NWMI
NORTHWEST MEDICAL ISOTOPES

Report Cover Sheet

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Approvals

Review (R) and Approval (A)		Printed Name	Affiliation or Signature	Date
Originator	A	Brian Sanders, PE	Geotechnology, Inc.	3/8/2019
Project Manager	R/A	C. Haass	Carolyn C. Haass	4/17/2019
Registered Professional Engineer's Stamp (if required)				☒ N/A

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Geotechnical Exploration
Lot 15, Discovery Ridge, Columbia, Missouri

NWMI-2019-RPT-001, Rev. 0
April 2019

Prepared for:
Northwest Medical Isotopes, LLC
815 NW 9th Ave, Suite 256
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Prepared by:
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St. Louis, Missouri

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GEOTECHNICAL EXPLORATION

LOT 15, DISCOVERY RIDGE
COLUMBIA, MISSOURI

Prepared for:

NORTHWEST MEDICAL ISOTOPES, LLC
CORVALLIS, OREGON

Prepared by:

GEOTECHNOLOGY, INC.
ST. LOUIS, MISSOURI

Date:

MARCH 8, 2019

Geotechnology Project No.:

J032982.01

SAFETY
QUALITY
INTEGRITY
PARTNERSHIP
OPPORTUNITY
RESPONSIVENESS

GEOTECHNOLOGY INC
FROM THE GROUND UP

March 8, 2019

Ms. Carolyn Haass
Northwest Medical Isotopes, LLC
777 NW 9th Avenue, Suite 404
Corvallis, Oregon 97330

Re: Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri
Geotechnology Project No. J032982.01

Dear Ms. Haass:

Presented in this report are the results of our geotechnical exploration and field resistivity survey completed for the referenced project. Our services were performed in general accordance with our Proposal P032982.01, which was dated on November 6, 2018.

We appreciate the opportunity to provide geotechnical services for this project. If you have any questions regarding this report, or if we can be of additional service, please do not hesitate to contact us.

Respectfully submitted,
GEOTECHNOLOGY, INC.

Brian Sanders, P.E
Project Manager

STATE OF MISSOURI
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EXECUTIVE SUMMARY

The executive summary is provided solely for the purpose of overview and a number of details are omitted, each of which could be crucial to the recommended application of this report. Parties who rely on this report should read the entire report.

- The project includes the construction of a research facility at Discovery Ridge, which is a proposed commercial development in Columbia, Missouri. The facility will consist of a single-story, high-ceiling structure, possibly with a mezzanine, and one to two below-grade levels. In addition to the main structure, various single-story, slab-on-grade structures are planned.

- Detailed loading information is not currently available for the structures; for the purposes of this report, for the main structure, maximum column loads have been assumed to be 100 kips and maximum wall loads have been assumed to be 35 kips per linear foot. Loads for the various outbuildings, maximum column and wall loads are assumed to be 50 kips and 3 kips per foot, respectively.

- The stratigraphy consists generally of lean and fat clay, underlain by fat clay till to the depths of auger refusal. Intermittent layers of sand and silt are present within the fat clay till. The soils are generally stiff to very stiff in consistency. Auger refusal occurred on limestone and shale bedrock. Groundwater was observed in 16 of the 39 borings during drilling.

- As finished grades are not yet finalized, some consideration should be given to establishing the lowest level excavation above El 795 to reduce the potential for exposing the saturated sand layer.

- The main structure may be supported on drilled piers proportioned for an allowable end-bearing pressure of 40 kips per square foot (ksf).

- The single-story outbuildings can be supported on shallow foundations proportioned for net allowable bearing pressures of 2,500 and 3,000 pounds per square foot (psf), respectively.

- Fat clay appears to be present at or below the proposed finished floor elevations. Fat clay remediation should be anticipated in the floor slab areas.

- Based on the results of the borings, our local knowledge of the soil conditions and the general procedures of the 2012 Editions of the International Building Code (IBC), the soil profile at the project site may be defined as Class C (Very Dense Soil and Soft Rock).

GEOTECHNICAL EXPLORATION
LOT 15, DISCOVERY RIDGE
COLUMBIA, MISSOURI
GEOTECHNOLOGY PROJECT NO. J032982.01

1.0 INTRODUCTION

Geotechnology, Inc., prepared this geotechnical report for Northwest Medical Isotopes, LLC the construction of a research facility at Discovery Ridge in Columbia, Missouri. The services documented in this report were provided in general accordance with the terms and scope of services described in our Proposal P032982.01 dated on November 6, 2018 and authorized on January 7, 2019.

The purpose of our services was to provide geotechnical recommendations for the design of the planned development. Our scope of services included review of previous geotechnical data on the subject site, site reconnaissance, geotechnical borings, field resistivity survey, laboratory testing, engineering analyses, and preparation of this report.

A copy of "Important Information about This Geotechnical-Engineering Report," published by the Geotechnical Business Council (GBC) of the Geoprofessional Business Association (GBA), is included in Appendix A for your review. The publication discusses report limitations and ways to manage risk associated with subsurface conditions.

2.0 PROJECT INFORMATION

The project includes construction of a research facility at Discovery Ridge, Columbia, Missouri. The facility will consist of a single-story, high-ceiling structure, possibly with a mezzanine, and two below-grade levels. The building may be on the order of 60,000 square feet in plan. Additionally, other small single-story structures such as administration building, generator house, waste management building, and others are planned around the main facility. Associated parking areas, and loading dock areas are planned for the remainder of the site and will be paved. The site location and regional topography of the area is shown in Figure 1 – Site location and Topography in Appendix B. The site is currently vacant, is grassed, and slopes downward to the south with approximately 25 feet of relief across the approximately 7.5-acre site from El 822[1] to El 797, but only approximately 10 feet of relief across the proposed main structure footprint.

Detailed loading information is not currently available for the structures; we understand the estimated maximum column loads are 100 kips and maximum wall loads are 35 kips per linear

[1] Elevations herein are in feet and reference the NAVD88 datum.

foot. Loads for the various outbuildings, maximum column and wall loads are assumed to be 50 kips and 3 kips per foot, respectively.

3.0 PREVIOUS GEOTECHNICAL EXPLORATION

A previous geotechnical exploration[2] for the Discovery Ridge development was performed by Terracon Consultants, Inc. in February, 2011. Boring data from this exploration shows the soil stratigraphy to generally consist of lean and fat clay loess underlain by glacial drift. The borings were terminated at 20 feet with the exception of two borings which encountered auger refusal between depths of 13 and 18.9 feet (El 777 and 761.1). Rock was not cored in any of the borings. The previous boring location within Lot 15 is shown on Figure 2 - Aerial Photograph and Exploration Locations in Appendix B and the associated boring log is attached in Appendix C.

4.0 GEOTECHNICAL EXPLORATION

The field exploration consisted of drilling thirty-nine borings designated as B-1 through B-39, at approximately the locations shown on Figure 2. The borings were surveyed and staked in the field by Engineering Surveys and Services, the project surveyor. The elevations at the boring locations, as shown on the boring logs, were provided by the project surveyor.

The borings were drilled to auger/sampler refusal or a predetermined termination depth of 25 feet using a CME 550X and a Diedrich D-50 rotary drill rig equipped with hollow stem augers. Standard Penetration Tests (SPTs) were performed using automatic hammers. Split-spoon samples and relatively undisturbed Shelby tube samples were obtained at the depths indicated on the boring logs presented in Appendix D. Rock was cored in twelve of the borings using NQ2-wireline coring techniques. Rock core photographs are included in Appendix E. A legend of the terms and symbols used on the borings and rock core descriptions are included in Appendix D.

Representatives from Geotechnology provided direction during field exploration, observed drilling and sampling, assisted in obtaining samples, and prepared field logs of the material encountered.

Observations for groundwater were made in the borings during drilling and/or before introducing drilling fluid for rock coring.

Unless noted on the boring logs, the lines designating the changes between various strata represent approximate boundaries. The transition between materials may be gradual or may occur between recovered samples. The stratification given on the boring logs, or described herein, is of use by Geotechnology in its analyses and should not be used as the basis of

[2] *Preliminary Geotechnical Engineering Report, Discovery Ridge - Certified Site Program, Lots 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, Columbia, Missouri*, prepared for Trabue, Hansen and Hinshaw, Inc. by Terracon Consultants, Inc., Report No. 09105094.1 and dated February 11, 2011.

design or construction cost estimates without realizing that there can be variation from that shown or describe.

4.1 Field Resistivity Survey

In addition to the soil boring program, Geotechnology completed an electrical resistivity survey. The purpose of this survey was to further assess the potential for karst features (e.g. voids) and variability in depth to bedrock. Electrical resistivity data were collected from January 14 through January 18, 2019, using a 56-channel SuperSting-R8 earth resistivity meter manufactured by Advanced Geosciences, Inc. (AGI). For this survey, a dipole-dipole electrode array was used, which is further described below.

Electrical Resistivity Method

Electrical resistivity is a surface geophysical technique for which the variation of apparent resistivity in the subsurface is determined by transmitting current into the subsurface with two current electrodes, and measuring the resulting ground voltage at various locations using pairs of potential (voltage) electrodes. The method is used to image stratigraphic and karst features such as voids or clay-filled zones in bedrock.

Numerous electrode arrays can be used, with the array choice depending on the site and geologic conditions, geometry of targets of interest, and depth of exploration. The dipole-dipole array was used for this project as it is considered good for imaging isolated 3-dimensional (3D) targets such as voids. This array involves injecting current with two current electrodes (a current dipole), and measuring the resulting ground voltages using pairs of potential electrodes (potential dipoles) at various distances along the electrode array. The greater the distance between the current and potential dipoles, the greater the depth of the measured electrical field in the subsurface. The measured resistivities are used to develop a resistivity profile from which geologic layering and possible voids can be interpreted.

The resistivity of a geologic material is based on many factors, including the conductivity of the matrix, porosity, fracture/void density, and water content. Karst features may be detected within limestone or dolomite bedrock because clay-filled solution features often exhibit low-resistivity values, and voids often exhibit high-resistivity values. In addition, voids within soil may be detected because the void space exhibits high-resistivity values compared to the surrounding clay-rich soil.

Data Acquisition

Prior to beginning the electrical resistivity survey, the geophysical lines were located in the field by Engineering Surveys and Services. A total of 15 resistivity lines were established as follows and as shown in Figure 2:

- Lines 1 through 12 were parallel, oriented generally northeast-southwest, and encompassed the footprint of the proposed RPF building. The lines were approximately 550 feet in length and spaced approximately 20 feet apart. Each line was collected using an electrode spacing of 10 feet.

- Line 13 was approximately 360 feet long and positioned generally northeast-southwest through the cluster of proposed buildings that include the Generator House and Waste Management Building in the north portion of the site. This line was collected using an electrode spacing of approximately 6.5 feet (2 meters).
- Line 14 was approximately 360 feet long and positioned through the footprint of the proposed Administration Building, in a generally northwest-southeast orientation. This line was collected using an electrode spacing of approximately 6.5 feet (2 meters).
- Line 15 was approximately 930 feet long, and oriented northeast-southwest within Lot 14. This line was collected using an electrode spacing of 10 feet. This line was shorter than originally planned (1,100 feet) due to the presence of electric fencing that was not known to us during the early planning stages.

For each line, electrodes were tested for high electrical resistance at the surface prior to data collection, to verify that electric current could be transmitted into the ground under low resistance conditions. Due to the presence of snow and a wet ground surface, there was no issue with injecting sufficient current into the ground.

Data Processing

Apparent resistivity data recorded during the surveys were modeled using AGI's resistivity inversion program(s) EarthImager 2D/3D to produce electrical resistivity models of the subsurface. These inversion programs use a finite-element modeling subroutine to calculate the apparent resistivity values, and a non-linear, smoothness-constrained, least-squares optimization technique to calculate two-dimensional and three-dimensional resistivity models. Data processing included removal of spikes and incorporating ground surface elevations prior to modeling.

Lines 1 through 12 were processed together in EarthImager 3D to produce a 3D resistivity model. Lines 13, 14 and 15 were processed separately using EarthImager 2D to produce two-dimensional (2D) resistivity models. In addition, Lines 4, 6 and 11 were also processed using EarthImager 2D since several soil borings were completed along these three profiles, and the boring information could be used in interpreting bedrock surface for the 3D resistivity model. Figures 6 through 13 show the resistivity models with annotations (soil boring information and interpretations).

Results

In general, the resistivity models exhibited a typical range of clay-rich soils overlying more resistive limestone bedrock. Based on correlations with site borings, the soils exhibited an approximately 1 to 5-foot-thick layer of moderately conductive surfical lean clay (20 to 32 ohm-m), underlain by conductive fat clays (5 to 10 ohm-m). Below the fat clays, the resistivity values increase to higher values (>32 ohm-m) that are interpreted as shale, limestone and sandstone bedrock, based on the soil boring data.

The shale generally has resistivities of 11 to 23 ohm-m, with the range likely due to the varying degrees of weathering observed in the rock cores. The limestone generally has resistivities of >23 ohm-m, with the values of 23 to 32 ohm-m likely indicating more weathered rock, and >32 ohm-m likely indicating more competent limestone (and some sandstone). We have interpreted the approximate top of competent rock to coincide with the 32 ohm-m resistivity contour on Figures 6 – 13. Based on our review of the resistivity data, we did not observe apparent evidence of karst features.

5.0 LABORATORY TESTING

Laboratory testing was performed on soil and rock samples to assess engineering and index properties. Laboratory testing of selected soil samples included the following: moisture content (for both soil and rock), Atterberg limits, unit weight determination, unconfined compression on select soil samples, consolidation test, corrosion series, modified Proctor and California Bearing ration tests. Laboratory test results are presented on the borings logs presented in Appendix D and in Appendix F.

5.1 Chemical Tests

Chemical analytical testing for evaluation of soil corrosivity was performed on a representative soil sample. Oxidation/reduction potential and concentrations of total sulfide, sulfate, and chloride were analyzed by Teklab or its subcontractor. Geotechnology measured pH and electrical resistivity. Chemical analytical test results are summarized in Table 1 and provided in Appendix G.

Table 1. Chemical analytical test results.

Boring No.	Sample Description	Sample Depth Interval (feet)	Total Sulfide (mg/kg -dry)	Sulfate (mg/kg -dry)	Chloride (mg/kg-dry)	Oxidation Reduction Potential (millivolts)	pH	Electrical Resistivity (ohm-cm)
B-2	Fat Clay	6-8	10	110	62	340	7.0	782
B-8	Lean Clay	8-10	<34	86	23	359	6.5	865
B-21	Fat Clay	18-20	<34	110	34	321	7.3	2,177

6.0 SUBSURFACE CONDITIONS

6.1 Stratigraphy

Generalized soil and rock profiles are shown for cross-sections A-A' and B-B', Figures 3 and 4 respectively, at the locations depicted in Figure 2. Actual conditions between the boring locations may differ from the generalized profile shown.

The topsoil section is approximately 6 inches thick. Below the topsoil, the soils are typically medium stiff to stiff, brown, lean and fat clay underlain by stiff to very stiff, reddish brown, fat clay till. In 23 of the borings, there is a layer of varying thickness of medium dense sand/stiff silt, generally at a depth of approximately 20 to 25 feet. Auger or sampler refusal was encountered at depths of 29 to 45 feet on limestone or shale bedrock in 35 of the 39 borings. The four borings where refusal was not encountered were terminated at depths of 20 to 25 feet.

Bedrock generally consisted of shale underlain by interbedded layers of shale and limestone. The shale typically consisted of very weak to weak, gray, thin bedded shale. The limestone typically consisted of medium strong to strong, gray, thin to medium bedded, finely crystalline, highly to slightly weathered limestone. More specific descriptions of the soil and rock layers are provided on the boring logs.

6.2 Groundwater

Groundwater was observed in 16 of the 39 borings during the geotechnical exploration at depths of approximately 19 to 38.5 feet below grade. The rock coring process introduces water into the borehole, which can mask the groundwater level. Consequently, the lack or presence of observed groundwater levels might not represent present or future levels. Groundwater levels could vary over time due to the effects of seasonal variation in precipitation, recharge, or other factors not evident at the time of exploration.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Geotechnology has prepared the following conclusions and recommendations based on our understanding of the proposed project, the field and laboratory data presented in this report, engineering analyses, and our experience and judgment. The client should recognize that the recommendations given herein might require modifications and related analysis if the final plans are different from those assumed herein.

The proposed finished site grades were not available at the time of this report. Geotechnology has assumed the site will be graded to approximately El 810, and has assumed a lower level finished floor elevation of approximately El 790. Excavation to achieve this lower level slab elevation appears to be mostly within cohesive soils; however, the assumed excavation depth will expose potentially saturated sands and silts in some locations. In other areas, it appears that the lower level slab will be bearing on fat clays, and as such fat clay remediation beneath the lower level slab will be required. Fat clay remediation and excavation in potentially saturated sands and silts is discussed herein.

7.1 SITE GRADING

Site Preparation. Initial preparation of the site for grading should include removal of vegetation and topsoil from the planned cut, fill, pavement, and structure areas. Topsoil can be stockpiled for future use on completed cut and fill slopes or in landscaped areas, whereas vegetation, root wads, and other organics should be disposed of offsite.

Proofroll. After performing site preparation and excavations in the cut areas, the exposed subgrade should be proofrolled using a heavily loaded truck (18,000 pounds per axle) under the review of the project geotechnical engineer or a representative thereof. Subgrades in areas unable to be proofrolled should be observed by the project geotechnical engineer or their representative.

Soft or yielding soils should be undercut to stiff cohesive soils; the depth of undercut below proposed subgrade can be limited to 2 feet. The undercut should be backfilled with new compacted fill satisfying the material and compaction requirements presented in Table 2. The undercut soils can be reused provided that they conform to the recommendations contained in this report regarding acceptable fill materials. Proofrolling can be waived if the project geotechnical engineer judges that it would disturb an otherwise acceptable subgrade.

If soft or yielding soils extend below the maximum undercut depth specified above, the subgrade can be stabilized using a biaxial or triaxial geogrid (e.g., Tensar BX-1100 or TriAx TX140) and an 8- to 12-inch lift of compacted well-graded crushed rock. The remainder of the undercut should be backfilled with well-graded crushed rock or clayey soils satisfying the material and compaction requirements presented in this section. If clayey soils are used, a separation geotextile fabric such as Mirafi 500X should be placed between the crushed rock and the clayey soils.

Suitable Fill Materials. Recommended off-site soils to be used for fill and backfill include low plastic, silty clay (liquid limit less than 45) or MODOT Type 5 material, or similarly graded material. In general, onsite existing fill materials consist of high plastic, fat clay. Fat clay can be reused in areas where fills are greater than 4 feet, provided that the fat clay is placed no closer than 3 feet beneath footings and 1 foot beneath pavements.

Fill and Backfill Placement. Fill or backfill should be placed in uniformly thick lifts and compacted. The loose lift thickness should not exceed 8 inches. The fill should be systematically compacted to the levels provided in the Compaction Summary. The soil should be placed at a moisture content compatible with the required unit weight as described in Table 2. Depending on the soil moisture at the time of construction, aeration or wetting might be required to achieve the required compaction. Deleterious material should not be included in fill, and the fill should not be placed on soft materials or frozen ground.

Table 2. Percent compaction and moisture-conditioning requirements for fill and backfill.

Category	Minimum Compaction [a]
General soil fill	90%
Rock backfill	95%
Pavement and floor slab soil subgrade	90%[b]
Pavement and floor slab rock base course	95%

[a] Measured as a percent of the maximum dry density as determined by the modified Proctor test in laboratory (ASTM D 1557).
[b] Moisture content within -1 to 3% of optimum moisture content

Trench Backfill. Settlement of utility trench backfill can result in depressions and localized pavement failures. Settlement of trench backfill can be reduced by mechanically compacting the backfill in lifts to the provided minimum compaction levels. Permeable backfill (e.g., clean rock) should not be used in building or pavement areas. Permeable backfill can collect water and promote subgrade softening, in the presence of potentially expansive soils, could lead to heaving, or cause settlement in uncontrolled fills due to migration of fines.

Maintaining the moisture content of bearing and subgrade soils within the acceptable range provided in Table 1 is important during and after construction for the proposed structures. The clayey bearing and subgrade soils should not be allowed to become wet or dry during or after construction, and measures should be taken to hinder water from ponding on these soils and to reduce drying of these soils during droughts. Groundwater is not expected to have an adverse effect on the proposed earthwork construction; however, the contractor should be prepared to remove seepage that accumulates on fill surfaces or at subgrade levels.

Managing site water is important in successful performance of the pavement and foundation systems. Water from surface runoff, downspouts, and subsurface drains should be collected and discharged through a storm water collection system. Positive drainage should be established around the proposed structures to promote drainage of surface water away from the structures and reduce ponding of water adjacent to these structures.

7.2 Fat Clay Remediation

Fat clay that is potentially expansive occurs at or near planned lower level slab elevations and in some areas at ground surface. Fat clay soil below the proposed structures should be removed and replaced as recommended herein to a depth of 2 feet below proposed floor subgrade elevations. Fat clay should also be removed and replaced to a depth of 2 feet below lightly loaded footings (bearing pressure less than 1,500 psf). The overexcavation can be backfilled with compacted, lean clay (i.e., liquid limit less than 45 percent) or MODOT Type 5 material, or similar low volume change material.

Alternatively, the fat clay subgrade may be modified with hydrated lime to reduce its plasticity. The recommended dosage for lime stabilization should be provided by laboratory testing. A dosage rate of 5 percent hydrated lime by weight can be used for budget purposes. The lime should be blended

into the soil using tilling equipment. During blending, the soil moisture should be approximately 5 percent wet of the optimum moisture content to facilitate modification of the clay mineralogy. Therefore, wetting of the lime-soil blend could be required. Lime-treated soil should also be allowed to cure before it is compacted. Cure time should be evaluated during construction and could range from 4 to 24 hours depending on the soil temperature. The treated soil should be compacted to the levels provided in the Compaction Summary.

For pavement areas, lime-modified clays can be considered to improve subgrade support and extend pavement life. Subgrade stabilization using hydrated lime as described above should be considered in the upper 12 inches of final pavement grade.

