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# SUBSOIL STUDY
# FOR FOUNDATION DESIGN
# PROPOSED LIVE/WORK BUILDING
# LOT 2, DREAMLAND SUBDIVISION
# BUILDINGS E, G & I
# 299, 293 & 285 SAWATCH ROAD
# EAGLE, COLORADO

**PROJECT NO. 21-7-832**

**FEBRUARY 25, 2022**

**PREPARED FOR:**

**SAWATCH 263 LLC**
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## PURPOSE AND SCOPE OF STUDY

This report presents the results of a subsoil study for proposed Live/Work Buildings E, G and I to be located on Lot 2, Dreamland Subdivision with addresses of 299, 293 and 285 Sawatch Road, Eagle, Colorado. The project site is shown on Figure 1. The purpose of the study was to develop recommendations for the foundation design. The study was conducted in accordance with our proposal for geotechnical engineering services to Sawatch 263 LLC dated October 20, 2021.

A field exploration program consisting of exploratory borings was conducted to obtain information on the subsurface conditions. Samples of the subsoils obtained during the field exploration were tested in the laboratory to determine their classification and other engineering characteristics. The results of the field exploration and laboratory testing were analyzed to develop recommendations for foundation types, depths and allowable pressures for the proposed buildings foundations. This report summarizes the data obtained during this study and presents our conclusions, design recommendations and other geotechnical engineering considerations based on the proposed construction and the subsurface conditions encountered.

## PROPOSED CONSTRUCTION

The three buildings, located on the lot as shown on Figure 1, will be two-story multi-unit commercial/residential structures. Ground floors will be slab-on-grade at an elevation slightly above the existing ground surface. Grading for the structures is expected to be relatively minor with cut depths between about 3 to 5 feet. We assume relatively light foundation loadings, typical of the proposed type of construction. There may be fill to the east of the buildings to partially fill in the existing detention pond for parking/drive areas for the buildings.

If building loadings, location or grading plans change significantly from those described above, we should be notified to re-evaluate the recommendations contained in this report.

## BACKGROUND INFORMATION

Review of Google Earth© historical photos dating back to 1999 indicate an excavation was present across the Lot 2 area and the site remained relatively undisturbed until sometime after the 2006 aerial photo. Aerial photos from 2010 and 2011 indicate the southern portion of the Lot 2 area had been filled and cobble/boulder stockpiles were present on what appear to be new fill slopes or near the edges of the excavation slopes. The next available photo from 2015 shows the

northern part of the lot had been mostly backfilled and graded. An existing boulder wall on the site was constructed and the remaining southern portion of the lot were backfilled sometime prior to the June 2017 aerial photo. The site in the 2017 photo appears to be relatively similar to the conditions observed during our site visits in October 2021.

A previous geotechnical study was conducted for the 700 Chambers Avenue development by Ground Engineering Consultants, report dated May 30, 2007, Job No. 07-6017, which included the area of Lot 2 of the current proposed development. Subsequently, the compaction of structural fill placed in the development area was monitored by Ground between June and August 2007. The Ground report information provided has been considered in our report preparation.

## SITE CONDITIONS

The lot is currently being used as a storage area for equipment and materials. The site has been graded with considerable and variable fill depth and a boulder retaining wall ranging in heights up to about 15 feet present along the western edges of the proposed building footprints. The terrain is relatively flat with a slight to gentle slope down to the southwest. Elevation difference across the proposed individual building footprints are about 3 feet but up to about 17 feet across the lot due to the existing detention pond excavation. The site is mostly barren and vegetation consists of scattered weeds. The detention pond to the west is relatively large and about 16 to 18 feet deep.

## SUBSIDENCE POTENTIAL

Bedrock of the Pennsylvanian age Eagle Valley Evaporite underlies the subdivision and nearby areas of Eagle. These rocks are a sequence of gypsiferous shale, fine-grained sandstone and siltstone with some massive beds of gypsum and limestone. There is a possibility that massive gypsum deposits associated with the Eagle Valley Evaporite underlie portions of the lot. Dissolution of the gypsum under certain conditions can cause sinkholes to develop and can produce areas of localized subsidence. During previous work in the area, several sinkholes were observed scattered throughout the Eagle area. These sinkholes appear similar to others associated with the Eagle Valley Evaporite in other areas of the Eagle River Valley.

Sinkholes were not observed in the immediate area of the subject lot; however, the existing grading and fill would likely have covered any surface depressions. No evidence of cavities was encountered in the subsurface materials; however, the exploratory borings were relatively shallow, for foundation design only. Based on our present knowledge of the subsurface

conditions at the site, it cannot be said for certain that sinkholes will not develop. The risk of future ground subsidence on Lot 2 throughout the service life of the proposed buildings, in our opinion, is low; however, the owner should be made aware of the potential for sinkhole development. If further investigation of possible cavities in the bedrock below the site is desired, we should be contacted.

## FIELD EXPLORATION

The field exploration for the project was conducted on October 20 and 25, 2021. Six exploratory borings were drilled at the locations shown on Figure 1 to evaluate the subsurface conditions. The borings were advanced with 4-inch diameter continuous flight augers powered by a truck-mounted CME-45B drill rig. The borings were logged by representatives of Kumar & Associates. Due to the site obstructions, Borings 3 and 5 could not be drilled along the proposed western sides of Buildings G and I.

Samples of the subsoils were taken with 1⅜-inch and 2-inch I.D. spoon samplers. The samplers were driven into the subsoils at various depths with blows from a 140 pound hammer falling 30 inches. This test is similar to the standard penetration test described by ASTM Method D-1586. The penetration resistance values are an indication of the relative density or consistency of the subsoils. Depths at which the samples were taken and the penetration resistance values are shown on the Logs of Exploratory Borings, Figure 2. The samples were returned to our laboratory for review by the project engineer and testing.

## SUBSURFACE CONDITIONS

Graphic logs of the subsurface conditions encountered at the site are shown on Figure 2. The subsoils were variable and consisted of about 5 feet to more than 20 feet of man-placed fill. At Borings 1 and 3, the fill was underlain at depths of 5 feet by medium dense/stiff, intermixed sand and silt with scattered gravel and some clayey zones that extended down to the depths drilled of 16 and 21 feet. At Borings 4 and 6, the fill was underlain at depths of about 6 and 9 feet by relatively dense, silty sandy gravel and cobbles. At Borings 3 and 5, the fill extended down to the boring depths drilled of 16 and 21 feet. The fill was somewhat variable, consisting primarily of sandy to very sandy silty clay with gravel and cobbles at Borings 1 and 2, and clayey silty sand and gravel with cobbles at Borings 3 through 6. The fill was generally medium dense and contained some construction debris including asphalt chunks. Drilling in the natural dense coarse granular soils with auger equipment was difficult due to the cobbles and probable boulders, however, drilling refusal was not encountered in the deposit.

