BRAUN
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December 15, 2011

Project SP-11-00429

Mr. Gerald Duffy
Monroe Moxness Berg PA
800 Norman Center Drive, Suite 1000
Minneapolis, MN 55437

Re: Addendum 1 to Geotechnical Evaluation Report
Progressive Rail, Inc., Mine
15870 Johnson Memorial Highway (US Highway 169)
Sand Creek Township, Minnesota

Dear Mr. Duffy:

This letter serves as Addendum 1 to our Geotechnical Evaluation Report dated May 20, 2011. On December 9, 2011, you contacted our firm and requested that we provide further clarification on two aspects of the project: If the restoration plan will (1) provide support to future pavements, including local roadways, and (2) maintain support of an existing railroad right-of-way that borders the eastern portion of the site along US Highway 169. This Addendum addresses these items.

Background

Our May 20, 2011, Geotechnical Evaluation Report focused on the compression characteristics of the mine byproducts and overburden materials likely to be used as hydraulic fill (fill placed below the water table without the aid of compaction), and the development of recommendations for placing and surcharging the hydraulic fill, and monitoring the progression of the fill's settlement for future structure support. We did not differentiate to a large extent between building and pavement areas when it came to assessing the need for and extent of surcharging, not knowing where buildings and pavements would be located; we did, however, recommend comprehensive surcharging based on the anticipated thickness of hydraulic fill. Our report also did not address the impact of mining excavations performed in advance of the filling on adjacent structures.

Future Pavement/Roadway Support

The restoration and monitoring recommendations referenced above and detailed in our May 20, 2011, Geotechnical Evaluation Report were developed with the understanding that it is desired to zone portions of the site for typical light industrial development consisting of one- to two-story warehouse/office type buildings. Since pavements in general and roadways specifically support lighter loads and are generally more tolerant of settlement than buildings, it can be assumed that restoration and monitoring procedures employed in the preparation of future building areas will be appropriate for paved areas as well (our recommendations for filling and surcharging having been based mainly on fill thickness, as mentioned, not structure type or load characteristics), and utilities.

In the event, however, that other more sophisticated infrastructure is required, such as a bridge crossing, for example, we recommend having a geotechnical review those plans on a case by case basis and provide additional commentary, as needed.

Stability of Existing Right-of-Way

As discussed in a 1980 Lehmann Report, the Jordan Sandstone in this area is variably cemented. As such, some layers of the sandstone are well cemented, and some are poorly cemented. It follows that the strength and hydraulic conductivity of the sandstone could vary accordingly.

On December 12, 2011, we were provided with general cross-section of the eastern portion of the site, one labeled as "interim Mining Slopes" and one labeled "Reclamation Condition Slope," which are attached to this Addendum. The cross sections show the submerged portion of the mining excavation extending up toward the aforementioned railroad right-of-way at a 1:1 (horizontal:vertical) gradient, and then at a "near vertical" slope above water into the existing overburden, which would be sloped back at a 1 1/2:1 gradient. The railroad right-of-way is shown 30 horizontal feel from the top of the mining limits.

With the variability of cementation within the sandstone, a concern was expressed whether or not the generally east-to-west flow of groundwater, combined with the mining operation, may cause the sandstone to flow into the excavation and create voids in or otherwise destabilize the excavation sideslopes, which could in turn lead to subsidence or distress to the railroad tracks. Given the geometric design as shown on the attached details, and the fact that groundwater flow in general won't be altered by dewatering, it is our opinion that the processes involved in the mining operations will not alter or create groundwater flow capable of causing subsidence, instability or other threats to the railroad. It is possible that the submerged sandstone bank may experience some general surface deterioration or sloughing, but that is not anticipated to be problematic.

As a precaution, we recommend (as we do in general for projects where excavations are made) that a geotechnical engineer or geologist periodically observe the conditions of the surface beyond the excavation limits, specifically the "Mining Setback" area. Items to note include general subsidence, tension cracking and lateral ground movements. We also recommend that provisions be made to confirm that the submerged portions of the mining excavations are being completed at the planned 1:1 gradient, and not at steeper gradients, which could impact stability. Finally, we recommend that the exposed (non-submerged) portion of the sandstone be established at a gradient of 1/4:1 or flatter, as opposed to "near vertical."

Remarks

This addendum should be attached to and considered a part of our original Geotechnical Evaluation Report. With the exception of any results or recommendations changed by this Addendum, the information contained in our Geotechnical Evaluation Report remains unchanged.

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

We appreciate the opportunity to be of continued service to you. If you have any questions about this letter, please contact Joel Kurpius at 651.487.7006.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
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.

Charles D. Hubbard, PE
Principal Engineer
License Number: 21153

Daniel B. Mahrt, PE
Senior Engineer

Attachments:

c: Ms. Kirsten Pauly, Sunde Engineering, PLLC

SP1100429 CDH

Geotechnical Evaluation Report

Great Plains Sand Mine
15870 Johnson Memorial Drive (US Highway 169)
Jordan, Minnesota

Prepared for

Monroe Moxness Berg PA

Professional Certification:
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.

Joel C. Kurpius, PE
Project Engineer
License Number: 43523
February 15, 2012

JOEL C. KURPIUS
LICENSED PROFESSIONAL ENGINEER
43523
STATE OF MINNESOTA

Project SP-11-00429

Braun Intertec Corporation

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February 15, 2012

Project SP-11-00429

Mr. Gerald Duffy
Monroe Moxness Berg PA
800 Norman Center Drive, Suite 1000
Minneapolis, MN 55437

Re: Geotechnical Evaluation
Great Plains Sand Mine
15870 Johnson Memorial Drive (US Highway 169)
Jordan, Minnesota

Dear Mr. Duffy:

We are pleased to present this Geotechnical Evaluation Report for the reclamation phase of the Great Plains Sand Mine operation in Sand Creek Township and Louisville Township, Minnesota. In brief, the purpose of this evaluation was to (1) characterize the engineering parameters of the native soils on this site and the processed soils generated from mining operations that will be used to restore the site, and (2) provide recommendations to help develop a restoration plan. It is our understanding that it is planned to restore the mined portion of the site for typical light-industrial development.

A summary of our results, and a summary of our recommendations in light of the geotechnical issues influencing design and construction, is presented below. More detailed information and recommendations follow.

Summary of Subsurface Exploration

Our firm performed seven soil borings for this evaluation. The borings were drilled to depths ranging from about 5 to 40 feet below the existing ground surface. Six of seven borings terminated on suspected bedrock, while the remaining boring was terminated at a depth of about 16 feet in glacial soils. The main purpose of the soil borings was to obtain samples of the native soils for classification and evaluation.

The borings initially encountered topsoil consisting of silty sand having thicknesses ranging from about 1/2 to 3 feet. Below the topsoil, the borings encountered terrace deposits consisting of poorly graded sand, poorly graded sand with silt and silty sand to depths ranging from 5 to 12 feet. The terrace deposits were typically brown and moist, but were locally wet.

Below the terrace deposits, six of the seven borings encountered glacial deposits prior to their termination depth. The glacial soils consisted of mostly poorly graded sand and, to a lesser extent, clayey sand and silty clayey sand. The glacial soils were typically moist, contained trace amounts of gravel and were various shades of brown.

Six of the seven borings were advanced to auger refusal. We suspect that the refusal was generally due to bedrock. At one of the six locations, we were able to penetrate about 7 feet into the bedrock. From the samples obtained at that location, it appeared the bedrock consisted of Jordon sandstone.