The proposed methods of fat clay remediation are based on generally accepted standards in the local engineering community. Clay properties, including plasticity, moisture content, unit weight, swell pressure, and mineralogy are variable and could, in some circumstances, be conducive to more severe swell pressures and volume change potential than can be mitigated by nominal treatment. Consequently, when building in an area where fat clay is present, the client should recognize that there is an inherent risk that damage associated with shrink or swell of the soil could occur, even with remedial treatment of subgrade soil.

7.3 Excavation in Potentially Saturated Silts and Sands

In 15 of the 39 borings, the boring logs indicate medium dense sands and very stiff to stiff silts approximately between El 790 and 785. Groundwater observed during drilling is approximately at El 787. These layers could provide a pathway for groundwater into the excavation. As finished grades are not yet finalized, some consideration should be given to establishing the lowest level excavation above El 795 to reduce the potential for exposing the saturated sand layer. Groundwater which is encountered in the excavation should be collected and routed to a sump system for discharge from the excavation.

Silty soils can quickly decrease in strength if disturbed, which can cause softening of the soil subgrade to a substantial depth. Maintaining a stable subgrade can be difficult in a constricted excavation if the subgrade is disturbed. Minimizing construction and foot traffic are suggested as a means of reducing the potential for subgrade disturbance. Additional precautions to reduce subgrade disturbance could include constructing a mud mat, cement-stabilization, or replacing the subgrade with crushed rock encapsulated in a filter fabric geotextile. Excavations in these soils should be performed using a trackhoe/backhoe equipped with a toothless bucket. Soft soil or yielding areas should be overexcavated and backfilled with flowable fill, concrete, or crushed rock as discussed in section 7.1 Site Grading.

7.4 Excavation Support

Excavation depths and inclinations (including adjacent existing slopes) should not exceed those specified in local, state or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926 or successor regulations). The soil materials in project excavations are anticipated to consist of medium stiff to stiff, lean clay that can generally be classified as OSHA Type B soils. OSHA guidelines require that temporary slopes in Type B soils

be constructed at 1V:1H or flatter. It is important to note that soils encountered in the construction excavations could vary across the site and that, even if the OSHA criteria are used, there is a potential for slope failure.

Planned depths of excavation are on the order of 20 plus feet for the below-grade levels. Due to the open nature of the site we anticipate the contractor will be able to bench or slope the excavations per the OSHA guidelines and temporary shoring will not be required. If space limitations are present temporary retention systems could be required. While many different types and configurations of retention systems can be used, the more common type of excavation support applicable are steel piles with timber lagging and bracing and/or sheet piling. The design of the system is often the responsibility of the contractor performing the work. The contractor should also be responsible for monitoring the performance of the retention system. OSHA regulations should be followed with respect to bracing requirements.

Temporary slopes left exposed more than 24 hours could undergo sloughing and fail. If the slope is expected to remain open for an extended time, polyethylene sheeting can be installed to reduce the potential for slope degradation and instability.

Excavation support is the responsibility of the contractor. Excavation support should be designed and implemented such that excavations are ventilated and braced, shored, and/or sloped to protect the safety of workers within and near the excavations and to protect adjacent ground, slopes, structures, and infrastructure. The analyses, discussions, conclusions, and recommendations throughout this report are not to be interpreted as pre-engineering compliance with safety regulations.

7.5 Corrosivity and Cement Type

Corrosion Potential. Analytical tests were conducted on select samples from Boring B-2, B-8, and B-21 to evaluate the corrosion potential of the subgrade soils. Resistivity, pH, oxidation/reduction potential and concentrations of sulfide were performed. The test results are presented in Table 1 and Appendix G, and are discussed below.

The Ductile Iron Pipe Research Association (DIPRA) in conjunction with the American Water Works Association has established a point system to determine corrosion potential on buried ductile-iron pipe based on the individual tests. DIPRA concludes that corrosive conditions exist if the point total is 10 or more. The soil resistivity and chemical test results indicate that the soils are corrosive to buried ductile-iron pipe. It should be noted, however, that subsurface conditions could vary significantly over short distances.

Cement Type. The analytical laboratory reported a negligible amount of sulfate content due to sample composition. Hence, use of Type I Cement for below-grade construction would be adequate.

7.6 Seismic Site Classification and Seismic Design Parameters

Based on the borings and our interpretation of the 2012 International Building Code (2012 IBC), it is our opinion that the site class and other seismic parameters in Table 3 are applicable for this project.

Table 3. Site class and seismic parameters.

Category/ Parameter	Designation/ Value	Reference
S_S	0.172g	Latitude 38.900506°N/Longitude 92.2276145°W
S_1	0.095g	
Seismic Site Class	C	Chapter 20 of ASCE 7
F_a	1.200	2012 IBC Table 1613.3.3(1)
F_v	1.700	2012 IBC Table 1613.3.3(2)
S_{MS}	0.207g	2012 IBC Equation 16-37
S_{M1}	0.162g	2012 IBC Equation 16-38
S_{DS}	0.138g	2012 IBC Equation 16-39
S_{D1}	0.108g	2012 IBC Equation 16-40

7.7 Drilled Pier Foundations

General Foundation Considerations. The magnitude of the wall loads preclude support of the building on conventional shallow foundations. Therefore, we recommend supporting the structures on drilled piers bearing on underlying bedrock. Although some of the structure loads could be candidates for alternative foundations systems, mixing foundation systems can lead to intolerable differential settlement. If wall loads are reduced, Geotechnology can reevaluate our foundation recommendations.

Shale-Supported Drilled Piers. Shale-supported drilled piers can be designed using a net allowable bearing pressure of 40 ksf. Bearing elevations should be determined during drilled pier construction.

Additional capacity may be obtained by mobilizing the skin friction between the pier and shale. Allowable skin friction values of 2.5 ksf may be used to determine the carrying capacity of drilled shafts in the shale. Required bearing depths of the shale should be based on careful inspection of the shale and its moisture content as exposed at the time of construction. Moisture content of the shale at the bearing elevation should be limited to 14 percent or less. We recommend that Geotechnology's engineer or his representative be present on a full-time basis throughout the course of drilled pier construction to document rock conditions, determine moisture content and evaluate bearing requirements. Provided the pier bottoms are sufficiently machine cleaned, manned entry into the piers is not required. Downhole camera inspection should be performed if the base cannot be observed from the surface. Foundation piers should have a minimum diameter of 30 inches and a maximum bell/shaft diameter ratio of 2.

Drilled Pier Construction Criteria. Drill rigs equivalent to a Hughes Tool Company LDH or greater should be used for augering and coring of soil and rock. As a minimum, the pier rig

should be capable of exerting a torque of 50,000 foot-pounds and a positive crowd force of at least 35,000 pounds. Flat plate augers should not be permitted. Augers should have carbide cutting teeth.

Uplift. The piers can be designed to withstand uplift load provided appropriate reinforcing steel is installed. Resistance to uplift forces on drilled piers is provided by the weight of pier concrete, the adhesion force that develops between the concrete and shale (1.5 ksf) in the sidewall of the pier. We recommend that the friction in the upper 3 feet of the pier be ignored in order to account for the separation of soil and concrete that may occur during the life of the structure.

Lateral Capacity. We recommend a nonlinear analysis to estimate the lateral load capacity of the piers because modulus of subgrade reaction of soil is not a constant property and varies nonlinearly with deflection. Based on the laboratory results and our experience on similar projects, soil parameters for use in the lateral load analysis program LPILE are given below in Table 4. Geotechnology can perform such a nonlinear lateral load analysis, if necessary. Excavation, which would remove the lateral resistance, cannot occur while the lateral load is in place.

Table 4. Parameters for LPILE analysis.

	Soil/Rock Type	
	Silty Clay/Clay	**Shale/Limestone**
Unit weight (pcf)	120	125
Effective Unit Weight (pcf)	58	63
Undrained Shear Strength (ksf)	2.0	-
Soil Strain, E50 or k_rm	0.005	0.0005
Soil Modulus pci	1,000	-
Rock Mass Modulus (psi)	-	50,000
Rock Quality Designation (%)	-	80
Unconfined Compressive Strength (psi)	-	400

Settlement. Settlement of pier foundations, designed in accordance with the recommendations given in this report, should be approximately 1/2 inch or less plus the elastic shortening.

7.8 Shallow Foundations

In addition to the main facility there is an administration building, generator house, waste management building, guard shacks, and other associated small pads and structures. These structures can be supported on shallow foundations. If fat clays are observed during footing excavation, they should be remediated as previously discussed.

Bearing Capacity. Strip and spread footings should be proportioned for net allowable bearing pressures of 2,500 and 3,000 psf, respectively, provided they bear on natural or remedially treated compacted soil. The minimum lateral dimensions for strip and spread footings should be 18 and 24 inches, respectively. Exterior footings and footings in unheated interior areas should be embedded 20 inches below the lowest adjacent exterior grade to provide protection from seasonal moisture variations and frost penetration.

Shallow foundations, proportioned and constructed as recommended above, are expected to settle approximately 1 inch. Differential settlement between any two adjacent footings could be approximately 3/4-inch. Estimated values of settlement contained in this report are based on our experience.

Uplift Capacity. Uplift loads can be resisted with the dead weight of the footing, and the weight of soil above the footing. A unit weight of 120 pounds per cubic foot (pcf) can be used for determining the soil weight above the footing, and the volume of soil acting on the footing can include a wedge of material within a line that extends from the top of footing and away from the footing edge to the ground surface at an angle of 30 degrees from the vertical.

Lateral Capacity. Lateral loads can be resisted considering frictional resistance between the base of the foundation and supporting soil and passive resistance acting on the side of the footing. Resistance to sliding can be computed assuming an ultimate coefficient of friction of 0.4; however, the ultimate resistance must be limited to 1,500 pounds per square foot. The ultimate passive resistance may be computed based on an equivalent fluid pressure of 225 pounds per cubic foot but the upper 30 inches should be neglected. Safety factors of 2 and 3 should be applied to determine the allowable sliding and passive resistance, respectively.

7.9 Floor Slabs

Floor slabs can be designed as slab-on-grade concrete. High plasticity soils within 2 feet of floor slab subgrades must be remediated as previously discussed.

Floor slabs should be underlain by a minimum 6-inch-thick layer of well-graded crushed rock to serve as a capillary break and a base of support. The crushed rock layer should be compacted per the requirements of Table 2. A 15-mil plastic sheet should be placed below the floor to reduce the potential for moisture to permeate the slab and the potential for mold growth within the building. The fat clay present near the floor slab subgrade should be remediated as previously discussed. The top 8 inches of floor slab subgrade should be compacted and moisture-conditioned per the requirements presented in Table 2 prior to placing the crushed rock layer. Constructed as such, the concrete floor slab thicknesses can be designed using a modulus of subgrade reaction (k) of 150 pounds per cubic inch (pci).

It is recommended that control joints be provided within the concrete slab-on-grade floors. These joints should be sealed to mitigate surface water infiltration until the building is enclosed. We recommend that the floor slab be structurally separated from walls, columns, footings, and penetrations to allow independent movement of the floor.

7.10 Perimeter Drain and Damp Proofing

Although we do not anticipate significant groundwater in planned excavations, design measures should be taken to reduce water infiltration into below-grade areas of the building. These measures include installation of a subsurface drain system, water stops between foundation walls and floor slabs, plastic sheeting beneath floor slabs, and sub-floor drains.

A drain system should be constructed around the perimeter of below-grade structures, as shown on Figure 5. The drain system should consist of 6-inch PVC or equivalent pipe with 1/4- or 3/8-inch perforations; the pipe should be laid with the perforations down and enveloped with drain filter having a gradation in the range shown on Figure 5. The drain filter should be

surrounded with Mirafi® 140 filter cloth or equivalent. The drainage system should be routed to a sump for collection and discharge.

7.11 Lateral Earth Pressures

Below-grade walls shall be designed to resist lateral soil loads. Design lateral pressures from surcharge loads shall be added to the lateral earth pressure load. Lateral earth pressures can vary with wall restraint conditions, type of backfill, slope of ground surface behind the wall, and method of backfill compaction.

Design values are given herein for soil lateral loads on permanent walls with horizontal backfill, subject to active and at-rest conditions in Table 5. Conventional concrete walls may be designed for active earth pressures if the top is permitted to tilt out (after construction) approximately 0.5 percent of its height. Walls with fixed-heads or rigid walls should be designed for at-rest earth pressures.

Table 5. Lateral earth pressure design values

Description of Backfill	Design soil lateral load (psf per foot of depth)	
	At-rest	Active
Inorganic clays of low to medium plasticity (CL)	65h + 0.55q	50h + 0.40q
Well graded gravel-sand mix (GW/SW) (e.g., 1-inch-minus, but not screenings)	50h + 0.40q	30h + 0.25q

Where:

h = depth below adjacent grade, feet

q = surcharge load, psf

Fat clays should not be used as wall backfill.

In giving these values, it is assumed that hydrostatic pressures will not develop behind the walls and that the wall backfill will be compacted as recommended in the Site Grading section of this report. Therefore, the walls should be provided with a drain system to allow for dissipation of hydrostatic pressures. Undrained walls may be subjected to additional pressures from groundwater, perched water, pipe leakages or surface water infiltration.

For the above equations to be valid for sand or gravel backfill, the backfill should be placed, in a wedge extending upward and away from the edge of the wall footing at a 45-degree angle or flatter. If sand and gravel are to be placed within a steeper wedge, the values for low plasticity soil given above should be used. Further, any soft uncompacted soil on the excavation slope

should be removed prior to placement of backfill. Design drawings should reflect this requirement.

7.12 Pavement Design and Construction

Standard asphaltic concrete pavement design for a given service life requires evaluation of the soil by California Bearing Ratio (CBR) tests or other methods, estimates of daily traffic volumes and axle weights, drainage requirements, and the desired level of maintenance. Laboratory tests using samples of on-site subgrade material exhibited a CBR value of 3.

Asphaltic pavement sections are frequently used that are thinner than would typically result from a pavement design. These reduced thickness sections often perform adequately; however, maintenance or an overlay is generally required sooner than would be required for a thicker, designed section. Based on our experience, pavement sections consisting of 4 inches of asphalt over 6 inches of well-graded crushed rock and 4 inches of asphalt over 8 inches of well-graded, crushed rock are often used in parking areas and main drive lanes, respectively, subjected to automobile traffic only. The pavement performance can be enhanced by lime-stabilizing the subgrade soils or incorporating a geogrid below the crushed rock. Where heavy wheel loads are concentrated, particularly at approaches to trash dumpsters and truck loading areas, a 7-inch concrete section underlain by 4-inches of base course is often used. Proper joint reinforcing should be provided at concrete pavement joints. The concrete pavement may be designed assuming a vertical subgrade modulus of 100 pci or less.

Regardless of which pavement sections are selected, the soil subgrade should be stable and the top 12 inches compacted as provided in Table 2. Pavement service life can decrease significantly if the pavement is constructed on a poor subgrade, if it has poor surface or subsurface drainage, and/or if the pavement is not maintained. Periodic maintenance, such as filling cracks and sealing, is required for any pavement section.

If pavements are not constructed immediately after grading, the subgrade should be shaped to prevent ponding. Minor ponding, of even short duration, can cause softening of a soil subgrade. If there is substantial lapse of time between grading and paving, or if the subgrade is disturbed by construction activities, the subgrade should be proof-rolled with a loaded, tandem-wheeled dump truck. Soft spots observed during initial construction or proof-rolling should be removed and replaced with compacted soil or rock, possibly combined with a geotextile or geogrid. The rock base course and soil subgrade should be compacted as provided in the Compaction Summary.

Depending on when the pavement is constructed, the subgrade might not support construction equipment such as rock trucks or asphalt trucks which have significantly heavier axle loads than those vehicles which the pavement section is expected to support. Such conditions will be more apparent during wetter periods of the year. Overexcavation of soft subgrade and placement of additional base course and/or geogrid could be required to construct the pavement during these periods.

8.0 RECOMMENDED ADDITIONAL SERVICES

The conclusions and recommendations given in this report are based on: Geotechnology's understanding of the proposed design and construction, as outlined in this report; site observations; interpretation of the exploration data; and our experience. Since the intent of the design recommendations is best understood by Geotechnology, we recommend that Geotechnology be included in the final design and construction process, and be retained to review the project plans and specifications to confirm that the recommendations given in this report have been correctly implemented. We recommend that Geotechnology be retained to participate in prebid and preconstruction conferences to reduce the risk of misinterpretation of the conclusions and recommendations in this report relative to the proposed construction of the subject project.

Since actual subsurface conditions between boring locations could vary from those encountered in the borings, our design recommendations are subject to adjustment in the field based on the subsurface conditions encountered during construction. Therefore, we recommend that Geotechnology be retained to provide construction observation services as a continuation of the design process to confirm the recommendations in this report and to revise them accordingly to accommodate differing subsurface conditions. Construction observation is intended to enhance compliance with project plans and specifications. It is not insurance, nor does it constitute a warranty or guarantee of any type. Regardless of construction observation, contractors, suppliers, and others are solely responsible for the quality of their work and for adhering to plans and specifications.

9.0 LIMITATIONS

This report has been prepared on behalf of, and for the exclusive use of, the client for specific application to the named project as described herein. If this report is provided to other parties, it should be provided in its entirety with all supplementary information. In addition, the client should make it clear that the information is provided for factual data only, and not as a warranty of subsurface conditions presented in this report.

Geotechnology has attempted to conduct the services reported herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions. The recommendations and conclusions contained in this report are professional opinions. The report is not a bidding document and should not be used for that purpose.

Our scope for this phase of the project did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors noted or unusual or suspicious items or conditions observed are strictly for the information of our client. Our scope did not include an assessment of the effects of flooding and erosion of creeks or rivers adjacent to or on the project site.

Our scope did not include: any services to investigate or detect the presence of mold or any other biological contaminants (such as spores, fungus, bacteria, viruses, and the by-products of such organisms) on and around the site; or any services, designed or intended, to prevent or lower the risk of the occurrence of an infestation of mold or other biological contaminants.

The analyses, conclusions, and recommendations contained in this report are based on the data obtained from the geotechnical exploration. The field exploration methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Consequently, subsurface conditions could vary gradually, abruptly, and/or nonlinearly between sample locations and/or intervals.

The conclusions or recommendations presented in this report should not be used without Geotechnology's review and assessment if the nature, design, or location of the facilities is changed, if there is a lapse in time between the submittal of this report and the start of work at the site, or if there is a substantial interruption or delay during work at the site. If changes are contemplated or delays occur, Geotechnology must be allowed to review them to assess their impact on the findings, conclusions, and/or design recommendations given in this report. Geotechnology will not be responsible for any claims, damages, or liability associated with any other party's interpretations of the subsurface data or with reuse of the subsurface data or engineering analyses in this report.

The recommendations included in this report have been based in part on assumptions about variations in site stratigraphy that can be evaluated further during earthwork and foundation construction. Geotechnology should be retained to perform construction observation and continue its geotechnical engineering service using observational methods. Geotechnology cannot assume liability for the adequacy of its recommendations when they are used in the field without Geotechnology being retained to observe construction.

