials as engineered fill. Such soils have USCS classifications of OL, OH, Pt.*

You should temper engineered fill, classified as clay for moisture content at the time of placement equal to and no more than four percent above the optimum content for as defined by the appropriate proctor test. Likewise, you should temper engineered granular fill [gravel or sand] such that moisture content at the time of placement enables compaction to appropriate criteria.

You should place all engineered fill in individual 8- inch maximum depth lifts. Each lift of fill should be compacted by large vibratory equipment until the in-place soil density is equal to or greater than the criteria established within the following tabulation.

Type of Construction	***Compaction Criteria (% respective Proctor)*** [1]	
	Clay	Sand or Gravel
General Embankment Fill	95 to 100	Min. 95
Engineered Fill below Foundations	Min. 95	Min. 95
Engineered Fill below Floor Slabs	95 to 98	Min. 95
Engineered Fill placed against Foundation Walls	95 to 98	95 to 100
Engineered Fill placed as Pavement Subgrade	Min. 95	Min. 95
Engineered Fill placed as Pavement Aggregate Base	NA	Min. 98
Engineered Fill placed within Utility Trench (to within 3 feet of pavement aggregate base or final grade	Min. 95	Min. 95
Engineered Fill placed as Utility Trench Fill (within 3 feet of pavement aggregate base or final grade	Min. 98	Min. 98

1 Unless otherwise required, compaction criteria per Standard Proctor Test (ASTM D698).

Density tests should be taken during engineered fill placement to document earthwork has achieved necessary compaction of the material(s). Recommendations for interior fill placement and backfill of foundation walls presented within other sections of this report.

SWELLING of CLAY SOILS

Swell of clay soil occurs when moderate to highly desiccated, "over consolidated", moderate to highly plastic clay absorbs moisture concurrent within removal of overburden pressure. The fat clay soils comprising the Glacial Lake Agassiz formation have "moderate" to "high risk" of swelling when conditions favorable for heave occur.

Clay minerals are generally elongated bipolar charged particles aligned in plate like structures. Absorption of water by the clay minerals is cause, in part, by the electrical attraction between the bipolar mineral and the electrical charged water molecule. The electrical attraction at the molecular level is a strong bond that forces separation of the clay particle into a stratified system of bonded clay and water. The resulting composite system has greatly increased volume as compared to the original clay minerals.

Major clay minerals include Kaolinite, Holloysite, Illite, Calcium Montmorillonite, Sodium Montmorillonite, and Sodium Hectorite. Mielenz and King (1955) have noted that absorption of water by clays leads to expansion or swelling with magnitude of swelling varied widely depending upon the type and quantity of clay mineral present, their exchangeable ions, electrolyte content of the aqueous phase, particle-size distribution, void size and distribution, the internal structure, water content, superimposed load, and possibly other factors. Research geology professor Mr. Ralph Grim [University of Illinois] collaborates free swelling of clay minerals varied widely [see below referenced table].

Free Swelling Data for Clay Minerals (%) [After Mielenz and King, 1955]

Clay Mineral Type	*Sample Source*	*Percent Swell*
Calcium Montmorillonite:	Forest, Mississippi	145
	Wilson Creek Dam, Colorado	95
	Davis Dam, Arizona	45 - 85
	Osage, Wyoming (prepared from Na-Mont.)	125
Sodium Montmorillonite:	Osage, Wyoming	1,400 - 1,600
Sodium Hectorite:	Hector, California	1,600 - 2,000
Illite:	Fithian, Illinois	115 - 120
	Morris, Illinois	60
	Tazewell, Virginia	15
Kaolinite:	Mesa Alta, New Mexico	5
	Macon, Georgia	60
	Langley, North Carolina	20
Halloysite:	Santa Rita, New Mexico	70

As shown above, the effective range of swell in percent varies widely from as little as 5% with Kaolinite to 2,000% with Sodium Hectorite. Of major concern, regional clay soils typically include varying concentration of montmorillonite mineral [commonly defined as smectite]. Note that defining the percent content and mineral type of clay soils calls for very costly and time intensive laboratory analysis. We cannot make such determination through visual classification or simple laboratory testing of soil samples.

You may achieve reduction of free swell through reduction or chemical modification of high swell mineral, elimination of water absorption, and/or replacement by soils having no risk of swell. Each of these issues requires further review and/or modification to recommendations of this report. Such may include but are not limited to the isolation of lightly loaded floor slabs from more heavily loaded foundation element, allowing unhindered movement between walls / floor and any piped penetrations and, most importantly, providing continuous automated drainage of site during construction and permanent subsurface drainage of foundations and at-grade floors long term. Lacking access to moisture, heave prone clay soils typically experience minimal volume change.

MUD SLAB CONSTRUCTION

Historically, construction typically installed a thin concrete “mud slab” at the base of project excavations to minimize further disturbance to supporting soils with construction of project. This placement also provides confirmed separation between foundation and earth thereby allowing lesser depth of concrete cover of footing reinforcement. Recent use of “mud slab” placement on other project has proved beneficial in maintaining schedule of construction in addition to above described benefits.

Forgoing any specific recommendation of report, we recommend you place a nominal 3-inch thick concrete “mud slab” across exposed clay soils within excavations advanced for project. The lean concrete for the “mud slab” should consist of a cementitious sand slurry mixture designed to provide a 28-day compressive strength on the order or slightly in excess of 300 pounds per square inch (psi). Compressive strengths below this threshold can result in premature failure of the protective system, while compressive strengths in excess of this threshold make installation of staking or construction of plumbing / electrical systems difficult. Slump of the lean concrete mixture should range between five and seven inches.

PROJECT SUMPS

The collection, control and removal of seepage and runoff from within project excavations is critical in maintaining the bearing capacity of native soils, in-place density of engineered fill and stability of embankments at project excavations.

As constructed, it is our opinion all sumps should consist of a 2 foot by 2 foot or larger plan dimension excavation(s) located adjacent to and directly exterior to the excavation oversize limit for structural engineered fill [see appended Figure 1]. Sump excavations should extend a minimum of 2 feet below the base of the excavation for collection of seepage and runoff.

You should line all sumps with a non-woven, needle-punched, geotextile having a grab tensile strength equal to or greater than 70 pounds per square inch (psi). A standpipe of 12 inches in diameter or larger should be centered within the sump excavation. This pipe should include sufficient openings for entry of seepage. We recommend that the standpipe extend to the ground surface to facilitate pumping during project construction. Infill within the sump area should consist of a 1½ to ¾ inch clear rock placed between the standpipe and walls of the sump excavation.

