



Geotechnical Engineering Report

**Scott Street & Levee Drive Parcels
Shakopee, Minnesota**

June 8, 2018

Terracon Project No. MP185083

Prepared for:

City of Shakopee
Shakopee, Minnesota

Prepared by:

Terracon Consultants, Inc.
Minneapolis, Minnesota

terracon.com

Terracon

Environmental



Facilities



Geotechnical



Materials

June 8, 2018

City of Shakopee
485 Gorman Street
Shakopee, Minnesota 55379



Attn: Mr. Michael Kerski
P: (952) 233-9346
E: MKerski@shakopeemn.gov

Re: Geotechnical Engineering Report
Scott Street & Levee Drive Parcels
Shakopee, Minnesota
Terracon Project No. MP185083

Dear Mr. Kerski:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PMP185083 dated April 23, 2018. This report presents the results of our subsurface exploration and provides geotechnical discussion and parameters, which will assist in the design and construction of building foundations, floor slab subgrade preparation and earthwork for the proposed project.

We appreciate the opportunity to be of service to you on your project, and look forward to providing the testing and observation services during construction. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.

A handwritten signature in black ink that reads "Lisa M. Breuer".

Lisa M. Breuer, P.E.
Senior Engineer

A handwritten signature in black ink that reads "Michael D. Ringler".

Michael D. Ringler
Senior Engineer



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Note: This report was delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the  logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS
EXPLORATION AND TESTING PROCEDURES
SUPPORTING INFORMATION

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INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed multi-family residential development to be located at Scott Street & Levee Drive in Shakopee, Minnesota. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- soil and rock conditions
- groundwater conditions
- site preparation and earthwork
- excavation considerations
- foundation design and construction
- floor slab design and construction
- lateral earth pressures
- frost considerations
- stormwater pond considerations

The geotechnical engineering scope of services for this project included the advancement of 19 soil borings and 5 rock cores (adjacent to previous soil borings) to depths ranging from approximately 2 to 30 feet below existing site grades.

Maps showing the site and boring locations are provided in **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on the samples obtained during the field exploration are included on the boring logs in **Exploration Results**.

SITE CONDITIONS

The following description of site conditions is derived from information provided by City of Shakopee (Shakopee) and our field observations.

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Item	Description
Parcel Information	The 2.8-acre project is located near Scott Street N & 1 st Avenue W in Shakopee. Latitude/Longitude: 44.7987, -93.5309 (approximate) See Site Location
Existing Improvements	The site currently has two residences, a commercial building, parking lots and vacant/wooded land. Based on a review of available historical information, the site has been developed since at least the 1860s. Several of the parcels were developed with residences in the late-1800s and early-1900s, and a limestone quarry was present on the northern parcels from at least 1890 through 1910. By the 1960s, the site appears much as it currently does.
Current Ground Cover	Lightly vegetated areas, wooded areas and paved parking and drive areas.
Existing Topography (from MnTopo Lidar)	About 10 feet of elevation difference in portion east of Scott Street N. and up to about 14 feet of elevation difference in the wooded area to the west of Scott Street N. sloping downward toward the Minnesota River to the north.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed in the project planning stage. Our understanding of the project conditions is as follows:

Item	Description
Project Description	The 2.8-acre project site is anticipated to include development of a midrise housing facility with underground parking.
Proposed Structure	Specific plans were not provided; however, we understand that the project includes a five-story wood-framed building with an underground concrete parking level.
Finished Floor Elevation	Not provided
Maximum Loads	Maximum column, wall and floor loads were not provided by the City. Unless provided at a later date, the following will be used in our analysis: ■ Columns: 500 kips ■ Walls: 15 kips per linear foot (klf) ■ Slabs: 150 pounds per square foot (psf)
Grading/Slopes	Finished floor elevations were not provided. We anticipate that the first floor level will be near existing grade of the adjacent streets. An excavation up to 12 feet deep is assumed to be required to develop final grade for the underground parking levels.

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Item	Description
Below Grade Structures	The building is anticipated to have one level of underground parking beneath the building footprint.
Retaining Walls	Walls anticipated along ramped drives into below ground parking areas.

GEOTECHNICAL CHARACTERIZATION

We developed a general characterization of the subsurface conditions encountered in our borings and our understanding of the geologic setting. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are possible. Previous grading and construction may have created additional variations. The following sections provide our geotechnical characterization.

Subsurface Profile

Subsurface conditions encountered at each boring location are provided on the individual boring logs provided in **Exploration Results** and summarized in the following table. Stratification boundaries on the boring logs represent the approximate depth where changes in soil types occur; in situ, the transition between native materials may be gradual.

Stratum	Approximate Depth to Bottom of Stratum	Material Description	Comments
Surface	--	Topsoil with light to moderate vegetation	Borings B-2 through B-6, B-10 through B-12, and B-14 through B-20
	---	Asphalt Pavement	Borings B-7 through B-9, B-13
1	2½ to 19½	Existing Fill—generally silty sand, sand, clayey sand and sandy lean clay with variable amounts of gravel Drillers noted possible slag in Borings B-2, B-11, B-13 and B-20 Possible coal, glass and metal in Borings B-11 and B-20 Possible ACM in Boring B-11	—
2 ¹	Boring B-3 terminated within this stratum at the planned depth of approximately 20 feet	Sand (SP) with gravel	Loose to Medium Dense

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Stratum	Approximate Depth to Bottom of Stratum	Material Description	Comments
3 ²	not determined	Limestone bedrock	Moderately to highly fractured, moderately to highly weathered
1. Stratum 2 only observed in Boring B-3. 2. Stratum 3 noted in all borings.			

Subsurface Water Conditions

Water was not observed in the borings while drilling, or for the short duration the borings could remain open; however, this does not necessarily mean the borings terminated above the water table. For this reason, longer term observations in piezometers or observation wells sealed from the influence of surface water could be considered to better define water levels.

Subsurface water level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, flow level in the adjacent river, and other factors not evident at the time the borings were performed. Therefore, subsurface water levels during construction or at other times in the life of the structure may vary. The possibility of water level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

Based on the results of the borings, the geotechnical considerations and recommendations presented in this report are summarized below, with additional details included in the following sections.

- n Fill was observed in each boring. The existing fill was generally comprised of silty sand, sand, clayey sand and sandy lean clay with varying amounts of gravel. The drillers noted presence of slag and other debris within the fill in some of the borings. Limestone bedrock was encountered at depths of near the ground surface to 19½ feet bgs at the boring locations.
- n We are recommending that the existing fills will be removed and replaced with structural backfill. Alternatively, ground improvement methods could be utilized to reduce the amount of existing fill excavation.
- n Bedrock excavation is anticipated over much of the building footprint to accommodate construction of the underground parking feature.

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- n Based on the anticipated foundation loads presented in **Project Description**, it is our opinion that the proposed building could be supported on spread footing foundations bearing on compacted granular structural fill or bedrock. A Terracon representative should observe subgrade conditions during earthwork activities.
- n Generally, the on-site soils appear to be suitable for use/reuse as structural fill.
- n This report is generated without the benefit of building, grading, or design details. Therefore, review of the design information, and confirmation that the recommendations in the report remain valid, is recommended.

The professional opinions and recommendations presented in this report are based on evaluation of data developed by testing discrete samples obtained from widely spaced borings. Site subsurface conditions have been inferred from available data, but actual subsurface conditions will only be revealed by excavation. So that variations in subsurface conditions which may affect the design can be addressed as they are encountered, we recommend that Terracon be retained to observe excavation and perform tests during the site preparation, earthwork and foundation construction phases of the project.

The **General Comments** section provides an understanding of the report limitations.

Additional Engineering Services

This subsurface exploration program included a total of 19 soil borings, widely spaced across the site. Design information concerning building layout and floor levels, structural loading and design conditions, and site grading information is not available. Therefore, review of the design information (when available), and confirmation that the recommendations in the report remain valid, is recommended. Additional field exploration, laboratory testing, and engineering evaluations may be necessary.

EARTHWORK

Bedrock was encountered at depths ranging from near the existing ground surface to 19½ feet bgs at the site. Based on our field exploration and our understanding of proposed site grading, excavation of bedrock is anticipated in the planned building area.