APPENDIX A – IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL-ENGINEERING REPORT

Important Information about Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely on Your ASFE-Member Geotechnical Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
THE BEST PEOPLE ON EARTH
8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

IIGER030815.0MRP

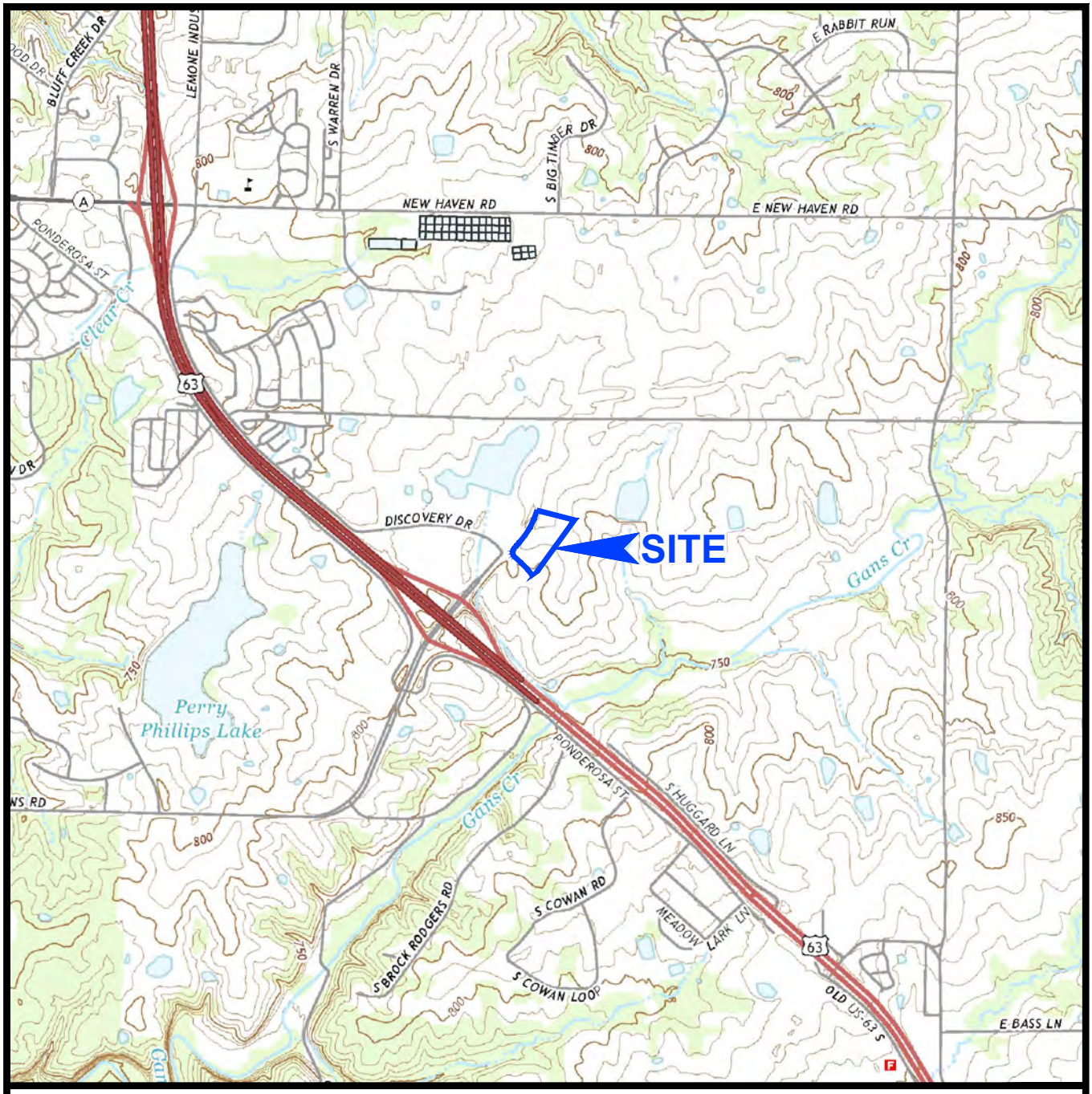
APPENDIX B – FIGURES

Figure 1 - Site Location

Figure 2 - Boring Locations

Figure 3 – Stratigraphic Cross-Sections

Figure 4 – Below-Grade Wall Schematic Drainage Detail



NOTES

1. Plan adapted from a 7.5 minute U.S.G.S. map for Columbia, Missouri quadrangle, last revised in 2015.

0 2,000 4,000

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: BJS	App'vd By: DWG
Date: 2-7-19	Date: 3-8-19	Date: 3-8-19

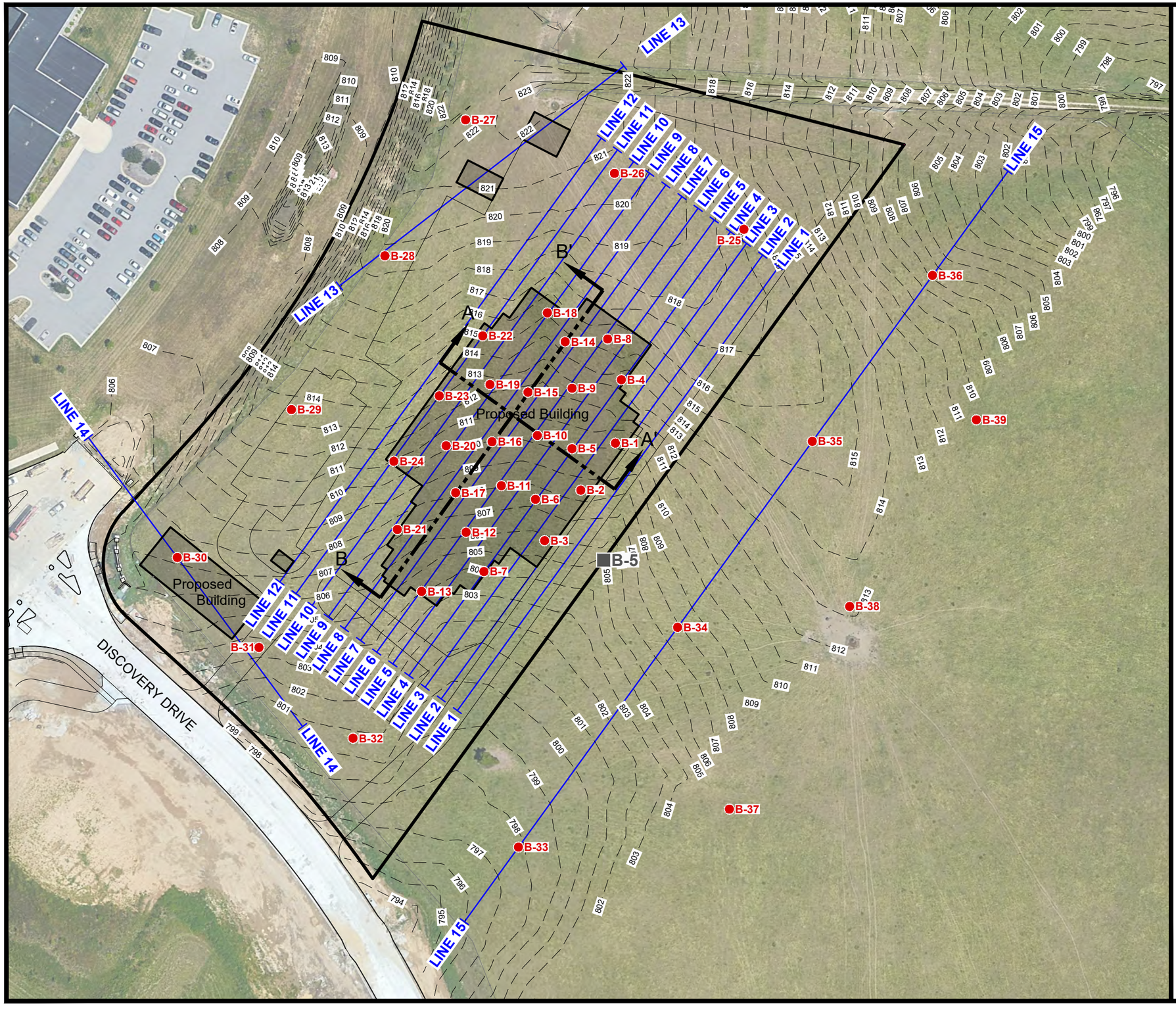
GEOTECHNOLOGY INC
FROM THE GROUND UP

Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

SITE LOCATION AND TOPOGRAPHY

Project Number
J032982.01

FIGURE 1



NOTES

1. Plan adapted from a July 20, 2017 aerial photograph courtesy of Google Earth and an undated, untitled, electronic drawing supplied by the project surveyor.
2. Borings and electrical resistivity survey lines were staked in the field by the project surveyor.

LEGEND

- Boring Location
- Previous Boring by Others
- Geologic Cross-Section (See Plates 3 and 4)
- Electrical Resistivity Survey Line

0 100 200

SCALE IN FEET

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Drawn By: WAH	Ck'd By: BJS	App'vd By: DWG
Date: 3-1-19	Date: 3-8-19	Date: 3-8-19

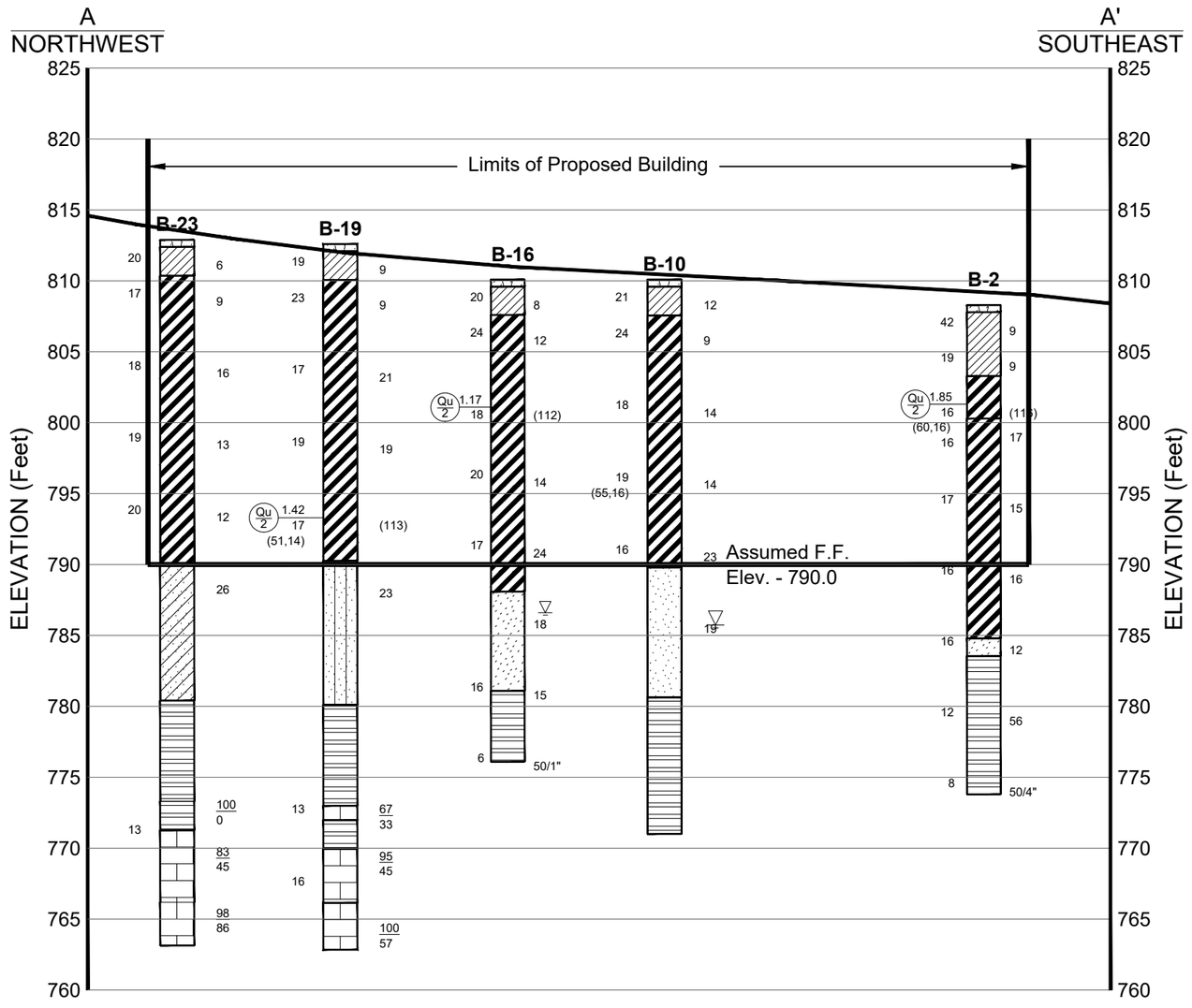
GEOTECHNOLOGY INC
FROM THE GROUND UP

Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

AERIAL PHOTOGRAPH OF SITE AND EXPLORATION LOCATIONS

Project Number
J032982.01

FIGURE 2



KEY TO BOREHOLE SYMBOLS

- Top Soil
- Silty Clay
- Clay
- Sand
- Sandy Silt
- Sandy Silty Clay
- Shale
- Limestone

KEY TO TEST DATA

- Natural Water Content in Percent
- Liquid and Plastic Limits (58,31)
- Shear Strength in TSF from Unconfined Compression Test Qu/2 0.73
- 9 Standard Penetration Test Resistance (No. of Blows of a 140-lb. Hammer Dropping 30-in. Required to Drive a 2-in. O.D. Split Spoon One Foot or Indicated Depth - "S" Denotes Seating)
- (97) Dry Unit Weight in Pounds per Cubic Foot
- ▽ Groundwater Elevation Observed at Time of Drilling
- 100/83 Percent Core Recovery R.Q.D.*

*R.Q.D. Denotes Modified Core Recovery Percentage in Which Only Pieces of Sound Core Over 4 Inches Long are Counted as Recovery

NOTES

1. See PLATE 2 for location of Subsurface Profile A-A'.
2. Data concerning subsurface conditions were obtained at boring locations only. Actual conditions at locations between borings could differ from the generalized profile shown here.

0 30 60
HORIZONTAL SCALE IN FEET

SCALE IN FEET
Horizontal 1" = 30'
Vertical 1" = 10'

Drawn By: WAH	Ck'd By: BJS	App'vd By: DWG
Date: 2-27-19	Date: 3-8-19	Date: 3-8-19

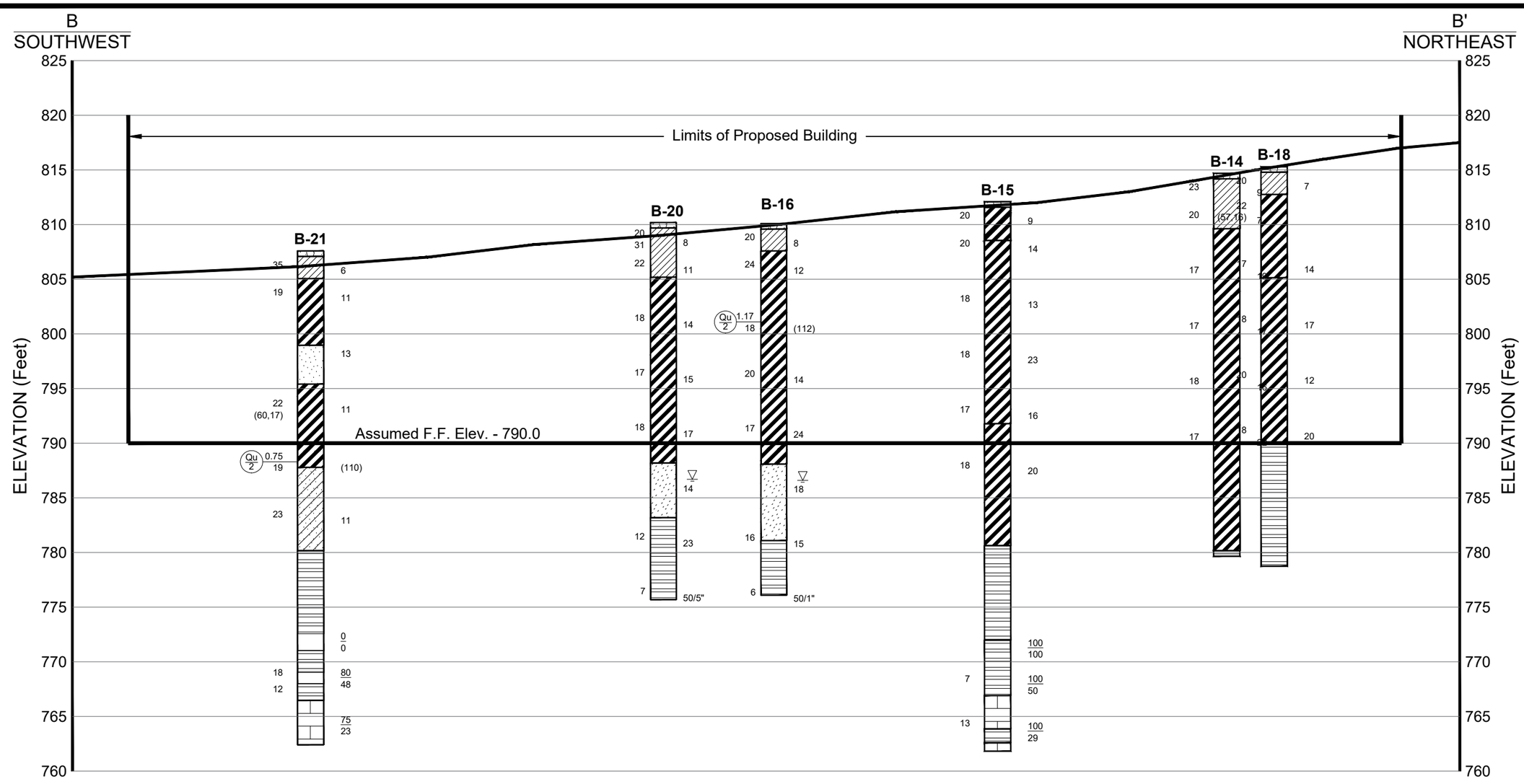
GEOTECHNOLOGY INC
FROM THE GROUND UP

Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

GENERALIZED SUBSURFACE CROSS-SECTION A-A'

Project Number J032982.01

FIGURE 3



SCALE IN FEET
Horizontal 1" = 30'
Vertical 1" = 10'

KEY TO BOREHOLE SYMBOLS

- Top Soil
- Silty Clay
- Clay
- Sand
- Sandy Silt
- Sandy Silty Clay
- Shale
- Limestone

KEY TO TEST DATA

- Natural Water Content in Percent (21) / Liquid and Plastic Limits (58,31)
- Shear Strength in TSF from Unconfined Compression Test: Qu/2 = 0.73
- 9 — Standard Penetration Test Resistance (No. of Blows of a 140-lb. Hammer Dropping 30-in. Required to Drive a 2-in. O.D. Split Spoon One Foot or Indicated Depth - "S" Denotes Seating)
- (97) — Dry Unit Weight in Pounds per Cubic Foot
- ▽ — Groundwater Elevation Observed at Time of Drilling
- 100/83 — Percent Core Recovery / R.Q.D.*

*R.Q.D. Denotes Modified Core Recovery Percentage in Which Only Pieces of Sound Core Over 4 Inches Long are Counted as Recovery

NOTES

1. See PLATE 2 for location of Subsurface Profile B-B'.
2. Data concerning subsurface conditions were obtained at boring locations only. Actual conditions at locations between borings could differ from the generalized profile shown here.

0 30 60
HORIZONTAL SCALE IN FEET

Drawn By: WAH	Ck'd By: BJS	App'vd By: DWG
Date: 2-27-19	Date: 3-8-19	Date: 3-8-19

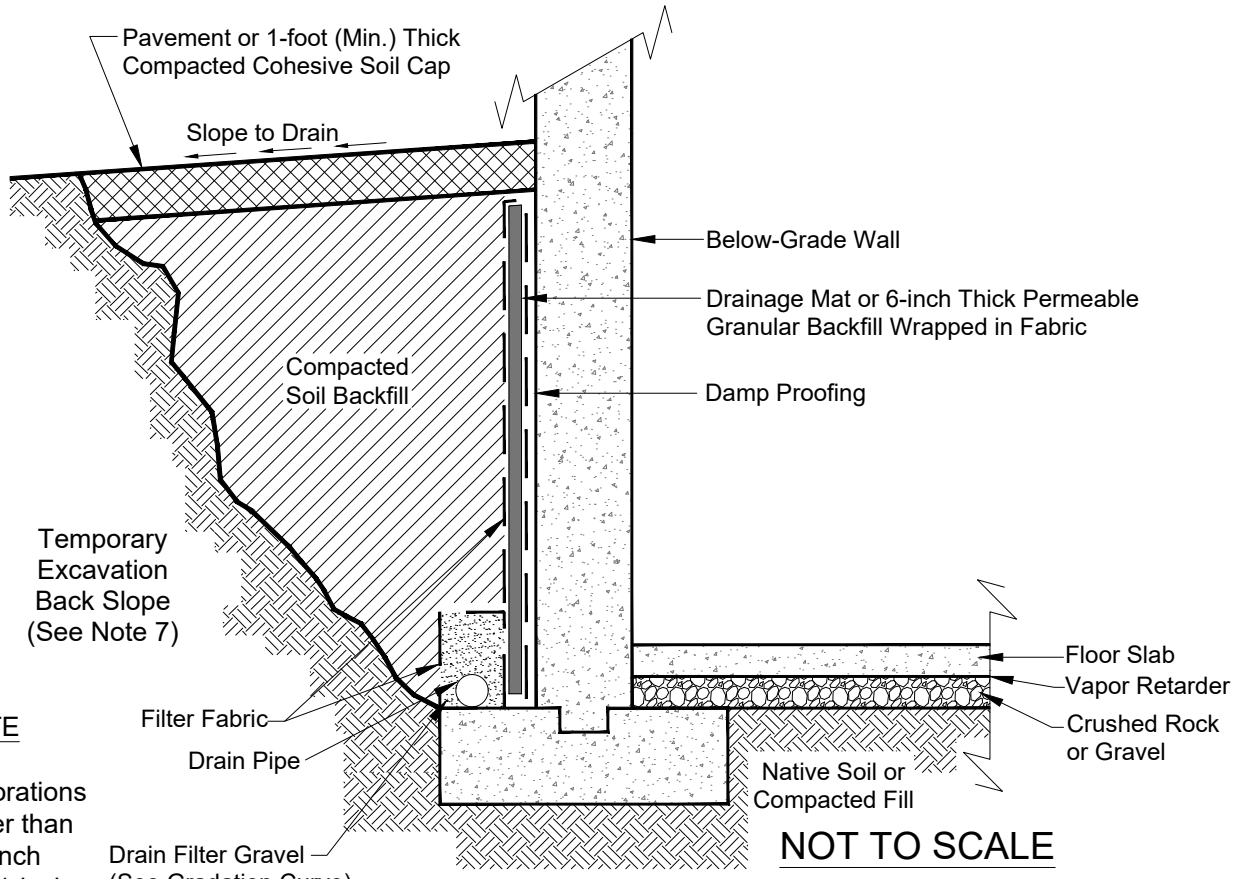
GEOTECHNOLOGY INC
FROM THE GROUND UP

Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

GENERALIZED SUBSURFACE CROSS-SECTION B-B'

Project Number
J032982.01

FIGURE 4

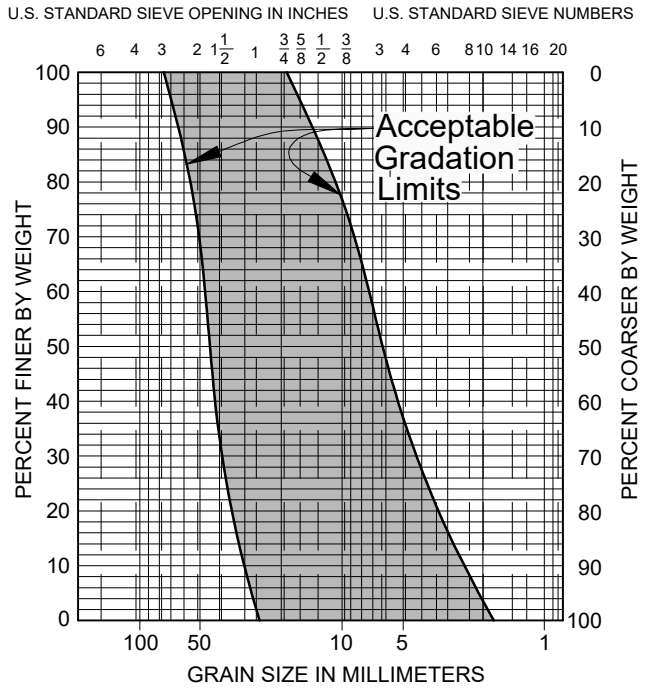


NOT TO SCALE

NOTE
For perforations larger than 3/8-inch use 1-inch clean rock.

NOTES

1. 4-inch or larger, Sch. 40 PVC drain pipe or equivalent with 1/4-inch to 3/8-inch perforations.
2. Perforations positioned downward.
3. Location and invert of pipe as required for drainage.
4. Route drain pipe to daylight to outside slope.
5. Cleanouts advisable at changes of direction.
6. As an alternate, ASTM D2729 sewer pipe may be used in conjunction with 1-inch clean filter rock and filter fabric.
7. A minimum 45-degree back slope may be required if the structural engineer designs the wall using lateral pressures for a granular backfill.



