GEOTECHNICAL EXPLORATION AND ENGINEERING REVIEW

ADH and EC Support Facility

St. Cloud VA Health Care Facility

St. Cloud

Minnesota

NTI Project No. 16.61531.100

***Prepared For**:*

Paradigm Architecture
433 West Wilshire Boulevard
Oklahoma City, Oklahoma 73116

NTI™
NORTHERN TECHNOLOGIES, LLC
6160 Carmen Avenue East
Inver Grove Heights, MN 55076
P: 651.389.4191 F: 651.389.4190
www.NTIgeo.com

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July 21, 2016

Paradigm Architecture
433 West Wilshire Boulevard
Oklahoma City, Oklahoma 73116

Attn: Mr. David Walton, P.E., CWI

Subject: Geotechnical Exploration and Engineering Review
ADH and EC Support Facility
St. Cloud, Minnesota
NTI Project No. 16.61531.100

Dear Mr. Walton,

In accordance to your request and subsequent authorization, Northern Technologies, LLC (NTI) conducted a Geotechnical Exploration for the above referenced project. Our services included advancement of exploration borings and preparation of an engineering report with recommendations developed from our geotechnical services. Our work was performed in general accordance with our proposal of dated June 10, 2016.

Soil samples obtained at the site will be held for 60 days at which time they will be discarded. 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. If there are any questions regarding the soils explored or our review and recommendations, please contact us at your convenience at (763) 433-9175.

Northern Technologies, LLC.

Debra A. Schroeder, P.E.
Senior Engineer

Ryan M. Benson, P.E.
Regional Manager/Principal Engineer

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1.0 EXECUTIVE SUMMARY

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

- We conclude you may support the proposed building upon standard perimeter strip and spread column footings on competent, non-organic natural soil(s) or engineered fill, as recommended within our report.
- Building linear strip footings and interior column footings (if required) may be proportioned using the maximum net allowable soil bearing pressures of 5,000 pounds per square foot.
- Measurable groundwater was encountered at the time of the field exploration in one of the four borings. Groundwater in boring SB-4 was encountered at approximately 15 feet below existing grade which correlates to an approximate elevation of 1028 feet. In addition, the onsite clay and silt laden soils can be relatively slow draining and are somewhat conducive to the development of zones of perched water at varying elevations and locations across the project site.
- Overall, the site soils are conducive to movement of groundwater both laterally and vertically over time. The moisture content of such soils 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.

2.0 INTRODUCTION

2.1 Site / Project Description

The proposed ADH and EC Support Facility project is to be constructed as defined within Table 1.

Table 1: Project & Site Description

Item	Description
Building Type	Two stories of above grade construction and a one level of below grade (basement) construction.
Floor Elevations	First floor assumed to be at an elevation of 1044 feet.
Proposed Maximum Change in Site Elevation	NTI assumes that site grades will remain within approximately 3 feet as compared to the grades encountered during the site exploration.
Site Description	
Location of Project	St. Cloud VA Health Care Facility in St. Cloud, MN.
Existing Land Use / Improvements to Parcel	The site is currently a vacant space which has undergone site grading at some point in the past.
Current Ground Cover	In the vicinity of soil borings SB-1 and SB-4 the ground surface was generally covered by maintained turf grasses. The area surrounding soil borings SB-2 and SB-3 was predominantly covered by aggregate base material associated with a temporary automobile parking rea.
Topography at Site	Generally flat with less than 2 feet of elevation change between the recently completed borings.

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 to a maximum depth of approximately 25 feet below existing grade, and conduct laboratory test(s) on representative samples for characterizing the index and engineering properties of the soils at the project site. Borings SB-1, SB-2 and SB-3 were terminated at depths ranging from approximately 18 to 21 feet below existing grade due to practical auger refusal on dense gravels and/or possible cobbles.

2. Prepare a report presenting our findings from our field exploration, laboratory testing, and engineering recommendations for foundation types, footing depths, allowable bearing capacity, estimated settlements, floor slab support, excavation, engineered fill, backfill, compaction and potential construction difficulties related to excavation, backfilling and drainage.

3.0 EXPLORATION PROGRAM RESULTS

3.1 Exploration Scope

Site geotechnical drilling occurred on June 29, 2016 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 utilizing a hand held Trimble GeoXH 6000 GPS unit. The elevation datum referenced is the WGS 84 ellipsoid. Please refer to the Boring Location Diagram and the Boring Logs in Appendix C for additional details.

3.2 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. Additional comment on the evaluation of recovered soil samples is presented within the report attachments.

Table 2: Typical Subsurface Stratigraphy at Project Site Note 1

Stratum	Depth to Base of Stratum below existing grade	Material Description	Notes
Surface	3 inches or 18 inches	Aggregate Base or Topsoil	Topsoil and Aggregate Base classifications by visual observation only and not intended to confer conformance with DOT or other municipal standards.
Fill	4.5 to 7.0 feet below existing grade.	Undocumented fill soils consisting of silty sand (SM), clayey sand (SC), and poorly graded with silt (SP-SM)	This soil strata was variably compacted and contained zones of organic material. There is the potential that the silty sand (SM) fill zone encountered in soil borings SB-2 and SB-3 is a buried topsoil fill zone from past grading activities. The organic content of sample #2 of boring SB-3 was tested at 9.4 percent.
Native Soils	Termination depth of the borings at approximately 21.0 feet below existing grade.	Native soils predominantly composed of granular soils predominantly consisting of poorly graded sand with silt and gravel (SP-SM)	Zone of dense gravels and possible cobbles were also encountered within the native soils. Borings SB-1 through SB-3 were terminated at depths ranging from approximately 18 to 21 feet below existing grade due to practical auger refusal.

Note 1 Table summary is a generalization of subsurface conditions and may not reflect variation in subsurface strata occurring on site. The general geologic origin of retained soil samples is listed on the boring logs.

