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SUBSOIL STUDY
FOR FOUNDATION DESIGN
PROPOSED MIXED-USE BUILDING
446 BROADWAY STREET
EAGLE, COLORADO

PROJECT NO. 24-7-573

DECEMBER 10, 2024

PREPARED FOR:

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PURPOSE AND SCOPE OF STUDY

This report presents the results of a subsoil study for a proposed mixed-use building to be located at 446 Broadway Street, Eagle, Colorado. The project site is shown on Figures 1A and 1B. The purpose of the study was to develop recommendations for the foundation design. The study was conducted in general accordance with our agreement for geotechnical engineering services to 446 Broadway, LLC dated September 27, 2024. The services performed were modified to include 3 exploratory borings rather than the planned 5 borings due to drill rig access constraints.

A field exploration program consisting of exploratory boring 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, compressibility or swell 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 building foundation. 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 existing development on the property is proposed to be razed and a mixed-used, retail and residential building constructed in its place. The building will be a 2 to 4-story structure of steel frame and masonry construction with an area of garage parking at the ground level. The ground level development plan is shown on Figure 1B. Ground floors will be slab-on-grade. Grading for the structure is assumed to be relatively minor with cut depths between about 4 to 6 feet. We assume moderate foundation loadings, typical of the proposed type of construction.

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.

SITE CONDITIONS

The property is occupied by a single-story residence, detached garage and other minor out buildings and improvements as shown on Figure 1A. The ground surface is relatively flat with a gentle slope down to the northwest with about 3 feet of elevation difference across the property. Vegetation consists of grass, weeds and deciduous and evergreen trees.

GEOLOGIC CONDITIONS

Bedrock of the Pennsylvanian age Eagle Valley Evaporite underlies the Town 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 property. Dissolution of the gypsum under certain conditions can cause sinkholes to develop and can produce areas of localized subsidence. Several sinkholes are known to be scattered throughout this area. These sinkholes appear similar to others associated with the Eagle Valley Evaporite in other areas of the Eagle River valley underlain by the Evaporite.

Sinkholes were not observed in the immediate area of the subject property. 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 at the subject site throughout the service life of the proposed building, 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 November 12, 2024. Three exploratory borings were drilled at the locations shown on Figures 1A and 1B (where accessible) 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 and logged by a representative of Kumar & Associates.

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 encountered in the borings, below landscape sod, consist of about 4 feet of stiff to very stiff, sandy silty clay overlying dense, silty sandy gravel and cobbles with possible boulders. Drilling in the coarse granular soils with auger equipment was difficult due to the cobbles and boulders and drilling refusal was 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 clay soils, presented on Figures 4 and 5, indicate variable low to moderate compressibility under conditions of loading and wetting. Results of gradation analyses performed on a small diameter drive sample (minus 1½-inch fraction) of the coarse granular subsoils are shown on Figure 6. The laboratory testing is summarized in Table 1.

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

FOUNDATION BEARING CONDITIONS

The clay soils encountered at the site have variable compressibility potential and relatively low bearing capacity while the underlying gravel and cobble soils have relatively high bearing capacity and low compressibility potential. Spread footings placed on the relatively dense granular soils are recommended for the building support. Our experience is that the dense granular soils extend to considerable depth in this area and will be the predominant soil material encountered at the site. Slabs-on-grade and possibly lightly loaded spread footings such as for site walls can be placed on the clay soils or on compacted structural fill with low settlement potential.

DESIGN RECOMMENDATIONS

FOUNDATIONS

Considering the subsurface conditions encountered in the exploratory borings and the nature of the proposed construction, we recommend the building be founded with spread footings bearing on the natural coarse granular soils.

The design and construction criteria presented below should be observed for a spread footing foundation system.

1) Footings placed on the undisturbed natural coarse granular soils should be designed for an allowable bearing pressure of 4,000 psf. Based on experience, we expect settlement of footings designed and constructed as discussed in this section will be about 1 inch or less. Lightly loaded spread footings separate from the main building, such as landscape walls, can be placed on the upper clay soils or compacted structural fill and designed for an allowable bearing pressure of 1,500 psf.
2) The footings should have a minimum width of 18 inches for continuous walls and 2 feet for isolated pads.
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.

