Geotechnical Engineering Report
San Antonio Water Rehabilitation Project
AWWU Project WW.00022
Anchorage, Alaska

November 2018

SHANNON & WILSON, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Excellence. Innovation. Service. Value.

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SAN ANTONIO STREET WATER REHABILITATION
AWWU PROJECT #WW.00022
ANCHORAGE, ALASKA

1.0 INTRODUCTION

This report presents the results of subsurface explorations, laboratory testing and geotechnical engineering studies conducted by Shannon & Wilson, Inc. for the San Antonio water main rehabilitation in Anchorage, Alaska. The purpose of this geotechnical study was to gather subsurface geotechnical and environmental data and make geotechnical engineering recommendations for design and construction of the project. To accomplish this, we advanced 20 geotechnical borings. Selected soil samples recovered from the borings were tested in our Anchorage laboratory. Presented in this report are descriptions of the site and project, subsurface exploration and laboratory test results, an interpretation of subsurface conditions, and our geotechnical engineering recommendations for design and construction of the water main rehabilitation project.

Authorization to proceed with this work was received in the form of two contract task orders (CTO Nos. 4400000397-006 and -021) from Mr. John Rescober, P.E. of Anchorage Water & Wastewater Utility (AWWU) on January 8 and July 23, 2018. Our work was conducted in general accordance with our November 30, 2017 and July 23, 2018 proposals.

2.0 SITE AND PROJECT DESCRIPTION

The project is bounded by West Sixth Avenue to the north and Debarr Road to the south and generally extends from Hoyt to Pine Streets. The area is developed with residential housing, an elementary school, and a small park. In general, the topography across the project area is relatively flat with slightly higher elevations to the northwest. A vicinity map indicating the general project location is presented as Figure 1. A site plan, included as Figure 2, shows prominent site features and the approximate boring locations.

We understand that AWWU wishes to replace or rehabilitate approximately 10,000 linear feet of existing 8-inch diameter cast iron water main. We understand that traditional open trenching is the preferred construction method for this project.

3.0 SUBSURFACE EXPLORATIONS

Subsurface explorations for this study consisted of drilling and sampling six borings, designated Borings B-1 through B-6, in the project area on March 7 and 8, 2018. Borings B-07 to B-20 were advanced in the northern portion of the project between August 20 and 22, 2018. The general boring locations were selected in the field by our representative to provide relatively even coverage for the project site and to avoid conflicts with buried utilities and traffic. The boring locations, shown on Figure 2, were recorded using a Global Positioning System (GPS). The surface elevations shown on the boring logs were estimated from the Municipality of Anchorage (MOA) Geographical Information Systems (GIS) 1-foot contours. Therefore, the boring locations shown on the site plan and the elevations reported on the boring logs should be considered approximate.

Drilling services for this project were provided by Discovery Drilling of Anchorage, Alaska, using a truck mounted CME-75 drill rig, and a Geoprobe 7822 DT. An experienced engineer from our firm was present during drilling to locate the borings, observe drill action, collect samples, log subsurface conditions, and observe groundwater conditions.

The borings were advanced with $3^1/_4$-inch inner diameter (ID), continuous flight, hollow-stem augers to depths ranging between approximately 15.9 and 16.5 feet below ground surface (bgs). As the borings were advanced, samples were typically recovered using standard penetration test (SPT) methods at 2.5-foot intervals to 15 feet bgs. In the SPT method, samples are recovered by driving a 2-inch outer diameter (OD) split-spoon sampler into the bottom of the advancing hole with blows of a 140-pound hammer free falling 30 inches onto the drill rod. For each sample, the number of blows required to drive the sampler the final 12 inches of an 18-inch penetration into undisturbed soil is recorded. Blow counts are shown graphically on the boring log figures as "penetration resistance" and are displayed adjacent to sample depth. The penetration resistance values give a measure of the relative density (compactness) or consistency (stiffness) of cohesionless or cohesive soils, respectively. In addition to the split spoon samples, a grab sample of the near-surface soils was collected from the auger cuttings in the upper 1.5 feet of each boring. To collect samples for corrosivity testing, a sample was obtained at 10 or 12.5 feet bgs by driving a 3-inch OD split-spoon sampler; blow counts were not recorded for this sample.

The soils were visually classified in the field, and then these classifications were later verified selectively through laboratory analysis. Samples selected for gradation testing were classified in general accordance with ASTM International (ASTM) D-2488 and the Unified Soils Classification System (USCS), presented in Appendix A, Figure A-1. Frost classifications were also estimated for samples based on laboratory testing (sieve analyses and P-200) and are shown on the boring logs. The frost classification system is presented in Appendix A, Figure A-2. Summary logs of the borings are presented in Appendix A, Figures A-3 to A-22. Frost classifications included on the logs in Appendix A are followed by “0.02 mm” or “P-200” to indicate whether frost classifications were based on hydrometer or sieve/P-200 data, respectively.

The soil samples were "screened" for volatile organic vapors using a the direct screening method and a photoionization detector (PID). The PID was calibrated before screening activities with 100 parts per million (ppm) isobutylene standard gas. Field screening results are presented on the boring logs in Appendix A, Figures A-3 and A-22.

After drilling, select borings were completed by installing a 1-inch, polyvinyl chloride (PVC) casing with slotted tip to facilitate observation of groundwater levels at a later date. The annular space between the borehole wall and casing was backfilled with cuttings produced during drilling activity and a steel, flush mount monument was installed to protect the top of the casing. The area around the monument was repaired with asphalt “cold patch”. Installation details for the observation wells are shown on the corresponding boring log.

4.0 DATA REVIEW

Data review of existing information was conducted prior to field work to evaluate the likely soil, groundwater, and environmental conditions that would be encountered along the project corridor.

4.1 Environmental Records Review

State database records were researched for pertinent information regarding the environmental conditions within the project area. For the purposes of this search, the project area, designated the “Project” is defined as the existing water main within San Roberto Avenue between Pine and Lane Streets, within San Antonio Street between San Roberto and Camilla Court, and within Camilla Court between San Antonio and DeLasala Place in Anchorage, Alaska.

4.1.1 Leaking Underground Storage Tank Database

The ADEC’s Leaking Underground Storage Tank (LUST) database was reviewed October 30, 2018. Four LUST sites were identified within 0.25-mile of the project area.

The closest “active” contaminated site is the Ride N Shine USTs 5 & 6 located at 1341 Bragaw Street, located approximately 1,100 feet southwest of the Project. The site was added to the database in 2015 when benzene-impacted soil was encountered during the removal of two 10,000-gallon USTs. One analytical sample collected during 2015 groundwater monitoring activities contained diesel range organics concentrations less than the applicable ADEC clean up levels. Site characterization activities for site closure are ongoing at the site but have not been accessed since 2016. Based on institutional knowledge of these ongoing activities, it is unlikely that this site has impacted the Property.

The remaining LUST sites are listed as "cleanup complete" or "cleanup complete with institutional controls" by the ADEC and located at least 1,000 feet from the Property. Based on considerations of distance to the Property and typical release, fate, and transport mechanisms, it is our opinion these remaining sites are not likely to impact the Project.

4.1.2 Contaminated Sites Database

The ADEC Contaminated Sites database was reviewed October 30, 2018. Three contaminated sites were identified within 0.25-mile of the project area.

The closest contaminated site is the Totem Trailer Town listed as "cleanup complete – institutional controls" (CC/IC) and located at 701 Klevin Street, approximately 700 feet northwest of the Project. However, after review of the ADEC database, the identified contamination associated with this site has been delineated between 7th and 8th Avenue and Klevin Street and Hoyt Street. The site was added to the database in 2000 when impacted soil and groundwater were encountered during the removal five heating oil USTs and associated piping at the trailer park. Approximately 2,000 cubic yards of contaminated soil was excavated and transported offsite for thermal remediation. Twenty-two monitoring wells were installed and sampled beginning in 2000 and through 2012 as part of site characterization activities. According to an ADEC letter dated July 11, 2016, the results of the long-term groundwater monitoring demonstrated that contaminating concentrations in groundwater at the site were stable, diminishing, or below ADEC cleanup levels. It was determined by the ADEC that environmental actions at the site were sufficient to include only the standard conditions for CC/IC status. According to a figure included in the ADEC letter, the soil and groundwater contamination is located within the parcel boundaries but is adjacent to the Hoyt Street right-of-way.

The closest "active" contaminated site is the Jiffy Lube #2464 Injection Wells, located at 1221 Bragaw Street, approximately 925 feet west of the Project. The site was added to the database in 2017 when contaminated soil and groundwater were identified in four injection wells during at Phase II Environmental Site Assessment activities. Several target analytes were detected at concentrations above DEC cleanup levels in soil beneath the building at the soil/water interface. The four injection wells were decommissioned in April 2017, however removal of contaminated soil was not possible due to its location beneath the building. Site characterization activities are ongoing at the site.

The remaining contaminated site is listed as CC/IC and is located 1,000 feet of the Project. Based on considerations of distance to the project area and typical release, fate, closure status, and transport mechanisms, it is our opinion these remaining sites are not likely to impact the Project.

4.2 Geotechnical Records Review

Site plans and boring logs provided by the Municipality of Anchorage were reviewed. In general the explorations were conducted in the 1970's and 1980's and used solid-flight auger. Because of the drilling method and shallow depth of the borings the information was not utilized in this project.

5.0 LABORATORY TESTING

Laboratory tests were performed on selected samples recovered from the borings to confirm field classifications and to estimate the index properties of the typical materials encountered. The laboratory testing was formulated with emphasis on estimating the material gradation and in-situ water content.

Water content tests were performed in general accordance with ASTM D2216. The results of the water content measurements are presented graphically on the boring logs in Appendix A, Figures A-3 through A-22.

Grain size classification (gradation) testing was performed to estimate the particle size distribution of selected samples from the borings. The gradation testing generally followed the procedures described in ASTM C117/C136 and D422. The test results are presented in Appendix A, Figure A-23 (14 sheets) and summarized on the boring logs as percent gravel, percent sand, and percent fines. Percent fines on the boring logs are equal to the sum of the silt and clay fractions indicated by the percent passing the No. 200 sieve. Plasticity characteristics (Atterberg Limits results) are required to differentiate between silt and clay soils under USCS.

6.0 SUBSURFACE CONDITIONS

The subsurface conditions encountered are presented graphically on the boring logs included in Appendix A, Figures A-3 through A-22. In general, our borings encountered between 3 and 4 feet of granular soil, possibly fill, overlying native soils, consisting of generally unsorted, highly variable, glaciofluvial sands containing various amounts of silt and gravel. The contact between fill and native soils was difficult to discern based on the frozen nature of the soil and the elevated fines content of the structural fill. Approximately 2 to 4 inches of asphalt was typically encountered at the ground surface.

The fill materials encountered by our borings generally consisted of well-graded sand with silt and gravel to silty sand with gravel fines contents of 9 to 26 percent. Samples of fill material subjected to laboratory testing contained moisture contents ranging from 3 to 6 percent. Based on observation of drill action and sampler penetration the unfrozen fill soils are medium dense to dense.

Below the fill we encountered native soils consisting of sand with varying amounts of silt and gravel, with the exception of Borings B-03, B-08, and B-16 which encountered sandy silt or silty clay beneath the fill. Additionally a layer of organic silt with wood fragments was encountered between 1.5 and 2.2 feet bgs in Boring B-16. Based on laboratory testing, the estimated fines contents of the predominantly granular, native soils ranged between 9 and 35 percent and moisture contents typically ranged between 4 and 13 percent. Based on penetration resistance values ranging between 43 and greater than 50 blows per foot (bpf), the native granular materials encountered by our borings are typically dense to very dense.

Groundwater was not encountered in Borings B-03 and B-04 during drilling. During drilling groundwater was observed in the other borings between 4.5 and 12.5 feet bgs. Static water levels were observed to vary from 4.2 to 11 feet bgs; these levels appear to correlate to an approximate elevation of 150 feet. Note that water levels may fluctuate by several feet seasonally and may vary during periods of high precipitation and rapid snow melt.

The soil samples recovered during drilling were field screened for volatile organics using the PID. Screening results typically registered between 0.0 and 1.9 parts per million (ppm). The highest value was registered in Boring B-1 Sample S1, from a depth interval of approximately 0 to 2 feet bgs. These values are within typical background levels for soils in the Anchorage area.

Select samples from the approximate waterline burial depth were submitted to Coffman Engineers for a corrosivity evaluation. Consistent with Coffman Engineers corrosivity evaluation, the soils tested should be considered potentially corrosive. Coffman Engineers soil corrosivity evaluation report is presented in Appendix B.

7.0 ENGINEERING CONCLUSIONS

Geotechnical considerations associated with this project consist of controlling excavation slopes, developing pipe bedding, excavation backfill and compaction, repairing or replacing pavements, potential settlements, controlling construction drainage, and planning for possible dewatering needs for excavations below the groundwater table. Based on the conditions encountered by our borings, the soils in the project area generally consist of several feet of sand and gravel fill (pavement structural sections) overlying dense glaciofluvial deposits of sand and gravel containing various amounts of silt. In our opinion, the native soils are relatively compact and should be adequate to support the proposed waterline rehabilitation. However, proper control of excavation (including construction dewatering) and backfilling activities will be paramount in achieving a well-constructed project.

7.1 Trench Excavation

Excavations will be required for open trenching for replacement of the existing main, fire hydrants and service connection. Buildings and other utilities may be in relatively close proximity to the existing water main. Structures encountered near an excavation will need to be adequately supported and braced during construction. In areas that are not in close proximity (within 10 feet) of existing structures, trenches should generally be constructed as presented in Figure 3. If trenches are excavated within 10 feet of existing structures or paved surfaces, the open trench (including undercutting caused by wall caving) should not penetrate a plane line extending out and down from the outer edge of the building foundation element or edge of pavement at a slope of 1 horizontal (H) to 1 vertical (V) unless shoring is provided to support the trench side and building/pavement surcharge loads. Note that this guidance is for temporary excavations that are open for less than about 1 week. Excavations that will remain open for longer periods of time should be flattened to 1.5H:1V.

During excavation, pockets of relatively low fines soils above the water table may initially tend to stand relatively steeply due to the apparent cohesion associated with the soil moisture. However, as the soils dry, they will tend to ravel and slough to their natural angle of repose, which for planning purposes is estimated at about 1.5 H to 1 V. Deeper silty soils will likely stand relatively steeply as long as the excavation sides are protected from moisture and the excavation is not left open for longer than 24 hours. The actual slope and excavation bottom conditions should be made the responsibility of the contractor, who will be present on a day to day basis and can adjust efforts to obtain the needed stability and meet the applicable Alaska and Federal (OSHA) safety regulations.

Groundwater was encountered as shallow as approximately 6 feet bgs during drilling and measured in piezometers at depths ranging from about 3.3 to 11 feet bgs which corresponds to an approximate elevation of 150 feet. Most of the soils observed below the water table had relatively high silt contents and heaving conditions were not encountered. Running ground and significant groundwater inflow is unlikely in the silty native materials at depth. However, depending on the season, groundwater may be perched on top of silty native soils in the existing road fill. As the perched groundwater drains after excavation, at the interface between the native and fill soils, a running ground condition may develop in the existing road fill. Running ground conditions may also be encountered in cleaner native soils below the water table, such as the fill soils placed above the existing water line. Excavation side slopes may be difficult to control if groundwater is not controlled. Recommendations for construction drainage and dewatering are discussed in Section 7.5.

If wet conditions persist at the trench bottom, crushed aggregate may be used to stabilize the trench bottom (i.e. provide a firm unyielding surface on which to support the new pipe) and E-Chips may be used as a substitute for pipe bedding material. This should only be done if it is too wet to compact mineral soils as E-Chips may be placed in relatively wet conditions and can be compacted with hand equipment.

We recommend that the contractor be required to submit an excavation plan once the utility layout and depths have been determined. The excavation plan should describe the methods and sequencing for excavation, as well as additional information for dewatering and shoring as necessary. The plan should highlight areas that may require dewatering and include details for the type or types of dewatering that will be undertaken (including, but not limited to, pump rates, discharge locations, treatment, etc.). The excavation plan should also include the types and locations of shoring to be used, and engineered plans for the shoring if required. We recommend that we be retained to review the excavation plan prior to authorizing work to proceed at the site to ensure that the plan contains the necessary information and is appropriate for the conditions at the site.

7.2 Trench Backfill

Below areas that are receiving pavement sections or concrete sidewalks, pipe bedding and trench backfill should be placed in maximum 12-inch loose lifts and compacted to at least 95 percent of the Modified Proctor maximum dry density, as discussed in Section 7.6 below. The bedding and fill material around the pipe should be compacted to at least 95 percent of the Modified Proctor maximum dry density or per manufacturer recommendations, to support and hold the pipe firmly in place. In areas where no paving is planned, less compaction is required and material may be placed in thicker lifts (up to 18 inches) and moderately compacted to achieve at least 90 percent compaction.

Utility trenches should be backfilled with existing inorganic native soils placed in original stratigraphic sequence, as much as practical, between the top of the pipe bedding and the bottom of the road subgrade as discussed in Section 7.3, or to original ground surface in areas where no pavement is needed. This procedure limits the contrast between trench backfill and the surrounding soil conditions that can lead to adverse settlement or frost heave behavior. Bulking of backfill into trenches should be discouraged, as this can cause variable subgrade support or voids and lead to differential movement and pavement distress. If existing inorganic soils become difficult to compact during construction due to the material properties, the contractor may utilize Municipality of Anchorage Standard Specifications (MASS) Type IIA structural fill at the discretion of the Project Engineer.

7.3 Asphalt Pavement Repairs

Asphalt pavement will need to be repaired in areas where utility trenches or other excavations penetrate the existing roadways, parking areas, or driveways. New asphalt pavements placed over trench excavations must be able to support the anticipated applied loads from vehicles. In designing the pavement repairs, the strength and frost susceptibility of the existing adjacent prism and backfill soils must be considered. We assume that the grade of the road and driveways will remain consistent with current grades, and that these surfaces will continue to be primarily used for relatively lightly-loaded vehicle traffic with occasional truck traffic for maintenance and other services. The relatively compact native subgrade soils (with typical frost classifications of F3) can provide suitable subgrade support for pavements if the section is designed to accommodate expected frost conditions. The recommendations below are intended for use in pavement repairs and not for full width road reconstruction.

The existing pavement appears to be showing signs of fatigue cracking, and a few potholes were noted. However, given the apparent age of the pavement, it appears to be performing relatively well based on limited observation of the road surface in the area of our explorations. Repair work should focus on creating new pavements that behave similarly to the existing surface. To accomplish this, the thickness and materials used to repair the pavement structural section and asphalt should generally match the existing conditions. Based on our observations during drilling, we estimate that the existing pavement structural section on area roadways consists of approximately 2 inches of asphalt over 2.5 to 4 feet of sand and gravel fill. Frost classifications of the road base fills subjected to laboratory testing typically ranged from F1 to F2; however, the fills generally do not appear to meet the gradation requirements of typical non-frost susceptible materials such as Municipality of Anchorage Type II/IIA.

In our opinion, the existing F1 and F2 fills appear to be performing relatively well and may be reused for pavement repairs to within 18 inches of finished grade. However, the reuse of these existing fill materials should be considered on a case by case basis during construction based on the gradation properties of the materials, and the contractors ability to compact with moisture and density control. Pockets of notably silty soil, containing greater than 20 percent fines, should not be reused within 3.5 feet of finished grade within the pavement structural sections. Based on our borings, a similar structural section should therefore consist of a minimum of 2 inches asphalt pavement, 4 inches MASS Leveling Course, 12 inches of compacted Type II/ IIA structural fill over reused existing fill.

Excavations through pavements should be backfilled with native, inorganic soils, placed and compacted as outlined in Section 7.6, up to the bottom of the structural section. If the existing conditions cannot be closely matched due to design or construction requirements, a transition should be designed with a 4H to 1V graduation in thickness, from new to existing pavement sections. Fill materials placed below asphalt pavement should be compacted to the standards presented in Section 7.6. Gradation requirements for Type II/IIA structural fill and leveling course are provided in Figure 4. Quality control inspection is strongly recommended when placing pavement support soils.

7.4 Settlements

The magnitudes of the settlements that will develop around the new utilities are dependent upon the applied loads, the gradation properties of the bedding and fill material, and the care with which the bedding and structural fills are placed and compacted. Additionally, careful excavation and construction practices to minimize disturbance to support soils should be employed for this project. With proper soil type, placement, and compaction it is estimated that total maximum settlements will be limited to elastic deflection of the bedding, or about ½-inch or less, all of with may be differential over a length of approximately 50 feet.

7.5 Construction Drainage and Dewatering

Based on measurements in PVC casings installed in several borings, the observed shallow water table at 3.3 to 11 feet bgs in the project area is likely due to perched water on top of silty native soils. These groundwater depths suggest that groundwater will likely be encountered during excavation work. The perched groundwater in the relatively free draining fill material could be significant and may cause running ground and sloughing of the excavation sides. Running ground is not anticipated in the very dense silty native soils, but may be possible in the cleaner native soils and in deeper fill soils assumed to be present above the existing water line, but not encountered in our borings. Dewatering with sumps, pumping equipment and staged excavation may be sufficient to control groundwater during excavations. These measures may also need to be used in tandem with temporary shoring or trench boxes to control trench walls. Construction should also be staged so that a minimum length of trench is left open for as short a time as possible. If sumps and pumps are not preferred or if they are proven to be insufficient for the project, local well points or other dewatering methods may be required. Based on the observed soil conditions, and a 10 foot wide, 50 foot long section of open trench requiring 5 feet of draw down, we estimate initial required pumping rates of up to 250 gallons per minute (gpm), with rates decreasing to approximately 100 gpm over 7 days. This rate is likely an upper bound estimate, and lower pumping rates would be expected where fines contents are higher and where the required drawdown is less.

Another critical water condition during construction will likely be surface runoff entering excavations. Thus, the ground around open excavations should be contoured to direct surface water around the excavations. Excavation and backfilling work should be closely coordinated such that seepage and surface runoff is not allowed to collect and stand in open trenches for long time periods. Seepage from the trench walls may cause local running or sloughing of the soil, which may require the use of a trench box or shoring depending on the excavation slope angles and depth of the excavations. Exposed silty soils should be protected from additional moisture during construction as they are likely moisture sensitive and may lose significant strength if saturated.

Based on the expected dewatering volumes, a Temporary Water Use Authorization (TWUA) from the Department of Natural Resources will be required. Based on the proximity of contaminated sites, discharges from dewatering systems will either need an ADEC Excavation Dewatering Permit or an AWWU Industrial Discharge permit. While the main expected contaminant is sediment, dewatering operations in Hoyt Street between approximately Seventh and Eighth Avenue could capture petroleum contamination.

7.6 Structural Fill and Compaction

Structural fill will be needed to support pavements and new utilities. Classified structural fill that is imported should be clean, granular soil free of organic material to provide drainage and frost protection. These soils should contain less than about six percent passing the No. 200 sieve. Generally, Type II or Type IIA material as specified in the MASS works well for this application as the subbase layer, since it can be placed under both wet and dry weather conditions. Gradation properties for the classified materials mentioned above are included in Figure 4.

Based on laboratory test results from our borings in the project area, fill and native soils generally contain greater than 9 percent fines. Therefore the fill and native sand materials do not meet the gradation requirements for Type II/IIA classified fill as shown on Figure 4. However, existing fill material may be used in the structural section deeper than 18 inches below finished grade as long as notably silty sands are not used. During construction, pockets of fill that are notably silty (fines contents above 20 percent) may be encountered and should not be reused in the structural section. Sandy soils that do not meet the requirements for Type II/ IIA fill may be used for backfill in nonstructural areas and below the pavement structural section. Note that excavated sands may be difficult to compact without adding large amounts of water or using thinner lifts.

Structural fills below pavements should be placed in lifts not to exceed 10 to 12 inches loose thickness, and compacted to at least 95 percent of the maximum dry density as determined by the

Modified Proctor compaction procedure (ASTM D1557). Non-structural fills, including fills outside of the road prism or beneath landscape areas that are not subject to building or traffic loads, should be compacted to at least 90 percent of the Modified Proctor optimum dry density. Bulking of backfill into the trench should be discouraged as this can cause voids and lead to large future surface settlements. During fill placement, we recommend that large cobbles or boulders with dimensions in excess of 8 inches be removed from any structural fills.

8.0 CLOSURE AND LIMITATIONS

The analyses, conclusions, and recommendations contained in this report are based on site conditions as they presently exist, and further assume that the explorations are representative of the subsurface conditions throughout the site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the explorations. If subsurface conditions different from those encountered in the explorations are encountered or appear to be present during construction, we should be advised at once so that we can review these conditions and reconsider our recommendations, where necessary. If there is a substantial lapse of time between the submission of this report and the start of construction at the site, or if conditions have changed because of natural forces or construction operations at or adjacent to the site, we recommend that we review our report to determine the applicability of the conclusions and recommendations.

Within the limitations of scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. We make no other warranty, either express or implied. These conclusions and recommendations were based on our understanding of the project as described in this report and the site conditions as observed at the time of our explorations.

Unanticipated soil conditions are commonly encountered and cannot be fully determined by merely taking soil samples from test borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

This report was prepared for the exclusive use of our client and their representatives for evaluating the site as it relates to the geotechnical aspects discussed herein. The data and report should be provided to the contractors for their information, but our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions included in this report.

If there is a substantial lapse of time between the submittal of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, it is recommended that this report be reviewed to determine the applicability of the conclusions considering the changed conditions and time lapse. Unanticipated soil conditions are commonly encountered and cannot fully be determined by merely taking soil samples or advancing borings. Shannon & Wilson has prepared the attachments in Appendix C *Important Information About Your Geotechnical/Environmental Report* to assist you and others in understanding the use and limitations of the reports.

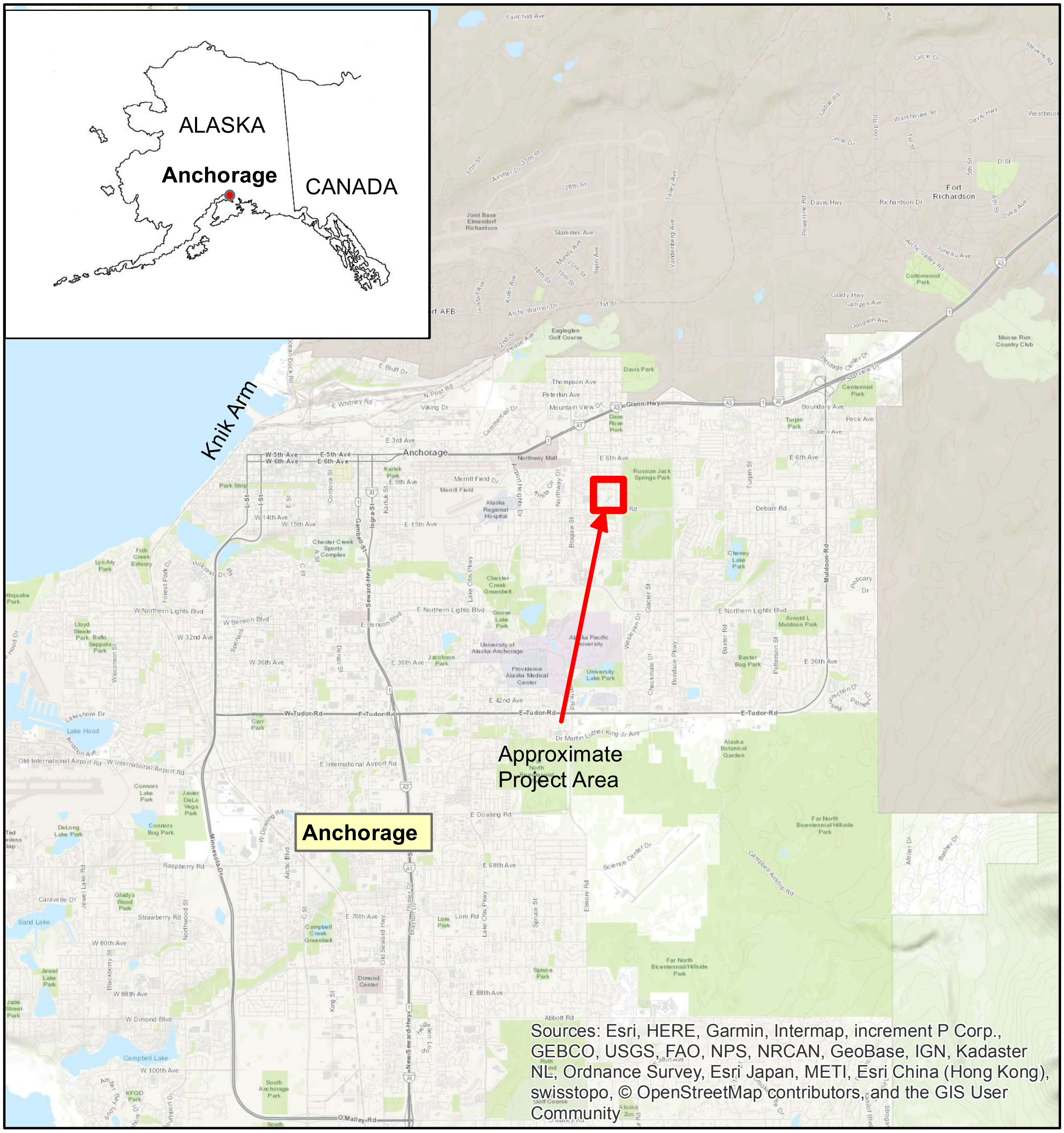
Copies of documents that may be relied upon by our client are limited to the printed copies (also known as hard copies) that are signed or sealed by Shannon & Wilson with a wet, blue ink signature. Files provided in electronic media format are furnished solely for the convenience of the client. Any conclusion or information obtained or derived from such electronic files shall be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, or you question the authenticity of the report please contact the undersigned.

