



GEOTECHNICAL EXPLORATION AND ENGINEERING REVIEW

Eastgate Apartments

Owatonna

Minnesota

NTI Project No. 20.MSP.09807.000

Prepared For:

LWO Development, LLC
1600 University Ave, Suite 212
Saint Paul, MN 55104



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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March 18, 2020

LWO Development, LLC
 Attention: Mr. Lawrence Olson
 1600 University Ave, Suite 212
 Saint Paul, Minnesota 55104

Subject: Geotechnical Exploration and Engineering Review
Eastgate Apartments
 Owatonna, Minnesota
 NTI Project No. 20.MSP.09807.000

In accordance with 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 revised proposal dated February 20, 2020.

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

Steven D. Gerber, P.E.
 Senior Engineer

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.

Steven D. Gerber

Date: March 18, 2020 Reg. No. 45298



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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.

- Our borings encountered existing, undocumented fill to depths of up to 11.5 feet. Additionally, a prior environmental investigation performed by AET found an organic layer at depths ranging between approximately 15 and 20 feet.
- NTI observed apparent hydrocarbon odor (detected by human perception only) in the native soils at Boring SB-1 through SB-3 locations. **It should be understood by all parties that all recommendations of the environmental consultant should be followed.**
- Due to the depth of the undocumented fill, the groundwater level, and the previously encountered organic layer, we recommend that foundations and slab bear upon ground improved soil, such as aggregate piers.
- Utility trenches may encounter the organic soils. Organic soils should be removed from beneath the utility trenches and replaced with properly compacted, inorganic backfill. Alternatively, the foundations could be supported with bents and deep foundations that penetrate the organic soils or ground improved soils.
- Additional exploration through test pits or soil borings is recommended for utilities that cannot accommodate differential settlement. Additional exploration may also be requested by the design-build specialty contractor for ground modification.
- The drill crew observed the borings for groundwater depth (if any) during and at the completion of drilling activities. Groundwater was observed at depths ranging between approximately 11 and 13 feet below the ground surface, although only in borings SB-1 through SB-3. Groundwater was not observed in the remaining borings.
- Overall, the site soils are conducive to movement of groundwater both laterally and vertically. 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. Seasonal variation or local infiltration may raise the groundwater elevation.
- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that the NTI be retained to monitor this portion of the work.



2.0 INTRODUCTION

2.1 Site / Project Description

The proposed project is to be constructed as defined within Table 1.

Table 1: Project & Site Description

Item	Description
Building Type	3-story senior housing apartments with below grade parking.
Floor Elevations	Based on the client provided plan, the first floor elevation will be at 1152 feet.
Proposed Maximum Change in Site Elevation	Finish site grades within 5 feet of existing site grades in the building areas and 10 feet elsewhere.
Below-Grade Elevation	Assumed to be approximately 10 feet below the first floor elevation.
Site Description	
Location of Project	Southeast of the intersection of Cheery Street Northeast and Mineral Springs Road Northeast in Owatonna, Minnesota.
Existing Land Use / Improvements to Parcel	Grass and trees.
Topography at Site	There is about 28 feet of grade change across the site; there is about 9.5 feet of grade across our soil 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 10 standard penetration test borings extending to depths ranging from approximately 10 to 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. Due to site constraints, two hand auger probes were substituted for one of the borings.
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, lateral earth pressures, pavement design, and estimated stormwater infiltration rates.



3.0 EXPLORATION PROGRAM RESULTS

3.1 Exploration Scope

Site geotechnical drilling occurred on February 27 and 28, 2020. Individual borings were advanced at approximate locations as presented on the Boring Location Diagram within the appendices. NTI located the borings relative to existing site features. Elevations were approximated using a Trimble GeoXH and are relative to the NAVD 1988 (Geoid 12A) datum. Please refer to the Boring Location Diagram and the Boring Logs in Appendix C.

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.

3.2 Subsurface Conditions

Please refer to the boring logs within the appendices for a detailed description and depths of stratum at each boring. 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 appendices.

Table 2: Observed Subsurface Stratigraphy at Project Site ¹

Stratum	Depth to Base of Stratum below existing grade	Material Description	Notes
Surface	Up to 18 inches	2 to 18 inches of apparent topsoil or 7 inches of apparent aggregate base	Apparent topsoil and aggregate base by visual classification and may not meet MnDOT or other specifications
Undocumented Fill	6.5 to 11.5 feet	Clayey sand (SC), silty sand (SM), sandy lean clay (CL), gravel with sand (GP), and sand with silt (SP-SM)	Portions of the fill contain organic matter.
Glacial Soils	Termination depths of the borings.	Clayey sand (SC), silty sand (SM), sand (SP), and sand with silt (SP-SM)	Generally loose to medium dense, locally dense. Apparent hydrocarbon odor (detected by human perception only) was observed at Boring SB-1 through SB-3 locations.

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. Groundwater was observed at depths ranging between approximately 11 and 13 feet below the ground surface, although only in borings SB-1 through SB-3. Groundwater was not observed in the remaining borings.

In addition, the onsite silt and clay laden soils are relatively slow draining and 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. 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.

3.4 Laboratory Test Program

Our analysis and recommendations of this report are based upon our interpretation of the standard penetration test 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 laboratory test reports.