Laboratory testing performed on samples obtained from the borings included natural moisture content and density, and gradation analyses. Results of swell-consolidation testing performed on relatively undisturbed drive samples of the fill and sand/silt soils, presented on Figures 4 and 5, indicate the low to moderate compressibility under conditions of loading and wetting with a nil to low hydro-compression potential. Results of gradation analyses performed on drive samples of the fill soils (minus 1½-inch fraction) are shown on Figures 6 and 7. The laboratory testing is summarized in Table 1.

No free water was encountered in the borings at the time of drilling. The subsoils were slightly moist to moist.

## FOUNDATION BEARING CONDITIONS

The proposed building sites overly from about 5 to 21 or more feet of somewhat variable fill. The deeper fill encountered at Borings 3 through 6 (Buildings G and I) generally contained more sand and gravel and a lesser amount of clay and silt. The fill appears to be at least moderately compacted and generally suitable for building support with some risk of long-term settlement, typical of deeper fills, and especially when wetted. The natural sand and silt soils are also compressible and present some risk of settlement when wetted under load. A heavily reinforced mat foundation that can withstand some differential settlement can be used for foundation support of the buildings with some risk of settlement and distress. Alternatively, a post-tensioned slab foundation system could also be used which can typically withstand the effects of some differential settlement better than conventionally reinforced mat foundations.

Alternatively, if a lower risk of foundation settlement is desired, a micro-pile foundation bearing in the underlying natural dense coarse granular soils at the site could be used. Provided below are recommendations for a mat foundation. If recommendations for a micro-pile foundation system are desired, we should be contacted.

## DESIGN RECOMMENDATIONS

### FOUNDATIONS

Considering the subsurface conditions identified at the site, we believe the buildings can be founded on a heavily reinforced mat foundation with a risk of settlement. To reduce the risk of settlement, we recommend a minimum 3 feet of compacted aggregate base course be placed below the mat foundation. The base course should consist of CDOT Class 2 (minus 3-inch) material. Existing granular fill may be acceptable to re-use as structural fill but should be further

evaluated by us during construction. The fill should be free of organics, topsoil, debris and oversized (plus 6-inch) rocks. A shallow depth of ¾-inch base course can be placed immediately below the mat as a leveling course. Precautions should be taken to prevent wetting of the bearing soils.

The design and construction criteria presented below should be observed for a reinforced mat foundation system.

1) A mat foundation placed on a minimum 3 feet of compacted base course, or re-compacted existing granular fill if found to be suitable, should be designed for an allowable bearing pressure of 1,500 psf or subgrade modulus of 125 tcf. Based on experience, we expect initial settlement of the foundation designed and constructed as discussed in this section will be about 1 inch or less. Future settlement could range up to 1 to 1½ inches mainly if the bearing soils below the structural fill were to become wetted. Foundations should be setback at least 10 feet from the proposed fill slope down to the detention pond.
2) Any spread footings should have a minimum width of 24 inches.
3) Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 48 inches below exterior grade is typically used in this area. Reduced frost cover should be feasible with ground insulation to help protect the foundation.
4) The mat foundation should be heavily reinforced with both longitudinal and transverse steel to withstand the potential settlements. Foundation walls acting as retaining structures (if any) should also be designed to resist a lateral earth pressure corresponding to an equivalent fluid unit weight of at least 50 pcf.
5) Prior to the structural fill placement, any loose disturbed or soft soils should be removed and the subgrade moistened and compacted. The base course or structural fill below the mat foundation should be compacted to at least 98% of the maximum standard Proctor density at a moisture content near optimum. The structural fill should extend laterally beyond the edges of the foundation a distance to at least ½ the depth of fill below the foundation.
6) A representative of the geotechnical engineer should observe all footing excavations and test compaction of structural fill placement on a regular basis prior to concrete placement to evaluate bearing conditions.

## UNDERDRAIN SYSTEM AND DAMP PROOFING

It is our understanding the proposed finished floor elevations at the lowest levels are at or above the surrounding grade. Therefore, foundation drain systems are not required. It has been our experience in the area that local perched groundwater can develop during times of heavy precipitation or seasonal runoff. Frozen ground during spring runoff can also create a perched condition. We recommend below-grade construction, such as retaining walls, crawlspace and basement areas, be protected from wetting and hydrostatic pressure buildup by an underdrain and wall drain system.

If the finished floor elevations of the proposed structures are revised to have a floor level below the surrounding grade, we should be contacted to provide recommendations for an underdrain system. All earth retaining structures should be properly drained.

## SITE GRADING

The risk of construction-induced slope instability at the site appears low to moderate provided the buildings are located away from the steep slope as recommended and cut and fill depths are limited. We assume the cut depths will not exceed about 4 to 6 feet. Fills up to about 15 to 17 feet deep are anticipated, especially at the downhill, western sides of the planned buildings for the parking/drive areas where the slope steepens down to the detention pond. Where fill is placed within 1 horizontal to 1 vertical (1H:1V) below foundations, the fill should be compacted to at least 98% of maximum standard Proctor density. Embankment fills should be compacted to at least 95% of the maximum standard Proctor density near optimum moisture content. Prior to fill placement, the subgrade should be carefully prepared by removing all vegetation and topsoil and compacting to at least 95% of the maximum standard Proctor density. The fill should be benched into the portions of the slope exceeding 20% grade.

Permanent unretained cut and fill slopes should be graded at 2H to 1V or flatter and protected against erosion by revegetation or other means. The risk of slope instability will be increased if seepage is encountered in cuts and flatter slopes may be necessary. If seepage is encountered in permanent cuts, an investigation should be conducted to determine if the seepage will adversely affect the cut stability. We should review site grading plans for the project prior to construction.

## SURFACE DRAINAGE

Positive surface drainage is an important aspect of the project to prevent wetting of the bearing soils. The following drainage precautions should be observed during construction and maintained at all times after the building has been completed:

1) Inundation of the foundation excavations and underslab areas should be avoided during construction.
2) Exterior backfill should be adjusted to near optimum moisture and compacted to at least 95% of the maximum standard Proctor density in pavement and slab areas and to at least 90% of the maximum standard Proctor density in landscape areas.
3) The ground surface surrounding the exterior of the building should be sloped to drain away from the foundation in all directions. We recommend a minimum slope of 12 inches in the first 10 feet in unpaved areas and a minimum slope of 2½ inches in the first 10 feet in paved areas.
4) Roof downspouts and drains should discharge well beyond the limits of all backfill.
5) Landscaping which requires regular heavy irrigation, such as sod, and lawn sprinkler heads should be located at least 5 feet from foundation walls. Consideration should be given to use of xeriscape to reduce the potential for wetting of soils below the building caused by irrigation.

## LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering principles and practices in this area at this time. We make no warranty either express or implied. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings drilled at the locations indicated on Figure 1, the proposed type of construction, our experience in the area and the previous Ground Engineering compaction information. Our services do not include determining the presence, prevention or possibility of mold or other biological contaminants (MOBC) developing in the future. If the client is concerned about MOBC, then a professional in this special field of practice should be consulted. Our findings include interpolation and extrapolation of the subsurface conditions identified at the exploratory borings and variations in the subsurface conditions may not become evident until excavation is performed. If conditions encountered during construction appear different from those described in this report, we should be notified so that re-evaluation of the recommendations may be made.

This report has been prepared for the exclusive use by our client for design purposes. We are not responsible for technical interpretations by others of our information. As the project evolves, we should provide continued consultation and field services during construction to review and monitor the implementation of our recommendations, and to verify that the recommendations

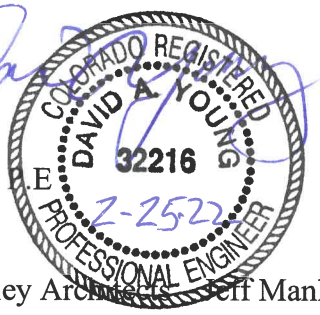
have been appropriately interpreted. Significant design changes may require additional analysis or modifications to the recommendations presented herein. We recommend on-site observation of excavations and foundation bearing strata and testing of structural fill by a representative of the geotechnical engineer.

Respectfully Submitted,

**Kumar & Associates, Inc.**

Mark Gayeski, E.I.T.

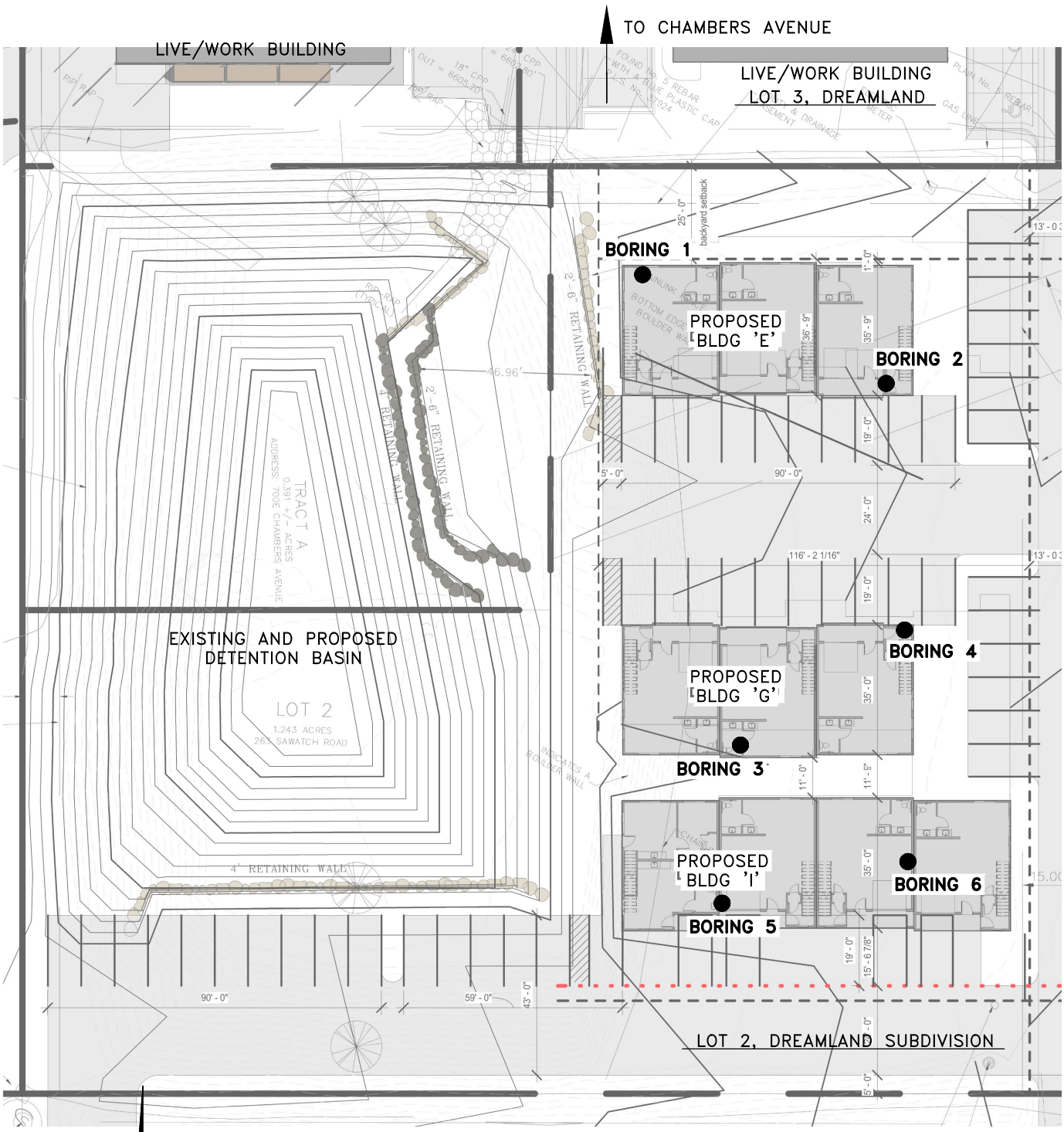
Reviewed By:




David A. Young, P.E.