We appreciate this opportunity to be of service. Please contact the undersigned at (907) 561-2120 with questions or comments concerning the contents of this report.

SHANNON & WILSON, INC.

Stafford Glashan, P.E.
Senior Engineer III

SJG:KLB



Map adapted from files provided by the Alaska Department of Natural Resources

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Miles

San Antonio Street Waterline Rehabilitation
Project WW.00022
Anchorage, Alaska

VICINITY MAP

November 2018 | 32-1-20095-002

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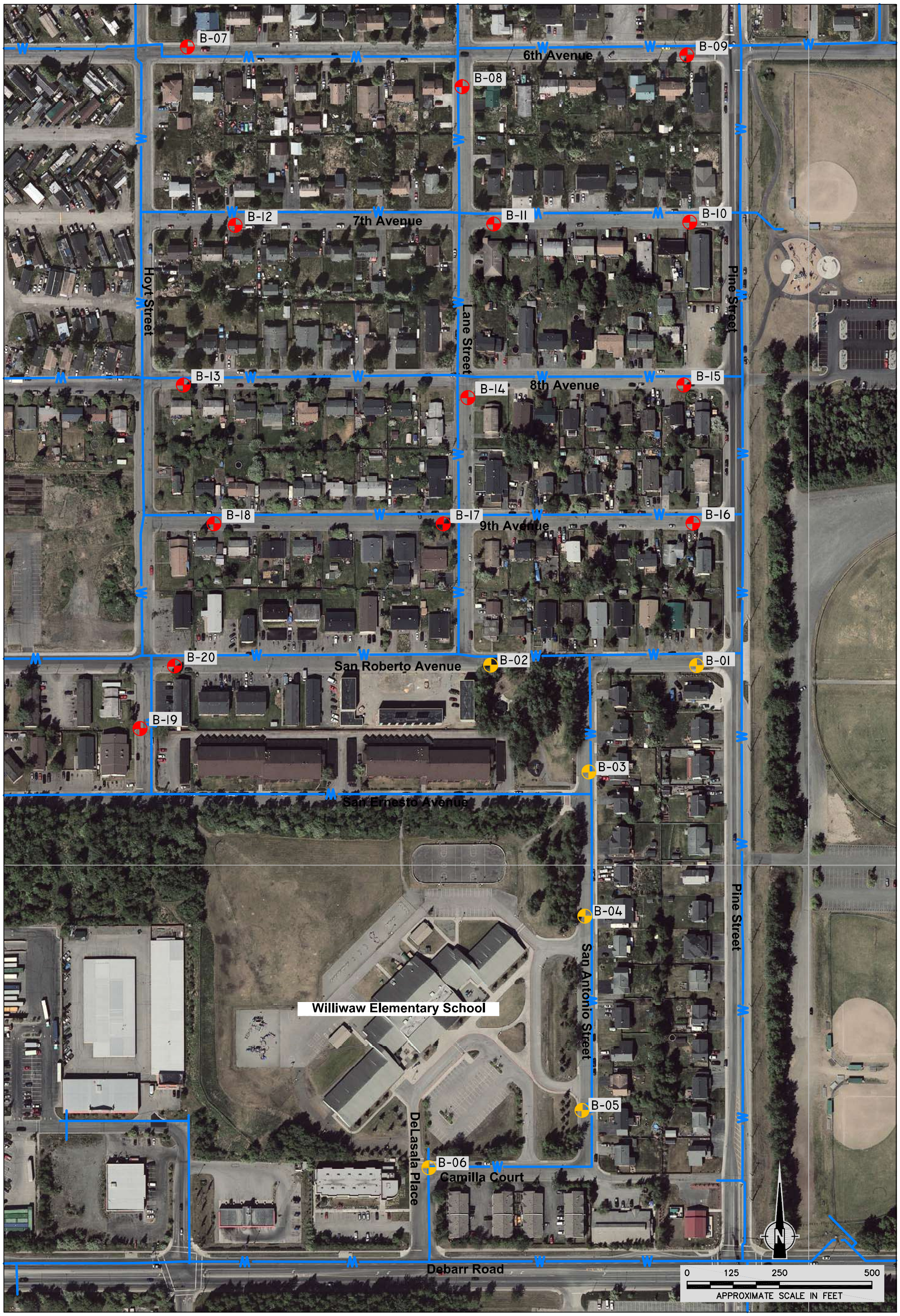
FIG. 1



LEGEND

B-01 Approximate Location of Boring B-01, Advanced by Shannon & Wilson, March 2018

B-07 Approximate Location of Boring B-07, Advanced by Shannon & Wilson, August 2018

Existing Water Line.

NOTES

1. Map adapted from aerial imagery provided by the Municipality of Anchorage. Image date: May 2015

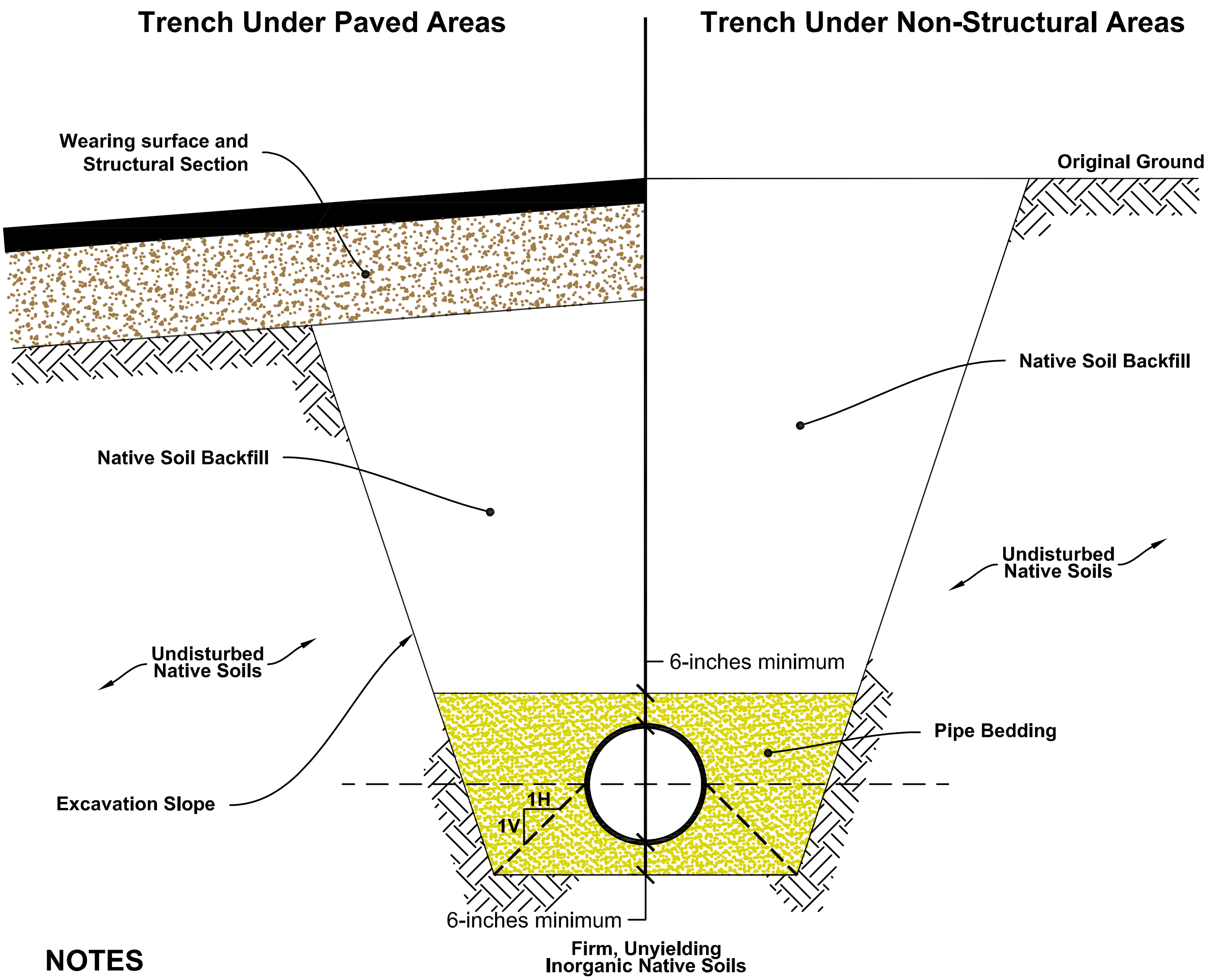
San Antonio Street Waterline Rehabilitation
Project WW.00022
Anchorage, Alaska

SITE PLAN

November 2018 32-1-20095-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 2



NOTES

1. Trench backfill under paved areas should be placed in loose lifts not to exceed 12 inches and compacted to at least 95 percent of its maximum dry density as determined by ASTM D-1557.

2. Trench backfill under non-structural areas should be placed in loose lifts not to exceed 18 inches and compacted to at least 90 percent of its maximum dry density as determined by ASTM D-1557.

3. Pipe bedding should conform to MOA Class E bedding material or as recommended by pipe manufacturer.

4. Pipe bedding and cover thickness shown above should be used absent pipe manufacturer requirements.

5. OSHA requires slope protection and support for all trenches greater than 4 feet deep. Side slope requirements are variable depending upon soil type and the duration of time in which the trench remains open. The contractor should be made responsible for compliance to these regulations as he/she is at the project on a day to day basis, is aware of the changing conditions and has authority to direct work.

San Antonio Street Waterline Rehabilitation
Project WW.00022
Anchorage, Alaska

UTILITY TRENCH DETAIL

November 2018 32-1-20095-002

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FIG. 3

GRADATION REQUIREMENTS

(Adapted from Municipality of Anchorage Standard Specifications, 2015)

LEVELING COURSE

U.S. STANDARD SIEVE SIZE English	Metric	PERCENT PASSING BY WEIGHT
1 in.	25.0 mm	100
3/4 in.	19.0 mm	70 - 100
3/8 in.	9.5 mm	50 - 80
No. 4	4.75 mm	35 - 65
No. 8	2.36 mm	20 - 50
No. 50	0.30 mm	8 - 28
No. 200	0.075 mm	0 - 6*

TYPE II BACKFILL

U.S. STANDARD SIEVE SIZE		PERCENT PASSING BY WEIGHT
8 in.	-	100
3 in.	75 mm	70 - 100
1-1/2 in.	37.5 mm	55 - 100
3/4 in.	19.0 mm	45 - 85
No. 4	4.75 mm	20 - 60
No. 10	2.00 mm	12 - 50
No. 40	0.425 mm	4 - 30
No. 200	0.075 mm	2 - 6**

TYPE IIA BACKFILL

U.S. STANDARD SIEVE SIZE		PERCENT PASSING BY WEIGHT
3 in.	75 mm	100
3/4 in.	19.0 mm	50 - 100
No. 4	4.75 mm	25 - 60
No. 10	2.00 mm	15 - 50
No. 40	0.425 mm	4 - 30
No. 200	0.075 mm	2 - 6***

CLASS E BEDDING

U.S. STANDARD SIEVE SIZE		PERCENT PASSING BY WEIGHT
1/2 in.	12.5 mm	100
3/8 in.	9.5 mm	100-80
No. 4	4.75 mm	20 - 75
No. 10	2.00 mm	12 - 60
No. 40	0.425 mm	2 - 30
No. 200	0.075 mm	0 - 6

E - CHIPS

U.S. STANDARD SIEVE SIZE		PERCENT PASSING BY WEIGHT
1/2 in.	12.5 mm	100
3/8 in.	9.5 mm	90 - 100
No. 4	4.75 mm	10 - 30
No. 8	2.36 mm	0 - 8
No. 200	0.075 mm	0 - 1

* The fraction passing the No. 200 sieve shall not exceed 75 percent of the fraction passing the No. 50 sieve.

** The fraction passing the No. 200 sieve shall not exceed 15 percent of the fraction passing the No. 4 sieve.

San Antonio Street Waterline Rehabilitation
Project WW.00022
Anchorage, Alaska

GRADATION REQUIREMENTS

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SHANNON & WILSON, INC.
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FIG. 4

APPENDIX A

BORING LOGS AND GEOTECHNICAL LABORATORY TEST RESULTS

Shannon & Wilson, Inc. (S&W), uses a soil identification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following pages. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

S&W INORGANIC SOIL CONSTITUENT DEFINITIONS

CONSTITUENT[2]	FINE-GRAINED SOILS (50% or more fines)[1]	COARSE-GRAINED SOILS (less than 50% fines)[1]
Major	***Silt, Lean Clay, Elastic Silt,*** or ***Fat Clay***[3]	***Sand*** or ***Gravel***[4]
Modifying (Secondary) Precedes major constituent	30% or more coarse-grained: ***Sandy*** or ***Gravelly***[4]	More than 12% fine-grained: ***Silty*** or ***Clayey***[3]
Minor Follows major constituent	15% to 30% coarse-grained: ***with Sand*** or ***with Gravel***[4]	5% to 12% fine-grained: ***with Silt*** or ***with Clay***[3]
	30% or more total coarse-grained *and* lesser coarse-grained constituent is 15% or more: ***with Sand*** or ***with Gravel***[5]	15% or more of a second coarse-grained constituent: ***with Sand*** or ***with Gravel***[5]

[1]All percentages are by weight of total specimen passing a 3-inch sieve.
[2]The order of terms is: *Modifying Major with Minor*.
[3]Determined based on behavior.
[4]Determined based on which constituent comprises a larger percentage.
[5]Whichever is the lesser constituent.

MOISTURE CONTENT TERMS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

STANDARD PENETRATION TEST (SPT) SPECIFICATIONS

Hammer:	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diam. cathead 2-1/4 rope turns, > 100 rpm NOTE: If automatic hammers are used, blow counts shown on boring logs should be adjusted to account for efficiency of hammer.
Sampler:	10 to 30 inches long Shoe I.D. = 1.375 inches Barrel I.D. = 1.5 inches Barrel O.D. = 2 inches
N-Value:	Sum blow counts for second and third 6-inch increments. Refusal: 50 blows for 6 inches or less; 10 blows for 0 inches.

NOTE: Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

PARTICLE SIZE DEFINITIONS

DESCRIPTION	SIEVE NUMBER AND/OR APPROXIMATE SIZE
FINES	< #200 (0.075 mm = 0.003 in.)
SAND	
Fine	#200 to #40 (0.075 to 0.4 mm; 0.003 to 0.02 in.)
Medium	#40 to #10 (0.4 to 2 mm; 0.02 to 0.08 in.)
Coarse	#10 to #4 (2 to 4.75 mm; 0.08 to 0.187 in.)
GRAVEL	
Fine	#4 to 3/4 in. (4.75 to 19 mm; 0.187 to 0.75 in.)
Coarse	3/4 to 3 in. (19 to 76 mm)
COBBLES	3 to 12 in. (76 to 305 mm)
BOULDERS	> 12 in. (305 mm)

RELATIVE DENSITY / CONSISTENCY

COHESIONLESS SOILS		COHESIVE SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
< 4	Very loose	< 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
> 50	Very dense	15 - 30	Very stiff
		> 30	Hard

WELL AND BACKFILL SYMBOLS

Bentonite Cement Grout	Surface Cement Seal
Bentonite Grout	Asphalt or Cap
Bentonite Chips	Slough
Silica Sand	Inclinometer or Non-perforated Casing
Perforated or Screened Casing	Vibrating Wire Piezometer

PERCENTAGES TERMS [1, 2]

Trace	< 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

[1]Gravel, sand, and fines estimated by mass. Other constituents, such as organics, cobbles, and boulders, estimated by volume.

[2]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

San Antonio Street Waterline Rehabilitation
Project WW.00022
Anchorage, Alaska

SOIL DESCRIPTION AND LOG KEY

November 2018 32-1-20095-002

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FIG. A-1
Sheet 1 of 3

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL	TYPICAL IDENTIFICATIONS
COARSE-GRAINED SOILS *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Gravel *(less than 5% fines)*	GW	Well-Graded Gravel; Well-Graded Gravel with Sand
			GP	Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel *(more than 12% fines)*	GM	Silty Gravel; Silty Gravel with Sand
			GC	Clayey Gravel; Clayey Gravel with Sand
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Sand *(less than 5% fines)*	SW	Well-Graded Sand; Well-Graded Sand with Gravel
			SP	Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand *(more than 12% fines)*	SM	Silty Sand; Silty Sand with Gravel
			SC	Clayey Sand; Clayey Sand with Gravel
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML	Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL	Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
		Organic	OL	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH	Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
			CH	Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
		Organic	OH	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat or other highly organic soils (see ASTM D4427)

NOTE: No. 4 size = 4.75 mm = 0.187 in.; No. 200 size = 0.075 mm = 0.003 in.

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, Sand with Silt)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart. Graphics shown on the logs for these soil types are a combination of the two graphic symbols (e.g., SP and SM).

2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, Lean Clay to Silt; SP-SM/SM, Sand with Silt to Silty Sand)* indicate that the soil properties are close to the defining boundary between two groups.

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SOIL DESCRIPTION AND LOG KEY

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FIG. A-1
Sheet 2 of 3

GRADATION TERMS

Poorly Graded	Narrow range of grain sizes present or, within the range of grain sizes present, one or more sizes are missing (Gap Graded). Meets criteria in ASTM D2487, if tested.
Well-Graded	Full range and even distribution of grain sizes present. Meets criteria in ASTM D2487, if tested.

CEMENTATION TERMS[1]

Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

PLASTICITY[2]

DESCRIPTION	VISUAL-MANUAL CRITERIA	APPROX. PLASITICTY INDEX RANGE
Nonplastic	A 1/8-in. thread cannot be rolled at any water content.	< 4
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 to 10
Medium	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.	10 to 20
High	It take considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.	> 20

ADDITIONAL TERMS

Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture, mix of strengths.

PARTICLE ANGULARITY AND SHAPE TERMS[1]

Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular, but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width/thickness ratio > 3.
Elongated	Length/width ratio > 3.

ACRONYMS AND ABBREVIATIONS

ATD	At Time of Drilling
Diam.	Diameter
Elev.	Elevation
ft.	Feet
FeO	Iron Oxide
gal.	Gallons
Horiz.	Horizontal
HSA	Hollow Stem Auger
I.D.	Inside Diameter
in.	Inches
lbs.	Pounds
MgO	Magnesium Oxide
mm	Millimeter
MnO	Manganese Oxide
NA	Not Applicable or Not Available
NP	Nonplastic
O.D.	Outside Diameter
OW	Observation Well
pcf	Pounds per Cubic Foot
PID	Photo-Ionization Detector
PMT	Pressuremeter Test
ppm	Parts per Million
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
rpm	Rotations per Minute
SPT	Standard Penetration Test
USCS	Unified Soil Classification System
q_u	Unconfined Compressive Strength
VWP	Vibrating Wire Piezometer
Vert.	Vertical
WOH	Weight of Hammer
WOR	Weight of Rods
Wt.	Weight

STRUCTURE TERMS[1]

Interbedded	Alternating layers of varying material or color with layers at least 1/4-inch thick; singular: bed.
Laminated	Alternating layers of varying material or color with layers less than 1/4-inch thick; singular: lamination.
Fissured	Breaks along definite planes or fractures with little resistance.
Slickensided	Fracture planes appear polished or glossy; sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

[1]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.
[2]Adapted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

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Anchorage, Alaska

SOIL DESCRIPTION AND LOG KEY

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FIG. A-1
Sheet 3 of 3

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FROST CLASSIFICATION

(after Municipality of Anchorage, 2009 Rev. 3)

GROUP		0.02 Mil.	P-200*	USC SYSTEM (based on P-200 results)
NFS	Sandy Soils	0 to 3	0 to 6	SW, SP, SW-SM, SP-SM
	Gravelly Soils	0 to 3	0 to 6	GW, GP, GW-GM, GP-GM
F1	Gravelly Soils	3 to 10	6 to 13	GM, GW-GM, GP-GM
F2	Sandy Soils	3 to 15	6 to 19	SP-SM, SW-SM, SM
	Gravelly Soils	10 to 20	13 to 25	GM
F3	Sands, except very fine silty sands**	Over 15	Over 19	SM, SC
	Gravelly Soils	Over 20	Over 25	GM, GC
	Clays, PI>12			CL, CH
F4	All Silts	Over 15	Over 19	ML, MH
	Very fine silty sands**			SM, SC
	Clays, PI<12			CL, CL-ML
	Varved clays and other fined grained, banded sediments			CL and ML CL, ML, and SM; SL, SH, and ML; CL, CH, ML, and SM

P-200 = Percent passing the number 200 sieve
0.02 Mil. = Percent material below 0.02 millimeter grain size

*Approximate P-200 value equivalent for frost classification. Value range based on typical, well-graded soil curves.

** Very fine sand : greater than 50% of sand fraction passing the number 100 sieve

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FROST CLASSIFICATION LEGEND

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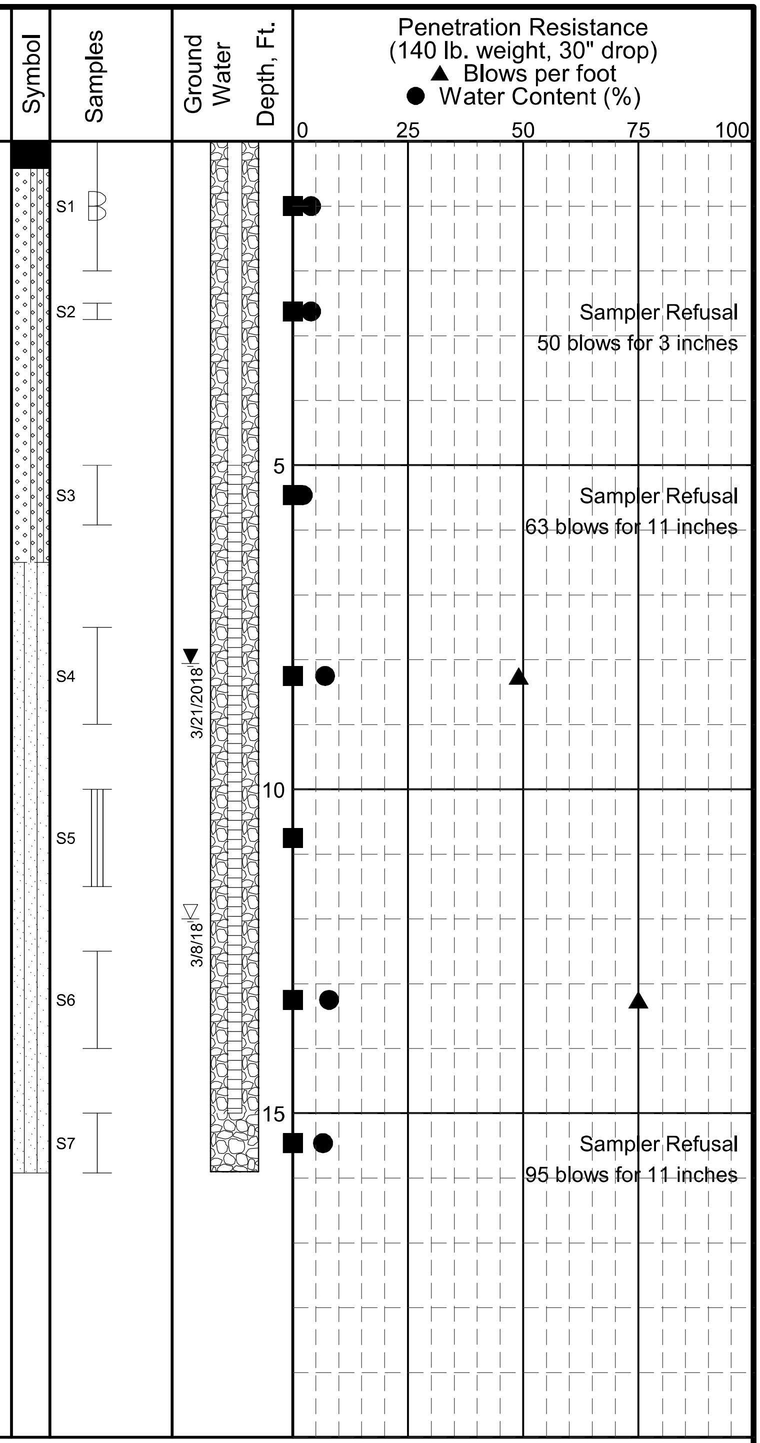
FIG. A-2

MATERIAL DESCRIPTION Approx. Elevation: 154 Ft.	Depth, Ft.
Asphalt Pavement	0.4
S1: 27% Gravel, 62% Sand, 11% Fines (F2 (P200)) Frozen, brown, *Well-Gradded Sand with Silt and Gravel (SW-SM)*; moist	6.5
Dense to very dense, gray, *Silty Sand with Gravel (SM)*; moist to wet S6: 21% Gravel, 44% Sand, 35% Fines (F3 (P200))	15.9
Bottom of Boring Boring Completed 3/8/2018	



0 25 50 75 100

● Water Content (%)

LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- ■ Frozen
- ▽ Ground Water Level At Time Of Drilling
- ▼ Static Water Level
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