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 that 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	10 kips per lineal foot or less
Interior Strip Footings	10 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)	2 feet or less in building pad areas 5 feet or less in other areas
Free Standing Retaining Walls	None Anticipated
Basement Excavation	1 Level of below grade parking.

4.2 Site Preparation

The undocumented, previously placed fill encountered in the soil borings is not considered suitable for direct support of the foundations. NTI observed apparent hydrocarbon odor (detected by human perception only) in the native soils at Boring SB-1 through SB-3 locations. Additionally, after reviewing Geoprobe logs that were generated by American Engineering and Testing (AET), it appears that there is a locally distributed vein of organic soils at depths of approximately 15 to 20 feet. The depth of this deposit and the potential environmental issues, makes it unlikely to be economical to remove all of the material. We recommend that the building be supported on ground modified soils, such as through aggregate piers.

With the inorganic soil cover over the organic soils, the organic soils may have been precompressed sufficiently to provide sufficient stability for construction of the pavements and external walkways. Some differential settlement should be anticipated, however, in the pavement areas.

Material Requirements

We anticipate that portions of the existing fill soils may be suitable for reuse as backfill beneath support of slabs and pavements. **Any organic or debris laden soils will need to be sorted and are not considered to be suitable for reuse as structural fill within the building pad. It should be understood by all parties that all recommendations of the environmental consultant should be followed.**

We recommend that backfill and fill consist of granular soils similar to those on site. Backfill should have a maximum particle size of 1 ½ inches and have a maximum of 25 percent material passing the No. 200 sieve (SP, SP-SM, SP-SC, some SM).

Clay soils, minimum of 40 percent passing the No. 200 sieve and a liquid limit less than 40 (CL, CL-ML, SC), may be used in landscaping areas and are recommended to be used in the upper 1 to 2 feet of subgrade behind walls. Backfill in areas where non-frost susceptible fill is required should have less than 5 percent materials passing the No. 200 sieve.

All engineered fill for site corrective earthwork and for support of project footings should be tempered for moisture content, placed, and be compacted to the criteria presented within Appendix B.



4.3 Shallow Foundations On Ground Improved Soils

Ground improvement techniques, specifically the installation of an aggregate pier (AP) system, would be appropriate for this project given the existing subsurface conditions. Similar to performing a soil correction, these systems would allow the proposed structure to be supported by typical on grade foundations.

These elements provide vertical reinforcement to the in-situ subgrade soils and produce a composite system that increases bearing capacity above pre-improvement values. In addition, the AP system will reduce both total and differential settlement as compared to pre-improvement conditions.

Aggregate piers are proprietary design build systems and are installed by specialty contractors with a turnkey design build approach. An experienced specialty contractor should be contracted if this alternative is selected and thereafter provide a design build ground modification system allowing for the construction of a traditional spread footing style of foundation system below the proposed structure. For *preliminary* design purposes, we estimate that the net allowable bearing capacity for foundations cast on the ground improved soils would be in the range of 4,000 to 6,000 pounds per square foot (psf) with a settlement of approximately 1 inch.

Foundations in unheated appurtenant areas, such as stoops and canopies, 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.

4.4 Subsurface Drainage

NTI considers the installation of a subsurface drain system at 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. This system, in conjunction with the clean granular slab subbase would act as an underdrain for the slab. You should also consider placement of a separate subsurface drainage system along the exterior of the perimeter 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).

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 of the design team should weigh the risks associated without installing a subsurface drainage system and determine actual need for subsurface drainage.

4.5 Utilities

Open cut 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.

Utility trenches may encounter the organic soils. Organic soils should be removed from beneath the utility trenches and replaced with properly compacted, inorganic backfill. NTI does not recommend the founding of utilities in or above swamp deposited soils. However, if the design team elects to take the risk of doing so, appropriate measures should be taken. If the utilities are to be founded above or within the organic soils, the least risky option for support of utilities would be to perform a soil correction below the utilities down to competent, non-organic native soils or to support the utilities on a deep foundation system with bents for support at the joints.

Another alternative would include the placement of additional bedding to provide a more stable platform to construct the utilities upon. However, the team should anticipate that utilities supported in this manner will likely undergo significant differential movement and/or sagging over time. This will be particularly evident at the connections to any proposed structure. At a minimum, flexible connections should be utilized within the pipe alignment where possible and at all connections to structures. To promote suitable gravity fed flow within zones that are likely to sag, consideration should be given to oversizing the pipe and/or increasing the pitch to help mitigate the negative effects of minor sags within the alignment.

Additional exploration through test pits or soil borings is recommended for utilities that cannot accommodate differential settlement.

Depending on the installation depth of the utility lines and due to the encountered groundwater, temporary dewatering may be required during the utility trench excavations. The dewatering contractor should take appropriate measures to protect any structures in close proximity to the area that is to be dewatered. Stabilization of the trench subgrade may also be required in order to provide a stable platform for construction. Stabilization could consist of a one half to one foot layer of crushed rock or sand with a maximum 5 percent material passing the No. 200 sieve and 50 percent passing the No. 40 sieve.

It should be understood by all parties that all recommendations of the environmental consultant should be followed.

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).