COBBLES	GRAVEL		SAND	
	COARSE	FINE	COARSE	MEDIUM

DRAIN FILTER GRADATION

Drawn By: WAH	Ck'd By: BJS	App'vd By: DWG
Date: 2-27-19	Date: 3-8-19	Date: 3-8-19

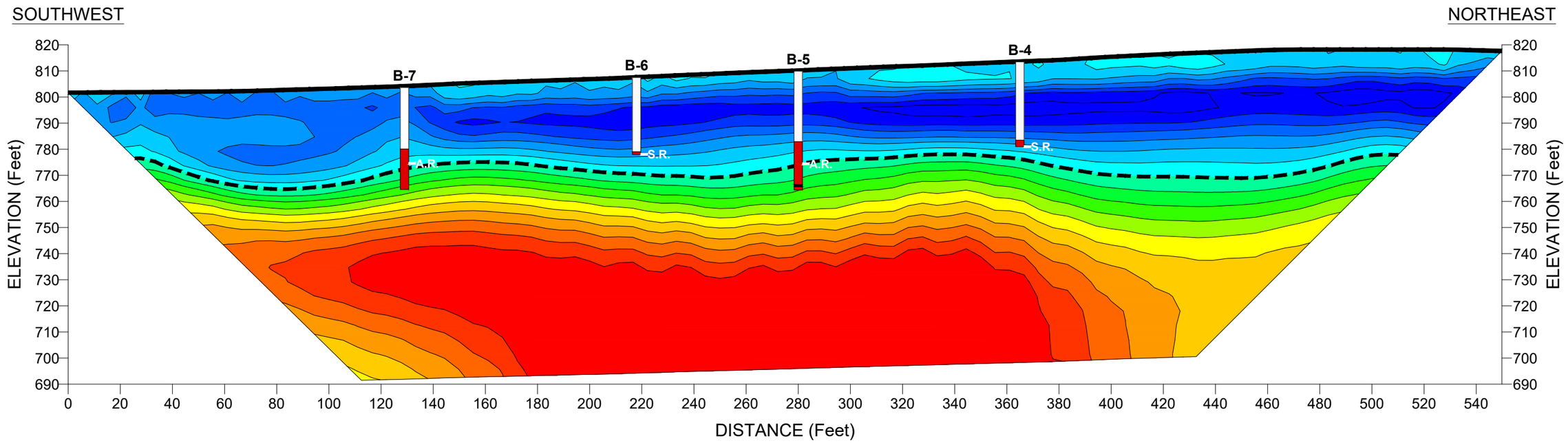
GEOTECHNOLOGY INC
FROM THE GROUND UP

Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

BELOW-GRADE WALL
SCHEMATIC DRAINAGE DETAIL

Project Number
J032982.01

FIGURE 5



RESISTIVITY (ohm-m)

6 9 11 14 17 21 26 32 40 49 61 76 94 117 145 180 223

NOTES

1. See PLATE 2 for location of electrical resistivity Line 4.
2. The interpreted approximate top of competent rock is designated by the 32 ohm-m contour. This interpretation is based on correlating boring log information with resistivity contours.

LEGEND

- Cohesive Soils
- Shale
- Limestone
- A.R. Auger Refusal
- S.R. Sampler Refusal
- Interpreted Top of Competent Rock

0 20 40 80

SCALE IN FEET

Drawn By: WAH	Ck'd By: JCD	App'vd By: DWL
Date: 3-8-19	Date: 3-8-19	Date: 3-8-19

GEOTECHNOLOGY INC
FROM THE GROUND UP

Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

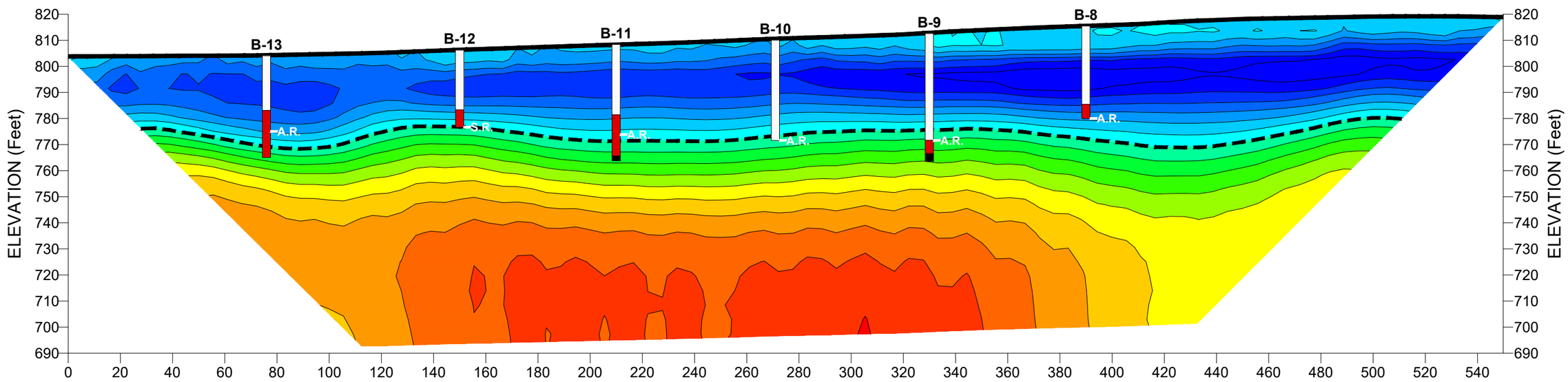
ELECTRICAL RESISTIVITY PROFILE LINE 4

Project Number J032982.01

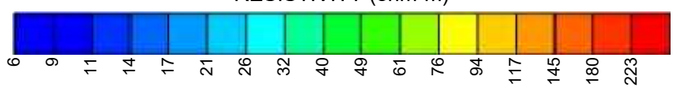
FIGURE 6

SOUTHWEST

NORTHEAST



RESISTIVITY (ohm-m)



NOTES

1. See PLATE 2 for location of electrical resistivity Line 4.
2. The interpreted approximate top of competent rock is designated by the 32 ohm-m contour. This interpretation is based on correlating boring log information with resistivity contours.

LEGEND

- Cohesive Soils
- Shale
- Limestone
- A.R. Auger Refusal
- S.R. Sampler Refusal
- Interpreted Top of Competent Rock

0 20 40 80

SCALE IN FEET

Drawn By: WAH	Ck'd By: JCD	App'vd By: DWL
Date: 3-8-19	Date: 3-8-19	Date: 3-8-19

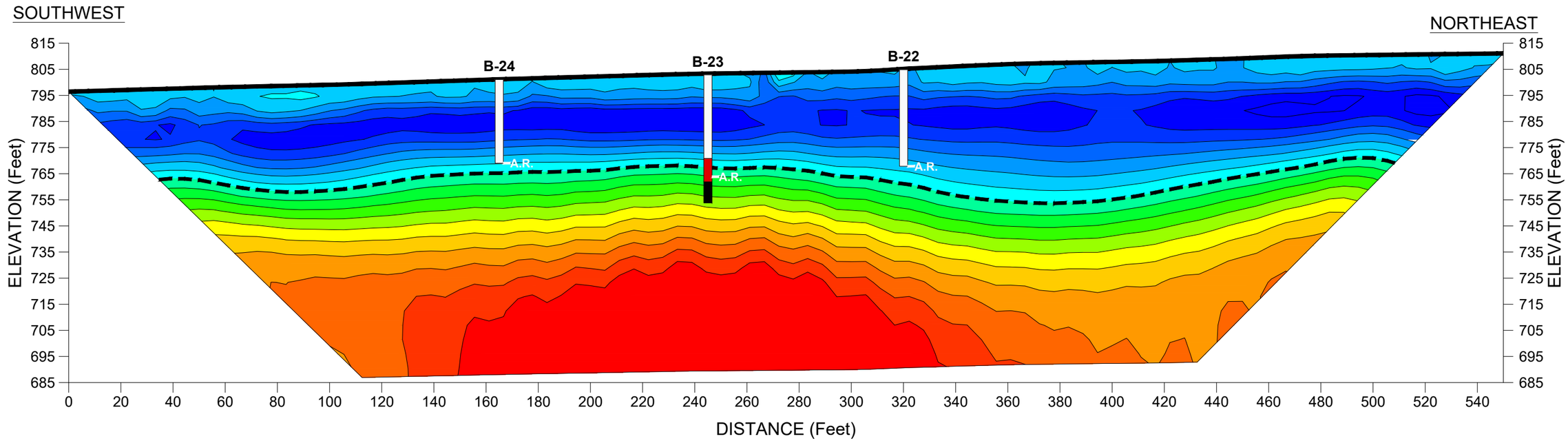
GEOTECHNOLOGY INC
FROM THE GROUND UP

Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

ELECTRICAL RESISTIVITY PROFILE
LINE 6

Project Number
J032982.01

FIGURE 7



RESISTIVITY (ohm-m)

6 9 11 14 17 21 26 32 40 49 61 76 94 117 145 180 223

NOTES

1. See PLATE 2 for location of electrical resistivity Line 4.
2. The interpreted approximate top of competent rock is designated by the 32 ohm-m contour. This interpretation is based on correlating boring log information with resistivity contours.

LEGEND

- Cohesive Soils
- Shale
- Limestone
- A.R. Auger Refusal
- S.R. Sampler Refusal
- Interpreted Top of Competent Rock

0 20 40 80

SCALE IN FEET

Drawn By: WAH	Ck'd By: JCD	App'vd By: DWL
Date: 3-8-19	Date: 3-8-19	Date: 3-8-19

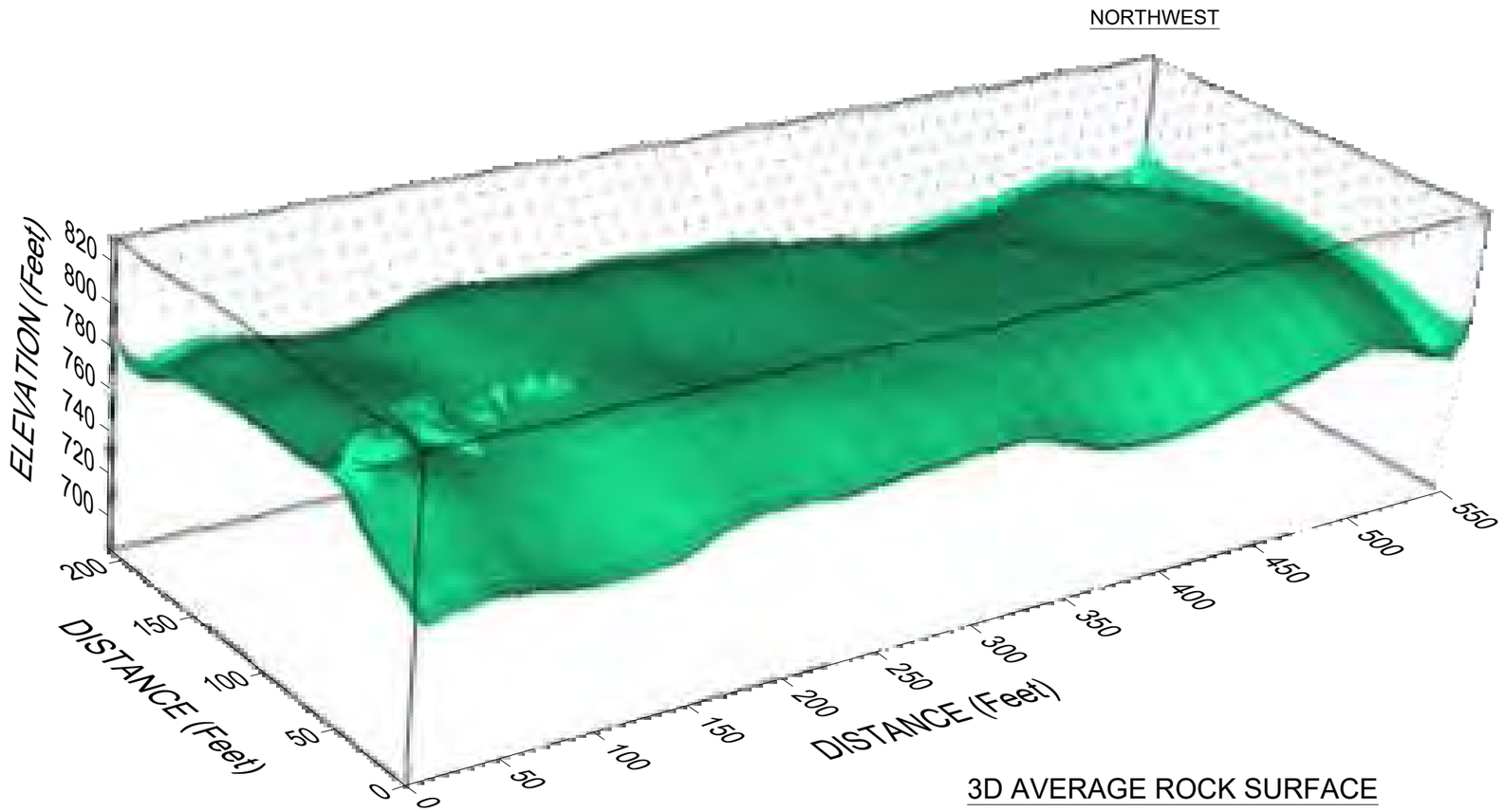
GEOTECHNOLOGY INC
FROM THE GROUND UP

Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

ELECTRICAL RESISTIVITY PROFILE LINE 11

Project Number J032982.01

FIGURE 8



3D AVERAGE ROCK SURFACE

RESISTIVITY (ohm-m)

7 17 40 94 223

NOTES

1. The interpreted approximate top of competent rock is designated by the 32 ohm-m contour. This interpretation is based on correlating boring log information with resistivity contours.

Drawn By: WAH	Ck'd By: JCD	App'vd By: DWL
Date: 3-8-19	Date: 3-8-19	Date: 3-8-19

GEOTECHNOLOGY INC
FROM THE GROUND UP

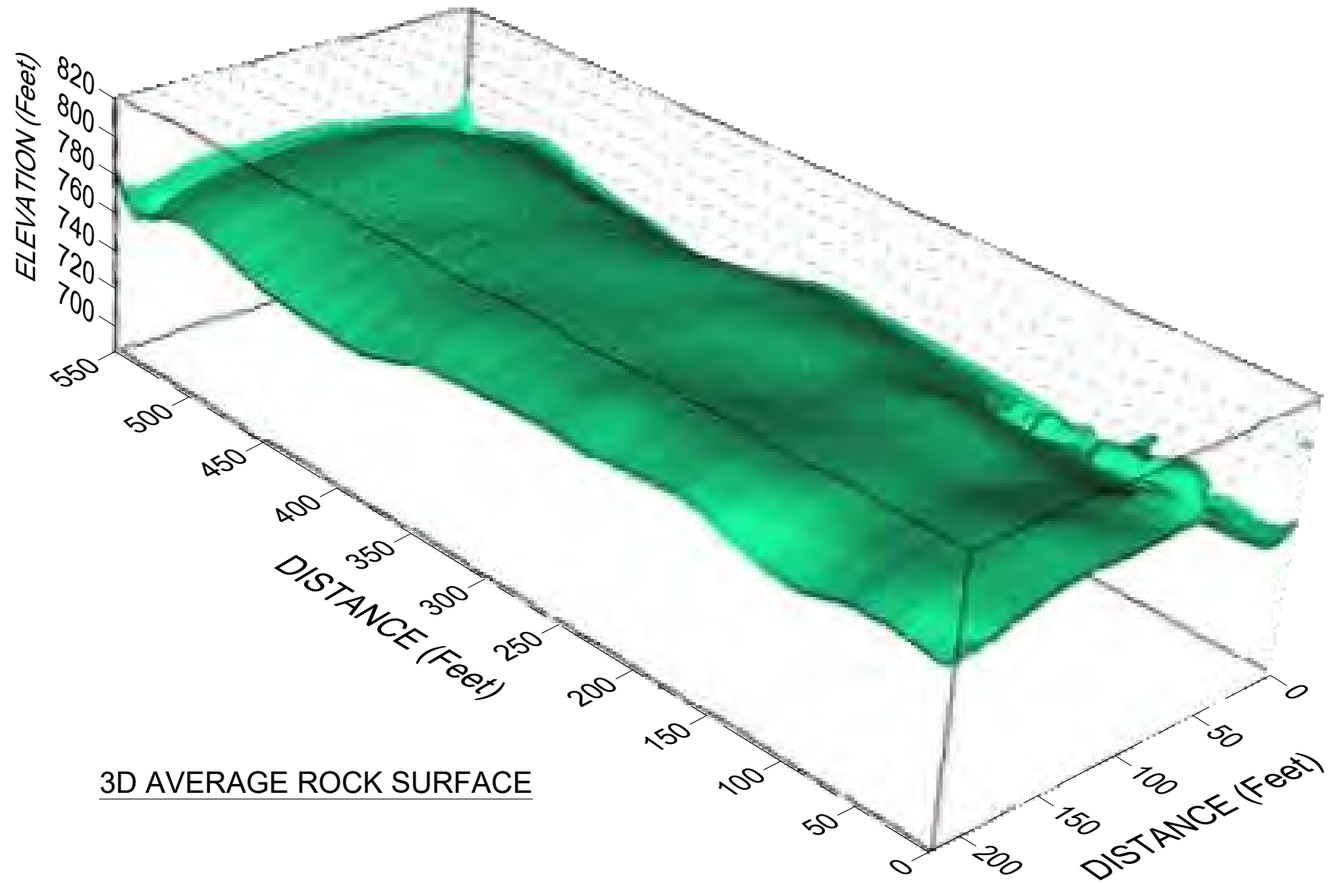
Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

3D ELECTRICAL RESISTIVITY MODEL SOUTHEAST TO NORTHWEST

Project Number
J032982.01

FIGURE 9

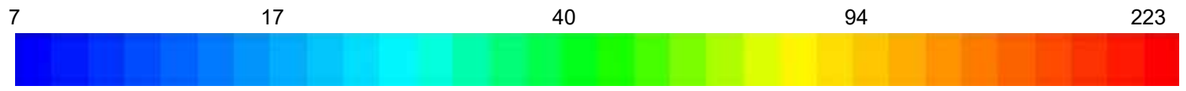
NORTHEAST



3D AVERAGE ROCK SURFACE

SOUTHWEST

RESISTIVITY (ohm-m)



NOTES

1. The interpreted approximate top of competent rock is designated by the 32 ohm-m contour. This interpretation is based on correlating boring log information with resistivity contours.

Drawn By: WAH	Ck'd By: JCD	App'vd By: DWL
Date: 3-8-19	Date: 3-8-19	Date: 3-8-19

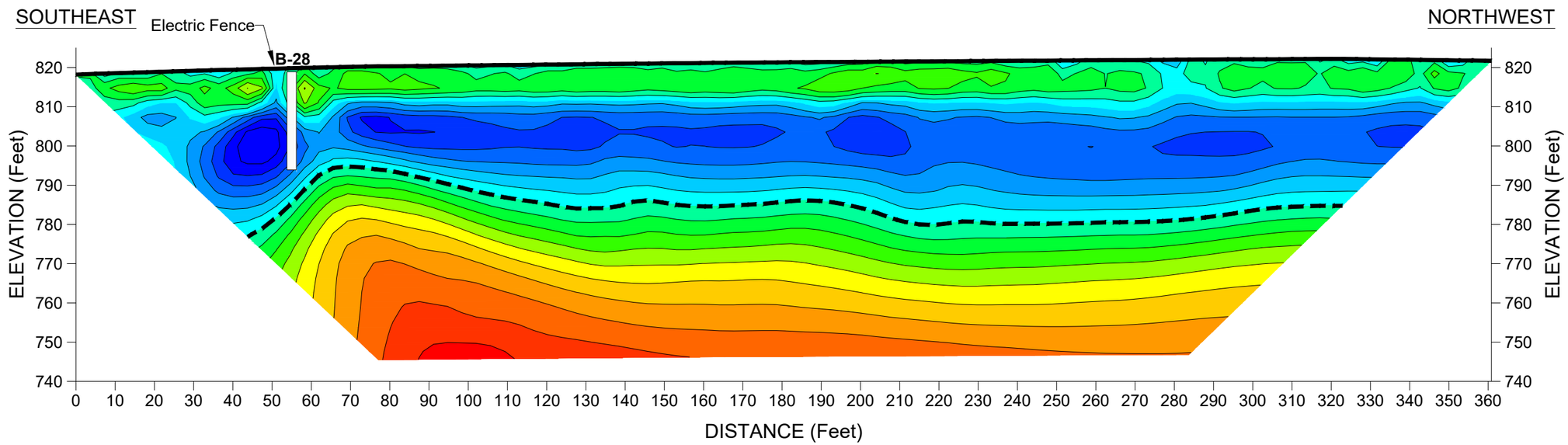
GEOTECHNOLOGY INC
FROM THE GROUND UP

Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

3D ELECTRICAL RESISTIVITY MODEL SOUTHWEST TO NORTHEAST

Project Number
J032982.01

FIGURE 10



RESISTIVITY (ohm-m)

6 9 11 14 17 21 26 32 40 49 61 76 94 117 145 180 223

NOTES

1. See PLATE 2 for location of electrical resistivity Line 4.
2. The interpreted approximate top of competent rock is designated by the 32 ohm-m contour. This interpretation is based on correlating boring log information with resistivity contours.