Based on penetration test results, the terrace deposits were overall loose to very loose, the glacial sands were overall medium dense and glacial clays were overall rather stiff to stiff.

Groundwater was not observed in the boreholes as the borings were advanced, or after withdrawal of auger. Based on the water level observations and soil moisture contents, it appears the groundwater surface is currently located at some depth below the termination depths of the borings. A previous report provided to us indicates that groundwater ranges in elevations of 723 along the eastern edge of the site down to 712 along the western edge. Seasonal and annual fluctuations of groundwater, however, should be anticipated. Also of note, given the layered nature of the native soils encountered, and as suggested by the wet silty sand encountered at Boring ST-4, it should be anticipated that groundwater could also be locally perched across the site at various depths/elevations.

Our field personnel also obtained samples of Jordan sandstone from an area the site south of Boring ST-1 where a vertical face of sandstone was exposed.

Overview of Mining Operation

As reported to us, the proposed mining operation will initially consist of removing native soils to expose Jordan sandstone. Once exposed, the Jordan sandstone will be excavated to depths as great as 50 feet below the groundwater surface. The mined sandstone will be processed to extract a certain range of sand granules, which will then be sold within the fracturing sand industry. The remaining portion of the mined materials and onsite terrace and glacial soils will then be reused to restore the site.

Key material descriptions/definitions used herein are:

- Native soils –the terrace and glacial soils that will be stripped away to gain access to the underlying Jordan sandstone.
- Jordan sandstone – bedrock that will be excavated down to depths as great as 50 feet below the groundwater surface. The Jordan sandstone will be processed to extract a certain range of sand granules, which will then be sold to the fracturing sand, or "frac sand," industry.
- Processed Fine Sand and Belt Press Fines– materials generated from the processing of the Jordan sandstone that will not be exported off site and will be used to restore the site. Processed Fine Sand is generally comprised of particles passing the No. 70 sieve, of which about 15 percent passing the No. 200 sieve. The Belt Press Fines are comprised of finer-grained particles that area passing the No. 200 Sieve (silt and clay).
- Hydraulic Fill – Processed Fine Sand and native soils that will be placed below and up to about 2 to 6 feet above the groundwater surface. Hydraulic fill will not be mechanically compacted when it is placed.
- Embankment Fill – Material that will be placed on top of the Hydraulic Fill to achieve design surface grades. Embankment Fill will be placed in thin lifts and will be mechanically compacted.

- Surcharge Fill – Material that will be placed on top of the Embankment Fill to help accelerate consolidation of the underlying materials (the reason for which is presented in greater detail in our report). Surcharge fill will remain in place in one area for a duration of time and then will be moved to another area for a similar duration of time.

Summary of Recommendations

Restoration Plan
The goal of the restoration plan is to provide the developer with alternatives to help induce settlement within the Hydraulic Fill (that material that will be placed below the water table, where it will not be possible to compact using more traditional methods) such that long term settlements below buildings and roadways will not exceed tolerable levels. It is our opinion that the general approach of inducing settlement within the Hydraulic Fill from embankment and surcharge loading is likely the most feasible approach to restore this site in order to support future light industrial development.

Our analysis indicates that the thickness of Surcharge Fill will depend on the thickness of Hydraulic Fill. With that, in areas where no more than 20 feet of Hydraulic Fill is placed, we recommend placing a surcharge of at least 10 feet on top of the Embankment Fill. In areas where more than 20 feet of Hydraulic Fill is placed, we recommend placing a surcharge of at least 15 feet on top of the Embankment Fill. We estimate that the surcharge will remain in place on the order of 2 years to reduce the risk of future long-term settlement exceeding tolerable limits (assumed to be 1 inch in this case).

Surcharge Monitoring
We recommend developing a program to monitor the progression of settlement within the Hydraulic Fill and overlying Embankment Fill. The program should include installation of settlement plates in close proximity to the Hydraulic Fill surface and near the surface of the Embankment Fill.

The settlement plates should be monitored at regular intervals from the time the hydraulic filling has been completed to beyond the completion of the surcharge placement. Settlement data should be obtained by a licensed surveyor and provided to a geotechnical engineer for review and commentary. As the restorative timelines provided in the following report are estimated values, decisions based on grading and development schedules will ultimately be determined by review of the settlement data.

Reuse of Processed and On-site Soils
We recommend removing topsoil from the mined areas and reusing it only as replacement topsoil.

We recommend that clayey materials, such as those classifying as silty clayey sand and clayey sand, and Belt Press Fines be reused only as Embankment Fill and Surcharge Fill. However, because those materials are fine-grained and are particularly susceptible to moisture and disturbance related issues, we recommend against placing those materials within 3 feet above the groundwater table and within 3 feet of proposed surface grades.

In our opinion, granular soils classifying as poorly graded sand, poorly graded sand as silt and silty sand, including Processed Fine Sand, may be reused as Hydraulic Fill, Embankment Fill and Surcharge Fill. We, however, recommend against placing Processed Fine Sand within 3 feet of proposed design grades.

Remarks

Thank you for making Braun Intertec your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please call Bob Janssen at 651.487.7017.

Sincerely,

BRAUN INTERTEC CORPORATION

Robert J. Janssen, PE
President – Principal Engineer

Joel C. Kurpius, PE
Project Engineer

c: Ms. Kirsten Pauly, Sunde Engineering
Mr. Don Vry, Don Vry PE

SP1100429

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Appendix

A. Introduction

A.1. Project Description

This Geotechnical Evaluation Report addresses the restoration phase of the Great Plains Sand Mine in Sand Creek Township and Louisville Township, Minnesota. The site encompasses a total footprint of about 140 acres to the west of US Highway 169 and north of Bluff Road, just south and east of the Louisville Swamp. The defined sandstone reserve (actual mining area) encompasses a footprint area of about 100 acres.

The site was subject of a geological study performed during the late 1970s into the early 1980s for the J.L. Shiely Company. To help us research the site and prepare this report, our firm was provided with excerpts from that geologic study.

We understand that a southern portion of the sandstone reserve had been previously mined; however, mining excavations in that area did not extend below the groundwater surface.

As reported to us, the proposed mining operations will consist of the following procedures.

- Native soils will be removed to expose Jordan sandstone.
- Jordan sandstone will be mined down to depths as great as 50 feet below the groundwater table.
- The mined sandstone will be processed to extract a certain range of sand granules, which will then be sold within the fracturing sand, or *frac sand*, industry. The remaining portion of the sandstone will be further processed into Fine Processed Sand and Belt Press Fines, both of which will be used to restore the site. The gradation of the Fine Processed Sand and Belt Press Fines is discussed in Section B.3.b this report.
- The mine excavation below the groundwater surface will be backfilled with Fine Processed Sands and granular native soils to a height of about 2 to 6 feet above the groundwater surface. The Fine Processed Sands will be pumped in place in slurry form and the granular native soils will be dumped in place. Materials placed within this zone are referred to herein as Hydraulic Fill and will not be mechanically compacted.

- Above the Hydraulic Fill, native clayey and granular soils, and Belt Press Fines will be placed to achieve design surface grades. Materials placed within this zone are referred to herein as Embankment Fill and will be mechanically compacted.

Once the mining operations have been completed, it is our understanding that it is desired to restore the area to a relatively level surface that can support typical light industrial development consisting of one- to two-story warehouse/office type buildings and roadways. As reported to us, it is likely that design surface grades will generally be about 8 to 10 feet above the groundwater surface.