Pump sump(s) until completion of the construction or until the Geotechnical Engineer of Record indicates such pumping is no longer necessary for stability of the project footings and related construction. Properly abandon or remove sumps per the more stringent of methods required by the Geotechnical Engineer of Record, or per Federal, State and local governmental statutes.

Discharge from sumps should be directed away from site and be disposed within storm water systems or other systems which comply with Federal, State and local governmental statute. As constructed and operated, the General Contractor should be responsible for all permits, operation and abandonment of sumps or other temporary dewatering systems.

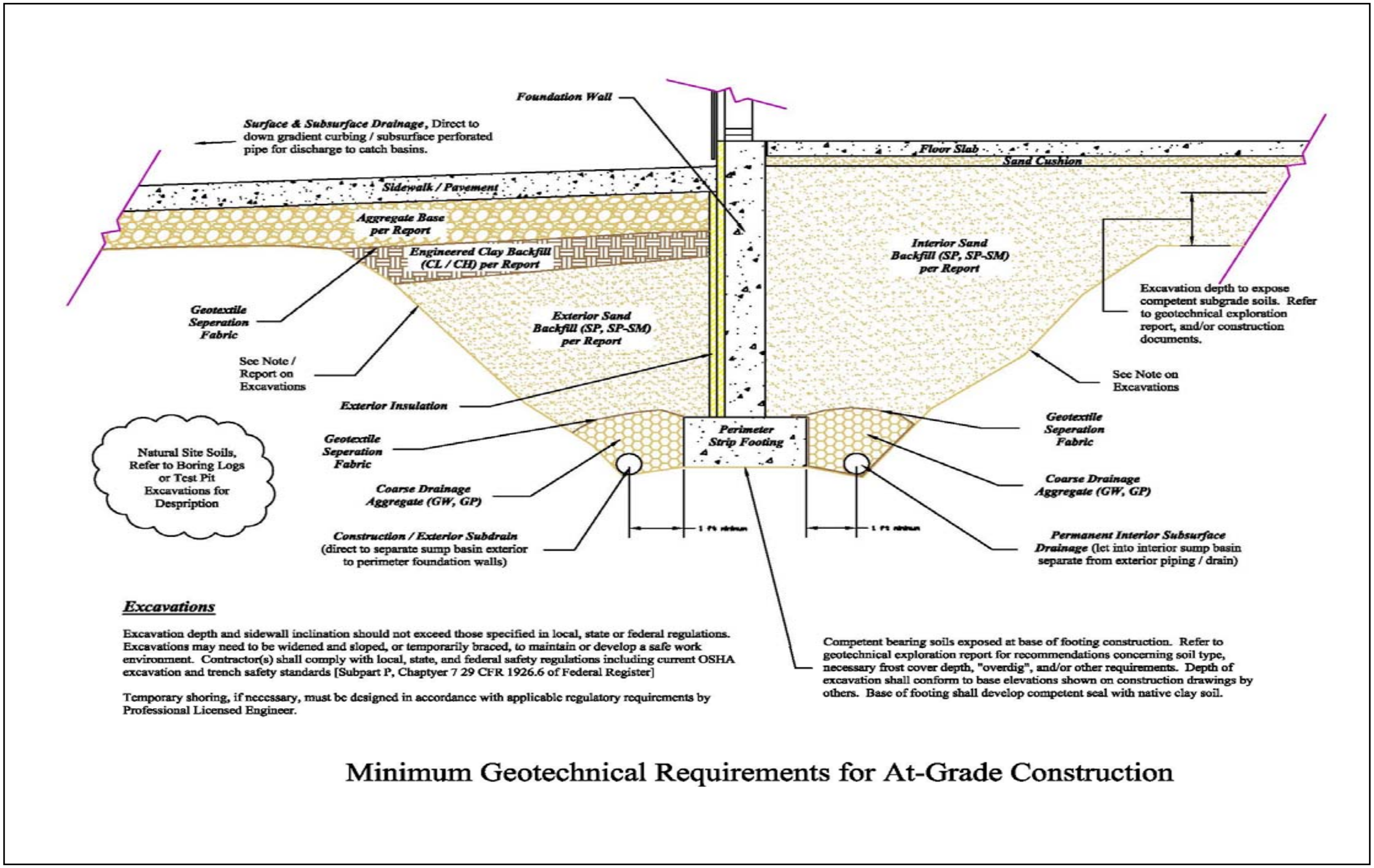


Figure 2: Minimum Geotechnical Requirements for At-Grade Construction

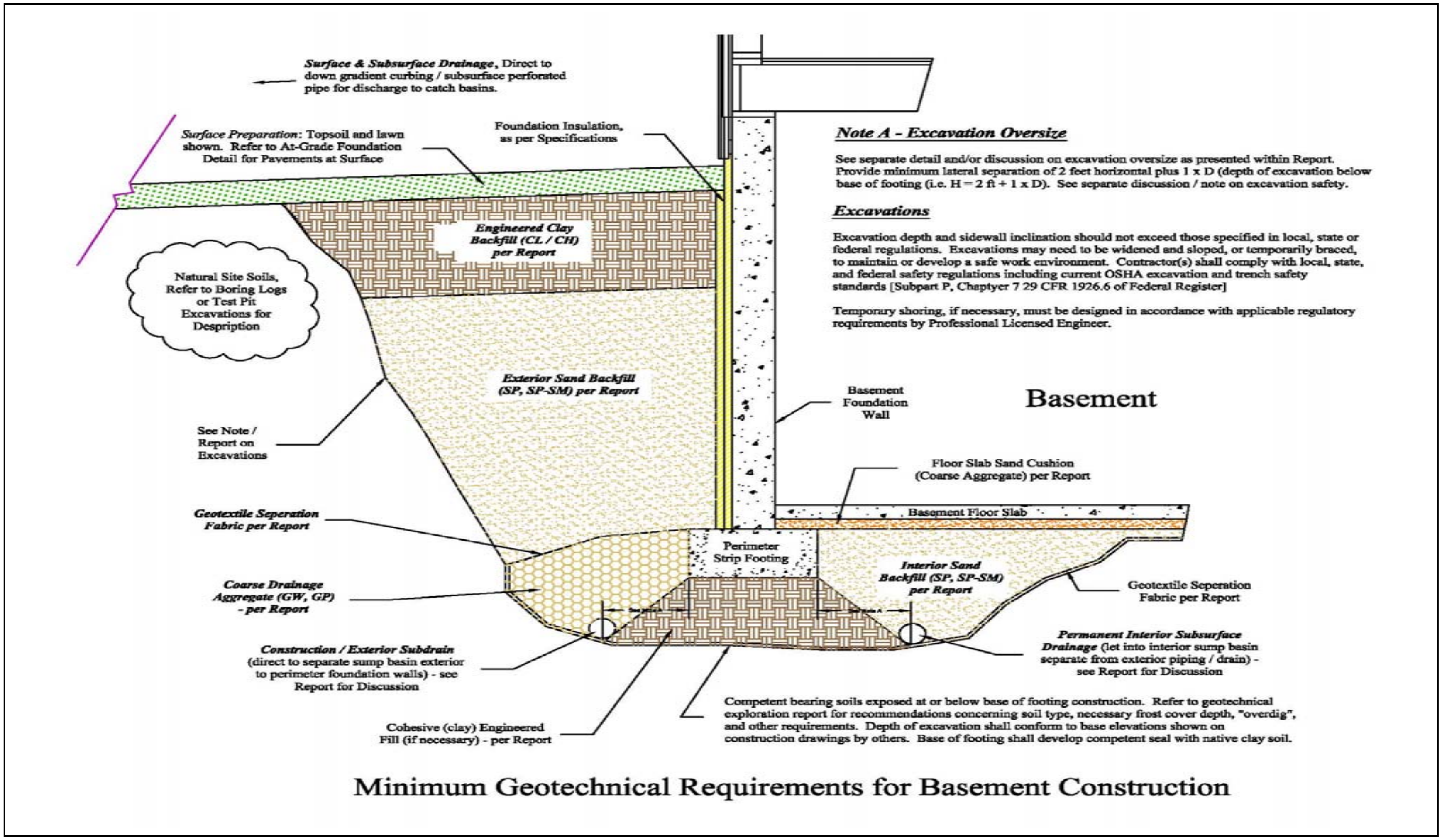


Figure 3: Minimum Geotechnical Requirements for Basement Construction

APPENDIX C

This page intentionally left blank.


Fargo VA - Building 1 Expansion
Project #20.FGO10880.000
Fargo, North Dakota
Legend
Soil Boring
Temporary Benchmark
TBM
SB-04
SB-03
SB-02
SB-01
Google Earth
© 2020 Google
N
100 ft

Northern Technologies LLC
3522 4th Ave S
Fargo, ND 58103
P: 701.232.1822 F: 701.232.1864
www.NTIGEO.com

BORING NUMBER SB-01

Long: -96.774007
Lat: 46.905391

CLIENT FOURFRONT Design, Inc.
PROJECT NAME Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 10/8/20 **COMPLETED** 10/8/20
GROUND ELEVATION 193.2 feet **HOLE SIZE** 6 1/2 in.
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4 in. H.S.A. then Rotary Drilling with Mud
AT TIME OF DRILLING --- --
LOGGED BY Chris Nelson **CHECKED BY** Dan Gibson
AT END OF DRILLING ---
CAVE IN (ft) NR **FROST DEPTH (ft)** NA
AFTER DRILLING ---
NOTES

DEPTH (ft)	MATERIAL DESCRIPTION	Elev.	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES
0.4	4.5" of CONCRETE	192.8	AU 1									
0.6	FILL, SILTY SAND, brown, fine to coarse grained, trace gravel	192.6										
4.0	FILL, FAT CLAY, black to dark brown	189.2	SS 2	78	5-6-9 (15)		90	31				
6.5	FILL, FAT CLAY, dark brown	186.7	SS 3	78	3-3-6 (9)	3.0	89	32				
9.0	FILL, FAT CLAY, bluish gray to black, organic odor	184.2	SS 4	67	2-2-3 (5)	1.0	82	42				
15.0	FILL, FAT CLAY, black to gray	178.2	SS 5	78	2-2-3 (5)	0.6	72	45				