It is our opinion that the bedrock encountered on the site is generally suitable to support the proposed structures on spread footings foundations provided that our subgrade preparation recommendations are followed.

Earthwork on this project should be observed and evaluated by Terracon. Recommendations for site preparation, excavation, subgrade preparation and fill placement are provided in the following sections.

Existing Fill

As noted in **Geotechnical Characterization**, the borings encountered existing fill to depths ranging from about 2½ to 19½ feet. The existing fill is generally comprised of silty sand, sand, clayey sand and sandy lean clay with varying amounts of gravel and other debris. We anticipate that much of the existing fill material will be removed as part of the excavation of the below grade parking area of the proposed building. The fill appears to have been placed in a controlled manner, but we have no records of control during fill placement or specifications concerning placement and compaction.

Therefore, there is risk for the Owner of excessive total/differential settlement when supporting structures on the existing fill materials, as low density zones or other unsuitable materials may be present. The risk of excessive total and/or differential settlement of existing fill materials is recommended to be mitigated by the complete removal of existing fill materials below the area of the planned construction during mass grading operations. We anticipate that removal of existing fill will require undercuts ranging from about 2½ to 19½ feet.

Excavation Considerations

Excavations on the order of 12 feet bgs are anticipated for construction of the below-grade parking area and are expected to extend through the existing fill materials and encounter bedrock at portions of the building closer to 1st Avenue West. Anomalous boulders or cobbles or other debris could also be encountered during the excavation. Unbraced sloped excavations in the fill and native sands are expected to be relatively broad and could potentially encroach upon adjacent structures and streets.

To reduce the overall width of the excavations and potential impact on adjacent structures and streets, installations of earth retention systems (i.e. permanent or temporary shoring), will be needed to protect adjacent existing structures and streets. Design and installation of shoring systems should be provided by the contractor. Structures, slabs, and pavements adjacent to the excavation could become undermined if sloughing occurs while the excavation remains open during construction. Flowable fills, mudjacking, or grouting could be needed during backfilling operations adjacent to existing structures. Terracon can assist this process by performing preconstruction surveys of existing structures, by assisting in developing a settlement monitoring program, and by vibration monitoring.

Bedrock Excavation

Bedrock is anticipated to be encountered at depths near the existing ground surface to about 19 ½ feet bgs based on the borings performed at the site. Excavation of the bedrock to develop the subgrade level for the lower parking level, or for foundation and utility installation could be difficult and require the use of large backhoes with rock teeth or hoe rams, or dozers with ripping attachments. The contractor should also expect to encounter boulder and cobble size fragments and possible nodules of slag or other debris within the existing fill. We anticipated that the amount of weathering of the bedrock surface may be variable across the site as this was observed in our rock cores (photos and descriptions of the rock cores are included in **Exploration Results**). Any excavations into the bedrock for utilities or foundations will also be difficult and overbreakage could occur potentially resulting in larger quantities of excavation and backfill materials. Rock excavation depends not only on the rock hardness, weathering and fracture frequency, but also the contractor's equipment, capabilities and experience. Therefore, it is the contractor's responsibility to determine the most effective methods for excavation.

Site Preparation

We expect existing pavements and structures in new construction areas will be removed. Demolition should include complete removal of all abandoned utilities, pavements, and foundations. Site preparation should also include stripping of all vegetation, organic soils, root systems, and any soft, frozen or otherwise unsuitable materials (if encountered). The depth of removal of unsuitable materials should be evaluated by Terracon personnel during construction.

Following stripping, existing fill materials should be completely removed below the footprint area of the planned construction. Consideration should be given to the excavation of test pits prior to construction to further evaluate the depth, extent, and composition of existing fill materials. Subgrade stabilization will be required where saturated and/or loose sands are exposed at the base of the undercut.

We recommend the exposed subgrade be proofrolled to help delineate soft, disturbed, or low-density fill zones. Proofrolling should be accomplished using a fully loaded, tandem axle dump truck or other equipment providing an equivalent subgrade loading (minimum gross weight of 25 tons is recommended for the proofrolling equipment). A vibratory smooth drum roller (minimum gross weight of 10 tons) should be used in areas where sands are exposed. Unstable areas identified by proofrolling should either be undercut to expose stable material and backfilled with structural fill or stabilized as described in this report.

Following proofrolling, and prior to placement of structural fill in areas below design grade and after completion of rough grading in cut areas of the site, the exposed subgrade should be

scarified to a depth of 9 inches, moisture conditioned, and compacted to the density and water content ranges recommended in this report.

Should unstable subgrade conditions be encountered or develop, stabilization measures will need to be employed. Improvement methods are influenced by schedule, weather, the size of the disturbed area, and the nature of the disturbance. Improvement methods include but are not limited to:

- n **Scarification and Compaction** – Soils can be scarified, moisture conditioned (i.e., dried or moistened), and compacted. The success of this procedure depends primarily upon favorable weather and sufficient time to manipulate the soils. Even with adequate time and favorable weather, stable subgrades may not be achieved if the thickness of the unstable material is greater than about 1 to 1½ feet.
- n **Undercutting and Replacement with Crushed Stone/Aggregate** – The use of crushed stone, crushed concrete, and/or gravel to replace loose soils could improve subgrade stability. To limit depths of potential undercuts, the use of a geotextile or geogrid could also be considered after underground work, such as utility construction, is completed. The specifications provided by the reinforcement product manufacturer should be verified prior to material purchase/delivery and placement at the site.

Structural Fill Material Requirements

Structural fill should meet the following material property requirements:

Fill Type ¹	Soil Classification	Acceptable Location for Placement
On-site soils ²	Existing fill of suitable classification Sand (SP), Silty sand (SM),	■ Below floor slabs - n Below foundations of at-grade structures if placed during mass grading on stable subgrades - n Sand soils can also be used below foundations of at-grade structures in overexcavations - n Suitability for backfill adjacent to below grade walls dependent on lateral earth pressure parameters used for design
Imported granular material	GW, GP, GM, GC SW, SP, SM, SC	■ Below foundations in overexcavations ■ Below grade-supported floor slabs (granular soils should contain <15% passing No. 200 sieve) ■ Backfill around structures - n Free-draining zones below slabs (granular soils should contain <6% passing No. 200 sieve)

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Fill Type ¹	Soil Classification	Acceptable Location for Placement
Imported drainage fill	SP, SW, GW	■ Well-graded, free-draining granular material placed adjacent to below-grade walls. A general gradation should be 100% passing the 1½-inch sieve, about 40% passing the No. 10 sieve, and less than 6% fines.
Unsuitable material	CL, CH, MH, OL, OH, PT	n Green (non-structural) locations

1. Structural fill should consist of approved materials that are free of organic matter and debris, and particles larger than 3 inches in dimension. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the geotechnical engineer for evaluation prior to use on this site.
2. Sorting of topsoil and on-site soils containing debris, organics, etc., will be necessary. Delineation of unsuitable on-site soils should be performed in the field by a Terracon representative. Moisture conditioning of the on-site soils will be necessary to facilitate compaction.

Appropriate laboratory tests, including standard Proctor (ASTM D698) moisture-density relationship tests, and Atterberg Limits should be performed on proposed fill materials. Further evaluation of any on-site soils or off-site fill materials should be performed by Terracon prior to their use.

Structural Fill Compaction Requirements

Structural fill should meet the following compaction requirements:

Item	Description
Fill lift thickness	n 9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used n 4 inches in loose thickness when hand equipment (e.g., jumping jack, vibratory plate compactor, etc.) is used
Compaction of granular material ^{1, 2, 3}	n At least 98%
Moisture content of granular material ⁴	n Workable moisture levels
Compaction of cohesive material ^{1, 2}	n At least 95%
Moisture content of cohesive material	n -2% to +3% of optimum

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Item	Description
1.	Compaction values and moisture contents are relative to standard Proctor maximum dry density and optimum moisture content (ASTM D 698).
2.	We recommend structural fill be tested for moisture content and compaction during placement. If the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
3.	If the granular material is a coarse sand or gravel, is of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254).
4.	Specifically, the moisture content of the granular material should be at a level to achieve compaction without the granular material bulking during placement or pumping when proofrolled.