LEGEND

- Cohesive Soils
- Shale
- Limestone
- A.R. Auger Refusal
- S.R. Sampler Refusal
- Interpreted Top of Competent Rock

0 30 60

SCALE IN FEET

Drawn By: WAH	Ck'd By: JCD	App'vd By: DWL
Date: 3-8-19	Date: 3-8-19	Date: 3-8-19

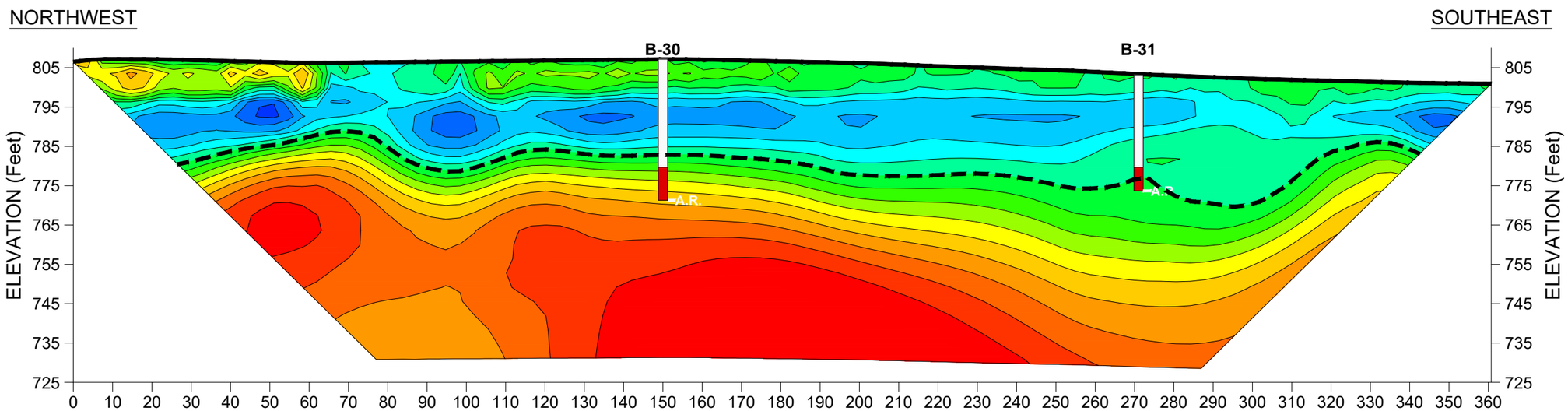
GEOTECHNOLOGY INC
FROM THE GROUND UP

Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

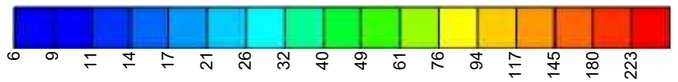
ELECTRICAL RESISTIVITY PROFILE LINE 13

Project Number J032982.01

FIGURE 11



RESISTIVITY (ohm-m)



NOTES

1. See PLATE 2 for location of electrical resistivity Line 4.
2. The interpreted approximate top of competent rock is designated by the 32 ohm-m contour. This interpretation is based on correlating boring log information with resistivity contours.

LEGEND

- Cohesive Soils
- Shale
- Limestone
- A.R. Auger Refusal
- S.R. Sampler Refusal
- Interpreted Top of Competent Rock

0 30 60

SCALE IN FEET

Drawn By: WAH	Ck'd By: JCD	App'vd By: DWL
Date: 3-8-19	Date: 3-8-19	Date: 3-8-19

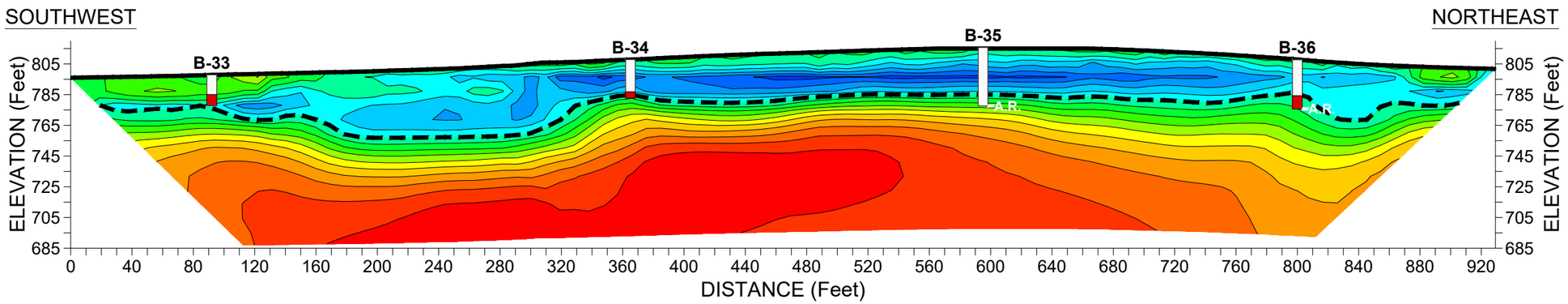
GEOTECHNOLOGY INC
FROM THE GROUND UP

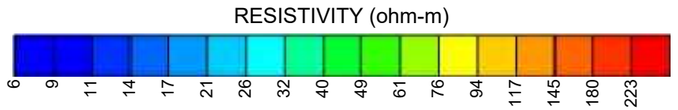
Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

ELECTRICAL RESISTIVITY PROFILE LINE 14

Project Number J032982.01

FIGURE 12





NOTES

1. See PLATE 2 for location of electrical resistivity Line 4.
2. The interpreted approximate top of competent rock is designated by the 32 ohm-m contour. This interpretation is based on correlating boring log information with resistivity contours.

LEGEND

- Cohesive Soils
- Shale
- Limestone
- A.R. Auger Refusal
- S.R. Sampler Refusal
- Interpreted Top of Competent Rock

0 40 80 160
SCALE IN FEET

Drawn By: WAH	Ck'd By: JCD	App'vd By: DWL
Date: 3-8-19	Date: 3-8-19	Date: 3-8-19

GEOTECHNOLOGY INC
FROM THE GROUND UP

Subsurface Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

ELECTRICAL RESISTIVITY PROFILE LINE 15

Project Number J032982.01

FIGURE 13

APPENDIX C – ARCHIVAL BORING

Archival Boring Logs, Terracon

BORING LOG NO. B-5

CLIENT: **Trabue Hansen & Hinshaw, Inc.**

ENGINEER: **Trabue Hansen & Hinshaw, Inc.**

SITE: **Discovery Ridge**
Columbia, Missouri

PROJECT: **Discovery Ridge - Certified Site Program**

Boring Location: Between Lot 14 & Lot 15

Approximate Surface Elevation: 805 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, ksf	TESTS ATTERBERG LIMITS (LL,PL,PI)
	0.3 4" TOPSOIL: 804.7				PA						
	LEAN CLAY: brown, trace gray, stiff		CL	1	ST	16		24	98	4000*	31, 21, 10
	3 802										
	FAT CLAY: gray with red, stiff		CH	2	ST	12		31	91	4000*	
		5			PA						
	8 797										
	FAT CLAY: reddish brown and light gray, trace sand and gravel, possible cobbles, very stiff (Glacial Drift)		CH	3	ST	21		16	119	7000*	
		10			PA						
	12 ▼ 793										
	SANDY LEAN TO FAT CLAY: reddish brown and light gray, trace gravel, possible cobbles, stiff (Glacial Drift)		CL CH	4	ST	19		21		4000*	
		15			PA						
	▽ 17 788										
	FAT CLAY: reddish brown and light gray, trace sand and gravel, possible cobbles, very stiff (Glacial Drift)		CH	5	SS	13	19	18		7500*	
	20 785	20									
	BOTTOM OF BORING AT 20 FEET										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140H SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft				
WL	▽ 16.5	WS	▼ 12	AB
WL	▼		▽	

Exhibit A-9

Terracon

BORING STARTED	12-28-10		
BORING COMPLETED	12-28-10		
RIG	550X	FOREMAN	SB
APPROVED	JMK	JOB #	09105094

BOREHOLE W FIGURE NO 09105094.GPJ GINT 001.GDT 2/18/11

APPENDIX D – BORING INFORMATION

Boring Logs

Boring Log Terms and Symbols

Rock Core Descriptions

Surface Elevation: **810.40** Completion Date: **2/2/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Stiff to medium stiff, gray, LEAN CLAY, trace roots - CL		3-3-6	SS1
			2-3-5	SS2
5	Stiff, gray, FAT CLAY, trace sand - CH			
			4-6-7	SS3
10				
			3-5-7	SS4
15				
	Stiff, gray, LEAN CLAY, some sand - (CL)		115	ST5
20				
	Very stiff, gray, sandy SILT, trace gravel - ML ▽			
			6-10-10	SS6
25				
30	Soft, SHALE			
35				
	Strong, gray, very finely crystalline LIMESTONE		100%/28%	NQ1
	Weak, gray, thin bedded SHALE			
40	Medium strong, gray, very finely crystalline, medium bedded, highly weathered LIMESTONE with shale layers core loss - 3 inches		90% / 0%	NQ2
	Medium strong, gray to greenish-gray, very finely crystalline, thin bedded, highly weathered, argillaceous LIMESTONE			
45	core loss - 5 inches		90% / 12%	NQ3
	Boring terminated at 48 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 24 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER JAS LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-1

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **808.30** Completion Date: **1/29/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Stiff, gray and brown, LEAN CLAY - CL		3-3-6	SS1
			3-4-5	SS2
5	Very stiff, gray and brown, FAT CLAY, some sand, trace gravel - (CH)		116	ST3
	Very stiff to stiff, gray and brown, FAT CLAY - CH (TILL)		4-7-10	SS4
10				
			3-6-9	SS5
15				
	Reddish-brown and gray, sandy		5-7-9	SS6
20				
	Medium dense, brown, fine SAND - SP		3-5-7	SS7
25	Soft, gray and red, weathered SHALE			
			9-18-38	SS8
30				
			30-50/4"	SS9
35	Auger refusal at 34.5 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

60

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-2

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **806.10** Completion Date: **2/1/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Soft, brown, LEAN CLAY - CL		2-2-2	SS1
	Medium stiff, brown, FAT CLAY - CH		2-3-5	SS2
5	Stiff to very stiff, gray and brown, FAT CLAY - CH (TILL)		3-5-7	SS3
10			5-8-11	SS4
15				
	Medium stiff, brown and gray SILT - ML		3-6-5	SS5
20	Medium stiff, gray and brown, sandy, FAT CLAY - CH			
	Soft, gray and orange, weathered SHALE		5-10-13	SS6
25				
	Very weak, gray and pink, thin to medium bedded SHALE			
30				
35			100%/44%	NQ1
			100% / 30%	NQ2
40	Weak, black, aphanitic, medium bedded, SHALE			
	Very weak, gray to greenish-gray, thin bedded SHALE weathered limestone seam - 3 inches		100% / 26%	NQ3
45	Medium strong, gray to greenish-gray, finely crystalline, medium bedded, argillaceous LIMESTONE with interbedded shale			
	Boring terminated at 44.5 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 19 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-3

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **813.50** Completion Date: **1/29/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown and gray, LEAN CLAY - CL		4-4-4	SS1
			2-3-5	SS2
5	Very stiff to stiff, brown and gray, FAT CLAY - CH (TILL)			
			4-7-10	SS3
10				
			3-7-16	SS4
15				
			3-6-8	SS5
20	Very stiff, sandy			
			4-10-13	SS6
25				
	Medium dense, gray, fine SAND - SP		7-9-10	SS7
30	Soft, gray, clayey SHALE			
			18-37-50	SS8
	Split-spoon refusal at 32.5 feet.			
35				
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

87

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER AAO LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-4

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **809.90** Completion Date: **2/2/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Stiff, brown, LEAN CLAY - CL		2-4-6	SS1
	Stiff to very stiff, brown and gray, FAT CLAY, some sand - CH		3-5-7	SS2
5				
			4-8-12	SS3
10	Reddish-brown and gray			
			3-5-8	SS4
15				
			4-8-11	SS5
20	Red and brown, sandy			
			6-7-11	SS6
25				
	Soft, SHALE			
30				
35				
	Strong, gray, very finely crystalline, thin bedded LIMESTONE			
	Weak, gray and brown, moderately weathered SHALE with limestone inclusions		100% / 94%	NQ1
40			100% / 60%	NQ2
	Brown, fine to medium grained, moderately weathered SANDSTONE			
45			100%/33%	NQ3
	Weak, bluish-gray, SHALE with limestone inclusions			
	Boring terminated at 45.5 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 24 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER AAO LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-5

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: 807.5 Completion Date: 1/29/19

Datum: NAVD 88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES	SHEAR STRENGTH, tsf (△ - UU/2, ○ - QU/2, □ - SV; 0.5 1.0 1.5 2.0 2.5) / STANDARD PENETRATION RESISTANCE ▲ N-VALUE (BLOWS PER FOOT) (ASTM D 1586) / WATER CONTENT, % (PL 10 20 30 40 50 LL)
	Topsoil - 6 inches				
	Medium stiff, brown, red, and gray, LEAN CLAY - CL		1-2-3	SS1	
	Stiff to very stiff, gray and brown, FAT CLAY - (CH) (TILL)		2-3-5	SS2	69 >>
5					
			4-4-8	SS3	
10					
			4-6-8	SS4	
15					Lower Level Finished Floor approximately El 790
			5-7-14	SS5	
20	Orange, sandy gray and brown, some sand				
			4-9-7	SS6	
25					
	Soft, tan and white, weathered SHALE		18-39 -50/4"	SS7	
30	Split-spoon refusal at 29.5 feet.				
35					
40					
45					

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM
WASHBORING FROM ___ FEET
BCS DRILLER KLR LOGGER
CME 550x DRILL RIG
HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-6

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **803.60** Completion Date: **2/1/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Soft, brown, LEAN CLAY, trace roots - CL		2-1-2	SS1
	Stiff to very stiff, brown and gray, FAT CLAY -(CH)		2-3-7	SS2
5				
			4-7-9	SS3
10				
	Brown and gray, fine to medium SAND - SP		107	ST4
15				
	Medium stiff, brown SILT - ML		4-3-5	SS5
20				
	Soft, gray, weathered SHALE		10-18-23	SS6
25				
	Very weak, gray, thin bedded SHALE		100% / 0%	NQ1
30			72% / 28%	NQ2
35	Core loss			
	Weak, gray and pink, thin to medium bedded SHALE		100% / 86%	NQ3
40	Boring terminated at 39 feet.			
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

71 >>

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-7

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **815.9** Completion Date: **1/29/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Stiff, brown, FAT CLAY - CH		3-4-6	SS1
	Very stiff, gray, brown, and red, LEAN CLAY - CL		4-12-13	SS2
5	Very stiff, gray, sandy, LEAN CLAY, little sand - (CL)		113	ST3
10			3-6-9	SS4
15	Very stiff, brown and gray, FAT CLAY - CH (TILL)		4-7-9	SS5
20			4-8-10	SS6
25	Sandy		5-7-13	SS7
30	Soft, red and gray SHALE		11-21-33	SS8
35	Auger refusal at 35.5 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER AAO LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-8

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **812.60** Completion Date: **2/1/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Stiff, brown, LEAN CLAY - CL		3-4-7	SS1
	Stiff to very stiff, brown and gray, FAT CLAY - CH		2-4-8	SS2
5				
			4-8-10	SS3
10				
			4-8-10	SS4
15				
			4-7-10	SS5
20				
	Lower Level Finished Floor approximately El 790			
			5-9-11	SS6
25				
30				
	Soft, SHALE			
35				
	Medium strong, gray, brown, and green, thin bedded LIMESTONE with interbedded shale		95% / 50%	NQ1
40	Very weak to weak, SHALE with interbedded limestone and chert		85% / 22%	NQ2
45	Core loss - 6 inches			
	Strong, gray, very finely crystalline, medium bedded LIMESTONE with chert		100% / 64%	NQ3
	shale seam - 2 inches			
50	Boring terminated at 49 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER AAO LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-9

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **810.10** Completion Date: **1/31/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Stiff, brown, LEAN CLAY - CL		3-5-7	SS1
	Stiff to very stiff, brown and gray, FAT CLAY - CH			
5			2-4-5	SS2
10			3-6-8	SS3
15			3-6-8	SS4
20			4-9-14	SS5
	Medium dense, red and brown, fine SAND - SP			
25			8-9-10	SS6
30	Soft, SHALE			
35				
	Auger refusal at 38.5 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 24 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER AAO LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-10

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **808.40** Completion Date: **2/3/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff to very stiff, brown, FAT CLAY - (CH)		2-3-4	SS1
			4-4-5	SS2
5				
			3-5-6	SS3
10				
			4-7-9	SS4
15				
			107	ST5
20	Stiff, red and brown, LEAN CLAY, some sand - (CL)			
			3-4-5	SS6
25				
	Soft, SHALE			
30				
			100% / 0%	NQ1
35	Very weak, gray, thin to medium bedded, slighty weathered SHALE			
			100% / 22%	NQ2
40	Weak, gray and green, thin bedded SHALE with interbedded limestone			
			92% / 58%	NQ3
	Strong, gray, very finely crystalline, medium bedded LIMESTONE			
45	shale layer - 6 inches			
	Boring terminated at 44.5 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

61 >>

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 24 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RFW LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-11

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **806.2** Completion Date: **1/29/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Soft to medium stiff, brown and gray, LEAN CLAY - CL		2-1-3	SS1
			2-3-4	SS2
5				
	Stiff to very stiff, brown and gray, FAT CLAY - CH (TILL)		2-4-8	SS3
10				
			4-8-9	SS4
15				
			4-7-14	SS5
20	Medium dense, gray and brown, fine SAND - SP			
	Soft, orange and gray, weathered SHALE		8-14-29	SS6
25				
			27-50/4"	SS7
30	Split-spoon refusal at 29.5 feet.			
35				
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-12

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **804.10** Completion Date: **2/1/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, LEAN CLAY - CL		5-2-4	SS1
	Stiff to very stiff, brown and gray, FAT CLAY - CH			
5			5-5-8	SS2
10			3-5-7	SS3
15			4-9-13	SS4
	Stiff, brown and gray SILT - ML			
20			3-5-7	SS5
	Soft, white and gray, weathered SHALE			
25			7-9-33	SS6
30	Very weak, gray and maroon, thin to medium bedded SHALE		100% / 25%	NQ1
			100% / 92%	NQ2
35	Very weak, green, thin to medium bedded SHALE with interbedded limestone limestone seam - 2 inches		100% / 25%	NQ3
40	Boring terminated at 39 feet.			
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-13

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **814.70** Completion Date: **1/31/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Stiff, brown, LEAN CLAY - CL		4-4-5	SS1
	medium stiff		2-3-4	SS2
5	Very stiff, gray and brown, FAT CLAY - CH			
			3-8-11	SS3
10				
			4-7-10	SS4
15				
			4-7-9	SS5
20				
			5-10-12	SS6
25				
30				
	Soft, SHALE			
35	Auger refusal at 34.5 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER AAO LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-14

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **812.10** Completion Date: **2/3/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown and gray, FAT CLAY - CH		3-4-5	SS1
	Stiff to very stiff, brown and gray, FAT CLAY - CH (TILL)		5-6-8	SS2
5				
			5-6-7	SS3
10				
			5-13-10	SS4
15				
			6-7-9	SS5
20	Very stiff, reddish-brown, sandy, FAT CLAY - CH			
			7-10-10	SS6
25				
30				
	Soft, SHALE			
35				
			100%/100%	NQ1
40	Weak, gray and green, thin to medium bedded SHALE		100% / 50%	NQ2
45	Medium strong, gray, very finely crystalline, thin to medium bedded, dolomitic LIMESTONE			
	shale seam - 2.5 inches		100% / 29%	NQ3
	Very weak, green, thin bedded SHALE with interbedded limestone			
50	Strong, gray, very finely crystalline, medium bedded LIMESTONE			
	Boring terminated at 49.5 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RFW LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-15

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **810.10** Completion Date: **1/29/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, LEAN CLAY - CL		2-3-5	SS1
	Stiff to very stiff, brown and gray, FAT CLAY - CH (TILL)		3-5-7	SS2
5			112	ST3
10			3-6-8	SS4
15			5-11-13	SS5
20	some sand			
	Medium dense, gray and brown, fine to medium SAND - SP ▽		1-7-11	SS6
25			3-7-8	SS7
30	Soft, purple and gray, weathered SHALE		34-50/1"	SS8
	Auger refusal at 34 feet.			
35				
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 23.5 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-16

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **807.80** Completion Date: **2/2/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, LEAN CLAY, some organics - CL		2-2-3	SS1
	Very stiff, brown and gray, FAT CLAY, some sand, trace gravel - CH		3-8-10	SS2
5				
	Stiff		4-5-7	SS3
10				
			114	ST4
15				
	Medium dense, brown and gray, SAND, trace silt - SM			
			9-11-14	SS5
20				
	Stiff, gray SILT - ML ▽			
			3-3-6	SS6
25				
	Soft, SHALE			
30				
35	Very weak, gray and green, thin bedded SHALE		100%/47%	NQ1
	Limestone layer - 4 inches		100% / 25%	NQ2
40	Medium strong, gray, very finely crystalline, thin bedded, moderately weathered, dolomitic LIMESTONE with interbedded shale		100% / 29%	NQ3
45	Boring terminated at 44.5 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 24 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-17

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **815.30** Completion Date: **1/31/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, LEAN CLAY - CL		2-4-3	SS1
	Stiff, brown and gray, FAT CLAY - (CH)			ST2
5				
			4-6-8	SS3
10	Very stiff, brown and gray, FAT CLAY - CH (TILL)			
			4-7-10	SS4
15				
	stiff		3-5-7	SS5
20				
			4-9-11	SS6
25	Soft, SHALE			
30				
35				
	Auger refusal at 36 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER AAO LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-18

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **812.60** Completion Date: **2/3/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches		
	Stiff, brown and gray, LEAN CLAY - CL	3-4-5	SS1
	Stiff to very stiff, brown and gray, FAT CLAY - (CH) (TILL)	3-4-5	SS2
5			
		5-8-13	SS3
10			
		4-8-11	SS4
15			
	Some sand	113	ST5
20			
	Medium dense, reddish-brown, SAND, and silt - SM		
		8-11-12	SS6
25			
30			
	Soft, SHALE		
35			
	Brown, thin to medium bedded, highly weathered, dolomitic LIMESTONE	67%/33%	NQ1
40	Very weak, gray and green, thin bedded SHALE with interbedded limestone	95% / 45%	NQ2
	Gray and green, thin bedded, slightly weathered, dolomitic LIMESTONE with interbedded shale		
45	Strong, gray, very finely crystalline, medium bedded LIMESTONE shale seam - 1 inch shale seam - 1 inch	100% / 57%	NQ3
50	Boring terminated at 49 feet.		