Regarding the duration of the mining process, we understand that it is planned to keep the mine operating for a period of about 15 to 20 years. Although much of the site restoration will be completed in phases while the mine is operational, it is anticipated that the final restoration phase will be completed after the mine has closed.

A.2. Purpose

The purpose of this geotechnical evaluation is to characterize the native soils, Processed Fine Sand and Belt Press Fines that will be used to restore the site and provide recommendations to help your civil consultants develop a restoration plan and schedule. We emphasize that this report does not address the mining procedures associated with this project, but focuses only on the restoration phase of the project.

A.3. Background Information and Reference Documents

To facilitate our evaluation, we were provided with or reviewed the following information or documents:

- *Geologic Atlas, Scott County, Minnesota,* University of Minnesota, 1982.
- Excerpts from *Geology and Ore Reserves of the Merriam Junction Silica-Sand Deposit,* Ernest K. Lehmann & Associates, 1980.
- Series of civil drawings taken from the Lehmann report, namely:
    - East–West Cross Sections
    - Isopach of Sandstone Below the Water Table
    - Structure Contour Map of Water Surface
    - Topographic Map
    - Isopach of Sandstone above Water Table
    - Base Map for Ore Reserve Calculations
    - Structure Contour Map of Sandstone Surface

- Electronic base drawing provided by Sunde Engineering; base drawing plan shows existing topography and horizontal and vertical limits of the mining excavation. We understand that the vertical excavation limits are planned to be extend down to depths as great as 50 feet below the groundwater surface.

- *Time Dependent Settlements in Hydraulic Fills,* Shailesh Singh and Nagaratnam Sivakugan, *International Journal of Geotechnical Engineering,* 2008.

- Meeting notes from a March 23, 2011, team meeting, and various follow-up electronic correspondences.

- Meeting notes from a February 8, 2012, meeting attended by Mr. Don Vry of Don Vry PE, and an engineer from our firm.

- Average/anticipated gradation of Processed Fine Sands and Belt Press Fines provided by Don Vry PE.

A.4. Site Conditions

Our referenced documents indicate that the surficial geology of the area consists mostly of terrace and glacial deposits underlain by Jordan Sandstone, and St. Lawrance Dolostone at depth. As reported by Lehmann, the Jordan Sandstone is normally divided into two members, the upper Van Oser and the lower Norwalk members; however, Lehmann indicated that only the Norwalk member is present on this site. Lehmann indicated that the Jordan Sandstone generally becomes finer-grained with depth, though Lehmann also indicated that it was difficult to determine specific gradation trends. As shown on Lehmann's Sandstone Surface map, the surface of the Jordan formation ranges in elevations from about 705 along the western and southern edges of the site to about 750 to 760 throughout most of the central, northern and eastern portions of the site. Overburden thicknesses range from about 5 to 50 feet across the site, with the thickest portions generally located along the western one-third of the site.

The central portion of the site is relatively flat, with most of this area containing surface elevations ranging from about 760 to 765. The western edge of the site typically slopes down to about elevation 740, while the steeper southern edge slopes down to elevations ranging from about 720 to 730 (down into the area previously mined). The eastern edge of the property gradually slopes downward to intersect with US Highway 169. The northern edge of the property gradually slopes upward to elevations ranging from 770 to 775. Railroad tracks are located along the western and eastern edges of the property. The site is covered with groups of trees and brush, and also remnants of several homesteads.

Lehmann's Water Surface map indicates that the groundwater table generally trends downward from east to west. The surface of the groundwater table ranges from about elevation 723 along the eastern edge of this site down to elevation 712 along the western edge. Thus, the groundwater table is down about 30 to 60 feet below existing grades. In relation to the Jordan sandstone, the groundwater table is about 20 to 40 feet below the surface of the Jordan sandstone throughout most of the eastern two-thirds of the site, and is down about 5 to 15 feet below the surface of the Jordan sandstone within the western third of the site.

A.5. Scope of Services

Our scope of services for this project was originally submitted in a February 1, 2011, Proposal to Mr. Gerald Duffy of Monroe Moxness Berg PA. We received authorization to proceed from Mr. Duffy on February 2, 2011. Tasks completed in accordance with our authorized scope of services are described below.

Our scope of services was performed under the terms of our June 15, 2006, General Conditions.

A.5.a. Reconnaissance

We performed a reconnaissance of the site primarily to evaluate equipment access to exploration locations.

A.5.b. Staking and Surveying

Exploration locations and surface elevations at the exploration locations were determined by our firm using GPS (Global Positioning System) technology that utilizes the Minnesota Department of Transportation's permanent GPS Virtual Reference Network (VRN).

A.5.c. Utility Clearance

After the exploration locations were staked and surveyed, prior to commencing with our subsurface exploration activities, we cleared the exploration locations of underground utilities through Gopher State One Call.

A.5.d. Subsurface Exploration

We performed seven penetration test borings at the approximate locations shown on Figure 1 in the Appendix. The borings were staked about 600 to 700 lineal feet apart from each other. The borings were ultimately extended to depths ranging from about 5 to 40 feet below the current ground surface. Six of the seven borings were advanced until they met auger refusal at depths ranging from about 5 to 40 feet, with one of the borings terminating in overburden soils at a depth of about 15 feet.

Coring or alternative drilling methods were not performed once auger refusal occurred.

Bulk bag samples were taken of the geologic materials that were encountered at Borings ST-4 and ST-5. The bulk samples obtained appeared to be representative of the predominant terrace and glacial sands encountered across the site.

A.5.e. Sandstone Sampling

Our field personnel obtained bulk bag samples of Jordan sandstone from the exposed bedrock face located south of Boring ST-1, which is located within the southern area of the proposed mine. Samples were obtained from the upper portion of the exposed face at elevations ranging from about 755 to 760 and from the lower portion of the exposed face at elevations ranging from about 735 to 740.

A.5.f. Laboratory Testing

We performed the following laboratory tests on selected penetration test samples and bulk samples of the local overburden and sandstone.

- Four sieve analyses with hydrometer were performed on both bulk samples of overburden and both sandstone samples.
- Two consolidation tests were performed, one on a composite sample of overburden sand and one on a composite sandstone sample that was processed to resemble the processed fine sand. (It was determined that the samples of Jordan sandstone were not texturally too different from each other to warrant individual testing.)

- Three permeability tests were performed, two on bulk samples of overburden and one on a composite sandstone sample (again, after it was processed to resemble the processed fine sand).
- Two minimum-maximum dry density tests were performed on bulk samples of the overburden.
- Three moisture content tests were performed on three selected penetration test samples.
- Three sieve analyses (through the No. 200 sieve only) were performed on selected penetration test samples.
- Two Atterberg limits test were performed on two selected penetration test samples.

A.5.g. Geotechnical Evaluation, Analysis and Reporting

Information obtained from the soil borings, laboratory tests and research documents was used to develop recommendations pertaining to the reuse of native soils, Processed Fine Sand and Belt Press Fines, and for development of a restoration plan that would enable the support of light industrial development.

B. Results

B.1. Exploration Logs

B.1.a. Log of Boring Sheets

Log of Boring sheets for our penetration test borings are included in the Appendix. The logs identify and describe the geologic materials that were penetrated, and present the results of penetration resistance and performed within them, laboratory tests performed on penetration test and bulk samples retrieved from them and groundwater measurements.

Strata boundaries were inferred from changes in the penetration test samples and the auger cuttings. Because sampling was not performed continuously, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may also occur as gradual rather than abrupt transitions.