4) Continuous foundation walls should be reinforced top and bottom to span local anomalies such as by assuming an unsupported length of at least 10 feet. Foundation walls acting as retaining structures should also be designed to resist lateral earth pressures as discussed in the "Foundation and Retaining Walls" section of this report.

5) All existing fill, debris, topsoil and any loose or disturbed soils should be removed and the footing bearing level extended down to the relatively dense, natural coarse granular soils. The exposed soils in footing areas should then be moistened and compacted. Structural fill used to reestablish design bearing level should consist of a well graded granular material, such as CDOT Class 6 base course, compacted to at least 98% of standard Proctor density at near optimum moisture content.

6) A representative of the geotechnical engineer should observe all footing excavations and test structural fill compaction on a regular basis prior to concrete placement to evaluate bearing conditions.

FOUNDATION AND RETAINING WALLS

Foundation walls and retaining structures which are laterally supported and can be expected to undergo only a slight amount of deflection should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of at least 55 pcf for backfill consisting of the on-site soils and at least 45 pcf for backfill consisting of imported granular material. Cantilevered retaining structures which are separate from the building and can be expected to deflect sufficiently to mobilize the full active earth pressure condition should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of at least 45 pcf for backfill consisting of the onsite soils and at least 35 pcf for backfill consisting of imported granular materials.

All foundation and retaining structures should be designed for appropriate hydrostatic and surcharge pressures such as adjacent footings, traffic, construction materials and equipment. The pressures recommended above assume drained conditions behind the walls and a horizontal backfill surface. The buildup of water behind a wall or an upward sloping backfill surface will increase the lateral pressure imposed on a foundation wall or retaining structure. An underdrain should be provided to prevent hydrostatic pressure buildup behind walls.

Backfill should be placed in uniform lifts and compacted to at least 90% of the maximum standard Proctor density at near optimum moisture content in landscape areas. Backfill placed in pavement and walkway areas should be compacted to at least 95% of the maximum standard Proctor density. Care should be taken not to over-compact the backfill or use large equipment near walls, since this could cause excessive lateral pressure on the wall. Some settlement of deep foundation wall backfill should be expected, even if the material is placed correctly, and could result in distress to facilities constructed on the backfill. Backfill should not contain organics, debris or rock larger than about 4 inches.

We recommend imported granular soils for backfilling foundation walls and retaining structures because their use results in lower lateral earth pressures and the backfill can be incorporated into the underdrain system. Subsurface drainage recommendations are discussed in more detail in the "Underdrain System" section of this report. Imported granular wall backfill should contain less than 15% passing the No. 200 sieve and have a maximum size of 4 inches.

The lateral resistance of foundation or retaining wall footings will be a combination of the sliding resistance of the footing on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the bottoms of the footings can be calculated based on a coefficient of friction of 0.50 for granular bearing soils and 0.30 for clay bearing soils. Passive pressure of compacted backfill against the sides of the footings can be calculated using an equivalent fluid unit weight of 450 pcf for granular backfill soils and 300 pcf for clay backfill soils. The coefficient of friction and passive pressure values recommended above assume ultimate soil strength. Suitable factors of safety should be included in the design to limit the strain which will occur at the ultimate strength, particularly in the case of passive resistance. Fill placed against the sides of the footings to resist lateral loads should be compacted to at least 95% of the maximum standard Proctor density at a moisture content near optimum.

FLOOR SLABS

The natural on-site soils, exclusive of topsoil, are suitable to support lightly loaded slab-on-grade construction. The clay soils show variable settlement/heave potential when wetted. For areas with movement-sensitive floor slabs, such as the retail areas, we recommend at least 2 feet of the clay subgrade be removed and replaced with CDOT Class 5 or 6 aggregate base course.

To reduce the effects of some differential movement, non-structural floor slabs should be separated from all bearing walls and columns with expansion joints which allow unrestrained vertical movement. Floor slab control joints should be used to reduce damage due to shrinkage cracking. The requirements for joint spacing and slab reinforcement should be established by the designer based on experience and the intended slab use. A minimum 6-inch layer of free-draining gravel should be placed beneath slabs for support. This material should consist of minus 2-inch aggregate with at least 50% retained on the No. 4 sieve and less than 12% passing the No. 200 sieve.