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RFW LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-19

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **810.2** Completion Date: **1/29/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff to stiff, brown and gray, LEAN CLAY - CL		3-3-5	SS1
			2-5-6	SS2
5	Stiff to very stiff, brown and gray, FAT CLAY - CH (TILL)			
			3-6-8	SS3
10				
	Sandy		7-7-8	SS4
15				
			9-8-9	SS5
20				
	Medium dense, brown, fine to medium SAND - SP ▽		4-6-8	SS6
25				
	Soft, gray and white, weathered SHALE		5-8-15	SS7
30				
			17-50/5"	SS8
35	Split-spoon refusal at 34.5 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 23.5 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-20

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **807.60** Completion Date: **2/2/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, LEAN CLAY - CL		2-3-3	SS1
	Stiff, brown and gray, FAT CLAY - CH (TILL)			
5			3-5-6	SS2
	Medium dense, reddish-brown, fine SAND - SP		8-7-6	SS3
10				
	Stiff, gray and brown, FAT CLAY, and sand - (CH) (TILL)			
			4-5-6	SS4
15				
			110	ST5
20	Medium dense, reddish-brown, SAND, some clay - SC			
			4-5-6	SS6
25				
	Soft, SHALE			
30				
35	Core loss - 18 inches		0%/0%	NQ1
	Very weak, gray and green, medium bedded SHALE			
	Core loss - 12 inches		80% / 48%	NQ2
40	Very weak, gray and green, thin bedded SHALE			
	Medium strong, gray, thin to medium bedded, dolomitic LIMESTONE with chert shale seam - 3 inches shale seam - 3 inches		75% / 23%	NQ3
45	shale layer - 4 inches			
	Boring terminated at 44.5 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

60

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RFW LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-21

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **814.90** Completion Date: **2/3/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown and gray, LEAN CLAY - CL		2-2-3	SS1
	Medium stiff to very stiff, gray and brown, FAT CLAY - CH (TILL)		2-3-5	SS2
5			5-7-9	SS3
10			6-9-9	SS4
15			7-7-7	SS5
20			5-7-11	SS6
25				
30				
35	Soft, SHALE			
	Auger refusal at 37 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RFW LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-22

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **812.90** Completion Date: **2/2/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, LEAN CLAY - CL		2-2-4	SS1
	Stiff to very stiff, gray and brown, FAT CLAY - CH (TILL)			
5			3-4-5	SS2
10			4-7-9	SS3
15			5-6-7	SS4
20			4-5-7	SS5
	Medium dense, reddish-brown, clayey SAND - SC			
25			8-13-13	SS6
30				
	Soft, SHALE			
35				
40	Very weak, gray and green, thin bedded, slightly weathered SHALE with chert		100%/0%	NQ1
	Medium strong, gray, very finely crysttalline, medium bedded, dolomitic LIMESTONE shale layer - 4 inches core loss - 3 inches		83% 45%	NQ2
45	core loss - 6 inches core loss - 1 inch			
	Strong, gray, very finely crystalline, medium bedded LIMESTONE		98% 86%	NQ3
	Boring terminated at 49 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RFW LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-23

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **811.10** Completion Date: **1/31/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, LEAN CLAY - (CL)		5-4-4	SS1
			110	ST2
5	Stiff, brown and gray, FAT CLAY, trace sand - CH			
			2-4-7	SS3
10				
	Stiff to very stiff, brown and gray, FAT CLAY - CH (TILL)		5-6-8	SS4
15				
			4-7-11	SS5
20				
	Medium dense, brown, clayey SAND - SC		10-11-15	SS6
25				
30	Soft, SHALE			
	Auger refusal at 32 feet.			
35				
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

Lower Level Finished Floor approximately El 790

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-24

Project No. J032982.01

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **817.10** Completion Date: **2/3/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Brown, FAT CLAY -(CH)			
	Stiff, brown and gray, FAT CLAY - CH			
			2-4-6	SS1
5				
	Very stiff, brown and gray, FAT CLAY - CH (TILL)		4-8-10	SS2
10				
			3-7-9	SS3
15				
			3-6-9	SS4
20				
	Orange and gray			
			4-9-10	SS5
25				
30				
35				
	Soft, SHALE			
	Auger refusal at 38 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER DJK LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-25

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **820.80** Completion Date: **2/1/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, LEAN CLAY - CL		2-3-4	SS1
	Very stiff, brown and gray, FAT CLAY - CH		1-5-11	SS2
5				
	Little sand and gravel		102	ST3
10				
			4-7-10	SS4
15	Very stiff, brown and gray, FAT CLAY - CH (TILL)			
			5-8-12	SS5
20				
			3-6-8	SS6
25				
30				
35				
40	Soft, SHALE			
	Auger refusal at 41.5 feet.			
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER AAO LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-26

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: 822.5 Completion Date: 1/28/19

Datum: NAVD 88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, LEAN CLAY - CL		1-2-4	SS1
	Very stiff, brown and gray, LEAN CLAY - CL		3-9-13	SS2
5	stiff		6-7-6	SS3
	Stiff to very stiff, brown and gray, FAT CLAY - CH (TILL)		3-3-7	SS4
10			4-6-8	SS5
15			4-6-9	SS6
20			3-6-8	SS7
25			4-8-10	SS8
30			6-9-17	SS9
35			9-11-11	SS10
40	Very stiff to hard, gray and brown, sandy, FAT CLAY - CH (TILL)		32-50/4"	SS11
45	Auger and split-spoon refusal at 44 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 38.5 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-27

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **819.80** Completion Date: **2/4/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Very stiff, brown, LEAN CLAY - CL		5-13-12	SS1
5	Stiff, gray and brown, FAT CLAY - (CH)		6-5-7	SS2
10				
15	Very stiff, brown, FAT CLAY - CH (TILL)		5-7-10	SS3
			3-10-27	SS4
20	Dense, brown, fine to medium SAND - SP			
	Stiff, gray and brown, FAT CLAY - CH (TILL)		4-6-7	SS5
25	Boring terminated at 25 feet.			
30				
35				
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

73 >>

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RFJ LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-28

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **813.50** Completion Date: **2/4/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Very stiff, brown, FAT CLAY - CH			
			5-11-13	SS1
5				
	stiff		5-5-6	SS2
10				
			4-7-9	SS3
15				
	Very stiff, brown and gray, FAT CLAY - CH (TILL)		5-10-12	SS4
20				
	Hard, gray, sandy, FAT CLAY - CH (TILL)		8-17-18	SS5
25	Boring terminated at 25 feet.			
30				
35				
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RFJ LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-29

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **807.30** Completion Date: **1/31/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, LEAN CLAY - CL		4-2-4	SS1
	Very stiff, gray and brown, FAT CLAY - (CH) (TILL)			
5			9-10-10	SS2
			2-5-6	SS3
10				
			4-7-9	SS4
15				
	Very stiff, gray and brown, clayey SILT - ML		4-10-12	SS5
20				
			1-3-4	SS6
25	Medium stiff, brown and gray, sandy, FAT CLAY - CH			
	Soft SHALE			
30				
35				
	Auger refusal at 36 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 25 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-30

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **803.20** Completion Date: **1/31/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, FAT CLAY, trace roots - (CH)		2-2-3	SS1
	Stiff, gray and brown, FAT CLAY - CH (TILL)		4-7-7	SS2
5				
			3-6-9	SS3
10				
	Very stiff, brown and gray, sandy, FAT CLAY - CH (TILL)		4-11-14	SS4
15				
	Medium dense, brown and gray, clayey SAND - SC ▽		4-6-7	SS5
20				
	Soft, gray and white, weathered SHALE		8-16-30	SS6
25				
	Auger refusal at 29.5 feet.			
30				
35				
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

90 >>

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 19 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-31

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **800.70** Completion Date: **1/31/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Medium stiff, brown, LEAN CLAY - CL		2-3-4	SS1
	Stiff, gray and brown, FAT CLAY - CH		4-6-8	SS2
5				
			110	ST3
10	Little sand and gravel			
	Very stiff, brown and gray, FAT CLAY - CH (TILL)		3-8-14	SS4
15				
	stiff		2-4-5	SS5
20				
	Soft, white, weathered SHALE		7-13-26	SS6
25				
	Auger refusal at 27.5 feet.			
30				
35				
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER KLR LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-32

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **798.00** Completion Date: **2/4/18**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Topsoil - 6 inches Stiff, brown, FAT CLAY - CH			
			3-4-5	SS1
5				
	Medium dense, brown, clayey SAND - SC			
			5-5-9	SS2
10				
	Soft, white and gray, weathered SHALE			
			6-14-16	SS3
15				
			13-18-24	SS4
20	Boring terminated at 20 feet.			
25				
30				
35				
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RFJ LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-33

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **807.8** Completion Date: **2/4/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Topsoil - 6 inches			
	Medium stiff, brown, FAT CLAY - (CH)		2-4-6	SS1
5				
			3-4-6	SS2
10				
	Medium dense, gray and reddish-brown, clayey SAND - SC		4-7-10	SS3
15				
			5-5-8	SS4
20	Soft, gray, weathered SHALE ▽			
			4-7-13	SS5
25	Boring terminated at 25 feet.			
30				
35				
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

62 >>

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 22 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RFJ LOGGER

CME 550x DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-34

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **815.70** Completion Date: **2/3/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Very stiff, brown, LEAN CLAY - CL		7-11-12	SS1
5	Very stiff, gray and brown, FAT CLAY - CH (TILL)		5-9-12	SS2
10				
	Stiff		4-7-7	SS3
15				
			6-6-10	SS4
20				
			5-8-10	SS5
25				
30				
	Soft SHALE			
35				
	Auger refusal at 38 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER DJK LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-35

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **807.70** Completion Date: **2/3/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil - 6 inches			
	Very stiff, tan and orange, FAT CLAY, some sand - CH (TILL)			
			4-8-8	SS1
			2-7-8	SS2
			4-7-12	SS3
			3-9-11	SS4
	Soft, tan and gray, weathered SHALE		9-17-25	SS5
	Auger refusal at 32 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER DJK LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-36

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **807.70** Completion Date: **2/3/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Topsoil - 6 inches			
	Stiff, brown and gray, FAT CLAY - CH		3-7-8	SS1
5	Very stiff, tan and gray, FAT CLAY - CH (TILL)			
			4-7-9	SS2
10				
			4-6-9	SS3
15				
	Stiff, gray, FAT CLAY, some sand - CH		5-6-6	SS4
20		▽		
	Stiff, gray SILT - ML		4-5-8	SS5
25	Soft, SHALE			
30				
35				
40				
45	Auger refusal at 45 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 22 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER DJK LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-37

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **813.40** Completion Date: **2/3/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Topsoil - 6 inches			
	Stiff, brown and gray, LEAN CLAY - CL		2-3-6	SS1
5				
	Stiff to very stiff, brown and gray, FAT CLAY - CH (TILL)		2-5-7	SS2
10				
			3-5-9	SS3
15				
			4-5-9	SS4
20	Medium dense, tan and orange, clayey SAND - SC			
			7-8-13	SS5
25				
30				
	Soft, SHALE			
35				
	Auger refusal at 37.5 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 23 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER DJK LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

LOG OF BORING: B-38

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

Surface Elevation: **810.20** Completion Date: **2/3/19**

Datum: **NAVD 88**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Topsoil - 6 inches			
	Brown, LEAN CLAY - CL			
	Stiff, gray and orange, FAT CLAY - (CH) (TILL)		2-5-6	SS1
5				
			2-6-8	SS2
10				
			3-6-9	SS3
15				
			5-6-9	SS4
20				
	Medium dense, tan and orange, clayey SAND - SC		10-6-6	SS5
25	Medium stiff, gray, FAT CLAY - CH (TILL)			
30	Soft, SHALE			
35				
	Auger refusal at 38 feet.			
40				
45				

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT)

(ASTM D 1586)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 24 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

ALL DRILLER DJK LOGGER

D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KLR	Checked by:	App'vd. by:
Date: 2/11/19	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri

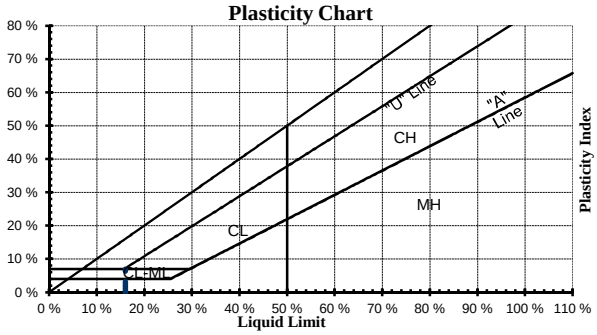
LOG OF BORING: B-39

Project No. J032982.01

LOG OF BORING 2002 N/E J032982.01 - NWMI.GPJ 00 CLONE ME.GPJ 3/11/19

BORING LOG: TERMS AND SYMBOLS

LEGEND	
CS	Continuous Sampler
GB	Grab Sample
NQ	NQ Rock Core
PST	Three-Inch Diameter Piston Tube Sample
SS	Split-Spoon Sample (Standard Penetration Test)
ST	Three-Inch Diameter Shelby Tube Sample
*	Sample Not Recovered
PL	Plastic Limit (ASTM D4318)
LL	Liquid Limit (ASTM D4318)
SV	Shear Strength from Field Vane (ASTM D2573)
UU	Shear Strength from Unconsolidated-Undrained Triaxial Compression Test (ASTM D2850)
QU	Shear Strength from Unconfined Compression Test (ASTM D2166)



SOIL GRAIN SIZE

US STANDARD SIEVE

12"	3"	3/4"	4	10	40	200

BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

300	76.2	19.1	4.76	2.00	0.42	0.074	0.005

SOIL GRAIN SIZE IN MILLIMETERS

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions			*Symbol*	*Description*
Coarse-Grained Soils (More than 50% Larger than No. 200 Sieve Size)	Gravel and Gravelly Soil	Clean Gravels Little or no Fines	GW	Well-Graded Gravel, Gravel- Sand Mixture
			GP	Poorly-Graded Gravel, Gravel-Sand Mixture
		Gravels with Appreciable Fines	GM	Silty Gravel, Gravel-Sand-Silt Mixture
			GC	Clayey-Gravel, Gravel-Sand-Clay Mixture
	Sand and Sandy Soils	Clean Sands Little or no Fines	SW	Well-Graded Sand, Gravelly Sand
			SP	Poorly-Graded Sand, Gravelly Sand
		Sands with Appreciable Fines	SM	Silty Sand, Sand-Silt Mixture
			SC	Clayey-Sand, Sand-Clay Mixture
Fine-Grained Soils (More than 50% Smaller than No. 200 Sieve Size)	Silts and Clays	Liquid Limit Less Than 50	ML	Silt, Sandy Silt, Clayey Silt, Slight Plasticity
			CL	Lean Clay, Sandy Clay, Silty Clay, Low to Medium Plasticity
			OL	Organic Silts or Lean Clays, Low Plasticity
	Silts and Clays	Liquid Limit Greater Than 50	MH	Silt, High Plasticity
			CH	Fat Clay, High Plasticity
			OH	Organic Clay, Medium to High Plasticity
	Highly Organic Soils		PT	Peat, Humus, Swamp Soil

STRENGTH OF COHESIVE SOILS

Consistency	*Undrained Shear Strength (tsf)*	*Unconfined Comp. Strength (tsf)*
Very Soft	less than 0.125	less then 0.25
Soft	0.125 to 0.25	0.25 to 0.5
Medium Stiff	0.25 to 0.5	0.5 to 1.0
Stiff	0.5 to 1.0	1.0 to 2.0
Very Stiff	1.0 to 2.0	2.0 to 3.0
Hard	greater than 2.0	greater than 4.0

DENSITY OF GRANULAR SOILS

Descriptive Term	*Approximate N_{60}-Value Range*
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	>50

N-Value (Blow Count) is the last two, 6-inch drive increments (i.e. 4/7/9, N = 7 + 9 = 16). Values are shown as a summation on the grid plot and shown in the Unit Dry Weight/SPT column.

RELATIVE COMPOSITION

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35 to 50%

OTHER TERMS

Layer - Inclusion greater than 3 inches thick.

Seam - Inclusion 1/8-inch to 3 inches thick

Parting - Inclusion less than 1/8-inch thick

Pocket - Inclusion of material that is smaller than sample diameter

GEOTECHNOLOGY INC
FROM THE GROUND UP

Relative composition and Unified Soil Classification System (USCS) designations are based on visual descriptions and are approximate only. If laboratory tests were performed to classify the soil, the USCS designation is shown in parenthesis.

ROCK CORE DESCRIPTIONS

TERM

Strength
Color
Crystallinity
Grain Size
Mass Bedding
Weathering
Voids
Quality

SEDIMENTARY ROCK TYPE

Sandstone - Predominantly quartz grains cemented by silica, iron, clay or carbonate material. Color depends on cementing agent; porous and pervious; hard and generally thickly bedded.

Siltstone - Composition similar to sandstone but at least 50% grains 0.002 to 0.02 millimeters in size. Rarely forms thick beds, but often hard.

Shale - Predominant particles are less than 0.002 millimeters with a well defined fissile fabric. Commonly interbedded with sandstone or limestone and relatively soft.

Limestone - Contains more than 50% calcium carbonate. The calcite can be precipitated chemically, organically, or it may be detrital in origin. Reacts with dilute HCL.

Dolomite - Harder and heavier than limestone. Forms by alteration of limestone or by direct precipitation from sea water. Reacts with dilute HCL only when powdered.

Coal - Composed of highly altered plant remains and varying amounts of clay, generally black in color.

Chert - Formed by silica deposited from solution in water. May occur as nodules or relatively thick beds.

GEOLOGIC DEFINITIONS

Stylolite - A term applied to parts of certain limestones which have a column like development that is grooved, sutured or striated and irregular in cross-section.

Fissility - A property of splitting along closely spaced parallel planes.

Argillaceous - A term applied to rock or substances having a notable portion, greater then 30%, clay in composition.

Oolitic - A spherical or ellipsoidal texture, 0.25 to 2.0 mm in diameter, with concentric or radial structure.

Brecciated - A rock texture which is composed of angular fragments which correspond in size to gravel and/or pebbles.

Slickenside - A polished or striated surface on or within a rock.

REFERENCE

STRENGTH

Description	***Uniaxial Compressive Strength (psi)***
Extremely Weak	less than 150
Very Weak	150 to 700
Weak	700 to 4,000
Medium Strong	4,000 to 7,000
Strong	7,000 to 15,000
Very Strong	15,000 to 36,000
Extremely Strong	greater than 36,000

COLOR

Common colors are gray, brown, black and white. Exotic colors such as green, blue, maroon can be used when necessary.

CRYSTALLINITY

Description	***Criteria***
Aphanitic	Crystals cannot be seen with the naked eye
Very Finely Crystalline	Crystals are barely visible with the naked eye
Finely Crystalline	Crystals are easily visible with the naked eye
Medium Crystalline	Crystals are medium size; up to 1/8-inch diameter
Coarsely Crystalline	Crystals are 1/8- to 1/4-inch in diameter
Very Coarsely Crystalline	Crystals are larger than 1/4-inch in diameter

GRAIN SIZE

Description	***Criteria***
Very Finely Grained	Grains cannot be seen with the naked eye
Fine Grained	Grains are barely visible with the naked eye
Medium Grained	Grains up to 2 mm in diameter
Coarse Grained	Grains are larger than 2 mm in diameter

BEDDING

Description	***Criteria***
Thin	less than 2 inches
Medium	2 to 24 inches
Thick	24 to 48 inches
Massive	greater than 48 inches

WEATHERING

Description	***Criteria***
Unweathered	No visible alteration of rock mass
Slightly Weathered	Slight discoloration inward from fractures
Moderately Weathered	Discoloration throughout, slight loss of strength, texture intact
Highly Weathered	Entire rock mass appears discolored and dull, texture indistinct, fabric intact
Severely Weathered	Majority of rock mass reduced to soil-like state with relic rock structure

VOIDS

Description	***Criteria***
Dense	Usually not visible with the naked eye
Pitted	Visible to 1/4-inch
Vuggy	1/4-inch to diameter of the core
Cavity	Larger than 6 inches in diameter

QUALITY

Percent RQD	***Description***
90 to 100	Excellent
75 to 90	Good
50 to 75	Fair
25 to 50	Poor
0 to 25	Very Poor

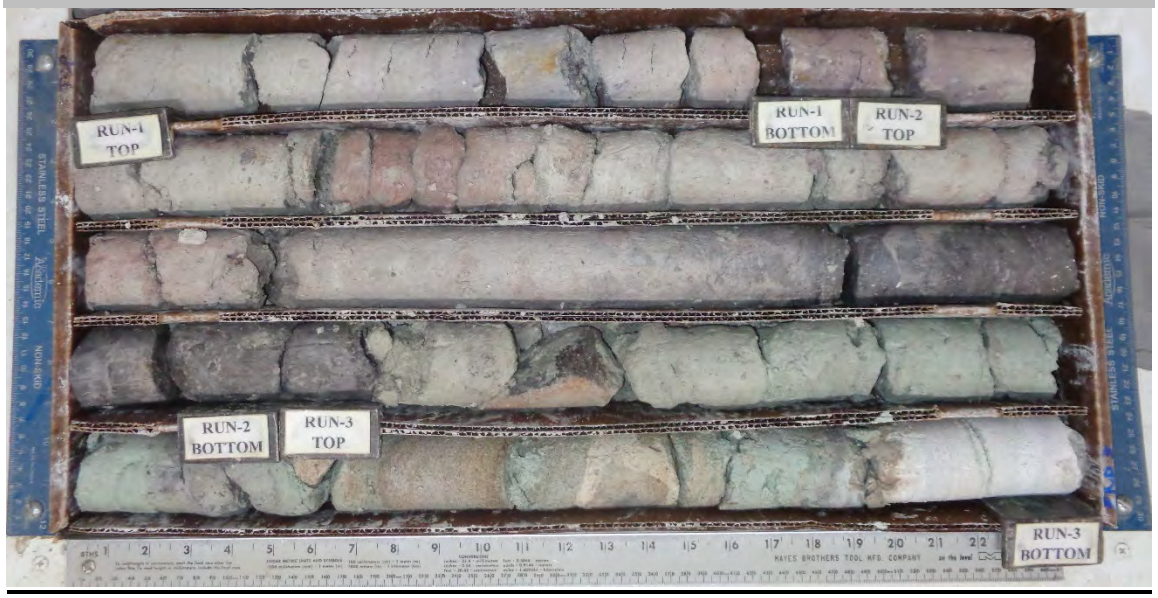
APPENDIX E – ROCK CORE PHOTOGRAPHS

J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-1
Box 1 of 1

BORING B-1

RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	38.0-39.5	100	28
2	39.5-41.0	90	0
3	41.0-48.0	90	12