B.1.b. Geologic Origins

Geologic origins assigned to the materials shown on the logs and referenced within this report were based on: (1) a review of the background information and reference documents cited previously, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance testing performed for the project, (4) laboratory test results, and (5) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

B.2. Geologic Profile

As revealed by the soil borings, the site is underlain with a variety of geologic materials including terrace deposits, glacial deposits and sandstone bedrock.

B.2.a. Topsoil

The borings initially encountered about 1/2 to 3 feet of topsoil consisting of silty sand (SM) that was dark brown, was moist and contained trace amounts of roots.

B.2.b. Terrace Deposits

Below the topsoil, the borings encountered terrace deposits to depths ranging from about 5 to 12 feet. The terrace deposits consisted of predominately poorly graded sand (SP) and poorly graded sand with silt (SP-SM) and, to a lesser extent, silty sand. The terrace deposits were various shades of brown, were typically moist, and locally wet at Boring ST-4, and sporadically contained trace amounts of gravel.

B.2.c. Glacial Outwash

With the exception of Borings ST-6 and ST-7, the borings encountered deposits of glacial outwash that consisted of poorly graded sand and was overall fine- to coarse-grained, was light brown to brown, and typically contained trace amounts of gravel. As noted on the Log of Boring sheets, we suspect that the glacial outwash is locally entrained with cobbles or bedrock fragments (in close proximity to the bedrock surface).

B.2.d. Glacial Till

Below the glacial outwash, Borings ST-1, ST-3 and ST-6 encountered scattered layers of glacial till consisting of silty clayey sand (SC-SM) and clayey sand (SC) that was light brown to brown, was moist and typically contained trace amounts of gravel.

B.2.e. Bedrock

All but two of the borings, Boring ST-1 and Boring ST-3, met refusal. Boring ST-1 terminated in glacial till. Boring ST-3 was advanced about 7 feet into the Jordan sandstone. Based on the documents provided to us, and review of the penetration samples obtained from Boring ST-3, it appears that the refusal was due to bedrock. Table 1, below, summarizes the depths and elevations to auger refusal/suspected bedrock.

Table 1. Depth to Auger Refusal/Suspected Bedrock

Boring	Surface Elevation	Approximate Depth to Auger Refusal/Suspected Bedrock (ft)	Corresponding Elevation[a]
ST-2	765.3	25	741
ST-3	766.4	33[b]	733
ST-4	766.4	16	751
ST-5	762.9	10	753
ST-6	764.8	6 1/2	759
ST-7	765.9	5	761

a Corresponding elevations round up to the nearest foot.

b Boring ST-3 was drilled about 7 feet into apparent Jordan sandstone before meeting refusal.

B.2.f. Penetration Resistance Testing

The results of our penetration resistance testing are summarized below in Table 2. Comments are provided to qualify the significance of the results.

Table 2. Penetration Resistance Data

Geologic Material	Classification	Range of Penetration Resistances	Comments
Terrace Deposits	SP, SP-SM, SM	4 to 16 BPF, most values less than 11 BPF	Overall very loose to loose, but locally medium dense.
Glacial Outwash	SP	10 to 39 BPF, most values exceeding 10 BPF	Overall medium dense to dense, locally loose.
Glacial Till	SC-SM, SC	6 to 20 BPF, moist values greater than 9 BPF	Overall rather stiff to very stiff, locally medium.

B.2.g. Groundwater

Groundwater was not observed as our borings were advanced. Based on the moisture contents of the geologic materials encountered, it appears that groundwater was below the depths explored, which, as mentioned previously, ranges in elevations of 723 along the eastern edge of the site down to 712 along the western edge.

Seasonal and annual fluctuations of groundwater, however, should be anticipated.

Given the layered nature of the native soils encountered, and as suggested by the wet silty sand encountered at Boring ST-4, it should be anticipated that groundwater could also become locally perched across the site at various depths/elevations.

B.3. Gradation of Sandstone, Processed Fine Sand and Belt Press Fines

B.3.a. Gradation of Sandstone

The gradation for the Jordan sandstone is shown below in Table 3. This gradation information was provided to us by Don Vry PE.

Table 3. Gradation of Sandstone

	Percent Passing		
Sieve	Reserve Above Water Table	Reserve Below Water Table	Average Combined
20	100	100	100
40	69	83	76
50	38	54	46
60	26	36	31
140	8	8	8
200	7	7	7

B.3.b. Gradation of Processed Fine Sand and Belt Press Fines

Regarding fracturing sand, we understand that the particles extracted from the sandstone larger than the No. 70 sieve are considered usable product. After those particles have been extracted from the sandstone, the remaining material consisting of particles passing the No. 70 sieve are further processed into two subsequent materials, Processed Fine Sand and Belt Press Fines. In general, the Processed Fine Sand is the coarser portion of the material and is comprised of particles falling between the No. 70 sieve and No. 250 sieve. The following gradation information presented below in Table 4 for the Processed Fine Sand was provided to us by Don Vry PE.

Table 4. Gradation of Processed Fine Sand

Sieve	Percent Passing
20	100
40	100
50	100
60	100
140	27
200	15

The Belt Press Fines is the finer material which is comprised of particles passing the No. 250 sieve.

B.4. Laboratory Test Results

Results of our laboratory tests are presented below in Tables 5 and 6. We note that the permeability, consolidation and density tests performed on the composite sandstone sample were performed on a sample processed to resemble of the anticipated Processed Fine Sand.

Of note, at the time our laboratory tests were conducted, the anticipated gradation for the Processed Fine Sand consisted of 39 percent of the particles by weight passing the No. 140 sieve and 34 percent of the particles by weight passing the No. 200 sieve. Since that time, the anticipated gradation has been revised to what is shown in Table 4. In our opinion, the tests results obtained from using the initial gradation are appropriate for this project; however, the results and recommendations derived from them may be slightly more conservative than had the gradation shown above in Table 4 been used.

Table 5. Laboratory Classification and Permeability Test Results

Location	Sample Depth (ft)	Class.	Minimum/ Maximum Dry Density (pcf)	Moisture Content (%)	Percent Passing the No. 200 Sieve	LL	PI	Perm. (cm/s)
ST-4	Bulk	SP-SM	101 / 120	--	4	--	--	1×10^{-2}
ST-5	Bulk	SP-SM	102 / 121	--	9	--	--	2×10^{-3}
Sandstone[a]	Comp.	BR	82 / 109	--	40	--	--	6×10^{-3}
ST-1	5	SP-SM	--	13	11	--	--	--
ST-1	12 1/2	SC-SM	--	11	40	16	4	--
ST-6	5	SC	--	16	33	25	11	--

a Composite sandstone samples were processed to resemble the anticipated Processed Fine Sand.

Table 6. Consolidation Test Results

Sample	Classification	Load Range (psf)		Average Percent Strain for Load Range[a]
		Low	High	
Native Soils (Average)	SP-SM	90	300	4.5
		300	500	7.5
		500	1,000	9.5
		1,000	2,000	10.5
		2,000	4,000	12.0
		4,000	8,000	13.5
		8,000	16,000	14.5
Processed Fine Sand[b]	SM	80	240	1.5
		240	460	4.5
		460	980	7.5
		980	1,960	9.5
		1,960	3,980	11.0
		3,980	8,000	12.5
		8,000	16,000	14.5

a Rounded up to the nearest 0.5 percent.

b Bedrock samples were processed to resemble the initial gradation for the Processed Fine Sand.