All fill materials for support of floor slabs should be compacted to at least 95% of maximum standard Proctor density at a moisture content near optimum. Required fill can consist of onsite granular soils devoid of debris, topsoil and oversized rocks (plus 4-inch), or of imported aggregate base course.

UNDERDRAIN SYSTEM

Although free water was not encountered during our exploration, 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 (if any), be protected from wetting and hydrostatic pressure buildup by an underdrain system.

The drains should consist of rigid perforated PVC drainpipe placed in the bottom of the wall backfill surrounded above the invert level with free-draining granular material. The drain should be placed at each level of excavation and at least 1 foot below lowest adjacent finish grade and sloped at a minimum ½% to a suitable gravity outlet or drywell based in the underlying natural coarse granular soils. Free-draining granular material used in the underdrain system should contain less than 2% passing the No. 200 sieve, less than 50% passing the No. 4 sieve and have a maximum size of 2 inches. The drain gravel backfill should be at least 1½ feet deep.

SURFACE DRAINAGE

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 6 inches in the first 10 feet in unpaved areas and a minimum slope of 2 inches in the first 10 feet in paved areas. Free-draining wall backfill should be covered with filter fabric and capped with about 2 feet of the onsite clay soils to reduce surface water infiltration.
4) Roof downspouts and drains should discharge well beyond the limits of all backfill.

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 and our experience in the area. 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.

COLORADO REGISTERED PROFESSIONAL ENGINEER STEVEN L. PAWLAK 15222 12/11/24

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SLP/kac

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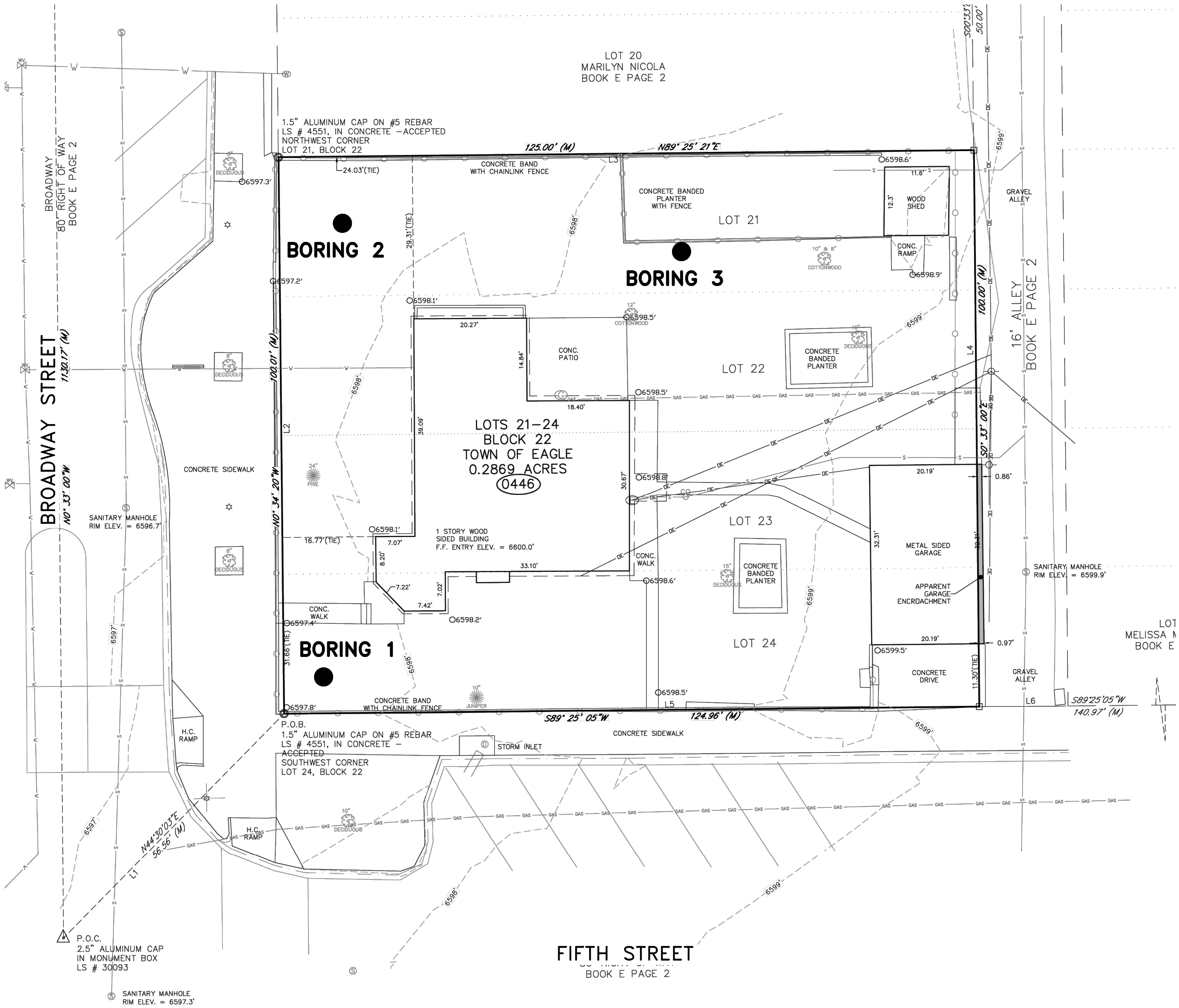