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LOG OF BORING B-01

November 2018 32-1-20095-002

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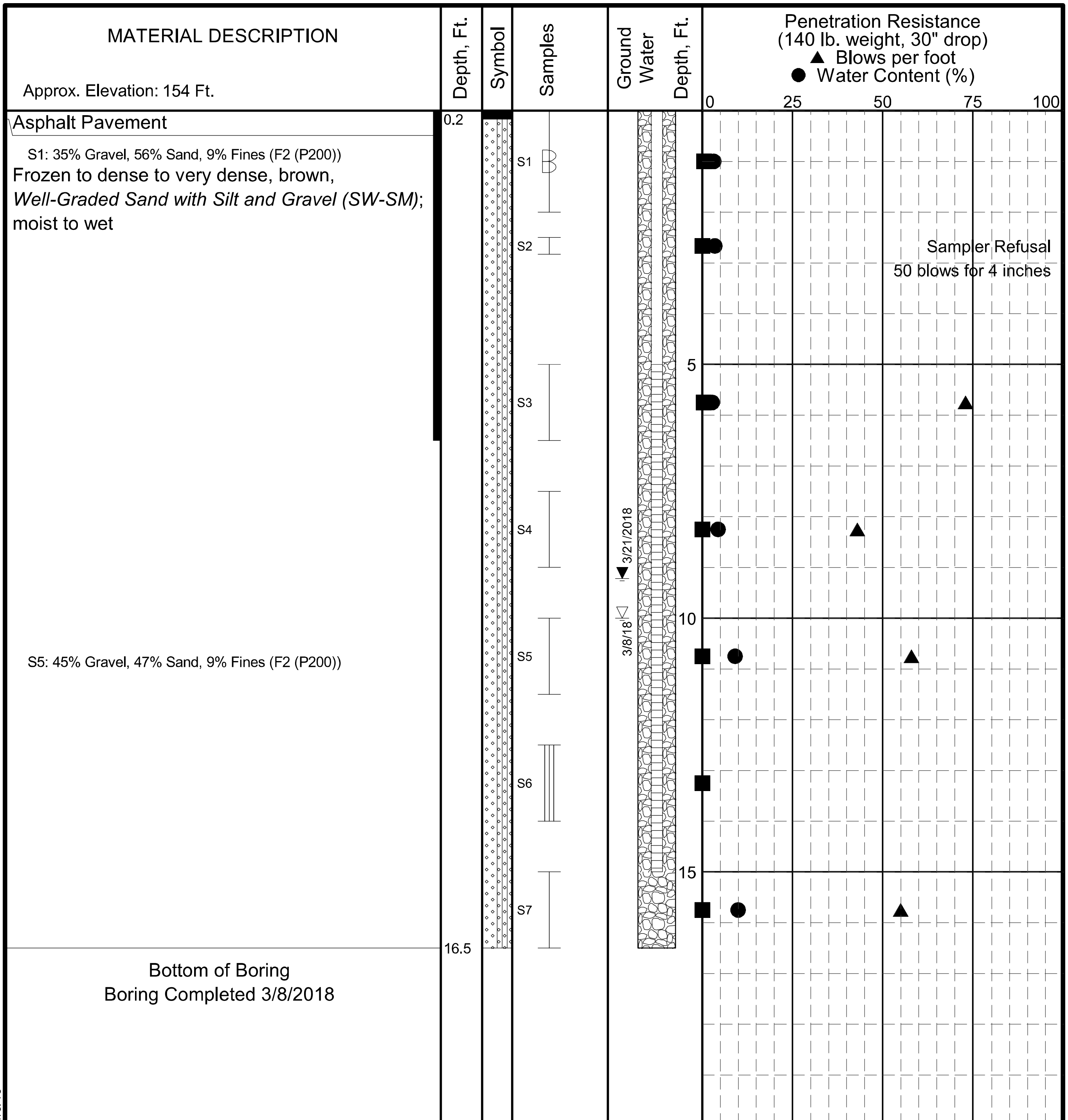
FIG. A-3

GEOTECHNICAL LOG GINT - COMBINED.GPJ S&W GEO1.GDT 11/5/18

REV 3 - Approved for Submittal



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Frozen
- Ground Water Level At Time Of Drilling
- Static Water Level
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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LOG OF BORING B-02

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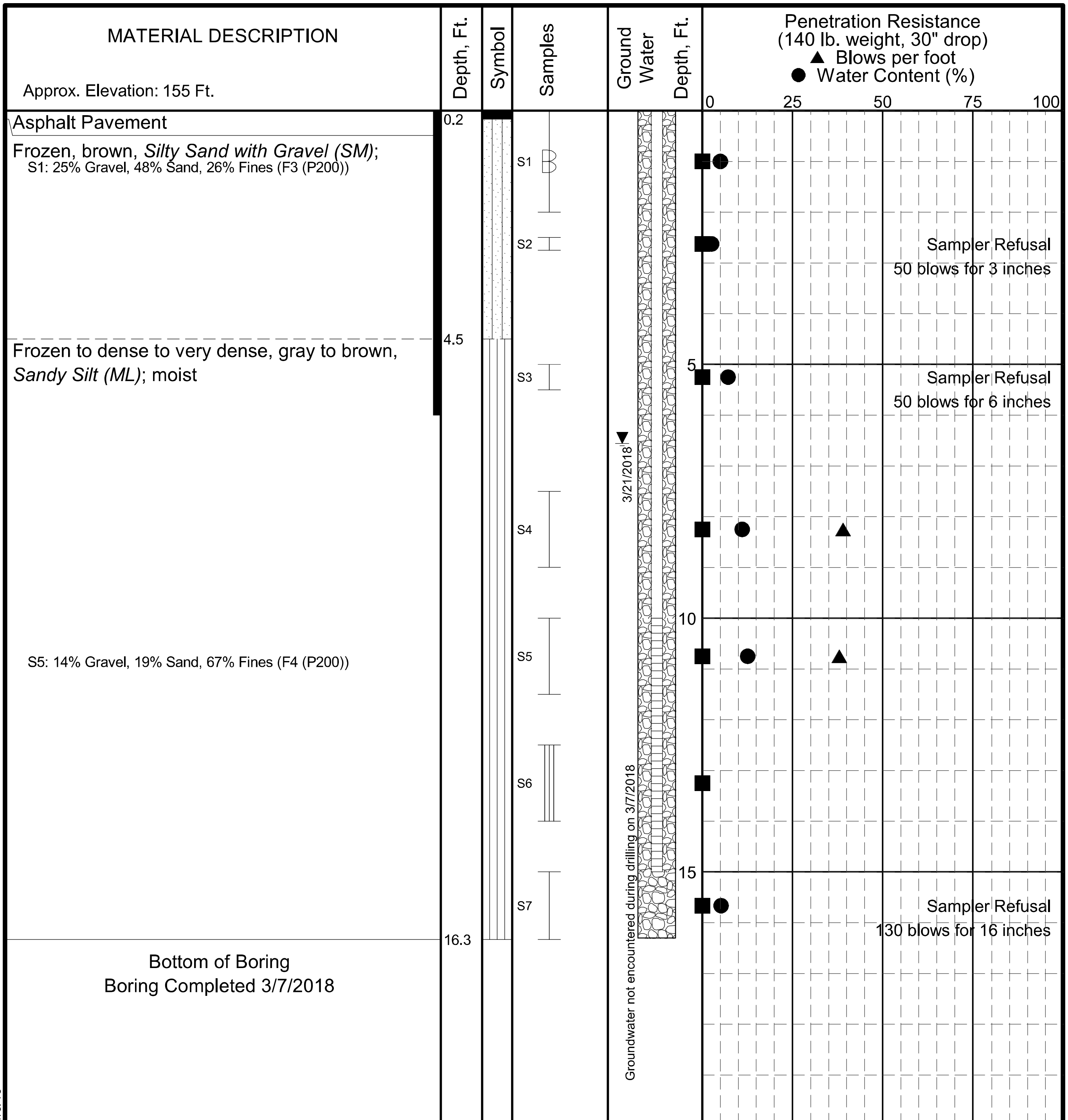
FIG. A-4

REV 3 - Approved for Submittal

GEOTECHNICAL LOG GINT - COMBINED.GPJ S&W GEO1.GDT 11/5/18



LEGEND

* Sample Not Recovered
Grab Sample
2" O.D. Split Spoon Sample
Frozen
Static Water Level
Blank Section, Cuttings Backfill
Slotted Section, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

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LOG OF BORING B-03

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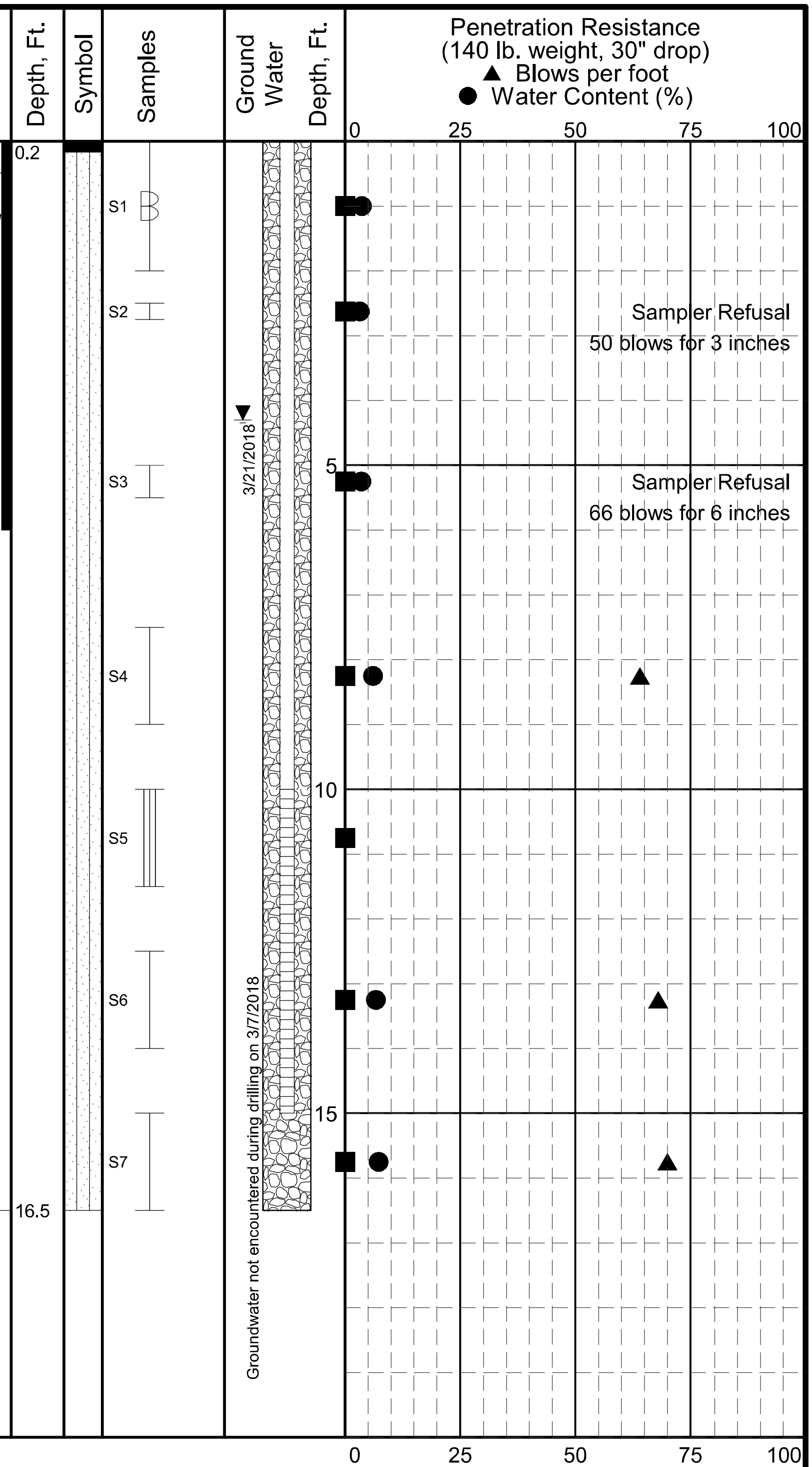
FIG. A-5

REV 3 - Approved for Submittal

MATERIAL DESCRIPTION
Approx. Elevation: 155 Ft.
Asphalt Pavement
S1: 25% Gravel, 52% Sand, 23% Fines (F3 (P200))
Frozen to very dense, gray, *Silty Sand with Gravel (SM)*; moist; fill in upper 3 feet
S4: 26% Gravel, 43% Sand, 31% Fines (F3 (P200))
Bottom of Boring Boring Completed 3/7/2018



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Frozen
- Static Water Level
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

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LOG OF BORING B-04

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FIG. A-6

MATERIAL DESCRIPTION

Approx. Elevation: 157 Ft.

Asphalt Pavement

S1: 23% Gravel, 67% Sand, 10% Fines (F2 (P200))

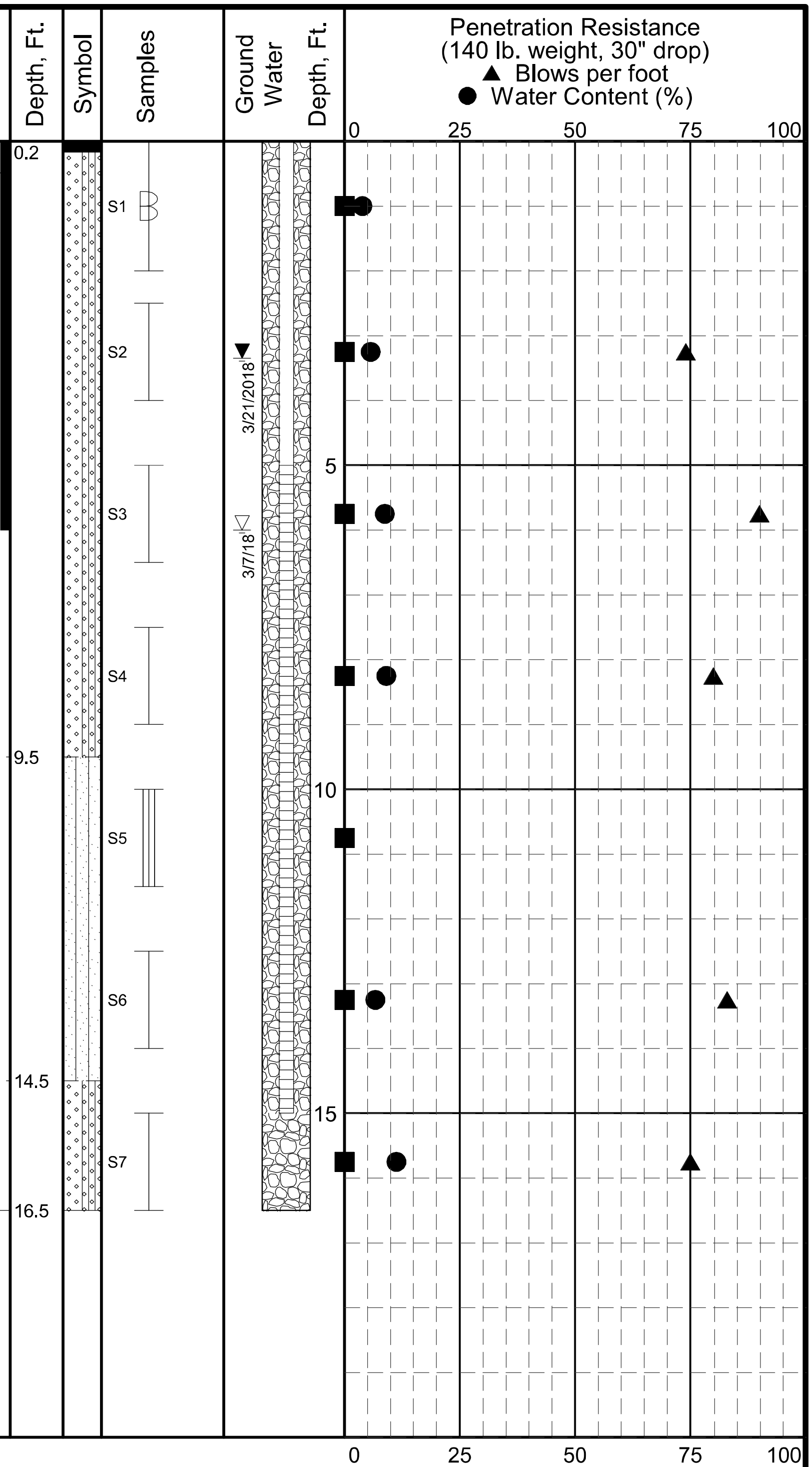
Frozen to very dense, brown, *Well-Graded Sand with Silt and Gravel (SW-SM) to Gravel with Silt and Sand (GW-GM)*; moist to wet; fill in upper 4.5 feet

Very dense, gray, *Silty Sand with Gravel (SM) to Silty Gravel with Sand (GM)*; moist to wet

S6: 43% Gravel, 43% Sand, 14% Fines (F2 (P200))

Very dense, gray, *Well-Graded Sand with Silt and Gravel (SW-SM)*; wet

Bottom of Boring
Boring Completed 3/7/2018



LEGEND

*	Sample Not Recovered	▽	Ground Water Level At Time Of Drilling
	Grab Sample	▼	Static Water Level
	2" O.D. Split Spoon Sample		Blank Section, Cuttings Backfill
■	Frozen		Slotted Section, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

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LOG OF BORING B-05

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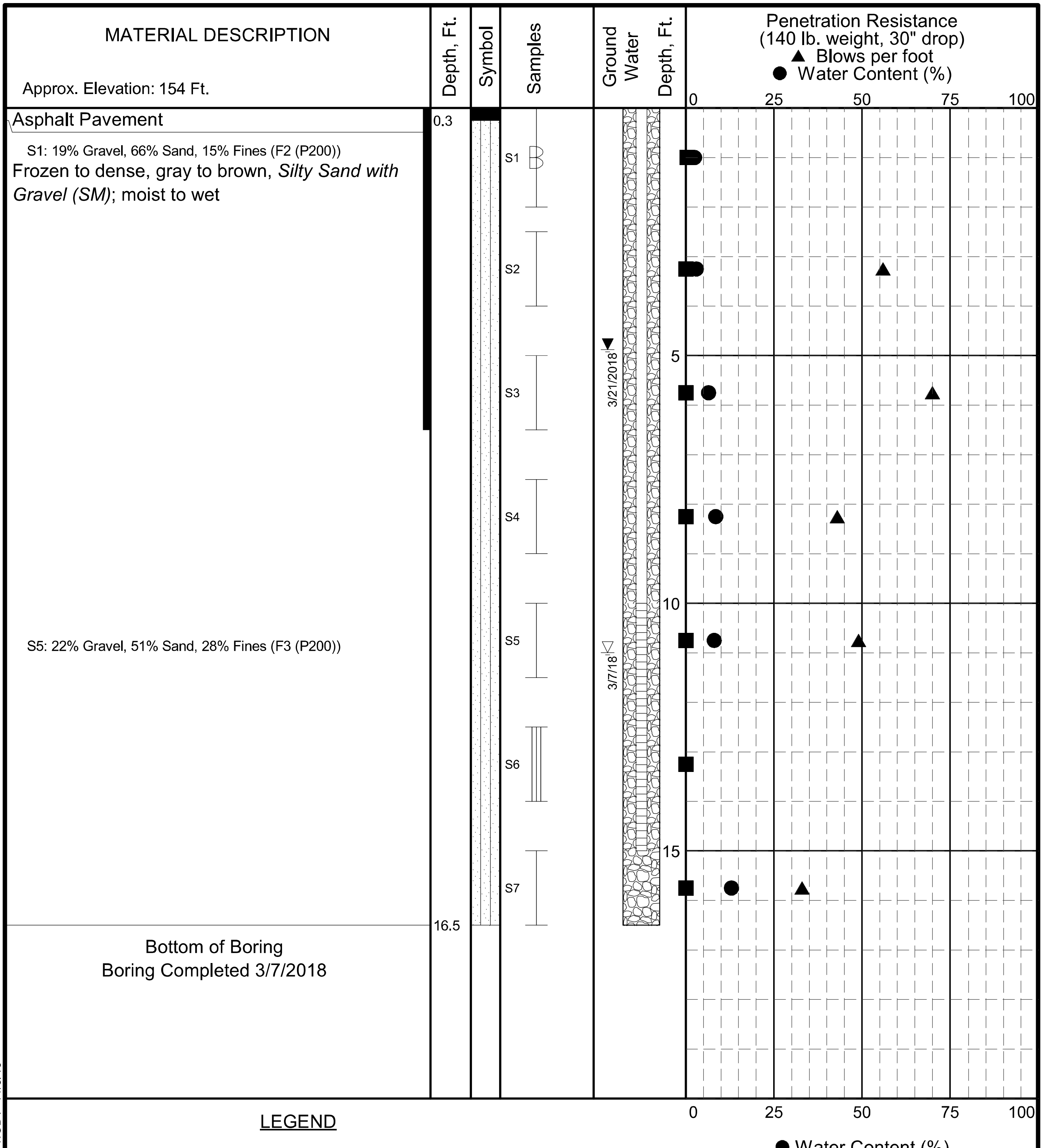
FIG. A-7

REV 3 - Approved for Submittal

GEOTECHNICAL LOG GINT - COMBINED.GPJ S&W GEO1.GDT 11/5/18



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- ■ Frozen
- Ground Water Level At Time Of Drilling
- Static Water Level
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

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LOG OF BORING B-06

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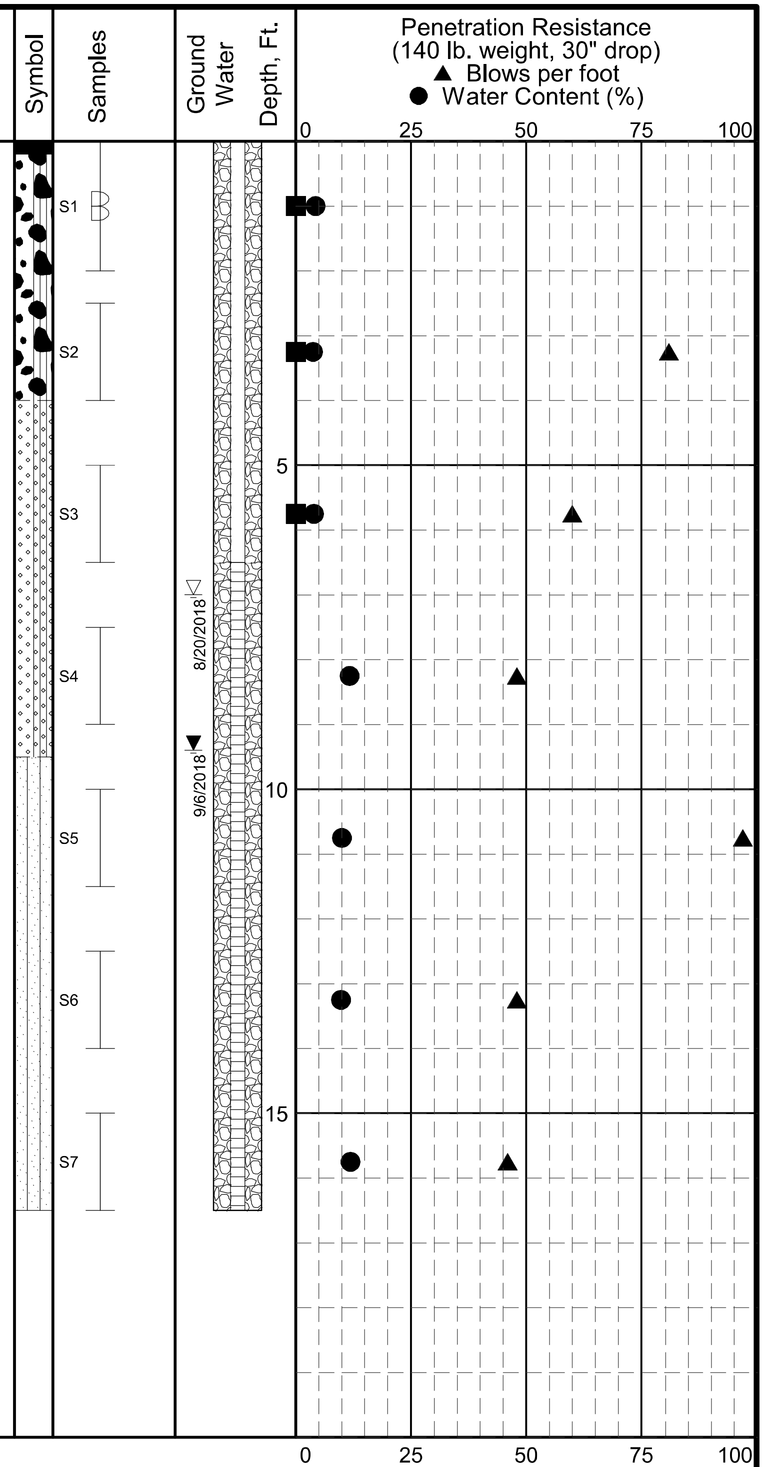
FIG. A-8

REV 3 - Approved for Submittal

GEOTECHNICAL LOG GINT - COMBINED.GPJ S&W GEO1.GDT 11/5/18

MATERIAL DESCRIPTION	Depth, Ft.
Approx. Elevation: 153 Ft.	
2 inches asphalt	0.2
Medium dense to very dense, brown, *Well-Graded Gravel with Silt and Sand (GW-GM)*; moist [FILL] S2: 47% Gravel, 43% Sand, 10% Fines (F1 [0.02mil])	
Dense to very dense, red-brown to brown, *Well-Graded Sand with Silt and Gravel (SW-SM)*; moist to wet S4: 31% Gravel, 60% Sand, 9% Fines (F2 [P200])	4.0
Dense to very dense, brown to gray, *Silty Sand with Gravel (SM)*; wet [TILL]	9.5
Bottom of Boring Boring Completed 8/20/2018	16.5



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Ground Water Level At Time Of Drilling
- Static Water Level
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

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LOG OF BORING B-07

November 2018 32-1-20095-002

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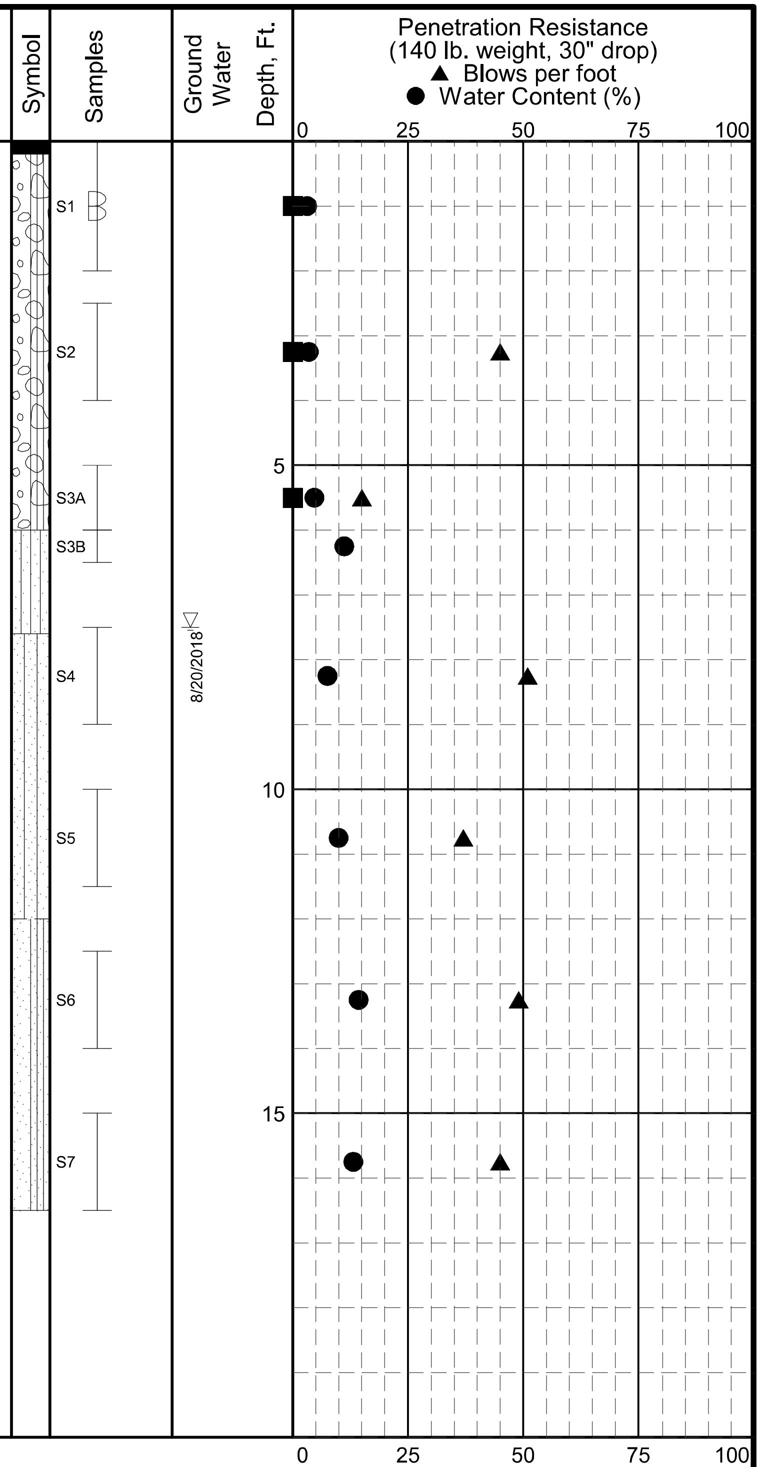
FIG. A-9