3.3 Groundwater Conditions

The drill crew observed the borings for groundwater depth (if any) during and at the completion of drilling activities. Measurable groundwater was encountered at the time of the field exploration in one of the four borings. Groundwater in soil boring SB-4 was encountered at approximately 15 feet below existing grade which correlates to an approximate elevation of 1028 feet. In addition, the onsite clay and silt laden soils can be relatively slow draining and are somewhat conducive to the development of zones of perched water at varying elevations and locations across the project site.

Overall, the site soils are conducive to movement of groundwater both laterally and vertically over time. The moisture content of such soils can vary annually and per recent precipitation. Such soils and other regional dependent conditions may produce groundwater entry of project excavations.

3.4 Laboratory Test Program

Our analysis and recommendations of this report are based upon our interpretation of the standard penetration resistance determined while sampling soils, laboratory test results and experience with similar soils from other sites near the project. The results of such tests are summarized on the boring logs or attached test forms.

4.0 ENGINEERING REVIEW AND RECOMMENDATIONS

The following recommendations are based on our present knowledge of the project. We ask that you or your design team notify us immediately if significant changes are made to project size, location or design as we would need to review our current recommendations and provide modified or different recommendations with respect to such change(s).

4.1 Project Scope

We understand the proposed structure will include concrete foundation walls and footings for support of above grade construction. NTI's assumed foundation loads and change in grade is summarized within Table 3. Our assessment of project soils, opinions, and report recommendations are based directly on application of estimated structural loads to site soils.

Table 3: Foundation Loads / Change in Grade / Footing Elevation

Building Element	Load / Condition
Perimeter Strip Footings	7.5 kips per lineal foot or less
Interior Strip Footings	7.5 kips per lineal foot or less
Isolated Interior Column Footings	500 kips or less
Exterior Column Footings	500 kips or less
Change in Overall Site Grade (from original ground surface)	3 feet or less
Basement Excavation	One level of below grade construction. Assumed to be approximately 10 feet or less below the proposed exterior finished grade.

4.2 Site Preparation

Project construction, as proposed, will include site grading and removal of all existing underground utilities from within the proposed building pad (if encountered).

The undocumented, previously placed fill encountered in the soil borings is not considered suitable for direct support of the foundations.

NTI recommends that all undocumented fill, topsoil, buried organic materials, and any other manmade structures that are encountered be removed from within the building pad.

We anticipate that a majority of the previously placed fill soil would be excavated incidentally to attain the proposed low floor basement elevation.

We recommend that all earthwork improvements and excavations be oversized where fill materials are placed below foundations. The minimum excavation oversize should extend per the requirements outlined in Appendix B. Table 4 provides a summary of excavation necessary to remove unsuitable materials at respective borings.

Table 4: Summary of Soil Correction / Excavation

Boring Number	Existing Ground Elevation (feet, NTI Datum)	Depth (feet)	Unsuitable Soil / Material	Estimated Excavation Elevation (feet)
SB-1	1043.5	7.0	Topsoil / Undocumented Fill	1036.5
SB-2	1044.0	7.0	Aggregate Base / Undocumented Fill	1037.0
SB-3	1044.0	4.5	Aggregate Base / Undocumented Fill	1039.5
SB-4	1043.0	7.0	Topsoil / Undocumented Fill	1036.0

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

There is the potential that excavations extend lower than the bottom of existing adjacent footing elevations at the interface with the connecting corridor. If this were to occur the existing structure must have sufficient temporary underpinning and shoring installed to protect the structure during the completion of the necessary excavations.

We recommend that native soils at the exposed grade (i.e. base of excavations) be compacted until such materials achieve no less than 100% of the standard proctor maximum dry density (ASTM: D 698-96). The earthwork contractor must implement suitable compaction methods when working in close proximity to existing structures as to not cause settlement of the existing structure.

Sidewalls should be benched or sloped to provide safe working conditions and stability for engineered fill placement. Any oversizing that is required should be performed in accordance with the diagram and table included in Appendix A.

Engineered fill should consist of onsite or imported sand with 100 percent passing the 1½ inch sieve and no more than 20 percent passing the No. 200 sieve.

Portions of the existing on-site granular undocumented fill soils have the potential to be re-used as engineered fill for preparation of the building pads when such soils are conditioned and placed as presented within this report. However, due to the undocumented nature of the fill soils and the results of the laboratory testing there is the potential that significant zones of organic or debris laden soils may be encountered as well. Any organic or debris laden soils will need to be sorted and are not considered to be suitable for reuse.

Considering that the composition and compaction effort of existing fill soils are not documented, the prediction of the percent of re-usable material is difficult. In addition, the exact delineation of native versus undocumented fill, in granular soils laden with gravel and cobbles, in particular, is difficult due to the limited sample size and soil disturbance due the sampling technique. For this reason, the design team should be aware that there is the potential that there may be some variation in the depth of fill encountered during site excavations as compared to the boring logs. If the Owner wishes to refine the understanding of the composition and depths of the undocumented fill soils across the site, NTI suggests that a series of test pits be advanced at the site prior to construction.

Placement of structural fill should be observed and tested by an experienced technician or engineer to criteria described in Appendix B. Structural fill with moisture contents outside of the recommended range should be conditioned (dried or wetted) as appropriate prior to placement. Engineered fill for site corrective earthwork and for support of project footings should be tempered for moisture content and placed and compacted as outlined Appendix B.

4.3 Shallow Foundations

The following bearing recommendations are based on our understanding of the project. You should notify us of any changes made to the project size, location, design, or site grades so we can assess how such changes impact our recommendations. We assume foundation elements will impose maximum vertical loads as previously noted within this report.

In our opinion, you may support the proposed structure by founding strip footings and interior column footings on competent, non-organic native soils, or engineered fill, providing such construction complies with the criteria established within this report. Design of footings may be based on the Table 5 maximum net allowable soil bearing pressures.