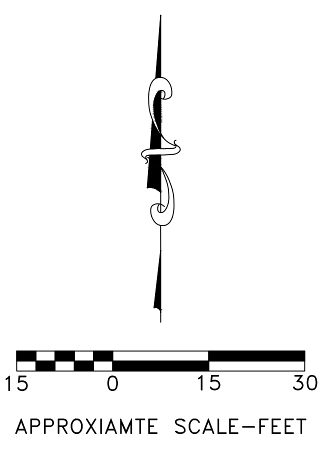

24-7-573	Kumar & Associates	LOCATION OF EXPLORATORY BORINGS EXISTING CONDITIONS	Fig. 1A

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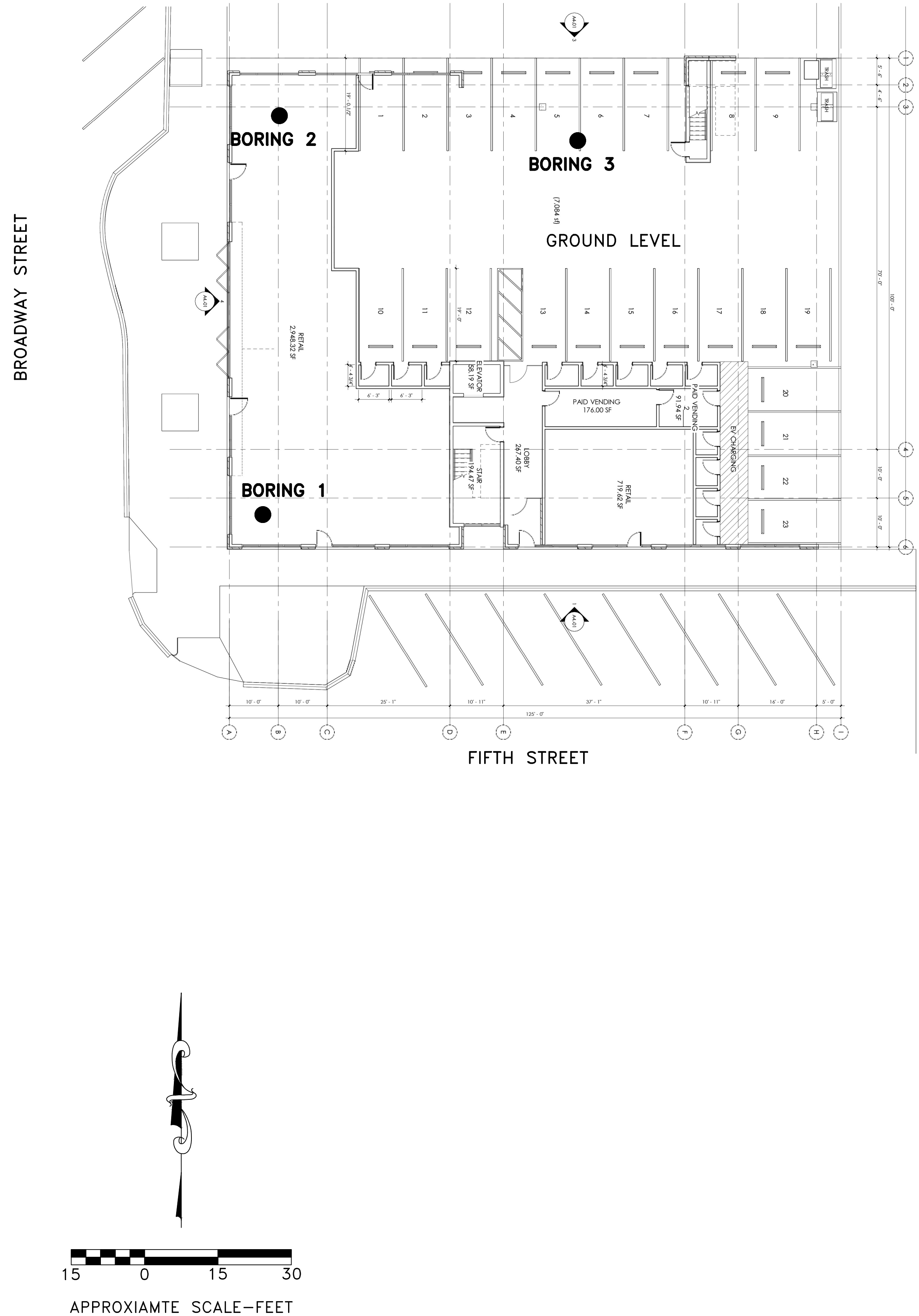