DAY/kac

Cc: Martin Manley Architects - Jeff Manley (jeff@martinmanleyarchitects.com)

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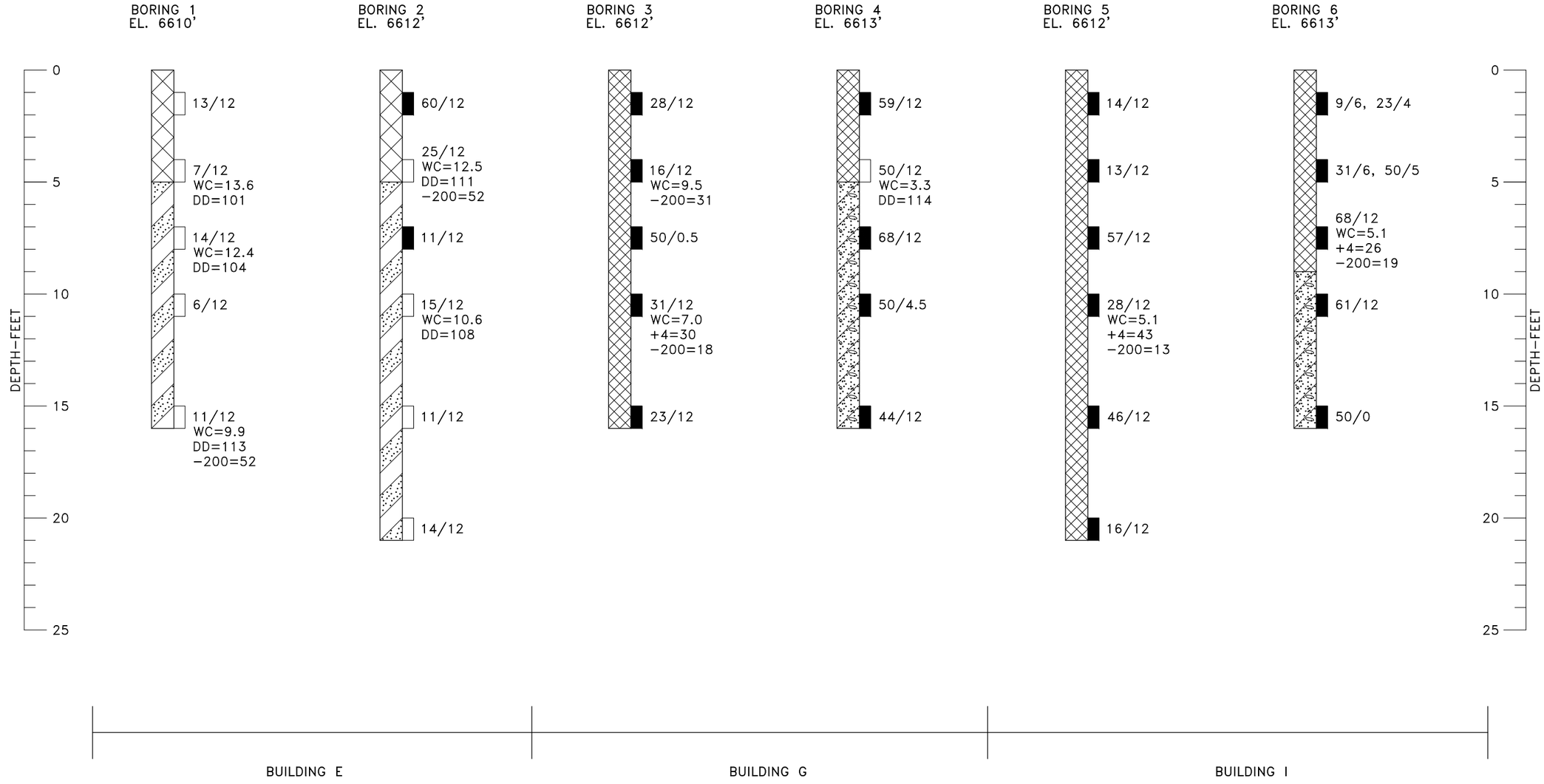
| 21-7-832 | Kumar & Associates | LOCATION OF EXPLORATORY BORINGS | Fig. 1 |
|---|---|---|---|






| 21-7-832 | Kumar & Associates | PROPOSED BUILDINGS E, G, AND I | LOGS OF EXPLORATORY BORINGS | Fig. 2 |
|---|---|---|---|---|

## LEGEND

FILL: SANDY TO VERY SANDY SILTY CLAY WITH GRAVEL AND COBBLES, MEDIUM DENSE, SLIGHTLY MOIST TO MOIST, MIXED BROWN.

FILL: CLAYEY SILTY SAND AND GRAVEL WITH COBBLES, SCATTERED CONSTRUCTION DEBRIS INCLUDING ASPHALT PIECES, MEDIUM DENSE, SLIGHTLY MOIST, MIXED BROWN AND BLACK.

SAND AND SILT (SM–ML); INTERMIXED SCATTERED GRAVEL, SOME CLAYEY ZONES, MEDIUM DENSE/STIFF, SLIGHTLY MOIST TO MOIST, MIXED BROWN.

GRAVEL AND COBBLES (GM); PROBABLE SMALL BOULDERS, SANDY TO VERY SANDY, SILTY, DENSE, MOIST, MIXED BROWN, LOCKS ARE PRIMARILY SUBROUNDED TO ROUNDED.