Table 5: Recommended Maximum Net Allowable Soil Bearing Pressure - Conventional Shallow Foundation Construction

Location	Criteria
Perimeter Strip Footings, Perimeter Columns: Perimeter strip footings and perimeter column footing supported on documented fill or competent native soils below depth of frost penetration. **Interior Strip Footings:** Interior strip footings supported on documented fill or competent native soils at a depth that provides no less than 6 inches of clearance between the top of footing and underside of floor slab (for sand cushion). **Interior Column Footings:** Supported on documented fill or competent native soils a depth that provides no less than 6 inches of clearance between the top of footing and underside of floor slab (for sand cushion).	Maximum 5,000 psf (All foundations)

1. Maximum net allowable soil bearing pressure recommendations predicated on footing design and construction complying with recommendations presented within this report. To minimize local failure of supporting soils, it is our opinion footing construction should comply with the International Building Code (IBC) requirements.

Foundations in unheated appurtenant areas, such as stoops, canopies, and garages, should be based at least 5 feet below the proposed finished grade for frost protection. Footings below structures anticipated to be heated (greater than 60 degrees F) in winter should be constructed at least 3.5 feet below proposed finished grade.

Continuous strip footings under bearing walls should be at least 1 foot wider than the walls they support. Interior footings should be based at least 1.5 feet below design floor elevation.

4.4 Bearing Factor of Safety and Estimate of Settlement

We estimate that the native soils, or properly compacted backfill, will provide a nominal 3 factor of safety against localized bearing failure when construction complies with report criteria and recommendations and the structural design of the foundations uses the Table 5 maximum net allowable soil bearing recommendation(s).

We estimate that footings loaded per report recommendations may experience long term, total settlement of approximately 1/2 to 1 inch. Differential settlement will be on the order of 25 to 50 percent of total settlement. Generally, the greatest differential settlement occurs between lightly loaded and heavily loaded footings, particularly if heavily loaded footings are located adjacent to lightly loaded strip footings. Most of the settlement will occur on first loading, as the structure is erected.

The design team must take into account that the footings of the existing structure are not likely to settle to the same magnitude as the foundations for the connecting corridor. There is a potential that the total settlement of the new footings will in effect be primarily a differential settlement as compared to the existing foundations.

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 in-situ conditions, and snow or ice lenses are incorporated into site earthwork.

4.5 Subsurface Drainage

While not necessarily required for this project due to the relatively free draining nature of the onsite granular soils at depth, NTI considers the installation of a subsurface drain system at the interior of the base of foundation walls to be a preferred practice of construction. The subsurface drain system will help to limit moisture accumulation within granular soils placed below interior floors.

A drain tile installed at the exterior of the base of foundation walls is recommended to prevent hydrostatic loading on the earth retaining basement walls. Please refer to the Exterior Wall Backfill section for additional recommendations regarding the placement of the exterior drain tile system.

As a general guideline, subsurface drainage consists of a geotextile and coarse drainage encased slotted or perforated pipe extending to sump basin(s). We recommend that exterior drainage be separated from interior drainage to reduce risk of cross flow and moisture infiltration below structure interior. The Owner with consultation from project Architect and/or Structural Engineer of Record should determine actual need for subsurface drainage.

4.6 Utilities

Utility trenches should be backfilled in 6-inch maximum depth loose lifts. It is especially important that you compact trench backfill of underground utilities to minimize future settlement of green space and pavement areas.

Please refer to Appendix B for compaction specifications.

The stability of embankments along utility excavations is dependent on soil strength, site geometry, moisture content, and any surcharge load for excavated soils and equipment. Cautionary comment on excavation stability is provided within other report sections.

We herein note that the Contractor is solely responsible for assessing the stability of and executing underground utility and project excavations using safe methods. Contractor is also responsible for naming the "competent individual" as per Subpart P of 29 CFR 1926.6 (Federal Register - OSHA).

4.7 Slab-on-Grade Floors

Floor slabs constructed directly over documented engineered fill or non-organic, competent native soil as described in the Site Preparation section may be based on an estimated modulus of subgrade reaction (k) of 200 pci.

The final 6 inches of fill below the concrete floor slabs should consist of pit run or processed sand (sand cushion) with 100 percent material passing the 1 inch, no more than 40 percent passing the No. 40 sieve and no more than 5 percent material passing the No. 200 U.S. Sieve. The moisture content of the sand cushion should be within plus or minus 2 percent of the optimum moisture content determined by the standard Proctor test.

All interior at-grade floors with impervious or near impervious surfacing such as, but not limited to, paint, hardening agent, vinyl tile, ceramic tile, or wood flooring, should include provision for installation of a vapor barrier system. Historically, vapor barrier systems can consist of many different types of synthetic membrane, and can be placed either below sand cushion materials or at the underside of the concrete floor.

All such issues are contentious and have both positive and negative aspects associated with long term performance of the floor. Overall, we recommend you install some form of vapor barrier below the project floor [for at-grade and basement construction, as appropriate].

We recommend that you isolate floor slabs from other building components by placement of a nominal ½ inch thick expansion joint between the floor and walls, and/or columns. This construction must also apply a compatible sealant after curing of the floor slab to reduce moisture penetration though the expansion joint. As a minimum, you should install a bond breaker to isolate and reduce binding of building components.

4.8 Exterior Backfill

Exterior wall backfill placement and associated final grading adjacent to the building can significantly impact the performance of a structure. ***We understand the project will include a below grade basement level with foundation walls that retain soils.***

NTI recommends that the exterior backfill for below grade foundation walls shall consist of either onsite or imported non organic debris free granular soils with less than 12 percent passing the No. 200 sieve. The final 1.5 to 2.0 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 as recommended for the respective construction. Backfill should be tempered for correct moisture content, then placed and compacted in individual lifts of exterior backfill per criteria presented within Appendix B.

Placement of exterior backfill against below-grade earth retaining foundation walls should be limited until lateral restraint of the foundation walls has been installed to the satisfaction of the Structural Engineer. Final grading of exterior backfill should provide sufficient grade for positive drainage away from the structure.