REV 3 - Approved for Submittal

GEOTECHNICAL LOG GINT - COMBINED.GPJ S&W GEO1.GDT 11/5/18

MATERIAL DESCRIPTION Approx. Elevation: 157 Ft.	Depth, Ft.
2 inches asphalt	0.2
Medium dense to dense, brown, *Poorly Graded Gravel with Silt and Sand (GP-GM) to Poorly Graded Sand with Silt and Gravel (SP-SM)*; moist [FILL] S1: 49% Gravel, 46% Sand, 5% Fines (NFS [P200])	6.0
Stiff, dark gray, *Sandy Silt (ML)*; moist; trace wood fragments at approximately 6.0 feet bgs; trace peat at approximately 7.6 feet bgs	7.6
Dense to very dense, brown to gray, *Silty Sand with Gravel (SM) to Silty Gravel with Sand (GM)*; wet	12.0
Dense, dark gray, *Poorly Graded Sand with Silt and Gravel (SP-SM)*; wet; trace coal at approximately 16.3 feet bgs S6: 24% Gravel, 69% Sand, 7% Fines (F2 [P200])	16.5
Bottom of Boring Boring Completed 8/20/2018	



LEGEND

* Sample Not Recovered
Grab Sample
2" O.D. Split Spoon Sample
Ground Water Level At Time Of Drilling

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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San Antonio Street Waterline Rehabilitation
Project WW.00022
Anchorage, Alaska

LOG OF BORING B-08

November 2018 32-1-20095-002

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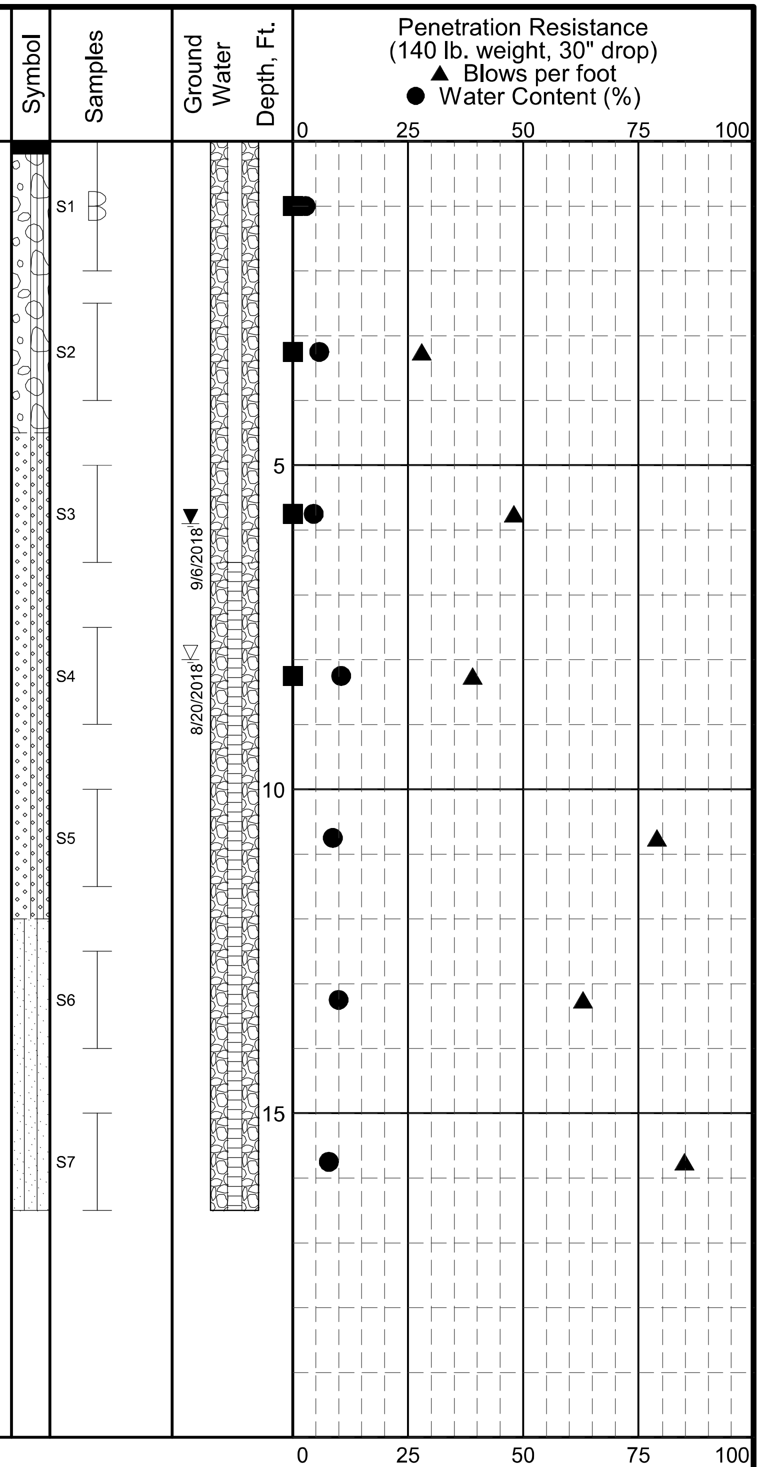
Geotechnical and Environmental Consultants

FIG. A-10

REV 3 - Approved for Submittal

MATERIAL DESCRIPTION	Depth, Ft.
Approx. Elevation: 159 Ft.	
2 inches asphalt	0.2
Medium dense, brown, *Poorly Graded Gravel with Silt and Sand (GP-GM)*; moist S1: 57% Gravel, 37% Sand, 7% Fines (F1 [P200])	4.5
Dense to very dense, light brown to brown to gray, *Well-Graded Sand with Silt and Gravel (SW-SM) to Silty Sand with Gravel (SM)*; moist to wet; occasional sand lenses up to 2 inches thick from approximately 7 to 9.5 feet bgs S4: 33% Gravel, 56% Sand, 11% Fines (F2 [P200])	12.0
Very dense, gray to brown, *Silty Sand with Gravel (SM)*; wet	16.5
Bottom of Boring Boring Completed 8/20/2018	



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Ground Water Level At Time Of Drilling
- Static Water Level
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill

NOTES

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Anchorage, Alaska

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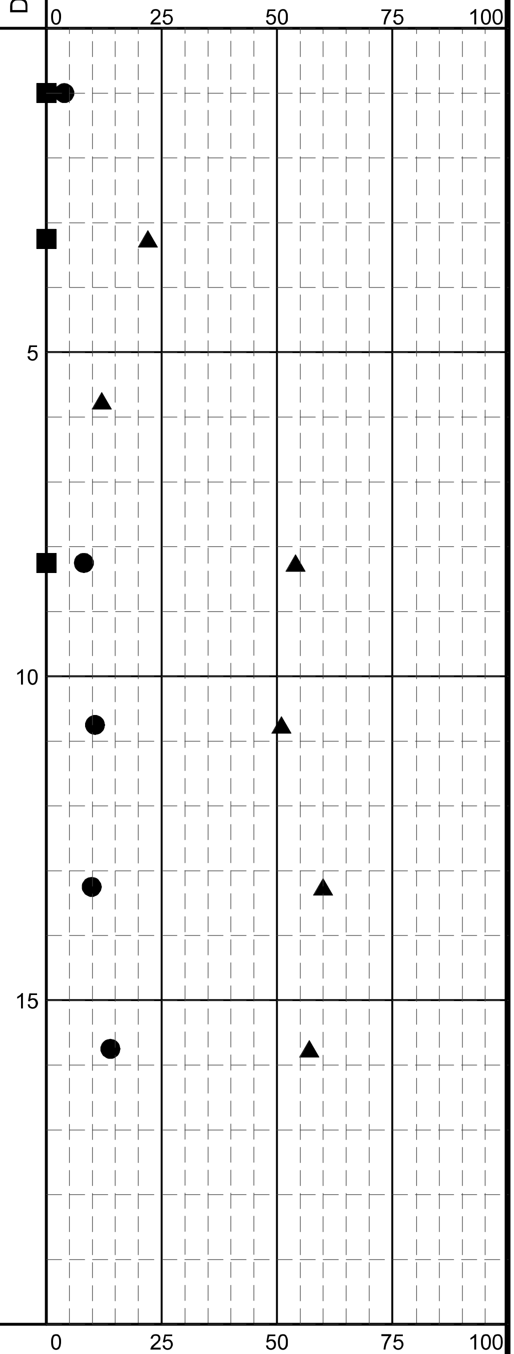
FIG. A-11

REV 3 - Approved for Submittal

MATERIAL DESCRIPTION	Depth, Ft.	Samples
Approx. Elevation: 159 Ft.		
2 inches asphalt	0.2	
Medium dense, brown, *Poorly Graded Sand with Silt and Gravel (SP-SM)*; moist S1: 34% Gravel, 59% Sand, 8% Fines (F2 [0.02mil])		S1, S2, S3
Very dense, gray to brown, *Silty Sand with Gravel to Silty Sand (SM)*; moist to wet S4: 34% Gravel, 51% Sand, 14% Fines (F2 [P200])	7.0	S4, S5, S6
Very dense, gray, *Poorly Graded Sand with Silt (SP-SM)*; wet	14.5	S7
Bottom of Boring Boring Completed 8/20/2018	16.5	

Ground Water: 8/20/2018

Penetration Resistance
(140 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Ground Water Level At Time Of Drilling

NOTES

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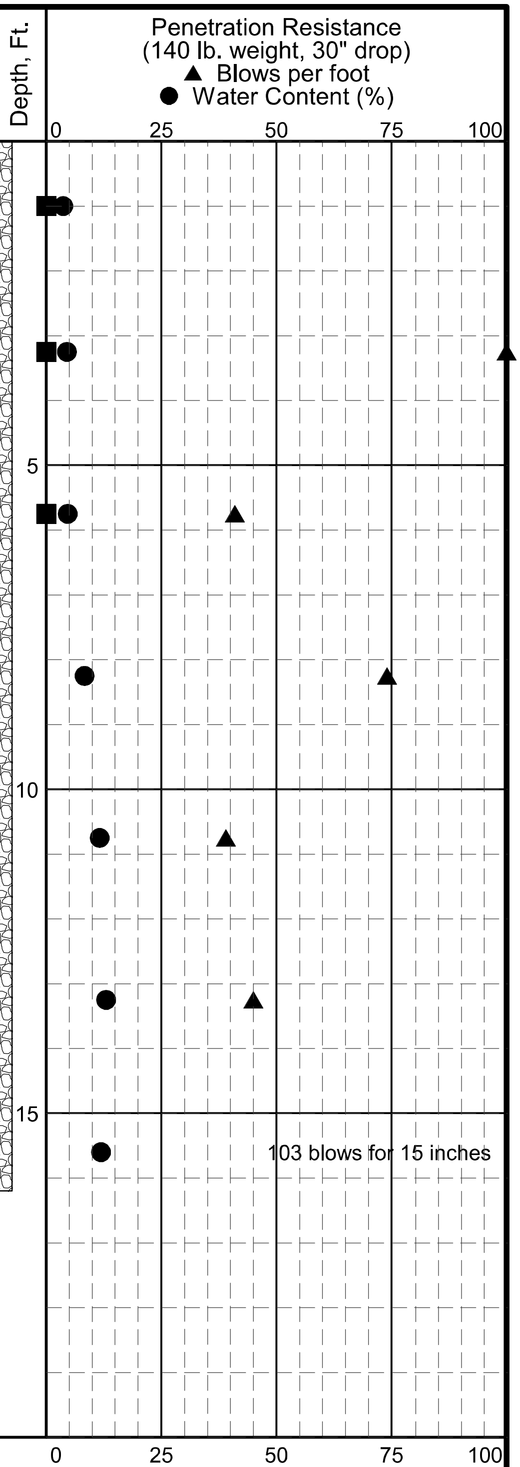
FIG. A-12

MATERIAL DESCRIPTION Approx. Elevation: 157 Ft.	Depth, Ft.	Samples	Ground Water
2 inches asphalt	0.2		
Medium dense to very dense, light brown to brown, *Silty Sand with Gravel (SM) to Silty Gravel with Sand (GM)*; wet to moist		S1	
S2: 43% Gravel, 43% Sand, 15% Fines (F2 [0.02mil])		S2	
		S3	9/6/2018
Dense to very dense, gray to dark gray, *Poorly Graded Sand with Silt and Gravel (SP-SM)*; wet; interbedded layers of Poorly Graded Sand (SP) up to 6 inches thick	7.0	S4	8/20/2018
S5: 33% Gravel, 62% Sand, 5% Fines (NFS [P200])		S5	
Dense to very dense, gray, *Poorly Graded Sand with Silt (SP-SM) to Well-Graded Sand with Silt (SW-SM)*; wet	12.0	S6	
		S7	
Bottom of Boring Boring Completed 8/20/2018	16.2		



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Ground Water Level At Time Of Drilling
- Static Water Level
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill

NOTES

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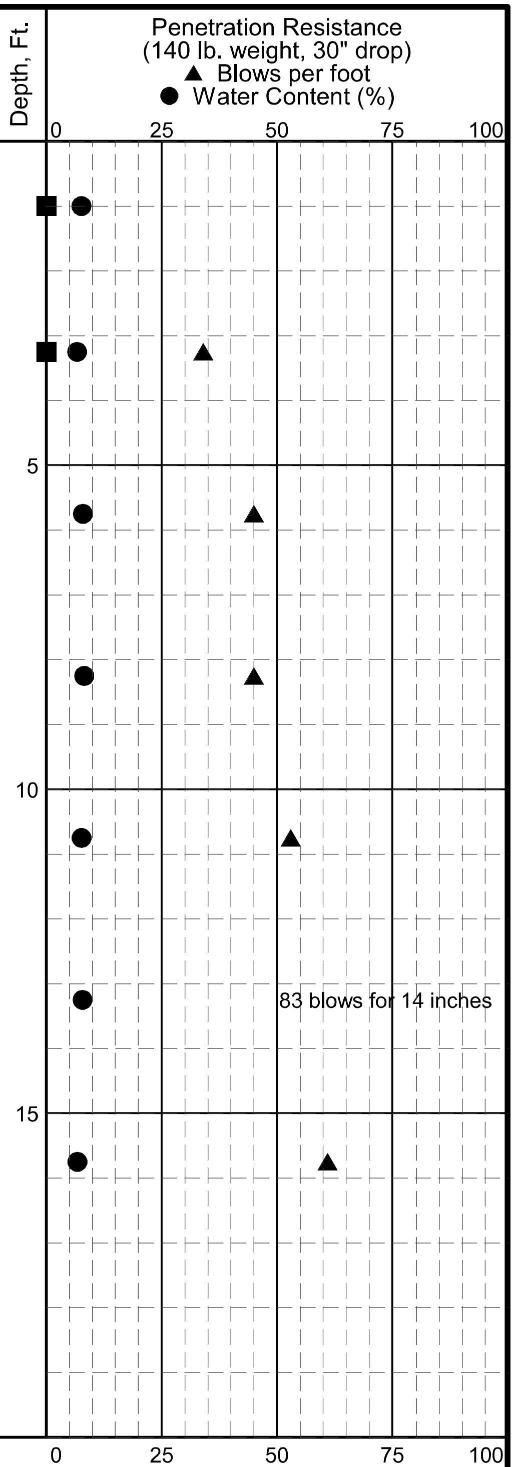
FIG. A-13

REV 3 - Approved for Submittal

MATERIAL DESCRIPTION Approx. Elevation: 154 Ft.	Depth, Ft.	Samples
2 inches asphalt	0.2	
Medium dense to dense, brown, *Poorly Graded Sand with Silt and Gravel (SP-SM)*; moist [FILL] S1: 42% Gravel, 52% Sand, 6% Fines (F2 [P200])		S1, S2
Dense, light brown to brown to gray, *Well-Graded Gravel with Silt and Sand (GW-GM)*; wet S3: 46% Gravel, 45% Sand, 10% Fines (F1 [P200])	4.5	S3, S4
Very dense, gray, *Silty Sand with Gravel (SM)*; wet; trace coal at approximately 13 feet bgs; few medium to coarse sand lenses at approximately 15.5 feet bgs; [TILL] S6: 23% Gravel, 42% Sand, 35% Fines (F3 [P200])	9.5	S5, S6, S7
Bottom of Boring Boring Completed 8/21/2018	16.5	

Ground Water: 8/21/2018



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Ground Water Level At Time Of Drilling

NOTES

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LOG OF BORING B-12

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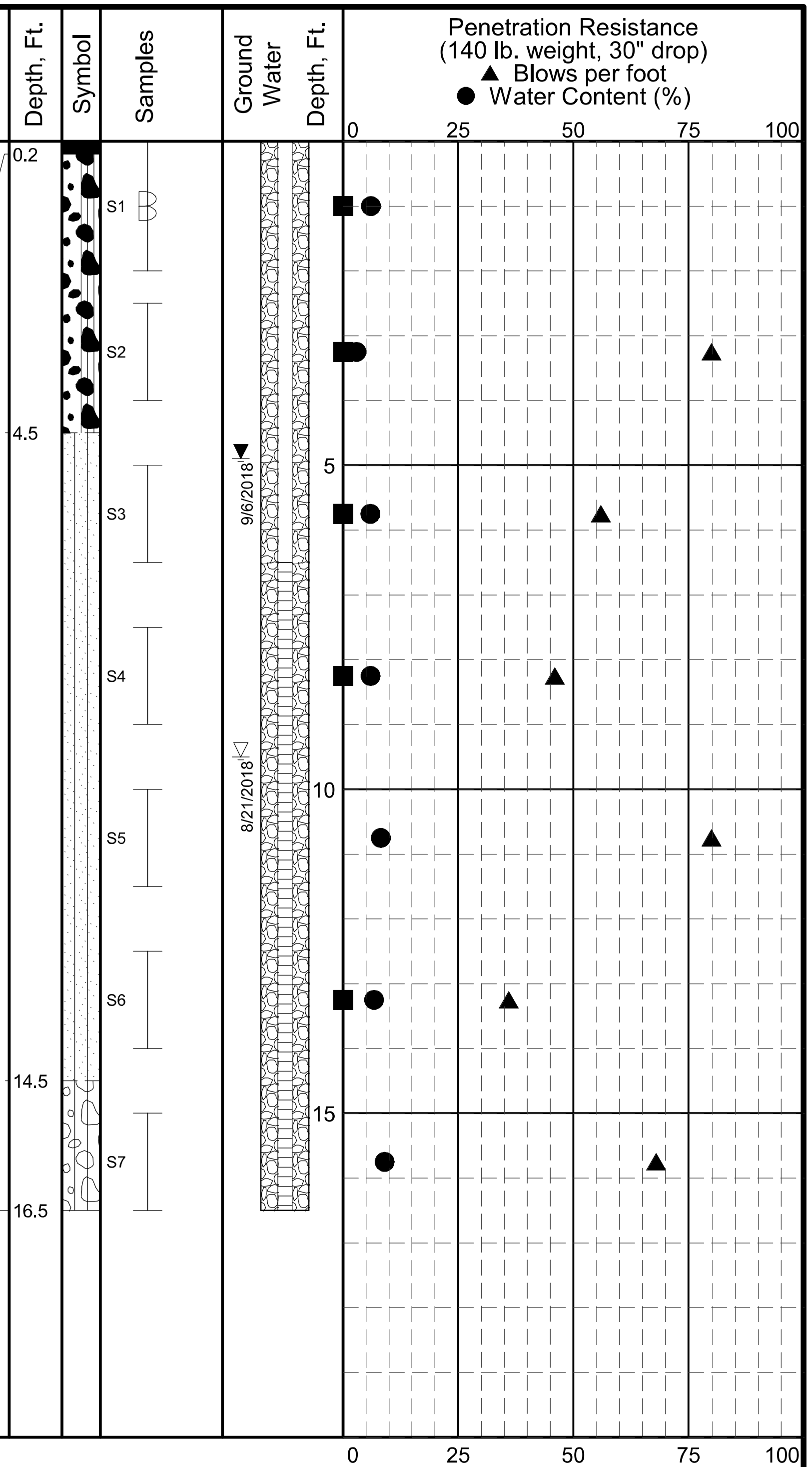
FIG. A-14

REV 3 - Approved for Submittal

MATERIAL DESCRIPTION

Approx. Elevation: 155 Ft.

Depth, Ft.	Material Description
0.2	2 inches asphalt
	Medium dense to very dense, light brown to brown, *Well-Graded Gravel with Silt and Sand (GW-GM)*; moist S1: 57% Gravel, 35% Sand, 8% Fines (F1 [P200])
4.5	Dense to very dense, brown to gray-brown, *Silty Sand with Gravel (SM)*; moist to wet S4: 32% Gravel, 47% Sand, 22% Fines (F3 [P200])
14.5	Very dense, gray, *Silty Gravel with Sand (GM)*; wet
16.5	Bottom of Boring Boring Completed 8/21/2018



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Ground Water Level At Time Of Drilling
- Static Water Level
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill

NOTES

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LOG OF BORING B-13

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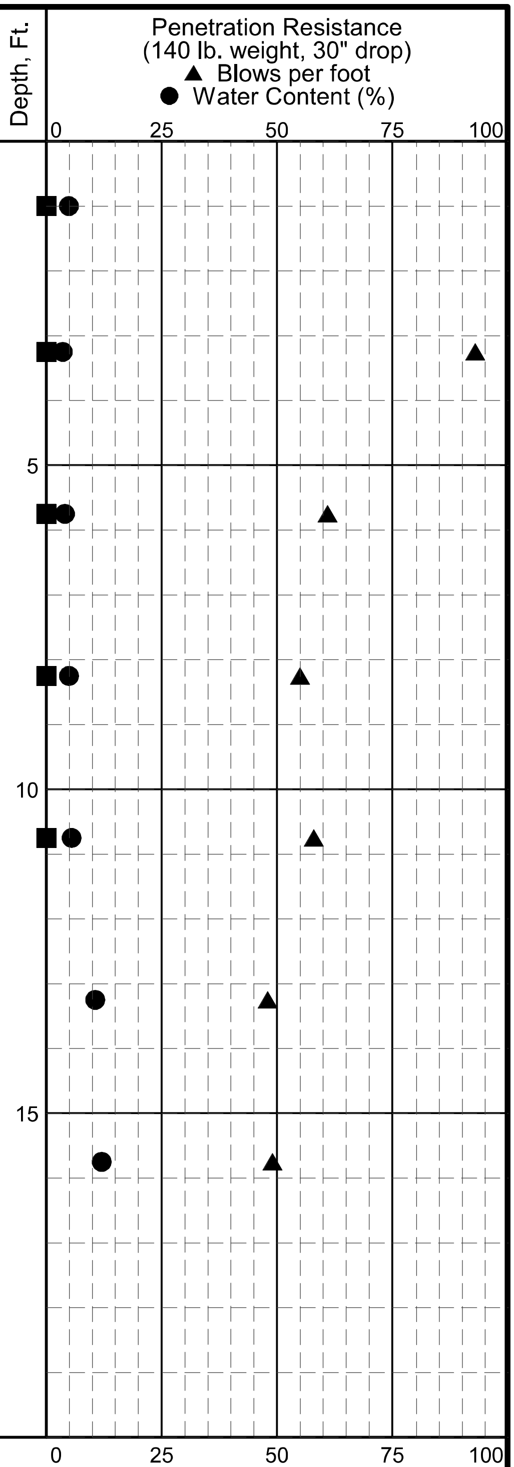
FIG. A-15

MATERIAL DESCRIPTION Approx. Elevation: 159 Ft.	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
2 inches asphalt	0.2				
Medium dense, brown, *Well-Graded Gravel with Silt and Sand (GW-GM)*: moist S1: 61% Gravel, 34% Sand, 5% Fines (F1 [0.02mil])			S1		
Very dense, tan to brown to gray-brown, *Poorly Graded Sand with Silt and Gravel (SP-SM)*; moist	2.2		S2 S3 S4		5
Dense to very dense, light brown to gray-brown to gray, *Well-Graded Sand with Silt and Gravel (SW-SM) to Silty Sand with Gravel (SM)*; moist to wet; small piece of wood at approximately 10 feet bgs S6: 35% Gravel, 54% Sand, 11% Fines (F2 [P200])	9.5		S5 S6 S7	8/21/2018	10 15
Bottom of Boring Boring Completed 8/21/2018	16.5				



LEGEND

* Sample Not Recovered

Grab Sample

2" O.D. Split Spoon Sample

Ground Water Level At Time Of Drilling

● Water Content (%)

NOTES

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LOG OF BORING B-14

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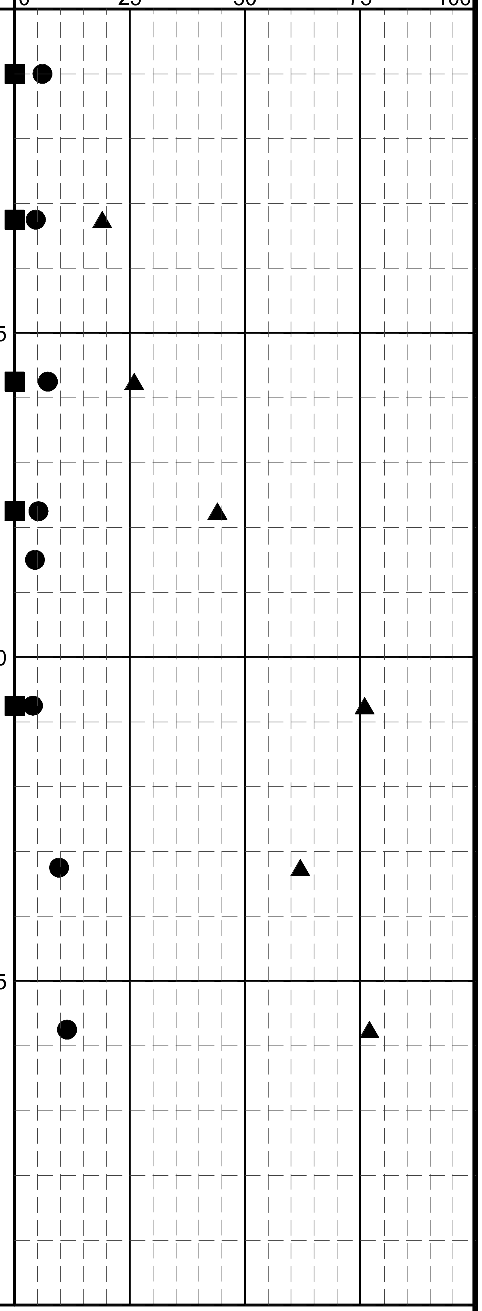
FIG. A-16

MATERIAL DESCRIPTION Approx. Elevation: 163 Ft.	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.	Penetration Resistance (140 lb. weight, 30" drop) ▲ Blows per foot ● Water Content (%)
2 inches asphalt	0.2					
Medium dense, brown, *Well-Graded Gravel with Silt and Sand (GW-GM)*; moist [FILL] S1: 45% Gravel, 43% Sand, 12% Fines (F1 [P200])			S1			
Medium dense to dense, brown, *Poorly Graded Sand with Silt (SP-SM) to Silty Sand with Gravel (SM)*; moist; interbedded with *Silty Sand with Gravel (SM)* from approximately 4.5 to 9.5 feet bgs S4B: 17% Gravel, 70% Sand, 13% Fines (F2 [P200])	2.5		S2 S3 S4A S4B		5	
Very dense, light brown to gray-brown to gray, *Silty Sand with Gravel (SM)*; moist to wet	9.5		S5 S6 S7	9/6/2018 8/21/2018	10 15	
Bottom of Boring Boring Completed 8/21/2018	16.5					



LEGEND

* Sample Not Recovered
Grab Sample
2" O.D. Split Spoon Sample
Ground Water Level At Time Of Drilling
Static Water Level
Blank Section, Cuttings Backfill
Slotted Section, Cuttings Backfill