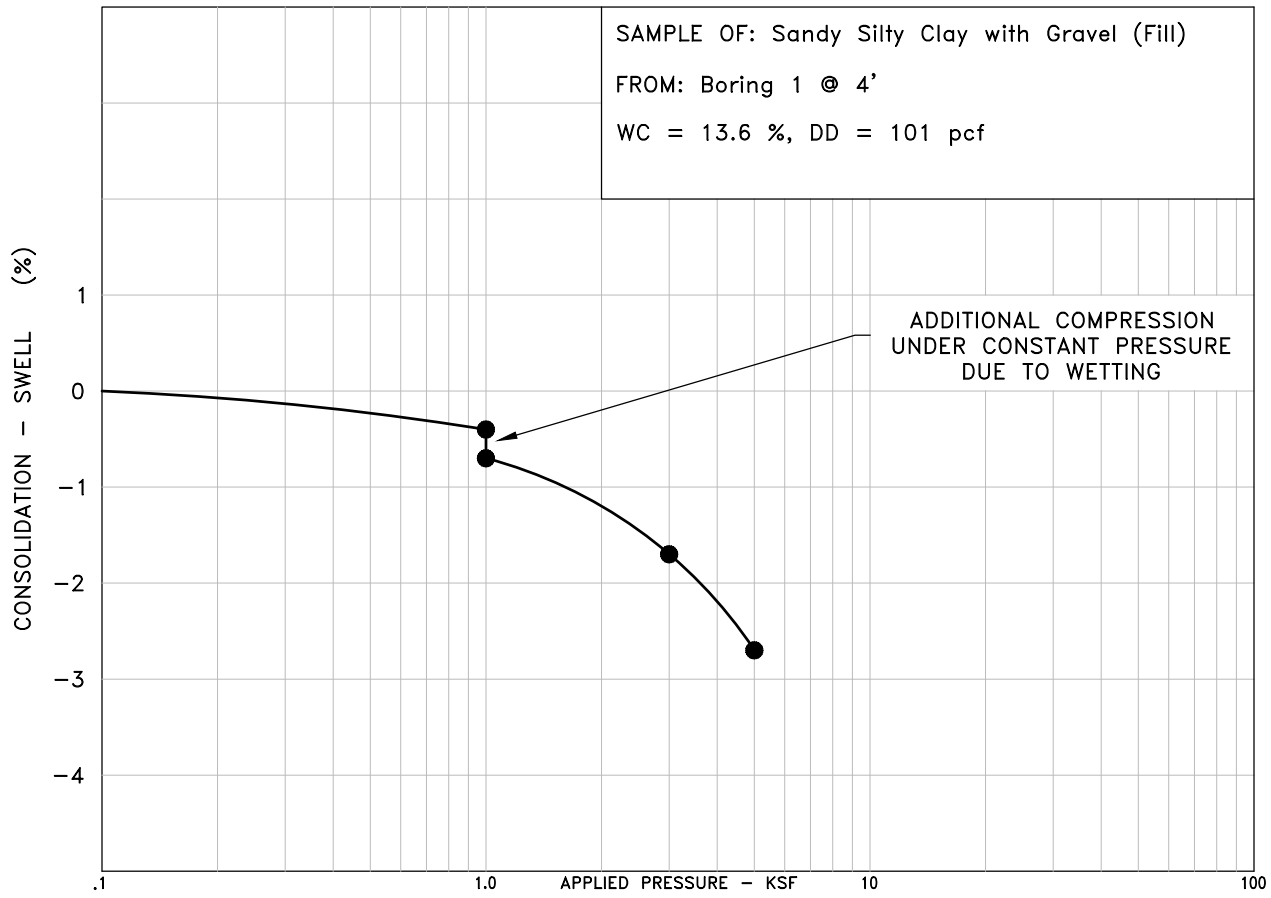
DRIVE SAMPLE, 2–INCH I.D. CALIFORNIA LINER SAMPLE.

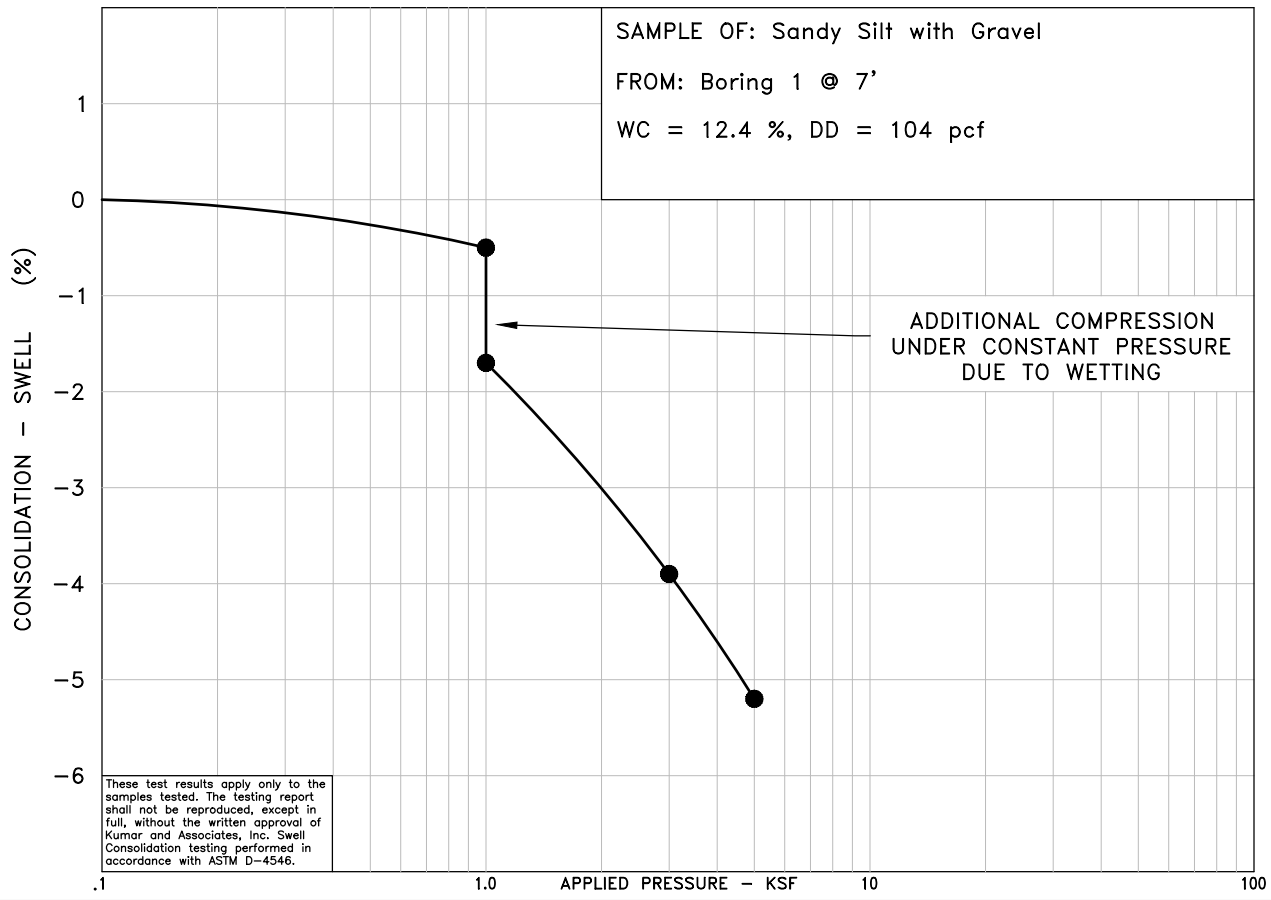
DRIVE SAMPLE, 1 3/8–INCH I.D. SPLIT–SPOON STANDARD PENETRATION TEST.