Foundation walls will experience lateral loading from retained soils. This lateral loading may be modeled as an equivalent fluid pressure applied to the foundation wall providing such complies with geometric conditions which support such modeling. We recommend using granular backfill designed to the Table 6 "at-rest" equivalent fluid pressure for design of respective below grade foundations.

Table 6: Estimate of Equivalent Fluid Weight of Retained Soils

Type of Retained Soil – (Moist Unit Weight[2])	Friction Angle[2] (deg.)	Equivalent Fluid Pressure[1] "At Rest" Condition (pcf)	"Active" Condition (pcf)	"Passive" Condition (pcf)
Sand, Sand with Silt (SP, SP-SM)[3] - (120 pcf)	32	55	40	375

1. *The recommendations for equivalent fluid pressure are based solely on assumed conditions with respect to sloping ground, hydrostatic pressures, and/or surcharge loads and do not include a factor of safety. Design professional is cautioned 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 Moist Unit Weights and Friction Angle recommendations noted above are estimates based on industry recognized empirical correlations, assumed conditions, and our experience with similar soil conditions.*
3. *For use of the equivalent fluid weights of a sand backfill, backfill must extend laterally a minimum of 2 feet away from the base of the wall and extend up to the surface at an angle no greater than 60 degrees from horizontal. If other materials are used as backfill within this zone the recommendations SP or SP-SM backfill in Table 6 are not applicable.*

A drain tile installed at the base of foundation walls is recommended to prevent hydrostatic loading on the walls. The drain tile should be sloped to provide positive gravity drainage or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5 percent passing the No. 200 sieve. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted clay to reduce infiltration of surface water into the drain system.

Exterior backfill for at-grade non earth retaining foundations walls (if proposed) should consist of native, non-organic, debris free soils. Placement of exterior backfill against at-grade non earth retaining foundation walls should be performed concurrent with interior backfill to minimize differential loading, rotation and/or movement of the wall system.

4.9 Surface Drainage

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

We understand sidewalks, curbing, pavements, and green space will direct drainage away from the structure. We recommend that you provide a 5 percent gradient within 10 feet of building for drainage from lawn, and 2 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.

Roof runoff should be directed away 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.

4.10 Pavement Construction

We assume project traffic will be separated into two distinct classes; heavy duty traffic comprised of refuse trucks and delivery trucks and light duty traffic comprised of passenger vehicles. Our pavement recommendations are predicated on separation of this traffic.

The resulting subgrade following site grading and removal of near surface organic laden soils should be scarified and re-compacted to a depth of 12 inches. A proofroll test should then be performed to determine soft or unstable subgrade areas. If rutting or localized unstable subgrade areas are observed, those areas should be subcut, moisture-conditioned, and re-compacted or removed to a stable depth. Excavations for soil corrections (if any) in paved areas should allow for a 2 foot oversize beyond the edges of the pavement.

The proof roll should be performed with a tandem axle dump truck loaded to gross capacity (at least 20 tons). Acceptance criteria of the proof roll shall be limited to rut formation no more than one inch (1”) depth (front or rear axles) and no pumping (rolling) observed during the visual inspection. Proof roll tests should be observed by an experienced technician or geotechnical engineer prior to placement of the aggregate base course to verify the subgrade will provide adequate pavement support.

If fill is required in paved areas, we recommend that it consist of soils similar in composition to the existing subgrade soils. If clean sand materials are utilized as engineered fill overlying clay or silt laden soils they will need to be adequately drained as to not create a “bathtub” effect. If not adequately drained there is the potential that groundwater may collect within the void spaces of the sand and result in vertical movements during periods of freeze/thaw.

Estimates of minimum thicknesses for new pavement sections for this project have been based on the procedures outlined in the MnDOT Pavement Design Manual using soil parameters based on soil types. The following minimum thicknesses were estimated based upon our estimated traffic loading, limited soils information, variation across the project area, and experience with similar projects and soil conditions. The performance of stabilometer or similar tests, were beyond the scope of this report; however, they may be performed, upon request, for an additional fee. We estimate that a properly prepared subgrade would have an average stabilometer R-value of 35.

For a 20-year design pavement life and light commercial traffic volumes, Table 7 presents our thickness recommendations for flexible (bituminous) pavement.

Table 7: Recommended Flexible Pavement Thickness Design Alternative

Pavement Section	Light Duty (Parking Stalls)	Heavy Duty (Drive Lanes / Truck Areas)
Bituminous Wear Course (inches)	1.5	2.0
Bituminous Base Course (inches)	2.0	2.0
Class 5 or 7 Aggregate Base (inches)	6.0	8.0

We recommend rigid Portland cement concrete pavements be constructed at driveway aprons, trash enclosures, loading and unloading areas, and other areas where point loads and turning stresses are more likely to damage the pavement. Based on the performance of concrete pavements at similar sites, we recommend the concrete pavement design alternative listed in Table 8.

Table 8: Recommended Rigid Pavement Thickness Design Alternative

Pavement Section	Heavy Duty (Drive Lanes / Truck Areas)	Static Loading Areas (Loading Docks, Dumpsters)
Unreinforced Concrete (inches)	6.0	7.0
Class 5 or 7 Aggregate Base (inches)	6.0	6.0

Pavement recommendations assume the subgrade soils and aggregate section below paved surfaces will drain to subsurface piping for eventual discharge into storm sewer, or above grade to ditching, or similar acceptable systems. Lack of surface and subsurface drainage will significantly reduce the capacity and longevity of the pavement systems indicated above.

We recommend pavements receive annual maintenance, as a minimum, to correct damages to the pavement structure, clean and infill cracks which develop, and repair or resurface areas which exhibit reduced subgrade performance. The lack of maintenance can lead to moisture infiltration of the pavement structure and softening of the subgrade soils. This, in turn, can degrade the performance of the pavement system and result in poorly performing pavements with shortened life expectancy.