4.6 Slab-on-Grade Floors

We recommend that the floor slab also be supported by a ground modification AP system. Final design of the floor slab support system shall be completed with close coordination between NTI, the structural engineer of record and the selected specialty contractor. For preliminary design a (K) value of 200 pounds per square inch per inch of depth (pci) may be utilized for slabs supported by an aggregate pier system. This value is to be verified by the selected aggregate pier design build contractor.



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.

If the interior floor slab is covered with impervious or near impervious surfacing such as, but not limited to, paint, hardening agent, vinyl tile, ceramic tile, or wood flooring, a vapor retarder should be installed. The retarder should consist of a synthetic membrane placed either below the sand cushion or at the underside of the concrete floor. The location of the membrane is contentious and has both positive and negative aspects on the long term performance of the floor system. NTI recommends the design team consult with the selected floor covering supplier for any specific vapor transmission mitigation requirements their product may have.

The floor slab should be isolated from the walls and columns. Such isolation should include installation of a ½ inch thick expansion joint between the floor and walls, and/or columns to minimize binding between the construction materials. Such construction should also include application of a sealant within the expansion joint after curing of the floor slab to reduce moisture penetration through the joint. We recommend that a bond breaker be incorporated between the floor slab and foundation walls to reduce binding between components.

4.7 Exterior Foundation Wall Backfill

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

The final one foot of exterior backfill for green areas may consist of clay or silt based topsoil. The final exterior backfill for areas supporting sidewalks and/or pavements should consist of a free draining aggregate base as recommended for the respective construction. 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.

4.7.1 Earth Retaining Walls

Earth retaining foundation wall backfill placement and associated final grading adjacent to the structure can significantly impact the performance of the structure. NTI recommends that the exterior backfill for the below grade foundation walls should consist of non-organic, debris free, granular soils with less than 12 percent passing the No. 200 sieve.

Placement of exterior backfill against below-grade foundation walls, which retain soils, 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.



A permanent subsurface drain system should be installed at the base of the wall to reduce the potential for hydrostatic loading on and water seepage through the foundation wall, in addition to an underdrain system for the slab. If a permanent drain system were to be omitted, there is the potential for, significantly larger lateral earth pressures to develop if the backfill adjacent to the below grade walls becomes saturated. A typical drainage system would consist of geotextile fabric encasing coarse drainage aggregate or aggregate encasement surrounding a geotextile wrapped perforated pipe with a sump pump that would direct the water to a positive outfall away from the structure.

Below grade walls which retain earth will experience lateral loading that may be modeled as an equivalent fluid pressure, pounds per cubic foot (pcf), applied to the walls, providing such complies with geometric conditions which support such modeling. We recommend using granular backfill designed to the Table 5 “at-rest” equivalent fluid pressure for design of respective soil retaining walls.

Table 5: Estimate of Equivalent Fluid Weight of Retained Soils

Type of Retained Soil – (Moist Unit Weight ²)	Equivalent Fluid Pressure ¹			
	Friction Angle ² (deg.)	“At Rest” Condition (pcf)	“Active” Condition (pcf)	“Passive” Condition (pcf)
Sand, Sand with Silt (SP, SP-SW) ³ - (120 pcf)	32	55	35	390
Silty Sand (SM) – (125 pcf)	30	65	45	335
Clayey Sand (SC) or Sandy Clay (CL) - (125 pcf)	26	70	50	320

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 the table above are not applicable.

The final 18 inches of exterior backfill for green areas should consist of clay based topsoil. The final exterior backfill for areas supporting sidewalks and/or 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 of our report.



4.8 Surface Drainage

You should maintain positive drainage during and after construction of the project and eliminate ponding of water on site soils. We recommend that you include provisions within the 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 recommend that sidewalks, curbing, pavements, and green space direct drainage away from the structure. We recommend that you provide a 5 percent gradient within 10 feet of the building for drainage from the lawn, and 2 percent minimum gradient from the building for drainage of the sidewalks / pavements. All pavements should drain to on-site storm collection, municipal collection system, or roadside ditching.

Roof runoff should be directed away from the 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.

4.9 Pavement Construction

If the owner is willing to assume some increase in potential for differential movement in the pavement section, the pavements maybe constructed with the existing fill and organic soils in place. Otherwise, a complete removal of the existing fill materials and organic soils would be necessary, requiring excavations of up to approximately 20 feet.

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 upper 2 feet of automobile parking areas and the upper three feet of heavy duty pavement areas should consist of properly compacted inorganic soil. Following the removal of topsoil, and unsuitable organic soils, and following the completion of site grading activities, the resulting subgrade should first be scarified and re-compacted to a depth of 12 inches. A proof roll test should then be performed to determine soft or unstable subgrade areas. 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 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.



If fill is required in paved areas, we recommend that it consist of soils similar in composition to the existing subgrade soils. Individual lifts of engineered fill in proposed paved areas should be tempered for moisture content, placed and compacted as listed in the Compaction Guidelines table in Appendix B.

For the predominant clayey sand subgrade soils encountered at the surface of site, we estimate that a properly prepared subgrade would have an average stabilometer R-value of 20.

For a 20-year design pavement life and light commercial traffic volumes, Table 6 presents our thickness recommendations for flexible (bituminous) pavement.