13/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 13 BLOWS OF A 140–POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

## NOTES

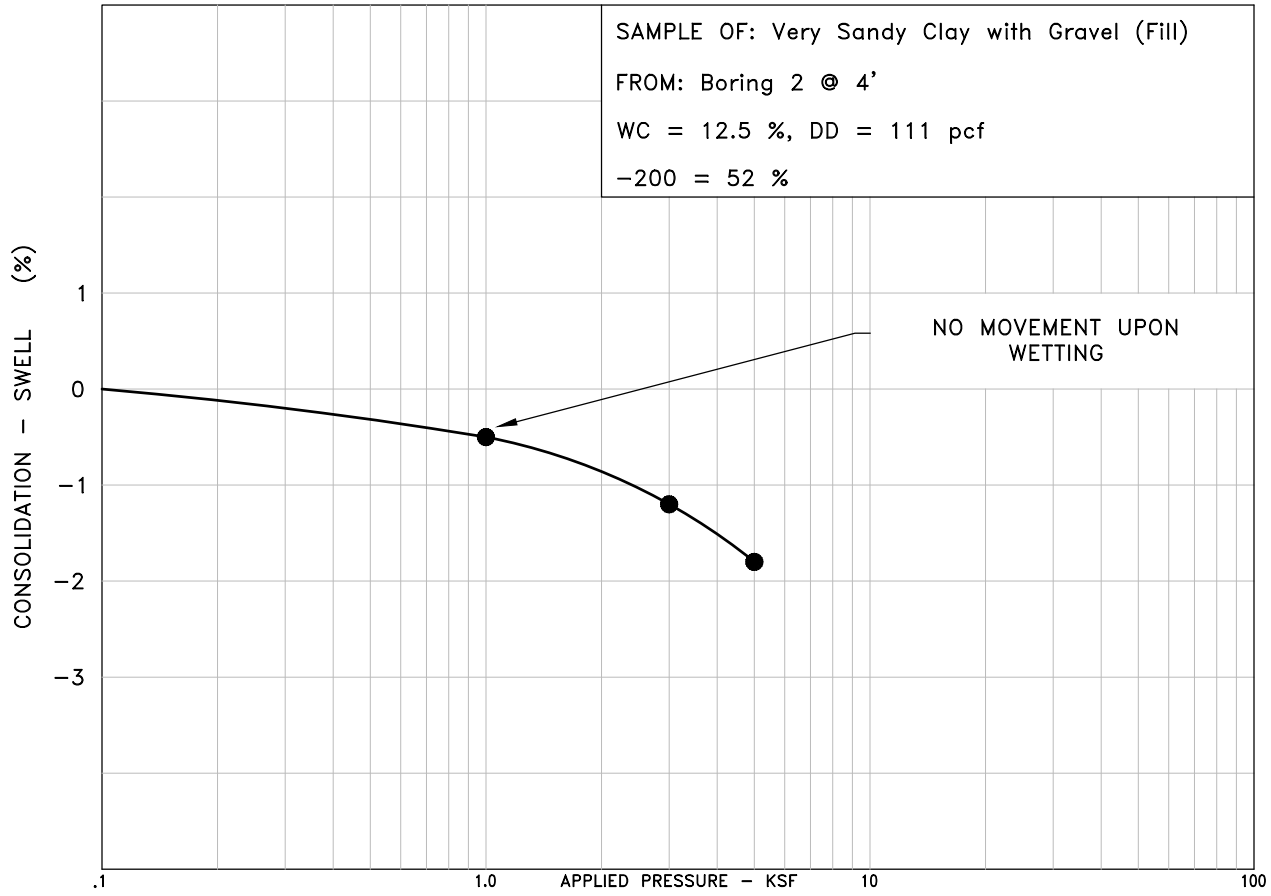
1. THE EXPLORATORY BORINGS WERE DRILLED ON OCTOBER 20TH AND 25TH, 2021 WITH A 4–INCH DIAMETER CONTINUOUS–FLIGHT POWER AUGER.
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED WITH THE CLIENT.
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE OBTAINED BY INTERPOLATION BETWEEN CONTOURS ON THE SITE PLAN PROVIDED.
4. THE EXPLORATORY BORING LOCATIONS AND ELEVATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
5. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.
6. GROUNDWATER WAS NOT ENCOUNTERED IN THE BORINGS AT THE TIME OF DRILLING. FLUCTUATIONS IN GROUNDWATER LEVEL MAY OCCUR WITH TIME.
7. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D2216);
   DD = DRY DENSITY (pcf) (ASTM D2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D6913);
   –200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D1140).