5.0 CONSTRUCTION CONSIDERATIONS

5.1 Frost Considerations

The clayey sand (SC) and silty sand (SM) soils on this site are moderately to highly frost susceptible. Small amounts of groundwater, or infiltrated surface water, can be detrimental to the performance of the slabs and pavements. Exterior slabs and pavements should be expected to heave. If frost action needs to be eliminated in critical areas, then we recommend the use of structurally supported exterior slabs (e.g., as structural stoops in front of building doors), as is common practice in the state of Minnesota. It is our opinion that placing non-frost susceptible material in large areas under exterior pavements and sidewalks would be exceedingly expensive and an unusual design and construction procedure in Minnesota.

A transition area between structurally supported slabs or non-frost susceptible materials should be constructed at a 3H:1V back slope to reduce the potential differential frost movements in the slabs or pavements. Draintile should be installed around the foundation perimeter and finger drains should be installed about catch basins and across low points in the pavement grades.

Non-frost susceptible fill should consist of sand or gravel with less than 5% material passing the number 200 sieve, and at least 50% retained on the number 40 sieve.

5.2 Excavation Stability

Excavation depth and sidewall inclination should not exceed those specified in local, state or federal regulations. Excavations may need to be widened and sloped, or temporarily braced, to maintain or develop a safe work environment. Also, contractors should comply with local, state, and federal safety regulations including current OSHA excavation and trench safety standards. Temporary shoring must be designed in accordance with applicable regulatory requirements.

5.3 Engineered Fill & Winter Construction

The Geotechnical Engineer of Record or their designated representative should 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.

Engineered fill should be approved by the Geotechnical Engineer of Record prior to placement. In addition, the engineered fill should be tempered for correct moisture content and then place and compact individual lifts of engineered fill to criteria established within the appendices attachment.

Frozen soil should never be used 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 have the potential to settle once ice lenses thaw.

You should 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 soils should consist of similar materials as those removed from the excavation with moisture content, placement and compaction conforming to report criteria.

6.0 CLOSURE

As the widely spaced, small diameter borings provide only a limited amount of data regarding the existing fill, the existing fill may contain soft zones, debris or significantly greater amounts of unsuitable materials than could be reasonably inferred from the boring information. Unsuitable materials may not be discovered during construction and may remain buried within the fill below the slabs and pavements, resulting in greater than anticipated settlements of the slabs and pavements. These risks cannot be eliminated without completely removing the fill, but can be reduced by thorough exploration and testing during site preparation and construction.

Our conclusions and recommendations are predicated on observation and testing of the earthwork directed by Geotechnical Engineer of Record. Our opinions are based on data assumed representative of the site. However, the area coverage of borings in relation to the entire project is very small. For this and other reasons, we do not warrant conditions below the depth of our borings, or that the strata logged from our borings are necessarily typical of the site. Deviations from our recommendations by plans, written specifications, or field applications shall relieve us of responsibility unless our written concurrence with such deviations has been established.

The scope of services for this project does not include either specifically or by implication any environmental or biological assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of Paradigm Architecture for specific application to the proposed ADH and EC Support Facility project in St. Cloud, Minnesota. 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

Debra A. Schroeder, P.E.
Senior Engineer

Ryan M. Benson, P.E.
Regional Manager/Principal Engineer

RMB/das

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

Ryan M. Benson

Date: 07/21/2016 Reg. No. 42724

APPENDIX A

GEOTECHNICAL EVALUATION OF RECOVERED SOIL SAMPLES

FIELD EXPLORATION PROCEDURES

GENERAL NOTES

WATER LEVEL SYMBOL

DESCRIPTIVE TERMINOLOGY

RELATIVE PROPORTIONS

PARTICLE SIZES

EXCAVATION OVERSIZE

GEOTECHNICAL EVALUATION OF RECOVERED SOIL SAMPLES

We visually examined recovered soil samples to estimate distribution of grain sizes, plasticity, consistency, moisture condition, color, presence of lenses and seams, and apparent geologic origin. We then classified the soils according using the Unified Soil Classification System (ASTM D2488). A chart describing this classification system and general notes explaining soil sampling procedures are presented within appendices attachments.

The stratification depth lines between soil types on the logs are estimated based on the available data. Insitu, the transition between type(s) may be distinct or gradual in either the horizontal or vertical directions. The soil conditions have been established at our specific boring locations only. 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. These variations must be properly assessed when utilizing information presented on the boring logs.

We request that you, your design team or contractors contact NTI immediately if local conditions differ from those assumed by this report, as we would need to review how such changes impact our recommendations. Such contact would also allow us to revise our recommendations as necessary to account for the changed site conditions.

FIELD EXPLORATION PROCEDURES

Soil Sampling – Standard Penetration Boring:

Soil sampling was performed according to the procedures described by ASTM D-1586. Using this procedure, a 2 inch O.D. split barrel sampler is driven 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. The N-value is an index of the relative density of cohesionless soils and an approximation of the consistency of cohesive soils.

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 as they were removed from the sampler(s). Representative fractions of soil samples were then sealed within respective containers and returned to the laboratory for further examination and verification of the field classification. In addition, select samples were submitted for laboratory tests. Individual sample information, identification of sampling methods, method of advancement of the samples and other pertinent information concerning the soil samples are presented on boring logs and related report attachments.

GENERAL NOTES

DRILLING and 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 and D 424
3 HSA	3 ¼" I.D. Hollow Stem Auger	Q_U	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		
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	Q_C	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, the indicated levels can be considered relatively reliable for most site conditions. In clay soils, it is not possible to determine the ground water level within the normal scope of a test boring investigation, except where lenses or layers of more pervious water bearing soil are present; and then a long period of time 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 ground water table. The available water level information is given at the bottom of the log sheet.