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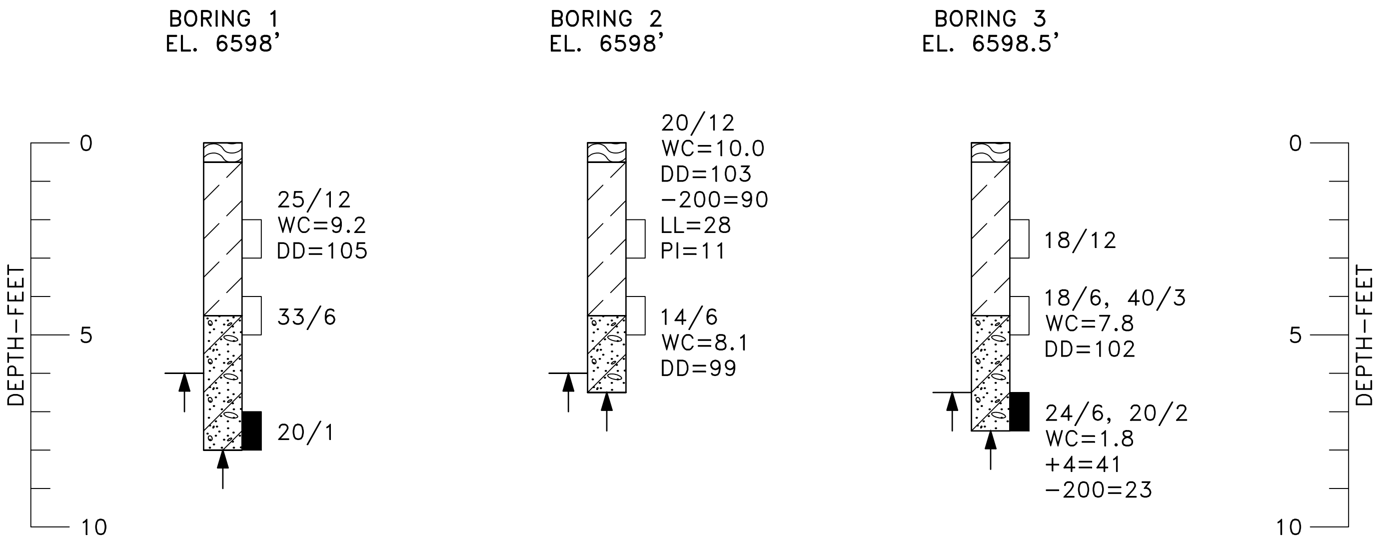
24-7-573	Kumar & Associates	LOCATION OF EXPLORATORY BORINGS PROPOSED CONSTRUCTION	Fig. 1B



24-7-573	Kumar & Associates	LOGS OF EXPLORATORY BORINGS	Fig. 2

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LEGEND

TOPSOIL; LANDSCAPE SOD.