Terracon should be retained to monitor fill placement and to perform field density tests as each lift of fill is placed in order to evaluate compliance with the design requirements. Terracon should be retained to observe and test subgrades immediately prior to paving.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5 percent away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted as necessary as part of the structure's maintenance program. Where paving or flatwork abuts the structure a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over, or adjacent to, construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected

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material should be removed, or the materials should be scarified, moisture conditioned, and recompacted, prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations. Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing pressure ^{1, 2}	3,000 psf (higher bearing capacity is possible if a ground improvement system is installed)
Required Bearing Stratum ³	Granular structural fill (overexcavation and backfill procedure) Weathered bedrock
Minimum Foundation Dimensions	Columns: 30 inches Continuous: 18 inches
Ultimate Passive Resistance ⁴ (equivalent fluid pressures)	For materials placed adjacent to footings: 285 pcf (cohesive backfill) 360 pcf (granular backfill)
Ultimate Coefficient of Sliding Friction ⁵	Footings on compacted granular material: 0.45
Minimum Embedment below Finished Grade ⁶	Unheated areas: 5 feet Heated areas: 3½ feet
Estimated Total Settlement from Structural Loads ²	Less than about 1 inch
Estimated Differential Settlement ^{2, 7}	Less than about 1 inch

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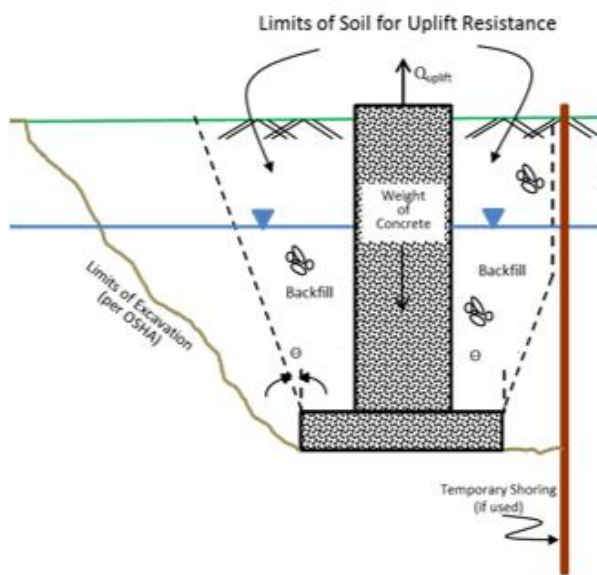
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Item	Description
1.	The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. Values assume that exterior grades are no steeper than 20 percent within 10 feet of structure.
2.	Values provided are for maximum loads noted in Project Description .
3.	Unsuitable, disturbed, or soft soils should be over-excavated and replaced per the recommendations presented in the Earthwork .
4.	Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face.
5.	Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6.	Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7.	Differential settlements are as measured over a span of 50 feet.

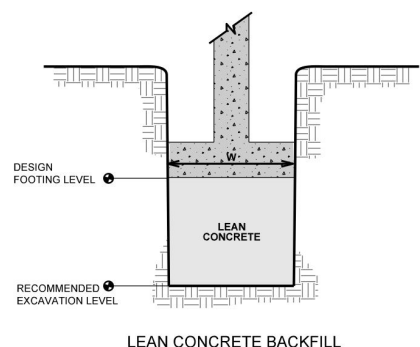
Design Parameters - Uplift Loads

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils. As illustrated on the following figure, the effective weight of the soil prism defined by diagonal planes extending up from the top of the perimeter of the foundation to the ground surface at an angle, ϕ , of 20 degrees from the vertical can be included in uplift resistance. The maximum allowable uplift capacity should be taken as a sum of the effective weight of soil plus the dead weight of the foundation, divided by an appropriate factor of safety. A maximum total unit weight of 100 pcf should be used for the backfill. This unit weight should be reduced to 40 pcf for portions of the backfill or natural soils below the highest anticipated groundwater elevation.



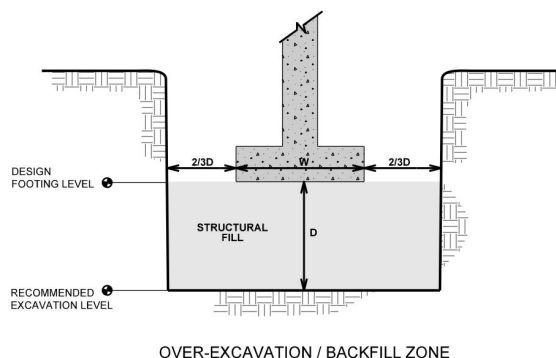
Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.



NOTE: EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. This is illustrated on the sketch below.



NOTE: EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

Over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation with well-graded granular material placed as recommended in the **Earthwork** section.

GROUND IMPROVEMENT

As an alternative to supporting the structure on bedrock and replacing the existing fill, the structure and potentially parking slabs could be supported on fill soils if ground improvement methods are utilized. These types of options can reduce the amount of existing fill excavation and increase the allowable bearing capacity. Ground improvement methods are proprietary systems designed by licensed contractors who could provide further information regarding support options once the building footprint and finished floor elevations are established. We should be contacted to provide further input if a ground improvement system is considered.

PARKING SLABS

Design parameters for heated parking slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and, positive drainage of the aggregate base beneath the parking slab.

Heated Parking Slab Design Parameters

Item	Description
Slab Support ¹	Minimum 6 inches of free-draining crushed aggregate compacted to at least 98% of ASTM D 698 ^{2,3}
Estimated Modulus of Subgrade Reaction ²	150 pounds per square inch per inch (psi/in) for point loads

1. Slabs should be structurally independent of building footings or walls to reduce the possibility of slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.
3. Free-draining granular material should have less than 6 percent fines (material passing the #200 sieve). Other design considerations such as cold temperatures and condensation development could warrant more extensive design provisions.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

A system of drain tiles should be installed to drain the granular layer below the lower level parking slab. The drain tiles should consist of perforated, rigid-pipe with a minimum diameter of 4 inches. We recommend the drain tiles be placed alongside the interior of the perimeter parking garage walls and at roughly 40 to 50 foot centers under the rest of the parking garage slab.

The inverts of the drain tiles should be installed in trenches which are at least 12 inches wide and incised at least 6 inches into the clay subgrade. A filter fabric is recommended as a liner in the trenches and lapped on the subgrade around the trenches for a distance of 3 feet beyond the trench edges. The drain tiles should be surrounded by free-draining granular material graded to prevent the intrusion of fines. The free-draining material should not contain particle sizes capable of entering or clogging the drain pipe perforations, or the drain pipes can be wrapped with a filter-fabric "sock" to help prevent infiltration of fines. These drain pipes should be sloped to a reliable discharge point (i.e., storm sewer or sump pit and pump). If gravity drainage cannot be provided, the drainage system will require a system of sump pits and pumps. As a precautionary measure, we recommend at least two pumps for redundancy, and the pumping system should be provided with a backup power supply. All drains should be provided with cleanouts.

Where slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means. The slab can be stiffened as determined by the project Structural Engineer by adding steel reinforcement, grade beams and/or post-tensioned elements.

Slab Construction Considerations

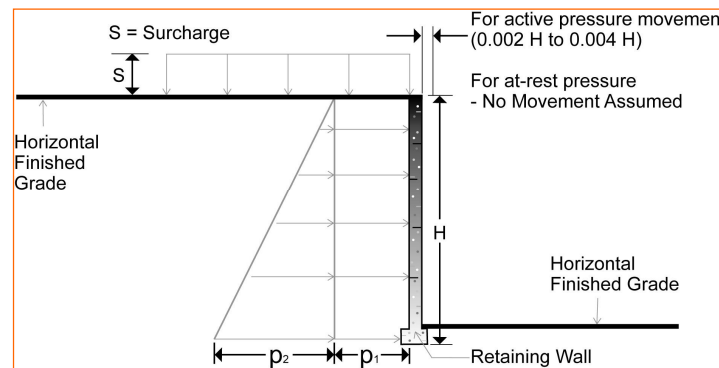
The finished slab subgrade should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the slab support course.