Table 6: 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 6 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 7.

Table 7: Recommended Rigid Pavement Thickness Design Alternative

Pavement Section	Heavy Duty (Drive Lanes / Truck / Bus Areas)	Static Loading Areas (Loading Docks, Dumpsters)
Unreinforced Concrete (inches)	6.0	7.0
Class 5 or 6 Aggregate Base (inches)	4.0	4.0

Pavement recommendations assume that 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.

Properly constructed pavements, even those constructed entirely over inorganic soil, will crack due to creep movements, changes in temperatures, frost action and other factors. Due to the organic nature of the subgrade at this site, the pavements should be expected to move and crack more than a typical pavement section. Features that would help reduce this movement and cracking include:

- Installing finger drains about catch basins, low lying areas, and periodically in large pavement areas,
- Placing a reinforcement geotextile or geogrid under the aggregate base or within the aggregate base, respectively,



- Adding a 1 foot or thicker section of clean sand to act as a drainage layer.

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.

4.10 Stormwater Infiltration

The encountered on-site silty sand (SM), clayey sand (SC) and sandy lean clay (CL), soils are generally considered to be marginal to poor for the infiltration of stormwater. Table 8 provides estimated infiltration rates for the various soil types encountered on-site.

Table 8: Estimated Infiltration Rates¹

Unified Soil Classification System - Soil Type	Estimated Cumulative Infiltration Rate (inches/hour)
Clayey Sand (SC)/Sandy Lean Clay (CL)	0.06
Silty Sand (SM)	0.45
Sand with Silt (SP-SM)	0.7
Sand (SP)	0.8
Gravel with Sand (GP)	1.63

1. All findings are approximate based on correlation of on-site soils to the Minnesota Stormwater Manual, or other published literature.

It should be understood by all parties that all recommendations of the environmental consultant should be followed.

4.11 Frost Considerations

Silt and clay-laden soils are highly to moderately 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).

In entrances with concrete plaza areas and ADA accessible ramps where structural support is not practical, we recommend placing non-frost susceptible clean sand (SP) or at a minimum (based on the owner's acceptance of potential risk), low-frost susceptible sand with silt (SP-SM) soils with less than 10 percent material passing the No. 200 sieve beneath these areas. Using drain tile, this area should be connected to the site drainage system if it is surrounded by silt or clay based soils. A 3H:1V (Horizontal:Vertical) transition zone should be constructed between non or low frost susceptible soils (SP, SP-SM) and other soils to help prevent differential frost movement.



Non-frost susceptible fill should consist of poorly graded sand or gravel with less than 5 percent material passing the No. 200 sieve (SP) and less than 50 percent passing the No. 40 sieve.

5.0 CONSTRUCTION CONSIDERATIONS

5.1 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.

5.2 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.

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 LWO Development, LLC, for specific application to the proposed Eastgate Apartments project in Owatonna, 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



APPENDIX A

GEOTECHNICAL EVALUATION OF RECOVERED SOIL SAMPLES

FIELD EXPLORATION PROCEDURES

GENERAL NOTES

WATER LEVEL SYMBOL

DESCRIPTIVE TERMINOLOGY

RELATIVE PROPORTIONS

PARTICLE SIZES

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

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. In-situ, 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

<i>DRILLING and SAMPLING SYMBOLS</i>		<i>LABORATORY TEST SYMBOLS</i>	
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 1/4" 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 1/2 C	2 1/2" 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

<i>RELATIVE DENSITY</i>		<i>CONSISTENCY</i>	
TERM	N₆₀ Value (corrected)	TERM	N₆₀ 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

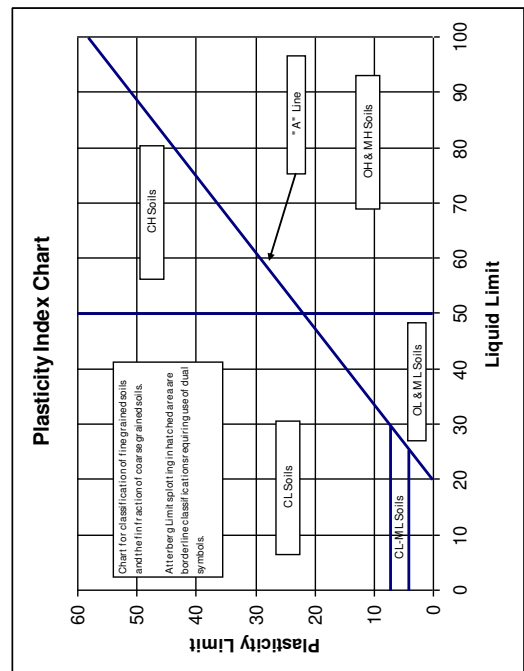
MATERIAL	DESCRIPTION	U.S. SIEVE SIZE
Boulders		Over 3"
Gravel	Coarse	3" to 3/4"
	Medium	3/4" to #4
Sand	Coarse	#4 to #10
	Medium	#10 to #40
	Fine	#40 to #200
Silt and Clay	Determined by Hydrometer Test	