			SS 6	33	2-1-2 (3)	0.8		39				
17.0	FAT CLAY, (CH) bluish gray, soft	176.2	SS 7	78	2-2-2 (4)	1.8	94	30				
27.0	FAT CLAY, (CH) brown, rather stiff to medium	166.2	SS 8	94	2-4-5 (9)	2.1	98	27				
			SS 9	94	3-4-5 (9)	2.7	94	30				
			SS 10	111	2-3-4 (7)	2.5	96	30				
	FAT CLAY, (CH) dark gray, soft		SS 11	133	1-2-2 (4)	1.3	65	60				
			SS 12	133	1-1-2 (3)	0.8	64	62				

(Continued Next Page)

NTI LOG - GENERAL WITH PHOTOS - NTI-2019-10-24.GDT - 11/18/20 10:01 - C:\USERS\CHRISN\DESKTOP\DESKTOP PROJECTS\2020 DESKTOP PROJECTS\FARGO VA - BUILDING 1 EXPANSION\FARGO VA - BUILDING 1 EXPANSION.GPJ

Northern Technologies LLC
3522 4th Ave S
Fargo, ND 58103
P: 701.232.1822 F: 701.232.1864
www.NTIGEO.com

BORING NUMBER SB-01

Long: -96.774007
Lat: 46.905391

CLIENT FOURFRONT Design, Inc. **PROJECT NAME** Fargo VA - Building 1 Expansion

PROJECT NUMBER 20.FGO10880.000 **PROJECT LOCATION** Fargo, North Dakota

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES
40		FAT CLAY, (CH) dark gray, soft *(continued)*										
45			SS 13	133	1-1-2 (3)	0.7	58	76				
50												
55			SS 14	133	1-1-1 (2)	0.6	64	64				
60												
65			SS 15	133	1-1-2 (3)	0.8	76	48				
70												
75			SS 16	133	1-1-1 (2)	0.7	75	49				
80												

(Continued Next Page)

Northern Technologies LLC
3522 4th Ave S
Fargo, ND 58103
P: 701.232.1822 F: 701.232.1864
www.NTIGEO.com

BORING NUMBER SB-01

Long: -96.774007
Lat: 46.905391

CLIENT FOURFRONT Design, Inc. **PROJECT NAME** Fargo VA - Building 1 Expansion

PROJECT NUMBER 20.FGO10880.000 **PROJECT LOCATION** Fargo, North Dakota

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES
		FAT CLAY, (CH) dark gray, soft *(continued)*										
85			SS 17	133	1-2-2 (4)	0.7	73	50				
90												
91.5		(Elev. 101.7) POORLY GRADED GRAVEL, (GP) gray, wet, very dense										
93.0		(Elev. 100.2) SANDY LEAN CLAY, (CL) dark gray, very stiff, trace gravel										
95			SS 18	44	4-25-46 (71)	6.0	106	12				
97.0		(Elev. 96.2) LEAN CLAY, (CL) dark gray, very stiff, trace sand, trace gravel										
100			SS 19	56	13-20-14 (34)	2.3	105	22				
105			SS 20		21-79/5"							
110			SS 21	94	16-54-37 (91)	6.0	109	18				
111.0		(Elev. 82.2)										

Bottom of borehole at 111.0 feet.
Borehole grouted.