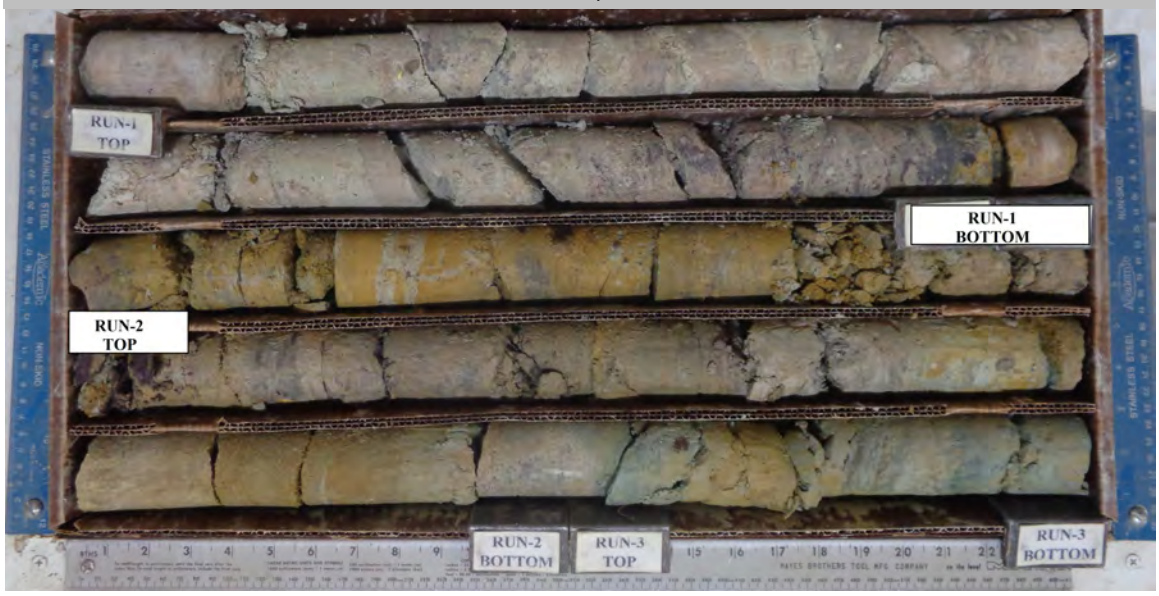
J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-3
Box 1 of 1



BORING B-3

RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	34.5-36.0	100	44
2	36.0-41.0	100	30
3	41.0-445	100	26

J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-5
Box 1 of 1



BORING B-5

RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	35.5-39.0	100	94
2	39.0-45.0	100	60
3	45.0-45.5	100	33

J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-7
Box 1 of 1

BORING B-7

RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	29.5-31.0	100	0
2	31.0-46.0	72	28
3	36.0-39.0	100	86

J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-9
Box 1 of 1

BORING B-9

RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	39.0-41.0	95	50
2	41.0-46.0	85	22
3	46.0-49.0	100	64

J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-11
Box 1 of 1

BORING B-11

RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	34.5-36.0	100	0
2	36.0-41.5	100	22
3	41.5-44.5	92	58

J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-13
Box 1 of 1

BORING B-13

RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	29.0-31.0	100	25
2	31.0-36.0	100	92
3	36.0-39.0	100	25

J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-15
Box 1 of 1

BORING B-15

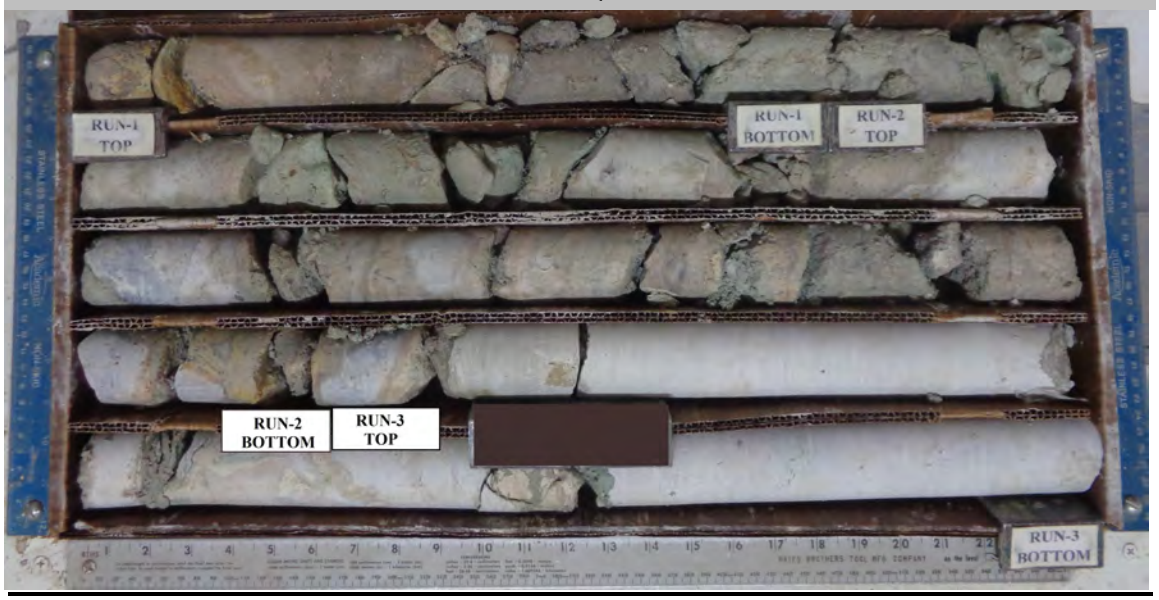
RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	39.5-41.0	100	100
2	41.0-46.0	100	50
3	46.0-49.5	100	29

J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-17
Box 1 of 1

BORING B-17

RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	34.0-35.0	100	47
2	35.0-41.5	100	25
3	41.5-44.5	100	29

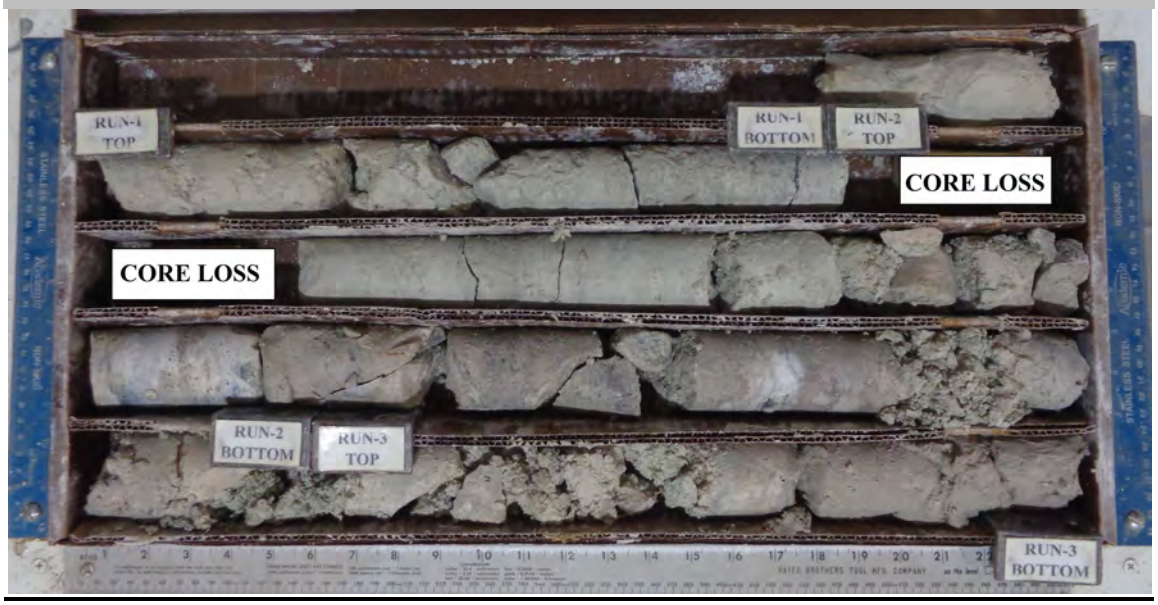
J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-19
Box 1 of 1



BORING B-19

RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	39.0-40.0	67	33
2	40.0-45.5	95	45
3	45.5-49.0	100	57

J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-21
Box 1 of 1



BORING B-21

RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	34.0-35.0	100	47
2	35.0-41.5	100	25
3	41.5-44.5	100	29

J032982.01 | Geotechnical Exploration
Lot 15, Discovery Ridge
Columbia, Missouri | B-23
Box 1 of 1

BORING B-23

RUN	DEPTH, FT	RECOVERY, %	RQD, %
1	39.0-40.5	100	0
2	40.5-45.5	83	45
3	45.5-49.0	98	86

APPENDIX F - LABORATORY RESULTS

TEST REPORT

Project No.:	**J032892.01**	**February 22, 2019**
Project Name:	**NWMI RFP Building**	**Page 1 of 1**
Material:	**Soil**	
Boring Number:	**B-2**	
Sample ID:	**ST3**	
Depth (ft):	**6 to 8**	

MINIMUM LABORATORY SOIL RESISTIVITY
AASHTO T288

Reading	Resistance Measurement	Soil Box Factor (cm)	Soil Resistivity (ohms-cm)	Moisture Content (%)
#1	3,085	0.57	1,758.45	12.8
#2	1,372	0.57	782.04	20.2
#3	1,532	0.57	873.24	26.1
#4	1,692	0.57	964.44	32.4
#5	1,930	0.57	1,100.10	39.3

Minimum Soil Resistivity **782.04**

TEST REPORT

Project No.:	**J032892.01**	**February 22, 2019**
Project Name:	**NWMI RFP Building**	**Page 1 of 1**
Material:	**Soil**	
Boring Number:	**B-8**	
Sample ID:	**ST3**	
Depth (ft):	**8 to 10**	

MINIMUM LABORATORY SOIL RESISTIVITY
AASHTO T288

Reading	Resistance Measurement	Soil Box Factor (cm)	Soil Resistivity (ohms-cm)	Moisture Content (%)
#1	3,498	0.57	1,993.86	13.2
#2	1,517	0.57	864.69	20.5
#3	1,720	0.57	980.40	24.4
#4	1,859	0.57	1,059.63	31.3
#5	2,163	0.57	1,232.91	39.3

Minimum Soil Resistivity **864.69**

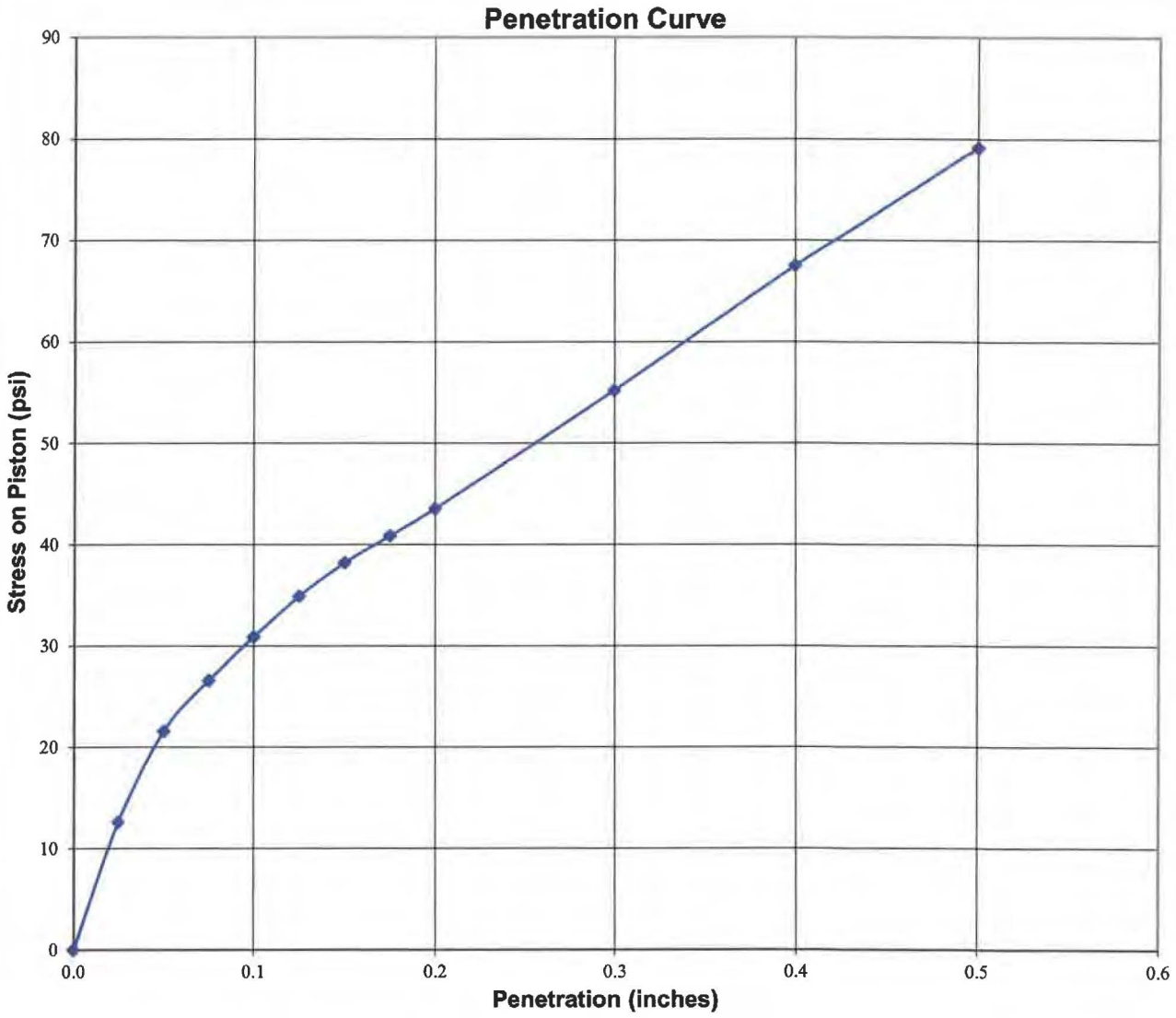
TEST REPORT

Project No.:	**J032892.01**	**February 22, 2019**
Project Name:	**NWMI RFP Building**	**Page 1 of 1**
Material:	**Soil**	
Boring Number:	**B-21**	
Sample ID:	**ST5**	
Depth (ft):	**18 to 20**	

MINIMUM LABORATORY SOIL RESISTIVITY
AASHTO T288

Reading	Resistance Measurement	Soil Box Factor (cm)	Soil Resistivity (ohms-cm)	Moisture Content (%)
#1	4,954	0.57	2,823.78	11.8
#2	3,820	0.57	2,177.40	18.6
#3	4,435	0.57	2,527.95	24.2
#4	5,359	0.57	3,054.63	31.6
#5	6,274	0.57	3,576.18	38.4

Minimum Soil Resistivity **2,177.40**



SAMPLE INFORMATION			
Boring: B-26	Sample: Bulk	Depth: 1 to 5	feet

SAMPLE DATA	
Maximum Dry Unit Weight (pcf):	116.2
Optimum Moisture Content (%):	14.3
Compacted Dry Unit Weight (pcf):	104.2

MOISTURE CONTENT DATA	
Before Compaction (%):	16.1
After Compaction (%):	16.0
After Soaking (Top 1-inch) (%):	30.7
After Soaking (Average) (%):	21.1

RESULTS	
Swell (%):	4.6
CBR at 0.1 inches:	3.1
CBR at 0.2 inches:	2.9
CBR at 0.1 inches (Corrected):	NA
CBR at 0.2 inches (Corrected):	NA

Tested By: EKG	Calc'd By: AGB	Check'd By: EKG
Date: 2/14/2019	Date: 2/22/2019	Date: 2/25/2019

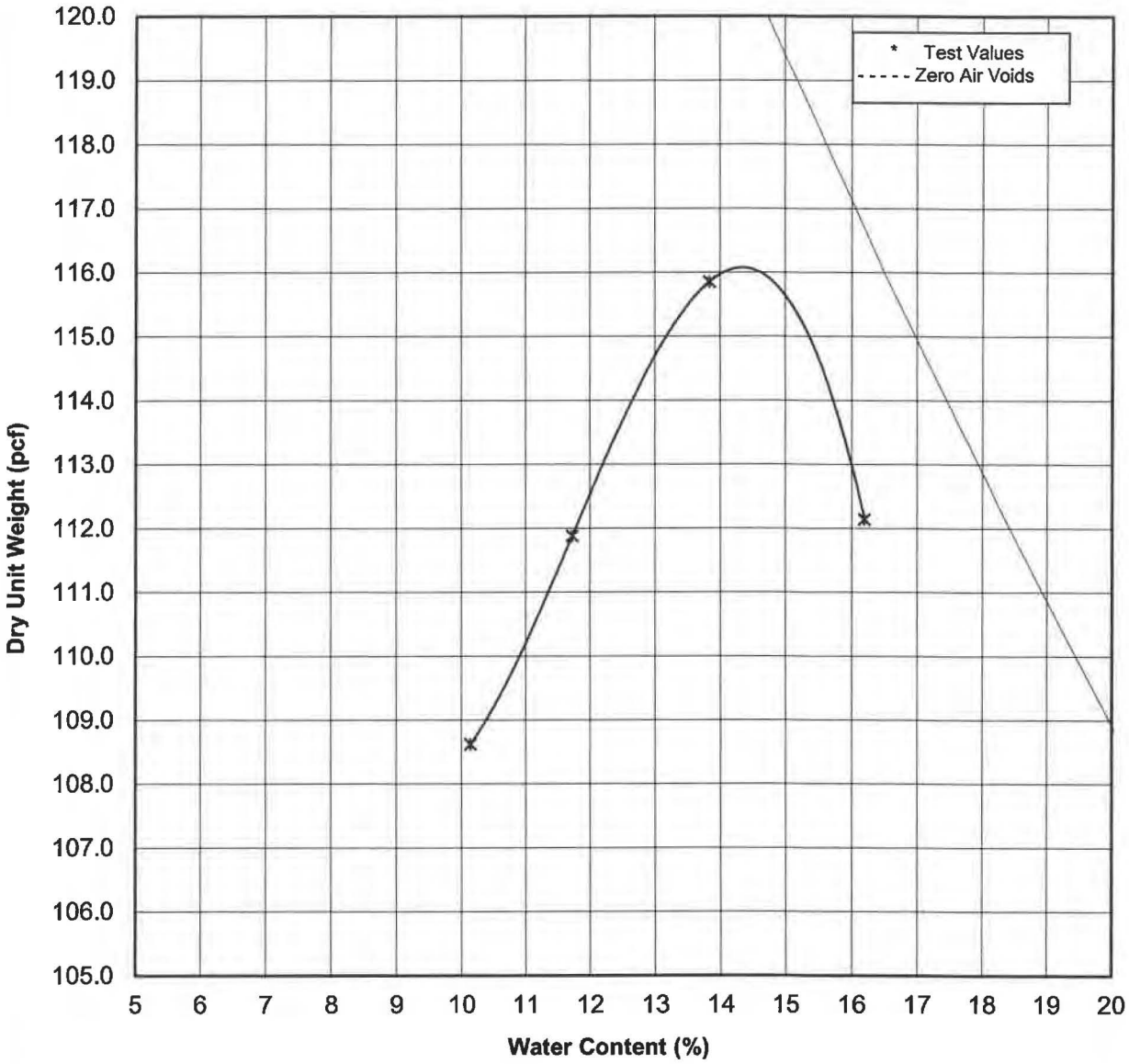
GEOTECHNOLOGY INC
FROM THE GROUND UP

NWMI RPF Building
Columbia, Missouri

CALIFORNIA BEARING RATIO (CBR) TEST
ASTM D1883

Project Number: J032982.01

LABORATORY COMPACTION TEST



SAMPLE INFORMATION

Boring: B-26 Sample: Bulk Depth: 1 to 5 feet

SAMPLE DATA

Moisture Content (%):	29.9
Liquid Limit:	60
Plastic Limit:	22
Plasticity Index:	38
Sample Classification:	CH
Estimated Specific Gravity:	2.680

RESULTS

Maximum Dry Unit Weight (pcf):	116.2
Optimum Moisture Content (%):	14.3

OVERSIZE CORRECTED RESULTS

Maximum Dry Unit Weight (pcf):	NA
Optimum Moisture Content (%):	NA

Tested By: DS	Calc'd By: AGB	Check'd By: EG
Date: 2/11/2019	Date: 2/13/2019	Date: 2/13/2019