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.	
		GP	Poorly graded gravels and gravel-sand mixtures, little or no fines.	
		GM	Silty gravels, gravel-sand-silt mixtures.	
		GC	Clayey gravels, gravel-sand-clay mixtures.	
	Sands More than 50% of coarse fraction passes No. 4 sieve. Clean Sands Sands with Fines	SW	Well-graded sands and gravelly sands, little or no fines.	
		SP	Poorly-graded sands and gravelly sands, little or no fines.	
		SM	Silty sands, sand-silt mixtures.	
		SC	Clayey sands, sand-clay mixtures.	
		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 dual symbols.		Cu = D60 / D10 greater than 4. Cz = (D30) ² / (D10 x D60) between 1 & 3. Not meeting both criteria for GW materials. Atterberg limits below "A" line, or P.I. less than 4. Atterberg limits above "A" line with P.I. greater than 7.
		Cu = D60 / D10 greater than 6. Cz = (D30) ² / (D10 x D60) between 1 & 3. Not meeting both criteria for SW materials. Atterberg limits below "A" line, or P.I. less than 4. Atterberg limits above "A" line with P.I. > 7.		Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols.
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.	
		Pt	Peat, muck and other highly organic soils.	
	Highly Organic Soils			

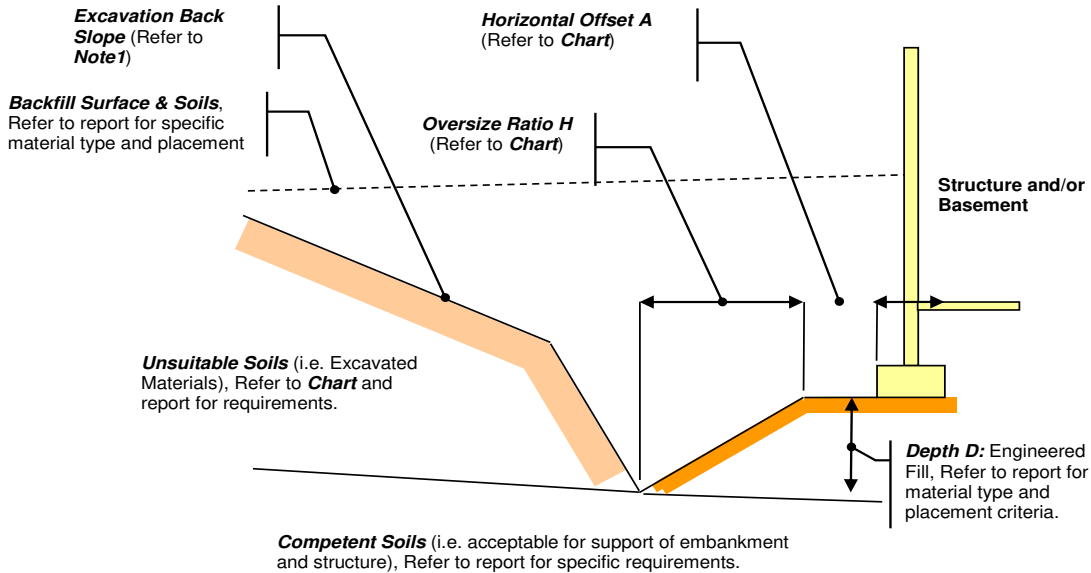




EXCAVATION OVERSIZE

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 3,500 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 3,500 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 3,500 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 3,500 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 system of sump pits and pumps located outside of the foundation areas would be suitable for control if perched groundwater were to be encountered. NTI cautions that such seepage may be heavy and will vary based on seasonal and annual precipitation, and ground related impacts in the vicinity of the 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 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.

Type of Construction	Compaction Criteria (% respective Proctor) ¹	
	Clay	Sand or Gravel
General Embankment Fill	Min. 95	Min. 95
Engineered Fill below Foundations ²	NA	Min. 98
Engineered Fill below Floor Slabs	NA	Min. 95
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
Engineered Fill placed below the root zone in landscaping areas	Min. 95	Min. 95