NTI LOG - GENERAL WITH PHOTOS - NTI-2019-10-24.GDT - 11/18/20 10:01 - C:\USERS\CHRISN\DESKTOP\DESKTOP PROJECTS\2020 DESKTOP PROJECTS\FARGO VA - BUILDING 1 EXPANSION\FARGO VA - BUILDING 1 EXPANSION.GPJ

Northern Technologies LLC
3522 4th Ave S
Fargo, ND 58103
P: 701.232.1822 F: 701.232.1864
www.NTIGEO.com

BORING NUMBER SB-02

Long: -96.77389
Lat: 46.90554

CLIENT FOURFRONT Design, Inc. **PROJECT NAME** Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000 **PROJECT LOCATION** Fargo, North Dakota
DATE STARTED 10/7/20 **COMPLETED** 10/7/20 **GROUND ELEVATION** 194.7 feet **HOLE SIZE** 6 1/2 in.
DRILLING CONTRACTOR NTI **GROUND WATER LEVELS:**
DRILLING METHOD 3 1/4 in H.S.A **AT TIME OF DRILLING** --- No Groundwater Encountered
LOGGED BY Chris Nelson **CHECKED BY** Dan Gibson **AT END OF DRILLING** ---
CAVE IN (ft) NR **FROST DEPTH (ft)** NA **AFTER DRILLING** ---
NOTES

DEPTH (ft)	MATERIAL DESCRIPTION	Elev.	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES
0.3	TOPSOIL, ORGANIC CLAY, (OH) black	194.5	AU 1									
	FILL, FAT CLAY, brown to black, trace lenses of sand		SS 2	44	3-3-5 (8)	2.1	88	29				
			SS 3	56	2-2-4 (6)	2.2	80	34				
6.5	FAT CLAY, (CH) brown, medium	188.2	SS 4	78	2-2-3 (5)	1.2	88	34				
9.0	FAT CLAY, (CH) dark gray, medium	185.7	SS 5	83	2-2-3 (5)	1.4	91	32				
11.5	FAT CLAY, (CH) brown, medium	183.2	SS 6	94	2-2-4 (6)	1.2	91	33				
			SS 7	111	2-3-5 (8)	1.7	91	32				
			SS 8	100	2-4-4 (8)	1.5	96	30				
19.0	FAT CLAY, (CH) brown to gray, rather stiff, trace laminations of silt	175.7	SS 9	111	4-4-8 (12)	2.8	94	29				
23.0	FAT CLAY, (CH) brown, rather stiff	171.7										
26.0		168.7	SS 10	111	3-5-6 (11)	2.8	95	29				

Bottom of borehole at 26.0 feet.
Borehole backfilled with auger cuttings.

NTI NORTHERN TECHNOLOGIES, LLC

Fargo
3522 4th Ave S
Fargo, ND 58103
P: 701.232.1822 F: 701.232.1864
www.NTIgeo.com

BORING NUMBER SB-03

Long: -96° 46' 25.5288"
Lat: 46° 54' 20.3652"

CLIENT FOURFRONT Design, Inc. **PROJECT NAME** Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000 **PROJECT LOCATION** Fargo, North Dakota
DATE STARTED 10/9/20 **COMPLETED** 10/9/20 **GROUND ELEVATION** 194.7 feet **HOLE SIZE** 6 1/2 in.
DRILLING CONTRACTOR NTI **GROUND WATER LEVELS:**
DRILLING METHOD 3 1/4 in. H.S.A. then Rotary Drilling with Mud **AT TIME OF DRILLING** --- --
LOGGED BY Chris Nelson **CHECKED BY** Dan Gibson **AT END OF DRILLING** ---
CAVE IN (ft) NR **FROST DEPTH (ft)** NA **AFTER DRILLING** ---
NOTES

DEPTH (ft)	MATERIAL DESCRIPTION	ELEV.	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES
0.3	TOPSOIL, ORGANIC CLAY, (OH) black	194.5	AU 1									
	FILL, FAT CLAY, dark brown to black, trace sand		SS 2	56	4-4-5 (9)		90	28				
			SS 3	56	4-4-5 (9)	3.0	91	28				
6.2	FAT CLAY, (CH) brown, medium	188.5	SS 4	67	3-3-4 (7)	2.8	92	31				
9.0	FAT CLAY, (CH) gray, medium	185.7	SS 5	83	3-3-4 (7)	1.1	88	35				
11.5	FAT CLAY, (CH) dark gray, medium	183.2	SS 6	89	2-3-4 (7)	1.3	88	33				
			SS 7	111	2-2-3 (5)	1.3	78	42				
18.0	FAT CLAY, (CH) gray, medium	176.7	SS 8	117	2-2-3 (5)	2.0	90	31				
19.0	FAT CLAY, (CH) brown to gray, medium	175.7	SS 9	100	2-3-4 (7)	2.4	91	32				
23.0	FAT CLAY, (CH) light brown to light gray, medium	171.7	SS 10	94	2-3-3 (6)	1.5	95	30				
			SS 11	100	2-3-5 (8)	1.8	92	30				
35.0	FAT CLAY, (CH) dark gray, soft	159.7	SS 12	133	0-1-2 (3)	0.8	60	66				

(Continued Next Page)

NTI LOG - GENERAL (USE THIS ONE) - NTI-2017-09-14.GDT - 11/25/20 15:05 - R:\FARGO\PROJECTS\GEO\GEOREP 2020\FARGO VA BLDG 1 ADDITION\FARGO VA - BUILDING 1 EXPANSION.GPJ

Fargo
3522 4th Ave S
Fargo, ND 58103
P: 701.232.1822 F: 701.232.1864
www.NTIgeo.com

BORING NUMBER SB-03

Long: -96° 46' 25.5288"
Lat: 46° 54' 20.3652"