C. Basis for Recommendations

C.1. Understanding of Future Development

It is our understanding that it is desired by governing agencies to zone the reclaimed mining area for commercial/industrial use. Since specific plans pertaining to the design of buildings are not yet available, we have assumed that construction will likely consist of one- to two-story office/warehouse buildings, bituminous and/or concrete roadways and parking lots, and other infrastructure (water main, sanitary sewer, etc.). We have assumed that structural loads associated with those buildings will range from about 150 to 300 kips per column and about 4 to 8 kips per lineal foot of wall. We have also assumed that the buildings can tolerate up to 1 inch of total settlement.

We have attempted to describe our understanding of future construction to the extent it was reported to us by others. Depending on the extent of available information, assumptions may have been made based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, we should be notified. New or changed information could require additional evaluation, analyses and/or recommendations.

C.2. Settlement Analysis and Restoration Plan

As described previously in Section A, the proposed mining operation will initially consist of removing native soils to expose Jordan sandstone. Once exposed, the Jordan sandstone will be excavated to depths as great as 50 feet below the groundwater surface. The mined sandstone will be processed to extract a certain range of sand granules, which will then be sold within the fracturing sand industry. The remaining portion of the mined materials and onsite materials will then be reused to restore the site. The mine excavation below the groundwater surface will be backfilled with Fine Processed Sands and granular native soils to a height ranging from about 2 to 6 feet above the groundwater surface. The Fine Processed Sands will be pumped in place in slurry form and the granular native soils will be dumped in place. Materials placed within this zone are referred to herein as Hydraulic Fill and will not be mechanically compacted. Materials placed above this zone to achieve design grades are referred to as Embankment Fill and will be placed in thin lifts and will be mechanically compacted.

Settlement of Hydraulic Backfill is induced by its own weight and the stress exerted on it by overlying overburden soils. Based on a conventional consolidation analysis, it appears that Processed Fine Sand can experience strain on the order of about 10 percent, the actual magnitude of which is dependent on the on the loading stresses (from self-weight of Hydraulic Fill and the Embankment Fill). It appears that the consolidation characteristics, i.e., measured strain, will likely be similar for the native sands as compared to the Processed Fine Sand.

Conventional consolidation theory also suggests that there are typically two components of resulting settlement—primary, or short-term, and secondary, or long-term. From our research and review of *Time Dependent Settlements in Hydraulic Fills,* Sing and Sivakugan suggest that about two-thirds of a fill's total strain/settlement will occur fairly quickly over the short term. The remaining one-third of strain/settlement will then occur long-term. For descriptive purposes, short-term is generally thought of in terms of weeks to months, and long-term is generally thought of in terms of months to years, which for this project, we estimate to be on the order of several years.

Since total settlement will vary based on the thickness of the Hydraulic Fill and the stress applied to it (including the stress from its own weight), and given that not all excavations will be extended down to the same depths below the groundwater surface, total settlements will vary from area to area across the site. To promote uniform building and roadway performance across the site, and to limit long-term settlement to tolerable levels by accelerating the rate of settlement, regardless of the thickness of Embankment Fill placed over the Hydraulic Fill to achieve design grades, we recommend placing a surcharge of material on top of the Embankment Fill. We estimate that the surcharges having thicknesses ranging from 10 to 15 feet will need to be left in place for a period on the order of 2 years to reduce future long-term settlement to tolerable limits (assumed to be 1 inch for this project).

C.3. Settlement Monitoring

A program should be developed to monitor the progression of settlement within the Hydraulic Fill and Embankment Fill. The program should include installation of settlement plates in close proximity to the Hydraulic Fill contact and near the surface of the Embankment Fill (before the surcharge material is placed). The settlement plates should be monitored at regular intervals from the time the hydraulic filling has been completed to beyond the completion of the surcharge placement. Frequency of readings should be greater near the beginning of the monitoring period. Settlement data should be obtained by a licensed surveyor and provided to a geotechnical engineer for review and commentary. As the restorative surcharge duration of on the order of 2 years is an estimated value, decisions based on grading and development schedules shall ultimately be determined by review of the settlement data.

C.4. Commentary on Processed Fine Sand

As previously mentioned, after the usable granules of the sandstone have been extracted, the remaining material will be further processed into Processed Fine Sand and Belt Press Sand. Based on the gradation information as described previously in Table 4 of Section B.3.b, the Processed Fine Sand will generally classify as fine-grained silty sand. Due to its fine-grained nature, in the event that Processed Fine Sand is placed as Embankment Fill on top of the Hydraulic Fill, we recommend against placing it within 3 feet of proposed surface grades.

C.5. Commentary on Belt Press Fines

It is our understanding that it is planned to mix Belt Press Fines (the fine-grained material that was removed from the Fine Process Sand and will generally consist of particles passing the No. 200 sieve—silt and clay particles) with granular native soils prior to being placed as Embankment Fill. In the event that Belt Press Fines alone are placed as Embankment Fill, we recommend that it be separated from the top of the Hydraulic Fill and from proposed surface grades by at least 3 feet of coarser material classifying as poorly graded sand, poorly graded sand with silt or silty sand having no more than 20 percent of the particles by weight passing the No. 200 sieve, with no more than 60 percent of the particles by weight passing the No. 40 sieve.

C.6. Reuse of On-site Soils

C.6.a. Topsoil

In our opinion, the topsoil should not be considered for reuse as Hydraulic Backfill or Embankment Fill. We recommend that the topsoil should be removed, stockpiled on site and reused only as replacement topsoil.

C.6.b. Clayey Soils

In our opinion, the clayey glacial soils (due to their cohesive nature) should not be reused as Hydraulic Backfill. However, it may be placed as Embankment Fill on top of the Hydraulic Fill provided that it is separated from the top of the Hydraulic Fill by at least 3 feet of coarser material classifying as poorly graded sand, poorly graded sand with silt or silty sand having no more than 20 percent of the particles by weight passing the No. 200 sieve, with no more than 60 percent of the particles passing the No. 40 sieve. Additionally, we recommend against placing this material within 3 feet of proposed subgrade elevations.

C.6.c. Granular Soils

The native granular soils classifying as poorly graded sand, poorly graded sand with silt and silty sand may be used as Hydraulic Fill and Embankment Fill. We understand that the native granular soils will likely be dumped into the mining excavation rather than being pumped in as slurry, which is how the Processed Fine Sand will be placed. In our opinion, this particular method is acceptable.

D. Recommendations

D.1. Selection of Fill Material

D.1.a. Topsoil

We recommend stripping topsoil from the mining area and stockpiling it. We recommend that it not be used as structural fill or mixed with other materials for reuse as structural backfill. We recommend that it only be used only as replacement topsoil after the restoration is complete.

D.1.b. Processed Fine Sand

In our opinion, Processed Fine Sand may be used as both Hydraulic Fill and Embankment Fill. If placed as Embankment Fill, we recommend against placing it within 3 feet of proposed design subgrade elevations.

D.1.c. Belt Press Fines

As mentioned previously, we understand that Belt Press Fines will be mixed with granular native soils prior to being placed as Embankment Fill. In our opinion, given the gradation of the predominant granular materials on this site, this particular approach for reuse of the Belt Press Fines is appropriate.

If Belt Press Fines alone are placed as Embankment Fill, we recommend, however, they be separated from the Hydraulic Fill surface by at least 3 feet of coarser granular soil classifying as poorly graded sand or poorly graded sand with silt having no more than 60 percent of the particles by weight passing the No. 40 sieve. Because fine-grained materials are susceptible to losing strength when disturbed, we also recommend against placing unblended Belt Press Fines within the upper 3 feet of design surface grades.