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

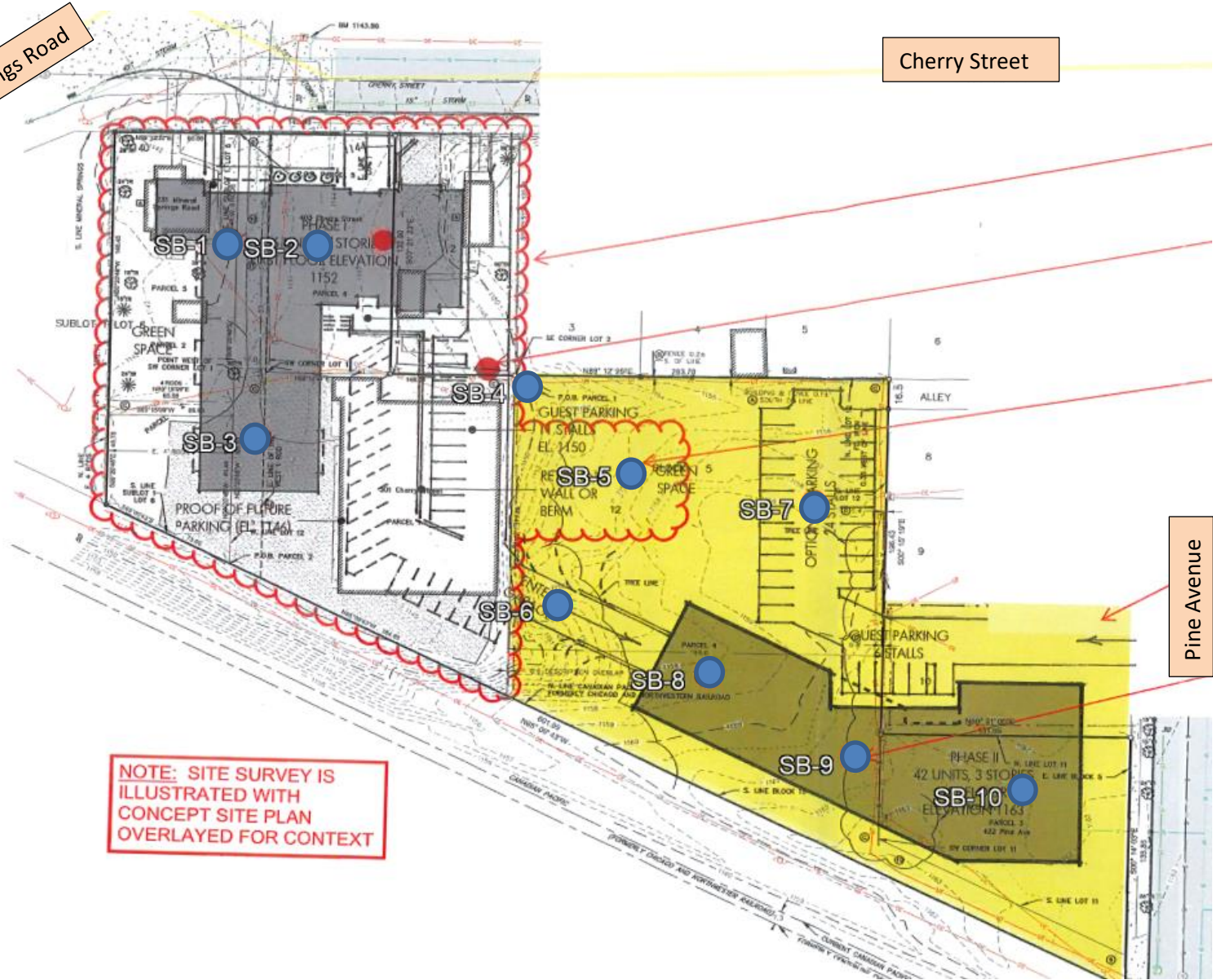
BORING LOCATION DIAGRAM

SOIL BORING LOGS

Mineral Springs Road

Cherry Street

Pine Avenue



NOTE: SITE SURVEY IS ILLUSTRATED WITH CONCEPT SITE PLAN OVERLAYED FOR CONTEXT



Boring Location Diagram
 Eastgate Apartments
 Owatonna, Minnesota
 NTI Project #: 20.MSP09807.000
 NOTE: Boring locations are approximate.

Completed Soil Borings: ●



NTI
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invergroveheights
 6160 Carmen Ave e
 Inver Grove Heights, Minnesota 55076
 P: 701.232.1822 F: 701.232.1964
 www.ntigeo.com

BORING NUMBER SB-4

CLIENT LWO Development, LLC **PROJECT NAME** Eastgate Apartments
PROJECT NUMBER 20.MSP09807.000 **PROJECT LOCATION** Owatonna, Minnesota
DATE STARTED 2/27/20 **COMPLETED** 2/27/20 **GROUND ELEVATION** 1149 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 observed
LOGGED BY Drew Faherty **CHECKED BY** Steve Gerber **AT END OF DRILLING** ---
CAVE IN (ft) --- **FROST DEPTH (ft)** .16 **AFTER DRILLING** ---
NOTES Elevation estimated using ALTA/NSPS LAND TITLE SURVEY map provided by client.

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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			FINES
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0												
0.5		TOPSOIL (6.0 inches)										
		CLAYEY SAND, (SC) brown, fine to coarse grained, moist, trace gravel (Undocumented Fill)	SS 1	39	1-1-2 (3)							
			SS 2	78	2-3-5 (8)			20				
			SS 3	83	3-3-10 (13)							
7.0		POORLY GRADED SAND, (SP) light brown, fine to coarse grained, moist, loose to medium dense, trace gravel (Glacial Outwash)	SS 4	44	4-3-4 (7)							
			SS 5	83	3-4-5 (9)							
10.5												

Bottom of borehole at 10.5 feet.



invergroveheights
 6160 Carmen Ave e
 Inver Grove Heights, Minnesota 55076
 P: 701.232.1822 F: 701.232.1964
 www.ntigeo.com

BORING NUMBER SB-5

CLIENT LWO Development, LLC **PROJECT NAME** Eastgate Apartments
PROJECT NUMBER 20.MSP09807.000 **PROJECT LOCATION** Owatonna, Minnesota
DATE STARTED 2/27/20 **COMPLETED** 2/27/20 **GROUND ELEVATION** 1156 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 observed
LOGGED BY Drew Faherty **CHECKED BY** Steve Gerber **AT END OF DRILLING** ---
CAVE IN (ft) --- **FROST DEPTH (ft)** .16 **AFTER DRILLING** ---
NOTES Elevation estimated using ALTA/NSPS LAND TITLE SURVEY map provided by client.