NOTES

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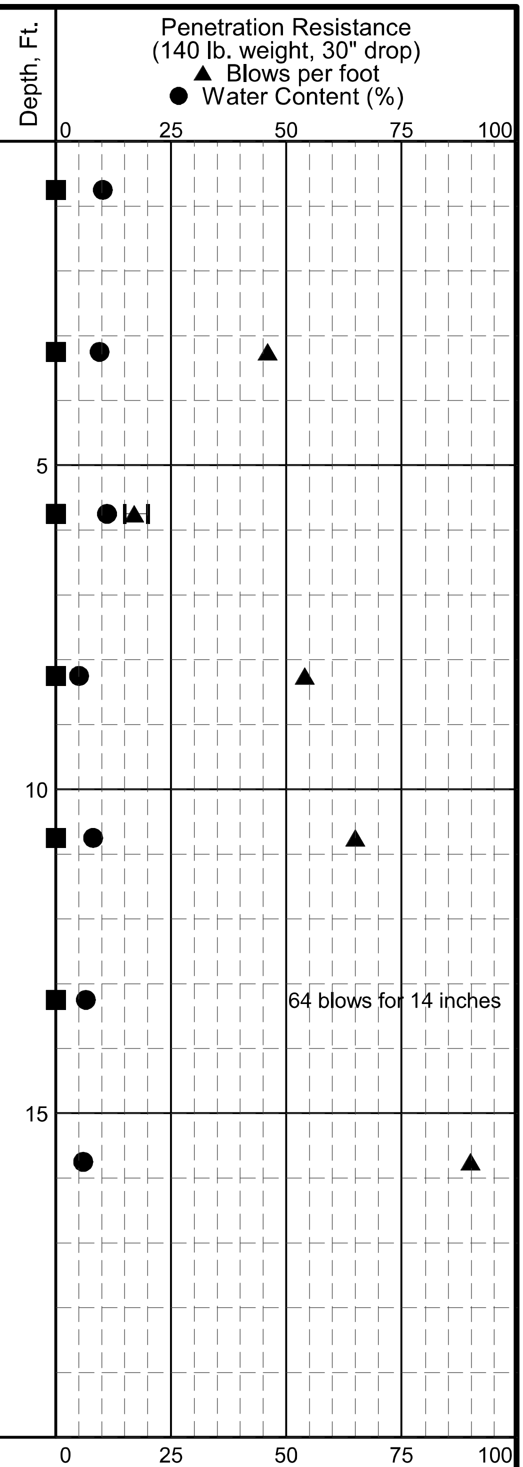
FIG. A-17

MATERIAL DESCRIPTION Approx. Elevation: 162 Ft.	Depth, Ft.	Samples
2 inches asphalt	0.2	
S1A: 38% Gravel, 44% Sand, 18% Fines (F3 [0.02mil])		S1A
Medium dense, brown, *Silty Sand with Gravel (SM)*; moist [FILL]	1.5	S1B
Stiff, gray-brown, *Organic Soil (OL)*; moist; wood matter present	2.2	
Dense, dark gray, *Silty Sand with Gravel (GM)*; moist to wet		S2
Very stiff, gray, *Silty Clay (CL-ML)*; moist	4.5	S3
Very dense, gray to dark gray, *Silty Sand with Gravel (SM)*; moist to wet [TILL]	7.0	S4
S5: 20% Gravel, 42% Sand, 38% Fines (F3 [P200])		S5
		S6
		S7
Bottom of Boring Boring Completed 8/21/2018	16.5	

Ground Water: 8/21/2018



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Ground Water Level At Time Of Drilling

● Water Content (%)

NOTES

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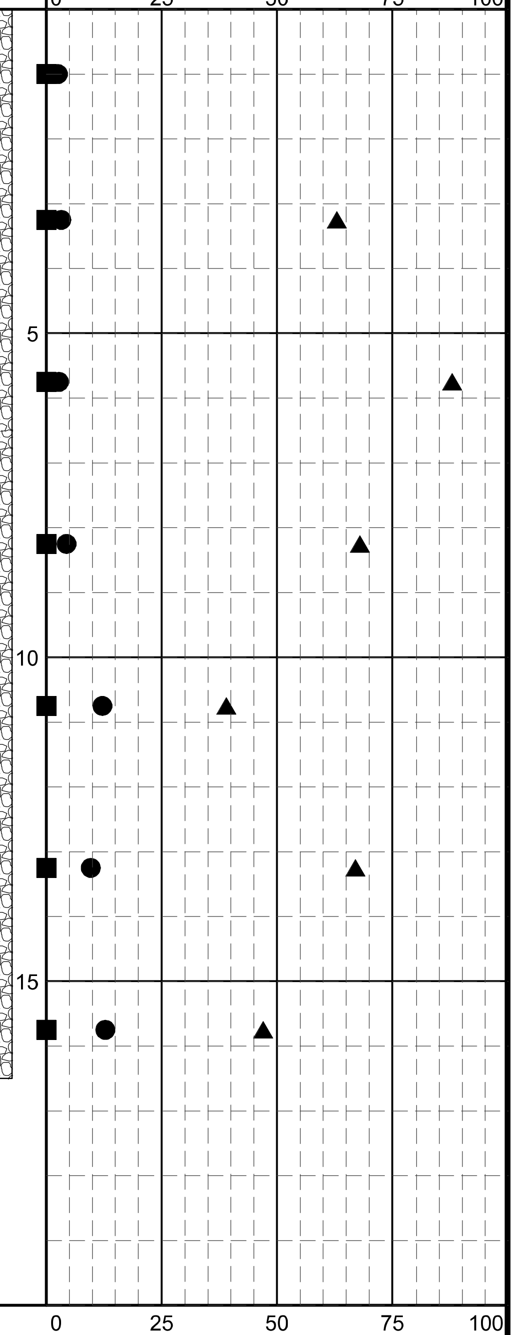
FIG. A-18

REV 3 - Approved for Submittal

MATERIAL DESCRIPTION Approx. Elevation: 158 Ft.	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
2 inches asphalt	0.2				
Medium dense to very dense, brown, *Silty Sand with Gravel (SM)*; moist to wet [FILL?]			S1		
S2: 38% Gravel, 48% Sand, 14% Fines (F2 [0.02mil])			S2		
					5
			S3		
			S4	9/6/20108	
Dense, gray-brown to brown, *Poorly Graded Sand with Silt and Gravel (SP)*; wet	9.5			8/22/2018	
					10
S5: 30% Gravel, 61% Sand, 9% Fines (F2 [P200])			S5		
Dense to very dense, gray, *Silty Sand with Gravel (SM)*; wet	12.0		S6		
					15
			S7		
Bottom of Boring Boring Completed 8/22/2018	16.5				

Penetration Resistance
(140 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Ground Water Level At Time Of Drilling
- Static Water Level
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill

NOTES

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LOG OF BORING B-17

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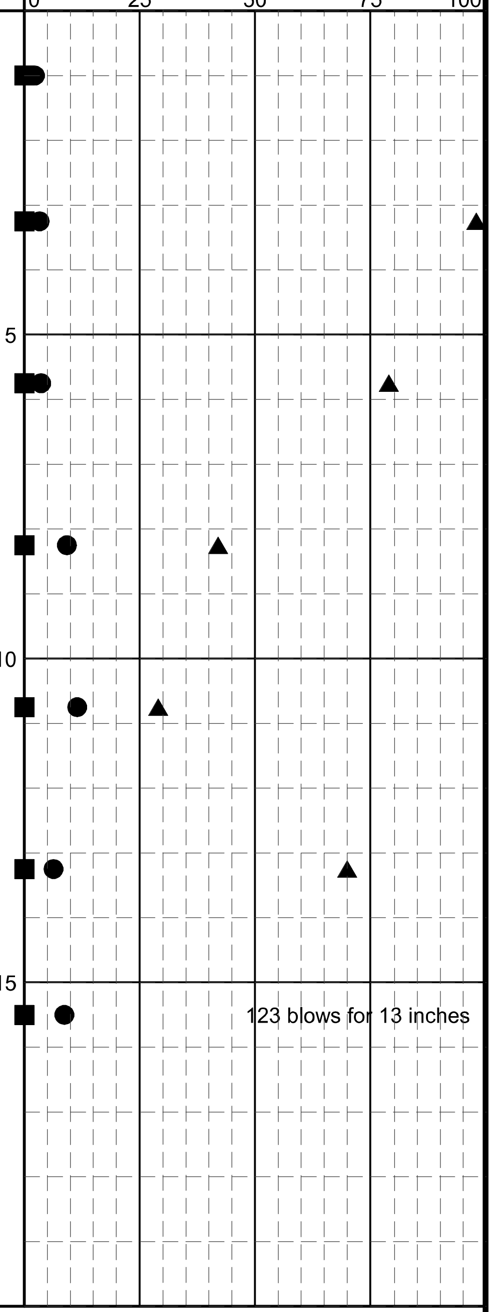
FIG. A-19

REV 3 - Approved for Submittal

MATERIAL DESCRIPTION Approx. Elevation: 156 Ft.	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
2 inches asphalt	0.2				0
Medium dense to very dense, brown, *Well-Graded Gravel with Sand (GW) to Well-Graded Sand with Silt and Gravel (SW-SM)*; moist [FILL] S1: 62% Gravel, 34% Sand, 4% Fines (NFS [P200])			S1 S2		
Medium dense to very dense, brown to gray, *Silty Sand with Gravel (SM)*; moist to wet; 6 inch thick PG Sand with Silt lense at approximately 10.5 feet bgs	4.5		S3 S4 S5	8/22/2018	5 10
Very dense, gray to gray-brown, *Silty Sand with Gravel (SM)*; wet S6: 24% Gravel, 50% Sand, 26% Fines (F3 [P200])	12.0		S6 S7		15
Bottom of Boring Boring Completed 8/22/2018	16.0				

Penetration Resistance
(140 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



● Water Content (%)

LEGEND

* Sample Not Recovered
Grab Sample
2" O.D. Split Spoon Sample
Ground Water Level At Time Of Drilling

NOTES

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LOG OF BORING B-18

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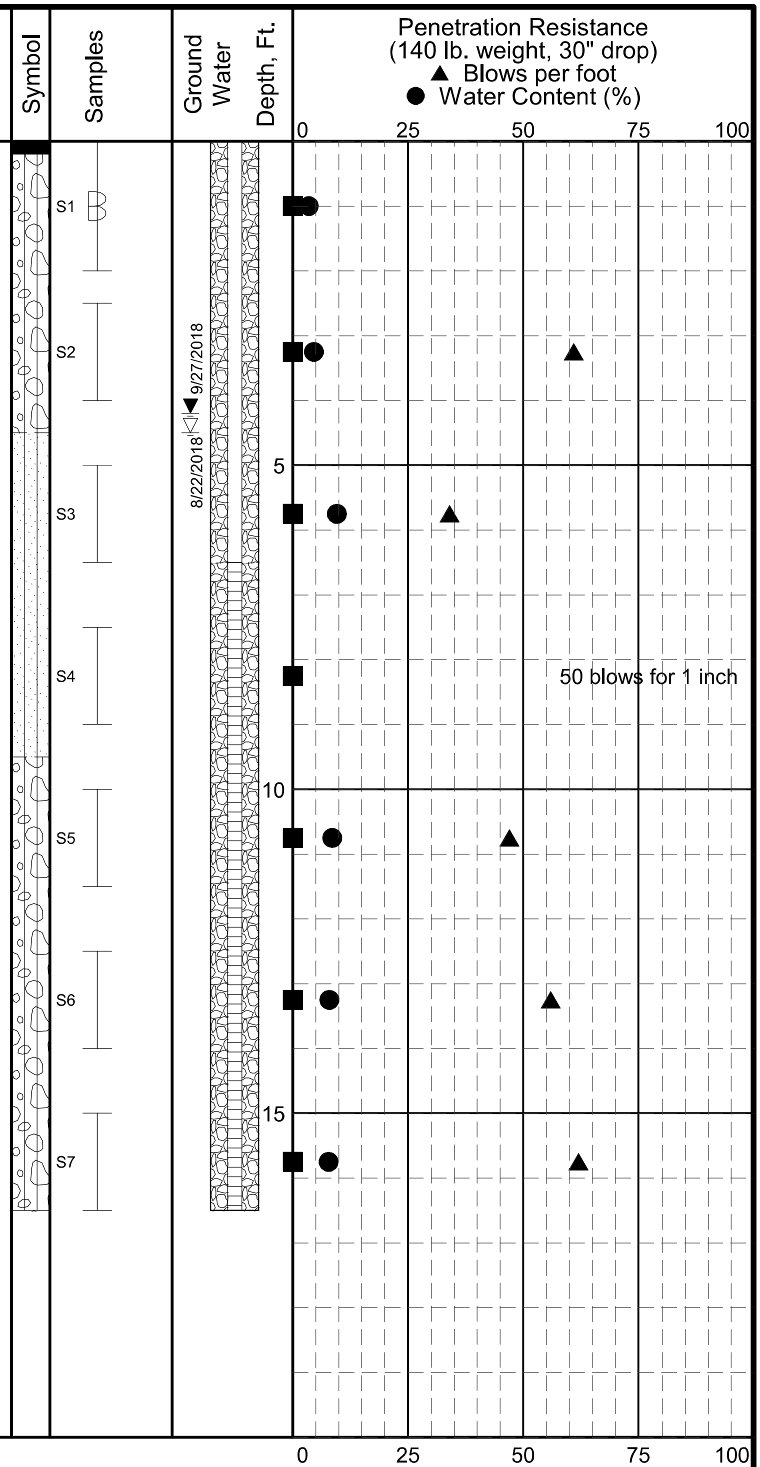
FIG. A-20

REV 3 - Approved for Submittal

GEOTECHNICAL LOG GINT - COMBINED.GPJ S&W GEO1.GDT 11/5/18

MATERIAL DESCRIPTION Approx. Elevation: 154 Ft.	Depth, Ft.
2 inches asphalt	0.2
Medium dense to very dense, gray-brown to brown, *Poorly Graded Gravel with Silt and Sand (GP-GM)*; moist [FILL] S1: 61% Gravel, 29% Sand, 9% Fines (F1 [0.02mil])	
Dense to very dense, gray-brown to brown, *Silty Sand with Gravel (SM)*; wet S3: 37% Gravel, 48% Sand, 15% Fines (F2 [P200])	4.5
Dense to very dense, gray, *Silty Gravel with Sand (GM) to Silty Sand with Gravel (SM)*; wet	9.5
Bottom of Boring Boring Completed 8/22/2018	16.5



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Ground Water Level At Time Of Drilling
- Static Water Level
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill

NOTES

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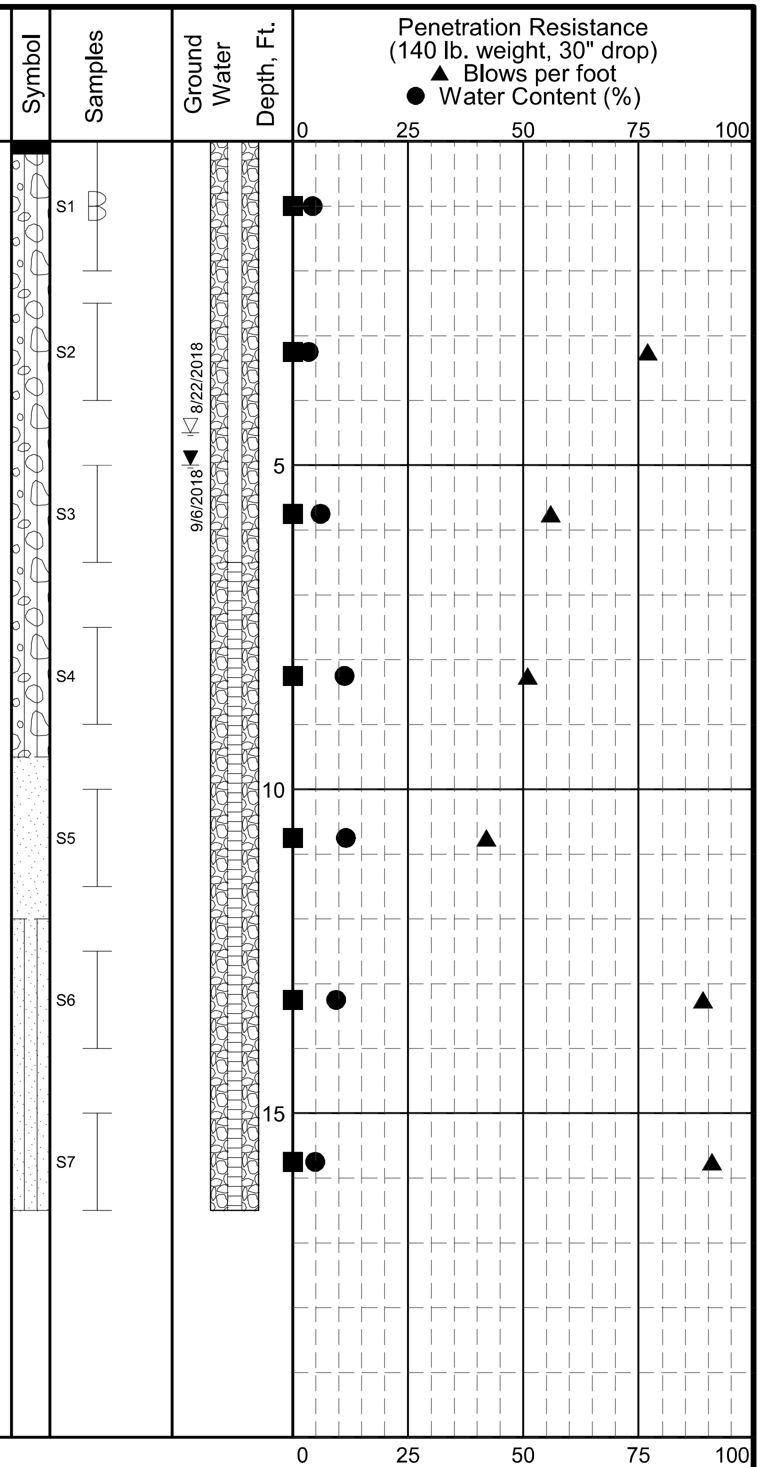
FIG. A-21

REV 3 - Approved for Submittal

GEOTECHNICAL LOG GINT - COMBINED.GPJ S&W GEO1.GDT 11/5/18

MATERIAL DESCRIPTION Approx. Elevation: 154 Ft.	Depth, Ft.
2 inches asphalt	0.2
Medium dense to very dense, brown to gray, *Silty Gravel with Sand (GM)*; moist to wet; possible base fill at 4.5 feet bgs S1: 51% Gravel, 33% Sand, 16% Fines (F2 [P200]) S4: 49% Gravel, 39% Sand, 12% Fines (F1 [P200])	9.5
Dense, gray, *Poorly Graded Sand with Silt and Gravel (SP)*; wet	12.0
Very dense, gray, *Silty Sand with Gravel (SM)*; moist to wet	16.5
Bottom of Boring Boring Completed 8/22/2018	



LEGEND

- * Sample Not Recovered
- Grab Sample
- 2" O.D. Split Spoon Sample
- Ground Water Level At Time Of Drilling
- Static Water Level
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill

NOTES

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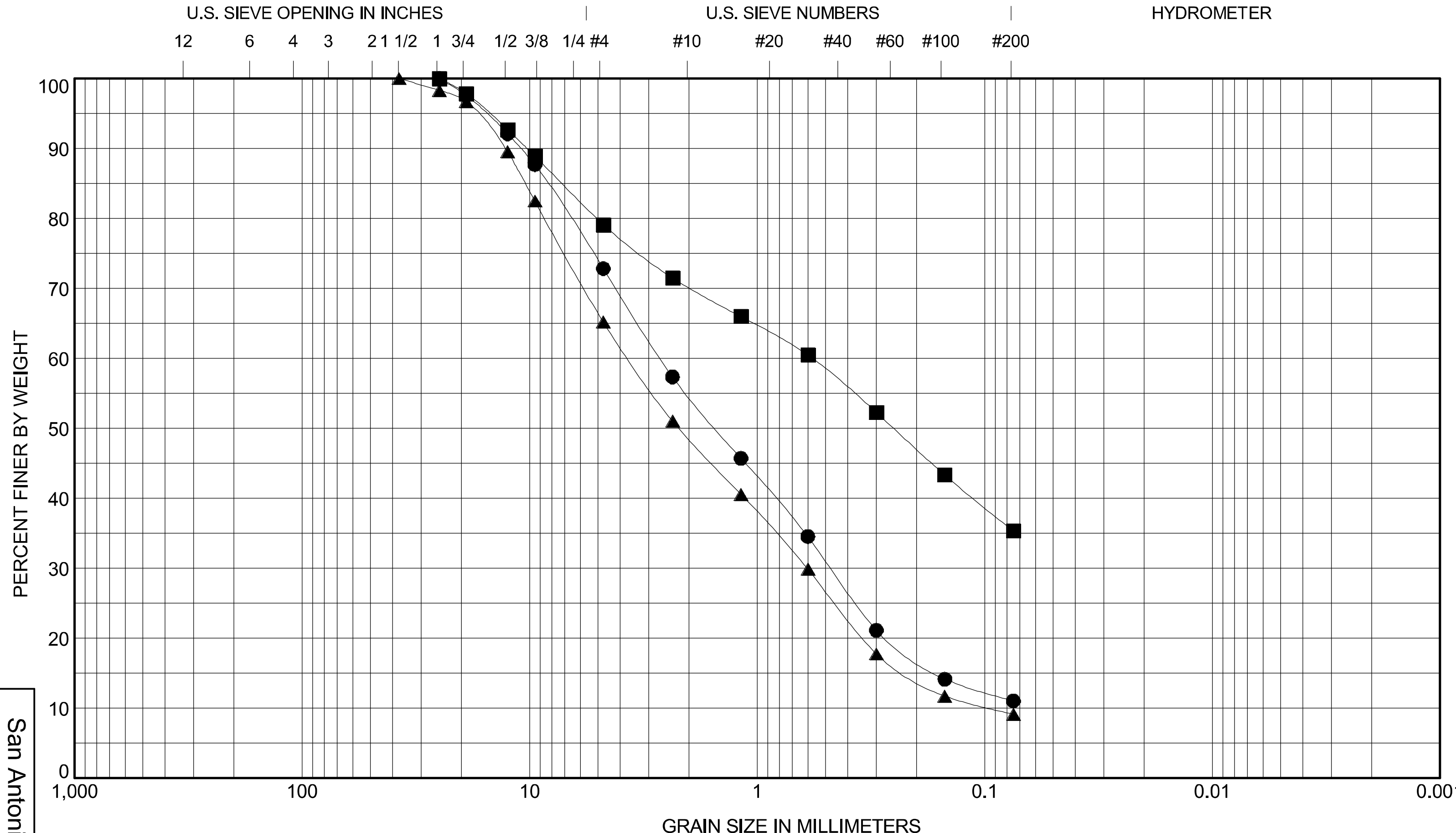
FIG. A-22

GEOTECHNICAL LOG GINT - COMBINED.GPJ S&W GEO1.GDT 11/5/18

REV 3 - Approved for Submittal



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**B-01 S1**	**0.0 - 1.5**	**Well-Graded Sand with Silt and Gravel (SW-SM)**				**1.4**	**44.6**
■	**B-01 S6**	**12.5 - 14.0**	**Silty Sand with Gravel (SM)**					
▲	**B-02 S1**	**0.0 - 1.5**	**Well-Graded Sand with Silt and Gravel (SW-SM)**				**1.0**	**38.8**

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-01 S1**	**0.0 - 1.5**	**25**	**2.66**	**0.47**		**27**	**62**	**11**	
■	**B-01 S6**	**12.5 - 14.0**	**25**	**0.58**			**21**	**44**	**35**	
▲	**B-02 S1**	**0.0 - 1.5**	**37.5**	**3.67**	**0.6**	**0.09**	**35**	**56**	**9**	

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GRAIN SIZE CLASSIFICATION

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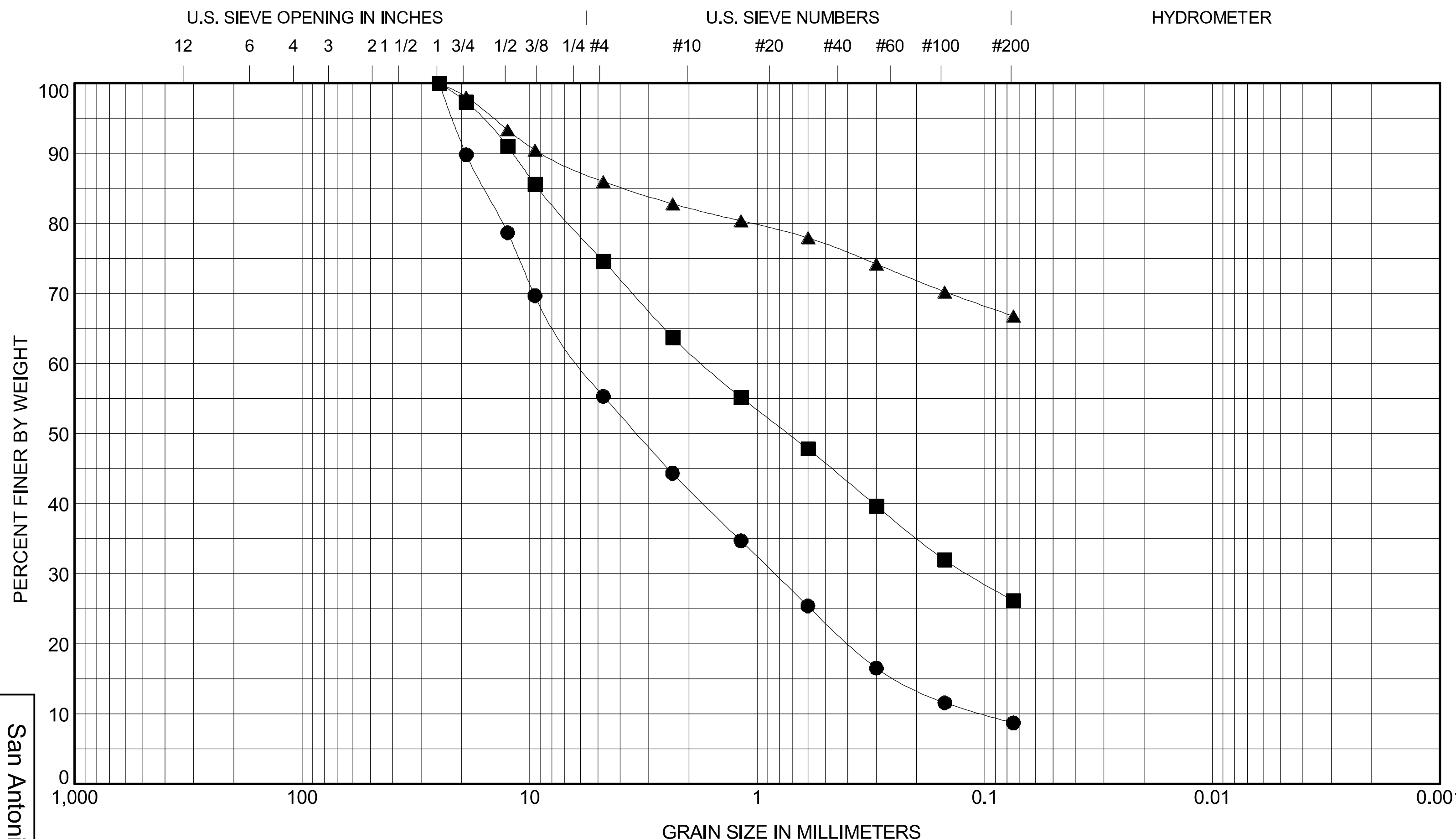
FIG. A-23
Sheet 1 of 14



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**B-02 S5**	**10.0 - 11.5**	**Well-Graded Sand with Silt and Gravel (SW-SM)**				**1.2**	**58.2**
■	**B-03 S1**	**0.0 - 1.5**	**Silty Sand with Gravel (SM)**					
▲	**B-03 S5**	**10.0 - 11.5**	**Sandy Silt (ML)**					

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-02 S5**	**10.0 - 11.5**	**25**	**5.95**	**0.84**	**0.1**	**45**	**47**	**9**	
■	**B-03 S1**	**0.0 - 1.5**	**25**	**1.74**	**0.12**		**25**	**48**	**26**	
▲	**B-03 S5**	**10.0 - 11.5**	**25**				**14**	**19**	**67**	