The Geotechnical Engineer should approve the condition of the subgrades immediately prior to placement of the support course, reinforcing steel and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

LATERAL EARTH PRESSURES

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Design Parameters			
Earth Pressure Condition ¹	Coefficient for Backfill Type ²	Surcharge Pressure ^{3, 4, 5} p_1 (psf)	Effective Fluid Pressures (psf) ^{2, 4, 5}
			Unsaturated ⁶
Active (K_a)	Granular - 0.31	$(0.31)S$	$(40)H$
	Fine Grained - 0.41	$(0.41)S$	$(50)H$
At-Rest (K_o)	Granular - 0.47	$0.47)S$	$(55)H$
	Fine Grained - 0.58	$(0.58)S$	$(70)H$
Passive (K_p)	Granular - 3.25	---	$(390)H$
	Fine Grained - 2.46	---	$(295)H$

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. Uniform, horizontal backfill, compacted to at least 95 percent of the ASTM D 698 maximum dry density, rendering a maximum unit weight of 120 pcf.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. No safety factor is included.

Lateral Earth Pressure Design Parameters			
Earth Pressure Condition ¹	Coefficient for Backfill Type ²	Surcharge Pressure ^{3, 4, 5} p_1 (psf)	Effective Fluid Pressures (psf) ^{2, 4, 5}
			Unsaturated ⁶

6. In order to achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

Subsurface Drainage for Below Grade Walls

To reduce hydrostatic pressure behind unbalanced walls, we recommend that a drain system be installed along the wall and extend to the foundation of the below grade walls. The wall drain system should be designed according to the following table.

Item	Description
Wall drainage pipe	n Minimum 4-inch diameter rigid perforated pipe
	n Pipe perforations should be appropriately sized to prevent free-draining granular material from entering the subdrain pipe
	n Pipe invert should be at least 5 feet below proposed grade, or at the foundation of the below grade walls, whichever is deepest
	n Drain lines should be sloped to provide positive gravity drainage to a reliable discharge point (e.g., storm sewer, sump pit and pump, etc.)
	n Pipes should be embedded in at least 4 inches of wall drainage backfill material
Wall drainage backfill	n MnDOT Coarse Filter Aggregate or equivalent, or
	n Free-draining granular material encapsulated with non-woven geotextile filter fabric (Contech C60NW or equivalent)
	n At least a 2-foot wide section of free-draining granular fill located above the drain line and adjacent to the walls, or
	n A prefabricated drainage structure ¹ located above a drain line and the surrounding filter.

1. A prefabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion, and is fastened to the walls prior to placing backfill.

If walls must resist combined hydrostatic and lateral earth pressures, then combined hydrostatic and lateral earth pressures should be calculated using the "undrained" values in the previous section. Water stops and other wall waterproofing measures should also be considered in designs.

FROST CONSIDERATIONS

The soils on this site are frost susceptible, and small amounts of water can affect the performance of doorways, sidewalks and pavements. Exterior slabs should be expected to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of low-frost susceptible fill or structural slabs (e.g., structural stoops in front of building doors). Placement of low-frost susceptible material in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave:

- Provide surface drainage away from the building and slabs, and toward the site storm drainage system.
- Install drain tiles around the perimeter of the building, stoops, below exterior slabs and pavements, and connect them to the storm drainage system.
- Grade clayey subgrades, so groundwater potentially perched in overlying more permeable subgrades, such as sand or aggregate base layers, slope toward a site drainage system.
- Placing low-frost susceptible fill as backfill beneath slabs and pavements that are critical to the project.
- Place a 3:1 (horizontal to vertical) transition zone between low-frost susceptible fill and other soils.
- Place low-frost susceptible materials in critical sidewalk areas.

STORMWATER MANAGEMENT

Plans for the proposed stormwater management areas to be located west of Scott Street were not available to Terracon to review at the time of this report. Based on our exploration in the area (Borings B-2 through B-4), the excavations in the proposed area will most likely encounter silty sand fill materials.

The fill material observed in Borings B-2 through B-4 have the following properties according to Minnesota Pollution Control Agency stormwater design infiltration rates.

USCS Classification	Hydrologic Soil Group	Infiltration Rate (inches/hour)
SM	B	0.45

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between boring locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Support of utilities and the floor slab above existing undocumented fill is discussed in this report. Even with the construction observation/testing recommended in this report, a risk remains for the owner Shakopee that unsuitable materials within or buried by the fill will not be discovered. This may result in a larger than normal settlement of the floor slab and utilities supported above existing fill. This risk cannot be eliminated without removing and replacing the existing fill. Terracon does not accept any risk if the owner Shakopee chooses to support the slab over the existing fill.

Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. An environmental Supplemental Site Investigation was performed by Terracon as submitted under a separate report dated, June 1, 2018.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of Shakopee for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended. Any third party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to Shakopee, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Geotechnical Engineering Report

Scott Street & Levee Drive Parcels ■ Shakopee, Minnesota

June 8, 2018 ■ Terracon Project No. MP185083



I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Minnesota.

A handwritten signature in black ink that reads "Lisa M. Breuer".

Lisa M. Breuer, P.E.

Date: June 8, 2018

Minnesota P.E. #19929

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Boring Number ¹	Boring Depth (feet) ²	Location
B-2 through B-4	Auger refusal between 18.7 to 20	Future stormwater area
B-5 through B-20	Auger refusal between 1.9 to 20.3	Building area
C-5, C-10, C-17 through C-19	Rock core 10 feet	At similarly numbered boring locations within the Building area

1. B-1 was not drilled due to access issues
2. Below ground surface

Boring Layout and Elevations:

Distances for laying out the borings were obtained by the drill crew using a measuring tape from the existing site features, and estimating right angles. We used a handheld GPS device to obtain latitude and longitude coordinates of the boring locations. The approximate elevations at the boring locations were obtained by the drill crew using an engineer's level and rod, and are referenced to the sewer cover near Boring B-3 as a temporary benchmark. The boring locations and elevations should be considered accurate only to the degree implied by the means and methods used for these measurements.

Subsurface Exploration Procedures: The borings were advanced using continuous flight hollow stem augers. Sampling was performed using split-barrel sampling procedures. In the split barrel sampling procedure, a standard 2-inch outer diameter split barrel sampling spoon is driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. The samples were containerized, taken to our laboratory for testing, and classified by the project engineer. In addition, we observed and record subsurface water levels during and after drilling.

Rock coring was also performed at five boring locations. Water used as a drilling fluid for rock coring was discharged on site.

Our exploration team prepared field logs as part of standard drilling operations including sampling depths, penetration distances, and other relevant sampling information, visual classifications of materials encountered during drilling, and our interpretation of subsurface conditions between samples. Boring logs included in our completed report are prepared from the field logs and represent the project engineer's interpretation, and include modifications based on observations and laboratory tests.

Geotechnical Engineering Report

Scott Street & Levee Drive Parcels ■ Shakopee, Minnesota

June 8, 2018 ■ Terracon Project No. MP185083



Laboratory Testing

The samples were tested in the laboratory to measure their natural water contents. These test results are provided on the boring logs included in **Exploration Results**.

The soil samples were also classified based on visual observation, texture, plasticity, and the limited laboratory testing described above. The soil descriptions presented on the boring logs are in accordance with the General Notes and Unified Soil Classification System (USCS) included in **Supporting Information**. The estimated USCS group symbols for native soil samples are shown on the boring logs, and a brief description of the USCS is included in **Supporting Information**.