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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			FINES
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0												
0.4		TOPSOIL (5.0 inches)										
		CLAYEY SAND, (SC) dark brown, fine to coarse grained, moist, trace gravel, trace organics (Undocumented Fill)	SS 1	67	3-3-3 (6)							
			SS 2	83	2-4-5 (9)			14				
4.0												
5		SANDY LEAN CLAY, (CL) dark brown to black, moist, trace gravel, trace organics (Undocumented Fill)	SS 3	78	3-3-3 (6)							
6.5												
		CLAYEY SAND, (SC) brown, fine to coarse grained, moist, medium dense to loose, trace gravel (Glacial Till)	SS 4	89	2-5-5 (10)							
10			SS 5	100	3-3-4 (7)							
11.5												
		POORLY GRADED SAND, (SP) light brown, fine to coarse grained, moist, loose to medium dense, trace gravel (Glacial Outwash)	SS 6	72	3-3-4 (7)							
			SS 7	78	4-4-5 (9)							
14.5												

Bottom of borehole at 14.5 feet.



invergroveheights
 6160 Carmen Ave e
 Inver Grove Heights, Minnesota 55076
 P: 701.232.1822 F: 701.232.1964
 www.ntigeo.com

BORING NUMBER SB-7

CLIENT LWO Development, LLC **PROJECT NAME** Eastgate Apartments
PROJECT NUMBER 20.MSP09807.000 **PROJECT LOCATION** Owatonna, Minnesota
DATE STARTED 2/27/20 **COMPLETED** 2/27/20 **GROUND ELEVATION** 1159 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 observed
LOGGED BY Drew Faherty **CHECKED BY** Steve Gerber **AT END OF DRILLING** ---
CAVE IN (ft) --- **FROST DEPTH (ft)** .16 **AFTER DRILLING** ---
NOTES Elevation estimated using ALTA/NSPS LAND TITLE SURVEY map provided by client.

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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			FINES
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0												
0.5		TOPSOIL (6.0 inches) 1158.5										
		CLAYEY SAND, (SC) dark brown to brown, fine to coarse grained, moist, trace gravel, trace organics (Undocumented Fill)	SS 1	67	2-2-2 (4)							
			SS 2	22	2-3-2 (5)			19				
5			SS 3	67	2-2-3 (5)							
6.5		SILTY SAND, (SM) light brown, fine to medium grained, moist, loose, trace gravel (Glacial Outwash) 1152.5										
			SS 4	100	2-2-3 (5)							
9.0		POORLY GRADED SAND, (SP) light brown, fine to coarse grained, moist, medium dense, trace gravel (Glacial Outwash) 1150.0										
10			SS 5	44	4-6-7 (13)							
10.5		1148.5										

Bottom of borehole at 10.5 feet.



invergroveheights
 6160 Carmen Ave e
 Inver Grove Heights, Minnesota 55076
 P: 701.232.1822 F: 701.232.1964
 www.ntigeo.com

BORING NUMBER SB-8

CLIENT LWO Development, LLC **PROJECT NAME** Eastgate Apartments
PROJECT NUMBER 20.MSP09807.000 **PROJECT LOCATION** Owatonna, Minnesota
DATE STARTED 2/28/20 **COMPLETED** 2/28/20 **GROUND ELEVATION** 1158 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 observed
LOGGED BY Drew Faherty **CHECKED BY** Steve Gerber **AT END OF DRILLING** ---
CAVE IN (ft) --- **FROST DEPTH (ft)** .08 **AFTER DRILLING** ---
NOTES Elevation estimated using ALTA/NSPS LAND TITLE SURVEY map provided by client.

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			FINES
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0												
1.0		TOPSOIL (12.0 inches) NOTE: Organic content in Sample No. 1 is : 3.3%	SS 1	67	1-2-2 (4)			19				
		CLAYEY SAND, (SC) dark brown to brown, fine to coarse grained, moist, trace gravel, trace organics (Undocumented Fill)	SS 2	100	0-1-2 (3)							
4.0												
5		SILTY SAND, (SM) brown, fine to coarse grained, moist, trace gravel (Undocumented Fill)	SS 3	83	3-3-4 (7)							
			SS 4	33	2-2-4 (6)							
9.0												
10		CLAYEY SAND, (SC) light brown, fine to coarse grained, moist, medium dense, trace gravel (Glacial Till)	SS 5	100	3-4-5 (9)							
			SS 6	100	3-4-5 (9)							
14.0			SS 7	100	4-6-8 (14)							
15		POORLY GRADED SAND, (SP) light brown, fine to medium grained, moist, medium dense, trace gravel, occasional silt seams (Glacial Outwash)										
			SS 8	28	7-7-7 (14)			5				4
20												
24.0												
25		CLAYEY SAND, (SC) light brown, fine to coarse grained, moist, very dense, trace gravel, occasional clean sand seams (Glacial Till)	SS 9	89	8-9-25 (34)							
25.5												
Bottom of borehole at 25.5 feet.												