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FIG. A-23
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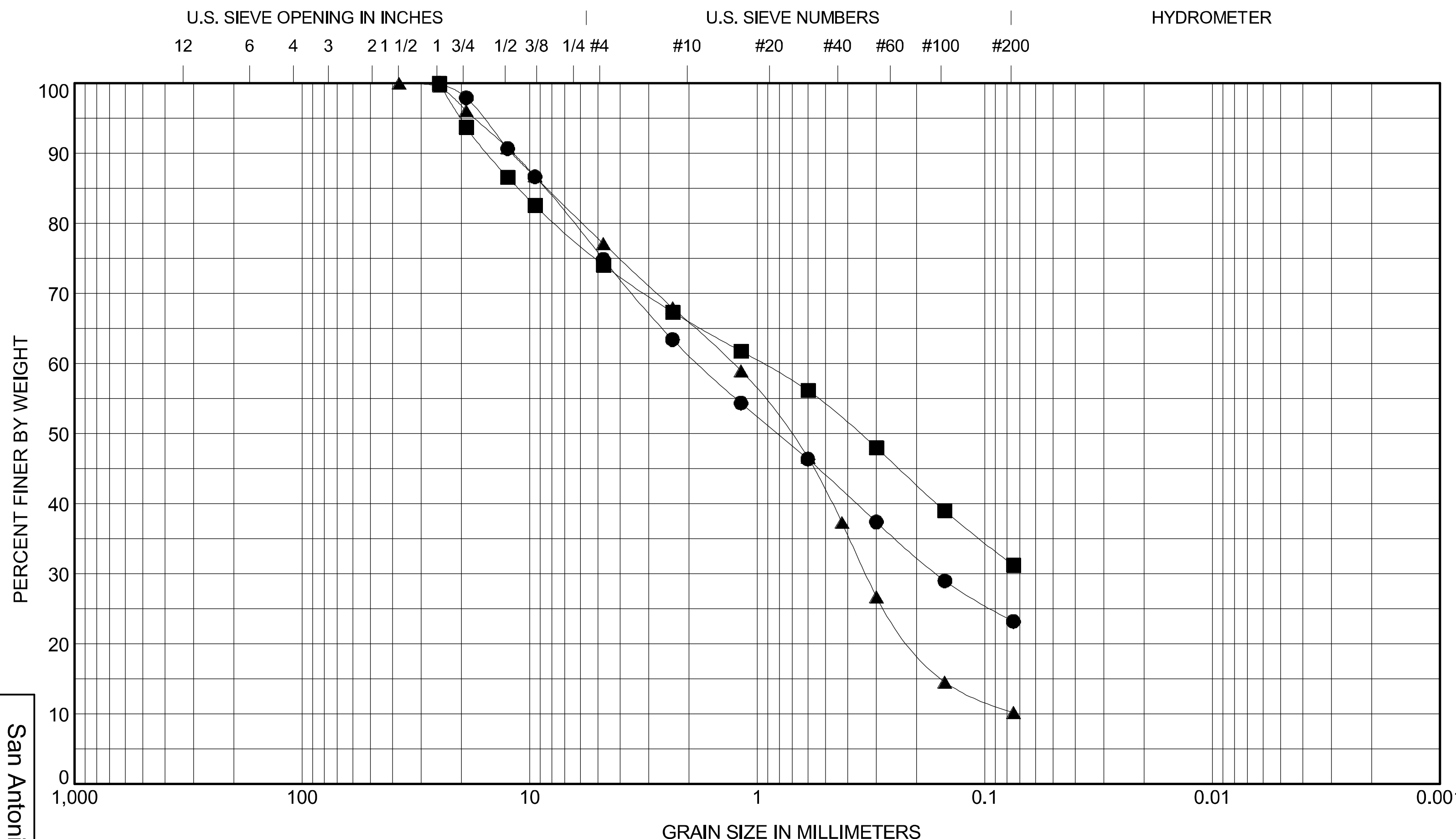

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-04 S1	0.0 - 1.5	**Silty Sand with Gravel (SM)**					
■	B-04 S4	7.5 - 9.0	**Silty Sand with Gravel (SM)**					
▲	B-05 S1	0.0 - 1.5	**Well-Graded Sand with Silt and Gravel (SW-SM)**				**1.2**	**17.5**

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-04 S1	0.0 - 1.5	**25**	**1.82**	**0.16**		**25**	**52**	**23**	
■	B-04 S4	7.5 - 9.0	**25**	**0.95**			**26**	**43**	**31**	
▲	B-05 S1	0.0 - 1.5	**37.5**	**1.28**	**0.33**		**23**	**67**	**10**	

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FIG. A-23
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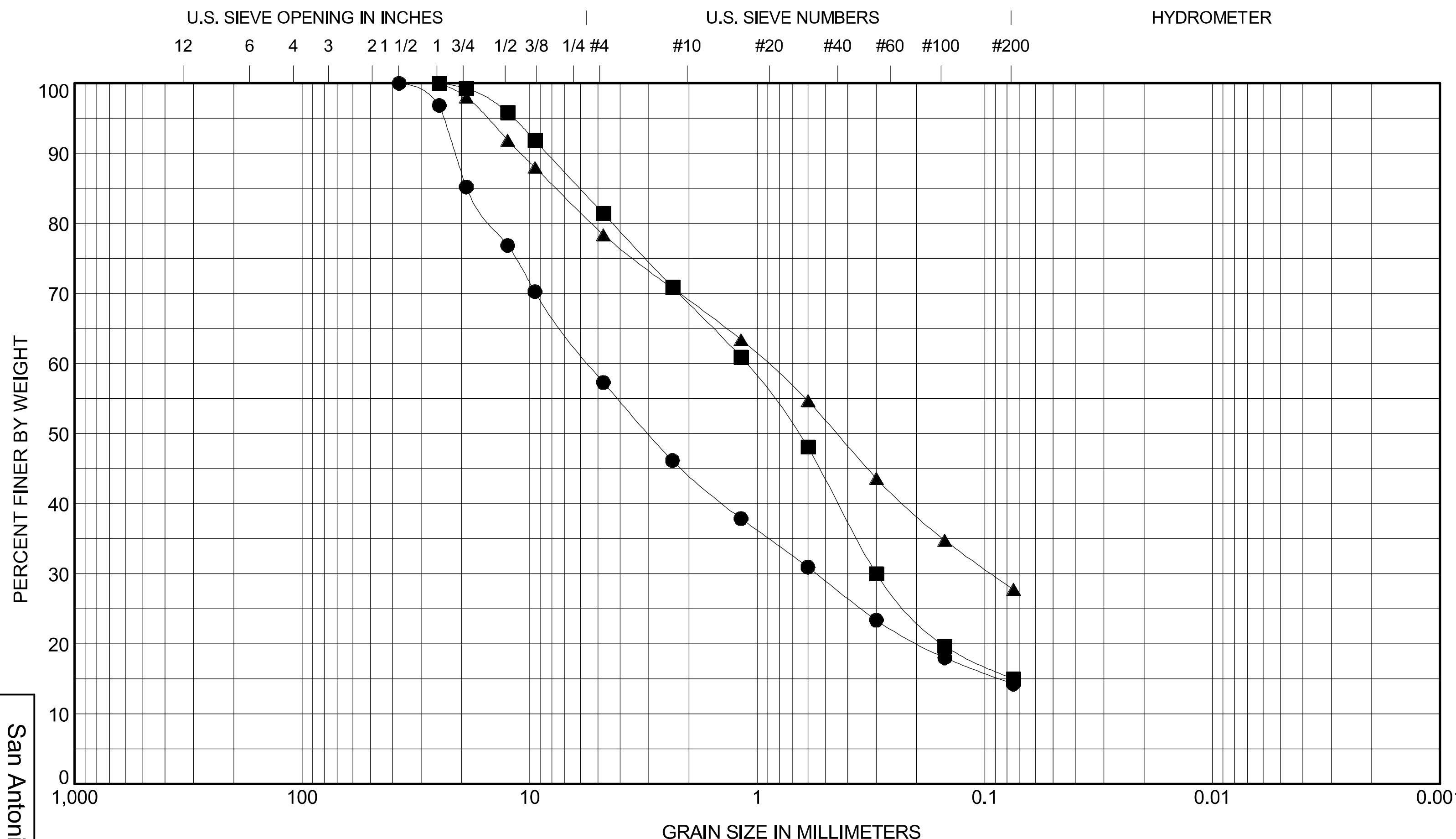

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
● B-05 S6	12.5 - 14.0	**Silty Sand with Gravel (SM)**					
■ B-06 S1	0.0 - 1.5	**Silty Sand with Gravel (SM)**					
▲ B-06 S5	10.0 - 11.5	**Silty Sand with Gravel (SM)**					

Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-05 S6	12.5 - 14.0	**37.5**	**5.49**	**0.55**		**43**	**43**	**14**	
■ B-06 S1	0.0 - 1.5	**25**	**1.12**	**0.3**		**19**	**66**	**15**	
▲ B-06 S5	10.0 - 11.5	**25**	**0.9**	**0.09**		**22**	**51**	**28**	

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FIG. A-23
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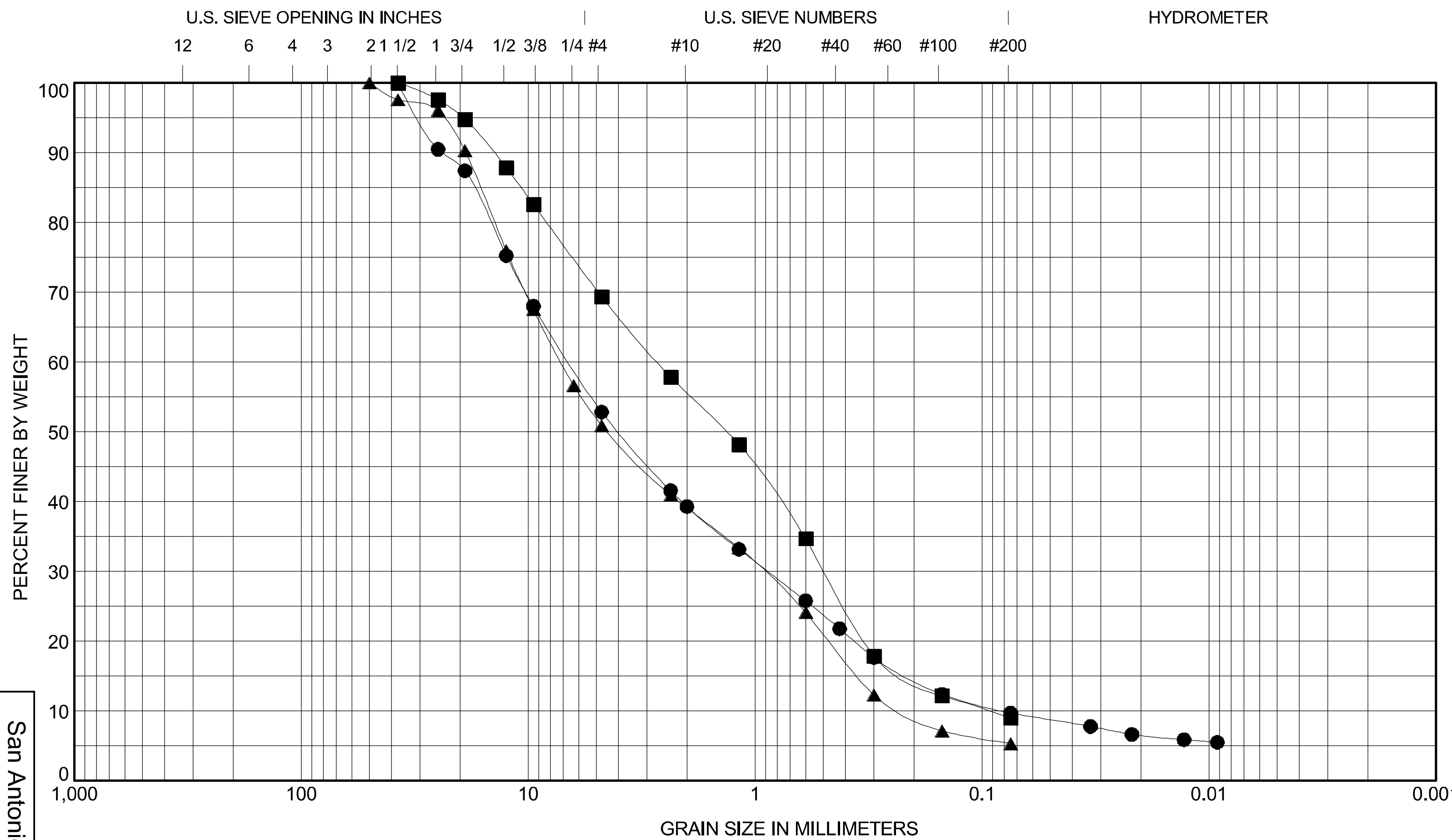

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-07 S2	2.5 - 4.0	**Well-Graded Gravel with Silt and Sand (GW-GM)**				1.5	81.1
■	B-07 S4	7.5 - 9.0	**Well-Graded Sand with Silt and Gravel (SW-SM)**				1.0	28.8
▲	B-08 S1	0.0 - 1.5	**Poorly Graded Gravel with Silt and Sand (GP-GM)**				0.5	32.4

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-07 S2	2.5 - 4.0	37.5	6.59	0.88	0.08	47	43	10	
■	B-07 S4	7.5 - 9.0	37.5	2.69	0.5	0.09	31	60	9	
▲	B-08 S1	0.0 - 1.5	50	7.16	0.92	0.22	49	46	5	

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FIG. A-23
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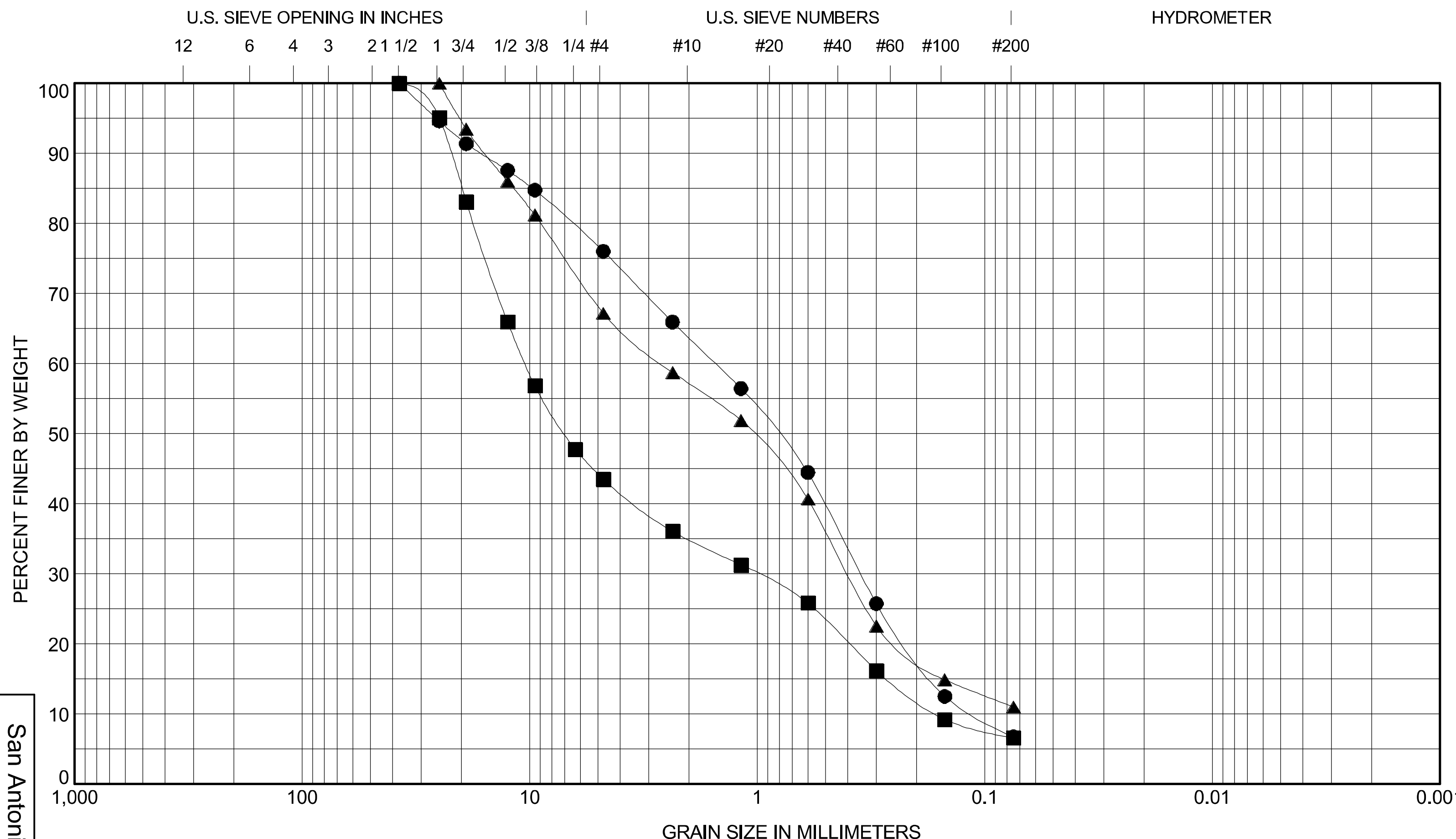

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-08 S6	12.5 - 14.0	**Poorly Graded Sand with Silt and Gravel (SP-SM)**				0.7	13.8
■	B-09 S1	0.0 - 1.5	**Poorly Graded Gravel with Silt and Sand (GP-GM)**				0.6	64.4
▲	B-09 S4	7.5 - 9.0	**Well-Graded Sand with Silt and Gravel (SW-SM)**				1.0	42.0

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-08 S6	12.5 - 14.0	37.5	1.53	0.35	0.11	24	69	7	
■	B-09 S1	0.0 - 1.5	37.5	10.46	1.01	0.16	57	37	7	
▲	B-09 S4	7.5 - 9.0	25	2.62	0.4		33	56	11	

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FIG. A-23
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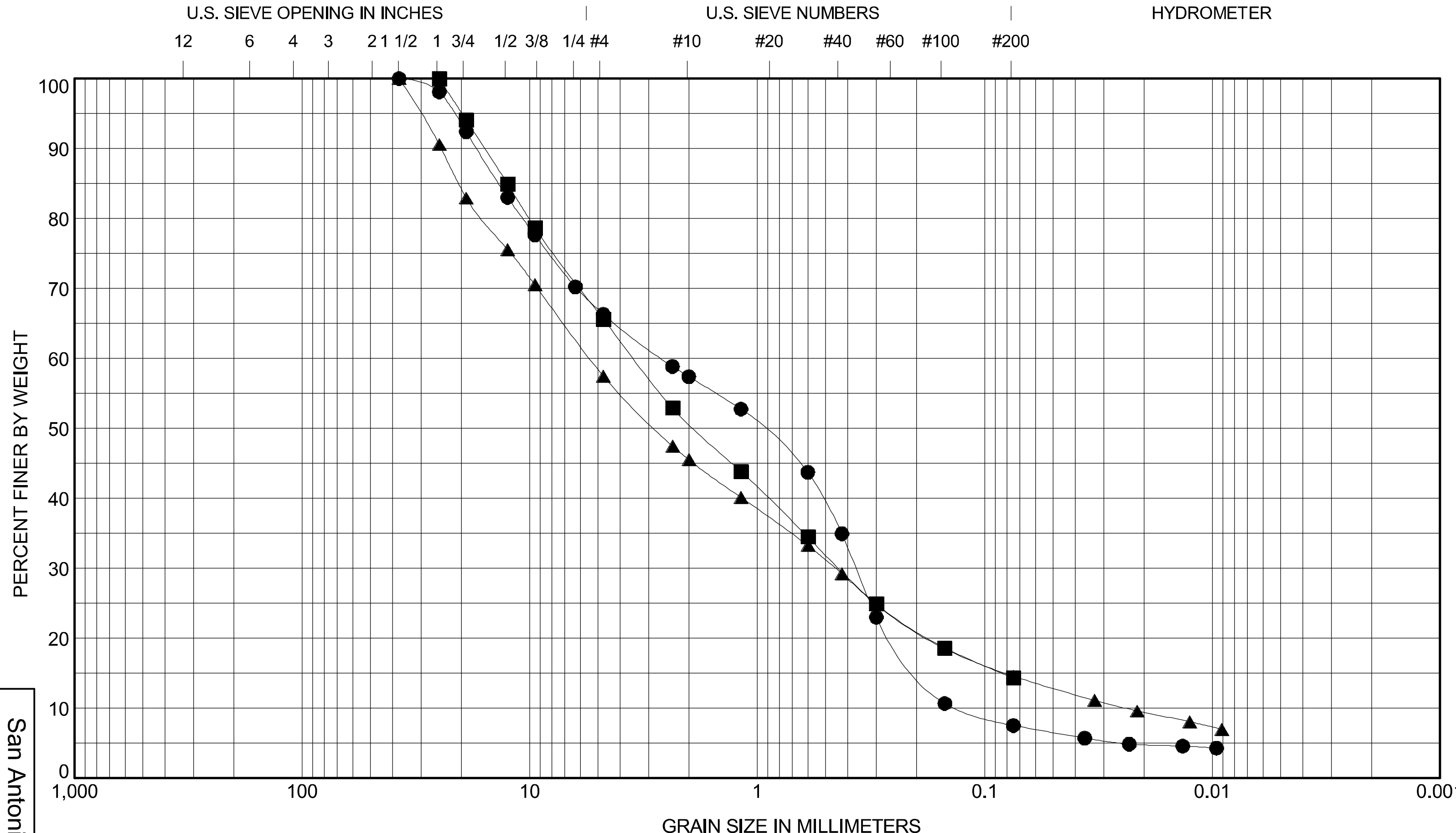

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-10 S1	0.0 - 2.0	**Poorly Graded Sand with Silt and Gravel (SP-SM)**				0.4	20.3
■	B-10 S4	7.5 - 9.0	**Silty Sand with Gravel (SM)**					
▲	B-11 S2	2.5 - 4.0	**Silty Gravel with Sand (GM)**				1.6	226.1

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-10 S1	0.0 - 2.0	37.5	2.63	0.37	0.13	34	59	8	
■	B-10 S4	7.5 - 9.0	25	3.49	0.43		34	51	14	
▲	B-11 S2	2.5 - 4.0	37.5	5.43	0.45	0.02	43	43	15	

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FIG. A-23
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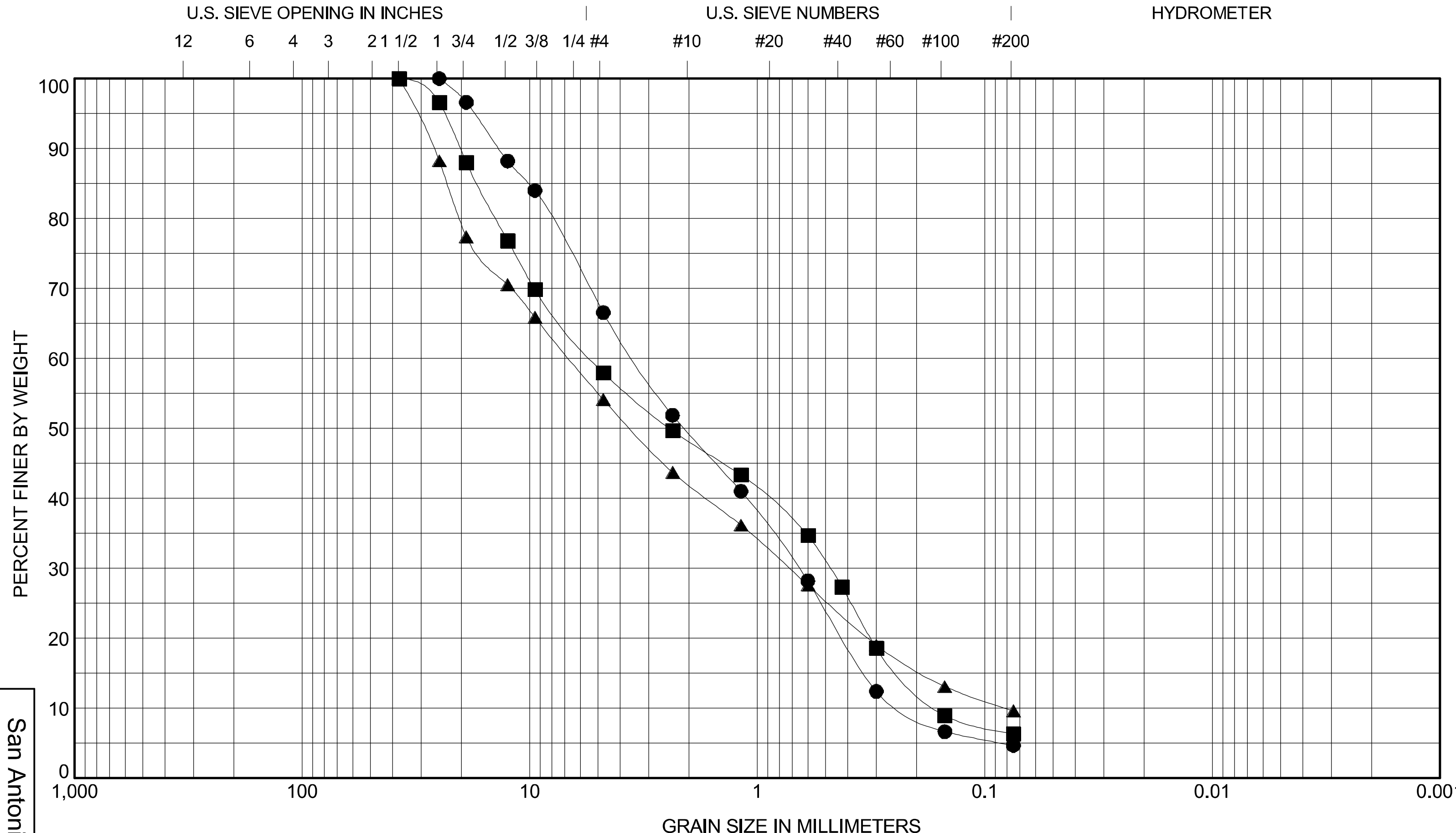

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-11 S5	10.0 - 11.5	**Poorly Graded Sand with Silt and Gravel (SP-SM)**				**0.6**	**15.5**
■	B-12 S1	0.0 - 1.5	**Poorly Graded Sand with Silt and Gravel (SP-SM)**				**0.3**	**33.1**
▲	B-12 S3	5.0 - 6.5	**Well-Graded Gravel with Silt and Sand (GW-GM)**				**1.0**	**82.7**

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-11 S5	10.0 - 11.5	**25**	**3.48**	**0.66**	**0.22**	**33**	**62**	**5**	
■	B-12 S1	0.0 - 1.5	**37.5**	**5.37**	**0.48**	**0.16**	**42**	**52**	**6**	
▲	B-12 S3	5.0 - 6.5	**37.5**	**6.72**	**0.73**	**0.08**	**46**	**45**	**10**	

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FIG. A-23
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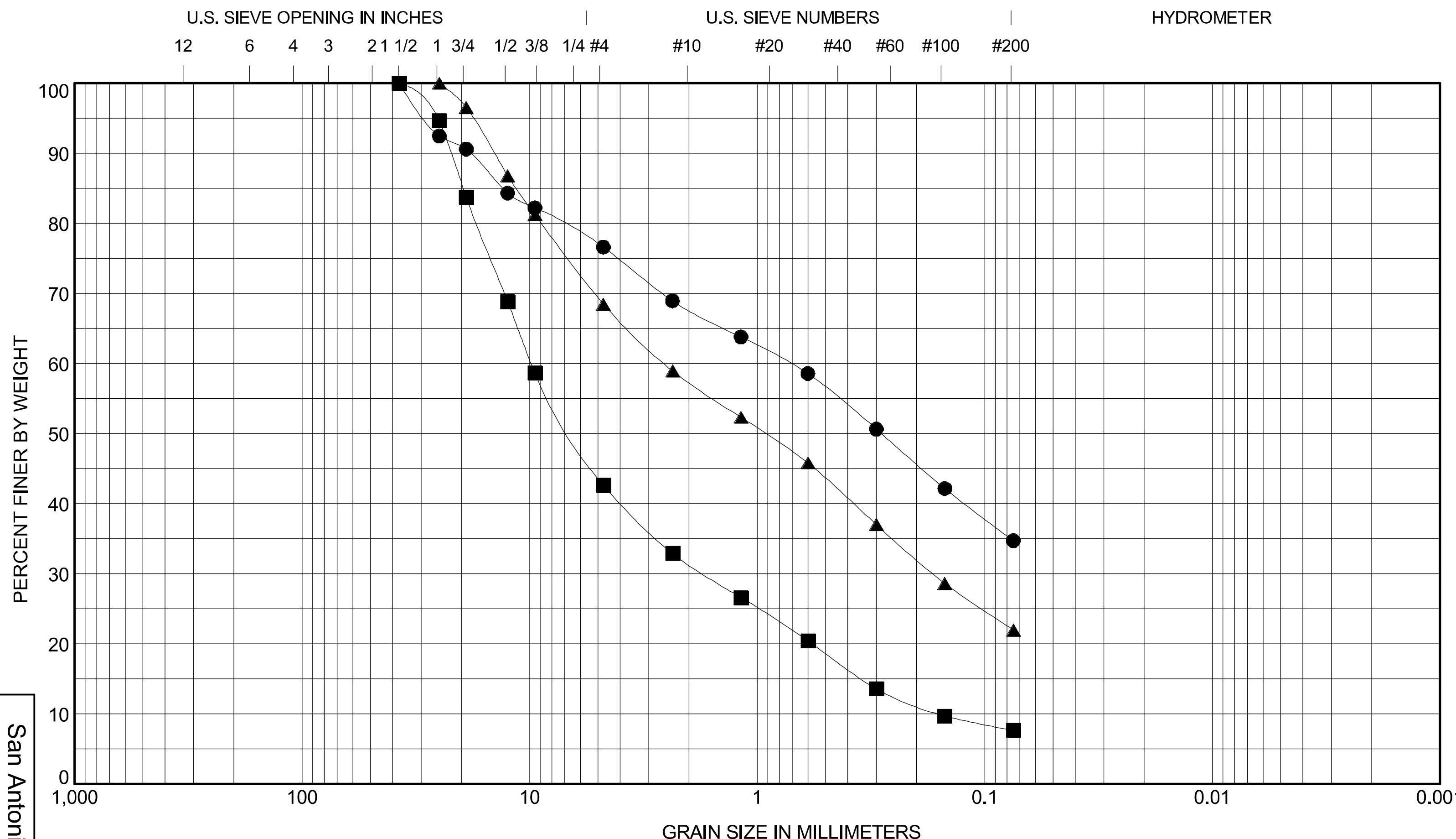