DESCRIPTIVE TERMINOLOGY

RELATIVE DENSITY		*CONSISTENCY*	
TERM	**N_{60} Value** (corrected)	**TERM**	**N_{60} Value** (corrected)
Very Loose	0 – 4	Soft	0-4
Loose	5 – 8	Medium	5-8
Medium Dense	9 – 16	Rather Stiff	9 – 15
Dense	16 – 30	Stiff	16 – 30
Very Dense	Over 30	Very Stiff	Over 30

RELATIVE PROPORTIONS

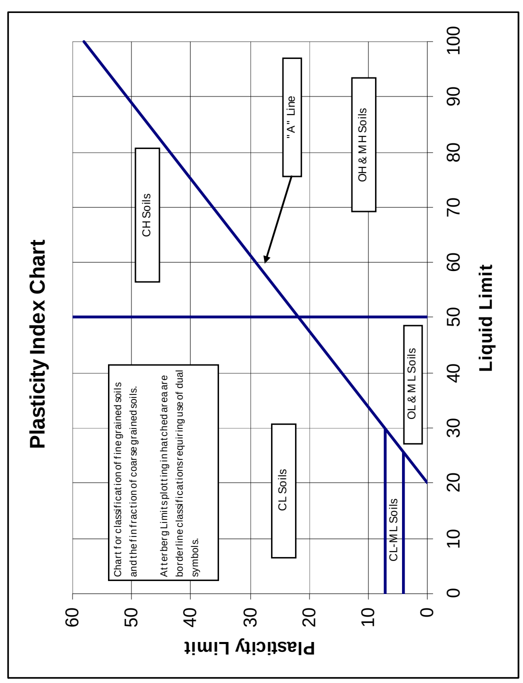
TERMS	RANGE
Trace	0 – 5%
A little	5 – 15%
Some	15 – 30%

PARTICLE SIZES

MATERIAL	DESCRIPTION	U.S. SIEVE SIZE
Boulders		Over 3"
Gravel	Coarse	3" to ¾"
	Medium	¾" to #4
Sand	Coarse	#4 to #10
	Medium	#10 to #40
	Fine	#40 to #200
Silt and Clay	Determined by Hydrometer Test	

CLASSIFICATION of SOILS for ENGINEERING PURPOSES

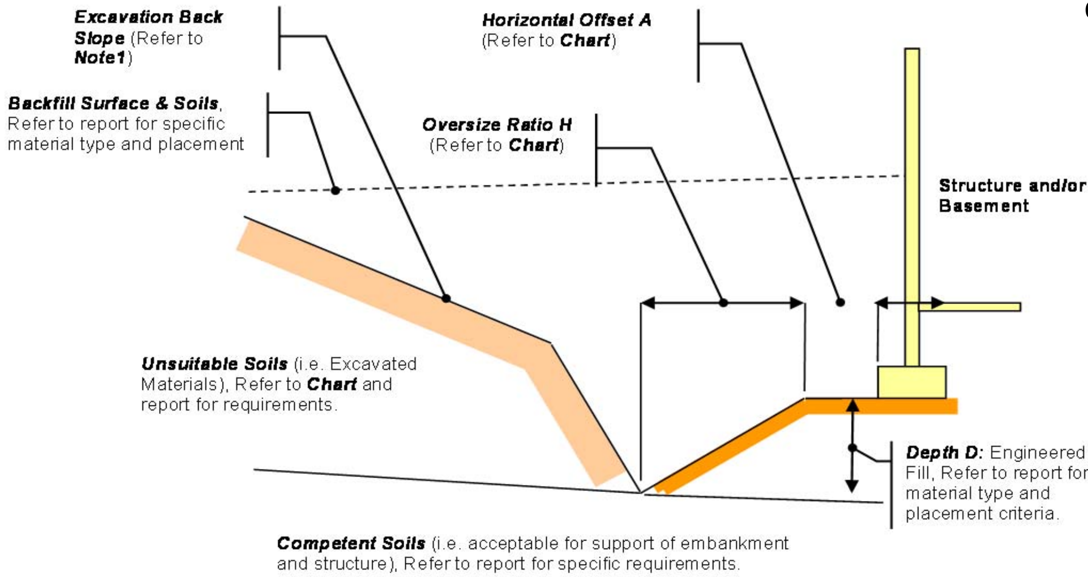
ASTM Designation D-2487 and D2488 (Unified Soil Classification System)

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. > 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 induced stress within 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). Excavations may need to be widened and sloped, or temporarily braced, 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	NA	Equal to or greater than one (1) times Depth D
Foundation Unit Load greater than 3,000 psf	SP, SM soils, CL & CH soils with cohesion less than 1,000 psf	NA	Equal to or greater than one (1) times 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) times 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) times Depth D

APPENDIX B

GROUNDWATER ISSUES

PLACEMENT and COMPACTION OF ENGINEERED FILL

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 borings logs may or may not accurately reflect actual conditions at your site.

Seasonal and yearly fluctuations of the ground water 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 that a well point system would be suitable for control of groundwater if excavations were to be advanced into the ground water table at depth in the free draining granular soils. 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 the vicinity of the project.

PLACEMENT and COMPACTION OF ENGINEERED FILL

Unless otherwise superseded within the body of the Geotechnical Exploration Report, the following criteria shall be utilized 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, or SM. 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, MH-CH. Use of topsoil, marl, peat, other organic soils construction debris and/or other unsuitable materials as fill is not allowed. Such soils have USCS classifications of OL, OH, Pt.

Engineered fill, classified as clay, should be tempered such that the moisture content at the time of placement is equal to and no more than 3 percent above the optimum content for as defined by the appropriate proctor test. Likewise, engineered fill classified as gravel or sand should be tempered such that the moisture content at the time of placement is within 3 percent of the optimum content.

All engineered fill for construction should be placed 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.