D.1.d. Clayey Materials

We recommend against using native clayey materials classifying as silty clayey sand (SC-SM), clayey sand (SC) and sandy lean clay (CL) as Hydraulic Backfill. We recommend that clayey materials be reused only as Embankment and Surcharge Fill, provided that they are separated from the Hydraulic Fill surface with at least 3 feet of granular soil classifying as poorly graded sand or poorly graded sand with silt, or silty sand having no more than 20 percent of the particles by weight passing the No. 200 sieve, with no more than 60 percent of the particles passing the No. 40 sieve.

Because clayey materials are susceptible to losing strength when disturbed, we also recommend against placing clayey materials within the upper 3 feet of design surface grades.

D.1.e. Granular Materials

In our opinion, on-site granular materials classifying as poorly graded sand (SP), poorly graded sand with silt (SP-SM), and silty sand (SM) having less than 20 percent of the particles by weight passing the No. 200 sieve may be reused as Hydraulic Fill, Embankment Fill and Surcharge Fill.

D.1.f. Imported Material

If needed to balance the site, we recommend importing backfill consisting of sand, silty sand, clayey sand or sandy lean clay. We recommend that the plastic index of these materials not exceed 15. If clays are imported, similar restrictions as provided above should be applied for their reuse.

D.2. Placement and Compaction of Embankment Fill

We recommend that all Embankment Fill placed on top of Hydraulic Fill be placed in thin lifts and those soils should be mechanically compacted.

We recommend spreading Embankment Fill in loose lifts of no more than 8 inches. We recommend placing soils having no more than 12 percent of the particles by weight passing the No. 200 sieve at a moisture content within 3 percentage points below to 3 percentage points above their optimum moisture content. We recommend placing soils having more than 12 percent of the materials by weight passing the No. 200 sieve at a moisture content within 1 percentage point below to 3 percentage points above their optimum moisture contents. We recommend compacting fill to at least 98 percent of its maximum dry density as determined by the standard Proctor method (ASTM D 698).

Because clayey soils, Fine Processed Sand and Belt Press Fines are susceptible to losing strength when disturbed, we recommend placing granular soils having less than 20 percent of the particles by weight passing the No. 200 sieve and less than 60 percent of the particles by weight passing the No. 40 sieve within three feet of design surface grades (upper 3 feet of Embankment Fill).

D.3. Restoration Plan and Surcharge Design

D.3.a. Restoration Plan

Our restoration plan accommodates three main variables, which are height of hydraulic fill, thickness of overburden and time. The goal of this plan is to provide the developer with alternatives to help induce settlement within the fill materials such that long term settlements below building will not exceed tolerable levels.

As discussed in Section C, it is our opinion that the general approach of inducing settlement within the hydraulic fill from overburden and surcharge loading is likely the most feasible approach to restore this site in order to support future light industrial development. Regardless of the thickness of material placed over the hydraulic fill to achieve design grades, we recommend placing a surcharge of material on top of the overburden.

Our analysis indicates that the thickness of surcharge material will depend on the thickness of hydraulic fill. With that, in areas where no more than 20 feet of hydraulic fill is placed, we recommend placing a surcharge of at least 10 feet. In areas where more than 20 feet of hydraulic fill is placed, we recommend placing a surcharge of at least 15 feet.

As discussed previously in Section C, total consolidation and duration will depend on many factors, mainly the thickness, composition and uniformity of the Hydraulic, Embankment and Surcharge Fill materials. We recommend that consolidation/performance of the Hydraulic and Embankment Fills be monitored by a geotechnical engineer through review of settlement plate data. Since the surcharge duration on the order of 2 years is an estimated range of time, decisions based on grading and development schedules shall ultimately be determined by review of the settlement data.

D.3.b. Surcharge Design and Fill Placement

For the surcharge itself, we recommend that it be sized such that upper perimeter of the surcharge extends out a horizontal distance equivalent to the height of the surcharge beyond the limits of the surcharged area. We recommend that embankment sideslopes be constructed with gradients of 1 1/2:1 (h:v) or flatter. In our opinion, a roving surcharge approach, where surcharge materials are moved from one area of the site to another, is appropriate for this site. We recommend that the outer perimeter of the top of the surcharge align with previous adjacent top of surcharges.

For the lowest 5 feet of the Surcharge Fill, we recommend placing granular soil having no more than 20 percent of the materials by weight passing the No. 200 sieve and no more than 60 percent of the particles by weigh passing the No. 40 sieve, we recommend spreading it in loose lifts of no more than 8 inches, and we recommend compacting it to at least 98 percent of its maximum dry density as determined by the standard Proctor method (ASTM D 698). Furthermore, we recommend soils having more than 12 percent of the materials by weight passing the No. 200 sieve at a moisture content within 1 percentage point below to 3 percentage points above their optimum moisture contents. We recommend placing soils having no more than 12 percent of the particles by weight passing the No. 200 sieve at a moisture content within 3 percentage points below to 3 percentage points above their optimum moisture content.

It is not necessary to compact the upper portion of the surcharge.

D.4. Settlement Monitoring

We recommend that settlement plates be installed both on top of the hydraulic fill and also on top of the proposed embankment materials (prior to placement of the surcharge material). We recommend that one to two sets of plates (lower and upper) be placed for every acre of surcharge area (depending on how much area is surcharged). We recommend installing a plastic slip form around the metal rod.

We recommend that the settlement plates be installed immediately after filling begins over the hydraulic fill (lower plate) and prior to placing the surcharge (upper plate). We recommend that the plates be surveyed by a licensed engineer with initial measures including surface elevations (i.e., bottom-of-plate elevation) and horizontal GPS coordinates. We recommend that the plates be surveyed at a frequency of twice per week for a period of 1 to 2 months, one time every 2 weeks for a period 2 to 3 months, then once per month thereafter.

Regarding the monitoring schedule, the actual frequency could also depend on what grading activities are occurring. For example, if embankment fill will not be placed over the hydraulic fill for a period of several months, then the frequency of measurements may be revised during that period. In any case, we recommend providing a geotechnical engineer with a restoration schedule to help in determining a monitor schedule.

We recommend that the survey information be provided to a geotechnical engineer for review and commentary. Review and evaluation of the survey data will ultimately determine when surcharges can be removed and when construction can begin.

D.5. Preliminary Design Data

D.5.a. Net Allowable Bearing Pressure

Assuming the recommendations presented herein are implemented, it is our opinion that foundations for proposed future buildings can be sized to exert a maximum net allowable bearing pressures ranging from 2,000, to 3,000 pounds per square foot.

D.5.b. Building Settlement

Assuming the implementation of the recommendations discussed herein, we estimate that total settlements among buildings and pavements will amount to less than 1 inch.

D.6. Construction Quality Control

D.6.a. Earthwork Observations

We recommend having a geotechnical engineer observe all excavations related to subgrade and surcharge preparation.

D.6.b. Materials Testing

We recommend density tests be taken on the Embankment Fill and the lowest 5 feet of Surcharge Fill.

D.6.c. Cold Weather Precautions

If site grading and construction is anticipated during cold weather, all snow and ice should be removed from cut and fill areas prior to additional grading. No fill should be placed on frozen subgrades. No frozen soils should be used as fill.

E. Procedures

E.1. Penetration Test Borings

The penetration test borings were drilled with a carrier-mounted core and auger drill equipped with hollow-stem auger. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 1/2- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

E.2. Material Classification and Testing

E.2.a. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars or bags and returned to our facility for review and storage.