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invergroveheights
 6160 Carmen Ave e
 Inver Grove Heights, Minnesota 55076
 P: 701.232.1822 F: 701.232.1964
 www.ntigeo.com

BORING NUMBER SB-9

CLIENT LWO Development, LLC **PROJECT NAME** Eastgate Apartments
PROJECT NUMBER 20.MSP09807.000 **PROJECT LOCATION** Owatonna, Minnesota
DATE STARTED 2/28/20 **COMPLETED** 2/28/20 **GROUND ELEVATION** 1161.5 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 observed
LOGGED BY Drew Faherty **CHECKED BY** Steve Gerber **AT END OF DRILLING** ---
CAVE IN (ft) --- **FROST DEPTH (ft)** .33 **AFTER DRILLING** ---
NOTES Elevation estimated using ALTA/NSPS LAND TITLE SURVEY map provided by client.

NTI LOG - GENERAL (USE THIS ONE) - NTI-2017-09-14.GDT - 3/18/20 15:00 - \\NTI\AZ\F50\ARCHIVES\RAISE\1-PROJECTS\2020 PROJECTS\EASTGATE APARTMENTS_GEO_20.MSP_09807.000\ENGINEERING REPORTS\INGINTEASTGATE APARTMENTS.GPJ

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			FINES
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0		TOPSOIL (12.0 inches)										
1.0				1160.5	SS 1	89	4-2-2 (4)					
1.5		SANDY LEAN CLAY, (CL) dark brown to black, moist, trace gravel, trace organics (Undocumented Fill)		1160.0	SS 2	56	2-2-3 (5)					
4.0		CLAYEY SAND, (SC) brown, fine to coarse grained, moist, trace gravel (Undocumented Fill)		1157.5								
5.0		POORLY GRADED SAND WITH SILT, (SP-SM) brown, fine to coarse grained, moist, trace gravel (Undocumented Fill)			SS 3	83	3-3-2 (5)					
					SS 4	67	8-9-18 (27)					
9.0				1152.5								
10.0		CLAYEY SAND, (SC) light brown, fine to coarse grained, moist, loose to medium dense, trace gravel (Glacial Till)			SS 5	100	2-4-4 (8)					
					SS 6	100	3-4-6 (10)					
13.0				1148.5								
15.0		POORLY GRADED SAND, (SP) light brown, fine to coarse grained, moist, dense, trace gravel (Glacial Outwash)			SS 7	83	7-9-11 (20)	4				4
					SS 8	100	7-9-8 (17)					
24.0				1137.5								
25.0		CLAYEY SAND, (SC) light brown, fine to coarse grained, moist, medium dense, trace gravel, occasional clean sand seams (Glacial Till)			SS 9	100	4-5-5 (10)					
25.5				1136.0								
Bottom of borehole at 25.5 feet.												



invergroveheights
 6160 Carmen Ave e
 Inver Grove Heights, Minnesota 55076
 P: 701.232.1822 F: 701.232.1964
 www.ntigeo.com

BORING NUMBER SB-10

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CLIENT LWO Development, LLC **PROJECT NAME** Eastgate Apartments
PROJECT NUMBER 20.MSP09807.000 **PROJECT LOCATION** Owatonna, Minnesota
DATE STARTED 2/27/20 **COMPLETED** 2/27/20 **GROUND ELEVATION** 1162 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 observed
LOGGED BY Drew Faherty **CHECKED BY** Steve Gerber **AT END OF DRILLING** ---
CAVE IN (ft) --- **FROST DEPTH (ft)** 1 **AFTER DRILLING** ---
NOTES Elevation estimated using ALTA/NSPS LAND TITLE SURVEY map provided by client.

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			FINES
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0												
0.8		TOPSOIL (10.0 inches)	1161.2									
		CLAYEY SAND, (SC) dark brown, fine to coarse grained, moist, trace gravel, trace organics (Undocumented Fill)	SS 1	78	8-4-2 (6)			16				
			SS 2	67	2-2-3 (5)							
4.0												
5		SILTY SAND, (SM) brown, fine to coarse grained, moist, trace gravel (Undocumented Fill)	1158.0									
			SS 3	61	4-3-3 (6)							
6.5												
7.5		CLAYEY SAND, (SC) dark brown, fine to coarse grained, moist, trace gravel (Undocumented Fill)	1155.5									
		CLAYEY SAND, (SC) brown to gray, fine to coarse grained, moist, trace gravel (Undocumented Fill)	1154.5									
10			SS 5	33	0-0-1 (1)							
11.5												
		CLAYEY SAND, (SC) brown, fine to coarse grained, moist, loose to medium dense, trace gravel (Glacial Till)	1150.5									
			SS 6	100	1-3-4 (7)							
14.0			SS 7	100	3-4-6 (10)							
15		POORLY GRADED SAND, (SP) light brown, fine to coarse grained, moist, medium dense, trace gravel (Glacial Outwash)	1148.0									
20			SS 8	78	7-7-7 (14)							
23.0												
		SILTY SAND, (SM) brown, fine to coarse grained, moist, loose, trace gravel (Glacial Till)	1139.0									
			SS 9	100	3-3-4 (7)							
			1138.0									
			1137.5									
		CLAYEY SAND, (SC) brown, fine to coarse grained, moist, loose, trace gravel (Glacial Till)										
Bottom of borehole at 24.5 feet.												

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