CLAY (CL); SILTY, SANDY, STIFF TO VERY STIFF, SLIGHTLY MOIST, BROWN, LOW PLASTICITY.

GRAVEL AND COBBLES (GM); SILTY, SANDY, PROBABLE BOULDERS, DENSE, SLIGHTLY MOIST, BROWN, ROUNDED ROCK.

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

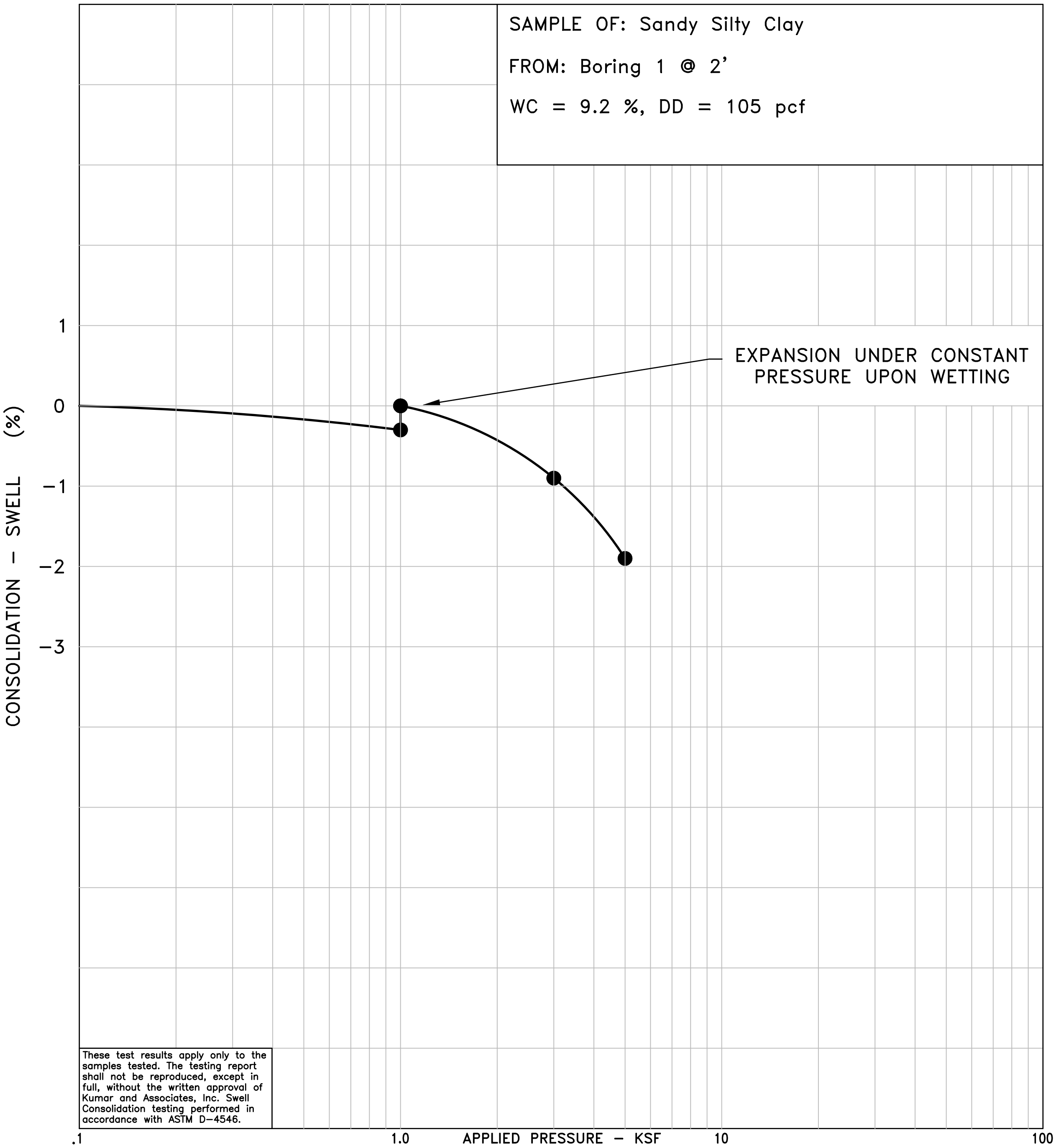
DRIVE SAMPLE, 1 3/8-INCH I.D. SPLIT SPOON STANDARD PENETRATION TEST.