GEOTECHNOLOGY INC
FROM THE GROUND UP

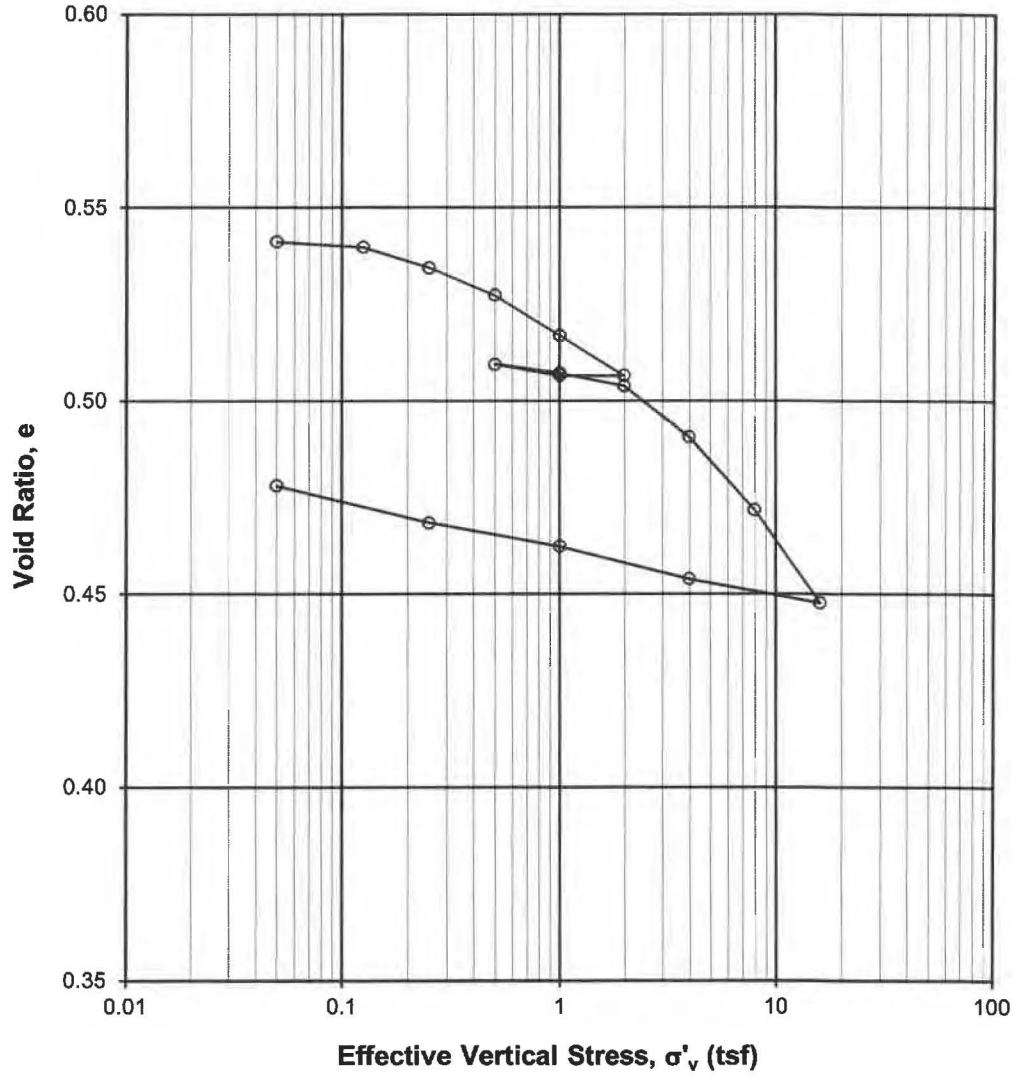
NWMI RPF Building
Columbia, Missouri

LABORATORY COMPACTION TEST
ASTM D1557 METHOD A
Project Number: J032982.01

GEOTECHNOLOGY INC
FROM THE GROUND UP

Liquid Limit=	41	Plastic Limit=	17	Plastic Index =	24	USCS:	CL

Compression Index, C_c =	0.07	Void Ratio, e_o =	0.541
Recompression Index, C_r =	0.01	Preconsolidation Pressure =	2.1 tsf



1-D CONSOLIDATION TEST: INCREMENTAL

ASTM D 2435
Project No.: J032982.01
Boring: B-11
Sample: ST5 - Depth: 18-20

APPENDIX G - CHEMICAL TEST RESULTS

February 20, 2019

Brian Sanders
Geotechnology, Inc.
11816 Lackland Road
St. Louis, MO 63146
TEL: (314) 997-7440
FAX: (314) 997-2067

RE: NWMI/J032982.01 **WorkOrder:** 19020641

Dear Brian Sanders:

TEKLAB, INC received 3 samples on 2/11/2019 5:33:00 PM for the analysis presented in the following report.

Samples are analyzed on an as received basis unless otherwise requested and documented. The sample results contained in this report relate only to the requested analytes of interest as directed on the chain of custody. NELAP accredited fields of testing are indicated by the letters NELAP under the Certification column. Unless otherwise documented within this report, Teklab Inc. analyzes samples utilizing the most current methods in compliance with 40CFR. All tests are performed in the Collinsville, IL laboratory unless otherwise noted in the Case Narrative.

All quality control criteria applicable to the test methods employed for this project have been satisfactorily met and are in accordance with NELAP except where noted. The following report shall not be reproduced, except in full, without the written approval of Teklab, Inc.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Emily Pohlman
Project Manager
(618)344-1004 ex 44
epohlman@teklabinc.com

Report Contents

Client: Geotechnology, Inc.
Client Project: NWMI/J032982.01

Work Order: 19020641
Report Date: 20-Feb-2019

This reporting package includes the following:

Client: Geotechnology, Inc. **Work Order:** 19020641

Client Project: NWMI/J032982.01 **Report Date:** 20-Feb-2019

Abbr Definition

*	Analytes on report marked with an asterisk are not NELAP accredited
CCV	Continuing calibration verification is a check of a standard to determine the state of calibration of an instrument between recalibration.
CRQL	A Client Requested Quantitation Limit is a reporting limit that varies according to customer request. The CRQL may not be less than the MDL.
DF	Dilution factor is the dilution performed during analysis only and does not take into account any dilutions made during sample preparation. The reported result is final and includes all dilution factors.
DNI	Did not ignite
DUP	Laboratory duplicate is a replicate aliquot prepared under the same laboratory conditions and independently analyzed to obtain a measure of precision.
ICV	Initial calibration verification is a check of a standard to determine the state of calibration of an instrument before sample analysis is initiated.
IDPH	IL Dept. of Public Health
LCS	Laboratory control sample is a sample matrix, free from the analytes of interest,spiked with verified known amounts of analytes and analyzed exactly like a sample to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.
LCSD	Laboratory control sample duplicate is a replicate laboratory control sample that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MBLK	Method blank is a sample of a matrix similar to the batch of associated sample (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences should present at concentrations that impact the analytical results for sample analyses.
MDL	"The method detection limit is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results."
MS	Matrix spike is an aliquot of matrix fortified (spiked) with known quantities of specific analytes that is subjected to the entire analytical procedures in order to determine the effect of the matrix on an approved test method's recovery system. The acceptable recovery range is listed in the QC Package (provided upon request).
MSD	Matrix spike duplicate means a replicate matrix spike that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
MW	Molecular weight
ND	Not Detected at the Reporting Limit
NELAP	NELAP Accredited
PQL	Practical quantitation limit means the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions.
RL	The reporting limit the lowest level that the data is displayed in the final report. The reporting limit may vary according to customer request or sample dilution. The reporting limit may not be less than the MDL.
RPD	Relative percent difference is a calculated difference between two recoveries (ie. MS/MSD). The acceptable recovery limit is listed in the QC Package (provided upon request).
SPK	The spike is a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery deficiency or for other quality control purposes.
Surr	Surrogates are compounds which are similar to the analytes of interest in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples.
TIC	Tentatively identified compound: Analytes tentatively identified in the sample by using a library search. Only results not in the calibration standard will be reported as tentatively identified compounds. Results for tentatively identified compounds that are not present in the calibration standard, but are assigned a specific chemical name based upon the library search, are calculated using total peak areas from reconstructed ion chromatograms and a response factor of one. The nearest Internal Standard is used for the calculation. The results of any TICs must be considered estimated, and are flagged with a "T". If the estimated result is above the calibration range it is flagged "ET"
TNTC	Too numerous to count (> 200 CFU)

Qualifiers

# -	Unknown hydrocarbon	B -	Analyte detected in associated Method Blank
C -	RL shown is a Client Requested Quantitation Limit	E -	Value above quantitation range
H -	Holding times exceeded	I -	Associated internal standard was outside method criteria
J -	Analyte detected below quantitation limits	M -	Manual Integration used to determine area response
ND -	Not Detected at the Reporting Limit	R -	RPD outside accepted recovery limits
S -	Spike Recovery outside recovery limits	T -	TIC(Tentatively identified compound)
X -	Value exceeds Maximum Contaminant Level		

Case Narrative

http://www.teklabinc.com/

Client: Geotechnology, Inc.
Client Project: NWMI/J032982.01

Work Order: 19020641
Report Date: 20-Feb-2019

Cooler Receipt Temp: 3.22 °C

Locations

Collinsville

Address 5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
Phone (618) 344-1004
Fax (618) 344-1005
Email jhriley@teklabinc.com

Springfield

Address 3920 Pintail Dr
Springfield, IL 62711-9415
Phone (217) 698-1004
Fax (217) 698-1005
Email KKlostermann@teklabinc.com

Kansas City

Address 8421 Nieman Road
Lenexa, KS 66214
Phone (913) 541-1998
Fax (913) 541-1998
Email jhriley@teklabinc.com

Collinsville Air

Address 5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
Phone (618) 344-1004
Fax (618) 344-1005
Email EHurley@teklabinc.com

Chicago

Address 1319 Butterfield Rd.
Downers Grove, IL 60515
Phone (630) 324-6855
Fax
Email arenner@teklabinc.com

Client: Geotechnology, Inc. **Work Order:** 19020641

Client Project: NWMI/J032982.01 **Report Date:** 20-Feb-2019

State	Dept	Cert #	NELAP	Exp Date	Lab
Illinois	IEPA	100226	NELAP	1/31/2019	Collinsville
Kansas	KDHE	E-10374	NELAP	4/30/2019	Collinsville
Louisiana	LDEQ	166493	NELAP	6/30/2019	Collinsville
Louisiana	LDEQ	166578	NELAP	6/30/2019	Collinsville
Oklahoma	ODEQ	9978	NELAP	8/31/2019	Collinsville
Arkansas	ADEQ	88-0966		3/14/2019	Collinsville
Illinois	IDPH	17584		5/31/2019	Collinsville
Indiana	ISDH	C-IL-06		2/28/2019	Collinsville
Kentucky	KDEP	98006		12/31/2019	Collinsville
Kentucky	UST	0073		1/31/2019	Collinsville
Louisiana	LDPH	LA016		12/31/2019	Collinsville
Missouri	MDNR	930		1/31/2022	Collinsville
Missouri	MDNR	00930		5/31/2019	Collinsville
Tennessee	TDEC	04905		1/31/2019	Collinsville

Client: Geotechnology, Inc. **Work Order:** 19020641

Client Project: NWMI/J032982.01 **Report Date:** 20-Feb-2019

Lab ID: 19020641-001 **Client Sample ID:** B-2 ST3 6-8 ft

Matrix: SOLID **Collection Date:** 02/11/2019 14:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
ASTM G200-09								
Oxidation-Reduction Potential	*	-2000		**340**	mV	1	02/15/2019 10:44	R258214
Sample was analyzed at 20C with KCl saturated Ag/AgCl electrode.								
EPA SW846 3550C, 5035A, ASTM D2974								
Percent Moisture	*	0.1		**14.5**	%	1	02/12/2019 17:27	R258087
STANDARD METHODS 4500-CL E (TOTAL) 1997								
Chloride	NELAP	58		**62**	mg/Kg-dry	1	02/18/2019 12:27	150310
SW-846 9030B, 9034								
Sulfide, Total	NELAP	30	J	**10**	mg/Kg-dry	1	02/13/2019 10:57	150294
SW-846 9036 (TOTAL)								
Sulfate	NELAP	120	J	**110**	mg/Kg-dry	1	02/18/2019 12:27	150309

Client: Geotechnology, Inc. **Work Order:** 19020641

Client Project: NWMI/J032982.01 **Report Date:** 20-Feb-2019

Lab ID: 19020641-002 **Client Sample ID:** B-8 ST3 8-10 ft

Matrix: SOLID **Collection Date:** 02/11/2019 14:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
ASTM G200-09								
Oxidation-Reduction Potential	*	-2000		**359**	mV	1	02/15/2019 10:44	R258214
Sample was analyzed at 20C with KCl saturated Ag/AgCl electrode.								
EPA SW846 3550C, 5035A, ASTM D2974								
Percent Moisture	*	0.1		**16.6**	%	1	02/12/2019 17:27	R258087
STANDARD METHODS 4500-CL E (TOTAL) 1997								
Chloride	NELAP	59	J	**23**	mg/Kg-dry	1	02/18/2019 12:38	150428
SW-846 9030B, 9034								
Sulfide, Total	NELAP	34		**< 34**	mg/Kg-dry	1	02/13/2019 10:59	150294
SW-846 9036 (TOTAL)								
Sulfate	NELAP	120	JS	**86**	mg/Kg-dry	1	02/18/2019 12:38	150429
Matrix spike did not recover within control limits. Results verified by dilution.								

Client: Geotechnology, Inc. **Work Order:** 19020641

Client Project: NWMI/J032982.01 **Report Date:** 20-Feb-2019

Lab ID: 19020641-003 **Client Sample ID:** B-21 ST5 18-20 ft

Matrix: SOLID **Collection Date:** 02/11/2019 14:30

Analyses	Certification	RL	Qual	Result	Units	DF	Date Analyzed	Batch
ASTM G200-09								
Oxidation-Reduction Potential	*	-2000		**321**	mV	1	02/15/2019 10:44	R258214
Sample was analyzed at 20C with KCl saturated Ag/AgCl electrode.								
EPA SW846 3550C, 5035A, ASTM D2974								
Percent Moisture	*	0.1		**15.0**	%	1	02/12/2019 17:28	R258087
STANDARD METHODS 4500-CL E (TOTAL) 1997								
Chloride	NELAP	58	J	**26**	mg/Kg-dry	1	02/18/2019 12:30	150310
SW-846 9030B, 9034								
Sulfide, Total	NELAP	34		**< 34**	mg/Kg-dry	1	02/13/2019 11:00	150294
SW-846 9036 (TOTAL)								
Sulfate	NELAP	120	J	**110**	mg/Kg-dry	1	02/18/2019 12:30	150309

Client: Geotechnology, Inc. **Work Order:** 19020641

Client Project: NWMI/J032982.01 **Report Date:** 20-Feb-2019

ASTM G200-09

Batch R258214 **SampType:** LCS Units **mV**

SampID: LCS-R258214

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Oxidation-Reduction Potential	-2000		**227**	235.0	0	96.8	95.74	104.26	02/15/2019

EPA SW846 3550C, 5035A, ASTM D2974

Batch R258087 **SampType:** LCS Units **%**

SampID: LCS

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Percent Moisture	0.1		**99.0**	99.00	0	100.0	90	110	02/12/2019

Batch R258087 **SampType:** LCSQC Units **%**

SampID: LCSQC

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Percent Moisture	0.1		**99.0**	99.00	0	100.0	90	110	02/12/2019

STANDARD METHODS 4500-CL E (TOTAL) 1997

Batch 150310 **SampType:** MBLK Units **mg/Kg**

SampID: MBLK 190213

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride	50		**< 50**	50.00	0	0	-100	100	02/18/2019

Batch 150310 **SampType:** MBLK Units **mg/Kg**

SampID: MB-R258288

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride	50		**< 50**	5.000	0	0	-100	100	02/18/2019

Batch 150310 **SampType:** LCS Units **mg/Kg**

SampID: LCS-R258288

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride	50		**198**	200.0	0	99.0	90	110	02/18/2019

Batch 150428 **SampType:** MBLK Units **mg/Kg**

SampID: MBLK 190215

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride	50		**< 50**	50.00	0	0	-100	100	02/18/2019

Batch 150428 **SampType:** MBLK Units **mg/Kg**

SampID: MB-R258288

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride	50		**< 50**	5.000	0	0	-100	100	02/18/2019

Client: Geotechnology, Inc. **Work Order:** 19020641

Client Project: NWMI/J032982.01 **Report Date:** 20-Feb-2019

STANDARD METHODS 4500-CL E (TOTAL) 1997

Batch 150428 **SampType:** LCS Units **mg/Kg**

SampID: LCS-R258288

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride	50		**198**	200.0	0	99.0	90	110	02/18/2019

Batch 150428 **SampType:** MS Units **mg/Kg-dry**

SampID: 19020641-002AMS

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Chloride	59		**259**	235.0	23.26	100.5	85	115	02/18/2019

Batch 150428 **SampType:** MSD Units **mg/Kg-dry** RPD Limit **15**

SampID: 19020641-002AMSD

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Chloride	59		**264**	235.0	23.26	102.4	259.4	1.71	02/18/2019

SW-846 9030B, 9034

Batch 150294 **SampType:** MBLK Units **mg/Kg**

SampID: MBLK 190213 TSUL

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfide, Total	30		**< 30**	10.70	0	0	-100	100	02/13/2019

Batch 150294 **SampType:** LCS Units **mg/Kg**

SampID: LCS 190213 TSUL

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfide, Total	30		**78**	79.60	0	98.5	66.8	113	02/13/2019

Batch 150294 **SampType:** DUP Units **mg/Kg-dry** RPD Limit **15**

SampID: 19020641-001ADUP

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Sulfide, Total	34		**< 34**				12.79	0.00	02/13/2019

SW-846 9036 (TOTAL)

Batch 150309 **SampType:** MBLK Units **mg/Kg**

SampID: MBLK 190213

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate	100		**< 100**	574.0	0	0	-100	100	02/18/2019

Batch 150309 **SampType:** MBLK Units **mg/Kg**

SampID: MB-R258285

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate	100		**< 100**	57.40	0	0	-100	100	02/18/2019

Client: Geotechnology, Inc. **Work Order:** 19020641

Client Project: NWMI/J032982.01 **Report Date:** 20-Feb-2019

SW-846 9036 (TOTAL)

Batch 150309 **SampType: LCS** Units **mg/Kg**
SampID: LCS-R258285

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate	100		**188**	200.0	0	93.8	90	110	02/18/2019

Batch 150429 **SampType: MBLK** Units **mg/Kg**
SampID: MBLK 190215

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate	100		**< 100**	574.0	0	0	-100	100	02/18/2019

Batch 150429 **SampType: MBLK** Units **mg/Kg**
SampID: MB-R258285

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate	100		**< 100**	57.40	0	0	-100	100	02/18/2019

Batch 150429 **SampType: LCS** Units **mg/Kg**
SampID: LCS-R258285

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate	100		**188**	200.0	0	93.8	90	110	02/18/2019

Batch 150429 **SampType: MS** Units **mg/Kg-dry**
SampID: 19020641-002AMS

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	Low Limit	High Limit	Date Analyzed
Sulfate	117	S	**147**	117.5	86.11	51.5	85	115	02/18/2019

Batch 150429 **SampType: MSD** Units **mg/Kg-dry** RPD Limit **10**
SampID: 19020641-002AMSD

Analyses	RL	Qual	Result	Spike	SPK Ref Val	%REC	RPD Ref Val	%RPD	Date Analyzed
Sulfate	117	S	**156**	117.5	86.11	59.3	146.6	6.06	02/18/2019

Receiving Check List

http://www.teklabinc.com/

Client: Geotechnology, Inc.
Client Project: NWMI/J032982.01

Work Order: 19020641
Report Date: 20-Feb-2019

Carrier: Gary Quigley

Received By: AMD

Completed by: Amber M. Dilallo
On: 11-Feb-2019

Reviewed by: Shelly A. Hennessy
On: 11-Feb-2019

Pages to follow: Chain of custody 1 Extra pages included 0

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	Temp °C	3.22	
Type of thermal preservation?	None ☐	Ice ☑	Blue Ice ☐	Dry Ice	☐	
Chain of custody present?	Yes ☑	No ☐				
Chain of custody signed when relinquished and received?	Yes ☑	No ☐				
Chain of custody agrees with sample labels?	Yes ☑	No ☐				
Samples in proper container/bottle?	Yes ☑	No ☐				
Sample containers intact?	Yes ☑	No ☐				
Sufficient sample volume for indicated test?	Yes ☑	No ☐				
All samples received within holding time?	Yes ☑	No ☐				
Reported field parameters measured:	Field ☐	Lab ☐	NA ☑			
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐				

When thermal preservation is required, samples are compliant with a temperature between 0.1°C - 6.0°C, or when samples are received on ice the same day as collected.

Water – at least one vial per sample has zero headspace?	Yes ☐	No ☐	No VOA vials ☑
Water - TOX containers have zero headspace?	Yes ☐	No ☐	No TOX containers ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	NA ☑
NPDES/CWA TCN interferences checked/treated in the field?	Yes ☐	No ☐	NA ☑

Any No responses must be detailed below or on the COC.

Print Form

Teklab Chain of Custody

Pg. ____ of ____ Workorder 19020641

5445 Horseshoe Lake Road ~ Collinsville, IL 62234 ~ Phone: (618)344-1004 ~ Fax:(618)344-1005

Client Name: Geotechnology, Inc.

Are the samples chilled? ( ) Yes (•) No with: (X) Ice ( ) Blue ice Preserved in ( ) Lab ( ) Field

Address: 11816 Lackland Rd. Suite 150

Cooler Temp 3.2.2 Sampler Erin Grimes

City: St. Louis | MO | 63146

Comments: No need to call about the samples not being on ice. Please proceed with testing as is.

Project Name/Number: NWMI/J032982.01

Contact Brian Sanders eMail bsanders@geotechnology. Phone 314-997-7440 Requested Due Date 2-11-19 Billing/PO GEO-6124-2019

Lab Use	Sample ID	Sample Date/Time	Preservative	Matrix	Sulfide	Chloride	Sulfate	Redox
19020641-001	B-2 ST3 6-8 ft	2/11/19 / 2:30 PM	Unpres	Soil	☒	☒	☒	☒
002	B-8 ST3 8-10 ft	2/11/19 / 2:30 PM	Unpres	Soil	☒	☒	☒	☒
003	B-21 ST5 18-20ft ~~B-50-SS3 6-8ft.~~ #2	2/11/19 / 2:30 PM	Unpres	Soil	☒	☒	☒	☒
			Unpres	Soil	☐	☐	☐	☐
			Unpres	Soil	☐	☐	☐	☐
			Unpres		☐	☐	☐	☐
			Unpres		☐	☐	☐	☐
			Unpres		☐	☐	☐	☐

Courier

Relinquished By *	Date/Time	Received By	Date/Time
	2/11/19 / 3:20 P.M.		2-11-19 16:55
	2-11-19 17:33		2/14/19 1733

* The individual signing this agreement on behalf of client acknowledges that they have read and understand the terms of this agreement and that they have the authority to sign on behalf of client.

2/11/19