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
● B-12 S6	12.5 - 14.0	**Silty Sand with Gravel (SM)**					
■ B-13 S1	0.0 - 1.5	**Well-Graded Gravel with Silt and Sand (GW-GM)**				**1.9**	**62.3**
▲ B-13 S4	7.5 - 9.0	**Silty Sand with Gravel (SM)**					

Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-12 S6	12.5 - 14.0	**37.5**	**0.72**			**23**	**42**	**35**	
■ B-13 S1	0.0 - 1.5	**37.5**	**9.85**	**1.71**	**0.16**	**57**	**35**	**8**	
▲ B-13 S4	7.5 - 9.0	**25**	**2.55**	**0.17**		**32**	**47**	**22**	

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FIG. A-23
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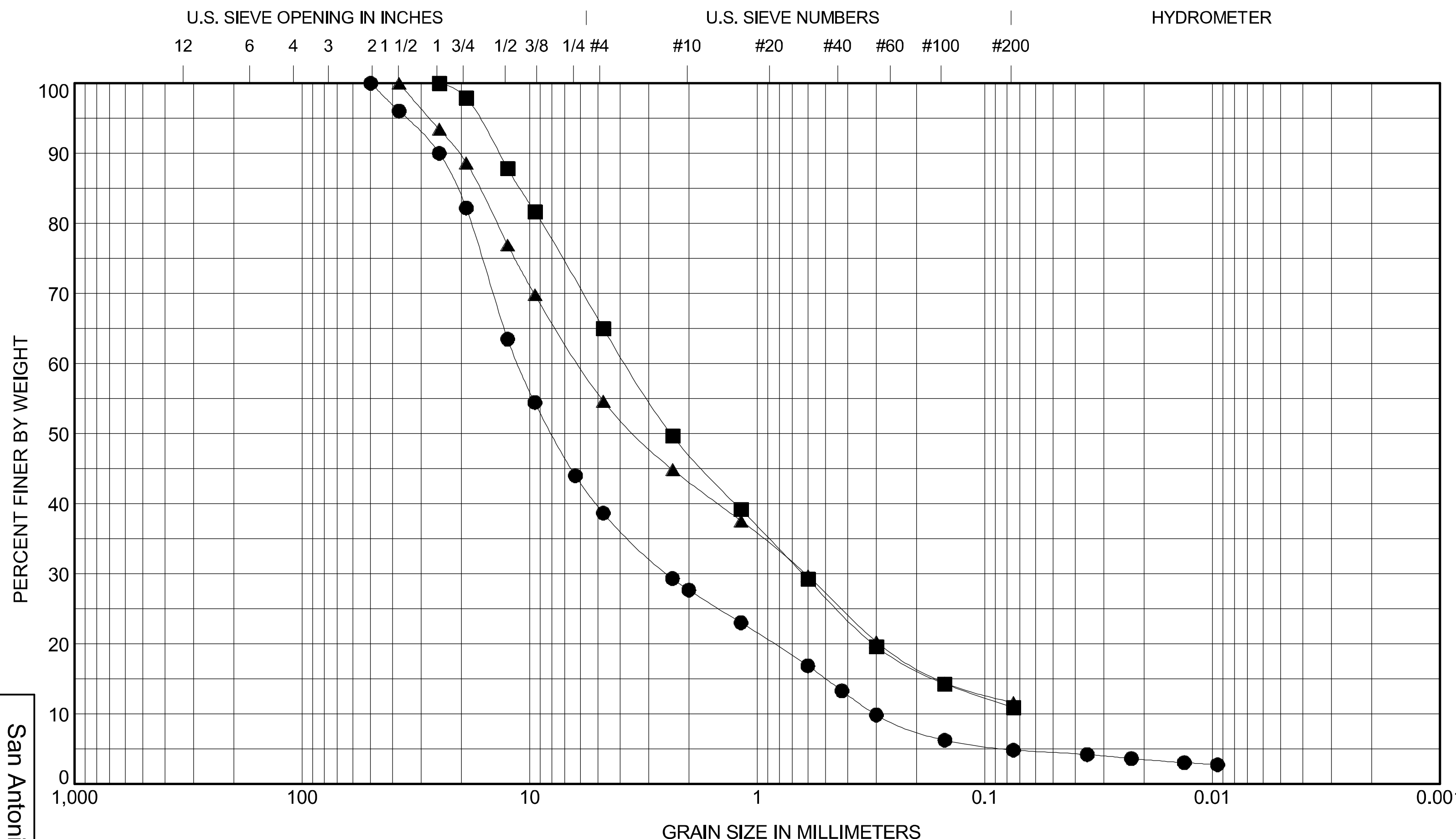

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**B-14 S1**	**0.0 - 2.0**	**Well-Graded Gravel with Silt and Sand (GW-GM)**				**1.8**	**36.9**
■	**B-14 S6**	**12.5 - 14.0**	**Well-Graded Sand with Silt and Gravel (SW-SM)**				**1.7**	**60.9**
▲	**B-15 S1**	**0.0 - 1.5**	**Well-Graded Gravel with Silt and Sand (GW-GM)**				**1.2**	**120.3**

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-14 S1**	**0.0 - 2.0**	**50**	**11.25**	**2.48**	**0.3**	**61**	**34**	**5**	
■	**B-14 S6**	**12.5 - 14.0**	**25**	**3.78**	**0.63**		**35**	**54**	**11**	
▲	**B-15 S1**	**0.0 - 1.5**	**37.5**	**6.07**	**0.61**		**45**	**43**	**12**	

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FIG. A-23
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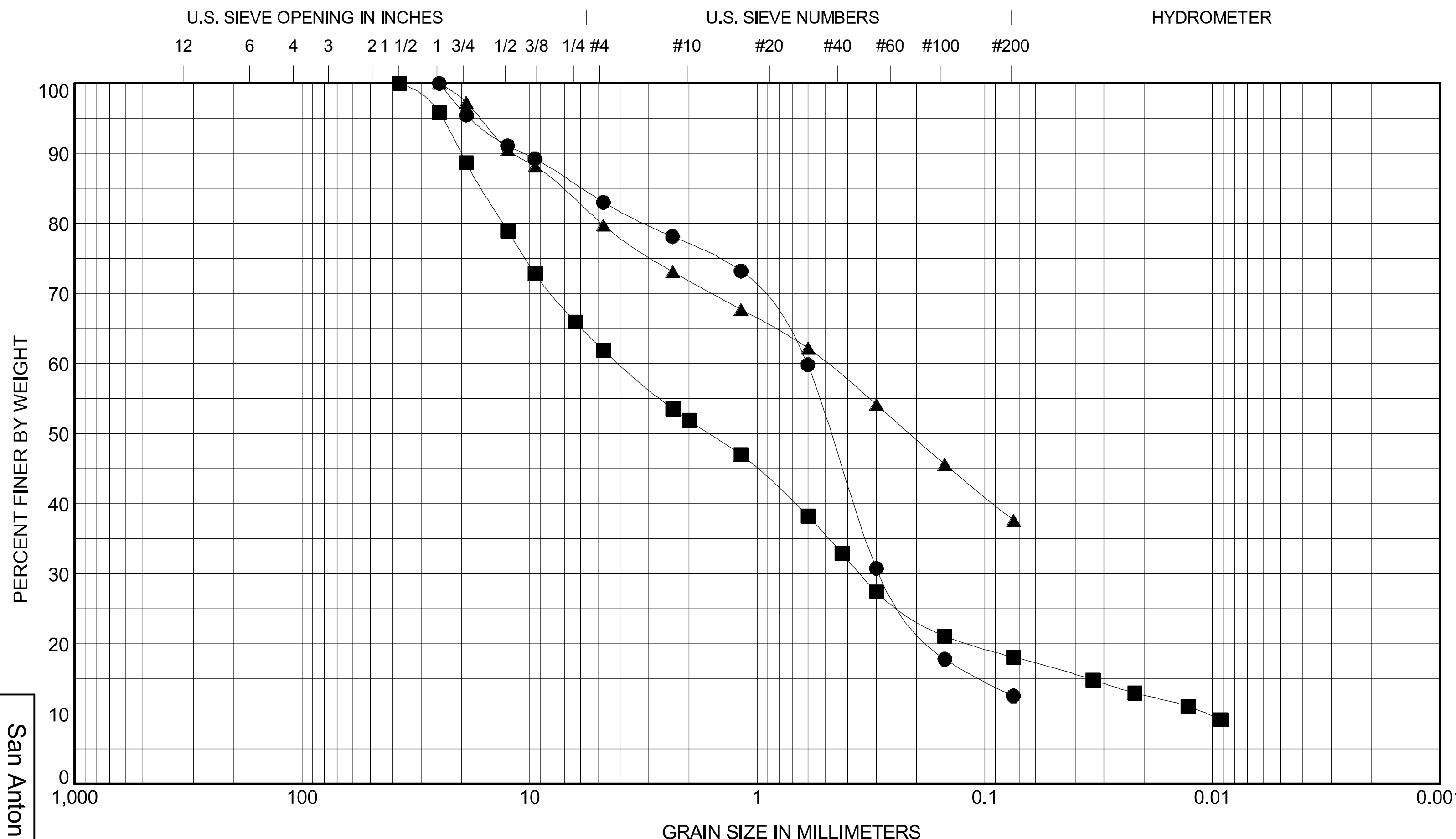

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-15 S4B	8.0 - 9.5	**Silty Sand with Gravel (SM)**					
■	B-16 S1	0.0 - 2.0	**Silty Sand with Gravel (SM)**				**2.9**	**381.5**
▲	B-16 S5	10.0 - 11.5	**Silty Sand with Gravel (SM)**					

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-15 S4B	8.0 - 9.5	**25**	**0.61**	**0.29**		**17**	**70**	**13**	
■	B-16 S1	0.0 - 2.0	**37.5**	**4.06**	**0.35**	**0.01**	**38**	**44**	**18**	
▲	B-16 S5	10.0 - 11.5	**25**	**0.5**			**20**	**42**	**38**	

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FIG. A-23
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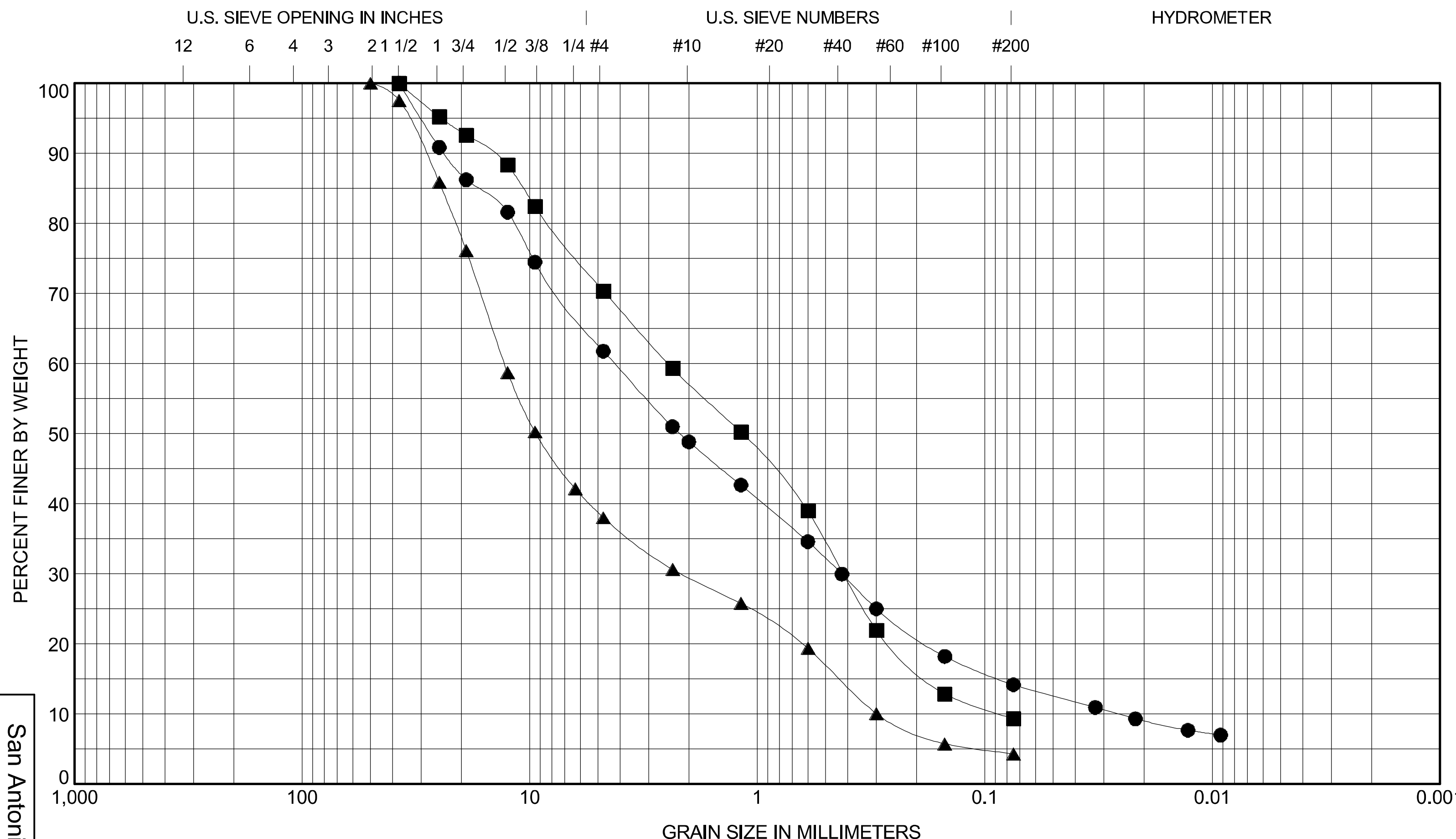

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-17 S2	2.5 - 4.0	**Silty Sand with Gravel (SM)**				1.7	163.3
■	B-17 S5	10.0 - 11.5	**Poorly Graded Sand with Silt and Gravel (SP-SM)**				0.8	28.9
▲	B-18 S1	0.0 - 1.5	**Well-Graded Gravel with Sand (GW)**				1.2	43.3

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-17 S2	2.5 - 4.0	37.5	4.24	0.43	0.03	38	48	14	
■	B-17 S5	10.0 - 11.5	37.5	2.46	0.42	0.09	30	61	9	
▲	B-18 S1	0.0 - 1.5	50	12.9	2.16	0.3	62	34	4	

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FIG. A-23
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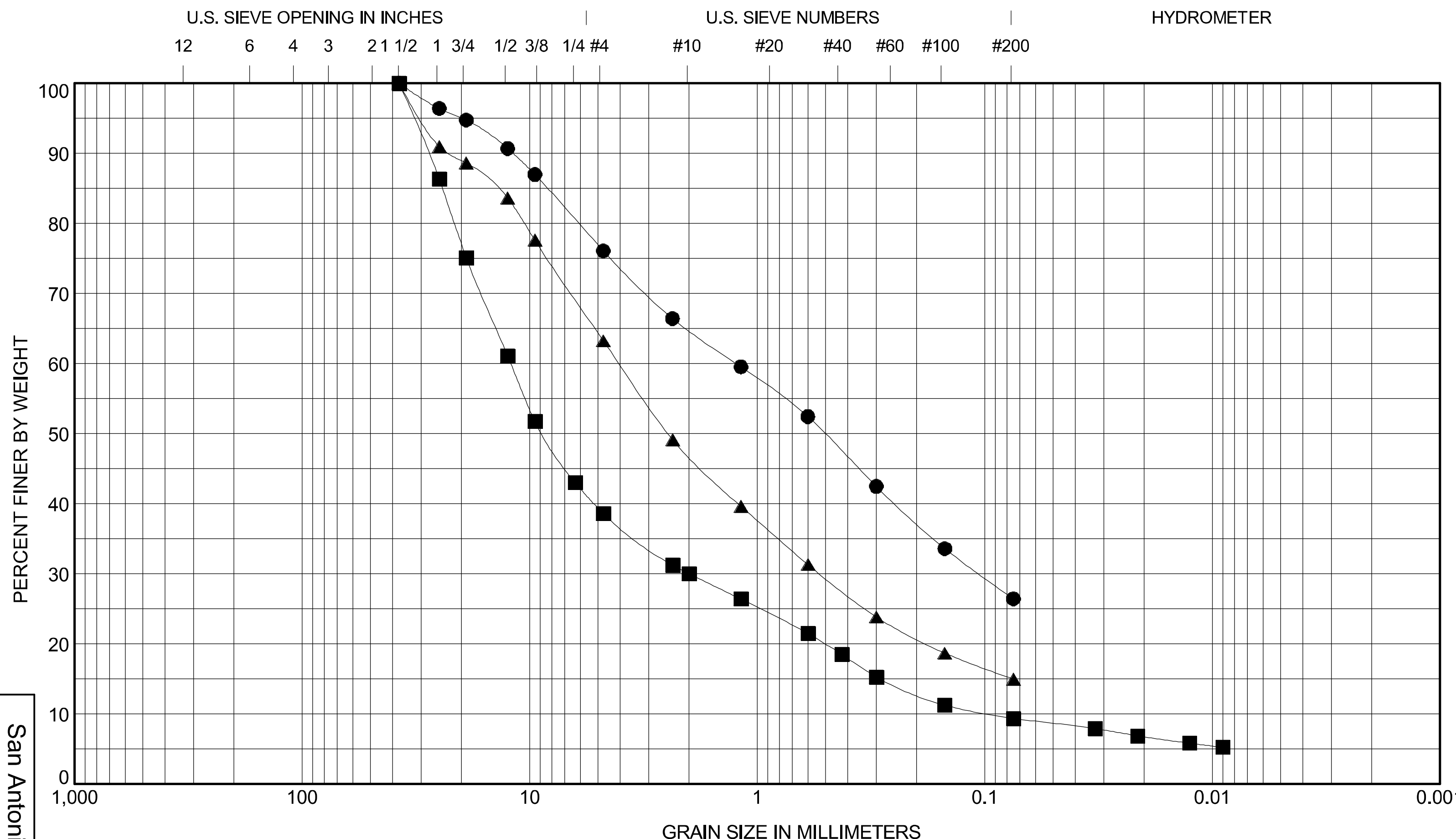

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-18 S6	12.5 - 14.0	**Silty Sand with Gravel (SM)**					
■	B-19 S1	0.0 - 2.0	**Poorly Graded Gravel with Silt and Sand (GP-GM)**				3.4	127.1
▲	B-19 S3	5.0 - 6.5	**Silty Sand with Gravel (SM)**					

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-18 S6	12.5 - 14.0	37.5	1.24	0.11		24	50	26	
■	B-19 S1	0.0 - 2.0	37.5	12.11	1.99	0.1	61	29	9	
▲	B-19 S3	5.0 - 6.5	37.5	4.04	0.53		37	48	15	

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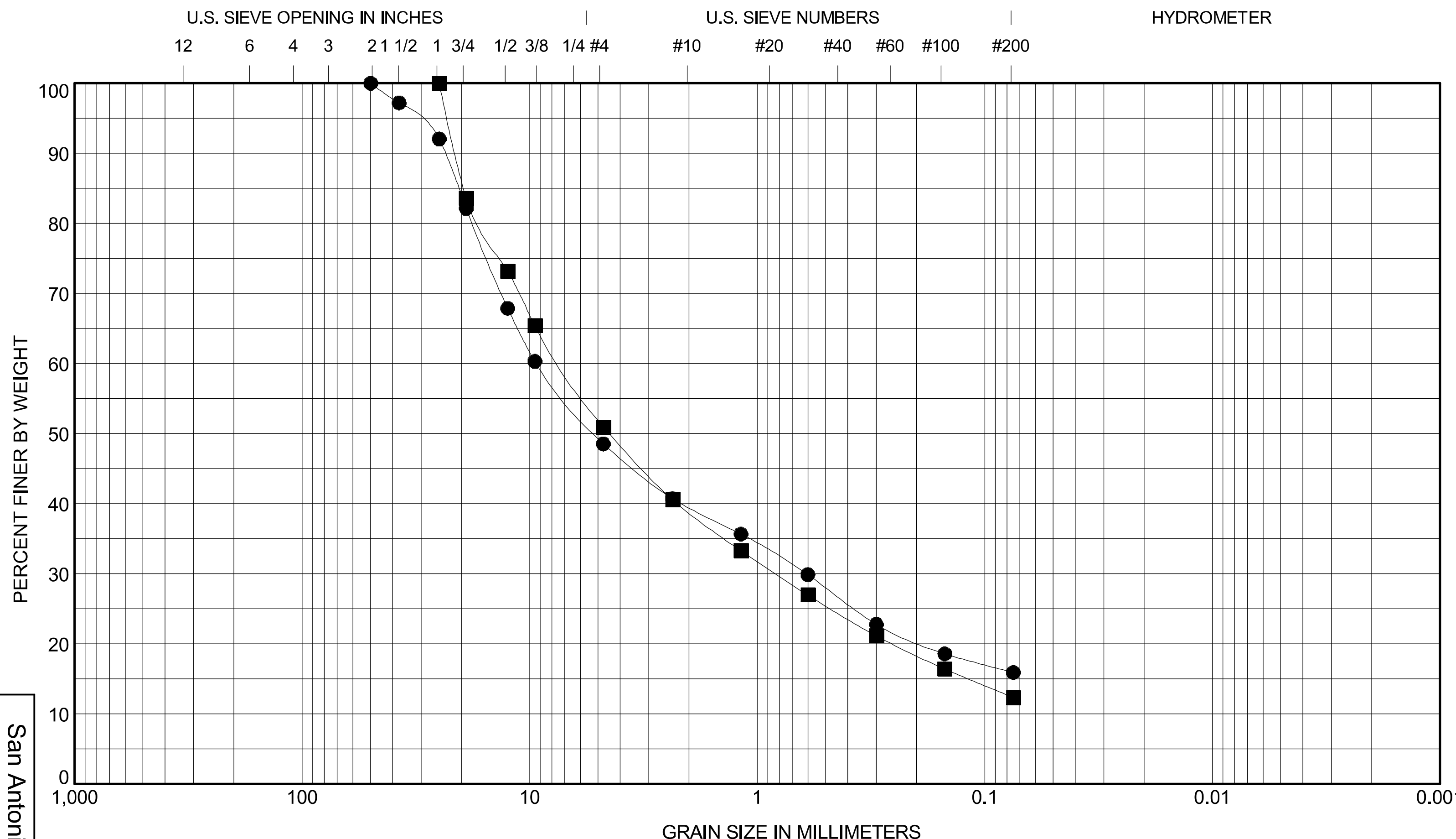

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
● B-20 S1	0.0 - 1.5	**Silty Gravel with Sand (GM)**					
■ B-20 S4	7.5 - 9.0	**Silty Gravel with Sand (GM)**				**1.9**	**146.3**

Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-20 S1	0.0 - 1.5	**50**	**9.33**	**0.61**		**51**	**33**	**16**	
■ B-20 S4	7.5 - 9.0	**25**	**7.33**	**0.83**		**49**	**39**	**12**	

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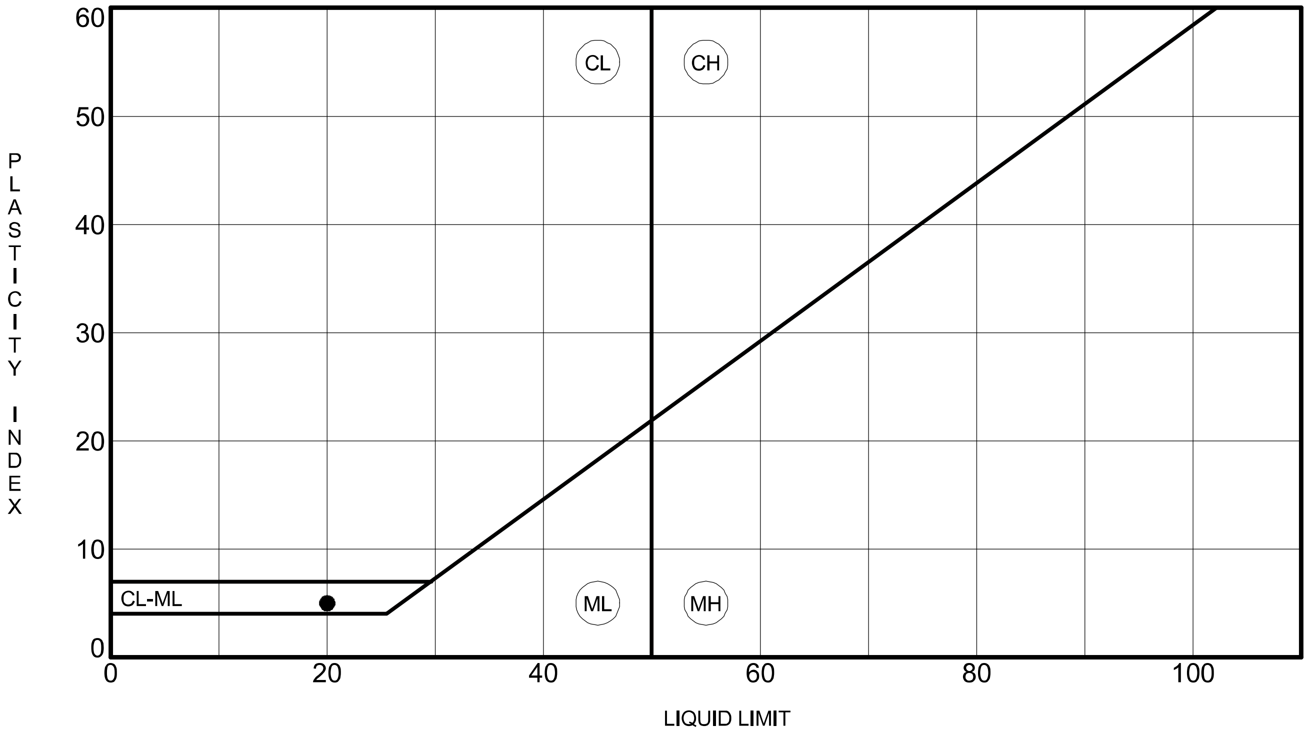

	Boring	Depth, Ft	LL	PL	PI	Fines	Classification
●	**B-16**	**5.0 - 6.5**	**20**	**15**	**5**		**Silty Clay (CL-ML)**

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ATTERBERG LIMITS RESULTS

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FIG. A-24

APPENDIX B

RESULTS OF CORROSIVITY EVALUATION BY COFFMAN ENGINEERS

April 15, 2018

Shannon & Wilson, Inc.
5430 Fairbanks Street, Suite 3
Anchorage, Alaska 99518

Attention: Mr. Thomas Keatts

Reference: AWWU SAN ANTONIO, CAMILA AND SAN ROBERTO SOIL CORROSIVITY REPORT
S & W PROJECT #32-1-20095

Dear Thomas:

A soil corrosivity evaluation was performed on six samples obtained for testing. The soil samples were tested and evaluated by Coffman Engineers. Testing was performed in accordance with ASTM G57-06 (Reapproved 2012) "Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method" and ASTM G51-95 (Reapproved 2012) "Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing".