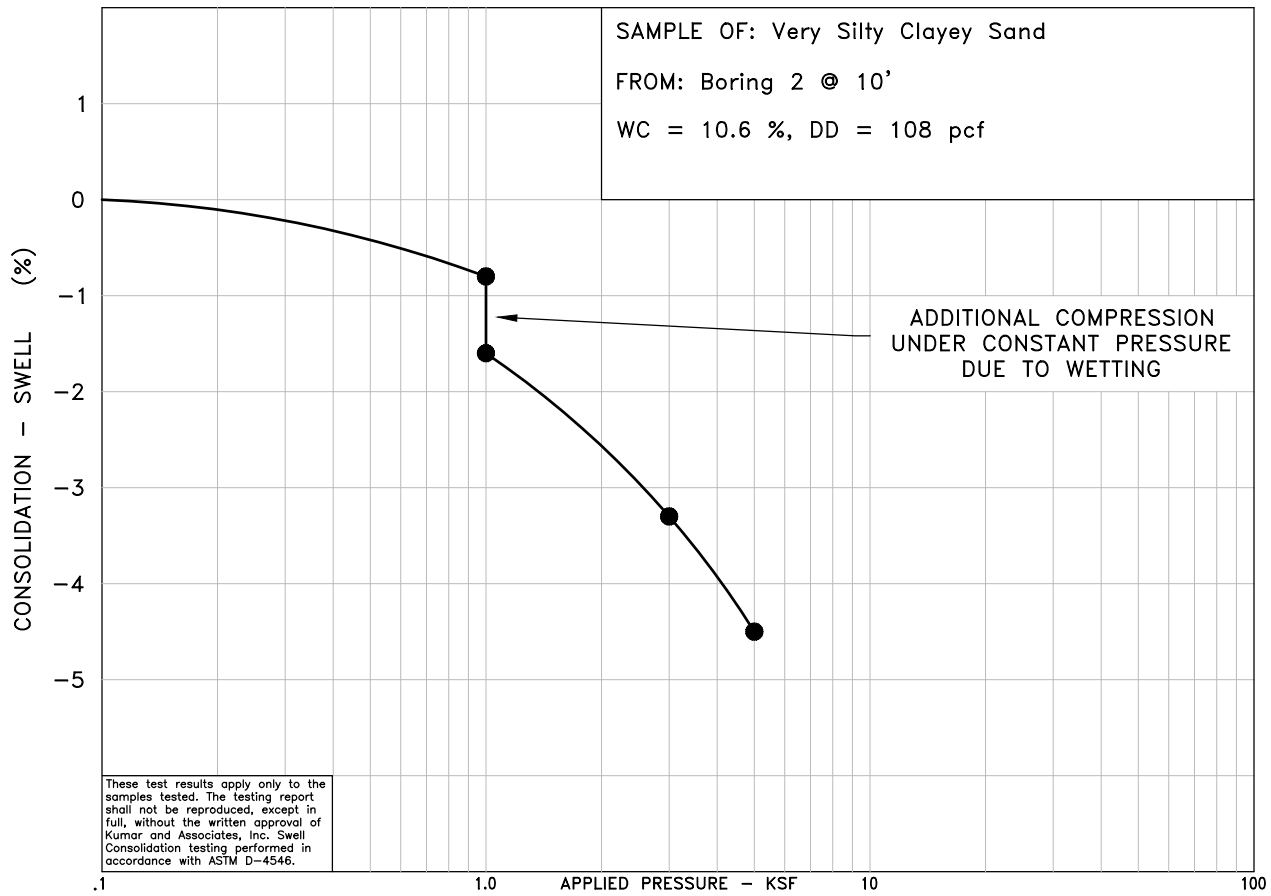




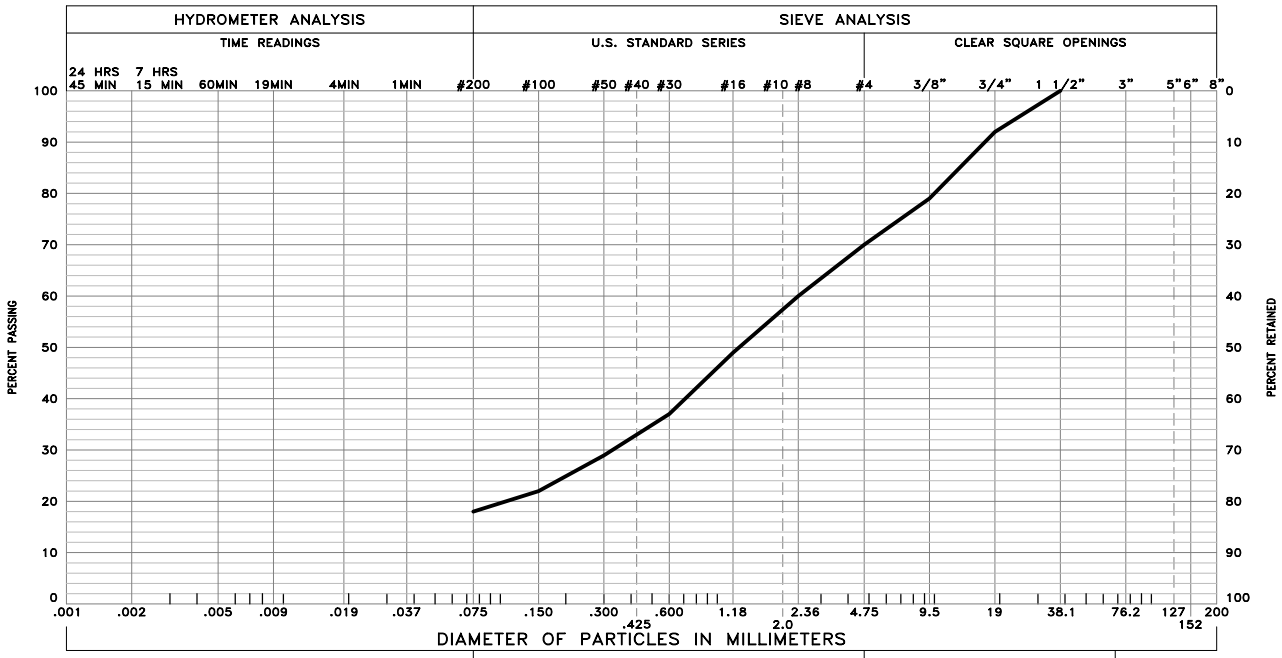

| 21-7-832 | Kumar & Associates | SWELL-CONSOLIDATION TEST RESULTS | Fig. 4 |
|---|---|---|---|





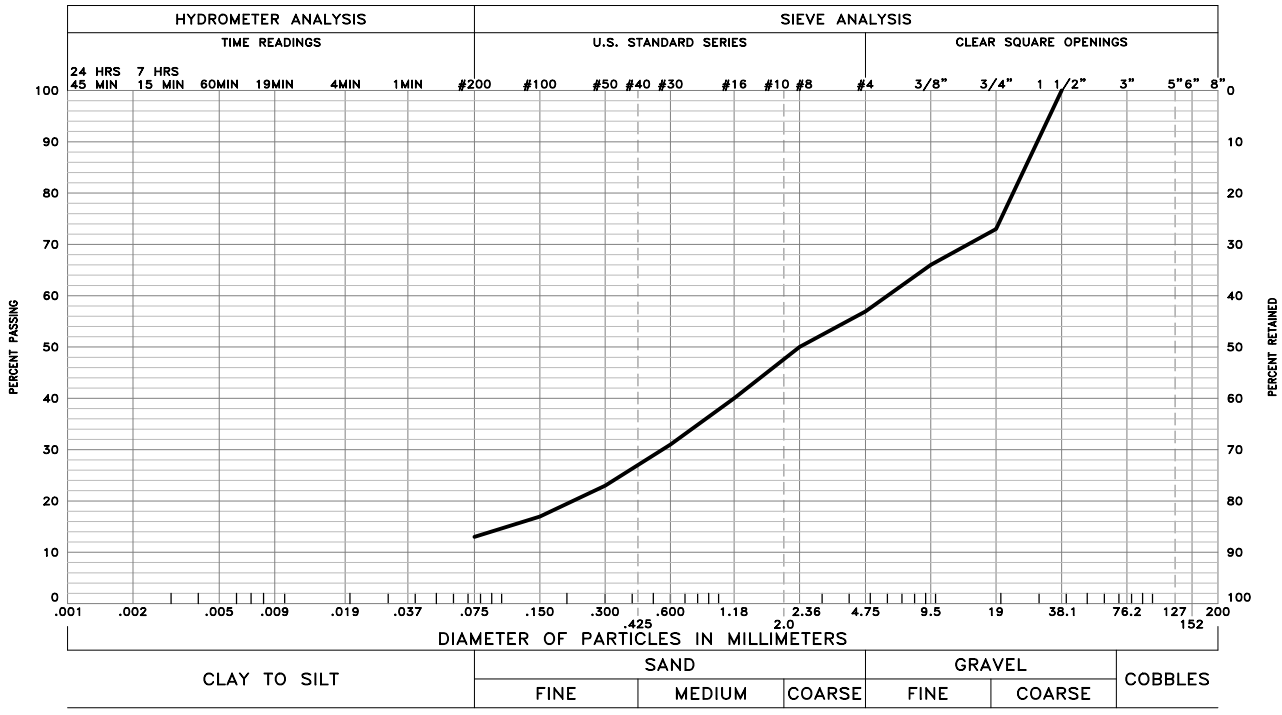

| 21−7−832 | Kumar & Associates | SWELL−CONSOLIDATION TEST RESULTS | Fig. 5 |
|---|---|---|---|