E.2.b. Laboratory Testing

Laboratory tests were performed in accordance with ASTM procedures.

E.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal, where allowed. The boreholes were then backfilled or grouted.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

F.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. Continuity of Professional Responsibility

F.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

F.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

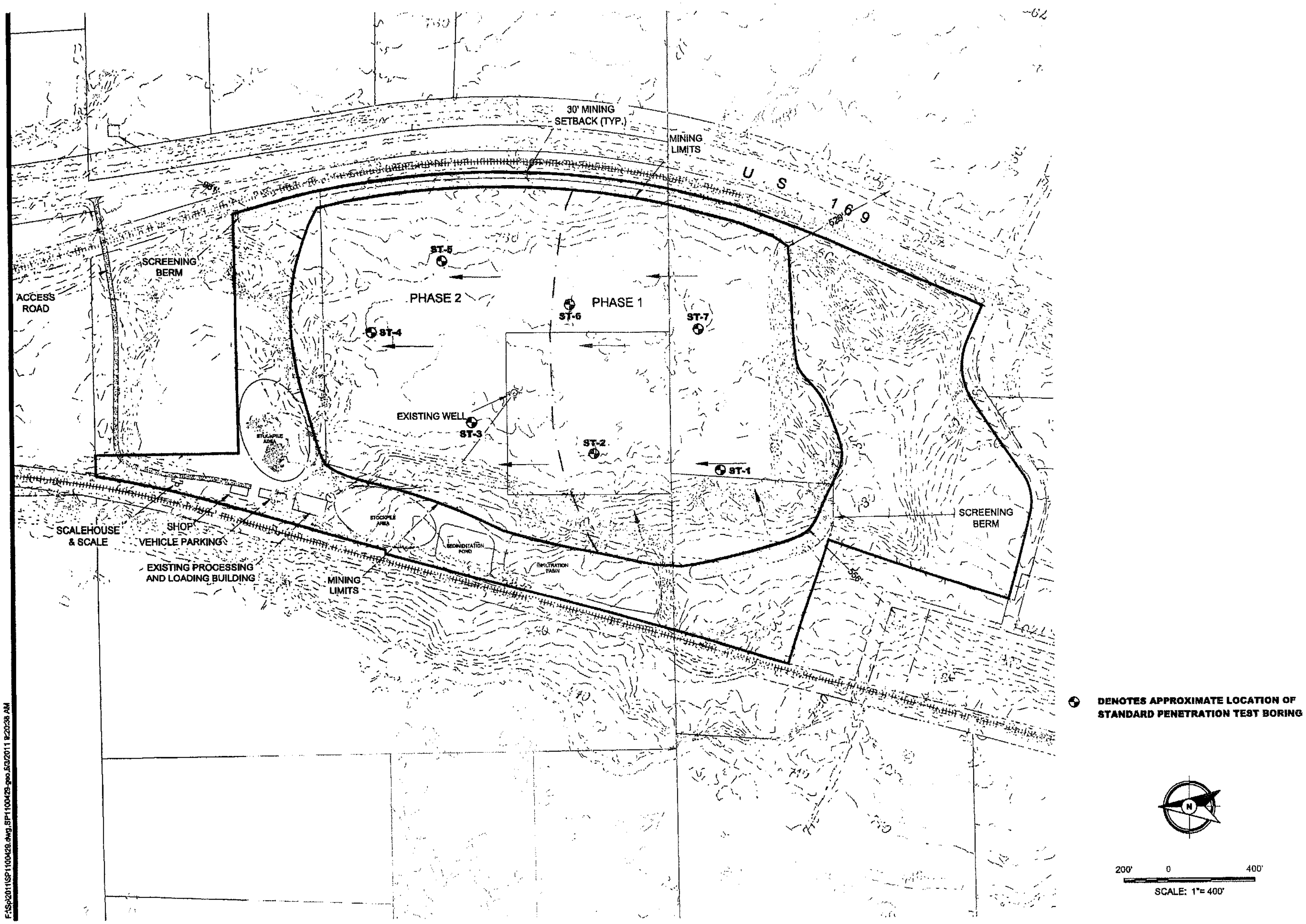
F.3. Use of Report

This report is for the exclusive use of the parties to which it has been addressed. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

F.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

Appendix



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Base Dwg Provided By:
BUNDE ENGINEERS

SOIL BORING LOCATION SKETCH
GEOTECHNICAL EVALUATION
PROGRESSIVE RAIL MINE
15870 JOHNSON MEMORIAL HIGHWAY (U.S. HIGHWAY 169)
JORDAN, MINNESOTA

Project No:	SP1100429
Drawing No:	SP1100429
Scale:	1"= 400'
Drawn By:	JAG
Date Drawn:	2/3/11
Checked By:	JCK
Last Modified:	5/3/11
Sheet: of	Fig:

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BRAUN INTERTEC

LOG OF BORING

Braun Project SP-11-00429
Geotechnical Evaluation
Progressive Rail, Inc., Mine
NW of US Highway 169 & Bluff Drive
Sand Creek Township, Minnesota

BORING: **ST-1**

LOCATION: See attached sketch.

DRILLER: M. Takada | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/11/11 | SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 765.1	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
763.1	2.0	SM	SILTY SAND, trace of roots, dark brown, moist. (Topsoil)			
756.1	9.0	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, trace of Gravel, brown, loose to medium dense. (Terrace Deposit)	7		
				6		MC=13%, P200 = 11%
				16*		* suspected cobble
749.1	16.0	SC-SM	SILTY CLAYEY SAND, trace of Gravel, light brown, moist, rather stiff to very stiff. (Glacial Till)	20		
				18		MC=11%, P200 = 40% LL = 16 PI = 14
				11		
			END OF BORING. Water not observed while drilling. Water not observed to cave-in depth of 12 immediately after withdrawal of auger. Boring then backfilled.			

LOG OF BORING N:\GINT\PROJECTS\STPAUL\2011\00429.GPJ BRAUN_V8_CURRENT.GDT 2/15/12 13:43

BRAUN INTERTEC

LOG OF BORING

Braun Project SP-11-00429 **Geotechnical Evaluation** **Progressive Rail, Inc., Mine** **NW of US Highway 169 & Bluff Drive** **Sand Creek Township, Minnesota**	BORING: **ST-2** LOCATION: See attached sketch.
DRILLER: M. Takada — METHOD: 3 1/4" HSA, Autohammer	DATE: 2/11/11 — SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 765.3	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
762.3	3.0	SM	SILTY SAND, trace of roots, dark brown, moist. (Topsoil)	4		
756.3	9.0	SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown, moist, loose. (Terrace Deposit)	8 8		
740.3	25.0	SP	POORLY GRADED SAND, fine- to coarse-grained, trace of Gravel, light brown, moist, medium dense. (Glacial Outwash)	15 17 12 13		
			REFUSAL OF AUGER AT 25 FEET. Water not observed while drilling. Boring then backfilled.	*		* 50 blows for 1" (set)

BRAUN INTERTEC

LOG OF BORING

Braun Project SP-11-00429
Geotechnical Evaluation
Progressive Rail, Inc., Mine
NW of US Highway 169 & Bluff Drive
Sand Creek Township, Minnesota

BORING: **ST-3**

LOCATION: See attached sketch.