Rock sample classifications and descriptions are in accordance with the enclosed General Notes - Sedimentary Rock Classification (**Supporting Information**), and are based on tactile and visual observations of the core samples. Petrographic analysis may reveal other rock types. Percent recovery and rock quality designation (RQD) were also determined for the rock core samples and are provided on the boring logs. RQD is the percent of total length cored consisting of sound pieces at least 4 inches in length and is a measure of the in-situ rock quality. The percent recovery and RQD are related to rock soundness and quality as illustrated below:

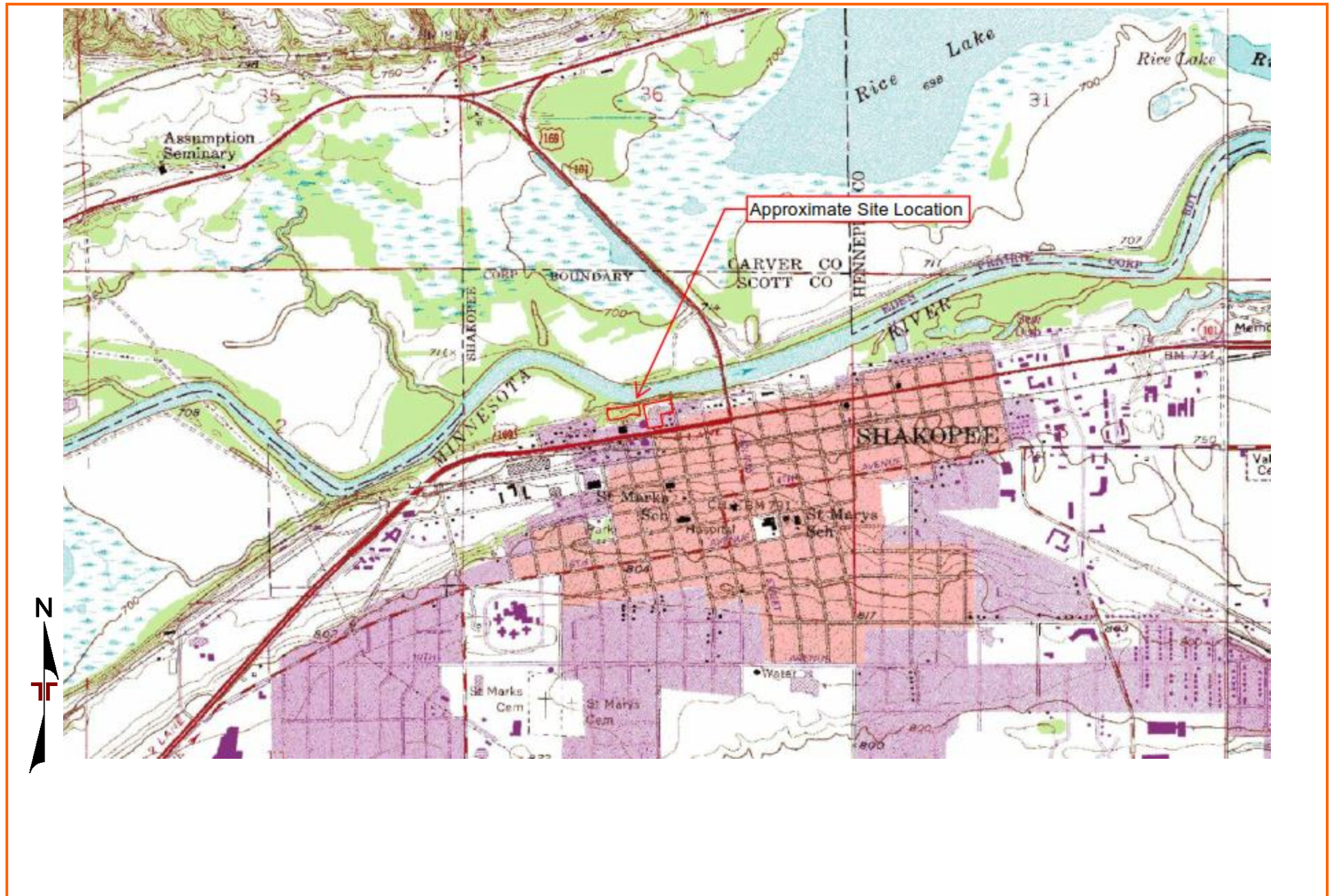
Relation of RQD and In-Situ Rock Quality (ASTM D6032)	
RQD (%)	Rock Quality
90 – 100	Excellent
75 – 90	Good
50 – 75	Fair
25 – 50	Poor
0 – 25	Very Poor

SITE LOCATION AND EXPLORATION PLAN

SITE LOCATION

Scott Street & Levee Drive Parcels ■ Shakopee, Minnesota

June 8, 2018 ■ Terracon Project No. MP185083



EXPLORATION PLAN

Scott Street & Levee Drive Parcels ■ Shakopee, Minnesota
June 8, 2018 ■ Terracon Project No. MP185083



EXPLORATION RESULTS

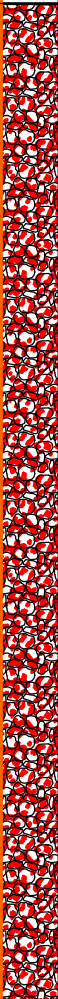
BORING LOG NO. 02

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Latitude: 44.7985° Longitude: -93.5323° Approximate Surface Elev: 109 (Ft.) +/- ELEVATION (Ft.)						
	DEPTH						
	Moderate vegetative ground cover FILL-SILTY SAND WITH GRAVEL , fine to medium grained, dark brown						
	trace organics			X	5-9-2 N=11	0.0	22
	No sample recovery from 3.5 to 5 feet	5		X	2-3-3 N=6		
				X	4-4-3 N=7	0.6	9
	trace slag	10		X	5-6-5 N=11	1.0	6
				X	4-9-6 N=15	0.0	11
	trace slag	15					
	18.5 18.7 LIMESTONE , tan	90.5+/- 90.5+/-		X	50/2"		18
	Boring Terminated at 18.7 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 18.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with bentonite grout upon completion

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

 After boring completion

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-15-2018

Boring Completed: 05-15-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. MP185083 CITY OF SHAKOPEE. GPJ TERRACON DATATEMPLATE.GDT 5/30/18

BORING LOG NO. 03

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 44.7986° Longitude: -93.5315° Approximate Surface Elev: 100.5 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	DEPTH						
	Moderate vegetative ground cover FILL-SILTY SAND TRACE TO WITH GRAVEL , coarse to medium grained, dark brown						
				X	1-1-1 N=2	0.0	12
				X	1-2-2 N=4	0.0	14
		5		X	2-1-2 N=3	0.0	14
				X	3-8-4 N=12	0.0	12
				X	2-4-2 N=6	0.0	8
		15		X	8-10-10 N=20	0.0	9
		20					
	13.5 POORLY GRADED SAND WITH GRAVEL (SP) , fine to coarse grained, brown, loose to medium dense 87+/-						
	20.0 Practical auger refusal at termination depth. Assumed bedrock surface. Boring Terminated at 20 Feet 80.5+/-						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 18.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with bentonite grout upon completion

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

 After boring completion

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-15-2018

Boring Completed: 05-15-2018

Drill Rig: 848

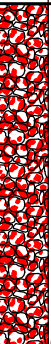
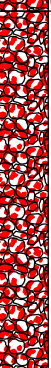
Driller: Terry

Project No.: MP185083

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Page 1 of 1

**CLIENT: City of Shakopee
Shakopee, MN**

GRAPHIC LOG	LOCATION See Exploration Plan		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Latitude: 44.7989° Longitude: -93.5312°	Approximate Surface Elev: 101 (Ft.) +/-						
DEPTH	ELEVATION (Ft.)							
	Moderate vegetative ground cover FILL-SILTY SAND , with gravel, fine to medium grained, dark brown							
6.5	94.5+/-							
	ASSUMED FILL , No sample recovery							
10	88.2+/-							
	LIMESTONE , tan							
13.5	87.5+/-							
	Boring Terminated at 19.4 Feet							
19.4	81.5+/-							