The correlation between soil corrosivity and the physical and chemical constituents that comprise the soil were evaluated. Factors that affect the corrosivity of soils include soil resistivity, soluble salt content, pH, soil type (permeability), aeration, moisture content, Redox potential, amount of microbes in the soil and stray currents. No single factor or measurement should be used to determine the corrosivity of soil.

The corrosion rate of metallic structures in soil depends on the nature of the soil and other environmental factors, such as the availability to moisture and oxygen. These factors can lead to extreme variations in the rate of the attack. For example, under extreme conditions a buried metallic structure may perforate and lose integrity in less than one year, conversely archeological digs in arid desert regions have uncovered iron tools that are hundreds of years old. The following general guidelines may be formulated: Soils with high moisture content, high electrical conductivity, high acidity, and high dissolved salts will typically be the most corrosive.

Soil Resistivity & Uniformity

One of the best criterions for estimating the corrosivity of a soil is to determine its resistivity, which depends largely upon the nature and amount of dissolved salts in the soil. It is generally recognized that soluble salts, such as chloride and sulfate ions, increase the corrosivity of soil. Temperature, moisture content, compaction and presence of inert materials also affect soil resistivity.

Soil resistivity affects corrosion in several ways. The lower the resistivity, the better the soil conducts current flow and the greater the soil corrosivity. Low resistivity soils may contain high concentrations of soluble salts. The salts attack the protective oxide films on the steel surface, accelerating the rate of the electrochemical reactions, therefore increasing the corrosivity of the soil.

A general guideline for soil corrosivity as related to resistivity is listed below:

Soil Resistivity (Ohm-cm)	Soil Corrosivity
Below 1,000	Very Corrosive
1,000 – 2,000	Corrosive
2,000 – 5,000	Moderately Corrosive
5,000-10,000	Mildly Corrosive
Above 10,000	Progressively Less Corrosive

The preceding guideline may be used as a soil corrosivity indicator, but no single measurement or criterion should be used to determine the corrosivity of soil. Corrosion of structures, where bacteria, oxygen concentration cells and other corrosion mechanisms exist, has been documented in soils in excess of 100,000 ohm-cm.

Soil uniformity is important because of the possible development of localized corrosion cells caused by discontinuous soils. Different soil types in contact with a metallic structure can cause anodic (where corrosion occurs) and cathodic areas within a structure. The extent of corrosion is determined by soil resistivity, pH and other factors.

Soil pH

The chemical composition and the degree of acidity or alkalinity of the soil affect corrosion of metals in soils. In general, decreasing pH increases soil corrosivity. The pH of most soils falls within the range of 3 to 10. Typically, a neutral soil pH range is considered to be 6.5 to 7.5. Above 7.5 is considered alkaline and below 6.5 is considered acidic.

Soil pH is often considered to be one of the controlling factors in underground corrosion. Soil pH is a measure of the environment's hydrogen-ion activity. In low pH environments (acidic), the protective corrosion films on steel are de-stabilized, resulting in localized or accelerated corrosion. In neutral pH environments, sulfate-reducing anaerobic bacteriological corrosion may occur. In high pH environments (alkaline), steel develops protective passive films.

Results & Conclusions

The results of the testing follow:

Sample # & Depth	**Soil Resistivity (As-received)**	**Soil Resistivity (Saturated)**	**pH**	**Comments**
B-1 S-5 10.0'-11.5'	18,000 ohm-cm	9,600 ohm-cm	6.08	moist brown silty sand
B-2 S-6 12.5'-14.0'	15,000 ohm-cm	15,000 ohm-cm	6.16	wet grey silty sand with gravel
B-3 S-6 12.5'-14.0'	29,000 ohm-cm	12,000 ohm-cm	6.03	moist grey sandy silt with gravel
B-4 S-5 10.0'-11.5'	17,000 ohm-cm	12,000 ohm-cm	6.49	moist grey silty sand with gravel
B-5 S-5 10.0'-11.5'	24,000 ohm-cm	10,300 ohm-cm	6.46	moist grey silty sand with gravel
B-6 S-6 12.5'-14.0'	17,500 ohm-cm	10,100 ohm-cm	6.22	moist grey silty sand with gravel

The soil characteristics, at the test location, should be considered potentially corrosive.

Groundwater was observed at approximately 3.5 to 9 feet (see the geotechnical logs showing the sample collection locations). The soil at the time of testing was moist to wet and may vary seasonally.

The soil resistivities varied, which could develop into a corrosion risk if sufficient moisture is present. The magnitude and variation in resistivity is often of greater significance than the absolute value of resistivity. When a structure is in contact with soils which vary significantly in resistivity, corrosion concentration cells may develop between the high and low resistivity areas. Sections in low resistivity areas become anodic to sections in high resistivity areas, and therefore corrode. The resistivities may also vary with seasonal soil moisture content.

The soil pH was acidic. In acidic pH environments, the protective corrosion films on metallic structures are de-stabilized, which may result in localized or accelerated corrosion.

Adequate corrosion control mitigation measures should be implemented to attain the AWWU specified 70-year design life of the structures. Corrosion resistant materials (i.e., non-metallic materials, stainless steel, etc.) should be used or metallic materials with a tightly bonded exterior coating and cathodic protection are recommended.

From a corrosion control perspective, non-metallic materials would be the preferred pipeline material for this project due to the soil corrosivity characteristics. If non-metallic pipeline materials are used, magnesium anodes should be installed on all below grade metallic features (flanges, valves, etc.). The features should also have a tightly bonded coating applied to them.

If ductile iron pipe is used, polyethylene encasements (baggies) should not be used unless it is used in combination with a tightly bonded coating such as Zinc coated ductile iron pipe as distributed by US Pipe. If polyethylene encasements (baggies) are used, the polyethylene encasements should also have corrosion control and bacteriological prevention additives built into the encasements to mitigate the potential for corrosion (i.e., VBio™ polyethylene encasements as distributed by US Pipe). Additionally, the AWWU standard cathodic protection design and construction practices for buried pipelines should also be followed (install one 70-pound packaged weight high potential magnesium anode on each joint of pipe and install two #2 AWG CP bond cables across each pipe joint).

If ductile iron pipe is used, without polyethylene encasements and Zinc coated pipe as described above, then a tightly bonded coating with cathodic protection should be used. The AWWU standard cathodic protection design and construction practices for buried pipelines should also be followed (install one 70-pound packaged weight high potential magnesium anode on each joint of pipe and install two #2 AWG CP bond cables across each pipe joint).

Thank you for the opportunity to work with you on this project. Please let me know if you need additional information or if I can be of further assistance.

Sincerely,

COFFMAN ENGINEERS, INC.

C. Dan Stears

C. Dan Stears, Vice President
Coffman Corrosion Control Engineering
NACE Cathodic Protection Specialist #3527

September 18, 2018

Shannon & Wilson, Inc.
5430 Fairbanks Street, Suite 3
Anchorage, Alaska 99518

Attention: Mr. Stafford Glashan

Reference: AWWU SAN ANTONIO STREET EXPANDED PROJECT SOIL CORROSIVITY REPORT
S & W PROJECT #32-1-20095-002

Dear Stafford:

A soil corrosivity evaluation was performed on fourteen samples obtained for testing. The soil samples were tested and evaluated by Coffman Engineers. Testing was performed in accordance with ASTM G57-06 (Reapproved 2012) "Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method" and ASTM G51-95 (Reapproved 2012) "Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing".

The correlation between soil corrosivity and the physical and chemical constituents that comprise the soil were evaluated. Factors that affect the corrosivity of soils include soil resistivity, soluble salt content, pH, soil type (permeability), aeration, moisture content, Redox potential, amount of microbes in the soil and stray currents. No single factor or measurement should be used to determine the corrosivity of soil.

The corrosion rate of metallic structures in soil depends on the nature of the soil and other environmental factors, such as the availability to moisture and oxygen. These factors can lead to extreme variations in the rate of the attack. For example, under extreme conditions a buried metallic structure may perforate and lose integrity in less than one year, conversely archeological digs in arid desert regions have uncovered iron tools that are hundreds of years old. The following general guidelines may be formulated: Soils with high moisture content, high electrical conductivity, high acidity, and high dissolved salts will typically be the most corrosive.

Soil Resistivity & Uniformity

One of the best criterions for estimating the corrosivity of a soil is to determine its resistivity, which depends largely upon the nature and amount of dissolved salts in the soil. It is generally recognized that soluble salts, such as chloride and sulfate ions, increase the corrosivity of soil. Temperature, moisture content, compaction and presence of inert materials also affect soil resistivity.

Soil resistivity affects corrosion in several ways. The lower the resistivity, the better the soil conducts current flow and the greater the soil corrosivity. Low resistivity soils may contain high concentrations of soluble salts. The salts attack the protective oxide films on the steel surface, accelerating the rate of the electrochemical reactions, therefore increasing the corrosivity of the soil.

A general guideline for soil corrosivity as related to resistivity is listed below:

Soil Resistivity (Ohm-cm)	Soil Corrosivity
Below 1,000	Very Corrosive
1,000 – 2,000	Corrosive
2,000 – 5,000	Moderately Corrosive
5,000-10,000	Mildly Corrosive
Above 10,000	Progressively Less Corrosive

The preceding guideline may be used as a soil corrosivity indicator, but no single measurement or criterion should be used to determine the corrosivity of soil. Corrosion of structures, where bacteria, oxygen concentration cells and other corrosion mechanisms exist, has been documented in soils in excess of 100,000 ohm-cm.

Soil uniformity is important because of the possible development of localized corrosion cells caused by discontinuous soils. Different soil types in contact with a metallic structure can cause anodic (where corrosion occurs) and cathodic areas within a structure. The extent of corrosion is determined by soil resistivity, pH and other factors.

Soil pH

The chemical composition and the degree of acidity or alkalinity of the soil affect corrosion of metals in soils. In general, decreasing pH increases soil corrosivity. The pH of most soils falls within the range of 3 to 10. Typically, a neutral soil pH range is considered to be 6.5 to 7.5. Above 7.5 is considered alkaline and below 6.5 is considered acidic.

Soil pH is often considered to be one of the controlling factors in underground corrosion. Soil pH is a measure of the environment's hydrogen-ion activity. In low pH environments (acidic), the protective corrosion films on steel are de-stabilized, resulting in localized or accelerated corrosion. In neutral pH environments, sulfate-reducing anaerobic bacteriological corrosion may occur. In high pH environments (alkaline), steel develops protective passive films.

Results & Conclusions

The results of the testing follow:

Sample # & Depth	Soil Resistivity (As-received)	Soil Resistivity (Saturated)	pH	Comments
B-1 S5B 10.0'-12.0'	18,000 ohm-cm	16,500 ohm-cm	6.45	moist brown silty sand and gravel
B-2 S5B 10.0'-12.0'	15,500 ohm-cm	15,500 ohm-cm	6.34	wet grey silty sand and gravel
B-3 S5B 10.0'-12.0'	19,000 ohm-cm	19,000 ohm-cm	6.62	wet grey silty sand and gravel
B-4 S5B 10.0'-12.0'	10,500 ohm-cm	10,500 ohm-cm	6.52	wet grey silty sand and gravel
B-5 S5B 10.0'-12.0'	17,000 ohm-cm	17,000 ohm-cm	6.46	wet grey silty sand and gravel
B-6 S5B 10.0'-12.0'	10,000 ohm-cm	10,000 ohm-cm	6.93	wet grey sandy silt and gravel
B-7 S5B 10.0'-12.0'	14,500 ohm-cm	14,500 ohm-cm	6.98	wet grey silty sand and gravel
B-8 S5B 10.0'-12.0'	13,000 ohm-cm	13,000 ohm-cm	6.90	wet grey silty sand and gravel
B-9 S5B 10.0'-12.0'	59,000 ohm-cm	19,000 ohm-cm	6.59	moist grey silty sand and gravel
B-10 S5B 10.0'-12.0'	8,300 ohm-cm	7,000 ohm-cm	6.75	moist grey silty sand and gravel
B-11 S5B 10.0'-12.0'	20,000 ohm-cm	20,000 ohm-cm	6.90	wet grey silty sand and gravel
B-12 S5B 10.0'-12.0'	12,000 ohm-cm	12,000 ohm-cm	6.72	wet grey silty sand and gravel
B-13 S5B 10.0'-12.0'	8,700 ohm-cm	8,700 ohm-cm	6.88	wet grey silty sand and gravel
B-14 S5B 10.0'-12.0'	12,000 ohm-cm	12,000 ohm-cm	6.80	wet grey silty sand and gravel

The soil characteristics, at the test location, should be considered potentially corrosive.

Groundwater was observed, at the time of drilling, between approximately 4.5 to 13 feet (see the geotechnical logs and site plan showing the sample collection locations). The soil at the time of testing was moist to wet and may vary seasonally.

The soil resistivities were relatively consistent and were within a range that could present a corrosion risk. The resistivities may also vary with seasonal soil moisture content.

The soil pH was neutral to acidic. In acidic pH environments, the protective corrosion films on metallic structures are de-stabilized, which may result in localized or accelerated corrosion. Dense neutral soil (silts and clays) and/or soils that contain organics are favorable to sulfate-reducing anaerobic bacteriological corrosion. This aggressive corrosion mechanism can substantially reduce the design life of the structures. Some of the soils at the project location are conducive sulfate-reducing anaerobic bacteriological corrosion.

Adequate corrosion control mitigation measures should be implemented to attain the AWWU specified 70-year design life of the structures. Corrosion resistant materials (i.e., non-metallic materials, stainless steel, etc.) should be used or metallic materials with a tightly bonded exterior coating and cathodic protection are recommended.

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COFFMAN ENGINEERS, INC.

C. Dan Stears

C. Dan Stears, Vice President
Coffman Corrosion Control Engineering
NACE Cathodic Protection Specialist #3527

APPENDIX C

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Date: November 2018
To: AWWU

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors which were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland

September 18, 2018

Shannon & Wilson, Inc.
5430 Fairbanks Street, Suite 3
Anchorage, Alaska 99518

Attention: Mr. Stafford Glashan

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S & W PROJECT #32-1-20095-002

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Results & Conclusions

The results of the testing follow:

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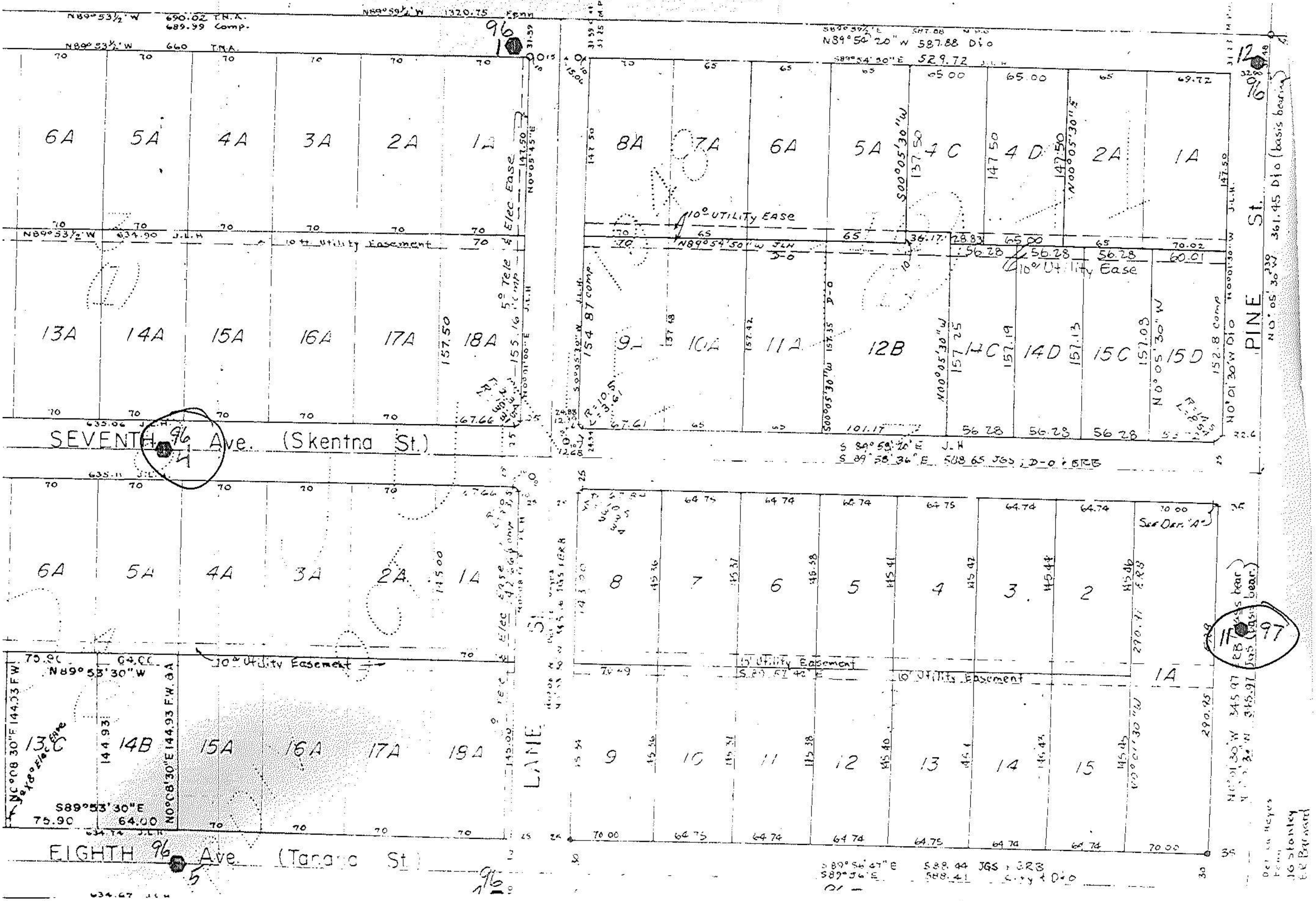
C. Dan Stears

C. Dan Stears, Vice President
Coffman Corrosion Control Engineering
NACE Cathodic Protection Specialist #3527


PINE St.
SEVENTH Ave. (Skentna St.)
EIGHTH Ave.
LANE St.
10' UTILITY EASE
10' Utility Ease
10' Utility Easement
15' Utility Easement
Elec Ease
5' Tele

1974-97

City of Anchorage
Office of the City Engineer
Soils Laboratory

Field Auger Log

R.E. BARCUS 8-4-72

Contract Number (4)
District SOUTH MT. VIEW

Hole Number 4

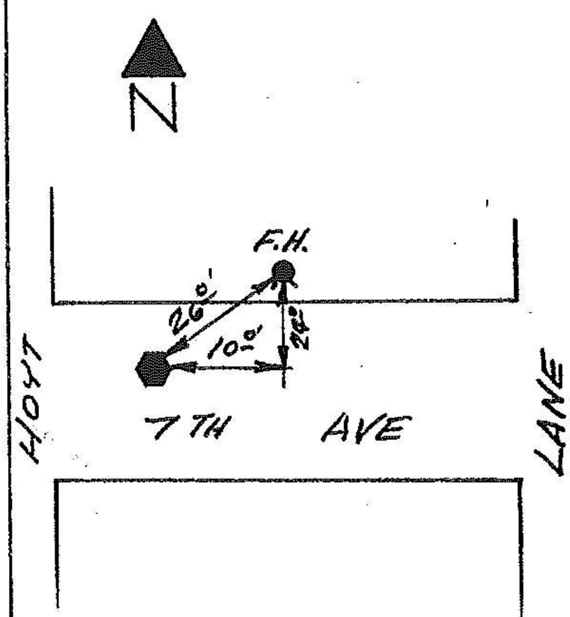
Location 7TH BTWN HOYT & LANE

Top Elevation SURFACE

w=water content
k=coef of permeability
D_{20} = 20% Diameter
c = unit cohesion
ø = ∠ of int. Friction
e = void ratio

Sample	Depth in feet	M.I.T. Classification
	1.0	MA-437 GW-GM 9% -200
	2.0	MA-438 GP 3% -200
	3.0	
	4.0	
	5.0	
	6.0	MA-439 GP 5% -200
	7.0	
	8.0	
	9.0	
	10	

Summary of Test Results



Hole Depth 7.0'

DATE 17 Feb. 70
W.O. NO. 10247

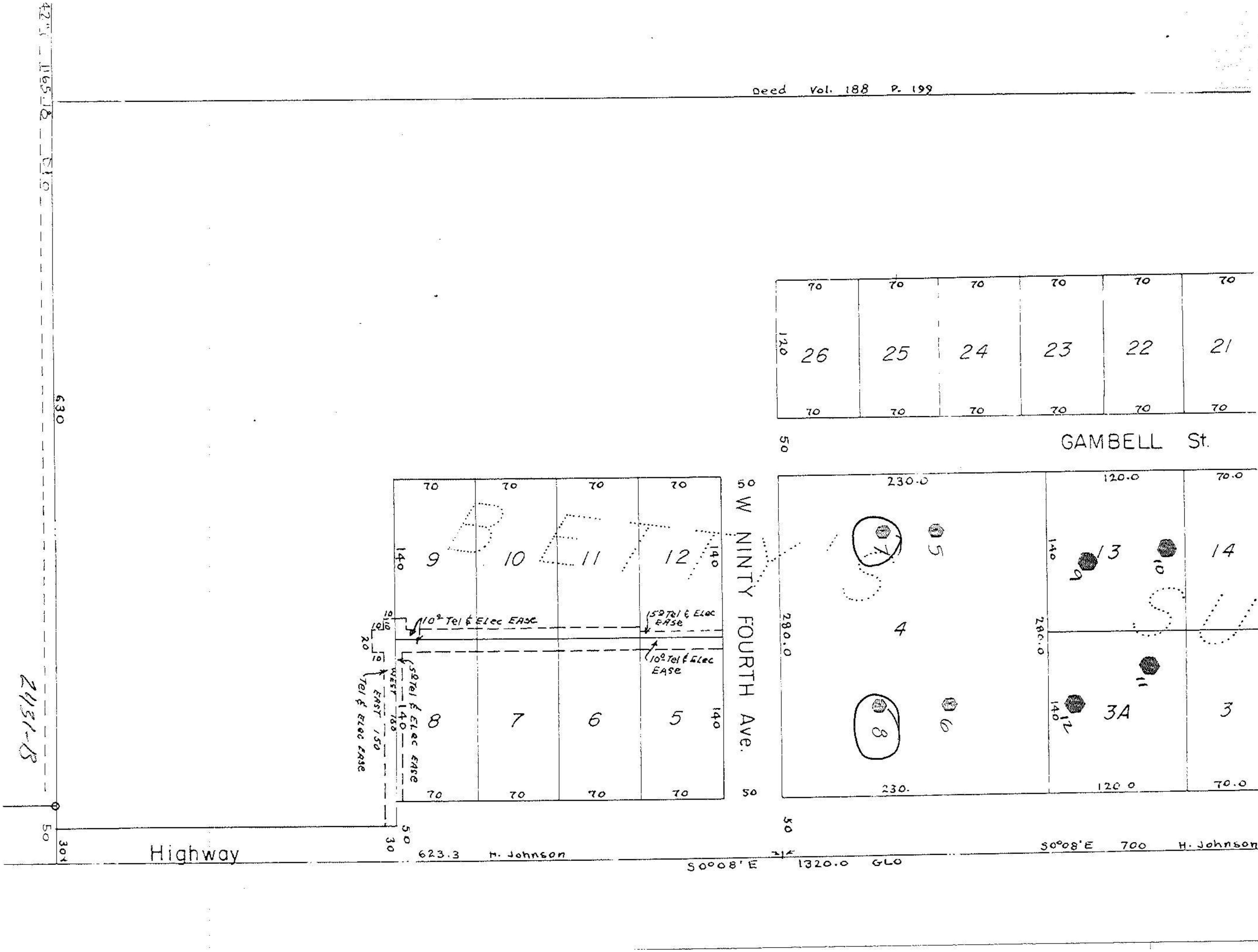
CLIENT GAAB
PROJECT Sewer Line

DEPTH IN FEET

11

T.H. 11-17 ELEV. Existing Ground

0'	2.5' Frost F-1, Brown, Damp, Well Graded Coarse To Medium To Fine Silty Sandy Gravel, Medium Density, Non Plastic Max. Size 2" Rounded (Fill From Ditch)
4.0'	F-4, Brown, Damp, Peat, Loose Density
7.0'	F-4, Grey, Damp, Well Graded Medium To Fine Gravelly Sandy Silt, Medium To Loose Density, Slightly Plastic Max. Size 1" Rounded
8.0'	Water Table Intercept After Drilling @ 12.0' F-1, Grey, Damp, Well Graded Coarse To Medium To Fine Silty Sandy Gravel, Medium Density, Non Plastic, Max. Size 2" Rounded Water Table Intercept While Drilling @ 15.0'
17.0'	F-4, Grey, Saturated, Well Graded Gravelly Very Silty Sand, Medium Density, Max. Size 1" Rounded
20.0'	C Cutting Sample
23.0' – 24.5'	Bottom Of Hole 26/35/43 Blows/6" Grey, Silty Sandy Gravel Note: Made Second Trip To Get 23.0' To 24.5' Not Able To Go Deeper On First Try


Deed Vol. 188 P. 199
GAMBELL St.
W NINTY FOURTH Ave.
Highway
10' Tel & Elec EASE
5' Tel & Elec EASE
10' Tel & Elec EASE
5' Tel & Elec EASE
WEST 180
EAST 150
Tel & Elec EASE
623.3 H. Johnson
S0°08'E 1320.0 GLO
S0°08'E 700 H. Johnson
630
280.0
230.0
120.0
70.0
2431-B

7

TEST BORING 10

ENTERED By [illegible] FEB 6 1986

SOILS LIBRARY
SUPPLEMENTAL DATA 2428-D

LOCATION=70+77
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	TEMP (DEG.F)	N (BLOWS/FT)	FROST DEPTH	SOIL	DESCRIPTION	DEPTH
0							PT	BROWN FIBROUS PEAT	
5								WATER SEEPING INTO HOLE FROM PEAT	
								∇ GROUND WATER LEVEL WHILE DRILLING	6.5
							SM	F2, GREY SILTY SAND, WET, DENSE	
		12.9		37.0	40				
10									12.0
							ML	F4, GREY SANDY GRAVELLY SILT, 2" MAXIMUM, DAMP TO WET, MEDIUM DENSE	
		10.9		39.0	18				
15									15.5
								TEST BORING COMPLETED 4/4/83 WATER TABLE OBSERVED TO RISE TO 4' AFTER DRILLING	
20									

KEY
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PI = PLASTIC INDEX
☐ = GRAB SAMPLE
◪ = SPT SAMPLE
[S] = SHELBY TUBE-PUSHED
☒ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL

ALASKA TESTLAB
LOG OF BORING

LOGGED BY: PMC
W.O. NO.: A21128
FIGURE

ENTERED
By [signature]
FEB 6 1986
SOILS LIBRARY

(8)

TEST BORING 11

LOCATION= 76+70
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	TEMP (DEG.F)	N (BLOWS/FT)	FROST DEPTH
5		15.6		32.0	61	
10		12.8		37.0	23	
15		10.5		40.0	17	

DEPTH

F1. BROWN SANDY GRAVEL WITH SILT. WET OR FROZEN. MEDIUM DENSE (SM)

— 3.7

F2. OLIVE SILTY GRAVELLY SAND. 2" MAXIMUM. FROZEN (SM)

SOIL DAMP AND MEDIUM DENSE

— 12.5

F4. GREY SANDY GRAVELLY SILT. NONPLASTIC. 1/2" MAXIMUM. SUBROUNDED. DAMP. STIFF TO VERY STIFF (ML)

— 16.5

TEST BORING COMPLETED 4/4/83
NO GROUND WATER ENCOUNTERED
NO WATER TABLE OBSERVED DURING DRILLING

KEY
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ALASKA TESTLAB
LOG OF BORING
LOGGED BY: PMC
W.O. NO.: A21128
FIGURE