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

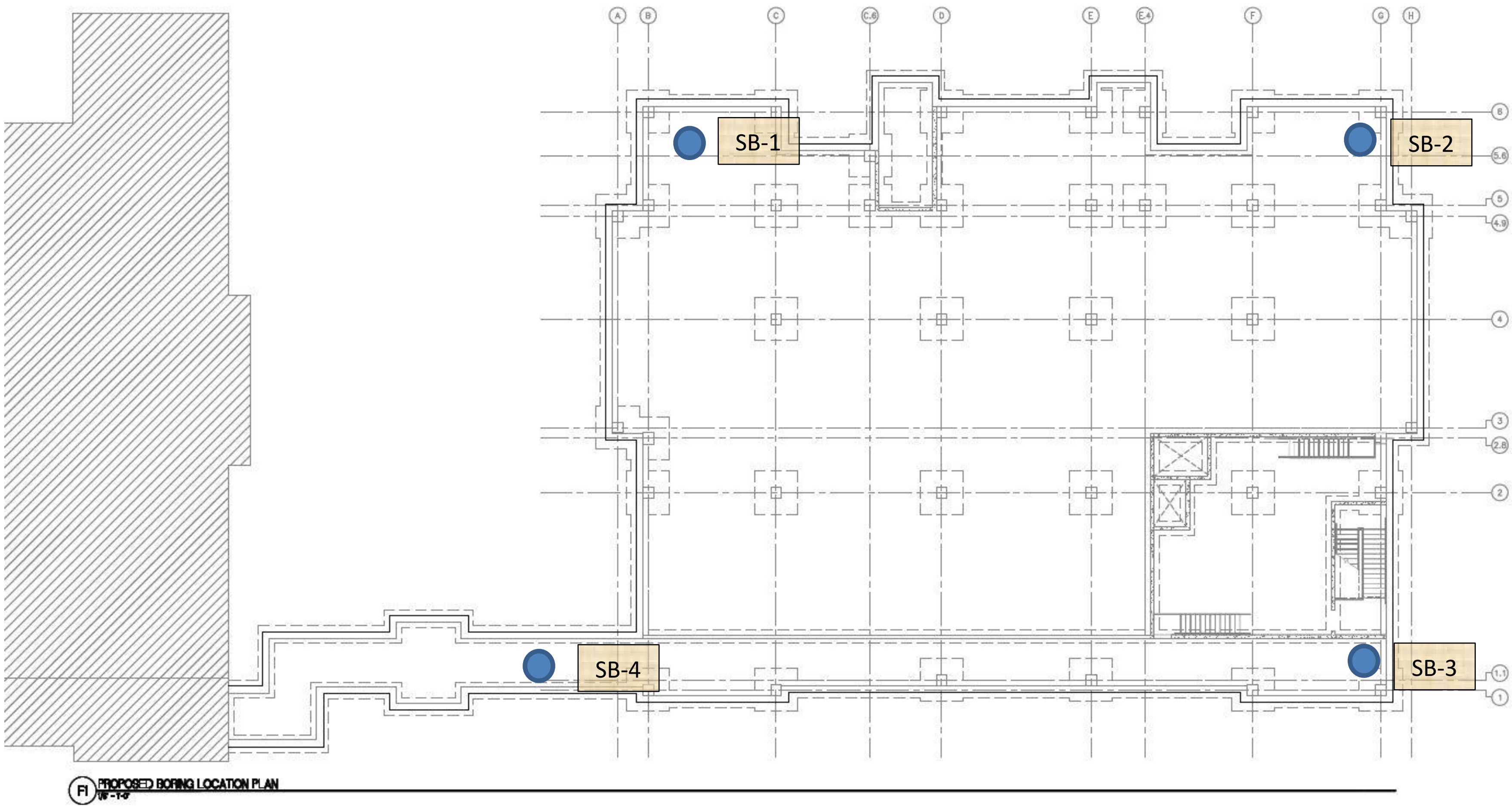
Note 1 Unless otherwise required, compaction shall be based on the Standard Proctor Test (ASTM D698).

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 are presented within other sections of this report.

APPENDIX C

SOIL BORING DIAGRAM

SOIL BORING LOGS



Completed Soil Borings:

Boring Location Diagram
ADH and EC Support Project
St. Cloud, Minnesota
NTI Project #: 16.61531.100

NOTE: Boring locations are approximate.

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NTI
NORTHERN TECHNOLOGIES, LLC

NTI NORTHERN TECHNOLOGIES, LLC
Inver Grove Heights
6160 Carmen Ave. E
Inver Grove Heights, MN, 55076
P: 651-389-4191
www.NTIGeo.com

BORING NUMBER SB-1

CLIENT Paradigm Architecture
PROJECT NAME ADH and EC Support Project
PROJECT NUMBER 16.61531.100
PROJECT LOCATION St. Cloud, MN
DATE STARTED 6/29/16 **COMPLETED** 6/29/16
GROUND ELEVATION 1043.5 ft **HOLE SIZE** 6 1/2 inches
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4 in H.S.A
AT TIME OF DRILLING --- No groundwater encountered
LOGGED BY Robert Hawkins **CHECKED BY** Ryan Benson
AT END OF DRILLING ---
NOTES Elev. Determined by Trimble GeoXH 6000. Accuracy Within 1/2 foot.
AFTER DRILLING ---

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
0		TOPSOIL (18 Inches)	AU 1									
1.5		(Elev. 1042.0) POORLY GRADED SAND, (SP) brown, fine to medium grained, moist, trace gravel (Fill)	SS 2	33	2-2-2 (4)			4				4
5			SS 3	44	4-5-7 (12)							
7.0		(Elev. 1036.5) POORLY GRADED SAND WITH SILT, (SP-SM) brown, fine to medium grained, moist, dense to very dense, little gravel (Alluvial)	SS 4	0	10-11-6 (17)							
10		NOTE: No recovery due to gravel in sample 4. Sampled auger cuttings.	SS 5	44	6-6-10 (16)			5				
		NOTE: No recovery due to gravel in sample 6. Sampled auger cuttings.	SS 6	0	50/6"							
15			SS 7	17	50/6"							
20		NOTE: Possible Cobbles	SS 8	17	50/6"							
21.0		(Elev. 1022.5)										

Encountered apparent auger refusal at 21 feet
Bottom of borehole at 21.0 feet.