Hammer Type: Automatic

 After boring completion

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL MP185083 CITY OF SHAKOPEE-GPJ TERRACON_DATATEMPLATE.GDT 5/30/18

BORING LOG NO. 05

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MNSITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 44.7982° Longitude: -93.5308° Approximate Surface Elev: 110 (Ft.) +/- DEPTH ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Light vegetative ground cover FILL-SILTY SAND WITH GRAVEL , trace organics, fine to coarse grained, dark brown				2-9-27 N=36	0.7	18
3.5		106.5+/-					
4.3	LIMESTONE , tan	105.5+/-			11-50/4"	0.9	14
Boring Terminated at 4.3 Feet ROCK CORE C-5 Depth 2 - 12 feet Recovery 95% RQD = 42 LIMESTONE, gray with rust staining, moderately to highly fractured, moderately weathered							
Stratification lines are approximate. In-situ, the transition may be gradual. Hammer Type: Automatic							
Advancement Method: Hollow stem auger to 3.5 feet		See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (if any).		Notes:			
Abandonment Method: Boring backfilled with auger cuttings upon completion.		See Supporting Information for explanation of symbols and abbreviations. Elevations measured in the field					
WATER LEVEL OBSERVATIONS <i>Groundwater not encountered</i>		 13400 15th Ave N Plymouth, MN		Boring Started: 05-14-2018		Boring Completed: 05-14-2018	
				Drill Rig: 848		Driller: Terry	
				Project No.: MP185083			

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BORING LOG NO. 06

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Latitude: 44.7985° Longitude: -93.5308° Approximate Surface Elev: 106.5 (Ft.) +/- ELEVATION (Ft.)						
	DEPTH						
	Light vegetative ground cover FILL-SILTY SAND , trace organics, fine to medium grained, dark brown					0.8	
	2.8 103.5+/-			X	1-1-50/4"	1.2	26
	Practical auger refusal at termination depth. Assumed bedrock surface. Boring Terminated at 2.8 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 1.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon

13400 15th Ave N
Plymouth, MN

Boring Started: 05-14-2018

Boring Completed: 05-14-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

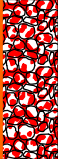
BORING LOG NO. 07

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Latitude: 44.7983° Longitude: -93.5307° Approximate Surface Elev: 110 (Ft.) +/- ELEVATION (Ft.)						
	DEPTH						
	Asphalt pavement FILL-SAND WITH GRAVEL , fine to coarse grained, brown						
	3.0 107+/-			X	4-4-22 N=26	0.2	8
	Practical auger refusal at termination depth. Assumed bedrock surface. Boring Terminated at 3 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 1.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-15-2018

Boring Completed: 05-15-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

BORING LOG NO. 08

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	See Exploration Plan Latitude: 44.7983° Longitude: -93.5306° Approximate Surface Elev: 110 (Ft.) +/- ELEVATION (Ft.)						
	Asphalt pavement FILL-SAND , fine to coarse grained, brown					0.1	
	2.5 107.5+/-				6-6-50 N=56	0.4	7
	3.1 107+/- LIMESTONE , tan						
	Boring Terminated at 3.1 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 1.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-15-2018

Boring Completed: 05-15-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

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BORING LOG NO. 09

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MNSITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Latitude: 44.7985° Longitude: -93.5307° Approximate Surface Elev: 107 (Ft.) +/- ELEVATION (Ft.)						
	DEPTH						
	Asphalt pavement FILL-SILTY SAND WITH GRAVEL , fine to medium grained, dark brown						
	3.0	104+/-		X	2-2-14 N=16	0.4	24
	LIMESTONE, tan			X	29-41-50/1"		5
	4.1	103+/-					
	Boring Terminated at 4.1 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 3 feetSee [Exploration and Testing Procedures](#) for a
description of field and laboratory procedures
used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.See [Supporting Information](#) for explanation of
symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-14-2018

Boring Completed: 05-14-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL MP185083 CITY OF SHAKOPEE-GPJ TERRACON_DATATEMPLATE.GDT 5/30/18

BORING LOG NO. 10

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MNSITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 44.7984° Longitude: -93.5311° Approximate Surface Elev: 107.5 (Ft.) +/- DEPTH ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Light vegetative ground cover FILL-SILTY SAND TRACE GRAVEL , trace organics, fine to medium grained, dark brown					0.1	
3.5		104+/-			2-2-9 N=11	0.1	15
4.4	LIMESTONE , tan	103+/-			4-50/5"		11
Boring Terminated at 4.4 Feet ROCK CORE C-10 Depth 4-14 feet Recovery 95% RQD= 65 LIMESTONE, gray with rust staining, moderately fractured, moderately weathered							
Stratification lines are approximate. In-situ, the transition may be gradual.		Hammer Type: Automatic					
Advancement Method: Hollow stem auger to 3.5 feet		See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).		Notes:			
Abandonment Method: Boring backfilled with auger cuttings upon completion.		See Supporting Information for explanation of symbols and abbreviations. Elevations measured in the field					
WATER LEVEL OBSERVATIONS <i>Groundwater not encountered</i>		 13400 15th Ave N Plymouth, MN		Boring Started: 05-14-2018		Boring Completed: 05-14-2018	
				Drill Rig: 848		Driller: Terry	
				Project No.: MP185083			

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL MP185083 CITY OF SHAKOPEE-GPJ TERRACON_DATATEMPLATE.GDT 5/30/18

BORING LOG NO. 11

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Latitude: 44.7987° Longitude: -93.5311° Approximate Surface Elev: 103.5 (Ft.) +/- ELEVATION (Ft.)						
	DEPTH						
	Light vegetative ground cover FILL-SILTY SAND WITH GRAVEL , fine to medium grained, dark brown						
				X	4-5-11 N=16	0.5	8
		5		X	4-4-4 N=8	2.6	10
	trace slag, coal, glass, metal, possible ACM			X	1-2-0 N=2	0.6	12
	trace glass	10		X	1-1-0 N=1	1.9	23
				X	4-7-3 N=10	1.0	12
	13.5 LIMESTONE , tan	90+/-					
	15.0	88.5+/-					
	Boring Terminated at 15 Feet	15					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 13.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with bentonite grout upon completion

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

 After boring completion

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-14-2018

Boring Completed: 05-14-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. MP185083 CITY OF SHAKOPEE-GPJ TERRACON DATATEMPLATE.GDT 5/30/18

BORING LOG NO. 13

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Latitude: 44.799° Longitude: -93.531° Approximate Surface Elev: 100 (Ft.) +/- ELEVATION (Ft.)						
	DEPTH						
	Asphalt pavement						
	<u>FILL-SILTY SAND WITH GRAVEL</u> , fine to medium grained, dark brown						
	3.5	96.5+/-		X	8-8-8 N=16	1.3	7
	<u>FILL-CLAYEY SAND WITH GRAVEL</u> , fine to medium grained, dark brown						
		5		X	3-4-11 N=15	0.9	
				X	6-7-14 N=21	1.2	19
		10		X	6-9-19 N=28	2.1	12
	trace slag	15		X	6-6-5 N=11	2.3	14
	18.5	81.5+/-					
	19.0 <u>LIMESTONE</u> , tan	81+/-		X	50		7
	Boring Terminated at 19 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 18.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with bentonite grout upon completion

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

 After boring completion

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-15-2018

Boring Completed: 05-15-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. MP185083 CITY OF SHAKOPEE. GPJ TERRACON DATATEMPLATE.GDT 5/30/18

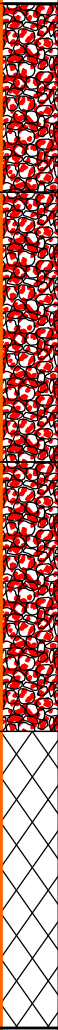
BORING LOG NO. 14

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	See Exploration Plan Latitude: 44.799° Longitude: -93.5311° Approximate Surface Elev: 98.5 (Ft.) +/- ELEVATION (Ft.)						
	DEPTH						
	Light vegetative ground cover FILL-SILTY SAND WITH GRAVEL , trace organics, fine to medium grained, dark brown						
	3.5	95+/-		X	5-6-7 N=13	2.2	12
	FILL-SANDY LEAN CLAY , brown			X	1-0-0 N=0	1.5	23
	8.5	90+/-		X	10-15-16 N=31	1.2	15
	FILL-CLAYEY SAND , trace gravel, dark brown			X	4-12-18 N=30	0.9	18
	13.5	85+/-		X	6-6-11 N=17	0.1	8
	LIMESTONE , tan						
	19.0	79.5+/-		X	50		
	Boring Terminated at 19 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 18.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with bentonite grout upon completion