DRILLER: M. Takada | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/11/11 | SCALE: 1" = 4'

Elev. feet 766.4	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
764.9	1.5	SM	SILTY SAND, trace of roots, dark brown, moist. (Topsoil)			
759.4	7.0	SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown, moist, loose. (Terrace Deposit)	5 6		
749.4	17.0	SP	POORLY GRADED SAND, fine- to coarse-grained, trace of Gravel, light brown, moist, loose to medium dense. (Glacial Outwash)	18 10 23 39		
744.4	22.0	SC-SM	SILTY CLAYEY SAND, trace of Gravel, brown, moist, stiff. (Glacial Till)	13		
		SP	POORLY GRADED SAND, fine-grained, brown, moist. medium dense. (Glacial Outwash)	11 17		

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN INTERTEC

LOG OF BORING

Braun Project SP-11-00429 Geotechnical Evaluation Progressive Rail, Inc., Mine NW of US Highway 169 & Bluff Drive Sand Creek Township, Minnesota	BORING: ST-3 (cont.) LOCATION: See attached sketch.
DRILLER: M. Takada · METHOD: 3 1/4" HSA, Autohammer	DATE: 2/11/11 · SCALE: 1" = 4'

Elev. feet 734.4	Depth feet 32.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
733.4	33.0					
		SS	JORDAN SANDSTONE, light brown to orangish-brown. (Bedrock)	*		* 50 blows for 5"
726.4	40.0					
			REFUSAL OF AUGER AT 40 FEET. Water not observed while drilling. Boring then grouted.	*		* 50 blows for 5" (set)

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project SP-11-00429 Geotechnical Evaluation Progressive Rail, Inc., Mine NW of US Highway 169 & Bluff Drive Sand Creek Township, Minnesota	BORING: ST-4 LOCATION: See attached sketch.

DRILLER: M. Takada	METHOD: 3 1/4" HSA, Autohammer	DATE: 2/10/11	SCALE: 1" = 4'

Elev. feet 766.4	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
766.0	0.4	SM	SILTY SAND, trace of roots, dark brown, moist. (Topsoil)			
757.4	9.0	SP	POORLY GRADED SAND, fine-grained, light brown, moist, loose. (Terrace Deposit)	7 7 8		
754.4	12.0	SM	SILTY SAND, fine-grained, brown, wet, loose. (Terrace Deposit)	5		
750.4	16.0	SP	POORLY GRADED SAND, fine- to coarse-grained, trace of Gravel, light brown, moist, medium dense. (Glacial Outwash)	20		
			REFUSAL OF AUGER AT 16 FEET. (Suspected Jordan Sandstone) Water not observed while drilling. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project SP-11-00429
Geotechnical Evaluation
Progressive Rail, Inc., Mine
NW of US Highway 169 & Bluff Drive
Sand Creek Township, Minnesota

BORING: **ST-5**

LOCATION: See attached sketch.

DRILLER: M. Takada | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/10/11 | SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 762.9	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
762.4	0.5	SM	SILTY SAND, trace of roots, dark brown, moist. (Topsoil)			
758.9	4.0	SP-SM	POORLY GRADED SAND with SILT, light brown, moist, very loose. (Terrace Deposit)	4		
755.9	7.0	SM	SILTY SAND, fine-grained, brown, wet, very loose. (Terrace Deposit)	4		
752.9	10.0	SP	POORLY GRADED SAND, fine- to coarse-grained, trace of Gravel, light brown, moist, dense. (Glacial Outwash)	*		* 50 blows for 1" (set) suspected bedrock fragments
			REFUSAL OF AUGER AT 10 FEET. (suspected Jordan Sandstone) Water not observed while drilling. Boring then backfilled.	*		* 50 blows for 1" (set)

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BRAUN INTERTEC

LOG OF BORING

Braun Project SP-11-00429 Geotechnical Evaluation Progressive Rail, Inc., Mine NW of US Highway 169 & Bluff Drive Sand Creek Township, Minnesota	BORING: ST-6 LOCATION: See attached sketch.
DRILLER: M. Takada — METHOD: 3 1/4" HSA, Autohammer	DATE: 2/10/11 — SCALE: 1" = 4'

Elev. feet 764.8	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
763.8	1.0	SM	SILTY SAND, trace of roots, dark brown, moist. (Topsoil)			
759.8	5.0	SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown, moist, loose. (Terrace Deposit)	5		
758.3	6.5	SC	CLAYEY SAND, trace of Gravel, brown, moist, medium. (Glacial Till)	6		MC=16%, P200 = 33% LL = 25 PI = 11
			REFUSAL OF AUGER AT 6 1/2 FEET. (suspected Jordan Sandstone) Water not observed while drilling. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project SP-11-00429 Geotechnical Evaluation Progressive Rail, Inc., Mine NW of US Highway 169 & Bluff Drive Sand Creek Township, Minnesota	BORING: ST-7 LOCATION: See attached sketch.
DRILLER: M. Takada · METHOD: 3 1/4" HSA, Autohammer	DATE: 2/11/11 · SCALE: 1" = 4'

Elev. feet 765.9	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
764.9	1.0	SM	SILTY SAND, trace of roots, dark brown, moist. (Topsoil)			
760.9	5.0	SP	POORLY GRADED SAND, fine-grained, brown, moist, very loose. (Terrace Deposit)	4		
			Refusal of auger at 5 feet. (suspected Jordan Sandstone) Water not observed while drilling. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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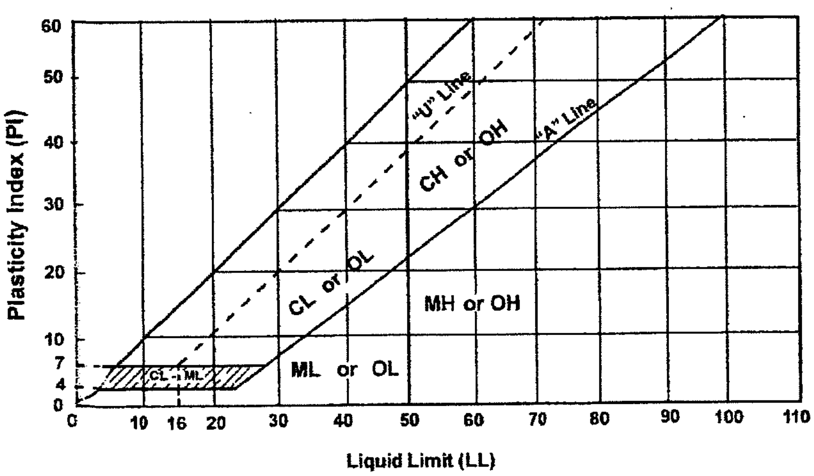
BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification: Group Symbol	Soils Classification: 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 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [k l m n]
				OL	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 / Liquid limit - not dried < 0.75	OH	Organic clay [k l m p]
				OH	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-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60}/D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. 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
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. 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
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 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.



Laboratory Tests

DD	Dry density, pcf	OC	Organic content, %
WD	Wet density, pcf	S	Percent of saturation, %
MC	Natural moisture content, %	SG	Specific gravity
LL	Liquid limit, %	C	Cohesion, psf
PL	Plastic limit, %	Ø	Angle of internal friction
PI	Plasticity index, %	qu	Unconfined compressive strength, psf
P200	% passing 200 sieve	qp	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3"
Fine	No. 4 to 3/4"
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	< No. 200, PI < 4 or below "A" line
Clay	< No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils

Very soft	0 to 1 BPF
Soft	2 to 3 BPF
Rather soft	4 to 5 BPF
Medium	6 to 8 BPF
Rather stiff	9 to 12 BPF
Stiff	13 to 16 BPF
Very stiff	17 to 30 BPF
Hard	over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise. Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.