CLIENT FOURFRONT Design, Inc.
PROJECT NAME Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000
PROJECT LOCATION Fargo, North Dakota

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES
40		FAT CLAY, (CH) dark gray, soft *(continued)*										
45			SS 13	133	1-1-2 (3)	0.6	60	67				
50												
55			SS 14	133	1-1-1 (2)	0.6	63	63				
60												
65			SS 15	133	1-1-2 (3)	0.6	69	55				
70												
75			SS 16	133	1-2-2 (4)	0.8	75	48				
80												

(Continued Next Page)

NTI LOG - GENERAL (USE THIS ONE) - NTI-2017-09-14.GDT - 11/25/20 15:05 - R:\FARGO\PROJECTS\GEO\GEOREP 2020\FARGO VA BLDG 1 ADDITION\FARGO VA - BUILDING 1 EXPANSION.GPJ

NTI NORTHERN TECHNOLOGIES, LLC

Fargo
3522 4th Ave S
Fargo, ND 58103
P: 701.232.1822 F: 701.232.1864
www.NTIgeo.com

BORING NUMBER SB-03

Long: -96° 46' 25.5288"
Lat: 46° 54' 20.3652"

CLIENT FOURFRONT Design, Inc. **PROJECT NAME** Fargo VA - Building 1 Expansion

PROJECT NUMBER 20.FGO10880.000 **PROJECT LOCATION** Fargo, North Dakota

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES
		FAT CLAY, (CH) dark gray, soft *(continued)*											
85				SS 17	133	2-2-2 (4)	0.7	80	42				
90													
93.0		POORLY GRADED GRAVEL, (GP) gray	101.7										
94.0		LEAN CLAY, (CL) dark gray, very stiff, trace sand, trace gravel	100.7										
95.0		SILTY SAND, (SM) dark red, very dense	99.7	SS 18	100	21-30-63 (93)	6.0	107	16				
100				SS 19	85	39-61/6"							
103.0		SANDY LEAN CLAY, (CL) dark gray, very stiff, trace gravel	91.7										
105				SS 20			4.9	109	15				
106.0			88.7										

Bottom of borehole at 106.0 feet.
Borehole grouted.

BORING NUMBER SB-04

Northern Technologies LLC
3522 4th Ave S
Fargo, ND 58103
P: 701.232.1822 F: 701.232.1864
www.NTIGEO.com

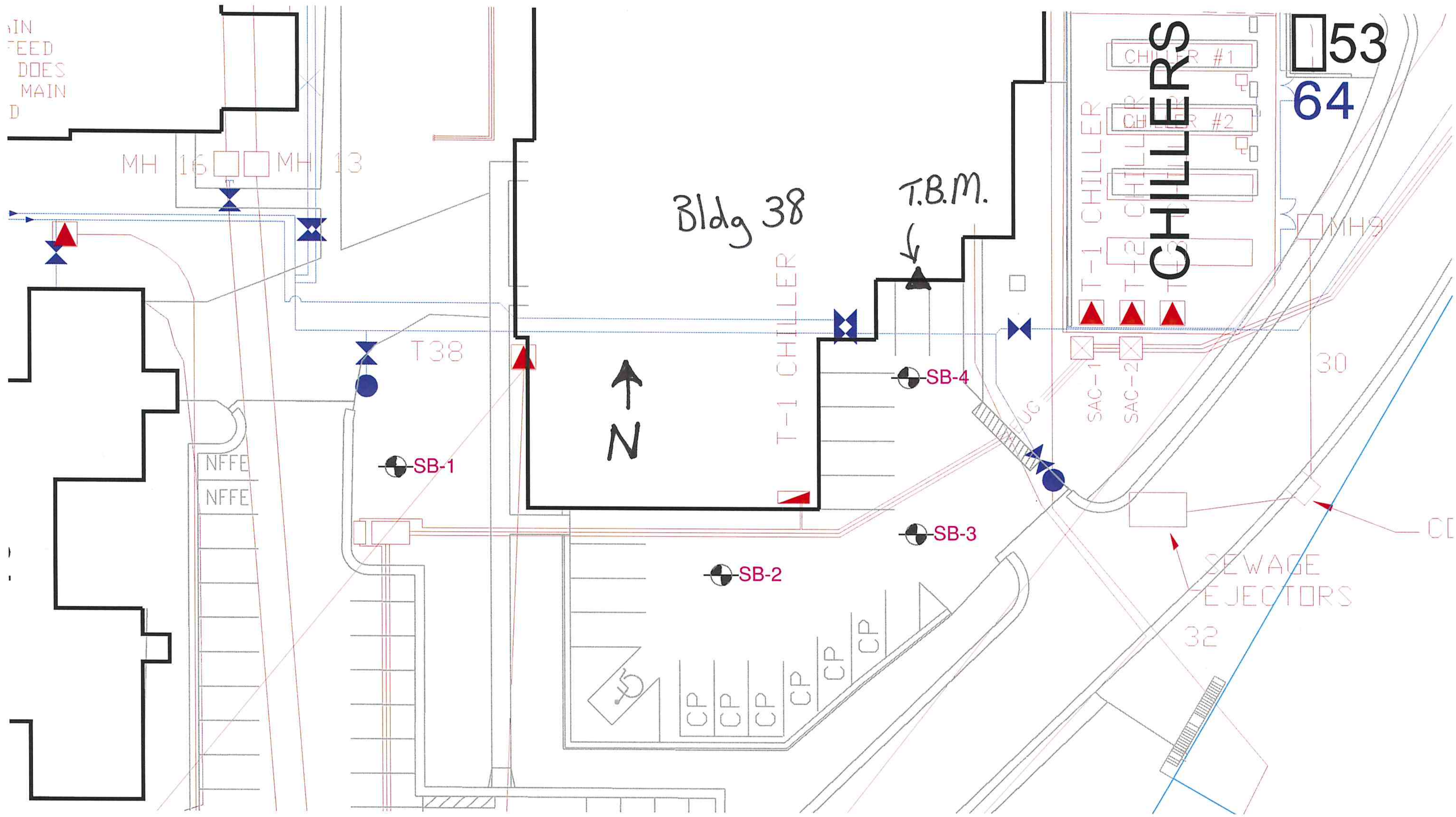
Long: -96.773966
Lat: 46.905681

CLIENT FOURFRONT Design, Inc.
PROJECT NAME Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 10/7/20 **COMPLETED** 10/7/20
GROUND ELEVATION 195.9 feet **HOLE SIZE** 6 1/2 in.
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4 in H.S.A
▽ **AT TIME OF DRILLING** 9.00 ft / Elev 186.90 ft
LOGGED BY Chris Nelson **CHECKED BY** Dan Gibson
AT END OF DRILLING ---
CAVE IN (ft) NR **FROST DEPTH (ft)** NA
AFTER DRILLING ---
NOTES