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

 After boring completion

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-14-2018

Boring Completed: 05-14-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

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BORING LOG NO. 15

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Latitude: 44.7991° Longitude: -93.5306° Approximate Surface Elev: 100.5 (Ft.) +/- ELEVATION (Ft.)						
	DEPTH						
	Light vegetative ground cover LIMESTONE , tan, Assumed bedrock surface.						
	1.9	98.5+/-		X	50/5"		
	Boring Terminated at 1.9 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 1.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-14-2018

Boring Completed: 05-14-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

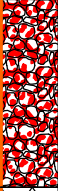
BORING LOG NO. 16

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Latitude: 44.7991° Longitude: -93.5301° Approximate Surface Elev: 100.5 (Ft.) +/- ELEVATION (Ft.)						
	DEPTH						
	Light vegetative ground cover FILL-SILTY SAND , trace organics, fine to medium grained, dark brown						
	3.5 97 +/- 3.8 96.5 +/-			X	3-7-5 N=12	0.2	20
	LIMESTONE, tan Boring Terminated at 3.8 Feet			X	50/4"		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 3.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-14-2018

Boring Completed: 05-14-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL MP185083 CITY OF SHAKOPEE-GPJ TERRACON_DATATEMPLATE.GDT 5/30/18

BORING LOG NO. 17

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Latitude: 44.799° Longitude: -93.5305°						
	Approximate Surface Elev: 100.5 (Ft.) +/-						
	DEPTH	ELEVATION (Ft.)					
	Light vegetative ground cover LIMESTONE , tan, Assumed bedrock surface.					0.4	
					8-9-50 N=59		8
	3.0	97.5+/-					

Boring Terminated at 3 Feet

ROCK CORE C-17 Depth 3-13 feet
Recovery 100% RDQ= 14
LIMESTONE, gray with rust staining, highly fractured, highly to moderately weathered, intermittent infilling with sand



Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 1.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-14-2018

Boring Completed: 05-14-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

BORING LOG NO. 18

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 44.7989° Longitude: -93.5307° Approximate Surface Elev: 100.5 (Ft.) +/- DEPTH ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	Moderate vegetative ground cover FILL-SILTY SAND WITH GRAVEL , trace organics, fine to medium grained, dark brown	3.5			7-6-4 N=10	0.0	11
	FILL-SANDY LEAN CLAY WITH GRAVEL , brown	97+/-			3-5-4 N=9	0.4	11
					1-1-1 N=2	0.9	14
					10-3-3 N=6	3.0	20
					2-3-2 N=5	0.8	20
	LIMESTONE , gray with rust staining, moderately fractured and weathered	81+/-			8-9-50 N=59	2.9	9
	LIMESTONE , tan	80+/-					
	Boring Terminated at 20.3 Feet ROCK CORE C-18 Depth 19-29 feet Recovery 85% RQD=56						
	Stratification lines are approximate. In-situ, the transition may be gradual.						
Advancement Method: Hollow stem auger to 18.5 feet	See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).						
Abandonment Method: Boring backfilled with bentonite grout upon completion	See Supporting Information for explanation of symbols and abbreviations. Elevations measured in the field						
WATER LEVEL OBSERVATIONS Groundwater not encountered							
 13400 15th Ave N Plymouth, MN							
 After boring completion							



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Boring Started: 05-15-2018

Boring Completed: 05-15-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

BORING LOG NO. 19

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 44.7988° Longitude: -93.5309° Approximate Surface Elev: 102.5 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
DEPTH							
	Light vegetative ground cover FILL-SILTY SAND WITH GRAVEL , trace organics, fine to medium grained, dark brown to brown				6-4-2 N=6	3.0	9
					3-1-0 N=1	1.0	13
					4-50/4"	0.3	
7.8	Practical auger refusal at termination depth. Assumed bedrock surface. Boring Terminated at 7.8 Feet	94.5+/-					
	ROCK CORE C-19 Depth 19-29 feet Recovery 75% RQD=32 LIMESTONE, gray with rust staining, moderately fractured, highly to moderately weathered, some clay infilling at about 27 feet						
Stratification lines are approximate. In-situ, the transition may be gradual.		Hammer Type: Automatic					
Advancement Method: Hollow stem auger to 6.5 feet		See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).		Notes:			
Abandonment Method: Boring backfilled with auger cuttings upon completion.		See Supporting Information for explanation of symbols and abbreviations. Elevations measured in the field					
WATER LEVEL OBSERVATIONS <i>Groundwater not encountered</i>				Boring Started: 05-15-2018		Boring Completed: 05-15-2018	
				Drill Rig: 848		Driller: Terry	
				Project No.: MP185083			

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL MP185083 CITY OF SHAKOPEE-GPJ TERRACON_DATATEMPLATE.GDT 5/30/18

BORING LOG NO. 20

Page 1 of 1

PROJECT: Scott Street Site

CLIENT: City of Shakopee
Shakopee, MN

SITE: Scott Street N & 1st Ave W
Shakopee, Minnesota

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 44.7988° Longitude: -93.5307° Approximate Surface Elev: 103 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	PID reading (ppm)	WATER CONTENT (%)
	DEPTH						
	Light vegetative ground cover FILL-SILTY SAND , trace organics, fine to medium grained, dark brown						
	3.5	99.5+/-		X	0-0-0 N=0	1.2	16
	FILL-CLAYEY SAND , trace gravel to with gravel, fine to coarse grained, dark brown			X	1-1-1 N=2	0.3	16
		5		X	4-3-6 N=9	0.1	12
				X	4-5-4 N=9	0.2	14
	13.5	89.5+/-		X	1-2-3 N=5	0.1	
	FILL-SANDY LEAN CLAY WITH GRAVEL , gray, debris including slag, coal, glass & metal						
	18.5	84.5+/-		X	8-39-50/1"	0.0	14
	LIMESTONE , tan						
	19.6	83.5+/-					
	Boring Terminated at 19.6 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 18.5 feet

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with bentonite grout upon completion

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations measured in the field

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13400 15th Ave N
Plymouth, MN

Boring Started: 05-14-2018

Boring Completed: 05-14-2018

Drill Rig: 848

Driller: Terry

Project No.: MP185083

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. MP185083 CITY OF SHAKOPEE. GPJ TERRACON DATATEMPLATE.GDT 5/30/18

SUPPORTING INFORMATION

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Scott Street & Levee Drive Parcels ■ Shakopee, Minnesota

June 8, 2018 ■ Terracon Project No. MP185083



SAMPLING	WATER LEVEL	FIELD TESTS
 Auger  Split Spoon  Shelby Tube  Macro Core  Ring Sampler  Rock Core  Grab Sample  No Recovery	 Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Subsurface water level variations will occur over time. In low permeability soils, accurate determination of subsurface water levels is not possible with short term water level observations.	(HP) Hand Penetrometer (T) Torvane (b/f) Standard Penetration Test (blows per foot) (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer (DCP) Dynamic Cone Penetrometer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve) Consistency determined by laboratory shear strength testing, field visual-manual procedures, or standard penetration resistance		
Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Descriptive Term (Consistency)	Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-Value Blows/Ft.
Very Loose	0 – 3	Very Soft	Less than 500	0 – 1
Loose	4 – 9	Soft	500 to 1000	2 – 4
Medium Dense	10 – 29	Medium Stiff	1000 to 2000	4 – 8
Dense	30 – 50	Stiff	2000 to 4000	8 – 15
Very Dense	> 50	Very Stiff	4000 to 8000	15 – 30
		Hard	> 8000	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL	
Descriptive term(s) of other constituents	Percent (%) of dry weight
Trace	< 15
With	15 – 29
Modifier	> 30

RELATIVE PROPORTIONS OF FINES	
Descriptive term(s) of other constituents	Percent (%) of dry weight
Trace	< 5
With	5 – 12
Modifier	> 12

GRAIN SIZE TERMINOLOGY	
Major component of sample	Particle size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 sieve (0.075mm)
PLASTICITY DESCRIPTION	
Term	Plasticity Index
Non plastic	0
Low	1 – 10
Medium	11 – 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Scott Street & Levee Drive Parcels ■ Shakopee, Minnesota