BORING NUMBER SB-2

NTI NORTHERN TECHNOLOGIES, LLC
Inver Grove Heights
6160 Carmen Ave. E
Inver Grove Heights, MN, 55076
P: 651-389-4191
www.NTIGeo.com

CLIENT Paradigm Architecture
PROJECT NAME ADH and EC Support Project
PROJECT NUMBER 16.61531.100
PROJECT LOCATION St. Cloud, MN
DATE STARTED 6/29/16 **COMPLETED** 6/29/16
GROUND ELEVATION 1044 ft **HOLE SIZE** 6 1/2 inches
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4 in H.S.A
AT TIME OF DRILLING --- No groundwater encountered
LOGGED BY Robert Hawkins **CHECKED BY** Ryan Benson
AT END OF DRILLING ---
NOTES Elev. Determined by Trimble GeoXH 6000. Accuracy Within 1/2 foot.
AFTER DRILLING ---

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
0.3		APPARENT AGGREGATE BASE (3 Inches)	1043.8	AU 1									
		SILTY SAND, (SM) black to dark brown, fine to medium grained, moist, little gravel, with organics (Fill)		SS 2	33	3-3-4 (7)			15				26
4.5		POORLY GRADED SAND WITH SILT, (SP-SM) brown, fine to medium grained, moist, trace gravel (Fill)	1039.5	SS 3	33	3-3-4 (7)			3				
7.0		POORLY GRADED SAND WITH SILT, (SP-SM) brown, fine to medium grained, moist, medium dense to dense, trace gravel (Alluvial)	1037.0	SS 4	33	6-7-8 (15)							
				SS 5	22	5-5-5 (10)							
				SS 6	33	15-15-15 (30)			3				
				SS 7	33	15-15-15 (30)							
		NOTE: Possible Cobbles / Dense Gravel											
21.0			1023.0										

Encountered apparent auger refusal at 21 feet
Bottom of borehole at 21.0 feet.

Inver Grove Heights
6160 Carmen Ave. E
Inver Grove Heights, MN, 55076
P: 651-389-4191
www.NTIGeo.com

BORING NUMBER SB-3

CLIENT Paradigm Architecture
PROJECT NAME ADH and EC Support Project
PROJECT NUMBER 16.61531.100
PROJECT LOCATION St. Cloud, MN
DATE STARTED 6/29/16 **COMPLETED** 6/29/16
GROUND ELEVATION 1044 ft **HOLE SIZE** 6 1/2 inches
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4 in H.S.A
AT TIME OF DRILLING --- No groundwater encountered
LOGGED BY Robert Hawkins **CHECKED BY** Ryan Benson
AT END OF DRILLING ---
NOTES Elev. Determined by Trimble GeoXH 6000. Accuracy Within 1/2 foot.
AFTER DRILLING ---

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	APPARENT AGGREGATE BASE (3 Inches)	1043.8	AU 1									
4.5	SILTY SAND, (SM) black to dark brown, fine to medium grained, moist, trace gravel, with organics (Fill) NOTE: Organic content at 2 feet = 9.4%.	1039.5	SS 2	33	3-3-4 (7)			10				
	POORLY GRADED SAND WITH SILT, (SP-SM) brown, fine to medium grained, moist, dense to medium dense, little gravel (Alluvial)		SS 3	33	3-3-4 (7)							
			SS 4	33	6-7-8 (15)			2				
			SS 5	22	5-5-5 (10)							
			SS 6	33	15-15-15 (30)							
			SS 7	33	15-15-15 (30)							
18.0	NOTE: Possible Cobbles / Dense Gravel	1026.0										

Encountered apparent auger refusal at 18 feet
Bottom of borehole at 18.0 feet.

Inver Grove Heights
6160 Carmen Ave. E
Inver Grove Heights, MN, 55076
P: 651-389-4191
www.NTIGeo.com

BORING NUMBER SB-4

CLIENT Paradigm Architecture
PROJECT NAME ADH and EC Support Project
PROJECT NUMBER 16.61531.100
PROJECT LOCATION St. Cloud, MN
DATE STARTED 6/29/16 **COMPLETED** 6/29/16
GROUND ELEVATION 1043 ft **HOLE SIZE** 6 1/2 inches
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4 in H.S.A
∇ **AT TIME OF DRILLING** 15.00 ft / Elev 1028.00 ft
LOGGED BY Robert Hawkins **CHECKED BY** Ryan Benson
AT END OF DRILLING ---
NOTES Elev. Determined by Trimble GeoXH 6000. Accuracy Within 1/2 foot.
AFTER DRILLING ---

DEPTH (ft)	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
0 – 1.5	TOPSOIL (18 Inches) — 1041.5	AU 1					5				
1.5 – 2.0	1041.0										
2.0 – 7.0	CLAYEY SAND, (SC) dark brown, fine to medium grained, moist, trace gravel (Fill) / POORLY GRADED SAND WITH SILT, (SP-SM) brown, fine to medium grained, moist, trace gravel (Fill) — 1036.0	SS 2	44	3-3-4 (7)							
		SS 3	56	3-4-7 (11)							
7.0 – 26.0	POORLY GRADED SAND, (SP) brown, fine to medium grained, moist to saturated, loose to dense, trace gravel (Alluvial)	SS 4	67	4-4-4 (8)			3				4
10		SS 5	33	10-10-12 (22)							
		SS 6	33	7-7-6 (13)							
15	∇	SS 7	33	12-12-12 (24)			8				
20		SS 8	67	12-12-12 (24)							
25 – 26.0	1017.0	SS 9	39	11-12-13 (25)							

Bottom of borehole at 26.0 feet.