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	Elev.	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES
0–0.5	Topsoil	TOPSOIL, ORGANIC CLAY, (OH) black	195.4	AU 1									
0.5–6.5	Fill	FILL, FAT CLAY, brown to black	189.4										
				SS 2	44	3-2-3 (5)	1.7	88	34				
				SS 3	56	2-2-4 (6)	1.8						
6.5–11.5	CH	FAT CLAY, (CH) dark brown, moist, medium to soft	184.4										
				SS 4	94	2-2-3 (5)	1.6	91	34				
		▽ (water level)											
				SS 5	106	2-2-2 (4)	1.0	80	45				
11.5–23.0	CH	FAT CLAY, (CH) brown, moist, medium to rather stiff	172.9										
				SS 6	111	2-2-4 (6)	1.8	94	32				
				SS 7	111	2-4-5 (9)	3.5	96	29				
				SS 8	117	2-4-4 (8)	2.7	98	28				
				SS 9	117	3-6-7 (13)	4.7	100	27				
23.0–26.0	CH	FAT CLAY, (CH) dark gray, medium	169.9										
				SS 10	133	2-3-3 (6)	0.9	63	62				

Bottom of borehole at 26.0 feet.
Borehole backfilled with auger cuttings.

NTI LOG - GENERAL WITH PHOTOS - NTI-2019-10-24.GDT - 11/18/20 10:01 - C:\USERS\CHRISN\DESKTOP\DESKTOP PROJECTS\2020 DESKTOP PROJECTS\FARGO VA - BUILDING 1 EXPANSION\FARGO VA - BUILDING 1 EXPANSION.GPJ


53
64
CHILLERS
CHILLER #1
CHILLER #2
T-1 CHILLER
T-2 CHILLER
SAC-1
SAC-2
MH9
30
32
SEWAGE
EJECTORS
UG
T.B.M.
Bldg 38
N
SB-1
SB-2
SB-3
SB-4
T38
MH 16
MH 13
NFFE
NFFE
CP

Northern Technologies, Inc.
3522 4th Avenue So.
Fargo, North Dakota 58103
Telephone: 701-232-1822
Fax: 701-232-1864

BORING NUMBER SB-1

CLIENT Image Group Architecture and Interiors
PROJECT NAME VA Medical Center - Outpatient Treatment Space
PROJECT NUMBER 11-11161.100
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 7/17/11 **COMPLETED** 7/17/11
GROUND ELEVATION 87.4 ft **HOLE SIZE** 6 1/2"
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4" H.S.A.
AT TIME OF DRILLING ---
LOGGED BY TS **CHECKED BY** DG
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							**Topsoil / Fill,** Organic fat clay, black (OH)
	AU 1						
	SS 2		4-4-6 (10)				
5	SS 3		5-6-8 (14)				
7.0							80.4
	SS 4		2-4-5 (9)	PP = 3.4 tsf MC = 30% DD = 92 pcf	CH		Fat Clay, brown and gray, lenses of light gray silt, rather stiff to medium (CH)
10	SS 5		2-3-6 (9)	PP = 2.9 tsf MC = 32% DD = 90 pcf			
	SS 6		2-3-4 (7)	PP = 1.7 tsf MC = 29% DD = 94 pcf			
15	SS 7		1-3-5 (8)	PP = 2.3 tsf MC = 31% DD = 90 pcf			
20	SS 8		1-4-5 (9)	PP = 2.7 tsf MC = 28% DD = 96 pcf Qu = 450 psf			
25	SS 9		2-3-5 (8)	PP = 1.8 tsf MC = 31% DD = 91 pcf Qu = 875 psf			
27.5							59.9
					CH		Fat Clay, dark gray, soft (CH)
30	SS 10	89	2-3-5 (8)	PP = 3.0 tsf MC = 36% DD = 86 pcf Qu = 500 psf			
35							
40							

(Continued Next Page)

Northern Technologies, Inc.
3522 4th Avenue So.
Fargo, North Dakota 58103
Telephone: 701-232-1822
Fax: 701-232-1864

BORING NUMBER SB-1

CLIENT Image Group Architecture and Interiors
PROJECT NAME VA Medical Center - Outpatient Treatment Space
PROJECT NUMBER 11-11161.100
PROJECT LOCATION Fargo, North Dakota

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40	SS 11	111	1-1-1 (2)	PP = 0.5 tsf MC = 73% DD = 59 pcf	CH		Fat Clay, dark gray, soft (CH) *(continued)*
50	SS 12	111	0-1-1 (2)	PP = 0.5 tsf MC = 70% DD = 59 pcf			
60	SS 13	111	0-0-1 (1)	PP = 0.5 tsf MC = 56% DD = 68 pcf			
70	SS 14	111	0-1-2 (3)	PP = 0.5 tsf MC = 60% DD = 65 pcf			
80	SS 15	111	1-2-2 (4)	PP = 0.1 tsf MC = 71%			
85							

(Continued Next Page)

Northern Technologies, Inc.
3522 4th Avenue So.
Fargo, North Dakota 58103
Telephone: 701-232-1822
Fax: 701-232-1864

BORING NUMBER SB-1

CLIENT Image Group Architecture and Interiors
PROJECT NAME VA Medical Center - Outpatient Treatment Space
PROJECT NUMBER 11-11161.100
PROJECT LOCATION Fargo, North Dakota

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
							Fat Clay, dark gray, soft (CH) *(continued)*
90	SS 16	28	2-2-2 (4)	PP = 0.1 tsf MC = 42% DD = 82 pcf	CH		
93.5							-6.1
95							Sandy Lean Clay, dark gray, very stiff (CL)
100	SS 17	78	8-12-25 (37)	PP = 1.8 tsf MC = 20%	CL		
105.0							-17.6
105	SS 18	78	24-35-50 (85)	PP = 6.0 tsf MC = 17% DD = 112 pcf			Lean Clay, trace of gravel, dark gray, very stiff (CL)
110	SS 19	89	28-94-39 (133)	PP = 6.0 tsf MC = 18% DD = 111 pcf	CL		
115	SS 20	100	32-85-91 (176)	PP = 6.0 tsf MC = 14% DD = 120 pcf			
116.0							-28.6
							Bottom of hole at 116.0 feet.