June 8, 2018 ■ Terracon Project No. MP185083



Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A					Soil Classification	
					Group Symbol	Group Name ^B
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines ^C	Cu ³ 4 and 1 ≤ Cc ≤ 3 ^E		GW	Well-graded gravel ^F
			Cu < 4 and/or 1 > Cc > 3 ^E		GP	Poorly graded gravel ^F
		Gravels with Fines: More than 12% fines ^C	Fines classify as ML or MH		GM	Silty gravel ^{F,G,H}
			Fines classify as CL or CH		GC	Clayey gravel ^{F,G,H}
	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	Cu ³ 6 and 1 ≤ Cc ≤ 3 ^E		SW	Well-graded sand ^I
			Cu < 6 and/or 1 > Cc > 3 ^E		SP	Poorly graded sand ^I
		Sands with Fines: More than 12% fines ^D	Fines classify as ML or MH		SM	Silty sand ^{G,H,I}
			Fines classify as CL or CH		SC	Clayey sand ^{G,H,I}
Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Inorganic:	PI > 7 and plots on or above “A” line		CL	Lean clay ^{K,L,M}
			PI < 4 or plots below “A” line ^J		ML	Silt ^{K,L,M}
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay ^{K,L,M,N}
			Liquid limit - not dried			Organic silt ^{K,L,M,O}
	Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above “A” line		CH	Fat clay ^{K,L,M}
			PI plots below “A” line		MH	Elastic Silt ^{K,L,M}
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay ^{K,L,M,P}
			Liquid limit - not dried			Organic silt ^{K,L,M,Q}
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

^A Based on the material passing the 3-inch (75-mm) sieve

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

$$^E \text{ Cu} = D_{60}/D_{10} \quad \text{Cc} = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains ³ 15% sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains ³ 15% gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

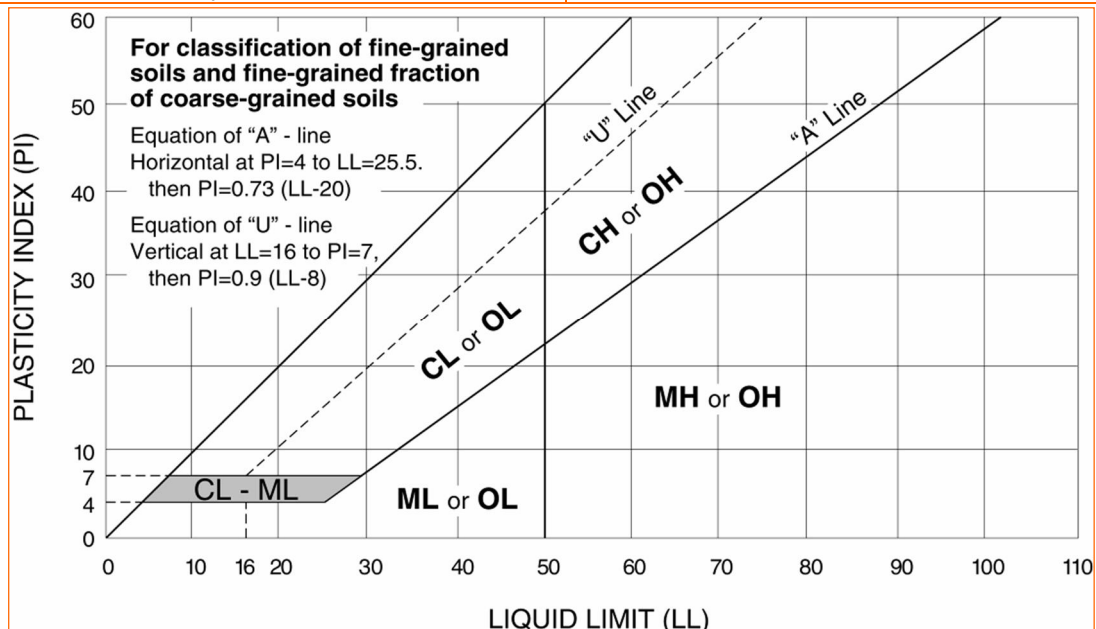
^M If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

^N PI ³ 4 and plots on or above "A" line.

^O PI < 4 or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.



GENERAL NOTES

Sedimentary Rock Classification

DESCRIPTIVE ROCK CLASSIFICATION:

Sedimentary rocks are composed of cemented clay, silt and sand sized particles. The most common minerals are clay, quartz and calcite. Rock composed primarily of calcite is called limestone; rock of sand size grains is called sandstone, or shale. Modifiers such as shaly, sandy, Dolomitic, calcareous, carbonaceous, etc. are used to describe various constituents. Examples: sandy shale; calcareous sandstone.

LIMESTONE	Light to dark colored, crystalline to fine-grained texture, composed of CaCO_3 , reacts readily with HCl.
DOLOMITE	Light to dark colored, crystalline to fine-grained texture, composed of $\text{CaMg}(\text{CO}_3)_2$, harder than limestone, reacts with HCl when powdered.
CHERT	Light to dark colored, very fine-grained texture, composed of micro-crystalline quartz (SiO_2), brittle breaks into angular fragments, will scratch glass.
SHALE	Very fine-grained texture, composed of consolidated silt or clay, bedded in thin layers. The unlaminated equivalent is frequently referred to as siltstone, claystone or mudstone.
SANDSTONE	Usually light colored, coarse to fine texture, composed of cemented sand size grains of quartz, feldspar, etc. Cement usually is silica but may be such minerals as calcite, iron-oxide, or some other carbonate.
CONGLOMERATE	Rounded rock fragments of variable mineralogy varying in size from near sand to boulder size but usually pebble to cobble size (1/2 inch to 6 inches). Cemented together with various cementing agents. Breccia is similar but composed of angular, fractured rock particles cemented together.

DEGREE OF WEATHERING:

SLIGHT	Slight decomposition of parent material on joints. May be color change.
MODERATE	Some decomposition and color change throughout.
HIGH	Rock highly decomposed, may be extremely broken.

**Classification of rock materials has been estimated from disturbed samples.
Core samples and petrographic analysis may reveal other rock types.**

DESCRIPTION OF ROCK PROPERTIES

Scott Street & Levee Drive Parcels ■ Shakopee, Minnesota

June 8, 2018 ■ Terracon Project No. MP185083



WEATHERING	
Term	Description
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

STRENGTH OR HARDNESS		
Description	Field Identification	Uniaxial Compressive Strength, psi (MPa)
Extremely weak	Indented by thumbnail	40-150 (0.3-1)
Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	150-700 (1-5)
Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	700-4,000 (5-30)
Medium strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	4,000-7,000 (30-50)
Strong rock	Specimen requires more than one blow of geological hammer to fracture it	7,000-15,000 (50-100)
Very strong	Specimen requires many blows of geological hammer to fracture it	15,000-36,000 (100-250)
Extremely strong	Specimen can only be chipped with geological hammer	>36,000 (>250)

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		Bedding Spacing (May Include Foliation or Banding)	
Description	Spacing	Description	Spacing
Extremely close	< ¾ in (<19 mm)	Laminated	< ½ in (<12 mm)
Very close	¾ in – 2-1/2 in (19 - 60 mm)	Very thin	½ in – 2 in (12 – 50 mm)
Close	2-1/2 in – 8 in (60 – 200 mm)	Thin	2 in – 1 ft. (50 – 300 mm)
Moderate	8 in – 2 ft. (200 – 600 mm)	Medium	1 ft. – 3 ft. (300 – 900 mm)
Wide	2 ft. – 6 ft. (600 mm – 2.0 m)	Thick	3 ft. – 10 ft. (900 mm – 3 m)
Very Wide	6 ft. – 20 ft. (2.0 – 6 m)	Massive	> 10 ft. (3 m)

Discontinuity Orientation (Angle): Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0-degree angle.

ROCK QUALITY DESIGNATION (RQD) ¹	
Description	RQD Value (%)
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009
Technical Manual for Design and Construction of Road Tunnels – Civil Elements