25/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 25 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

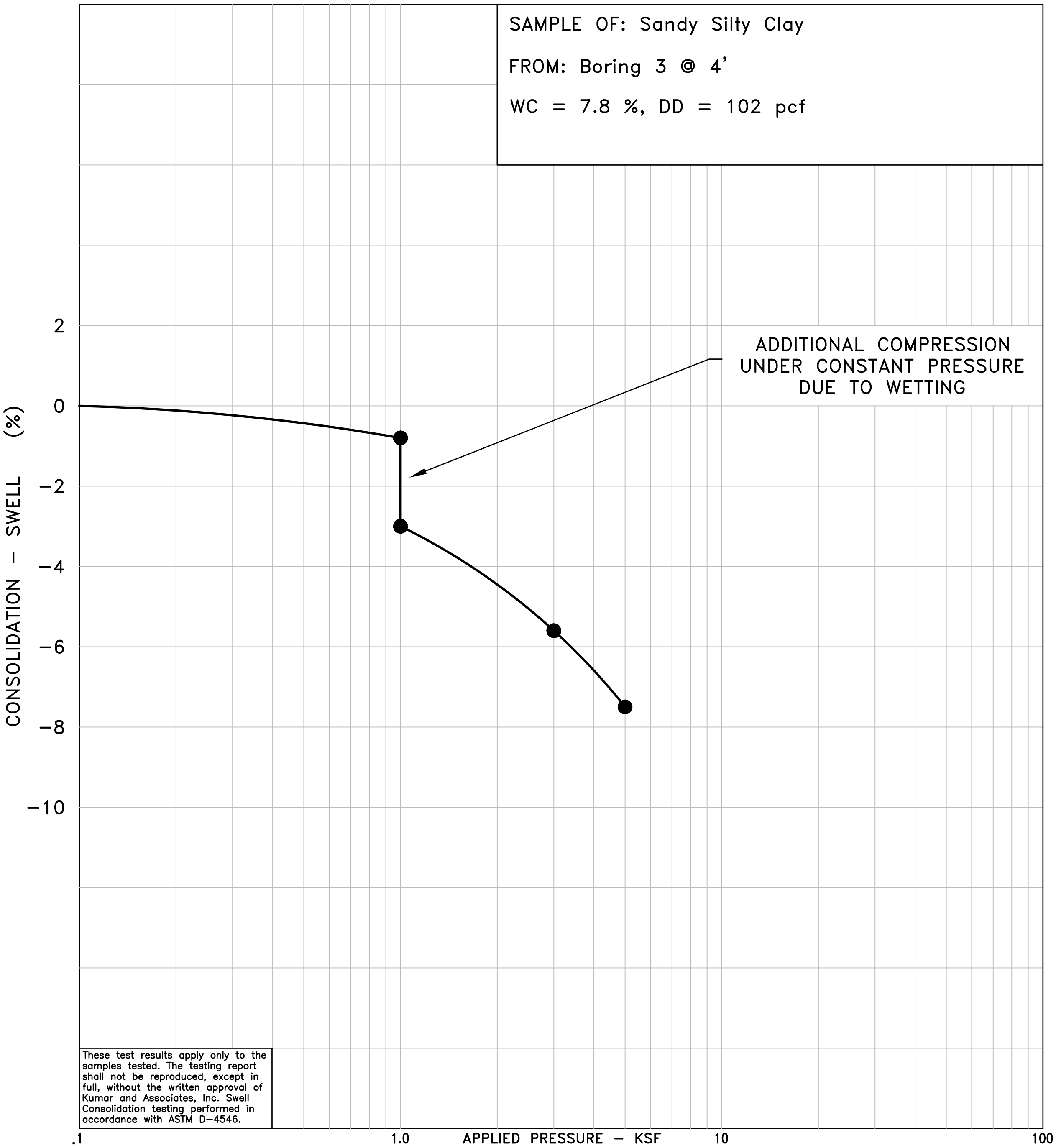
PRACTICAL AUGER REFUSAL. WHERE SHOWN ABOVE BOTTOM OF BORING, INDICATES THAT MULTIPLE ATTEMPTS WHERE MADE TO ADVANCE THE HOLE.