Northern Technologies, Inc.
3522 4th Avenue So.
Fargo, North Dakota 58103
Telephone: 701-232-1822
Fax: 701-232-1864

BORING NUMBER SB-2

CLIENT Image Group Architecture and Interiors
PROJECT NAME VA Medical Center - Outpatient Treatment Space
PROJECT NUMBER 11-11161.100
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 7/17/11 **COMPLETED** 7/17/11
GROUND ELEVATION 87.6 ft **HOLE SIZE** 6 1/2"
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4" H.S.A.
AT TIME OF DRILLING ---
LOGGED BY TS **CHECKED BY** DG
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						**Pavement,** 5 inches of Asphalt over 7 inches of gravel.
1.0						86.6
	AU 1					**Topsoil / Fill,** Organic fat clay, black
	SS 2	67	2-3-5 (8)			
5	SS 3	67	3-4-6 (10)			
	SS 4	67	2-3-6 (9)	PP = 2.2 tsf		
9.0						78.6
10						Fat Clay, Grayish brown, lenses of light gray silt, medium to rather stiff (CH)
	SS 5	78	1-3-3 (6)	PP = 2.5 tsf		
	SS 6	89	2-2-4 (6)	PP = 1.6 tsf		
15	SS 7	100	2-3-4 (7)	PP = 3.1 tsf		
20	SS 8	100	1-4-5 (9)	PP = 23.2 tsf		
22.0						65.6
						Fat Clay, Dark gray, rather stiff (CH)
25	SS 9	100	2-4-5 (9)	PP = 2.6 tsf		
26.0						61.6
						Bottom of hole at 26.0 feet.

GENERAL BH / TP / WELL VA LOGS.GPJ GINT US.GDT 8/23/11

Northern Technologies, Inc.
3522 4th Avenue So.
Fargo, North Dakota 58103
Telephone: 701-232-1822
Fax: 701-232-1864

BORING NUMBER SB-3

CLIENT Image Group Architecture and Interiors
PROJECT NAME VA Medical Center - Outpatient Treatment Space
PROJECT NUMBER 11-11161.100
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 7/17/11 **COMPLETED** 7/17/11
GROUND ELEVATION 85.4 ft **HOLE SIZE** 6 1/2"
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4" H.S.A.
AT TIME OF DRILLING ---
LOGGED BY TS **CHECKED BY** DG
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						**Pavement,** 5 inches of Asphalt over 7 inches of gravel.
1.0	AU 1					**Topsoil / Fill,** Organic fat clay, black (84.4)
	SS 2	33	3-5-6 (11)			
5	SS 3	56	3-4-6 (10)			
7.0						**Fill,** Fat clay, dark gray, medium (CH) (78.4)
	SS 4	56	2-3-4 (7)			
10.0	SS 5	78	2-2-3 (5)	PP = 1.4 tsf		Fat Clay, Brown and gray, medium (CH) (75.4)
	SS 6	89	1-2-3 (5)	PP = 1.3 tsf		
15	SS 7	89	1-2-3 (5)	PP = 1.5 tsf		
17.0						Fat Clay, Grayish brown, medium to rather stiff (CH) (68.4)
20	SS 8	78	1-3-4 (7)	PP = 2.0 tsf		
25	SS 9	67	1-4-5 (9)	PP = 2.2 tsf		
26.0						Bottom of hole at 26.0 feet. (59.4)

Northern Technologies, Inc.
3522 4th Avenue So.
Fargo, North Dakota 58103
Telephone: 701-232-1822
Fax: 701-232-1864

BORING NUMBER SB-4

CLIENT Image Group Architecture and Interiors
PROJECT NAME VA Medical Center - Outpatient Treatment Space
PROJECT NUMBER 11-11161.100
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 7/17/11 **COMPLETED** 7/17/11
GROUND ELEVATION 85.8 ft **HOLE SIZE** 6 1/2"
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4" H.S.A.
AT TIME OF DRILLING ---
LOGGED BY TS **CHECKED BY** DG
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						1.0	**Pavement,** 5 inches of Asphalt over 7 inches of gravel. 84.8
	AU 1						**Topsoil / Fill,** Organic fat clay, black and dark gray
	SS 2	33	2-4-6 (10)				
5	SS 3	56	3-3-6 (9)			7.5	78.3
	SS 4	78	2-4-6 (10)	PP = 3.5 tsf MC = 28% DD = 95 pcf	CH		**Fill,** Fat Clay, Brown and gray, rather stiff to soft (CH)
10	SS 5	89	2-2-3 (5)	PP = 1.3 tsf MC = 35% DD = 85 pcf		13.0	72.8
	SS 6	78	1-2-3 (5)	PP = 1.2 tsf MC = 38% DD = 82 pcf	CH		Fat Clay, Brown and dark gray, rather stiff to soft (CH)
15	SS 7	100	1-1-3 (4)	PP = 1.3 tsf MC = 40% DD = 81 pcf		17.0	68.8
20	SS 8	100	1-3-4 (7)	PP = 1.5 tsf MC = 36% DD = 86 pcf	CH		Fat Clay, Grayish brown, medium to rather stiff (CH)
25						25.0	60.8
	SS 9	89	1-4-5 (9)	PP = 2.2 tsf MC = 27% DD = 98 pcf	CH		Fat Clay, Dark gray with brown mottling, medium (CH)
30	SS 10	100	2-3-5 (8)	PP = 1.7 tsf MC = 30% DD = 93 pcf Qu = 475 psf		33.0	52.8
35	SS 11	100	1-1-1 (2)	PP = 0.5 tsf MC = 71% DD = 58 pcf Qu = 300 psf	CH		Fat Clay, Dark gray, soft to medium (CH)
40							

(Continued Next Page)

Northern Technologies, Inc.
3522 4th Avenue So.
Fargo, North Dakota 58103
Telephone: 701-232-1822
Fax: 701-232-1864