GRAVEL 30 % SAND 52 % SILT AND CLAY 18 %

LIQUID LIMIT – PLASTICITY INDEX –

SAMPLE OF: Clayey Silty Gravelly Sand (Fill) FROM: Boring 3 @ 10'




GRAVEL 43 % SAND 44 % SILT AND CLAY 13 %

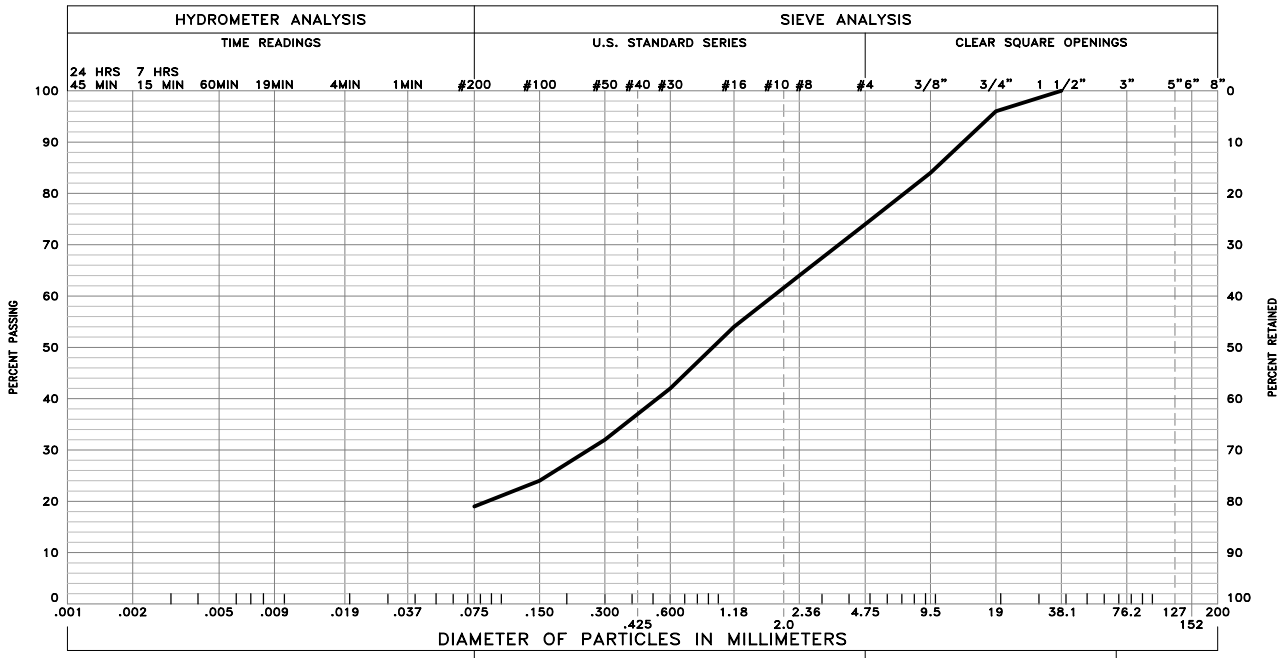
LIQUID LIMIT – PLASTICITY INDEX –

SAMPLE OF: Clayey Silty Sand and Gravel (Fill) FROM: Boring 5 @ 10'





| 21-7-832 | Kumar & Associates | GRADATION TEST RESULTS | Fig. 6 |
|---|---|---|---|




GRAVEL 26 % SAND 55 % SILT AND CLAY 19 %

LIQUID LIMIT – PLASTICITY INDEX –

SAMPLE OF: Clayey Silty Gravelly Sand (Fill) FROM: Boring 6 @ 7'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

| 21-7-832 | Kumar & Associates | GRADATION TEST RESULTS | Fig. 7 |
|---|---|---|---|

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# TABLE 1
# SUMMARY OF LABORATORY TEST RESULTS

Project No. 21-7-832

| SAMPLE LOCATION | | NATURAL MOISTURE CONTENT | NATURAL DRY DENSITY | GRADATION | | PERCENT PASSING NO. 200 SIEVE | ATTERBERG LIMITS | | UNCONFINED COMPRESSIVE STRENGTH | | SOIL TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BORING | DEPTH (ft) | (%) | (pcf) | GRAVEL (%) | SAND (%) | | LIQUID LIMIT (%) | PLASTIC INDEX (%) | (psf) | | |
| 1 | 4 | 13.6 | 101 | | | | | | | | Sandy Silty Clay with Gravel (Fill) |
| | 7 | 12.4 | 104 | | | | | | | | Sandy Silt with Gravel |
| | 15 | 9.9 | 113 | | | 52 | | | | | Very Sandy Silt with Gravel |
| | | | | | | | | | | | |
| 2 | 4 | 12.5 | 111 | | | 52 | | | | | Very Sandy Silty Clay with Gravel (Fill) |
| | 10 | 10.6 | 108 | | | | | | | | Very Silty Clayey Sand |
| | | | | | | | | | | | |
| 3 | 4 | 9.5 | | | | 31 | | | | | Clayey Silty Sand and Gravel (Fill) |
| | 10 | 7.0 | | 30 | 52 | 18 | | | | | Clayey Silty Gravelly Sand (Fill) |
| | | | | | | | | | | | |
| 4 | 4 | 3.3 | 114 | | | | | | | | Clayey Silty Sand and Gravel (Fill) |
| | | | | | | | | | | | |
| 5 | 10 | 5.1 | | 43 | 44 | 13 | | | | | Clayey Silty Sand and Gravel (Fill) |
| | | | | | | | | | | | |
| 6 | 7 | 5.1 | | 26 | 55 | 19 | | | | | Clayey Silty Gravelly Sand (Fill) |