NOTES

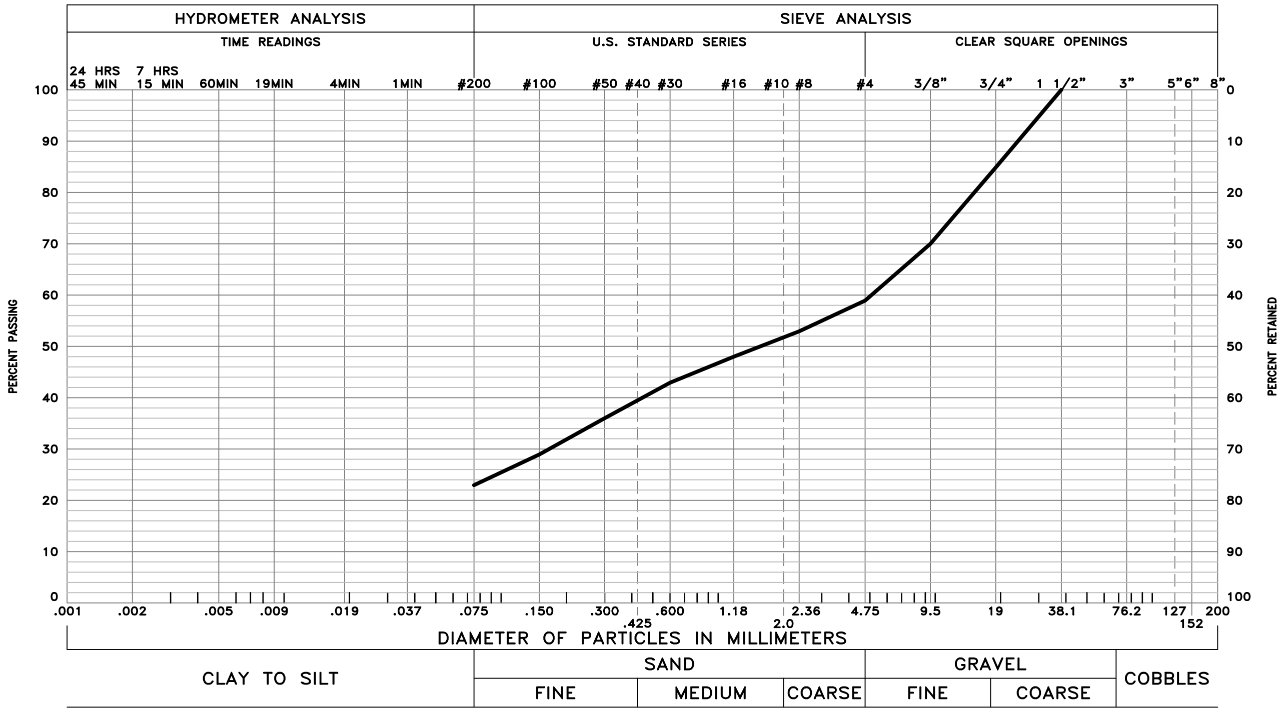
1. THE EXPLORATORY BORINGS WERE DRILLED ON NOVEMBER 12, 2024 WITH A 4-INCH-DIAMETER CONTINUOUS-FLIGHT POWER AUGER.
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE OBTAINED 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.
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);
   LL = LIQUID LIMIT (ASTM D4318);
   PI = PLASTICITY INDEX (ASTM D4318).



24-7-573	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 4



24-7-573	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 5



GRAVEL 41 % SAND 36 % SILT AND CLAY 23 %

LIQUID LIMIT – PLASTICITY INDEX –

SAMPLE OF: Silty Sandy Gravel FROM: Boring 3 @ 6.5'

 Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

24–7–573	Kumar & Associates	GRADATION TEST RESULTS	Fig. 6

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TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

Project No. 24-7-573

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	2	9.2	105							Sandy Silty Clay
2	2	10.0	103			90	28	11		Sandy Silty Clay
	4	8.1	99							Sandy Silty Clay
3	4	7.8	102							Sandy Silty Clay
	6½	1.8		41	36	23				Silty Sandy Gravel