BORING NUMBER SB-4

CLIENT Image Group Architecture and Interiors

PROJECT NAME VA Medical Center - Outpatient Treatment Space

PROJECT NUMBER 11-11161.100

PROJECT LOCATION Fargo, North Dakota

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40	SS 12	100	0-1-1 (2)	PP = 0.4 tsf MC = 69% DD = 59 pcf Qu = 550 psf	CH		Fat Clay, Dark gray, soft to medium (CH) *(continued)*
45	SS 13	100	0-0-1 (1)	PP = 0.5 tsf MC = 59% DD = 65 pcf			
50	SS 14	100	0-0-1 (1)	PP = 0.4 tsf MC = 66%			
55	SS 15	67	2-2-2 (4)	PP = 0.6 tsf MC = 66% DD = 62 pcf			
60	SS 16	111	0-1-1 (2)	PP = 0.5 tsf MC = 55% DD = 66 pcf			
65	SS 17	111	0-1-1 (2)	PP = 0.5 tsf MC = 82% DD = 61 pcf			
70	SS 18	111	0-1-1 (2)	PP = 0.5 tsf MC = 49% DD = 73 pcf			
75	SS 19	111	0-1-1 (2)	PP = 0.5 tsf MC = 50% DD = 71 pcf			
80	SS 20	111	1-1-2 (3)	PP = 0.3 tsf MC = 60% DD = 65 pcf			
85	SS		1-1-1	PP = 0.2 tsf			

GENERAL BH / TP / WELL VA LOGS.GPJ GINT US.GDT 8/23/11

(Continued Next Page)

Northern Technologies, Inc.
3522 4th Avenue So.
Fargo, North Dakota 58103
Telephone: 701-232-1822
Fax: 701-232-1864

BORING NUMBER SB-4

CLIENT Image Group Architecture and Interiors

PROJECT NAME VA Medical Center - Outpatient Treatment Space

PROJECT NUMBER 11-11161.100

PROJECT LOCATION Fargo, North Dakota

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
	21	111	(2)	MC = 57% DD = 68 pcf	CH		Fat Clay, Dark gray, soft to medium (CH) *(continued)*
90	SS 22	111	1-2-3 (5)	PP = 0.1 tsf MC = 52% DD = 70 pcf			92.0 -6.2
					CL		Lean Clay, trace of gravel, dark gray, very stiff (CL)
95	SS 23	67	18-20-23 (43)	PP = 1.5 tsf MC = 18% DD = 114 pcf			
100	SS 24	78	21-27-34 (61)	PP = 2.9 tsf MC = 21%			102.5 -16.7
					CL		Sandy Lean Clay, dark gray, very stiff (CL)
105	SS 25	100	35-66-128 (194)	PP = 4.7 tsf MC = 21% DD = 101 pcf			
110	SS 26	100	42-78-135 (213)	PP = 4.4 tsf MC = 19% DD = 103 pcf			111.0 -25.2
							Bottom of hole at 111.0 feet.

GENERAL BH / TP / WELL VA LOGS.GPJ GINT US.GDT 8/23/11

Job Summary

Job Date : 10/6/2020

Customer Northern Technologies Inc. **Phone Number** 701.232.1822

Billing Address	City	State	Zip
3522 4th Ave S	Fargo	ND	58103

Job Details

Jobsite Location	2101 N. ELM ST
City	FARGO
State	ND

WA Number	222567
Job Num	
PO Num	

Lead Technician BARTLETT, TROY **Phone** 320-247-0451 **Email** troy.bartlett@gprsinc.com

Thank you for using GPRS on your project. We appreciate the opportunity to work with you. If you have questions regarding the results of this scanning, please contact the lead GPRS technician on this project.

EQUIPMENT USED

The following equipment was used on this project:

- Underground Scanning GPR antenna. Typically capable of detecting objects up to 8' deep or more in ideal conditions but maximum effective depth can vary widely and depends on site and soil conditions. Depth penetration is most commonly limited by moisture and clay/conductive soils. Depths provided should always be treated as estimates as their accuracy can be affected by multiple factors.
- Electromagnetic Pipe and Cable Locator. Detects electromagnetic fields. Used to actively trace conductive pipes and tracer wires, or passively detect power and radio signals traveling along conductive pipes and utilities. Depths provided should always be treated as estimates as their accuracy can be affected by multiple factors.
- Scanning to mark private utilities within 10' radius of four soil boring locations located in area SE of VA hospitals old chiller plant.

Work Performed

Ground Penetrating Radar Systems performed the following work on this project:

Underground Utility

The scope of work included scanning the specified area to locate underground utilities. A tracer signal was sent along any accessible metallic utility or tracer wire, and the area was scanned with GPR to locate any additional targets. The locations of any detected utilities and anomalies were marked directly at the site with paint, flags, stakes, or other appropriate means, and results were reviewed with onsite personnel unless otherwise noted.

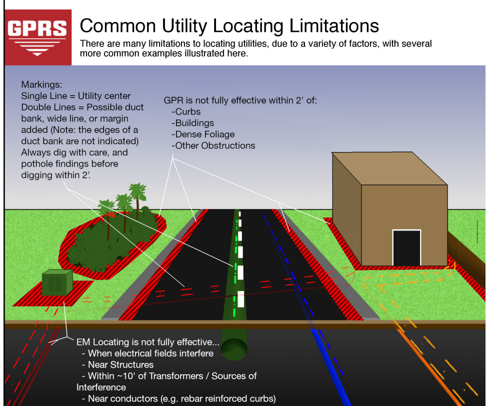
- The total area scanned was approximately 7500 square feet.
- The scope of work included scanning the areas around proposed soil borings. A radius of approximately 10' around each proposed soil boring was scanned unless otherwise noted. A total of four boring locations were scanned.
- Using Rd 8100/400 MHz GPR to scan to mark private utilities/live power/unknown anomalies within 10' radius of up to four soil boring locations on SE side of VA hospital near old chiller plant.

Job Summary

Job Date : 10/6/2020

- The effective depth of GPR will vary throughout a site depending on surface and soil conditions. In this area, the maximum effective GPR depth was approximately 3 feet.
- Used Rd 8100/400 MHz GPR to scan to attempt to mark private utilities in 10' radius of four soil boring locations. Marked lines verified and unknowns with paint/flags. Hand dig within 2' of markings. Used Rd in passive mode to sweep for live power and unknowns in areas staked for future soil bores. Effective depth of GPR less than 2 feet. Could not verify any utilities with 400 MHz GPR due to site/soil conditions. Verified site lighting and some but not all sanitary lines. Reviewed findings on site wiyh Dan Gibson.

Pictures



Utility Limitations

Job Summary

Job Date : 10/6/2020

TERMS & CONDITIONS

http://www.gprsinc.com/termsandconditions.html

Job Summary

Job Date : 10/6/2020

SIGNATURE

X

Contact Name

Dan Gibson 701.232.1822 dang@ntigeo.com